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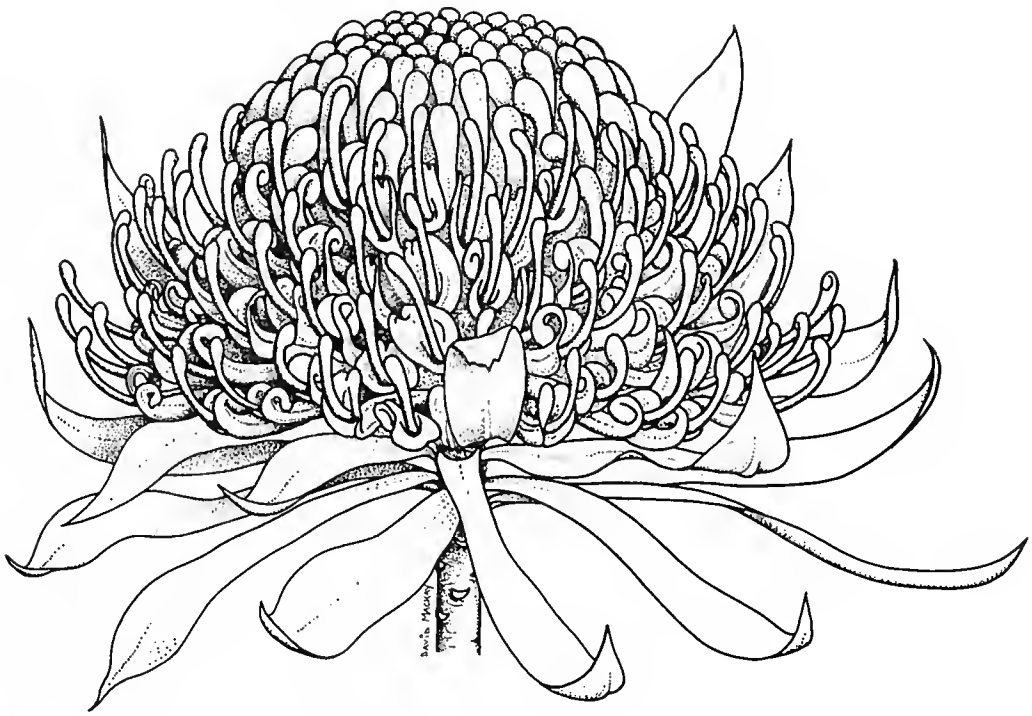

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The Waratah, *Telopea speciosissima* (Sm.) R. Br., belongs to the family Proteaceae. The species is endemic in eastern New South Wales and is the official State floral emblem. Illustration by David Mackay

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Ammobium and *Nablonium* (Asteraceae–Gnaphalieae) – an alternative view

A.E. Orchard

Abstract

*Orchard, A.E.** *(Tasmanian Herbarium, GPO Box 252C, Hobart, Tasmania, Australia 7001) 1992.* Ammobium *and* Nablonium *(Asteraceae–Gnaphalieae) – an alternative view.* Telopea *5(1): 1–12.* The transfer of *Nablonium* to *Ammobium* by Anderberg (1990) is re-examined in light of additional characters. Some of the characters used by Anderberg to link *Nablonium* with *Ammobium craspedioides* are shown to be based on misinterpretations. *Nablonium* differs from the two species of *Ammobium* by a group of 14 characters, while the links between the genera are much less than previously suggested. These relationships are best reflected in a classification which keeps the two genera distinct.

Introduction

The genus *Nablonium*, endemic to Tasmania, and consisting of a single, well-defined species, has always been difficult to place within the tribal subdivisions of the Asteraceae. At various times it has been placed in the Anthemideae, Heliantheae and Inuleae. Within the Inuleae it has been assigned to the Bupthalminae, Angianthiinae and Gnaphaliinae. The taxonomic history has been surveyed by Anderberg (1990) and a full account can be found there.

Anderberg (1990) has recently compared *Nablonium* with *Ammobium*, the two species of which occur in eastern mainland Australia. On the basis of a limited number of characters he concluded that the three taxa were congeneric. This synonymy was retained in a later cladistic analysis of the Tribe (Anderberg 1991). He has thus performed a valuable service in finally finding a secure tribal resting place for *Nablonium* in the Gnaphalieae. However, his claim of congenericity has led me to a closer examination of a wider range of characters, and a conclusion that, while *Ammobium* and *Nablonium* are in all likelihood indeed closely related, their relationship is better described by their retention as two genera, rather than combining them into one.

Anderberg's choice of outgroup

Anderberg (1990) chose to use *Cassinia* as the outgroup for his cladistic analysis. In retrospect this may have been an unfortunate choice. In his 1991 analysis of the whole tribe, Anderberg arrives (Fig. 12) at a tree which demonstrates that not only is the sister group of his *Ammobium s.l.* the genus *Basedowia*, but that *Cassinia* is just one member of a group of essentially shrubby or arborescent taxa which branch off as a distinct group at a relatively high level of the cladistic tree. It is also interesting to compare his Fig. 8 with Fig. 12 in the same paper and to note how the topology of the tree changes in the vicinity of *Cassinia/Ozothamnus/Ixodia* when more groups are added to the analysis. With a tree as unstable as this it is not unreasonable to suggest

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that if Anderberg had used a different outgroup (e.g. *Basedowia* or *Raoulia*) in his initial analysis of *Nablonium* and *Ammobium*, then the result may have been quite different.

However, it seems to me that a potentially far greater source of error lies in his interpretation and choice of characters, and this aspect is examined in the balance of this paper.

Re-examination of Anderberg's characters

Anderberg used only 10 characters in his detailed comparison of the taxa. Most of these were found to exist in two states within *Ammobium/Nablonium* and his chosen 'sister group' the *Cassinia* generic complex, although one had three states and another four.

The Anderberg characters were:

1. Life Form. The outgroup, *Cassinia* and its relatives (including *Helichrysum* subgenus *Ozothamnus*, *Ixodia*, *Odixia*, and *Haeckeria*), are shrubs or small trees almost without exception. *Ixodia*, while woody, might be considered a perennial herb, but in fact behaves also as a shrub, albeit short-lived. *Nablonium* and *Ammobium* on the other hand are not in the least shrub-like, being rosette-forming perennial herbs. In this respect they more closely resemble many of the other genera of the Gnaphalieae (*Gnaphalium*, *Helipterum*, *Helichrysum s.lat.* excluding *Ozothamnus*, etc.). Hence, if they do indeed belong to the *Cassinia* 'clade' then they either represent a reversion from the woody growth habit or, as seems more likely, have retained the ancestral form while the rest of the group has become frutescent.

2. Stem Branching. The taxa of the *Cassinia* 'clade', being shrubby, necessarily have a branching habit. In addition, the inflorescence usually consists of a very complex compound structure, comprising dozens or hundreds of individual heads, usually aggregated into an umbelliform structure at the apex of the main and secondary branches. In *Nablonium/Ammobium* the structure is again as one would find in, for example, the herbaceous members of *Helichrysum s.lat.* A single stem arises from a rosette, and this forms the flowering scape. In *Ammobium alatum* it is sparingly branched towards the top, and each branch bears a flower head. In *Ammobium craspedioides* it is very similar, but unbranched with just a single capitulum. *Nablonium* also has an unbranched scape in most cases, although occasional plants, presumably those in which the growing apex has been damaged, will sometimes bear a forked scape with two capitula. I believe that in the scoring of this character there has been confusion between two non-homologous structures. The outgroup has branched vegetative stems, as well as a branched inflorescence. *Ammobium* and *Nablonium* species all have unbranched stems, *A. alatum* has a branched inflorescence, and *A. craspedioides* and *Nablonium* have unbranched inflorescences (apart from occasional freaks). This single character is thus better treated as two, vegetative branching, and branching of the scape.

3. Leaves decurrent in stems (scapes). The scape in *A. alatum* is strongly winged, and the cauline leaves or bracts are certainly decurrent with these wings. *A. craspedioides* has an angled scape, and the bracts are more or less decurrent, particularly near the base of the plant. *Nablonium* usually lacks bracts on the scape, but when one is occasionally present it has a broad, sub-winged 'petiole'. However the scape itself is approximately round, and there is little sign of any decurrence. This latter state seems to be the general condition in most of the 'outgroup' although in a few species (e.g. *Ixodia*), the leaves are decurrent in stem wings. However, the *Nablonium* situation would

seem to be representative of the ancestral form, in the *Cassinia* clade at least, with *A. craspedioides* forming an intermediate stage in a transformtion series to the winged stems/decurrent leaves of *A. alatum.* On this hypothesis, winged stems would have arisen more than once within the clade.

4. Presence of a rosette. There is an element of double counting in this character, in that it is largely accounted for already by character number 1. Obviously the shrubby outgroup, by virtue of being frutescent, cannot have leaves in basal rosettes.

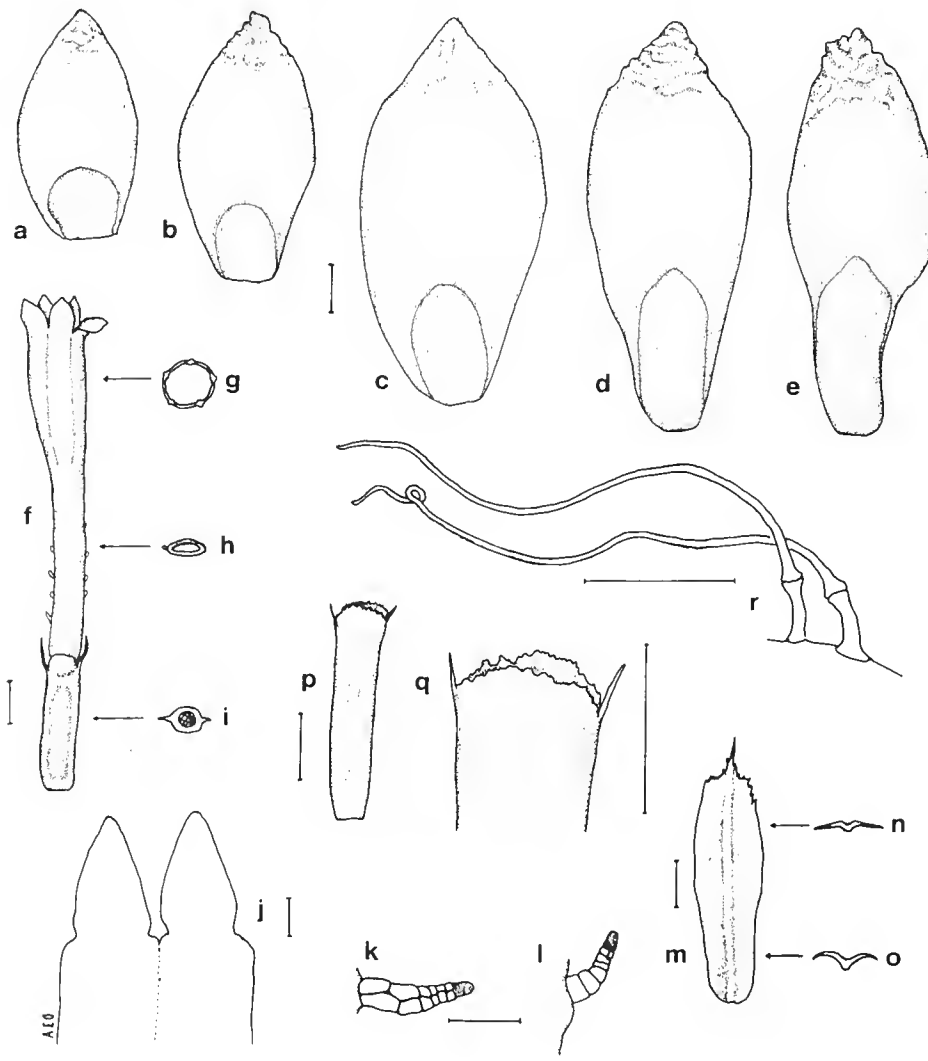

Figure 1. *Ammobium alatum.* **a–e,** involucral bracts, a range from outer to inner; **f,** floret; **g–i,** transverse sections of the floret; **j,** anther appendages; **k, l,** glandular hairs on the corolla tube (k, seen from the front, showing the double row of cells; l, seen from the side, both with the terminal vesicle shed); **m,** palea from the receptacle of a fruiting head; **n, o,** transverse sections of the palea; **p,.** ripe achene; **q,** detail of the top of the achene, showing the cup formed from the chartaceous ligule; **r,** hairs of the leaf. (a–e, j, m–r from *J.H. Maiden s.n., HO 9700;* f–i, k–l from *I.R. Telford 10002, HO.* Scales represent 1 mm in all cases except j–l, r, where they represent 0.1 mm).

5. Capitula few or many. This character seems to me to have been used already in character number 2. As already stated, the branching treated there confused vegetative branching with branching in the inflorescence. Only if these are separated can character 5 be considered a separate character.

6. Involucral bracts tawny or white. Anderberg considered that *A. alatum* had white involucral bracts while the other two species had 'tawny' bracts. This distinction overlooks the facts that the tawny bracts of *A. craspedioides* and *Nablonium* are quite different in shape and structure, and can scarcely be considered homologous. In the outgroup, and in both *Ammobium* species the involucral bracts are scarious, with a relatively small basal stereome and a large more or less hyaline wing, which may or may not be coloured (and therefore opaque). In *Nablonium* the involucral bracts are entirely (outer bracts) or almost entirely (inner bracts) sub-fleshy, with at most a scarious margin. In herbarium material they may appear dry and tawny but in life, or when soaked up, they are clearly fleshy. There are also differences in general shape, which will be discussed further below. The involucral bracts of the two *Ammobium* species differ only in colour, being structurally virtually identical, and thus far from providing a means of separating *A. craspedioides* and *Nablonium* from *A. alatum*, as Anderberg's analysis would suggest, in fact provide good reason to keep the two *Ammobium* species distinct from *Nablonium*.

7. Paleae entire or lacerate. Despite Anderberg's assertion to the contrary, these bracts in at least some of the outgroup (e.g. *Cassinia aculeata*, the type species of that genus) are lacerate at the apex, even if only slightly so. Certainly they are distinctly lacerate in both species of *Ammobium* and in *Nablonium*. These bracts in fact provide a good set of characters to keep the three taxa together, as a distinct transformation series can be constructed in their form and function. This will be discussed further below. However, if this attribute is redefined as paleae not or only slightly lacerate vs. paleae distinctly lacerate, then it provides an additional character to distinguish the *Ammobium/Nablonium* group from *Cassinia* and the other frutescent genera.

8. Colour of the disc florets. Within the *Ammobium/Nablonium* group this character provides a useful distinction. *Ammobium* species have yellow florets, *Nablonium* has white ones. The latter is the character state found most frequently in the outgroup. Even in species like *Cassinia aureo-nitens*, which has bright golden yellow involucral bracts, the flowers are white or off-white. Other *Cassinia* species however have cream or yellow flowers.

9. Shape of the achene. Anderberg scored the achene of *A. craspedioides* as being 'stout', i.e. as having a diverging apex, as in *Nablonium*, rather than being elongate as in *A. alatum*. I find that the distinction is not as clear cut as this. While the outer achenes in the heads of *A. craspedioides* may have slightly divergent apices, it is not quite as marked as he claims. The inner achenes are elongate as in *A. alatum* (Figs. 1p, 2l). To some extent, the shapes of the achenes are linked to the next character, the size of the spines, as these influence the outer shape of the fruit. It would be better to redefine this character in terms of the relative length and breadth of the achene (excluding the spines), if in fact it is useful at all. If the character became 'Achene up to twice as long as broad (excluding spines)' vs. 'Achene more than twice as long as broad', then the two *Ammobium* species are distinguished from *Nablonium*.

10. Size of achenial spines. This character, and the presumed transformation series from small spines to large in the direction *A. alatum* – *A. craspedioides* – *Nablonium* seems to be the central thesis in Anderberg's paper. He advanced the view that the cup at the top of the achene in the three species was essentially the same strucure, and that it had been modified from one to the next by an increase in the size of the spines. This view, if correct, would provide strong evidence for linking the three taxa

into one genus. Unfortunately, after a careful study of the structure of the cup and spines of each species, I cannot agree that all represent homologous structures. In the two *Ammobium* species the cup is formed from a membranous, obtuse 'ligule'. These two lips are confluent in a notch at either side of the achene, and the spines arise at this notch. In *Nablonium* the cup is barely apparent in the bud or young flowering stage (Fig. 3d). It is formed at the late flowering/fruiting stage by confluence of the woody bases of the spines. This is shown, particularly in the outer fruits of the capitulum, where on one side there is a distinct notch where the spine bases have not fused completely (Figs. 3e, 3j). In fruits where there is no notch, the cup splits easily at the midpoint between the spines, at a line of weakness. There are other differences

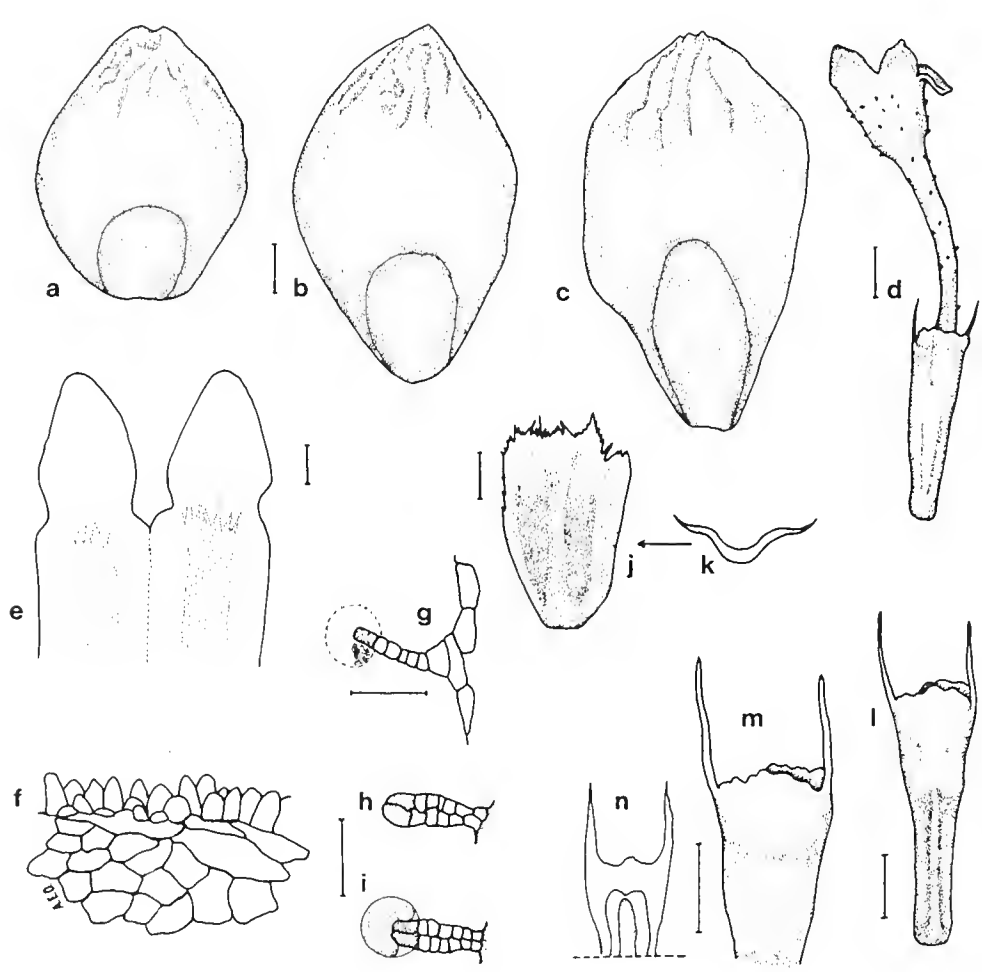

Figure 2. *Ammobium craspedioides*. **a–c**, involucral bracts, a range from outer to inner; **d**, floret; **e**, anther appendages; **f**, edge of a petal showing papillae; **g–i**, glandular hairs on the corolla tube (i showing the terminal vesicle complete, g & h with the vesicle burst); **j**, palea from the receptacle of a fruiting head; **k**, transverse section of the palea; l, mature achene; **m**, detail of the top of the achene showing the cup formed from the chartaceous ligule; **n**, transverse section through the walls of the cup. (a–k from *M.M. Richardson & G. Butler 351a, HO*; l–n from *I.R. Telford & A.M. Lyne 11001, HO*. Scales represent 1 mm in all cases, except e–i, where they represent 0.1mm).

in the shape of the spines, and in the structure of the cup wall, which suggest that the *Ammobium* species are much more closely allied to each other than to *Nablonium* in this series of characters also. These characters are discussed in the next section. Thus while the presence of spines on the achene provides a strong link binding this group of three species together, in contrast to the more normal pappus found in the outgroup, I believe it may be misleading to score the spine size and associated cup structure as a transformation series in the way proposed by Anderberg.

Other characters not used by Anderberg

Perennation: Anderberg noted in his text that *Nablonium* proliferated by stolons, but this character did not form part of his analysis. Both of the *Ammobium* species lack stolons, propagating themselves by seed only, as do the taxa in his outgroup.

Leaf indumentum: The leaves of *Ammobium alatum* are densely clothed on both surfaces by loose cottony hairs, consisting of 1–2 short basal cells with swollen junctions and a long tapering terminal cell (i.e. similar to Drury & Watson's (1966) Type A hairs) (Fig. 1r). Those of *Ammobium craspedioides* have similar cottony hairs on their lower surface, but on their upper surface bear a completely different kind of indumentum. The hairs are spreading, uniseriate, and composed of several short, broad, thin-walled cells. On drying these hairs collapse onto the leaf surface. In *Nablonium* there are no cottony hairs on the leaves. Instead both surfaces bear the second type of hair mentioned above, with numerous large thin-walled cells. These are sparse on the upper surface of the *Nablonium* leaves, and usually dense on the lower surface, and when they collapse they form a dense white matted layer (Figs. 3n–s). On wetting, they swell once again to their previous shape and become spreading. Cottony hairs in *Nablonium* are confined to a sparse covering on the scape.

Scape characters: In *Nablonium* the scape is more or less circular in section, and usually lacks bracts (cauline leaves). Rarely, in very robust specimens, there may be a single bract on the scape. It has a broad ± winged 'petiole' but is not decurrent. In *A. craspedioides* the scape is angled, and the bracts (2–6) are decurrent. In *A. alatum* the scape is strongly 4-winged, and the bracts (2–6) are strongly decurrent into the wings. In all three species the scape is covered in cottony hairs.

Involucral bracts: The involucral bracts of *Nablonium* are sub-fleshy, ovate, with an acute or shortly attenuate tip, and a scarious tawny-hyaline margin (Figs. 3a–c). The involucral bracts of both species of *Ammobium* are scarious throughout, with a relatively small basal stereome and large membranous lamina (Figs. 1a–e, 2a–c). In both the lamina is blunt at the tip (the bracts often obovate to spathulate in shape), coloured white (opaque) in *A. alatum*, and tawny-hyaline in *A. craspedioides*. In both species of *Ammobium* the involucral bracts are usually wrinkled at the tips. The inner involucral bracts in *A. alatum* may be narrowed at the base to form a ± distinct claw. The taxa of Anderberg's outgroup have bracts most closely resembling those of *Ammobium* in all of these characters.

Florets: The corolla tube in *Nablonium* is white and glabrous. In both species of *Ammobium* it is yellow, and bears stalked glandular hairs both on the tube and the outer surface of the lobes. These hairs consist of two parallel rows of small ± cubic cells topped by two larger elongate cells (Figs. 1k–l, 2g–i). These apical cells exude a golden resinous substance which is contained at first in a thin-walled envelope. This later bursts, releasing the resin. As the hairs dry and age the small cells of the stalk shrivel and collapse. The inner surfaces of the corolla lobes in *A. craspedioides* bear a dense covering of tiny papillose hairs (Fig. 2f). These are also present in *A. alatum*, but are not quite so obvious or widespread. In *Nablonium* they are absent. Stalked glandular hairs on the corolla are common in *Cassinia*.

Anther appendages: In both species of *Ammobium* the sterile appendages at the tips of the anthers are broad (about as wide as the individual anthers), ovate and blunt (Figs. 1j, 2e). In *Nablonium*, they are much narrower, approximately lanceolate to deltoid in shape, and acute (Fig. 3g).

Paleae: The receptacular bracts in *Nablonium* are broadly oblong, and distinctly lacerate at the top (Fig. 3h). They are frequently coloured reddish purple. Throughout the development of the flower and fruit they remain membranous, and they are overtopped by the mature achene. In *A. craspedioides* the receptacular bracts are similar to those of *Nablonium*, but as the fruit develops they become woody, and cradle

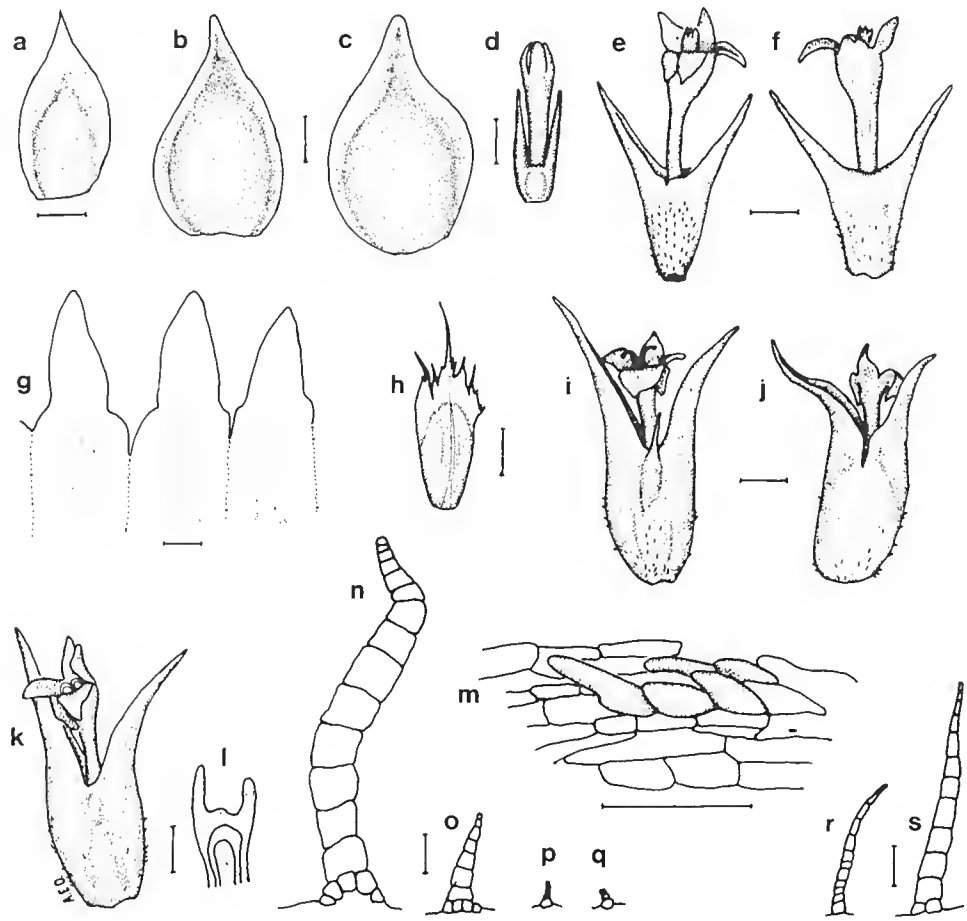

Figure 3. *Nablonium calyceroides*. **a–c**, involucral bracts, a range from outer to inner; **d**, bud; **e**, f, floret, the two sides of the same floret (e showing the notch where the spine bases have not fused properly); **g**, anther appendages; **h**, palea from the receptacle of a fruiting head; **i**, j, two sides of the same achene, one with a short notch, the other with a short auxilliary spine; K, another achene with more normal smooth cup margin; **l**, transverse section through the subwoody cup of the achene shown as k; **m**, a group of 5 papillate hairs from the surface of the achene; **n–q**, hairs from the upper surface of the leaf; **r**, **s**, hairs from the lower surface of the leaf. (All from A.E. *Orchard 5708, HO*. Scales represent 1 mm in all cases, except g & k–s, where they represent 0.1 mm).

the ripening achene in their concave inner face, thus affording it protection against predation up to and beyond maturity (Fig. 2j). In *A. alatum* this transformation series is taken a step further. The bract, from an early stage, is sub-woody, becoming very woody at maturity. It is lacerate at the top, but not as much as the other two species (Fig. 1m). Instead it develops a strong woody spine at the tip. These woody, spined paleae are retained on the plant long after the achenes have matured, forming an effective 'hedgehog', amongst which the ripe achenes are retained and protected. Here it would seem are two convergent methods that have been developed for protection of the achenes. In *Nablonium* the spines on the fruit are robust and effectively provide their own protection. In *Ammobium craspedioides* the lightly woody paleae provide some mechanical protection, which is supplemented by moderate-sized spines on the fruits themselves. In *A. alatum* the fruit spines are of little effective value for protection, but their function has been replaced by the heavily sclerised pungent paleae. The transformation series must be read from the membranous paleae (the situation in *Nablonium* and Anderberg's outgroup) to the increasingly woody ones. The spine development could be read in the opposite direction (from small spines in *A. alatum* to large spines in *Nablonium*), and this is the way it was interpreted by Anderberg. However, as shown below, this may be a misinterpretation.

Achene indumentum: Anderberg stated that the achenes of all three species were glabrous. While this is true for the *Ammobium* species, the achenes of *Nablonium* bear in their lower half a ± dense indumentum of unicellular papillose hairs (Fig. 3m).

Spines of the fruit: Anderberg proposed a transformation series from the tiny spines of *A. alatum* to the massive spines of *Nablonium*. However, careful study of the spines and the associated ligule or cup at the top of the achenes shows that the spines of *Nablonium* are quite different from those of the other two species. In *Nablonium* the spines are sub-woody, and have a groove along their upper surface, making them U-Y shaped in section. At the base the two wings of the 'U' are confluent around the top of the achene, forming a shallow cup with massive sub-woody walls (Figs. 3i–l). In the two *Ammobium* species the spines are not only shorter, but much less substantial. They are circular in cross section and the cup is formed, not by confluence of the spines, but by a separate structure, a membranous 'ligule' which is present even in quite young buds (Figs. 1p–q, 2l–n). The cup in *Ammobium* is therefore membranous when the flower is young, and may become chartaceous in a mature achene, but is never sub-woody. The margin of the cup in *Nablonium* is thick and rounded, in *A. crasspedioides* it is membranous and undulate, and in *A. alatum*, membranous and erose. As mentioned above, there may be a transformation series discernible in the spines of these species. However, from their different structure, the spines of *Nablonium* should be excluded from it, and their development considered separately. The transformation series probably runs from the generalised medium spines of *A. craspedioides*, which have a protective function, to the tiny spines of *A. alatum* which have lost this function to the spinous paleae, and are now only vestigial. This series runs in the reverse direction to that proposed by Anderberg.

The characters mentioned above, along with those of Anderberg, are summarised in Table 1 (pp. 680–681).

Conclusions

Consideration of the characters in Table 1 indicates that the *Ammobium/Nablonium* group is quite distinct from the Anderberg outgroup, and further, that the two *Ammobium* species have far more in common with each other than either does with *Nablonium*. The character states defining the outgroup, genera and species are summarised below.

Separation of *Ammobium/Nablonium* from Anderberg's outgroup

Four independent characters separate *Ammobium* and *Nablonium* from the outgroup (character state of the outgroup given in brackets):

Growth form perennial herbs (shrubs or small trees); inflorescence of 1–few heads (inflorescences compound, of many individual heads); paleae distinctly lacerate (paleae not or only minutely lacerate); and achene bearing apical spines (achenes with a pappus of barbed hairs). If the presence/absence of leaves in a basal rosette is considered to be a good character, separate from growth habit, then this provides a fifth point of distinction.

Separation of *Ammobium* species from *Nablonium*

Fourteen independent characters are available to distinguish the two species of *Ammobium* from *Nablonium* (character state in *Nablonium* is given in brackets):

No form of vegetative reproduction (stolons present); leaves with cottony 'Type A' hairs (leaves lacking cottony hairs); scape winged or angled (scape round in section); scape with 2–6 bracts (scape lacking bracts, or if present, 1 only on robust plants); involucral bracts membranous with a small basal stereome (bracts subfleshy with a membranous margin and obscure stereome); involucral bracts blunt and wrinkled at the tip (bracts acute to subapiculate and smooth); paleae subwoody to woody (paleae membranous); florets yellow (florets white); florets with glandular hairs on the outside of the tube (florets glabrous); anther appendages broad (anther appendages narrow); achenes linear/cylindric, more than twice as long as broad (achenes short with diverging apex, up to twice as long as broad); spines of the achene circular in section (spines U- to Y-shaped in section); cup at top of achene formed by a special submembranous 'ligule' (cup formed by fusion of woody bases of spines); and achenes glabrous (achenes bearing papillose hairs in lower part).

Separation of *Ammobium alatum* from *A. craspedioides*

Three independent characters satisfactorily separate the two species of *Ammobium* (the character state of *A. craspedioides* is given in brackets):

Hairs of the upper leaf surface cottony 'Type A', semi-appressed (hairs of upper leaf surface thin-walled, multicellular, spreading); involucral bracts white (involucral bracts tawny-hyaline); paleae with a woody terminal spine (paleae lacerate but lacking a distinct spine).

On this hypothesis, the *Ammobium/Nablonium* group is seen as a satellite group to the *Cassinia* outgroup, linked by such characters as the paleae on the receptacle, but retaining more of the ancestral Gnaphalieae characters such as a perennial herb habit with rosette leaves. The two *Ammobium* species are very closely allied to each other, in characters ranging from vegetative features to those of the inflorescence and fruit, and the internal links are closer than those of either to *Nablonium*. Both share some character states with *Nablonium*, although the spines of the achene represent convergence rather than an *a priori* relationship.

These relationships are best reflected in a classification which maintains the two previous genera, rather than merging them as in Anderberg (1990).

Table 1. Character compositions in *Cassinia*, *Ammobium* and *Nablonium*.

Character	*Cassinia*	*Ammobium alatum*	*Ammobium craspedioides*	*Nablonium calyceroides*
Life form	Shrubs	Perennial herb	Perennial herb	Perennial herb
Vegetative reproduction	None	None	None	Stolons
Vegetative stem branching	Frequent	None	None	None
Branching within inflorescence/ scape	Frequent	Sparse	Unbranched	Unbranched
Scape winged/angled	Usually round	Strongly winged	Angled	Round
Bracts on scape	Numerous	2–6	2–6	Usually 0
Leaves decurrent	Sometimes	Strongly	Weakly	No
Leaf hairs, upper surface	None, or sparse cottony (Type A)	Dense cottony (Type A)	Multicellular erect	Multicellular erect
Leaf hairs, lower surface	Various	Dense cottony (Type A)	Dense cottony (Type A)	Multicellular erect.
Involucral bracts, shape	Oblong to ovate, obtuse, smooth or wrinkled	Ovate to obovate/spathulate, obtuse, wrinkled at tip	Ovate to obovate, obtuse, wrinkled at tip	Ovate, acute, smooth
Involucral bracts, texture	Scarious with small stereome	Scarious with small stereome	Scarious with small stereome	Subfleshy, no obvious stereome
Involucral bracts, colour	Hyaline, tawny, white, pink or yellow	White	Tawny/hyaline	Green with hyaline margins
Paleae	Scarious, entire to sublacerate	Woody, shortly lacerate and apiculate	Subwoody, lacerate	Membranous, lacerate
Floret colour	White to yellow	Yellow	Yellow	White

Character	***Cassinia***	***Ammobium alatum***	***Ammobium craspedioides***	***Nablonium calyceroides***
Glandular hairs on corolla tube	Yes	Yes	Yes	No
Papillae on corolla lobes	Absent, or very short	Present	Present	Absent
Anther appendage	Various	Ovate, blunt, as wide as anther	Ovate, blunt, as wide as anther	Lanceolate/deltoid, acute, narrower than anther
Achene indumentum	Twin hairs	None	None	Papillose hairs
Achene shape	± Cylindrical	Flattened, cylindrical	± Flattened, cylindrical	Flattened, flared at apex
Pappus	Uniseriate, barbellate setae	Two tiny spines + 'ligule'	Two small spines + 'ligule'	Two large spines
Spine structure	-	Subwoody, round in section	Subwoody, round in section	Massive woody, U or Y shaped on section
Cupule	-	Formed from membranous ligules	Formed from membranous ligules	Formed by fusion of spine bases
Preferred habitat	Dry sclerophyll savannah	Dry sclerophyll savannah	Dry sclerophyll savannah	Maritime interdunal hollows

Acknowledgements

I am most grateful to Mr I.R. Telford who provided me with flowering and fruiting material of the two *Ammobium* species, and to the Curator of the National Botanic Gardens Herbarium (CBG) for the loan of specimens.

Ms Joy Everett kindly made a number of eminently sensible suggestions for improvements which were much appreciated.

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In defence of the transfer of *Nablonium* to *Ammobium* (Asteraceae–Gnaphalieae), a reply to Orchard

Arne A. Anderberg

Abstract

Anderberg, Arne A. (Swedish Museum of Natural History, Department of Phanerogamic Botany, P.O. Box 50007, S-104 05 Stockholm, Sweden) 1992. In defence of the transfer of Nablonium *to* Ammobium *(Asteraceae–Gnaphalieae), a reply to Orchard.* Telopea *5(1): 13-19.* The relationship between *Ammobium* (2 species) and *Nablonium* (1 species) has once again been examined. A cladistic parsimony analysis has been undertaken based on the data presented in support of an alternative taxonomic treatment (Orchard this volume). The result of the analysis is illustrated with a cladogram. It is concluded that *Ammobium* is paraphyletic, and the problem with paraphyletic groups is discussed. *Ammobium calyceroides* (= *Nablonium calyceroides*) and *Ammobium craspedioides* are sister species, and most similarities between *A. craspedioides* and *A. alatum* are symplesiomorphies.

Introduction

The systematic position of *Nablonium calyceroides* Cass. (Asteraceae) has been a matter of discussion for many years, but in a recent paper (Anderberg 1990) it was concluded that the genus belongs in the tribe Gnaphalieae subtribe Cassiniinae, being a close relative of *Ammobium* R. Br. The two genera have many characters in common that diagnose them as a derived, monophyletic group within the subtribe (Anderberg 1990, 1991). Apart from *Ammobium*, the Cassiniinae also include genera such as *Ixodia*, *Cassinia* and *Ozothamnus* (Anderberg 1991, cf. Orchard 1981). Based on the results of a cladistic analysis using the paleate genus *Cassinia* as outgroup, I concluded that *Ammobium* is paraphyletic, and that *A. craspedioides* Benth. is the closest relative of *Nablonium calyceroides* (Anderberg 1990). Many of the derived character states found in *Nablonium* were after the analysis interpreted as autapomorphies, integral parts of sets of nested character transformation series leading from the less derived morphology of *Cassinia* via more derived features in *Ammobium* to *Nablonium*. *Nablonium* was therefore transferred to *Ammobium* as *A. calyceroides* (Cass.) A. Anderb. In response to this paper, Telford (in litt.) pointed out that the distribution I gave for *Ammobium alatum* R. Br. was not complete since the species also occurs further south in N.S.W. Although I believe Telford is right, this does not basically change the scenario of vicariance biogeography that was briefly presented in my paper. A similar pattern has also been found in the genus *Telopea* (Weston & Crisp 1987).

My paper on *Nablonium* has also generated a response to the taxonomic conclusions presented therein: an alternative view of the systematics of the two genera has been put forward (Orchard 1992). Orchard accepted most of my conclusions, stating: 'He [Anderberg] has thus performed a valuable service in finally finding a secure tribal resting place for *Nablonium* in the Gnaphalieae', and also: '*Ammobium* and *Nablonium* are in all likelihood indeed closely related'. Orchard presented the results of a detailed morphological investigation of the three taxa, in which a few of the characters I used for my analysis (Anderberg 1990) were reinterpreted and modified to the better. Orchard presented an extensive list of characters together with a correspond-

ing list for *Cassinia*. In spite of our mutual agreement on the systematic position of *Nablonium*, Orchard disagreed with my lumping of *Nablonium* and *Ammobium*. In support of his opinion Orchard stated that: 'the two *Ammobium* species have far more in common with each other than either does with *Nablonium*', and he concluded from these differences that a traditional circumscription of *Ammobium*, with two species, and separate from *Nablonium* would be preferred. I was permitted by the editor to read Orchard's manuscript, and since I do not agree with Orchard's conclusion I am grateful for the opportunity to submit a further paper in response to Orchard.

The choice of outgroup for assessing character polarity was discussed by Orchard. However, lacerate paleae in the two *Ammobium* species and *Nablonium* are unique features, supporting the hypothesis that they form a monophyletic group. Presence of paleae is a rare feature in the tribe, and for an analysis of *Nablonium* and *Ammobium* a paleate taxon should be used as outgroup not to lose information relating to this organ. In this particular case *Cassinia* was chosen, but the differences between *Cassinia* and other paleate genera, e.g. *Ixodia*, are possibly restricted to autapomorphies in the latter. Being a genus belonging outside the *Ammobium-Nablonium* group, *Cassinia* is thus a useful outgroup. In explanation of the topological difference which Orchard observed (between Figs. 8 and 12 in Anderberg 1991), this is the effect always encountered in macrosystematic cladistic analysis, when the most parsimonious character distribution changes as a result of increasing data and an increasing number of taxa.

The additions and reinterpretations offered by Orchard (1992) made it interesting to find out whether the additional information would change the results of my previous paper (Anderberg 1990). Accordingly, I have submitted Orchard's data to a cladistic parsimony analysis. Some included characters are seen to be autapomorphies and will increase the consistency and retention index values, but they are still included here because they were used by Orchard in support of his alternative view. The characters are numbered as they follow in his list, but three entries had to be divided in two since they clearly included more than one character:

1. cypsela shape was divided into 'cylindrical vs. flared cypselas' (character 19 below), and 'not flattened vs. flattened cypselas' (character 20 below).

2. pappus was divided into 'no spines, two tiny spines, two small spines, two large spines' (character 21 below), and 'ligule present, later fusing into cupule, vs. ligule absent' (character 22 below).

3. spine structure was divided into 'subwoody vs. massive woody spines' (character 23 below), and 'rounded vs. 'U- or Y-shaped' spines' (character 24 below).

Lacerate paleae is a character found in all three taxa and thus it is not informative, except for diagnosing the three-taxon group from other paleate genera.

The penultimate entry, the cupule, had to be omitted since Orchard himself considered the fusion in the *Ammobium* species and in *Nablonium* to be non-homologous, as they evolved from different structures. In my earlier paper (Anderberg 1990: character 10 on p. 132) I suggested that the cupules in *Ammobium* and *Nablonium* formed a transformation series. Orchard showed that the two cupules are formed from different kinds of tissue, and concluded that the spines in *Ammobium* and *Nablonium* were non-homologous. Even if the cup-shaped tissues associated with the spines are non-homologous, there is nothing indicating that the spines themselves are not homologous.

Orchard disagreed with my interpretation of a successive transformation in spine-size from no spines at all (outgroup) to massive spines (*Nablonium*), but I cannot see any logical reason for a transformation such as hypothesized by Orchard (no spines-large spines-small spines-tiny spines). The fact that *Nablonium* has a different shape of

the spines in transsection is hardly surprising considering all the other unique features of this species.

Here I present only a short summary of the characters involved and their numbers, which correspond to the numbers on the cladogram in Fig. 1, and in Table 1. For details see Orchard (1992) and Anderberg (1990).

1. **Life form**: Shrubs (0) perennial herbs (1).
2. **Vegetative reproduction**: Stolons none (0) stolons present (1).
3. **Vegetative stem branching**: Branching frequent (0) branching none (1).
4. **Branching within inflorescence/scape**: Branched inflorescence (0) unbranched (1).
5. **Scape winged/angled**: Stem at least sometimes winged/angled (0) round stem (1).
6. **Bracts on scape**: Bracts on scape numerous (0) 2–6 (1) none (2).
7. **Leaves decurrent**: Leaves decurrent (0) not decurrent (1).
8. **Leaf hairs, upper surface**: Without multicellular erect hairs (0) with multicellular erect hairs (1).
9. **Leaf hairs, lower surface**: Leaf lower surface cottony (0) not cottony, with erect hairs (1).
10. **Involucral bracts, shape**: Involucral bracts ovate, obtuse, wrinkled (0) involucral bracts acute, smooth (1).
11. **Involucral bracts, texture**: Involucral bracts scarious with small stereome (0) involucral bracts fleshy with large stereome (1).
12. **Involucral bracts, colour**: Involucral bracts showy white or yellow (0) involucral bracts tawny or at least with tawny margins (1).
13. **Paleae**: Paleae scarious (0) woody (1) subwoody (2) herbaceous (3).
14. **Floret colour**: Flowers yellow (0) flowers white (1).
15. **Glandular hairs on corolla tube**: Corolla with glandular hairs (0) corolla without glandular hairs (1).
16. **Papillae on corolla lobes**: Corolla with papillae in the throat (0) corolla without papillae in the throat (1).
17. **Anther appendage**: Anther appendage blunt, as wide as anther (0) anther appendage lanceolate, narrower than anther (1).
18. **Cypsela indumentum**: Cypselas without unicellular papillose hairs (0) cypselas with unicellular papillose hairs (1).
19. **Cypsela shape (outline)**: Cypsela shape cylindrical (0) cypsela shape flared at apex (1).
20. **Cypsela shape (shape in transsection)**: Cypselas not flattened (0) cypselas flattened (1).
21. **Pappus (spines)**: Pappus of bristles, no spines (0) pappus of two tiny spines (1) pappus of two small spines (2) pappus of two large spines (3).
22. **Pappus (ligule)**: Ligule absent (0) ligule present, later fusing into cupule (1).
23. **Spine structure (texture)**: Cypselas with subwoody spines (0) cypselas with massive woody spines (1).
24. **Spine structure (shape in transsection)**: Cypsela with spines round in section (0) spines U- or Y-shaped in section (1).
25. **Preferred habitat**: Inhabiting dry sclerophyll savanna (0) inhabiting maritime interdunal hollows (1).

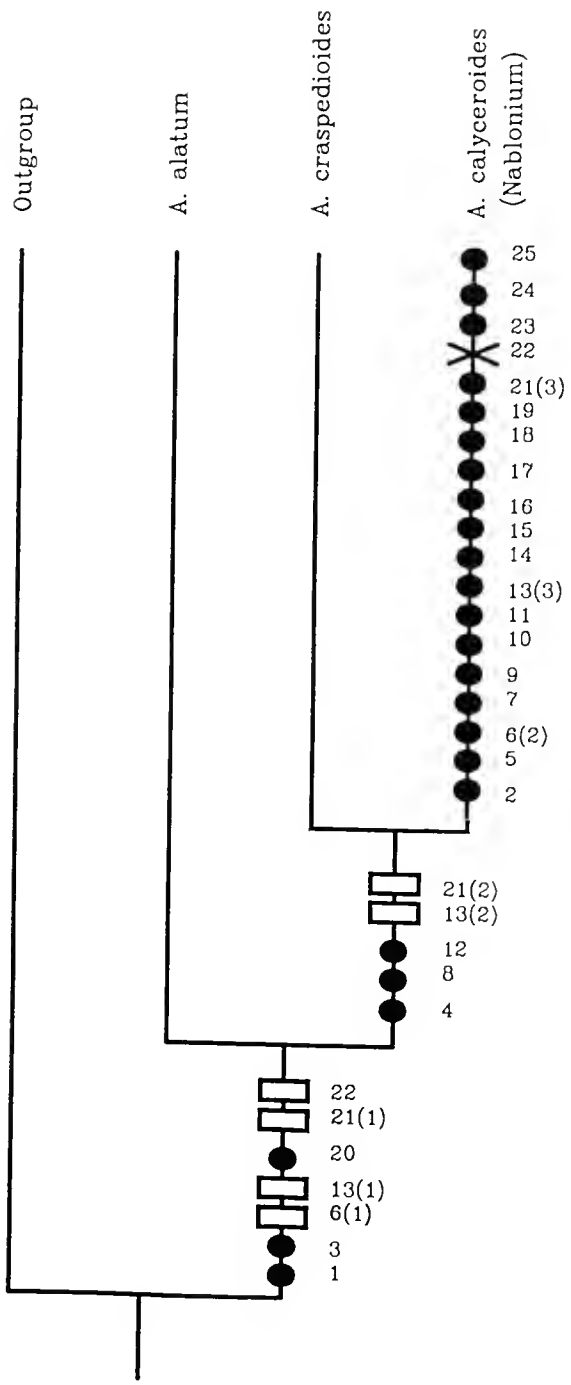

Fig. 1. Cladogram showing the interrelationships between *Ammobium alatum*, *A. craspedioides* and *A. calyceroides (Nablonium)*. The characters are numbered in accordance with Table 1 and with the text.
Black dot = synapomorphy (ci=1), Open box = synapomorphy (ci<1), Cross = reversal.

Cladistic analysis

The data in Table 1 were analysed with the parsimony program Hennig86 (Farris 1988) using the implicit enumeration option 'ie', with the results certain to be of minimal length. All characters were coded as nonadditive except characters 6 and 21, which were coded as an additive transformation series. The analysis of Orchard's data resulted in one cladogram, 31 steps long with a consistency index (ci) of 0.96, a retention index (ri) of 0.75. The most parsimonious character distribution is shown in Fig.1.

The data were also computed with all characters coded as nonadditive, and this analysis gave the same result except for a somewhat lower retention index (ri=0.66). Whether characters are coded as additive or nonadditive the genus *Ammobium* s. str. becomes paraphyletic, and *Nablonium* the sister-species of *Ammobium craspedioides*.

The logical basis of phylogenetic analysis was presented in detail by Farris (1983) pointing out the need for simple scientific hypotheses. Ad hoc hypotheses of parallelisms and reversals must be minimized in number, even if evolution has not proceeded in a simple straightforward maner. One of the fundamentals of phylogenetic systematics is that sister-groups must be placed in taxa of the same rank. Hence, a genus cannot be the sister-group of a species from another genus without the latter being paraphyletic. Generic circumscriptions of 'easily recognizable' groups will inevitably exclude derived relatives, and result in the formation of paraphyletic groups.

In the absence of phylogenetic hypotheses, paraphyletic groups could tentatively be used as taxonomic units during a process of taxonomic work leading from splitting of polyphyletic assemblages to the formulation of hypotheses based on strict monophyly. I have myself separated and reclassified taxa from the large, polyphyletic genera *Helichrysum* and *Gnaphalium* into smaller groups of somewhat uncertain phylogenetic status (Anderberg 1991). Such a pragmatic approach was used, for example, in my transfer of several former *Helichrysum* species to the genus *Ozothamnus*. This latter genus could well prove to be monophyletic when the Cassiniinae are analysed in detail, but intuitively it seemed to be paraphyletic and delimited from *Cassinia* and *Haeckeria* by the mere absence of receptacular paleae. In any case, it is quite clear that the *Ozothamnus* species are only distantly related to *Helichrysum* s. str., and should be removed from their vicinity. Rather than leaving *Helichrysum* as it was, I chose my approach to initiate a process of taxonomic and nomenclatural change intended as one step on the way to a better understanding of the phylogeny of the Gnaphalieae.

Table 1. Data matrix based on the data in the table presented by Orchard (1992). The characters are numbered in accordance with the text, and with Fig. 1.

		1111111111	222222
Character No.	123456789	0123456789	012345
Outgroup	000000000	00?0000000	000??0
A. alatum	101001000	0001000000	111000
A. craspedioides	101101010	0012000000	121000
A. calyceroides (*Nablonium*)	111112111	1113111111	130111

Paraphyletic groups do not represent phylogenetic lineages, and any circumscription of taxa based on paraphyletic groups should be rejected if it is at odds with an available hypothesis of phylogenetic interrelationships based on strictly monophyletic taxa.

Discussion

Orchard presented 14 characters to distinguish *Nablonium* from *Ammobium*, and although the differences are correct it is crucial to remember that 'similarity' can be either symplesiomorphic or synapomorphic. Whereas synapomorphic similarity is diagnostic and useful for hypotheses, symplesiomorphic similarity is not. It can be noted that most differences between the species of *Ammobium* and *Nablonium* are due to specializations in *Nablonium*, either transformations or reversals. A few examples: the presence of stolons is an autapomorphy unique to *Nablonium*, but absence of stolons is not diagnostic of *Ammobium* since stolons are missing also from the related genera. The presence of a ligule forming a cupule with age in the two *Ammobium* species (non-homologous with the similar structure in *Nablonium*) is, for parsimonious reasons, interpreted as lost in *Nablonium* where spines instead form a cupule by fusion of their bases. The occurrence of *Nablonium* in a maritime habitat instead of in sclerophyll savanna is also an autapomorphy, which also has affected the morphology of the plant. The fleshy involucre is probably an adaptation to saline influence, and succulent organs are common in maritime plants, e.g. *Cakile* (Brassicaceae) and *Salicornia* (Chenopodiaceae).

The fact that Orchard amended my data set with reinterpretations of certain characters and by adding more information makes the result of the present analysis more interesting. My original hypothesis was not falsified, but corroborated by a new and larger data set. The most parsimonious hypothesis is that *Nablonium* and *Ammobium craspedioides* have evolved from a common ancestor with unbranched scape, upper leaf surface with multicellular erect hairs, tawny involucral bracts (further transformed into green bracts with tawny margin in *Nablonium*), subwoody paleae (further transformed into herbaceous paleae in *Nablonium*), and prominent spines (even more prominent in *Nablonium*). No single apomorphic character could be found to support a group comprising *A. alatum* and *A. craspedioides* only, and the apparently salient features of *Ammobium* s. str. are also present in *Nablonium* albeit disguised in the form of derived character states and reversals.

The hypothesis is corroborated that *Ammobium (Nablonium) calyceroides* and *Ammobium craspedioides* have evolved from a common ancestor, and that *Ammobium* becomes paraphyletic with *A. calyceroides* placed in a separate genus. *Nablonium* should consequently be included in *Ammobium* to avoid unnatural groupings.

If systematics is to be a science in which biologists other than systematists find the results useful in their own pursuits, we must ensure that taxa are circumscribed in such a way that hypotheses of phylogenetic interrelationships are taken into consideration. Otherwise, taxonomy becomes a concern for taxonomists alone, without explanatory power for disentangling the effects of history and of natural processes in the living world.

Acknowledgements

I would like to thank Joy Everett, Sydney, for valuable comments to improve the presentation of this paper.

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A new species and a neotypification in Australian *Tribulus* (Zygophyllaceae)

K.L. Wilson

Abstract

Wilson, K.L. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1992. A new species and a neotypification in Australian Tribulus *(Zygophyllaceae).* Telopea *5(1): 21–29.* A new species, **Tribulus eichlerianus**, is described from Queensland, New South Wales, Northern Territory and South Australia. A neotype is chosen for *T. occidentalis* R. Br. These two species and *T. hystrix* R. Br. are the only Australian species with numerous spines on the fruits. Differences between these three species are discussed.

Introduction

Australia has about twelve species of *Tribulus* L. sens. strict. (that is, excluding *Tribulopis* R. Br.). The most widespread species is *T. terrestris*, which, as currently recognised, may include both native and weedy introduced forms, even after *T. micrococcus* Domin and *T. minutus* Leich. ex Benth. are separated (Wilson in prep.). This paper deals only with the strictly native species that have many-spined fruits: *T. hystrix* R. Br., *T. occidentalis* R. Br. and an unnamed species for which a name is needed in the forthcoming 'Flora of New South Wales' volume 3. The new species has been confused with *T. occidentalis*. The latter species does not occur in New South Wales but, to stabilise application of the name, a neotype is here chosen.

Tribulus eichlerianus *K.L. Wilson*, **sp. nov.**

Affinis *T. occidentali* sed fructibus dense villosis, spinis fructus brevioribus, pedicellis tempore florescentiae brevioribus, differt.

TYPE: NORTHERN TERRITORY: Central North: Sandover Highway, 5 km SW of Utopia turn-off, *K.L. Wilson 4646 & R. Barker*, 17 April 1983; holo NSW; iso CANB, NT.

Prostrate, ± villous, taprooted herb with long radiating branches to 1 m long. Leaves opposite, pinnate, with 6–9 pairs of leaflets; leaflets ± oblong, acute to broad-acute, base often oblique, discolorous, sparsely villous adaxially, more densely villous abaxially, 7–15 mm long, 3–6 mm wide. Flowering pedicels 7–16 mm long, elongating to 20–35 mm long in fruit. Sepals acuminate, densely villous abaxially, 4–7 mm long. Petals bright yellow, obovate, glabrous, 5–11 mm long, from slightly longer than sepals to twice as long as sepals. Anthers 10, 0.6–0.8(–1.5) mm long. Stigma elongated-conical, 1.3–2.5 mm long, longer than style. Fruit breaking up into 5 broad, woody cocci, sometimes 1 or 2 poorly developed; body of fruit 7–13 mm long, 10–20 mm diam. (excluding the spreading spines), densely villous (hairs to 1 mm long, thicker terminal bristle on each spine c. 2.5 mm long), with numerous spines abaxially of various lengths on the one fruit; spines rigid, spreading at right angles to the coccus surface, 0.5–5 mm long (most spines on the one fruit less than 2 mm long, often only 2–6 spines exceeding that length), covered in spreading white hairs. Seeds 3–5 per coccus. Figure 1.

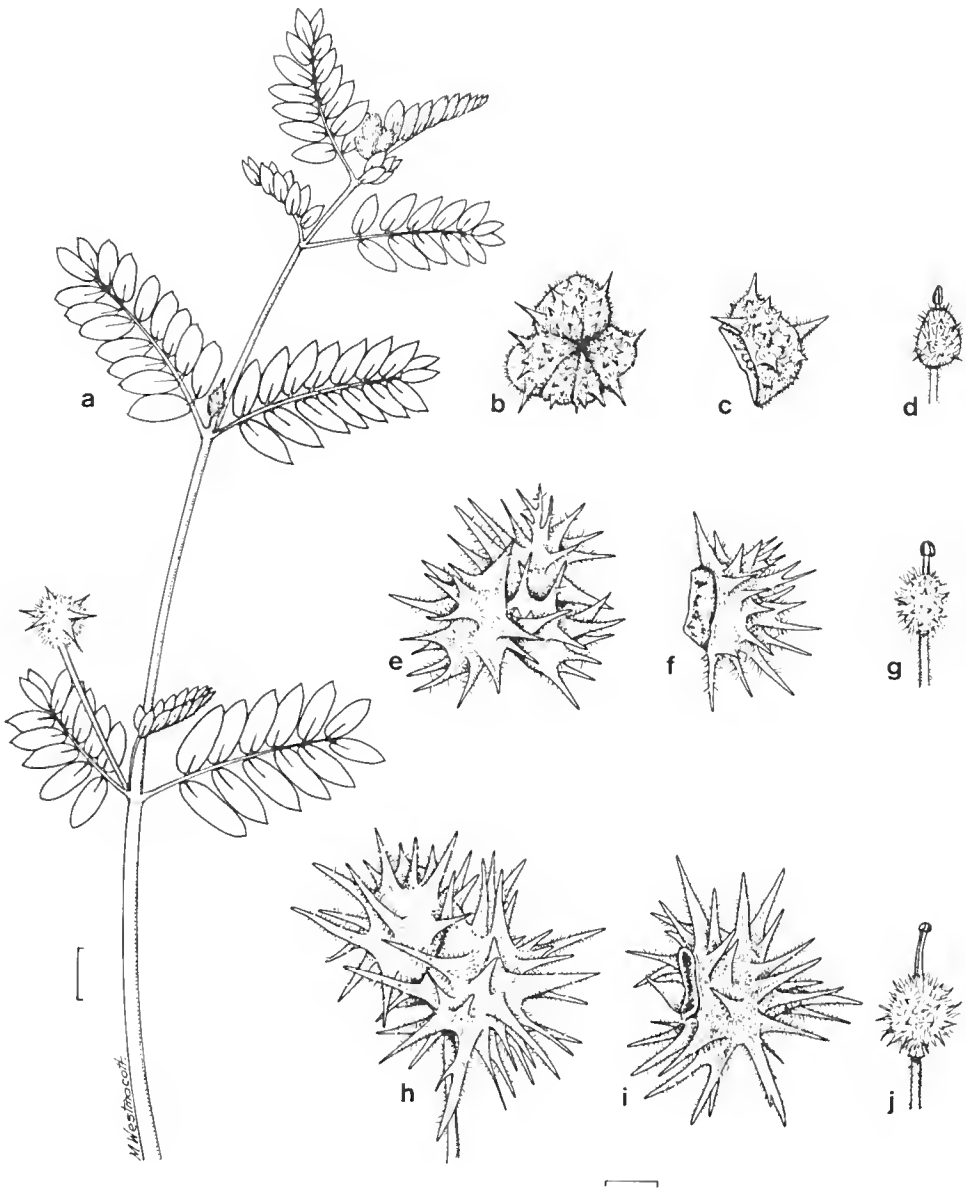

Figure 1. *Tribulus eichlerianus*: **a**, the apex of a branch (the indumentum of which has largely been omitted); **b**, plan view of fruit; **c**, side view of one coccus; **d**, immature fruit with stigma and very short style. *T. occidentalis*: **e**, plan view of fruit; f, side view of one coccus; **g**, immature fruit with stigma and style of similar lengths. *T. hystrix*: **h**, three-quarter view of fruit with stalk attached; **i**, side view of one coccus; j, immature fruit with short stigma and very long style.

a, c from *Perry 3286*; b, d from *Basedow NSW 145406*; e–g from *Ballingall 2561*; h, i from *Wilson 4601*; j from *Jacobs 5846*. a: scale bar = 10 mm; b–j: scale bar = 5 mm.

DISTRIBUTION AND HABITAT: Found in arid and semi-arid Australia, from western Northern Territory to northern South Australia, western Queensland and New South Wales. Apparently usually in dry but non-saline habitats, often as a pioneer species (e.g. in dry creek-beds). The Dareton (south-western N.S.W.) record is perhaps an introduction in that irrigation area.

DERIVATION OF EPITHET: Named after the late Dr Hansjoerg Eichler (1916–1992), who contributed notably to our understanding of the Australian flora, especially the family Zygophyllaceae, over many years. In addition to his own studies, he encouraged many others during his career in Adelaide and later in Canberra to contribute in their individual ways to systematic botany. Whimsically, Hansjoerg had suggested to me that I should explain the epithet as follows: 'The fruit of the species resembles the person it is named after – prickly, but not as prickly as some.'

NOTES: In the classification of the genus by Hadidi (1978), this species falls within *Tribulus* sect. *Tribulus* (sect. *Terrestris* Hadidi), along with the type species *T. terrestris*, and *T. occidentalis*, *T. hystrix* and various other species with spiny cocci and deciduous sepals.

This species differs from *T. terrestris*, which may be found in the same areas, in having larger flowers with more conspicuous petals and a longer stigma and style. In addition, *T. eichlerianus* has bigger, more densely hairy fruits, with more rounded cocci and with spines that are more numerous and scattered all over the abaxial surface of the coccus, whereas *T. terrestris* usually has two long well-developed spines on the upper half of the abaxial surface of the coccus, spreading at right angles to the coccus, and two shorter spines near the base of the coccus, spreading downwards.

T. eichlerianus has mostly been confused with *T. occidentalis* or referred to as 'sp. aff. *occidentalis*'. However, it differs from *T. occidentalis* in various features (Table 1). Its fruits differ in being densely villous with shorter, untoothed spines, the majority of spines on each coccus being generally no more than 2 mm long but with a few spines markedly longer (spines mostly 3–8 mm long in *T. occidentalis*). Spines on immature fruits of *T. eichlerianus* (e.g. *Martensz 2758*) are more or less uniformly long, as in immature fruits of *T. occidentalis* and *T. hystrix*, but this changes with maturity in *T. eichlerianus*. The petals in *T. eichlerianus* are mostly shorter (usually 10–20 mm long in *T. occidentalis*) and the flowering pedicel is shorter (15–20(–35) mm long in *T. occidentalis*) although it elongates in fruit to about the same length as in *T. occidentalis* (to 35 mm long). In addition, *T. eichlerianus* has the stigma much longer than the style whereas in *T. occidentalis* the stigma is 1.0–2.0 mm long and the style 1.0–3.0 mm, that is, the two parts are more similar in length in the latter species. Label information is limited, as is my field knowledge of the two species (I have not seen *T. occidentalis* in the field), so I cannot say whether there is any habitat difference between these species. Distribution and typification of *T. occidentalis*, a mainly west-coast species, are discussed below.

T. eichlerianus differs from *T. hystrix*, the only other previously known Australian species with numerous spines, in having densely villous fruits with shorter untoothed spines, much smaller flowers (petals 15–27 mm long in *T. hystrix*), and the stigma longer than the style (the reverse in *T. hystrix*). Distinguishing features of these two species and *T. occidentalis* are given in Table 1.

The only extra-Australian species with numerous spines on the fruit are *T. rajasthanensis* M.M. Bhandari & V.S. Sharma from India, Afghanistan and Arabia and *T. echinops* Kers from Angola and Namibia. I have seen only one specimen of the former (collected near Jaisalmer, Rajasthan, *no. 3416* [no collector], 1 Sep 1976; CANB) and none of the latter, but both protologues give full descriptions and are accompanied by good illustrations.

Table 1. Distinguishing features of *T. eichlerianus*, *T. occidentalis* and *T. hystrix*

	T. eichlerianus	*T. occidentalis*	*T. hystrix*
Leaves			
Pairs of leaflets per leaf	6–9	7–11	7–10
Pedicel			
Flowering length (mm)	7–16	15–20(–35)	15–40(–60)
Fruiting length (mm)	20–35	15–35	25–40(–60)
Flowers			
Sepal length (mm)	4–7	6–12	11–13
Petal length (mm)	5–11	(7–)10–17(–20)	15–27
Anther length (mm)	0.5–0.8(–1.5)	0.7–1.1(–1.5)	(1.2–)1.6–2.3
Stigma length (mm)	1.3–2.5	1.0–2.0	0.5–2.5
Style length (mm)	0.5–1.0	1.0–3.0	4.0–6.0
Fruit			
Diameter, incl. spines (mm)	10–20	15–25	30–40
Indumentum	dense; hairs c. 1 mm long	sparse; hairs c. 0.5 mm long	sparse; hairs c. 0.5 mm long
Number of cocci well-developed	3–5	2–4	2–3
Coccus length, excl. spines (mm)	7–13	10–14	10–20
Spines	numerous, some long, most short	numerous, long	numerous, long
	not toothed	often toothed	often toothed
	0.5–5 mm long	(1–)3–8 mm long	4–15 mm long

T. rajasthanensis (Bhandari & Sharma 1977) differs from *T. eichlerianus* in having a fruit covered in shorter hairs and with only two long spines that are always in a central position on the coccus surface, in contrast to the usually more numerous long spines on the coccus in *T. eichlerianus*. *T. rajasthanensis* also differs in having usually shorter and thinner cocci (6–7 mm long), a short stigma that is shorter than the style, and longer anthers (1.5–1.7 mm long).

T. echinops (Kers 1971) has numerous elongated spines (4–14 mm long) covering the fruit, which makes the species look (at least superficially) more like *T. hystrix* than *T. eichlerianus*. The spines do not, however, appear to be toothed as in *T. hystrix*. Petals, anthers and fruit are all larger, and the stigma is shorter, than in *T. eichlerianus*.

SELECTED SPECIMENS SEEN:

QUEENSLAND: Gregory North: Toko Gorge, Toko Range, *Purdie 2271*, 10 July 1982 (CANB); Sandringham Station, *Morton*, Feb 1980 (NSW 145403); Currawilla, c. 100 miles [160 km] W of Windorah, *Everist 3901*, 9 June 1949 (CANB ex BRI). Gregory South: 38 miles [61 km] W of Windorah, *Boyland 154*, 18 Sep 1966 (NSW ex BRI).

NEW SOUTH WALES: North Far Western Plains: Tibooburra, *Morris 803*, 30 Sep 1921 (NSW); Salisbury Downs Station, *Martensz 2758*, 11 Mar 1964 (CANB); c. 30 km NW of Milparinka on Hawkers Gate road, *Jacobs 3501*, 11 May 1979 (NSW, AD); Yandama, Milparinka, *Collier*, Mar 1910 (NSW 145396); Mt Browne, *Corbett*, May 1898 (NSW 145398); Callandary Station, *Libke 1500*, Apr 1967 (NSW); Broken Hill, *Bennetts*, – (NSW 145399). South Far Western Plains: Dareton, *Parsons*, 5 Mar 1980 (NSW 245400).

NORTHERN TERRITORY: Central North: 27 miles [43 km] NE of Barrow Creek township, *Lazarides 5824*, 24 Aug 1956 (CANB, NSW). Central South: Acacia Well Bore, 25 miles [40 km] NE of Undoolya Station, *Perry 3286*, 6 Mar 1953 (CANB); 1 mile [1.6 km] E of Alice Springs township, *Perry 3225*, 5 Mar 1953 (CANB); Palm Valley, Cycad Gorge, *Eichler 22642*, 26 Aug 1978 (CANB); Uluru National Park: Kata Tjuta (The Olgas), on the Docker River road, 45 km WNW of the Ranger Station, *Lazarides & Palmer 081*, 14 May 1988 (CANB, NSW).

SOUTH AUSTRALIA: North-western: Granite Downs, near the homestead, *Eichler 17944*, 14 July 1964 (CANB, NSW). Lake Eyre: 12 km NW of Moomba, *Wasson ANU 31025*, 14 June 1981 (CANB ex ANU); Kingoonya – Mount Eba, *Basedow*, Apr–May 1917 (NSW 145406); Priscilla Creek, 30 km NW of Finniss Creek on Oodnadatta road, *Wilson 4600 & R. Barker*, 10 Apr 1983 (NSW, AD, CANB). Flinders Ranges: Munyallina Creek, 'Wooltana' – 'Balcanoona' road, *Jacobs 3616*, 17 May 1979 (NSW); c. 5 km N of Witchitie Station, *Copley 3766*, 20 Mar 1972 (CANB ex AD).

Tribulus occidentalis R. Br.

Brown (1849: 69)

TYPE CITATION: 'Found on the west coast of Australia, or on some of its islands, in the voyage of the Beagle'

NEOTYPE (here designated): WESTERN AUSTRALIA: Carnarvon: on the outskirts of Onslow town, near the hospital, *D.E. Symon 5420*, 1 July 1967 (CANB 209684). Isoneo: AD (n.v.), B (n.v.), CANB 209685, K (n.v.), PERTH (n.v.).

Robert Brown briefly but clearly described this species in a note following his description of *T. hystrix*. Unfortunately, the specimen or specimens of *T. occidentalis* collected on the voyage of the survey vessel 'Beagle' in 1837–1843 and seen by Brown cannot now be found in BM.

Bentham (1863) put *T. occidentalis* in the synonymy of *T. hystrix* but made it clear that he had not seen adequate material of either species; indeed, that he had not been able

to find any of the specimens seen by Brown. This was partly confirmed by Moore (1920), who agreed that the type of *T. occidentalis* could not be found in BM but pointed out that the type of *T. hystrix* was certainly still present there. Moore did not comment on Bentham's detailed statement in the preface to 'Flora of Australia' (1863: 9* [sic]) about the difficulty, if not impossibility, of getting access in BM to specimens such as those of the 'Beagle' voyage, beyond suggesting that Bentham's infrequent visits to the Museum accounted for his not finding the relevant specimens.

Moore (1920) discussed the differences between *T. occidentalis* and *T. hystrix*, as he understood the species, pointing out that the former has shorter sepals and petals, smaller fruits, and shorter spines (that vary less amongst themselves on the one fruit) compared to the latter. His plate 11 illustrates the fruits of both species but not well. He suggested that the pedicels were shorter in *T. occidentalis*, but this is not always so at either the flowering or fruiting stage. One difference not mentioned by him is the relative and absolute lengths of stigma and style: *T. occidentalis* has the stigma 1.0–2.0 mm long, slightly shorter than or equalling the style, while *T. hystrix* has the stigma 0.5–3.0 mm long, and no more than half as long as the style (which can be to 6 mm long).

Here, the name *T. occidentalis* is applied, in agreement with Moore (1920), to a taxon with numerous long spines that matches the protologue in all significant features. This species is most common on the north-west coast of Australia, extending from Carnarvon north to Broome.

T. occidentalis and *T. hystrix* are the only two Australian species that have numerous long spines (3–15 mm long) on the cocci of the fruit, both described by Brown (1849). *Tribulus hystrix* was based on a collection (BM!) made by Sturt in Central Australia, on sandhills at about the latitude of the current Queensland – South Australian border (west or south-west of Birdsville). Brown's brief description of this species was followed by the even briefer note describing *T. occidentalis*.

He distinguished *T. occidentalis* from *T. hystrix* on the basis of being silky-woolly, as opposed to woolly in *T. hystrix* [presumably this refers to the leaflets, stems and new shoots]; having about 8 pairs of leaflets per leaf (8–10 in *T. hystrix*); and having all the spines on the cocci equal in length and conical-subulate (spines unequal in length and subulate in *T. hystrix*).

Two of the features listed by Brown are not distinctive. Leaflet number varies considerably within any species of *Tribulus* (7–10 pairs of leaflets in *T. hystrix*, 7–11 in *T. occidentalis*). Indumentum also varies within a species, being affected by stage of growth and probably also by habitat conditions.

The only really distinctive characteristic mentioned by Brown is the form of the spines on the fruit (Figure 1, Table 1). Spines are numerous, long and toothed in both species, a condition found in no other Australian species. In *T. occidentalis* the spines are somewhat thicker and shorter than in *T. hystrix*. Brown refers to them all being of equal length in *T. occidentalis* but this is only superficially so in both species. While the overall appearance is of subequal spines in the specimens here referred to *T. occidentalis*, the spines actually vary from 1 mm to 8 mm long on a specimen. In *T. hystrix*, spines often range in length from 4 mm to 15 mm on any one fruit.

We do not know on which portion of the north-west coast of Australia visited by the 'Beagle' this species was collected because Stokes (1846) mentioned plants only very generally except in a very few cases. However, he did mention landing on various occasions in 1840–41 on islands and the mainland between Barrow Island and Red Hill (which is in the southern half of Eighty Mile Beach) – a stretch of coast that falls within the main distribution of the taxon here called *T. occidentalis*.

Both species are found in the Pilbara region but *T. occidentalis* is much more common, especially near the coast. Three specimens from farther inland in Western Australia and south-western Northern Territory (*George 15640*, *Latz 2127 & 2420*) probably also belong to *T. occidentalis* although they are more slender. It is not clear whether this patchy distribution is real or is an artifact of inadequate collecting in arid areas.

T. hystrix has only been collected a few times in the Pilbara; its main distribution is in and around the Simpson Desert, with only scattered collections farther west. Near the Northern Territory – Western Australian border, a few puzzling collections have been made: *Fryxell et al. 4505*, *Gittins 2452* and *Hunt 76/38*. These have big flowers with long styles as in *T. hystrix*, but the fruits are somewhat smaller and only have short spines. They may be a short-spined form of *T. hystrix*, but further study needs to be made to discount other possibilities such as hybridisation or new taxa.

Other species found near the north-west coast of Australia include *T. terrestris* and possibly *T. zeyheri* Sond. but neither of these has numerous long spines and both differ in other features.

I conclude that it is possible to identify the taxon named *T. occidentalis* by Robert Brown, even in the absence of its type specimen. The type of *T. hystrix*, the other Australian species with numerous spines on the fruit, is extant, and has been compared with other specimens of the two species. All available data are in agreement with Moore's (1920) and my assessments of the application of the name *T. occidentalis*. Since the original specimen(s) mentioned by Brown still cannot be found, a neotype needs to be chosen for *T. occidentalis*.

Moore (1920) listed several other old specimens held at BM: North Goulburn Island, *A. Cunningham*; N.W. Coast, *A. Cunningham 133 of 1818 voyage*; N.W. Coast, *De Bouley*. I have seen only a photographic slide of the first two specimens, which are mounted on the same sheet. The North Goulburn Island specimen has buds and immature fruits apparently with numerous spines. I cannot be sure of the identity of this Northern Territory specimen. The locality is well outside the known range of *T. occidentalis* but there is, of course, the possibility of an incorrect locality. The other two specimens seem to be *T. occidentalis*. Moore also stated that there were other specimens (not listed by him) of this species at K that had been (wrongly) annotated by Bentham as *T. hystrix*. I have seen three specimens in K to which this comment apparently refers. Firstly, there is *Ridley's Expedition* ('Nicol Bay and De Grey River', sent December 1863 to Kew), which has been determined as *T. hystrix?* by Bentham and re-determined as *T. occidentalis* by Moore. It is a fruiting specimen of what is here called *T. occidentalis*. Secondly, *A. Cunningham 133, First Voyage [of the 'Mermaid']* (presented by R. Heward 1862) has a flower with petals c. 11 mm long. Thirdly, and mounted on the same sheet as the second specimen, there is *A. Cunningham* ('N.W. Coast; T. echinatus v. cassioides'), which includes a flowering sprig (petals c. 12 mm long) and a piece with immature fruits with numerous spines. Both the specimens on this sheet have been annotated as *T. hystrix?* by Bentham, with no annotation by Moore. Both are *T. occidentalis*.

These old specimens of *T. occidentalis* are either not in very good condition or lack good collecting information, and so a recent specimen, *Symon 5420* (sheet CANB 209684), which shows the diagnostic features of the species, is clearly and fully labelled, and has duplicates, is here chosen as neotype. This includes part of the base of a plant as well as various branches bearing flowers and fruit. There is also a less complete isoneotype, sheet CANB 209685, which consists of a fruiting branch taken from the lower right of sheet CANB 209684.

SELECTED SPECIMENS SEEN: ***Tribulus occidentalis***

WESTERN AUSTRALIA: Dampier: Broome, *Mjoeberg 152*, July 1911 (NSW), *Symon 5344*, 26 June 1967 (CANB ex AD), *Kenneally 9389*, 10 Aug 1985 (CANB ex PERTH). Fortescue: Nicol Bay and De Grey River, NW Australia, *Ridley's Expedition*, sent Dec 1863 (K); Shaw River crossing by Great Northern Highway to Port Hedland, c. 98 km by road NW of Marble Bar, *Jackson 3018*, 25 Aug 1977 (CANB ex AD); Port Hedland at wharf area, *Ballingall 2552*, 8 Aug 1989 (CANB); c. 35 km NNW of Goldsworthy, 11 km along Great Northern Highway – Shellborough track, *Telford 6525*, 6 Aug 1977 (CANB ex CBG); Dampier, at Dampier Clinic (Marine Biological Station), *Eichler 23602*, 28 Aug 1985 (CANB); NW Coastal Highway 15 km N of Fortescue River crossing, *Ballingall 2561*, 11 Aug 1989 (CANB); between the Ashburton and De Grey Rivers, *Clement*, purchased Aug 1900 (K). Carnarvon: Yannarie River at road crossing, Barradale Roadhouse, *Ballingall 2567*, 12 Aug 1989 (CANB); along North West Coastal Highway, 4.8 km SE of Minilya Roadhouse, *Eichler 23625*, 3 Sep 1985 (CANB); c. 14 km SE of Carnarvon along the North West Coastal Highway, *Short 1574*, 27 Aug 1982 (CANB).

SPECIMENS SEEN: ***?T. occidentalis* (smaller flowers and fruits)**

NORTHERN TERRITORY: Central North: Newhaven Station, *Latz 2127*, 19 Jan 1972 (NSW ex NT). Central South: S of Lake Neale, *Latz 2420*, 11 Apr 1972 (NT n.v., CANB, NSW)

WESTERN AUSTRALIA: Canning: Tobin Lake, Great Sandy Desert, *George 15640*, 6 May 1979 (NSW ex PERTH).

SELECTED SPECIMENS SEEN: ***Tribulus hystrix***

QUEENSLAND: Gregory North: Sandringham Station, *Morton*, Feb 1980 (NSW 144948). Gregory South: Poeppel Corner, *Boyland 280*, 24 Sep 1966 (CANB ex BRI, K); between Roseberth and Miranda, *Filson 3375*, 1 Oct 1960 (CANB).

NORTHERN TERRITORY: Central South: Window Hill, Simpson Desert, *Chippendale 1606*, 8 Sep 1955 (CANB, NSW ex NT); Mayfield Swamp, *Mitchell 97*, 15 Aug 1974 (CANB ex NT).

SOUTH AUSTRALIA: Lake Eyre: sandhills in about lat. 26°, *Sturt* (BM, holotype); Purni Bore, Mt Dare, *Latz 4753*, 3 Apr 1974 (CANB); Bloodwood Bore, Cordillo Station, *U. Johnson 38*, 16 June 1972 (NSW 128006, K); Priscilla Creek, 30 km NW of Finniss Creek on Oodnadatta road, *K.L. Wilson 4601 & R. Barker*, 10 Apr 1983 (NSW, AD, CANB); Yandama Creek, 72 km SW of Hawker Gate, *Jacobs 3554*, 13 May 1979 (NSW, AD).

WESTERN AUSTRALIA: Fortescue: 3.3 km from the centre of Newman along the track to Coombanbunna Well, *Mollemans 2449*, 6 Mar 1987 (CANB). Carnarvon: 116 km S of Barradale, Carnarvon road, *S. Jacobs 5846 & P. Wilson*, 8 June 1988 (NSW); 5 km S of Minilya River on NW Coastal Highway, *Ballingall 2569*, 13 Aug 1989 (CANB).

SPECIMENS SEEN: ***?T. hystrix* (short-spined, smaller fruits)**

NORTHERN TERRITORY: Central North: on Tanami Track c. 472 km NW of Alice Springs (140 km SE of Rabbit Flat), *Fryxell, Craven & Stewart 4505*, 25 May 1985 (CANB); alongside Tanami Creek, 306 miles [492 km] NE [sic] of Alice Springs, *Hunt 76/38*, 20 June 1976 (NSW).

WESTERN AUSTRALIA: Mueller: Bloodwood Bore, near Balgo, *Gittins 2452*, July 1972 (NSW).

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Macrozamia johnsonii, a new species of *Macrozamia* section *Macrozamia* (Zamiaceae) from northern New South Wales

D.L. Jones and K.D. Hill

Abstract

Jones, D.L.[1], and Hill, K.D.[2] ([1] Australian National Botanic Gardens, GPO Box 1777, Canberra, ACT, Australia 2601; [2] Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1992. Macrozamia johnsonii, *a new species of* Macrozamia *section* Macrozamia *(Zamiaceae) from northern New South Wales.* Telopea *5(1): 31–34.* **Macrozamia johnsonii**, a previously undescribed species confused with *M. moorei*, is described and figured below.

Macrozamia johnsonii *D. Jones & K. Hill*, **sp. nov.**

M. moorei F. Muell. affinis sed habitu breviore, frondibus viridibus, foliolis amphistomaticis et plantula dissimili (petiolo tereti, rhachidi recta vix tortili ad apicem non curvata, et pinnis late patentibus falcatis nitenti-viridibus tenuibus, hypostomaticis, cum basi callosa alba) differt.

TYPE: NEW SOUTH WALES: c. 12 km east of Dalmorton on slopes above the Nymboida River, *D. Jones 6748 and C. H. Broers*, 18 October 1990 (holo CBG; iso BRI, CBG, NSW)

Trunk broadly cylindrical 0.3–1.5 m tall, to 80 cm diameter. Fronds very numerous, bright green, to 120 in the crown, at first erect, later spreading obliquely, then drooping, 1.5–3 m long on mature plants, flat in cross–section, straight to arching in profile; spine–free petiole (excluding the woolly, swollen base) 2–8 cm long; rhachis not twisted or with a very gentle half spiral, more or less flattened, usually 25–28 mm broad at the lowest pinnae, shallowly convex above (sometimes with 2 or 3 broad furrows in the proximal region) with 2 narrow lateral grooves decurrent from the bases of the pinnae, convex beneath. Pinnae 150–250, widely spreading, inserted on the rhachis at about 40 degrees, moderately crowded (0.5–2 cm apart), moderately rigid, pungent-tipped, entire, straight, linear, 40 or more of the lower ones progressively reduced, rigid and spine-like; median leaflets linear, 20–40 cm x 5–11 mm, with 7–12 scarcely raised nerves beneath, amphistomatic, gradually tapered to the pungent apex, contracted to the whitish, anteriorly callous, more or less rugose base. Cones pedunculate, the females 1–6, the males 10–50 per plant, axillary amongst the lower fronds, the base of the peduncle surrounded by several, brownish, spine-like, angular, subulate, ligulate cataphylls 8–15 cm long; reduced, decurrent cataphylls present also on the peduncle. Male cones cylindrical, semi-erect to spreading, straight or more usually curved, 25–40 cm long, 8–10 cm diameter; sporophylls cuneate, 1.8–3 cm x 1.2–1.8 cm, with an apical, erect, spine–like appendage 0.2–2 cm long, the longest ones on the distal sporophylls; peduncle 10–12.5 cm long, 2–3 cm diameter. Female cones cylindrical to barrel–shaped, green with pink areas on the sporophylls, 50–80 cm long, 10–20 cm diameter, usually spreading, drooping with age; sporophylls 5–7 cm long, broadly cuneate, expanded towards the apex where glaucous (3–6 cm across), with an apical, erect, spine-like appendage 3–7 cm long, the longest ones on the distal sporophylls; peduncle 15–22 cm long, 3–4 cm diameter. Seeds 4–6 cm long, 2.5–3 cm thick, oblong, sarcotesta bright red.

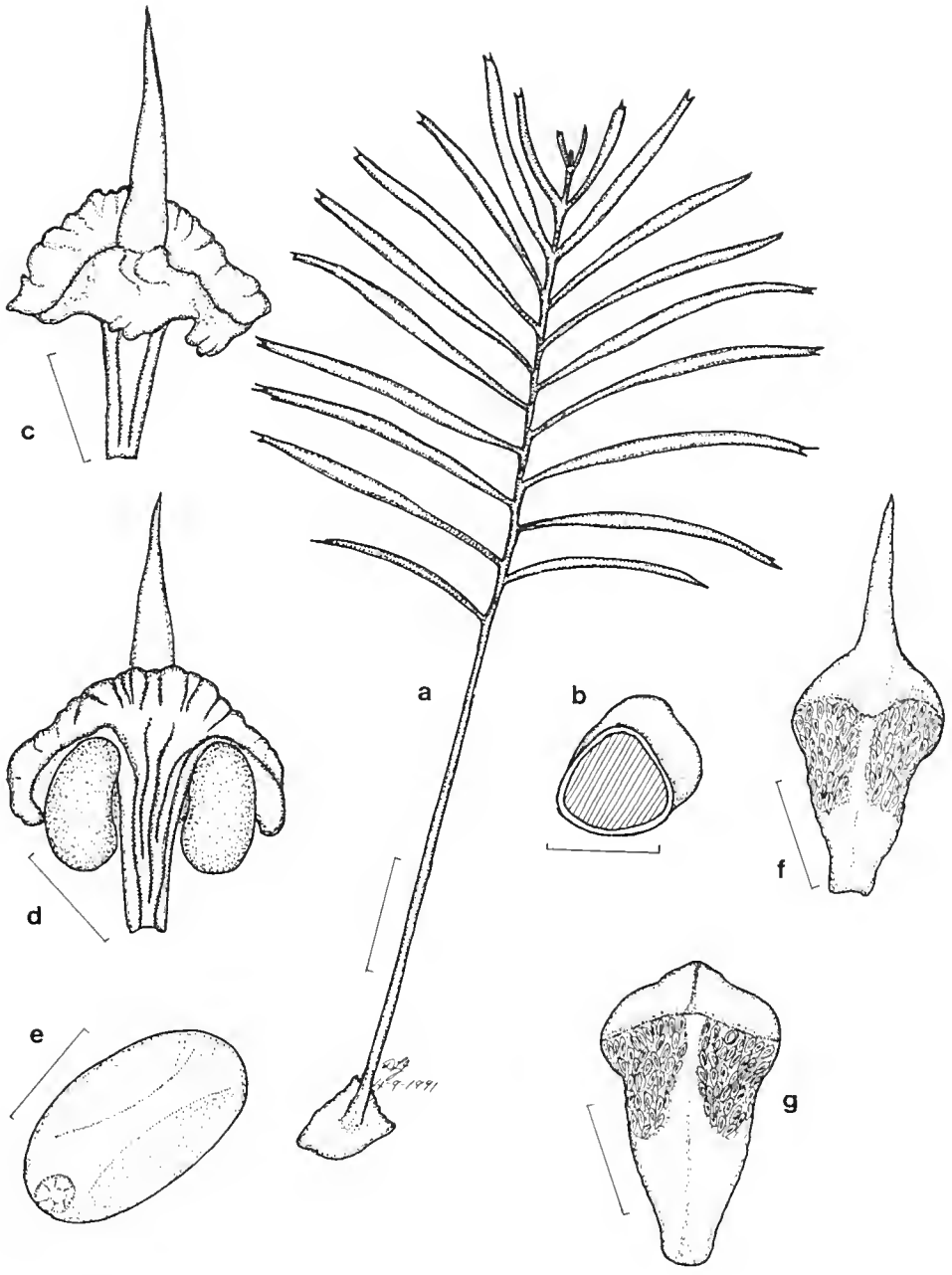

Figure 1. *Macrozamia johnsonii*. **a**, seedling leaf; b, cross-section through rhachis; **c**, female sporophyll from above; **d**, female sporophyll from below; **e**, seed; **f**, male sporophyll (from below) from apical portion of cone; **g**, male sporophyll (from below) from basal portion of cone (all from *Jones 6748*). Scale bar: a, c, d, e = 2 cm; f, g = 1 cm; b = 2 mm.

DISTRIBUTION AND HABITAT: Occurring on the North Coast Region of New South Wales where it grows on sheltered ridges and steep southerly and easterly slopes in wet and dry sclerophyll forest. The soils are skeletal clay loams with shale fragments over shale.

SELECTED SPECIMENS: NEW SOUTH WALES: North Coast: 3 miles (c. 5 km) E of Dalmorton, *Morris*, Jan 1960 (NSW 49023 – juvenile, NSW 49024 – adult); Marara Creek, Dalmorton, *Floyd* AGF 1215 (adult), *AGF 1216* (juvenile), 21 Feb 1979 (NSW); Tower Hill Creek, Dalmorton, *Constable*, 29 Oct 1952 (NSW); 3 miles (c. 5 km) E of Dalmorton, *Johnson & Constable*, 7 June 1957 (NSW 43070 – juvenile, previously determined as *M. lucida*, NSW 42180 – adult).

NOTES: *M. johnsonii* is closely related to *M. moorei* and has been included with that taxon (Johnson 1961). *M. johnsonii* never develops the tall, massive trunks of *M. moorei* and has green rather than grey-green fronds. In addition, the seedlings of each are quite distinct. Those of *M. johnsonii* have a nearly rounded petiole, a straight, hardly twisted rhachis not recurved at the tip and widely spreading falcate pinnae that are shiny green, hypostomatic, thin-textured, with a prominent white callous base obvious from an early age. Development of shiny, hypostomatic pinnae continues on juvenile plants for several years, then an abrupt change to the adult form occurs, in which the pinnae are amphistomatic. Seedlings of *M. moorei* have a petiole flat on the adaxial surface, a prominently twisted rhachis recurved at the tip and erect, straight pinnae which are dull, amphistomatic, dark blue-green, with a callous base which is prominent only on later fronds. Seedling pinnae resemble adult pinnae from a very early stage and are always amphistomatic. *M. johnsonii* and *M. moorei* are separated geographically by a distance of about 800 km. *M. johnsonii* is locally common in the Dalmorton area and grows in large colonies that are regenerating freely.

Macrozamia lucida has been reported from the Dalmorton area of New South Wales on the basis of sterile specimens (Johnson 1961). Later extensive searches of the area by various collectors have failed to locate fertile material (Johnson pers. comm.; Floyd, in litt. herb. NSW). Collections from the same plant (*Floyd* AGF 1215, AGF 1216) show that leaves of the juvenile stage of *M. johnsonii* develop a long spine-free petiole and glossy hypostomatic pinnae with more or less prominent veins on the undersurface. In these respects, they resemble adult leaves of *M. lucida*, although the latter have more prominent white basal callous regions on the pinnae. The two Floyd collections include one leaf with the long spine-free petiole and hypostomatic pinnae, and one with spinescent lower pinnae and amphistomatic pinnae, both from the same plant. All records of *M. lucida* from New South Wales are now regarded as resulting from confusion with juvenile stages of *M. johnsonii*.

CONSERVATION STATUS: 2R (Briggs and Leigh 1988). *M. johnsonii* occurs exclusively in state forests and is not included in any reserve. Although not specifically protected, large populations occur in areas unlikely to be under immediate threat, and the species is not considered to be threatened in the short term.

ETYMOLOGY: The name honours Lawrence A. S. Johnson, in recognition of his pioneering studies in the Cycadaceae and Zamiaceae.

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Four new Australian species of *Craspedia* sens. strict. (Asteraceae: Gnaphalieae)

J. Everett and A.N.L. Doust

Abstract

Everett, J. and Doust, A.N.L. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1992. Four new species of Craspedia *sens. strict. (Asteraceae: Gnaphalieae).* Telopea *5(1): 35–38.* The new species **Craspedia paludicola**, **C. variabilis**, **C. canens** and **C. haplorrhiza** are described. Notes on the flowering periods, habitat and general distribution are included.

Introduction

Prior to the publication of an account of *Craspedia* Forst. f. (Asteraceae: Gnaphalieae) in volume 3 of the *Flora of New South Wales* it is necessary to describe the following four species.

This paper deals with species of *Craspedia* sens. strict., that is those plants with pedunculate capitula within the compound head, but excludes those of alpine and subalpine regions. Further papers in this volume deal with alpine and subalpine *Craspedia* species, and those species with sessile capitula that have been removed to the reinstated genus *Pycnosorus*. All specimens cited have been seen unless otherwise indicated.

C. paludicola *Everett & Doust,* **sp. nov.**

Species foliis atroviridibus longe oblongis, basibus foliorum late vaginantibus, a speciebus nobis notis distincta.

TYPE: VICTORIA: Region L: Top End Reference Area Barmah State Park, Murray Valley Study Area Sector: F, sub-block: 41B, *A.C. Beauglehole 81321*, 28 Sep 1985 (holo MEL 681491; iso NSW, CANB, HO n.v.).

Robust herb with large dark olive-green flaccid leaves usually tinged deep red at the base, with one to three flowering scapes to 75 cm high; roots thick, tomentose. Leaves basal and cauline, narrow-obovate, obtuse, attenuate and broadly stem-clasping at the base, 15–30 cm long, 8–20 mm wide, with one to several prominent longitudinal veins, glabrous or with few scattered long, fine, tangled hairs or multi-septate hairs, or these denser on the margins or mid-vein; old leaf bases retained. Inflorescence a single globular, terminal compound head. Scape purplish with scattered long fine hairs. Compound head 1.7–3.0 cm in diameter with up to 300 partial heads. Partial heads with 7–12 florets; main bract of the partial involucre broadly triangular to ovate, with a small, diffuse, ovate herbaceous stereome with silky hairs at the base and glandular hairs overall, the margins membranous. Corolla bright yellow; achenes 1–1.8 mm long, 0.5–1.0 mm diam., with dense appressed silky hairs; pappus of 13–17 plumose bristles 3–4 mm long.

DERIVATION: From the Latin *paludis*, a marsh, and *-cola*, a dweller; referring to the swampy habitat.

FLOWERING PERIOD: Spring to summer.

HABITAT: Restricted to swampy areas and drainlines, and often grows with its leaves partly submerged.

DISTRIBUTION: Tasmanian midlands, Victoria and southern New South Wales, particularly associated with the Murray River system.

Can be distinguished by its long, oblong, very dark green leaves, with very broad leaf bases.

SELECTED SPECIMENS: NEW SOUTH WALES: South Western Plains: Narrandera–Ganmain, *Moore 1373*, 6 Sep 1950 (CANB). VICTORIA: 4 km W of Poolaijelo, *Short 3245*, 27 Sep 1988 (MEL, BRI n.v., CANB n.v., NSW); Goulburn River State Forest, *Beauglehole 80289*, 10 Sep 1985 (NSW, MEL); 2 km NW of Conara, *Buchanan 7290*, 12 Oct 1985 (NSW, MEL). TASMANIA: Roadside c. 2 km north west of Conara, *A.M. Buchanan 7290*, 12 Oct 1985 (HO, NSW n.v., MEL n.v.).

C. variabilis *Everett and Doust*, **sp. nov.**

Species foliis anguste spathulatis pilis plurisegmentatis grossis, a speciebus nobis notis distincta.

TYPE: SOUTH AUSTRALIA: South Eastern Region: c. 15 km south-east of Mt Burr Township, *I.B. Wilson 511*, 7 Sep 1966 (holo AD; iso CANB).

Erect herb with one to several flowering scapes to 50 cm high, branched simply at the base, with thick, spreading woolly roots and broad, reddish, overlapping leaf-bases retained at the base. Leaves in a basal rosette and cauline, narrow-spathulate, 5–13 cm long, 5–13 mm wide, broad-acute, gland-tipped, pale to olive-green, with glandular hairs and multi-septate hairs and with very sparse long fine simple hairs. Inflorescence a globose terminal compound head. Scape straw-coloured to reddish, with multi-septate hairs and a few long fine hairs. Compound head 10–25 mm diam., with c. 40–100 partial heads. Partial heads prominently pedunculate, with 7–12 florets; main bract of the partial involucre ovate-cordate to broadly triangular, decurrent on the peduncle, with an ovate, glandular, herbaceous stereome, finely and sparsely woolly at the base, and with a colourless to brown, membranous lamina. Corolla golden-yellow; lobes broad-acute, conspicuously papillate on the inner surface; achenes 1.5–2.5 mm long, with fine, appressed, short, silky hairs; pappus of 13–21 colourless, plumose bristles 3–5 mm long.

DERIVATION: Refers to the number of different forms across its wide distribution.

FLOWERING PERIOD: Early spring to early summer.

HABITAT: A wide variety of habitats but never alpine.

DISTRIBUTION: In temperate regions of all mainland States except the Northern Territory.

This is a complex species with several forms, some of which may be separable on further work. It can be distinguished from other species in its geographical range by the narrow-spathulate leaves, with long, coarse, multi-septate hairs. This species is referred to as sp. C (in part), sp. M and sp. N in Jacobs & Pickard (1981).

SELECTED SPECIMENS: WESTERN AUSTRALIA: South West Botanical Province: 22 km from York towards Perth along Great Southern Highway, *Short 1660*, 5 Sep 1982 (MEL, NSW, PERTH, CANB). SOUTH AUSTRALIA: Eyre Penisula: Marble Range, slopes of North Block, *Weber 6018*, 30 Sep 1979 (AD, BRI). NEW SOUTH WALES: Central Western Slopes: Dubbo, *Boorman*, Aug 1903 (NSW 217241). South Western Plains: Vermont Hill Reserve, *Cunningham & Milthorpe*, 29 Sep 1978 (NSW 217237).

C. canens *Everett & Doust*, **sp. nov.**

C. variabili similis sed foliis incanis pilis tenuis differt.

TYPE: NEW SOUTH WALES: Central Tablelands: Wingecarribee [Wingicarribee] Swamp 34° 30' S 150° 30' E, *L.A. Craven 1981*, 26 Oct 1971 (holo NSW 221409 (ex CANB); iso CANB, L n.v.).

Herb with 1, or occasionally up to 5, flowering scapes 15–65 cm high; roots thick, spreading, tomentose. Leaves mainly basal, narrow-ovate, attenuate to long-attenuate, acute to broad-acuminate, 6–25 cm long, 5–15 mm diam.; upper surface with long fine white hairs, evenly covering the surface or confined to the main veins and leaf margins, minute glandular hairs sometimes present; lower surface covered with long fine white hairs, occasionally with minute glandular hairs. Inflorescence a single globose to hemispherical terminal compound head. Scape green to purplish, minutely glandular and often woolly with long fine hairs. Compound head 1.3–2.5 cm diam., with c. 100 partial heads. Partial heads with 5–9 florets; main bract of the partial involucre ovate with a narrow-ovate to deltoid herbaceous stereome with a membranous lamina tinged brown. Corolla yellow; achenes 1–1.5 mm long, with fine appressed short silky hairs; pappus of 14–17 colourless plumose bristles 2.5–4 mm long.

DERIVATION: From the Latin *canus*, referring to the greyish whiteness of the leaves, caused by hairs overlying the green of the lamina.

FLOWERING PERIOD: Early spring to summer.

HABITAT: In wet or dry situations in open woodland or grassland.

DISTRIBUTION: On Australia's east coast and tablelands, from southern Queensland southwards.

This is a complex species with several forms, some of which may be separable on further work. It can be distinguished from other species in its geographical range by the hoary leaf surfaces. This species is in part referred to as sp. C in Jacobs & Pickard (1981).

SELECTED SPECIMENS: QUEENSLAND: Darling Downs: Racecourse Creek near Mt Norman, *L. Pedley 1568*, 31 Oct 1963 (BRI, CANB). NEW SOUTH WALES: South Coast: 4 miles [6 km] W of Green Cape, *Constable*, 10 Oct 1954 (NSW 30388). Northern Tablelands: Barrington Tops, *Boorman*, Dec 1915 (NSW 241489). Central Tablelands: Wingecarribee Swamp, near Burrawang, *Pullen 8521* (NSW, BRI, PERTH, CANB). VICTORIA: 2 miles [3 km] ESE from Morwell, *Jernakov*, 12 Oct 1963 (MEL 1534649).

C. haplorrhiza *Everett & Doust*, **sp. nov.**

C. variabili similis sed radice palari differt.

TYPE: NEW SOUTH WALES: South Far Western Plains: southern crossroad, north of Ranger's Station, Kinchega National Park, *A. Denham 039*, 12 Sep 1989 (holo NSW; iso AD).

Erect herb with one to many flowering scapes 7–15 cm high, branched simply at the base from a small taproot. Leaves in a basal rosette and cauline, spathulate to narrow-obovate, 1–8 cm long, 2–12 mm wide, obtuse to broad-acute, gland-tipped, pale-green, with glandular hairs and multi-septate hairs and with sparse long fine tangled

hairs on the margins. Inflorescence a globose terminal compound head. Scape straw-coloured to reddish, glandular with translucent globules and with a few multi-septate hairs. Compound head 7–28 mm diam., with c. 30–60 partial heads. Partial heads prominently pedunculate, with 6–11 florets; main bract of the partial involucre ovate-cordate to almost circular, decurrent on the peduncle, with a small ovate to deltoid glandular, herbaceous stereome, finely and sparsely woolly at the base, and with a colourless membranous lamina. Corolla golden-yellow; lobes broad-acute, conspicuously papillate on the inner surface; achenes 1.5–2 mm long, with fine, dense, appressed, short, silky hairs; pappus of 10–16 colourless, plumose bristles 2–3 mm long.

DERIVATION: From the Greek *haplo*, single, and *-rhiza*, root; referring to the single taproot.

FLOWERING PERIOD: Early spring to early summer.

HABITAT: On heavy soils, on floodplains and in damp situations.

DISTRIBUTION: In the western and far western divisions of New South Wales, north-western Victoria, south-western Queensland, southern Western Australia, and in South Australia.

Can be distinguished from all other *Craspedia* species by its single taproot.

This species was referred to as sp. O in Jacobs & Pickard (1981).

SELECTED SPECIMENS: QUEENSLAND: Maranoa: 7 km W of St George, *Trapnell 288 & Williams*, 1 Sep 1973 (BRI). NEW SOUTH WALES: North Western Plains: Grawen Creek, S of Collarenebri on Cryon road, *Thompson 2621*, 27 Aug 1976 (NSW). South Far Western Plains: Menindee Billabong near Darling River, 6 km south of Menindee on Pooncarie road, *Corrick 7334*, 30 Aug 1981 (NSW, HO, AD, MEL). SOUTH AUSTRALIA: Northern Lofty: Barrier Highway, North Terowie, *Catford 205*, 24 Sep 1984 (AD). WESTERN AUSTRALIA: Eastern Goldfields, *Mann*, May 1918 (NSW 218800).

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Jacobs, S.W.L. & Pickard, J. (1981) *Plants of New South Wales* (Govt Printer: Sydney).

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New species and a new combination in *Pycnosorus* (Asteraceae: Gnaphalieae)

J. Everett and A.N.L. Doust

Abstract

Everett, J. and Doust, A.N.L. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW Australia 2000) 1992. New species and a new combination in Pycnosorus *(Asteraceae: Gnaphalieae).* Telopea *5(1): 39–43.* The genus *Pycnosorus* Benth. is reinstated, the new species **Pycnosorus eremaeus, P. melleus** and **P. thompsonianus** are described and the new combination **P. pleiocephalus** (F. Muell.) Everett & Doust is made. Notes on the flowering periods, habitat and general distribution are included.

Introduction

In the course of revising *Craspedia* (Asteraceae) in Australia we have concluded that the species fall into two generic groups, and consequently we are re-establishing the genus *Pycnosorus* Bentham, to include the six species with sessile capitula. Two species have been published under *Pycnosorus*, *P. globosus* Benth. and *P. chrysanthes* (Schldl.) Sond. [as *chrysanthus*]; one species has been published only under *Craspedia*, *C. pleiocephala* F. Muell.; three species were undescribed, one of these from New South Wales. Formal names for the N.S.W. species are required for use in the forthcoming *Flora of New South Wales*. Here we describe the three new species and make the new combination.

We have decided to reinstate *Pycnosorus* because it differs from *Craspedia* primarily by having sessile partial heads and yellow bracts, paleae and pappus hairs. This separation is supported by chromosome counts for *P. pleiocephalus* of $n = 6$ (Short 1986) and for *C. uniflora* of $n = 11$ (Turner 1970, Beuzenberg & Hair 1984), although further counts are needed to confirm this apparent distinction.

Short *et al.* (1989) compared single specimens of two taxa, *Pycnosorus aff. pleiocephalus* and *Craspedia uniflora* s.l., and noted some differences in crystal occurrence in the pericarp, but this needs to be confirmed by further work. A detailed discussion of these and other characters, and of the taxonomic relationships, will appear in a separate paper. All specimens cited have been seen unless otherwise indicated.

P. pleiocephalus *(F. Muell.) Everett & Doust*, **comb. nov.**

Basionym: *Craspedia pleiocephala* F. Mueller (1852: 404).

Type: South Australia: Flinders Ranges: At the eastern side of the Flinders Range, in the flat parts and on lower hills toward Mount Brown [An der ostseite des Flindersgebirges in der Ebene und auf niedern Hügeln, auf Mount Brown zu], *F. Mueller s.n.*, Oct 1851 (holo MEL 612328).

Ascending or erect herb with many stems to 40 cm high from a woody taproot. Basal leaves withering early, leaves mainly cauline oblong to oblanceolate, 3–7 cm long, 2–10 mm wide, decreasing in length up the stem to 1 cm long, broad-acute, gland-tipped, concolorous, olive-brown to green, with glandular hairs and coarse multi-septate hairs especially on the margins. Inflorescence a single ovoid or globose com

pound head or of one main compound head, branched below or from the centre, giving rise to smaller secondary globose heads. Main compound head 10–20 mm long, 10–15 mm diam., with up to 50 partial heads. Partial heads sessile, each with 4–6 florets; main bract of the partial involucre ovate, with a broad yellow hyaline margin and a small linear to narrow-ovate brown herbaceous and glandular stereome, very finely ciliate overall. Corolla lemon-yellow; lobes narrow-acute, inconspicuously papillate on the inner surface; achenes 1.5–2 mm long, 1–1.5 mm diam., with long, appressed dense silky hairs; pappus of 8–15 plumose bristles 2–4 mm long, yellow at least at the tip, the tips brush-like.

FLOWERING PERIOD: Mostly early spring-early summer, but can be found flowering at any time of the year, probably dependent on time of rainfall.

HABITAT: Often in wet sandy or clayey depressions but also on stony ridges. In mallee and chenopod shrubland.

DISTRIBUTION: Mainly in areas associated with the Murray–Darling drainage system and with the catchment area for Lakes Eyre and Frome.

SELECTED SPECIMENS: NEW SOUTH WALES: South Western Plains: Yathong, Mt Hope, *Milthorpe 2605 & Cunningham*, 17 Aug 1974 (NSW). North Far Western Plains: 0.2 km SE of Mt Wood homestead, Sturt NP, *Denham 054*, 17 Sep 1989 (NSW). VICTORIA: Pirta, Far NW, *Beauglehole 39495*, 12 Sep 1960 (MEL). SOUTH AUSTRALIA: c. 2 km W of turnoff to Uno Homestead, Gawler Ranges, *Conn 3115 & Scott*, 11 Sep 1989 (NSW, AD n.v., MEL, MO n.v.); between Frome Downs Homestead and Black Oak Bore, *Weber 2108*, 24 July 1971 (AD, SYD n.v., NT n.v.).

Pycnosorus eremaeus *Everett & Doust*, **sp. nov.**

Pycnosoro pleiocephalo similis sed margine bracteae principalis involucrorum partialium haud scarioso, indumento albolanato foliorum et capitulorum compositorum immaturorum, differt.

TYPE: QUEENSLAND: Gregory South: Coopers Creek, Windorah, 25° 22' S 142° 43' E, alt 100 metres, *P.G. Wilson 400 & R. Pickering*, 24 Sep 1989 (holo NSW; iso BRI, AD).

Ascending or erect herb with few to many stems to 35 cm high from a woody taproot. Leaves mainly cauline, linear-ovate to narrow-spathulate, attenuate, 2–6 cm long, 2–6 mm wide, decreasing in length upwards; leaves with glandular hairs and coarse multi-septate hairs on the upper surface, and with glandular hairs, coarse multiseptate hairs, or more or less dense fine woolly hairs below, fine woolly on margins, often making a distinct white margin to the leaf; lower leaves with mucronate glandular tip, upper leaves with hyaline to pale brown membranous tips to 2 mm long. Inflorescence a single ovoid or globose compound head, or of one main compound head, branched below or from the centre, giving rise to smaller secondary globose heads. Main compound head 7–25 mm long, 6–13 mm diam., mostly less than twice as long as broad, densely woolly at least when young, with 50–100 partial heads. Partial heads sessile, each with 5–8 florets; main bract of the partial involucre narrow-ovate, with a brown herbaceous stereome, with glandular and fine woolly hairs below, and an acuminate membranous tip not extending down the margins of the stereome. Corolla golden-yellow; lobes narrow-acute, inconspicuously papillate on the inner surface; achenes 1–2 mm long, 0.5–1 mm diam., with long appressed white to pink silky hairs; pappus of 9–15 plumose bristles, 1.5–3 mm long, yellow at least at the tip, the tips brush-like.

Distinguished from *P. pleiocephalus* by the white woolly indumentum of the leaves and immature flowering heads, and in the main bract of the partial involucre lacking a scarious margin.

DERIVATION: From the Greek *eremos*, meaning solitary, referring to the remote inland distribution.

FLOWERING PERIOD: Winter to early summer, probably dependent on time of rainfall.

HABITAT: Found on mostly heavy or rocky soils.

DISTRIBUTION: A large area of Central Australia.

SELECTED SPECIMENS: NORTHERN TERRITORY: 17 miles [27 km] WNW of Rankine River Police Station, *Perry 1552*, 18 June 1948 (NSW, BRI, CANB, MEL, AD, NT). QUEENSLAND: WARLUS VI Site H69, 27 km WNW of 'Marion Downs', *Purdie 1437*, 8 Sep 1978 (BRI); approx. 7 km SE of 'Davenport Downs' station, *Aston 2042*, 18 Aug 1980 (BRI, MEL, AD). SOUTH AUSTRALIA: Bloods Creek, *Lothian 4617*, 26 July 1968 (AD); Margaret Creek, *Alcock 6477*, 3 Oct 1978 (AD, COLO *n.v.*).

P. melleus *Everett & Doust*, **sp. nov.**

Pycnosoro pleiocephalo similis sed inflorescentia composita cylindrica pallidiore differt.

TYPE: SOUTH AUSTRALIA: Lake Eyre Basin: Between Birdsville and Cadelga c. 90 km from Bluff (Roseberth) Homestead, Miranda track, swamp flat, *T.R.N. Lothian 593 & D.E. Francis*, 29 Aug 1960 (holo AD 96045011; iso CANB, NY n.v., W n.v., L n.v., Tripoli n.v.).

Ascending or erect herb with few to many stems to 25 cm high from a woody taproot. Leaves mainly cauline, linear to narrow-ovate, 1–3.5 cm long, 2–5 mm wide, decreasing in length upwards; leaf hairs long and short glandular above and below, fine woolly below, fine woolly on the margins; lower leaves with mucronate glandular tip, upper leaves with hyaline to pale brown membranous tips to 2 mm. Inflorescence a cylindrical compound head, 8–38 mm long, 5–11 mm diam., mostly more than twice as long as wide; 50–120 partial heads. Partial heads sessile, with 4–6 florets; main bract of the partial involucre narrow-ovate, with a brown clavate herbaceous stereome, with glandular and fine woolly hairs below, surrounded by a ± narrow membranous margin and surmounted by an acuminate membranous tip. Corolla yellow; lobes narrow-acute, inconspicuously papillate on the inner surface; achenes 0.5–1.1 mm long, with long appressed pink to rust coloured silky hairs; pappus of 9–12 plumose bristles, pale yellow at least at tip, the tips brush-like.

Distinguished from other *Pycnosporus* species by the cylindrical compound heads and by the heads being a pale honey colour.

DERIVATION: From the Latin *melleus* meaning honey-coloured or honey-like; referring to the pale honey-yellow colour of the compound head, which is different from the darker, golden colour of other *Pycnosorus* species.

FLOWERING PERIOD: Winter to early summer, probably dependent on time of rainfall.

HABITAT: Found on dry watercourses and alluvial flats.

DISTRIBUTION: Restricted to a small area on the Queensland–South Australia border.

SELECTED SPECIMENS: QUEENSLAND: Birdsville, *Blake 12219*, 19 Jul 1936 (BRI), *Boyland 177*, 20 Sep 1966 (BRI); Mulligan River, *Clarke*, ? 9 Sep 1904 (NSW 220836). SOUTH AUSTRALIA: c. 110 km SSW of Birdsville, *Riederer s.n.*, 2 Sep 1962 (AD 966070714, E n.v., G n.v., M n.v., AAU n.v.); Goyders Lagoon, *S.A. Pastoral Board*, 23 June 1953 (AD 97930189).

P. thompsonianus *Everett & Doust*, **sp. nov.**

Pycnosoro chrysantho similis sed foliis concoloribus, margine bracteae principalis involucrorum partialium scarioso, differt.

TYPE: NEW SOUTH WALES: South Far Western Plains: Junction of north crossroad & River Drive, N of Ranger Station, Kinchega National Park, 32° 27' S, 142° 22' 30" E, *A. Denham 042*, 12 Sep 1989 (holo NSW; iso BRI, AD, DNA).

Ascending or erect herb with woody stems to 35 cm high, branching at the base from a woody taproot. Basal leaves withering early, leaves mainly cauline, linear, mostly 1–5 cm long, 1–5 mm wide, occasionally to 10 cm long, broad-acute, concolorous, white to grey, with dense, appressed, fine woolly hairs; lower leaves gland-tipped, uppermost leaves with a lanceolate golden hyaline tip, although this occasionally caducous. Inflorescence a globose or slightly ovoid compound head. Compound head 4–12 mm diam., with c. 45–100 partial heads. Partial heads sessile, with 3–6 florets; main bract of the partial involucre with a narrow-ovate, brown, stiffly herbaceous and glandular stereome, with dense, woolly hairs, and an acuminate yellow membranous tip. Corolla golden-yellow; lobes acute, inconspicuously papillate on the inner surface; achenes 1–1.5 mm long, c. 0.5 mm diam., with long appressed dense silky hairs; pappus of 12–14 plumose bristles 1.5–2.5 mm long, yellow at least at the tip, the tips brush-like.

Distinguished from *P. chrysanthes* by the concolorous leaves not contrasting with the white-woolly stems, and by the main bract of the partial involucre possessing a scarious margin. This species was referred to as *Craspedia* sp. P in Jacobs & Pickard (1981).

DERIVATION: In honour of Joy Thompson, a colleague at NSW whose collections from the semi-arid interior of New South Wales have added to our knowledge of *Pycnosorus* and whose detailed acquaintance with the alpine areas of New South Wales has clarified the taxonomy of *Craspedia*.

FLOWERING PERIOD: Early spring to early summer but also dependent on time of rainfall.

HABITAT: Usually on heavy soils, on floodplains, in chenopod shrubland, occasionally on red sandy ridges.

DISTRIBUTION: The western and far western plains of New South Wales and south-western Queensland.

SELECTED SPECIMENS: QUEENSLAND: 36 miles [56 km] S of Wyandra, *Williams 90*, 25 Sep 1968 (BRI). NEW SOUTH WALES: North Western Plains: 27 km SE of Collerina towards Brewarrina, *Dunlop 920*, 25 Aug 1969 (CBG); 2 km NW Louth on Bourke road, *Cunningham 2872*, 2 Sep 1972 (NSW). South Western Plains: c. 35 km NW of Hay along road to Thelangerin, *James 424*, 10 Oct 1983 (NSW); Woorandara Station near Booligal, *Canning 3574*, 30 Sep 1973 (CBG). North Far Western Plains: 2 km SE of Eagle Tank on Twelve Mile Ck floodout, *Denham 048*, 15 Sep 1989 (NSW, PERTH).

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We wish to thank Andrew Denham for his assistance particularly in the collection of numerous western New South Wales specimens and for his observations in the early stages of this project when the reinstatement of *Pycnosorus* was first proposed. Thanks are also due to Karen Wilson for the Latin diagnoses, and to Leonie Stanberg, Ross Rowe and Dianne Godden for technical assistance. We are grateful to the Heads of AD, PERTH, BRI, DNA, MEL, CANB, CBG, and HO for the loan of specimens that have made this study possible. The work has been in part supported by grants from the Australian Biological Resources Study which we gratefully acknowledge.

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New alpine and subalpine species in *Craspedia* sens. strict. (Asteraceae: Gnaphalieae)

J. Everett and J. Thompson

Abstract

Everett, J. and Thompson, J. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1992. New alpine and subalpine species in Craspedia *sens. strict. (Asteraceae: Gnaphalieae).* Telopea *5(1): 45–51.* The new species **Craspedia coolaminica, C. maxgrayi, C. alba, C. crocata, C. jamesii, C. aurantia, C. costiniana** and **C. lamicola** are described, all of them occuring only in alpine or subalpine areas. Notes on the flowering periods, habitat and general distribution are included.

Introduction

Prior to the publication of an account of *Craspedia* Forst. f. (Asteraceae: Gnaphalieae) in volume 3 of the *Flora of New South Wales* it is necessary to describe the following eight new species. These species have been known by a confusing range of alphabetic codes used in various publications. Thompson (1981) based the alphabetic codes for six of the nine undescribed species in Kosciusko National Park on Costin *et al.* (1979) adding three further species to their alphabetic series. Jacobs & Pickard (1981) referred to sixteen undescribed species of *Craspedia* sens. lat., as used at the time in the National Herbarium of New South Wales, with a different alphabetic series that does not correspond to the other two publications. Herbarium specimens carry annotations from yet another incongruent alphabetic series.

This paper deals with alpine and subalpine species of *Craspedia* sens. strict. *Craspedia* sens. strict covers those plants with pedunculate capitula within the compound head. Other papers dealing with non-alpine *Craspedia* species, and those species with sessile capitula under the generic name *Pycnosorus*, appear in this volume.

C. coolaminica *Everett & Thompson*, **sp. nov.**

Species foliis argenteis, basibus foliorum longe attenuatis, a speciebus nobis notis distincta.

TYPE: NEW SOUTH WALES: Southern Tablelands: Happy Jacks, Snowy Mountains, near Happy Jacks Road, above sheepyard, *M.E. Phillips 20419*, 27 Jan 1964 (holo NSW; iso CBG).

Silver-grey herb with a single flowering scape 8–65 cm high; roots thick, tomentose. Leaves mainly basal, linear to narrow-spathulate, narrow-attenuate at the base, acute to broad-acuminate, 5–20 cm long, 5–20 mm wide; upper surface silvery with dense, long, fine, appressed hairs, lower surface grey-green with sparse, fine, appressed hairs; margins woolly with long fine hairs. Inflorescence a single globose to hemispherical terminal compound head. Scape cream to red, glandular or with multiseptate hairs at the base and woolly upwards. Compound head 1–2.5 cm diam., with c. 25–100 partial heads. Partial heads with 6–8 florets; main bract of the partial involucre broadly triangular to ovate, with an ovate or triangular herbaceous stereome,

finely woolly at the base and with a broad, dark brown membranous margin or lobes. Corolla yellow; achenes 0.5–2 mm long with silky hairs; pappus of 13–18 plumose bristles 2–4.5 mm long.

DERIVATION: Refers to Coolamine Plain in Kosciusko National Park, which is one of the habitats of this species.

FLOWERING PERIOD: Summer.

HABITAT: Subalpine, among grasses on creek flats and in eucalypt woodland.

DISTRIBUTION: Subalpine areas of Victoria, Tasmania and New South Wales.

Can be distinguished from other subalpine *Craspedia*s by the long-attenuate, silvery-grey leaves and small compound heads. This species was referred to as sp. K in Jacobs & Pickard (1981), and as sp. G in Thompson (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: 84 km SE of Tumut, *Jacobs 4638*, 15 Dec 1985 (NSW); 5 km W of Tolbar Rd on Happy Jacks Rd, *Everett 1047 & Stanberg*, 3 Feb 1989 (NSW). VICTORIA: 1.5 km NNE of Mt Cope, *van Rees 298*, 1 Jan 1982 (NSW ex MEL); Gow Plain, Dargo High Plains, *Walsh 598*, 5 Jan 1982 (NSW ex MEL); Mt Higginbotham, *Forbes 749*, 12 Jan 1982 (NSW ex MEL).

C. **maxgrayi** *Everett & Thompson*, **sp. nov.**

Species grandis tomento argenteo a speciebus nobis notis distincta.

TYPE: NEW SOUTH WALES: Southern Tablelands: Mt Kosciusko, *M. Gray 4756*, 25 Feb 1960 (holo NSW; iso CANB).

Silvery-white woolly herb with a single flowering scape 20–50 cm high; roots thick, tomentose. Leaves mainly basal, oblanceolate to narrow-spathulate, slightly tapered at the base, 5–15 cm long, 5–15 mm wide; both surfaces and margins silvery-white and densely white-woolly. Inflorescence a single globose terminal compound head. Scape red-brown, densely woolly with long fine hairs. Compound head 2.5–4.5 cm wide, with c. 70–120 partial heads. Partial heads with 9–11 florets; main bract of the partial involucre broadly triangular to ovate, with an ovate or triangular, herbaceous minutely glandular stereome, finely woolly at the base and with a dark brown membranous margin. Corolla yellow; achenes 1–1.5 mm long with silky hairs; pappus of 12–15 plumose bristles 2.5–5 mm long.

DERIVATION: Named in honour of Max Gray, a colleague from CANB who has worked extensively on the alpine and subalpine flora of the Southern Tablelands, and particularly in recognition of his work on *Craspedia*.

FLOWERING PERIOD: Summer.

HABITAT: Usually alpine, occasionally subalpine, in grassland.

DISTRIBUTION: New South Wales and Victoria.

This is the largest silvery-white *Craspedia* in the alpine or subalpine areas, both in height and in size of the flowering heads. This species was referred to as sp. J in Jacobs & Pickard (1981), and as sp. C in Costin *et al.* (1979) and Thompson (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: Snowy R. above Guthega Dam, *Thompson 1741*, 26 Jan 1973 (NSW, CBG, MEL); Etheridge Range, *Totterdell 279a*, 4 Feb 1972 (CANB, NSW); slopes of Mt Twynam, *Hind 5540*, 3 Mar 1988 (NSW, CBG); Mt Tate, *Thompson 2941*, 10 Feb 1978 (NSW). VICTORIA: near Mt Loch carpark, Hotham Heights, *Everett 836*, 8 Feb 1985 (NSW).

C. alba *Everett & Thompson*, **sp. nov.**

Species pusilla flosculis albis, tomento albo, a speciebus nobis notis distincta.

TYPE: VICTORIA: Bogong High Plains, Pretty Valley, Cope Creek, *S.J. Forbes 1189*, 4 Dec 1982 (holo MEL; iso NSW, CANB).

Small herb with a single flowering scape 9–15 cm high; roots thick, tomentose. Leaves mostly basal, oblong to narrow-oblanceolate, 1.5–5 cm long, 2–5 mm wide, often folded; lower surface with a silvery covering of long fine appressed hairs, upper surface similar, rarely glabrescent in upper leaves; margins entire or undulate, glabrescent or silky-hairy; upper leaves decurrent. Inflorescence a single hemispherical terminal compound head. Scape red with dense silvery hairs. Compound head 1–1.5 cm diam., with c. 30–60 partial heads. Partial heads with 4–5 florets; main bract of the partial involucre broadly ovate-cordate, with an ovate to triangular glandular and herbaceous stereome, finely woolly at the base, and broad, dark brown membranous margins. Corolla white; achenes 1–1.5 mm long, with silky hairs; pappus of 12–18 colourless plumose bristles 2–3 mm long.

DERIVATION: Refers to the white colour of the corolla and leaves.

FLOWERING PERIOD: Summer.

HABITAT: In moist depressions and alpine bogs, often growing with leaves partially submerged.

DISTRIBUTION: Rare. In very few areas of alpine New South Wales and Victoria, presumably because of the restricted distribution of appropriate habitats.

This species is distinguished from other silvery-leaved *Craspedia*s by its white flowers and small size. The only other mainland white-flowered species, *C. leucantha*, has long, green leaves. This species was referred to as sp. H in Jacobs & Pickard (1981), and as sp. A in Costin *et al.* (1979) and Thompson (1981).

SELECTED SPECIMENS: The localities given are approximate; more accurate locality details are on record at NSW and can be made available where appropriate.

NEW SOUTH WALES: Southern Tablelands: Cootapatamba Creek, *Thompson 3054*, 4 Apr 1979 (NSW, CANB); 1 km NW of Charlottes Pass, *Everett 1041 & Stanberg*, 2 Feb 1989; Snowy River, below junction with Merritts Creek, *Thompson 3079*, 6 Apr 1979 (NSW, CBG). VICTORIA: NW of Mt Cope, *van Rees 290*, 31 Dec 1981 (NSW, CANB, MEL n.v.).

C. crocata *Everett & Thompson*, **sp. nov.**

Species capitulis compositis croceis, basibus foliorum longe attenuatis, a speciebus nobis notis distincta.

TYPE: NEW SOUTH WALES: Southern Tablelands: Pipers Creek near junction with Daners Creek, *J. Everett 1395*, 2 Feb 1989 (holo NSW 213348; iso MEL, CBG).

Herb with a single flowering scape 12–52 cm high; roots thick, tomentose. Leaves mainly basal; upper surface green with scattered glandular hairs with translucent globules or glabrous, lower surface with similar glandular hairs or with multi-septate hairs; margins with finely woolly or multi-septate hairs, tips glabrous or with sparse, loose woolly hairs. Basal leaves linear-spathulate to spathulate, extremely long-attenuate at the base, 5–25 cm long, 2–12 mm wide. Upper leaves stem-clasping and acuminate, 0.5–15 cm long, 1–10 mm wide. Inflorescence a single spherical terminal compound head. Scape straw-coloured to crimson with multi-septate and/or long fine hairs. Compound head 1–2 cm diam., with c. 30–60 partial heads. Partial heads

with 5–10 florets; main bract of the partial involucre triangular to ovate or cordate, with an ovate to triangular herbaceous stereome, finely woolly at the base, occasionally with hairs on the margins, and with dark brown membranous margins or lobes. Corolla deep reddishorange; achenes 0.5–1.5 mm long, with silky hairs; pappus of 14–18 plumose bristles 2–5 mm long.

DERIVATION: From the Latin *croceus* referring to the red-orange colour of the flowering heads.

FLOWERING PERIOD: Summer.

HABITAT: Uncommon in lower subalpine grasslands, usually in moister areas associated with stream catchments.

DISTRIBUTION: Subalpine New South Wales and Victoria.

Can be distinguished by the extremely attenuate leaf bases usually red-tinged and the deep reddish orange colour of the corolla. This species was referred to as sp. A in Jacobs & Pickard (1981) and sp. I in Thompson (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: Bimberi Range, Murrays Gap, *Canning 4184*, 2 Feb 1977 (NSW, CANB n.v.); base of Mt Piper, *Thompson 2423*, 23 Jan 1976 (NSW, CANB n.v.); 1 km N of Horse Camp Hut, *Everett 895 & Norris*, 14 Feb 1985 (NSW); near Diggers Creek Reservoir, *Thompson 1457*, 21 Jan 1972 (NSW, CANB).

C. jamesii *Everett & Thompson*, **sp. nov.**

Species capitulis compositis hemisphaericis citrinus, foliis spathulatis viridisque, a speciebus nobis notis distincta.

TYPE: NEW SOUTH WALES: Southern Tablelands: between Pryors Hut and Mt Ginini, Brindabella Range, A.C.T., 35° 33'S 148° 46'E, 1600 m, *R. Coveny 11542 & P. Hind*, 19 Jan 1983 (holo NSW; iso CBG).

Bright green herb with a single flowering scape 25–80 cm high; roots thick, tomentose. Leaves bright green, mainly basal, spathulate, usually long-attenuate at the base, acute to broad-acuminate, 3.5–20 cm long, 5–30 mm wide; surfaces and margins evenly covered with multi-septate or occasionally glandular hairs or glabrous, the tips glabrous. Upper leaves lanceolate, stem-clasping, 0.5–17 cm long, 2–20 mm wide. Inflorescence a more or less flattened hemispherical terminal compound head. Scape cream to crimson with multi-septate or glandular hairs. Compound head 1.5–3.5 cm in diameter with c. 25–125 partial heads. Partial heads with 5–12 florets; main bract of the partial involucre broadly triangular to ovate, often with three distinct lobes, with a generally ovate herbaceous stereome with silky hairs at the base and occasionally hairy in the centre or on the margins, the lobes and margins membranous. Corolla golden-yellow; achenes 0.5–2.0 mm long, with silky hairs; pappus of 14–24 plumose bristles 1.5–5.5 mm long.

DERIVATION: Named after Joy Everett's son James Everett Armstrong, whose arrival has done much to delay this publication.

FLOWERING PERIOD: Summer.

HABITAT: Widespread in lower subalpine areas in grassland.

DISTRIBUTION: Subalpine areas of N.S.W. and Victoria.

Can be distinguished from other alpine and subalpine species by the shape of the flowering heads, being hemispherical rather than spherical, thus the involucral bracts

of the general involucre are easily visible below and these are oblong. The leaves are bright green with inconspicuous hairs while most other species are glaucous or grey with fine hairs.

This seems to hybridise with orange-flowered species, *C. crocata* and *C. aurantia*, when they grow close together. This species was referred to as sp. B in Jacobs & Pickard (1981) and as sp. H in Thompson (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: Prussian Creek, *Thompson 2028*, 31 Jan 1974 (NSW, CANB); c. 5 km NNE of Rennix Gap, *Thompson 2504*, 26 Jan 1976 (NSW); Upper Tumut R near Kiandra, *Rodway 4489*, Mar 1924 (NSW); Blackfellows Gap, c. 4 miles [6 km] N of Mt Bimberi, *Schodde 1294*, 15 Feb 1961 (CANB).

C. aurantia *Everett & Thompson*, **sp. nov.**

Species capitulis compositis sphaericis aurantiis, foliis spathulatis, a speciebus nobis notis distincta.

TYPE: NEW SOUTH WALES: Southern Tablelands: Above Blue Lake, Kosciusko National Park, *J. Thompson 2534*, 27 Jan 1976 (holo NSW; iso CBG).

Robust herb with a single flowering scape 15–60 cm high, from a simple rootstock; roots thick, tomentose. Leaves mainly basal, spathulate, more or less attenuate at the base, acute to broad-acuminate, 2–16 cm long, 2–25 mm wide, and sparsely covered with multi-septate hairs or glabrous. Upper leaves lanceolate, linear-acuminate, stem-clasping, 0.5–12.5 cm long, 1–16 mm wide. Inflorescence a single globose to hemispherical terminal compound head. Scape straw to red-brown, variously hairy. Compound head 1.5–3.0 cm diam., with c. 40–90 partial heads. Partial heads with 5–10 florets; main bract of the partial involucre broadly triangular to ovate, with a variable stereome usually ovate and herbaceous with hairs at the base and on the margins, and with membranous margins or lobes. Corolla orange; achenes 0.5–1.5 mm long, with appressed silky hairs; pappus of 14–19 plumose bristles 2–5 mm long.

DERIVATION: From the New Latin *aurantia* meaning orange, referring to the orange colour of the flowerheads.

FLOWERING PERIOD: Flowers summer.

HABITAT: In grassland. Common at higher subalpine levels, occasionally in sheltered alpine places where it appears to hybridise with yellow-flowered species.

DISTRIBUTION: Alpine and subalpine N.S.W. and Victoria.

Can be distinguished by its spherical, orange-coloured flower heads and the spathulate green leaves, which are glabrous or inconspicuously hairy. This species was referred to as sp. D in Jacobs & Pickard (1981), and as sp. F in Costin *et al.* (1979) and Thompson (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: Blue Cow Creek, Kosciusko Nat. Park, *Thompson 1399*, 19 Jan 1972 (NSW); near Charlotte[s] Pass, *Skottsberg* s.n., 14 Mar 1949 (NSW 245466); below Paralyser/Perisher saddle, *Thompson 3089*, 8 Apr 1979 (NSW, CBG n.v.). VICTORIA: north face of Mt Cope, *van Rees 294*, 31 Dec 1981 (MEL, NSW); 2.7 km S of Mt Nelse, *Forbes 776, Adair & Gray*, 13 Jan 1982 (MEL, NSW).

C. costiniana *Everett & Thompson*, **sp. nov.**

Species foliis dense pilosis a speciebus nobis notis distincta.

TYPE: NEW SOUTH WALES: Southern Tablelands: above Lake Albina, Kosciusko dist., 6800ft. [2040 m], *L.A.S. Johnson & E.F. Constable*, 20 Jan 1951 (holo NSW 29293; iso CBG, MEL).

Conspicuously hairy herb with a single flowering scape 10–50 cm high, with a simple rootstock; roots thick, tomentose. Leaves mainly basal, spathulate, usually broad at the base, obtuse, 2.5–12 cm long, 2–11 mm wide; surfaces and margins densely and evenly covered with multi-septate, glandular hairs and long fine hairs, leaf tips glabrous. Inflorescence globose. Scape cream to crimson with scattered, long fine hairs and multi-septate or glandular hairs. Compound head 1.5–3.5 cm in diameter with up to 100 partial heads. Partial heads with 7–12 florets; main bract of the partial involucre broadly triangular to ovate, with an ovate herbaceous stereome with silky hairs, the margins membranous, colourless or dark brown. Corolla golden-yellow; achenes 0.75–1.5 mm long, with appressed silky hairs; pappus of 14–18 plumose bristles 2.5–5.5 mm long.

DERIVATION: Named in honour of Alec B. Costin, who has a deep and continuing involvement in the study and management of alpine areas.

FLOWERING PERIOD: Summer.

HABITAT: In drier sites in alpine or high subalpine grassland.

DISTRIBUTION: Endemic to Kosciusko National Park.

This species was referred to as sp. F in Jacobs & Pickard (1981), and as sp. D in Costin *et al.* (1979) and Thompson (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: below Seamans Hut, *Thompson 1419*, 22 Jan 1972 (NSW); Mount Kosciusko, *Curran s.n.*, Jan 1896 (NSW 245161); Soil Conservation Hut, N of Mt Carruthers, *Totterdell 308*, 17 Mar 1972 (CANB, NSW); Ramshead Range beyond Merritts Creek, E of Merritts Spur, *Thompson 1707*, 24 Jan 1973 (NSW, CANB); S of Mt Stilwell, *Thompson 3043*, 2 Apr 1979 (NSW, CANB).

C. lamicola *Everett & Thompson* **sp. nov.**

Species foliis grandis turgidis, marginibus foliorum lanatibus, a speciebus nobis notis distincta.

TYPE: NEW SOUTH WALES: Southern Tablelands: below Seamans Hut, Kosciusko National Park, alt. 2000 m, *J. Thompson 1418*, 22 Jan 1972 (NSW).

Stout flaccid-leaved herb with a single flowering scape 20–50 cm high; roots thick, tomentose. Leaves basal and cauline, gradually grading down in size up the scape, broadly spathulate, broadly stem-clasping, obtuse, 4–25 cm long, 1–4 cm wide; with a few multi-septate hairs and long fine hairs sparsely scattered over the surface, but usually fringing the margins densely; margins of upper leaves often undulate. Inflorescence a single globular compound head. Scape often tinged red, densely woolly especially just below the head. Compound head 1.5–3.5 cm in diameter with up to 90 partial heads. Partial heads with 7–11 florets; main bract of the partial involucre broadly triangular to ovate, with an ovate herbaceous stereome, glandular and with silky hairs, the margins membranous, and brown or colourless. Corolla golden-yellow; achenes 1–2.5 mm long, with appressed silky hairs; pappus of 15–22 plumose bristles 4–6 mm long.

DERIVATION: From the Latin *lama*, a bog or fen, and *-cola*, an inhabitant, referring to the boggy habitat.

FLOWERING PERIOD: Summer.

HABITAT: In wet high alpine sites.

DISTRIBUTION: Endemic to Kosciusko National Park.

This species was referred to as sp. E in Jacobs & Pickard (1981) and as sp. E in Costin *et al.* (1979) and Thompson (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: S of Mt Stilwell, *Thompson 3042*, 2 Apr 1979 (NSW, CANB); Upper Snowy R. below road bridge, *Thompson 1424*, 22 Jan 1972 (NSW).

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New species of *Acacia* (Fabaceae, Mimosoideae) from tropical Australia

Mary D. Tindale and Phillip G. Kodela

Abstract

Tindale, Mary D. & Kodela, Phillip G. (National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquaries Road, Sydney, NSW, Australia 2000) 1992. New species of Acacia *(Fabaceae, Mimosoideae) from tropical Australia.* Telopea *5(1): 53-66.* **Acacia arafurica, A. cataractae, A. delicatula, A. gracilenta** and **A. brockii** from the north of Western Australia and the Top End of the Northern Territory are described and illustrated. Although some of these species occur in national parks, several have restricted distributions and should be considered especially in the management plans of Kakadu and Katherine Gorge National Parks.

Introduction

In the last decade or so the Top End and Kimberley regions of northern Australia have been more widely explored, resulting in the discovery of many new plant species. Several of these species are described here, so that they may be published prior to the forthcoming volume on *Acacia* in the *Flora of Australia*. Further collections are required to provide more information on taxonomic variation, distributions and ecology, since existing specimens are often in limited numbers or concentrated from more accessible areas. Recent findings of new taxa emphasise our limited current knowledge of these areas and the potential of future discoveries, which need to be considered in the management of National Parks and future planning for mining and tourism in the region.

The terminology of shapes in the descriptions of species is that defined by Lee (1948: 144). The diameter of flower-heads is only given as a guide, since it is often affected by the degree of pressure on the specimens during drying.

Sect. Plurinerves (Benth.) Maiden & Betche, Triangulares group

1. Acacia arafurica *Tlnd. et Kodela*, **sp. nov.**

Ab *Acacia sublanata* Benth. differt phyllodiis crassioribus, 15–34 mm longis, 9–25 mm latis, inflorescentiis spicatis, 10–21 mm longis et pedunculis 2-5 mm longis.

TYPE: NORTHERN TERRITORY: Arnhem Land, Anguldili Creek, Murgenella Road, 11°45'S, 133°10'E, *R. Hinz* 2, 25 May 1988; holo NSW 235594; iso BRI, CANB, DNA 32714, K, PERTH.

Rounded shrub to 3 m high. *Branchlets* terete, light brown or greyish brown, with a rusty or greyish hue resulting from the indumentum which is sparsely to densely pubescent to cobwebbed (the hairs hyaline, white and/or fawn, often curled, to 0.5 mm long, sometimes intermixed with red-brown papillose hairs); longitudinal ridges to 0.2 mm high. *New shoots and young foliage* reddish brown, resinous, cobwebbed. *Phyllodes* borne singly, subsessile, obliquely ovate-rhomboidal, asymmetrical, the lower margin almost straight to slightly curved, the upper margin abruptly curved to more

than 90° near pulvinus, then curved to apex, 1.5–3.4 cm long, 0.9–2.0(–2.5) cm wide, flat, coriaceous, with a sparse to moderate cover of nonglandular, erect to subappressed hairs to 0.5(–0.7) mm long (the hairs being similar to those on the branchlets), with (3–)4(–5) prominent longitudinal nerves, the minor nerves strongly reticulate, the margin thickened, often wavy when dry, the mucro minutely glanduliferous, acuminate, pungent, straight or oblique, 0.4–1.2 mm long; gland on the upper margin of the phyllode prominent, 1.6–2.5(–5.0) mm above the pulvinus, orbicular to elliptical, pale yellow, glabrous, 0.4–0.6 mm long, 0.3–0.5 mm wide, the orifice < 0.1 mm in diam.; *pulvinus* 0.5–1.2 mm long, cobwebbed-pubescent; *stipules* lanceolate to narrow-ovate, 1.5–2.1 mm long, glabrous or ciliolate with hairs to 0.4 mm long, striate with several nerves arising from the base, the apex acute to acuminate. *Inflorescences* spicate, borne singly or very rarely in pairs in the axils of the phyllodes, (10–)15–21 mm long, 4.0–5.5 mm wide, golden yellow; *peduncles* 2–5 mm long, moderately to densely pubescent; *bracteoles* composed of a narrow deltate lamina 0.6–1.1 mm long (the pointed apex longer than the young flower buds), with white hairs to 0.2 mm long on the margin, attached perpendicularly to a glabrous claw 0.2–0.6 mm long. *Flowers* 5-merous; *calyx* membranous, 0.5–0.8(–1.1) mm long, dissected for 1/3–1/2 its total length, with faint midribs or keeled, the apices ciliolate with hairs to 0.2 mm long, otherwise glabrous; *corolla* 1.1–1.4(–1.8) mm long, resinous, dissected for 1/3–1/2 its length, the petals oblanceolate to narrow-obovate, glabrous, with a midrib, the apices thickened, incurved and often cucullate, darker than the rest of corolla; *stamens* with filaments to 3.6 mm long; *ovary* ± oblong or narrow-obovate, red-brown, densely pubescent with white hairs to 0.25 mm long; *style* eccentric, to 2.7 mm long, often curled. *Legumes* linear, tapering gradually at both ends, ± straight, constricted between the seeds, 6.5–10.5 cm long, (2.5–)4.0–4.5 mm wide, chartaceous, raised and longitudinally ribbed over seeds, clothed with appressed to erect, white, usually interwoven hairs to 0.5 mm long. *Seeds* 4–7 arranged longitudinally in the legume, (5.2–)6.0–7.0 mm long, 2.1–3.1 mm wide, black, glossy; *pleurogram* open, very slightly constricted towards the hilum; *areole* same colour as the rest of the seed, 3.8–5.3 mm long, 0.9–1.3 mm wide; *funicle* cream-coloured, expanded into a turbinate aril, folded c. 3 times beneath the seed (only one specimen with fruit and seeds was examined). *Flowering* April–May, July. *Fruiting* September. Figure 1.

DISTRIBUTION: NORTHERN TERRITORY: Darwin and Gulf District: Cobourg Peninsula southeast to Maningrida and Nabarlek. Figure 2.

HABITAT: In sandy soil on coastal river flats or near streams in the gorge country of the inland, sometimes in tall open forest. Often in swampy areas.

ETYMOLOGY: The specific epithet refers to the Arafura Sea which lies to the north of the region in which *A. arafurica* occurs.

NOTES: R. Hinz uses the collecting number '2' for two separate specimens (including the specimen we have chosen as holotype, i.e. *NSW 235594*), possibly applying the number to indicate that they are the same species.

We are following Pedley's classification (1987) where *Acacia sublanata* has been referred to the Triangulares group in sect. *Plurinerves*, whereas Cowan & Maslin (1990) placed *A. sublanata* with *A. deltoidea* Cunn. ex Don and its allies in sect. *Plurinerves*.

Acacia sublanata Benth., which occurs in the Top End of the Northern Territory, is allied to *A. arafurica* which has very similar flowers, but there are differences in the phyllodes and shape of inflorescences. In *A. sublanata* the inflorescences are globular or rarely shortly oblong (Pedley 1987: 319, Figure 2f) whereas in *A. arafurica* they are spicate (Figure 1a). In *A. sublanata* the minor reticulate nervation is less distinct and

the areolae more acute, running ± parallel with the main nerves, whereas the phyllodes of *A. arafurica* are larger and slightly thicker with a strong reticulate network between the main nerves (Figure 1b). The phyllodes of *A. sublanata* are mostly broadest at or above the middle (as stated by Cowan & Maslin 1990). This is particularly noticeable in the specimens of *A. sublanata* with larger phyllodes, e.g. *Maconochie 1519*, but this is not always the case, e.g. *Slee & Craven 3078*, whereas in *A. arafurica* they are broadest at or below the middle.

Pedley (1987) describes the legumes of *A. sublanata* (under *Racosperma sublanatum* (Benth.) Pedley) as 'glabrous'. In the material of *A. sublanata* that we have examined, e.g. *v. Balgooy 1310 & Byrnes, Lazarides & Adams 171, Maloney NSW 126756, Must 771, Craven 6068* and *Slee & Craven 3078*, the legumes are pubescent, although in *Specht 819* the fruit is subglabrous.

Specimens examined: Northern Territory: Darwin and Gulf District: 12 km N Three Ways, Cobourg Peninsula, 11°13'S, 132°17'E, *Sivertsen 793*, 29 May 1983 (DNA 24309, PERTH); near Tomkinson River, Maningrida, *Brigden*, Apr 1972 (BRI, DNA D4432); Nabarlek, 12°21'S, 133°20'E, *Hinz 2*, 3 Apr 1988 (BRI, DNA 31436, MEL); Arnhem Land, Maningrida, 12°30'S, 134°17'E, *Coleman 31*, 25 Sep 1988 (DNA 36642).

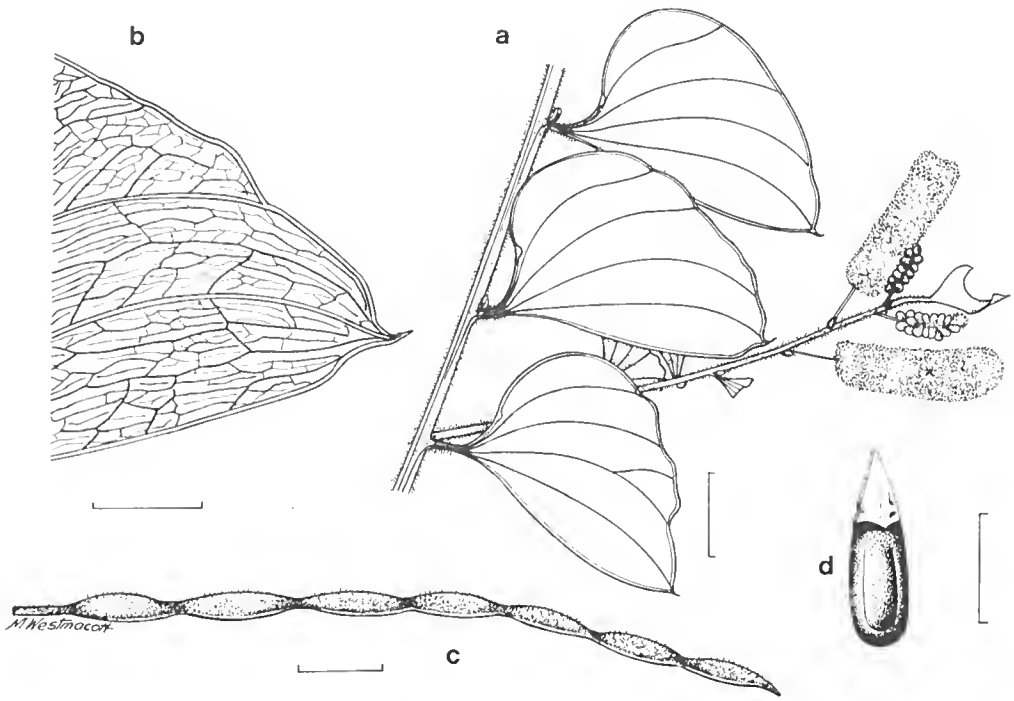

Figure 1. *A. arafurica*. **a**, habit study with spicate inflorescences; **b**, upper portion of phyllode; **c**, legume; **d**, seed (a,b, *Sivertsen 793*; c,d, *Coleman 31*). a,c, scale bar = 1 cm; b,d, scale bar = 5 mm.

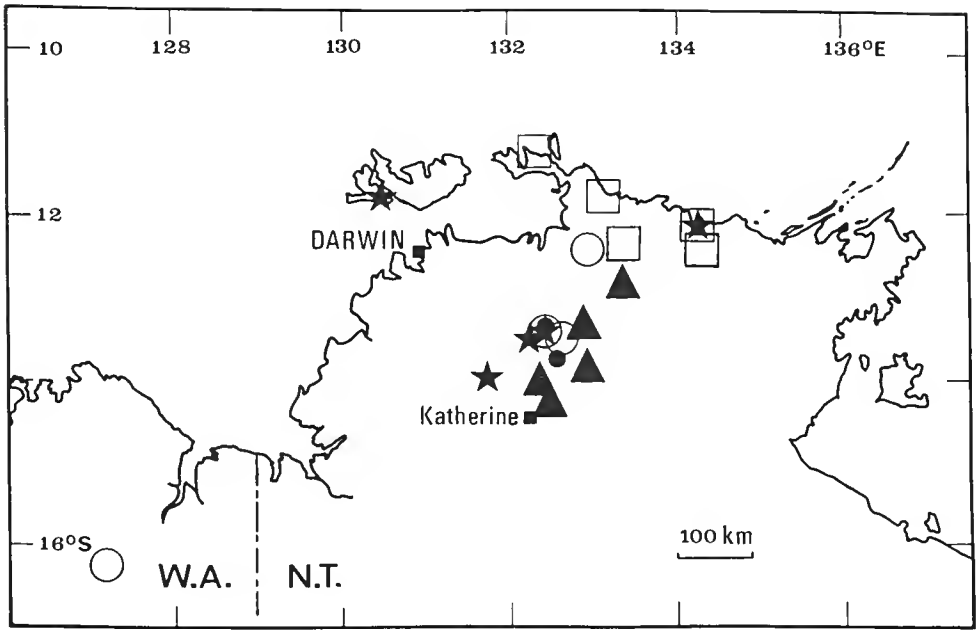

Figure 2. Distribution of *Acacia arafurica* (□), *A. cataractae* (★), *A. delicatula* (○), *A. gracilenta* (▲) and *A. brockii* (●).

Key to *A. arafurica* and *A. sublanata*

1 Phyllodes (2.5–)5–13(–24) mm long, (1.5–)3-10(–14) mm wide, thinly coriaceous. Inflorescences mostly globular, (4.5–)6–7 mm in diam. or sometimes oblong. Peduncles (4–)7–15(–20) mm long ..... *A. sublanata*

1* Phyllodes 15–34 mm long, 9–20(–25) mm wide, coriaceous. Inflorescences spicate, (10–)15–21 mm long. Peduncles 2–5 mm long ..... *A. arafurica*

Acacia stigmatophylla Cunn. ex Benth. group

2. Acacia cataractae *Tind. et Kodela*, **sp. nov.**

Acacia cataractae: *A. stigmatophyllae* Cunn. ex Benth. affinis, a qua differt phyllodorum nervis 1–3 longitudinalibus margine inferiore plerumque confluentibus, calycibus 0.75–1.0 mm longis, 2/3 partibus vel ad basin dissectis et petalis costa inconspicua.

TYPE: NORTHERN TERRITORY: Above U.D.P. Falls [Gunlom Falls, on Waterfall Creek], *C.H. Gittins 2851*, 3 May 1975; holo NSW 236250; iso BRI, CANB, DNA, K.

Shrub to 2 m high; bark brown, fibrous. *Branchlets* markedly angled to almost flattened towards apices, greenish brown to mid-brown, glabrous, with resinous, minutely

crenulated ridges to 0.3(–0.5) mm high. *New shoots and young foliage* yellowish green, resinous particularly towards apices. *Phyllodes* borne singly, oblanceolate to narrow-oblanceolate or very narrow-elliptical, sometimes slightly asymmetrical, straight or very slightly curved, (3.5–)4.0–10.5 cm long, (6.5–)7.5–20.0(–23.0) mm wide, (3–)4–8 times as long as wide, grey-green, mid-green or dull dark green, flat, thinly coriaceous, glabrous, the margins nerve-like, crenulated with resin, with 3 prominent longitudinal nerves pale yellow, 2 of these reaching the base while the other usually confluent with the lower margin 0.5–1.7 cm from the pulvinus, sometimes with 4 subprominent longitudinal nerves, all other nerves faint with moderate anastomosing, 1–4 nerves per mm of phyllode width (longitudinal wrinkling produces a fine striated appearance); apex obtuse, often asymmetrically retuse or truncate, with a blunt, red-brown mucro 0.3–0.7 mm long, the gland minute; basal gland prominent, a ± elliptical swelling on the upper margin just above the pulvinus, (0.8–)1.5–2.6 mm long, 0.4–1.2 mm wide, glabrous, with a ± circular, slightly exserted, pale yellow lip c. 0.2 mm wide, the ± circular orifice to 0.2 mm in diam.; *pulvinus* (0.5–)1.0–2.5(–3.5) mm long, glabrous, often mealy; *stipules* deltate, 0.7–1.2 mm long, often somewhat mealy. *Inflorescences* spicate, borne singly or in twos or threes in the upper axils of the phyllodes (when in threes the spikes are often at different stages of development), (10–)14–50 mm long, (4.5–)5.5–7.5 mm wide, usually dense, yellow or bright to golden yellow, often densely mealy between flowers; *buds* obovate to very broad-obovate, very resinous; *peduncles* 4–12 mm long, glabrous, resinous. *Flowers* 5-merous; *calyx* membranous, 0.75–1.0 mm long, deeply cut to c. 2/3–3/4 its length, the sepals often ± free, 0.1–0.2 mm wide, with a faint midrib, glabrous, the apex usually rounded; *corolla* 1.0–1.5 mm long, dissected 1/3–1/2 its length, glabrous, the petals elliptical to almost broad-elliptical or narrow-ovate, with a faint midrib, often mealy, often resinous, the apex acute; *stamens* with filaments to 3.2 mm long; *ovary* oblong to elliptical, granular, pubescent (especially towards the apex) or almost glabrous with a few minute hairs towards apex; *style* to 3.5 mm long. *Legumes* very narrow-oblanceolate (rarely linear), the base tapering gradually, straight or very slightly curved, 2.6–5.0 cm long, 4–7(–9.5) mm wide, straight-sided, woody, flat, slightly raised over the seeds, brown (greenish brown when young), glabrous, often scurfy, resinous (especially when young), the margins thickened, the surface with conspicuous diagonal nerves and some anastomosing, opening elastically from the apex, the apex ± hooked. *Seeds* 7–13 obliquely arranged in the legume, ellipsoid or oblongoid, sometimes ± rhomboidal, (2.7–)3.0–4.0(–5.3) mm long, 1.3–2.0 mm wide, brown, glossy; *plenrogram* open and slightly constricted towards the hilum; *areole* the same colour or slightly darker than rest of the seed, (1.8–)2.3–3.1(–4.2) mm long, 0.7–0.9 mm wide, often with a pale halo; *funicle* expanded into a cupular aril beneath the seed, the combined funicle–aril cream-coloured to tawny, narrowly turbinate. *Flowering* late December–January, March–July. *Fruiting* March–May. Figure 3a–e.

Distribution: Northern Territory: Darwin and Gulf District: From Bathurst Island and the Maningrida area, south to Umbrawarra Gorge (13°58'S) near Pine Creek. Recorded in Kakadu National Park at Gunlom Falls, Graveside Gorge and Billiard Creek Road. Figure 2.

Habitat: Usually found on sandy soil near streams in sandstone plateau–gorge country or on coastal plains, mostly in *Eucalyptus* woodland amongst rocks and boulders.

Etymology: The epithet refers to Waterfall Creek at Gunlom (U.D.P.) Falls, about 15 km NW of El Sharana, where this species is locally abundant.

Notes: It is a member of the *A. stigmatophylla* Cunn. ex Benth. group, which connects the *Juliflorae* with the *Plurinerves* (Tindale 1980). *A. stigmatophylla* is common in the Top End of the Northern Territory and in the Kimberley, Western Australia.

A. cataractae has been confused with other tropical Australian species, viz. *A. limbata* F. Muell. (Kimberley, W.A., northern N.T. and north-western Queensland) and *A. lazaridis* Pedley (northern Queensland). The latter two species have larger legumes and seeds, longer peduncles (except in *Adams 1138*), more asymmetrical phyllodes and cupular calyces that are dissected for 1/4–1/3 of their length. *A. lazaridis* usually has longer flowers than the other two species.

SELECTED SPECIMENS: NORTHERN TERRITORY: Darwin and Gulf District: Bathurst Island, 11°45'S, 130°35'E, *Stevenson 159*, 28 Dec 1975 (DNA); Maningrida area, 12°02'S, 134°17'E, *Clark 1306*, 26 Jul 1987 (BRI, DNA); Kakadu, Graveside Gorge 13°19'S, 132°33'E, *Brock 190*, 30 Dec 1986 (DNA); U.D.P. Falls, Sth Alligator R., *Byrnes 1783*, 4 Mar 1970 (BRI, DNA, K, NSW, NT); Kakadu National Park: U.D.P. Falls area: 0.7 km upstream from the top of falls, on Waterfall Creek, 13°25'S, 132°24'E, *Slee & Craven 3045*, 30 Apr 1990 (CANB, NSW); Waterfall Creek, *Hancock 364*, 26 May 1991 (CANB, DNA, K, NSW, PERTH); Kakadu National Park, Billiard Creek Road, 13°30'S, 132°14'E, *Menkhorst 297*, 4 Mar 1989 (DNA); road to Umbrawarra Gorge, 13°56'S, 131°45'E, *Brock 205*, 13 Jan 1987 (DNA); Umbrawarra Gorge Rd, 13°58'S, 131°40'E, *Brock 94*, 13 Mar 1986 (DNA).

3. Acacia delicatula *Tind. et Kodela*, sp. nov.

Acacia delicatula: *A. subternatae* F. Muell. affinis, sed phyllodiis linearibus-filiformibus, semiteretibus, 0.2–0.5 mm latis, capitulis 4.0–6.5 mm diametro, calycibus 0.6–1.0 mm longis, ad dimidiam vel plus dissectis, sepalorum apicibus plus minusve subulatis vel acuminatis et corollis 1.3–1.75 mm longis.

TYPE: NORTHERN TERRITORY: 2.7 km W of 'Rock Pools' (Bulbe gardar) along high track skirting the base of 'Geringbah' Escarpment [SW of Cahills Crossing], 12°28'S, 132°55'E, *C.F. Puttock & J.T. Waterhouse*, 24 July 1980; holo NSW 237163; iso DNA, K, UNSW 10162.

Erect to ascending, often spreading, resinous shrub to 1.5 m high, branching from the base; *bark* finely fissured. *Branchlets* ± terete, striated, becoming markedly angular towards apices, light brown to brown, sometimes grey or greenish brown, glabrous, sometimes mealy, often resinous, the minutely crenulated ridges to 0.2 mm high. *Phyllodes* single or in clusters of 2–6, linear to filiform, semiterete, (4.5–)7–13(–18) mm long, (0.2–)0.3–0.4(–0.5) mm wide, straight or slightly curved, glabrous, nerves inconspicuous, the mucro acute to ± aristate, often fawn-coloured, straight or oblique, to 0.5 mm long, bearing a minute gland. *Capitula* borne singly, 4.0–6.5 mm diam.; *peduncles* (5–)8–15(–18) mm long. *Flowers* 5-merous, 34–38 per capitulum; *calyx* 0.6–1.0 mm long, dissected for 1/2–3/4 of its length, glabrous, the sepals 0.1–0.2 mm wide, usually with ± subulate to acuminate apices; *corolla* c. twice the length of the calyx, 1.3–1.75 mm long, dissected by 1/2 or more of its length, the petals very narrow-elliptical to narrow-lanceolate or narrow-oblanceolate, 0.2–0.4 mm wide, glabrous, with a distinct midrib, the apex thickened and often cucullate; *stamens* with filaments to 3 mm long; *ovary* glabrous, usually with a bulbous yellow cap on the summit. *Legumes* straight-sided or slightly indented between the seeds, very narrow-oblanceolate or sometimes ± linear, basally tapered, (2.0–)3.0–4.0(–4.4) cm long, 3–4 mm wide, flat, woody, glabrous, resinous (especially when young), opening elastically from the apex, obliquely to longitudinally nerved with minor anastomosing nerves, margins and partitions between seeds prominent, the apex hooked. *Seeds* 2–10, obliquely arranged in legume, ellipsoid or oblongoid (often irregularly shaped), (2.6–)3.0–3.9 mm long, (1.1–)1.3–2.1 mm wide, brown; *pleurogram* open, with a pale halo; *areole* slightly darker brown than rest of the seed; *funicle–aril* narrowly turbinate. *Flowering* January, March–April, July. *Fruiting* January, March–April, July–August. Figure 3f–j.

DISTRIBUTION: Occurs in north-western Western Australia and Kakadu National Park, Northern Territory. Figure 2.

HABITAT: Usually in shrubland or open eucalypt savannah on rocky or stony plateaux and hill slopes.

ETYMOLOGY: The epithet refers to the fine, narrow phyllodes of this species.

NOTES: *A. delicatula* is closely allied to *A. subternata* F. Muell., which occurs in drier areas further south than the former (between c. 14°20'S and 16°17'S) in the Northern Territory near Borroloola, Tanumbirini and Willeroo. Another closely allied species *A. manipula* Cowan & Maslin ms., from the Kimberley area, Western Australia, differs from the former species in having less angular branchlets without prominent, minutely crenulated, resinous ridges and has longer phyllodes to 23 mm long. We have only seen one specimen of *A. manipula* ms., i.e. 9 miles [14.5 km] NE of Tablelands Homestead, Kimberleys, *M. Lazarides 6398*.

These species are members of the *A. stigmatophylla* group, which connects the *Juliflorae* with the *Plurinerves* (Tindale 1980). They differ from the other species listed in that their phyllodes are usually in groups of 2–6. In *A. delicatula*, *A. subternata* and *A. manipula* ms. there is often a bulbous, yellow or brown cap on top of the ovary.

SELECTED SPECIMENS: NORTHERN TERRITORY: Darwin and Gulf District: Kakadu, c. 2 km S East Alligator Ranger Stn, 12°25'S, 132°59'E, *Noske*, Aug 1987 (DNA 37225); near East Alligator River Ranger Station, Kakadu National Park, 12°29'S, 132°56'E, *Russell-Smith 936*, 23 Jan 1984 (CANB, DNA, PERTH); Jabiluka Outlier, East of Ja Ja, [c. 12°30'S, 132°55'E], *Waterhouse & Sanderson*, 30 Mar 1980 (DNA, NSW, UNSW 9618); U.D.P. Falls, 7 miles [11.2 km] NW of El Sharana, [13°25'S, 132°25'E], *Martensz AE560*, 24 Jan 1973 (BRI, CANB, DNA, NT); 13 miles [21 km] E of El Sharana Mine, 13°31'S, 132°42'E, *Lazarides 7971*, 2 Mar 1973 (CANB, NSW, PERTH). WESTERN AUSTRALIA: Fitzgerald: Gibb River – El Questro road, Karungi [Karunjie] Station turn-off, c. 130 km SW of Wyndham, [16°16'S, 127°12'E], *Beauglehole 51489*, 28 May 1976 (BRI, PERTH); 50 metres E of turnoff to Pentecost Downs (Karunjie), Gibb River Road, *Keith 225 & Pellow*, 7 Jul 1986 (NSW, SYD).

Key to *A. delicatula* and *A. cataractae* and close allies

1 Phyllodes usually in clusters of 2–6, cultrate to filiform, or sometimes ± narrow-oblanceolate, 4–18 mm long, 0.2–0.85 mm wide, nerves inconspicuous.

2 Phyllodes linear to filiform, (0.2–)0.3–0.4(–0.5) mm wide. Capitula 4.0–6.5 mm in diam. Calyx 0.6–1.0 mm long, dissected by 1/2–3/4, the sepals with ± subulate or acuminate apices. Corolla 1.3–1.75 mm long, the petals with midrib only ..... *A. delicatula*

2* Phyllodes cultrate to linear or sometimes ± narrow-oblanceolate, (0.4–)0.5–0.8 (–0.85) mm wide. Capitula (5.0–)6.5–8.5 mm in diam. Calyx (0.9–)1.1–1.2(–1.4) mm long, dissected c. 1/2, the sepals ± spathulate with broadly rounded apices. Corolla 1.7–2.3 mm long, the petals striated longitudinally ..... *A. subternata*

1* Phyllodes borne singly, oblanceolate to narrow-oblanceolate, or narrow-elliptical to very narrow-elliptical, 2.5–10.5 cm long, 6–23 mm wide, with several prominent longitudinal nerves.

3 Phyllodes with 1 of the 3 prominent longitudinal nerves usually confluent with the lower margin. Calyx 0.75–1.0 mm long, dissected by 2/3 or to the base. Petals with faint midrib ..... *A. calaractae*

3* Phyllodes with 3 prominent longitudinal nerves reaching the base. Calyx 0.5–0.75 mm long, cupular, dissected by 1/8–1/5. Petals with prominent midrib ..... *A. stigmatophylla*

Figure 3. *A. cataractae.* **a**, habit study with spicate inflorescences; **b**, upper portion of phyllode; **c**, habit study with legumes; **d**, inside of legume; **e**, seed (a,c, *Brock 94;* b,d,e, *Menkhorst 297*). *A. delicatula*: **f**, habit study with young capitula; **g**, phyllode; **h**, inside of legume; **i**, outside of legume; **j**, seed (f,g, *Russell-Smith 936;* h–j, *Puttock & Waterhouse UNSW 10162*). a,c,f,h,i, scale bar = 1 cm; b,d,e,g,j, scale bar = 5 mm.

Sect. Juliflorae (Benth.) Maiden & Betche

4. Acacia gracilenta *Tind. et Kodela*, **sp. nov.**

Acacia gracilenta: *A. linarioidi* Benth. affinis, sed phyllodiis late dispositis, non rigide erectis, 2.7–10.2 cm longis et 1.4–6.5 mm latis, stipulis basi 0.3–0.6 mm latis, ramulis, pedunculis et inflorescentiarum axibus glabris vel fere glabris et ramulis minus angularibus statim diagnoscenda.

TYPE: NORTHERN TERRITORY: Arnhem Land, Upper East Alligator R., 12°50'S, 133°20'E, *J. Russell-Smith 5270 & D. Lucas*, 22 Apr 1988; holo DNA 36422; iso BRI, NSW 235962.

Shrub to 3 m high, often spindly, spreading from a single stem close to the ground (e.g. from c. 15 cm); branches, branchlets and foliage resinous; *bark* greyish or light brown, ± smooth. *Branchlets* terete, finely striate, pale green and usually mottled with light brown, glabrous or sometimes with sparsely scattered, subappressed, minute, hyaline hairs, lenticels prominent. *New shoots and young foliage* greenish brown to red-brown, the margins of the phyllodes with appressed transparent hairs. *Phyllodes* borne singly or occasionally in pairs, linear or sometimes ± very narrow-elliptical, tapering gradually and equally from the centre or sometimes widest c. 2/3 from the base, straight or slightly curved, (2.7–)4.0–6.0(–10.2) cm long, 1.4–5.0(–6.5) mm wide, 7–30(–45) times as long as wide, bright green, flat, herbaceous, glabrous or with appressed, opaque to transparent hairs to 0.6 mm long on the margin, the stomates prominent, the margins ± nerve-like; main nerves longitudinal, arising from the base of the phyllode; midnerve prominent, usually with 1 semi-prominent nerve either side, (2–)3–6(–7) nerves per 1 mm of phyllode width, sparsely anastomosing; apices acute to obtuse, often slightly constricted, mucro straight to oblique, red-brown to orange-brown, 0.2–0.8 mm long, an inconspicuous gland to 0.2 mm in diam. just below the apex; an inconspicuous gland to 6 mm above the pulvinus, often slightly indented in the upper margin, broad-elliptical to elliptical or oblong, 0.3–0.6 mm long, 0.2–0.3 mm wide, glabrous, the lip usually fawn, the orifice elliptical to slit-like, usually darker; *pulvinus* 0.5–1.8 mm long, wrinkles mostly transverse and often folded, brown or orange-brown, glabrous, often resinous; *stipules* 2 either side of pulvinus, 0.5–1.2 mm long, 0.3–0.6 mm wide at base, deltate, glabrous, with midnerve. *Inflorescences* spicate, borne singly in the axils of the upper phyllodes, 20–55 mm long, (3.5–)4.0–6.5 mm wide, c. 101–107 flowers per spike, golden; *buds* broad-ovate to very broad-ovate; *peduncles* 13–26 mm long, finely striate, glabrous, often resinous; *bracteoles* orange-brown, glabrous, usually resinous, the claw 0.15–0.3 mm long, the lamina ± perpendicular to the claw, 0.25–0.55 mm long, ± narrowly deltate, sometimes dentate. *Flowers* 5-merous; *calyx* membranous, inconspicuous, the sepals almost free, cultrate to linear, 0.2–0.3(–0.4) mm long, the apices obtuse or ± spathulate; *corolla* (0.9–)1.0–1.3(–1.5) mm long, dissected for 1/3–1/2 of the total length (often to the base in older flowers), the petals elliptical to broad-elliptical or narrow-obovate, 0.5–0.7 mm wide, with a distinct midrib, glabrous, often resinous, the apex thickened, often incurved and sometimes cucullate; *stamens* with filaments to 2.8 mm long; *ovary* oblong-elliptical, subsessile, brown, glabrous or sometimes with a few scattered, ± appressed, hyaline hairs to 0.15 mm long; *style* ± eccentric, 1.5–3.0 mm long. *Legumes* linear, usually curved, constricted between the seeds, coriaceous, (2–)4–9(–12) cm long, 2.5–4.0 mm wide, brown; margins paler, ± prominent; surface ± flat, slightly raised over the seeds, with several longitudinal nerves and minor anastomosing nerves, glabrous, usually resinous. *Seeds* (1–)6–11 arranged longitudinally in the legume, ellipsoid to narrow-ellipsoid, 3.5–4.3(–5.7) mm long, 1.6–1.9(–2.7) mm wide, very dark brown or red-black to black; *pleurogram* closed, a very narrow groove separating the areole from the rest of

the seed, often with a shallow trough around the pleurogram; *areole* 1.6–2.0(–2.6) mm long, 0.4–0.55(–1.0) mm wide, flat or slightly depressed, ± the same colour as the rest of the seed, sometimes less shiny; *funicle* cream-coloured, filiform, expanded into a cap-like aril, folded c. 5 times beneath the seed. *Flowering and fruiting* April–May, August. Figure 4.

DISTRIBUTION: NORTHERN TERRITORY: Darwin & Gulf District: Arnhem Land, Kakadu National Park and Katherine Gorge National Park. Figure 2.

HABITAT: Occurs in sandy soils on dissected sandstone plateaux and in gorges; often on slopes near rivers and creeks, growing amongst shrubs and sometimes with spinifex in open eucalypt woodland or *Allosyncarpia* forest.

ETYMOLOGY: The epithet refers to the rather graceful canopy of this member of sect. *Juliflorae*.

NOTES: *A. gracillima* Tind., which is restricted to the Kimberley region of W.A. especially in the King Leopold Ranges, is frequently confused with *A. linarioides*, which is a member of the *A. lysiophloia* group (Tindale 1978). It can be easily distinguished from *A. gracilenta* by its dark red, very curly bark, i.e. 'Minni Ritchi', and long hairs on the legumes. *A. linarioides* Benth. (occurring in the N.T. north of 17°S and on islands in the Gulf of Carpentaria) has slightly more angled branchlets and is more hairy than *A. gracilenta*.

SPECIMENS EXAMINED: NORTHERN TERRITORY: Darwin & Gulf District: Twin Falls, Jim Jim Falls area, 13°18'S, 132°52'E, *Fox 559*, 17 Aug 1974 (DNA 11803); 20 km south-east of Twin Falls, 13°27'S, 132°54'E, *Lazarides 8962*, 24 May 1980 (BRI, CANB, NSW 235981); Kakadu National Park, upper Birdie Creek area, 13°53'S, 132°57'E, *Slee & Craven 2512*, 18 Apr 1990 (CANB, DNA?, NSW 235987); Second Spring, Seventeen Mile Valley, Katherine [Gorge] National Park, 14°06'S, 132°24'E, *Tindale 6038 & Dunlop*, 8 July 1979 (CANB, K, NSW 235964, UNSW); Katherine Gorge National Park, 14°18'S, 132°28'E, *King 117*, 2 June 1982 (DNA 23304).

Key to *A. gracilenta* and *A. linarioides*

1 Phyllodes ± well-spaced, not stiffly erect, (2.7–)4–6(–10.2) cm long, 1.4–5(–6.5) mm wide. Stipules 0.3–0.6 mm wide at base. Branchlets, peduncles and axes of the inflorescences glabrous or almost so. Legumes 2.5–4.0 mm wide ..... *A. gracilenta*

1* Phyllodes numerous, usually crowded, rather stiffly erect, 1–4.3 cm long, 0.4–2 mm wide. Stipules 0.1–0.2(–0.3) mm wide at base. Branchlets, peduncles and axes of the inflorescences usually sparsely to densely clothed with hairs to 0.7 mm long. Legumes 1.0–3.5 mm wide ..... *A. linarioides*

5. Acacia brockii *Tind. et Kodela*, **sp. nov.**

Arbor gracilis, ad 5 m altam, phyllodiis argenteogriseis. Ramuli lenticellis, pilis albis plus minusve vestitis. Phyllodia juvenilia resinosa. Phyllodia linearia, recta vel parum curvata, 8.5–25.6 cm longa, 1.4–2.75 mm lata, plana, plus minusve rigida, pilis albis, caducis, appressis; nervis principalibus longitudinalibus, non anastomosantibus; mucrone apicali obliquo, 0.9–2.5 mm longo, glandula modo supra pulvinum disposita. Inflorescentiae spicatae, singulares vel binatim e phyllodiorum axillis ortae, 23–43 mm longae, 3.5–4.5 mm latae, flavidae. Bracteolae florum ciliatae, alabastra superantiae apicibus acuminatis vel subulatis. Flores quinquemeri; calyx 0.8–0.9 mm longus,

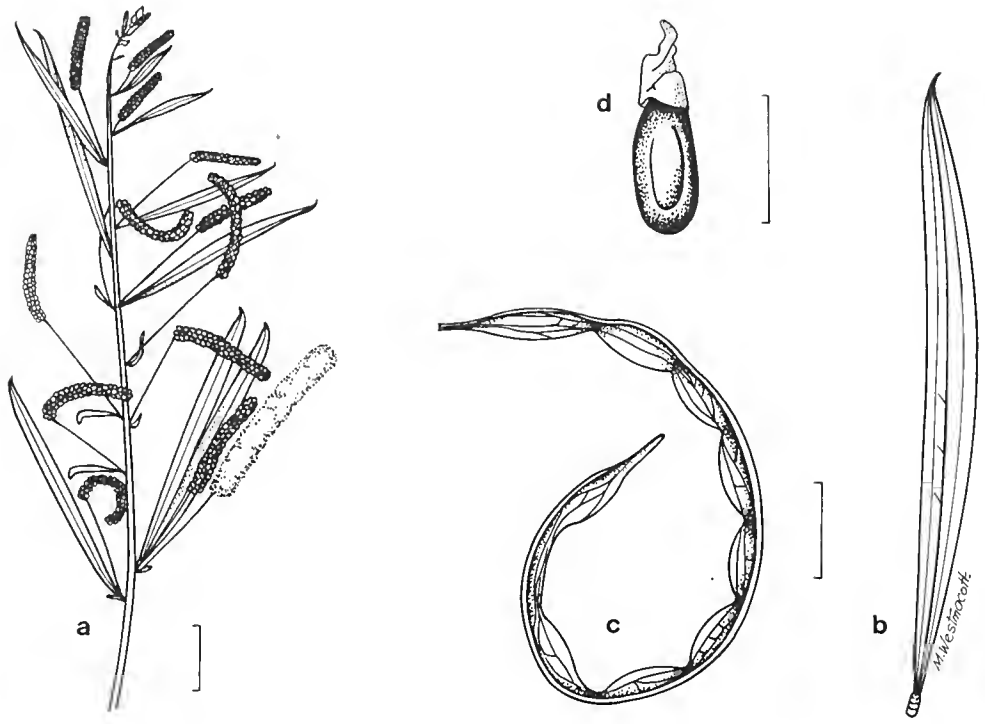

Figure 4. *A. gracilenta*. **a**, habit study with spicate inflorescences; **b**, phyllode; **c**, legume; **d**, seed (a, *Tindale 6038 & Dunlop*; b, *Slee & Craven 2512*; c,d, *King 117*). a,b,c, scale bar = 1 cm; d, scale bar = 5 mm.

pilis tenuibus argenteis vestiti; corolla 1.2–1.5 mm longa. Legumina linearia, recta vel parum curvata, raro indentata, 8.0–11.7 cm longa, 4.7–6.0 mm lata, papyracea, pallide brunnea, glabra. Semina 9–11, longitudinalia, 3.6–4.7 mm longa, 2.3–2.9 mm lata, brunnea; areolus brunneus; funiculus hinnuleus, ter plicatus arillum cupulum faciens, secus seminis latum unum prolongatus.

Type: Northern Territory: Kakadu National Park: 18.5 km S of Gimbat HS [Homestead] (below E edge of Marawal Plateau), 13°44'S, 132°36'E, *A.V. Slee & L.A. Craven 2694*, 21 Apr 1990; holo NSW 236231; iso BRI, CANB, DNA, K, L, MEL, US.

Slender tree to 5 m high appearing silver-grey due to indumentum of the foliage, *bark* tight, smooth, dark grey. *Branchlets* terete, becoming angular towards the apices, red-brown, with lenticels, sparsely to densely (more dense towards apices) covered with appressed to semi-erect whitish hairs, with 5–7 prominent, longitudinal ridges to 0.2 mm high. *New shoots and young foliage* resinous, reddish brown, densely pubescent with appressed hairs. *Phyllodes* borne singly, linear, tapering gradually to the base and apex, straight or slightly curved, (8.5–)11.0–25.6 cm long, 1.4–2.75 mm wide, 45–113 times as long as wide, flat, ± rigid, covered with appressed, caducous, silvery hairs to 0.6(–1.2) mm long (mixed with fawn hairs on younger phyllodes), older phyllodes bright green and only partly covered with hairs or almost glabrous; main nerves longitudinal, arising from the base of the phyllode, the midnerve usually slightly more prominent, 5–8 nerves per mm of phyllode width, not anastomosing;

mucro reddish black or orange-brown, oblique or sometimes straight, 0.9–3.0 mm long, often resinous, glanduliferous, the gland cobwebbed to ± glabrous, 0.2–0.4(–0.6) mm long, 0.2–0.3(–0.4) mm wide; *gland just above the pulvinus* glabrous or covered with appressed hairs, ± circular to elliptical, (0.3–)0.5–0.8 mm long, 0.3–0.55 mm wide, the orifice circular to elliptical, 0.05–0.2 mm in diam.; *pulvinus* 1.4–2.9(–3.5) mm long, wrinkles mostly transverse, pale yellow to pale brown, glabrous or sparsely to densely hairy; *stipules* 0.7–0.9 mm long, deltate, ciliolate. *Inflorescences* spicate, borne singly or in pairs in the axils of the phyllodes, (15–)20–43 mm long, 3.5–4.0(–4.5) mm wide, pale yellow; immature spikes with bracteoles extending beyond the silvery white, hairy flower-buds; *peduncles* 2–3 mm long, densely pubescent with whitish and fawn to brown hairs; *bracteoles* brown or orange-brown, the claw 0.3–0.6 mm long, pubescent, the lamina perpendicular to the claw, narrowly deltate with an acuminate to ± subulate apex, ribbed, 1.0–1.7 mm long, with silvery white hairs to 0.3 mm long on the paler margins and usually covering the outer surface. *Flowers* 5-merous; *calyx* cupular, membranous, pale cream to fawn, 0.8–0.9 mm long, dissected for 1/5–1/3 of its total length, ciliolate, covered with silky hairs to 0.2 mm long, markedly incurved at the apices, sepals adaxially keeled; *corolla* 1.2–1.5 mm long, dissected for 2/5–1/2 of its length into 5 narrow-oblanceolate to narrow-obovate or narrow-elliptical, glabrous petals; *stamens* with filaments to 2.5 mm long; *ovary* subsessile, ± oblong, sparsely to moderately pubescent; *style* borne centrally on the ovary apex, to c. 2 mm long. *Legumes* linear, straight or very slightly curved, straight-sided or sometimes very slightly constricted between the seeds, 8.0–11.7 cm long, 4.7–6.0 mm wide, papyraceous, pale brown, flat, convex over the seeds, glabrous (only a few mature legumes and no developing legumes were examined). *Seeds* 9–11 longitudinal in the legume, oblongoid to broad-oblongoid or ellipsoid to broad-ellipsoid, 3.6–4.7 mm long, 2.3–2.9 mm wide, mid-brown, smooth, glossy; *pleurogram* open and slightly constricted towards the hilum; *areole* same colour as the rest of the seed, 2–3 mm long, 0.7–1.1 mm wide, with a pale halo 0.15–0.25 mm wide; *funicle* fawn, filiform, expanded into a cap-like aril, folded 3 times beneath the seed and prolonged along one side. *Flowering* April–May, July. *Fruiting* May, October. Figure 5.

DISTRIBUTION: NORTHERN TERRITORY: Darwin and Gulf District: south-western part of Kakadu National Park. Figure 2.

HABITAT: Occurs in dry *Asteromyrtus* heathland on crumbly red kaolinitic soil and in sandstone gorges on deep sands; often near permanent or seasonal streams.

ETYMOLOGY: The specific epithet honours Mr John Brock (1951–), who collected the first specimens of this new species. His extensive collections throughout the Top End have extended our knowledge of its flora as well as raised an awareness of the needs for conservation.

NOTES: *A. brockii* is a distinctive member of sect. *Juliflorae*, being characterised by the caducous, appressed hairs on the phyllodes, the ciliate ribbed bracteoles with acuminate to subulate apices extending beyond the flower-buds, the pale yellow spikes and by fine, long, silvery hairs on the calyces.

SPECIMENS EXAMINED: NORTHERN TERRITORY: Darwin and Gulf District: Barramundie Gorge, 13°19'S, 132°26'E, *Brock*, 16 May 1984 (DNA 25091); Barramundie Gorge, 13°20'S, 132°25'E, *Brock 100*, 11 Jul 1986 (DNA 28309), ditto, *Brock 109*, 8 Oct 1983 (DNA 28310); Kakadu National Park, 13°44'S, 132°37'E, *Dunlop 8543 & Munns*, 21 Apr 1990 (BRI, CANB, DNA, MEL, MO, NSW 236608, PERTH, UC).

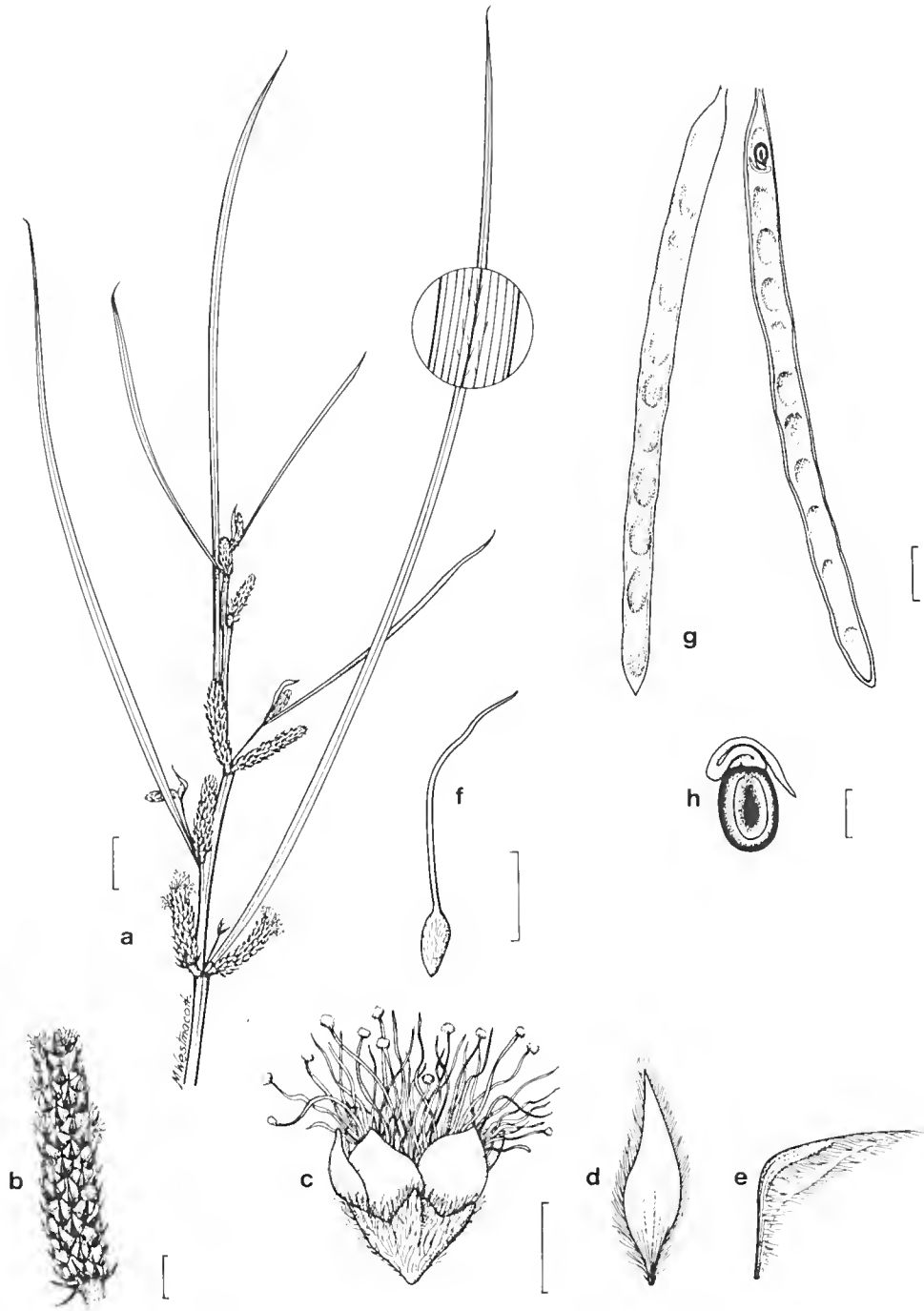

Figure 5. *A. brockii*. **a**, habit study with young inflorescences and inset showing nerves; **b**, young inflorescence; **c**, flower; **d**,**e**, bracteoles; **f**, gynoecium; **g**, legume; **h**, seed (a,b, *Dunlop 8543 & Munns*; c–f, *Brock 100*; g,h, *Brock 109*). a,g, scale bar = 1 cm; b,h, scale bar = 2 mm; c,d,e,f, scale bar = 1 mm.

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Australian hepatic types at the National Herbarium of New South Wales (NSW) and the Ray Herbarium (SYD)

E.A. Brown, H.P. Ramsay and J. Seur

Abstract

E.A. Brown, Ramsay, H.P. & Seur, J. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1992. Australian hepatic types at the National Herbarium of New South Wales (NSW) and the Ray Herbarium (SYD). Telopea *5(1): 67–90.* The National Herbarium of New South Wales and the Ray Herbarium in Sydney, New South Wales hold important collections of type specimens of Austalian hepatics. A total of 99 names are listed here, together with details of the protologue, complete label data for each specimen, other herbaria known to hold part of the type, and recent information concerning the status of the name. Included are many Stephani and Carrington and Pearson names as well as more recent ones described by Hewson and Na-Thalang.

Introduction

While the Hepatic Collections in the two herbaria in Sydney, New South Wales, are not large [6000 specimens, 100 types (NSW) and 2284 specimens, <10 types (SYD)] (Ramsay & Seur 1990), type specimens of many Australian and exotic species are present. Particularly significant collections held at the National Herbarium of New South Wales [NSW] are those of T. Whitelegge, W.W. Watts (including some from W. Gunn), and H.J. Hewson; and at the Ray Herbarium, University of Sydney [SYD], those of Hewson and O. Na-Thalang. The main geographical regions represented by the types are Australia including Lord Howe Island (Whitelegge, Watts, Na-Thalang), presented in this paper, and Vanuatu [New Hebrides] (W. Gunn) and Papua New Guinea (Hewson) to be reported separately.

The earliest descriptions of New South Wales hepatics are those of B. Carrington & W.H. Pearson (1888) who determined and published a list of Whitelegge's collections. R.H. Bastow's work on Tasmanian hepatics (1888, 1914) also included reference to many New South Wales collections. Watts published several papers on Australian hepatics (1902, 1903, 1905) and left a manuscript (1912), as part of a Census of New South Wales Plants, that he had intended publishing in the same way as he had done for the mosses (Watts & Whitelegge 1902, 1906). In this unpublished manuscript he listed species, localities and collector's names for 205 Hepatics and 10 Anthocerotes. The names contained in this unpublished manuscript include many described by F. Stephani based on specimens sent to him for identification (Stephani 1884, 1889; Stephani & Watts 1914).

The cryptogamic collection at NSW was increased greatly in the late 19th and early 20th century by W.W. Watts. After his departure to Victoria in 1916 (Ramsay 1980) curation and addition to the collections was very limited. Conditions at NSW were extremely cramped until 1982 when a new building opened and the W.W. Watts room was set aside for cryptogams.

A period of inactivity in collecting and describing hepatics in New South Wales persisted from 1920 until the mid 1960s, when taxonomic research was undertaken

by G.K. Berrie and R. Carolin's students Hewson and Na-Thalang, at Sydney University. In 1963 Berrie published *Haplomitrium intermedium*, the first member of the Calobryales recorded in Australia, from a type collected in the Blue Mountains (Berrie 1963). Hewson (1970*a*, *b*) revised the family Aneuraceae in Australia and New Guinea while Na-Thalang (1980) revised the genus *Riccia* in Australia. Hewson and Na-Thalang types are located either at SYD or NSW and in some cases at both.

There is still much to be learnt about hepatics in New South Wales; we do not even have a complete species list for this State in which both subtropical and temperate taxa occur. Some recent publications (Ramsay *et al.* 1990, Downing *et al.* 1991) and further studies being undertaken by H.P. Ramsay *et al.* list the hepatics for specific areas in N.S.W. and form the basis for the eventual production of a Census of New South Wales hepatics.

Locating types is essential for taxonomic revisions and a register providing details and locations of type specimens can be useful. Ramsay & Seur (1990) and Ramsay *et al.* (1990) outlined the methods for collection and recording of data for a register of type collections of mosses. Their investigations highlighted the often incomplete information in many type citations in taxonomic literature (e.g. date of collection and collector's number). Since most descriptions of species of hepatics published prior to the 1970s do not cite the herbarium holding the type the holotype cannot be clearly defined. Examining the type specimen and its label data may give important details not included in the protologue.

Method

In this paper we deal only with those hepatic type specimens of Australian species held in the two herbaria named NSW and SYD.

The studies were carried out in a series of steps:

1. All data on each herbarium packet containing specimens designated as types or sp. nov. (i.e. putative types) were recorded on index cards.

2. The type description for each taxon was obtained and the label data compared with that in the protologue. Where these matched, the specimen is recorded as a probable type.

3. Where possible, reference is made to the herbarium holding the major collections of the author of the basionym if this is not NSW or SYD. In most cases, except for species named after the mid 1970s, the holotypes are held in European herbaria and specimens in Australia usually are isotypes. For a number of species a series of specimen numbers were listed with the type description and are syntypes and it may be desirable, therefore, when taxonomic revisions are carried out, to designate a lectotype at that time.

4. References are given for recent studies, name changes, lectotypification etc. for each taxon.

5. To ensure that we have detected all relevant type specimens held at NSW and SYD, we checked publications and searched through all collections at NSW and SYD for specimens not labelled as types but carrying the original label data. As the status of quite a number of specimens had been overlooked in the repackaging at NSW during the early 1980s these further checks, although time-consuming, proved rewarding.

6. The information is now stored on disk and will remain available for future updating.

The register of type specimens of Australian hepatics presented here has been arranged alphabetically by genera and species based on the name for which the specimen is a type. The list contains the original name for each taxon and reference, the protologue **[Proto]** (collection details as cited in the protologue), full label data **[Label]** for each separate specimen (label 1, 2 etc.) at NSW and/or SYD if more than one was present. Also listed are location and status of all types **[Types]** where known (from examination or from literature), synonymy where applicable, as well as any other recent information such as lectotypification **[Comment]**.

At some time in the past many of Watts' collections have been broken up, repacketted and relabelled; the duplicates may all be contained within the one specimen folder or sometimes they have been separated. Where label information does not differ significantly between packets it is usually listed only once, with a note that there are 2 or more specimens; sometimes information on packets within the same specimen folder differs markedly and this has been recorded. The labels on the outer specimen folders has not been recorded as it is only a more recent copy of the information on the Watts' packets.

No taxonomic decisions other than those already in the literature are presented here, nor is lectotypification of any species implied. This is particularly important for taxa described by Stephani; in his later years he broke up many of his specimens and sold duplicates to BM, FH and other institutions. Some of these duplicates, when they come from mixed collections, are not the taxon referred to in the protologue and great care must be taken when typifying. It is probably unwise and inaccurate, therefore, to cite holotypes and this has not been done, even when Stephani specified a collector's number. Herbaria, other than NSW and SYD, holding types have been listed from *Index Hepaticarum. Index Hepaticarum* VIII (Bonner 1976) and prior volumes were used to obtain putative label information for many of the types held at G. E.A. Brown has examined the type specimens from overseas herbaria for the genera *Riccardia* and *Aneura* in the course of other studies (Brown & Braggins 1989).

Register of names

Aneura aequicellularis *Stephani* (Stephani & Watts 1914: 95)

PROTO: 'Australia, New South Wales (Wentworth Falls): Watts legit No. 117 [1117].'

LABEL: NEW SOUTH WALES: Wentworth Falls, cave, *W.W. W[atts] 1117*, Sep 1912.

TYPES: G (lectotype), NSW (isolectotype).

COMMENT: = *Riccardia aequicellularis* (Stephani) Hewson fide Hewson (1970*b*: 79). Lectotypified by Brown & Braggins (1989: 26).

Aneura athertonensis *Hewson* (1970*a*: 188)

PROTO: 'Holotype — Charmillan Creek, Tully Falls Road, Atherton Tableland, on basalt rock on creek bank in disturbed rain-forest, Qld. Hewson, 422, 8.1964 (NSW): Isotype (BRI).'

LABEL: QUEENSLAND: Charmillan Creek, rock, rainforest, basalt, *H.J. Hewson H.64.71.422*, 22 Aug 1964.

TYPES: NSW (179239: holotype), BRI (isotype).

COMMENT: Name in current use.

Aneura coriacea *Stephani* (1917: 23)

PROTO: 'Australia: New South Wales (Watts legit.).'

LABEL: NEW SOUTH WALES: Katoomba Falls, *W.W. Watts 567*, 15 Jan 1902.

TYPES: G (11036: lectotype), NSW (H241: isolectotype).

COMMENT: No particular specimen cited in protologue. The NSW specimen has been annotated by Hewson: 'Isotype of *A. coriacea* = *Riccardia crassa*, published Hewson 1970*b*'. Lectotypified by Brown & Braggins (1989: 85). Specimen in G seen by Stephani is *Watts 567* (Icones Hep. 474).

Aneura eachamensis *Hewson* (1970*a*: 184)

PROTO: 'Holotype — Vision Falls, Lake Eacham, Atherton Tableland, on basalt rock in rain-forest, Queensland. Hewson, 398, 8.1964 (NSW): Isotype (BRI).'

LABEL: QUEENSLAND: Vision Falls, Lake Eacham, *H.J. Hewson H.64.68.398*, 20 Aug 1964.

TYPES: NSW (179240: holotype), BRI (isotype).

COMMENT: Name in current use.

Aneura gigantea *Stephani* (Stephani & Watts 1914: 95)

PROTO: 'Australia, N.S. Wales, (Cambewarra): Watts legit No. 920.'

LABEL: NEW SOUTH WALES: under cliff, above Baldy's, Cambewarra,

W.W. Watts 920, 18 Oct 1907 [3 packets in one specimen folder].

TYPES: G (11042), NSW.

COMMENT: = *Aneura alterniloba* (Hook. f. & Taylor) Taylor & Hook. f. in Gottsche, Lindenb. & Nees var. *gigantea* (Stephani) Hewson; G 11042 and '920 NSW' are cited as the holotype and isotype respectively by Hewson (1970*a*: 187).

Aneura pusilla *Stephani* (Stephani & Watts 1914: 96)

PROTO: 'Australia, (Old Railway Cutting, Blackheath): Watts legit, 1051.'

LABEL: NEW SOUTH WALES: old railway cutting, Blackheath, *W.W. Watts 1051*, Jan 1911 [3 packets in one specimen folder].

TYPES: G (11049: lectotype), NSW (H242: isolectotype).

COMMENT: Listed as a synonym of *Riccardia crassa* (Schwaegr.) Carrington & Pearson (Hewson 1970*a*: 104). Taxon reinstated and transferred to *Riccardia*; lectotypified by Brown & Braggins (1989: 82).

Aneura rodwayi *Hewson* (1970*a*: 188)

PROTO: 'Holotype—Hartz River, Mt. Hartz National Park, on clay soil near river bank, Tas., Hewson, 215, 9.1963, (NSW.).'

LABEL: TASMANIA: Hartz River, Mt Hartz, on soil near river, *H.J. Hewson H63.33.215*, 10 Sep 1963.

TYPE: NSW (179241: holotype).

COMMENT: Name in current use.

Aneura rufescens *Stephani* (Stephani & Watts 1914: 96)

PROTO: 'Australia, New South Wales, (National Pass, Wentworth Falls): Watts legit, 1124.'

LABEL: NEW SOUTH WALES: National Pass, Wentworth Falls, *W.W. Watts 1124*, Sep 1912 [2 packets in one specimen folder].

TYPES: G (11050: lectotype), NSW (H243: isolectotype).

COMMENT: = *Riccardia crassa* fide Hewson (1970*b*: 104). Lectotypified by Brown & Braggins (1989: 85).

Aneura rupicola *Stephani* (1917: 41)

PROTO: 'Australia: New South Wales (Watts legit.).'

LABEL: NEW SOUTH WALES: 1. Shaws Bay, log, *W.W. Watts 579*, 20 Sep 1901; 2. Shaws Bay, Ballina, R[ichmond] R[iver], log, *W.W. W[atts] 579*, 20 Sep 1901 [both packets are in one specimen folder].

TYPES: G (11051 ex Hb Levier 3388), NSW (H248).

COMMENT: G specimen annotated 'Original. Shaw's Bay, east Ballina. Icones Hep. 520'. = *Riccardia rupicola* (Stephani) Hewson; G 11051 cited as holotype and 'NSW 579' as isotype by Hewson (1970*b*: 99).

Aneura walesiana *Stephani* (Stephani & Watts 1914: 97)

PROTO: 'Australia, New South Wales, (Blackheath): Watts legit, 1023.'

LABEL: NEW SOUTH WALES: Horseshoe Falls, Blackheath, wet cliff, *W.W. W[atts] 1023*, 7 Jan 1911 [3 packets in one specimen folder].

TYPES: G (lectotype), NSW (H244: isolectotype).

COMMENT: = *Riccardia crassa* fide Hewson (1970*b*: 104). Lectotypified by Brown & Braggins (1989: 85).

Aneura wattsiana *Stephani* (1917: 46)

PROTO: 'Australia, New South Wales (Watts legit.).'

LABEL: NEW SOUTH WALES: 1. E Ballina, [Richmond River], on tree fern, wet places, *W.W. W[atts] 237*, 2 Mar 1901 (NSW H252); 2. label identical, no NSW number.

TYPES: G (11057 ex Hb Levier 3018), NSW.

COMMENT: No specific locality or specimen number cited in protologue. Specimen in G (11057) has the following data '*W.W. Watts 237*, 1901, Ballina, New South Wales. Icones Hep. 299'. = *Riccardia wattsiana* (Stephani) Hewson; G 11057 cited as holotype and 'NSW 237' as isotype by Hewson (1970*b*: 91). The un-numbered NSW specimen has a second Watts collection attached to it (*Watts 346*).

Archilejeunea australis *Stephani* (1911: 734)

PROTO: 'Australia, New South Wales.'

LABEL: NEW SOUTH WALES: back of Wickham's, nr. Ballina, tree, *W.W. Watts 415*, 3 June 1902.

TYPES: G (ex Hb Levier 3483), NSW.

COMMENT: = *Thysananthus australis* (Stephani) Thiers & Gradstein; specimen in G (ex Hb Levier 3483-*Watts 415*) cited as the holotype by Thiers & Gradstein (1989: 66); no reference is made to the G specimen being labelled as the type by Stephani.

Balantiopsis decurrens *Stephani* (Stephani & Watts 1914: 98)

PROTO: 'Australia, (Wyong): Watts, 985.'

LABEL: NEW SOUTH WALES: gully south of house, 'Kingwell', Wyong, *W.W. Watts 985*, Nov 1907 [3 packets in one specimen folder].

TYPES: G, NSW.

COMMENT: = *B. diplophylla* (Hook. f. & Taylor) Mitten fide Engel (1968: 109, 111).

Balantiopsis hastatistipula *Stephani* (Stephani & Watts 1914: 98)

PROTO: 'Australia, (Blackheath), Watts, 1052.'

LABEL: NEW SOUTH WALES: Blackheath, old railway cutting, *W.W. Watts 1052*, Jan 1911 [2 packets in one specimen folder].

TYPES: G, NSW.

COMMENT: = *Isotachis* sp. fide Engel (1968: 118).

Balantiopsis kingwella *Stephani* (Stephani & Watts 1914: 99)

PROTO: 'Australia (Kingwell, Wyong): Watts 943.'

LABEL: NEW SOUTH WALES: gully south of house, 'Kingwell', Wyong, *W.W. Watts 943*, Nov 1907 [3 packets in one specimen folder].

TYPES: G, NSW.

COMMENT: = *B. diplophylla* fide Engel (1968: 109, 111).

Balantiopsis subkingwella *Stephani* (Stephani & Watts 1914: 99)

PROTO: 'Australia (Kingwell, Wyong): Watts 945, 971[a].'

LABEL: NEW SOUTH WALES: 1. 'Kingwell', Wyong, *W.W. W[atts] 945*, 20 Aug 1909; 2. 'Kingwell', Wyong, gully south of house, *W.W. Watts 971a*, Nov 1907 (NSW H285) [2 packets in one specimen folder].

TYPES: G, NSW.

COMMENT: = *B. diplophylla* fide Engel (1968: 109, 111). *Watts 971b* is the type of *Mastiogobryum corbieri* Stephani, see below.

Brachiolejeunea robusta *Stephani* (1912: 141)

PROTO: 'Australia. New South Wales.'

LABEL: NEW SOUTH WALES: 1. Hopkins Creek, Stanwell Park, rocks, *W.W. W[atts] 830*, May 1905; 2. Hopkins Creek, Stanwell Park, *[W.W.] Watts 830*, May 1905.

TYPES: FH, G (ex Hb Levier 4882), NSW, U.

COMMENT: Specimen in G (Hb Levier 4882-*Watts 830*) cited as holotype and FH as isotype by Thiers & Gradstein (1989: 64) but there is no supporting discussion. Reduced to synonymy under *Spruceanthus thozetianus* (Gottsche & F. Muell.) Thiers & Gradstein.

Chiloscyphus maximus *Stephani* (Stephani & Watts 1914: 103)

PROTO: 'Australia (Etta's Glen, Black Spur, Vict.): Watts, 968.'

LABEL: VICTORIA: Etta's Glen, Black's Spur, Healesville, *W.W. Watts 968 & 968a*, 21 Dec 1906 [5 packets in one specimen folder].

TYPES: G, NSW.

COMMENT: The NSW specimen consists of 5 small packets variously labelled *Watts 968*, *Watts 968a* or *Watts 968 + 968a*. All are annotated '*Chiloscyphus maximus* St. sp. n. 1913' in Watts' hand. Apparently a large variety of *C. coalitus* (Hook.) Nees in Gottsche, Lindenb. & Nees (Scott 1985: 133).

Chiloscyphus montanus *Stephani* (Stephani & Watts 1914: 103)

PROTO: 'Australia (Neate's Glen, Blackheath): Watts, 927.'

LABEL: NEW SOUTH WALES: Rotunda, Neate's Glen, B[lack]heath, on damp ground base of cliff, *W.W. Watts 927*, 7 Apr 1903 [3 packets in one folder].

TYPES: G, NSW.

COMMENT: = *Geocalyx caledonicus* Stephani fide Grolle (1979).

Fimbriaria dioica *Stephani* (Stephani & Watts 1914: 104)

PROTO: 'Australia, N.S. Wales (near Gladesville): Watts 1095.'

LABEL: NEW SOUTH WALES: off Pittwater Road, Gladesville, *W.W. Watts 1095 & [J.F.] Shirley*, Nov 1911 [3 specimens in one folder].

TYPES: G, NSW.

COMMENT: *Fimbriaria* is an illegitimate name but this taxon has not been formally transferred to *Asterella*, where it belongs. This group is under revision.

Fossombronia grossepapillata *Stephani* (1917: 73)

PROTO: 'Australia (Watts legit.).'

LABEL: NEW SOUTH WALES: park, Young, (mining holes), *W.W. Watts 988*, Sep-Oct 1906 [3 packets in one folder].

TYPES: G (22171), NSW.

COMMENT: G 22171 (*Watts 988*) designated as type specimen by Scott & Pike (1988: 196).

Fossombronia integrifolia *Stephani* (1917: 73)

PROTO: 'Australia orientalis (N.S. Wales).'

LABEL: NEW SOUTH WALES: 1. Parramatta, *E. Cheel (Hb Watts 799)*, 1 Oct 1910 [2 packets]; 2. Rookwood, Sydney, *E. Cheel (Hb Watts 812)*, 5 Aug 1900 [2 packets].

TYPES: FH (812), G (22174), NSW.

COMMENT: Specimens of *Watts 812* held at FH and G designated as the type by Scott & Pike (1988: 197).

Fossombronia wattsii *Stephani* (1917: 75)

PROTO: 'Australia, New South Wales (Watts legit.).'

LABEL: NEW SOUTH WALES: The Gap, near Young, *W.W. W[atts] 881*, 26 Sep 1905.

TYPES: G (Hb Levier 5155), NSW.

COMMENT: No locality or specimen number cited in protologue but G specimen of *Watts 881* cited as type in Bonner (1965: 221). Type material (at NSW) checked and studied by Pike: 'abnormal spores present 8/3/82'.

Frullania asperifolia *Stephani* (Stephani & Watts 1914: 105)

PROTO: 'Australia (Yarrangobilly Caves & Mount Wilson): Watts 1093, etc).'

LABEL: NEW SOUTH WALES: 1. Yarrangobilly Caves, *W.W. Watts 923*, Jan 1906; 2. 'Yarrawa', Mt Wilson, *W.W. Watts 1063*, 10 Jan 1911; 3. Denmarque, Mt Wilson, *W.W. Watts 1078*, 13 Jan 1911; 4. Falls beyond Kiandra road, Yarrangobilly Caves, *W.W. Watts 926*, Jan 1906; 5. Yarrangobilly [Caves], gully beyond hostel, *W.W. Watts 922*, Jan 1906; 6. Avenue, Mt Wilson, *W.W. Watts 1093*, 11 Jan 1911.

TYPES: G (18193), NSW.

COMMENT: Although two localities were cited in the protologue only one number (*Watts 1093*) was given and this is cited as the type by Bonner (1965: 239). Hattori (1979*a*) cites the type as 'G18193, the Avenue, Mt Wilson, 3500 ft on tree Jan 11, 1911, leg. W.W. Watts (Hep. Aust. ex Herb. Watts 109 [= 1093])' and considers this taxon conspecific with *F. falciloba* Taylor ex Lehm.

Frullania australis *Stephani* (1911: 659)

PROTO: 'Australia orientalis, New South Wales.'

LABEL: NEW SOUTH WALES: E Ballina, tree, *W.W. Watts 117*, 14 Aug 1900 [3 packets in one folder].

TYPES: G (18194 ex Hb Levier 2638), NSW.

COMMENT: G 18194 is cited as the type by Bonner (1965: 241), without the Watts collection number. Known only from the type collection (Hattori 1979*b*: 123).

Frullania belmorensis *Stephani* (Stephani & Watts 1914: 106)

PROTO: 'Australia (Belmore Falls): Watts, 931.'

LABEL: NEW SOUTH WALES: Belmore Falls, *W.W. Watts 931*, 5 Oct 1908 [3 packets in one folder].

TYPES: G, NSW.

COMMENT: Known only from the type collection (Hattori 1979*b*: 126).

Frullania difficilis *Stephani* (1889: 160)

PROTO: 'Australia, New South Wales.'

LABEL: NEW SOUTH WALES: Park, Gray's Island, Richmond River, *W.W. Watts 125*, 6 May 1900.

TYPES: G (ex Hb Levier 2632), MEL 61558, NSW.

COMMENT: No specimen number or specific locality is cited in the protologue but the type is cited by Bonner (1965: 288) as 'New South Wales, Richmond River, Pearce's Creek, 2 VIII 1900, W.W. Watts s.n., Hb Levier 2632 in Hb G'. Hattori (1987: 553) lists a number of other possible syntypes (including the above NSW specimen) and places *F. difficilis* in synonymy under *Frullania (Trachycolea) seriata* Gottsche ex Stephani.

Frullania elongata *Stephani* (1910: 423)

PROTO: 'Australia orientalis.'

LABEL: NEW SOUTH WALES: Pearce's Creek nr R. Trimble's, bark of old tree stump, *W.W. Watts 96*, 2 Aug 1900.

TYPES: G, NSW.

COMMENT: *Watts 96* is cited by Bonner (1965: 296) as the type. = *F. rubella* fide Hattori (1979*a*: 354); = *F. rubella* Gottsche ex Stephani var. *elongata* (Stephani) Hattori fide Hattori (1983: 165).

Frullania excisula *Stephani* (Stephani & Watts 1914: 107)

PROTO: 'Australia, N.S. Wales (Mount Wilson and Blackheath): Watts 1030, 1071.'

LABEL: NEW SOUTH WALES: 1. Horseshoe Falls to Jungle, Blackheath, (rock by track), *W.W. Watts 1030*, 7 Jan 1911 [2 packets]; 2. Yarrawa, Mt Wilson, *W.W. Watts 1071*, 11 Jan 1911 [3 packets].

TYPES: G, MEL, NSW.

COMMENT: Bonner (1965: 229) cited *Watts 1017* [= *1071*] as the type. The NSW specimens of both *Watts 1030* and *1071* are annotated by S. Hattori Apr. 1986: 'not type of *F. squarrulosa* but syntype of *F. excisula*'. *F. excisula* seems to be conspecific with *Frullania falciloba* (Hattori 1979*a*: 336).

Frullania ferdinandi-muelleri *Stephani* (1910: 417)

PROTO: 'Australia, New South Wales.'

LABEL: NEW SOUTH WALES: Tintenbar(?), R[ichmond] R[iver], tea tree bark, *W.W. Watts 153*, 2 Aug 1900.

TYPES: G (18211 ex Hb Levier 2628), NSW.

COMMENT: No information on locality, date, collector or specimen number(s) appears in the protologue but Hattori (1979*a*) describes this species as known only from the type collection and cites G 18211 as the type.

Frullania filipendula *Stephani* (1910: 419)

PROTO: 'Australia, Queensland, New South Wales.'

LABEL: NEW SOUTH WALES: E Ballina, base of saplings and on ground, heath, *W.W. Watts 468*, 17 June 1902 [2 packets in folder].

TYPES: G (18212 ex Hb Levier 3416), NSW.

COMMENT: No information on locality, date, collector or specimen number(s) appears in the protologue but Bonner (1965: 304) cites this specimen (G 18212) as the type. Seems to be conspecific with *F. rubella* (Hattori 1979*a*: 340).

Frullania howeana *Stephani* (Stephani & Watts 1914: 107)

PROTO: 'Lord Howe Island. (Watts 62).'

LABEL: NEW SOUTH WALES: near Face, east side of Mt Lidgbird, L[ord] H[owe] I[sland], *W.W. W[atts] 62*, 27 July 1911 [2 packets in folder].

TYPES: G (18215), NSW.

COMMENT: Endemic, known only from the type collection (Hattori 1979*a*: 346).

Frullania minutistipula *Stephani* (Stephani & Watts 1914: 108)

PROTO: 'Australia (Rodriguez Pass): Watts 1001^{b},1001^{c}.'

LABEL: NEW SOUTH WALES: Rodriguez Pass, Blackheath, *W.W. Watts 1001b & c*, 4 Jan 1911.

TYPES: G, NSW.

COMMENT: NSW specimen has been annotated (by Watts?): 'mixed with *Frullania gracillima* sp. n. and *Radula wattsiana*'. = *F. rostrata* (Hook. f. & Taylor) Hook. f. & Taylor ex Gottsche, Lindenb. & Nees fide Hattori (1979*a*: 352).

Frullania simmondsii *Stephani* (Stephani & Watts 1914: 109)

PROTO: 'Australia (near Brisbane): Simmonds leg. (Watts 1110).'

LABEL: QUEENSLAND: near Brisbane, *J.H. Simmonds, Hb Watts 1110*, 27 Aug 1887.

TYPES: G, NSW.

COMMENT: NSW specimen annotated as isotype by Hattori. Known only from the type collection (Hattori 1979*b*: 143).

Frullania subtropica *Stephani* (1910: 416)

PROTO: 'Australia, New South Wales.'

LABEL: NEW SOUTH WALES: off Tintenbar road, 3 miles [5 km] from Ballina, Richmond River, tree, *W.W. Watts 107*, 30 June 1900.

TYPES: G (18230 ex Hb Levier 2602), NSW.

COMMENT: Protologue does not include locality, date, collector or specimen information but G 18230 is cited as the type by Bonner (1965: 440).

Frullania variabilis *Stephani* (1910: 420)

PROTO: 'Australia, New South Wales.'

LABEL: NEW SOUTH WALES: Cambewarra Mtn, *W.W. W[atts] 628*, 22 May 1903.

TYPES: G (ex Hb Levier 4416), NSW.

COMMENT: Protologue does not include locality, date, collector or specimen information but the above specimen in G (Hb Levier 4416) is cited as the type by Bonner (1965: 462). Known only from the type collection; probably a form of *F. pycnantha* (Hook. f. & Taylor) Taylor ex Gottsche, Lindenb. & Nees (Hattori 1979*b*: 149).

Haplomitrium intermedium *Berrie* (1963: 191)

PROTO: 'Between one and two miles along the road from Bilpin to Mount Irvine, Blue Mountains, N.S.W. HOLOTYPE: Sydney University Herbarium, Bryophyte No. 2/62. COTYPE: Professor R.M. Schuster Collection No. 50,616.'

LABEL: see below

TYPES: SYD (holotype; not located).

COMMENT: Probably on loan, but record not found.

Isotachis grandis *Carrington & Pearson* (1888: 1041)

PROTO: 'On wet rocks, Lawson, Blue Mountains, June, 1884.'

LABEL: NEW SOUTH WALES: 1. Lawson, Blue Mountains, on wet rocks, [*T. Whitelegge*], June 1884; 2. Lawson, no 14 liverwort, [*T. Whitelegge*], June 1884.

TYPES: BM, MANCH?, NSW.

COMMENT: The former NSW specimen has been further annotated by Whitelegge: '17 *Isotachis grandis* n. sp. (small portion of stem) plXXVI 34 TW W.H.P.' and the latter has the additional information: '17 N. sp. No 34 P. *Isotachis grandis*'. Probably no. 34 of a batch sent to Pearson by Whitelegge.

Isotachis terricola *Stephani* (Stephani & Watts 1914: 10)

PROTO: 'Australia (Blackheath): Watts, 1016.'

LABEL: NEW SOUTH WALES: short cut to Neate's Glen, Blackheath, creek, swamp, *W.W. Watts 1016*, 5 Jan 1911 [3 packets in folder].

TYPES: G, NSW.

COMMENT: = *I. intortifolia* (Hook. f. & Taylor) Gottsche fide Hatcher (1960: 602).

Jungermannia wattsiana *Stephani* (1917: 96)

PROTO: 'Australia, New South Wales (Watts legit.)'

LABEL: NEW SOUTH WALES: 1. Alst[onville] Cutting, 7 miles [11 km] nearly, *W.W. Watts 303*, 24 June 1901; 2. Alstonville Cutting, R[ichmond] R[iver], nearly 7 miles [11 km] from Ballina, *W.W. W[atts] 303*, 24 June 1901.

TYPES: G (14307 ex Hb Levier 3141), NSW.

COMMENT: No specimen numbers given in protologue but Bonner (1976: 410) cites the type as: 'NSW, Alstourith [= Alstonville] cutting, 7 miles from Ballina, 24.June.1901, Rev. Watts 303, Hb Levier 3141, Hb G 14307.'

Jungermannia whiteleggei *Carrington & Pearson* (1888: 1051)

PROTO: no specimens cited.

LABEL: NEW SOUTH WALES: Moore Park, [Sydney], [*T. Whitelegge*] *37*, Dec 1884.

TYPES: K or MANCH?, NSW.

COMMENT: The NSW specimen has been annotated by Whitelegge: '*Jungermannia whiteleggei* n. sp., pl XXXII 36 T.W. W.H.P.' It is probably no. 36 of a batch sent to W.H. Pearson. No specimen information is given in the protologue but the information on the packet is consistent with that found on other type specimens sent by Whitelegge to Pearson. = *Chaetophyllopsis whiteleggei* (Carrington & Pearson) R. Schuster fide Schuster (1960: 69).

Lejeunea wildii *Stephani* (1889: 165)

PROTO: 'Queensland, leg. C. Wild. - Herb. Brotherus.'

LABEL: QUEENSLAND: Hamilton, *C.[J.] Wild*, July 1887 [2 identically labelled specimens].

TYPES: G (15847), BM, MANCH, MEL, NSW (H495 & H496).

COMMENT: G 15847 cited as holotype and BM, MANCH and MEL as isotypes by Thiers & Gradstein (1989: 6); almost certainly the only specimen matching the protologue. Reduced to synonymy under *Acrolejeunea securifolia* (Nees) Stephani ex Watts ssp. *securifolia* by Thiers & Gradstein.

Lembidium dendroides *Carrington & Pearson* (1888: 1047)

PROTO: 'On wet earth, Mermaids Glen, Blackheath, Blue Mountains, 3,000ft. September 5, 1885.—T. Whitelegge.'

LABEL: NEW SOUTH WALES: Mermaids Glen, Blackheath, Blue Mts, on wet earth, [*T. Whitelegge*] *28*, 5 Sep 1885 [2 similarly labelled specimens].

TYPES: BM, NSW (H170 & H171).

COMMENT: NSW specimens annotated by Whitelegge: '*Lembidium dendroides* n. sp., No. 16 P.' and is probably no. 16 of a batch sent to Pearson. Although no collector's number is cited in the protologue all other label data are consistent with these NSW specimens being part of the type. = *Kurzia dendroides* (Carrington & Pearson) Grolle fide Grolle (1963: 175). Still known only from the type (Schuster 1980: 394).

Lepidozia appressifolia *Stephani* (1909: 583)

PROTO: 'Australia orientalis (Watts); Tasmania (Moore)'

LABEL: NEW SOUTH WALES: Katoomba Falls, Blue Mountains, *W.W. Watts 571*, 15 Jan 1902.

TYPES: G, NSW.

COMMENT: NSW specimen of *Watts 571* is labelled 'TYPE' in Watts' handwriting.

Lepidozia buffalona *Stephani* (Stephani & Watts 1914: 111)

PROTO: 'Australia, (Buffalo Creek, near Gladesville; Blue Mountains and Cambewarra): Watts 977, 941, 978, 965, 982, 914 etc).'

LABEL: NEW SOUTH WALES: 1. Centennial Glen, B[lack]heath, *W.W. W[atts] 1045*, 11 Jan 1911; 2. Horseshoe Falls, Blackheath, wet cliffs, *W.W. W[atts] 1025*, 7 Jan 1911; 3. Rotunda, Blackheath, *W.W. Watts 1011*, 4 Jan 1911 [3 packets]; 4. Cambewarra Mtn, damp places under cliffs above Baldys, *W.W. W[atts] 914*, Oct 1907.

TYPES: G, NSW.

COMMENT: Icones Hep. Steph. 5076 is based on *Watts 977* (Geissler & Bischler 1985: 21).

Lepidozia communis *Stephani* (Stephani & Watts 1914: 111)

PROTO: 'Australia, (Grand Canyon, Blackheath): Watts, 1014.'

LABEL: NEW SOUTH WALES: Grand Canyon, Blackheath, *W.W. Watts 1014*, 4 Jan 1911 [3 packets in folder].

TYPES: G, NSW.

COMMENT: Name in current use.

Lepidozia crassitexta *Stephani* (Stephani & Watts 1914: 111)

PROTO: 'Australia, (Rodriguez Pass, Blackheath): Watts, 1005.'

LABEL: NEW SOUTH WALES: Rodriguez Pass, Blackheath, *W.W. Watts 1005*, 4 Jan 1911 [3 packets in folder].

TYPES: G, NSW.

COMMENT: Name in current use.

Lepidozia furcatifolia *Stephani* (Stephani & Watts 1914: 112)

PROTO: 'Australia, (Horse Shoe Falls, Blackheath): Watts, 1027.'

LABEL: NEW SOUTH WALES: 1. Horse Shoe [Horseshoe] Falls, Blackheath, wet cliff, *W.W. Watts 1027*, Jan 1911; 2. Horse Shoe [Horseshoe] Falls, Blackheath, wet cliff, *W.W. Watts 1027b*, Jan 1911 [2 packets].

TYPES: G, NSW (Watts 1027, also? 1027b).

COMMENT: The NSW specimen of *W.W. Watts 1027(b)*, which is labelled 'TYPE' (probably Watts' handwriting), may also be part of the type.

Lepidozia gracillima *Carrington & Pearson* (1888: 1045)

PROTO: 'on wet rocks, Botany Bay, June, 1885'

LABEL: NEW SOUTH WALES: 1. Botany Bay, on wet rocks, [*T. Whitelegge 24*], June 1885; 2. Botany Bay, on wet rocks, [*T. Whitelegge 24*], June 1885.

TYPES: BM or MANCH?, NSW.

COMMENT: The former NSW specimen has been annotated by Whitelegge: *'Lepidozia gracillima* n. sp. plXXVII, 51 TW. W.H.P.' and the latter: '24 N. sp. No 51.P. *Lepidozia gracillima'*. Probably no. 51 of a batch sent to Pearson by Whitelegge.

Lepidozia hastatistipula *Stephani* (Stephani & Watts 1914: 113)

PROTO: 'Australia, (Healesville, Vict.): Watts, 966.'

LABEL: VICTORIA: 'Airlee', Healesville, (by summer house), *W.W. Watts 966*, 22 Dec 1906 [2 similarly labelled packets in specimen folder].

TYPES: G, NSW (H159).

COMMENT: Name in current use.

Lepidozia lateconica *Stephani* (Stephani & Watts 1914: 113)

PROTO: 'Australia, (Barron Falls, North Queensland; leg Mrs Brotherton) Watts, 976.'

LABEL: QUEENSLAND: 1. Kuranda, *Mrs Brotherton, W.W. Watts 976*, June 1910 [3 similarly labelled packets in folder]; 2. Kuranda, Barron Falls, *Mrs Brotherton, W.W. Watts 976*, June 1910 (NSW H160).

TYPES: G, NSW.

COMMENT: = *Kurzia lateconica* (Stephani) Grolle fide Grolle (1963: 175). Apparently known only from the type (Schuster 1980: 387).

Lepidozia microstipula *Stephani* (Stephani & Watts 1914: 114)

PROTO: 'Australia, (Lane Cove River, above Fig Tree Bridge): Watts, 958.'

LABEL: NEW SOUTH WALES: 1. Lane Cover River, under rocks, old residential area, first wharf above Fig Tree, *W.W. Watts 958*, Nov 1910; 2. Near Lane Cove River, above Hunters Hill, under rock in old residential area, *W.W. Watts 958*, Nov 1910 [2 packets in folder: NSW H161].

TYPES: G, NSW.

COMMENT: Name in current use.

Lepidozia multifida *Stephani* (Stephani & Watts 1914: 114).

PROTO: 'Australia, New South Wales (Blue Mountains): Watts, 974, 975, 964.'

LABEL: NEW SOUTH WALES: 1. Water Nymphs Dell, Wentworth Falls, *W.W. Watts 974*, 3 Jan 1910; 2. Nymphs Dell, Wentworth Falls, *W.W. Watts 975*, 3 Jan 1910 [3 packets in folder, 2 mistranscribed as Jan 1911]; 3. Loc?, [*W.W. Watts*] *964*, 1910.

TYPES: G, NSW.

COMMENT: Name in current use.

Lepidozia nova *Stephani* (Stephani & Watts 1914: 115)

PROTO: 'Australia, (Blue Mountains and Mount Wilson): Watts, 1033, 1054 and 1066.'

LABEL: NEW SOUTH WALES: 1. Mermaids Glen, Blackheath, *W.W. Watts 1054*, 3 Jan 1911; 2. Mermaids Glen, Blackheath, *W.W. W[atts] 1054*, 3 Jan 1911 (NSW H162); 3. Track from Horse Shoe [Horseshoe] Falls to Jungle, Blackheath, *W.W. Watts 1033*, Jan 1911; 4. Horse Shoe [Horseshoe] Falls to jungle, Blackheath, *W.W. W[atts] 1033*, 7 Jan 1911 (NSW H163); 5. 'Yarrawa', Mt Wilson, *W.W. Watts 1066*, 11 Jan 1911 [2 packets].

TYPES: G, NSW.

COMMENT: Name in current use.

Lepidozia quadriseta *Stephani* (1909: 582)

PROTO: 'N. South Wales (Watts).'

LABEL: NEW SOUTH WALES: 1. Horseshoe Falls, Blackheath, W.W. *W[atts] 1027*, 7 Jan 1911 (NSW H164); 2. E Ballina, swamp, heath, *W.W. Watts 433*, 11 June 1902.

TYPES: G, NSW.

COMMENT: NSW H164 has been annotated 'type' by Watts. = *Telaranea tetradactyla* (Hook. f. & Taylor) E. Hodgson fide Grolle (1963).

Lepidozia quadristipula *Stephani* (Stephani & Watts 1914: 115)

PROTO: 'Australia, (Rotunda, Neate's Glen, Blackheath): Watts 1009.'

LABEL: NEW SOUTH WALES: 1. Rotunda, Blackheath, *W.W. Watts 1009*, 4 Jan 1911; 2. Rotunda, Blackheath, *W.W. Watts 1009*, 4 Jan 1911 (NSW H167).

TYPES: G, NSW.

COMMENT: Name in current use.

Lepidozia septemfida *Stephani* (1909: 588)

PROTO: 'Australia, N.S. Wales (Watts).'

LABEL: NEW SOUTH WALES: Katoomba Falls, *W.W. Watts 574*, 15 Jan 1902.

TYPES: G, NSW (H212).

COMMENT: NSW specimen annotated by Watts: 'Co-type. Mixed with *L. appressifolia*.' Name in current use.

Lepidozia tripilosa *Stephani* (Stephani & Watts 1914: 116)

PROTO: 'Australia, (Centennial Glen, Blackheath): Watts, 1043.'

LABEL: NEW SOUTH WALES: Centennial Glen, Blackheath, W.W. *Watts 1043*, 10 Jan 1911 [2 similarly labelled packets in specimen folder].

TYPES: G, NSW.

COMMENT: Icones Hep. Steph. n. 5100 is based on *Watts 1043* (Geissler & Bischler 1985: 47).

Leptocolea wattsiana *Stephani* (1916: 856)

PROTO: 'Australia. New South Wales.'

LABEL: NEW SOUTH WALES: 1. nr. beach, H. C[ree]k, [*W.W. Watts*] *232*, Mar 1901; 2. on tree by J.W. Sharpe's sliprails, nr. beach, above Ballina, *W.W. Watts 232*, Mar 1901 [both specimens in same folder].

TYPES: G, NSW.

COMMENT: Specimen 1 above further annotated by Watts: '*Cololejeunea wattsiana* sp. n. in letter from Dr. Levier July '02'. It has not been possible to identify the locality of 'H. Ck' or 'J.W. Sharpe's sliprails'. Specimen of *Watts 232* at G cited as holotype and NSW specimen as isotype by Thiers (1988: 123) who does not indicate if the G specimen has been labelled as the type by Stephani. Reduced to synonymy under *Cololejeunea lanciloba* Stephani by Thiers.

Marchantia paludicola *Stephani* (Stephani & Watts 1914: 120)

PROTO: 'Australia, New South Wales, (Cambewarra): Watts, 1106, 1102.'

LABEL: NEW SOUTH WALES: 1. above Baldys, Cambewarra Mountain, *W.W. W[atts] 1106*, 18 Oct 1907; 2. above Baldys, Cambewarra Mountain, [*W.W.*] *Watts 1106*, Oct 1907; 3. In swamp, 3900 ft [1170 m], Mt Werong, *R.H. Cambage*, 4 Dec 1911, Hb Watts No. 1102.

TYPES: G, NSW.

COMMENT: NSW specimen collected by *R.H. Cambage* has been further annotated 'co-type' whilst the other two NSW specimens have been annotated 'type' by Watts. = *Marchantia berteroana* Lehm. & Lindenb. fide Bischler-Causse (1989: 82). NSW specimens cited as syntypes by Bischler-Causse.

Marchantia wattsiana *Stephani ex Bonner* (Bonner 1953: 112)

PROTO: 'Australia: New South Wales, on stone in Whian Creek, Federal, Richmond River, 13 Aug 1902, Watts, s.n. (Hb Levier 4529), lectotype; Miami [= Minmi] July 1901 Watts 317 (Hb Levier 3116 bis); Richmond River, 1901, Watts 308 (Hb Levier 3111).'

LABEL: NEW SOUTH WALES: 1. Whian Whian Creek, Federal, Richmond River (above Crossing), on stone, *W.W. Watts 512*, 13 Aug 1902; 2. Richmond River, probably Shaw's Bay, *W.W. Watts 308*, 1901; 3. loc.?, perhaps Minmi, *W.W. Watts 317*, July 1901.

TYPES: G (ex Hb Levier 4529: lectotype), NSW.

COMMENT: In 1953 Bonner published a Stephani manuscript, adding to the protologue a lectotype and list of specimens based on Stephani's herbarium at G; he did not examine Watts' collections held at NSW. = *Marchantia pileata* Mitten fide Bischler-Causse (1989: 119) who considers Stephani's description to be based, at least partly, on *Watts 308*.

Mastigobryum corbieri *Stephani* (Stephani & Watts 1914: 122)

PROTO: 'Australia, (Kingwell, Wyong): Watts, 971[b].'

LABEL: NEW SOUTH WALES: gully south of house, 'Kingwell', Wyong, *W.W. Watts 971b*, Nov 1907 [2 similarly labelled specimens].

TYPES: G, NSW (H286 & H301).

COMMENT: *Mastigobryum* is an illegitimate name but this taxon has never been formally transferred to *Bazzania*, where it belongs (Scott & Bradshaw 1986: 67). *Watts 971a* is the type specimen of *Balantiopsis subkingwella*, see above.

Mastigobryum dentistipulum *Stephani* (Stephani & Watts 1914: 122)

PROTO: 'Australia, New South Wales (Lane Cove River and Valley of Waters): Watts 1096, 1129, 1104.'

LABEL: NEW SOUTH WALES: 1. Lane Cove River, *W.W. Watts 1096*, May 1912 (NSW H287); 2. Valley of Waters [Wentworth Falls], *W.W. Watts 1129*, [3 packets in folder: NSW H288]; 3. Lane Cove River, *W.W. Watts 1104*, May 1912.

TYPES: G, NSW.

COMMENT: NSW H287 & H288 have been annotated 'co-type' and 'type' respectively by Watts. *Mastigobryum* is an illegitimate name but this taxon has never been formally transferred to *Bazzania*, where it belongs (Scott & Bradshaw 1986: 67).

Mastigobryum erosifolium *Stephani* (Stephani & Watts 1914: 122)

PROTO: 'Australia (Cambewarra Mountain): Watts legit, 917.'

LABEL: NEW SOUTH WALES: 1. Damp places under cliff, Cambewarra Mountain, *W.W. Watts 917*, Oct 1907; 2. Under cliff, above Baldy's, Cambewarra, *W.W. Watts 917*, Oct 1907.

TYPES: G (15074), NSW (H302 & H289).

COMMENT: = *Acromastigum colensoanum* (Mitten) Evans ex Reimers fide Grolle (1972: 547).

Mastigobryum gracillimum *Stephani* (Stephani & Watts 1914: 123)

PROTO: 'Australia, New South Wales, (Wyong and Valley of Waters): Watts, 939, 987.'

LABEL: NEW SOUTH WALES: 1. Gully south of house, 'Kingwell', Wyong, *W.W. Watts 939*, Nov 1907 [2 specimens in separate folders: original Watts packet is NSW H291]; 2. S Wyong, *W.W. Watts 987*, 1909 (NSW H292); 3. Valley of Waters [Wentworth Falls], *W.W. W[atts] 1130*, Sep 1912 (NSW H290) [3 packets in folder].

TYPES: G, NSW.

COMMENT: The NSW specimens of *Watts 1130* are annotated: '*Mastigobryum gracillimum* St. sp. n. Jan 1913' (the specimens of *Watts 939 & 987* are similarly labelled but lack the 'sp. n.' designation). *Mastigobryum* is an illegitimate name but this taxon has never been formally transferred to *Bazzania*, where it belongs (Scott & Bradshaw 1986: 67).

Mastigolejeunea wattsiana *Stephani* (1912: 780)

PROTO: no specimens cited.

LABEL: NEW SOUTH WALES: Wallace's Hill, Possum Shoot, R[ichmond] R[iver], on vine, *W.W. W[atts] 350*, Oct 1901.

TYPES: FH, G (21835), NSW.

COMMENT: G 21835 (*Watts 350*) cited as holotype and FH as isotype by Thiers & Gradstein (1989: 50) who do not indicate if the G specimen has been labelled as the type by Stephani. Reduced to synonymy under *Mastigolejeunea ligulata* (Lehm. & Lindenb.) Schiffner by Thiers & Gradstein.

Metzgeria howeana *Stephani* (Stephani & Watts 1914: 126)

PROTO: 'Australia, Mount Wilson and Wyong: Watts legit 1065.'

LABEL: NEW SOUTH WALES: 1. 'Yarrawah', Mt Wilson, *W.W. W[atts] 1065*, 11 Jan 1911; 2. gully over mountain SW of 'Kingwell', Wyong, *W.W. Watts 948*, 24 Aug 1910.

TYPES: G, NSW.

COMMENT: There are four other NSW collections from Yarrawa (*Watts 1058, 1061, 1069 & 1072*), all dated 11 Jan 1911 and annotated 'co-type'. The NSW specimen from Wyong is annotated 'type' in Watt's hand. This species is not listed in Scott & Bradshaw (1986); name in current use.

Pallavacinia campanulata *Stephani* (Stephani & Watts 1914: 127), as 'Pallavacinius'

PROTO: 'Australia, New South Wales, (Valley of Waters): Watts legit, 1111.'

LABEL: NEW SOUTH WALES: Valley of Waters [Wentworth Falls], [*W.W.*] *Watts 1111*, Sep 1912 [2 packets in folder].

TYPES: G, NSW (H224).

COMMENT: Name in current use.

Physocolea casuarinae *Stephani* (1916: 909)

PROTO: 'Australia orientalis. New South Wales.'

LABEL: NEW SOUTH WALES: 1. Fig Tree, Lane Cove R[iver], [Sydney], on *Casuarina, W.W. W[atts] 792*, 1903; 2. bottom of gully above bridge, Fig Tree, Lane Cove River, on *Casuarina*, [*W.W.*] *Watts 792*, 1903 [both specimens are in the same folder].

TYPES: G (17524), NSW.

COMMENT: G 17524 (*Watts 792*) cited as holotype by Thiers (1988: 134) who does not indicate if the G specimen is labelled as the type by Stephani. Reduced to synonymy under *Cololejeunea minutissima* (Smith) Schiffner by Thiers.

Plagiochasma queenslandicum *Stephani* (1917: 9)

PROTO: 'Australia, Queensland (Simmonds legit).'

LABEL: QUEENSLAND: *ex Hb Simmonds, Watts Q258*, Aug 1887.

TYPES: G, NSW.

COMMENT: = *Reboulia hemisphaerica* fide Bischler (1979: 76). Recently reinstated as *Reboulia queenslandica* (Stephani) Hicks fide Hicks (1992: 114) who cites the type as nr Brisbane, *J.H. Simmonds 16340*, 1887, Herb. Watts 611 (4490) (G, FI [FH]).

Plagiochila rossii *Stephani* (Stephani & Watts 1914: 130)

PROTO: 'Australia, N.S. Wales (The Jungle, Blackheath): Watts 1035.'

LABEL: NEW SOUTH WALES: Blackheath, The Jungle, *W.W. Watts 1035*, 7 Jan 1911 [3 packets in folder].

TYPES: G, NSW (H344).

COMMENT: = *Plagiochila baileyana* Stephani fide Inoue (1986: 377).

Plagiochila serrifolia *Stephani* (Stephani & Watts 1914: 130

PROTO: 'Australia, New South Wales (Wyong): Watts, 1100.'

LABEL: NEW SOUTH WALES: gully over mountain SW of 'Kingwell', Wyong, [*W.W.*] *Watts 1100*, 23 Aug 1910 [2 packets in folder].

TYPES: G, NSW (H345).

COMMENT: = *Plagiochila vitiensis* Mitten fide Inoue (1986: 364).

Plagiochila victoriae *Stephani* (Stephani & Watts 1914: 131)

PROTO: 'Australia, Victoria (Lorne: leg. Miss E.L. Watts) Hb Watts, 910.'

LABEL: VICTORIA: Lorne, *leg. Ethel Watts, Hb W.W. Watts 910*, Dec 1909.

TYPES: G, NSW (H370).

COMMENT: = *Plagiochila baileyana* fide Inoue (1986: 377).

Plagiochila wattsii *Stephani* (in Rodway 1918: 105)

PROTO: 'On Fagus log, Pioneer track, Blue Tier (Weymouth). Determined by Stephani.'

LABEL: NEW SOUTH WALES: Pearce's Creek, Richmond River, on tree, *W.W. Watts 19*, 19 June 1900.

TYPES: G (ex Hb Levier 2306), NSW.

COMMENT: Rodway (1918: 105) reported this species from Tasmania, attributing the species description and identification to Stephani. In 1921 Stephani redescribed *Plagiochila wattsii* as a new species (the protologue cites the type specimen as: 'Australia. New South Wales (Watts legit)'. The Stephani description does not match the one published in Rodway. Inoue & Schuster (1971) were unable to locate Rodway's specimen, and they suggested that it is probably a species of *Lophocolea*. The G specimen of *Watts 19* is cited as the type by Inoue & Schuster (1971: 221) and Inoue (1986: 371). Further work to clarify the status of this taxon is required!

Porella crawfordii *Stephani* (1889: 270), as 'cranfordi'

PROTO: 'New England, Moona near Walcha leg. A. R. Cranford 1884....Queensland, Toowoomba, Hartmann 1876, Queensland F. M. Bailey (Herb. Brotherus Nr. 11). N. S. Wales Rev. Dr. Woolls. 1884'

LABEL: NEW SOUTH WALES: Moona near Walcha, New England, *A.R. Crawford*, 1884.

TYPE: G (lectotype), NSW (H259: isolectotype).

COMMENT: Lectotypified by Hattori (1985: 53). This species was named after its collector, A.R. Crawford, but Stephani appears to have misread the handwritten label. Stephani's spelling, although original, must count as an orthographic error and was amended by Scott & Bradshaw (1986: 79).

Riccardia babindae *Hewson* (1970*b*: 85)

PROTO: 'Holotype-The Boulders, Babinda, N. Qld., Hewson 460, viii.1964 (NSW): ISOTYPE (BRI).'

LABEL: QUEENSLAND: Babinda, The Boulders, *H.J. Hewson H64.79.460*, 26 Aug 1964.

TYPE: NSW (179242: holotype), BRI (isotype).

COMMENT: Name in current use.

Riccardia bliklika *Hewson* var. **bliklika** (Hewson 1970*b*: 83)

PROTO: 'Holotype-Vision Falls, Lake Eacham, Atherton Tableland, N. Qld., on weathering basalt in rainforest, Hewson, 387, 8.1964, (NSW): ISOTYPE (BRI).'

LABEL: QUEENSLAND: Lake Eacham, Vision Falls, *H.J. Hewson H64.68.387*, 20 Aug 1964.

TYPES: NSW (179243: holotype), BRI (isotype).

COMMENT: Name in current use.

Riccardia hypipamensis *Hewson* (1970*b*: 97)

PROTO: 'Holotype- The Crater, Mt. Hypipamee, N. Qld, on weathering basalt in rainforest, Hewson, 448, 8.1964 (NSW): ISOTYPE (SYD).'

LABEL: QUEENSLAND: Mt Hypipamee, The Crater, *H.J. Hewson H64.76.448*, 24 Aug 1964.

TYPES: NSW (holotype), SYD (isotype-not located).

COMMENT: Name in current use.

Riccardia macdonaldiana *Hewson* (1970*b*: 93)

PROTO: 'Holotype- Mossman Gorge, 3/4 mile beyond Mossman Mission, on soil and roots in rainforest, Hewson 326 [= 362], 8.1964, (NSW): ISOTYPE (BRI).'

LABEL: NORTH QUEENSLAND: about 3/4 mile [1 km] beyond Mossman Mission, Mossman Gorge-Creek, soil and roots, rainforest, granite, *H.J. Hewson H64.66.362*, 19 Aug 1964.

TYPES: NSW (holotype), BRI (isotype).

COMMENT: In the protologue the number is given as *326*, a typographical error for the correct number *362*.

Riccardia minima *Carrington & Pearson* (1888: 1055)

PROTO: 'On the surface of peat, in bogs, Coogee Bay, New South Wales, May, 1885.'

LABEL: NEW SOUTH WALES: Coogee Bay, in flower, [*T. Whitelegge 45*], May 1885.

TYPES: MANCH (Kk854), BM, NSW (H247).

COMMENT: NSW specimen further annotated by Whitelegge: '45 N. sp. *Riccardia minima* No. 37.' i.e. probably no. 37 of a batch sent to Pearson by Whitelegge. MANCH Kk854 cited as holotype by Hewson (1970*b*: 84). = *Riccardia lobulata* (Colenso) E. Hodgson fide Brown & Braggins (1989: 43).

Riccia areolata *Na-Thalang* (1980: 78)

PROTO: 'HOLOTYPE: New South Wales, Prospect Reservoir, *Na-Thalang 236*, 15.vi.1967 (NSW).'

LABEL: NEW SOUTH WALES: Prospect Reservoir, open grassland at roadside, *O. Na-Thalang 236*, 15 June 1969.

TYPES: NSW (M11480: holotype), SYD (isotype-not located).

COMMENT: Name in current use.

Riccia asprella *Carrington & Pearson* (1888: 1039)

PROTO: 'On earth, Head of Double Bay, Sydney, July, 1885.'

LABEL: NEW SOUTH WALES: Head of Double Bay, on earth, [*T. Whitelegge 50*], June 1885.

TYPES: BM or MANCH?, NSW (H94).

COMMENT: The NSW specimen has been further annotated by Whitelegge: '50 N. sp., *Riccia asprella*, No 53.P.'; probably no. 53 of a batch sent to Pearson. NSW specimen cited as holotype by Na-Thalang (1980: 84) but the original specimen is almost certainly held at MANCH or BM.

Riccia blackii *Na-Thalang* (1980: 81)

PROTO: 'HOLOTYPE: Central Australia, Mt Olga. *D. Black (Na-Thalang 87)*, 11.viii[vi].1966 (NSW); ISOTYPE (SYD).'

LABEL: NORTHERN TERRITORY: top of Mt Olga, along creek bank, *D. Black, O. Na-Thalang 87*, 11 June 1966.

TYPES: NSW (M11478: holotype), SYD (isotype).

COMMENT: Name in current use.

Riccia bullosa *Link* var. **vesiculosa** *Carrington & Pearson* (1888: 1058)

PROTO: 'On earth, Parramatta, August, 1885.'

LABEL: NEW SOUTH WALES: 1. Parramatta, on earth, [*T. Whitelegge 49*], Aug 1885 (NSW H87); 2. Parramatta North, on earth, [*T. Whitelegge 49*], 16 Aug 1885; 3. Parramatta (North), on earth, [*T. Whitelegge 49*], 16 Aug 1885 (NSW H254).

TYPES: BM or MANCH?, NSW.

COMMENT: The NSW specimens are further annotated by Whitelegge: '49, 21 T.W. W.H.P', '49, No. 21, *Riccia bulbosa* var. *vesiculosa*' and 'No. 49 C&P, No. 24W.' respectively. No collector or number are cited in the protologue but the other data and annotations are consistent with the NSW specimens being part of the type. Probably no. 21 of a batch sent to Pearson. Na-Thalang (1980: 116) cites the type as 'Holotype: New South Wales, Parramatta, *Whitelegge 8*, 1885 (NSW H87); isotype (SYD).' No material was located at SYD and the original specimen is almost certainly held at MANCH or BM. = *Riccia vesiculosa* (Carrington & Pearson) Stephani fide Na-Thalang (1980: 114).

Riccia caroliniana *Na-Thalang* (1980: 72)

PROTO: 'HOLOTYPE: Robin Water Fall, N.T., *Na-Thalang 288* 28.i.1969 (NSW); ISOTYPE (SYD).'

LABEL: NORTHERN TERRITORY: c. 2 miles [3 km] from Robin Waterfall, creek bank among grass, *O. Na-Thalang 288* 28 Jan 1969.

TYPES: NSW (holotype; not located), SYD (isotype).

COMMENT: Probably on loan.

Riccia collata *Na-Thalang* (1980: 122)

PROTO: 'HOLOTYPE: New South Wales, Tunmallallee *Na-Thalang 220* 26.iii.1967 (NSW); ISOTYPE (SYD).'

LABEL: NEW SOUTH WALES: Tunmallallee, along creek bank, *O. Na-Thalang 220*, 26 Mar 1967.

TYPES: NSW (M11478: holotype), SYD (isotype).

COMMENT: Name in current use.

Riccia duplex *Lorbeer* var. **megaspora** *Na-Thalang* (1980: 128)

PROTO: 'HOLOTYPE: Northern Territory, East Alligator River, R.C. Carolin 6880 15.v.1968 (NSW).'

LABEL: NORTHERN TERRITORY: margins of lagoon, East Alligator River, about 7 miles [11 km] S Cahills Crossing, *R.C. Carolin 6880*, 16 May 1968.

TYPE: NSW (holotype).

COMMENT: Name in current use.

Riccia longiciliata *Na-Thalang* (1980: 75)

PROTO: 'HOLOTYPE: Northern Territory, Palm Valley, *Na-Thalang 100A*, 15.viii.1966 (NSW); ISOTYPE (SYD).'

LABEL: NORTHERN TERRITORY: Palm Valley, open sandy soil or on pocket of rocks, grow[ing] mix[ed] with R. albida, *O. Na-Thalang 100A*, 15 Aug 1966.

TYPES: NSW (M11477: holotype), SYD (isotype-not located).

COMMENT: Name in current use.

Riccia luticola *Na-Thalang* (1980: 123)

PROTO: 'HOLOTYPE: Northern Territory, c. 5 miles south of Katherine. *Na-Thalang 321*, 5.ii.1969 (NSW).'

LABEL: NORTHERN TERRITORY: c. 5 miles [8 km] south of Katherine, margin of swamp, among grass, *O. Na-Thalang 321*, 5 Feb 1969.

TYPE: NSW (2 specimens labelled holo- and isotype respectively).

COMMENT: Name in current use.

Riccia marginata *Carrington & Pearson* (1888: 1056)

PROTO: 'Parramatta, N.S.W., August 1885.'

LABEL: NEW SOUTH WALES: 1. Parramatta North, on earth, [*T. Whitelegge 48*], 16 Aug 1885; 2. Parramatta, on earth, [*T. Whitelegge 48*], Aug 1885.

TYPES: BM or MANCH?, NSW (H89 & H91), SYD.

COMMENT: The latter NSW specimen is further annotated by Whitelegge: '48 *Riccia marginata* n. sp., plXXXV, 20 TW WHP.' i.e. probably no. 20 of a batch sent to Pearson. Na-Thalang (1980: 100) cites NSW H89 as the holotype and NSW H91 and SYD as isotypes but there is almost certainly a BM or MANCH specimen which would have been the material seen by Pearson.

Riccia multifida *(Stephani) Stephani* var. **filiformis** *Na-Thalang* (1980: 131)

PROTO: 'HOLOTYPE: New South Wales, Coonabarabran, Mallallee Creek, *O. Na-Thalang 215*, 26.iii.1967 (NSW).'

LABEL: NEW SOUTH WALES: along the Mallallee Creek, Coonabarabran, *O. Na-Thalang 215*, 26 Mar 1967 [2 similarly labelled specimens in separate folders].

TYPE: NSW (holotype).

COMMENT: Name in current use.

Riccia multifida *(Stephani) Stephani* var. **torticolla** *Na-Thalang* (1980: 134)

PROTO: 'HOLOTYPE: Western Australia, Poison Creek, 50 miles north of Leonora, *R.C. Carolin 5834*, Aug 1966 (NSW).'

LABEL: WESTERN AUSTRALIA: Poison Creek, 50 miles [80 km] N of Leonora, mud at edge of water hole, *R.C. Carolin 5834*, Aug 1967.

TYPE: NSW (holotype).

COMMENT: Name in current use.

Riccia olgensis *Na-Thalang* (1980: 100)

PROTO: 'HOLOTYPE: Central Australia, Mt Olga, D.*R. Selkirk, (Na-Thalang 136 [= 135])*, 20 Aug 1966 (NSW); ISOTYPE (SYD).'

LABEL: NORTHERN TERRITORY: on top of Mt Olga, along creek bank, *D.R. Selkirk (O. Na-Thalang 135)*, 20 Aug 1966.

TYPES: NSW (M11479: holotype), SYD (isotype).

COMMENT: Error in protologue; the number on the NSW and SYD specimens is *135* not *136*.

Riccia rorida *Na-Thalang* (1980: 101)

PROTO: 'HOLOTYPE: A.C.T., Cotter R., *Na-Thalang 191*, 27.i.1969 (NSW).'

LABEL: AUSTRALIAN CAPITAL TERRITORY: Cotter River, open grassland along the river bank, *O. Na-Thalang 191*, 27 Jan 1969.

TYPE: NSW (holotype).

COMMENT: Name in current use.

Riccia spongiosula *Na-Thalang* (1980: 113)

PROTO: 'HOLOTYPE: New South Wales, Jubbal, *W.W. Watts 144 [= 744]*, 22.vii.1903 (NSW H97).'

LABEL: NEW SOUTH WALES: 1. near Tubbul, Young, ground among rocks, *W.W. W[atts] 744*, 22 July 1903; 2. near Tubbul, Young, ground among rocks, (this was prob[ably] opp[osite] Fowlers), [*W.W. Watts*] *744*, 22 July 1903.

TYPES: NSW (H97: holotype; 244529: isotype).

COMMENT: Both of the NSW specimens are annotated: '*Riccia spongiosa* Steph. sp. n. ms. 1906' in Watt's hand. Na-Thalang appears to have made three typographic errors in the protologue but all the other information available (Na-Thalang 1980: 114) suggests that these are the correct specimens.

Symphyogyna interrupta *Carrington & Pearson* (1888: 1053)

PROTO: no specimens cited.

LABEL: NEW SOUTH WALES: 1. Mossmans Bay, [near Sydney], wet rocks, [*T. Whitelegge 42*], 8 Aug 1885; 2. Mossmans Bay, [near Sydney], [*T. Whitelegge 42*], 8 Aug 1885.

TYPES: BM or MANCH?, NSW (2 specimens).

COMMENT: NSW H360 has been annotated by Whitelegge: '*Symphyogyna interrupta* n. sp., plXXXIII, 55 T.W. W.H.P.' and NSW H361 as 'n. sp., No 55P.' Presumably specimen no. 55 of a batch sent to Pearson. No specimen information is given in the protologue and the type material at BM or MANCH has not been sighted but the information on the packet is consistent with that found on other type specimens sent by Whitelegge to Pearson.

Symphyogyna multiflora *Stephani* (1917: 68)

PROTO: 'Australia. New South Wales (Watts legit.).'

LABEL: NEW SOUTH WALES: Valley of Waters [Wentworth Falls], *W.W. Watts 1127*, Sep 1912.

TYPES: G, NSW.

COMMENT: The NSW specimen is further annotated: '*Symphyogyna multiflora* St. sp. nov. det Jan.1913 (type)' in Watts' hand.

Trichocolea minutifolia *Stephani* (Stephani & Watts 1914: 134)

PROTO: 'Australia (Wyong): Watts legit, 950.'

LABEL: NEW SOUTH WALES: gully over mountain, SW of 'Kingwell', Wyong, *W.W. Watts 950*, 23 Aug 1910 [4 packets in one folder].

TYPES: G, NSW (H80).

COMMENT: Name in current use.

Trichocolea wattsiana *Stephani* (Stephani & Watts 1914: 135)

PROTO: 'Australia (Wyong): Watts, 986.'

LABEL: NEW SOUTH WALES: 1. Gully beyond mountain SW of 'Kingwell', Wyong, *W.W. Watts 946*, Aug 1910; 2. Gully over mountain SW of 'Kingwell', Wyong, *W.W. Watts 946*, 23 Aug 1910 [3 packets in one folder].

TYPES: G, NSW (H75 & H257).

COMMENT: *Watts 986* in the protologue is probably a typographic error for 946. The former NSW specimen (H257) has been further annotated: '*Trichocolea wattsiana* St. sp. n. 1913, Type' in Watts' hand.

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P. Geissler kindly checked data sent to Geneva against specimens examined by Stephani in preparing descriptions, to assist with designation of status of types held in Sydney. H.J. Hewson checked data based on her studies.

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A revision of the genus *Wahlenbergia* (Campanulaceae) in Australia

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Abstract

Smith, Peter J. (44 Hawkins Parade, Blaxland, NSW, Australia 2774) 1992. A revision of the genus Wahlenbergia *(Campanulaceae) in Australia.* Telopea *5(1): 91–175.* The Australian species of *Wahlenbergia* are examined from morphological and cytological evidence, and their relationships are discussed. Twenty-six species are recognised, including one introduced species. The following species are described as new: **W. glabra, W. islensis, W. planiflora, W. scopulicola** and **W. victoriensis.** Two subspecies are recognised in each of two species, with **W. planiflora** subsp. **longipila** and *W. stricta* subsp. **alterna** being described as new. The native Australian species have a basic chromosome number of $x = 9$. Polyploidy is common, with at least 11 taxa having two or more chromosome races (diploid, tetraploid, hexaploid or octoploid). It appears that speciation has occurred mainly at the diploid level, followed by extensive development of polyploid races within species and then another, lesser phase of speciation at the polyploid level. The native species are placed into four informal groups that reflect their supposed evolutionary relationships. The groups differ in growth-form, extent of polyploidy, habitat preferences and distribution patterns. Two groups have representatives elsewhere in Australasia and southern Asia. The affinities of all groups appear to be with African species of the *W. undulata* type, which also have a basic chromosome number of $x = 9$.

Introduction

Wahlenbergia is a large genus of the family Campanulaceae, comprising some 200 species. Although some species occur in the northern hemisphere, the great majority of species are confined to the southern hemisphere. It forms a broad geographic and taxonomic complement to the mainly northern hemisphere genus, *Campanula*. The greatest diversity of species occurs in Africa, with lower numbers in South America, Asia and Australasia.

The name *Wahlenbergia* was first introduced by Schrader (1814). However, as pointed out by van Steenis (1960), Schrader's name is a nomen nudum and the first validly published description was by Roth (1821). An earlier validly published name for the genus is *Cervicina* (Delile 1813), which has been made a nomen rejiciendum in favour of *Wahlenbergia* (I.C.B.N. 1988: 275).

Tuyn (1960) reduced the genera *Lightfootia* and *Cephalostigma* to *Wahlenbergia*, an approach also followed by Thulin (1975). *Lightfootia* L'Héritier (1789) is an older name than *Wahlenbergia*, but is a later homonym of *Lightfootia* Swartz (1788). Neither *Lightfootia* nor *Cephalostigma* is represented in Australia. Black (1934) described *Cephalostigma fluminale* from South Australia, but this species has since been transferred to *Wahlenbergia* sens. strict. (Eichler 1963).

The first major treatment of *Wahlenbergia* was by de Candolle (1830, 1839), who considered all species known at the time. There have been no subsequent worldwide treatments. Von Brehmer (1915*a*, *b*) provided a detailed revision of the genus for Africa. Thulin (1975, 1987) provided a detailed revision for tropical Africa and Madagascar.

The first Australian treatment was by Robert Brown (1810), who recognised three species, one of which was divided into four varieties. These were described under a

new section (*Campanopsis*) of *Campanula*, but have since been transferred to *Wahlenbergia*. Although several additional species had been described by the 1860s, Bentham (1869) recognised only two, reducing all except *W. saxicola* to *W. gracilis*.

N.E. Brown (1913), in a partial review of Australian and New Zealand *Wahlenbergia*, recognised five species in Australia, two of which were divided into two varieties each. Black (1934) recognised five species in South Australia, including one described under *Cephalostigma*.

Lothian (1947*a,b,c*) recognised 14 native and one introduced species in Australia, including Lord Howe Island. He stated, however, that this was an incomplete list, especially for Queensland and Western Australia. He later described two additional alpine species (Lothian 1956).

Tuyn (1960), in his treatment of Malesian *Wahlenbergia*, reduced many of the species recognised by Lothian to synonymy with the Japanese species, *W. marginata* (Thunb.) A. DC., which was considered to have a wide distribution from Asia to Australia and New Zealand. This treatment has not been followed by any subsequent authors in Australia, although Webb et al. (1988: 457) have recently used the name in New Zealand.

Carolin (1964) provided taxonomic and nomenclatural notes on seven Australian species, two of which were described as new.

The present study involved examination of herbarium specimens together with field, glasshouse and cytological investigations. Altogether, some 5500 specimens have been examined and annotated, comprising collections from the following Australian herbaria: AD, ADW, BRI, CANB, CBG, DNA, HO, MEL, NSW, NT, PERTH and SYD. Type material held at European herbaria was only examined from photographs, but these specimens had been examined previously by R. Carolin. Twenty-two taxa were studied in the field, and 15 of these were grown in a glasshouse. Chromosome counts were obtained for the same 22 taxa, with up to 30 counts per taxon.

The major part of the study formed the basis of a Ph.D. thesis (Smith 1976). Five new species were described in an account of *Wahlenbergia* in South Australia (Smith 1986). Another new species was described (Smith 1989) for an account of the genus in the Kimberley Region of Western Australia (Wheeler & Smith, in press). An account of the genus in New South Wales has also been prepared (Smith, in press).

Morphology

Habit

Although shrubby *Wahlenbergia* species occur elsewhere in the world, especially in South Africa and on islands such as Juan Fernandez and Ascension, the species in Australia are all perennial or annual herbs. Four growth-forms may be distinguished (Figure 1):

I. Densely tufted perennials with much-branched stems and short inflorescences, typically with only solitary flowers. This growth-form is found in three species, all of which grow in rock crevices: *W. glabra*, *W. islensis* and *W. scopulicola*.

II. Rhizomatous perennials with aerial stems and inflorescences that are unbranched or only sparingly branched. This growth-form is typical of the alpine and subalpine species, *W. ceracea*, *W. densifolia*, *W. gloriosa* and *W. saxicola*, but also occurs in two non-alpine species, *W. gymnoclada* and *W. insulae-howei*. *W. insulae-howei*, which typ-

ically grows in rock crevices, often has a more tufted habit than the other species, but develops rhizomes in suitable conditions.

III. Tufted perennials with few to many stems and with branched inflorescences covering the upper half or more of the plant. This is the most common growth-form, typical of the majority of the more widespread species (see Table 2 for a list of species with this growth-form). The lateral roots of these species may give rise to other tufted, taprooted plants away from the original plant. This was confirmed in the field or glasshouse in *W. communis*, *W. fluminalis*, *W. littoricola*, *W. luteola*, *W. planiflora* and *W. queenslandica*, and is probably a general characteristic.

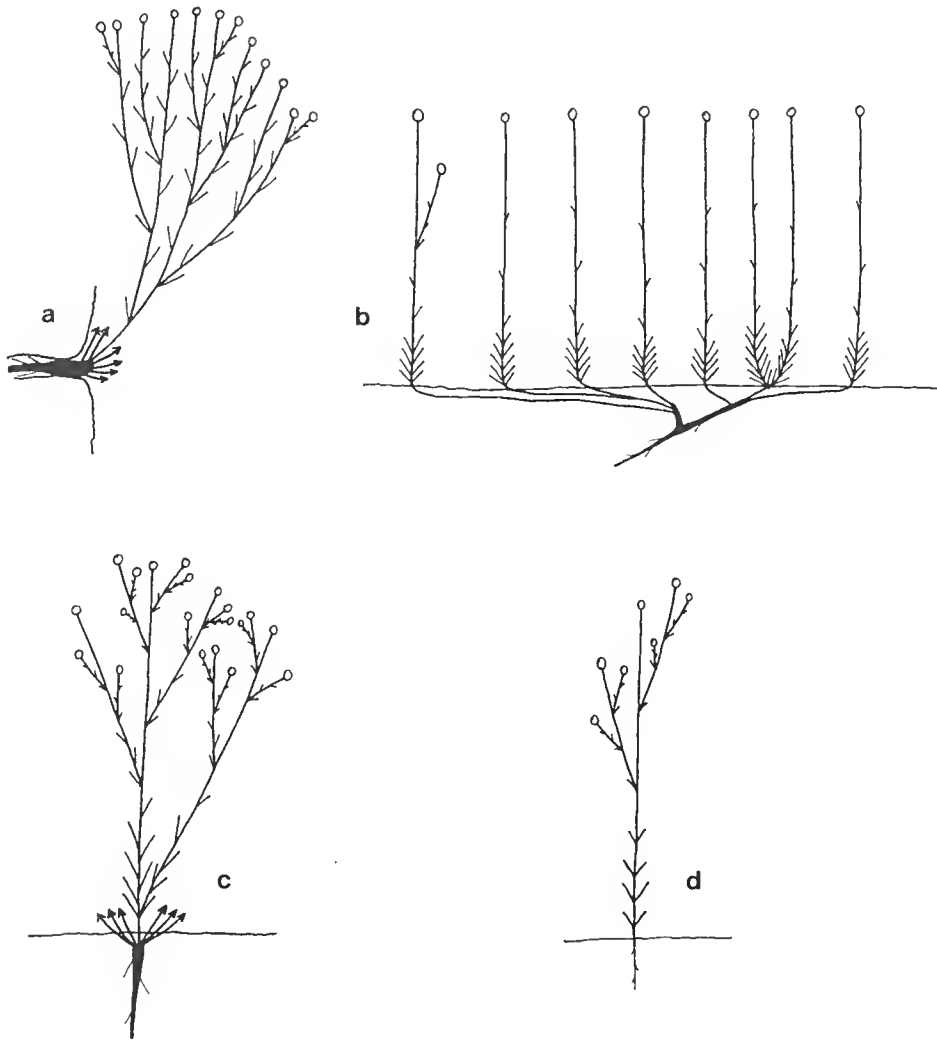

Figure 1. Growth-forms of Australian *Wahlenbergia* species. **a**, growth-form I, tufted perennial with ± solitary flowers (*W. islensis*); **b**, growth-form II, rhizomatous perennial with ± solitary flowers (*W. gymnoclada*); **c**, growth-form III, tufted perennial with branched inflorescence (*W. communis*); **d**, growth-form IV, annual with branched inflorescence (*W. gracilenta*).

IV. Annuals with only one or a few stems and with branched inflorescences. The species that are consistently annual are *W. caryophylloides*, *W. gracilenta*, *W. preissii*, *W. victoriensis* and the introduced *W. capensis*. Young plants of normally perennial species are similar in appearance to annuals, and may not survive to a second year if conditions are unfavourable. However, only *W. tumidifructa* appears to have both a consistently annual form and a perennial form.

Leaves

The leaves may be alternate throughout, opposite on the lower stem becoming alternate above, or irregularly opposite and alternate. No species has leaves which are consistently opposite throughout. Only *W. saxicola* (regularly), *W. insulae-howei* (frequently) and *W. gloriosa* (occasionally) have leaves confined to basal rosettes, whereas this is the typical form of rhizomatous *Wahlenbergia* species in New Zealand.

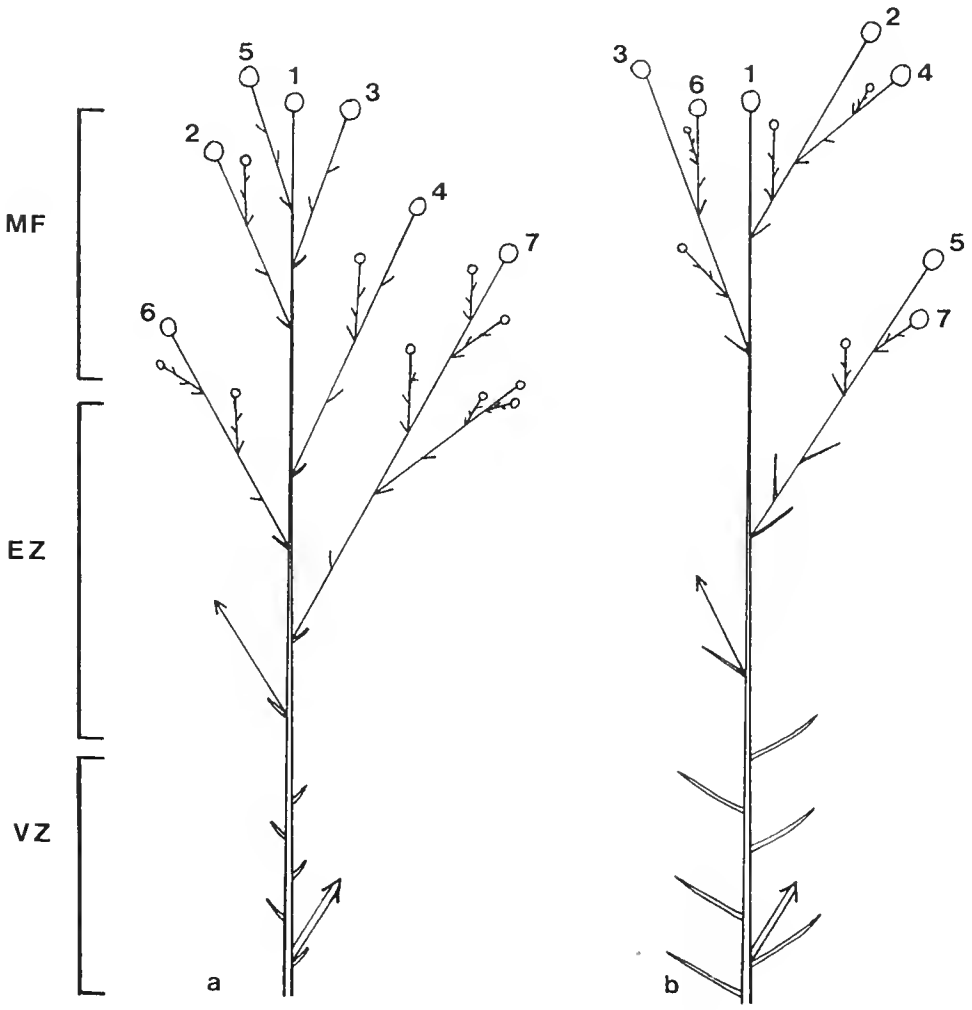

Figure 2. Inflorescences of African and Australian *Wahlenbergia* species. **a**, *W. virgata*, typical of African species (Thulin 1975, Fig. 2); **b**, *W. communis*, typical of Australian species. MF = main florescence; EZ = enrichment zone; VZ = vegetative zone. Figures indicate order of flowering.

The leaves are variable in size and shape along the stem, becoming smaller and more widely spaced on the upper stem, and typically changing in shape from broadest distally to broadest proximally. Considerable leaf variation is also induced by environmental conditions, with plants growing in sheltered sites tending to have larger, broader, thinner, flatter, more persistent leaves than plants growing in exposed sites.

Despite this variability, leaf shape and, to a lesser extent, size are often useful diagnostic characters. For example, the long, linear leaves of *W. gymnoclada* and the short, narrowly oblong leaves of *W. densifolia* readily distinguish these species from others of the same growth-form.

The leaves are sessile in all species except *W. scopulicola*, most leaves of which are distinctly petiolate.

Indumentum

The species vary from entirely glabrous (*W. glabra* and *W. islensis*) to extensively and consistently hirsute (*W. capensis* and *W. scopulicola*). However, the extent and density of the indumentum are often highly variable between and within local populations.

The indumentum terms used in this account are: 'hirsute' for the typical condition of longish, moderately stiff, white, simple hairs; 'pubescent' for the much shorter but otherwise similar indumentum of *W. densifolia*; and 'puberulous' for the very short, soft, white, simple hairs found inside the base of the corolla-tube in most species.

Inflorescence

Thulin (1975: 19–25) has discussed the inflorescence in African *Wahlenbergia* in relation to the concepts and terminology of Troll (1964, 1969) and Carolin (1967). He concluded that in the basic type, as illustrated by *W. virgata* Engl. (Figure 2), the main florescence consists not only of the terminal flower (as maintained by Troll 1964: 183), but also the three flowering branches immediately below, each of which has two bracteoles (prophylls) and may develop into a cyme. Flowering branches below the main florescence have 3–5 'bracteole-like leaves' (2 prophylls and 1–3 later phyllomes) and are similar in construction to the main florescence. These represent coflorescences arising from the enrichment zone of the main shoot. The whole flowering system is a synflorescence (Troll 1964: 148, Carolin 1967: 25). The order of flowering in the main florescence is acropetal, whereas it is basipetal for the terminal flowers in the enrichment zone.

The basic type in Australian *Wahlenbergia* is similar, but with a number of differences. It may be illustrated by *W. communis* (Figure 2). The main florescence consists of the terminal flower and the first two (not three) flowering branches below. The cymose branching of the main florescence is more extensive than in *W. virgata*, while fewer coflorescences develop. Also, the order of flowering is basipetal throughout the inflorescence. Thulin (1975: 20) stressed the generality among African species of acropetal flowering in the main florescence versus basipetal flowering in the enrichment zone. However, in Australia, only the introduced *W. capensis* has a consistently acropetal order of flowering in the main florescence.

Using the terminology of Briggs & Johnson (1979), the basic inflorescence-type in Australian *Wahlenbergia* may be described as a complex thyrsoid.

The native species with growth-forms III and IV all have similar flowering systems to that of *W. communis*. In the species with growth-form II, the main florescence is reduced to a solitary flower or 2–3 flowers, and coflorescences are usually absent (Figure 1). The species with growth-form I also have reduced inflorescences, with solitary

flowers in *W. glabra* and *W. scopulicola*, and inflorescences of 1–6 flowers in *W. islensis*.

Pedicel lengths reported here were measured from the base of the hypanthium to the third leaf organ down or the first branch, whichever was shorter.

Sepals

Most species have more or less narrowly triangular sepals that gradually taper to the apex. However, two annual species, *W. gracilenta* and *W. preissii*, are characterised by narrowly oblong sepals that narrow abruptly to an obtuse to broadly acute apex.

Corolla

The size and shape of the corolla are important diagnostic characters among Australian *Wahlenbergia*. There are characteristically small-flowered species of each growth-form, namely, *W. gracilis*, *W. tumidifructa*, *W. gracilenta*, *W. preissii*, *W. insulae-howei* and *W. islensis*. These all have corollas with lobes usually < 6 mm long. Occasional slightly larger-flowered specimens of these species are large in all flower parts, so that the corolla still appears small in relation to the hypanthium.

Three corolla shapes may be distinguished from the relative length of tube and lobes (Figure 3). The terms used for these are: 'deeply campanulate' for corollas with lobes less than twice as long as the tube; 'shortly campanulate' for corollas with lobes about three times as long as the tube; and 'rotate' for corollas with lobes more than four times as long as the tube. Most species have campanulate corollas. Rotate corollas, combined with capitate styles, are a particular feature of three closely related species, *W. fluminalis*, *W. multicaulis* and *W. planiflora*.

Most species have a zone of short hairs inside the corolla tube at the base, these hairs being especially long and dense in *W. capensis*. Thulin (1975: 25) suggested that this may be a general feature of the genus. However, several Australian species of growth-forms II and IV have entirely glabrous corollas: *W. caryophylloides*, *W. densifolia*, *W. gloriosa* and *W. saxicola*.

The normal number of corolla lobes (also sepals and stamens) is five in all species, although occasional specimens have either more or fewer lobes. There is similar variation in the colour of the corolla, with occasional white- or pink-flowered specimens of species that are normally blue-flowered. Other colour variations are more

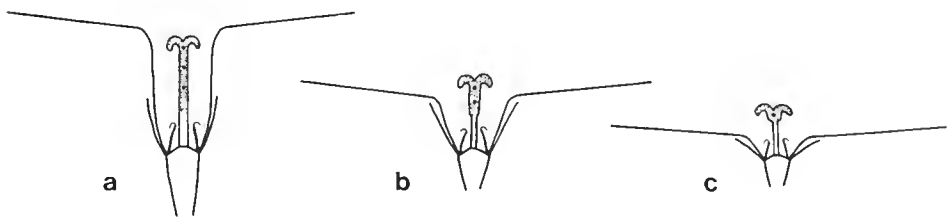

Figure 3. Flower types of Australian *Wahlenbergia* species. **a**, deeply campanulate corolla, unconstricted style (*W. communis*); **b**, shortly campanulate corolla, style constricted halfway down (*W. graniticola*); **c**, rotate corolla, style strongly constricted close to the stigmatic lobes (*W. planiflora*).

diagnostic, particularly the dark purple of *W. gloriosa* and the greenish blue with dark blue centre of *W. capensis*.

Stamens

Von Brehmer (1915*a*, *b*) attached great importance to the shape of the dilated filament-bases as a diagnostic character for African *Wahlenbergia*. The overall range of filament types among Australian species is much less than among African species (as is true for most characters), but the variation within species is considerable. Some differences are apparent between species, but their value as a diagnostic character is very limited. The reliability and value of this character have also been questioned by Thulin (1975: 25) for African species.

Style

Styles in Australian *Wahlenbergia* are 2-, 3- or 5-fid, corresponding to the number of loculi in the ovary and capsule. The only 5-fid species is the introduced *W. capensis*. Most species are normally 3-fid. *W. densifolia*, *W. gloriosa*, *W. preissii* and *W. saxicola* are normally 2-fid. *W. caryophylloides* may be either 2-fid or 3-fid. Except for *W. preissii*, the 2-fid species are also the ones with entirely glabrous corollas (see above).

The lower style is glabrous or has scattered normal hairs, while the upper style, including the outside of the stigmatic lobes, is densely covered with coarser hairs to which the shed pollen adheres. These hairs are often termed 'pollen-collecting' (e.g. Carolin 1960), but are referred to here as 'pollen-presenting' to avoid confusion with the stigmatic hairs. The genus is distinctly protandrous, as are other members of the Campanulaceae. Pollen is shed onto the pollen-presenting hairs while the flower is in bud, and the anthers wither before the flower opens. The stigmatic lobes are erect and appressed when the flower first opens, and the stigmatic hairs are very short. The pollen-presenting hairs soon collapse and the pollen begins to fall away from the style. Meanwhile, the stigmatic hairs grow to their full length and the stigmatic lobes open to become recurved and receptive.

The lower part of the style is often narrower than the upper part, with an abrupt constriction at the junction. The position and degree of constriction are useful diagnostic characters. The three main types of style are illustrated in Figure 3 (see also the species illustrations). As indicated in the diagram, there is often a correlation between type of style and type of corolla. Thus, *W. planiflora*, *W. fluminalis* and *W. multicaulis* have a rotate corolla and a capitate style, strongly constricted close to the stigmatic lobes. *W. graniticola*, *W. aridicola* and *W. littoricola* have a shortly campanulate corolla and a more or less distinct constriction about halfway down the style. *W. communis*, *W. stricta* and *W. queenslandica* have a deeply campanulate corolla and a more or less unconstricted style on which the pollen-presenting zone typically extends into the lower half.

The large raised glands that may be present in the pollen-presenting zone have provided useful diagnostic characters for African *Wahlenbergia* in terms of their presence/absence (or apparent absence – they may be detectable only under high magnification), number and position (von Brehmer 1915*a*, *b*, Thulin 1975). These glands are generally more numerous in Australian species than in African species, but are more variable and of less value as a diagnostic character. There may be as many as 15 glands on the style, arranged in columns of up to five glands under each stigmatic cleft. The number of glands is generally correlated with the extent of the pollen-presenting zone, but often varies markedly within species, even as to presence/absence (see species accounts). The function of the glands, whether related to adhesion of the pollen-grains to the style or attraction of pollinating insects, is unclear.

Style lengths reported here are total lengths, including the straightened stigmatic lobes. The length of the lobes is reported separately.

Capsule

The shape of the capsule varies between species and is often a useful diagnostic character. The terms used in this account are illustrated in Figure 4. Measurements of capsule length do not include the persistent sepals.

Chromosome numbers

Two authors have reported chromosome counts for Australian *Wahlenbergia* species, although voucher specimens are lacking and the species identifications should be treated with caution. H. Gulline (in Darlington & Wylie 1955: 289) reported counts of $n = 9$ for *W. gracilenta* and *W. gymnoclada*, $n = 18$ for *W. stricta*, $n = 27$ for *W. gracilis*, and $n = 36$ for *W. saxicola*. These counts were probably all from Tasmania. Want (1963: 165) reported counts of $n = 18$ for *'W. bicolor'* (most likely *W. communis* or *W. luteola*) and another unidentified species from north-eastern New South Wales.

A total of 111 counts were made during this study. The counts were made on meiotic stages in pollen mother cell squashes stained with propionic orcein. Another 54 counts made by R. Carolin prior to the study are also reported here. All counts were from sites in eastern mainland Australia. The counts are summarised in Table 1 and details of voucher specimens are provided in the species accounts.

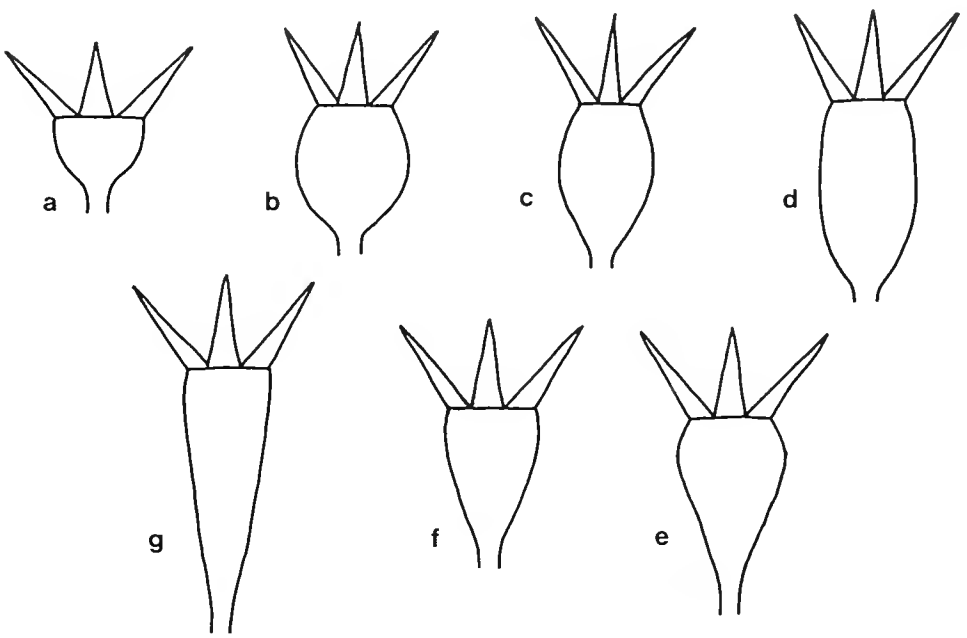

Figure 4. Capsule shapes of Australian *Wahlenbergia* species. **a**, hemispherical; **b**, globose; **c**, ellipsoid; **d**, cylindrical; **e**, obovoid; **f**, obconic; **g**, elongated-obconic.

All counts in Australian *Wahlenbergia* species have had a base number of $x = 9$ except for one count of $n = 8$ in *W. communis*, which appears to represent a local aberration arising through fusion of two chromosomes. Polyploidy is a recurring feature and four levels of ploidy have been found: diploid ($n = 9$), tetraploid ($n = 18$), hexaploid ($n = 27$) and octoploid ($n = 36$).

J. Petterson (pers. comm.) has made a series of unpublished counts on New Zealand *Wahlenbergia* species: $n = 18$ for several species of growth-form II, and $n = 36$ for several species of growth-form III. Various counts have been reported for the *W. marginata*/*W. gracilis* complex of southern Asia and Australasia: $n = 9$ (Taiwan; Hsu 1967: 126), $n = 18$ (Taiwan; Hsu 1968: 17), $n = 27$ (New Guinea; Borgmann 1964: 146), $n = 36$ (garden origin; Gadella 1966: 506) and $n = c.\ 45$ (New Guinea; Borgmann 1964: 126). A count of $n = 32$ has also been reported for this complex (garden origin; Sugiura 1942: 425), but its validity has been questioned (Thulin 1975: 44).

Table 1. Chromosome numbers in Australian *Wahlenbergia* species in relation to growth-form.

Taxon	Growth-form (Fig. 1)	*n*	Number of counts Smith	Carolin
W. scopulicola	I	9	1	
W. glabra	I	9	1	
W. islensis	I	9	1	
W. ceracea	II	9		4
W. gloriosa	II	9		1
W. densifolia	II	9		1
W. gymnoclada	II	9	1	
W. stricta				
subsp. *stricta*	III	9	6	3
		18	4	8
subsp. *alterna*	III	9	1	
		18	1	1
W. luteola	III	9	2	1
		18	4	3
W. communis	III	8*		1
		9	3	2
		18	20	4
W. queenslandica	III	9	2	
		18	4	
W. graniticola	III	9	5	1
		18	8	1
W. aridicola	III	9	1	
		18	1	1
W. littoricola	III	27	6	3
		36		1
W. planiflora				
subsp. *planiflora*	III	18	3	1
		27		1
subsp. *longipila*	III	9	1	1
		18	5	1
W. fluminalis	III	18	5	1
W. multicaulis	III	18	1	
		27	6	3
		36		1
W. gracilis	III	27	8	4
W. tumidifructa	III/IV	27	9	5
W. gracilenta	IV	18	2	

* One chromosome very large.

It thus appears that $x = 9$ is the base number for *Wahlenbergia* species throughout Australasia and southern Asia, and that polyploidy is common throughout. By contrast, Thulin (1975: 45) reported base numbers among African *Wahlenbergia* of $x = 7$ (2 taxa), $x = 8$ (10 taxa) and $x = 9$ (3 taxa), with only one example of polyploidy. A base number of $x = 9$ is otherwise rare among genera of the Campanulaceae (Darlington & Wylie 1955).

Counts on Australian species of growth-forms I and II have been consistently diploid, except for Gulline's unconfirmed octoploid count in *W. saxicola*. On the other hand, all species of growth-form III are partly or entirely polyploid, with most species having at least two chromosome races. The only species of growth-form IV that has been examined, *W. gracilenta*, also appears to have at least two chromosome races, with tetraploid counts made during this study and an unconfirmed diploid count reported by Gulline.

It appears that speciation in Australian *Wahlenbergia* has occurred mainly at the diploid level, followed by extensive development of polyploid races within species, particularly those of growth-form III. A subsequent phase of speciation at the polyploid level is indicated by the species (and subspecies) of growth-form III for which

Figure 5. Geographic distribution of chromosome counts. **a**, *W. communis*; **b**, *W. queenslandica*. Star: $n = 8$; triangle: $n = 9$; circle: $n = 18$.

only polyploid counts have been made. Tetraploid *W. fluminalis*, tetraploid/hexaploid/octoploid *W. multicaulis* and tetraploid/hexaploid *W. planiflora* subsp. *planiflora* are morphologically very close to each other and to diploid/tetraploid *W. planiflora* subsp. *longipila*. Hexaploid/octoploid *W. littoricola* is close to diploid/tetraploid *W. graniticola* and diploid/tetraploid *W. aridicola*.

The only polyploid taxa of growth-form III which are not clearly linked to known diploid forms are *W. gracilis* and *W. tumidifructa*, two closely related species for which only hexaploid counts have been made in Australia. There has been an unpublished octoploid count on *W. gracilis* material from New Caledonia (J. Petterson, pers. comm.). This species also occurs in New Zealand, New Guinea and possibly elsewhere. It may well have originated at the diploid level outside Australia. *W. tumidifructa* would seem to be an Australian arid-zone derivative of hexaploid *W. gracilis*.

The geographic distribution of the chromosome races in 12 taxa of growth-form III are illustrated in Figures 5–7. There is a concentration of diploid races in north-eastern New South Wales and eastern Queensland, suggesting that this was the original centre of diversity of the group in Australia. The development of tetraploid races has apparently resulted in a general expansion of the species southwards and westwards, accompanied by morphological differentiation at the tetraploid level in the

Figure 6. Geographic distribution of chromosome counts. a, *W. luteola*; b, *W stricta* subsp. *stricta* (small symbols) and subsp. *alterna* (large symbols). Triangle: $n = 9$; circle: $n = 18$.

W. planiflora / *W. fluminalis* / *W. multicaulis* complex, and development of hexaploid and octoploid forms in this complex and *W. littoricola*.

Species of growth-form III often grow in disturbed sites such as roadsides. In a couple of instances, diploid and tetraploid races were found growing in close proximity, with the diploids in relatively undisturbed sites and the tetraploids on roadsides or erosion gutters. This occurred in *W. stricta* subsp. *alterna* in the Cocoparra Range, and in *W. planiflora* subsp. *longipila* in the Nandewar Range. However, there were also many instances of diploids growing in highly disturbed sites (including diploid *W. planiflora* subsp. *longipila*), indicating that the ability to colonise such sites is by no means a characteristic solely of the polyploid races

Some general features of hexaploids became apparent from observations of glasshouse plants. Hexaploid plants grow to maturity much more rapidly than either diploids or tetraploids. For example, for a variety of taxa germinating in the glasshouse over a one month period in autumn, the mean time until first flowering was 108 ± SD 16 days for hexaploids (10 samples, 4 taxa), compared with 168 ± 32 days for tetraploids (9 samples, 8 taxa) and 171 ± 44 days for diploids (6 samples, 5 taxa).

Figure 7. Geographic distribution of chromosome counts. a, *W. graniticola* (small ▲ and ●), *W. aridicola* (large ▲ and ●) and *W. littoricola* (◆ and ■); b, *W. planiflora* subsp. *planiflora* (small closed symbols), subsp. *longipila* (open symbols), *W. fluminalis*(large closed symbols) and *W. multicaulis* (medium closed symbols). Triangle: $n = 9$; circle: $n = 18$; diamond: $n = 27$; square: $n = 36$.

These differences between hexaploids and tetraploids/diploids are statistically significant (t-tests, $p < 0.05$).

The flowers of hexaploids regularly self-fertilise by the stigmatic lobes opening and recurving while there is still viable pollen on the outside of the style. The stigmatic lobes open much later in diploid and tetraploid flowers, and these fail to set seed in the absence of pollinators. This was demonstrated by exclosure experiments in the glasshouse. The flowers of hexaploid *W. gracilis*, *W. littoricola*, *W. multicaulis* and *W. tumidifructa* all regularly self-fertilised and produced fertile progeny, but never those of the various diploid and tetraploid taxa that were tested. However, artificial selfings by transfer of pollen between flowers showed that at least three diploid taxa and five tetraploid taxa are self-compatible and thus capable of self-fertilisation in the presence of pollinators.

Hexaploids also hybridise more readily than do diploids and tetraploids. This was demonstrated in a series of attempted crosses in the glasshouse. All 25 attempts between diploids (6 species) were unsuccessful; 45 attempts between tetraploids (7 species) resulted in a single hybrid between the closely related *W. fluminalis* and *W. planiflora* subsp. *planiflora*; while various hybrids (all infertile) were obtained in 25 of 37 attempts between the four hexaploid species. These differences are statistically significant (chi-squared test, $p < 0.001$).

The extent of hybridisation among Australian *Wahlenbergia* species is difficult to gauge. Only one hybrid is described in the species accounts, namely *W. gloriosa* X *W. stricta*. These are two distinctive species and the hybrid specimens can be fairly readily identified. In general, however, the similarities and variability of the species make it difficult to identify hybrid specimens with any certainty. Wherever there has been doubt I have assigned specimens to species rather than to putative hybrids. During fieldwork I have encountered instances of hybrid swarms forming between hexaploid species such as *W. gracilis* and *W. littoricola*, but obvious examples have been few. I would suggest, as did Lothian (1947*a*: 205), that hybridisation is a less extensive phenomenon among Australian *Wahlenbergia* species than is often supposed.

Distribution

Wahlenbergia is widespread in Australia and probably occurs in every one-degree grid-square on the continent, although with marked differences in the numbers of taxa (Figure 8). The distribution of the taxa in relation to major phytogeographic zones (Barlow 1986) is summarised in Table 2.

The greatest concentration of species is in the South-eastern Zone, where there are 21 taxa, eight of which are local endemics, including five of the six species of growth-form II and two of the three species of growth-form I. Overall, 14 taxa appear to have originated within this zone, and a further three taxa in the overlap area between this zone and the North-eastern Zone. These include representatives of all four growth-forms. A southern origin within the zone is indicated for taxa of growth-forms II and IV, while a predominantly northern origin is indicated for taxa of growth-forms I and III.

Ten taxa occur in the North-eastern Zone. These include one endemic species of growth-form I (*W. islensis*); one widespread species of growth-form III that is likely to have originated within the zone (*W. queenslandica*); and, as noted above, three other species of growth-form III that are likely to have originated in the overlap area between this zone and the South-eastern Zone.

Only five taxa occur in the Northern Zone. However, one species, *W. caryophylloides*, is restricted to this zone and the adjacent North-eastern Zone. At present this species is only known from Australia, but it may well occur, and may even have originated, to the north of Australia.

Sixteen taxa occur in the Eyre-Murray Zone, making it the second richest zone for *Wahlenbergia*. Four taxa of growth-form III have apparently originated within this zone. All four are closely related to taxa from more mesic regions further east: *W. aridicola* is close to *W. graniticola*, *W. fluminalis* to *W. planiflora*, *W. tumidifructa* to *W. gracilis*, and *W. stricta* subsp. *alterna* to subsp. *stricta*.

Only four taxa occur in the Western Shield Zone. All four are widespread species that have apparently colonised the area from eastern Australia.

Nine taxa occur in the South-western Zone. These include two introduced species: *W. capensis* from South Africa, and *W. stricta* subsp. *stricta* from eastern Australia. Only one species, *W. preissii*, appears to have originated within the zone. This species is closely related to another species of growth-form IV, *W. gracilenta*, whose apparent origins are in south-eastern Australia.

Only two taxa occur on Lord Howe Island, including one endemic species of growth-form II, *W. insulae-howei*.

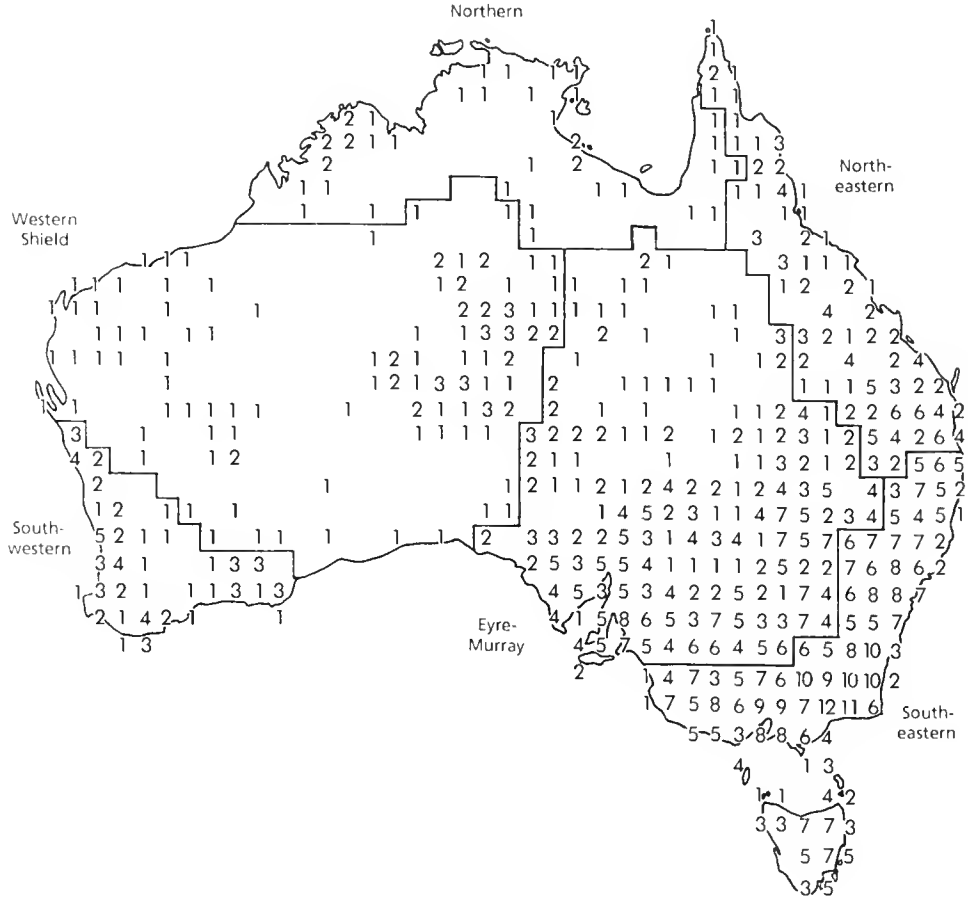

Figure 8. Number of *Wahlenbergia* taxa (species or subspecies) recorded in each one-degree grid-square. Also shown are the major phytogeographic zones as defined by Barlow (1986).

Relationships

No satisfactory subgeneric classification of *Wahlenbergia* has yet been developed. De Candolle (1839), revising his earlier classification (de Candolle 1830), recognised six sections in *Wahlenbergia* sens. strict. One of these has since been transferred to *Codonopsis*, and four others had only one species each. The great majority of species were classified in a single section, *Aikinia*, including all the native Australian species and *W. capensis*.

Von Brehmer (1915*a*) distinguished 30 'series' of *Wahlenbergia* sens. strict. in Africa, but these were found to be of little value in the subsequent study by Thulin (1975: 14–15). Thulin noted a correlation among African species between basic chromosome

Table 2. Distribution of Australian *Wahlenbergia* species in relation to the phytogeographic zones of Barlow (1986).

Taxon	Growth-form (Fig. 1)	Phytogeographic zone						
		LHI	SE	NE	N	EM	WS	SW
W. scopulicola	I		(e)					
W. glabra	I		(e)					
W. islensis	I			(e)				
W. ceracea	II		(e)					
W. gloriosa	II		(e)					
W. densifolia	II		(e)					
W. gymnoclada	II		(e)					
W. saxicola	II		(e)					
W. insulae-howei	II	(e)						
W. stricta								
subsp. *stricta*	III		(+)	(+)		+		-i
subsp. *alterna*	III		-			(+)		
W. luteola	III		(+)			+		
W. communis	III		(+)	(+)	-	+	+	-
W. queenslandica	III		-	(+)	+	+	+	-
W. graniticola	III		(+)	(+)		+		
W. aridicola	III					(e)		
W. littoricola	III		(+)			+		+
W. planiflora								
subsp. *planiflora*	III		(e)					
subsp. *longipila*	III		(+)	-		-		
W. fluminalis	III		+	-		(+)		
W. multicaulis	III		(+)			-		+
W. gracilis	III	-	+	+	-	-		
W. tumidifructa	III/IV			-	-	(+)	+	-
W. gracilenta	IV		(+)			+	-	+
W. preissii	IV					-		(+)
W. victoriensis	IV		(+)			-		
W. caryophylloides	IV			+	+			
**W. capensis*	IV							+i
Total taxa		2	21	10	5	16	4	9
Endemic taxa		1	8	1	0	1	0	0
Introduced taxa		0	0	0	0	0	0	2

LHI, Lord Howe Island; SE, South-eastern; NE, North-eastern; N, Northern; EM, Eyre-Murray; WS, Western Shield; SW, South-western; +, major occurrence; -, minor occurrence; e, endemic; i, introduced; ( ), likely site of origin (based on distribution and chromosome number data).

number and some important morphological characters. He refrained from making a formal subdivision of the genus until more information was available, but placed species into informal groups reflecting their supposed natural affinities.

Thulin (1975: 76) suggested a relationship between his *W. undulata* (L. f.) A. DC. Group and the Asian *W. marginata* complex and related species in Australia. The *W. undulata* Group consists of six species and is characterised by a basic chromosome number of $x = 9$, a distinct corolla-tube and usually stylar glands. The group is distributed in almost all parts of Africa and also in southern Europe. It includes *W. undulata*, *W. virgata* (Figure 2) and other species from de Candolle's (1839) section *Aikinia*. It also includes *W. lobelioides* (L. f.) A. DC., which had been classified by de Candolle in a separate, monotypic section, *Lobelioides*.

The results of the present study support Thulin's contention. The general affinities of all native Australian species would seem to be with the *W. undulata* Group of Africa. However, the introduced *W. capensis*, with its pentamerous gynoecium, is distinct from both the native species and the African species considered by Thulin. Other species of this type occur in South Africa, but none is included in Thulin's treatment, which only deals with the tropical African species.

Within Australia, the morphological and cytological evidence indicates four groups of related native species corresponding to the four major growth-forms (Figure 1). Three subgroups may also be distinguished within one of these groups. The species order used in the taxonomic treatment reflects these putative relationships. The groups are:

The *W. scopulicola* Group, consisting of *W. scopulicola*, *W. glabra* and *W. islensis*. These are three distinctive species with very restricted distributions in north-eastern temperate Australia. All grow in rock crevices and are characterised by growth-form I. Other shared characters are deeply campanulate corollas and hemispherical capsules. A single diploid count has been made on each species.

The *W. gloriosa* Group, consisting of *W. ceracea*, *W. gloriosa*, *W. densifolia*, *W. gymnoclada*, *W. saxicola* and *W. insulae-howei*. These six species are characterised by growth-form II. One species is endemic to Lord Howe Island; the others are endemic to south-eastern Australia. All are distinctive species with more or less restricted distributions, typically occurring in natural habitats at high montane to alpine levels. All chromosome counts have been diploid except for an unconfirmed octoploid count in *W. saxicola*. Related species, also typically associated with higher altitudes, are found in New Guinea (*W. papuana* P. Royen) and New Zealand (*W. albomarginata* Hook., *W. brockiei* J. Hay, *W. cartilaginea* Hook. f., *W. congesta* (Cheeseman) N.E. Br., *W. matthewsii* Cockayne, *W. pygmaea* Colenso and *W. simpsonii* J. Hay). Chromosome counts on the New Zealand species have all been tetraploid (J. Petterson, pers. comm.), suggesting a spread of the group from Australia to New Zealand rather than the reverse.

The *W. communis* Group, consisting of 12 species characterised by growth-form III. Most species have two or more chromosome races. All are partly or entirely polyploid, and at least seven species have diploid races as well. Most species have wide distributions and grow in a variety of vegetation types, often in disturbed sites. There is a concentration of diploid races in north-eastern temperate Australia, suggesting that this was the original centre of diversity of the group in Australia. Several species extend outside Australia and related species occur elsewhere (e.g. *W. marginata* of Japan). This group is badly in need of revision in Asia, Malesia and New Zealand. Poor knowledge of the taxa in these regions makes it difficult to assess the extent to which Australian taxa are represented there.

The Australian members of the group are *W. stricta*, *W. luteola*, *W. communis*, *W. queenslandica* and three subgroups of closely related species. The *W. graniticola* Subgroup, consisting of *W. graniticola*, *W. aridicola* and *W. littoricola*, is characterised by medium to large, shortly campanulate corollas, and styles that are more or less distinctly constricted about halfway down. The *W. planiflora* Subgroup, consisting of *W. planiflora*, *W. fluminalis* and *W. multicaulis*, is characterised by rotate corollas and capitate styles, strongly constricted close below the stigmatic lobes. The *W. gracilis* Subgroup, consisting of *W. gracilis* and *W. tumidifructa*, is characterised by small, deeply campanulate corollas and more or less unconstricted styles. There appears to have been speciation at the polyploid level in all three subgroups, but not among other Australian members of the *W. communis* Group. Hexaploid and octoploid forms have developed in all three subgroups, but are unknown in other Australian members of the group.

The ***W. gracilenta* Group**, consisting of *W. gracilenta*, *W. preissii*, *W. victoriensis* and *W. caryophylloides*. These species are characterised by growth-form IV, i.e. they are consistently annual. They also all have opposite, more or less elliptic, more or less hirsute lower leaves. *W. gracilenta* and *W. preissii* both have distinctive, narrowly oblong sepals with obtuse to broadly acute apices. *W. gracilenta* and *W. victoriensis* both have lanceolate bracteoles and ellipsoid to globose capsules. These three species all have southern distributions, with a south-eastern origin indicated for *W. gracilenta* and *W. victoriensis*, and a south-western origin indicated for *W. preissii*. *W. caryophylloides* has a northern distribution and is less clearly related to the other species of the group. There have been tetraploid counts and an unconfirmed diploid count for *W. gracilenta*, but no counts for the other species.

Taxonomy

Wahlenbergia

Wahlenbergia Schrader ex Roth (1821: 399), nom. cons. (I.C.B.N. 1988: 275); de Candolle (1830: 142), (1839: 424); von Brehmer (1915*a*: 9), (1915*b*: 72); Lothian (1947*a*: 201); van Steenis (1960: 122); Tuyn (1960: 111); Carolin (1964: 235); Thulin (1975: 1). *Wahlenbergia* Schrader (1814: 3), nom. nud.

Type: *W. elongata* (Willd.) Schrader ex Roth, nom. illeg. ≡ *W. capensis* (L.) A. DC.

Campanula Linnaeus (1753: 169), p.p.; auct. mult.

Cephalostigma de Candolle (1830: 117). Type: *C. perrottetii* A. DC. ≡ *W. perrottetii* (A. DC.) Thulin.

[*Lightfootia* L'Héritier (1789: 4), nom. illeg. Non Swartz (1788: 83). Type: *L. oxycoccoides* L'Hérit. ≡ *L. parvifolia* (Berg) Adamson]

[*Cervicina* Delile (1813: 7), nom. rej. Type: *C. campanuloides* Delile ≡ *W. campanuloides* (Delile) Vatke]

[*Campanopsis* (R.Br.) Kuntze (1891: 378), nom. illeg. *Campanula* (sect.) I. *Campanopsis* R. Brown (1810: 561), nom. nud.]

The following description covers only the Australian species.

Annual or perennial herbs, tufted or rhizomatous. *Taproot* slender and soft in annual or young plants, becoming thickened and woody with age. *Stems* one to many, usually erect or ascending, sometimes decumbent or pendent, branched or unbranched,

terete, usually faintly ribbed with decurrent leaf margins, glabrous to hirsute; hairs simple, white. *Leaves and bracts* simple, exstipulate, confined to basal rosettes in some species but usually spread along stem, becoming smaller and more widely spaced on upper stem, alternate throughout or opposite on lower stem becoming alternate above or irregularly opposite and alternate, typically changing in shape from broadest distally at base of stem to broadest proximally on upper stem, obtuse to subulate, usually sessile but shortly petiolate in one species, glabrous to hirsute, midrib obscure on upper surface, usually prominent below, at least on lower leaves, lateral venation obscure; margins flat or undulate, ± cartilaginous, entire or with small, distant callus-teeth, sometimes ± serrate. *Flowers* terminal, solitary or in cymes or thyrsoids of varying complexity, actinomorphic, bisexual, protandrous; pedicels usually ± glabrous, with two small, alternate bracteoles. *Hypanthium* not extended above the ovary, glabrous to hirsute. *Sepals* usually 5, free, erect or spreading, usually ± narrowly triangular, sometimes narrowly oblong, glabrous to hirsute, persistent in fruit. *Corolla* campanulate or rotate, usually blue, darker in colour on inner surface of lobes, entirely glabrous in some species but usually puberulous inside tube at base, sometimes also sparsely hirsute along veins; lobes usually 5, spreading, ovate to obovate, usually acute. *Stamens* usually 5, free; filaments persistent in open flower, usually white but dark blue in one species, upper section filiform and glabrous, lower section expanded, triangular to obtrullate, with or without extended shoulders, usually ciliate on upper margins; anthers basifixed, with 2 cylindrical cells, dehiscing and wilting before the flower opens, dehiscence introrse by longitudinal slits. *Ovary* inferior, usually 2- or 3-locular but 5-locular in one species; ovules numerous; placentation axile. *Style* usually white and 2- or 3-fid but dark blue and 5-fid in one species, unconstricted or with a constriction of varying degree and location separating the pollen-presenting upper section of the style from the narrower, non-pollen-presenting lower section, lower style glabrous or with scattered normal hairs, upper style densely covered with coarse pollen-presenting hairs bearing shed pollen when the flower first opens, the hairs later wilting and the pollen falling, a column of 1–5 raised glands in the pollen-presenting zone below each stigmatic cleft or glands absent; stigmatic lobes erect and appressed when flower first opens, later becoming recurved and receptive, inner surface puberulous with glandular hairs. *Fruit* a capsule bearing the persistent sepals, opening by apical slits, glabrous to hirsute. *Seeds* numerous, compressed-ellipsoid, dark brown at maturity, smooth, shining.

About 200 species, mostly in the southern hemisphere, especially Africa. Twenty-six species in Australia, 22 species apparently endemic (but note that knowledge of the taxa in surrounding regions is poor, especially for the *W. communis* Group), one species introduced from South Africa.

Key to species

1 Style 5-fid ..... **26. *W. capensis**

1* Style 2- or 3-fid **2**

2 Stems much-branched; flowers solitary or in few-flowered cymes; inflorescence confined to the upper third of the stem, pedicels ≤ 5 cm long; tufted perennials growing in rock crevices in Queensland and north-eastern New South Wales **3**

2* Habit and inflorescence various but never a combination of much-branched stems with single- or few-flowered inflorescences **5**

3 Leaves hirsute, petiolate, elliptic ..... **1. W. scopulicola**
3* Leaves glabrous, sessile, linear or narrowly elliptic 4

4 Stems decumbent or pendent; corolla-lobes 5.5–9 mm long; leaves partly opposite, narrowly elliptic, up to 4 mm wide ..... **2. W. glabra**
4* Stems ascending; corolla-lobes 3.5–5.5 mm long; leaves all alternate, linear, ≤ 1.5 mm wide ..... **3. W. islensis**

5 Rhizomatous perennials (although *W. insulae-howei* becoming tufted when growing in rock crevices); aerial stems and inflorescence unbranched or only sparingly branched 6
5* Tufted perennials or annuals; stems usually becoming much-branched, at least in the inflorescence (sometimes unbranched in small annuals) 11

6 Leaves linear or narrowly oblong, ≤ 2 mm wide (sometimes lowermost slightly wider in *W. gymnoclada*) 7
6* Lower leaves obovate to narrowly elliptic, > 2 mm wide 8

7 All leaves ≤ 15 mm long; style usually 2-fid ..... **6. W. densifolia**
7* Most leaves > 15 mm long; style 3-fid ..... **7. W. gymnoclada**

8 Corolla-lobes 10–25 mm long; pedicels (4–)8–40 cm long; leaves rarely confined to basal rosettes 9
8* Corolla-lobes 3–11 mm long; pedicels 2–10 cm long; leaves often confined to basal rosettes 10

9 Corolla blue; style 3-fid; leaves all alternate, margins ± flat; capsules obconic ..... **4. W. ceracea**
9* Corolla purple; style usually 2-fid; some leaves usually opposite, margins usually undulate; capsules elongated-obconic ..... **5. W. gloriosa**

10 Style usually 2-fid; corolla-tube similar in length to the sepals; endemic to Tasmania ..... **8. W. saxicola**
10* Style 3-fid; corolla-tube distinctly longer than the sepals; endemic to Lord Howe Island ..... **9. W. insulae-howei**

11 Corolla rotate, lobes > 4 times as long as the tube; style capitate, deeply constricted less than a third of the way down from the stigmatic lobes 12
11* Corolla campanulate, lobes < 4 times as long as the tube; style unconstricted or constricted more than a third of the way down from the stigmatic lobes 14

12 Capsules elongated-obconic, more than twice as long as broad; corolla-lobes 2–9 mm long, less than twice as long as the hypanthium; mesic regions of south-eastern and south-western Australia ..... **19. W. multicaulis**
12* Capsules hemispherical to obconic, less than twice as long as broad; corolla-lobes more than twice as long as the hypanthium 13

13 Corolla-lobes 6–14 mm long; lower leaves obovate to narrowly elliptic, up to 11 mm wide; plants typically few-stemmed; mesic regions of eastern Australia ..... **17. W. planiflora**

13* Corolla-lobes 3–9 mm long; lower leaves oblanceolate to linear, ≤ 5 mm wide; plants typically many-stemmed; inland floodplains of the Murray–Darling Basin ..... **18. W. fluminalis**

14 Lower leaves opposite, linear; capsules elongated-obconic, at least 3 times as long as broad ..... **11. W. luteola**

14* Lower leaves alternate or, if opposite, then broader than linear and capsules less than 3 times as long as broad **15**

15 Corolla-lobes 2–4 times as long as the tube **16**

15* Corolla-lobes 1–2 times as long as the tube **20**

16 Annuals with slender taproots, often single-stemmed; lower leaves opposite; capsules elongated-obconic or ellipsoid to globose **17**

16* Perennials developing thickened, woody taproots, few- to many-stemmed; lower leaves alternate (sometimes the lowermost opposite); capsules hemispherical to obconic **18**

17 Corolla-lobes 1.5–4 mm long; capsules elongated-obconic; Western Australia and South Australia ..... **23. W. preissii**

17* Corolla-lobes 6–12 mm long; capsules ellipsoid or globose; New South Wales and Victoria ..... **24. W. victoriensis**

18 Lower leaves oblanceolate to linear, ≤ 4 mm wide; corolla-lobes 5–9 mm long; mesic regions ..... **16. W. littoricola**

18* Lower leaves obovate to narrowly elliptical, up to 15 mm wide; corolla-lobes 5–19 mm long **19**

19 Corolla-lobes 6–19 mm long; plants hirsute, typically few-stemmed; mesic and semi-arid regions ..... **14. W. graniticola**

19* Corolla-lobes 5–8 mm long; plants glabrous to sparsely hirsute, typically many-stemmed; arid regions ..... **15. W. aridicola**

20 Corolla-lobes 6–20 mm long **21**

20* Corolla-lobes 0.5–6 mm long **23**

21 At least the lowermost leaves opposite, margins typically undulate; sepals 3–16 mm long; capsules ellipsoid or globose, often hirsute ..... **10. W. stricta**

21* Leaves alternate, margins typically flat; sepals 1–6 mm long; capsules hemispherical, obconic or elongated-obconic, always glabrous **22**

22 Capsules obconic to elongated-obconic, 4–9 mm long; lower leaves mostly linear ..... **12. W. communis**

22* Capsules hemispherical to shortly obconic, 1.5–5 mm long; lower leaves broader than linear ..... **13. W. queenslandica**

23 Annuals with slender taproots, often single-stemmed **24**
23* Perennials developing thickened, woody taproots, few- to many-stemmed **26**

24 Sepals narrowly oblong; capsules often hirsute; lower leaves opposite; mesic and semi-arid regions of southern Australia ..... **22. W. gracilenta**
24* Sepals narrowly triangular; capsules glabrous **25**

25 Lower leaves alternate; corolla-tube shorter than the lobes; arid and semi-arid regions ..... **21. W. tumidifructa**
25* Lower leaves opposite; corolla-tube often longer than the lobes; wetter tropical regions ..... **25. W. caryophylloides**

26 Capsules obconic to obovoid; mesic regions ..... **20. W. gracilis**
26* Capsules globose to cylindric, often very swollen; arid and semi-arid regions ..... **21. W. tumidifructa**

1. Wahlenbergia scopulicola *Carolin ex P.J. Smith*, **sp. nov.**

Herba perennis, hirsuta. Caules numerosi, decumbentes vel pendentes, ramosissimi, 5–35 cm longi. Folia irregulariter opposita et alterna, elliptica pro maxima parte, 3–20 mm longa, 0.5–5 mm lata, breviter petiolata. Flores solitarii, pedicellis 1–5 cm longis. Sepala 5, erecta vel effusa, 1.5–3 mm longa. Corolla campanulata, caerulea, tubo 3.5–6 mm longo, lobis 5, 5–9 mm longis. Capsula hemisphaerica, 2–5 mm longa.

TYPE: QUEENSLAND/NEW SOUTH WALES: Moreton/North Coast: Mt Lindesay, *R.C. Carolin 964*, 31 May 1959; holo NSW.

[*W. scopulicola* Carolin ex Beadle (1984: 769), nom. nud.]

[*W.* species D, Jacobs & Pickard (1981: 96)]

[*W.* species 2, Stanley & Ross (1986: 475)]

[*W.* species 3, Briggs & Leigh (1988: 28)]

Perennial herb with a thickened taproot, tufted, many-stemmed. *Stems* 5–35 cm long, decumbent or pendent, crowded, much-branched, hirsute; hairs to 1 mm long. *Leaves* irregularly opposite and alternate, elliptic, becoming narrowly elliptic at top of stem, obtuse to acute, ± petiolate, 3–20 mm long (including petiole up to 2 mm long), 0.5–5 mm wide, hirsute; margins flat, entire or with small, distant callus-teeth. *Flowers* solitary; pedicels 1–5 cm long, glabrous, without bracteoles. *Hypanthium* hemispherical, 0.5–2.5 mm long, ± glabrous. *Sepals* 5, erect or spreading, ± narrowly triangular, 1.5–3 mm long, ± glabrous. *Corolla* deeply campanulate, blue, puberulous inside at base, otherwise glabrous; tube 3.5–6 mm long, longer than the sepals; lobes 5, elliptic to ovate, acute, 5–9 mm long, 2.5–3.5 mm wide. *Stamens* 5; filaments white, 1.0–1.6 mm long, upper section filiform, lower section trullate to rhombic, with or without extended shoulders, ciliate on upper margins; anthers 2–4 mm long. *Ovary* 3-locular. *Style* white, 4–7 mm long, 3-fid, indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 0–1 gland below each stigmatic cleft; stigmatic lobes 0.5–1.3 mm long. *Capsule* hemispherical, 2–5 mm long, 2.5–4.5 mm wide, ± glabrous. *Seeds* c. 0.6 mm long. Figure 9a–d.

CHROMOSOME NUMBER: $n = 9$ (*Smith 57*).

FLOWERING PERIOD: Throughout the year (records for Mar, May, June, Sep, Nov, Dec).

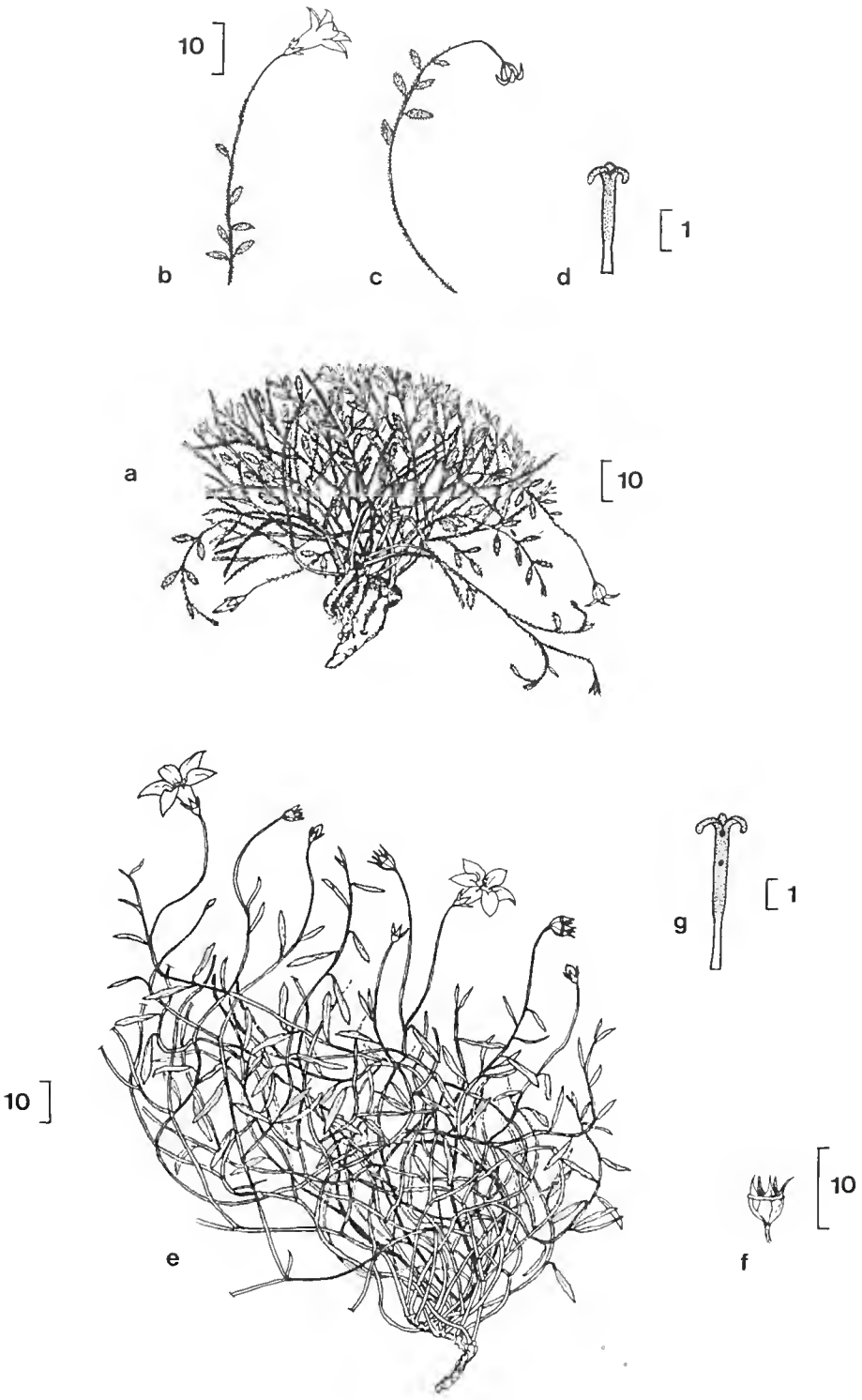

Figure 9. *W. scopulicola*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. glabra*: **e**, habit; **f**, capsule; **g**, style. a–d from *Coveny 4552*; e–g from *Smith 55*. Scale bars in mm.

DISTRIBUTION: Restricted to the McPherson Range on the Queensland/New South Wales border. Figure 24a.

HABITAT: Grows in crevices on rock outcrops. The rock type at the Mt Lindesay site is rhyolite.

CONSERVATION STATUS: A rare species with a very restricted distribution, coded 2RC- by Briggs & Leigh (1988). The Mt Lindesay population is conserved in Mt Lindesay Flora Reserve and Mt Lindesay National Park. The species is also represented in Lamington National Park.

NOTES: Characteristic features of *W. scopulicola* are its densely tufted habit; decumbent or pendent, much-branched, hirsute stems; irregularly opposite and alternate, elliptic, petiolate, hirsute leaves; solitary flowers on short pedicels; corolla-lobes ≥ 5 mm long; and hemispherical capsules.

The epithet refers to the species' rock-face habitat. It was devised by R. Carolin in the 1960s in his unpublished notes on the species. Latin *scopulus*, cliff or crag, *-cola*, dweller. The epithet is a noun in apposition and would retain its ending unchanged irrespective of the gender of the generic name.

OTHER SPECIMENS EXAMINED: QUEENSLAND: Moreton: McPherson Ra., Araucaria Lookout, 28°14' S, 153°12' E, *Telford 8212*, June 1980 (CBG). QUEENSLAND/NEW SOUTH WALES: Moreton/North Coast: Sources of Logan and Tweed, *Cottins & Taylor*, 1895 (MEL 57399); Mt Lindesay, *Everist 1120*, June 1935 (BRI), *White 12737*, Mar 1944 (BRI), *Dowling 107*, Sep 1973 (BRI), *Constable*, May 1949 (NSW 66877), *Constable*, Nov 1952 (NSW 24347, SYD), *Coveny 4552 & Rodd*, Sep 1972 (NSW), *Smith 57*, Dec 1973 (SYD).

2. Wahlenbergia glabra *P.J. Smith*, **sp. nov.**

Herba perennis, glabra. Caules numerosi, decumbentes vel pendentes, ramosissimi, 5–35 cm longi. Folia irregulariter opposita et alterna, anguste elliptica pro maxima parte, 3–27 mm longa, 0.5–4 mm lata, sessilia. Flores solitarii, pedicellis 1–5 cm longis. Sepala 5, erecta, 2–3.5 mm longa. Corolla campanulata, tubo albo, 3–6.5 mm longo, lobis 5, caeruleis, 5.5–9 mm longis. Capsula hemisphaerica, 2–4.5 mm longa.

TYPE: QUEENSLAND: Darling Downs/Moreton: near the summit of Mt Cordeaux, *P.J. Smith 55*, Dec 1973; holo NSW.

[*W.* species A, Jacobs & Pickard (1981: 96)]

[*W.* species 1, Stanley & Ross (1986: 475)]

[*W.* species 2, Briggs & Leigh (1988: 28)]

Perennial herb with a thickened taproot, tufted, many-stemmed. *Stems* 5–35 cm long, decumbent or pendent, crowded, much-branched, glabrous. *Leaves* irregularly opposite and alternate, narrowly elliptic, becoming linear at top of stem, acute to subulate, sessile, 3–27 mm long, 0.5–4 mm wide, glabrous; margins flat, entire or with small, distant callus-teeth. *Flowers* solitary; pedicels 1–5 cm long, glabrous, without bracteoles. *Hypanthium* hemispherical, 0.5–2.5 mm long, glabrous. *Sepals* 5, erect, ± narrowly triangular, 2–3.5 mm long, glabrous. *Corolla* deeply campanulate, blue on lobes, white on tube, puberulous inside at base, otherwise glabrous; tube 3–6.5 mm long, longer than the sepals; lobes 5, elliptic to ovate, acute, 5.5–9 mm long, 2.5–4 mm wide. *Stamens* 5; filaments white, 0.9–1.6 mm long, upper section filiform, lower section obtrullate, with extended shoulders, ciliate on upper margins; anthers 2–4 mm long. *Ovary* 3-locular. *Style* white, 4.5–7 mm long, 3-fid, indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 0–2 glands below each stigmatic cleft; stigmatic lobes 0.5–1.3 mm long.

Capsule hemispherical, 2–4.5 mm long, 2–4.5 mm wide, glabrous. *Seeds* c. 0.5 mm long. Figure 9e–g.

CHROMOSOME NUMBER: $n = 9$ (*Smith 55*).

FLOWERING PERIOD: Throughout the year (records for Jan, May, June, Aug, Oct, Dec).

DISTRIBUTION: Restricted to south-eastern Queensland and north-eastern New South Wales. The only known localities are in the McPherson Range and at Cunninghams Gap. Figure 24b.

HABITAT: Grows in crevices on rock outcrops. It grows on basalt at Mt Cordeaux, Mt Mitchell, Wilsons Peak and Morans Falls.

CONSERVATION STATUS: A rare species with a very restricted distribution, coded 2RC- by Briggs & Leigh (1988). Populations are conserved in Main Range and Lamington National Parks.

NOTES: Characteristic features of *W. glabra* are its densely tufted habit; decumbent or pendent, much-branched, glabrous stems; irregularly opposite and alternate, narrowly elliptic, glabrous leaves; solitary flowers on short pedicels; corollas with white tubes and blue lobes, the lobes > 5 mm long; and hemispherical capsules.

The epithet refers to the species' glabrous nature. Latin *glaber*, glabrous.

OTHER SPECIMENS EXAMINED: QUEENSLAND: Darling Downs/Moreton: Mt Mitchell, Cunninghams Gap, *Telford 1528*, May 1970 (CBG, NSW); Mt Cordeaux, *Phillips*, June 1961 (CBG 018920), *Briggs*, June 1961 (NSW 67183). Moreton: Morans Falls, Lamington Natl Park, *Smith 25*, Dec 1943 (BRI), *Telford 3382*, Oct 1973 (CBG); head of Little Nerang R, McPherson Ra., *White*, Jan 1916 (BRI 159845). NEW SOUTH WALES: North Coast: Wilsons Peak, McPherson Ra., *Whaite 279*, Aug 1949 (NSW).

3. Wahlenbergia islensis *P.J. Smith*, **sp. nov.**

Herba perennis, glabra. Caules numerosi, ascendentes, ramosissimi, 7–50 cm longi. Folia alterna, linearia, infima interdum oblanceolata, 3–35 mm longa, 0.5–1.5 mm lata, sessilia. Inflorescentia cyma brevis vel flores solitarii, pedicellis 1–5 cm longis. Sepala 5, erecta vel effusa, 1–3 mm longa. Corolla campanulata, caerulea vel alba, tubo 1.5–3.5 mm longo, lobis 5, 3.5–5.5 mm longis. Capsula hemisphaerica, 1.5–3.5 mm longa.

TYPE: QUEENSLAND: Leichhardt: near Isla Gorge, *P.J. Smith 132*, 13 Sep 1974; holo NSW.

[*W.* species 1, Briggs & Leigh (1988: 28)]

Perennial herb with a thickened taproot, tufted, many-stemmed. *Stems* 7–50 cm long, ascending, crowded, much-branched, glabrous. *Leaves* alternate, linear and subulate, sometimes lowermost oblanceolate and acute, sessile, 3–35 mm long, 0.5–1.5 mm wide, glabrous; margins flat, entire or with small, distant callus-teeth. *Flowers* solitary or in short cymes of 2–6 flowers confined to the upper third of the plant; pedicels 1–5 cm long, glabrous; bracteoles linear, 2–10 mm long, glabrous. *Hypanthium* hemispherical, 0.5–2 mm long, glabrous. *Sepals* 5, erect or spreading, narrowly triangular, 1.0–2.7 mm long, glabrous. *Corolla* deeply campanulate, blue to white, puberulous inside at base, otherwise glabrous; tube 1.5–3.5 mm long, longer than the sepals; lobes 5, elliptic to ovate, acute, 3.5–5.5 mm long, 1.5–2.5 mm wide. *Stamens* 5; filaments white, 0.6–1.5 mm long, upper section filiform, lower section trullate, with or without extended shoulders, ciliate on upper margins; anthers 1.5–3.5 mm long. *Ovary* 3-locular. *Style* white, 2.5–5.5 mm long, 3-fid, unconstricted or indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 0–2 glands below each stigmatic cleft; stigmatic lobes 0.5–1.0 mm long. *Capsule* hemispherical, 1.5–3.5 mm long, 1.5–3 mm wide, glabrous. *Seeds* c. 0.5 mm long. Figure 10.

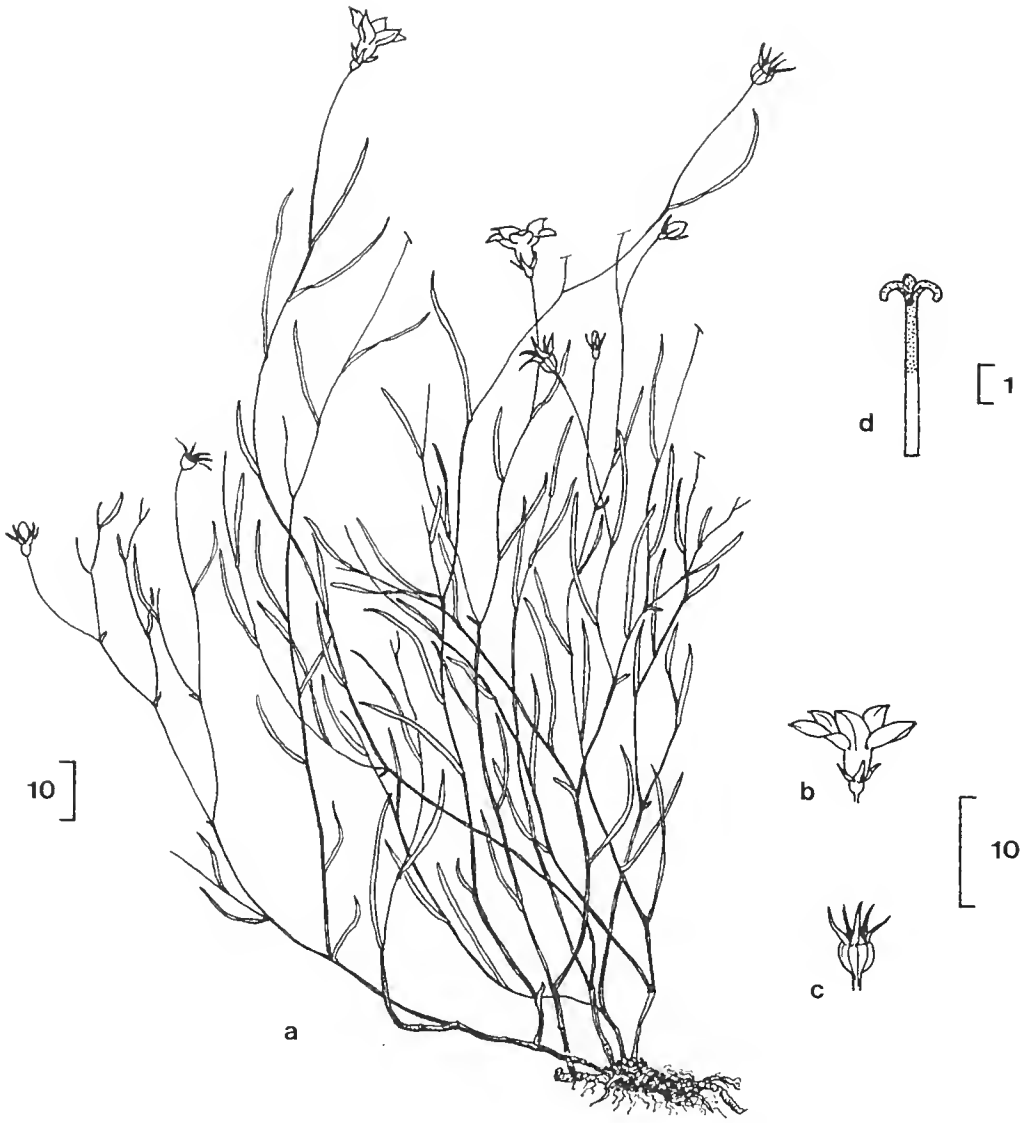

Figure 10. *W. islensis*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. From *Crisp 3110*. Scale bars in mm.

CHROMOSOME NUMBER: $n = 9$ (*Smith 132*).

FLOWERING PERIOD: The few records available cover the period June–November. It is likely that the species flowers throughout the year.

DISTRIBUTION: Endemic to Queensland, where it is known from only three localities: Isla Gorge, Carnarvon Range and Chesterton Range. Figure 25a.

HABITAT: Grows in crevices on rock outcrops. It grows on sandstone at Isla Gorge and Chesterton Range.

CONSERVATION STATUS: A rare species with a restricted and disjunct distribution, coded 3RC- by Briggs & Leigh (1988). Populations are conserved in Isla Gorge and Carnarvon National Parks.

NOTES: Characteristic features of *W. islensis* are its densely tufted habit; ascending, much-branched, glabrous stems; alternate, linear, glabrous leaves; single- or few-flowered inflorescences confined to the upper third of the stem; corolla-lobes ≤ 5.5 mm long; and hemispherical capsules.

The epithet refers to the species' occurrence at Isla Gorge.

OTHER SPECIMENS EXAMINED: QUEENSLAND: Leichhardt: Isla Gorge, c. 18 miles [30 km] SW of Theodore, *Everist 8069*, Sep 1968 (BRI). Maranoa: Maranoa R., W branch, c. 110 km NW of Injune, The Tombs, *Crisp 3110*, June 1977 (CBG, BRI, NSW). Leichhardt/Maranoa: Wanderers Cave, Carnarvon Ra., *Hockings*, June 1962 (BRI 033730); Carnarvon Ra., *Jones*, Nov 1963 (BRI 051880).

4. Wahlenbergia ceracea *Loth.*

Lothian (1956: 166); Curtis (1963: 407); Burbidge & Gray (1970: 346); Willis (1972: 627); Costin et al. (1979: 226).

TYPE: NEW SOUTH WALES: Southern Tablelands: Kosciusko Plateau, on moist grassy slopes at Chalet, c. 5700 feet [1710 m], *J.H. Willis*, 5 Feb 1946; holo MEL 56931.

Perennial herb with a thickened taproot and spreading rhizomes ending in single stems. *Stems* 10–115 cm long, erect or ascending, usually unbranched or with only 1–2 branches, usually glabrous, sometimes lower stem sparsely hirsute; hairs to 1 mm long. *Leaves* alternate, obovate to narrowly elliptic, becoming lanceolate to linear on upper stem, obtuse to subulate, sessile, 5–50 mm long, 1–10 mm wide, usually glabrous, sometimes lower leaves sparsely hirsute; margins ± flat, ± entire. *Flowers* solitary or 2–3 per stem, rarely more; pedicels 5–40 cm long, glabrous; bracteoles lanceolate to linear, 3–19 mm long, glabrous. *Hypanthium* obconic, 2.5–7 mm long, glabrous. *Sepals* 5, ± erect, narrowly triangular, 2.5–6 mm long, glabrous. *Corolla* shortly campanulate, usually blue, sometimes white, puberulous inside at base, otherwise glabrous; tube 3–7.5 mm long, equal to or longer than the sepals; lobes 5, elliptic to ovate, acute, 10–23 mm long, 5.5–8.5 mm wide. *Stamens* 5; filaments white, 1.2–2.0 mm long, upper section filiform, lower section rhombic to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 4–7 mm long. *Ovary* 3-locular. *Style* white, 5.5–12 mm long, 3-fid, unconstricted or indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 0–2 glands below each stigmatic cleft; stigmatic lobes 1–3 mm long. *Capsule* obconic, 5–10 mm long, 3.5–5.5 mm wide, glabrous. *Seeds* c. 0.6 mm long. Figure 11a–b.

CHROMOSOME NUMBER: $n = 9$ (*Carolin W25, W144, W145, 482*).

FLOWERING PERIOD: November–May.

DISTRIBUTION: High country of eastern New South Wales (north to near Tenterfield),

eastern Victoria (west to Mt Buller) and northern Tasmania (south to Lake St Clair). Figure 25b.

HABITAT: Grows in dense, low vegetation in moist sites at high montane to alpine levels. Typically found along watercourses, in bogs and other types of swamp vegetation, and in dense, moist grassland. Recorded at altitudes of 900–2200 m on the mainland, and down to about 600 m in Tasmania.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. ceracea* are its rhizomatous habit; unbranched or seldom-branched stems and inflorescence; alternate leaves with relatively flat margins; long pedicels; very large, blue, shortly campanulate corollas; 3-locular ovaries and 3-fid styles; and obconic capsules.

SELECTED SPECIMENS (172 examined): NEW SOUTH WALES: Northern Tablelands: Spirabo Valley, 20 miles [33 km] SSE of Tenterfield, *Constable*, May 1961 (NSW 56095); Careys Peak, Barrington Tops, *Carolin 482*, Apr 1958 (SYD). Central Tablelands: Running Stream, 60 km N by road from Lithgow, *Briggs 3478*, Mar 1970 (NSW); upper Boyd R. [Kowmung R.], junction of Little Morong Ck, *Carolin 3007*, Apr 1961 (SYD). Southern Tablelands: 0.5 mile [1 km] NW of Big Badja Mill [45 km NE of Cooma], *Briggs & Rodd*, Apr 1968 (NSW 125005); Betts Valley, *Carolin W25*, Jan 1956 (SYD); Island Bend, *Carolin W144*, Feb 1957 (SYD); Kiandra–Adaminaby, 10 miles [17 km], *Carolin W145*, Feb 1957 (SYD); Snowy River bridge below Seaman's Hut, Kosciusko area, *Gray 6194 & Totterdell*, Feb 1968 (CANB, NSW). AUSTRALIAN CAPITAL TERRITORY: c. 33 km SW of Tharwa, *Adams & Hoogland 2691*, Feb 1972 (CANB). VICTORIA: R: Mt Buffalo Natl Park, *Short 1408*, Jan 1982 (MEL, CBG). S: The Bluff, 7 miles [12 km] SE of Mt Buller, *Muir 2774*, Jan 1963 (MEL); 1 mile [2 km] N of Mt Wellington, *Muir 3827*, Jan 1966 (MEL). V: 6.4 km NW of Falls Creek, *Beauglehole 22382*, Jan 1967 (MEL); Native Cat Plain, *Beauglehole & Finck*, Jan 1971 (MEL 56944). W: Upper Tambo Valley, *Wakefield*, Feb 1938 (MEL 56933); Dargo High Plains, *Walsh 599*, Jan 1982 (MEL). Z: Delegate River, *Merrah*, 1889 (MEL 56938). TASMANIA: Central Highlands: N of Lake St Clair, *Curtis*, Feb 1953 (HO 82579); Ben Lomond, *Gulline*, Feb 1950 (HO 8303). Western and South-western: Hatfield R. crossing, c. 33 km Rosebery–Wynyard, *Canning 1987*, Jan 1969 (CBG).

5. **Wahlenbergia gloriosa** *Loth.*

Lothian (1947*a*: 224), (1956: 165); Burbidge & Gray (1970: 347); Willis (1972: 627); Costin et al. (1979: 227).

TYPE: VICTORIA: R: Mt Buffalo, *P.R.H. St John*, Mar 1930; lecto MEL 57090 (here chosen); isolecto MEL 57091.

[*W. marginata* var. *grandiflora* Tuyn (1960: 118), p.p., nom. nud.]

Perennial herb with a thickened taproot and spreading rhizomes ending in single stems. *Stems* 6–40 cm long, erect or ascending, usually unbranched or with only 1–2 branches, lower stem glabrous to hirsute, upper stem ± glabrous; hairs to 1.5 mm long. *Leaves* often crowded, sometimes forming a basal rosette, usually irregularly alternate and opposite, sometimes all alternate, obovate to narrowly elliptic, becoming lanceolate to linear on upper stem, obtuse to subulate, sessile, 4–35 mm long, 1–15 mm wide, glabrous to hirsute; margins usually undulate, entire or with small, distant callus-teeth. *Flowers* solitary or 2–3 per stem, rarely more; pedicels 4–25 cm long, ± glabrous; bracteoles lanceolate to linear, 3–18 mm long, ± glabrous. *Hypanthium* elongated-obconic, 2.5–6.5 mm long, glabrous. *Sepals* usually 5, sometimes 4 or 6, ± erect, narrowly triangular, 2.5–7 mm long, glabrous. *Corolla* usually shortly campanulate, sometimes rotate, purple, entirely glabrous; tube 2.5–8.5 mm long, equal to or sometimes longer than the sepals; lobes usually 5, sometimes 4 or 6, elliptic, acute, 11–25 mm long, 6–12 mm wide. *Stamens* usually 5, sometimes 4 or 6; filaments white,

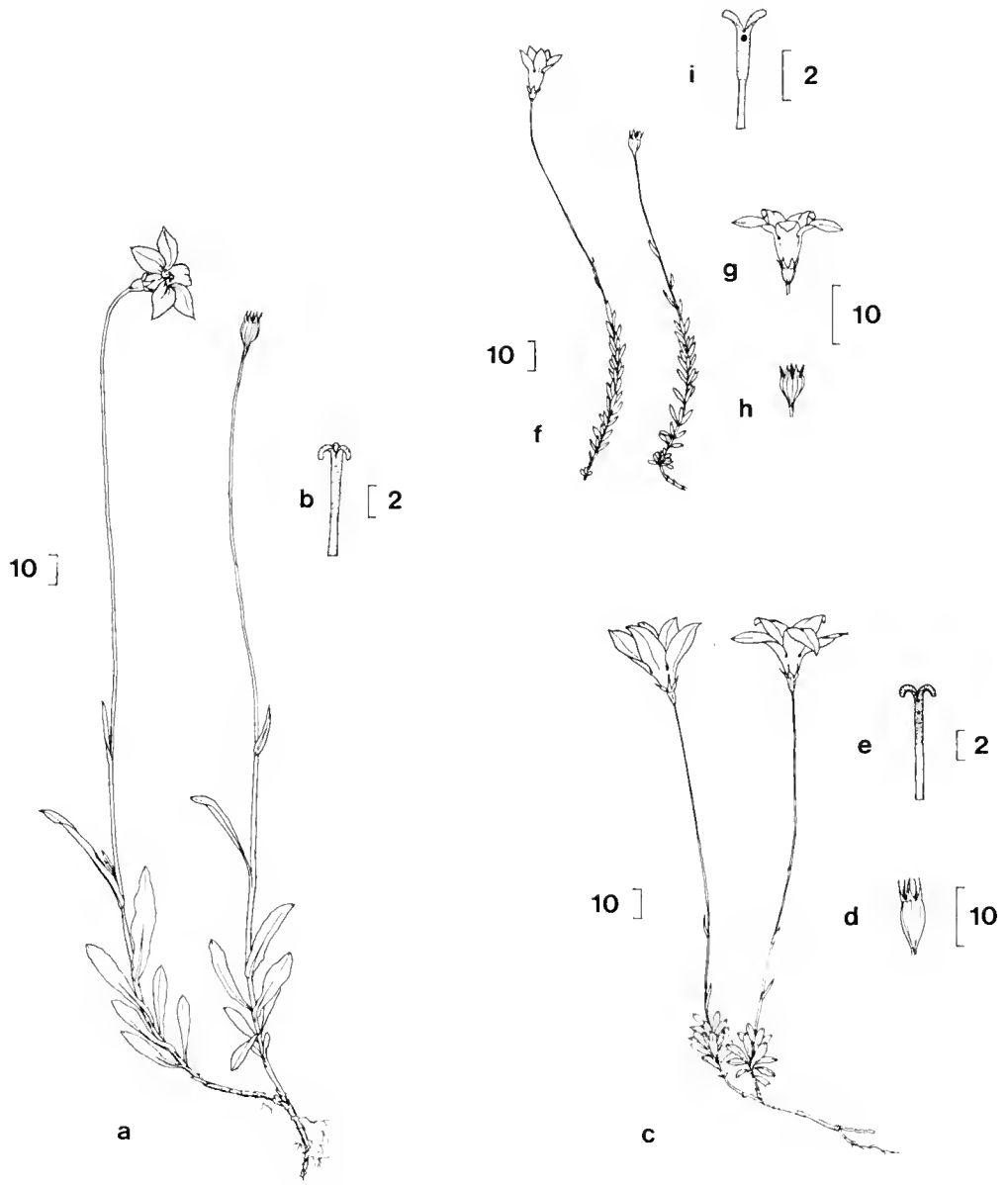

Figure 11 *W. ceracea*: **a**, habit; **b**, style. *W. gloriosa*: **c**, habit; **d**, capsule; **e**, style. *W. densifolia*: **f**, habit; **g**, flower; **h**, capsule; **i**, style. a–b from *Gray 6194*; c–e from *Hartley 13608*; f–i from *NSW 67060*. Scale bars in mm.

1.9–2.7 mm long, upper section filiform, lower section trullate to obtrullate, with extended shoulders, ciliate on upper margins; anthers 4–7 mm long. *Ovary* usually 2-locular, sometimes 3-locular. *Style* white, 6.5–13 mm long, usually 2-fid, sometimes 3-fid, unconstricted or indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 1–2 glands below each stigmatic cleft; stigmatic lobes 1–3 mm long. *Capsule* usually elongated-obconic, sometimes obconic, 8–12 mm long, 3–5 mm wide, glabrous. *Seeds* c. 0.7 mm long. Figure 11c–e.

CHROMOSOME NUMBER: $n = 9$ (*Carolin W26*).

FLOWERING PERIOD: December–May.

DISTRIBUTION: Restricted to the high country of south-eastern New South Wales, the Australian Capital Territory and eastern Victoria. Recorded from the Brindabella Range in the north-east to the Royston Range in the south-west. Figure 25a.

HABITAT: Grows mainly in eucalypt woodland and forest of the subalpine and high montane zones, but also extends to the alpine zone. Typically found in rocky sites. Recorded at altitudes of 1100–1800 m.

CONSERVATION STATUS: The species has a fairly restricted distribution but is common there and is not considered at risk.

NOTES: Characteristic features of *W. gloriosa* are its rhizomatous habit; unbranched or seldom-branched stems and inflorescence; leaves that typically have undulate margins and are partly opposite; long pedicels; very large, purple, shortly campanulate, entirely glabrous corollas; predominantly 2-locular ovaries and 2-fid styles; and elongated-obconic capsules.

SELECTED SPECIMENS (146 examined): NEW SOUTH WALES: Southern Tablelands: Mt Gingera, *Burbidge 1741*, Mar 1947 (CANB); Guthega–Island Bend, 3 miles [5km] from Island Bend, *Carolin W26*, Jan 1956 (SYD); Andrews Lookout, Kosciusko Natl Park, *Thompson 2831*, Feb 1978 (NSW); Thredbo River–Hotel Kosciusko Rd, *Johnson & Constable*, Jan 1951 (NSW 67069). AUSTRALIAN CAPITAL TERRITORY: Mt Franklin, *Singh 18295*, Jan 1973 (CANB); Tinderry Mtns, *Hartley 13608*, Mar 1972 (CANB, NSW). VICTORIA: R: Mt Buffalo, road to Mt McLeod, *Todd 303*, Feb 1975 (MEL). S: Mt Stirling, *Melville 3231 & Willis*, Mar 1953 (K, BRI, AD, PERTH); 1 mile [2 km] N of Mt Wellington, *Muir 3826*, Jan 1966 (MEL); Mt Torbreck, *Willis*, Mar 1943 (MEL 57179). V: The Razorback, Mt Feathertop–Mt Hotham, *Craven 1539*, Feb 1969 (CANB, MEL); Cobberas, W ascent, *Wakefield 3012*, Jan 1949 (MEL). W: Nunniong Plains, *Beauglehole 36271 & Finck*, Jan 1971 (MEL); Mt Nugong, *Melville 3121 & Wakefield*, Jan 1953 (K, CANB, BRI, AD, PERTH). Z: Mt Tingaringy, *Beauglehole 35749*, Jan 1971 (MEL).

Wahlenbergia gloriosa x **W. stricta** subsp. **stricta**

Occasional specimens within both the New South Wales and Victorian distributions of *W. gloriosa* appear to represent hybrids with *W. stricta* subsp. *stricta*. These specimens show various mixtures of the characters of the two species. The leaves are more scattered and more consistently opposite than typical *W. gloriosa*; the flowers are usually in cymes or thyrsoids, although sometimes solitary; the large, shortly campanulate corollas are usually purple but sometimes blue; and the styles are sometimes 3-fid, sometimes 2-fid.

SPECIMENS EXAMINED: NEW SOUTH WALES: Southern Tablelands: Schlink Pass Rd (near Geehi–Island Bend Rd), *Stead*, Jan 1964 (NSW 64340); 0.5 km above Pilot Lookout, Kosciusko Natl Park, *Thompson 1761*, Jan 1973 (NSW). VICTORIA: V: near Carmodys Hut (Nariel to Gibbo Ck, N of Omeo), *Ford*, Jan 1959 (NSW 67018, CHR). W: Mt St Bernard, *Williamson*, Jan 1919 (NSW 66986).

6. Wahlenbergia densifolia *Loth.*

Lothian (1956: 165); Willis (1972: 625).

TYPE: NEW SOUTH WALES: Southern Tablelands: Wragges Ridge, Kosciusko Plateau, c. 5000 feet [1500 m], *A.B. Costin*, 18 Apr 1947; holo MEL 57075.

Perennial herb with a thickened taproot and spreading rhizomes ending in single stems. *Stems* 7–30 cm long, erect or ascending, usually unbranched or with only 1–2 branches, upper stem glabrous, lower stem ± pubescent; most hairs ≤ 0.2 mm long, with scattered larger hairs to 0.5 mm long. *Leaves* ± crowded, irregularly opposite, alternate and whorled, becoming alternate above, mostly narrowly oblong, with lowermost oblanceolate and uppermost lanceolate, mostly obtuse, sessile, 3–15 mm long, 0.5–2 mm wide, upper leaves glabrous, lower leaves glabrous on upper surface, ± pubescent on lower surface; margins flat, entire or with small, distant callus-teeth. *Flowers* solitary or 2–3 per stem, rarely more; pedicels 3–12 cm long, glabrous; bracteoles lanceolate to linear, 1–9 mm long, glabrous. *Hypanthium* obconic, 1.5–3.5 mm long, glabrous. *Sepals* 5, ± erect, triangular or narrowly triangular, 2–4.5 mm long, glabrous. *Corolla* deeply or shortly campanulate, blue to purplish-blue, entirely glabrous; tube 2.5–6.5 mm long, equal to or longer than the sepals; lobes 5, elliptic to obovate, acute to obtuse, 8–15 mm long, 3–7.5 mm wide. *Stamens* 5; filaments white, 8 mm long, upper section filiform, lower section oblong to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 2.5–4 mm long. *Ovary* usually 2-locular, sometimes 3-locular. *Style* white, 4–8 mm long, usually 2-fid, sometimes 3-fid, ± distinctly constricted about halfway down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 1 gland below each stigmatic cleft; stigmatic lobes 1–2 mm long. *Capsule* obconic, 3.5–8 mm long, 2.5–4 mm wide, glabrous. *Seeds* c. 0.5 mm long. Figure 11f–i.

CHROMOSOME NUMBER: $n = 9$ (*Carolin W148*).

FLOWERING PERIOD: November–May.

DISTRIBUTION: Restricted to the high country of south-eastern New South Wales (Kosciusko National Park) and eastern Victoria (from Nunniong Plain west to Dargo High Plains). Figure 24a.

HABITAT: Grows in the subalpine zone in dense, moist grassland, sometimes under a sparse *Eucalyptus pauciflora* canopy. Recorded at altitudes of 1200–1550 m.

CONSERVATION STATUS: A rare species with a restricted distribution, coded 3RCa by Briggs & Leigh (1988). The New South Wales populations are conserved in Kosciusko National Park.

NOTES: Characteristic features of *W. densifolia* are its rhizomatous habit; unbranched or seldom-branched stems and inflorescence; very short indumentum on lower stems and leaves; short, narrowly oblong, obtuse leaves in a typically crowded, irregular arrangement; large, entirely glabrous corollas; and predominantly 2-locular ovaries and 2-fid styles.

SELECTED SPECIMENS (30 examined): NEW SOUTH WALES: Southern Tablelands: Cooleman Plain, N of Tantangara Reservoir, *Thompson 1987*, Jan 1974 (NSW); Gurrangorambla Ck, Currango Plain, N of Tantangara Dam, *Thompson 772*, Jan 1971 (NSW); Kiandra–Adaminaby, 3 miles [5 km], *Carolin W148*, Feb 1957 (SYD); 2 km from Kiandra on road to Adaminaby, *Smith 61*, Mar 1974 (SYD); a few miles E of Kiandra, *Thompson*, Jan 1958 (NSW 67060); Happy Jacks Plain, headwaters of Happy Jacks R., 15 miles [25 km] S of Kiandra, *Thompson*, Jan 1958 (NSW 67059, CHR); Barneys Ck, part of the headwaters of Happy Jacks R., 16 miles [27 km] S of Kiandra, *Thompson*, Jan 1958 (NSW 67061); McKeahnies Ck valley (tributary of Happy Jacks R.), *Mueller*, Jan 1954 (NSW 67062); Long Plain, Kosciusko Natl Park, *Jackson & Canning*, Jan 1979 (CBG 7901044); Mount

Kosciusko, Hotel Kosciusko, *Costin*, May 1947 (NSW 67063); Thredbo Diggings, Kosciusko Natl Park, *Thompson 2261*, Jan 1975 (NSW). VICTORIA: V: 28 km NW of Omeo, *Scarlett 81–26*, Feb 1982 (MEL). W: Dargo High Plains, *Willis*, Jan 1946 (MEL 57077–57078); Nunniong Plain, about 18 miles [30 km] NNE of Ensay, Gippsland, *Melville 3104 & Wakefield*, Jan 1953 (K, MEL, NSW, AD, BRI, PERTH); Nunniong Plain, *Rogers*, Jan 1967 (MEL 600034); Nunniong Plain, *Beauglehole 36296 & Finck*, Jan 1971 (MEL).

7. Wahlenbergia gymnoclada *Loth.*

Lothian (1947*a*: 227); Curtis (1963: 408); Carolin (1964: 240); Willis (1972: 627); Smith (1986: 1380).

TYPE: VICTORIA: E: Gorae West near Portland, *A.C. Beauglehole*, Nov 1943; lecto MEL 57198 (here chosen); isolecto MEL 57211, 57212, 628537.

W. billardierei Lothian (1947*a*: 226), as 'billardieri' ≡ *Campanula littoralis* Labillardière (1805: 49). *C. gracilis* (var.) γ *littoralis* (Labill.) R. Brown (1810: 561). *W. gracilis* (var.) γ *littoralis* (Labill.) de Candolle (1830: 142), (1839: 433). *W. gracilis* f. *littoralis* (Labill.) Wawra (1883: 133). *W. vinciflora* var. *littoralis* (Labill.) N.E. Brown (1913: 355). *W. marginata* var. *littoralis* (Labill.) Hochreutiner (1934: 29). Non *W. littoralis* Schltr. & von Brehmer (1915*b*: 127). TYPE: AUSTRALIA: Nouvelle Hollande, Herb. Labillardière ex Herb. M.E. Moricand; lecto G (Carolin 1964: 237). Lothian (1947*a*: 227) selected a Robert Brown specimen as a neotype, but this must be rejected as Labillardière's material is extant. The names *W. billardierei* and *W. gymnoclada* were both published in the same paper, but the latter has become the name generally applied to the species and is retained here.

Perennial herb with a thickened taproot and spreading rhizomes ending in single stems. *Stems* 10–60 cm long, erect or ascending, usually unbranched or with only 1–2 branches, usually glabrous, sometimes a few scattered hairs on lower stem. *Leaves* opposite, becoming alternate above, linear, sometimes lowermost oblanceolate, obtuse to acute at base of stem, becoming subulate above, sessile, 5–50 mm long, 1–3.5 mm wide, usually glabrous, sometimes a few scattered hairs on lower leaves; margins flat, entire or with small, distant callus-teeth. *Flowers* solitary or 2–3 per stem, rarely more; pedicels 5–20 cm long, glabrous; bracteoles linear, 2–12 mm long, glabrous. *Hypanthium* obconic to elongated-obconic, 2.5–4 mm long, glabrous. *Sepals* 5, ± erect, narrowly triangular, 2–6 mm long, glabrous. *Corolla* shortly campanulate, blue, puberulous inside at base, otherwise glabrous; tube 3–6 mm long, varying from shorter to longer than the sepals; lobes 5, elliptic, acute, 7–16 mm long, 4–7 mm wide. *Stamens* 5; filaments white, 1.4–3.0 mm long, upper section filiform, lower section trullate to obtrullate, with extended shoulders, ciliate on upper margins; anthers 3–5 mm long. *Ovary* 3-locular. *Style* white, 6–10.5 mm long, 3-fid, unconstricted or indistinctly constricted about halfway down from the stigmatic lobes, upper half covered with pollen-presenting hairs, 2 glands below each stigmatic cleft; stigmatic lobes 1–2 mm long. *Capsule* obconic to elongated-obconic, 5–9 mm long, 2–4 mm wide, glabrous. *Seeds* c. 0.7 mm long. Figure 12a–d.

CHROMOSOME NUMBER: $n = 9$ (*Smith 171*). H. Gulline (in Darlington & Wylie 1955: 289) also reported a count of $n = 9$, probably from Tasmania, but there is no voucher specimen to check the identification.

FLOWERING PERIOD: September–March, with one record in June.

DISTRIBUTION: Widespread in Tasmania and from the far south-east of South Australia across southern Victoria to Mallacoota. Figure 24b.

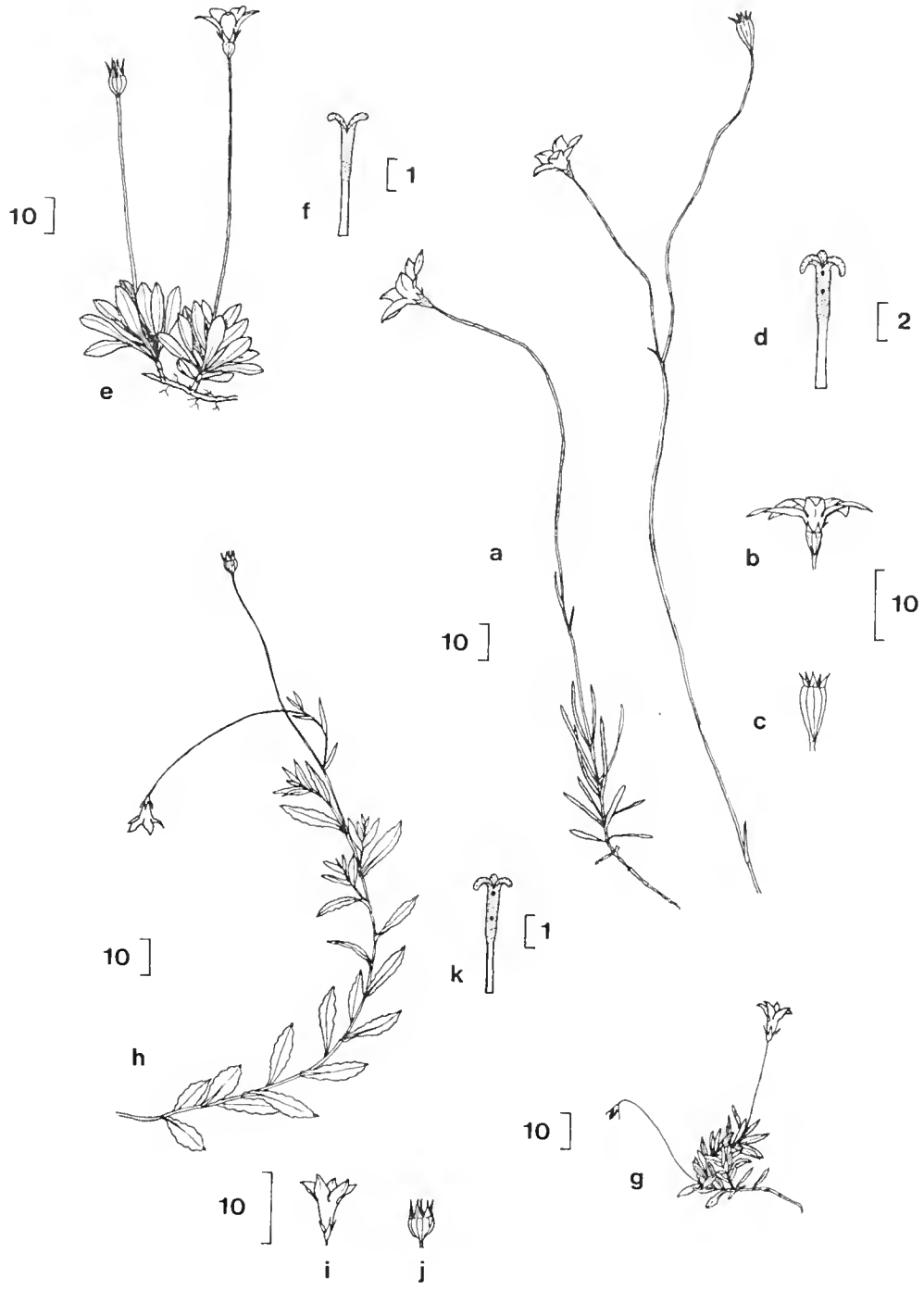

Figure 12. *W. gymnoclada*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. saxicola*: **e**, habit; **f**, style. *W. insulae-howei*: **g,h**, habit; **i**, flower; **j**, capsule; **k**, style. a,d from *Melville 2521*; b,c from *CBG 022916*; e,f from *Rodway 5600*; g from *NSW 120479*; h–k from *NSW 120478*. Scale bars in mm.

HABITAT: Grows in eucalypt forest and woodland, coastal scrub and heath, cleared pastureland and swamp margins. Typically found in open sites, including disturbed sites. Recorded at altitudes from sea level to c. 750 m.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. gymnoclada* are its rhizomatous habit; unbranched or seldom-branched stems and inflorescence; long, linear, opposite, glabrous lower leaves; long pedicels; and large, shortly campanulate corollas.

SELECTED SPECIMENS (107 examined): SOUTH AUSTRALIA: South-eastern: Marshs Swamp, *Wilson 945*, Nov 1968 (AD). VICTORIA: D: Wilkin, 12 miles [20 km] SW of Casterton, *Aston 796*, Oct 1960 (MEL, NSW, AD); Victoria Ra., Grampians, *Beauglehole 6605*, Nov 1964 (MEL, AD). E: 10 km SSW of Portland, *Crisp 6855*, Nov 1980 (CBG). K: Port Campbell Natl Park, *Beauglehole 21400 & Finck*, Oct 1966 (MEL). N: Wandin, *St John*, Nov 1906 (MEL 57684). P: Arthurs Seat, Mornington Peninsula, *Melville 2163 & Wakefield*, Nov 1952 (K, CANB, MEL, NSW, AD, BRI, PERTH). T: 19 km from Yarram on road to Traralgon, *Smith 171*, Jan 1975 (SYD). Z: Marlo, *Hunter 23*, Sep 1951 (MEL); Bastion Point, Mallacoota, *Muir 1888*, Nov 1960 (MEL, AD). TASMANIA: Central Highlands: Breona, *Burbidge 3447*, Jan 1949 (CANB, HO); Lake St Clair Natl Park, *Eichler 16657*, Jan 1960 (AD). Western and South-western: 1.5 miles [3 km] from Arthur R. mouth to Marrawah, *Phillips*, Nov 1965 (CBG 025269); Sandfly, *Rodway 15*, Jan 1931 (HO). North-eastern: 11 miles [18 km] from Bridport towards Waterhouse, *Phillips*, Dec 1965 (CBG 022916, NSW); 4 miles [7 km] along Lake Leake turnoff from Tasman Hwy, *Melville 2521*, Dec 1952 (K, CANB, MEL, NSW, AD, BRI, PERTH); near Copping, *Curtis*, Nov 1959 (HO 53443).

8. Wahlenbergia saxicola *(R. Br.) A. DC.*

De Candolle (1830: 144); Hooker (1856: 239); Bentham (1869: 138); Rodway (1903: 107); N.E. Brown (1913: 354); Lothian (1947*a*: 232); Curtis (1963: 410); Curtis & Stones (1969: 110); [misapplied by Bailey (1900: 922)]. *Campanula saxicola* R. Brown (1810: 561). *Campanopsis saxicola* (R. Br.) Kuntze (1891: 379).

TYPE: TASMANIA: Western and South-western: summit of Mt Wellington, *R. Brown*; lecto BM (Lothian 1947*a*: 232); isolecto K.

Streleskia montana Hooker (1847: 267). TYPE: TASMANIA: Western and South-western: summit of Mt Wellington, *R.C. Gunn 1178*; holo K.

Perennial herb with a thickened taproot and spreading rhizomes ending in single stems. *Stems* 2–15 cm long, erect or ascending, unbranched or with only 1–2 branches, glabrous or sometimes with a few scattered hairs. *Leaves* usually crowded into basal rosettes, sometimes more spread out (opposite, becoming alternate above), obovate to elliptic, becoming ovate above, obtuse to acute, sessile, 4–30 mm long, 2–10 mm wide, glabrous or sometimes with a few scattered hairs; margins ± flat, with small, distant callus-teeth. *Flowers* solitary or 2–3 per stem; pedicels 2–10 cm long, glabrous; bracteoles located either within or above the basal rosette, ovate to lanceolate, 3–15 mm long, glabrous. *Hypanthium* hemispherical to obconic, 1.5–3.5 mm long, glabrous. *Sepals* usually 5, sometimes 3 or 4, ± erect, ± narrowly triangular, 2–4 mm long, glabrous. *Corolla* deeply or shortly campanulate, blue, entirely glabrous; tube 2–4 mm long, similar in length to the sepals; lobes usually 5, sometimes 3 or 4, elliptic, acute, 3–11 mm long, 1.5–4.5 mm wide. *Stamens* usually 5, sometimes 3 or 4; filaments white, 1.1–2.1 mm long, upper section filiform, lower section rhombic to obtrullate, without extended shoulders, ciliate on upper margins; anthers 1–2.5 mm long. *Ovary* usually 2-locular, sometimes 3-locular. *Style* white, 3.3–6 mm long, usually 2-fid, sometimes 3-fid, unconstricted or indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 0–2 glands below each stigmatic cleft; stigmatic lobes 0.5–1 mm long. *Capsule* hemispherical to obconic, 3–7 mm long, 2.5–5 mm wide, glabrous. *Seeds* c. 0.7 mm long. Figure 12e–f.

CHROMOSOME NUMBER: H. Gulline (in Darlington & Wylie 1955: 289) reported a count of $n = 36$, but there is no voucher specimen to check the identification.

FLOWERING PERIOD: December–April.

DISTRIBUTION: Restricted to the high country of Tasmania. Figure 24a.

HABITAT: Grows in the alpine and subalpine zones in herbfield, grassland, heath and woodland, usually amongst rocks.

CONSERVATION STATUS: The species has a fairly restricted distribution but is common there and is not considered at risk.

NOTES: Characteristic features of *W. saxicola* are its rhizomatous habit; unbranched or seldom-branched stems and inflorescence; leaves crowded into basal rosettes; pedicels ≤ 10 cm long; medium-sized, entirely glabrous corollas with the tube similar in length to the sepals; and predominantly 2-locular ovaries and 2-fid styles.

SELECTED SPECIMENS (47 examined): TASMANIA: Central Highlands: Ironstone Plateau, *Rodway*, Dec 1899 (NSW 67147); Great Lake Rd, *Curtis*, Dec 1968 (HO 8350); Projection Bluff, *Burns 279*, Jan 1960 (HO); Drys Bluff marshes, *Moscal 683*, Feb 1981 (HO); Lake St Clair, *Rodway*, Dec 1917 (NSW 67145); Ben Lomond Natl Park, *Short 1927*, Feb 1983 (MEL); Mt Victoria, *Rodway*, Dec 1919 (HO 61209); S end of Lake Youl, *Noble 28315*, Feb 1979 (HO). Western and South-western: summit of Mt Bischoff, *Atkinson*, Jan 1923 (MEL 57238); Waratah, *Burbury*, 1893 (HO 90583); Windy Moor, SW of Mt Field East, *Carolin 1605*, Jan 1960 (SYD); Golden Stairs, Lake Dobson, *Smith 419*, Jan 1978 (HO); Big Bend, Mt Wellington, *Orchard 5252*, Jan 1981 (HO, MEL, AD); Mt Wellington, *Rodway 5600*, Feb 1903 (NSW).

9. Wahlenbergia insulae-howei *Loth.*

Lothian (1947*a*: 234); Rodd & Pickard (1983: 271); Pickard (1983: 139).

TYPE: NEW SOUTH WALES: Lord Howe Island: Lord Howe Island, *W.W. Watts*, Aug 1911; holo NSW 120477; iso MEL.

Lothian (1947*a*: 234) mistakenly stated that the collector of the type was W. Woolls (who died in the 1890s).

W. limenophylax Lothian (1947*a*: 233), as 'limnophylax' (Lothian 1947*b*: 366). TYPE: NEW SOUTH WALES: Lord Howe Island: North Hills, *W.R.B. Oliver*, 6 Nov 1913; holo NSW 120479; iso MEL 57724. The names *W. limenophylax* and *W. insulae-howei* were both published in the same paper, but the latter has become the name generally applied to the species and is retained here.

Perennial herb with a thickened taproot, tufted or with spreading rhizomes ending in single stems. *Stems* 4–25 cm long, erect or ascending, usually unbranched or with only 1–3 branches, glabrous or sometimes with a few scattered hairs. *Leaves* either crowded into basal rosettes or scattered along stem (alternate or with some leaves opposite), obovate to narrowly elliptic, obtuse to acute, sessile, 5–25 mm long, 2–7 mm wide, glabrous or sometimes with a few scattered hairs; margins ± flat, with small, distant callus-teeth and also faintly serrate. *Flowers* solitary or 2–3 per stem, rarely more; pedicels 2–9 cm long, glabrous; bracteoles narrowly elliptic to lanceolate, 2–14 mm long, glabrous. *Hypanthium* hemispherical to shortly obconic, 1–2 mm long, glabrous. *Sepals* 5, erect, narrowly triangular, 2–3 mm long, glabrous. *Corolla* deeply campanulate, blue, puberulous inside at base, otherwise glabrous; tube 3–6 mm long, longer than the sepals; lobes 5, elliptic, acute, 3.5–6 mm long, 1.8–3.5 mm wide. *Stamens* 5; filaments white, 0.9–1.6 mm long, upper section filiform, lower section rhombic to obtrullate, with extended shoulders, ciliate on upper margins; anthers

1.5–2.5 mm long. *Ovary* 3-locular. *Style* white, 4–5 mm long, 3-fid, ± distinctly constricted about halfway down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 2 glands below each stigmatic cleft; stigmatic lobes 0.5–1 mm long. *Capsule* hemispherical to shortly obconic, 2–4.5 mm long, 2–4 mm wide, glabrous. *Seeds* c. 0.6 mm long. Figure 12g–k.

FLOWERING PERIOD: Throughout the year (records for Feb, Apr, Aug, Sep, Oct, Nov).

DISTRIBUTION: Endemic in Lord Howe Island and nearby Balls Pyramid.

HABITAT: Typically grows in crevices on cliffs or in other rocky, exposed sites.

CONSERVATION STATUS: Classified as a rare species on Lord Howe Island by Pickard (1983). Subsequently listed as rare in Australia by Briggs & Leigh (1988), coded 2RCa. It is well represented in the Lord Howe Island Permanent Park Preserve.

NOTES: Characteristic features of *W. insulae-howei* are its unbranched or seldom-branched stems and inflorescence; leaves often crowded into basal rosettes; pedicels ≤ 9 cm long; small corollas with the tube distinctly longer than the sepals; and hemispherical capsules.

SELECTED SPECIMENS (23 examined): NEW SOUTH WALES: Lord Howe Island: Mt Lidgbird, E side, *Nicholls*, Apr 1944 (NSW 120478); Mt Lidgbird, SE side, *Beauglehole 5636*, Nov 1962 (CANB); Mt Eliza, *Beauglehole 5637*, Nov 1962 (CANB); Malabar, *Beauglehole 5800*, Sep 1963 (CANB); North Head, *Beauglehole 6116*, Sep 1963 (CANB); Balls Pyramid, *Pettigrew*, Feb 1969 (NSW 59744); Malabar Track, *Crisp & Telford 4456*, Oct 1978 (CBG); Dawsons Point, *Crisp & Telford 4494*, Oct 1978 (CBG); Mt Gower, *Crisp & Telford 4528*, Oct 1978 (CBG), *Fullagar* (MEL 57723); near Malabar Hill, *Willis*, Aug 1981 (MEL 628433).

10. Wahlenbergia stricta *(R. Br.) Sweet*

Sweet (1830: 593).

Perennial herb with a thickened taproot, tufted, few- to many-stemmed. *Stems* 10–90 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, usually ± hirsute, at least on lower stem, sometimes glabrous throughout; hairs to 2 mm long. *Leaves and bracts* usually opposite at base of stem, becoming alternate above, sometimes all opposite or all alternate or lower leaves in whorls of 3, obovate to narrowly elliptic on lower stem, becoming lanceolate to linear above, obtuse to subulate, sessile, 5–70 mm long, 1–13 mm wide, usually at least the lower leaves ± hirsute, sometimes all leaves glabrous; margins usually ± undulate, sometimes flat, entire or with small, distant callus-teeth, sometimes faintly serrate. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–19 cm long, glabrous to sparsely hirsute; bracteoles lanceolate to linear, 2–15 mm long, glabrous to sparsely hirsute. *Hypanthium* ellipsoid or globose, 2–4 mm long, glabrous to hirsute. *Sepals* usually 5, sometimes 4 or 6, erect or sometimes spreading, narrowly triangular, 3–16 mm long, glabrous to hirsute. *Corolla* deeply campanulate, usually blue, at least on the lobes, sometimes white or with a yellowish brown wash outside, puberulous inside at base and often sparsely hirsute along the veins; tube 4–11 mm long, shorter to longer than the sepals; lobes usually 5, sometimes 4 or 6, elliptic to ovate, acute, 6–20 mm long, 2.5–12 mm wide. *Stamens* usually 5, sometimes 4 or 6; filaments white, 1.3–2.5 mm long, upper section filiform, lower section rhombic to obtrullate, with extended shoulders, ciliate on upper margins; anthers 4–6 mm long. *Ovary* 3-locular. *Style* white, 5.5–13 mm long, 3-fid, unconstricted or sometimes indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 2–4 glands below each stigmatic cleft; stigmatic lobes 1–3 mm long. *Capsule* ellipsoid or globose, 3–10 mm long, 2.5–8 mm wide, glabrous to hirsute. *Seeds* c. 0.5 mm long.

NOTES: Characteristic features of *W. stricta* are its typically opposite, hirsute and undulate-margined lower leaves; long sepals; large, deeply campanulate corollas that are often sparsely hirsute along the veins; and ellipsoid or globose, often hirsute capsules.

Key to subspecies

1 Leaves mostly opposite (only the uppermost alternate), up to 13 mm wide; corolla usually all blue; style seldom exserted above corolla tube ..... **a. subsp. stricta**

1* Leaves mostly alternate (only the lowermost opposite), ≤ 6 mm wide; corolla usually blue inside, white outside; style usually exserted above corolla tube ..... **b. subsp. alterna**

10a. W. stricta subsp. stricta

W. stricta (R. Br.) Sweet (1830: 593); Carolin (1964: 235); Burbidge & Gray (1970: 344); Willis (1972: 628); Cunningham *et al.* (1981: 627); Grieve & Blackall (1982: 669); Beadle et al. (1982: 432); Beadle (1984: 771); Smith (1986: 1383); Stanley & Ross (1986: 476); Wheeler (1987: 600). *Campanula gracilis* (var.) β *stricta* R. Brown (1810: 561). *W. gracilis* (var.) β *stricta* (R. Br.) de Candolle (1830: 142). *C. gracilis* f. *stricta* (R. Br.) Siebert & Voss (1896: 572). *C. erecta* Sweet (1830: 326). *W. bicolor* Lothian (1947*a*: 230).

TYPE: An illustration with dissections, labelled '*C. gracilis* Forst.', J.E. Smith (1805: t. 45); lecto (Carolin 1964: 236).

Brown (1810: 561) clearly based *C. gracilis* β *stricta* primarily on Smith's plate (Carolin 1964: 236). He also referred to specimens from Port Jackson, but these are not conspecific with the plate (they are, in fact, specimens of *W. luteola*, q.v.). Sweet (1830: 593) subsequently supplied the name *C. erecta* for the species depicted in Smith's plate, then, in the same publication, transferred the species to *Wahlenbergia* as *W. stricta*, mistakenly attributing the epithet to Smith, who had never used it in a published form in this connection. More recently, Lothian (1947*a*: 230) supplied the name *W. bicolor* to replace *C. gracilis* β *stricta* R. Br., selecting as a 'lectotype' a specimen of *W. luteola* collected by Brown at Port Phillip. This 'lectotype' must be rejected as it was not chosen from the Port Jackson material referred to by Brown.

W. consimilis Lothian (1947*a*: 223); Curtis (1963: 408). TYPE: VICTORIA: R: Warby Ra., *T.R.N. Lothian*, 20 Sep 1942; lecto MEL 57010 (Carolin 1964: 236).

W. trichogyna Stearn (1951: 169); Black & Robertson (1957: 810). *W. marginata* var. *grandiflora* subvar. *trichogyna* (Stearn) Tuyn (1960: 118). TYPE: NEW SOUTH WALES: Central Coast: Ingleburn, *F.M. Hilton 448*, Nov. 1943; holo MEL.

W. vinciflora f. *eriocalyx* Domin (1929: 638). TYPE: QUEENSLAND: Moreton: near the Logan R., *K. Domin*, Mar 1910; lecto PR *Domin 8739* (Carolin 1964: 237), isolecto PR *Domin 8738*.

[*W. vinciflora* (Vent.) Decaisne (1849: 41), as 'vincaeflora'; N.E. Brown (1913: 355); Domin (1929: 638); Black (1934: 183); Lothian (1947*a*: 220). *C. vinciflora* Ventenat (1803: 12), as 'vincaeflora', nom. illeg. (Stearn 1951: 169; Carolin 1964: 236) ≡ *C. gracilis* Forster (1786: 84). *C. gracilis* (var.) α *vinciflora* (Vent.) R. Brown (1810: 561), as 'vincaeflora'. *W. gracilis* var. *vinciflora* (Vent.) Hooker (1856: 239), as 'vincaeflora'. The name *C. vinciflora* was superfluous when first published as it included, as a synonym, *C. gracilis* Forster f. Its type is therefore that of *W. gracilis*, although the epithet has generally been misapplied to *W. stricta*.]

[*W. marginata* var. *grandiflora* Tuyn (1960: 118), p.p., nom. nud.]

Stems 10–90 cm long, usually ± hirsute, at least on lower stem, sometimes glabrous throughout; hairs to 2 mm long. *Leaves and bracts* mostly opposite, becoming alternate above, sometimes all opposite or lower leaves in whorls of 3, 5–70 mm long, 1–13 mm wide, usually at least the lower leaves ± hirsute, sometimes all leaves glabrous. *Pedicels* 2–19 cm long, glabrous to sparsely hirsute; bracteoles 2–15 mm long, glabrous to sparsely hirsute. *Hypanthium* 1.5–5 mm long, glabrous to hirsute. *Sepals* usually 5, sometimes 4 or 6, 3–16 mm long, glabrous to hirsute. *Corolla* usually blue, sometimes white on the outside or all white; tube 4–11 mm long; lobes usually 5, sometimes 4 or 6, 6–20 mm long, 2.5–12 mm wide. *Stamens* usually 5, sometimes 4 or 6, 1.6–2.5 mm long. *Style* 5.5–13 mm long, seldom exserted above the corolla tube; stigmatic lobes 1–3 mm long. *Capsule* 3–10 mm long, 2.5–8 mm wide, glabrous to hirsute. Figure 13a–c.

CHROMOSOME NUMBER: $n = 9$ (*Carolin 495, 2090, s.n.* [Nowendoc], *Smith 27, 35, 40, 82, 88, 90*); $n = 18$ (*Carolin W19, W20A, W22, W24, W34, W132, W147, W154, Smith 50, 52, 74, 170*). H. Gulline (in Darlington & Wylie 1955: 289) also reported a count of $n = 18$, probably from Tasmania, but there is no voucher specimen to check the identification.

FLOWERING PERIOD: Throughout the year, particularly September–February.

DISTRIBUTION: Widespread in south-eastern Australia, from the Carnarvon Range, Queensland, south to southern Tasmania and west to Eyre Peninsula, South Australia. Small, isolated populations in Western Australia (around Perth) and New Zealand appear to be introduced. Figure 26.

HABITAT: Grows in forest, woodland, scrub and grassland, typically amongst other herbs rather than in the open. Recorded over a wide altitudinal range, from sea level to about 1500 m.

CONSERVATION STATUS: Not considered at risk.

SELECTED SPECIMENS (1038 examined): QUEENSLAND: Darling Downs: Leslie Dam near Warwick, *Smith 90*, Dec 1973 (SYD); Applethorpe, *Smith 82*, Dec 1973 (SYD). Darling Downs/Burnett: Bunya Mts, *White*, Oct 1919 (BRI 159834). Leichhardt: Carnarvon Ck Gorge, 70 miles [117 km] NW of Injune, *Johnson 2405*, May 1952 (BRI, NSW). Moreton: Hollywell, *Smith 27*, May 1972 (SYD). Wide Bay: Cooloola, *Harrold 152*, Oct 1971 (BRI). NEW SOUTH WALES: North Coast: 8 km N of Hawks Nest on coast road, *Smith 35*, Oct 1972 (SYD). Central Coast: 72 km from Windsor on road to Putty, *Smith 40*, Nov 1972 (SYD); Colo Heights, *Carolin 2090*, Jan 1961 (SYD); 3 km from Wisemans Ferry on eastern road to St Albans, *Smith 74*, Nov 1973 (SYD). South Coast: South Crookhaven Head, *Rodway 11763*, Jan 1941 (NSW). Northern Tablelands: 58 km from Inverell on road to Glen Innes, *Smith 88*, Dec 1973 (SYD); Moonbi Ra., *McKee (Carolin W132)*, Dec 1956 (SYD); Nowendoc, *Carolin* (SYD); Corker Pinch, Barrington Tops, *Carolin 495*, Apr 1958 (SYD). Central Tablelands: 2 miles [3 km] Pinnacle–Orange, *Carolin W20A*, Dec 1955 (SYD); Rocks Ck, Bathurst–Orange, *Carolin W19*, Dec 1955 (SYD); 60 km from Bathurst on road to Lithgow, *Smith 52*, Dec 1972 (SYD); 55 km from Bathurst on road to Lithgow, *Smith 50*, Dec 1972 (SYD); Goulburn–Mittagong 2 miles [3 km], *Carolin W22*, Jan 1956 (SYD). Southern Tablelands: Braidwood–Bungendore, *Moore 2238*, Dec 1952 (NSW); Kiandra–Adaminaby 10 miles [17 km], *Carolin W147*, Feb 1957 (SYD); Jindabyne–Kosciusko, *Carolin W34*, Jan 1956 (SYD); Mt Kosciusko Rd, *Carolin W24*, Jan 1956 (SYD); Brown Mt, facing sea, *Carolin W154*, Mar 1957 (SYD). North Western Slopes: 8 km NE of Coonabarabran, *Briggs 3048*, Nov 1969 (NSW). Central Western Slopes: Weddin Mt, 18 km W of Grenfell, *Pullen 10.225*, Dec 1975 (CANB, MEL, AD). South Western Slopes: Burrinjuck Rd, *Moore 2177*, Dec 1952 (NSW). North Western Plains: 21 miles [35 km] NE of Byrock, *Thompson*, Sep 1969 (NSW). AUSTRALIAN CAPITAL TERRITORY: Kowen Forest, 8 miles [13 km] E of Canberra, *Evans 2575*, Dec 1966 (CANB). NEW SOUTH WALES/VICTORIA: South Far Western Plains/A: junction of Darling R. and Murray R., *Holding* (MEL 57508). VICTORIA: A: 3 miles [5 km] N of Red Cliffs, *Henshall 778*, May 1968 (NT). C: Briggs Bluff, Grampians, *Muir 2188*, Sep 1961 (MEL). D: Victoria Valley, Grampians, *Gullan*, Nov 1976 (MEL 524103). E: 16.4 miles [27 km] N of Portland, *Anderson 378*, Jan 1969 (MEL, AD). G: Lower Loddon, *Thorn*, 1882 (MEL 57598). J: near Stawell, *Banfield*, Nov 1941 (MEL 57671). K: 14 km SSW of Winchelsea,

Beauglehole 63689, Jan 1979 (MEL). M: Kangaroo Flat towards Bendigo, *Tadgell*, Oct 1934 (MEL 57049). N: Dandenong Ra., *Muir 271*, Nov 1957 (MEL). P: 11 km WSW of Anglesea, *Beauglehole 63473*, Jan 1979 (MEL). R: c. 5 miles [8 km] SE of Euroa, *Muir 1384*, Oct 1960 (MEL). S: Snobs Creek, *Willis*, Mar 1943 (MEL 57627). T: 13 km from Yarram on road to Traralgon, *Smith 170*, Jan 1975 (SYD). U: Pine Mt, c. 12 km from Walwa, *Wheeler 194*, Dec 1972 (CBG, PERTH). V: c. 50 km SSE of Tallangatta, *Wilson*, Dec 1961 (MEL 62862). W: Omeo–Mt Hotham, *Rae*, Jan 1940 (MEL 57363). Z: Gap Rd–Goongerah Ck, *Beauglehole 34889*, Nov 1970 (MEL). TASMANIA: Bass Strait Islands: Kings I., *Neate* (MEL 57345). Central Highlands: Ben Lomond Natl Park, *Noble 28467*, Mar 1979 (HO). Western and South-western: Kingston, *Curtis*, Nov 1941 (HO 53484). North-eastern: Picnic I., *Buchanan 394*, Jan 1981 (HO). SOUTH AUSTRALIA: Flinders Ranges: Alligator Gorge, Wilmington, *Cooper*, Oct 1954 (AD 97415263). Eyre Peninsula: Hundred of Hutchison, Section 99, *Alcock C23*, Nov 1964 (AD). Northern Lofty: Spring Gully Conservation Park, *Yeatman 224*, Oct 1980 (AD). Murray: Kinchina, *Spooner 3842*, Dec 1974 (AD). Yorke Peninsula: Hundred of Ramsay, Section 141, *Blaylock 1032*, Oct 1968 (AD). Southern Lofty: between Finniss and Goolwa, *Carrick 2985*, Feb 1971 (AD). South-eastern: Big Heath Natl Park, *Alcock 3087*, Nov 1969 (AD). WESTERN AUSTRALIA: Drummond: Bayswater near Perth, *Nicholls*, Dec 1947 (MEL). Dale: 70 km S of Perth on Albany Hwy, *Fairall 1705*, Nov 1965 (PERTH). NEW ZEALAND: Dunedin, Aug 1938 (K, MEL 57438).

10b. W. stricta subsp. alterna *P.J. Smith*, **subsp. nov.**

Ab subsp. *stricta* foliis alternis pro parte maxima, ≤ 6 mm latis, corolla extra vulgo alba, stylo tubo corollae vulgo longiore, differt.

TYPE: NEW SOUTH WALES: South Western Slopes: Northern slopes of The Rock, *B.G. Briggs 2983*, 25 Oct 1969; holo NSW.

[*W. stricta* subspecies A, Jacobs & Pickard (1981: 96)]

Stems 15–85 cm long, hirsute below, glabrous above; hairs to 1.2 mm long. *Leaves and bracts* mostly alternate but usually a few opposite leaves at base of stem, 5–50 mm long, 1–6 mm wide, most leaves ± hirsute, uppermost leaves glabrous. *Pedicels* 2–15 cm long, glabrous; bracteoles 2–11 mm long, glabrous. *Hypanthium* 1.5–3 mm long, glabrous. *Sepals* 5, 3–9.5 mm long, glabrous. *Corolla* usually blue only on inner side of lobes, otherwise white, sometimes with a yellowish brown wash on the outside; tube 4–8.5 mm long; lobes 5, 6–13 mm long, 2.5–5.5 mm wide. *Stamens* 5, 1.3–1.8 mm long. *Style* 6–11 mm long, usually exserted above the corolla tube; stigmatic lobes 1–2 mm long. *Capsule* 3–6 mm long, 2.5–5 mm wide, glabrous. Figure 13d–f.

CHROMOSOME NUMBER: $n = 9$ (*Smith 116*); $n = 18$ (*Peacock 6110.15.1*, *Smith 115*).

FLOWERING PERIOD: April–November.

DISTRIBUTION: Replaces subsp. *stricta* in western New South Wales and south-western Queensland. Distributed from Cunnamulla in the north to The Rock in the south, and from Peak Hill in the east to Mootwingee in the west. Figure 26.

HABITAT: Grows in woodland or scrub, typically in hilly, rocky terrain. Also found in disturbed sites such as roadsides. In the Cocoparra Range, plants growing in eucalypt woodland were found to be diploid, while roadside plants were tetraploid.

CONSERVATION STATUS: Not considered at risk.

NOTES: The chief character separating the two subspecies is the arrangement of the leaves, which are mostly opposite in subsp. *stricta* but only opposite at the very base of the stem in subsp. *alterna*. Other typical features of subsp. *alterna* are its relatively narrow leaves, corollas that are white outside, and styles that are exserted above the corolla-tube. Occasional specimens within the distribution of subsp. *alterna* have more pairs of opposite leaves and generally resemble subsp. *stricta*.

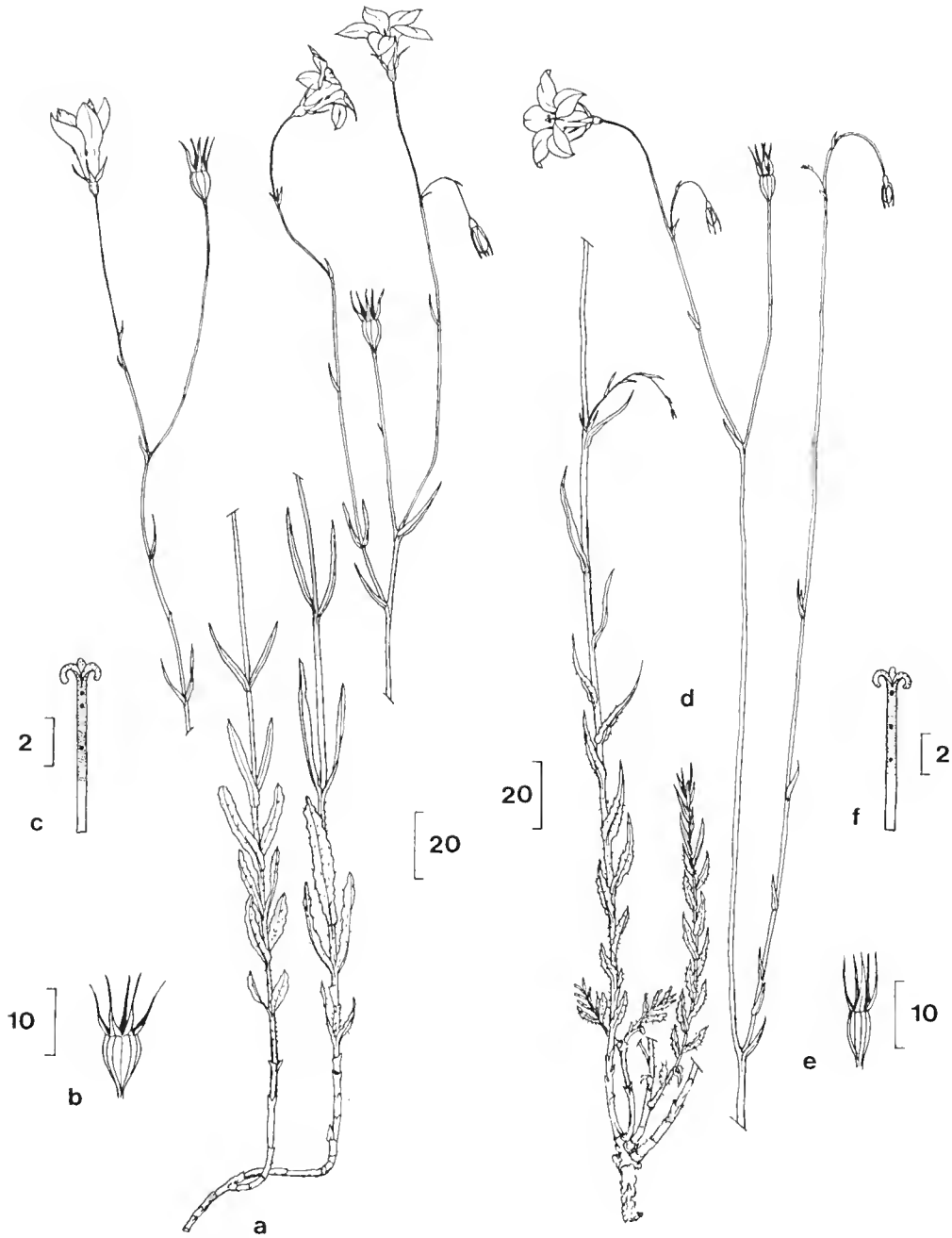

Figure 13. *W. stricta* subsp. *stricta*: **a**, habit; **b**, capsule; **c**, style. *W. stricta* subsp. *alterna*: **d**, habit; **e**, capsule; **f**, style. a–c from *Moore 2238*; d–f from *Cunningham 858*. Scale bars in mm.

The epithet refers to the predominantly alternate arrangement of the leaves. Latin *alternus*, alternate.

SELECTED SPECIMENS (50 examined): QUEENSLAND: Warrego: Gilruth Plains, E of Cunnamulla, *Blake 14048*, May 1939 (NSW). NEW SOUTH WALES: Central Western Slopes: Trewilga, Peak Hill, *Peacock 6110.15.1*, Oct 1961 (SYD); Mt Bunganbil, Ardlethan, *Cunningham 5493 & Milthorpe*, Nov 1978 (NSW). South Western Slopes: The Rock Nature Reserve, 30 km SW of Wagga Wagga, *Crisp 1824*, Nov 1975 (CBG, SYD). North Western Plains: 'Lynwood', Cobar, *Milthorpe & Cunningham 5547*, Nov 1978 (NSW); near 'Florida', Canbelego, *Cunningham 858*, Sep 1969 (NSW). South Western Plains: Naradham Ra., 30 km N of Rankins Springs toward Lake Cargelligo, *Sikkes 462 & Telford*, Oct 1972 (CBG, SYD); southern tip of Cocoparra Ra., *Smith 115, 116*, Apr 1974 (SYD); 11 miles [18 km] Roto–Mt Hope, *Dunlop 1507*, Sep 1969 (CBG). North Far Western Plains: Lake Nucha, Mootwingee, *Milthorpe*, Oct 1971 (NSW).

11. **Wahlenbergia luteola** *P.J. Smith*

Smith (1986: 1380).

TYPE: NEW SOUTH WALES: Northern Tablelands: 15 km from Glen Innes on road to Inverell, *P.J. Smith 84*, Dec 1973; holo NSW.

[*W. bicolor* Lothian (1947*a*: 230); Black & Robertson (1957: 810) ≡ *Campanula gracilis* (var.) β *stricta* R. Brown (1810: 561). Lothian clearly intended *W. bicolor* to replace *C. gracilis* β *stricta* R. Br. (Carolin 1964: 236). Its type is therefore that of *W. stricta* (R. Br.) Sweet. Lothian's 'lectotype', a specimen of *W. luteola* collected by Brown at Port Phillip, must be rejected as it was not chosen from material referred to by Brown.]

Perennial herb with a thickened taproot, tufted, few- to many-stemmed. *Stems* 6–80 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, usually glabrous, sometimes lower stem ± hirsute; hairs to 1.0 mm long. *Leaves and bracts* opposite, becoming alternate above, sometimes all opposite or only lowermost opposite, linear, subulate, sometimes lowermost oblanceolate and acute to obtuse, sessile, 4–60 mm long, 1–4 mm wide, usually glabrous, sometimes lower leaves ± hirsute; margins flat, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–18 cm long, glabrous; bracteoles linear, 2–16 mm long, glabrous. *Hypanthium* elongated-obconic, 3–7 mm long, glabrous. *Sepals* usually 5, sometimes 6, ± erect, narrowly triangular, 3–8.5 mm long, glabrous. *Corolla* deeply or shortly campanulate, usually blue inside lobes, whitish elsewhere, often with a yellowish brown wash on the outside, sometimes entirely white or pink, puberulous inside at base, otherwise glabrous; tube 2–5 mm long, shorter than or equal in length to the sepals; lobes usually 5, sometimes 6, elliptic to ovate, acute, 6–14 mm long, 2.5–7.5 mm wide. *Stamens* usually 5, sometimes 6; filaments white, 1.3–2.0 mm long, upper section filiform, lower section trullate to obtrullate, with extended shoulders, ciliate on upper margins; anthers 3–5.5 mm long. *Ovary* 3-locular. *Style* white, 4.5–9 mm long, 3-fid, unconstricted or indistinctly constricted about halfway down from the stigmatic lobes, upper half covered with pollen-presenting hairs, 2–3 glands below each stigmatic cleft; stigmatic lobes 1–2 mm long. *Capsule* elongated-obconic, 5–12 mm long, 1.5–3.5 mm wide, glabrous. *Seeds* c. 0.6 mm long. Figure 14a–c.

CHROMOSOME NUMBER: $n = 9$ (*Carolin 414, Smith 92, 104*); $n = 18$ (*Carolin 478, 3006, Peacock 6110.3.1, Smith 37, 49, 72, 114*).

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: Widespread in south-eastern mainland Australia, from Tenterfield in the north-east to southern Eyre Peninsula in the south-west. Specimens were recorded

as collected near Sydney early last century (see specimen list), but there have been no subsequent records from coastal districts in New South Wales. Figure 27a.

HABITAT: Grows in woodland and grassland, typically in the open. Often found in disturbed sites such as roadsides.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. luteola* are its opposite, linear lower leaves; corollas that are whitish on the outside, often with a yellowish brown wash; relatively short corolla-tubes, shorter than or equal in length to the sepals; and elongated-obconic capsules.

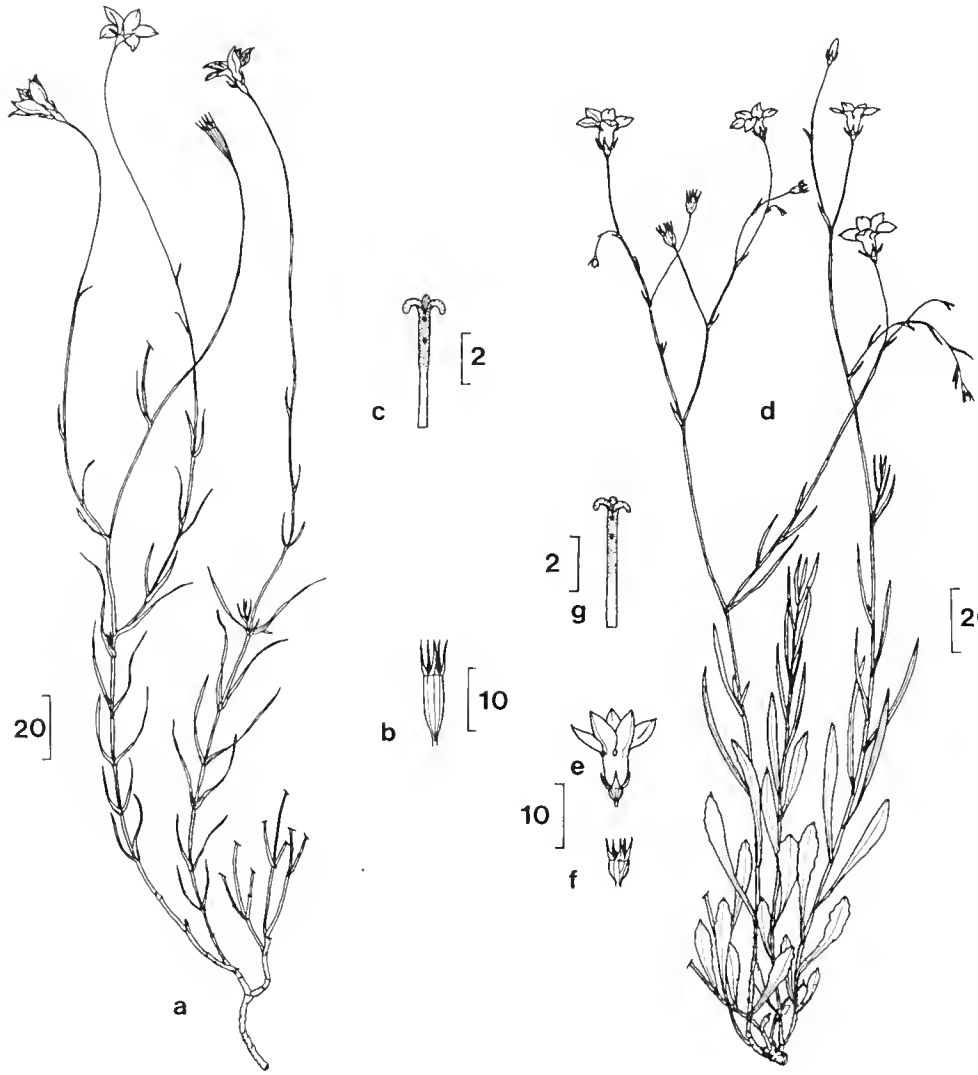

Figure 14. *W. luteola*: **a**, habit; **b**, capsule; **c**, style. *W. queenslandica*: **d**, habit; **e**, flower; **f**, capsule; **g**, style. a–c from *NSW 66861*; d–g from *Crisp 2673*. Scale bars in mm.

Selected Specimens (334 examined): New South Wales: Central Coast: Port Jackson district, including Cow Pastures, *Brown*, 1803 (CANB 279013). Northern Tablelands: 5 km from Glen Innes on road to Grafton, *Smith 92*, Dec 1973 (SYD); Glencoe, *Carolin 414*, Nov 1957 (SYD). Central Tablelands: 60 km from Bathurst on road to Lithgow, *Smith 49*, Dec 1972 (SYD); upper Coxs R., c. 6 miles [10 km] SW of Little Hartley, *Carolin 3006*, Apr 1961 (SYD); Tarana, *Carolin 478*, Apr 1958 (SYD); S of Hartley, *Garden*, Nov 1952 (NSW 66861). Southern Tablelands: 12 km from Jindabyne on road to Mt Kosciusko, *Smith 104*, Mar 1974 (SYD). North Western Slopes: 18 km from Coolah on road to Binnaway, *Smith 37*, Nov 1972 (SYD). Central Western Slopes: Dubbo–Wellington, 20 miles [33 km], *Peacock 6110.3.1*, Oct 1961 (SYD). South Western Slopes: Hume Hwy, 18 miles [30 km] W of Yass, *Rodd & Coveny 2713*, Dec 1969 (NSW). North Western Plains: 87 km from Nyngan on road to Cobar, *Smith 72*, Nov 1973 (SYD). South Western Plains: 15 km from Pulletop Faunal Reserve on road to Griffith, *Smith 114*, Apr 1974 (SYD). South Far Western Plains: between Euston and Gol Gol, *Vickery*, Oct 1949 (NSW 67043). Australian Capital Territory: Canberra, *Pryor*, Nov 1937 (CANB 307697). Victoria: B: E of Pine Plains, Wyperfield Natl Park, *Beauglehole 29316 & Finck*, Oct 1968 (MEL). C: Glenlee, *Galbraith*, Oct 1941 (MEL 57427). G: 5 km NW of Gama, *Beauglehole 56898*, Oct 1977 (MEL). H: Llanelly, *Dale (Beauglehole 44006)*, Jan 1950 (MEL). J: 3 km NE of Nerrin Nerrin, *Beauglehole 63096*, Jan 1979 (MEL). L: 3 miles [5 km] NW of Strathmerton, *Muir 4623*, Oct 1967 (MEL). M: Bendigo, *Robbins (Beauglehole 43999)*, Nov 1948 (MEL). N: 8 km SSW of Melton, *Stuwe 544*, Nov 1978 (MEL). P: Torquay, Jan 1943 (MEL 57471). R: 10 miles [17 km] W of Rutherglen, *Muir 4609*, Oct 1967 (MEL). S: 2 miles [3 km] W of Molesworth, *Muir 3562*, Oct 1964 (MEL). T: Garfield, Apr 1939 (MEL 57467). V: Hume Reservoir, *Muir 2361*, Oct 1961 (MEL). W: Reedy R. chasm, Nunniong Plateau, *Beauglehole 41361*, Feb 1973 (MEL). South Australia: Lake Eyre: Lake Callabonna, *Black*, May 1924 (AD 97606197). Flinders Ranges: Alligator Ck, *Reichstein*, Oct 1960 (AD 96139074). Eyre Peninsula: 10 km WSW of Whyalla, *Chinnock 5000*, Oct 1979 (AD). Northern Lofty: N Tothill Ra., *Kraehenbuehl 2182*, Oct 1967 (AD). Murray: near Monarto New Town, *Spooner 6224*, Nov 1978 (AD). Yorke Peninsula: Barunga Ra., *Copley 755*, Oct 1966 (AD). Southern Lofty: c. 1.6 km N of Nuriootpa, *Kraehenbuehl 1733*, Oct 1966 (AD). South-eastern: Bool Lagoon, *Hunt 464*, Nov 1961 (AD).

12. Wahlenbergia communis *Carolin*

Carolin (1964: 237); Burbidge & Gray (1970: 344); Willis (1972: 626); Cunningham *et al.* (1981: 627); Carolin (1981: 350); Grieve & Blackall (1982: 669); Beadle *et al.* (1982: 432); Beadle (1984: 771); Smith (1986: 1378); Stanley & Ross (1986: 476).

Type: New South Wales: Northern Tablelands: Glen Innes, *R.C. Carolin 2095*, Jan 1961; holo NSW.

W. gracilis (var.) γ *capillaris* (R. Br.) de Candolle (1830: 142), (1839: 433); Hooker (1852: 159), (1864: 170). *Campanula gracilis* (var.) γ *capillaris* R. Brown (1810: 561). Type: New South Wales/Queensland: Botany Bay, Bustard Bay, Bay of Inlets, *J. Banks & D.C. Solander*; lecto BM (Carolin 1964: 238).

W. multicaulis var. *dispar* N.E. Brown (1913: 337). Type: Western Australia: Coolgardie: Fraser Ra., *R. Helms, Elder Exploring Expedition*, 29 Oct 1891; lecto K (Carolin 1964: 238).

[*C. capillaris* Loddiges (1828: 1406), nom. nud.]

Perennial herb with a thickened taproot, tufted, few- to many-stemmed. *Stems* 5–75 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, glabrous or lower stem sparsely hirsute; hairs to 1.1 mm long. *Leaves and bracts* alternate, all linear or lowermost oblanceolate, acute to subulate, sessile, 4–80 mm long, 0.5–6 mm wide, glabrous or lower leaves sparsely hirsute; margins flat or sometimes undulate, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–10 cm long, glabrous; bracteoles linear, 2–16 mm long, glabrous. *Hypanthium* obconic to elongated-obconic, 2–5 mm long, glabrous. *Sepals* 5, erect, narrowly triangular, 2–6

mm long, glabrous. *Corolla* deeply campanulate, usually blue, sometimes white on the outside or all white, puberulous inside at base and often sparsely hirsute along the veins; tube 4–9 mm long, usually longer than the sepals; lobes 5, elliptic to ovate, acute, 6–13 mm long, 2.5–6 mm wide. *Stamens* 5; filaments white, 1.2–2.2 mm long, upper section filiform, lower section rhombic to obtrullate, with extended shoulders, ciliate on upper margins; anthers 3–6 mm long. *Ovary* 3-locular. *Style* white, 4.5–9.5 mm long, 3-fid, unconstricted or indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 2–5 glands below each stigmatic cleft; stigmatic lobes 1–2 mm long. *Capsule* obconic to elongated-obconic, 4–9 mm long, 1.5–5 mm wide, glabrous. *Seeds* c. 0.5 mm long. Figure 15.

CHROMOSOME NUMBER: $n = 8$ (*Carolin W129*, one chromosome very large); $n = 9$ (*Carolin W131, 2096, Smith 48A, 60, 82A*); n = 18 (*Carolin W83, W150, 6974, s.n.* [Jerrys Plains], *Smith 24, 26, 34, 40A, 42A, 44A, 45, 50A, 52A, 54A, 56, 58, 64, 72A, 86A, 102, 139, 146, 147, 149*).

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: Widespread in all mainland States but absent from Tasmania and not recorded north of 22° S in either Western Australia or the Northern Territory. The species also occurs in the New Guinea highlands. Figure 28.

HABITAT: Occurs in a variety of vegetation types, typically in the open. It is often found in disturbed sites and is especially common along roadsides.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. communis* are its alternate, predominantly linear leaves; large, deeply campanulate corollas with tubes usually longer than the sepals; and obconic to elongated-obconic capsules.

SELECTED SPECIMENS (810 examined): QUEENSLAND: Burke: 20 km N of Mt Isa, *Schmid 211*, May 1977 (BRI). Burnett: 3 km from Gayndah on road to Goomeri, *Smith 42A*, Nov 1972 (SYD); Goomeri, *Smith 40A*, Nov 1972 (SYD). Cook: 125 miles [208 km] N of Hughenden on the Lynd Rd, *Carolin 8492*, Apr 1974 (SYD). Darling Downs: Yuleba, *Smith 149*, Sep 1974 (SYD); 10 km from Warwick on road to Killarney, *Smith 82A*, Dec 1973 (SYD); 60 km from Goondiwindi on road to Moonie, *Smith 50A*, Nov 1972 (SYD). Gregory North: between Raven Downs and Muellers Ra., *Birch* (MEL 57851). Gregory South: Simpson Desert, Lake Muncoonie, *Crisp 182*, July 1974 (AD). Leichhardt: 57 km from Taroom on road to Wandoan, *Smith 44A*, Nov 1972 (SYD). Maranoa: 40 km E of St George, *McDonald 270*, Sep 1966 (BRI). Mitchell: 68 km from Barcaldine on road to Blackall, *Smith 139*, Sep 1974 (SYD). Moreton: Gatton, *Watson*, Oct 1930 (BRI 12932). North Kennedy: junction of Cooloomon and Little Cooloomon Cks, SW of Herberton, *Whitehouse*, May 1962 (BRI 037964). Port Curtis: Biloela, *Smith 3503*, Oct 1947 (BRI). South Kennedy: Springvale near Jericho, *Scarth-Johnson 68b*, Sep 1968 (BRI). Warrego: 79 km from Tambo on road to Augathella, *Smith 147*, Sep 1974 (SYD); Morven, *Smith 146*, Sep 1974 (SYD). Wide Bay: 7 km from Gin Gin on road to Gladstone, *Smith 48A*, Nov 1972 (SYD). NEW SOUTH WALES: North Coast: 5 km from Warkworth on road to Broke, *Smith 24*, Apr 1972 (SYD). Central Coast: Glenbrook, *Smith 58*, Dec 1972 (SYD). South Coast: 18 km from Bega on road to Cobargo, *Smith 102*, Mar 1974 (SYD). Northern Tablelands: 8 km from Glen Innes on road to Grafton, *Smith 86A*, Dec 1973 (SYD); Moonbi Ra., *McKee (Carolin W131)*, Dec 1956 (SYD). Central Tablelands: 17 km from Bathurst on road to Lithgow, *Smith 56*, Dec 1972 (SYD). Southern Tablelands: near Cooma church, *Carolin W150*, Mar 1957 (SYD). North Western Slopes: 27 km from Gunnedah on road to Breeza, *Smith 60*, June 1973 (SYD); Peel R., Tamworth, *Carolin 2096*, Jan 1961 (SYD); Nemingha, *Smith 26*, May 1972 (SYD); Quirindi–Werris Creek 5 miles [8 km], *Carolin 6974*, Oct 1968 (SYD). Central Western Slopes: 3 km from Cassilis on road to Merriwa, *Smith 34*, Nov 1972 (SYD); Jerrys Plains, *Carolin* (SYD). South Western Slopes: 13 km from Wagga Wagga on road to Temora, *Smith 54A*, Dec 1972 (SYD). North Western Plains: 8 km from Narrabri on road to Moree, *Smith 45*, Nov 1972 (SYD); 6 miles [10 km] ESE of Brewarrina on banks of Barwon R., *Thompson*, Sep 1969 (NSW 120488); Nyngan, *Smith 64*, Oct 1973 (SYD); 12 miles [20 km] W of Nyngan on

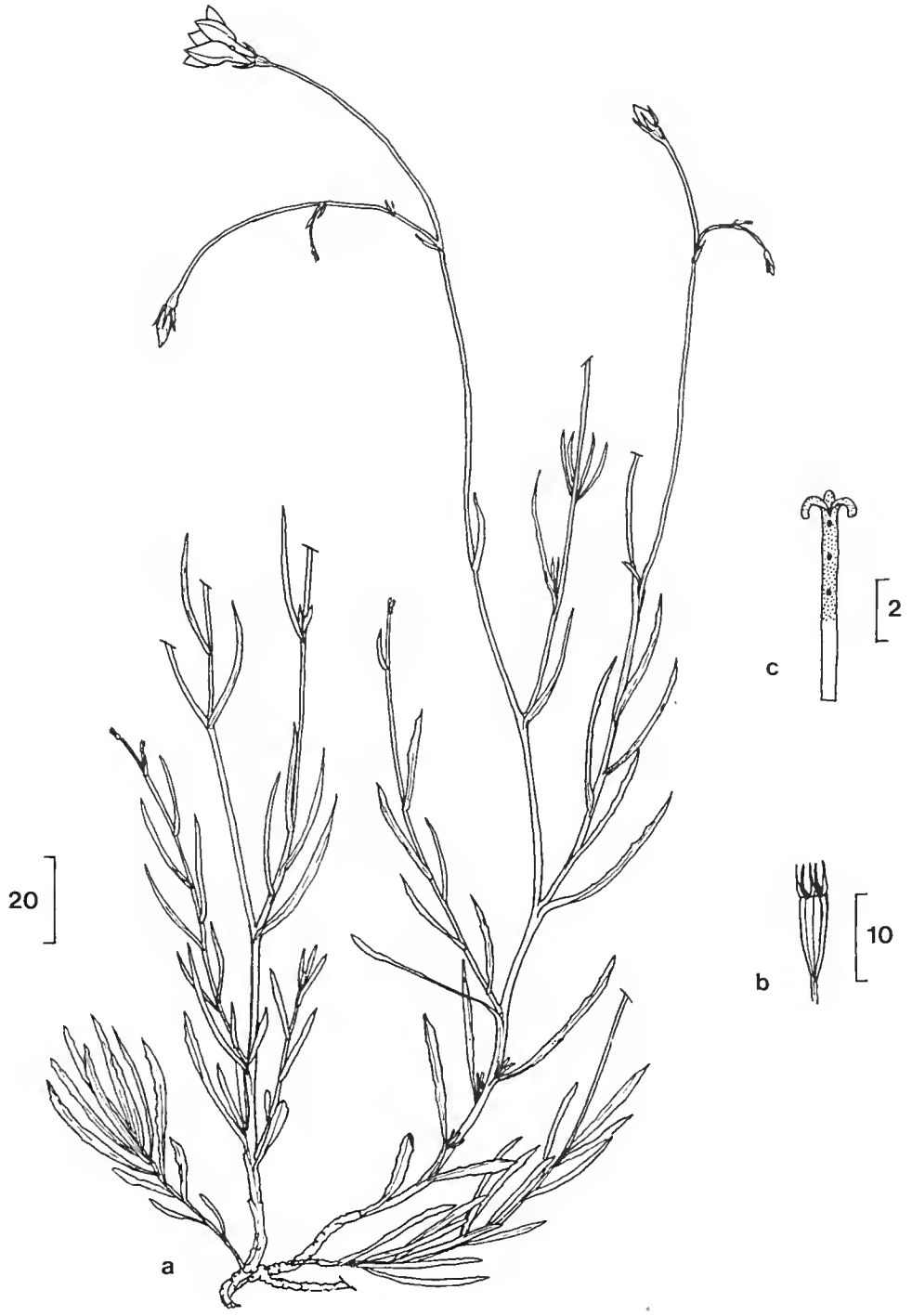

Figure 15. *W. communis*: **a**, habit; **b**, capsule; **c**, style. a from *NSW 120488*; b–c from *Briggs 2685*. Scale bars in mm.

Barrier Hwy, *Briggs 2685*, May 1969 (NSW); 63 km from Cobar on road to Wilcannia, *Smith 72A*, Nov 1973 (SYD). South Western Plains: 30 km from Rankins Springs on road to West Wyalong, *Smith 52A*, Dec 1972 (SYD). North Far Western Plains: Fowlers Gap–Tibooburra 5 miles [8 km], *Carolin W83*, June 1956 (SYD). South Far Western Plains: 28 miles [47 km] S of Broken Hill, *Leigh W64*, Oct 1966 (NSW). Region uncertain: Tamworth–Sydney, *McKee (Carolin W129)*, Dec 1956 (SYD). AUSTRALIAN CAPITAL TERRITORY: Black Mt, *Pullen 2062*, Feb 1960 (CANB). VICTORIA: A: W edge of Raak Plain, *Short 1240*, Sep 1981 (MEL). B: 95 km SW of Mildura, *Barnsley, Crisp & Cummings 100*, Oct 1978 (CBG). C: Dimboola, Field Naturalist Reserve, *Kraehenbuehl 38*, Oct 1958 (AD). F: c. 25 km SSW of Robinvale, *Beauglehole 56060*, May 1977 (MEL). G: 5 km SW of Chinkapook, *Beauglehole 55487*, Apr 1977 (MEL). H: near Charlton, *Ashby 2827*, Mar 1969 (AD, CANB). L: Strathmerton, *Aston 2215*, Jan 1982 (MEL). M: Chewton towards Bendigo, *Tadgell* (MEL 57462). N: Ashburton, Melbourne, *Muir 5636*, Oct 1977 (MEL). T: Darnum Railway Station, *Galbraith*, May 1939 (MEL 57828). V: Ingeegoodbee R., *Wakefield*, May 1969 (MEL 1509988). W: c. 65 km N of Bairnsdale, *Willis*, Oct 1963 (MEL 628365). Z: upper Genoa R., *Beauglehole 35018 & Rogers*, Nov 1970 (MEL). SOUTH AUSTRALIA: North-western: Everard Ra., near Mareena Cave soak, *Whibley 1221*, Sep 1963 (AD). Lake Eyre: Terrapinne, *Bates 293*, May 1979 (AD). Nullarbor: Nullabor, 15 km S of Hwy, *Toelken*, Oct 1983 (AD 98415026). Gairdner–Torrens Basin: c. 15 km W of Yadlakina Well, *Lothian 3406*, Nov 1964 (AD). Flinders Ranges: Artipena Springs, *Orchard 323*, Apr 1968 (AD). Eastern: c. 6 km S of Milang Outstation on Koonamore Stn, *Schodde 1122*, May 1959 (AD). Eyre Peninsula: between Hesso and Tent Hill, *Blaylock 471*, June 1967 (AD). Northern Lofty: c. 15 km NNW of Port Wakefield, *Kraehenbuehl 3510*, Aug 1967 (AD). Murray: Brookfield Zoo Wombat Reserve, Blanchetown, *Weber 3639*, Oct 1973 (AD). Yorke Peninsula: Innes Natl Park, *Alcock 4948*, Oct 1974 (AD, SYD). Southern Lofty: Finniss, *Cleland*, Mar 1967 (AD 97207262). South-eastern: bank of Bool Lagoon, *Hunt 1769*, Jan 1964 (AD). Western Australia: Eucla: Eucla, *Richards* (MEL 57546). Carnarvon: Ningaloo Stn, Exmouth, *Hutchinson 169*, Aug 1971 (PERTH). Austin: Malcolm, *Rodway 220*, Sep 1907 (HO). Irwin: 42 km Northampton–Carnarvon, *Telford 6710*, Aug 1977 (CBG, SYD). Coolgardie: Fraser Ra., *Aplin 1770*, Sep 1962 (PERTH). NORTHERN TERRITORY: Central Australia North: Aileron, 22°39' S, 133°20' E, *Donner 6264*, Aug 1978 (AD, NSW). Central Australia South: 17 miles [28 km] W of Arltunga, *Chippendale*, Mar 1958 (NT 4078, MEL, NSW, AD, BRI, PERTH). NEW GUINEA: 20 miles [33 km] along Gemboge Rd from Kundiawa, *Hewson 71*, Aug 1965 (SYD).

13. Wahlenbergia queenslandica *Carolin ex P.J. Smith*

Smith (1986: 1381).

TYPE: QUEENSLAND: Leichhardt: Grosvenor near Clermont, *R.C. Carolin 608*, 19 Aug 1958; holo NSW; iso SYD.

[*W. queenslandica* Carolin ex Beadle (1984: 771), nom. nud.]

[*W.* species C, Carolin (1981: 350)]

[*W.* species C, Jacobs & Pickard (1981: 96)]

[*W.* species 3, Stanley & Ross (1986: 475)]

Perennial herb with a thickened taproot, tufted, few- to many-stemmed. *Stems* 10–90 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, usually lower stem ± hirsute, upper stem glabrous, sometimes glabrous throughout; hairs to 1.5 mm long. *Leaves and bracts* alternate or sometimes lowermost opposite, obovate to narrowly elliptic on lower stem, lanceolate to linear on upper stem, obtuse to subulate, sessile, 5–60 mm long, 1–9 mm wide, usually ± hirsute on lower stem, glabrous on upper stem, sometimes all glabrous; margins flat or sometimes undulate, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–9 cm long, glabrous; bracteoles linear, 2–10 mm long, glabrous. *Hypanthium* hemispherical to shortly obconic, 1–3 mm long, glabrous. *Sepals* 5, ± erect, ± narrowly triangular, 1–4

mm long, glabrous. *Corolla* deeply campanulate, blue, puberulous inside at base, otherwise glabrous; tube 4–6.5 mm long, longer than the sepals, often rather swollen in the middle; lobes 5, elliptic, acute, 6–10 mm long, 3–6 mm wide. *Stamens* 5; filaments white, 1.0–1.7 mm long, upper section filiform, lower section rhombic to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 3–5 mm long. *Ovary* 3-locular or sometimes 2-locular. *Style* white, 5–8.5 mm long, 3-fid or sometimes 2-fid, unconstricted or indistinctly constricted 1/2 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 2–4 glands below each stigmatic cleft; stigmatic lobes 0.6–1.7 mm long. *Capsule* hemispherical to shortly obconic, 1.5–5 mm long, 1.5–3.5 mm wide, glabrous. *Seeds* c. 0.4 mm long. Figure 14d–g.

CHROMOSOME NUMBER: n = 9 (*Smith 38, 135*); n = 18 (*Smith 39, 81, 85, 140*).

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: Widespread across Northern Australia, north of 30° S. Figure 29.

HABITAT: Grows in a wide variety of mesic, semi-arid and arid vegetation types, typically in open sites, including disturbed sites.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. queenslandica* are its alternate, non-linear, ± hirsute lower leaves; large, deeply campanulate corollas with tubes longer than the sepals and often rather swollen in the middle; and hemispherical capsules.

SELECTED SPECIMENS (140 examined): QUEENSLAND: Burnett: Goomeri, *Smith 38*, Nov 1972 (SYD). Cook: c. 12 miles [20 km] SE of Mareeba, *Pedley 2262*, Apr 1967 (BRI). Darling Downs: 22 km from Miles on road to Wandoan, *Smith 39*, Nov 1972 (SYD); Applethorpe, *Smith 85*, Dec 1973 (SYD). Leichhardt: Isla Gorge, *Everist 8081*, Sep 1968 (BRI, CANB). Mitchell: Barcaldine, *Smith 140*, Sep 1974 (SYD). Moreton: Moreton I., 17 km SSE of Tangalooma, *Durrington 1176*, Oct 1973 (BRI). North Kennedy: 71 km from Pentland on road to Charters Towers, *Smith 135*, Sep 1974 (SYD). Port Curtis: Rockhampton, *Boorman*, Aug 1912 (NSW 66973). South Kennedy: 9 miles [15 km] E of Yarrowmere Stn, *Adams 1164*, July 1964 (CANB, BRI, NSW, AD). Warrego: 20 km W of Charleville, *Purdie 4850*, June 1976 (BRI). Wide Bay: Moorlands, 25 km by road W of Bundaberg, *Crisp 2673*, May 1977 (CBG, NSW). NEW SOUTH WALES: Northern Tablelands: 57 km from Inverell on road to Glen Innes, *Smith 81*, Dec 1973 (SYD). North Western Plains: Lightning Ridge, *Constable*, May 1951 (NSW 66999). SOUTH AUSTRALIA: North-western: Musgrave Ra., *Cleland*, Aug 1954 (AD 97218326). Lake Eyre: Karawinnie Waterhole, *Donner 5205*, Aug 1975 (AD). WESTERN AUSTRALIA: Gardner: Dromaius Ck, Drysdale River Natl Park, *George 13434*, Aug 1975 (PERTH, CANB). Giles: S end of Dean Ra., *Carolin 6091*, Aug 1967 (SYD). Irwin: Murchison R. at Galena, *Gardner 2595*, Aug 1931 (PERTH). NORTHERN TERRITORY: Victoria River District: 39 miles [65 km] S of Hookers Ck, *Chippendale*, July 1956 (NT 2266). Central Australia North: Anningie Stn, Central Mt Stuart, *Mitchell 26*, July 1974 (NT, DNA, CANB). Central Australia South: Ayers Rock, *Wittmann*, Aug 1964 (CANB 147353).

14. Wahlenbergia graniticola *Carolin*

Carolin (1964: 239); Burbidge & Gray (1970: 346); Willis (1972: 626); Beadle *et al.* (1982: 432); Beadle (1984: 771); Stanley & Ross (1986: 475); [misapplied by Grieve & Blackall (1982: 669)].

TYPE: NEW SOUTH WALES: Central Tablelands: Lithgow to Mt Victoria 6 miles [10 km from Lithgow on road to Mt Victoria], *R.C. Carolin W106*, Nov 1956; holo NSW.

Perennial herb with a thickened taproot, tufted, typically few-stemmed. *Stems* 7–95 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, lower stem hirsute, upper stem ± glabrous; hairs to 2.5 mm long. *Leaves and bracts* alternate or sometimes lowermost opposite, obovate to narrowly elliptic on lower

stem, lanceolate to linear on upper stem, obtuse to subulate, sessile, 5–80 mm long, 1–15 mm wide, hirsute on lower stem, ± glabrous on upper stem; margins flat or undulate, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–14 cm long, glabrous or sometimes sparsely hirsute; bracteoles linear or sometimes lanceolate, 2–9 mm long, glabrous or sometimes sparsely hirsute. *Hypanthium* obconic, 1.5–5 mm long, glabrous or sometimes ± hirsute. *Sepals* 5, ± erect, ± narrowly triangular, 2–6 mm long, glabrous or sometimes ± hirsute. *Corolla* shortly campanulate, usually blue, sometimes white, puberulous inside at base, otherwise glabrous; tube 2–6.5 mm long, varying from shorter to longer than the sepals; lobes 5, elliptic or sometimes obovate, acute or sometimes obtuse, 6–19 mm long, 3–10 mm wide. *Stamens* 5; filaments white, 1.0–2.3 mm long, upper section filiform, lower section rhombic to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 3–6 mm long. *Ovary* 3-locular. *Style* white, 4.5–10 mm long, 3-fid, ± distinctly constricted 1/3 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 1–3 glands below each stigmatic cleft; stigmatic lobes 1–2 mm long. *Capsule* obconic, 3–10 mm long, 1.5–4.5 mm wide, glabrous or sometimes ± hirsute. *Seeds* c. 0.5 mm long. Figure 16.

Chromosome number: $n = 9$ (*Carolin 576*, *Smith 43*, *53*, *86*, *141*, *142*, *145*); $n = 18$ (*Carolin W115*, *Smith 47*, *48*, *54*, *66*, *68*, *70*, *87*).

Flowering period: Throughout the year.

Distribution: South-eastern Queensland, eastern New South Wales and north-eastern Victoria, extending from Barcaldine in the north to Nunniong Plateau in the south. Figure 27b.

Habitat: Grows in forest, woodland, scrub and grassland. Tends to grow amongst other herbs rather than in the open, although it occurs in more open sites in the drier parts of its range.

Conservation status: Not considered at risk.

Notes: Characteristic features of *W. graniticola* are its typically few-stemmed habit; alternate, hirsute, non-linear lower leaves; large, shortly campanulate corollas; styles with a distinct constriction about halfway down; and obconic capsules.

Selected Specimens (149 examined): Queensland: Burnett: Gayndah, *Hewson*, Sep 1964 (SYD). Darling Downs: Yuleba, *Smith 145*, Sep 1974 (SYD); 28 km from Moonie on road to Goondiwindi, *Smith 48*, Nov 1972 (SYD); Leslie Dam near Warwick, *Smith 87*, Dec 1973 (SYD). Leichhardt: 50 km from Taroom on road to Theodore, *Smith 47*, Nov 1972 (SYD); 57 km from Taroom on road to Wandoan, *Smith 43*, Nov 1972 (SYD). Maranoa: 79 miles [132 km] SSE of Charleville, *Williams 86*, Sep 1968 (BRI). Mitchell: 9 km from Barcaldine on road to Blackall, *Smith 141*, Sep 1974 (SYD); Barcaldine, *Smith 142*, Sep 1974 (SYD). Moreton: St Lucia, *Pedley*, Aug 1955 (BRI 026580). Port Curtis: c. 100 km N of Bundaberg on coast, *Smith 53*, Nov 1972 (SYD). South Kennedy: Alpha, *Carolin W229*, Aug 1958 (SYD). Warrego: SW of Charleville, *Everist 1429*, Dec 1935 (BRI). Wide Bay: 10 miles [18 km] N of Gin Gin, *Carolin 576*, Aug 1958 (SYD). New South Wales: Northern Tablelands: 60 km from Inverell on road to Glen Innes, *Smith 86*, Dec 1973 (SYD). Central Tablelands: 60 km from Bathurst on road to Lithgow, *Smith 54*, Dec 1972 (SYD); Lithgow–Mt Victoria, *Carolin W115*, Sep 1956 (SYD). Southern Tablelands: Colinton, *Costin* , Oct 1948 (NSW 67080). North Western Slopes: 8 km from Coonabarabran to Bugaldi, *Pulley 1101*, Sep 1972 (CBG). Central Western Slopes: Coulsons Ck, foot of Liverpool Ra., N of Merriwa, *Briggs 2196 & Rodd*, Sep 1968 (NSW). South Western Slopes: Eastern Hill Stone Quarry near Saleyards, Albury, *McBarron 1846*, Aug 1948 (NSW). North Western Plains: 17 km from Bourke on road to Fords Bridge, *Smith 66*, Oct 1973 (SYD); 20 km S of Gongolgon on road to Coolabah, *Smith 68*, Oct 1973 (SYD); Nyngan, *Smith 70*, Oct 1973 (SYD). South Western Plains: Booberoi Railway Siding, 33°02' S, 146°30' E, *Cunningham & Milthorpe 4535*, Oct 1973 (NSW). North Far Western

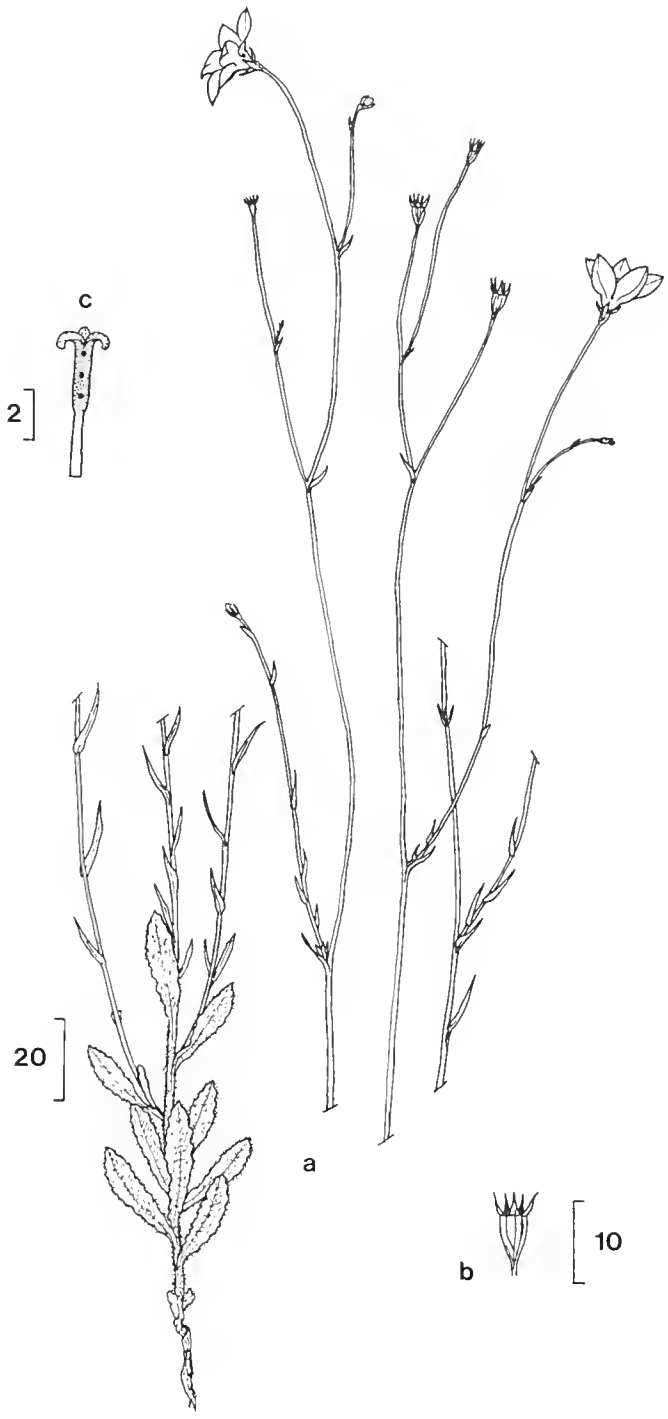

Figure 16. *W. graniticola*: **a**, habit; **b**, capsule; **c**, style. From *Briggs 2196*. Scale bars in mm.

Plains: Lake Woytchugga, Wilcannia, *Smith 3225*, July 1990 (NSW). Australian Capital Territory: Kowen Pine Forest, *D'Arnay 334*, Nov 1964 (CANB). Victoria: R: c. 13 km N of Beechworth, *Beauglehole 43826*, Dec 1973 (MEL). V: 12 miles [20 km] W of Corryong, *Muir 3703*, Dec 1964 (MEL). W: Nunniong Plateau, *Willis*, Nov 1964 (MEL 628246). Z: Bidwell, upper Delegate R., *Willis*, Jan 1948 (MEL 628644).

15. Wahlenbergia aridicola *P.J. Smith*

Smith (1986: 1377).

Type: New South Wales: North Far Western Plains: Smithville–Hawker Gate, *R.C. Carolin W91*, 6 June 1956; holo NSW.

[*W.* species A, Carolin (1981: 350)]

Perennial herb with a thickened taproot, tufted, typically many-stemmed. *Stems* 12–75 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, glabrous or lower stem sparsely hirsute; hairs to 1.1 mm long. *Leaves and bracts* alternate, obovate to narrowly elliptic on lower stem, lanceolate to linear on upper stem, obtuse to subulate, sessile, 5–50 mm long, 1–6 mm wide, glabrous or lower leaves sparsely hirsute; margins flat or undulate, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–10 cm long, glabrous; bracteoles linear, 2–7 mm long, glabrous. *Hypanthium* hemispherical to obconic, 1.5–2.5 mm long, glabrous. *Sepals* 5, ± erect, ± narrowly triangular, 1.5–4 mm long, glabrous. *Corolla* shortly campanulate, blue, puberulous inside at base, otherwise glabrous; tube 2–3 mm long, varying from shorter to longer than the sepals; lobes 5, elliptic or sometimes obovate, acute, 5–8 mm long, 3–3.5 mm wide. *Stamens* 5; filaments white, 0.9–1.7 mm long, upper section filiform, lower section rhombic to obtrullate, with extended shoulders, ciliate on upper margins; anthers 2–4 mm long. *Ovary* 3-locular. *Style* white, 4–6 mm long, 3-fid, ± distinctly constricted 1/3 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 2–4 glands below each stigmatic cleft, the uppermost gland sometimes elongated; stigmatic lobes 0.5–1 mm long. *Capsule* hemispherical to obconic, 2.5–5 mm long, 1.5–2.5 mm wide, glabrous. *Seeds* c. 0.5 mm long. Figure 17a–d.

Chromosome number: $n = 9$ (*Smith 77*); $n = 18$ (*Carolin W94*, *Smith 75*).

Flowering period: Throughout the year (records for Jan, May, June, Aug, Sep, Nov, Dec).

Distribution: Arid regions of eastern South Australia and western New South Wales. Figure 27b.

Habitat: Recorded growing on dune swales and beside watercourses.

Conservation status: An uncommon species with a fairly restricted distribution. Included by Pressey *et al.* (1990) in a list of plant species with restricted distributions in the Western Division of New South Wales.

Notes: *W. aridicola* is closest to *W. graniticola*, differing in its typically many-stemmed habit; glabrous or only sparsely hirsute stems and leaves; generally smaller flowers; and generally shorter capsules. Some recent specimens (e.g. *W. graniticola*, *Smith 3225*) have indicated that the two species intergrade in north-western New South Wales and may be better treated as subspecies.

Other Specimens Examined: New South Wales: North Far Western Plains: Yandama Ck track, 32 km from Hawker Gate, *Carolin 13032*, May 1979 (SYD); 12 km from Packsaddle on road to

Broken Hill, *Smith 77*, Nov 1973 (SYD); 56 miles [90 km] NNW of Wilcannia on road to White Cliffs, *Briggs 2726*, May 1969 (NSW); Fowlers Gap–Milparinka 6 miles [10 km], *Carolin W84a*, June 1956 (SYD); Fowlers Gap, *Cunningham 1034 & Milthorpe*, Sep 1973 (NSW); 48 km from Wilcannia on road to Broken Hill, *Smith 75*, Nov 1973 (SYD); Broken Hill, *Morris*, Dec 1919 (ADW 17450). NEW SOUTH WALES/SOUTH AUSTRALIA: North Far Western Plains/Lake Eyre: Hawker Gate, *Carolin W93*, June 1956 (SYD). North Far Western Plains/Eastern: Smithville, *Carolin W90*, June 1956 (SYD). SOUTH AUSTRALIA: Lake Eyre: Coonanna Bore, *Carolin W94*, June 1956 (SYD); 0.5 mile [1 km] SW of Hawker Gate, *Johnson & Constable*, June 1955 (NSW 66976). Flinders Ranges: Gammon Ra., *Boyce 10*, Aug 1974 (AD); SE Gammon Ra., *Eichler 12889*, Sep 1956 (AD); Orroroo, *Kenny*, Jan 1944 (AD 97915047).

16. Wahlenbergia littoricola *P.J. Smith*

Smith (1986: 1380), as 'litticola'. The epithet, based on Latin *littus*, coast, and *-cola*, dweller, was wrongly formed when originally published. This was an unintentional error. The correct combining form of *littus* is *littor-* not *litt-*. Accordingly, the spelling of the epithet is corrected here to *littoricola*.

TYPE: VICTORIA: Z: 2 km from Mallacoota on Betka Rd, *P.J. Smith 100*, Mar 1974; holo NSW.

[*W. graniticola* auct. non Carolin: Grieve & Blackall (1982: 669)]

Perennial herb with a thickened taproot, tufted, few- to many-stemmed. *Stems* 10–80 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, lower stem glabrous to hirsute, upper stem glabrous; hairs to 1.9 mm long. *Leaves and bracts* alternate or sometimes lowermost opposite, all ± linear or lowermost oblanceolate, acute to subulate, sometimes lowermost obtuse, sessile, 4–60 mm long, 1–4 mm wide, glabrous to hirsute on lower stem, glabrous on upper stem; margins flat or undulate, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–12 cm long, glabrous; bracteoles linear, 2–10 mm long, glabrous. *Hypanthium* obconic, 2–3 mm long, glabrous. *Sepals* 5, ± erect, ± narrowly triangular, 2–4 mm long, glabrous. *Corolla* shortly campanulate, blue, puberulous inside at base, otherwise glabrous; tube 2–3 mm long, equal to or shorter than the sepals; lobes 5, elliptic, acute, 5–9 mm long, 2.5–4 mm wide. *Stamens* 5; filaments white, 0.9–1.8 mm long, upper section filiform, lower section rhombic to obtrullate, with or without extended shoulders, usually ciliate on upper margins; anthers 2–4 mm long. *Ovary* 3-locular. *Style* white, 4–7 mm long, 3-fid, ± distinctly constricted 1/3 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 1–3 glands below each stigmatic cleft; stigmatic lobes 0.5–1.5 mm long. *Capsule* obconic, 3–8 mm long, 1.5–3.5 mm wide, glabrous. *Seeds* c. 0.5 mm long. Figure 17e–g.

CHROMOSOME NUMBER: $n = 27$ (*Carolin W36C, W121, W133, Smith 4B, 33, 91, 98, 100, 168*); $n = 36$ (*Carolin W165*).

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: Widespread in south-eastern Australia, from the McPherson Range, Queensland, through eastern New South Wales, Victoria, Tasmania and south-eastern South Australia, west to Eyre Peninsula. A disjunct population occurs in the far south-west of Western Australia. Figure 30.

HABITAT: Grows in forest, woodland, scrub, heath and grassland, often in disturbed sites. Tends to grow amongst other herbs rather than in the open.

NOTES: *W. littoricola* is similar to *W. graniticola* and *W. aridicola*, the three species being characterised by a tufted, branching habit; predominantly alternate leaves; shortly

campanulate, medium or large corollas; styles with a more or less distinct constriction about halfway down; and hemispherical or obconic capsules. *W. littoricola* differs from the other two species chiefly in its narrow, mostly linear, lower leaves. It also has generally smaller flowers and tends to have a more multicauleate habit than *W. graniticola*, which has an overlapping distribution. Specimens from eastern New South Wales are usually more or less glabrous, while those from Victoria, Tasmania and South Australia are typically hirsute on the lower stems and leaves.

Selected Specimens (230 examined): Queensland: Moreton: Green Mts, McPherson Ra., *Smith 2502*, Sep 1988 (NSW). New South Wales: North Coast: Ironbark Ridge, Apsley–Macleay Gorges, *Smith 1032*, Sep 1984 (NSW). Central Coast: 72 km from Windsor on road to Putty, *Smith 33*, Nov 1972 (SYD); East Hills, S side of Georges R., *Carolin W121*, Nov 1956 (SYD); East Hills–Milperra 2 miles [3 km], *Carolin W133*, Nov 1956 (SYD). South Coast: 8 km from Moruya on road to Narooma, *Smith 98*, Mar 1974 (SYD); State Forest between Tilba and Punkella, *Carolin W165*, Mar 1957 (SYD); 40 km W of Narooma, *Briggs 3093*, Dec 1969 (NSW). Northern Tablelands: Apsley Falls–Walcha 12 miles [20 km], *Briggs (Carolin W113)*, Nov 1956 (SYD). Central Tablelands:

Figure 17. *W. aridicola*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. littoricola*: **e**, habit; **f**, capsule; **g**, style. a–d from *Cunningham 1034*; e–g from *Briggs 3093*. Scale bars in mm.

Mittagong, *Smith 4B* (SYD). Southern Tablelands: Barneys Ridge, Cooma to Jindabyne, *Carolin W36C*, Feb 1956 (SYD); 12 km from Jindabyne on road to Mt Kosciusko, *Smith 91*, Mar 1974 (SYD). AUSTRALIAN CAPITAL TERRITORY: Black Mt, *Taylor 77*, Nov 1975 (CBG). VICTORIA: A: Kulkyne National Forest, *Willis*, Oct 1960 (MEL 628645). B: Wyperfield Natl Park, *Landy & Beauglehole 5182*, Nov 1960 (MEL). C: Wail, *Willis*, Dec 1959 (MEL 628245). D: Wilkin near Casterton, *Beauglehole 8238*, Oct 1960 (MEL). F: c. 16 km NNW of Piangil, *Macfarlane (Beauglehole 57660)*, Jan 1973 (MEL). G: 17 km SSW of Swan Hill, *Beauglehole 55993 & Macfarlane*, May 1977 (MEL). J: Creswick, *Willis*, Jan 1944 (MEL 57360). N: Upper Beaconsfield, *Opie & Gullan*, Jan 1980 (MEL 628540). P: c. 13 km NW of Anglesea, *Beauglehole 49566*, Nov 1974 (MEL). T: 3.5 km N of Mirboo North, *Beauglehole 62063*, Dec 1978 (MEL). V: 2.7 miles [4 km] from Harrietville to Mt Hotham, *Canning*, Dec 1967 (CBG 024882). W: 2 miles [3 km] W of Bairnsdale, *Muir 1986*, Nov 1960 (MEL). X: 8 km from Sale on road to Bairnsdale, *Smith 168*, Jan 1975 (SYD). Z: c. 12 km SE of Orbost, *Hunter 27*, Nov 1951 (MEL). TASMANIA: Central Highlands: Breona, *Dale (Beauglehole 44005)*, Jan 1950 (MEL). Western and South-western: Smithton, *Barber*, Apr 1950 (HO 8332). North-eastern: Coles Bay tip, *Allan*, Mar 1977 (HO 28467). SOUTH AUSTRALIA: Eyre Peninsula: near Yangie, *Alcock 547*, Nov 1964 (AD). Murray: c. 20 km W of Walkers Flat, *Donner 992*, Mar 1964 (AD). Yorke Peninsula: Pondalowie Bay, *Blaylock 59*, Oct 1965 (AD). Southern Lofty: Seaton Golf Course, Adelaide, *Whibley 3850*, Nov 1972 (AD). South-eastern: Messent Wildlife Reserve, *James 149*, Nov 1965 (AD). WESTERN AUSTRALIA: Menzies: West Cape Howe, W of Albany, *Royce 5401*, Mar 1956 (PERTH). Warren: Carey Brook, Donnelly R., *Butler*, Mar 1965 (PERTH). Eyre: Nancy Peak, Porongorup Ra., *Royce 6127*, Oct 1959 (PERTH).

17. **Wahlenbergia planiflora** *P.J. Smith*, **sp. nov.**

W. multicauli et *W. fluminali* affinis, sed a *W. multicauli* lobis corollae 6–14 mm longis, capsulis hemisphaericis vel obconicis, differt; a *W. fluminali* caulibus typice paucis, foliis solum summis linearibus, lobis corollae 6–14 mm longis, differt.

TYPE: NEW SOUTH WALES: Central Tablelands: 2 km from Hartley on road to Lithgow, *P.J. Smith 28*, 16 Mar 1972; holo NSW.

Perennial herb with a thickened taproot, tufted, typically few-stemmed. *Stems* 12–70 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, glabrous to hirsute; hairs to 2 mm long. *Leaves and bracts* alternate or sometimes lowermost opposite, obovate to narrowly elliptic on lower stem, lanceolate to linear on upper stem, 4–95 mm long, 1–11 mm wide, obtuse to subulate, sessile, glabrous to hirsute; margins flat or sometimes undulate, entire or with small, distant callus-teeth, sometimes faintly serrate. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–14 cm long, glabrous to sparsely hirsute; bracteoles linear, 2–9 mm long, glabrous to sparsely hirsute. *Hypanthium* hemispherical to obconic, 1–4 mm long, glabrous to hirsute. *Sepals* 5, spreading, ± narrowly triangular, 1–5 mm long, glabrous to hirsute. *Corolla* rotate, blue or sometimes white, puberulous inside at base and sometimes sparsely hirsute along the veins; tube 1–3 mm long, equal to or shorter than the sepals; lobes 5, elliptic to obovate, sometimes ovate, obtuse to acute, 6–14 mm long, 3.5–8.5 mm wide. *Stamens* 5; filaments white, 0.8–2.1 mm long, upper section filiform, lower section trullate to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 2–4 mm long. *Ovary* 3-locular. *Style* white, 2.5–6 mm long, 3-fid, deeply constricted no lower than 1/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 1–2 glands below each stigmatic cleft; stigmatic lobes 0.5–1.5 mm long. *Capsule* hemispherical to obconic, 2–8 mm long, 2–5 mm wide, glabrous to hirsute. *Seeds* c. 0.5 mm long.

NOTES: Characteristic features of *W. planiflora* are its typically few-stemmed habit; alternate, non-linear lower leaves; large, rotate corollas; styles deeply constricted close below the stigmatic lobes; and hemispherical to obconic capsules.

The epithet refers to the 'flat-flowered' appearance resulting from the very short corolla-tube. Latin *planus*, flat, *flos*, flower.

Key to subspecies

1 Plants glabrous or sometimes sparsely hirsute on lower stems and leaves; capsules obconic, 3–8 mm long, glabrous ..... **a. subsp. planiflora**

1* Plants hirsute; capsules hemispherical, 2–6 mm long, usually hirsute ..... b.subsp. **longipila**

17a. Wahlenbergia planiflora subsp. **planiflora**

[*W. multicaulis* auct. non Benth.: Beadle (1984: 769); Stanley & Ross (1986: 475)]

[*W. multicaulis* form A, Jacobs & Pickard (1981: 96)]

Stems 12–65 cm long, glabrous or sometimes lower stem sparsely hirsute; hairs to 1.3 mm long. *Leaves and bracts* 4–95 mm long, 1–10 mm wide, glabrous or sometimes sparsely hirsute on lower stem. *Pedicels* 2–14 cm long, glabrous; bracteoles 2–9 mm long, glabrous. *Hypanthium* obconic, 1.5–4 mm long, glabrous. *Sepals* 1–5 mm long, glabrous. *Corolla* blue; tube 1–3 mm long; lobes 6–13 mm long, 3.5–7 mm wide. *Filaments* 1.0–1.9 mm long, lower two-thirds rhombic to obtrullate, with extended shoulders. *Style* 3–5.5 mm long. *Capsule* obconic, 3–8 mm long, 2–5 mm wide, glabrous. Figure 18a–d.

Chromosome number: $n = 18$ (*Carolin s.n.* [Owens Gap], *Smith 28, 93, 96*); $n = 27$ (*Carolin W199*).

Flowering period: Throughout the year.

Distribution: South-eastern New South Wales and north-eastern Victoria, from Barrington Tops in the north to Nunniong Plains in the south. Figure 31a.

Habitat: Grows in forest, woodland and grassland, typically amongst other herbs rather than in the open. Recorded over a wide altitudinal range, from near sea level to about 1500 m.

Conservation status: Not considered at risk.

Selected Specimens (56 examined): New South Wales: North Coast: Wingham to Killawarra, c. 2 miles [3 km] W of Wingham, *Salasoo 2769*, Jan 1964 (NSW); 1 mile [2 km] W of Monkey Jacket, NW of Tea Gardens, *Johnson*, Oct 1953 (NSW 67116). Central Coast: Lake Macquarie, Myuna Bay, *Salasoo 1642*, Dec 1958 (NSW); All Saints Cemetery, Albion Park, *McBarron 10856*, Aug 1965 (NSW). South Coast: Princes Hwy, 1 mile [2 km] S of Nowra, *Briggs 3075*, Dec 1969 (NSW). Northern Tablelands: Bottom of Corker Lookout, *Carolin W199*, Apr 1958 (SYD); 'Fingerpost' track to Barrington Tops, *Carolin W187*, June 1957 (SYD). Central Tablelands: 1 mile [2 km] SW of Lowther, *Briggs (Carolin W41)*, Feb 1956 (SYD); 4 miles [7 km] WNW of Mittagong, *Thompson 712*, Nov 1970 (NSW). Southern Tablelands: 2 km from Cooma on road to Adaminaby, *Smith 96*, Mar 1974 (SYD); 10 km from Jindabyne on road to Mt Kosciusko, *Smith 93*, Mar 1974 (SYD); SE of Nimmitabel, *Salasoo 1971*, Dec 1960 (NSW). Central Western Slopes: Wappinguy Ck near Merriwa, *Carolin 6990*, Oct 1968 (SYD); Owens Gap, *Carolin* (SYD). Australian Capital Territory: NE side of Boboyan Divide, *Burbidge & D'Arnay 6974*, Mar 1961 (CANB). Victoria: R: 10 miles [17 km] W of Rutherglen, *Muir 4610*, Oct 1967 (MEL). V: Cobberas Mts, *Beauglehole 36519 & Finck*, Jan 1971 (MEL); W ascent of Cobberas, *Wakefield 3010*, Jan 1949 (MEL). W: Lake Hill, SW of Nunniong Plains, *Beauglehole 36340 & Finck*, Jan 1971 (MEL).

17b. Wahlenbergia planiflora subsp. **longipila** *Carolin ex P.J. Smith*, **subsp. nov.**

Ab subsp. *planiflora* plantis hirsutis, capsulis magis hemisphaericis, typice hirsutis, differt.

TYPE: NEW SOUTH WALES: North Western Plains: 8 miles [13 km] NE of Boggabri, *S. James (R.C. Carolin W137)*, 15 Nov 1956; holo NSW.

[*W. multicaulis* form B, Jacobs & Pickard (1981: 96)]

Stems 12–75 cm long, hirsute towards base, glabrous to sparsely hirsute above; hairs to 2 mm long. *Leaves and bracts* 4–65 mm long, 1–11 mm wide, hirsute on lower stem, glabrous to sparsely hirsute on upper stem. *Pedicels* 2–13 cm long, usually sparsely hirsute; bracteoles 2–8 mm long, glabrous to sparsely hirsute. *Hypanthium* hemispherical, 1–3 mm long, usually hirsute. *Sepals* 1.5–4.5 mm long, usually hirsute. *Corolla* blue or sometimes white; tube 1–3 mm long; lobes 6–14 mm long, 4–8.5 mm wide. *Filaments* 0.8–2.1 mm long, lower two-thirds trullate to rhombic, with or without extended shoulders. *Style* 2.5–6 mm long. *Capsule* hemispherical, 2–6 mm long, 2–5 mm wide, usually hirsute. Figure 18e–h.

CHROMOSOME NUMBER: $n = 9$ (*Carolin 2093, Smith 80*); $n = 18$ (*Carolin 2092, Smith 41, 42, 44, 59, 83*).

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: South-eastern Queensland and north-eastern New South Wales, from Kingaroy in the north to Dunedoo in the south. Figure 31a.

HABITAT: Grows in forest, woodland and grassland, typically amongst other herbs rather than in the open.

CONSERVATION STATUS: Not considered at risk.

NOTES: Subsp. *longipila* differs from subsp. *planiflora* in its plentiful indumentum (which usually includes the capsules and sepals), and its shorter, more hemispherical capsules. However, occasional specimens within the distribution of each subspecies resemble the other subspecies. Field observations indicated that this was due to variation among individual plants rather than local populations.

The epithet refers to the long-haired indumentum. It was devised by R. Carolin in the 1960s in his unpublished notes on the species. Latin *longus*, long, *pilus*, hair.

SELECTED SPECIMENS (70 examined): QUEENSLAND: Burnett: Kingaroy–Chahpingah Rd, E of Boyne R., *Johnson 468*, May 1958 (BRI, CANB, NSW). Darling Downs: Cottonvale–Amiens Rd, *Byrnes 3934*, Oct 1979 (BRI, NSW); Stanthorpe, *Pedley 1423*, Oct 1963 (BRI); Moreton: Helidon–Ravensbourne, 1 mile [2 km], *Phillips*, Aug 1963 (CBG 022922). NEW SOUTH WALES: Northern Tablelands: 58 km from Inverell on road to Glen Innes, *Smith 83*, Dec 1973 (SYD); Nandewar Ra., *Carolin 2092, 2093*, Jan 1961 (SYD); 2 km from Bendemeer on road to Tamworth, *Smith 80*, Dec 1973 (SYD). North Western Slopes: 25 km from Coonabarabran on road to Narrabri, *Smith 59*, June 1973 (SYD); 8 km from Coonabarabran on road to Narrabri, *Smith 42*, Nov 1972 (SYD); 7 km from Coonabarabran on road to Binnaway, *Smith 41*, Nov 1972 (SYD); 18 km from Coolah on road to Binnaway, *Smith 44*, Nov 1972 (SYD); Mt Terrible near Currabubula, *Johnson*, Oct 1951 (NSW 67103). Central Western Slopes: Cobbora, *Garden*, Oct 1949 (NSW 66776); Coulsons Ck, foot of Liverpool Ra., N of Merriwa, *Briggs 2195 & Rodd*, Sep 1968 (NSW). North Western Plains: Narrabri–Boggabri Rd, *Althofer*, Sep 1967 (NSW 133173).

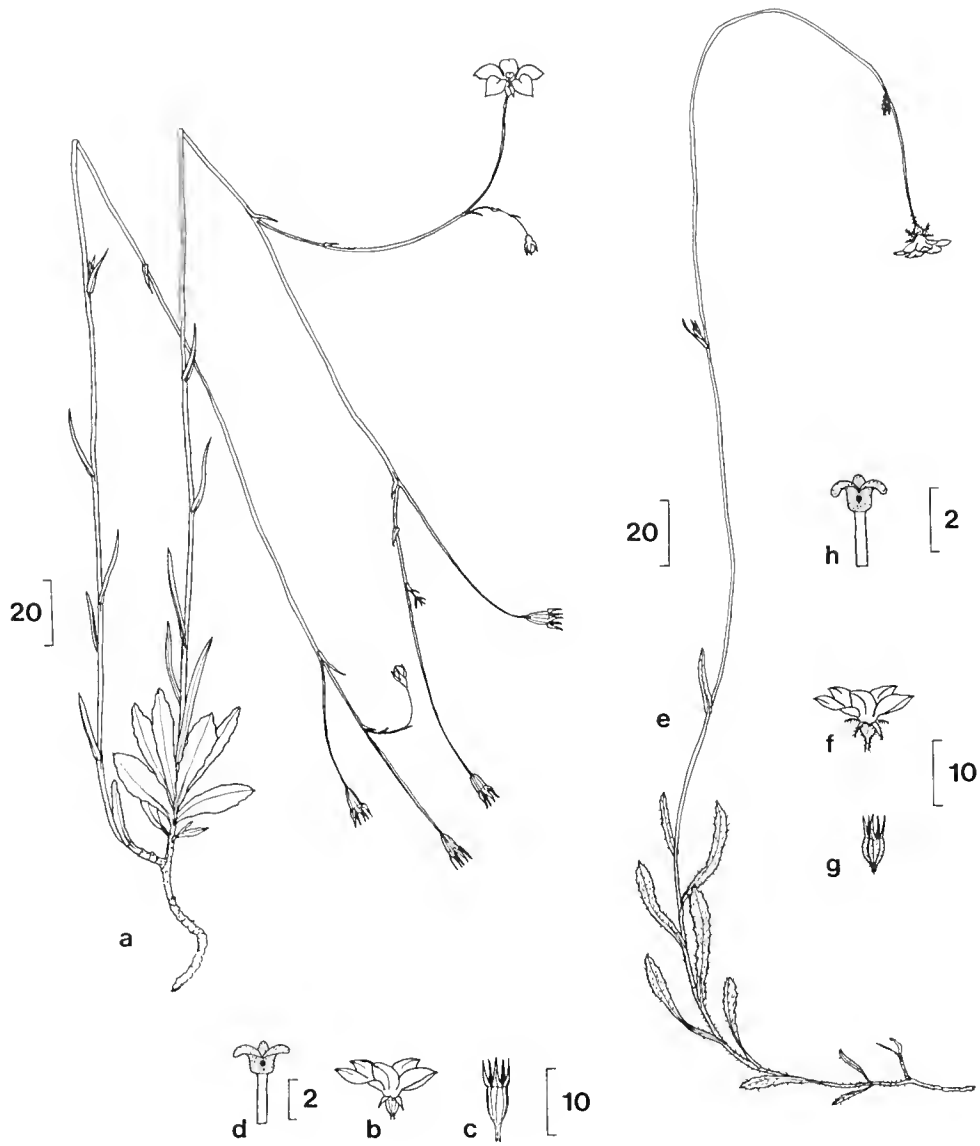

Figure 18. *W. planiflora* subsp. *planiflora*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. planiflora* subsp. *longipila*: **e**, habit; **f**, flower; **g**, capsule; **h**, style. a–d from *Salasoo 1971*; e–h from *NSW 67103*. Scale bars in mm.

18. Wahlenbergia fluminalis *(J. Black) F. Wimmer ex H. Eichler*

Eichler (1963: 297); Carolin (1964: 239); Willis (1972: 626); Cunningham *et al.* (1981: 627); Beadle (1984: 769); Smith (1986: 1378); Stanley & Ross (1986: 475). *Cephalostigma fluminale* Black (1934: 184); Black & Robertson (1957: 809).

TYPE: SOUTH AUSTRALIA: Murray: Murray R., *S.A. White*, Dec 1913; holo AD.

Perennial herb with a thickened taproot, tufted, typically many-stemmed. *Stems* 5–80 cm long, erect or ascending, usually becoming much-branched, glabrous or sometimes lower stem sparsely hirsute; hairs to 1 mm long. *Leaves and bracts* alternate, all ± linear or lowermost oblanceolate, acute to subulate, sometimes lowermost obtuse, sessile, 4–60 mm long, 0.5–5 mm wide, glabrous or sometimes lower leaves sparsely hirsute; margins flat or sometimes undulate, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–10 cm long, glabrous; bracteoles linear, 2–10 mm long, glabrous. *Hypanthium* hemispherical to shortly obconic, 1–3 mm long, glabrous. *Sepals* 5, spreading, ± narrowly triangular, 1–3 mm long, glabrous. *Corolla* rotate, blue, puberulous inside at base, otherwise glabrous; tube 0.5–1.5 mm long, equal to or shorter than the sepals; lobes 5, elliptic to obovate, obtuse to acute, 3–9 mm long, 2–5.5 mm wide. *Stamens* 5; filaments white, 0.7–1.5 mm long, upper section filiform, lower section trullate to rhombic, with extended shoulders, ciliate on upper margins; anthers 0.5–2 mm long. *Ovary* 3-locular. *Style* white, 2.5–4 mm long, 3-fid, deeply constricted no lower than 1/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 1–2 glands below each stigmatic cleft; stigmatic lobes 0.5–1.5 mm long. *Capsule* hemispherical to shortly obconic, 2–5 mm long, 1.5–3 mm wide, glabrous. *Seeds* c. 0.3 mm long. Figure 19a–d.

CHROMOSOME NUMBER: $n = 18$ (*Peacock 6110.12C, Smith 46, 62, 67, 69, 69A*).

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: Restricted to the Murray–Darling Basin but widespread within the Basin, from the Darling Downs in the north-east to Mannum in the south-west. Figure 31b.

HABITAT: Usually grows on the banks and floodplains of inland watercourses.

CONSERVATION STATUS: Not considered at risk.

NOTES: *W. planiflora*, *W. multicaulis* and *W. fluminalis* are all characterised by rotate corollas and styles deeply constricted close below the stigmatic lobes. *W. fluminalis* differs from *W. planiflora* in its more branched habit, narrow, mostly linear lower leaves, and generally smaller flowers. It differs from *W. multicaulis* in its more branched habit and hemispherical to shortly obconic capsules.

SELECTED SPECIMENS (169 examined): QUEENSLAND: Darling Downs: 'Rockwood', c. 20 miles [33 km] E of Condamine, *Cameron*, Jan 1970 (BRI 114039). Maranoa: Moonie R., c. 50 km E of St George, *Pedley 782*, May 1961 (BRI). NEW SOUTH WALES: Central Western Slopes: 20 miles [33 km] S of Dubbo, *Peacock 6110.12C*, Oct 1961 (SYD); 23 km from Parkes on road to Peak Hill, *Smith 67*, Nov 1973 (SYD). South Western Slopes: Billabong Ck, Rand, *McBarron 3049*, Feb 1949 (NSW). North Western Plains: Nyngan, *Smith 62*, Oct 1973 (SYD); 47 km from Cobar on road to Wilcannia, *Smith 69*, Nov 1973 (SYD). South Western Plains: near Mossgiel, *Leigh*, Oct 1964 (NSW 77488); Hay, *Smith 46*, Dec 1972 (SYD). North Far Western Plains: Wilcannia, *Smith 69A*, Nov 1973 (SYD). South Far Western Plains: Willow Point Stn, Darling R. Anabranch, 65 miles [108 km] N of Wentworth, *Johnson & Constable*, Mar 1959 (NSW 47288). VICTORIA: A: Hattah Lakes Natl Park, *Beauglehole 17195*, Oct 1960 (MEL). B: Wyperfield Natl Park, *Muir 896*, Oct 1959 (MEL). C: Woraigworm, Little Desert, *Beauglehole 1670*, Oct 1948 (MEL). F: c. 16 km SE of Robinvale, *Beauglehole 56119*, May 1977 (MEL). G: Swan Hill, *Gammon* (MEL 57183). H: Mt Korong Scenic

Reserve, *Beauglehole 69399*, Oct 1981 (MEL). J: near Stawell, *Mining Department* (MEL 57840). L: Barmah State Forest, *Muir 3410*, June 1964 (MEL). M: Tabilk Lagoon Wildlife Reserve, *Beauglehole 68892*, May 1981 (MEL). N: Fryers Ridge Flora Reserve, *Beauglehole 70030 & Blake*, Nov 1981 (MEL). Q: Yarrawonga–Cobram, *Aston 2202*, Jan 1982 (MEL). R: Warby Ra., Sep 1942 (MEL 57493). SOUTH AUSTRALIA: Murray: c. 3 km NE of the ferry at Mannum, *Eichler 14906*, Apr 1958 (AD).

19. Wahlenbergia multicaulis *Benth.*

Bentham (1837: 75); N.E. Brown (1913: 337), p.p.; Lothian (1947*a*: 229); Grieve & Blackall (1982: 668); Smith (1986: 1381); Wheeler (1987: 599); [misapplied by Beadle (1984: 769) and Stanley & Ross (1986: 475)]. *W. gracilis* f. *multicaulis* (Benth.) Wawra (1883: 132).

TYPE: WESTERN AUSTRALIA: Drummond: Swan R., *C. von Hügel*; lecto W (Lothian 1947*a*: 229); isolecto K.

Lothian mistakenly stated that the lectotype was at GOET, but the specimen at W has been labelled by him 'undoubtedly the type' (R. Carolin, pers. comm.).

W. simplicicaulis Vriese (1848: 241); Lothian (1947*a*: 209); Grieve & Blackall (1982: 668). TYPE: WESTERN AUSTRALIA: interior regions of south-western Australia, *L. Preiss 1887*, Nov 1840; lecto MEL (Lothian 1947*a*: 209); isolecto L.

W. tadgellii Lothian (1947*a*: 228); Curtis (1963: 409); Willis (1972: 626); Beadle *et al.* (1982: 432), p.p. TYPE: VICTORIA: P: Torquay, *T.R.N. Lothian*, Oct 1943; holo MEL 57254.

Lobelia dubia Vriese (1848: 242). TYPE: WESTERN AUSTRALIA: Drummond: near 'Pine-Aple', Perth, *L. Preiss 1440*, 7 Oct 1839; holo G.

Perennial herb with a thickened taproot, tufted, typically few-stemmed. *Stems* 10–75 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, glabrous throughout or lower stem sparsely hirsute; hairs to 1.5 mm long. *Leaves and bracts* alternate or sometimes lowermost opposite, all ± linear or lower leaves obovate to oblanceolate, acute to subulate, sometimes lowermost obtuse, sessile, 4–80 mm long, 1–6 mm wide, glabrous or lower leaves sparsely hirsute; margins flat, entire or with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–13 cm long, glabrous; bracteoles linear, 2–9 mm long, glabrous. *Hypanthium* elongated-obconic or sometimes obconic, 2–7 mm long, glabrous. *Sepals* 5, spreading, ± narrowly triangular, 0.5–5.5 mm long, glabrous. *Corolla* rotate, blue, puberulous inside at base, otherwise glabrous; tube 0.5–1.5 mm long, equal to or shorter than the sepals; lobes usually 5, sometimes 4 or 6, elliptic to obovate, obtuse to acute, 2–9 mm long, 1–5.5 mm wide. *Stamens* 5; filaments white, 0.7–2.0 mm long, upper section filiform, lower section trullate to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 0.5–2.5 mm long. *Ovary* 3-locular or sometimes 2-locular. *Style* white, 2–5.5 mm long, 3-fid or sometimes 2-fid, deeply constricted no lower than 1/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 0–1 gland below each stigmatic cleft; stigmatic lobes 0.5–1.5 mm long. *Capsule* elongated-obconic or sometimes obconic, 4–12.5 mm long, 1.5–4.5 mm wide, glabrous. *Seeds* c. 0.4 mm long. Figure 19e–h.

CHROMOSOME NUMBER: $n = 18$ (*Smith 169*); $n = 27$ (*Carolin W149A, W173, Smith 29, 51, 94, 95, 97, 161*); $n = 36$ (*Carolin W17B*).

FLOWERING PERIOD: Throughout the year.

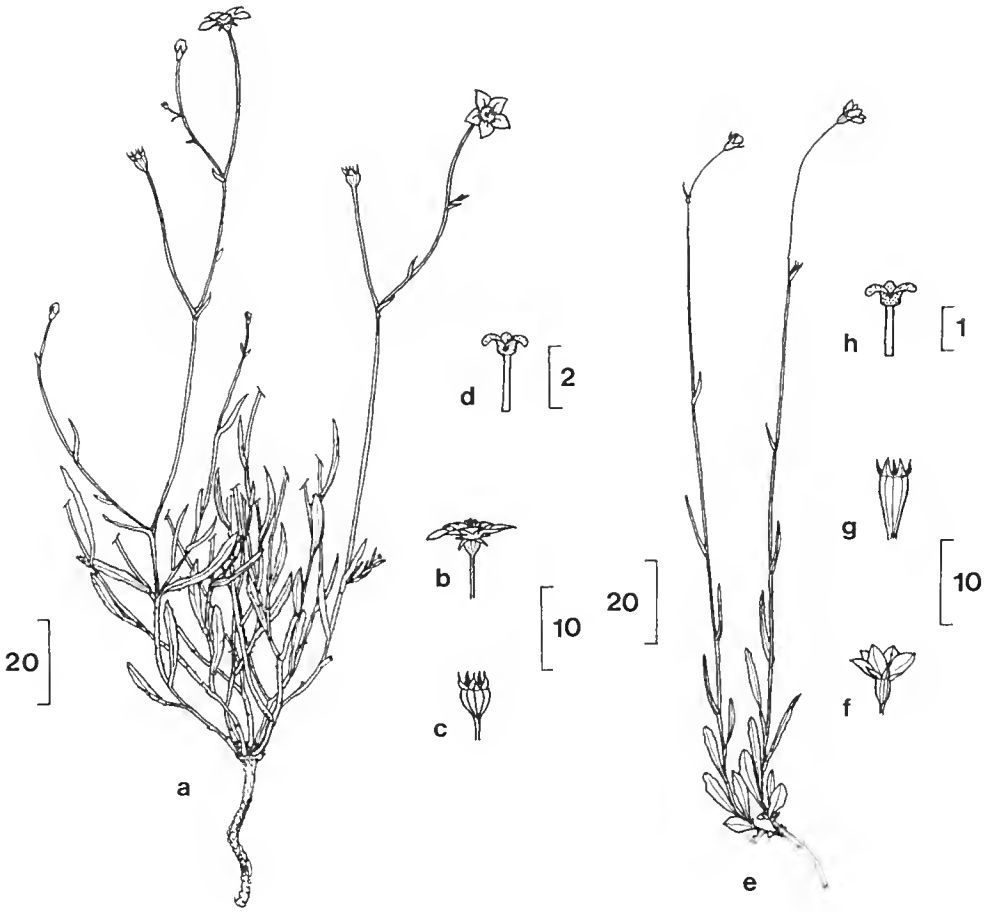

Figure 19. *W. fluminalis*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. multicaulis*: **e**, habit; **f**, flower; **g**, capsule; **h**, style. a–d from *NSW 77488*; e–f from *Pullen 2407*; g–h from *Briggs 2500*. Scale bars in mm.

DISTRIBUTION: Widespread in south-eastern Australia, from the Blue Mountains in the north-east to Hobart in the south and Kangaroo Island in the west. Also occurs widely in south-western Australia, from Rat Island in the north-west to Cape Arid in the south-east. Figure 32.

HABITAT: Grows in forest, woodland and grassland, typically amongst other herbs rather than in the open. Recorded over a wide altitudinal range, from near sea level to about 1500 m.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. multicaulis* are its relatively small, rotate corollas; styles deeply constricted close below the stigmatic lobes; and elongated-obconic capsules. There is some variation in flower size but specimens with larger corollas are usually large in all flower parts, so that the corollas still appear small in relation to the hypanthium and sepals.

SELECTED SPECIMENS (305 examined): NEW SOUTH WALES: Central Coast: Punchbowl, *Green*, Apr 1953 (NSW 66813). South Coast: 8 km from Moruya on road to Narooma, *Smith 97*, Mar 1974 (SYD). Central Tablelands: Clwydd, *Smith 29*, Mar 1972 (SYD); 17 km from Bathurst on road to Lithgow, *Smith 51*, Dec 1972 (SYD); 2 miles [3 km] E of Sodwalls, *Carolin W17B*, Dec 1955 (SYD). Southern Tablelands: Braidwood-Moruya, 5 miles [8 km], *Carolin W173*, Mar 1957 (SYD); 2 km from Kiandra on road to Adaminaby, *Smith 94*, Mar 1974 (SYD); 17 km from Adaminaby on road to Kiandra, *Smith 95*, Mar 1974 (SYD); Sawpit Ck–Jindabyne, 2 miles [3km], *Carolin W149A*, Mar 1957 (SYD); Bradleys Ck, 3 miles [5 km] E of Yaouk, NNE of Adaminaby, *Briggs 2500*, Feb 1969 (NSW). South Western Slopes: Monument Hill, Albury, *McBarron 3287*, May 1949 (NSW). South Western Plains: Millewa State Forest, Millewa River Rd, c. 4 km E of Toupna Crossing Rd, *Smith 2367*, Nov 1987 (NSW). AUSTRALIAN CAPITAL TERRITORY: Blue Gum Ck, upper Paddys R., c. 2 miles [3 km] S of 'Booroomba' Stn, *Pullen 2407*, Nov 1960 (CANB, NSW). VICTORIA: C: Mt Arapiles, Grampians, *Beauglehole 16615*, Oct 1964 (MEL). D: Wilkin near Casterton, *Beauglehole 8246*, Oct 1960 (MEL). E: Lower Glenelg Natl Park, *Beauglehole 7079 & Willis*, Jan 1965 (MEL). H: c. 7 km WSW of Inglewood, *Beauglehole 50188*, Aug 1975 (SYD). J: Major Mitchell Plateau, Grampians, *Beauglehole 16486*, Dec 1967 (MEL). K: Port Campbell Natl Park, *Beauglehole 21544 & Finck*, Oct 1966 (MEL). M: Bendigo, *Smith 161*, Jan 1975 (SYD). N: Eltham, *St John*, Sep 1927 (MEL 57674). P: Narre Warren East, *Beauglehole 7015*, Oct 1945 (MEL). R: Cornishtown via Chiltern, *Cleaves*, 1942 (MEL 57497). S: Eildon, *Muir 1608*, Oct 1960 (MEL). T: c. 5 miles [8 km] E of Traralgon, *Melville 2155*, Nov 1952 (K, MEL). V: c. 50 km SSE of Tallangatta, *Wilson*, Dec 1961 (MEL 628364). W: McKillops Bridge, Snowy R., *Muir 2075*, Mar 1961 (MEL). X: 8 km from Sale on road to Bairnsdale, *Smith 169*, Jan 1975 (SYD). Z: Tubbut, *Wakefield 4786*, Jan 1953 (MEL). TASMANIA: Bass Strait Islands: Little Green Island, Furneaux Group, *Whinray 1014*, Jan 1975 (MEL). Central Highlands: Forest Lagoon, Verwood Rd, *Brown 165*, Jan 1981 (HO, MEL, AD). Western and South-western: Domain, Hobart, *Gulline*, Aug 1949 (HO 8349). North-eastern: Little Musselroe Bay, *Moscal 2926*, Sep 1983 (HO). SOUTH AUSTRALIA: Northern Lofty: Spring Gully Conservation Park, *Yeatman 225*, Oct 1980 (AD). Murray: Kaiserstuhl Conservation Park, *Spooner 7390*, Nov 1980 (AD). Southern Lofty: Mt Compass, *Hunt 3302*, Oct 1970 (AD). Kangaroo Island: upper part of South West R., *Cleland*, Nov 1954 (AD). South-eastern: Big Heath Reserve, *Hunt 2585*, Nov 1965 (AD). WESTERN AUSTRALIA: Irwin: Rat I., *Saumy 115*, Sep 1972 (PERTH). Drummond: Byford, *Craufield 1080*, Nov 1979 (PERTH). Dale: Darling Ra., *Wilson 11610*, Oct 1973 (PERTH). Menzies: Margaret R., *Royce 105*, Jan 1945 (PERTH). Eyre: c. 45 km NW of Bremer Bay, *Newbey 5087*, Sep 1977 (PERTH). Roe: 1 mile [2 km] E of Tambellup, *Newbey 1185*, Oct 1963 (PERTH). Avon: banks of Swan R., 2–4 miles [3–7 km] above Northam, *Salasoo 170*, Oct 1949 (NSW).

20. Wahlenbergia gracilis *(Forster f.) A. DC.*

De Candolle (1830: 142); [Schrader (1827: 38) indicated but did not validly make the combination]; Hooker (1852: 159), (1856: 239), p.p.; Bentham (1869: 137), p.p.; Moore & Betche (1893: 302), p.p.; Bailey (1900: 922), p.p.; Rodway (1903: 107), p.p.; N.E. Brown (1913: 316); Ewart (1930: 1060), p.p.; Carolin (1964: 240); Cunningham et al. (1981: 628); Beadle *et al.* (1982: 433); Beadle (1984: 771); Smith (1986: 1378); Stanley & Ross (1986: 476); [misapplied by Carolin (1981: 349)]. *Campanula gracilis* Forster (1786: 84); R. Brown (1810: 561), p.p. *Cervicina gracilis* (Forster f.) Britten (1901: 56).

TYPE: NEW CALEDONIA OR NEW ZEALAND: *J.R. & J.G.A. Forster*; lecto GOET (Carolin 1964: 240); isolecto BM, K, KlEL.

W. quadrifida (R. Br.) de Candolle (1830: 144); N.E. Brown (1913: 317); Domin in Diels (1929: 638); Lothian (1947*a*: 210); Black & Robertson (1957: 811); Curtis (1963: 409); Willis (1972: 625); [misapplied by Black (1934: 183)]. *Campanula quadrifida* R. Brown (1810: 561); Sweet (1830: 326). TYPE: NEW SOUTH WALES: Central Coast: around Port Jackson, *R. Brown (Bennett 2615)*; lecto BM (Lothian 1947*a*: 210); isolecto K.

W. sieberi de Candolle (1830: 144); Black (1934: 183); Lothian (1947*a*: 219); Black & Robertson (1957: 811). *Campanula sieberi* (A. DC.) Dietrich (1839: 752). TYPE: AUSTRALIA: New Holland, *F.W. Sieber 577*; holo G; iso P.

W. dioica Domin (1929: 639). TYPE: QUEENSLAND: Cook: near Chillagoe, *K. Domin*, Feb 1910; lecto PR *Domin 8750* (here chosen); isolecto PR *Domin 8749*.

W. eurycarpa Domin (1929: 638). TYPE: NEW SOUTH WALES: Central Tablelands: Blue Mts at Katoomba, *K. Domin 8741*, Apr 1910; holo PR.

[*W. vinciflora* (Vent.) Decaisne (1849: 41), as 'vincaeflora'. *C. vinciflora* Ventenat (1803: 12), as 'vincaeflora', nom. illeg. (Stearn 1951: 169; Carolin 1964: 236) ≡ *C. gracilis* Forster (1786: 84). *C. gracilis* (var) α *vinciflora* (Vent.) R. Brown (1810: 561), as 'vincaeflora'. *W. gracilis* var. *vinciflora* (Vent.) Hooker (1856: 239), as 'vincaeflora'. The name *C. vinciflora* was superfluous when first published as it included, as a synonym, *C. gracilis* Forster f. Its type is therefore that of *W. gracilis*, although the epithet has generally been misapplied to *W. stricta*.]

[*W. gracilis* var. *minutiflora* Bailey (1900: 922), nom. nud.]

[*W. marginata* var. *neo-caledonica* Lothian (1947*a*: 214), nom. illeg. (Carolin 1964: 240). Lothian based var. *neo-caledonica* on part of the type collection of *C. gracilis* Forster f., namely the isolectotype at K.]

Perennial herb with a thickened taproot, tufted, few- to many-stemmed. *Stems* 5–80 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, glabrous or lower stem sparsely hirsute; hairs to 1.3 mm long. *Leaves and bracts* alternate throughout or lower leaves opposite, becoming alternate above, obovate to narrowly elliptic on lower stem, lanceolate to linear on upper stem, obtuse to subulate, sessile, 2–60 mm long, 0.2–10 mm wide, lower leaves glabrous to sparsely hirsute, upper leaves glabrous; margins flat or undulate, entire or with small, distant callus-teeth, sometimes faintly serrate. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–11 cm long, usually glabrous, sometimes sparsely hirsute; bracteoles linear, 1.5–5 mm long, glabrous. *Hypanthium* obconic to obovoid, 1–3 mm long, glabrous. *Sepals* 5 or sometimes 3 or 4, ± erect, ± narrowly triangular, 1–3 mm long, glabrous. *Corolla* deeply campanulate, usually blue, sometimes white or pink, puberulous inside at base, otherwise glabrous; tube 1–4.5 mm long, varying from shorter to longer than the sepals; lobes 5 or sometimes 3 or 4, elliptic to ovate, acute, 1.5–6 mm long, 1–3 mm wide. *Stamens* 5 or sometimes 3 or 4; filaments white, 0.7–1.8 mm long, upper section filiform, lower section trullate to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 1–3 mm long. *Ovary* 3-locular or sometimes 2-locular. *Style* white, 1.5–6.5 mm long, 3-fid or sometimes 2-fid, unconstricted or indistinctly constricted 1/3 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 0–3 glands below each stigmatic cleft; stigmatic lobes 0.3–1.2 mm long. *Capsule* obconic to obovoid, 2.5–7 mm long, 1.5–3.5 mm wide, glabrous. *Seeds* c. 0.3 mm long. Figure 20a–d.

CHROMOSOME NUMBER: $n = 27$ (*Carolin W5, W82, W110, W120, Smith 21, 30, 31, 32, 71, 89, 107, 113*). H. Gulline (in Darlington & Wylie 1955: 289) also reported a count of $n = 27$, probably from Tasmania, but there is no voucher specimen to check the identification. J. Petterson (pers. comm.) has made an unpublished count of $n = 36$ on material from New Caledonia.

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: Widespread in eastern Australia from Cape York Peninsula to southern Tasmania, extending west to the McArthur River in the Northern Territory and the Adelaide area in South Australia. The species also occurs in New Guinea, New Caledonia and New Zealand. Figure 33b.

HABITAT: Grows in many vegetation types, often in disturbed sites, including lawns and gardens. Typically grows amongst other herbs rather than in the open.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. gracilis* are its perennial habit; small, deeply campanulate corollas; and obconic to obovoid capsules.

A number of authors have treated *W. gracilis* as a much more broadly defined taxon encompassing various *Wahlenbergia* species in Australasia (e.g. Bentham 1869: 137, Allan 1961: 788) and southern Asia (e.g. Hooker 1881: 429). Other authors have reduced *W. gracilis* to synonymy with a very broadly defined *W. marginata* (Thunb.) A. DC. (e.g. Lothian 1947*a*: 212, Tuyn 1960: 115). Although further studies are needed on the morphological and geographic limits of *Wahlenbergia* species in Asia and Malesia, I do not consider any Australian material to be referable to *W. marginata* of Japan.

SELECTED SPECIMENS (362 examined): QUEENSLAND: Burnett: 58 km W of Eidsvold, 2 km NW of Redbank Ck bridge, *Johnson 7149 & Briggs*, June 1971 (NSW). Cook: 8 km E of Babinda, *McDonald & Batianoff 1508*, Apr 1975 (BRI). Darling Downs: Chinchilla, *Lithgow*, July 1978 (BRI 241691). Leichhardt: c. 80 km SW of Rolleston, *Crisp 3072*, June 1977 (CBG, BRI). Moreton: West Burleigh, *Smith 31*, May 1972 (SYD). North Kennedy: Hinchinbrook I., Cape Richards, *Everist 9646*, Aug 1970 (BRI). Port Curtis: Round Hill Head, 24°10' S, 151°54' E, *Everist*, Mar 1970 (BRI 214539). South Kennedy: Mackay, *Stanley & Ross 78257*, Nov 1978 (BRI). Wide Bay: 1 km N of Coolum Beach, *Sharpe 2017*, Apr 1976 (BRI). NEW SOUTH WALES: Lord Howe Island: Northern Hills, *Hoogland 8700*, Oct 1963 (CANB, NSW). North Coast: 15 km from Kempsey on road to Armidale, *Smith 32*, May 1972 (SYD); Warkworth, *Smith 30*, Apr 1972 (SYD). Central Coast: Sanitation Depot, Pearl Beach, *Carolin W5*, Oct 1955 (SYD); Castle Hill, *Barlow (Carolin W82)*, May 1956 (SYD); Longueville, *Smith 21*, Mar 1972 (SYD); East Hills–Milperra 1 mile [2 km], *Carolin W120*, Nov 1956 (SYD). South Coast: S slope of Mt Coolangatta, SE of Berry, *Salasoo 3147*, Jan 1966 (NSW). Northern Tablelands: 8 km from Glen Innes on road to Grafton, *Smith 89*, Dec 1973 (SYD). Central Tablelands: Bell–Lithgow 3 miles [5 km], *Carolin W110*, Nov 1956 (SYD). Southern Tablelands: Greenwich Rd near Wollondilly R., Goulburn District, *Salasoo 5050*, Sep 1972 (NSW). North Western Slopes: Mt Martha, 8 km SW of Curlewis, *Briggs 2998*, Nov 1969 (NSW). Central Western Slopes: 12 miles [20 km] NW of Coolah, *Johnson & Briggs 954*, Oct 1966 (NSW). South Western Slopes/Southern Tablelands: 3 miles [5 km] from Khancoban, *Phillips & Carroll*, Oct 1965 (CBG 025271). North Western Plains: 3 km from Nyngan on road to Tottenham, *Smith 71*, Nov 1973 (SYD). South Western Plains: southern tip of Cocoparra Ra., *Smith 113*, Apr 1974 (SYD). AUSTRALIAN CAPITAL TERRITORY: Canberra, *Cleland*, Jan 1939 (AD 966071624). Victoria: D: above 'The Nook', Grampians, *Symon 58*, Nov 1959 (ADW). E: Mt Eccles Natl Park, *Beauglehole 44016*, Oct 1960 (MEL). J: Grampians, Major Mitchell Plateau, *Beauglehole 16547*, Dec 1967 (MEL). K: Otway Ra., *Muir 1833*, Nov 1960 (MEL). L: Ulupna I. Reserve, 3 miles [5 km] NW of Strathmerton, *Muir 4703*, Oct 1969 (MEL). N: Dandenong Ra., *Muir 733*, Mar 1959 (MEL). P: French I., 38°24' S, 145°21' E, *Opie & van Berkel*, Dec 1980 (MEL 581212). S: Warburton–Cement Ck, *Tadgell*, Oct 1937 (MEL 57446). T: 4 km NE of Leongatha, *Beauglehole 61866*, Dec 1978 (MEL). V: Bogong massif, E of Tawonga, *Eichler 14796*, Feb 1958 (AD). W: Ensay, *Tadgell*, Nov 1938 (MEL 57235). Z: Bastion Point, Mallacoota, *Smith 107*, Mar 1974 (SYD). TASMANIA: Bass Strait Islands: Deal I., Kents Group, *Whinray 85a*, Dec 1968 (NSW). Central Highlands: Forth Falls, *Gulline*, May 1950 (HO 8324). Western and South-western: Mt Wellington, *Gulline*, Apr 1950 (HO 8315). Northeastern: Bluestone Tier, *Moscal 8147*, May 1984 (HO). SOUTH AUSTRALIA: Southern Lofty: Mt Lofty Botanic Garden, SW section, *Weber 538*, Apr 1967 (AD). Northern Territory: Darwin and Gulf: McArthur R. area, 16°04' S, 136°28' E, *Craven 4692*, July 1977 (CANB). NEW GUINEA: Tovobada Hills, c. 8 miles [13 km] NNW of Port Moresby, *Pullen* (BRI 084320). NEW CALENDONIA: Plateau de Dogny, *McKee 8197*, Jan 1961 (CANB). NEW ZEALAND: Awarua Bay, Southland, *Powell*, Dec 1974 (CHR 358039, AD).

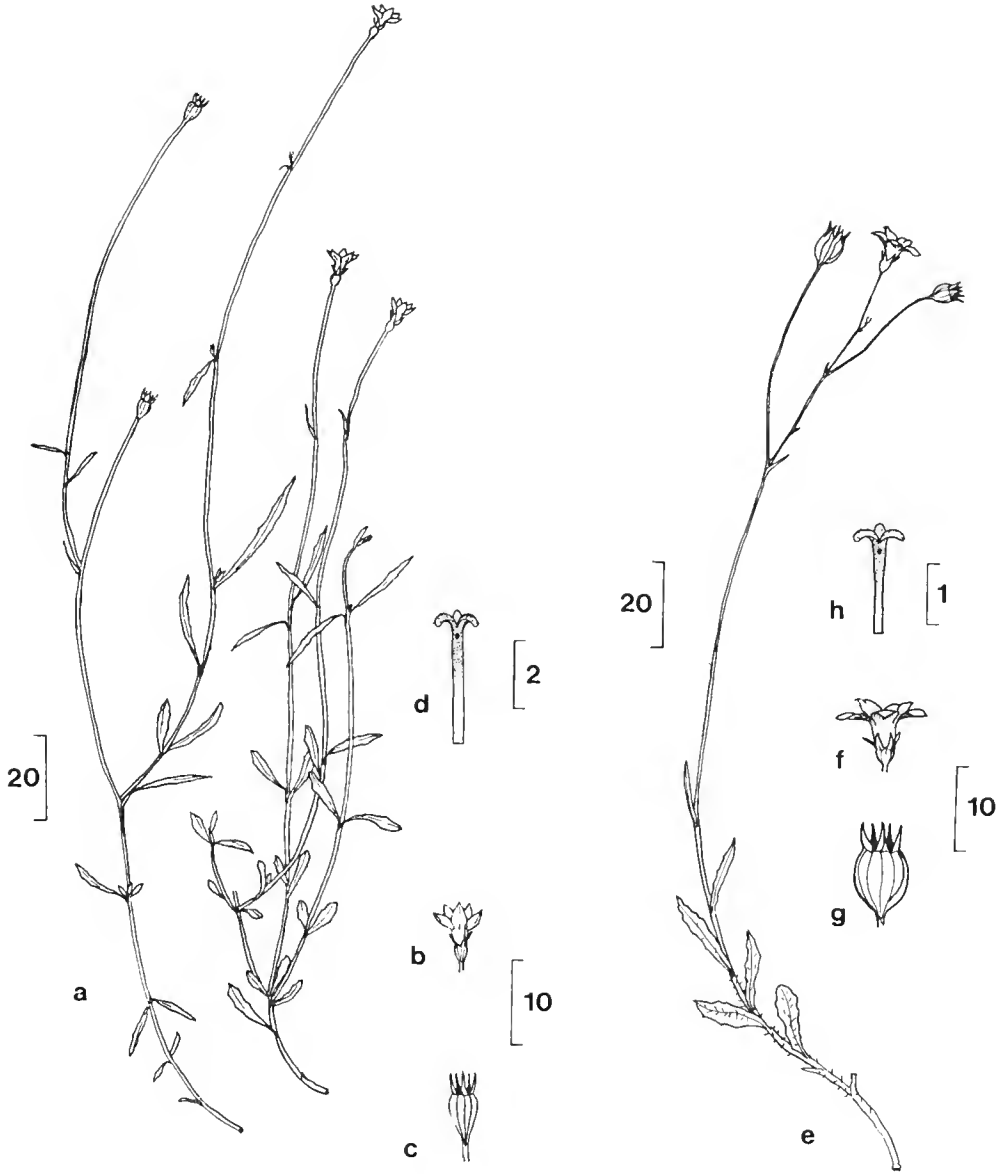

Figure 20. *W. gracilis*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. tumidifructa*: **e**, habit; **f**, flower; **g**, capsule; **h**, style. a–d from *Salasoo 3147*; e–h from *NSW 120470*. Scale bars in mm.

21. Wahlenbergia tumidifructa *P.J. Smith*

Smith (1986: 1383).

TYPE: NEW SOUTH WALES: North Western Plains: 85 km from Cobar on road to Wilcannia, *P.J. Smith 73*, 4 Nov 1973; holo NSW.

[*W.* species B, Jacobs & Pickard (1981: 96)]

[*W.* species B, Carolin (1981: 350)]

[*W. gracilis* auct. non (Forster f.) A. DC.: Carolin (1981: 350)]

Annual herb with a slender taproot, single- or few-stemmed, or perennial, tufted herb with a thickened taproot, few- to many-stemmed. *Stems* 4–90 cm long, erect or ascending, usually becoming much-branched, at least in the inflorescence, lower stem ± hirsute, upper stem glabrous, sometimes glabrous throughout; hairs to 1.5 mm long. *Leaves and bracts* alternate or sometimes lowermost opposite, obovate to narrowly elliptic on lower stem, lanceolate to linear on upper stem, obtuse to subulate, sessile, 2–60 mm long, 0.2–12 mm wide, ± hirsute on lower stem, glabrous on upper stem, sometimes all glabrous; margins flat or undulate, entire or with small, distant callus-teeth, sometimes faintly serrate. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–11 cm long, glabrous or sometimes sparsely hirsute; bracteoles linear, 1.5–6 mm long, glabrous or sometimes sparsely hirsute. *Hypanthium* globose, cylindric or elongated-obconic, often appearing swollen, especially in perennials, 1–3 mm long, glabrous. *Sepals* 5, ± erect, ± narrowly triangular, 1–4 mm long, glabrous. *Corolla* deeply campanulate, usually blue, sometimes white or pink, puberulous inside at base, otherwise glabrous; tube 1–5 mm long, varying from shorter to longer than the sepals; lobes 5, elliptic, acute, 2–7 mm long, 1–3.5 mm wide. *Stamens* 5; filaments white, 0.7–1.5 mm long, upper section filiform, lower section rhombic to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 1–3 mm long. *Ovary* 3-locular. *Style* white, 2.5–6 mm long, 3-fid, unconstricted or indistinctly constricted 1/3 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above this point, 0–3 glands below each stigmatic cleft, the uppermost gland often elongated; stigmatic lobes 0.5–1 mm long. *Capsule* globose, cylindric or elongated-obconic, often appearing swollen, especially in perennials, 2.5–9 mm long, 2–4.5 mm wide, glabrous. *Seeds* c. 0.4 mm long. Figure 20e–h.

CHROMOSOME NUMBER: $n = 27$ (*Carolin W84, W88, W89, W92, W92A, Smith 63, 73, 76, 78, 138, 143A, 143B, 144, 148*).

FLOWERING PERIOD: Throughout the year.

DISTRIBUTION: Widespread in arid and semi-arid regions of Australia, occurring in all mainland states. Figure 34.

HABITAT: Grows in a variety of arid and semi-arid vegetation types, typically in open sites, including disturbed sites such as roadsides.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. tumidifructa* are its alternate leaves; small, deeply campanulate corollas; and capsules that are globose, elongated-obconic or cylindric, and typically appear swollen. Occasional specimens with a slightly larger corolla (lobes ≥ 6 mm long) also have a larger hypanthium, so that the corolla still appears small by comparison.

SELECTED SPECIMENS (538 examined): QUEENSLAND: Burke: 26 km W of Mt Isa, *Schmid 219*, July 1977 (BRI). Darling Downs: 55 km from Roma on road to Yuleba, *Smith 148*, Sep 1974 (SYD). Gregory North: 78 km from Mt Isa on road to Dajarra, *Smith 138*, Sep 1974 (SYD). Gregory South: Diamantina R., just N of Queensland/South Australia border, *Lothian 517*, Aug 1960 (AD, NT). Maranoa: 12 miles [20 km] N of St George, *6118*, Sep 1959 (BRI). Mitchell: Barcaldine, *Smith 143A, 143B, 144*, Sep 1974 (SYD). South Kennedy: 120 km NW of Clermont, *Dale 133*, July 1977 (BRI). Warrego: Warrego R., W of Cunnamulla, *Pedley 2434*, Sep 1967 (BRI). NEW SOUTH WALES: North Western Plains: 3 miles [5 km] SE of Byrock, *Thompson*, Sep 1969 (NSW 120470); 28 km from Bourke on road to Wanaaring, *Smith 63*, Oct 1973 (SYD); 162 km from Wilcannia on road to Cobar, *Smith 78*, Nov 1973 (SYD). South Western Plains: 32 miles [53 km] N of Deniliquin, *Leigh*, Aug 1968 (NSW 87871). North Far Western Plains: near Avenel Homestead, *Carolin W88*, June 1956 (SYD); Fowlers Gap–Milparinka 6 miles [10 km], *Carolin W84*, June 1956 (SYD); 48 km from Wilcannia on road to Broken Hill, *Smith 76*, Nov 1973 (SYD). South Far Western Plains: Mungo Natl Park, 12 km from Mungo Homestead towards Mildura, *Canning & Lodder 4741*, Oct 1979 (CBG). NEW SOUTH WALES/SOUTH AUSTRALIA: North Far Western Plains/Lake Eyre: Hawker Gate, *Carolin W92, W92A*, June 1956 (SYD). North Far Western Plains/Eastern: Smithville, *Carolin W89*, June 1956 (SYD). VICTORIA: A: Hattah Lake, *Beauglehole 44021*, Sep 1960 (MEL). B: Big Desert, *Ackland 56*, Sep 1963 (MEL). SOUTH AUSTRALIA: North-western: Musgrave Ra., Mt Caroline, *Weber 5608*, Sep 1978 (AD). Lake Eyre: Less Hill, c. 25 km S of Stuart Ck Homestead, *Chorney 1080*, Oct 1978 (AD). Nullarbor: Barton, on transcontinental railway, *Ising*, Sep 1920 (AD 97644176). Gairdner-Torrens Basin: Mt Gunson Mines, *Jones*, Oct 1974 (AD 97451179). Flinders Ranges: c. 24 km S of Moolawatana, *Whibley 2537*, Aug 1968 (AD). Eastern: c. 10 km W of Quinyambie Homestead, *Whibley 3530*, July 1971 (AD, PERTH, NT). Eyre Peninsula: Childara Rockhole, *Weber 3242*, Sep 1972 (AD). Murray: c. 120 km NNE of Morgan, *Wilson 2192*, Sep 1961 (AD). Yorke Peninsula: c. 140 km NNW of Adelaide, *Copley 1906*, Apr 1968 (AD, NSW). WESTERN AUSTRALIA: Hall: c. 16 km S of Wolf Ck Meteorite Craters turnoff, *Carr & Beauglehole 47410*, July 1974 (MEL). Canning: Rudall R. Natl Park, *Mitchell 859*, Apr 1979 (NT, PERTH). Carnegie: Elder Ck, c. 2 miles [3 km] W of Warburton Mission, *George 3922*, Aug 1962 (PERTH). Giles: S end of Dean Ra., *Carolin 6091*, Aug 1967 (NSW). Helms: c. 30 km W of Plumridge Lakes, *Crisp, Taylor & Jackson 5845*, Sep 1979 (CBG). Eucla: 8 miles [13 km] E of Rawlinna, *Aplin & Trudgen 5786*, June 1974 (PERTH). Fortescue: Bamba Pool, Harding R., *Weston 12780*, Sep 1981 (PERTH). Ashburton: 6 km SE of Ashburton Downs, *Toelken 6344*, Sep 1979 (AD). Carnarvon: 74 km E of Carnarvon, *Wilson 8401*, July 1969 (PERTH). Austin: Belele Stn NNW of Meekatharra, *Goodall 3413*, Aug 1965 (PERTH). Irwin: 3–15 miles [5–25 km] S of Binnu on the NW Coastal Hwy, *Tindale 1310A*, Mar 1970 (NSW, SYD). Avon: Karolin, *Helms*, Nov 1891 (MEL 57381, AD). Coolgardie: Fraser Ra. Stn, 31°51' S, 123°02' E, *Keighery 3838*, Aug 1980 (PERTH). NORTHERN TERRITORY: Barkly Tableland: Powells Ck, Central Australia, *Holtze*, 1894 (MEL 57663). Central Australia North: 20 miles [33 km] N of Huckitta Homestead, *Latz 1072*, Jan 1971 (NT). Central Australia South: Alice Springs Flora Reserve, *Chippendale*, Oct 1958 (NT 5070, SYD).

22. **Wahlenbergia gracilenta** *Loth.*

Lothian (1947*a*: 217); Black & Robertson (1957: 810); Curtis (1963: 407); Burbidge & Gray (1970: 344); Willis (1972: 625); Cunningham *et al.* (1981: 628); Grieve & Blackall (1982: 668); Beadle (1984: 771); Smith (1986: 1378).

TYPE: TASMANIA: Bass Strait Islands: Flinders I., *J. Milligan 629*, 21 Nov 1845; lecto MEL 57109 (here chosen); isolecto MEL 57110, MEL 57111, BM.

[*W. quadrifida* auct. non (R. Br.) A. DC.: Black (1934: 183)]

Annual herb with a slender taproot, single- or few-stemmed. *Stems* 1.5–35 cm long, erect or ascending, usually branched, at least in the inflorescence, glabrous to hirsute, typically lower stem hirsute, upper stem ± glabrous; hairs to 1.5 mm long. *Leaves and bracts* usually opposite on lower stem, becoming alternate above, sometimes alternate throughout, obovate to elliptic on lower stem, ovate to lanceolate on upper stem, obtuse to subulate, sessile, 1–40 mm long, 0.2–11 mm wide, glabrous to hirsute,

typically lower leaves hirsute, upper leaves ± glabrous; margins flat or sometimes undulate, entire or with small, distant callus-teeth. *Flowers* sometimes solitary but usually in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 1–15 cm long, glabrous to sparsely hirsute; bracteoles lanceolate, 0.5–8 mm long, glabrous to sparsely hirsute. *Hypanthium* ellipsoid or globose, 0.5–3 mm long, glabrous to hirsute. *Sepals* usually 5, sometimes 3 or 4, ± erect, narrowly oblong, 0.5–4 mm long, glabrous to hirsute. *Corolla* deeply campanulate, usually blue, sometimes white or pink, puberulous inside at base, otherwise glabrous or sometimes sparsely hirsute; tube 0.5–4 mm long, usually similar in length to the sepals; lobes usually 5, sometimes 3 or 4, elliptic, acute, 0.5–5 mm long, 0.3–2.5 mm wide. *Stamens* usually 5, sometimes 3 or 4; filaments white, 0.5–1.8 mm long, upper section filiform, lower section triangular, oblong or rhombic, with or without extended shoulders, ciliate on upper margins; anthers 0.5–2.0 mm long. *Ovary* usually 3-locular, sometimes 2-locular. *Style* white, 0.5–5.5 mm long, usually 3-fid, sometimes 2-fid, ± distinctly constricted 1/4 to 1/2 way down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 0–1 gland below each stigmatic cleft; stigmatic lobes 0.1–1.0 mm long. *Capsule* ellipsoid or globose, 1–7 mm long, 0.6–6 mm wide, glabrous to hirsute. *Seeds* c. 0.4 mm long. Figure 21a–d.

Chromosome number: $n = 18$ (*Smith 65, 76A*). H. Gulline (in Darlington & Wylie 1955: 289) reported a count of $n = 9$, probably from Tasmania, but there is no voucher specimen to check the identification.

Flowering period: July–February.

Distribution: Widespread in Tasmania and across southern mainland Australia. All records are south of latitude 30° S, except for one record from Dirk Hartog Island. Figure 35.

Habitat: Grows in a variety of mesic and semi-arid vegetation types, typically in open sites.

Conservation status: Not considered at risk.

Notes: Characteristic features of *W. gracilenta* are its annual, single- or few-stemmed habit; opposite, obovate to elliptic, typically hirsute lower leaves; lanceolate bracteoles; narrowly oblong sepals; small, deeply campanulate corollas; and ellipsoid to globose, often hirsute capsules.

Selected Specimens (505 examined): New South Wales: Southern Tablelands: Queanbeyan, *McKee 9636*, Oct 1962 (NSW). North Western Slopes: Calala near Tamworth, *Monk*, Oct 1951 (NSW 67168). Central Western Slopes: Mt Duke, Wellington, *Althofer*, Oct 1966 (NSW 120484). South Western Slopes: Bulgandry Reserve, Bulgandry, *McBarron 3796*, Oct 1949 (NSW). North Western Plains: 183 km from Bourke on road to Nyngan, *Smith 65*, Oct 1973 (SYD). South Western Plains: Deniliquin, *Whaite 2153*, Nov 1960 (NSW). North Far Western Plains: Silverton, *Smith 76A*, Nov 1973 (SYD). South Far Western Plains: near Lake Victoria, *Mulham*, Oct 1978 (NSW). Australian Capital Territory: between Mts Ainslie and Majura, *Beeton*, Oct 1964 (NSW 82200). Victoria: A: 83 km SW of Mildura, *Crisp 3346*, Oct 1977 (CBG, MEL). B: Wyperfield Natl Park, W of Lake Albacutya, *Cheel*, Sep 1978 (MEL 1507173). C: Little Desert Natl Park, *Muir 6360*, Nov 1978 (MEL). D: Grampians, near Glenisla Stn, *Muir 1493*, Oct 1960 (MEL). E: Gorae West, Portland, *Beauglehole 44018*, 1946 (MEL). G: Swan Hill, *Gammon* (MEL 57151). H: c. 7 miles [12 km] SW of Inglewood, *Muir 1366*, Oct 1960 (MEL). J: 2 miles [3 km] W of Maryborough, *Muir 1461*, Oct 1960 (MEL). M: Bendigo, *Robbins (Beauglehole 44004)*, Sep 1948 (MEL). N: c. 9 miles [15 km] W of Castlemaine, *Muir 1444*, Oct 1960 (MEL). P: Quail I., Western Port Bay, *Melville 2108*, Nov 1952 (K, MEL, NSW, AD). R: Warby Ra., *Mason*, Oct 1960 (MEL 57282). T: Snake I., 25 km SSW of Yarram, *Beauglehole 62185*, Dec 1978 (MEL). W: Sperm Whale Head, Gippsland, *Muir 2298*, Oct 1961 (MEL). Z: upper Rodger R., East Gippsland, *Chesterfield*, Feb 1983 (MEL 626315). Tasmania: Bass Strait Islands: Cape Barren I., *Whinray 550*, Oct 1973 (MEL). Western and South-western: Sundown Point, *Moscal 479*, Nov 1980 (HO). North-eastern: Bridport, *Curtis*, Nov 1952 (HO 53383). South Australia: Flinders Ranges: 11 miles [18 km] N of Wilpena on floodplain of

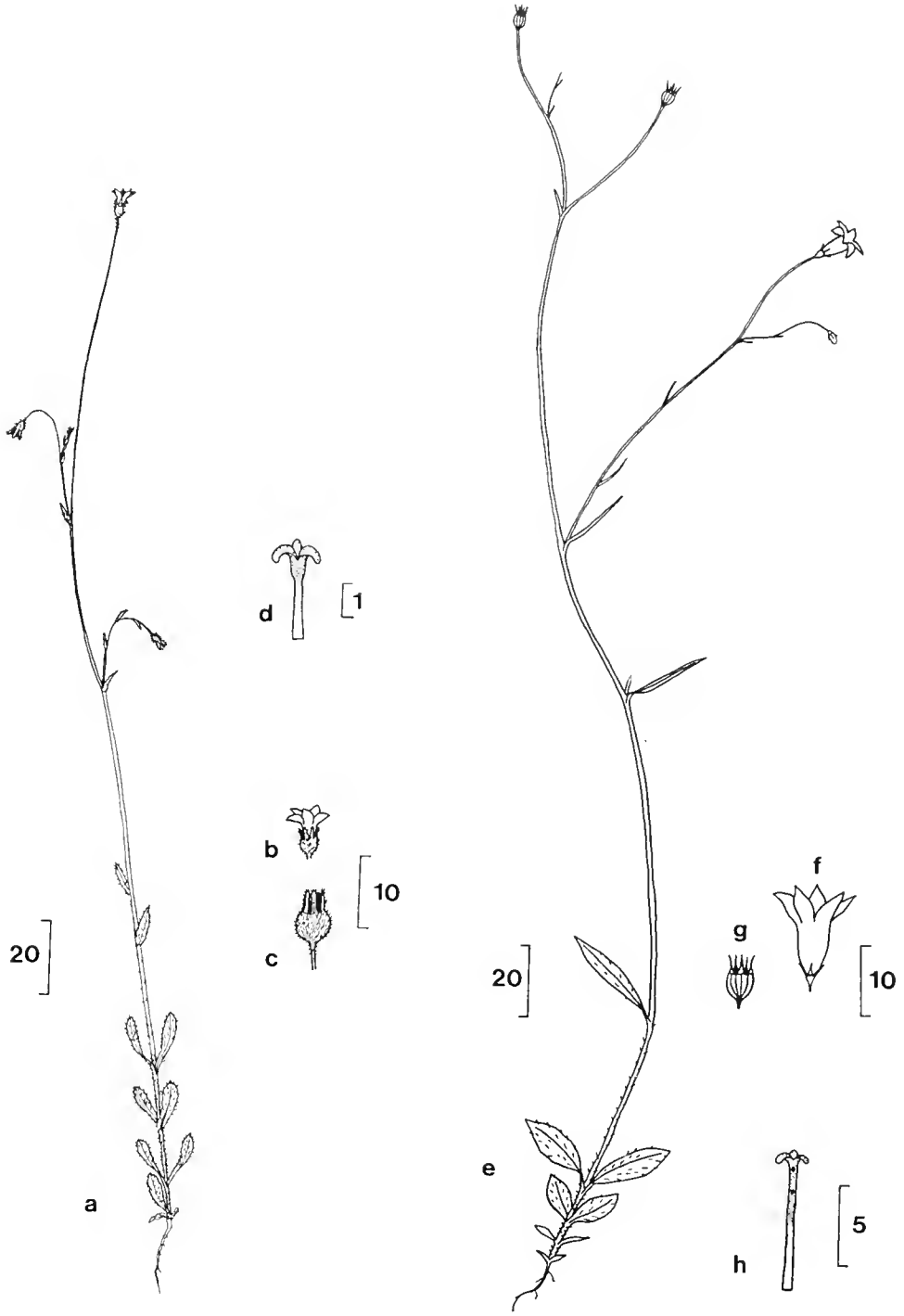

Figure 21. *W. gracilenta*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. caryophylloides*: **e**, habit; **f**, flower; **g**, capsule; **h**, style. a,b,d from *NSW 82200*; c from *NSW 67168*; e–h from *Gittins 994*. Scale bars in mm.

Wilpena Ck, *Lothian 1474*, Sep 1955 (AD). Eastern: Koonamore, outstation, Aug 1923 (AD 97739075). Eyre Peninsula: Marble Ra., slopes of N block, *Weber 5985*, Sep 1979 (AD). Northern Lofty: Napperby Gorge, *Spooner 6012*, Sep 1978 (AD). Murray: Billiatt Flora and Fauna Reserve, *Cleland*, Oct 1960 (AD 97229152). Yorke Peninsula: Innes Natl Park, *Alcock 4954*, Oct 1974 (AD). Southern Lofty: Black Hill, Athelstone, *Spooner 4760*, Sep 1976 (AD). Kangaroo Island: Flinders Chase, Rocky R., *Wheeler 1262*, Oct 1968 (AD). South-eastern: c. 16 km NE of Keith, *Specht*, Sep 1952 (AD 97417231). WESTERN AUSTRALIA: Irwin: C. 5 km N of Cape Ransonnet, Dirk Hartog I., *George 11408*, Sep 1972 (PERTH). Menzies: Busselton, *Stoward*, Nov 1912 (NSW 67171). Warren: Mt Chudalup, S of Northcliffe, *Aplin 1431*, Dec 1961 (PERTH). Eyre: Middle I., Recherche Archipelago, *Weston & Trudgen 8836*, Nov 1973 (PERTH, CANB). Avon: Wongan Hills, *Kenneally 6917*, Sep 1978 (PERTH). Coolgardie: Queen Victoria Rock, *Wittwer W1943*, Nov 1976 (PERTH).

23. Wahlenbergia preissii *Vriese*

Vriese (1848: 241); Grieve & Blackall (1982: 668); Smith (1986: 1381); Wheeler (1987: 600).

TYPE: WESTERN AUSTRALIA: Eyre: on a sandy hill near the town of Albany (Plantagenet), *L. Preiss 1890*, 25 Sep 1840; lecto MEL (here chosen).

Annual herb with a slender taproot, single- or few-stemmed. *Stems* 6–40 cm long, erect or ascending, usually branched, at least in the inflorescence, lower stem ± hirsute, upper stem glabrous; hairs to 1.2 mm long. *Leaves and bracts* opposite on lower stem, alternate on upper stem, obovate to narrowly elliptic on lower stem, lanceolate to linear on upper stem, obtuse to subulate, sessile, 2–30 mm long, 0.5–6 mm wide, lower leaves ± hirsute, upper leaves glabrous; margins flat or sometimes undulate, usually with small, distant callus-teeth. *Flowers* sometimes solitary but usually in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–8 cm long, ± glabrous; bracteoles linear, 1–8 mm long, ± glabrous. *Hypanthium* elongated-obconic, 2–4 mm long, usually glabrous, sometimes with short hairs. *Sepals* 5, ± erect, narrowly oblong, 1–2.5 mm long, usually glabrous, sometimes with short hairs. *Corolla* shortly campanulate, usually blue, sometimes white, puberulous inside at base, otherwise glabrous; tube 0.5–1.5 mm long, equal to or shorter than the sepals; lobes 5, elliptic, acute, 1.5–4 mm long, 0.8–2.5 mm wide. *Stamens* 5; filaments white, 0.7–1.5 mm long, upper section filiform, lower section triangular to oblong, without extended shoulders, usually ciliate on upper margins; anthers 0.5–1.5 mm long. *Ovary* 2-locular. *Style* white, 2–3.5 mm long, 2-fid, distinctly constricted about 1/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, without glands; stigmatic lobes 0.4–0.8 mm long. *Capsule* elongated-obconic, 3–7 mm long, 0.8–2.2 mm wide, usually glabrous, sometimes with short hairs. *Seeds* c. 0.3 mm long. Figure 22a–d.

FLOWERING PERIOD: August–November.

DISTRIBUTION: South-western Australia, from Geraldton in the north-west to Israelite Bay in the south-east. There are also isolated populations in South Australia (northern Eyre Peninsula and the Adelaide area). Figure 36.

HABITAT: Grows in open sites in a variety of vegetation types.

CONSERVATION STATUS: Not considered at risk at species level or in Western Australia, but has a restricted and disjunct distribution in South Australia.

NOTES: Characteristic features of *W. preissii* are its annual, single- or few-stemmed habit; opposite lower leaves; narrowly oblong sepals; small, shortly campanulate corollas; 2-locular ovaries and 2-fid styles; and elongated-obconic capsules.

SELECTED SPECIMENS (38 examined): SOUTH AUSTRALIA: Eyre Peninsula: Wudinna, *Ising*, Sep 1939 (AD 97616182); Hambidge Flora and Fauna Reserve, *Alcock 1137*, Oct 1966 (AD). Southern Lofty: Black Hill, Athelstone, *Spooner 3082*, Sep 1973 (AD). WESTERN AUSTRALIA: Irwin: 19 km E of Dongara, *Cranfield 1950a*, Sep 1981 (PERTH); Lake Indoon, *Hnatiuk 770883*, Sep 1977 (PERTH). Drummond: West Perth, *Helms*, Sep 1898 (NSW 67017); Kings Park, *Wittwer 2284*, Oct 1979 (PERTH, CANB); South Perth, *Cranfield R419*, Oct 1980 (PERTH). Dale: Helena Valley, *Seabrook 297*, Sep 1977 (PERTH). Menzies: 18 miles [30 km] W of Nannup, *Royce 2920*, Oct 1948 (PERTH). Eyre: Chillitup, Pallinup R., *Gardner 6504*, Oct 1942 (PERTH). Roe: Israelite Bay, *Brooke*, 1885 (MEL 57607). Avon: Northam–Perth Hwy, 4–6 miles [7–10 km] from Northam, *Salasoo 111*, Sep 1949 (NSW).

24. Wahlenbergia victoriensis *P.J. Smith*, **sp. nov.**

W. gracilentae et *W. preissii* affinis, sed a *W. gracilenta* sepalis anguste triangularibus, lobis corollae ≥ 6 mm longis, 2–4-plo tubo, differt; a *W. preissii* bracteis lanceolatis, sepalis anguste triangularibus, lobis corollae ≥ 6 mm longis, ovario 3-loculato, stylo 3-fido, capsulis ellipsoideis vel globosis, differt.

TYPE: VICTORIA: R: near Killawarra, 10 miles [17 km] NW of Wangaratta, *T.B. Muir 1708*, 1 Nov 1960; holo MEL.

Annual herb with a slender taproot, single- or few-stemmed. *Stems* 10–40 cm long, erect or ascending, usually branched, at least in the inflorescence, lower stem ± hirsute, upper stem glabrous; hairs to 1.5 mm long. *Leaves and bracts* opposite on lower stem, alternate on upper stem, obovate to elliptic on lower stem, ovate to lanceolate on upper stem, obtuse to subulate, sessile, 2–35 mm long, 0.5–7 mm wide, lower leaves ± hirsute, upper leaves glabrous; margins flat or sometimes undulate, ± entire. *Flowers* sometimes solitary but usually in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 2–12 cm long, ± glabrous; bracteoles lanceolate, 2–9 mm long, ± glabrous. *Hypanthium* ellipsoid or globose, 1–3 mm long, usually glabrous, sometimes sparsely hirsute. *Sepals* 5, ± erect, narrowly triangular, 2–5 mm long, usually glabrous, sometimes sparsely hirsute. *Corolla* shortly campanulate, usually blue, sometimes white, puberulous inside at base, otherwise glabrous; tube 1.5–3.5 mm long, equal to or shorter than the sepals; lobes 5, elliptic to ovate, acute, 6–12 mm long, 3–8 mm wide. *Stamens* 5; filaments white, 0.8–1.2 mm long, upper section filiform, lower section rhombic with extended shoulders, ciliate on upper margins; anthers 2–3 mm long. *Ovary* 3-locular. *Style* white, 4–7 mm long, 3-fid, ± distinctly constricted 1/3 to 2/3 down from the stigmatic lobes, covered with pollen-presenting hairs above the constriction, 1–2 glands below each stigmatic cleft; stigmatic lobes 0.8–1.2 mm long. *Capsule* ellipsoid or globose, 3–6 mm long, 2–4 mm wide, usually glabrous, sometimes sparsely hirsute. *Seeds* c. 0.5 mm long. Figure 22e–g.

FLOWERING PERIOD: August–January.

DISTRIBUTION: Victoria and New South Wales, from Orange in the north-east to Hawkesdale in the south-west. Figure 36.

HABITAT: Grows in open sites in eucalypt woodland, grassland and saltbush plains. Recorded locations have ranged from floodplains to dry, stony ridges.

CONSERVATION STATUS: Reasonably widespread and occurring in a variety of habitats, but an uncommon species within its range and not often collected.

NOTES: Characteristic features of *W. victoriensis* are its annual, single- or few-stemmed habit; opposite, obovate to elliptic lower leaves; lanceolate bracteoles; narrowly triangular sepals; shortly campanulate corollas with lobes ≥ 6 mm long; and ellipsoid or

globose capsules.

The epithet refers to the species' occurrence in Victoria.

SELECTED SPECIMENS (29 examined): NEW SOUTH WALES: Central Tablelands: Four Mile Ck via Orange, *Giles*, Dec 1961 (SYD). Central Western Slopes: Murrumburrah, *Friedricks*, 1887 (MEL 57573). South Western Plains: 20 miles [33 km] S of Hay, *Semple 1118*, Oct 1981 (NSW); 50 km E of Hay, *Semple 1630*, Oct 1983 (NSW); 9 miles [15 km] N of Moama, *Filson 5411*, Oct 1963 (MEL). VICTORIA: C: Nhill, *D'Alton* (MEL 57567). D: Mt Bepcha, the Grampians, *Beauglehole 30005*, Dec 1969 (MEL). E: Hawkesdale, *Williamson*, Nov 1902 (NSW 5334). L: Ulupna Island Reserve, 3 miles [5 km] NW of Strathmerton, *Muir 4704*, Oct 1969 (MEL). M: Corop, SE of Rochester, *Beattie*, Oct 1962 (MEL 56930). P: Torquay, *Lothian*, Oct 1934 (MEL 56926). R: Reef Hills Regional Park, SW of Benalla, *Beauglehole 66128*, Nov 1979 (SYD).

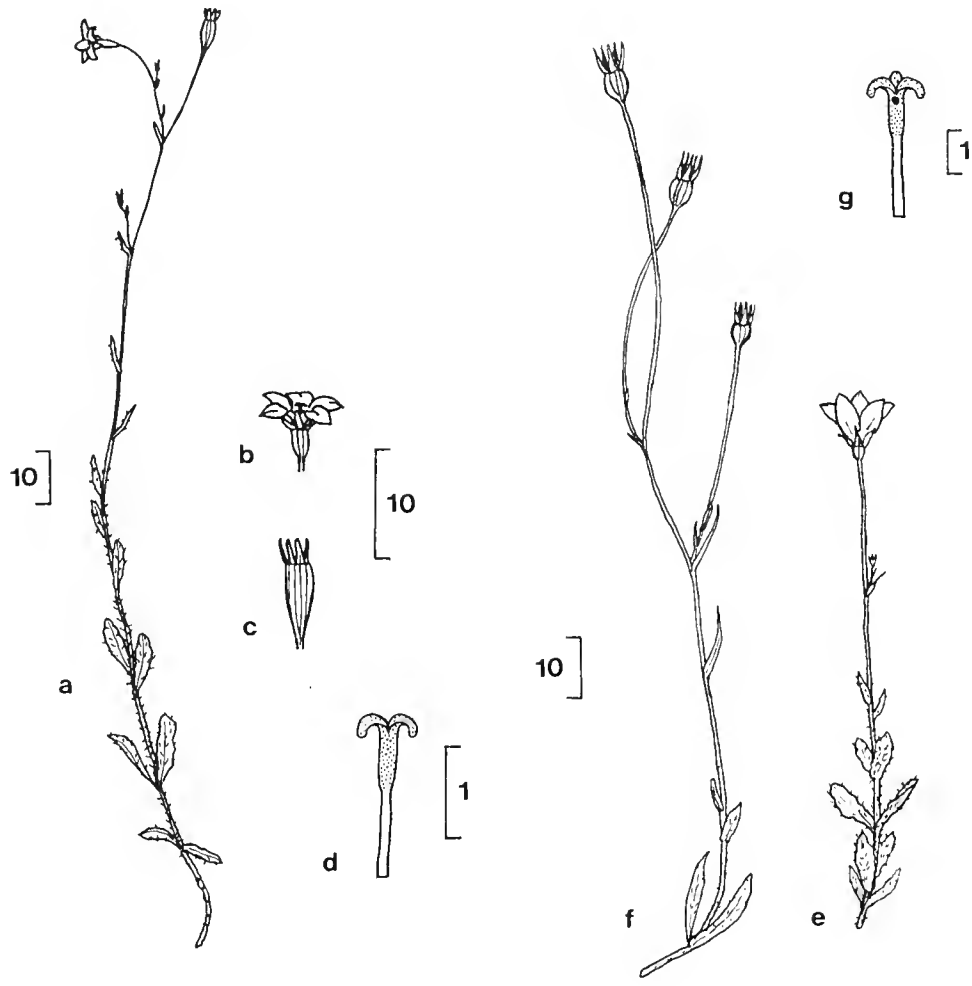

Figure 22. *W. preissii*: **a**, habit; **b**, flower; **c**, capsule; **d**, style. *W. victoriensis*: **e**,**f**, habit; **g**, style. a–c from *Salasoo 111*; d from *NSW 67017*; e from *Semple 1118*; f–g from *Semple 1630*. Scale bars in mm.

25. Wahlenbergia caryophylloides *P.J. Smith*

Smith (1989: 63).

TYPE: QUEENSLAND: Cook: Kennedy Rd, 15 miles [25 km] N of Musgrave, *C.H. Gittins 994*, Aug 1965; holo NSW; iso BRI.

Annual herb with a slender taproot, single- or few-stemmed. *Stems* 13–85 cm long, erect or ascending, usually branched, at least in the inflorescence, lower stem ± hirsute, upper stem glabrous; hairs to 1.5 mm long. *Leaves and bracts* opposite on lower stem, becoming alternate above, elliptic on lower stem or sometimes lowermost obovate, narrowly elliptic to linear on upper stem, obtuse to subulate, sessile, 5–45 mm long, 1–10 mm wide, lower leaves ± hirsute, upper leaves glabrous; margins usually flat with small, distant callus-teeth. *Flowers* in thyrsoids of varying complexity covering the upper half or more of the plant; pedicels 1.5–10 cm long, glabrous, usually very slender; bracteoles linear, 1–8 mm long, glabrous. *Hypanthium* hemispherical to cylindric, 1–2 mm long, glabrous. *Sepals* 5, ± erect, ± narrowly triangular, 1–3.5 mm long, glabrous. *Corolla* deeply campanulate, blue to purple, sometimes white or pink, entirely glabrous; tube 2–8 mm long, usually longer than the sepals, often rather swollen in the middle; lobes 5, elliptic, acute, often shorter than the tube, 1–6.5 mm long, 0.6–3 mm wide. *Stamens* 5; filaments white, 1–2.5 mm long, upper section filiform, lower section trullate to obtrullate, with or without extended shoulders, ciliate on upper margins; anthers 1–4 mm long. *Ovary* 2– or 3-locular. *Style* white, 2.5–9 mm long, 2- or 3-fid, unconstricted, the upper half covered with pollen-presenting hairs, 1–2 glands below each stigmatic cleft; stigmatic lobes 0.5–1.5 mm long. *Capsule* hemispherical to cylindric, 2–6.5 mm long, 1–3 mm wide, glabrous. *Seeds* c. 0.4 mm long. Figure 21e–h.

FLOWERING PERIOD: May–October, with one record in February.

DISTRIBUTION: Widespread in the wetter tropical regions of Queensland, the Northern Territory and Western Australia. The species may well occur in New Guinea and Indonesia, but I have seen no specimens to confirm this. Figure 36.

HABITAT: Often grows on the edges of swamps, lagoons and streams, but also found in drier sites in eucalypt woodland. A preference for sandy soils is indicated.

CONSERVATION STATUS: Not considered at risk.

NOTES: Characteristic features of *W. caryophylloides* are its annual, single- or few-stemmed habit; opposite, elliptic lower leaves; linear bracteoles; narrowly triangular sepals; and deeply campanulate, entirely glabrous corollas with lobes often shorter than the tube.

Specimens may be divided into those with large flowers (corolla tube c. 7 mm long, lobes c. 6 mm long, e.g. *Gittins 994*, *Byrnes 2365* and *Beauglehole 4196*) and those with small flowers (corolla tube c. 3 mm long, lobes c. 2 mm long, e.g. *Craven 4817*, *Kanis 1717* and *Beauglehole 3044*). Both types occur throughout the species' range and without obvious ecological separation.

SELECTED SPECIMENS (98 examined): QUEENSLAND: Burke: Circle Lagoon, 18°02' S, 141°48' E, *Craven 4817*, July 1977 (CANB). Cook: Badu I., Torres Strait, *Garnett 129*, July 1979 (BRI); Davies Ck Forestry Rd, c. 15 miles [25 km] E of Mareeba, *Schodde 3315*, Aug 1963 (CANB, BRI, AD). North Kennedy: Louisa Lake, c. 8 km S of Lyndhurst, *Lazarides 8180*, Aug 1976 (CANB, BRI); near Pentland, *Blake 19310*, July 1954 (BRI). NORTHERN TERRITORY: Darwin and Gulf: near Mt Saunders, Gove, *Byrnes 2365*, July 1971 (NT, DNA, CANB); 8 miles [13 km] N of Mudginberri, *Byrnes 819*, May 1968 (NT). Barkly Tableland: 17°46' S, 137°43' E, *Kanis 1717*, June 1974 (CANB, NT); Attack Ck, *Carr & Beauglehole 46306*, July 1974 (MEL). WESTERN AUSTRALIA: Gardner: 15 km W of Lake Argyle turnoff, *Carr & Beauglehole 3044*, July 1974 (MEL); Rocky Cove, Vansittart Bay,

Gardner 1519, Aug 1921 (PERTH); Blyxa Ck, 15°48'S, 125°20' E, *George 12569*, Aug 1974 (PERTH). Fitzgerald: Adcock Gorge, *Carr & Beauglehole 4196*, July 1974 (MEL). Dampier: Camballin, *Power 845*, May 1970.

26. *Wahlenbergia capensis *(L.) A. DC.*

De Candolle (1830: 136); Lothian (1947*a*: 220); Grieve & Blackall (1982: 669); Wheeler (1987: 599). *Campanula capensis* Linnaeus (1753: 169).

TYPE: An illustration by Commelin (1701: t. 35).

[*W. elongata* (Willd.) Schrader ex Roth (1821: 399). *C. elongata* Willdenow (1814: 10), nom. illeg.]

[*Roella decurrens* Andrews (1802: t. 238), nom. illeg.]

Annual herb with a slender taproot, single- or few-stemmed. *Stems* 14–50 cm long, erect or ascending, usually only sparingly branched, hirsute; hairs to 2.3 mm long. *Leaves and bracts* alternate or lowermost opposite, obovate to narrowly elliptic on lower stem, becoming lanceolate above, obtuse to acute, sessile, 9–40 mm long, 1.5–10 mm wide, hirsute; margins flat or undulate, with small callus-teeth, serrate to lobed. *Flowers* solitary or 2–4 per stem; pedicels 9–33 cm long, sparsely hirsute or ± glabrous; bracteoles lanceolate, 6–13 mm long, hirsute. *Hypanthium* hemispherical to shortly obconic, 3–6 mm long, hirsute. *Sepals* 5, erect or spreading, triangular or narrowly triangular, 4–7.5 mm long, hirsute. *Corolla* shortly campanulate, bluish green but dark blue in the centre and often with black spots, densely hirsute inside tube, otherwise ± glabrous; tube 2–3 mm long, shorter than the sepals; lobes 5, ovate to broadly elliptic, acute or sometimes obtuse, 6–11 mm long, 3–7.5 mm wide. *Stamens* 5; filaments dark blue, 2.5–4 mm long, upper half filiform, lower half obtrullate to obtriangular, ciliate, with rounded shoulders; anthers 2–3.5 mm long. *Ovary* 5-locular. *Style* dark blue, 4.5–7 mm long, 5-fid, deeply constricted close to the stigmatic lobes, covered with pollen-presenting hairs above the constriction, without glands; stigmatic lobes 1–1.5 mm long. *Capsule* hemispherical to shortly obconic, 5–11 mm long, 5–9 mm wide, hirsute. *Seeds* c. 0.4 mm long. Figure 23.

FLOWERING PERIOD: September–November.

DISTRIBUTION: Native to South Africa. Introduced to south-western Australia, where it now occurs from Kalbarri in the north to Tambellup in the south. Figure 33a.

HABITAT: Disturbed sites.

NOTES: Characteristic features of *W. capensis* are its annual, single- or few-stemmed habit; dense indumentum; sparingly branched stems; strongly toothed leaves; long pedicels; large, shortly campanulate, bluish green, hirsute corollas; dark blue filaments and style; 5-locular ovaries and 5-fid styles; and broad, densely hirsute capsules.

The earliest Australian specimen was collected in 1898 at Perth.

SELECTED SPECIMENS (31 examined): WESTERN AUSTRALIA: Irwin: Kalbarri, *Corrick 8223*, Sep 1982 (MEL, NSW); 5 km W of Kalbarri, *Crisp, Taylor & Jackson 6304*, Oct 1979 (CBG); c. 8 km SW of Lake Indoon, *Hnatiuk 770924*, Sep 1977 (PERTH). Drummond: Yanchep Natl Park, *Scrymgeour 129*, Oct 1965 (PERTH); Guildford, *Andrews*, May–Oct 1901 (PERTH); Perth, *Helms*, Nov 1898 (NSW 67010). Dale: 300 m S of Edgewater Rd, Canning R., *Clark 166*, Oct 1974 (PERTH). Menzies: Cape Naturaliste, *Canning 6600*, Oct 1968 (CBG). Eyre: 1 mile [2 km] E of Tambellup, *Newbey 1183*, Oct 1963 (PERTH). Avon: Wongan Hills, *Clyne*, Oct 1969 (NSW).

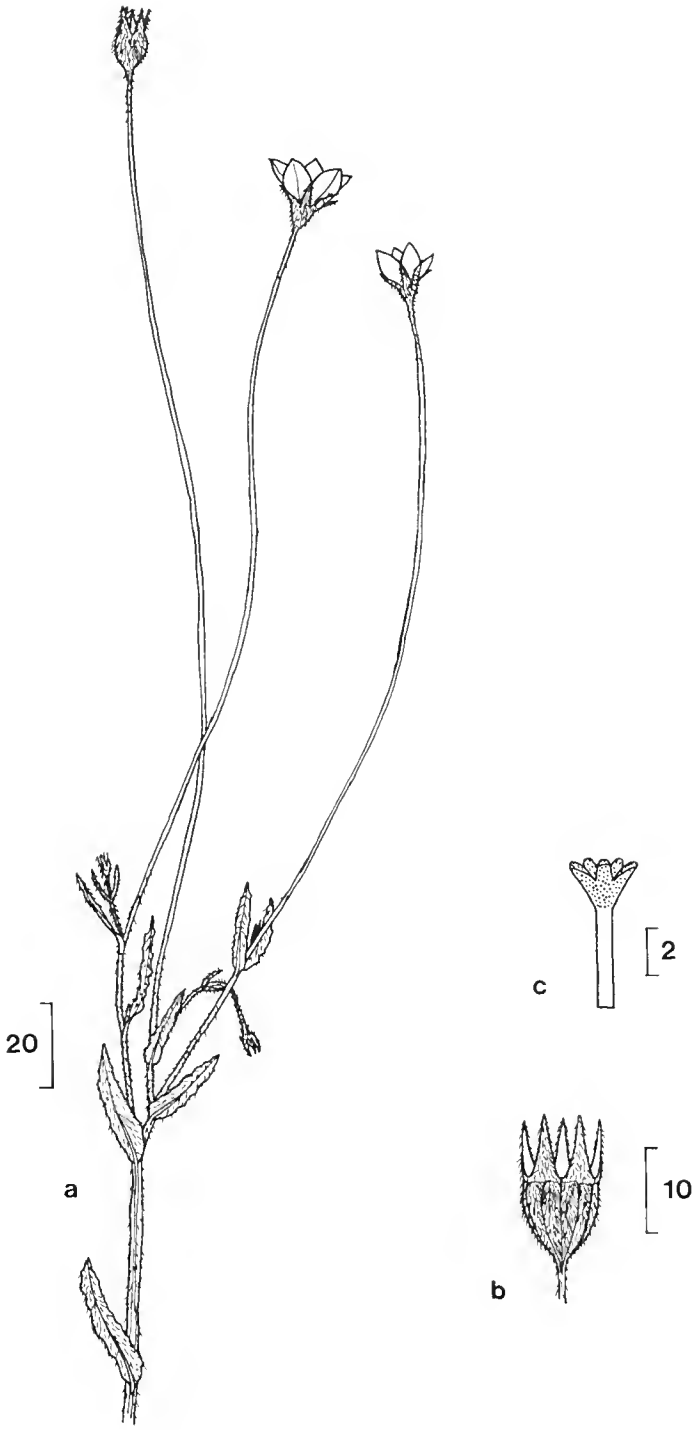

Figure 23. *W. capensis*: **a**, habit; **b**, capsule; **c**, style. From *Corrick 8223*. Scale bars in mm.

Unplaced names

Wahlenbergia gracilis var. *alba* Guilfoyle (1909: 365), nom. nud.

W. gracilis var. *polymorpha* de Candolle (1830: 142). *W. marginata* var. *polymorpha* (A. DC.) Hochreutiner (1934: 290). TYPE: 'Campanula polymorpha diffusa Soland. Herb. Banks.'

W. gracilis var. *pygmaea* Wawra (1883: 133). TYPE: 'Victoria; Wiessengründe im Murraygebiet. Coll. I. 487.'

W. vinciflora var. *rosulata* Black (1934: 183). TYPE: 'Gladstone; Quorn.'

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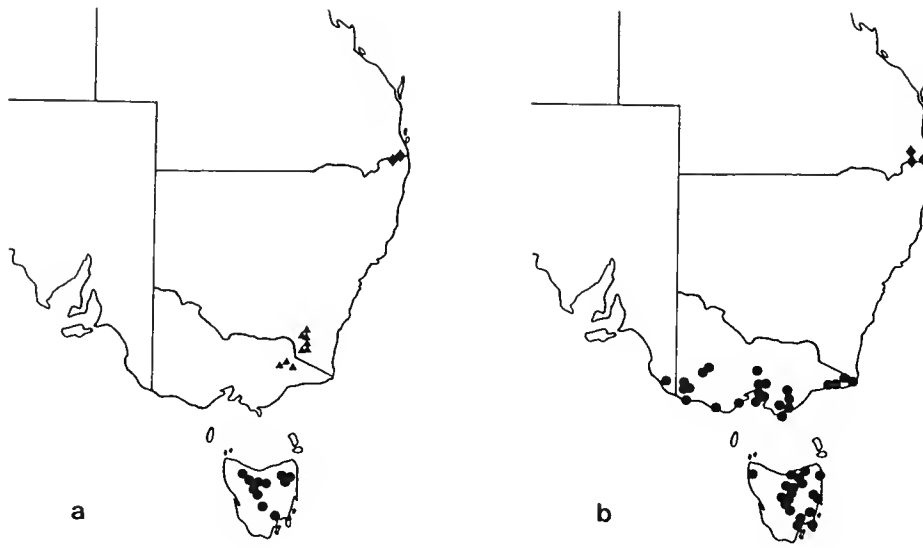

Figure 24. Distribution of: **a**, *W. scopulicola* (◆), *W. densifolia* (▲) and *W. saxicola* (●); **b**, *W. glabra* (◆) and *W. gymnoclada* (●).

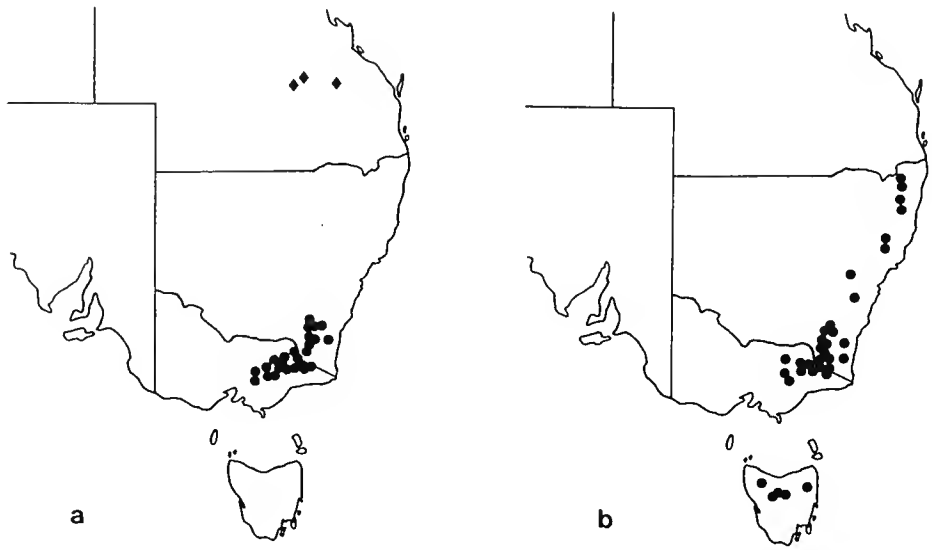

Figure 25. Distribution of: **a**, *W. islensis* (◆) and *W. gloriosa* (●); **b**, *W. ceracea*.

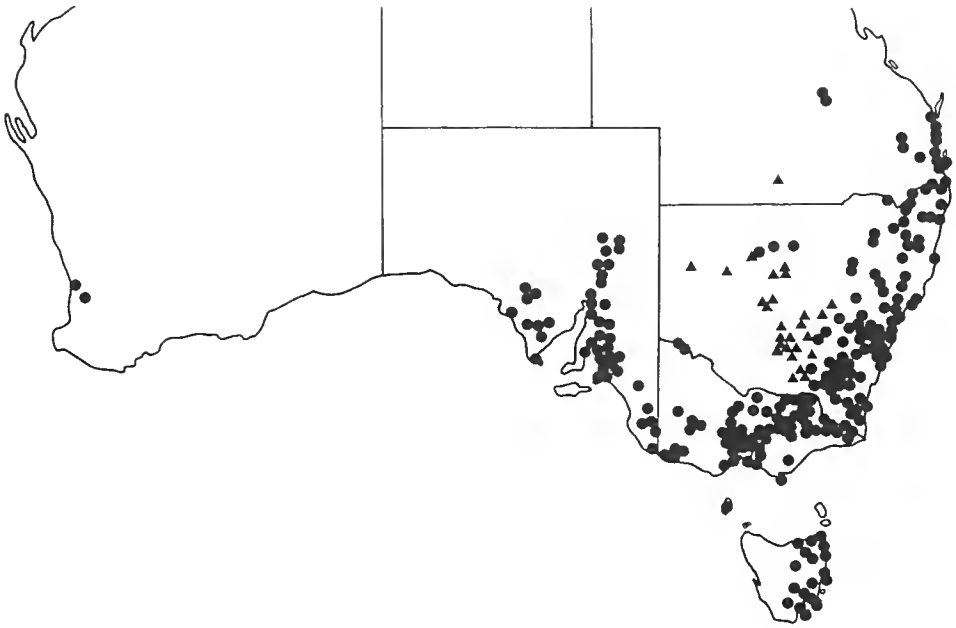

Figure 26. Distribution of *W. stricta* subsp. *stricta* (●) and subsp. *alterna* (▲).

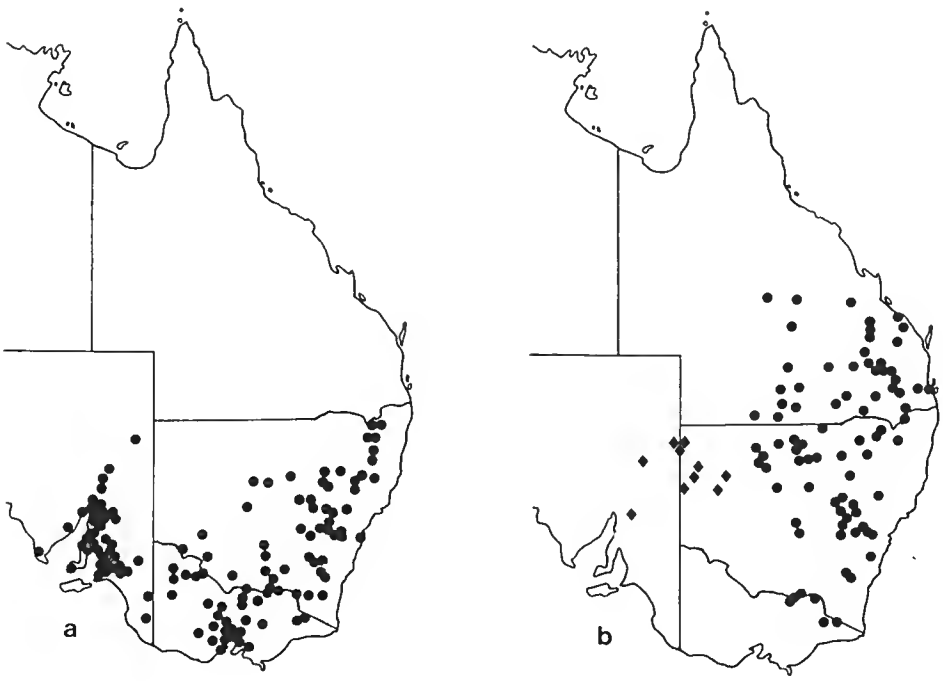

Figure 27. Distribution of: **a**, *W. luteola*; **b**, *W. graniticola* (●) and *W. aridicola* (◆).

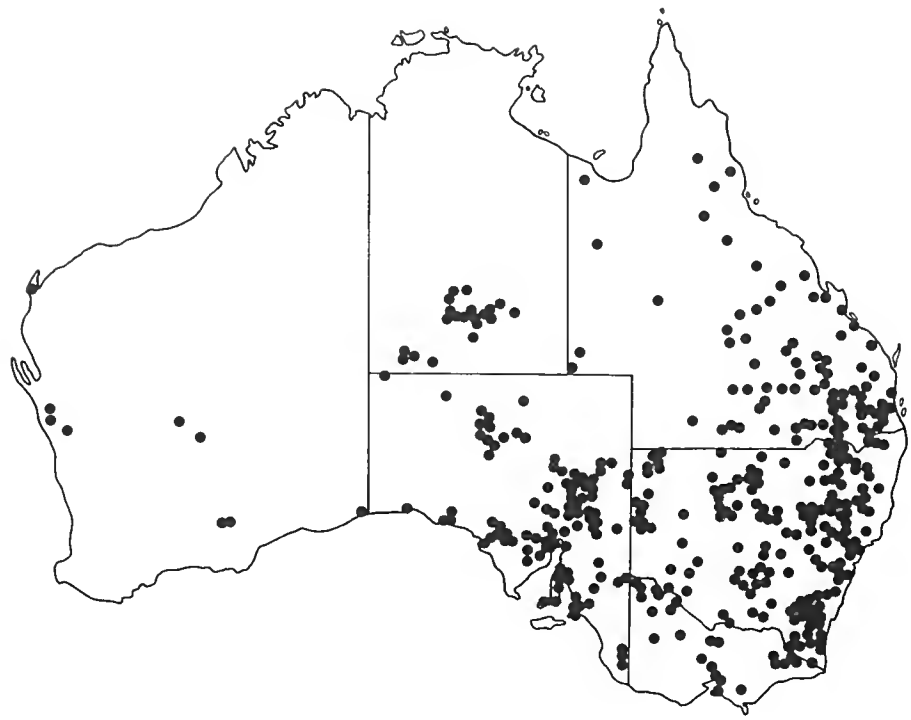

Figure 28. Distribution of *W. communis*.

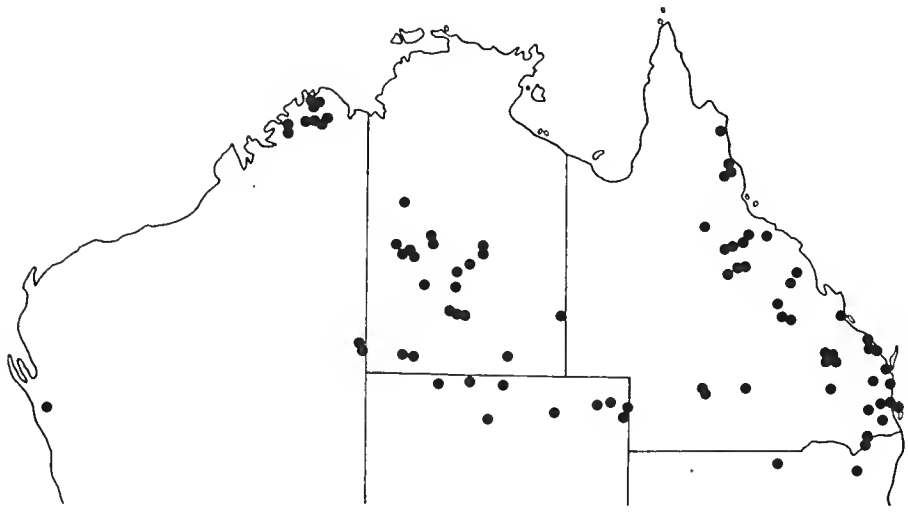

Figure 29. Distribution of *W. queenslandica*.

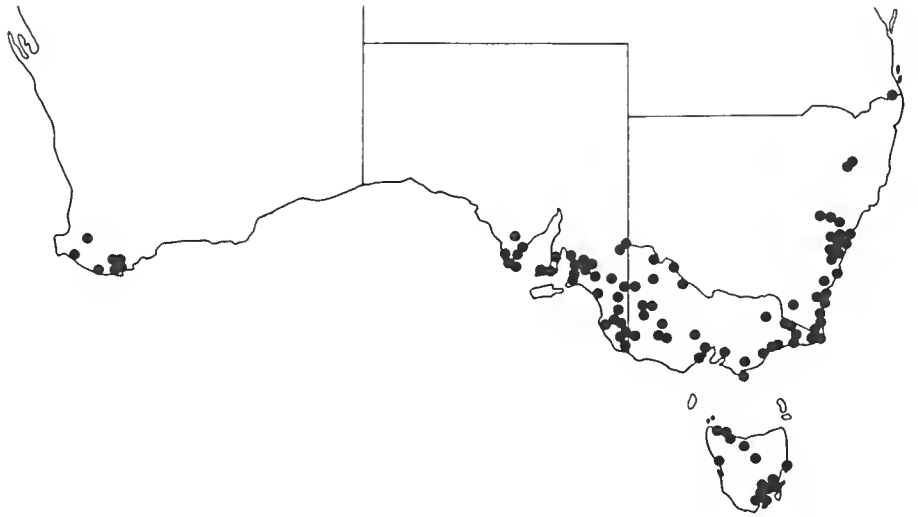

Figure 30. Distribution of *W. littoricola.*

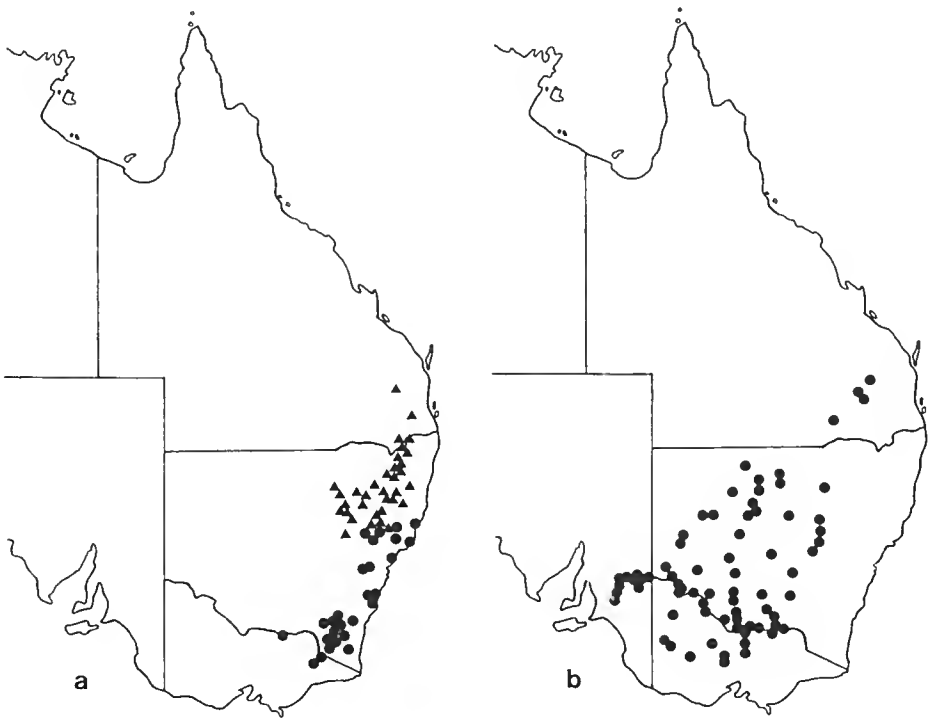

Figure 31. Distribution of: a, *W. planiflora* subsp. *planiflora* (●) and subsp. *longipila* (▲); b, *W. fluminalis.*

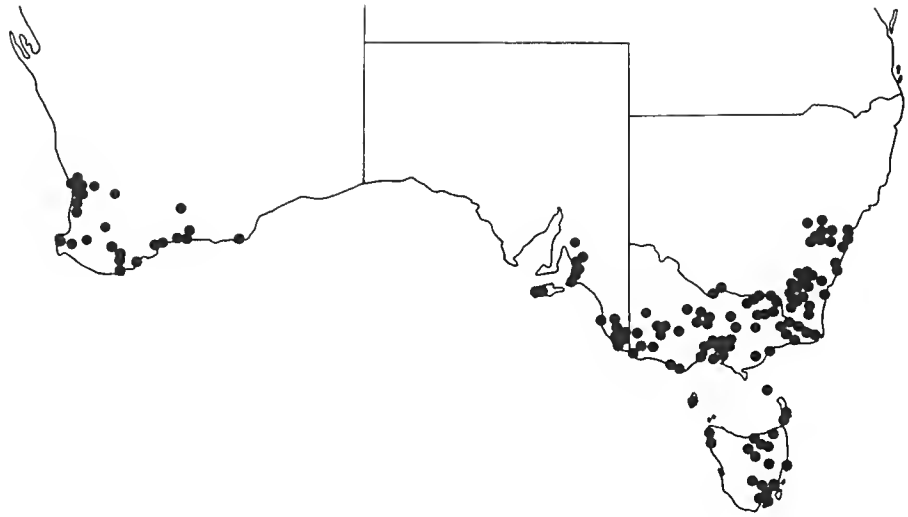

Figure 32. Distribution of *W. multicaulis*.

Figure 33. Distribution of **a**, *W. capensis*; **b**, *W. gracilis*.

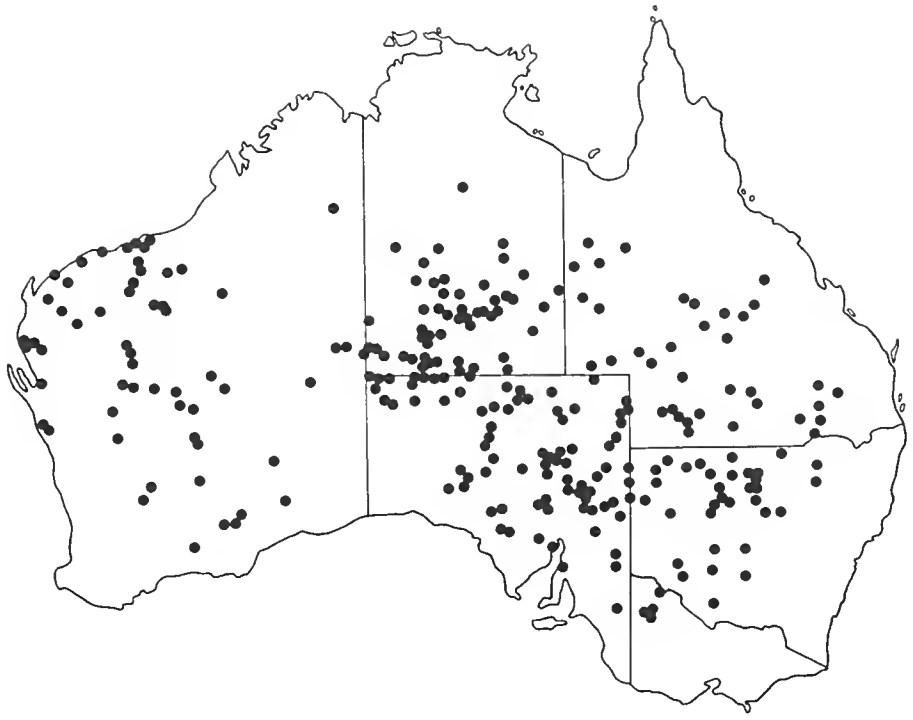

Figure 34. Distribution of *W. tumidifructa*.

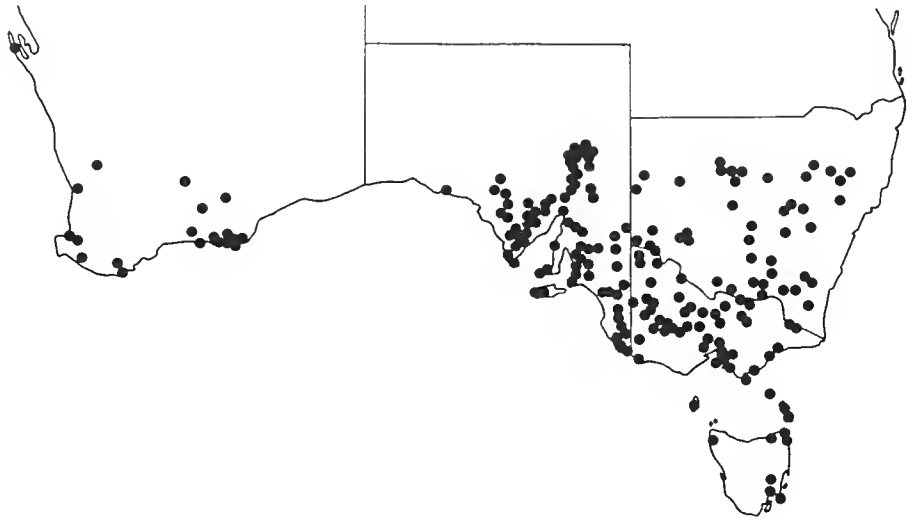

Figure 35. Distribution of *W. gracilenta*.

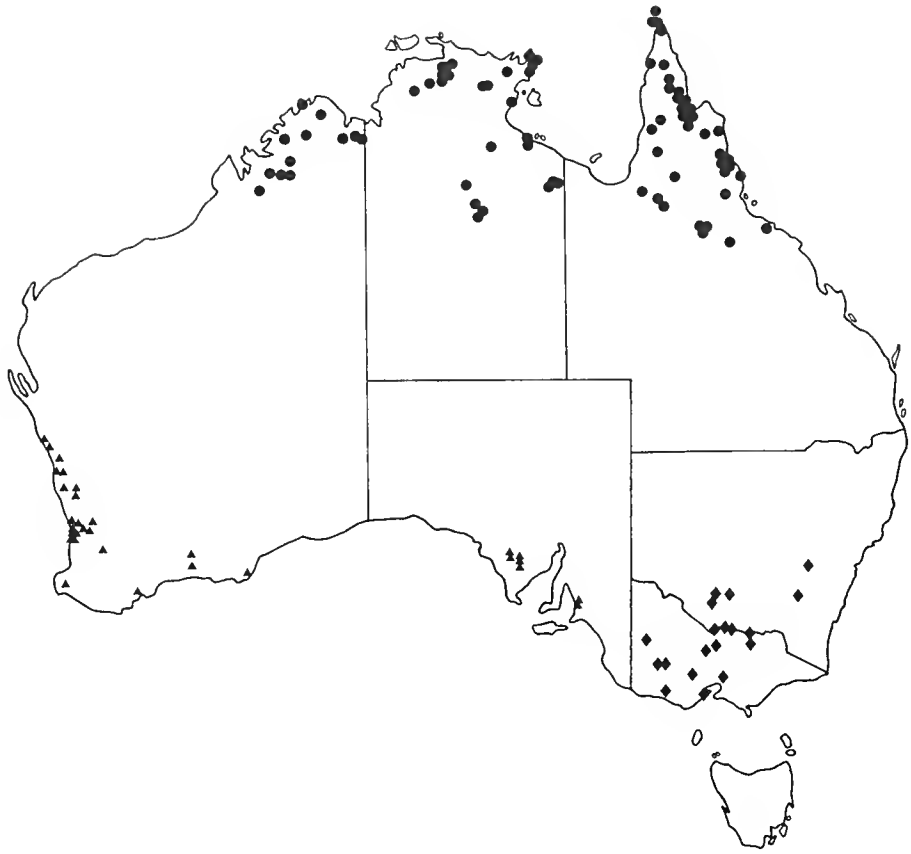

Figure 36. Distribution of *W. preissii* (▲), *W. victoriensis* (◆) and *W. caryophylloides* (●).

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New names are printed in **boldface**, synonyms and illegitimate names are printed in *italics*.

A preliminary account of *Cycas* (Cycadaceae) in Queensland

K.D. Hill

Abstract

Hill, K.D. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia, 2000) 1992. A preliminary account of Cycas *(Cycadaceae) in Queensland.* Telopea *5(1): 177–206.* Taxonomic studies initiated by the late John Maconochie on *Cycas* have been continued. Nine species are recognised in Queensland, six of them newly described here (**C. brunnea, C. couttsiana, C. megacarpa, C. ophiolitica, C. platyphylla** and **C. silvestris**). The circumscriptions of *C. media* R. Br. and *C. cairnsiana* F. Muell. are clearly defined, with reference to the type specimens and recent collections from around the type localities, and the names *C. gracilis, C. normanbyana* and *C. kennedyana* are placed in the synonymy of *C. media*. Species definition in the *C. circinalis – C. rumphii* complex is discussed with reference to the new species *C. silvestris* described from Cape York Peninsula.

Introduction

The genus *Cycas* has long presented problems for taxonomists (e.g. Bentham 1873). The late John Maconochie commenced a major project on this group in Australia but died in a motor accident before nearing completion of it. His notes and specimens have been made available to me to allow continuation of this work.

Terminology

Morphological terminology follows Johnson (1959, see also Johnson & Wilson 1990), with the exception that the terms *peduncle, microsporophyll* and *megasporophyll* (and derived terms) are used where appropriate (in place of *cone-stalk, male sporophyll* and *female sporophyll* respectively). Measurements of pinnae and associated angles are all taken at the mid-point of the axis bearing the pinnae (both basal and apical pinnae may be very different from median pinnae in form and arrangement). The two angles associated with the pinnae are the angle included by opposing pinnae (this angle when low, i.e less than 120°, gives the frond a keeled or V-shaped section), and the angle between an individual pinna and the rhachis measured in the plane of the rank of pinnae. *Seed* is used for the mature structure developed from the fertilised megaspore including all testa layers and excluding the stipe and lamina of the megasporophyll. The widened infertile apex of the megasporophyll is referred to as the *lamina* (following Carruthers 1893, Zamora & Co 1986), and the remainder of the megasporophyll as the *stipe* (Johnson 1959). The microsporophyll is described in three sections, the *fertile zone* (the broad area bearing the microsporangia), the *sterile zone* (the infertile more or less continuous apical extension from the fertile zone), and the usually sharply upturned apical spine (the *apical spine*). Measurements given for stem diameter refer to diameter at the narrowest point. Minimum diameter is fairly consistent within and between species, whereas maximum diameter can vary widely depending on age, injury history and the number of crowns on the plant.

Taxonomic history

Cycas was described by Linnaeus (1753) with a single species *C. circinalis*, although much of the material he cited has since been separated as different taxa. *C. circinalis* as now circumscribed is based on *Todda Panna* of Rheede (1682), from the Malabar coast of southwestern India. *C. circinalis* and the segregate taxon *C. rumphii* Miq. (type from the Moluccas) nevertheless remain a difficult and unresolved complex (see Stapf 1916, Smith 1979).

Robert Brown (1810) then recognised two taxa in Australia, *C. media* and *C. angulata*.

The next major study of *Cycas* was that of Miquel, who published a series of works on the cycads (1840, 1842, 1868, 1869). He published *C. gracilis* and *C. armstrongii* from Australia, the latter being the first non-Queensland species to be described.

Bentham (1873) reduced all Australian species to *C. media*, with the qualification that the group was complex and required further critical study, particularly in the field.

Mueller (1874, 1876, 1882) described *C. kennedyana*, *C. normanbyana* and *C. cairnsiana*. The first two in particular were described from inadequate material. These two were thought to occur in mixed stands with *C. media* in the Townsville to Mackay region by early collectors (Fitzalan 1882).

Gardner (1922, 1923) recognised two further taxa, *C. basaltica* and *C. lane-poolei*, both from the Kimberley region of Western Australia. At about the same time, Fitzgerald (1918) described *C. furfuracea* from the same region.

The Australian species were then treated by Schuster (1932), who made no advances in the understanding of the group (see comments by Johnson (1959) and Read & Solt (1986) on the value of the Schuster study).

Johnson (1959) revised the Australian cycads excluding *Cycas* and established the currently accepted family placement. He recognised some of the problems in *Cycas*, stating that 'a difficult and protracted task awaits any responsible monographer of the genus'.

Maconochie commenced a revision of Australian *Cycas*, but had made little progress on the Queensland taxa. He had, however, recognised some of the problems, and described two new taxa in Western Australia and the Northern Territory (*C. pruinosa* and *C. calcicola*, described in 1978).

The present study

The present study originated out of an undertaking to prepare a treatment of the 'gymnosperms' for the Flora of Australia project in 1985. During the course of this preparation, it became clear that the taxonomic *status quo* was not adequate in the case of the genus *Cycas*. I was able to undertake a number of field trips through tropical Australia in 1984, 1986, 1988, 1990 and 1991 as part of a major study of *Eucalyptus*, allowing opportunity to also examine populations of most Australian *Cycas* across their full range in the field. Preliminary notes by John Maconochie were also made available by DNA. My field observations have been combined with the observations of a number of astute amateur 'cycadologists' (see acknowledgements), gradually leading to better understanding of the genus in Australia. Specimens held by BRI, CANB, CBG and DNA have been also examined.

This account is restricted to Queensland taxa. There are also several new taxa in the

Northern Territory, some of which are under study by botanists in Darwin (Chirgwin, in press and in prep.). The work of Maconochie (1978) completed the catalogue of *Cycas* species in northern Western Australia.

Hybridism

Evidence is mounting to suggest that there are weak fertility barriers between cycad species (Vorster 1986, Norstog 1990). This is shown by the numbers of natural hybrids being discovered. The lack of pollinator specificity, when combined with the apparently weak inherent fertility barriers, results in the major reproductive barrier between *Cycas* species in nature being geographic separation. Consequently, populations of natural *Cycas* species are geographically distinctly separated, and hybrid and intermediate zones are found where different species have spread to within pollination range of each other.

Naturally occurring hybrids and intergrades have been recorded from the Northern Territory, where four species grow in relatively close proximity and hybrids are reported between *C. armstrongii* and *C. conferta*, *C. calcicola* and *C. armstrongii*, and *C. calcicola* and *C. maconochii*. In Queensland, the Irvinebank cycad population is morphologically and geographically intermediate between *C. media* and *C. platyphylla*, and also shows the considerable variability to be expected in hybrid swarms.

Breakdown of breeding barriers would also appear to have contributed to the complexity of the *C. media* complex in eastern Queensland. Here, it seems that several discrete species have arisen at some time in the past, probably when the range of an ancestral taxon was fragmented by climatic change. More recently, their ranges have expanded to meet and overlap. This has resulted in the present zones of intergradation in this complex in Queensland. Areas of hybridism are discussed below under the species involved, but in summary are as follows:

1. *C. media* – *C. platyphylla* near Irvinebank, mentioned above.
2. *C. media* – *C. ophiolitica* in the area between Mackay and St Lawrence.
3. *C. ophiolitica* – *C. megacarpa* in the area between Rockhampton and Mt Morgan.

Taxonomic treatment

Cycas *L.*, Sp. Pl. 1: 1188 (1753); Gen. Pl. edn 5: 495 (1754).

TYPE: *Cycas circinalis* L.

Dioecious palm-like shrubs with erect, pachycaul, cylindrical stems clad with persistent frond-bases (stems subterranean in some extra-Australian taxa). Fronds loosely pubescent when young, pinnate, spirally arranged, produced in seasonal growth flushes interspersed with cataphylls, lower pinnae often reduced to spines. Longitudinal ptyxis erect or rarely reflexed, horizontal ptyxis circinate. Pinnae with a single thick midrib and no lateral veins; stomata confined to abaxial surface in most species; individual ptyxis involute. Trichomes transparent, branched or simple. Microsporophylls aggregated into determinate cones and bearing numerous microsporangia (pollen-sacs) on abaxial surfaces, with a simple sterile tip, which is often produced into an upturned spine; microsporangia opening by slits; pollen cymbiform, monosulcate. Megasporophylls spirally arranged in an indeterminate terminal rosette with the central axis continuing vegetative growth. Ovules two to many (rarely one),

marginally inserted on the stipe and directed obliquely outwards ('ascending'); sporophyll apically dilated, pinnatifid, pectinate, toothed or entire. Seeds with a yellow, orange or brown fleshy outer sarcotesta, and with or without spongy tissue beneath the inner woody sclerotesta. Endosperm haploid, derived from the female gametophyte. Embryo straight; with 2 cotyledons that are usually united at the tips; seeds platyspermic; germination cryptocotylar. $2n = 22$ (Sax & Beale 1934; counts on three extra-Australian species).

The generic name is from the supposed Greek 'kykas', used by Theophrastus. This was an error of transcription for 'koikas,' the accusative form of 'koix', for the Egyptian Doum-palm, *Hyphaene thebaica* (L.) Mart.

About 30 species, chiefly Australian (about 20 species) and Chinese (about 10 species). The genus also occurs in Malesia, Japan and South-east Asia, with outliers in Polynesia, Madagascar and East Africa. Plants are commonly understorey shrubs in forest, woodland or savanna habitats. Several species are cultivated as ornamentals; of these the Japanese species *C. revoluta* Thunb. is the most widely grown, including in Australia.

Most plant parts contain toxic methylazoxymethyl glycosides at some stage of their development (cycasin and compounds derived from it), and various species have been recorded as human and livestock poisons. *Cycas media* in particular is known as 'ricketty bush' in parts of Queensland, and is widely known as a cause of the degenerative neuromuscular disease 'rickets' in cattle. All cycads were listed as noxious weeds in Queensland until recently for this reason, and many landholders have conducted cycad eradication programs, and are still doing so in some areas.

Several Australian species were important food sources for Australian Aborigines, who made a flour or sago from the starchy endosperm after removing the toxic elements with an extensive leaching and cooking process.

The genus *Cycas* is a coherent natural group with no sister genera, and with few obvious infrageneric subdivisions. The few attempts at infrageneric subdivision have differed substantially, and there is no accepted classification (Schuster 1932, Smitinand 1971, Dehgan 1987). All of the Australian species and some of the taxa from Papua New Guinea form a group defined by the combination of glabrous ovules, a non-pectinate megasporophyll lamina, and the absence of a spongy layer in the seeds. These characters are implicit in all species descriptions below.

The seed number per megasporophyll given is also the usual number observed, in all species some plants may develop as few as one seed on a megasporophyll, particularly in stressed plants or on the first or last megasporophylls of a seasonal flush. Seeds are slightly dorsiventrally flattened in all Australian species, and the measurements of diameter given below apply in all cases to the widest diameter. All Queensland species also have more or less mucronulate pinnae (with a fine apical spine developed from an extension of the midrib).

Key to the species

1 Margins of pinnae revolute; pinnae narrow (mostly less than 4 mm wide) ..... **6. C. cairnsiana**

1* Margins of pinnae flat or recurved, not revolute; pinnae more than 4 mm wide

2 Fronds flat (opposing pinnae at c. 180 degrees)

3 Pinnae mostly more than 10 mm wide; fronds with up to 150 pinnae ..... **1. C. silvestris**

3* Pinnae mostly less than 9 mm wide; fronds with more than 160 pinnae ..... **2. C. media**

2* Fronds keeled (opposing pinnae at less than 150 degrees)

4 New growth with mainly white trichomes ..... **7. C. couttsiana**

4* New growth with mostly brown or orange trichomes

5 New growth green ..... **3. C. megacarpa**

5 New growth blue

6 Brown trichomes on new growth; cataphylls not densely woolly

7 Pinnae mostly less than 6.0 mm wide; pinnae 6–9 mm apart on rachis; seeds not pruinose ..... **9. C. angulata**

7* Pinnae 6.0 mm wide or wider; pinnae 9–13 mm apart on rachis;seeds distinctly pruinose ..... **8. C. brunnea**

6* Orange trichomes on new growth; cataphylls densely woolly

8 Pinnae 6.0–7.5 mm wide; fronds keeled at 80–120 degrees ..... **4. C. ophiolitica**

8* Pinnae 4.5–6.0 mm wide; fronds keeled at 45–60 degrees ..... **5. C. platyphylla**

1. Cycas silvestris *K. Hill*, **sp. nov.**

Ab aliis speciebus australiensibus pinnis adultis latioribus tenuioribusque distinguitur.

TYPE: QUEENSLAND: Cook District: c. 0.75 km NW of Bolt Head, *J. Clarkson 8813 & J. Neldner*, 14 July 1990 (holo NSW, iso BRI, MBA).

Stem to 3 m tall, rarely to 4 m, 10–15 cm diam. Fronds 100–200 cm long, flat in section (opposing pinnae inserted at 180 degrees on rhachis), with 90–150 pinnae; rhachis terminated by paired pinnae or a short spine (4–5 mm long); petiole glabrous, 40–50 cm long; median pinnae at 80–90 degrees to rhachis, 150–300 mm long, 9.0–15.0 mm wide, glabrous, glossy mid-green, flat in section, decurrent for 5–9 mm, narrowed to 4–5 mm at base (narrowed to 30–40% of maximum width), 12–14 mm apart on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with grey-white and some pale orange-brown trichomes, usually persistent. Cataphylls slender, grey to orange-brown-tomentose. Microsporangiate cones not seen. Megasporophylls 25–30 cm long, brown-tomentose, with 2–10 ovules; lamina 30–40 mm long, 15–22 mm wide, narrowly triangular, regularly dentate, apical spine 8–15 mm long. Seeds ovoid, green becoming yellowish, not pruinose, 30–35 mm long, 25–30 mm diam.; sarcotesta 1.5–2 mm thick. Fig. 1.

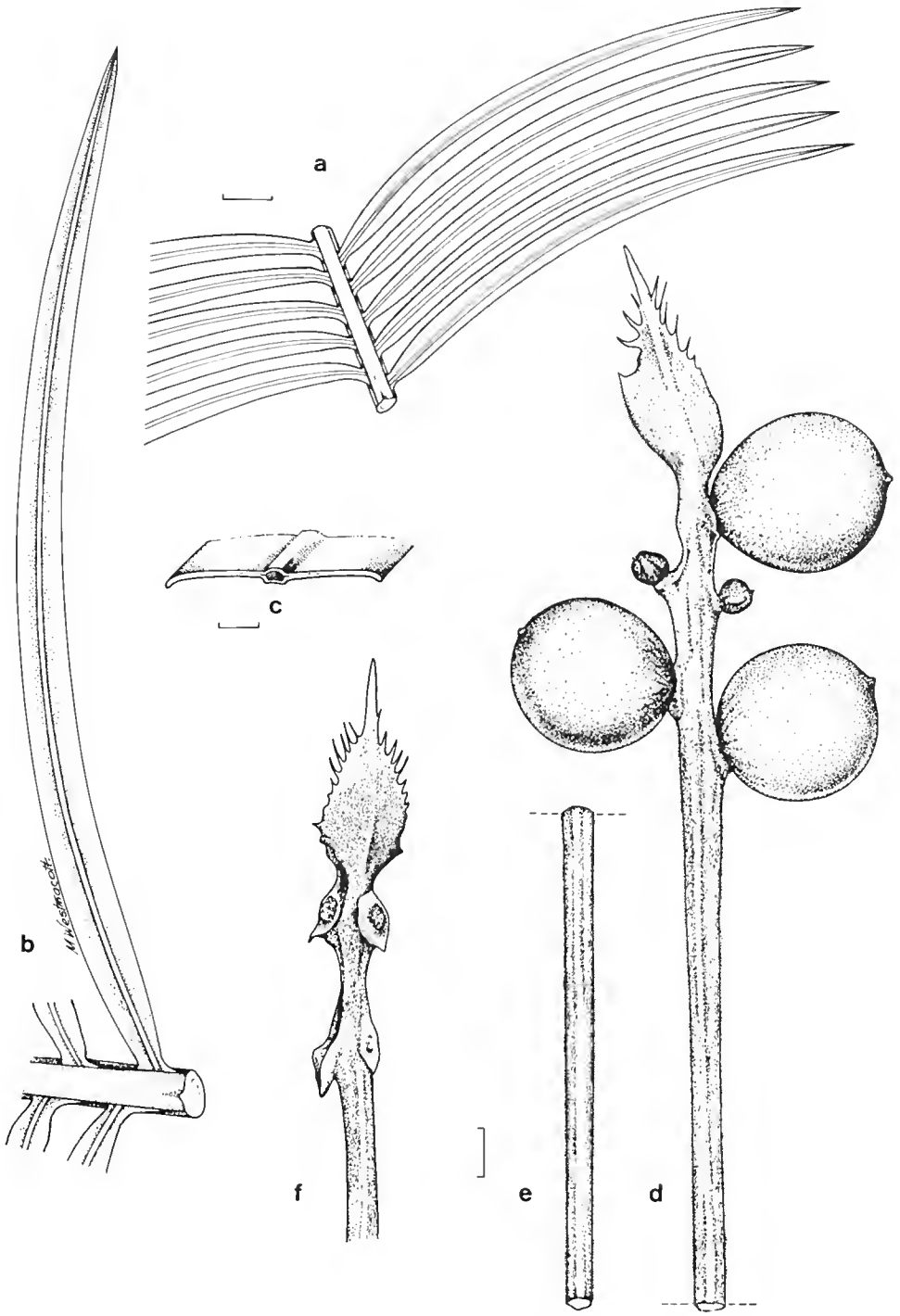

Fig. 1. *Cycas silvestris*. **a**, part of frond; **b**, pinna; **c**, section of pinna; **d**, **e**, megasporophyll with seeds and stipe (in two sections); **f**, tip of megasporophyll (a, b, c, f, from *Hill 1818*; d, e, from *Clarkson 8813*). Scale bar: a, b, d, e, f = 1 cm; c = 2 mm.

Distinguished from other Australian species by the broader and relatively thinner adult pinnae. The broad, falcate pinnae and the non-pectinate megasporophyll apex with a distinct apical spine are similar to those of the complex surrounding *C. circinalis* L. and *C. rumphii* Miq., which comprises an unknown number of taxa ranging from India and East Africa to Fiji. Seeds, however, lack the spongy layer present in both *C. circinalis* and *C. rumphii* (Dehgan & Yuen 1983). *C. silvestris* also differs from superficially similar taxa on South Pacific Islands (*C. seemanii* A. Br.) in the strongly spinose petiole in seedling plants (the Pacific Island plants have no or rarely few spines in seedling material) and the small seeds. Three taxa in this group are known from Papua New Guinea, although precise definition is unclear on available materials. Two near-coastal taxa correspond more or less with *C. rumphii* and *C. undulata* Desf., and *C. scratchleyana* F. Muell. is apparently an endemic species from higher elevations and more inland sites. These all differ from *C. silvestris* in the large seeds. Material from Vanuatu and New Caledonia corresponds more with typical *C. rumphii* (the same coastal taxon that is present in New Guinea). *C. papuana* F. Muell. has been erroneously placed with the *C. circinalis* – *C. rumphii* complex by some authors (White 1922, Kanehira 1938), but in fact is close to *C. armstrongii* Miq.

The status of *C. circinalis* and *C. rumphii* is still unresolved (Smith 1979). The species are taken as distinct here (Table 1, following Stapf 1916). In the protologue of *C. circinalis*, Linnaeus (1753, 1754) cites treatments of *Cycas* from eight earlier works, including at least three taxa as they are at present circumscribed, but also stating 'Habitat in India'. Stapf (1916) states '... the *Cycas circinalis* of India represented by Rheede's *Todda Panna* (Hort. Malab. iii tab 13–21 [Rheede 1682]), the accepted basis of Linnaeus's species.' This can be accepted as a lectotypification, with the series of cited illustrations constituting the type.

C. silvestris is known only from subcoastal forests near the northeastern tip of Cape York Peninsula, to the north and south of the Olive River estuary (Fig. 2). These quite rich and complex rainforests and *Melaleuca*-dominated forests occur on white siliceous old beach-dune sands.

The epithet is from the Latin *silvestris*, 'of the forests', in reference to the closed forest habitat.

Conservation status: 2V-. This taxon is known from few small stands that are not conserved.

Selected specimens (from 4 examined): Queensland: Cook District: c. 1 km N of Olive River mouth, *Webb & Tracey 13741*, 12 Sep 1974 (QRS, BRI); 1 km SW of Bolt Head, *Hill 1818, Hind & Healey*, 26 July 1986 (NSW).

Table 1. Differences between *C. circinalis*, *C. rumphii* and *C. silvestris* (after Stapf 1916)

	C. circinalis (Bangalore)	C. rumphii (Singapore)	C. silvestris
Fronds (length)	150–250 cm	100–200 cm	100–200 cm
Pinnae (per frond)	80–100	50–70	90–150
Pinnae (length)	18–24 cm	20–30 cm	15–30 cm
Pinnae (width)	9–13 mm	15–17 mm	9–15 mm
Midrib on upper surface	raised	flat	raised
Seed (length)	25–50 mm	50–75 mm	30–35 mm
Seed (spongy layer)	present	present	absent

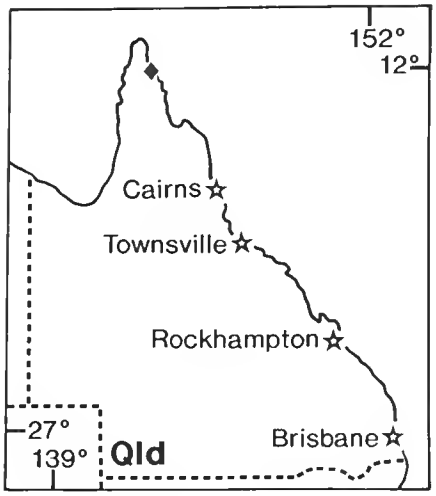

Fig. 2. Distribution of *C. silvestris*.

2. Cycas media *R. Br.*, Prodr.: 348 (1810).

TYPE CITATION: '(T.) v.v.'.

TYPE: *R. Brown* (holo BM, Bennett's numbering 3106 p.p., photo seen). Probably collected on 16 Oct 1802 from Calder Island, in the Cumberland Group off Mackay (Groves & Moore 1989). Bennett allocated the same number (3106) to Brown's collections of both *C. media* and *C. angulata* (below).

Cycas gracilis Miq., Versl. K. Acad. Wet. Amsterdam 15: 366 (1863). TYPE CITATION: 'in regione fluminis Burdikin [sic], prope Prom. Upstart: F. MUELLER.' TYPE: QUEENSLAND: near Cape Upstart, F. Mueller (holo U 028108, photo seen).

Cycas normanbyana F. Muell., Fragm. 8: 169 (1874).

Cycas rumphii Miq. subsp. *normanbyana* (F. Muell.) Schuster, in Engl., Pflanzenr. 99: 75 (1932). TYPE: QUEENSLAND: Port Denison, *E. Fitzalan*, Apr 1874 (holo MEL 68048, photo seen). Although the specimens were labelled 'Port Denison', this was merely the port from which they were dispatched to Mueller. Fitzalan in his correspondence to Mueller gave the actual locality of collection as 'near the Burdekin River estuary'.

Mueller distinguished this taxon by the curled fronds and 4-seeded megasporophylls. Both of these characters occur in most populations of *C. media*.

Cycas gracilis Miq. var. *glauca* Regel, Act. Hort. Petropol. 4: 282 (1876). TYPE CITATION: 'C. media h. Van Houtte.- C. Boddami h. Haage et Schm.- Macrozamia latifrons h. Bull.- C. Normanbyana h. Belg.' TYPE: probably from cultivated material in collections of or supplied by the above (not seen).

Cycas gracilis Miq. var. *viridis* Regel, Act. Hort. Petropol. 4: 282 (1876). TYPE CITATION: 'C. gracilis h. Paull.- C. Riumiana h. Turic. Habitat in Nova Hollandia tropica.' TYPE: probably from cultivated material in collections of or supplied by the above (not seen).

Cycas kennedyana F. Muell., Austral. Chem. Drugg. 4(47): 85 (1882). TYPE CITATION: 'In the Normanby-Ranges, near Port Denison; Eugene Fitzalan, Esq.' TYPE: QUEENSLAND: Port Denison, *E. Fitzalan*, 1881 (holo MEL 68039, 68044, photos seen). Fitzalan (1882) stated that this species occurred in mixed stands with *C. media* through the Normanby Range, which lies about the Normanby gold mine, southwest of Bowen (the locality 'Port Denison' on the specimen label was merely the point from which the specimens were dispatched to Mueller).

Mueller distinguished this species by the curled fronds, the 2-seeded megasporophylls and the blunt tips on the microsporophylls. The first two characters occur in most populations of *C. media*. Study of populations around the type locality has revealed no microsporophyll material matching the type, and it can only be concluded that Mueller drew up his diagnosis from damaged material. A sheet regarded as part of the type (MEL 68044) has some damaged microsporophylls with no upturned spine, but also has others with a distinct though small upturned apical spine. The two sheets labelled as 'Type' in MEL (above) also do not include any leaf material.

ILLUSTRATION: Elliot & Jones (1984: 149).

Stem to 3 m tall, rarely to 6 m, 10–18 cm diam. Fronds 90–180 cm long, flat in section or almost so (opposing pinnae inserted at 150–180 degrees on rhachis), with 160–300 pinnae; rhachis terminated by paired pinnae or a spine; petiole glabrous or lightly grey-tomentose, 30–40 cm long; median pinnae at 60–90 degrees to rhachis, 160–260 mm long, 6.0–10.0 mm wide, glabrous, glossy mid-green, flat in section, decurrent for 2–3 mm, narrowed to 2.5–4.0 mm at base (30–50% of maximum width), 7–13 mm apart on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with pale orange-brown trichomes, not persistent. Cataphylls slender, pale grey-brown-tomentose, to 12 cm long. Microsporangiate cones ovoid, 15–25 cm long, 8–15 cm diam. Microsporophyll fertile zone 16–22 mm long, 8–12 mm wide, abruptly narrowed; sterile zone 8–11 mm long, recurved; apical spine sharply upturned, 6–10 mm long. Megasporophylls 20–30 cm long, ferruginous- or grey-tomentose, with 4–10 ovules (occasionally fewer); lamina 35–90 mm long, 17–30 mm wide, narrowly triangular, regularly dentate, apical spine 15–40 mm long. Seeds ovoid, green becoming orange-yellow, not pruinose, 31–38 mm long, 26–32 mm diam.; sarcotesta 3–4 mm thick. Fig. 3.

Distinguished in Australia by the glabrous, glossy green fronds with more or less flat pinnae, and the relatively small seeds. The similar *C. silvestris* has broader pinnae and smaller seeds, and the similar *C. megacarpa* has usually shorter, more keeled leaves with fewer pinnae, larger seeds, and a more slender trunk.

Widespread and locally common in open or closed forest or occasionally rainforest in eastern Queensland, from south of Mackay to the tip of Cape York Peninsula, and into Papua New Guinea (Fig. 4a). Plants from northern parts of Cape York Peninsula often show strongly keeled pinnae (V-shaped in section). Plants from southeastern Papua New Guinea (Port Moresby district) match these northern forms, and may belong to the same taxon. These are placed in *C. media* for the moment, but further study is required to evaluate possible differences. Plants from the Western Province of Papua New Guinea (including the type of *C. papuana* F. Muell.) are not the same, and more nearly match *C. armstrongii* Miq. from the Northern Territory. Occurrences from northern parts of Papua New Guinea are similar to *C. media*, but differ in the more persistent tomentum. These probably represent *C. schumanniana* Lauterb. Plants from near-coastal sites in the Cooktown district have wider and more distinctly falcate pinnae, possibly indicating some introgression from *C. silvestris*.

The names *C. kennedyana* and *C. normanbyana* have been widely applied to forms of *C. media*, and also erroneously to two undescribed species from south of the range of

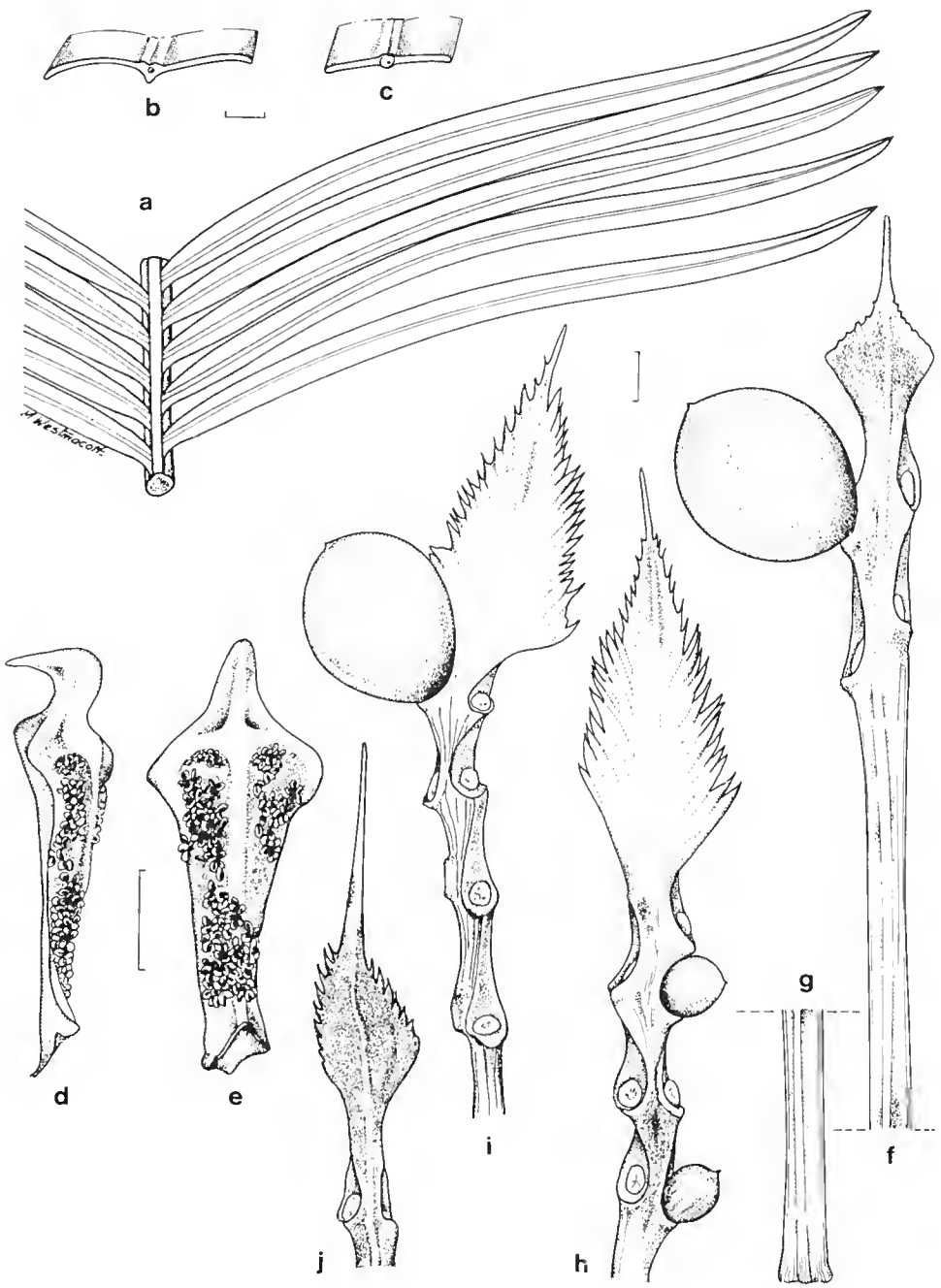

Fig. 3. *Cycas media.* **a**, part of frond; **b**, **c**, section of pinnae; **d**, **e**, microsporophyll; **f**, **g**, megasporophyll with seed and stipe (in two sections); **h**, **i**, **j**, tips of different megasporophylls (a, c, h, from *Hill 3713*; d, e, f, g, from *Hill 3711*; b, i, from *Hill 3777*; j from *Hill 3785*). Scale bar: a = 1 cm; b, c = 2 mm; d–i = 1 cm.

C. media. The diagnostic features of these 'taxa' as originally described occur at random through most populations of *C. media*, and *C. media* is here regarded as a highly variable and widespread species. The distinguishing features given above are, however, constant and may be used to diagnose this taxon throughout its range.

Seeds of *C. media* were an important food source for Aboriginal people.

CONSERVATION STATUS: not considered to be at risk.

SELECTED SPECIMENS (from 31 examined): QUEENSLAND: Cook District: 3.8 km N of Moreton telegraph station, *Hill 1779*, 22 July 1986 (NSW); c. 29 km N of Silver Plains homestead, *Hind 2289*, 14 Aug 1978 (NSW); 7 km along Silver Plains track from Coen road, *Maconochie 2690*, 15 June 1981 (DNA, BRI, NSW); base of Grassy Hill, Cooktown, *Hill 3774 & Stanberg*, 2 Aug 1990 (NSW); 0.9 km N of Wujal Wujal (Bloomfield), *Hill 3777 & Stanberg*, 3 Aug 1990 (NSW, BRI); 31 miles [c. 50 km] N of Cairns, *Byrnes 2422 a*, 9 Nov 1971 (DNA, NSW); 5 miles [8 km] from Gordonvale on Atherton road, *Briggs 1971*, 3 Aug 1968 (NSW); crest of Herberton Range on Atherton–Herberton road, *Hill 3768 & Stanberg*, 1 Aug 1990 (NSW). North Kennedy District: 40 km S of Ingham, *Maconochie 2733*, 24 June 1981 (DNA, BRI, NSW); Storth, *Hill 3713 & Stanberg*, 25 July 1990 (NSW); Cape Upstart, SW side, *Hill 3711 & Stanberg*, 25 July 1990 (NSW). South Kennedy District: track over Normanby Range on Mt Hector station, *Hill 3784, 3785 & Stanberg*, 6 Aug 1990 (NSW, BRI); 1 km S of Kuttabul road on Seaforth–Mackay road, *Hind 2869 A & B*, 29 Dec 1980 (NSW). Port Curtis District: c. 13 km S of Clareview on Bruce Highway, *Hind 2858*, 25 Dec 1980 (NSW). PAPUA NEW GUINEA: Rigo Road, at '17 mile', Port Moresby Subdistrict, Central District, *Streimann NGF 39487*, 25 June 1969 (NSW ex LAE).

INTERGRADING POPULATIONS (fig. 4b): *C. media* – *C. ophiolitica*

QUEENSLAND: Port Curtis District: 25.5 km from Bruce Highway at St Lawrence towards Croydon, *Hill 3788 & Stanberg*, 6 Aug 1990 (NSW, BRI); 48 km N of Marlborough, *Hind 2878*, 30 Dec 1980 (NSW).

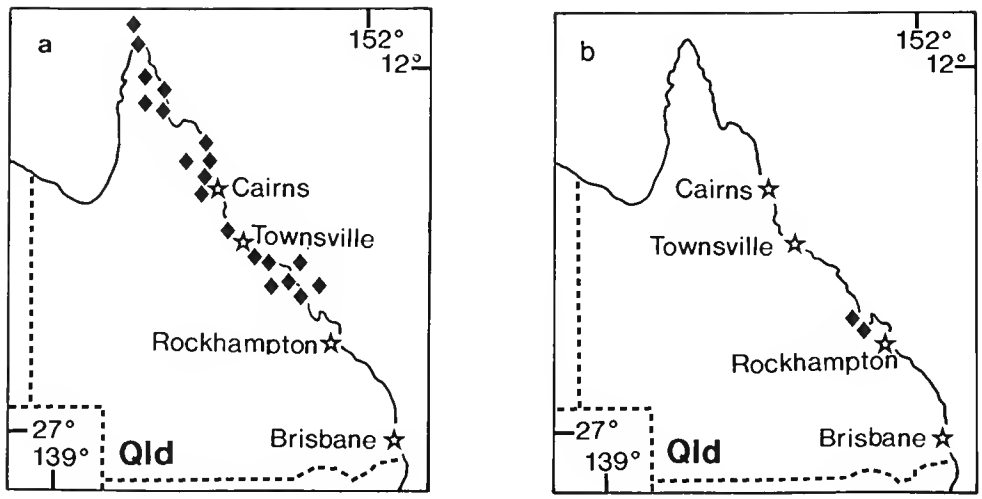

Fig. 4. a, Distribution of *C. media*; b, distribution of *C. media* – *C. ophiolitica* intergrades.

3. Cycas megacarpa *K. Hill*, **sp. nov.**

Inter species australienses combinatione pinnarum latarum viridiumque, fructuum grandium non glaucorumque, distinguitur.

TYPE: QUEENSLAND: Port Curtis District: W side of Blackmans Gap, 20.9 km from Bruce Highway at Miriam Vale on Manypeaks road, *K.D. Hill 4142 & L. Stanberg*, 1 Oct 1991 (holo NSW; iso BRI, CANB, DNA).

Stem to 3 m tall, rarely to 6 m, 8–14 cm diam. Fronds 70–110 cm long, openly keeled (opposing pinnae inserted at 90–135 degrees on rhachis), with 120–170 pinnae; rhachis terminated by paired pinnae or a spine; petiole glabrous or grey-tomentose, 20–36 cm long; median pinnae at 40–70 degrees to rhachis, 120–200 mm long, 5.0–7.5 mm wide, glabrous, glossy mid- to dark green, flat or slightly keeled in section, decurrent for 2–3 mm, narrowed to 2.5–4.0 mm at base (40–60% of maximum width), 5–12 mm apart on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with orange-brown trichomes, usually not persistent. Cataphylls slender, orange-brown-tomentose, to 7 cm long. Microsporangiate cones ovoid, c. 18 cm long, c. 7 cm diam. Microsporophyll fertile zone c. 25 mm long, c. 11 mm wide, abruptly narrowed; sterile zone c. 7 mm long, recurved; apical spine sharply upturned, 5–8 mm long. Megasporophylls 14–25 cm long, brown- and grey-tomentose, with 2–4 ovules; lamina 40–70 mm long, 15–32 mm wide, narrowly triangular, regularly dentate, apical spine 8–20 mm long. Seeds ovoid, green becoming yellowish, not or slightly pruinose, 38–50 mm long, 35–45 mm diam.; sarcotesta 4–5 mm thick. Fig. 5.

Distinguished within Australia by the green fronds with broad pinnae, and the large non-glaucous seeds. Adult fronds are also generally smaller and more keeled, the trunk is more slender, and seeds are larger than those of the similar *C. media*.

Scattered and localised on clay-loam soils over various substrates, usually on sloping country in wet eucalypt forests or rainforests. This species ranges from near Mount Morgan south to near Goomeri, occurring in locally more mesic microhabitats, becoming quite sporadic and occurring further inland in the south of the range (Fig. 6a). Populations near Mt Morgan show extensive intergradation with *C. ophiolitica*, but also have larger seeds than more southerly occurring plants.

C. megacarpa has been cultivated in Australia under the name *C. kennedyana*, but the type of the latter name belongs to *C. media* (which see).

The epithet is from the Greek *mega-*, large, and *karpos*, fruit, referring to the distinctive large seeds.

CONSERVATION STATUS: 3VC. Although locally abundant, the eucalypt forest habitat of this species is not well conserved, and there is considerable risk of habitat removal for forestry and pastoral activity.

SELECTED SPECIMENS (from 12 examined): Queensland: Port Curtis District: Kroombit Tops, *Gillison 2520, Brooker & Nix*, 24 July 1976 (CANB, NSW); W side of Blackmans Gap, Manypeaks Range, *Hind 2881*, 31 July 1980 (NSW); 3.7 km E of junction of Monto road and Gladstone road, *Hind 2882*, 31 July 1980 (NSW). Burnett District: 6.1 km N of Kalpowar railway station on road to Manypeaks, *Hind 2883*, 31 July 1980 (NSW); 6.9 km from Mt Perry on Eidsvold road, *Hill 3803 & Stanberg*, 8 Aug 1990 (NSW, BRI); Goodnight scrub, 18.2 km from Mt Perry – Gayndah road, *Hill 3807 & Stanberg*, 9 Aug 1990 (NSW, BRI). Wide Bay District: Woowonga Range, N of Biggenden, *Young 279 & Randall*, Sep 1979 (BRI); Kinbombi, S of Kilkivan, *Rogers*, June 1957 (BRI).

INTERGRADING POPULATIONS (fig. 6b): *C. megacarpa* – *C. ophiolitica*

QUEENSLAND: Port Curtis District: 21.8 km from Bruce Highway towards Mt Morgan, *Hill 3799, 3800 & Stanberg*, 8 Aug 1990 (NSW); 10 km E of Mt Morgan, *Hind 2844*, 21 Dec 1980 (NSW).

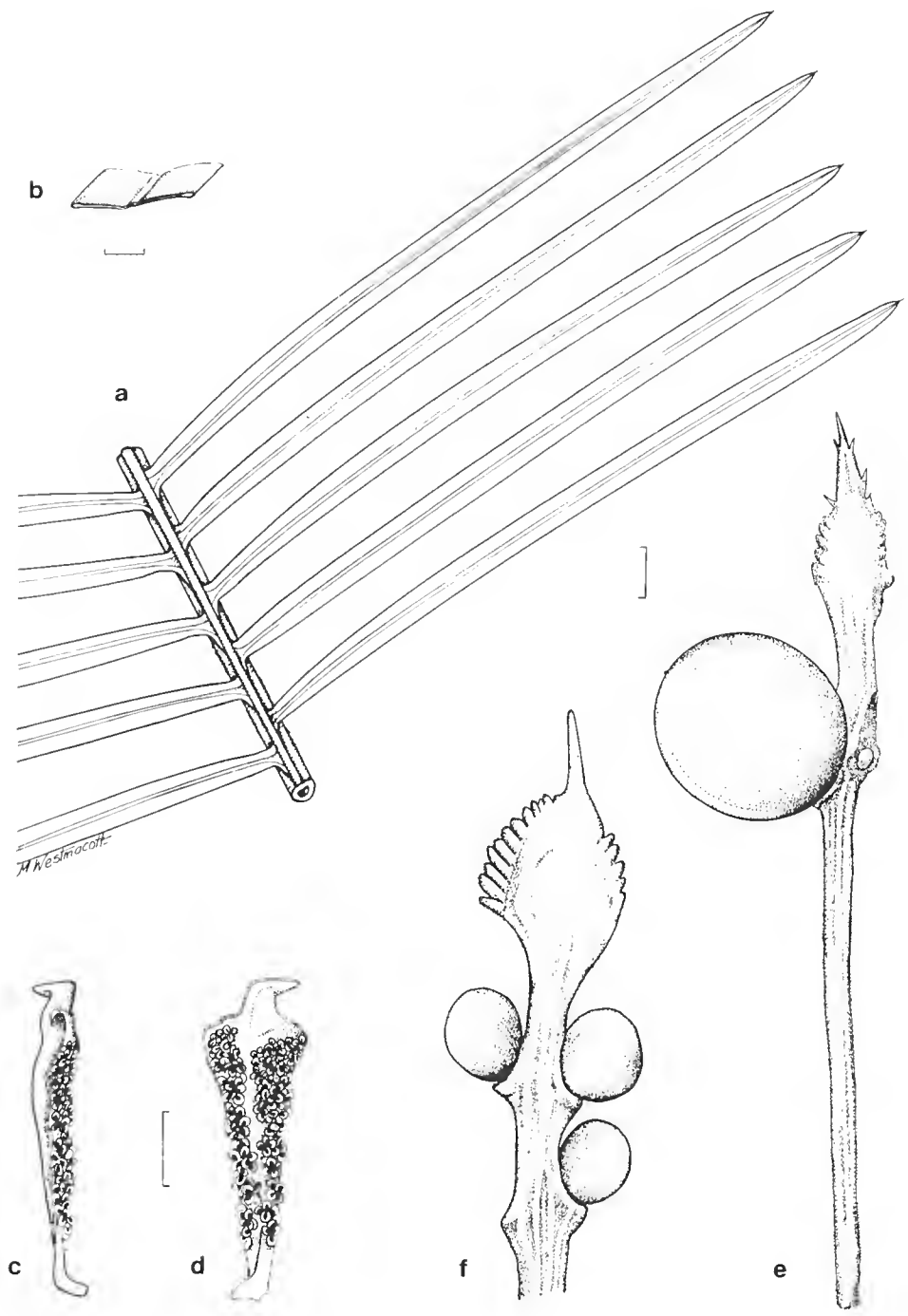

Fig. 5. *Cycas megacarpa*. **a**, part of frond; **b**, section of pinna; **c**, **d**, microsporophyll; **e**, megasporophyll with seed and stipe; f, tip of megasporophyll (a, b, e, from *Hill 4142*; c, d, from *Hind 2881*; f from *Hind 2882*). Scale bar: a, c, d, e, f = 1 cm; b = 2 mm.

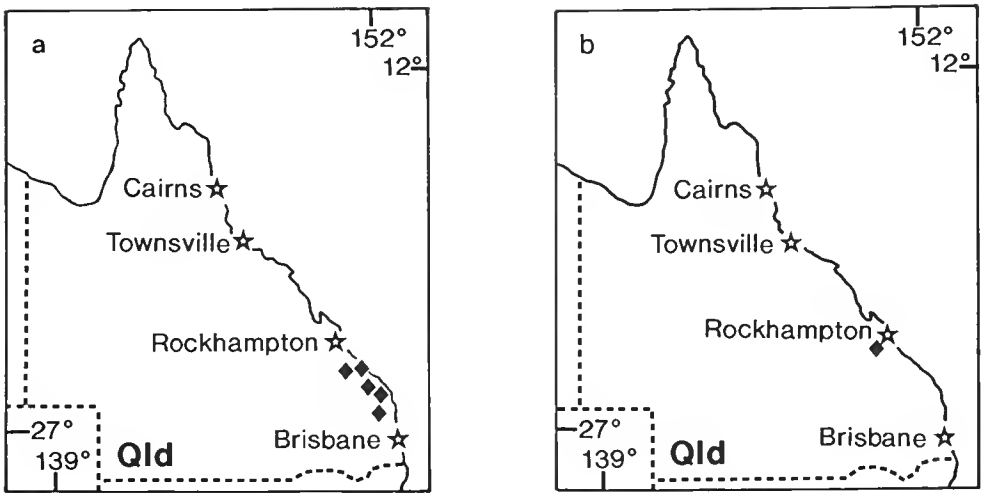

Fig. 6. a, Distribution of *C. megacarpa*; b, distribution of *C. megacarpa* – *C. ophiolitica* intergrades.

4. Cycas ophiolitica *K. Hill*, **sp. nov.**

Inter species australienses combinatione pinnarum latarum confertarumque carinatarumque plus minusve glaucarumque, petiolorum cinereo- vel albotomentosorum, fructuum parvorum, distinguitur.

TYPE: QUEENSLAND: Port Curtis District: 48.6 km S of Marlborough on Bruce Highway, *K.D. Hill 4140 & L. Stanberg*, 1 Oct 1991 (holo NSW; iso BRI, CANB, K, DNA).

Stem to 2 m tall, rarely to 4 m, 14–20 cm diam. Fronds 95–140 cm long, keeled in section (opposing pinnae inserted at 80–120 degrees on rhachis), with 170–220 pinnae; rhachis usually terminated by a spine; petiole usually grey- or light brown-tomentose, 18–35 cm long; median pinnae at 45–70 degrees to rhachis, 140–240 mm long, 6.0–7.5 mm wide, grey-white tomentose or glabrous, glossy dark green, flat in section, decurrent for 1.5–3 mm, narrowed to 3.5–5.0 mm at base (55–80% of maximum width), 6–9 mm apart on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with grey-white and some pale orange-brown trichomes, usually persistent. Cataphylls slender, orange-brown-tomentose. Microsporangiate cones ovoid, c. 17 cm long, c. 8 cm diam. Microsporophyll fertile zone 22–26 mm long, 10–14 mm wide, abruptly narrowed; sterile zone 10–15 mm long, recurved; apical spine sharply upturned, 7–11 mm long. Megasporophylls 18–30 cm long, brown-tomentose, with 2–6 ovules; lamina 40–70 mm long, 12–30 mm wide, narrowly triangular, regularly dentate, apical spine 8–20 mm long. Seeds ovoid, green becoming yellowish, usually more or less pruinose, 29–33 mm long, 28–32 mm diam.; sarcotesta 2.5–3.5 mm thick. Fig. 7.

Distinguished in Australia by the relatively broad, crowded, keeled and more or less glaucous pinnae, the grey- or white-tomentose petioles, and the small seeds. Pinnae are generally narrower and more crowded than those of both *C. media* and *C. megacarpa*, and ovules are fewer in number than those of *C. media*. Fronds are also more frequently (but not always) terminated by a spine rather than a pair of pinnae (both *C. media* and *C. megacarpa* show about equal development of terminal spine or

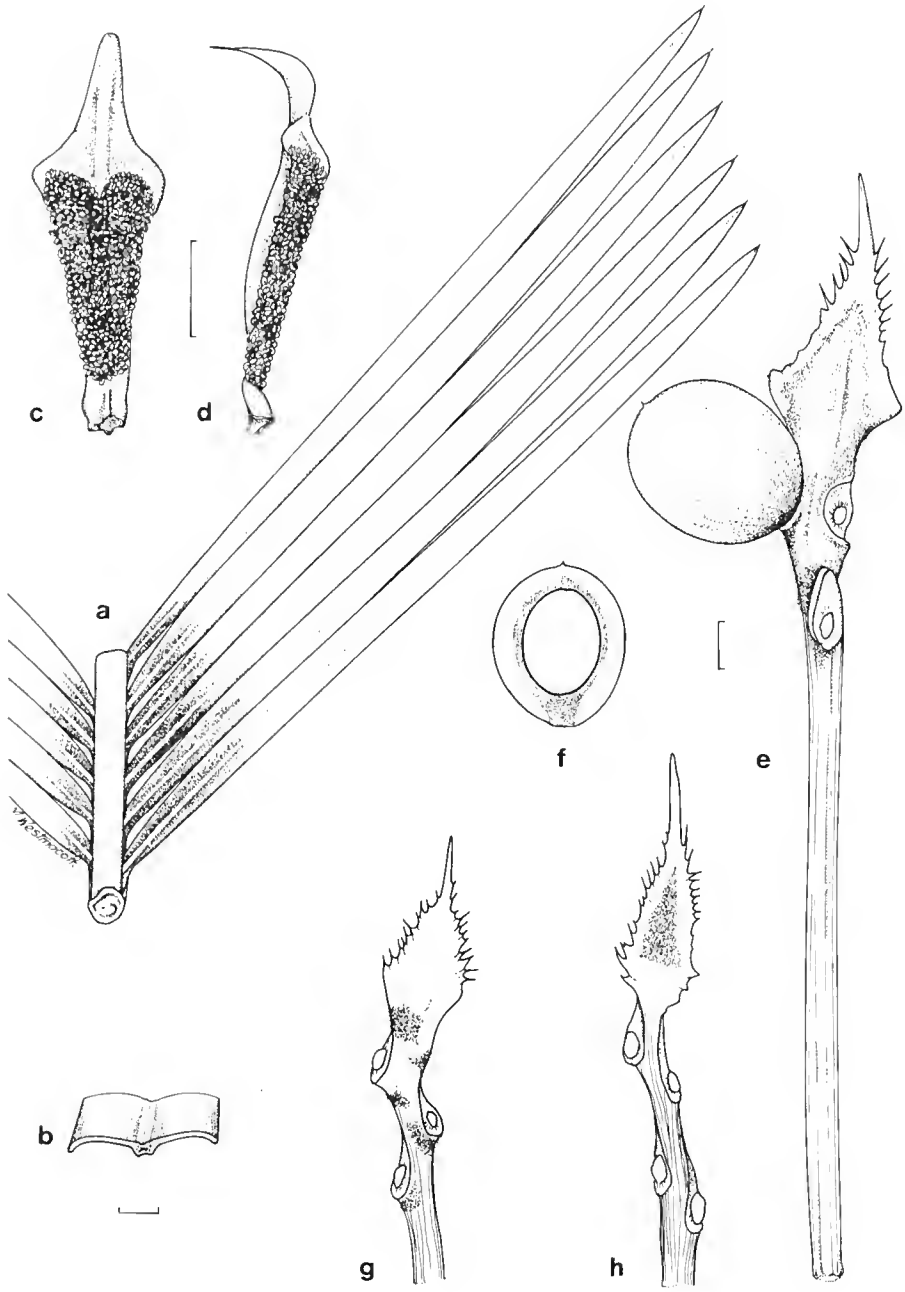

Fig. 7. *Cycas ophiolitica*. **a**, part of frond; **b**, section of pinna; **c**, **d**, microsporophyll; **e**, megasporophyll with seed and stipe; **f**, longitudinal section of seed; **g**, **h**, tips of different megasporophylls (a, b, e, f, g, h, from *Hill 4141A*; c, d, from *Hill 4141B*). Scale bar: a, c, d, e, f = 1 cm; b = 2 mm.

pinnae). Pure forms are quite blue in new growth, becoming dark green with age, and have narrow, stiff pinnae. In these characters, *C. ophiolitica* resembles both *C. platyphylla* and *C. couttsiana*. It differs from the former in the somewhat longer and broader pinnae on longer fronds with longer petioles and the lesser amount of orange tomentum around the cataphylls, and from the latter in lacking the persistent white trichomes and by the less keeled fronds.

This species reaches its best development on red clays over serpentinites in the region between Marlborough and Rockhampton (Fig. 8). Substantial intergradation occurs with *C. media* and *C. megacarpa* respectively north and south of this region (figs. 4b, 6b, specimens cited under those taxa), and plants from throughout the range may show characters of these taxa.

The 'core' form is in cultivation (mostly as wild-collected plants) as *Cycas* 'Marlborough Blue'. Some of the intergrading material is also cultivated as *C. normanbyana*, although the type of the latter name belongs to *C. media* (which see).

The epithet is from the Greek, *ophis, ophios*, serpent or snake, and *lithos*, stone or rock, in combination 'ophiolite' as used for the rock serpentinite, referring to the main occurrence of this species on serpentinite-derived soils.

CONSERVATION STATUS: 2V-. The habitat is poorly conserved (or unconserved), and the species is also under significant commercial collecting pressure.

SELECTED SPECIMENS (from 17 examined): QUEENSLAND: Port Curtis District: 49.9 km W of Marlborough on old highway, *Hill 3789 & Stanberg*, 7 Aug 1990 (NSW, BRI); 13.2 k S of Marlborough on Bruce Highway, *Hill 3791 & Stanberg*, 7 Aug 1990 (NSW); 15 km S of Marlborough on Bruce Highway, *Maconochie 2758*, 27 June 1981 (DNA, BRI); 48.6 km S of Marlborough on Bruce Highway, *K.D. Hill 4141A,B & L. Stanberg*, 1 Oct 1991 (NSW); 36 miles [58 km] S of Marlborough on Bruce Highway, *Rodd 1163*, 14 Aug 1970 (NSW); 1 km from Bruce Highway on Yeppoon road, *Hill 3796 & Stanberg*, 7 Aug 1990 (NSW, BRI).

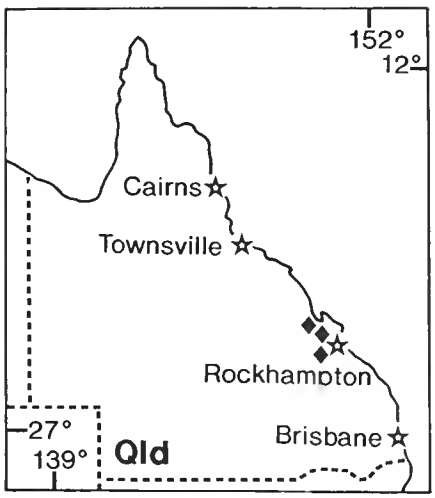

Fig. 8. Distribution of *C. ophiolitica*.

5. Cycas platyphylla *K. Hill*, **sp. nov.**

Inter species australienses frondibus pruinosis maturitate flavovirescentibus, pinnis modice latis marginibus recurvatis, tomento cataphyllorum aurantiaco, apice sterili megasporophyllorum lato, distinguitur.

TYPE: QUEENSLAND: Cook District: 4.3 km from Petford on Herberton road, *K.D. Hill 3764 & L. Stanberg*, 1 Aug 1990 (holo NSW; iso BRI, CANB, DNA, MEL).

ILLUSTRATION: Elliot & Jones (1984: 147), as *C. cairnsiana*.

Stem to 2 m tall, rarely to 4 m, 10–15 cm diam. Fronds 55–110 cm long, sharply keeled in section (opposing pinnae inserted at 45–60 degrees on rhachis), with 120–260 pinnae; rhachis usually terminated by a spine; petiole glabrous, 12–24 cm long; median pinnae at 45–60 degrees to rhachis, 90–170 mm long, 4.0–6.0 mm wide, glabrous, semi-glossy, mid-green to yellow-green, flat in section, decurrent for 2–4 mm, narrowed to 3.0–4.0 mm at base (65–85% of maximum width), 5–10 mm apart on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with ferruginous trichomes, not persistent. Cataphylls slender, thickly orange-brown-tomentose. Microsporangiate cones ovoid, 15–20 cm long, 8–11 cm diam. Microsporophyll fertile zone 22–26 mm long, 9–13 mm wide, abruptly narrowed; sterile zone 7–10 mm long, recurved; apical spine sharply upturned, 6–9 mm long. Megasporophylls 16–32 cm long, loosely ferruginous-tomentose, with 4–6 ovules; lamina 50–80 mm long, 16–37 mm wide, narrowly triangular, regularly finely dentate, apical spine 20–25 mm long. Seeds ovoid, green becoming yellowish, strongly pruinose, 30–40 mm long, 27–38 mm diam.; sarcotesta 3–4 mm thick. Fig. 9.

Distinguished in Australia by the initially bluish fronds becoming yellowish green, the moderately broad pinnae with recurved margins, the thick orange tomentum around the cataphylls, and the broad lamina of the megasporophylls.

Known from the Petford district on the northwestern Atherton Tableland, and a disjunct population about 250 km to the south on Wandovale station (Fig. 10a). In both localities, it occurs in open grassy ironbark-dominated woodland on shallow loamy soils on stony slopes over acid to intermediate volcanics.

The name *C. cairnsiana* has been misapplied to this taxon by botanists and growers alike. The type locality of *C. cairnsiana* was unknown for a long period, but has been recently rediscovered.

An extensive and variable population in the Irvinebank–Ravenshoe–Mt Garnet district (fig. 10b) on the western Atherton Tableland is intermediate in all respects between *C. platyphylla* and *C. media*. This occurrence is regarded as a highly variable breeding population that was originally of hybrid origin between these two taxa, but would now have limited scope for genetic interchange with the parent species.

The epithet is from the Greek *platys*, broad, and *phyllon*, leaf, in reference to the broad sterile tip of the megasporophyll.

CONSERVATION STATUS: 2V-. The range of this species is small, and none of the habitat is conserved. The species is also under threat from commercial collectors.

SELECTED SPECIMENS (from 11 examined): QUEENSLAND: Cook District: between Lappa and Petford, 80 km W of Mareeba, *Moriarty 1454*, 24 Aug 1973 (CANB, BRI); Lappa Junction, *Martin & Gould*, Apr 1965 (BRI); 1 km from Lappa Junction on road to Petford, *Clarkson 4248*, 13 Jan 1982 (BRI); 4 km from Petford towards Lappa Junction, *Maconochie 2675*, 13 June 1981 (DNA, NSW); 4.3 km from Petford on Herberton road, *Hill 3763 & Stanberg*, 1 Aug 1990 (NSW); 57.6 km from Chillagoe on road to Petford, *Hind 6094 & Holland*, 21 Oct 1990 (NSW). North Kennedy District: Montgomery Range, Wandovale station, *Hill 4137, 4138 & Stanberg*, 28 Sep 1991 (NSW, BRI, CANB).

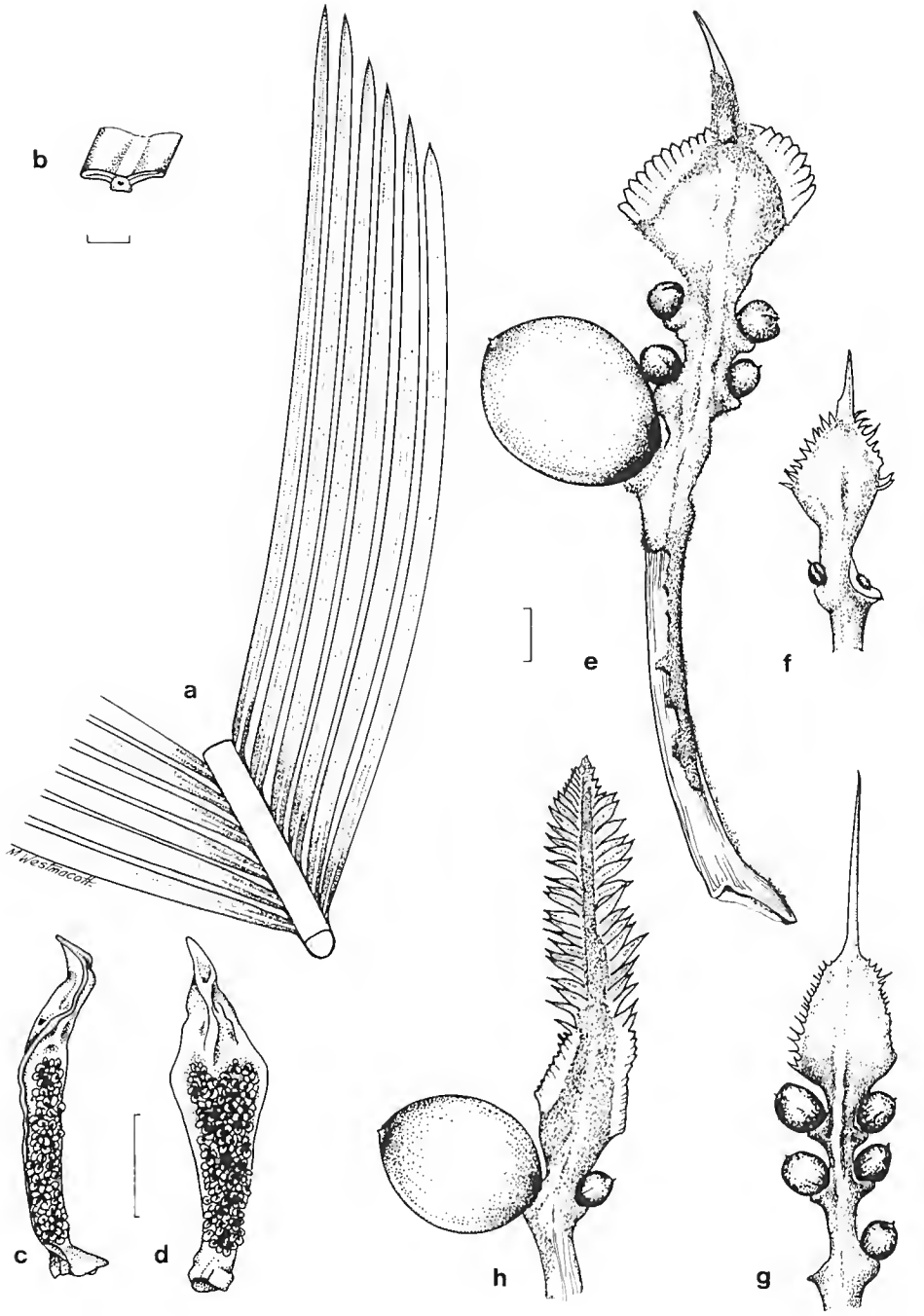

Fig. 9. *Cycas platyphylla*. **a**, part of frond; b, section of pinna; **c**, **d**, microsporophyll; e, megasporophyll with seed and stipe; **f**, **g**, h, tips of different megasporophylls (a, b, g, h, from *Hind 6094*; c, d, from *Hill 3763*; e from *Hill 3764*; f from *Hill 4137*). Scale bar: a, b, d, e, f = 1 cm; c = 2 mm.

INTERGRADING POPULATIONS: *C. platyphylla – C. media*

QUEENSLAND: Cook District: Stannary Hills, *Gittins*, June 1962 (NSW); 1.5 km E of Irvinebank, *Hill 3766 & Stanberg*, 1 Aug 1990 (NSW, BRI, CANB, DNA, MEL); 2 km E of Irvinebank, *Maconochie 2668*, 13 June 1981 (DNA, BRI, NSW).

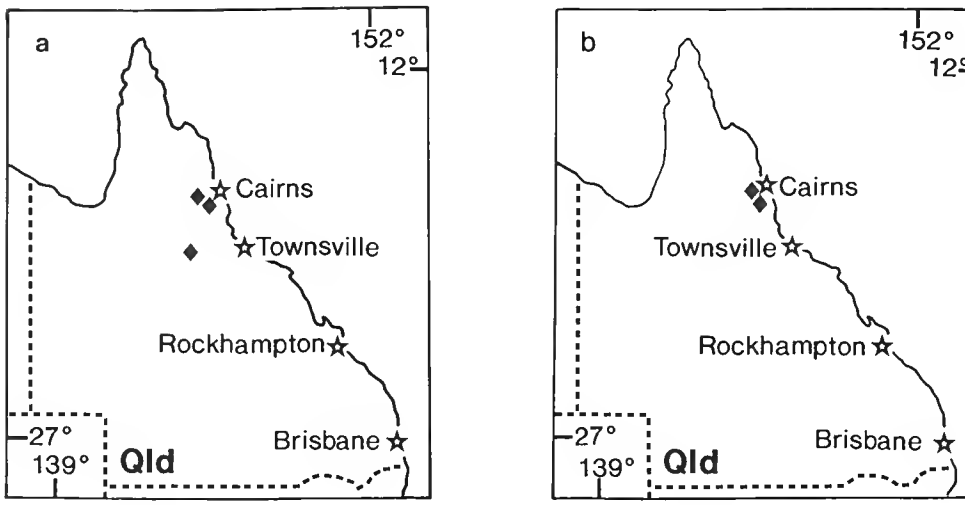

Fig. 10. a, Distribution of *C. platyphylla*; b, distribution of *C. media – C. platyphylla*.

6. Cycas cairnsiana *F. Muell.*, Fragm. 10: 63 (1876).

TYPE CITATION: 'Ad montes Newcastle-Range; Armit.'

TYPE: holo MEL (photo seen). This matches most nearly the material collected recently from the O'Briens Creek locality.

Stem to 2 m tall, rarely to 5 m, 12–16 cm diam. Fronds 60–110 cm long, strongly keeled in section (opposing pinnae inserted at 30–90 degrees on rhachis), with 180–280 pinnae; rhachis usually terminated by paired pinnae; petiole glabrous, 18–27 cm long; median pinnae at 20–60 degrees to rhachis, 80–180 mm long, 2.0–3.0 (rarely to 4.0) mm wide, glabrous, strongly waxy glaucous light blue, strongly recurved or revolute in section, decurrent for 2–3 mm, narrowed to 2.0–3.0 mm at base (80–100% of maximum width), 5–6 mm apart on rhachis; midrib not or slightly raised above, prominent below. New growth densely loosely tomentose with thick orange-brown trichomes, not persistent. Cataphylls slender, thickly bright orange-brown-tomentose. Microsporangiate cones ovoid, 16–20 cm long, 7–10 cm diam. Microsporophyll fertile zone 22–34 mm long, 12–15 mm wide, abruptly narrowed; sterile zone 12–15 mm long, recurved; apical spine sharply upturned, 6–9 mm long. Megasporophylls 16–21 cm long, loosely orange-brown-tomentose, with 2–4 ovules; lamina 40–70 mm long, 15–25 mm wide, narrowly triangular, regularly dentate, apical spine 15–20 cm long. Seeds ovoid, green becoming yellowish, strongly white-pruinose, 36–42 mm long, 30–37 mm diam.; sarcotesta 3–4 mm thick. Fig. 11.

Distinguished in Australia by the dense but very loose orange tomentum on new growth, the glabrous, strongly waxy and very glaucous mature fronds and seeds, and the very narrow pinnae with strongly recurved margins.

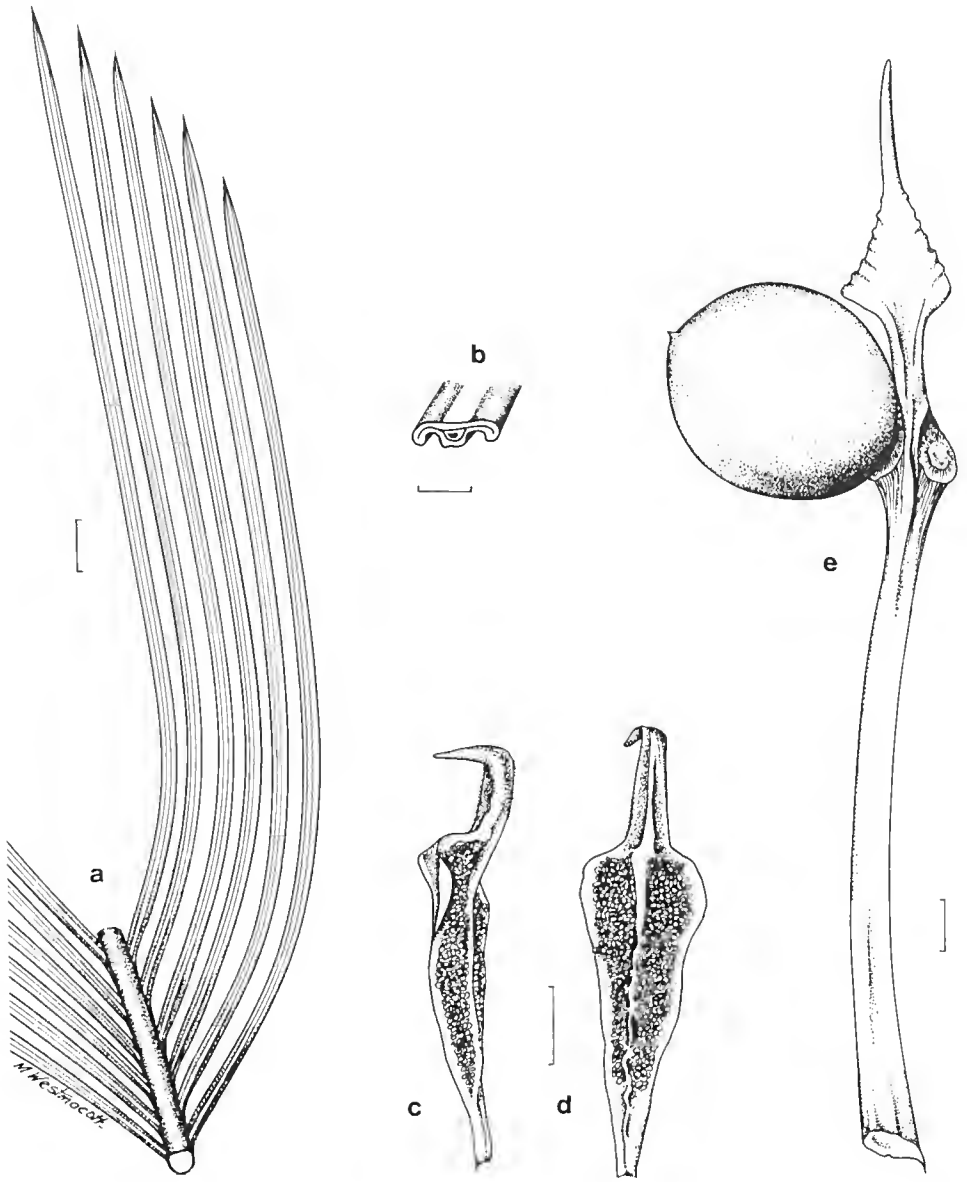

Fig. 11. *Cycas cairnsiana*. **a**, part of frond; **b**, section of pinna; **c**, **d**, microsporophyll; **e**, megasporophyll with seed and stipe (from *Hill 3756*). Scale bar: a, c, d, e = 1 cm; b = 2 mm.

Known from only two rather extensive and scattered populations about the Newcastle Range in the drier country of northeastern Queensland, on shallow to skeletal gritty soils over siliceous granites (Fig. 12). Plants from the population near Forsayth have slightly wider pinnae than those from near Mt Surprise.

CONSERVATION STATUS: 2V-. Although both known populations are large, neither area is conserved and the striking appearance of this plant places it under considerable long-term threat from commercial collectors.

SPECIMENS EXAMINED: QUEENSLAND: Cook District: O'Briens Creek, 42 km by road from Mt Surprise, *Hill 3757 & Stanberg*, 31 July 1990 (NSW, BRI); Robin Hood station, c. 1 km E of homestead, *Hill 3756*, 30 July 1990 (NSW); heads of the Robinson and Percy Rivers, *Armit*, 1876 (BRI, NSW).

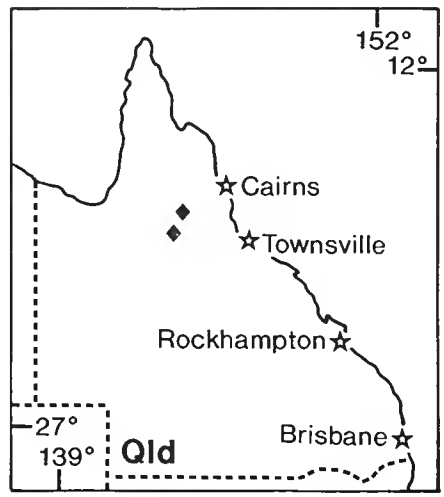

Fig. 12. Distribution of *C. cairnsiana*.

7. Cycas couttsiana *K. Hill*, sp. nov.

Inter species australienses pinnis latis subsecundisque glaucisque marginibus leviter recurvatis vel fere planis, tomento albo persistentique, fructibus valde glaucis, distinguitur.

TYPE: QUEENSLAND: Burke District: Chudleigh Park station, Gregory Range, on the upper Stawell River, *Hill 3738 & Stanberg*, 29 July 1990 (holo NSW; iso BRI, CANB, DNA, K, MEL).

Stem to 3 m tall, rarely to 7 m, 14–20 cm diam. Fronds 100–130 cm long, strongly keeled in section (opposing pinnae inserted at 30–90, sometimes to 150 degrees on rhachis), with 180–270 pinnae; rhachis usually terminated by a spine; petiole usually grey-tomentose, 17–21 cm long; median pinnae at 40–80 degrees to rhachis, 170–210 mm long, 4.5–6.0 mm wide, glabrous above, usually sparsely white-tomentose below, dull blue-green, margins recurved, decurrent for 2–5 mm, narrowed to 3.0–4.5 mm at base (60–80% of maximum width), 5–9 mm apart on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with grey-white and some pale orange-brown trichomes, usually persistent. Cataphylls slender, thinly pale grey-brown-tomentose. Microsporangiate cones ovoid, 15–20 cm long, 7–9 cm diam.

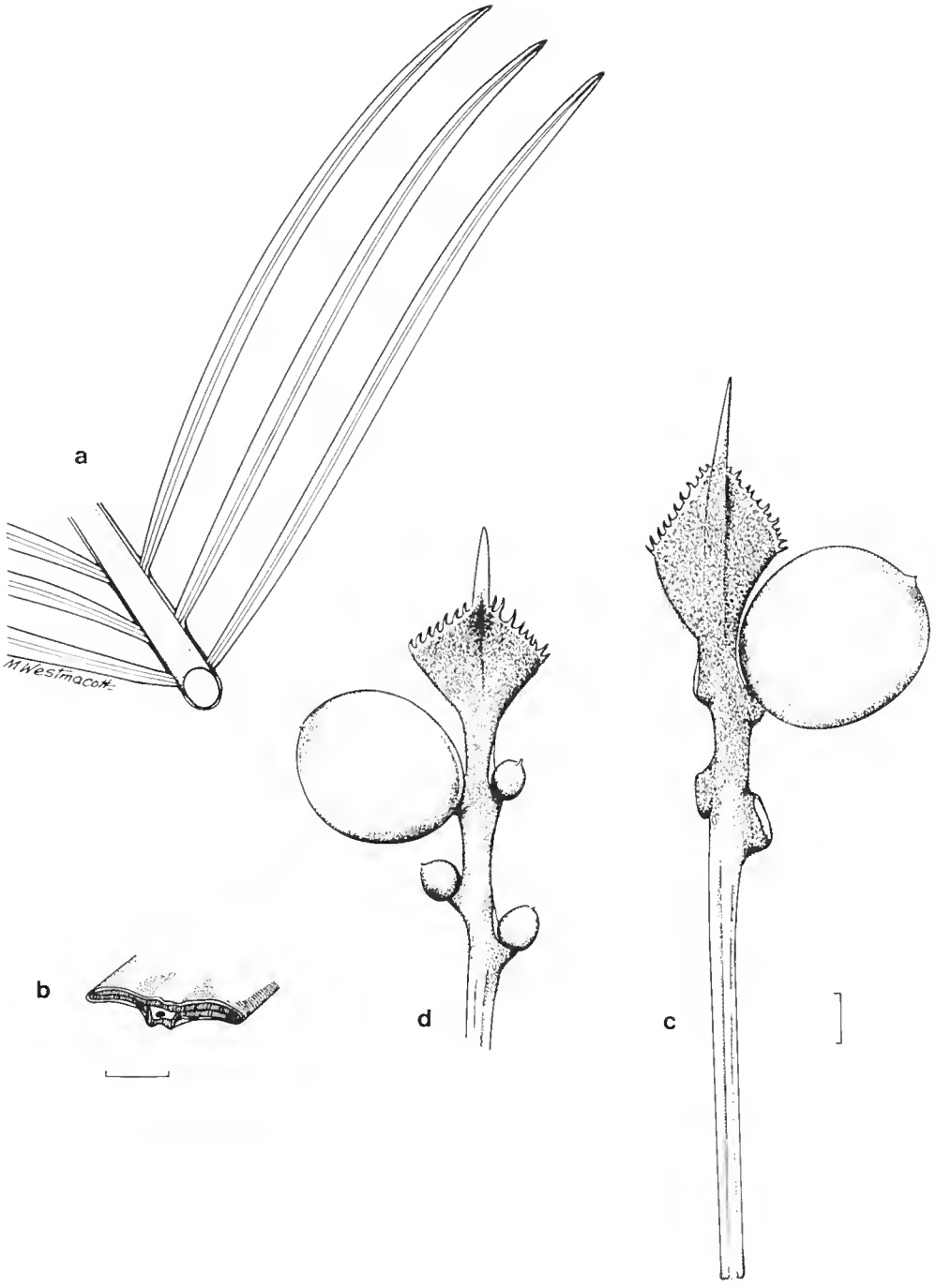

Fig. 13. *Cycas couttsiana*. **a**, part of frond; **b**, section of pinna; **c**, megasporophyll with seed and stipe; **d**, tip of megasporophyll with seed (a, b, c, from *Hill 3738*; d, from *Hill 3726*). Scale bar: a, c, d = 1 cm; b = 2 mm.

Microsporophyll fertile zone c. 25 mm long, c. 12 mm wide, abruptly narrowed; sterile zone c. 8 mm long, recurved; apical spine sharply upturned, c. 8 mm long. Megasporophylls 16–26 cm long, grey-tomentose, with 4–6 ovules; lamina 40–60 mm long, 20–30 mm wide, narrowly triangular, regularly dentate, apical spine 15–25 mm long. Seeds ovoid, green becoming yellowish-brown, strongly pruinose, 35–46 mm long, 28–38 mm diam.; sarcotesta 3–4 mm thick. Fig. 13.

Distinguished in Australia by the relatively broad, subsecund, bluish pinnae with slightly recurved to almost flat margins, the persistent white tomentum, and the strongly glaucous seeds. This species is similar to *C. brunnea* and *C. angulata*, but the plants are less robust and it lacks dark brown trichomes. *C. angulata* differs from the other two species in being less glaucous.

Known from several populations in the southern Gregory Range of Queensland (Fig. 14). It occurs in open grassy woodlands on red sandy loams derived from basalt or dolerite. An occurrence represented by a collection ostensibly from near Pentland (below) could not be corroborated during recent enquiries around this area.

The epithet honours Pat and David Coutts, leaseholders of 'Chudleigh Park' station and cycad enthusiasts, who brought this taxon to my attention and who are taking steps to ensure its conservation in the habitat.

CONSERVATION STATUS: 3R- (or 2R-). Although restricted, several of the known populations are large and not under substantial threat.

SPECIMENS EXAMINED: QUEENSLAND: Burke District: 'Chudleigh Park' station, Gregory Range, on the upper Stawell River, *Hill 3726, 3730, 3740 & Stanberg* (from separate populations), 29 July 1990 (NSW); 'Chudleigh Park' station, c. 20 miles [32 km] W of homestead, *Neal*, 11 Apr 1965 (BRI); Betts Creek, Pentland, *Carson*, Jan 1960 (BRI).

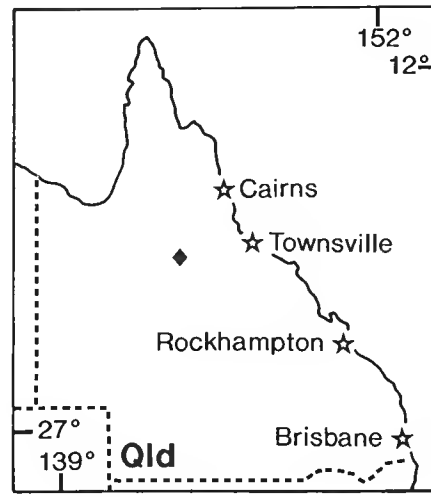

Fig. 14. Distribution of *C. couttsiana*.

8. **Cycas brunnea** *K. Hill*, **sp. nov.**

Inter species australienses pinnis latis glaucisque et late patentibus marginibus leviter recurvatis vel fere planis, trichomatibus frondium juvenilium brunneis, fructibus grandibus et valde glaucis, distinguitur.

TYPE: QUEENSLAND: Burke District: Running Waters, Lawn Hill Creek (18°43'S 138°28'S, *Maconochie 1661*, 16 Nov 1972 (holo DNA, iso BRI).

Stem to 2 m tall, rarely to 5 m, 17–23 cm diam. Fronds 120–170 cm long, usually keeled in section (opposing pinnae inserted at 90–135 degrees on rhachis), with 160–240 pinnae; rhachis usually terminated by a short spine (to 10 mm); petiole glabrous or grey-tomentose, 28–60 cm long; median pinnae at 40–50 degrees to rhachis, 170–270 mm long, 6.0–7.5 mm wide, glabrous or loosely grey-white-tomentose, distinctly blue when new, becoming glossy greyish green, flat or keeled in section, with usually slightly recurved margins, decurrent for 2–6 mm, narrowed to 4–5 mm at base (55–75% of maximum width), spaced at 9–13 mm on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with brown trichomes, cataphylls orange-brown-tomentose. Microsporangiate cones ovoid, c. 21 cm long, c. 13 cm diam. Microsporophyll fertile zone c. 39 mm long, c. 19 mm wide; sterile zone c. 17 mm long, not recurved; apical spine slender, sharply upturned, c. 28 mm long. Megasporophylls 28–32 cm long, orange-tomentose, with 4–6 ovules; lamina 45–80 mm long, 18–22 mm wide, narrowly triangular, regularly finely dentate, apical spine 16–32 mm long. Seeds ovoid, green becoming orange, pruinose, 36–39 mm long, 28–32 mm diam.; sarcotesta 2–4 mm thick. Fig. 15.

Distinguished in Australia by the relatively broad bluish pinnae with slightly recurved to almost flat margins on openly keeled fronds, the dark brown trichomes on new growth, and the large, strongly glaucous seeds. Most similar to *C. angulata* in habit, the large seeds, the dark brown tomentum, and the regularly finely dentate megasporophyll lamina, but distinguished from that species by the broader, flatter pinnae (margins less recurved) which are more widely spaced on the rhachis, the generally more strongly glaucous leaves and seeds, and the smaller seeds.

Known from several populations in the headwaters of Lawn Hill Creek and its tributaries in Queensland, and on Wollogorang station in the Northern Territory (Fig. 16). The Lawn Hill Creek occurence is on limestone or alluvium derived from limestone, in exposed situations along small, open creek valleys. The Wollogorang occurrences are small relictual stands in sandy alluvium in gorges in siliceous sandstone.

The epithet is from the late Latin *brunneus*, brown, in reference to the brown trichomes on new growth that distinguish this from related taxa.

CONSERVATION STATUS: 3RC. Although restricted, some populations are within a national park and not under substantial threat.

SELECTED SPECIMENS (from 6 examined): QUEENSLAND: Burke District: Running Waters, Lawn Hill Creek (18°43'S 138°28'S, *Maconochie 1659*, 16 Nov 1972 (DNA, NSW); Bubbling Brook, Lawn Hill Station (18°43'S 138°27'E), *Latz 1620C*, 24 July 1971 (DNA, BRI); c. 30 km E of 'Highland Plains' station (18°43'S 138°28'E), *Maconochie 1658*, 16 Nov 1972 (DNA, BRI); Colless Creek, Lawn Hill Natl Park, *O'Keefe*, Aug 1990 (NSW); Colless Creek, Lawn Hill Natl Park, *Hill 4136 & Stanberg*, 28 Sep 1991 (NSW). NORTHERN TERRITORY: Darwin & Gulf District: Wollogorang station, upper Settlement Creek, *Hill 4135 & Stanberg*, 27 Sep 1991 (NSW, CANB, DNA).

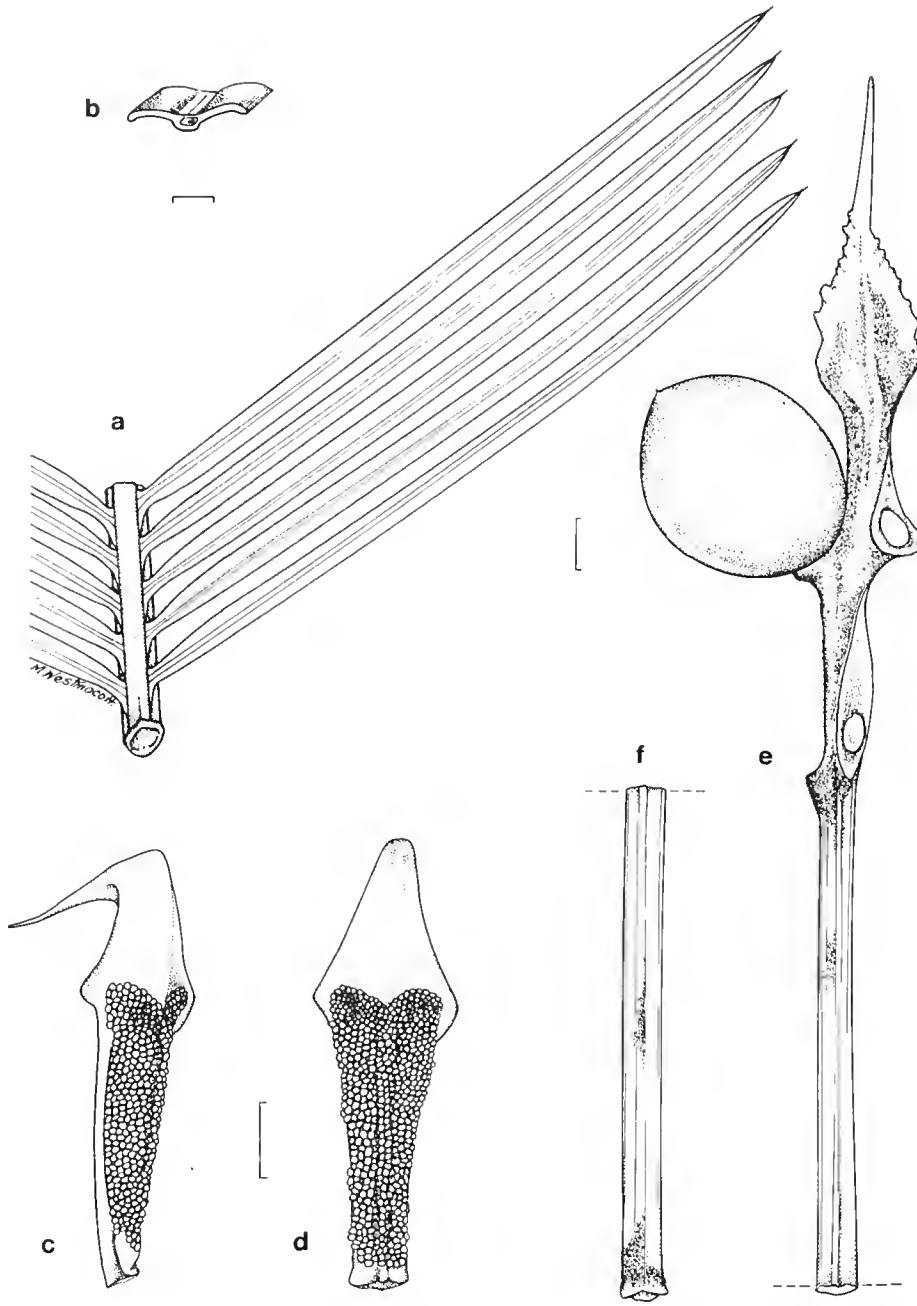

Fig. 15. *Cycas brunnea*. **a**, part of frond; **b**, section of pinna; **c**, **d**, microsporophyll; **e**, **f**, megasporophyll with seed and stipe (in two sections) (a, b, e f from *O'Keefe*, Aug 1990; c, d, from *Hill 4136*). Scale bar: a, b, d, e, f = 2 cm; c = 5 mm.

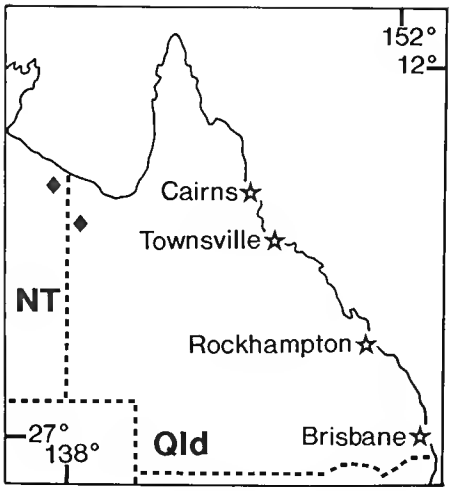

Fig. 16. Distribution of *C. brunnea*.

9. **Cycas angulata** *R. Br.*, Prodr., 348 (1810).

TYPE CITATION: '(T.) v.v.'

TYPE: *R. Brown* (holo BM, Bennett's numbering 3106 p.p., no original label, photo seen). Probably collected on 3–4 Dec 1802 from Bountiful Island, near Mornington Island in the Gulf of Carpentaria (Groves & Moore 1989). Recent recollections on that island have included this taxon (*Clarkson 7649*).

Stem to 5 m tall, rarely to 12 m, 15–25 cm diam. Fronds 110–170 cm long, usually keeled in section (opposing pinnae inserted at 90–135 degrees on rhachis), with 180–320 pinnae; rhachis terminated by paired pinnae; petiole glabrous or grey-tomentose, 28–52 cm long; median pinnae at 40–60 degrees to rhachis, 140–230 mm long, 4.5–6.5 mm wide, glabrous, distinctly blue when new, becoming glossy greyish green, flat or keeled in section, with recurved margins, decurrent for 2–4 mm, narrowed to 3–5 mm at base (70–80% of maximum width), spaced at 6–9 mm on rhachis; midrib not or slightly raised above, prominent below. New growth densely tomentose with white and orange trichomes. Cataphylls densely orange-tomentose. Microsporangiate cones ovoid, c. 20–25 cm long, c. 12–15 cm diam. Microsporophyll fertile zone 30–40 mm long, 15–20 mm wide; sterile zone 15–20 mm long, not recurved; apical spine slender, sharply upturned, 20–30 mm long. Megasporophylls 25–50 cm long, grey to orange-tomentose, with 6–12 ovules; lamina 50–105 mm long, 25–35 mm wide, narrowly triangular, regularly finely dentate, apical spine 12–38 mm long. Seeds ovoid, green becoming orange, not pruinose, 45–60 mm long, 40–50 mm diam.; sarcotesta 3–4 mm thick. Fig. 17.

Distinguished in Australia by the very robust habit, the keeled fronds with long bluish pinnae arranged at a relatively low angle to the rhachis, and the long megasporophylls with large numbers of large seeds and a relatively short, finely toothed lamina.

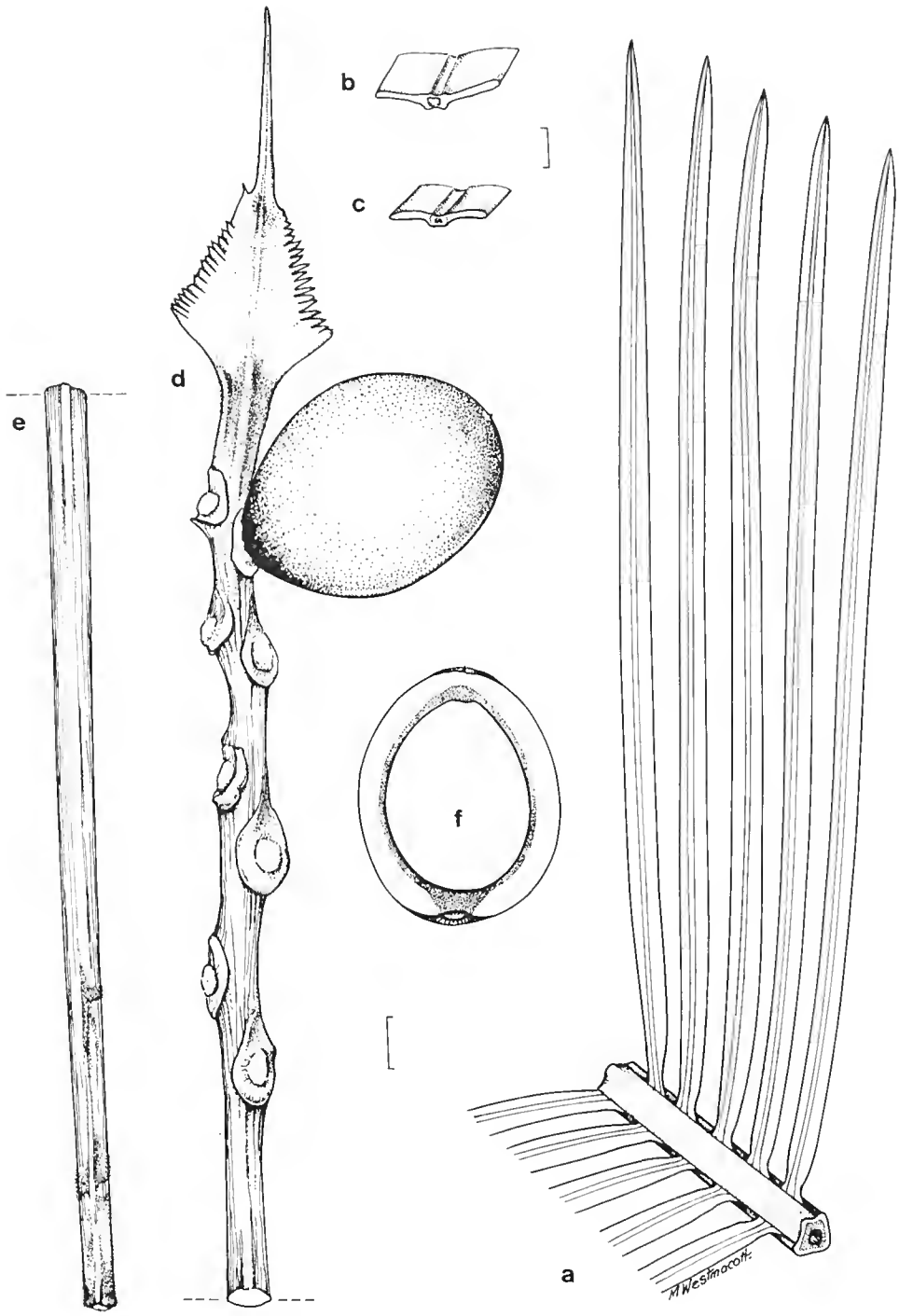

Fig. 17. *Cycas angulata*. **a**, part of frond; **b**, **c**, sections of pinnae; **d**, **e**, megasporophyll with seed and stipe (in two sections); **f**, longitudinal section of seed. (a, b, d, e, f, from *Hill 4132*; c, from *Hill 1146*). Scale bar: a, d, e, f = 1 cm; b, c = 2 mm.

A distinctive localised species, known from the lower reaches of the Wearyan, Foelsche and Robinson Rivers near Borroloola, and from the Bountiful Island group further east in the Gulf of Carpentaria (Fig. 18). In both areas it occurs in open grassy woodland or grassland on flat country on sandy alluvium.

This species forms local cycad-dominated woodlands in parts of the Northern Territory, but is less abundant in Queensland, where it is known at present only from offshore islands.

CONSERVATION STATUS: not considered to be at risk.

SELECTED SPECIMENS (from 6 examined): QUEENSLAND: Burke District: Bountiful Island (16°39'S 139°52'E), *Clarkson 7649 & Dillewaard*, 4 Dec 1988 (MBA, NSW). Northern Territory: Darwin & Gulf District: Wearyan River crossing on Borroloola – Burketown road, *Hill 1146, Johnson & Benson*, 6 Aug 1984 (NSW); 2 miles [3.2 km] E of Wearyan River, *Byrnes 2782*, 14 Sep 1972 (DNA, NSW); Manangoora station, at homestead, *Hill 4132 & Stanberg*, 26 Sep 1991 (NSW, CANB, DNA).

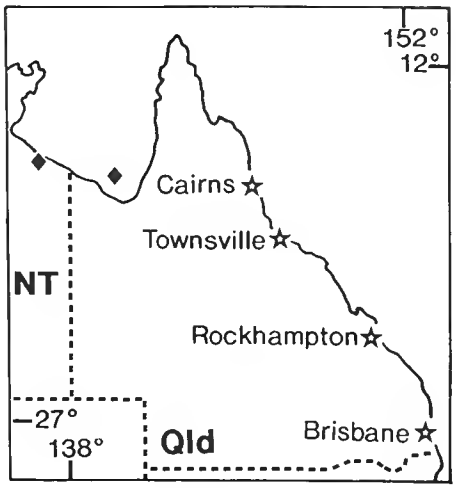

Fig. 18. Distribution of *C. angulata*.

Acknowledgements

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Studies in Australian Epacridaceae: Changes to *Styphelia*

J.M. Powell, G. Robertson, B.M. Wiecek and J.A. Scott

Abstract

J.M. Powell, G. Robertson, B.M. Wiecek and J.A. Scott (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1992. Studies in Australian Epacridaceae: Changes to Styphelia. Telopea *5(1): 207–227.* Two new species are described: **Styphelia psiloclada** J. Powell and **S. perileuca** J. Powell and variation within *S. laeta* and *S. viridis* studied. Two subspecies are recognised within *S. laeta* (subsp. *laeta* and subsp. **latifolia** (R. Br.) J. Powell, based on *S. latifolia* R. Br.) and var. *angustifolia* (DC.) Benth. is reinstated at species level as *S. angustifolia* DC. Within *S. viridis* two subspecies are recognised: subsp. *viridis* and subsp. **breviflora** (Benth.) J. Powell, based on *S. viridis* Andr. var. *breviflora* Benth. Notes on the nomenclature, types, distribution and ecology are given.

Introduction

Currently in Australia the genus *Styphelia* is accepted in the strict sense, as defined by Robert Brown (1810) rather than in the wider interpretation of F. Mueller (1867, 1889). It comprises 12 endemic species (possibly 18 taxa) and is found in all States except the Northern Territory.

The genus is distinguished from other members of the tribe Styphelieae in having revolute corolla lobes, filiform filaments and well-exserted versatile anthers. All *Styphelia* species are shrubby, and all have an erect to spreading habit except *S. adscendens*, which is decumbent. The flowering shoots are auxotelic, the flowers usually solitary with a bract-like rudiment of a second, or rarely two together on a short peduncle. The corolla has a cylindrical tube, hairy inside at the throat and either glabrous or with fine tufts of hair below the middle; the lobes are linear and bearded inside with ornamented hairs. The anthers are free, linear, attached at their midpoint to the filiform filaments that are inserted in the throat. The ovary is five-locular, the style filiform and longer than the corolla tube, the stigma small, lobed; the nectary is annular or in distinct scales. The mesocarp of the fruit can be dry or fleshy, the endocarp always hard and bony.

Bentham (1869) distinguished two sections within the genus on the basis of corolla hair distribution, namely *Eustyphelia* (equivalent to section *Styphelia*), having the corolla-tube with five dense tufts of hair below the middle, sometimes confluent in a ring, and *Soleniscia*, with the corolla-tube glabrous inside except for a few hairs in the throat. In New South Wales nine taxa within six species were described by Bentham (1869), all belonging to section *Styphelia*.

Study of collections held at the National Herbarium of New South Wales undertaken while preparing a treatment for the Flora of New South Wales indicated the presence of two new species and that re-assessment of the status of taxa within *Styphelia laeta* and *S. viridis* was needed.

Methods

Characters traditionally used in distinguishing taxa within *Styphelia* include leaf shape, surface flatness, leaf margin type and to a lesser extent leaf colour, apex shape, branch hairiness and habit and flower position. These characters were studied together with others, found also to be of value in distinguishing some taxa: leaf size, ratio of leaf length: width, leaf base shape, petiole length, numbers of flowers per inflorescence, bracteole and sepal size, sepal apex shape, corolla tube and lobe length, and the length of the anther and filament. Scanning electron microscopy of branchlet and leaf surfaces, of leaf margins and apices, and of corolla hairs and pollen was also used to provide additional and more detailed information.

In studying variation within each of *S. laeta* and *S. viridis* respectively, ranges of qualitative and quantitative attributes were tabulated, and polygonal graphs of the main discriminatory attributes drawn for the *S. laeta* taxa, to provide a preliminary assessment of the overall similarity of the taxa within each species.

Additionally, the main quantitative attributes were examined using the PATN package (pattern analysis, Belbin 1989a, b). A hierarchical classification was produced using the Gower Metric association measure together with UPGMA (FUSE program). The Gower Metric association measure was chosen as the most appropriate for continuous taxonomic data as it has the advantage of range standardization. The groupings displayed in the dendrogram (DEND) were defined using the group definition program GDEF and the attributes most responsible for forming the groups were determined using the GSTA program.

Ordination of the data was carried out using the SSH multidimensional scaling on the Gower metric association matrix and displayed as a scatter diagram (SCAT program). The principal correlation axes were derived using the PCC routine. These indicate how well the attributes relate to the ordination.

Results and Discussion

The new species

Specimens of the two new species had been included in *S. triflora*, or in *S. viridis*, since some of their leaf and floral characters are similar to one or other of these taxa, or intermediate between them. The main characters separating the two new species from *S. triflora* and *S. viridis* are given in Table 1.

S. psiloclada is similar to *S. triflora* in having glabrous branchlets and the leaf margins entire; the corollas and anthers of the two species are also of similar size. It differs, however, in leaf shape (being more like *S. viridis*), and in having shorter petioles and sepals. *S. perileuca*, on the other hand, is more distinct. The branchlet indumentum is of stiff hairs rather than soft (as in *S. viridis*), and the leaves are shorter than in either *S. triflora* or *S. viridis*. The flower colour may parallel some *S. triflora* populations but in flower size *S. perileuca* is at the lower end of the range of *S. triflora*. The leaves of both new species are convex adaxially while in *S. triflora* the leaves are usually concave adaxially. The habitats and distributions of the two new species as currently known also differ from *S. triflora* but, as the latter is the most widespread and variable species within *Styphelia*, further study of its populations is warranted. The new taxa are being recognised at the species level as they are morphologically distinct in a number of attributes or in the combination of attributes shown.

Table 1. Comparison of attributes of *S. triflora* and *S. viridis* with the two new taxa

Character	*S. triflora*	*S. viridis*	*S. psiloclada*	*S. perileuca*
Branchlet indumentum	glabrous	puberulent	glabrous	scabrous to hispid
Leaf shape	elliptic to oblong-elliptic	oblong to oblong-obovate or oblong-elliptic	oblong	broad-elliptic or oblong-elliptic
Leaf-blade length (mm)	14–33	14.8–25.6	8.3–17.4	6.2–11.8
Leaf-blade width (mm)	3–8.3	2.9–7.2	3.9–7.5	2.9–4.9
Leaf apex	acute	more or less obtuse	more or less obtuse	acute
Leaf base	cuneate	obtuse or ± cuneate	obtuse	± cuneate
Leaf indumentum	glabrous	glabrous	scabrous above	glabrous
Leaf margin	entire	denticulate-ciliolate	entire	denticulate-serrulate,hyaline
Lamina in T.S.	flat to concave	flat	flat to convex	slightly convex
Petiole length (mm)	2–4	1–2	0.3–1	0.5–1
Flower position	spreading to pendant	suberect to spreading	spreading to pendant	pendant
Flower no./inflorescence	1–3	1	1–2	1
Flower colour	pink to red, cream or pale yellow-green	translucent green	pink with fine red stripes	translucent yellow-green
Peduncle indumentum	glabrous	pubescent	scabrous	scabrous
Sepal length (mm)	8.2–13.4	12.7–16	5.5– 6.6	8.7–10
Sepal apex	± obtuse	acute to broadly so	obtuse	± obtuse
Sepal indumentum	glabrous	glabrous to puberulent near apex	glabrous	glabrous
Corolla-tube length (mm)	13–29.4	17–23	13.4–18.1	12–13.8
Corolla-lobe length (mm)	12.5–18	19–21	16.1–17.9	11.9–14.3
Anther length (mm)	3–5	5.9–6.3	3.7–4.8	2.4–3
Filament length (mm)	9–17.2	12–16	12.5–15.5	10.5–11.3

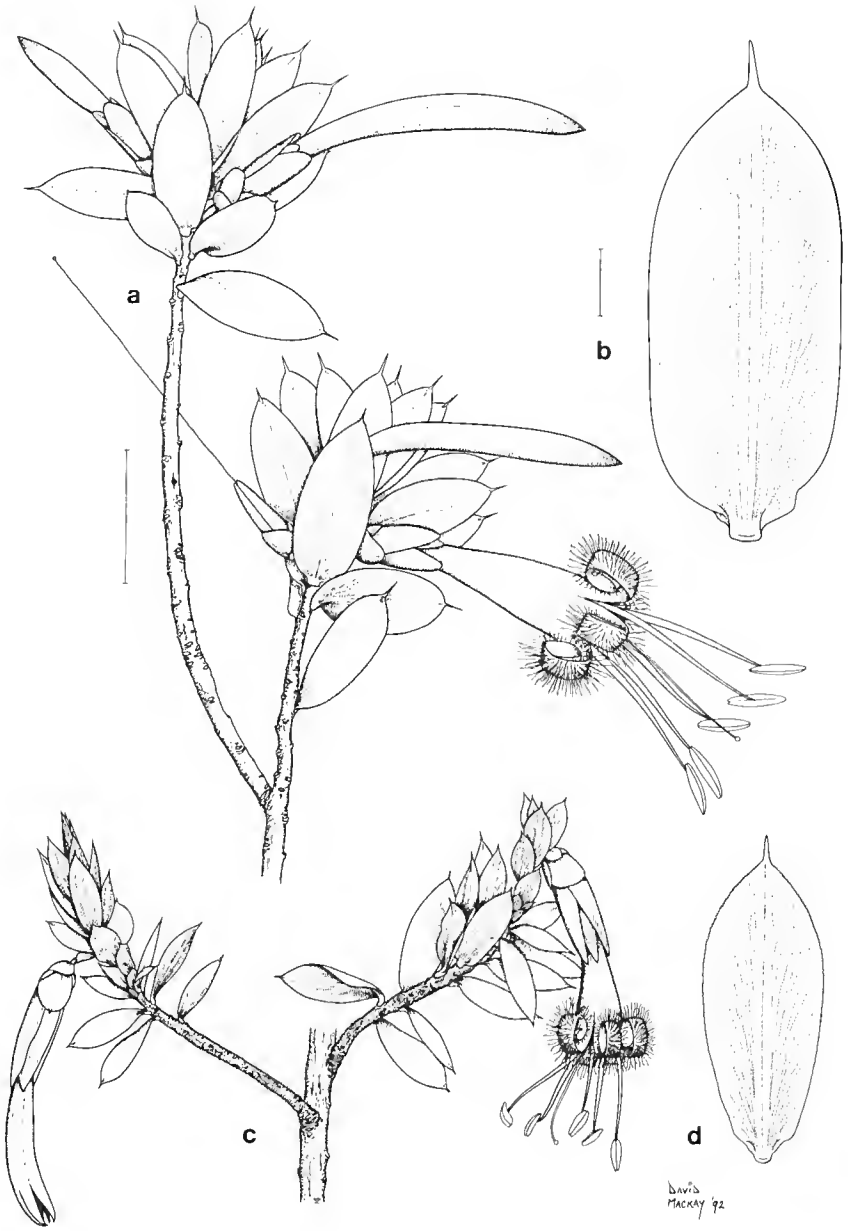

Figure 1. *S. psiloclada* J. Powell. **a**, habit; **b**, leaf detail (type specimen). *S. perileuca* J. Powell. **c**, habit; **d**, leaf detail (type specimen). Scale for habit = 1 cm; scale for leaf = 2 mm.

S. psiloclada *J. Powell*, **sp. nov.**

A *S. triflora* foliis venetis brevibus late oblongis aliquantum convexis, apicibus foliorum subobtusatis atque floribus parvulis differt; a *S. viridi* ramulis glabris et floribus roseis vel carmesinis differt.

TYPE: NEW SOUTH WALES: South Coast: Wadbilliga National Park, near Green Hole, N of Green Creek, c. 12 km ENE of Kydra, 36°25'45"S, 149°31'12"E, 1130 m alt., *P. Beesley 349 & D. Binns*, 27 Mar 1985 (holo CBG8502565, iso NSW, MEL; Figure 1a, b).

Erect to spreading shrub, 60–150 cm high; *stems* grey-brown, rounded, glabrous, with pale brown bark, rough and corky towards the base; *branchlets* brown or red-brown, slightly ribbed, glabrous. *Leaves* bluish or greyish green, evenly spaced, suberect to horizontally spreading, non-imbricate, spiral, oblong, rarely broadly ovate or more elliptic, 8.3–17.4 mm long, 3.9–7.5 mm wide (length:width ratio 1.9–2.8:1); apex broadly acute or obtuse, with an aristate tip 0.7–1.7 mm long; base obtuse; lamina flat to slightly convex and glabrous adaxially, discolorous, paler and papillose-scabrid abaxially; venation inconspicuous above, striate below with 3–5 central veins and many branches to the margin; margin very slightly recurved, entire but irregular, almost undulate towards the apex; *petiole* poorly developed to c. 1 mm long. Young seasonal growth leaves are shorter, broader, elliptic or obovate, the margin hyaline and minutely fringed overall. *Flowers* solitary or sometimes two together in the upper leaf axils, spreading to pendant, light pink or darker pinkish crimson outside, paler inside; *peduncles* 1.5–2 mm long, hispid, with a bract-like rudiment above the flower (when solitary) and 3–4 sterile bracts at the base. *Bracts* and *bracteoles* broadly ovate, subobtuse or obtuse, glabrous except for the ciliolate margins; bracts 1–1.9 mm long, 1.5–2.1 mm wide; bracteoles 2.6–3.2 mm long, 2.3–3.4 mm wide. *Sepals* tinged red, ovate, 5.5–6.6 mm long, 3–3.3 mm wide, obtuse, glabrous except for the ciliolate margins. *Corolla tube* exceeding sepals, cylindrical, 13.4–18.1 mm long, 4.6–4.9 mm wide, glabrous outside, sparsely pubescent inside and with a ring of hairs towards the base; *lobes* erect at the base, revolute above, 16.1–17.9 mm long, 2.1–2.5 mm wide, glabrous outside, inside sparsely hairy with the hairs longer over the upper half. *Anthers* fully exserted, 3.7–4.8 mm long, attached above the midpoint to the filament; filaments 12.5–15.5 mm long, glabrous. *Ovary* ovoid, 4–5 mm long, 3–4.2 mm wide, ridged, 5-locular, glabrous; style filiform, 27.5–35.3 mm long, glabrous; *nectary* annular but readily breaking apart into scales, 1–1.2 mm high, with lobed upper margin. *Fruit* not seen.

DERIVATION OF EPITHET: From the Greek *psilos*, bare or smooth and *clada*, branches, reflecting the lack of hairs on the stems and branches.

FLOWERING PERIOD: Flowers January to March.

HABITAT: Recorded as rare or occasional in open forests dominated by *Eucalyptus fastigata – E. radiata, E. fraxinoides* or *E. pauciflora – E. kybeanensis*, on rocky ridges, steep slopes and broad gullies with well- to poorly-drained skeletal sandy soils or sandy loams over granite or other igneous rocks at 900–1300 m altitude.

DISTRIBUTION: Known only from a few locations in the South Coast and Southern Tableland areas of New South Wales: the Northern Budawang Range and further south in Wadbilliga and Nalbaugh National Parks (Figure 2).

CONSERVATION STATUS: Listed in Briggs & Leigh (1988) as *Styphelia* sp.1 and coded as 3RC. While it is conserved in some southern New South Wales National Parks little is known of its abundance or overall distribution.

NOTES: The species belongs in section *Styphelia*. The pollen is periporate, scabrate and 'warty' as typical of other species within that section. The corolla hairs are unicellular, twisted and ornamented with short linear tubercles (Figure 3).

SPECIMENS EXAMINED: NEW SOUTH WALES: South Coast: Nalbaugh National Park, 1 km NW of Wog Wog Mt trig, *Albrecht 3058*, 21 Feb 1987 (MEL, NSW); ridge between White Rock and Wog Wog Mountains, *Gilmour 6169*, 21 Feb 1987 (CBG, NSW). Southern Tablelands: Wadbilliga National Park, Wadbilliga Fire Trail, c. 1 km E of Bunberry Ck crossing, *Gilmour*, 8 Mar 1983 (CBG 8313471, NSW); Wadbilliga Track near Tuross River, *Hamilton*, 28 Jan 1985 (CBG 8500846); Bulea Brook, Northern Budawang Range, *Olsen 2459*, Jan 1975 (NSW); c. 0.5 km S of Razorback Fire Trail, 14.6 km from junction with New England Fire Trail, *Rodd 6170, Kennedy & Whitehead*, 25 Jan 1991 (NSW, MEL).

Styphelia perileuca *J. Powell*, **sp. nov.**

A *S. triflora* ramulis hispidulis, foliis brevibus aliquantum convexis, marginibus foliorum denticulato-serrulatis et albidis vel hyalinis atque floribus parvulis differt.

TYPE: NEW SOUTH WALES: Northern Tablelands: Ebor to Guyra road, 5.3 km NW of Armidale road turnoff, *J.M. Powell 4500*, 3 Sep 1987 (holo NSW, iso BRI, MEL, K; Figure 1c,d).

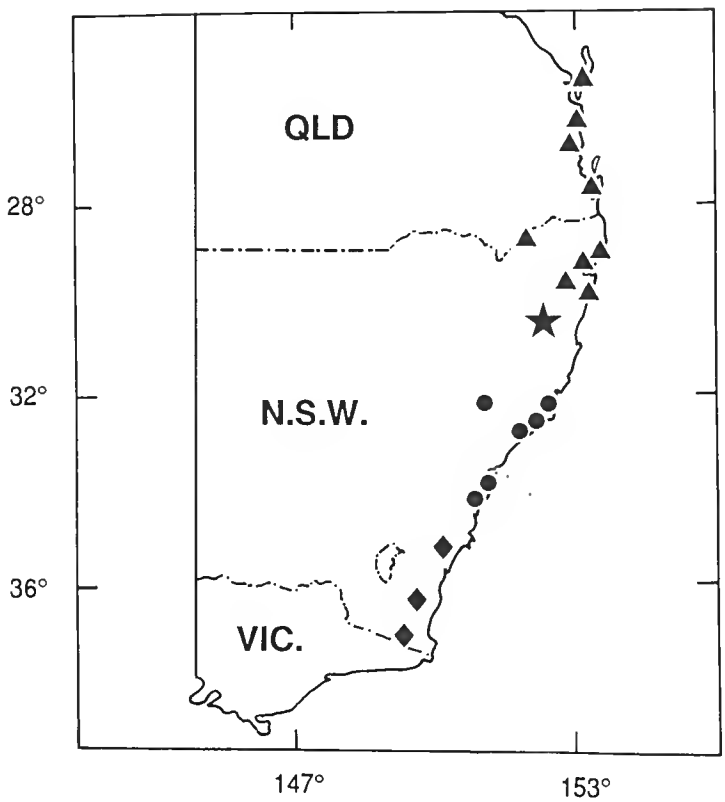

Figure 2. Distribution of *S. psiloclada* (◆), *S. perileuca* (★) and *S. viridis* subsp. *viridis* (●) and subsp. *breviflora* (▲).

Erect to spreading shrub 0.6–1.5–(3.3) m high and 1.0–3.6 m across; *stems* branching from the base, thin, grey-brown, rounded, glabrous, with tesselated bark; *branchlets* red-brown, slightly ribbed, scabrous to hispid. *Leaves* evenly spaced, suberect to horizontally spreading, non-imbricate, spiral, broadly elliptic or oblong-elliptic and sometimes obovate, 6.2–11.8 mm long, 2.9–4.9 mm wide (length:width ratio = 3–3.3:1); apex acute, straight, with an aristate tip 0.5–0.8 mm long; base narrowing; lamina thick, slightly convex adaxially, concolorous or slightly paler below, the upper surface glabrous or hispidulous towards the base, the lower glabrous; venation inconspicuous above, finely multiveined below, with three central parallel veins and many branches to the margin; margin slightly recurved, denticulate-serrulate and densely so towards the apex, usually white or hyaline; *petiole* ill-defined, yellowish, 0.5–1 mm long, scabrous above. Young seasonal growth leaves are shorter, broader, obovate and flatter, the margins straight rather than recurved, hyaline and minutely fringed with hairs. *Flowers* solitary in the upper leaf axils, pendant, translucent yellow-green with fine red stripes or pale green; *peduncles* 3.5–5 mm long, hispid, with a bract-like rudiment above the flower and 4–5 sterile bracts at the base. *Bracts* and *bracteoles* broadly ovate to sub-orbicular, obtuse, apiculate, striate-veined and with the midrib thickened towards the apex, glabrous except for the ciliolate margins; bracts 1.6–2 mm long, 2.1–2.6 mm wide; bracteoles 3.1–4.5 mm long, 3.2–6 mm wide. *Sepals* often reddish with the margins green, ovate, 8.7–10 mm long, 3.3–3.9 mm wide, sub-obtuse or obtuse, apiculate, glabrous except for the ciliolate to ciliate margins. *Corolla tube* exceeding the sepals, cylindrical, 12–13.8 mm long, 3.4–5.3 mm wide, glabrous externally, sparsely pubescent inside with a ring of hairs near the base; *lobes* erect at the base, revolute above, 11.9–14.3 mm long, 1.6–2.6 mm wide, acute, glabrous outside, inside sparsely hairy on the lower half, the hairs becoming denser towards the apex. *Anthers* 2.4–3 mm long, fully exserted, attached at or above the midpoint to the filament; filaments 10.5–11.3 mm, glabrous. *Ovary* ovoid 5–6 mm long, 2–3.5 mm wide, ridged, 5–locular; style filiform, 22–23 mm long; *nectary* annular, 1.4–1.6 mm high, with irregularly lobed upper margin. *Fruit* just exceeding the sepals, 8–11 mm high, 4–7 mm wide, 5–ridged, somewhat fleshy, translucent yellow-green.

Derivation of epithet: From the Greek *peri*, all round and *leukos*, white, referring to the white margin of the leaves.

Flowering period: Flowers and young fruit recorded mainly in September, December and January, with single records of buds and flowers in March and April respectively.

Habitat: Recorded as locally occasional in open eucalypt forests (associated with *E. dalrympleana, E. youmanii, E. radiata*) on broad ridges and gentle slopes at 1250-1500 m altitude, growing in sandy soils or light brown sandy loams over granite, and one record from heath on trachyte (J.B. Williams, pers. comm.).

Distribution: Known only from the Snowy Mountain Range and Round Mountain on the Northern Tablelands of New South Wales (Figure 2), and one record from the Lyrebird Track, New England National Park (J.B. Williams, pers. comm.).

Conservation status: This species can be classified as 2VC following Briggs & Leigh (1988). It is known to be conserved within Cathedral Rock National Park, but its overall abundance there is low – it is locally common over only 2–3 square kilometres and absent from all other areas visited within that park and from nearby granite areas (J.B. Williams, pers. comm.).

Notes: The species belongs to section *Styphelia*. The pollen is periporate, scabrate and sparsely 'warty', the corolla hairs unicellular, twisted and ornamented with short linear tubercles (Figure 3). It was collected in December 1893 by J.H. Maiden and labelled as *S. viridis* var. *breviflora* on the sheet, but he noted in his report (Maiden

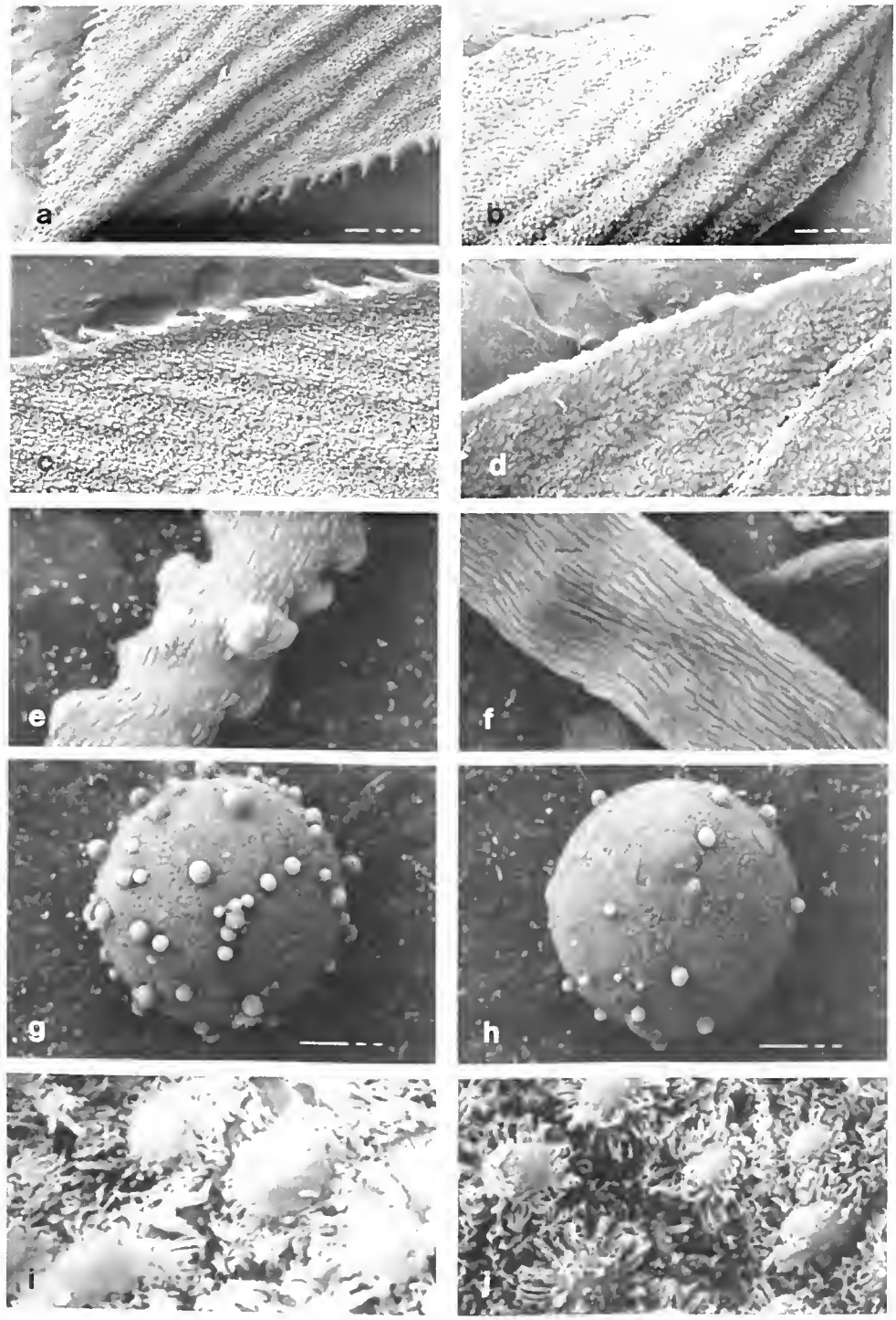

Figure 3. Scanning electron micrographs of the leaf apex, leaf margin, corolla hairs, pollen and lower leaf surface of *S. perileuca* (**a,c,e,g,i**) and *S. psiloclada* (**b,d,f,h,j**). a,b, leaf apex x 30; c,d, mid-leaf margin x 60; e,f, corolla hair x 900; g,h, pollen x 600; i,j, lower leaf surface x 1200 *S. perileuca*, x 900 *S. psiloclada*.

1895) '*Styphelia viridis*, Andr. var., *breviflora*, Benth. — Guy Fawkes to Round Mountain (on the very summit). — It is not likely that Bentham's "northern parts of New South Wales" includes this sub-alpine locality in which I found it.' The species was collected again in 1968 by H. Wissman and recognised as a distinct taxon by Wissman and J.B. Williams in April 1970, with specimens in the herbarium at the University of New England (NE) being annotated as such.

SPECIMENS EXAMINED: NEW SOUTH WALES: Northern Tablelands: Round Mountain, Snowy Range, Ebor-Armidale, *Burgess*, 26 Sep 1972 (NSW 245925); Guy Fawkes and Round Mountain, *Maiden*, Dec 1893 (NSW 245929); Ebor - Guyra road, 5.3 km NW from Armidale Road turnoff, *Powell 4505*, 3 Sep 1987 (NSW, CANB, MEL); Snowy Mountain Range, track to Woolpack Rocks, 5 km NNE of Round Mountain, *Telford 10417*, 27 Sep 1987 (CBG, BRI, MEL, NSW); Cathedral Rock National Park, c. 2 km N of Cathedral Rock, *Telford 10783*, 2 Jan 1989 (CBG, NSW); 10 miles [16 km] WSW of Ebor and 1 mile [1.6 km] NW of Round Mountain, *Williams*, 26 Sep 1972 (NE 045342); Hill 0.5 km N of Round Mountain, c. 12 km W of Ebor, *Williams*, 14 Mar 1970 (NE 037390); near Snowy Creek, Ebor, *Williams & Wissman*, 21 Oct 1969 (NE 022139); *Wissman*, Apr 1968 (NE 022138).

Variation within *Styphelia laeta* R. Br.

Bentham's (1869) treatment of *Styphelia laeta* as a species with three varieties has been generally accepted, but the two infraspecific taxa, var. *latifolia* (R. Br.) Benth. and var. *angustifolia* (DC.) Benth., were originally considered to be of specific rank and described as such by R. Brown (1810) and de Candolle (1839) respectively. The characters used to distinguish the taxa included leaf shape, surface flatness, and leaf margin type. Descriptions of some of the taxa included also leaf colour, leaf apex, branch hairiness, habit and flower position.

Many of these characters, together with leaf-base shape, sepal-apex shape and measurements of leaf-blade length and width, petiole length, bracteole and sepal length and hairiness, and anther and filament lengths (Figure 4) formed the basis for our reassessment of the variation within the species in the broad sense. Three specimens from Brisbane Water National Park included in *S. laeta* var. *laeta* appeared somewhat distinct in a number of attributes and were treated as a separate entity. The above characters were tabulated (Table 2). The qualitative attributes of importance in separating the taxa are branchlet indumentum and the leaf margin structure (Figures 5, 6), the adaxial leaf surface and the shape of the leaf apex and base. Discontinuities were present also in a number of the quantitative attributes. A preliminary assessment of the overall similarity of the taxa and a polygonal graph of the best discriminatory attributes suggested that *S. laeta* var. *angustifolia* was more distinct from both *S. laeta* var. *laeta* and *S. laeta* var. *latifolia* than they were from each other, and could warrant specific rank.

These observations were examined using PATN (Belbin 1989*a*, *b*). The data set consisted of the measurements of leaf-blade length, leaf-blade width, petiole length, sepal length, bracteole length and the angle subtended by the leaf apex (Figure 4) from 35 specimens.

The classification analysis indicated four groupings. The group 'statistics' (GSTA) showed that leaf-blade width separated the var. *angustifolia* taxon completely from the other three groups and var. *latifolia* from the other two groups. The leaf-apex angle and bracteole length both partly separated the groups although the ranges overlapped. Sepal length and blade length separated the Brisbane Water taxon from the other three groups. The ordination confirmed the presence of four groups and the distinctiveness of both the var. *angustifolia* and the Brisbane Water specimens.

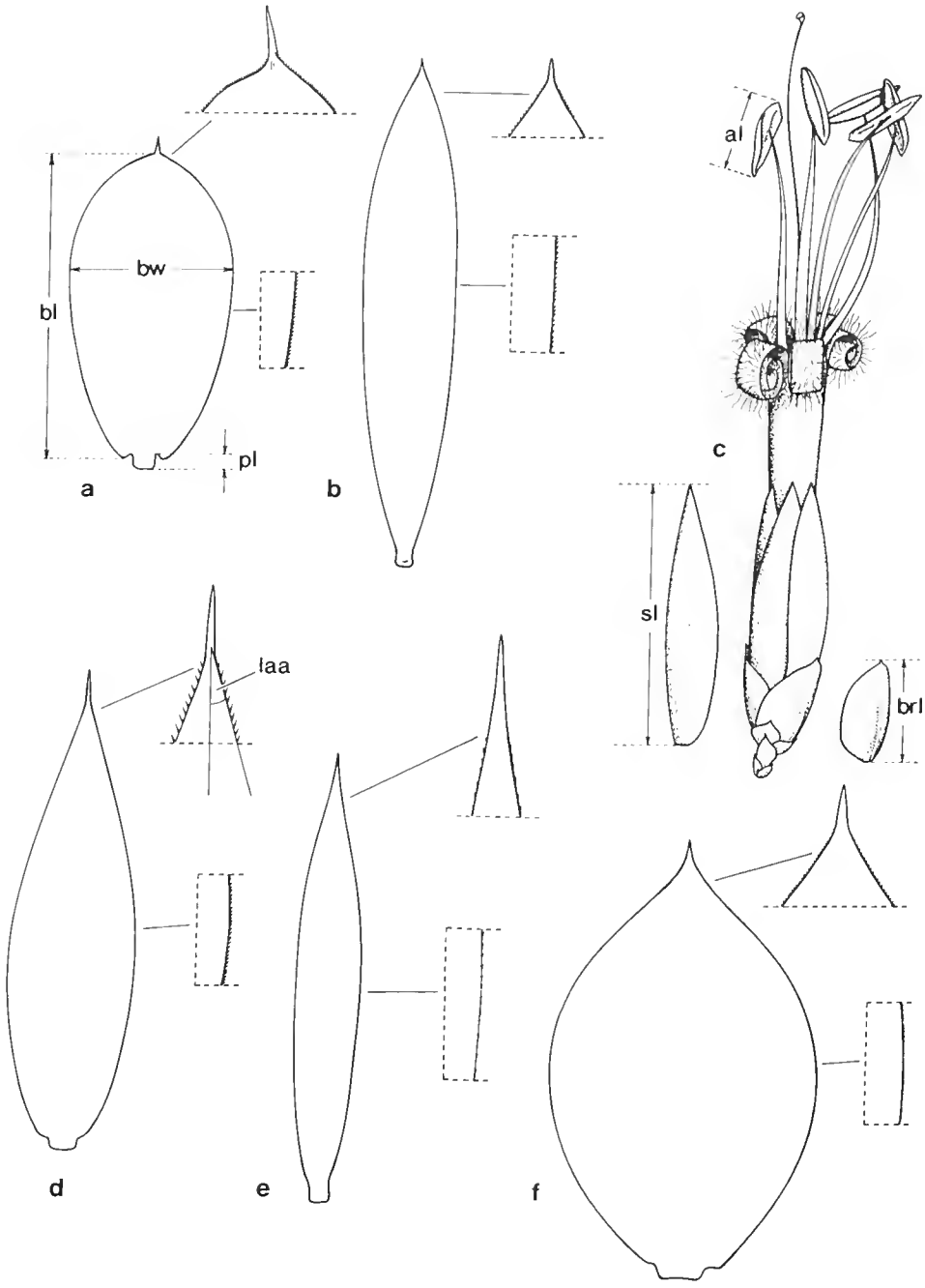

Figure 4. Attributes of *Styphelia* studied and measured. **a**, *S. viridis* subsp. *viridis*; **b,c**, *S. viridis* subsp. *breviflora*; **d**, *S. laeta* subsp. *laeta*; **e**, *S. angustifolia*; **f**, *S. laeta* subsp. *latifolia*; bl: blade length; bw: blade width; pl: petiole length. al: anther length; sl: sepal length; brl: bracteole length; laa: leaf apex angle.

Table 2. Comparison of attributes of taxa within *Styphelia laeta*

Character	var. *laeta*	var. *laeta* (Brisbane Water)	var. *latifolia*	var. angustifolia
Branchlet indumentum	sparsely velutinous	velutinous	woolly	densely velutinous
Leaf shape	elliptic to ovate-elliptic	narrowly ovate-elliptic	ovate	elliptic
Leaf margin	denticulate–ciliolate	ciliolate	fine-ciliolate	sparsely denticulate–serrulate
No. teeth/mm margin mean	9–17 (–34) 14.8	10–24 15.2	22–35 27.2	3.6–7.8 5.1
Leaf-blade length (mm)	17.4–24.3	27.9–31	15.8–24.8	18.9–25.1
Leaf-blade width (mm)	5.0–7.2	6.5–7.5	8.8–11.3	2.7–4.5
Leaf length:width ratio	2.5–3.8	4–4.3	1.6–2.4	3.8–8.3
Leaf apex	acute–acuminate	acuminate	cuspidate–acute	narrow-acute
Leaf-apex angle	32–48	21–37	45–75	14–27
Leaf indumentum adaxial surface	scabridulous	hispidulous or tuberculate	tuberculate	scabrous at midline
Leaf base	truncate	truncate	truncate	± cuneate
Petiole length (mm)	0.5–1	0.5–1.2	0.5–1.2	0.5–2
Bracteole length (mm)	2.3–4	4.2–6.5	4–5	3–4
Sepal length (mm)	8.5–10.5	12.3–15.5	10–12.5	8.5–11.5
Sepal apex	acute–obtuse	acute	acute	acute–obtuse
Sepal margin	ciliate	ciliolate	ciliate overall or towards apex	±glabrous or very sparse-ciliolate
Sepal indumentum	glabrous to pubescent	pubescent	glabrous or antrorse pubescence at apex	glabrous, tip pubescent

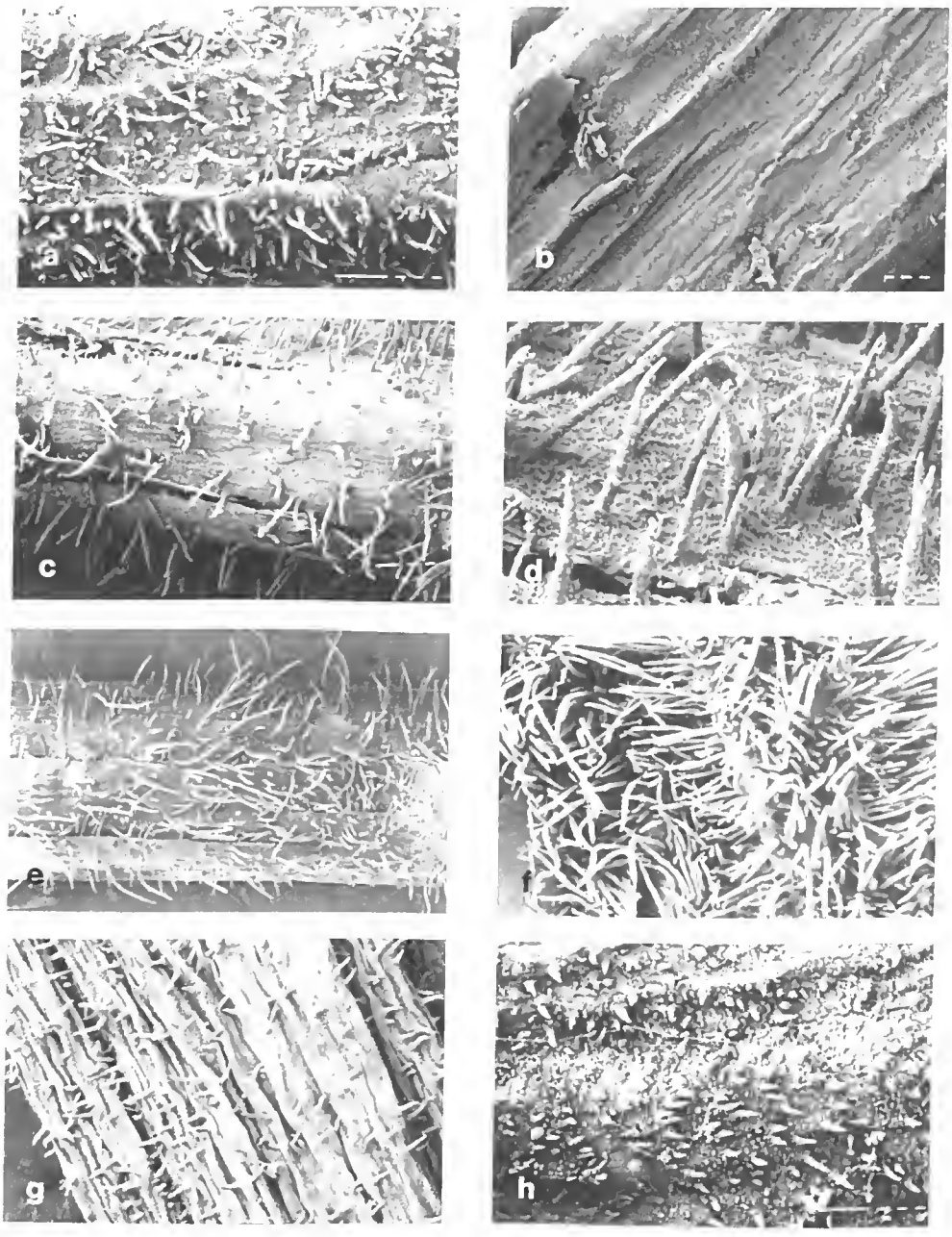

Figure 5. Scanning electron micrographs of branchlets hairs of *Styphelia*. **a**, *S. perileuca* x 60; **b**, *S.psiloclada* x 120; **c,d**, *S. laeta* subsp. *laeta* x 30, x 150; **e**, *S. angustifolia* x 30; **f**, *S.laeta* subsp. *latifolia* x 30; **g**, *S. viridis* subsp. *breviflora* x 60; **h**, *S. viridis* subsp. *viridis* x 60.

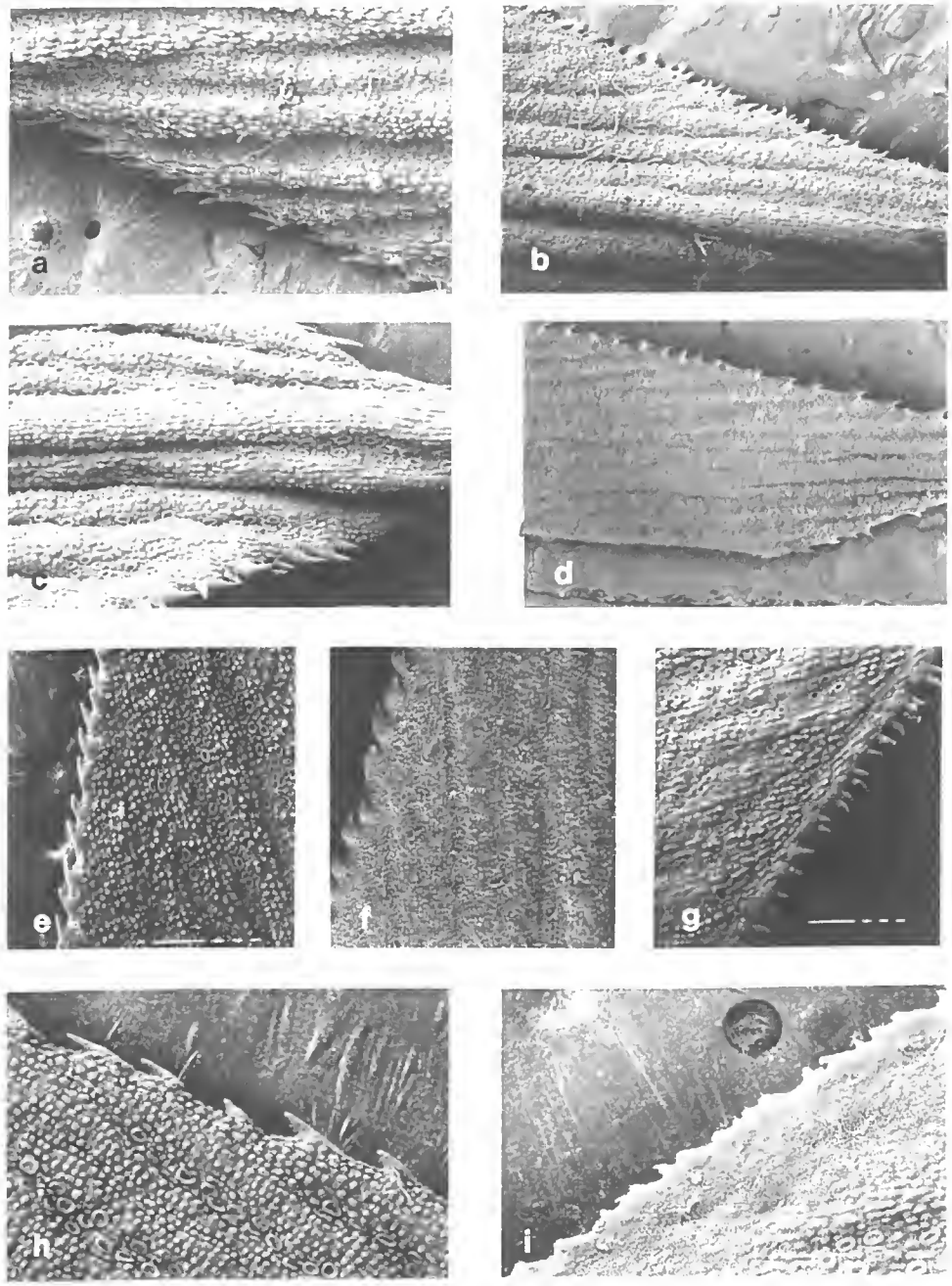

Figure 6. Scanning electron micrographs of the leaf apex margin (**a–d**) and mid-leaf margin (**e–i**) of *S. laeta* subsp. *laeta* (a x 60, e x 60); *S. laeta* subsp. *latifolia* (b x 30, g x 60); *S. viridis* subsp. *breviflora* (c x 60, h x 60); *S. angustifolia* (d x 30, f x 60) and *S. viridis* subsp. *viridis* (i x 60).

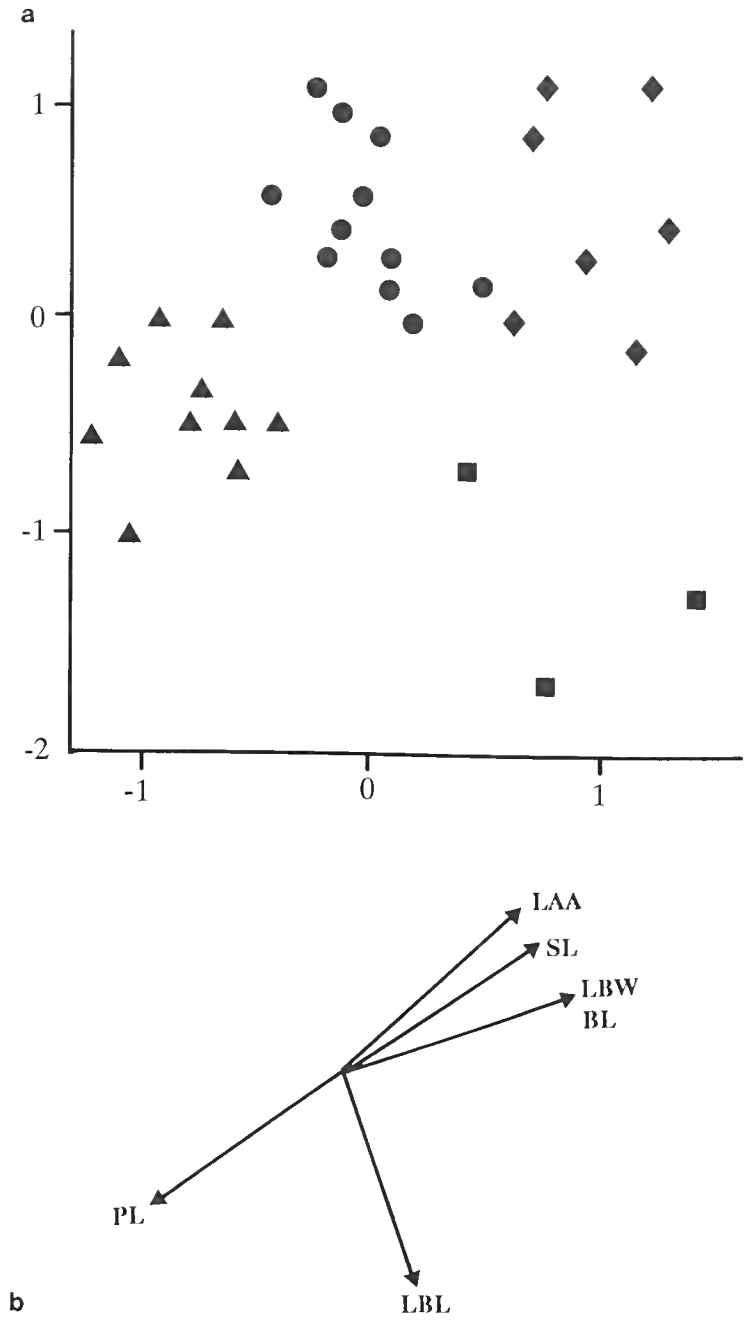

Figure 7. Morphometric analysis of *Syphelia laeta*. a, scatter diagram of ordination of *S. laeta* and *S. angustifolia* specimens. *S. laeta* subsp. *laeta* (●), Brisbane Water National Park specimens (■),*S. laeta* subsp. *latifolia* (◆), *S. angustifolia* (▲); b,vectors showing direction of maximum linear correlation between each of the six attributes and the ordination space. LBL: leaf-blade length; LAA: leaf-apex angle; LBW: leaf- blade width; BL: bracteole length; SL: sepal length; PL: petiole length. Note that the vectors for leaf-blade width and bracteole length have the same direction.

The groups resulting from the analyses (Figure 7) correspond well to the taxa defined previously and support our earlier conclusions based on both qualitative and quantitative measures. We consider that var. *angustifolia* warrants specific rank (because of its distinct morphology and distribution), but var. *laeta* and var. *latifolia* should be treated as subspecies; they have a number of morphological attributes that show overlapping ranges, but appear to be ecologically, if not geographically distinct. The Brisbane Water specimens differ from the other material studied in leaf-blade length, sepal length, in the adaxial leaf surface sometimes being hispidulous (two specimens out of three) and the margin ciliolate rather than denticulate-ciliolate; they appear to represent a new taxon, but further material is needed for study before their status can be determined. Because of recent devastating fires in the area it has not been possible to obtain further collections.

Ecological notes

The *S. laeta* subspecies are probably parapatric if not sympatric, while *S. angustifolia* is parapatric or allopatric with them. *S. laeta* subsp. *laeta* is found in the Sydney region and the lower Blue Mountains (Central Coast and Central Tablelands), growing in the understorey of open dry sclerophyll forest on sandstone. It flowers between February and August but mainly in March and May. Its conservation status is 2RC; it is conserved in Brisbane Water National Park and Yengo National Park and has been recorded recently from the Cumberland Plain Woodlands and Castlereagh Woodlands as well as Hawkesbury Sandstone areas (Benson & McDougall 1991). *S. laeta* subsp. *latifolia* is found north of the Hawkesbury River from Mt White north to Ourimbah and west to Kulnura (Central Coast), and has been recorded also from the North Western Slopes at Warialda. It grows in open sites in mixed shrublands, on the margins of low open eucalypt woodland or swamps and appears to be tolerant of some disturbance. It flowers between March and June. Its conservation status is 3RC; in the Mt White to Kulnura area it is locally common but vulnerable as it often grows on the road margins; it is conserved in the Brisbane Water National Park.

Styphelia angustifolia is found at lower elevations in the Blue Mountains (CC) and has been collected also from Pigeon House Range in the Southern Tablelands and from Warialda (North Western Slopes). It is found in open rocky areas in open sclerophyll forest. Flowers are recorded in July, August, November and December, with fruit recorded in April, May and August. Its conservation status is 3V?C; the lack of recent collections suggest that the species is now rare; it is possibly conserved in Morton National Park.

The single specimen records from Warialda for *S. laeta* subsp. *latifolia* and for *S. angustifolia* require field investigation as they indicate a very considerable disjunction in the distribution range of each taxon.

Nomenclatural notes

S. laeta *R. Br.*

(Brown 1810: 537).

TYPE CITATION: '(J.) v.v.'

LECTOTYPE (here designated): NEW SOUTH WALES: in sylvis prope Parramatta versus Sydney, *R. Brown* (*Bennett No. 2395*), desc 23 May 1802, 'Styphelia glauca Nob' (BM); isolectotype NSW. The typed label of the lectotype has the date of the collection as 19 May 1802. The date of 23 May 1802 in Brown's hand refers to the description, as 'desc' precedes the date. Another sheet at BM has 'Port Jackson' in Brown's hand.

Two subspecies are recognised:

S. laeta *R. Br.* subsp. **laeta**

TYPE: as cited above.

ILLEGITIMATE NAME: *S. laeta* R. Br. var. *typica* Domin (Domin 1928: 1050); this is the type variety, *S. laeta* R. Br. var. *laeta*.

SELECTED SPECIMENS EXAMINED: NEW SOUTH WALES: Central Coast: Londonderry Road near Rickabys Creek, *Burgess*, 4 Dec 1962 (NSW 143347); Blakehurst, *Camfield*, Apr 1893 (NSW 246705); Dural, *Debenham*, Apr 1959 (NSW 246702); Brisbane Water National Park, *Fallding & Benson*, 3 May 1979 (NSW 246699); Warrah to Patonga track, *Fallding & Benson*, 23 May 1979 (NSW 246701); Revesby to Georges River, *Foster*, 9 Apr 1956 (NSW 36659); Mellong Range, 1 mile [1.6 km] N of Grassy Hill, *Johnson*, 9 Apr 1953 (NSW 23446); Yerrinbool, *Johnson* 15 Apr 1951 (NSW 143344); Bucketty, 12 miles [c. 19 km] by road north west from Kulnura, *McGillivray 1243*, 5 July 1965 (NSW); Lawson Ridge Road, *Powell 420*, 6 Dec 1975 (NSW); Lawson area, *Reilly*, 11 Nov 1975 (NSW 246704); Pearl Beach, *Whaite 688*, 31 May 1950 (NSW).

S. laeta *R. Br.* subsp. **latifolia** *(R. Br.) J. Powell*, **comb. et stat. nov.**

BASIONYM: *Styphelia latifolia* R. Br. (Brown 1810: 537).

TYPE CITATION: '(J.) v.v.'

LECTOTYPE (here designated): NEW SOUTH WALES: Banks of the Hawkesbury [River], *R. Brown* (*Bennett No. 2398*), [1802–5], (BM).

SYNONYM: *S. laeta* R. Br. var. *latifolia* (R. Br.) Benth. (Bentham 1869: 147).

The lectotype has mature and old flowers present. Another sheet at BM has a typed label '*Brown*, 19 May 1802, Banks of Hawkesbury river'; the specimen has old flowers only, but may be an isolectotype.

NOTES: Bentham (1869) in reducing *S. latifolia* to varietal level stated 'Var. *latifolia* Leaves short, very broadly ovate and very concave — *S. latifolia*, R. Br. Prod. 537; ... — Hawkesbury river, *R. Brown*.'

SPECIMENS EXAMINED: NEW SOUTH WALES: Central Coast: Girrakool, Brisbane Water National Park, *Bishop 226 & Gunnell*, 10 June 1984 (NSW); Ourimbah State Forest, *de Beuzeville*, Apr 1918 (NSW 35709); Somersby, *Fallding*, 30 Mar 1979 (NSW 245291); Lake Womberall, *Fletcher*, Aug 1888 (NSW 245281); Point Clare [Gosford], *Forsyth* 23 June 1897 (NSW 35633); 3 miles [c. 5 km] north of Kulnura store, *Foster*, 26 Apr 1956 (NSW 36656); 7 miles [c. 11 km] south of Central Mangrove, *Foster*, 26 Apr 1956 (NSW 35633); Kulnura, *Johnson*, 29 June 1954 (NSW 154799); 3 miles [c. 5 km] north of Peats Bridge, *Salasoo*, 20 July 1969 (NSW 245286). North West Slopes: Warialda, *McCusker*, June 1957 (NSW 245288).

S. angustifolia *DC.*

(Candolle 1839: 735).

TYPE CITATION: 'St. laeta Sieb.! pl. exs. n. holl. n. 79 non Brown'.

TYPE: *Sieber n. 79* (holo G-DC; iso BM).

SYNONYM: *S. laeta* var. *angustifolia* Benth. (Bentham in Endlicher 1837). TYPE CITATION: 'Styphelia *laeta* Sieb. *Pl. Nov. Holl. exs. n. 79* est ejusdem varietas angustifolia'.

SPECIMENS EXAMINED: NEW SOUTH WALES: Central Coast: [Royal] National Park, *Betche*, Dec 1889 (NSW 35704); Loftus, *Camfield*, May 1899 (NSW 35705), Aug 1897 (NSW 35706); Hill Top, *Cheel*, 10 Nov 1923 (NSW 245202); Rocky Creek, near Hill Top, *Cheel*, Jan 1912 (NSW 245206); Valley

Heights, *Fletcher*, –, (NSW 245198); Falconbridge, *Fletcher*, 29 Dec 1886 (NSW 35703); Linden, *Hamilton*, Jan 1915 (NSW 237906). Southern Tablelands: c. 1 mile [1.6 km] east of Endrick River on road from Braidwood to Nowra, *Hoogland 11370*, 4 Feb 1968 (NSW). North West Slopes: Warialda, *Boorman*, July 1905 (NSW 143343), *Paterson*, 10 Aug 1958 (NSW 245204).

Status of *Styphelia laeta* R. Br. var. *glabra* R. Baker

(Baker 1896: 456).

TYPE: 'Camboon; October.' Baker states 'I am in doubt about the specimens placed here under a new variety, but I prefer this to proposing a new species. The flowers are red, the sepals acute, and the leaves narrow-lanceolate, — characters not included under Bentham's description of the species'. The specimens were collected 'during the months of September, October, November and December, in the years 1895, 1893, 1892 and 1890 respectively ...'

Three sheets of specimens collected by R.T. Baker at Camboon in September and October, 1893 are lodged at NSW; they have been re-determined as *Styphelia triflora* Andr. They have the glabrous branchlets, glabrous leaves, entire leaf margins, cuneate leaf base and more or less distinct petiole characteristic of this species.

Variation within *Styphelia viridis* Andr.

This species was described and illustrated by Andrews (1803) using a cultivated plant as his basis. Robert Brown (1810) used the name *S. viridiflora* R. Br. for the same species and referred to Andrews' publication as well as his own specimens. Brown's name, although more appropriate for this green-flowered species, is superfluous.

Bentham (1869) described a new variety, *S. viridis* Andr. var. *breviflora* Benth. This variety had 'leaves narrower. Sepals more obtuse, about 4 lines [8 mm] long. Corolla-tube about 1/2 in. [12 mm] long'. He noted that 'To this belong the specimens from Queensland and from the northern parts of N. S. Wales'.

Stanley & Ross (1986) in their treatment for the Flora of SE Queensland place *S. viridis* var. *breviflora* Benth. in synonymy under *S. viridis* Andr. stating that 'a few specimens with short obtuse sepals and short corolla tube have been called *S. viridis* var. *breviflora* Benth. but there is no apparent discontinuity in the population to justify varietal status for them.'

Specimens held at NSW under the name *S. viridis* Andr. exhibit considerable variation in the shape of the leaf-blade, apex and base, in petiole length and in corolla lobe length: tube length ratios. Measurements and descriptions of the following attributes were tabulated as a basis for re-assessment of taxa within the species: leaf blade length and width, length of petiole, bracteole, sepal, corolla-tube and -lobe, anther and filament, and the overall shape of the leaf, its apex and base (Table 3). The qualitative attributes that separate the taxa were mainly the shape of the leaf-blade and the leaf base, the branchlet indumentum (Figure 6) and to some extent the leaf apex and margin (Figure 7). In quantitative attributes the variation appeared at least partly discontinuous in leaf blade length, blade width, petiole length, sepal length and anther length and these attributes were used in the morphometric analyses.

Data from 44 specimens were analysed using PATN. The resultant classification indicated the presence of two groupings and separated the Central Coast and near North Coast specimens from those found on the far North Coast and in Queensland. The group 'statistics' (GSTA) indicated that it was a combination of attributes that separated the taxa, the most important being petiole length, sepal length, anther length,

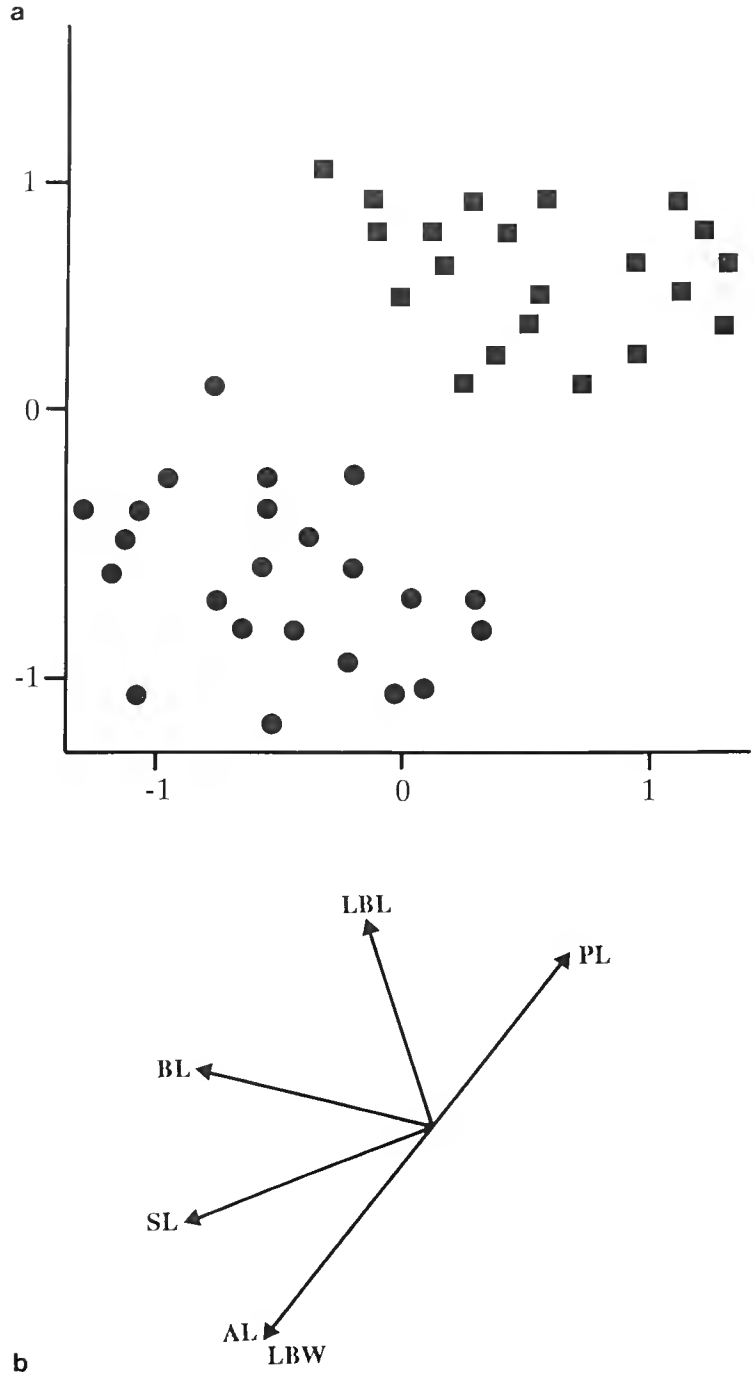

Figure 8. Morphometric analysis of *Styphelia viridis*. **a**, scatter diagram of ordination of *S. viridis* subsp. *viridis* (●) and subsp. *breviflora* (■); **b**, vectors showing direction of maximum linear correlation between each of the six attributes and the ordination space. LBL: leaf-blade length; PL: petiole length; AL: anther length; LBW: leaf-blade width; SL: sepal length; BL: bracteole length. Note that the vectors for leaf-blade width and anther length have the same direction.

and leaf-blade width. The ordination (Figure 8) confirmed the presence of the two groups and their relative distinctiveness.

Given that the ranges of many of the morphological attributes overlapped it was concluded that the two taxa distinguished should be treated as subspecies. Study of the specimens from Queensland regions showed that they belonged to subsp. *breviflora*. The name 'breviflora' is somewhat inappropriate as corolla tube lengths in the two taxa overlap to a considerable extent (Table 3). However, Bentham's description is correct with regard to the leaves being narrower and the distribution of the taxa.

Ecological notes

The subspecies appear to be allopatric. *S. viridis* subsp. *viridis* is found on the Central and near North Coast of New South Wales in coastal scrub-heath and in the understorey of open forest and woodlands on sandy soils over sandstone. It flowers between April and August. Its conservation status is 3RC; it is locally common but widespread habitat destruction in recent years makes it vulnerable. *S. viridis* subsp. *breviflora* occupies much the same habitat on the far North Coast of New South Wales and extends into Queensland as far north as Fraser Island. It is found in coastal scrub-heaths, on sand dunes with open forests of *Angophora costata* and *Eucalyptus pilularis*. It flowers mainly between May and July and occasionally also in September. This subspecies appears to be adequately conserved in National Parks in New South Wales and Queensland.

Table 3. Comparison of attributes of taxa in *S. viridis*

Character	**var. *viridis***	**var. *breviflora***
Leaf shape	oblong to oblong-obovate	oblong to oblong-elliptic
Leaf-blade length (mm)	14.8–22.4	19.6–25.6
Leaf-blade width (mm)	4.7–7.2	2.9–4.9
Leaf length:width ratio	2.3–4.1	4.5–7.3
Leaf apex	broadly acute to obtuse	acute to broadly acute
Leaf base	obtuse	narrowing
Petiole length (mm)	0.5–1.1	1.0–2.1
Bracteole length (mm)	3.6–4.8	3–5
Sepal length (mm)	12.4–18	8.5–13.3
Corolla-tube length (mm)	16–21.5	14–23
Corolla-lobe length (mm)	13.5–18	12–16
Anther length (mm)	4.8–6.8	3.2–4.5
Filament length (mm)	9.5–17.5	10–16

Nomenclatural notes

S. viridis *Andr.*

(Andrews 1803: t. 312)

TYPE CITATION: 'Our figure was taken from a plant in the Hibbertian collection, in the month of April, 1803.'

Stafleu & Cowan (1976) suggest that the text was 'probably written by John Kennedy', but Andrews is the botanical artist and engraver and is generally accepted as the author.

SYNONYM: *S. viridiflora* R. Brown (Brown 1810: 537). TYPE CITATION: '(J.) v.v.'

LECTOTYPE (here designated): NEW SOUTH WALES: Port Jackson, *R. Brown* (*Bennett No. 2396*), [17 May 1802], (BM); isolectotype NSW. The specimen is in flower. A second BM sheet has the same annotation.

Two subspecies are recognised:

S. viridis *Andr.* subsp. **viridis**

TYPE: as cited above.

SPECIMENS EXAMINED: NEW SOUTH WALES: North Coast: Port Stephens, *Boorman*, May 1912 (NSW 143359); Tuncurry State Forest, *Burgess*, 22 June 1961 (NSW 241789); Tuncurry, *Cheel*, 11 May 1925 (NSW 241787); Seal Rocks, *Fox 7907039*, 7 July 1979 (NSW), *Tate*, 6 Aug 1977 (NSW 241785); Nelson Bay, *Lithgow 156*, 10 May 1965 (NSW); Tomago sandbeds, *McDonald* 23 Aug 1966 (NSW 241791); Belmont, *McReadie*, June 1961 (NSW 241790). Central Coast: Kurnell, *Boorman*, May 1906 (NSW 241783); La Perouse, *Camfield*, July 1898 (NSW 143360); *Coveny 11129 & J. Thomas*, 7 July 1982 (NSW); Lady Robinson Beach, *Fletcher*, 30 Apr 1887 (NSW); Rose Bay, *Helms*, 22 June 1901 (NSW); Vaucluse to Bondi, *Maiden* Aug 1887 (NSW 241778); Port Jackson district, *Maiden*, July 1896 (NSW 35717); Bundeena, *Oxenford*, 16 May 1948 (NSW 35719); Waterfall, *G. Rodway*, 23 July 1933 (NSW 241782); Port Hacking, *Whaite 1178*, 9 Aug 1952 (NSW).

S. viridis *Andr.* subsp. **breviflora** *(Benth.) J. Powell* **comb. et stat. nov.**

BASIONYM: *S. viridis* Andr. var. *breviflora* Benth. (Bentham 1869: 148), as 'Var. *?breviflora.*'

TYPE CITATION: 'To this belong the specimens from Queensland and from the northern parts of N.S. Wales'. Queensland specimens cited under the name *S. viridis* included 'Morton island, *F. Mueller*' and 'Darling Downs, *F. Law*'. The other specimens cited belong to the type subspecies.

LECTOTYPE (here designated): QUEENSLAND: Moreton Island, *F. Mueller* (MEL 226791); isolectotype K.

SPECIMENS EXAMINED: NEW SOUTH WALES: North Coast: 3 km west of Red Rock, *Foreman 937*, 24 Aug 1985 (MEL); Bunjalung National Park, *Powell 4529*, 4 Sep 1987 (NSW), *Powell 4593*, 1 May 1989 (NSW); Coaldale Road, *Powell 4587*, 1 May 1989 (NSW); Diggers Camp, *Powell 4551*, 5 Sep 1987, (NSW); 9 km NE of Evans Head, Broadwater National Park, *Powell 4602*, 2 May 1989 (NSW). Queensland: Moreton: Nambour, *Ward*, July 1964 (NSW 241795); Stradbroke Island, *White* 1701, July 1922 (NSW, BRI, MEL). Wide Bay: 22 miles [c. 35 km] E of Gympie, *Smith 12111*, 12 May 1964 (BRI, NSW); Cooloolah sand hills, *Thorne 21292, Coaldrake & Ridley*, 18 May 1959 (BRI, NSW); Fraser Island, *Willis*, Aug 1953 (NSW 241794).

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Budawangia and *Rupicola*, new and revised genera of Epacridaceae

Ian R. H. Telford

Abstract

Telford, I.R.H. (Australian National Botanic Gardens, Canberra, ACT, Australia 2601) 1992. Rupicola *and* Budawangia, *new and revised genera of Epacridaceae.* Telopea *5(1): 229–239. Rupicola* Maiden & Betche consists of four species endemic in New South Wales. Besides the type species, *R. sprengelioides* Maiden & Betche, **R. ciliata** Telford and **R. decumbens** Telford are described as new and a new combination is made for **R. apiculata** (Cunn.) Telford, which is transferred from *Epacris*. *R. gnidioides* Summerh. is transferred from *Rupicola* to the monotypic new genus *Budawangia* Telford as **B. gnidioides** (Summerh.) Telford.

Introduction

Rupicola Maiden & Betche (1898) was established as monotypic with its only species, *R. sprengelioides*, endemic to New South Wales in the southern Blue Mountains. A second species, *R. gnidioides* Summerh., was described from the Southern Tablelands escarpment SW of Nowra, N.S.W., in 1927. This species has been shown to be misplaced and is here transferred from *Rupicola* to a new monotypic genus. More recent discoveries have yielded two new species of *Rupicola* described in this paper. Studies in staminal morphology have shown that a species previously included in *Epacris* must also be transferred to *Rupicola*.

Vegetative characters of *Rupicola* sens. str., *R. gnidioides* and *Epacris* are discussed briefly. The results of investigation of floral morphology of Australian species of tribe Epacrideae as defined by Watson (1967: 503) constitute the major part of this paper. Conclusions on systematic placement of the genera are presented.

Vegetative characters

Habit: Members of the genera *Rupicola* sens. str., *R. guidioides* and *Epacris* are small multi-stemmed shrubs, usually less than one metre tall. All species of *Rupicola* sens. str., as well as *R. guidioides* and several species of *Epacris*, are restricted to cliff-line niches and show a similarity of habit, often with decumbent or pendulous stems. *Rupicola guidioides* is rhizomatous, with leafless stems spreading and proliferating through cracks in rock faces or sand on ledges. This kind of growth has not been observed in *Rupicola* sens. str. or *Epacris*.

Leaves: *Rupicola* sens. str., *R. guidioides* and *Epacris* all exhibit the characteristic leaves of tribe Epacrideae with narrow, not sheathing, bases and longitudinal venation.

In leaf fibre pattern, in their unilacunar nodal anatomy and in homogeneous pith structure, *Rupicola* and *Epacris* belong to the 'Epacris group' of Watson (1967: 502). *R. sprengelioides* was the only member of *Rupicola* sens. lat. examined by Watson.

Indumentum: Indumentum in *Rupicola* sens. str., *R. gnidioides* and *Epacris* is of simple, unicellular white hairs, typical of tribe Epacrideae. Distribution of indumentum and direction of hairs are described below under each species.

Floral morphology

The characters are discussed below with respect to the genera *Rupicola* sens. str. (using *R. sprengelioides*, type species of the genus), *Rupicola gnidioides* and *Epacris*.

Corolla: In *R. sprengelioides*, the corolla is similar to the short-tubed species of *Epacris*. The tube is broadly campanulate, shorter than the lobes, with the limb widely spreading. Corolla lobes are imbricate in bud. In *R. gnidioides*, corolla characters are similar.

Staminal morphology: Traditionally in generic delimitation in Epacridaceae, staminal morphology (including position of insertion of the stamens on the corolla, attachment of filaments to anthers, anthers free or cohering and anther dehiscence) remains of major significance as shown by Powell et al. (1987).

Insertion of stamens: *R. sprengelioides* has the stamens inserted at the base of the corolla tube. In *R. gnidioides*, the stamens are inserted at the mouth of the corolla tube. *Epacris* has the stamens inserted at the mouth of the corolla tube.

Filament characters: *R. sprengelioides* has filaments compressed and more or less equal in length to the anthers. The anthers are adnate to the filaments along their dorsal sides for most of the length of the anther. The filaments curve towards the style, with the anthers connivent but not cohering around the style. In *R. gnidioides*, the filaments are terete for most of their length, several times longer than the anthers, and curve outwards with the anthers exserted and spreading. *Epacris* has terete filaments shorter than the anther cells, the anthers attached dorsally at about their midpoints with the anther cells included or partly exserted from the corolla tube.

Anther dehiscence: In *R. sprengelioides*, the anther locules dehisce by a single common slit, starting apically and extending 1/3 to 1/2 the length of the anthers, the apices of the locules becoming curved and valve-like. In *R. gnidioides* dehiscence is longitudinal, each locule with a slit the length of the locule, the anther cell turning 'inside-out'. *Epacris* shows complete longitudinal anther dehiscence similar to *R. gnidioides*.

Nectary: *R. sprengelioides* possesses a discontinuous hypogynous disc of five minute swellings in the furrows at the base of the ovary. These appear to have no nectary function. In *Epacris* the disc is enlarged to five broad nectary scales well developed to about 1/3 the length of the ovary. In *R. gnidioides*, neither nectary scales nor swellings are present.

Morphological evidence indicates *R. gnidioides* should be excluded from *Rupicola*. Although staminal insertion and anther dehiscence are similar to those in *Epacris*, other character states indicate it would be misplaced in that genus also. *Rupicola* (4 spp.) and *Epacris* (c. 40 spp.) hold consistently within their generic circumscription. Inclusion of *R. gnidioides* in either genus would destroy their natural groupings. This is borne out by studies in Epacridaceae by Powell et al. (1987). In their cladistic analyses of the family (1987: 74), *Rupicola*, *R. gnidioides* and the two *Epacris* groups constitute an unresolved trichotomy in the monophyletic tribe Epacrideae but with autapomorphic character states separating the three genera. A monotypic new genus is erected below to accomodate the anomalous species, *R. gnidioides*.

Epacris apiculata proved to have the staminal morphology of *Rupicola*. A new combination is provided in *Rupicola* below. It is remarkable that this species has been retained in *Epacris* for so long as it will not key to that genus in published Floras. Bentham (1869: 241) noted its differences from other species in that genus in respect to its large anthers adnate to thick filaments.

Systematic placement

Maiden & Betche (1898: 775) compared the anther morphology of *Rupicola* with the Tasmanian endemic *Prionotes* and corolla aestivation and vegetative characters with *Epacris*. Tentatively, they placed it next to *Epacris* in tribe Epacrideae. These studies, together with those of Watson (1967: 502) and Powell et al. (1987: 74), indicate *Rupicola* belongs in tribe Epacrideae adjacent to *Epacris*. The proposed new genus for *R. gnidioides* would occupy an intermediate systematic position.

Budawangia *Telford* **gen. nov.**

Rupicolae affinis, staminibus in orificio tubi corollae insertis, filamentis teretibus secus maximam partem longitudinis, antheris exsertis patentibus in longitudinem dehiscentibus differt.

TYPE SPECIES: *B. gnidioides* (Summerh.) Telford

Small rhizomatous shrubs, stems decumbent to ascending. Leaves alternate, shortly petiolate. Flowers pedicellate, solitary in upper leaf axils; pedicels bearing imbricate bracts. Bracts usually 8, lanceolate. Sepals 5, narrowly ovate, acute. Corolla shortly tubular, limb 5-lobed; lobes narrowly ovate, acute. Stamens exserted, spreading; filaments inserted at the mouth of the corolla tube, filiform for most of their length; anthers adnate to the flattened upper part of the filaments, minutely papillate, dehiscing by longitudinal slits. Ovary superior, 5-locular, 5-lobed, each lobe grooved, truncate at the apex; nectary absent; style gradually thickening towards apex, obscurely ribbed; stigma minute; ovules many per locule; placentation axile. Fruit a 5-valved capsule, dehiscing loculicidally. Seeds numerous, oblong to elliptic, reticulate.

The genus is named from the Budawang Range of the Southern Tablelands escarpment of New South Wales, to which and its associated plateaus the genus is restricted.

Budawangia gnidioides *(Summerh.) Telford* **comb. nov.**

BASIONYM: *Rupicola gnidioides* Summerh., Kew Bull. 8: 357 (1927)

HOLOTYPE: SOUTH COAST: Ettrema River, SW of Nowra, New South Wales, *F.A. Rodway s.n.*, Feb. 1927 (K, photograph seen).

Stems to 40 cm long, villous with simple white hairs. Leaves suberect to spreading; petiole c. 0.8 mm long; lamina narrowly lanceolate, acuminate, concave adaxially in T.S., with 3 longitudinal veins, 5–8 mm long, 1–2 mm wide, sparsely hirsute with simple white hairs on both surfaces, the margins ciliate with longer hairs. Flowers on pedicels 1.5–5 mm long. Sepals 2.5–3 mm long, 0.7–0.8 mm wide, glabrous or pilose outside, ciliate. Corolla white, glabrous or with a few hairs at lobe apices; tube 1–1.2 mm long; lobes 2.7–3 mm long, c. 1.5 mm wide. Filaments 1.7–2.3 mm long; anthers c. 1 mm long. Ovary c. 1 mm long, c. 1 mm diameter, puberulent at the summit; style 3–3.5 mm long. Capsule c. 2 mm long, puberulous, brown. Seeds c. 0.5 mm long, brown. Fig. 1.

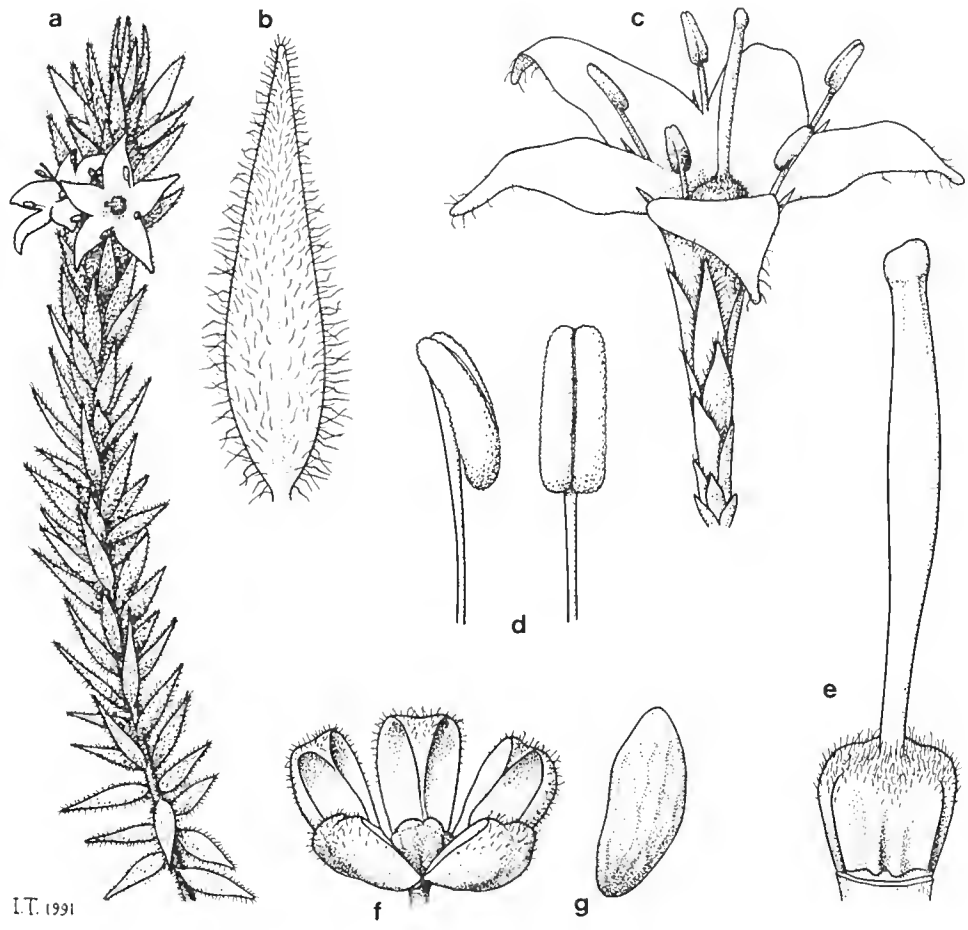

Fig. 1. *Budawangia gnidioides*. **a**, flowering stem (x 3); **b**, lower surface of leaf (x 10); **c**, flower (x 10); **d**, stamens (x 20); **e**, gynoecium (x 20) from *Telford 4125*; **f**, fruit (x 10); g, seed (x 50) from *Telford 10392*.

SELECTED SPECIMENS EXAMINED: NEW SOUTH WALES: South Coast: Myall Ck, 16 km NE of Nerriga, 34°59'S 150°10'E, *Telford 9606* (CBG, AD, BRI, MEL, NSW); Northern Budawang Range, The Castle, 35°17'S 150°12'E, *Telford 4125* (CBG, BISH, NSW, US); Little Forest, N of Milton, *Rodway 2541* (NSW). Southern Tablelands: Upper Corang River, c. 10 miles [16 km] SE of Nerriga, *Sturgiss s.n.* (NSW 137893); Northern Budawang Range, Mt Cole, 35°28'S 150°11'E, *Telford 9802* (CBG, HO, K).

DISTRIBUTION: *Budawangia gnidioides* is restricted to the northern Budawang Range and associated sandstone plateau escarpments of the South Coast and Southern Tableland districts of New South Wales. Fig. 2.

ECOLOGY: *Budawangia gnidioides* occurs only in cliff-line niches, growing in cracks in sandstone rock faces or on sandy ledges, usually beneath cliff overhangs and adjacent to open forest or heathland. Associated species include *Baeckea linifolia* Rudge, *Gleichenia rupestris* R. Br. and *Todea barbara* L.

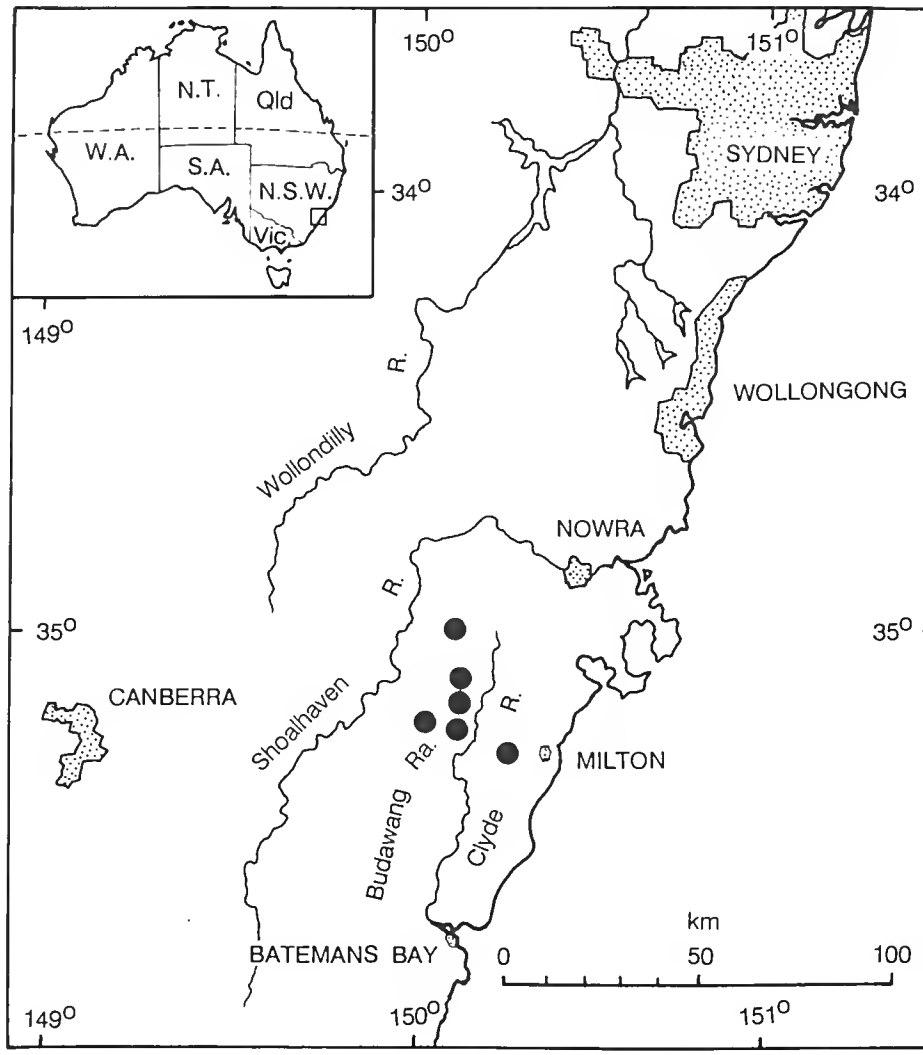

Fig. 2. Distribution of *Budawangia gnidioides.*

FLOWERING PERIOD: September to December.

CONSERVATION: The narrow range of the species, mostly within Morton National Park, gives the species a 2VC-t coding, conserved but vulnerable, following Briggs & Leigh (1988: 37) as *Rupicola gnidioides.* Possible threats are from wildfires and bush-walkers. Disturbance of some populations, including uprooting of plants, has been observed in camping caves.

Rupicola *Maiden & Betche*

Maiden & Betche (1898: 775, t. 28)

TYPE SPECIES: *R. sprengelioides* Maiden & Betche

Shrubs with ascending or decumbent stems, branching alternate or irregularly verticillate; branchlets terete, pilose with simple hairs, usually marked by persistent leaf scars. Leaves alternate, shortly petiolate or subsessile, the lamina ovate, narrowly ovate or narrowly elliptic, glabrous, puberulous or pilose with simple hairs. Flowers solitary in the upper axils, the pedicels covered by imbricate bracts increasing in size towards the flower; bracts narrowly ovate, narrowly acute, the upper somewhat smaller than the sepals. Sepals 5, narrowly ovate, acute, ciliolate. Corolla shortly tubular, glabrous, white; tube broadly campanulate; limb 5-lobed, widely spreading; lobes ovate, acute, longer than the tube, imbricate in the bud. Stamens hypogynous, inserted at the base of the corolla tube; filaments compressed, as long as or shorter than anther locules; anthers papillate, adnate to filaments, connivent around the style; locules 2-celled, dehiscing by a shared single slit from the apex to 1/3 to 1/2 length of locules. Hypogynous disc discontinuous, of 5 minute non-nectiferous scales, 1 at the base of each ovary furrow. Ovary superior, shortly cylindrical to oblate, 5-lobed, 5-locular; placentation axile; ovules numerous. Style short, terete to obscurely ribbed, inserted in a depression in the summit of the ovary; stigma minute. Fruit a 5-valved capsule, dehiscing loculicidally. Seeds many, elliptic to reniform, pale brown, with reticulate ornamentation.

A genus of 4 species endemic to the Central Tablelands and adjacent western parts of the Central Coast of New South Wales.

Key to the species

1 Leaves ovate, cordate, the acuminate apices thickened ..... **2. R. apiculata**

1* Leaves narrowly elliptic to elliptic, occasionally narrowly ovate, the apices not thickened

2 Corolla 13–17 mm diam.; ovary pilose ..... **4. R. decumbens**

2* Corolla 8–12 mm diam.; ovary glabrous

3 Leaf lamina pilose, ciliate ..... **3. R. ciliata**

3* Leaf lamina usually glabrous ..... **1. R. sprengelioides**

1. Rupicola sprengelioides *Maiden & Betche* (1898: 774).

HOLOTYPE: NEW SOUTH WALES: Central Tablelands: Southern edge of Kings Tableland, Blue Mountains, *J.H. Maiden & W. Forsyth*, Sept 1898 (NSW).

Collection date is misquoted as Oct 1898, in the protologue.

Erect shrub to 2 m; branchlets puberulent to villous with antrorse white hairs to 0.5 mm long, the hairs becoming more spreading with age. Leaves suberect to spreading; petioles c. 1 mm long, puberulent; lamina narrow-elliptic with an obtuse rigid apex, adaxially shallowly concave in T.S., venation obscure with 5 longitudinal veins, (10–)20–32 mm long, 1.5–3 mm wide, usually glabrous, minutely ciliolate, sometimes

puberulent at base on underside. Flowers on puberulent pedicels 4–9 mm long; bracts 0.5–4 mm long, ciliolate. Sepals 3–7 mm long, ciliolate. Corolla 8–10 mm diameter, glabrous, white; tube 1.5–2 mm long; lobes (3–)4–6 mm long. Stamens with filaments c. 1 mm long; anthers c. 2 mm long. Ovary c. 1.5 mm long, glabrous. Style 2–4 mm long. Capsule c. 2 mm diameter, glabrous.

DISTRIBUTION: The species is apparently restricted to the cliff-lines of the Burragorang Valley of the Central Tablelands where it has been recorded from McMahons and Burragorang Lookouts and the adjacent catchment of Erskine Creek at Nepean Lookout. Fig. 4.

ECOLOGY: *R. sprengelioides* inhabits rocky cliff top niches, growing in sand on sandstone in open forest at altitudes of 450–650 m. Associated species include *Allocasuarina littoralis* (Salisb.) L. Johnson, *Banksia serrata* L. f. and *Platysace lanceolata* (Labill.) C. Norman.

FLOWERING PERIOD: October to November, sometimes with an autumn flowering in April.

CONSERVATION STATUS: 2RC-t, following Leigh & Briggs (1988: 38). The species is known from only three populations, two of which lie within Blue Mountains National Park.

SELECTED SPECIMENS EXAMINED: NEW SOUTH WALES: Central Tablelands: McMahons Lookout, Kings Tableland, *Bowden,* Jan 1968 (NSW 137887); Burragorang Lookout, 20 km NW of Picton, *Telford 7219,* 27 Nov 1978 (CBG, BISH, HO, K, MEL, NSW, US).

2. Rupicola apiculata *(Cunn.) Telford* **comb. nov.**

BASIONYM: *Epacris apiculata* Cunn. in Field, Geogr. Mem. New South Wales: 340 (1825)

TYPE CITATION: 'Ravines, Kings Table Land'.

Apparently three gatherings of Allan Cunningham in 1822 are held in BM and K (photographs seen). The BM sheet is annotated 'Epacris apiculata. Cunningham 1822' in Cunningham's handwriting. The K sheet bears three elements, one labelled '8. Epacris apiculata. A very rare plant discovered in rocky ravines in the vic[init]y of the Kings Tableland, Blue Mtns, Oct. 1822', the other two 'Epacris apiculata. Rare on moist mossy rocks, ravines, B[lue] M[ountains]' in Cunningham's handwriting. These are best regarded as syntypes. The tagged flowering twig on the K sheet bearing the Herbarium Hookerianum stamp is the best specimen.

LECTOTYPE (here chosen): NEW SOUTH WALES: Central Tablelands: Rare on moist mossy rocks, ravines, B[lue] M[ountains], *A. Cunningham,* 1822 (K, photograph seen).

Decumbent to erect shrub; stems to 1 m long; branchlets puberulent with antrorse to spreading white hairs. Leaves spreading to reflexed, subsessile; lamina ovate, cordate, adaxially concave in T.S., venation obscure with 5 longitudinal nerves, 3–10(–12) mm long, 2.5–7 mm wide, acuminate with a rigid thickened apex, glabrous. Flowers on glabrous pedicels 1.5–2 mm long; bracts 0.7–2.5 mm long, glabrous. Sepals 2–2.5(–4) mm long, glabrous. Corolla 7–9 mm diameter, glabrous, white; tube 1–3.5 mm long; lobes 3–3.5(–5) mm long. Stamens with filaments c. 0.75 mm long; anthers 1.5–2 mm long. Ovary c. 1 mm long, glabrous. Style 3.5–5(–6) mm long. Capsule c. 1.5 mm diameter, glabrous. Fig. 3.

DISTRIBUTION: The species is restricted to the Central Tablelands in the higher Blue Mountains between Blackheath and Leura. Fig. 4.

ECOLOGY: *R. apiculata* inhabits cliff-line niches on moist sandstone shelves beneath rock overhangs adjacent to heathland or open forest at altitudes of 850–1000 m. Associated species include *Epacris reclinata* Cunn. ex Benth., *Sprengelia monticola* (Cunn. ex DC.) Druce and *Glichenia rupestris* R.Br.

FLOWERING PERIOD: September to November, sometimes with an autumn flowering in April.

CONSERVATION STATUS: 2RCa, following Briggs & Leigh (1988: 36) as *Epacris apiculata*. Several populations lie within Blue Mountains National Park.

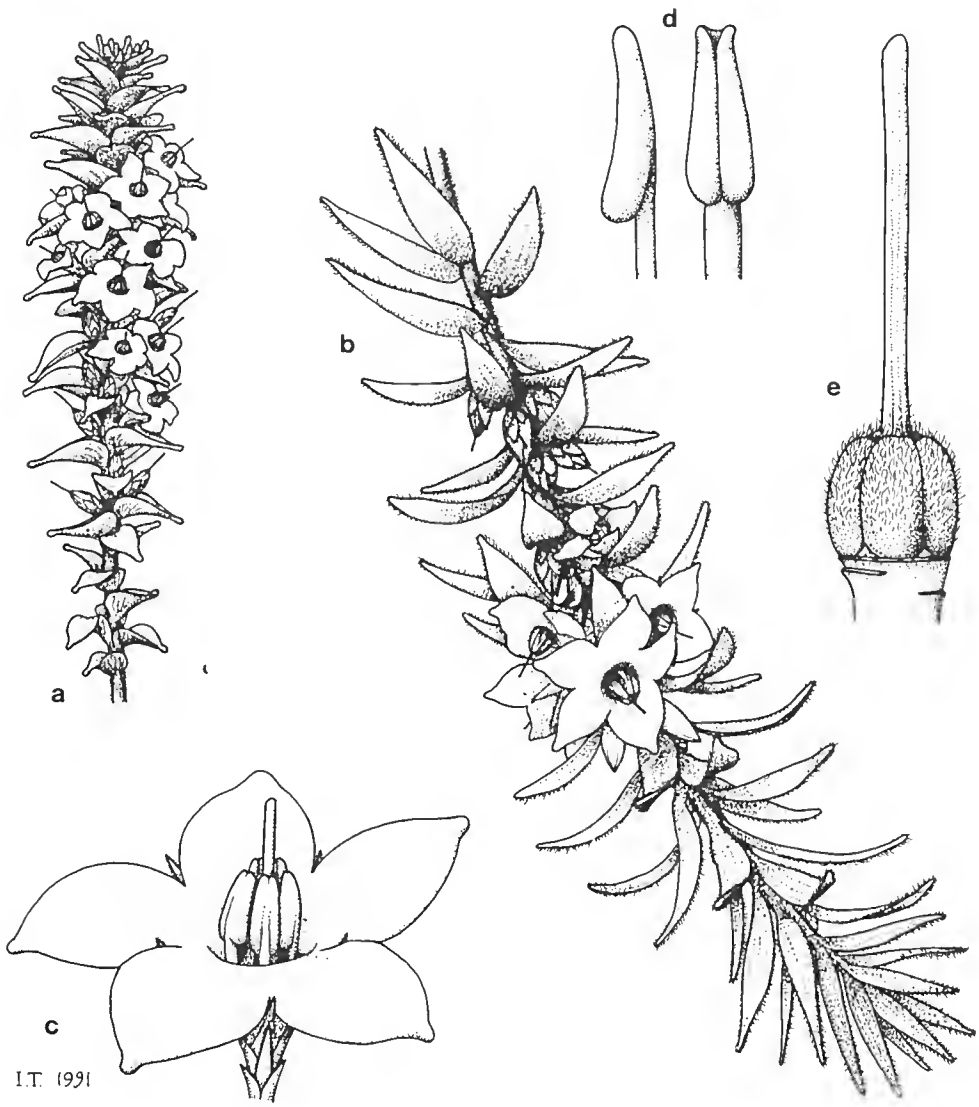

Fig. 3. *Rupicola* spp. *R. apiculata*. **a**, flowering stem (x 2) from *Telford 7229*. *R. decumbens*. **b**, flowering stem (x 1.5) from *Telford 7227*; **c**, flower (x 5); **d**, stamens (x 10); **e**, gynoecium (x 10) from holotype.

SELECTED SPECIMENS EXAMINED: CENTRAL TABLELANDS: Centennial Glen, 1 km W of Blackheath, *Telford 7229*, 9 Dec 1978 (CBG, BISH, HO, K, MEL, NSW, US); Leura Falls, *Hamilton*, Nov 1913 (NSW *249664*); Lake Medlow, c. 2 miles [3 km] SE of Blackheath, *Constable* 8 Jul 1959 (NSW *249694*,); Minni Ha Ha Falls, Katoomba, *Evans*, 7 Nov 1961 (NSW), Wentworth Falls, *Constable NSW 38000*, 4 Oct 1948 (NSW)

3. Rupicola ciliata *Telford* **sp. nov.**

R. sprengelioidi affinis, habitu decumbente vel effuso et foliis plerumque latioribus lamina pubescente marginibus pilis longioribus ciliatis differt.

HOLOTYPE: NEW SOUTH WALES: Central Coast: Wheeny Ck catchment, 4 km from Kurrajong Heights towards Bilpin along Bells Line of Road, 33°31'S 150°37'E, *I.R. Telford 10824 & D.H. Moffatt*, 13 November 1989 (CBG; isotypes BISH, HO, K, MEL, NSW).

Pendulous, decumbent to spreading shrub; stems to 50 cm long; branchlets pubescent with spreading more or less crisped white hairs. Leaves suberect to spreading on erect stems, becoming reflexed on pendulous stems; petioles 0.5–1 mm long, puberulent; lamina narrow-elliptic to narrowly ovate, bluntly acute, adaxially shallowly concave in T.S., venation obscure with 5 longitudinal nerves, 3 extending to the lamina apex, 6–13(–16) mm long, 1.5–4 mm wide, sparsely white puberulent on both surfaces, the margins ciliate with longer white hairs. Flowers on sparsely puberulent pedicels 2–8 mm long; bracteoles 0.7–3 mm long, ciliolate. Sepals 3–4 mm long, ciliolate. Corolla 10–13 mm diameter, glabrous, white; tube 2–3 mm long; lobes 3.5–5 mm long. Stamens with filaments 1–2 mm long; anthers c. 2 mm long. Ovary oblate, c. 1 mm long, glabrous. Style c. 3 mm long, glabrous. Capsule c. 2.5 mm diameter, glabrous.

The specific epithet refers to the leaf margins.

DISTRIBUTION: The species is apparently restricted to the lower north-eastern Blue Mountains in the Central Tablelands and the adjacent north-western part of the Central Coast. Fig. 4.

ECOLOGY: *Rupicola ciliata* inhabits cliff-lines of ridges and gorges, in crevices and on ledges of sandstone and conglomerate in open forest. Associated species include *Alania endlicheri* Kunth. and *Gleichenia rupestris* R. Br.

FLOWERING PERIOD: October to December.

CONSERVATION STATUS: 2RCt, following the criteria in Briggs & Leigh (1988). All known populations lie within Blue Mountains and Wollemi National Parks.

NOTES: On herbarium sheets, this species superficially resembles *R. sprengelioides* but that species is a more robust erect shrub, whereas *R. ciliata* has pendulous to spreading stems.

SPECIMENS EXAMINED: NEW SOUTH WALES: Central Coast: First fireplace W of Kurrajong Heights on Bells Line of Road,14 Oct 1987, *Hind 5368* (NSW); 'Froth and Bubble' Ck, Bungleboori Ck area, N bank tributary of Wollangambe R., N of Mt Wilson, 33°22'S 150°20'E, *Gibson 14*, 27 Dec 1988 (NSW); Blue Mtns, Lower Yarramun Ck, 33°28'S 150°22'E, *Gibson 20 & Miller* (NSW, CBG). Central Tablelands: Bilpin, 33°30'S 150°32'E, *Constable NSW 48901* (NSW, CBG).

4. Rupicola decumbens *Telford* **sp. nov.**

R. ciliatae affinis, foliis plerumque majoribus, floribus in pedicellis brevioribus (1–2 mm longis), corollae majoribus (13–17 mm diam.) et ovariis pubescentibus differt.

HOLOTYPE: NEW SOUTH WALES: Central Tablelands: Green Gully, 33°07'S 150°16'E, 2.5 km SW of Glen Davis, *I.R. Telford 5019 & M.D. Crisp*, 25 Oct 1976 (CBG; isotypes K, NSW).

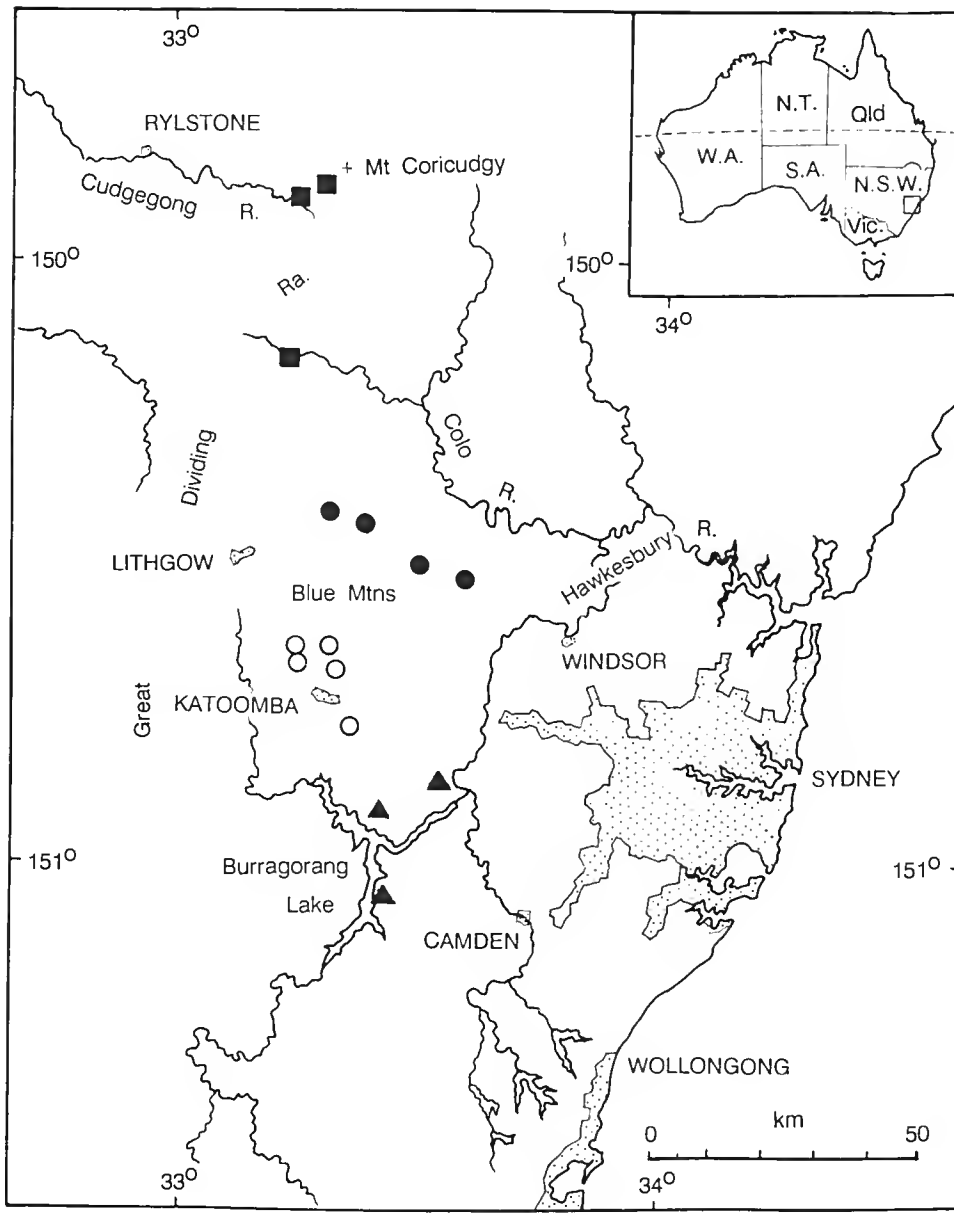

Fig. 4. Distribution of *Rupicola* spp. (▲)*R sprengelioides*, (○) *R. apiculata*, (●) *R. ciliata* and (■) *R. decumbens*.

Decumbent shrub; stems to 1 m long; branchlets pubescent with crisped and straight white hairs 0.5–1 mm long. Leaves spreading to reflexed; petioles c. 1 mm long, puberulent; lamina narrowly elliptic to narrowly ovate,bluntly acute, adaxially shallowly concave in T.S., venation obscure with 5 longitudinal nerves, (7–)10–18 mm long, 3–4.5 mm wide, sparsely white pubescent on upper surface, more densely so beneath, ciliate around the margins with straight white hairs to 1 mm long. Flowers on puberulent pedicels 1–2 mm long; bracts 1–7 mm long, ciliolate. Sepals 5–7 mm long, ciliolate. Corolla 13–17 mm diameter, glabrous, white; tube 1–1.5 mm long; lobes 7–8 mm long. Stamens with filaments c. 1.5 mm long; anthers 2.5–5 mm long. Ovary 1.5–2 mm long, pubescent. Style 4.5–7 mm long, sparsely pubescent. Capsule c. 4 mm diameter, pubescent. Fig. 3.

The specific epithet refers to the habit of the plant.

DISTRIBUTION: The species is restricted to the Central Tablelands in the northern Blue Mountains and the adjacent Mount Coricudgy area E of Rylstone. Fig. 4.

ECOLOGY: *R. decumbens* inhabits cliff base niches on sandstone ledges and in crevices adjacent to open forest at altitudes of 500–950 m. Associated species include *Leptospermum rupicola* J. Thompson, *Gleichenia rupestris* R. Br. and *Epacris reclinata* Benth.

FLOWERING PERIOD: November to December.

CONSERVATION STATUS: 2RC-, following the criteria of Briggs & Leigh (1988: 36) where it is listed as *Rupicola* sp. 1 (Glen Davis). Several populations lie within Wollemi National Park.

SELECTED SPECIMENS EXAMINED: NEW SOUTH WALES: Central Tablelands: c. 2 miles [3 km] NNW of Mt Coricudgy, *McGillivray 117 & Rodd*, 25 Apr 1965 (NSW); head of Cudgegong River, *Whaite 961*, 15 Aug 1951 (NSW); Kelgoola Picnic Area, Cudgegong River, *Powell 2974*, 25 Jul 1987 (NSW, CBG, HO); 2 km SSW of Glen Davis, *Coveny 9449 & Telford*, 18 May 1977 (NSW, CBG).

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A revision of the Australian species of *Parahebe* and *Derwentia* (Scrophulariaceae)

Barbara G. Briggs and F. Ehrendorfer

Abstract

Briggs, Barbara G.[1] *and Ehrendorfer F.*[2] ([1] *National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000;* [2] *Institut für Botanik, Univ. Wien, Rennweg 14, A-1030 Wien, Austria) 1992. A revision of the Australian species of* Parahebe *and* Derwentia *(Scrophulariaceae). Telopea 5 (1): 241–287.* The relationships of the Australian species placed in or related to *Parahebe* W. Oliver are considered. It is concluded, on the basis of phylogenetic analyses to be published elsewhere, that only one Australian species is appropriately referred to *Parahebe*, namely **P. lithophila**, which is described as a new species. The genus *Derwentia* Raf. is revived for a group of eight species restricted to Australia and previously undescribed or referred to *Veronica* or *Parahebe*. **Derwentia arcuata**, **D. blakelyi** and **D. velutina** are described as new. Combinations are provided for **D. arenaria** and **D. nivea**, both transferred from *Veronica*, as well as for **D. derwentiana** (including five subspecies). The chromosome number n=21 is reported for *Parahebe lithophila* and n=20 and 19 in *Derwentia*. The Tasmanian *Veronica formosa* is discussed and is considered to be allied to a group of taxa including *Chionohebe*.

1 Introduction

Parahebe W. Oliver was distinguished from *Hebe* Comm. ex Juss. by a combination of features (Oliver 1944) including chromosome numbers (Frankel & Hair 1937, Frankel 1941), leaf serration, short corolla and laterally compressed capsule. Recent usage has included species of New Guinea (Royen & Ehrendorfer 1970, Royen 1972) in addition to the New Zealand species (e.g. Ashwin 1961*b*, Moore 1967, Garnock-Jones & Langer 1980, Chalk 1988). Three Australian species have been transferred to *Parahebe* from *Veronica* (Briggs & Ehrendorfer 1968, 1986) and the combinations have been used in other publications (e.g. Burbidge & Gray 1970, Jacobs & Pickard 1981, Beadle et al. 1982, Beadle 1984, Barker 1986).

The genera have been regarded as poorly characterised but there has been agreement that *Parahebe*, *Hebe*, *Chionohebe* B. Briggs & Ehrend. (formerly *Pygmea* J.D. Hook. non *Pygmaea* Stackh.) and *Detzneria* Schltr. ex Diels (the last mentioned by only some authors) form a southern-hemisphere assemblage distinct from *Veronica* (Frankel & Hair 1937, Royen 1972, Briggs & Ehrendorfer 1976, Ehrendorfer 1971).

Hong (1984), Garnock-Jones (1991 and pers. comm.) and the present authors have made cladistic analyses relevant to the *Hebe* group of genera. Hong made a wide-ranging study of the Veroniceae and concluded that *Parahebe* grouped with *Hebe* and *Chionohebe* and more distantly with *Detzneria*, and that this assemblage of genera has 'its own developmental history based on a different geographical, morphological and chromosomal background from that of *Veronica*'. Garnock-Jones is investigating the whole assemblage but especially the numerous and diverse New Zealand members. We have found that relationships among the Australian taxa could not be studied satisfactorily without considering relationships among the major groups within *Parahebe* and *Hebe* and thus extending our study to the New Zealand groups. The results of our cladistic studies will be published elsewhere, depending on the outcome of other work.

Grayer-Barkmeijer (1973, 1978 and unpublished, see Hong 1984) found that the *Hebe* group differed from *Veronica*, and from other Scrophulariaceae studied, in its iridoid-phenolic acid metabolism. She also found differences in leaf flavonoids in different groups included in *Parahebe* sens. lat.

Parahebe (Oliver 1944) is predated by *Derwentia* Raf. (Rafinesque 1836), which was never taken into general use. *Parahebe* has been proposed for conservation against *Derwentia* (Garnock-Jones et al. 1990) so that a broad concept of *Parahebe* can, if appropriate, be retained without nomenclatural change. Such conservation does not prevent the adoption of *Derwentia* for a group of species that excludes the New Zealand *P. catarractae* (G. Forster) W. Oliver, type of *Parahebe*.

Originally it was our intention to transfer to *Parahebe* all the species that are revised in this paper, and herbarium annotations were made accordingly, using manuscript names under *Parahebe*. Further study, including more extensive consideration of species in New Zealand and New Guinea, as well as phylogenetic analysis, has convinced us that this is not appropriate. We conclude that only one Australian species should be placed in *Parahebe* (*P. lithophila*) and that *Derwentia* can appropriately be adopted at generic level. But we exclude *Veronica formosa* R. Br. from *Veronica*, *Parahebe* and *Derwentia* and refer to it in discussion as 'Formosa' without generic assignment.

We refer in discussion and description of features to groups within *Hebe* and *Parahebe* and allies by names based for the New Zealand species on Moore (1961) and Ashwin (1961*b*, 1961*c*) and as listed below. (A few of the following groups are not referred to in the present paper but are included to indicate the range of our cladistic analyses):

Parahebe sens. strict. (Ashwin's *Parahebe* group A, New Zealand)

Parahebe B (Ashwin's *Parahebe* group B, New Zealand)

'Lithophila' (*Parahebe lithophila*, Australia)

Parahebe New Guinean species

Derwentia (Australia)

'Formosa' (Australia)

Hebe sens. strict. (Moore's *Hebe* groups A–D, New Zealand, South America)

'Buxifoliatae' (Moore's *Hebe* group E, New Zealand)

'Flagriformes a' (Moore's *Hebe* 'Flagriformes' group a, New Zealand)

'Flagriformes b' (Moore's *Hebe* 'Flagriformes' group b, New Zealand)

'Flagriformes c' (Moore's *Hebe* 'Flagriformes' group c, New Zealand)

'Connatae' (Moore's *Hebe* group G, New Zealand)

'Paniculatae' (Moore's *Hebe* group H, New Zealand)

'Grandiflorae' (Moore's *Hebe* group I, New Zealand)

'Semiflagriformes' (Moore's *Hebe* group J, New Zealand)

Chionohebe (Australia and New Zealand)

Detzneria (New Guinea)

The informal groups and placements of Moore and Ashwin are used here and listed above, although Heads (1987, but see also Garnock-Jones 1989) referred some of the species to his new genus *Leonohebe* Heads and formalised a number of sections within *Leonohebe*, some of them apparently based on Moore's informal sections or subsections.

Detzneria is sister group to the remainder of the *Hebe* group of genera in the preferred hypothesis arising from our cladistic studies. It has small trichomes near the leaf-base reminiscent of but smaller than those in the *Chionohebe* clade mentioned below. It shows a considerable number of striking autapomorphies in leaf shape and the large tubular flowers (unless the latter are plesiomorphic – many other Scrophulariaceae have large flowers). Its pollen, seeds and chromosome number (n=24) are distinctive among the *Hebe* group of genera (Hong 1984).

2 Chromosome numbers

Parahebe was originally distinguished from *Veronica* partly on the basis of chromosome numbers. Base numbers of x=20 and x=21 have been recorded (Frankel & Hair 1937, Frankel 1941, Hair 1967, Hair 1970, Moore & Edgar 1970, Beuzenberg & Hair 1983); both base numbers are found within *Parahebe* sens. strict.

The number n=21 is widely distributed; only *Derwentia* (n=20, 19), '*Hebe* Flagriformes group a' (n=20) and *Detzneria* (n=24) do not, so far as known, include any species with n=21, while all species of *Hebe* sens. strict. reported have n=20 except *H. vernicosa* J.D. Hook. (n=21). Reduction to n=20 has apparently occurred repeatedly: within *Chionohebe*, *Parahebe* sens. str. and, according to our phylogenetic analysis, at least twice in *Hebe* sens. lat.

Our findings and those of Frankel (pers. comm.) (Table 1, Figs. 1 and 2) show n=21 in *P. lithophila* and '*Veronica formosa*'. The finding of n=19 in *D. decorosa* and *D. arenaria* brings a new number for the *Hebe* group of genera, but other *Derwentia* species counted (*D. nivea*, *D. derwentiana*, *D. perfoliata*) showed n=20. Chromosome number determinations by BGB were made on root tips using *p*-dichlorobenzene pre-treatment and alcoholic carmine stain, or on pollen mother cells.

The *Hebe* group is considered, by other authors and ourselves, to be palaeopolyploid, in contrast to *Veronica* which has base chromosome numbers of x=7, 8 and 9. The number n=19 indicates further dysploid reduction. *Detzneria*, reported to have $2n$=48 (Borgmann 1964), may share with the *Hebe* group the synapomorphy of polyploidy, or its hexaploid level could possibly be derived separately, perhaps even from a different diploid base number.

Table 1. Chromosome number determinations. Initials in the 'Det.' column refer to the determiner of the chromosome number record. BB, FE and OF refer respectively to Briggs, Ehrendorfer and Frankel. All vouchers in herb. NSW are also included with fuller information in the lists of specimens examined.

Taxon	*n*	2*n*	Det.	Source & Voucher
Parahebe lithophila		42	BB	Mt Colong, *Briggs 1125* (NSW)
		42	BB	Bulga Ridge, *Rodd 517* (NSW)
'Veronica formosa'	21		OF	cult. Bot. Garden Christchurch 1932, *Frankel HV289*
		42	BB	cult. Australian National Botanic Garden, Canberra ex Freycinet Peninsula, *Phillips*
		42	FE	
Derwentia nivea		40	FE	
D. decorosa	19	38	BB	Germein Gorge, *Eichler 19209* (AD, NSW)
D. arenaria	19	38	BB	Blackmans Lookout, Warrumbungle Mtns, *Ehrendorfer, Briggs 941 & Johnson* (NSW)
D. derwentiana				
subsp. not termined	20		OF	cult. Bot. Garden Christchurch 1937, d e - *Frankel s.n.*
subsp. not determined	20		OF	Condor Ck below Blundells plantation ACT, *Burbidge & Frankel HV414*, 5.2.55
subsp. *homalodonta*		40	BB	Hindmarsh Tiers, *McArthur NSW 118325*
subsp.? (subsp. *homalodonta* & *anisodonta* occur in the vicinity)	c.20		OF	Flinders Chase, Kangaroo I., *Cleland HV415*, 15.12.54
subsp. *subglauca*		40	BB	Hampton, *Briggs 1011 & Johnson* (NSW)
D. perfoliata	20		OF	Cabramurra, Tumut R. Rd, *Frankel HV410*
	20		OF	Condor Ck, *Burbidge & Frankel HV415*, 5.2.55
		40	FE	Cherry Tree Hill, *Ehrendorfer 8801* et al.
		40	BB	W of Tuross Falls, *Johnson NSW 854491*
		40	BB	Granya Gap, *Rodd 606* (NSW)

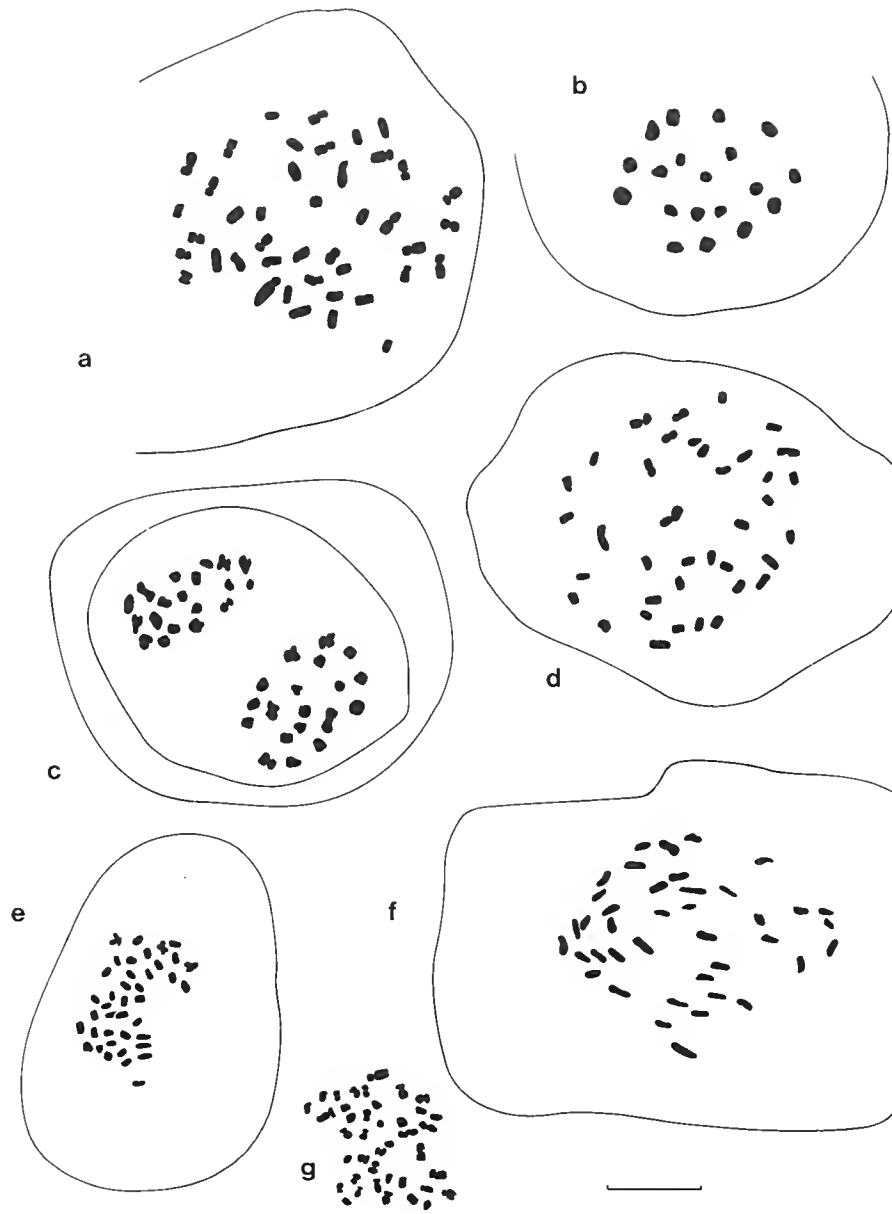

Figure 1. Chromosome complements. Counts from meiosis (1b, 1c) or root-tip mitosis. Vouchers are indicated in Table 1. **a**, *Parahebe lithophila* $2n=42$; **b**, *Derwentia decorosa* $n=19$; **c,d** *D. arenaria* $n=19$, $2n=38$; **e**, *D. derwentiana* subsp. *subglauca* $2n=40$; **f**, *D. velutina* $2n=40$; **g**, *D. perfoliata* $2n=40$.

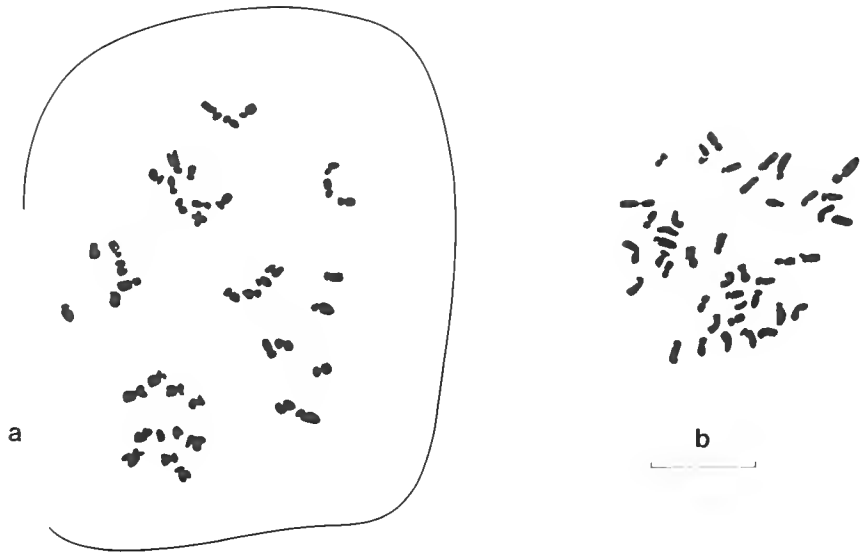

Figure 2. Chromosome complements. Counts from root-tip mitosis. Vouchers are indicated in Table 1. **a**, *'Veronica formosa'* $2n$=42; **b**, *Chionohebe densifolia* $2n$=42.

3 Notes on features of the taxa

(Some comments extend beyond the species covered in this paper to give context of allied taxa.)

3.1 Woody or shrubby habit

This feature reflects the general rigidity and form of the plant and has involved somewhat arbitrary distinctions. 'Formosa', for example, has short-lived woody stems, whereas *'Parahebe* B', 'Lithophila', *Parahebe* sens. strict. and *Derwentia* are softly woody or have woody bases. Many of the differences in habit depend on the extent of elongation and longevity of seasonal growth units (SGUs as in Briggs & Johnson 1979 and equivalent here to repeating growth units of Grimes 1992). The habit is shrubby where SGUs are short but numerous and not regularly replaced by new growth, whereas *Derwentia* and possibly the New Guinean *Parahebe* species, and to a lesser extent 'Formosa', have elongated but little-branched and short-lived main stems.

Stems of all groups have a cylinder of secondary woody tissue even in soft, slender stems such as the erect stems of 'Lithophila' (<1 mm diam.) or the peduncles of racemes of *D. derwentiana*. Stems of *Derwentia* have a relatively thin xylem cylinder surrounding a broad pith whereas rigid woody stems, for example in *Hebe propinqua* (Cheesem.) Cockayne & Allan (group 'Flagriformes a'), have a much narrower pith and thicker xylem. The xylem appears very similar in the species examined (only a small sample of the total species), having radial rows of small thick-walled cells with or without scattered larger vessels. Annual rings are usually visible in stems that have grown through several years. The species of *Derwentia* with longest-lived stems, *D. velutina*, showed up to four annual rings. *Chionohebe* species have a rather thick bark but the secondary xylem is poorly developed.

Hong regarded a woody or shrubby habit as apomorphic within the Veroniceae but as a synapomorphy of the *Hebe* group of genera. Observations within this group of genera, and references such as Metcalfe & Chalk (1950), suggest that woody Scrophulariaceae do not show highly unusual wood features, unlike several other families where woody members are considered to be derived from herbaceous ancestors, although Carlquist (1988) reports paedomorphic features in the wood of various Scrophulariaceae. The family is associated with others that are woody, such as Bignoniaceae and Myoporaceae, but is also close to largely herbaceous groups such as Acanthaceae, Selaginaceae and Lentibulariaceae (Thorne 1992, Dahlgren et al. 1981, Cronquist 1981, Dahlgren 1989). Most genera of Scrophulariaceae are herbaceous, and herbaceous tribes have generally been considered to be primitive within it (e.g. Thieret 1967), but there appears to be little evidence as to its plesiomorphic habit condition. Our cladistic analyses showed greater congruence and shorter trees when shrubby habit was treated as plesiomorphic and the non-woody taxa were scored for the apomorphy 'loss of shrub habit'.

3.2 Trichomes

The stout 2–4-celled trichomes ('cilia') on leaf margins in *Chionohebe* and 'Semiflagriformes' have a rough surface, sometimes with a spiral ornamentation of the cell walls, a feature shown by some trichomes of different morphology among these species and elsewhere in the Scrophulariaceae (Raman 1987). 'Formosa' and '*Parahebe* B' have these stout trichomes although they are of variable abundance and sometimes few in these taxa. Our attention was drawn to the significance of these trichomes, and to those in the corolla throat of *Derwentia*, by Dr Garnock-Jones (pers. comm.).

Short or very short glandular hairs with a 2-celled head are found in many species, and within Scrophulariaceae are not confined to the Veroniceae. Longer multicellular hairs occur on calyces of *Chionohebe* species; these have a single globular or pear-shaped apical cell that generally collapses so that the apex is broad but concave and obconical. Similar hairs are seen, for example, in *Hebe raoulii* (J.D. Hook.) Cockayne & Allan of the 'Paniculatae' and may be widespread. Other trichome types are present in some of the taxa and in particular locations, e.g. on calyx lobes and in the corolla throat of *Derwentia*, and warrant further study.

3.3 Inflorescences

The terminology and concepts of Briggs & Johnson (1979), which include many of the definitions and terms of Troll (see Weberling 1981), assist in describing the inflorescences. As with other Scrophulariaceae, the basic unit-inflorescence (uniflorescence) is a raceme, generally anauxotelic. Some taxa show flexibility, with racemes either terminal or lateral or in both positions (Hamann 1960, Moore 1967). In other taxa, increasing fixity of structure appears to have restricted uniflorescences to either lateral (many taxa) or terminal positions. *Veronica* shows similar trends from a flexible condition (Hamann 1958).

Individual flowers in the racemes lack bracteoles (prophylls) but, where the uniflorescence is reduced to a solitary flower, a pair of 'bracteoles' (prophylls of the uniflorescence axis) generally remains and gives evidence that there has been reduction of axes. Phyllotaxy is spiral in the raceme, in contrast to the generally opposite phyllotaxy of vegetative parts. Sometimes, as in 'Formosa', the racemes are borne on an axis that may develop spiral phyllotaxy and is a short shoot with a bracteose, rather than a frondose, axis in the raceme-bearing region (a bracteose and often anauxotelic R_y axis supporting bracteose R_z raceme axes). Racemes in *Derwentia* are exclusively lateral except rarely on leafy lateral stems; the illustration in Barker (1986: 1301)

depicts terminal as well as lateral inflorescences, rather than the characteristic condition for the species illustrated, namely *D. decorosa* and *D. derwentiana*.

The branching inflorescence of 'Paniculatae' apparently represents the reduction of a branching system of stem axes, hence the inflorescence 'peduncle' cannot be equated with that of a simple raceme as in *Derwentia* or *Parahebe*. Although the peduncles are bracteose and differentiated from the leafy parts of the plant in each case, those of the 'Paniculatae' are higher order axes (R_y not R_z axes). The short leafy lateral branches of 'Formosa' appear homologous (in supporting lateral racemes) to the tall, erect, usually unbranched stems of *Derwentia* species such as *D. derwentiana*. The branched inflorescences of *Hebe diosmifolia* (A. Cunn.) Cockayne & Allan may have also resulted from reduction of more extensive branching systems; it is the only instance of terminal racemes in *Hebe* sens. strict. which otherwise has racemes limited to lateral positions.

A contrasting interpretation of the limits of the inflorescence was put forward by Heads (1987). On the basis of differences between juvenile (or reversion-shoot) and adult foliage, he considered that, in most of the species of *Hebe* and *Chionohebe* with connate leaf bases, the adult leaves are derived from sterilised inflorescence bracts. As Garnock-Jones (1989) aptly states, this 'is a most novel interpretation of the evolutionary origin of the leaves, and no way is given to distinguish these supposedly bract-derived leaves from the true leaves of *Hebe*'.

Illustrations of New Guinean species referred to *Parahebe* (Royen & Ehrendorfer 1970, Royen 1972) give the impression that the inflorescences mostly bear terminal flowers. Observation shows that the inflorescences are terminated by non-floral buds (blastotelic rather than anthotelic) conforming to the general inflorescence structures in this group of genera and in the Scrophulariaceae as a whole.

In part of *Hebe* sens. strict. small flower-size is associated with very numerous crowded flowers and the raceme may function as a single 'blossom' in attracting pollinators.

3.4 Pollen

Hong (1984) used six characters of the pollen grains in his cladistic analysis. He reported reticulate exine structure and a smooth colpus membrane in *Detzneria* but striate-reticulate exine and granular membrane in all samples of *Hebe*, *Chionohebe* or *Parahebe* [sens. lat.] studied.

Our SEM observations on the ten Australian species of these genera found all to have '*Veronica*-type' pollen (Fig. 3). Thus they show colpate grains with striate-reticulate partial tectum, the colpus membrane is granular with fairly large irregular processes. As observed, the colpi range from wide (e.g. *D. nivea*) to narrow (e.g. *P. lithophila*, *D. decorosa*) but, since the grains were not acetolysed, these differences may reflect age of sample or be artifacts.

3.5 Seeds

The seed-coats of *Derwentia* species are ovoid, rugose abaxially but flattened adaxially. Those of 'Formosa' are circular, thin, smooth on both surfaces apart from a fine cell-pattern, concave adaxially and convex abaxially. Seeds of these groups lack the fine reticulate pattern of collapsed cells illustrated by Hong (1984) (and considered by him to be plesiomorphic in Veroniceae) and elsewhere in Scrophulariaceae by Sutton (1988), but that is only one of the ornamentation types in this diverse family (Corner 1976).

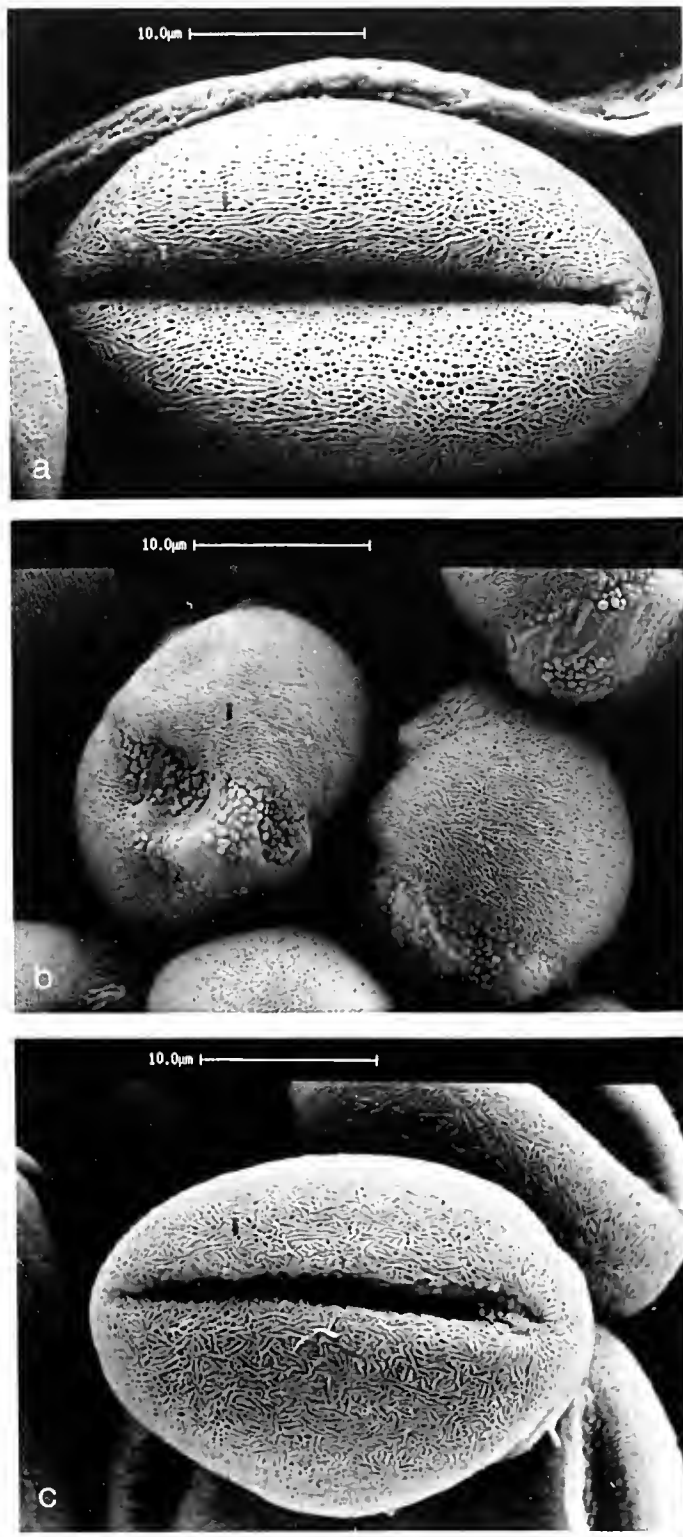

Figure 3. Pollen grains. **a**, *Parahebe lithophila;* **b**, *Derwentia nivea;* **c**, *D. velutina.*

4 The Veroniceae and phylogenetic studies

Studies by Hong (1984) provide a context for investigations within the Veroniceae and suggest directions of character evolution. In his cladogram the *Hebe* group of genera appears to be relatively advanced within the tribe, although *Detzueria* retains plesiomorphic seed and pollen features that are shared with other Veroniceae. Some of these characters show much homoplasy, with granular pollen colpus membrane appearing four times in his cladogram. Largely because of these seed and pollen features, the first divergence that he shows among these genera is between *Detzueria* and a clade consisting of *Chionohebe*, *Hebe* and *Parahebe*.

Our cladistic studies used CLAX (Johnson & Briggs 1984) and Hennig86 (Farris 1988). Because of extensive homoplasy and low levels of congruence among the relatively small number of characters (27), there were several competing equal-length minimal cladograms from CLAX and many from the Hennig analysis. The different results from these programs arise from their different treatment of character reversals. From them our preferred hypothesis is similarly that *Detzueria* is sister-group to the remainder, among which the analyses gave evidence of the four clades listed below.

(1) *Parahebe* clade (*Derwentia*, *Parahebe* – New Zealand, *P. lithophila*, '*Parahebe* – New Guinea');

(2) *Hebe* clade (*Hebe* sens. strict., *Connatae*, *Buxifoliatae*, 'Flagriformes');

(3) *Chionohebe* clade (*Chionohebe*, 'Semiflagriformes', 'Formosa', '*Parahebe* B');

(4) 'Paniculatae'.

Hebe 'Grandiflorae' was variable in position and it associated in equal-length cladograms with any of the first three clades.

Dr Garnock-Jones (pers. comm.) was the first to point out the grouping *Chionohebe* – 'Semiflagriformes' – 'Parahebe B' and also the very isolated position of 'Paniculatae', as found also in our study. We thank him for valuable unpublished information provided on various features used in the analysis.

Other workers have proposed alternative hypotheses which are at variance with our conclusions:

(i) In the course of a study of sexual conditions and floral form in *Hebe* and *Chionohebe*, Delph (1990) suggested that the 'Connatae' and 'Semiflagriformes' are phylogenetically close and that their common ancestor may have also given rise to *Chionohebe*. Our study does not support so close a link between 'Connatae' and *Chionohebe*.

(ii) Largely on the basis of an interpretation of leaf derivation and phyllotaxy, in an extremely brief treatment, Heads (1987) brought together 31 species under his new genus *Leonohebe*, typified by a species of the 'Semiflagriformes'. As well as separating the 'Semiflagriformes', 'Buxifoliatae', 'Connatae' and 'Flagriformes' from the remainder of *Hebe*, he divided *Chionohebe*. In the latter he retained the species with irregularly imbricate leaves but he transferred to *Leonohebe* two species with quadrifariously imbricate leaves (Ashwin 1961*a*). The quadrifariously imbricate condition is, of course, simply a condensation of the regularly decussate arrangement that is plesiomorphic for the whole group, whereas the irregularly imbricate arrangement is a modification of this condition.

Garnock-Jones (1989) gave a valuable summary and assessment of the taxonomic changes made by Heads (1987); we agree with his strong doubt that *Leonohebe*, as circumscribed by Heads, is worthy of recognition. Our phylogenetic analysis placed components of *Leonohebe* in the *Hebe* and *Chionohebe* clades, each of which is marked by a considerable range of synapomorphies.

5 Phytogeographic connections

The *Hebe* group of genera, although restricted to the Southern Hemisphere, has an Australasian rather than Gondwanic distribution. It is absent from South Africa and the only representatives in South America are two or three species that occur also in New Zealand. These far-flung members give evidence of trans-oceanic dispersal, as do two species common to New Zealand and Australia.

Of the principal groups, the *Parahebe* clade includes members in Australia, New Zealand and New Guinea. The members of the *Hebe* and 'Paniculatae' clades are exclusively in the New Zealand region (from the Kermadecs to Chatham and Campbell Islands) except for the two species of *Hebe* sens. strict. found also in South America. Australia shares with New Zealand two species of *Chionohebe*; some limited distance-dispersal of high altitude or temperate species is the simplest explanation of this. Questions remain as to the regions of initial diversification of this assemblage of genera and of the clades that span several land-masses. The only region where all the main clades (excluding *Detzneria*) are represented is New Zealand.

Detzneria occurs on the highest alpine peaks in Papua New Guinea. Since the New Guinea mountains did not reach such altitudes or such climatic zones until the Pleistocene (Ollier 1986), the ancestors of *Detzneria* may have existed in other regions.

Our phylogenetic conclusions imply the following dispersal or separation events for species of different land-masses. These events may have occurred at very different times and the directions of movement are not established:

New Zealand–Australia

– Separation of 'Formosa' from common ancestor with *Chionohebe* and allies.

– Separation of *Derwentia* or common ancestor of *Derwentia* and '*Parahebe* New Guinea' from *Parahebe* sens. strict.

– Dispersal or separation of 'Lithophila' from the other species of its genus, i.e. *Parahebe* sens. strict.

– Dispersal of two species of *Chionohebe*, presumably from New Zealand to mountain or temperate regions of Australia (Briggs & Ehrendorfer 1976).

Other regions–New Guinea

– *Detzneria* separated from the common ancestor of the other members of the *Hebe* group of genera.

– '*Parahebe* New Guinea' separated from common ancestor with *Derwentia*, or common ancestor of *Parahebe* clade.

New Zealand–South America

– Dispersal of two species of *Hebe* sens. strict., presumably from New Zealand to South America.

6 Generic classification

Decisions concerning the non-Australian taxa are best deferred until the cladistic analyses are published and studies by others are completed. The following decisions on generic levels are restricted to Australian taxa but have wider implications among these genera; they are adopted in Briggs & Makinson (1992). It is relevant to note that many of our conclusions are also supported by the work of Dr Garnock-Jones, who will deal more comprehensively with these taxa in future publications, but that our conclusions diverge in some aspects.

6.1 *Parahebe*

Parahebe sens. lat., as recognised in the past, appears from our analyses to be a polyphyletic assemblage, defined by characters that are mostly plesiomorphic. The genus is therefore adopted in a narrow sense, with only one Australian species, *P. lithophila*, described below, included within it. In a study of breeding systems and floral morphology of New Zealand *Parahebe*, Garnock-Jones (1976) made clear both the diversity of groups that have been included within *Parahebe* and the important feature of folded lateral corolla lobes. He has also (Garnock-Jones 1991) observed that, in the *Hebe* group of genera, 'traditional use of both plesiomorphic and apomorphic character states has resulted in taxa that are paraphyletic' as well as others that are polyphyletic.

P. lithophila shares with *Parahebe* sens. strict. a generally similar corolla shape marked by 'honey guides'. The lateral corolla lobes show longitudinal folds in the newly open flower as in the New Zealand species, and the stamens spread close to the lateral corolla lobes in a generally similar way. The decumbent scrambling habit, leaf form, inflorescence and capsules are shared with New Zealand species but these features may be largely plesiomorphic. Grayer-Barkmeijer (1978) noted the presence of an unusual flavonoid-like compound in *Parahebe* sens. strict. but no information on chemical constituents is available for *P. lithophila*.

6.2 *Derwentia*

This group is accorded generic rank. There could be a case for adopting *Parahebe* sens. lat. to include *Derwentia* and the New Guinean species, since these appear to form a clade, albeit poorly characterised. *Derwentia* is, however, marked by a number of characters that are considered to be distinctive: the acutely toothed (rather than crenate) leaves, numerous flowers on short pedicels, presence of hairs in the corolla tube, and reduced chromosome number (n=20 or n=19). It also differs from *Parahebe* in its primarily septicidal capsule dehiscence, a feature it shares with the New Guinean species. Grayer-Barkmeijer (1978) noted that *D. derwentiana* and *D. perfoliata* (which she reported under *Parahebe* sens. lat.) had similar flavonoid patterns but that there was 'no clear indication of any close relationships' with New Zealand species of *Parahebe*.

As a consequence of the recognition of *Derwentia* and narrow definition of *Parahebe*, it will presumably be necessary eventually to accord generic rank also to the New Guinean species, since they do not appear to be appropriately placed within *Parahebe* or *Derwentia* as now defined. The New Guinean species share a characteristic trichome type (brown hairs with frequent cell collapse).

The *Derwentia* species have a distinctive aspect and inflorescence form, but retain apparently plesiomorphic features such as the acute and scarcely compressed capsules of some species. Apparently apomorphic change to strongly compressed, emarginate capsules and dissected leaves has occurred within *Derwentia*, especially in *D. nivea*.

Hebe species have toothed leaves in the juvenile stage (Garnock-Jones pers. comm.), and the deep lobing of juvenile leaves of *H. cupressoides* (J.D. Hook.) Cockayne (Cheeseman 1914: t.154) ('Flagriformes' group c), for example, is reminiscent of *Derwentia nivea*. It is possible that the condition in *D. nivea*, and perhaps the toothing of other *Derwentia* species, may be neotenous. Seedling leaves of *D. derwentiana* subsp. *derwentiana* have a few pairs of very shallow acute teeth. A population of *D. perfoliata* that has the adult leaves entire or with a few teeth showed similarly entire or shallowly toothed leaves at seedling stage. Thus, in the species for which we have information, *Derwentia* does not have markedly different adult and juvenile leaf forms.

6.3 *Veronica formosa* R. Br. and allied groups

The taxon referred to above as 'Formosa' has generally been retained under *Veronica* in recent years (e.g. Curtis 1967: 522; Stones & Curtis 1969: 98, t.52) although the combination *Hebe formosa* (R. Br.) Cockayne (Cockayne 1929: 434) has been made. It has been referred to informally as '*Parahebe formosa*' (Hutchins 1990) and in the past we made herbarium determinations using this unpublished combination, which we no longer support.

The clade indicated by our analyses, that consists of this species together with the 'Semiflagriformes', *Chionohebe* and probably '*Parahebe B*', has synapomorphies of entire and connate adult leaves (rarely crenate lobing has been observed in *Chionohebe densifolia* (F. Muell.) B. Briggs & Ehrend. and toothing of leaves on lower branches of 'Formosa'), also the inflorescence is exclusively lateral and reduced to short racemes or single flowers.

Since other Australian members of the *Hebe* group of genera are now being removed from *Veronica*, retention of 'Formosa' under that generic name gives a misleading indication of its relationships. It appears unlikely that it will be appropriate to regard it as congeneric with any other member of its clade; we therefore intend to address its generic position in a forthcoming paper.

6.4 Key to genera of the *Hebe* group in Australia

1 Leaves toothed or crenate with leaf bases separate and leaf margins without stout trichomes *or* if leaves entire and connate (some individuals of *Derwentia perfoliata*) then leaf margins glabrous.

2 Corolla throat glabrous or with sparse short hairs, lateral corolla lobes longitudinally folded around stamens in newly-opened flowers, stamens spreading widely across lateral corolla lobes; capsule dehiscing primarily loculicidally *or* both loculicidally and septicidally; seeds broad-ovate or circular, flat and smooth on both surfaces; racemes with 1–18 flowers ..... ***Parahebe***

2* Top of corolla throat with a ring of dense hairs, lateral corolla lobes not folded around stamens in newly opened flowers, stamens not spreading widely; capsule dehiscing primarily septicidally; seeds elliptic or ovate, flat adaxially but rounded and rugose abaxially; racemes with (4–)20–160 flowers ..... ***Derwentia***

1* Leaves entire, leaf bases connate, leaf margins with stout white trichomes near the leaf base. [Corolla throat glabrous.]

3 Flowers in racemes of 2–25 flowers, 4-merous, bracteoles absent; shrubs >0.5 m tall; leaves not imbricate, 5–21 mm long; capsule dehiscing primarily septicidally ..... **gen. nov. ('Formosa', *Veronica formosa*)**

3* Flowers solitary, 5-merous, bracteoles present; low or cushion-like shrubs to 0.3 m tall; leaves imbricate, 2.5–7 mm long; capsule dehiscing both loculicidally and septicidally into 4 valves ..... ***Chionohebe***

6.5 Notes on the systematic treatment

Most of the following descriptions include two indices used to quantify aspects of leaf shape.

Leaf index is the ratio of lamina length to lamina breadth (breadth being measured between the base of sinuses rather than between the tips of leaf teeth). *Dentation index* is the ratio 'outer breadth'/'inner breadth' of lamina; that is, the ratio of lamina breadth measured between the tips of the leaf lobes or teeth/the breadth measured between the base of sinuses of the lobes or teeth.

All specimens cited have been seen by one or both authors except where stated.

Several species are of restricted distribution and endangered but most *Derwentia* species and *Parahebe lithophila* will colonise moderately disturbed sites. However it is unlikely that *Chionohebe* species – even though they occur in sparsely vegetated microhabitats – would be effective colonisers.

Conservation status is given for rare and restricted species with conservation status codes as in J. Briggs & Leigh (1988).

7 *Parahebe* Oliver

Parahebe Oliver (1944: 229). TYPE: *Parahebe catarractae* G. Forster (New Zealand).

Softly woody shrubs or herbaceous but with woody bases; stems arising from a woody rootstock or trailing, sometimes rooting at nodes, pilose, hairs often in bifarious bands. *Leaves* opposite, petiolate, ± pilose; margins crenate-dentate without stout marginal trichomes. *Inflorescences* racemose, bracteose, borne laterally, with spiral phyllotaxy in the raceme; flowers several to many but not very numerous, well-spaced, pedicellate. *Calyx* deeply 4-lobed, often ciliolate but without stout marginal cilia. *Corolla* white, lavender or pinkish, shortly tubular with 4 widely spreading, unequal lobes, often with darker nerves ('honey-guides'), without hairs in the tube or throat; lateral lobes longitudinally folded around the stamens after anthesis; veins branching (with curving lateral branches) in the tube or at the base of the tube. *Stamens* 2, epipetalous, inserted in the corolla tube, the filaments spreading over the lateral corolla lobes. *Ovules* many, crowded on a convex placenta. *Capsule* laterally compressed, emarginate, dehiscing both loculicidally and septicidally or less deeply septicidally. *Seeds* usually many, flat, not reticulate. *Chromosome number*: n=21 or less often n=20.

SPECIES AND DISTRIBUTION: Several species in New Zealand and one in Australia. Other Australian species that have been referred to *Parahebe* are now excluded from the genus and the inclusion of New Guinean species and some New Zealand species is under review (Garnock-Jones pers. comm.)

Parahebe lithophila *B. Briggs & Ehrend.*, **sp. nov.**

Inter species *Parahebes* combinatione characterum sequentium distinguitur: laminae foliorum (5–)12–25 mm longae, (3.5–)8–15 mm latae, pagina abaxiale non pallida sed saepe laete purpurea; pedunculi nec dense glandularepilosi nec albopubescentes; corolla lavandulacea.

TYPE: NEW SOUTH WALES: Central Tablelands: Bulga Range, c. 6 miles [10 km] NW of Yerranderie; map reference, Yerranderie sheet, approx. 145924; alt. 670 m, *A. Rodd 517*, 17 Sep 1967; holo NSW; iso AD, CHR. The type collection is also the chromosome count voucher.

Softly woody herb. *Stems* ascending to 15(–30) cm or prostrate and rooted at the nodes and to 0.5 m long, usually sparingly branched, longest internodes 1–3(–5) cm long, terete, 0.5–2 mm diam., with short fine hairs evenly and densely distributed or in longitudinal bands; hairs rigid, antrorsely curved, 0.2–0.6 mm long. *Leaves* spreading, petiolate; petiole 2–7.5 mm long, 0.2–0.8 mm broad, lamina broad-ovate or lanceolate, (5–)12–25 mm long, (3.5–)8–15 mm broad, leaf index 1.2–1.6, with 2–9 slightly spreading shallow acute teeth on each side, dentation index 1.05–1.5, commonly bright purple below, flat except for the narrow revolute margin, with 3–5 nerves from near the base and usually 2 major nerves from the midrib, the nerves prominent on the lower surface, glabrous or with sparse short curved hairs abaxially on the midrib, the base truncate or subcordate, the apex acute. *Racemes* single or opposite at each of 1–2 upper nodes of stems or lateral on prostrate stems, the floriferous portion 2–9 cm long with (1–)3–10(–18) flowers; the peduncle (1–)2–5 cm long. *Bracts* narrow-ovate, subacute, (1–)2–5 mm long, (0.3–)0.6–1(–2.5) mm broad. *Fruiting pedicels* 7–22 mm long, the lower longer than the upper. *Calyx lobes* elliptic, obtuse to subacute, imbricate in bud, 2–4.5 mm long and 0.7–1.8 mm broad in fruit, glabrous or with very short sparse curved papillose hairs, the margins glabrous. *Corolla* lavender with darker nerves, 6–7 mm long; adaxial lobe more prominently nerved, very broad ovate, obtuse, 7–8 mm broad; abaxial lobe ovate, obtuse, 3–4.5 mm broad, lateral lobes folded longitudinally around the stamens in bud and at anthesis; the throat with sparse very short hairs. *Stamen* filaments white, 3.5–6 mm long; anthers cream, 1.2–2 mm long. *Ovules* many, crowded on a convex placenta. *Capsules* broad-obovate or broad-elliptic, glabrous, glossy, compressed, emarginate, (2.5–)3–5.5 mm long, about as broad as long, 1.2–1.8 mm thick; dehiscing by a septicidal split 1/3 of the distance to the base and loculicidally along the upper margin, or rarely dehiscing loculicidally with or without later septicidal dehiscence, finally usually splitting to the base along both sutures; style glabrous, 5–9 mm long, often eventually deciduous. *Seeds* to 30(–40), broad ovate or circular, c. 1.3 mm long, 1 mm broad. *Chromosome number* (Fig. 1a): n=21. (Fig. 4a, 5, 6).

DISTRIBUTION AND HABITAT: Localised towards the south-east of the Central Tablelands of New South Wales. Rooted in shallow pockets of soil on flat or almost vertical rocks, mostly on south-facing slopes, with stems trailing over the rock surfaces. On exposures of coarse sandstone, conglomerate, and quartzite, surrounded by eucalypt forest on ridges in mountainous country, c. 650–870 m alt. (Fig. 10).

CONSERVATION STATUS: Rare and with restricted distribution, but occurring in Blue Mountains National Park, Code 2RC-, listed by Briggs & Leigh (1988) as '*Parahebe* sp. 1 (Blue Mountains)'.

The epithet is derived from Greek *lithos*, a stone, and *phileo*, to love, referring to the species' occurrence on rock exposures.

Beadle et al. (1982) refer to this species in the comment that an undescribed species occurs in 'the Mt Colong area'. It was referred to as '*Parahebe* sp. A' in Jacobs & Pickard (1981).

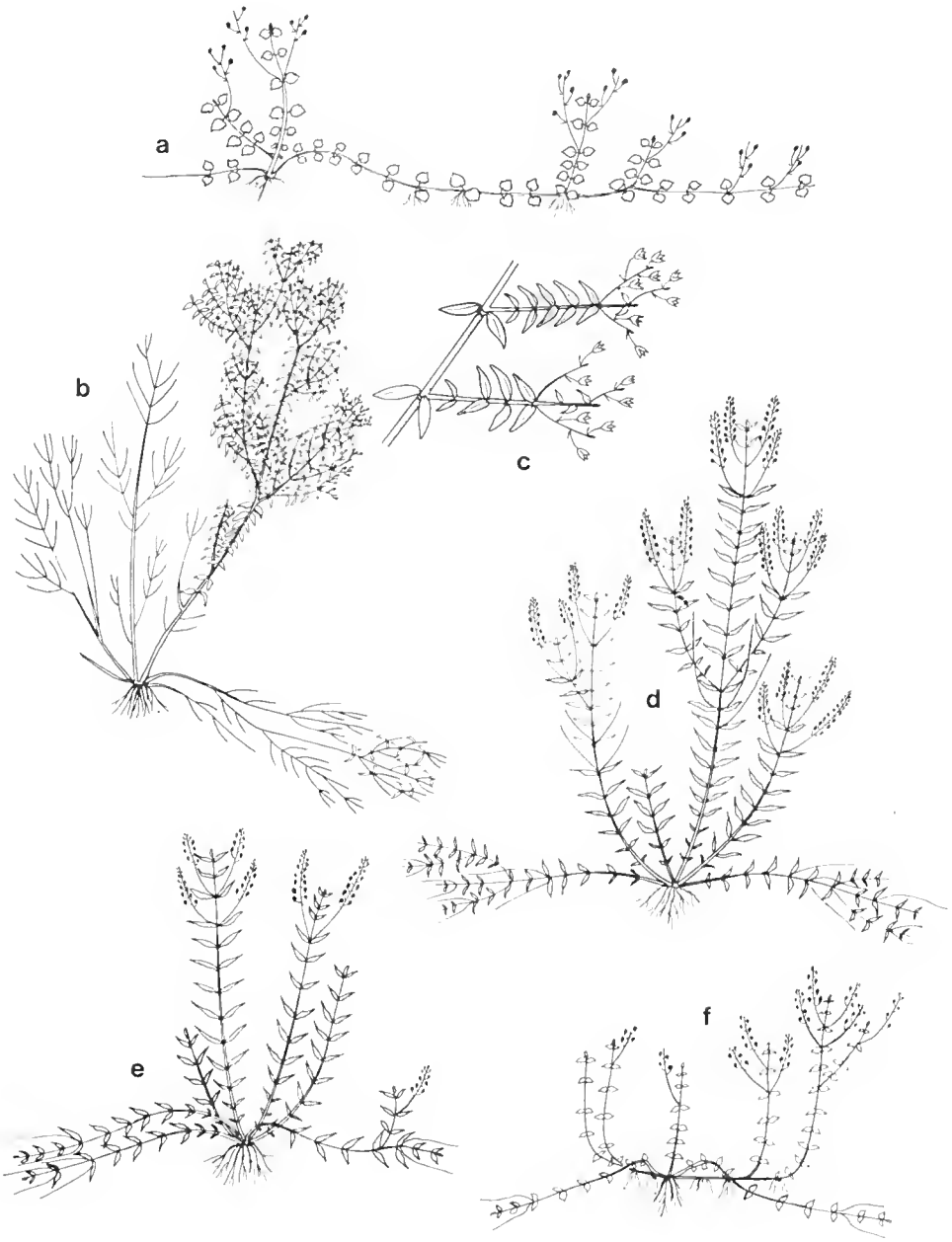

Figure 4. Habit types (diagrammatic). **a**, *Parahebe lithophila*: stems prostrate or ascending; inflorescences lateral on nodes of prostrate or erect stems; **b**,**c**, *'Veronica formosa'*: stems erect from a woody base, much branched, producing inflorescences over several seasons, finally becoming procumbent; (c) enlargement of inflorescence region; **d**, *D. decorosa*, *D. velutina*: stems erect from a woody base, sparsely branched, producing inflorescences over several seasons before falling to ground, sometimes showing limited further growth after becoming procumbent; **e**, *D. nivea*, *D. arenaria*, *D. derwentiana*, *D. blakelyi*: stems erect from a woody base, usually producing inflorescences in only one season, procumbent stems sometimes producing further terminal or lateral growth but rarely flowering again; **f**, *D. perfoliata*: similar to (e) but stems at first somewhat rhizomatous and plant forming a diffuse clump. *D. arcuata* may show type (e) or (f).

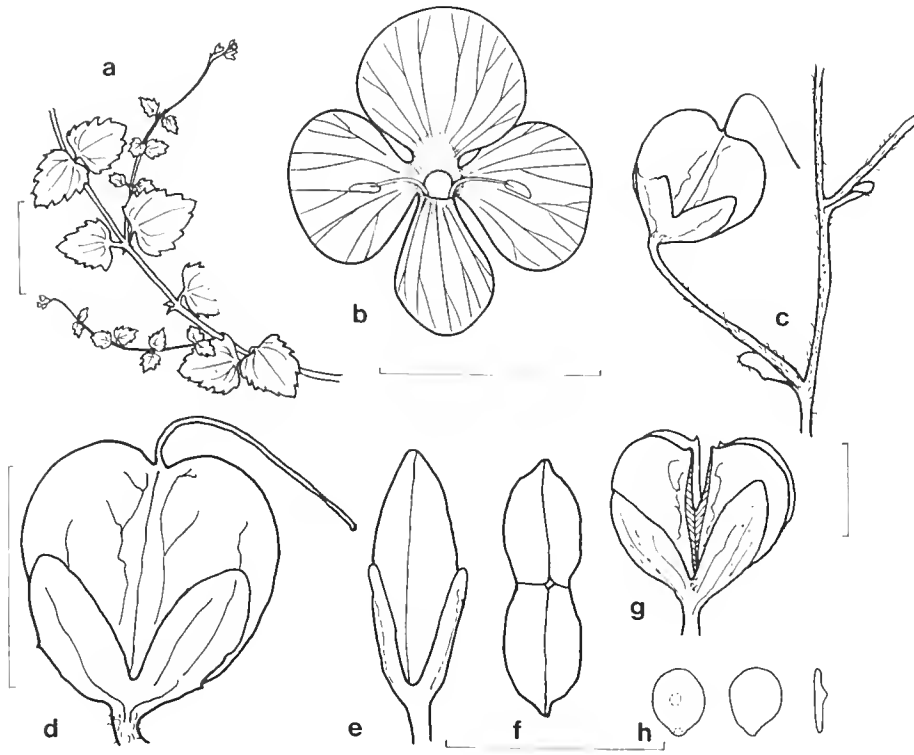

Figure 5. *Parahebe lithophila*. **a**, leafy stem; **b**, fully open corolla with stamens (cf. shape of corolla in recently opened flowers Fig. 6); **c**, portion of fruiting inflorescence; **d–f**, capsule with calyx – lateral, abaxial and apical views; **g**, dehisced capsule; **h**, seeds – adaxial, abaxial and side views; a–f, h from *Rodd 517* (holotype); g, *NSW 98190*. Scale bars: a = 2 cm, b = 5 mm, c = 2 mm, d–f =2.5 mm, g = 2.5 mm.

The species shows marked similarity to two New Zealand species, namely *P. lyallii* (J.D. Hook.) Oliver and the widespread and variable *P. catarractae* (Forst. f.) Oliver (Garnock-Jones & Langer 1980). It resembles these in prostrate or decumbent habit, petiolate leaves of generally similar shape and dentation, mostly glabrous but the petioles hairy above; long-peduncled racemes; long pedicels; corollas of generally similar form, deeply cut into broad and obtuse lobes and with similar longitudinal folds around the stamens. Differences from the New Zealand species include fine curved rigid hairs on stems and peduncles, glabrous calyx margins, and frequently purple abaxial leaf surfaces.

Selected specimens: New South Wales: Central Tablelands: McMahons Lookout, Kings Tableland, *A. Fairley & R. Miller*, 2 Sep 1984 (NSW 166368); 1 km on track below McMahons Lookout, c. 20 km S of Wentworth Falls, *B. Briggs 8958*, 2 May 1992 (NSW, CHR); Kalang Falls, Kanangra Walls, *A. Fairley*, 15 Dec 1985 (NSW 156174); Coxs R., Blue Mtns, *Willows*, 6 Oct 1950 (NSW 13581); New South Wales, [*Barrallier* per?] *Caley*, 1799–1810 (BM, NSW); eastern spur of Mt Colong, *Garden*, 1 Oct 1951 (NSW 17266); Mt Colong, 1 km NE of summit, *Briggs 1125, Rodd, & Johnson*, 23 Feb 1967 (NSW, AD, MEL), *Briggs 1126 et al.* (NSW, CANB, CHR, WELT), *Briggs 1131 et al.* (NSW, WU); Mt Colong, *Carolin 5510*, 23 May 1967 (SYD, NSW).

There are also reliable but unvouchered records of *P. lithophila* from: 'Spur of Scotts Main Range above Kowmung River near Christies Creek junction'; 'Gangerang Range

between Gabes Gap and Mt Cloudmaker'; and 'headwaters of Little River near E boundary of Jenolan State Forest' (photo Fig. 6 Rodd 1985; note in herb. NSW).

The specimens cited in BM and NSW bearing Caley's name lack a locality note such as usually accompanies his specimens. The BM sheet was annotated by Caley: 'I suspect this to be the Veronica which Mr Brown saw in looking over the specimens gathered by Mr Barralier [sic]'. In 1802 Barrallier traversed the region about 30 km west of Nattai Junction (i.e. from about 25 to 60 km west by south of Camden) and his route probably included the area of the Bulga Range.

8 *Derwentia* Raf.

Derwentia Rafinesque (1836: 55). TYPE SPECIES: *D. derwentiana* (Andrews) Briggs & Ehrend. Lectotypified by Garnock-Jones et al. (1990: 537).

Semi-woody shrubs or herbs with woody bases. *Stems* usually sparsely branched, often short-lived and arising from a woody rootstock; glabrous or pilose. *Leaves* opposite, sessile or with short broad petioles, glabrous or pilose, margins toothed or entire or leaves pinnatisect, without stout marginal cilia. *Inflorescences* racemose, bracteose, borne laterally, with spiral phyllotaxy in the raceme; flowers numerous to very numerous, often crowded, shortly pedicellate. *Calyx* deeply 4-lobed, without stout marginal trichomes (cilia). *Corolla* white, lavender, deep blue or rarely pink, shortly tubular with spreading, somewhat unequal lobes; sometimes with darker nerves ('honey-guides'),

Figure 6. *Parahebe lithophila* showing corolla shape in newly opened flowers, at Little River, south-western Blue Mountains. Photo A.N. Rodd.

lobes not folded longitudinally in the open flower but often ± hooded toward apex; veins branching (with curving lateral branches) in the tube or at the base of the tube; the corolla tube or throat with long thin-walled hairs. *Stamens* 2, epipetalous, inserted in the corolla tube, the filaments not very widely spreading. *Ovules* on a narrow vertical placenta, few (6–12) and in two rows *or* relatively numerous (to c. 40) and irregularly crowded *or* in 2–4 ± irregular rows. *Capsule* slightly or markedly laterally compressed, acute or truncate or emarginate, dehiscing septicidally and often less deeply loculicidally. *Seeds* several or many, ovoid, flattened adaxially, rugose abaxially, not reticulate. *Chromosome number*: n=20 or 19.

SPECIES AND DISTRIBUTION: Eight species, endemic in south-eastern Australia, from south-eastern Queensland to Tasmania and west to Kangaroo Island in South Australia, mostly in tableland or cool temperate regions.

Key to species

1 Leaves linear or with linear lobes or divisions, not glaucous; capsules emarginate.

2 Leaves pinnately divided with the primary segments c. 1/3–1/2 as long as the leaves and often further divided or lobed; usually with compact clusters of leaves on very short lateral shoots at the lower nodes; capsules strongly compressed [4–6.5 mm long, 3–5.5 mm broad, 1–1.5 mm thick] ..... **1. D. nivea**

2* Leaves entire or with teeth or lobes less than 1/5 as long as the leaf; not developing compact clusters of leaves; capsules compressed or scarcely compressed.

3 Corolla white with lilac nerves; most leaves entire; capsules scarcely compressed, 2.5–3.5 mm long, 2–3 mm broad, 1.5–2 mm thick ..... **2. D. decorosa**

3* Corolla bright violet-blue; lower leaves mostly toothed; capsules compressed, 3.5–6 mm long, 2.5–3.5 mm broad, c. 1.5 mm thick ..... **3. D. arenaria**

1* Leaves very narrow-ovate to broad-ovate, entire or toothed, green or glaucous; capsules acute or truncate or emarginate.

4 Vegetative parts not conspicuously glaucous, except sometimes the lower surface of leaves; stems with sparse or dense short hairs or glabrous; leaves with 15–80 teeth on each side.

5 Leaves glabrous except for sparse hairs on the margins; stems usually with denser hairs 0.2–1(–2) mm long in longitudinal bands; corolla white or pale lilac or pale blue ..... **4. D. derwentiana**

5* Leaves and stems densely and evenly covered with very short (0.1–0.3 mm) hairs; corolla violet-blue or pale lavender ..... **5. D. velutina**

4* Vegetative parts glaucous and glabrous; leaves entire or with up to 22 teeth on each side.

6 Leaves mostly V-shaped in transverse section, recurved, toothed; capsules obtuse or truncate or emarginate; fruiting pedicels 2–6 mm long

7 Corolla 6–7 mm long; capsules slightly or distinctly emarginate, compressed, 4–6.5 mm long, 1–2 mm thick ..... **6. D. blakelyi**

7* Corolla 9.5–11 mm long; capsules obtuse or truncate, slightly compressed, (4.5)6–9.5 mm long, 2.2–2.8mm thick..... **7. D. arcuata**

6* Leaves mostly flat and spreading, entire or toothed; capsules acute or obtuse [very slightly compressed, 4.5–8.5 mmm thick]; fruiting pedicels (3–)5–12 mm long ..... **8. D. perfoliata**

1. Derwentia nivea *(Lindley) B. Briggs & Ehrend.*, **comb. nov.**

BASIONYM: *Veronica nivea* Lindley, Edwards Bot. Reg. Misc. n.s. 2: 42 (1842), *non* J.D. Hook. (Hooker 1844).

TYPE: TASMANIA: Van Diemen's Land, *Gunn 269*, 1835; holo Lindley Herb. CGE, not seen, photo NSW; iso K, photo 2635 CANB (3 specimens on left of sheet).

Softly woody shrub to 0.5 m tall. *Stems* single or several, herbaceous or ± woody toward the base, erect or ascending, appearing unbranched but with short lateral branches at most nodes developing a compact cluster of several leaves or with the laterals elongated and sometimes themselves branched, usually each stem flowering in only one season before dying back to the base; old stems sometimes becoming decumbent and with ascending lateral shoots; the stem-bases forming a compact or ± spreading sympodially branched stock; stems terete, 2–5.5 mm diam., longest internodes 2–7 cm long; hairs in longitudinal bands, often sparse, antrorsely curved or irregularly twisted, 0.3–0.5 mm long, the cells often collapsed when dry. *Leaves* sessile, 15–30(–40) mm long, pinnately divided into linear segments, leaf index 12–30, dentation index 8–28, rachis 0.7–1.5(–2.5) mm broad, with (1–)2–5(–8) segments on each side; longest primary divisions 3–20 mm long and often further divided or toothed; the ultimate segments 0.5–1.2 mm broad, subacute, erect or spreading, flat or grooved above when dry, inconspicuously veined, glabrous except for the ciliolate bases of the margins, the margins thickened. *Racemes* single or usually opposite at each of 1–5 uppermost nodes, the floriferous portion (1.5–)5–17 cm long with (8–)20–40(–65) flowers; peduncle (1–)3–5 cm long. *Bracts* mostly linear or narrow-ovate, 2.5–5 mm long; lower bracts often larger and pinnately divided. *Fruiting pedicels* 4–8 mm long. *Calyx lobes* ovate or narrow-ovate, subacute, 2–5 mm long and 1–1.5 mm broad in fruit, glabrous or with sparse short hairs near the base. *Corolla* white or pale lilac or bright blue, 3.5–6 mm long; adaxial lobe obovate or broad-obovate, obtuse, 1.3–2.5 mm broad; abaxial lobe obovate or narrow-obovate, obtuse, 0.8–2.5 mm broad. *Stamen* filaments white or lilac, 2.5–3.5 mm long; anthers cream or lilac, 1–1.5 mm long. *Ovules* mostly in two rows on a narrow vertical placenta. *Capsules* broad-obovate, glabrous, glossy, strongly compressed, deeply emarginate, 4–6.5 mm long, almost as broad as long, 1–1.5 mm thick, dehiscing by a loculicidal split across the upper margin and sometimes a shallow septicidal split for c. 1/3 of the distance to the base; persistent style 3–5 mm long, glabrous. *Seeds* 10–25, c. 1.5 mm long, 0.8 mm broad. *Chromosome number*: n=20. (Fig. 4d, 7).

DISTRIBUTION AND HABITAT: Kosciusko region of south-eastern New South Wales (most collections at 1500–2000 m alt.), mountain areas of eastern Victoria (1300–1500 m), and in Tasmania above (610?–)1050 m alt. In alpine and subalpine grassland, heath and bogs, and in subalpine woodland. (Fig. 8).

This species was referred to as *'Paraliebe* sp. C' in Jacobs & Pickard (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: near Guthega Reservoir, *Gauba*, 9 Apr 1957 (GAUBA); Perisher Gap, *Burbidge 6237*, 7 Jan 1959 (CANB); head of Spencers Ck, *Johnson & Constable*, 19 Jan 1951 (NSW 18426); near Betts Camp, c. 10 km ENE of Mt Kosciusko, *Eichler 13607*, 3 Feb 1957 (AD). VICTORIA: Snowfields: Mt Buffalo, *Cambage 3732*, 19 Jan 1913 (NSW 599); Falls Ck Ski Village, Bogong High Plains, *Eichler 14673*, 2 Feb 1958 (AD); Falls Ck, aqueduct above township, *Forbes 1185*, 5 Dec 1982 (MEL, CANB, HO, NSW); Mt Wellington, *Mueller*, Nov 1854 (MEL); Echo Flat, Lake Mtn, *Muir 2063*, 26 Feb 1961 (MEL), *Carroll*, 26 Feb 1964 (CBG); Baw Baw Mtns, *Williamson*, Jan 1905 (MEL). TASMANIA: Central Highlands: Pine Lake, near Breona, *Whaite 2703*, 21 Jan 1963 (NSW). Ben Lomond: Mt Arthur, *Ratkowsky 1021*, 20 Dec 1973 (MO, NSW); Mt Barrow, *Burbidge 3002*, 9 Jan 1949 (CANB). South West: Mt Field East, *Mueller*, Jan 1869 (MEL); Mt Field Natl Park, Lake Dobson area, *Eichler 16774*, 24 Jan 1960 (AD); Mt Wellington, *Gunn 269 p.p.*, 1 Mar 1839 (BM photo CANB); *Maiden & Cambage*, Jan 1902 (NSW 6000), *Darbyshire 1058*, 3 Jan 1963 (CANB); Hartz Mtns, *Lucas*, Jan 1901 (NSW 6001).

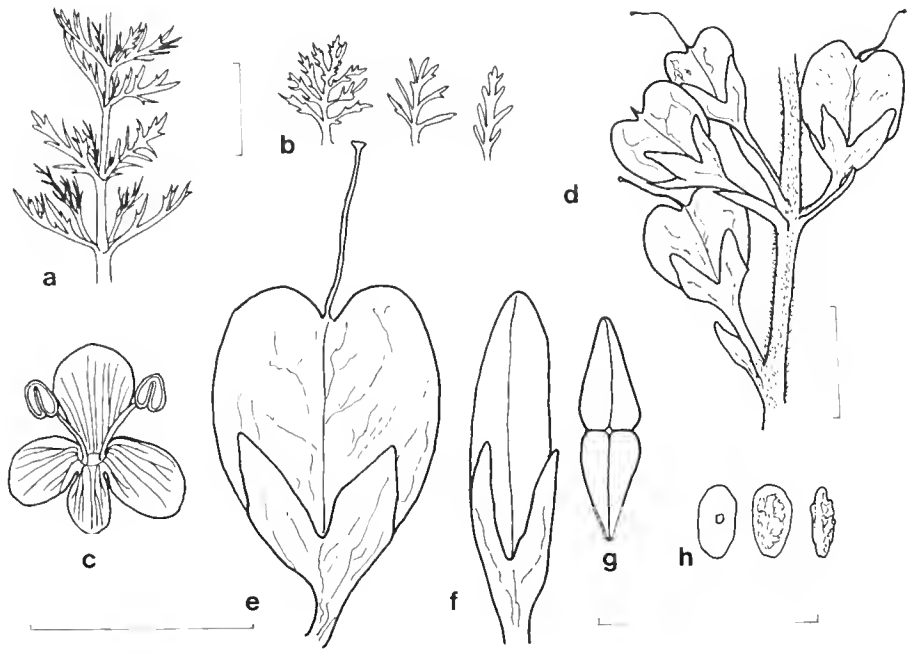

Figure 7. *Derwentia nivea.* **a**, leafy stem; **b**, leaves; **c**, corolla with stamens; **d**, part of fruiting inflorescence; **e–g**, capsule with calyx – lateral, abaxial and apical views; **g**, dehisced capsule; **h**, seeds – adaxial, abaxial and side views; a–d from *Johnson NSW 84497*; e–h *GAUBA 9271*. Scale bars: a–b = 2 cm, c = 5 mm, d = 2 mm, e–h = 2.5 mm.

2 Derwentia decorosa *(F. Muell.) B. Briggs & Ehrend.*, **comb. nov.**

Basionym: *Veronica decorosa* F. Mueller, Linnaea 25: 430 (1853).

Parahebe decorosa (F. Muell.) B. Briggs & Ehrend. (1986: 1301), non *P. decora* Ashwin (1961*b*: 974, 877).

Type: South Australia: In vallibus saxosis montium Flinders ranges, [*F. Mueller*], Oct 1851; lecto MEL 21494 (here selected); iso K. Residual syntypes: Flinders-ranges prope M. [Mt] Remarkable, M. [Mt] Brown, *F. Mueller*, Oct 1851 (MEL 21495); interior of South Australia, *Mueller*, Oct 1851 (K, photo 2630 CANB).

Erect softly woody shrub 50–130 cm. *Stems* much branched, continuing growth for several seasons; longest internodes 1.5–3 cm long, terete, 2–3(–5) mm diam., with short fine hairs in longitudinal bands or scattered; hairs rigid, antrorsely curved, 0.1–0.4 mm long. *Leaves* sessile, linear or subulate, acute, entire or the broader ones rarely with remote small teeth (teeth up to 7 on each side, spreading, to 1.5 mm long), (15–)30–55(–70) mm long, 1–2.5(–5.5) mm broad, leaf index 15–40, dentation index 1–1.4, grooved adaxially with a broad keel below, thickened and recurved at the margin, inconspicuously veined, glabrous or with very short glandular hairs along the adaxial groove. *Racemes* single or opposite at each of 1–5 of the upper nodes of one season's growth, the floriferous portion 10–18 cm long with (4–)10–45 flowers; peduncle 3–7 cm long; the inflorescence sometimes irregularly branched with lateral branches

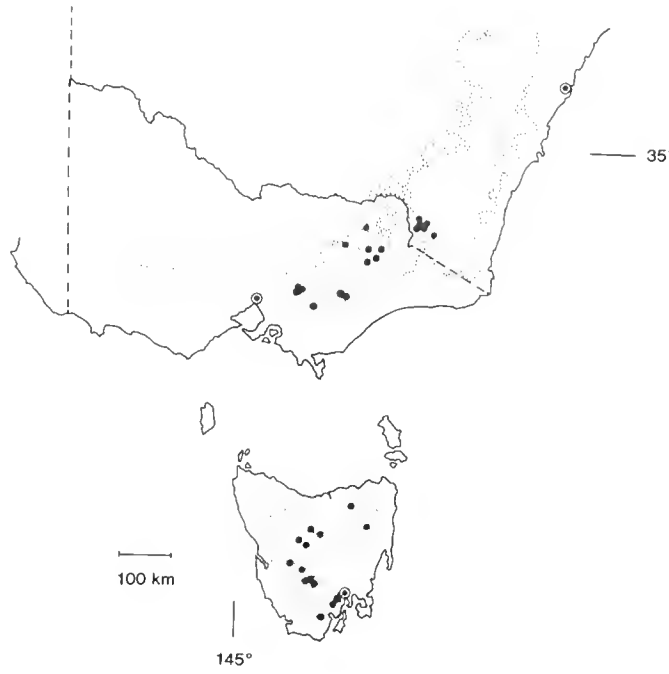

Figure 8. Distribution of *D. nivea*. The dotted line shows the 610 m (c. 2000 ft) contour.

bearing flowers and also further lateral inflorescences. *Bracts* linear to narrow-ovate, acute, 4–5 mm long. *Fruiting pedicels* 6–20 mm long. *Calyx lobes* narrow-ovate, acute, 4–8 mm long and c. 1.5 mm broad in fruit, glabrous or with a few short hairs at the base. *Corolla* white with lilac streaks, 4–10 mm long, hairy in the throat; adaxial lobe more prominently streaked, ovate to very broad-ovate, obtuse, 4.5–6 mm broad; abaxial lobe ovate or oblong, 2–4.5 mm broad. *Stamen* filaments white, 4–7 mm long; anthers 1–1.5 mm long. *Ovules* few in two rows on a narrow vertical placenta. *Capsules* glossy, broad-ellipsoidal or almost globular, shallowly emarginate, slightly compressed, 2.5–3.5 mm long, 2–3 mm broad, 1.5–2 mm thick, glabrous, dehiscing by a septicidal split which finally reaches the base and sometimes splitting loculicidally 2/3 of the distance to the base; persistent style c. 5 mm long, glabrous. *Seeds* (mature) not seen. *Chromosome number* (Fig. 1b); n=19. (Fig. 4d, 9).

The epithet *decorosa* is derived from the Latin *decorus*, graceful, handsome and *-osus* having the quality of, full of. It thus includes an additional element not present in *decora*, the epithet of a New Zealand *Parahebe* species, and the two epithets are not to be treated as homonyms (L. Johnson pers. comm., advice on the conclusions of the Orthography Committee of International Association of Plant Taxonomists on similar cases).

DISTRIBUTION AND HABITAT: South Australia, in the Flinders Ranges, and south to near the head of St Vincents Gulf, rocky sites, on ridges and more often in moist or sheltered sites within the generally arid region. (Fig. 10).

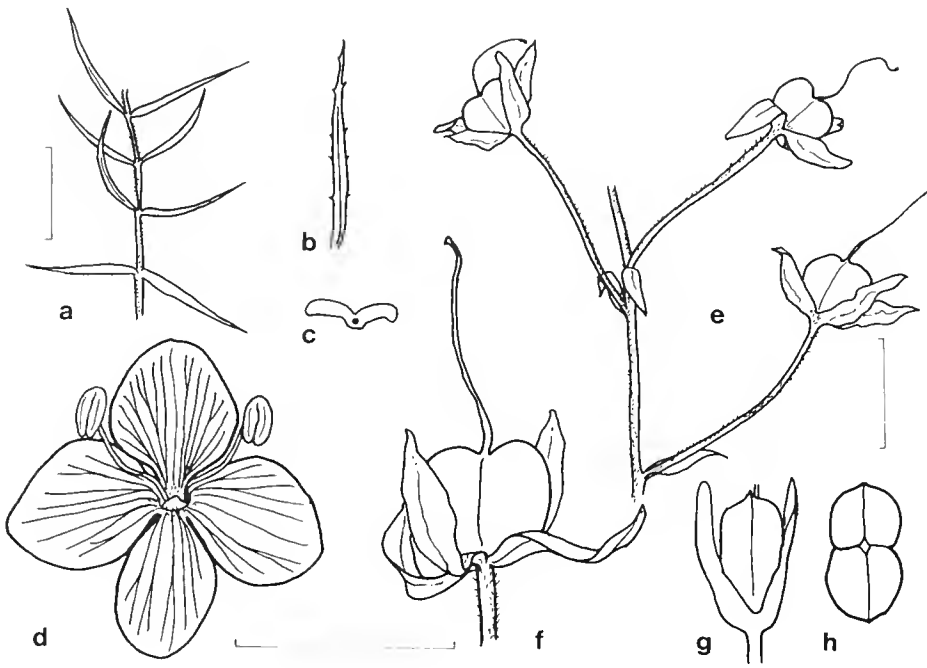

Figure 9. *D. decorosa.* a, leafy stem; b, leaf; c, transverse section of leaf; d, corolla with stamens; e, part of fruiting inflorescence; f, capsule with calyx – lateral, abaxial and apical views; a, d–f *Beauglehole 13453*; b and c AD 96509254. Scale bars: a–b = 2 cm, c = 0.5 mm, d = 5 mm, e = 2 mm, f–h = 2.5 mm.

SELECTED SPECIMENS: SOUTH AUSTRALIA: Eastern: Bibliando Stn 2 km from homestead in SW direction, *T. Hall 136*, 7 Oct 1984 (AD). Flinders Ranges: Mt Searle [Mt Serle, E of Leigh Ck], *Warburton* (K, photo CANB, MEL); Gammon Ranges, c. 65 km E of Leigh Ck, *Eichler 1281*, 19 Sep 1956 (AD); southern slopes of Yankininna Ra., *Lothian 2095*, 25 Aug 1956 (AD); Mt Hack, *Lothian 5273*, 19 Sep 1973 (AD); Arcoona Ck, *L.D. Williams 11673*, 31 Oct 1980 (AD, HO); Fergusons Gorge near Moolooloo, *Ising*, 9 Oct 1918 (AD); W of Pompeys Pillar at Wilpena Pound, *Jackson 465*, 7 Oct 1962 (AD); between Hawker and Moolooloo Stn, *Carrodus*, Sep 1956 (AD); Quorn, herb. *Black*, Oct 1924, 12 Oct 1926 (AD); 2 km SE of Mt Brown, 15 km NW of Wilmington, *Sikkes 566*, 20 Sep 1973 (CBG, AD, NSW); Mambray Ck, 3 miles [4.8 km] E of hwy, *Beauglehole 13453*, 28 Sep 1965 (NSW); Lower Mambray Ck, *Symon 469*, 11 Jun 1960 (AD); Germein Gorge, c. 8 miles from Port Germein, *Eichler 19209*, 29 Aug 1967 (AD, NSW); Jamestown, *Francis* (AD); Mt Bryan, *Snell*, Nov 1894 (AD); Worlds End, c. 30 km SE of Burra, *Brummitt*, 10 Nov 1892 (AD).

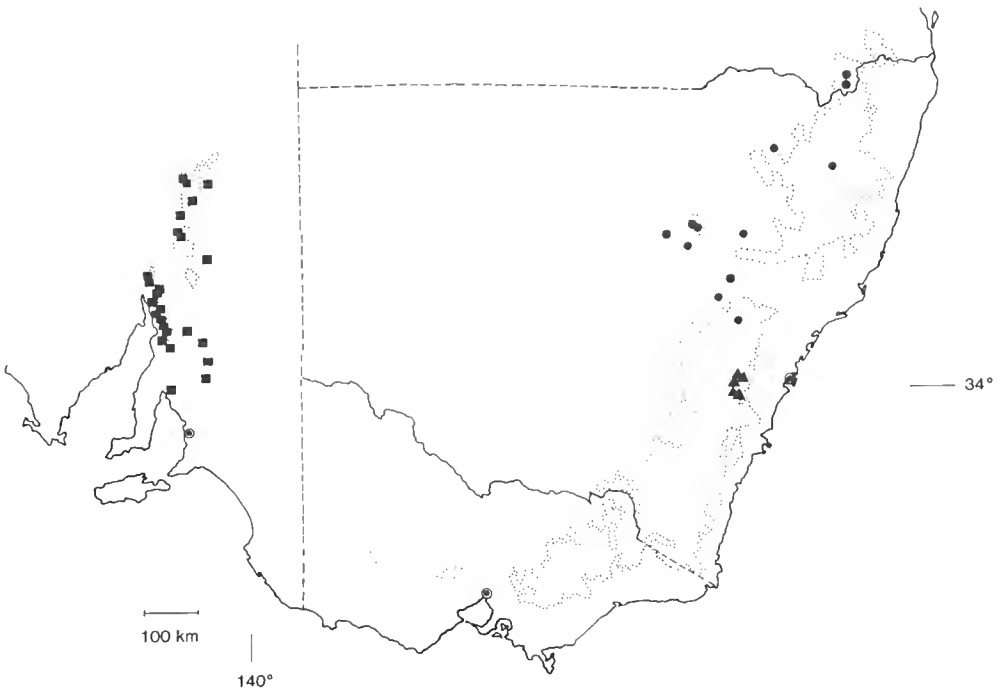

Figure 10. Distribution of *Parahebe lithophila* (▲), *Derwentia decorosa* (■) and *D. arenaria* (●). The dotted line shows the 610 m (c. 2000 ft) contour.

3 Derwentia arenaria *(A. Cunn. ex Benth.) B. Briggs & Ehrend.*, **comb. nov.**

Basionym: *Veronica arenaria* A. Cunn. ex Bentham in Candolle, Prodr. 10: 463 (1846).

Type: New South Wales: Central Western Slopes: arid sandy flat on the plain of Daby, Cugeegong [Cudgegong] River ... 50 miles [80 km] north from Bathurst, *A. Cunningham*, Apr 1823; holo K, 2 sheets, photos 2632, 2633 CANB; iso BM, MEL, NSW.

[*V. dianthifolia* A. Cunn. ex G. Don in Loudon (1830: 467), nom. nud. This and the following name are each accompanied only by horticultural comments which do not constitute a description.]

[*V. pulchra* G. Don in Loudon (1830: 7), nom. nud., invalid, published in synonymy. This name was altered to *V. dianthifolia* in the simultaneously published supplement.]

V. arenaria var. *macrocalycina* Moore & Betche (1893: 340). Type: Upper Hunter River, *L. Stephenson*, Dec 1886; holo NSW 6090; iso MEL 21492.

Few-stemmed, slender, erect, softly woody shrub 0.3–1 m tall. *Stems* several from a narrow woody rootstock, sparingly branched, terete, 1–3 mm diam., the longest internodes 1–4 cm long, with short hairs mainly but not entirely confined to the longitudinal bands; the hairs rigid, antrorsely curved, 0.1–0.3 mm long; the primary stem soon ceasing growth and overtopped by laterals arising at the lower nodes, each stem usually growing for only one season before dying back almost to the base. *Leaves* sessile, linear and entire or with rather remote teeth or linear lobes, acute, 20–55 mm long, 1–3 mm broad (excluding lobes), leaf index 17–28; the teeth or lobes spreading, irregular in arrangement and size, up to 7 on each side, to 8 mm long and 1.3 mm

broad, dentation index 1–15, tending to blacken when dry, only the midvein conspicuous, slightly thickened but not recurved at the margin, with short antrorsely-curved papillose hairs on the margin but otherwise usually glabrous. *Racemes* single or mostly opposite at 1–5 upper nodes, the floriferous portion (9–)20–35 cm long with (20–)50–100 flowers; peduncle 4–7.5 cm long. *Bracts* linear, acute, mostly 2–6 mm long, the lower ones to 14 mm long. *Pedicels* 4–7 mm long in fruit. *Calyx lobes* linear, acute, 4–10 mm long and 1–1.5 mm broad in fruit, shorter than or considerably exceeding the capsule, with sparse very short papillose hairs on the margins. *Corolla* bright violet-blue, the nerves not conspicuous when fresh, 7–10 mm long, the throat with dense hairs to 1 mm long; adaxial lobe ovate or broad-ovate, obtuse or acute, 3.5–5.5 mm broad; abaxial lobe narrow-ovate, acute, 1.5–3.5 mm broad. *Stamen* filaments dark blue, 6–7 mm long; anthers cream, 1–1.5 mm long. *Ovules* in 2–4 irregular rows on a narrow vertical placenta. *Capsules* slightly glossy, broad-obovate, compressed, emarginate, 3.5–6 mm long, 2.5–3.5 mm broad, c. 1.5 mm thick with short hairs on the upper margins, dehiscing septicidally and eventually splitting to the base on both sutures; style usually persistent, 6–12 mm long in fruit, pilose toward the base. *Seeds* c. 20, c. 1.2 mm long and 0.7 mm broad. *Chromosome number* (Fig. 1c, 1d): *n*=19. (Fig. 4e, 11).

Distribution and habitat: The Stanthorpe district of south-eastern Queensland, and in New South Wales on the Northern Tablelands and from the Warrumbungles to the Cudgegong R. in the North and Central Western Slopes. On rocky slopes to c. 870 m altitude and on river flats, in sandy soils, often in woodland. (Fig. 10).

Conservation status: *D. arenaria* is reasonably widespread and occurs in Warrumbungle National Park but is usually found only as scattered individuals. It would be coded 3RC.

This species was referred to as "*Parahebe* sp. B' in Jacobs & Pickard (1981).

Selected specimens: Queensland: Darling Downs: Wyberba, *Blake 4659*, 24 Jan 1933 (BRI, CANB); Stanthorpe district, *Gittins*, Feb 1948 (NSW 6092); Wallangarra, *Boorman*, Nov 1904 (NSW 6087), Jan 1906 (NSW 6091), *Betche*, Dec 1891 (NSW 6086). New South Wales: Northern Tablelands: R. Ann [NE of Guyra], *Beckler* (MEL). North Western Slopes: Copeton Dam, 32 km NW of Bundarra, *Wissman*, 25 Aug 1976 (NSW 223489); Warrabah [Nature Reserve?], Namoi River, *J. Coveny*, Mar 1970 (NSW 223490); near Blackmans Lookout, N side of Belougery Split Rock, Warrumbungle Mtns, *Ehrendorfer 9404, Briggs 941 & Johnson*, 24 Oct 1966 (NSW, WU); Belougery Split Rock, Warrumbungle Mountains, *Briggs*, 31 Jan 1961 (NSW 53766); Warrumbungle Natl Park, near junction of Burbie and Crooked Cks, *Willis*, 13 May 1969 (NSW 118256); Warrumbungle Mts, *Godfrey*, Mar 1970 (NSW 131641); Fans Horizon, Warrumbungle Ra., 28 km W of Coonabarabran, *Streimann 498*, 4 Dec 1973 (CBG, A, AD, BRI, K, NSW). Central Western Slopes: 'Wolaroi', Castlereagh R., c. 16 km W of Mendooran, *Coveny 10420 & Benson*, 16 Aug 1979 (NSW, AD, CANB, CHR, K, MEL); Dingo Ck, Goulburn R. Valley, *Tame 1152*, Nov 1984 (NSW).

4 Derwentia derwentiana *(Andrews) B. Briggs & Ehrend.*, **comb. nov.**

Basionym: *Veronica derwentiana* Andrews, Bot. repos. t. 531 (1808). Originally published as *V. derwentia*, the corrected orthography was used in the 'Errata', published a few months later in 1808 with the index to Volume 8 of the *Botanist's Repository*. Being made by the author in such a manner, this change is to be accepted as a correction of an unintentional orthographic error under the International Code of Botanical Nomenclature. Brown (1810: 434) and Moore & Betche (1893: 340) attributed the description of *V. derwentia* to Littlejohn but there is no reference to the latter author in the protologue.

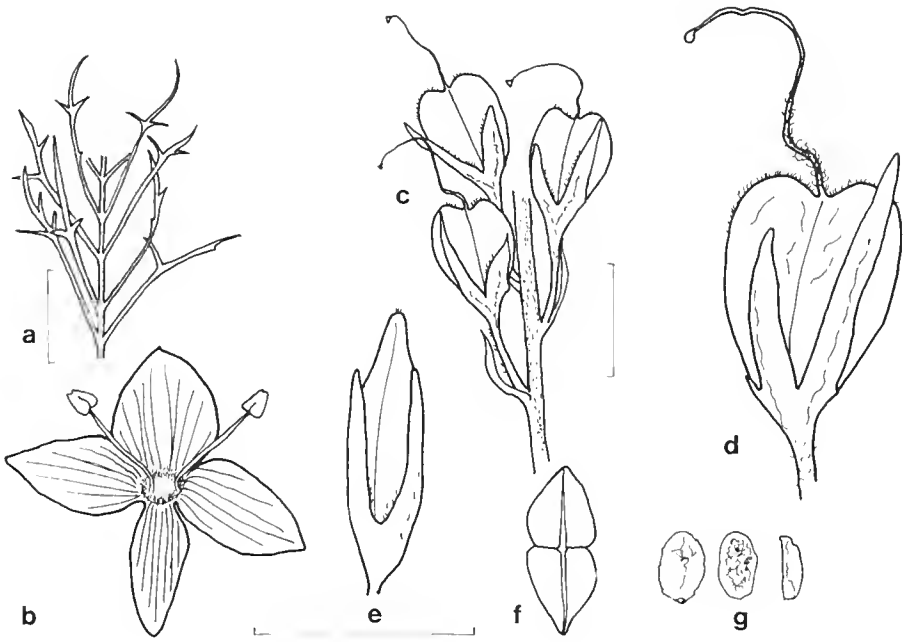

Figure 11. *D. arenaria*. **a**, leafy stem; **b**, corolla with stamens; **c**, part of fruiting inflorescence; **d–f**, capsule with calyx – lateral, abaxial and apical views; **g**, seeds – adaxial, abaxial and side views; a and b from *Ehrendorfer & Briggs 941*; c–g *Boorman NSW 6091*. Scale bars: a = 2 cm, b = 5 mm, c = 2 mm, d–g = 2.5 mm.

TYPE: TASMANIA: Plate 531 of Andrews (1808); 'native of Botany Bay on the banks of the Derwent', 'sent over by one of the settlers' per *A.B. Lambert*, holo [the locality 'Botany Bay' is here used very loosely, to refer to the whole of south-eastern Australia].

V. labiata R. Br. (Brown 1810: 434), nom. illegit. The earlier name *V. derwentiana* (as *'derwentia'*) is cited as a synonym.

Derwentia suaveolens Raf. (Rafinesque 1836: 55), nom. illegit.; based on *Veronica derwentiana* Andrews (cited by Rafinesque as *Veronica derwentia* Andrews).

Parahebe derwentiana (Andrews) B. Briggs & Ehrend. (1968: 742).

Stems several or numerous from a large woody rootstock, mostly erect and unbranched below the inflorescence, at first herbaceous but becoming softly woody, (25–)50–140(–200) cm long, terete, 2–7(–10) mm diam., the basal 2–15 cm usually ± prostrate and with adventitious roots, the longest internodes 3–8(–11) cm long, glabrous or with short fine hairs in longitudinal bands or rarely over the whole surface; hairs antrorsely curved or irregularly twisted, 0.2–1(–2) mm long, the cells rigid or collapsing when dry; each stem growing for only one season but often persisting for a further season before the leaves and stem wither, the old stems often becoming ± decumbent and sometimes producing erect lateral flowering shoots at their lower nodes or rarely with leafy lateral branches from near the base of the inflorescence. *Leaves* sessile or with short broad petioles, the laminae narrow-ovate to ovate, (45–)65–15(–240) mm long, (7–)15–40(–50) mm broad, the base cuneate or truncate or cordate, the apex acute or acuminate, with (17–)30–80 apiculate teeth on each side (the teeth antrorsely

directed or spreading or incurved at the tip, ± uniform in spacing and depth or irregular), the upper surface dark green and slightly glossy, the lower surface paler and sometimes pruinose, with 5–7 nerves from near the base and 2–10 major nerves from the midrib, the margin thickened and often recurved, glabrous or rarely with sparse curved hairs on the margin. *Racemes* single or opposite at each of 2–8 of the uppermost nodes, the floriferous portion 8–25(–33) cm long, with (25–)40–100(–130) flowers, the peduncle 2–8(–13) cm long. *Bracts* linear, acuminate, mostly 3.5–8 mm long; the lowermost larger, to 18 mm long. *Fruiting pedicels* 2–10 mm long. *Calyx lobes* elliptic or narrow-triangular, acute to acuminate, 2–5 mm long and 0.7–1 mm broad in fruit, glabrous or with scattered very short glandular hairs and sometimes a few short hairs at the bases of the lobes. *Corolla* white or pale lilac or pale blue, tinged with pink or lilac in bud, 5–9 mm long; adaxial lobe ovate or elliptic, obtuse to acuminate, 2.8–5.5 mm broad; abaxial lobe narrow-ovate or elliptic, usually acute, 1.4–2.8 mm broad. *Stamen* filaments usually white, 4.5–5.5 mm long; anthers pink or purple, 1.5–2 mm long. *Ovules* irregularly placed or in irregular rows on a narrow vertical placenta. *Capsules* slightly glossy, narrow- to broad-obovoid, ± compressed, the apex acute or truncate or emarginate, 2.8–5.5 mm long, 2.5–4.5 mm broad, 1.3–2 mm thick, glabrous or with short hairs on the upper margin and the base of the style, dehiscing by a septicidal split and eventually splitting to the base septicidally and for c. 1/2 of the distance to the base loculicidally; style usually persistent, pilose toward the base or glabrous, 4–7 mm long. *Seed* 4–26, 0.7–1.5 mm long, 0.4–1 mm broad. (Figs. 4e, 12–15).

D. derwentiana is here divided into five subspecies, differing in geographic range. In one case (subsp. *derwentiana* intergrading with subsp. *maideniana*, see under the latter), plants with intermediate morphological features are common where the ranges of the subspecies adjoin. A probably hybrid with *D. perfoliata*, arising in cultivation, is mentioned under the latter species.

Key to subspecies of *D. derwentiana*

1 Summit of capsule subacute or truncate or rarely slightly emarginate; leaves paler on lower surface but not pruinose; base of style and summit of ovary pilose or glabrous.

2 Base of style and summit of capsule sparsely or densely pilose or rarely glabrous.

3 Leaves narrow- or very narrow-ovate, (7–)15–25(–35) mm broad, length (3–)4–11 times breadth, leaf base cuneate or truncate; pedicels (3.5–)5–7(–9) mm long in fruit ..... 4a subsp. **derwentiana**

3* Leaves ovate to narrow-ovate, (20–)30–40(–50) mm broad, length 1.6–3.5 (–5.2) times breadth, leaf base cordate or less often truncate; pedicels 2–4 (–5) mm long in fruit ..... 4b subsp. **maideniana**

2* Base of style and summit of capsule glabrous or rarely with a few hairs.

4 Leaves ovate or narrow-ovate, 17–40 mm broad, length 2.5–3.5(–5) times breadth, serrate with uniform shallow antrorse or incurved teeth, leaf base cordate ..... 4c subsp. **homalodonta**

4* Leaves very narrow-ovate, 14–28 mm broad, length 5–7 times breadth, serrate with deep irregular spreading teeth, leaf base abruptly cuneate ..... 4d subsp. **anisodonta**

1* Capsule emarginate; leaves pruinose on lower surface (more noticeable in old leaves, this feature may be destroyed by heat-drying of specimens); base of style and summit of ovary glabrous ..... 4e subsp. **subglauca**

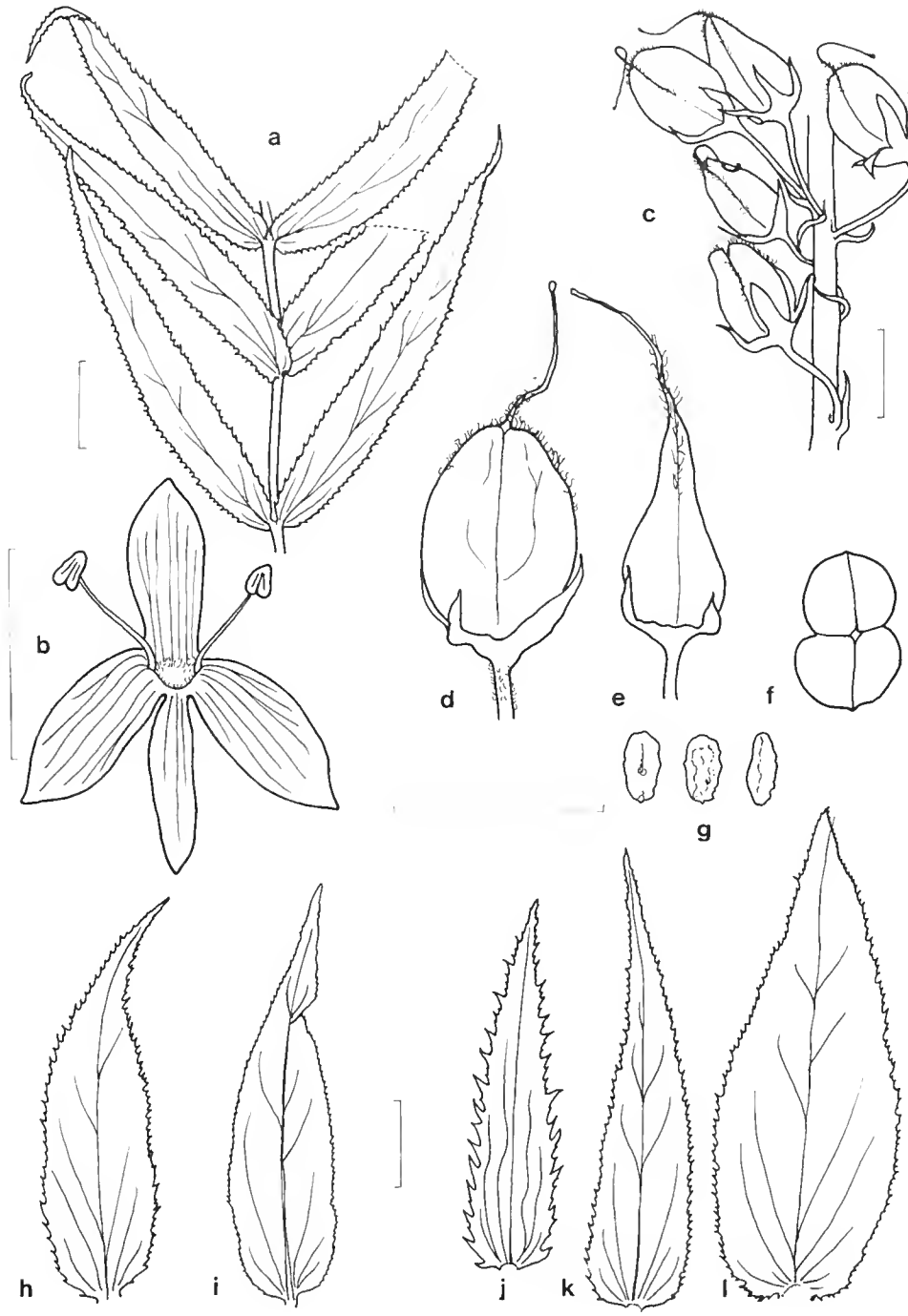

Figure 12. a–i, *D. derwentiana* subsp. *derwentiana*. **a**, leafy stem; b, corolla with stamens; c, part of fruiting inflorescence; **d–f**, capsule with calyx – lateral, abaxial and apical views; **g**, seeds – adaxial, abaxial and side views; **h–i**, leaves: variation in two collections from Wandin, Victoria; a from *Rodd 606a*; b–g NSW 64434; h from *Baker* Dec 1906 (MEL); i sine coll., Feb 1905 (MEL). **j–l**, *D. derwentiana*. Variation in leaves of different plants within a site in region of intergradation between subsp. *derwentiana* and subsp. *maideniana*; from *Rodd NSW 101633-5*. Scale bars: a, h–l = 2 cm, b = 5 mm, c = 2 mm, d–g = 2.5 mm.

4a. Derwentia derwentiana subsp. derwentiana

Leaves sessile; laminae narrow- or very narrow-ovate, the base cuneate or truncate, the apex acuminate, 80–150(–240) mm long, (7–)15–25(–35) mm broad, leaf index (3–)4–11; teeth ± uniform in spacing and depth or irregular, antrorsely curved or spreading or incurved at the tip, dentation index 1.02–1.25, lower surface paler than the upper but not pruinose (but dried specimens sometimes with small scattered white patches on lower surface). *Racemes*: floriferous portion 9–20(–32) cm long. *Pedicels* (3.5–)5–7(–9) mm long in fruit. *Capsules* acute or truncate or rarely slightly emarginate, the summit and base of the style pilose with a sparse or dense indumentum of short hairs. *Chromosome number*: n=20. (Fig. 12).

Distribution and habitat: South-eastern Queensland; New South Wales, on the South Coast, Northern Tablelands and Southern Tablelands; widespread in Victoria except for the north-west; in the extreme south-east of South Australia and in Tasmania. On a wide range of rock types including granite, basalt and shale, but neither this nor the other subspecies occur on soils of very low nutrient status. In moist situations in *Eucalyptus* forest, also on steep rocky slopes and alluvial river banks. (Fig. 13).

This taxon was referred to as '*P. derwentiana* subsp. A' in Jacobs & Pickard (1981).

This is by far the most widespread of the five subspecies of *D. derwentiana* and includes the greatest morphological diversity. It may represent the basic stock from which the other subspecies are relatively local developments.

In south-eastern Queensland and the Northern Tablelands of New South Wales it is the only subspecies present and extends from about 600 m to 1350 m altitude. It is absent from the Central Tablelands of N.S.W., where subsp. *subglauca* occurs in generally similar habitats. In southern N.S.W. and in Victoria it extends to low altitudes in coastal regions but does not occur in the drier inland districts. Some plants referred to subsp. *derwentiana* occur as high as 1300 m, but above about 750 m alt. it is largely replaced by subsp. *maideniana* and plants morphologically intermediate between these two subspecies. In Tasmania it is the only subspecies represented and extends from low altitudes to very approximately 1000 m alt.

Occasional specimens are found at low altitudes with broad leaves resembling those of subsp. *maideniana*, but differing from the latter in other features, e.g. Frankston, Vic., *Morrison*, 21 Feb 1885 (CANB); Huon, Tas., *Colbourn*, 2 Jan 1926 (MEL 21573). In each case normal narrow-leaved plants are known from the same or nearby areas, e.g. Frankston, *Morrison*, 10 Jan 1892 (CANB, PERTH). There is great variation, often in a single locality, in the depth and regularity of the leaf serration (Fig. 12).

Plants with the ovary and style-base almost or completely glabrous are a rare occurrence at widely scattered localities, e.g. Nandewar Range, N.S.W., *Schofield*, 1 Mar 1965 (NSW 89388); Huon, Tasmania, *Colbourn*, 2 Jan 1926 (MEL 21573). These plants are not in areas where interbreeding with any of the regularly glabrous-styled subspecies is feasible.

Populations near the coast at Apollo Bay and from the Grampians in western Victoria to Mt Burr in eastern South Australia are very diverse and require further study. Some have very broad leaves and regular serration, e.g. Point Bunbury, *Cowle* (MEL); S side of Major Mitchell Plateau, Grampians, *Beauglehole*, 10 Dec 1967 (NSW 118317); while others have narrow leaves that are coarsely serrate, e.g. Grampians, *Meebold 2150*, 1 Jan 1929 (AD); Heywood, *Renfrey*, 3 Nov 1888 (MEL). Despite resemblances to other subspecies in particular features, these appear to be local developments from subsp. *derwentiana*, rather than being outliers from the range of any other taxon. The Heywood specimen mentioned has glabrous gynoecia but in western Victoria there is no

general approach in this feature to the glabrous condition of the two localised South Australian subspecies.

SELECTED SPECIMENS: QUEENSLAND: Darling Downs: 8 km SW of Cunninghams Gap, *Pilkington*, 5 Dec 1987 (BRI); Gladfield, *Bailey*, June 1892 (NSW 6167). NEW SOUTH WALES: South Coast: Moruya, *Boorman*, Nov 1911 (NSW 6189); Mt Dromedary, *Reader* (MEL); Belowra, 40 km W of Narooma, *Briggs 3095*, 16 Dec 1969 (NSW, CBG, K, MO); Towamba, Eden district, *McKee 6930*, 3 Jan 1960 (CANB). Northern Tablelands: Southern end of Pheasant Mtn ... [29 km NE of Guyra], *McGillivray & Coveny 3612*, 21 Apr 1971 (NSW, AD, CHR, K); c. 0.5 km W of Sinclair Peak, Nandewar Mtns, c. 1350 m alt., *Johnson 7843*, 1 Sep 1974 (NSW 222880); 1/2 mile [0.8 km] E of Bakers Ck Falls, near Hillgrove, *Williams*, 11 Dec 1966 (NE); Barrington Tops, *Althofer & McReaddie*, 8 Mar 1967 (NSW 95771). Southern Tablelands: Mt Majura (c. 4 miles [6.5 km] NNE of Canberra, ACT), *Gauba*, 1 Dec 1949 (GAUBA, CANB); Laurel Hill, [via] Tumbarumba, *Cambage*, 14 Mar 1903 (CANB); Brown Mtn near Bega, *Constable*, 25 Feb 1951 (NSW 15890); Wyndham to Cathcart, *Gray 5681*, *5683*, *5685*, 28 Jan 1965 (CANB, NSW). VICTORIA: Wannon: Lower Glenelg R., *Eckert*, 1891 (MEL). Grampians: Grampians, *Sullivan* (MEL 21605); along Forest Access Rd to Ararat near top William Ra., *Whaite*, 11 Nov 1953 (NSW 30068). Midlands: S side of Granya Gap, Murray Valley Hwy between Tallangatta and Jingellic, *Rodd 606a*, Apr 1968 (NSW). Volcanic Plains: 25 km NW of Portland on rd to Mt Deception, *Briggs 5431 & Beauglehole*, 18 Feb 1975 (NSW, MEL). Otway Plain: Curdie R., *Williamson*, Dec 1899 (NSW 6180); Port Fairy, *Whan* (MEL). Victorian Highlands: Mountain Creek, Tawonga district, *Rodd 381*, 27 Dec 1966 (NSW); c. 5 miles [8 km] S of Harrietville on the Alpine Hwy, *Craven 1554*, 2 Feb 1969 (CANB, MEL, K, NSW); Ferntree Gully, *Morrison*, 5 Jan 1895 (AD). Gippsland Plain: Werribee, *Fullager* (MEL). Snowfields: south slopes of Mt Stirling, near Howqua Gap, *Corrick 7971*, 31 Jan 1982 (MEL, AD, NSW). East Gippsland: between Bemm and Coombinbah rivers, *Sayer*, 1887 (MEL). SOUTH AUSTRALIA: South-eastern: Mt Burr, c. 35 km NW of Mt Gambier, Herb. *Tate*, Dec 1883 (AD). TASMANIA: Glen Leith, *Gunn 2/1842*, 2 Feb 1840 (NSW 6169); Mt Ben Nevis, *Green* (MEL); Cataract Gorge, Launceston, *Johnson*, 11 Jan 1949 (NSW 7299); Western Tier, 5 miles [8 km] from Poatina, *Phillips*, 6 Dec 1965 (CBG); Tunnel Hill, *Ratkowsky 1055*, 25 Dec 1973 (MO, NSW).

4b. Derwentia derwentiana subsp. **maideniana** *(Gand.) B. Briggs & Ehrend.*, **comb. et stat. nov.**

BASIONYM: *Veronica maideniana* Gand., Bull. Soc. Bot. France 66: 220 (1919).

TYPE: NEW SOUTH WALES: Southern Tablelands: Mt Kosciusko, *Maiden*; holo LY, not seen; iso: Mt Kosciusko up to 5500 ft. [*c.* 1700 m], *J.H. Maiden*, 1. 1898 (NSW 6201).

Leaves sessile; laminae ovate or narrow-ovate, the base truncate or usually cordate, the apex acute, (45–)7–100(–140) mm long, (20–)30–40(–50) mm broad, leaf index 1.6–3.5(–5.2); the teeth ± uniform in spacing and depth or alternately large and small, antrorse or spreading, dentation index 1.02–1.17, the lower surface paler than the upper but not pruinose (dried specimens sometimes with small scattered whitish patches). *Racemes*: floriferous portion 8–17 cm long. *Pedicels* 2–4(–8) mm long in fruit. *Capsules* as in subsp. *derwentiana*. (Fig. 14).

DISTRIBUTION AND HABITAT: Southern Tablelands of New South Wales and the Eastern Highlands of Victoria, mostly in montane and lower subalpine situations, at about 750–1500(–1800) m altitude. Sometimes in peaty sites but usually on siliceous soil developed on granite, gneiss, quartzite or conglomerate. On rocky slopes or in grassland, herbfield, eucalypt woodland and at the edges of bogs. (Fig. 13).

This taxon was referred to as *'Parahebe derwentiana* subsp. B' in Jacobs & Pickard (1981).

It is absent from the Northern Tablelands of New South Wales, although the higher areas would provide apparently suitable habitats. Also it does not occur in Tasmania

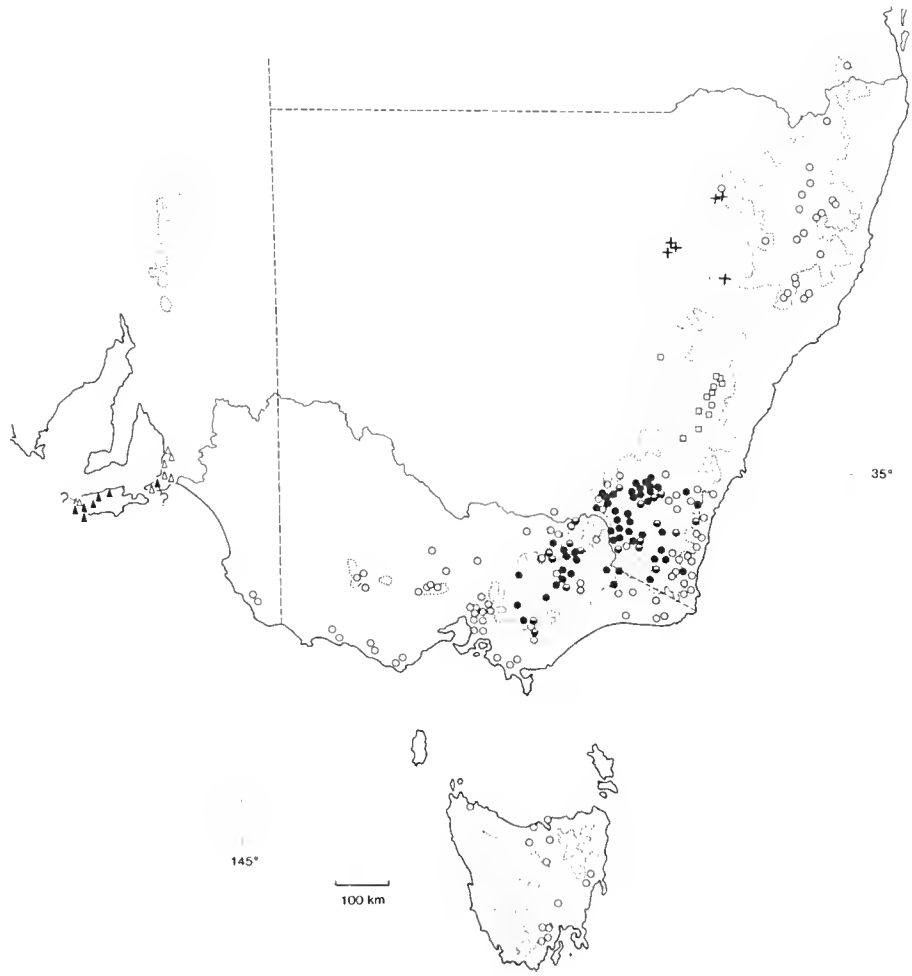

Figure 13. Distribution of *D. derwentiana*: subsp. *derwentiana* (○), subsp. *maideniana* (●), intergrades between subsp. *derwentiana* and subsp. *maideniana* (◒), subsp. *homalodonta* (△), subsp. *anisodonta* (▲), subsp. *subglauca* (□); *D. velutina* (+). The dotted line shows the 610 m (c. 2000 ft) contour.

where there are extensive montane areas and where *D. derwentiana* is uncommon or absent at the higher altitudes.

Toward its lower altitudinal limit there is extensive intergradation with subsp. *derwentiana*. Morphologically intermediate stands may be relatively uniform (e.g. 1 km W of Tuross Falls, SE of Countegany, *Johnson*, 5 Jan 1968, NSW 85492), or very variable (e.g. between Mountain Creek and Trappers Gap, Tawonga district, Vic., *Rodd*, 16 Apr 1968 (NSW 101633–5) (Fig. 12c, d, e).

Selected specimens: New South Wales: Southern Tablelands: Sandhills Ra. (E of Queanbeyan), *Moore 1748*, 9 Sep 1952 (CANB); Bulls Head, Brindabella Ra., *Campbell 32*, 22 Mar 1959 (CANB); between Pryors Hut and Mt Gingera, Brindabella Ra., *Coveny 11537 & Hind*, 19 Jan 1983 (NSW,

AD, CHR, K, MO); Fishing Gap, Mt Tidbinbilla, ACT, *Burbidge 2751*, 27 Jan 1948 (CANB); Brindabella Ra., *Lothian*, 16 Jan 1954 (AD); Mt Franklin, ACT, *Burbidge 1713*, Feb 1947 (CANB); Rules Point to Brindabella Rd, above Goodradigbee R., *Walker*, Dec 1962 (CANB); c. 4.8 km SE of Captains Flat on rd to Braidwood, *Briggs 3207*, 25 Dec 1969 (NSW, LE); Laurel Hill, 15 miles [24 km] N of Tumbarumba, *Cambage 837*, 14 Mar 1903 (NSW); Happy Jacks Plain, *Phillips*, 20 Mar 1962 (CBG), turn-off to Island Bend on Mt Kosciusko Rd, *McKee 6987*, 5 Jan 1960 (CANB); Pretty Point, Mt Kosciusko, *Maiden & Forsyth*, Jan 1899 (NSW 6200); New Chum Hill, Kiandra, *Briggs 2586*, 11 Feb 1969 (NSW, MEL); Dead Horse Gap, *Bishop 365 & Gunnell*, 14 Jan 1985 (NSW, MEL); Smiggin Holes, Mt Kosciusko, *Johnson & Constable*, 23 Jan 1951 (NSW 18409); Wallace Craige Lookout SW of Ingebyra, *Briggs*, 25 Dec 1964 (NSW 90671). VICTORIA: Midlands: SE slopes of Mt Buangor, 21 km NW of Beaufort, *Chinnock 1365*, 29 Dec 1973 (AD, BRI, NSW). Victorian Highlands: Mt Beauty area, c. 16 km E of Bright, *Hill 1315*, 1 Jan 1964 (AD). Snowfields: between Howmans Gap and Falls Ck, *Aston 222*, 29 Dec 1958 (MEL); N slope of Rocky Knobs, Bogong High Plains, *Eichler 14691*, 3 Feb 1958 (AD); Mt Hotham, *Rae*, Feb 1937 (MEL); Mt Hump, near Mt Buller, *Whaite*, 11 Jan 1949 (NSW 7656); [Mt] Buffalo, *Pryor*, 1 Mar 1949 (CBG); Snowy Plains 3 miles [4.8 km] N of Mt Reynard, *Muir 4544*, 18 Jan 1967 (MEL). East Gippsland: Avalanche Lookout, 5 miles [8 km] from Suggan Buggan R. toward Wulgulmerang, *Carroll*, 18 Dec 1965 (CBG).

The following are examples of collections more or less intermediate in morphology between subsp. *derwentiana* and subsp. *maideniana*:

NEW SOUTH WALES: Southern Tablelands: near Coree Mtn, *Story 6528*, 9 Jul 1959 (CANB); Upper Cotter, *Brooker 1047*, 2 Jan 1966 (GAUBA); Rules Point to Brindabella Rd, *Walker 961*, Dec 1962 (CANB, NSW); Laurel Hill, NE of Tumbarumba, *McBarron*, 27 Dec 1948 (NSW 7246); Thredbo R., *Maiden & Forsyth*, Jan 1899 (NSW 6193); Dicky Cooper Ck, *Gittins 424*, Jan 1962 (NSW); Brown Mt E of Nimmitabel, *Gray 5669*, 27 Jan 1965 (CANB). VICTORIA: Midlands: S side of Granya Gap, NE of Tallangatta, *Rodd*, 16 Apr 1968 (NSW 101631). Victorian Highlands: Tali Karng, *Muir 2979*, 31 Dec 1963 (MEL); 13 km S of Woods Point on Walhalla Rd, *Briggs*, 30 Dec 1964 (NSW 72452); Thompson R., *Howitt*, 1882 (MEL). Snowfields: [Mt] Buffalo, *Baker*, Mar 1910 (MEL); Mt St Bernard, *Maiden*, Jan 1900 (NSW 6173). East Gippsland: Cann R. 4 miles [6.5 km] S of Vic.–N.S.W. border, *Fagg*, 19 Jan 1963 (AD).

4c. Derwentia derwentiana subsp. **homalodonta** *B. Briggs & Ehrend.*, **subsp. nov.**

Inter subspecies *D. derwentianae* combinatione sequenti characterum distinguitur: capsulae glabrae non emarginatae, laminae foliorum basi cordatae non pruinosae et dentibus antrorsis uniformiter brevibus instructae.

TYPE: SOUTH AUSTRALIA: Mt Lofty, c. 15 km south-east of Adelaide, Herb. *R. Tate*, 4 Dec 1880; holo AD 96645003.

Leaves sessile; laminae narrow-ovate, the base cordate, the apex acuminate, 65–120 mm long, 17–40 mm broad, leaf index 2.4–3.8 (–5); teeth shallow, uniform in spacing and depth, antrorse and often incurved at the apex, dentation index 1.01–1.1; the lower surface not pruinose (but sometimes with scattered small whitish patches in dried specimens). *Racemes*: floriferous portion 9–15 cm long. *Pedicels* 3–4.5 mm long in fruit. *Capsules* glabrous, the apex obtuse. *Chromosome number*: n=20. (Fig. 14).

DISTRIBUTION AND HABITAT: South Australia; Adelaide district to Port Elliot and apparently also Kangaroo Island. Relatively moist sites in gullies and near creeks. (Fig. 13).

CONSERVATION STATUS: not well known but may be at risk, code 3K.

The subspecific epithet is derived from the Greek *homalos*, even, level or uniform and *odous, odontos*, a tooth, referring to the uniform-sized leaf teeth.

The eastern boundary of subsp. *homaloudonta*, isolating it from subsp. *derwentiana*, is the Murray River valley and the low-lying area of Pleistocene fluvial and lacustrine

deposits and calcareous dunes to the south-east of the present position of the Murray River mouth. Kangaroo Island was continuous with the Fleurieu Peninsula (west of Port Elliot) until Pleistocene or Holocene time (David 1950).

Subspecies *homalodonta* and *anisodonta* are closely allied. Their distribution and variation require more study and the following two specimens depart from the general areas of occurrence of the subspecies and are mapped with some doubt in Fig. 13. Flinders Chase, western end Kangaroo I., *Cleland* 25 Nov. 1945 (AD) has relatively broad leaves and shallow uniform teeth, as in subsp. *homalodonta*, although recorded from a region where subsp. *anisodonta* occurs. By contrast, the following specimen has narrow leaves and spreading teeth that would identify it as subsp. *anisodonta* but is from a locality that also supports subsp. *homalodonta*: Kyeema Conservation Park, Hundred [of] Kuitpo, *Heddle KCP109*, Jan 1974 (AD).

SELECTED SPECIMENS: SOUTH AUSTRALIA: Southern Lofty: Port Adelaide, *Blandowsky*, 1850 (MEL); Upper Sturt, *Ashby*, Jan 1920 (ADW); inter Port Adelaide et Hahndorf, *Blandowsky*, 1849 or 1850 (MEL); Onkaparinga R., *Griffith*, 31 Dec 1906 (AD); Hindmarsh Tiers, Fleurieu Peninsula, *I. McArthur*, Jan 1969 (AD, CANB, NSW 118325); Wild Dog Ck, Myponga, *Dunstan*, Nov 1945 (AD); waterfall off Inman Valley, *J.B. Cleland*, Jan 1928 (AD); near Port Elliot, *Hussey*, Jan 1895 (AD); Kyeema Conservation Park, *Spooner 6751*, 28 Oct 1979 (AD).

4d Derwentia derwentiana subsp. **anisodonta** *B. Briggs & Ehrend.*, **subsp. nov.**

Inter subspecies *D. derwentianae* combinatione sequenti characterum distinguitur: capsulae glabrae non emarginatae, laminae foliorum basi cuneata, non pruinosae et dentibus grossiusculis irregularibus patentibusque instructae.

TYPE: SOUTH AUSTRALIA: Kelly Hill, c. 13 km east-north-east of Cape du Couedic, S.W. Kangaroo Island, *P.G. Wilson 657*, 2 Nov 1958; holo AD 95934088; iso M.

Leaves sessile or with petioles c. 3 mm broad and to 3 mm long; laminae narrow or very narrow ovate, the base abruptly cuneate, the apex acuminate, (50–)90–140 mm long, (10–)14–28 mm broad, leaf index 5–6.8; teeth coarse, usually irregular in spacing and depth, spreading, dentation index 1.08–1.25; the lower surface not pruinose (but sometimes with small scattered white patches in dry specimens). *Racemes*: floriferous portion to c. 25 cm long. *Pedicels* c. 4 mm long. *Capsules* glabrous, subacute. (Fig. 14).

DISTRIBUTION AND HABITAT: Kangaroo Island, South Australia. Relatively moist sites in gullies and near creeks. (Fig. 13).

CONSERVATION STATUS: Represented in conserved areas but with restricted distribution, code 3KC.

The subspecific epithet is derived from the Greek *anisos*, unequal, and *odous, odontos*, a tooth, referring to the uneven-sized leaf teeth.

SELECTED SPECIMENS: SOUTH AUSTRALIA: Kangaroo I.: Stokes Bay, *Jackson 996*, Nov 1973 (AD); Karatta Caves, *Cashmore*, 20 Nov 1933 (ADW); Cygnet R., *Eardley*, Nov 1933 (ADW); Wights, Cygnet R., *Cashmore*, 19 Dec 1933 (ADW); Middle R., *Ashby*, Oct 1905 (NSW 6182); Stunsail Boom R., south coast rd, *Eichler 15423*, 12 Nov 1958 (AD); Ravine des Casoars, *Cleland* Mar 1926 (AD); Rocky R., *Cleland* Mar 1926 (AD), Dec 1934 (AD); Breakneck R., Western Flinders Chase, *Spooner 3799*, 12 Dec 1974 (AD); Flinders Chase 35° 52'S 136° 42' E, –, Oct 1922 (AD); Kellys Hill, near the caves, *E. Briggs*, Oct 1973 (NSW 224343, AD, BRI, CANB, CBG, CHR, MEL, K, L, LE, MO); Kellys Hill Caves, Phillips 27 Sep 1965 (CBG); Kangaroo I., *Staer*, Mar 1911 (NSW 6183).

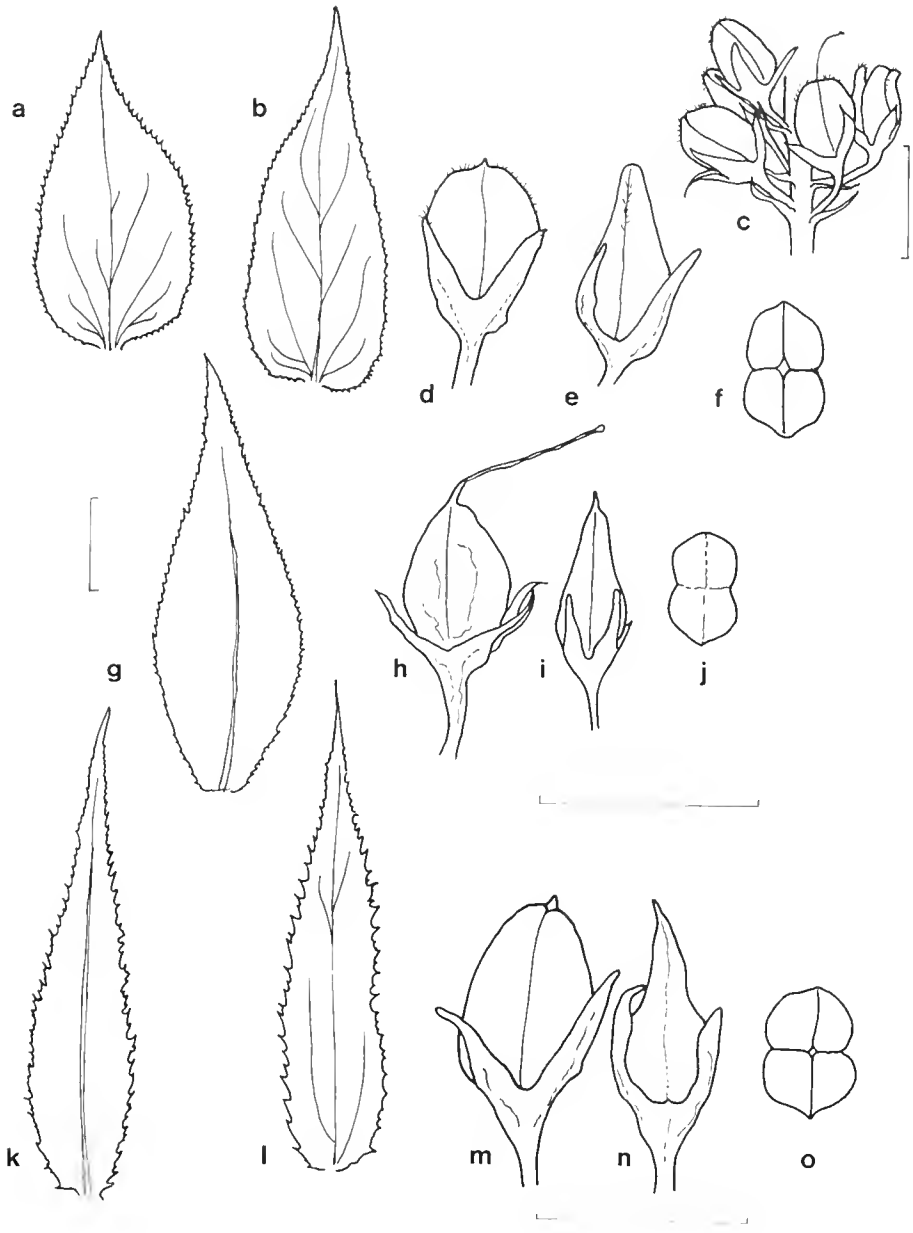

Figure 14. *D. derwentiana* subsp. *maideniana*. **a–b**, leaves; **c**, part of fruiting inflorescence; **d–f**, capsule with calyx – lateral, abaxial and apical views; a from *Muir 4544*; b–f CBG 7744.

D. derwentiana subsp. *homalodonta*. **g**, leaf; **h–j**, capsule with calyx – lateral, abaxial and apical views; a from AD 96645003; h–j NSW 6182. Scale bars: a–b, g, k–l = 2 cm, c = 2 mm, d–f, h–j, m–o = 2.5 mm.

D. derwentiana subsp. *anisodonta*. **k–l**, leaves; **m–o**, capsule with calyx – lateral, abaxial and apical views; k from *Wilson 657* (holotype); l *Eichler 15423*; m–o ADW 1904. Scale bars: a–c = 2 cm, d = 2 mm, e–g = 2.5 mm.

4e. Derwentia derwentiana subsp. **subglauca** *B. Briggs & Ehrend.*, **subsp. nov.**

Inter subspecies *D. derwentianae* combinatione sequenti characterum distinguitur: capsulae emarginatae glabraeque; laminae foliorum basi cuneata, infra plus minusve pruinosae et dentibus grossiusculis patentibus vel antrorsisque instructae.

TYPE: NEW SOUTH WALES: Central Tablelands: Jenolan Caves Road, alt. 1350 m, *E.F. Constable*, 9 March 1950; holo NSW 11133; iso CANB.

Leaves sessile or very shortly petiolate; petioles to 5 mm long, 3–4 mm broad; laminae narrow or very narrow ovate, the base cuneate, the apex acuminate, 75–145 mm long, 18–50 mm broad, leaf index 2.7–7.5; teeth rather coarse, spreading or antrorsely curved, dentation index 1.03–1.14, the lower surface pruinose in old leaves (pruinosity scarcely noticeable in young leaves and sometimes destroyed by heat-drying of specimens). *Racemes*: floriferous portion 8–25 cm long. *Pedicels* 5–10 mm long in fruit. *Capsules* emarginate, glabrous. *Chromosome number* (Fig. 1e): n=20. (Fig. 15).

DISTRIBUTION AND HABITAT: Central Tablelands of New South Wales, south of Lithgow. On granite, shale, sandstone and probably limestone, in moist situations in *Eucalyptus* forest, often on slopes and rocky gully situations, at about 780–1350 m alt. (Fig. 13).

The subspecific epithet derives from the Latin *sub-*, under or somewhat, and *glaucus*, grey or bluish green, referring to the greyish undersides of the leaves.

This taxon was referred to as *'Parahebe derwentiana* subsp. C' in Jacobs & Pickard (1981).

Figure 15. *D. derwentiana* subsp. *subglauca*. **a–c**, leaves; **d**, part of fruiting inflorescence; **e–g**, capsule with calyx – lateral, abaxial and apical views; from *Constable NSW 11133* (holotype). Scale bars: a–c = 2 cm, d = 2 mm, e–g = 2.5 mm.

It is not known to overlap geographically or intergrade with any other of the subspecies of *D. derwentiana* and is the most distinctive of them. The glabrous emarginate ovary and pruinose lower surfaces of the leaves may suggest a possible origin from hybridisation between subsp. *derwentiana* and *D. blakelyi*. However, the indumentum of vegetative parts as well as corolla size and colour are among features in which this resembles other subspecies of *D. derwentiana* and shows no approach to *D. blakelyi*.

SELECTED SPECIMENS: NEW SOUTH WALES: Central Tablelands: Mt Canobolas, *Briggs 6244 & Johnson*, Nov 1975 (NSW); Esk Bank [Eskbank], *Hamilton*, Dec 1910 (NSW 6165); Browns Gap, 2 miles [3.2 km] S of Lithgow, *Briggs 1006 & Johnson*, 26 Nov 1966 (NSW 101606, CANB); near Hassans Walls, *Fletcher*, Nov 1893 (NSW 6186, AD, MEL, MO); Mt Victoria, *Hamilton* (NSW 6191); Blue Mtns, *Woolls* (MEL); Hampton, *Briggs 1012 & Johnson*, 26 Nov 1966 (NSW CANB, CHR, K, MEL, MO); near Hampton on Jenolan rd, *Vickery*, 28 Nov 1948 (NSW 6969); Gingkin near Jenolan, *Maiden*, Mar 1912 (NSW 6160); Jenolan Caves, *Blakely*, Nov 1899 (NSW 6163), Dec 1899 (NSW 16373); Jenolan, *Johnston*, Jan 1904 (CANB); Jenolan Caves, *Duff* (MEL); Murdering Gully, Kanangra, 10 miles [16 km] SE of Jenolan Caves, *Constable 5904*, 23 May 1965 (NSW, AD, CHR); Thurat Rivulet between Kanangra Tops and Thurat Tops, *Johnson*, 3 Oct 1948 (NSW 6530); 1 mile [1.6 km] W of Kanangra Plateau, *Coveny*, 15 Apr 1967 (NSW 118259); Mt Werong, 25 miles [40 km] S of Oberon, *Constable 4085*, 27 Nov 1962 (NSW); 1 mile [1.6 km] S of Mt Werong, *Briggs 1102 & Johnson*, 29 Nov 1966 (NSW 95688 – 2 sheets, CBG, LE), *Briggs 1103* (NSW, K); 2 miles [c. 3 km] NW of Wombeyan Caves, *Briggs & Johnson*, 29 Nov 1961 (NSW 101562 – 2 sheets, AD); Taralga, *Cheel*, 12 Dec 1919 (NSW 6154).

5. Derwentia velutina *B. Briggs & Ehrend.*, **sp. nov.**

Affinis *D. derwentianae* sed characteribus sequentibus distinguitur: omnes partes vegetativae pilis perbrevibus (0.1–0.3 mm longis) vestitae; caules per annis pluribus crescentes tunc decumbentes, folia sectione transversa saepe V-formia.

TYPE: NEW SOUTH WALES: North Western Slopes: Siding Spring Mountain, 800 m alt., on road to Mopera Gap, Warrumbungle Mountains, *F. Ehrendorfer 9201, B. Briggs & L. Johnson*, 24 Dec 1966; holo NSW; iso AD, CANB, CHR, MEL, WU.

Slender erect softy woody shrub, 0.5–1.7 m tall, densely and evenly covered with very short fine hairs on the stems, leaves, part of the calyx lobes, ovary, and the outer surface of the corolla (but not the inner surface of corolla and lower half of the calyx lobes); the hairs spreading or recurved, 0.1–0.3 mm long, of 1–3 cells. *Stems* several from an erect or prostrate woody rootstock, softly woody, erect, mostly unbranched below the inflorescence, terete, 3.5–7 mm diam., the basal 2–3 cm often prostrate and with adventitious roots, the longest internodes 0.5–2 (–4.5) cm long; each stem flowering for up to 3 seasons before becoming decumbent and dying back to the rootstock, commonly continuing growth during flowering; sometimes with erect lateral shoots developed from old decumbent branches. *Leaves* sessile, spreading or recurved, often V-shaped in transverse section, narrow-ovate, (30–)45–90 mm long, (7–)10–16 mm broad, leaf index 3.5–7.5, tapering gradually to the narrow base and the acute or acuminate apex, with 15–30 apiculate teeth on each side (the teeth spreading, ± irregular, commonly alternately large and small), dentation index 1.05–1.3, with 3–5 nerves from the base and 4–6 major nerves from the midrib, the margin slightly thickened but not recurved. *Racemes* single or usually opposite at each of 1–5(–9) upper nodes of one season's growth, floriferous portion (9–)15–30 cm long with 50–160 flowers; the peduncle 1.5–5(–7) cm long. *Bracts* subulate, 5–14 mm long. *Fruiting pedicels* 3–5(–7) mm long. *Calyx lobes* subulate or narrow-triangular, equalling or exceeding the capsules, 4.5–9 mm long and 1–1.5 mm broad in fruit. *Corolla* violet-blue or pale lavender with darker nerves, 7.5–11 mm long, the throat with hairs c. 1.5 mm long; adaxial lobe broad-ovate, acute or obtuse, 3.5–5 mm broad; abaxial lobe narrow-ovate, usually acute, 1.5–2.5 mm broad. *Stamen* filaments 4–6 mm long; anthers 1–1.5

mm long. *Ovules* in 2–4 irregular rows on a narrow vertical placenta. *Capsules* not glossy, compressed, ovate, 4–6 mm long, 3–5 mm broad, 2–2.8 mm thick, obtuse or truncate, the margin with short stiff hairs, dehiscing by a septicidal split to (or almost to) the base and splitting loculicidally for 1/3 of the distance to the base; persistent style 5.5–7 mm long with soft twisted hairs near the base. *Seeds* 10–30, 1–1.5 mm long, c. 0.8 mm broad. *Chromosome number*: n=20. (Fig. 4d, 16).

DISTRIBUTION AND HABITAT: Three separate elevated areas in the western parts of the Northern Tablelands and North Western Slopes of New South Wales: the Nandewar Range E of Narrabri, the Warrumbungle Mountains and the northern slopes of the Liverpool Range. In eucalypt woodland and in dense scrub, also commonly a coloniser of disturbed sites. In moist or rather dry sites, at about 750–1200 m alt. (Fig. 13).

The epithet is derived from the post-classical Latin *velutinus*, velvety, referring to the fine short erect hairs on most parts of the plant.

The species was referred to as '*Parahebe* sp. D' in Jacobs & Pickard (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Northern Tablelands: Coryah Gap, Nandewar Ra., *Briggs*, 2 Mar 1961 (NSW 53767); West Kaputar Lookout, Mt Kaputar Natl Park, *R. Pullen 10.380*, 15 Mar 1977 (CANB, K, NSW); Mt Kaputar plateau, *Briggs 4298 & Johnson*, 5 Jun 1971 (NSW, CHR); range between Coomoo Coomoo Ck and Henrys Ck, c. 38 miles [61 km] WSW of Quirindi, *Pickard & Coveny 1158*, Jun 1969 (NSW). North Western Slopes: Siding Spring Mtn, Warrumbungle Mtns, *Johnson*, 26 Mar 1967 (NSW 95847); Warrumbungle Mtns, *Hartley*, 5 Jun 1966 (NSW 82407); Warrumbungle Ra., *Forsyth*, Oct 1899 (NSW 6211); Timor Rock to Mopera (as Mobara) Rock, Warrumbungle Ra., *Salasoo 2289*, Jan 1962 (NSW); Mt Wombelong, Warrumbungle Ra., 30 km W of Coonabarabran, *H. Streimann 524*, 5 Dec 1973 (CBG, A, AD, K, NSW).

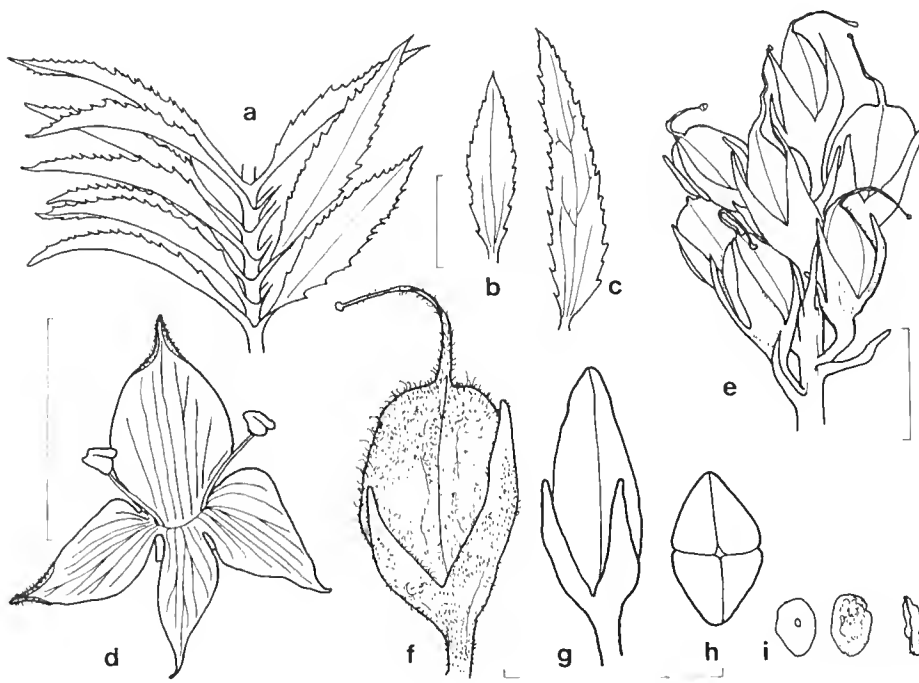

Figure 16. *D. velutina*. **a**, leafy branch; **b–c**, leaves; **d**, corolla and stamens; **e**, part of fruiting inflorescence; **f–h**, capsule with calyx – lateral, abaxial and apical views; **i**, seeds – adaxial, abaxial and side views; a and b from *Pickard & Coveny 1158*; c–d *Ehrendorfer 9201* (holotype); f–i *Johnson NSW 95847*. Scale bars: a–c = 2 cm, d = 5 mm, e = 2 mm, f–i = 2.5 mm.

6. Derwentia blakelyi *B. Briggs & Ehrend.*, **sp. nov.**

A *D. perfoliata* et *D. arcuata* capsula late obovata, compressa, emarginata, (3–)4–6.5 mm longa, 3–3.5 mm lata, 1.2–2 mm crassa differt.

TYPE: NEW SOUTH WALES: Central Tablelands: On hill west of Clarence [Railway] Platform, *W.F. Blakely & W.J. Buckingham*, 31 Dec 1938; holo NSW 6221; iso AD, CANB, CHR, K, MEL.

Softly woody small slender shrub, 0.15–0.7 m tall, vegetative parts, calyx, and ovary glabrous and glaucous. *Stems* one to several from a narrow woody rootstock, mostly erect and unbranched below the inflorescence, at first herbaceous but becoming softly woody, 15–40(–70) cm long, terete, 1.5–4 mm diam., each stem flowering in only one season, commonly continuing growth above the nodes subtending the racemes but not flowering again before dying back to the base, the longest internodes 1.5–6 cm long, the basal 1–3 cm often with adventitious roots but usually erect. *Leaves* sessile, usually recurved, V-shaped in transverse section, ovate to very narrow-ovate, 25–55 mm long, (7–)10–20(–27) mm broad, leaf index 1.8–4(–5.5), with 8–18 shallow teeth on each side, dentation index 1.02–1.2, with 3–7 nerves from near the base and usually 1–2 on the midrib, the base cordate or truncate or cuneate, the apex acute or subacute, the margin thickened. *Racemes* single or usually opposite at each of 1–3 upper nodes, floriferous portion (2.5–)8–40 cm long, with (6–)15–35(–70) flowers; the peduncle 4.5–14 cm long. *Bracts* linear, acute, 2–3.5 mm long. *Pedicels* 2.5–6 mm long in fruit. *Calyx lobes* narrow-elliptic, obtuse, 3–5.5 mm long and 0.7–1.3 mm broad in fruit. *Corolla* bright blue-violet, 6–7 mm long, with short hairs in the throat; adaxial lobe ovate, obtuse to acute, 2.5–4 mm broad; abaxial lobe narrow-ovate, subacute, 2–2.5 mm broad. *Stamen* filaments violet, 2–3.5 mm long; anthers cream, 1.4–2 mm long. *Ovules* few in 2 vertical rows. *Capsules* glabrous, glaucous, broad-obovate, slightly or distinctly emarginate, compressed, (3–)4–6.5 mm long, 3–5.5 mm broad. 1.2–2 mm thick, splitting septicidally and along the upper margin and eventually splitting to the base along both sutures; style usually persistent, glabrous, 4–5 mm long. *Seeds* 2–12, 1–1.5 mm long. (Fig. 4e, 17).

DISTRIBUTION AND HABITAT: Central Tablelands of New South Wales: at several locations in the region north, east and west of Lithgow, but all within a range of 100 km. In eucalypt forest or woodland on soils of rather low fertility on shale or sandstone. (Fig. 19).

CONSERVATION STATUS: The restricted distribution and possible occurrence in Wollemi National Park leads to a coding of 2R or 2RC.

The epithet commemorates William Faris Blakely (1875–1941), botanist at NSW, who collected this species and recognised its distinctiveness, and who made notable studies of many plant groups but especially of eucalypts.

This species was referred to as '*Paraluebe* sp. E.' in Jacobs & Pickard (1981). Beadle et al. (1963) refer to it in their comment that 'intermediate forms between [*Derwentia perfoliata* and *D. derwentiana*] occur, e.g. near Clarence'. In a later edition (Beadle et al. 1982) this is replaced by a comment that 'Specimens previously thought to be intermediates between these two species are probably an undescribed species'.

SPECIMENS EXAMINED: NEW SOUTH WALES: Central Tablelands: Coricudgy Ra., *Baker*, Oct 1897 (NSW 156175); Mt Horrible, Upper Limekilns rd, *Constable*, 19 Mar 1955 (NSW 39743); W slope of Mt Horrible, between The Limekilns and Palmers Oakey, *Johnson 8120*, 5 May 1975 (NSW); on track at the head of the long swamp E of Lithgow Water-Works, *Blakely*, 31 Dec 1938 (NSW 6224); 1.3 km NW of Clarence, *Briggs 6976*, 3 Dec 1978 (NSW, AD, CHR, MEL); Clarence, 1/3 mile [0.5 km] NW of Railway Station, *Ehrendorfer, Briggs & Johnson*, 23 Oct 1966 (NSW 95678, CANB, MO), *Briggs 1410a*, 26 Dec 1967 (NSW, BRI, CBG, HO, L, LE, RSA), *Briggs 1410b* (NSW);

Shepherds Swamp, Clarence, *Blakely & Buckingham*, 30 Dec 1938 (NSW 6223, CANB, CHR); on the W side of Shepherds Swamp, Clarence, *Blakely & Buckingham*, 26 Nov 1938 (NSW 6226); head of the long swamp E of The Clay Pits, *Blakely & Buckingham*, 31 Dec 1938 (NSW 6222); along the old railway line, Clarence, *Blakely & Buckingham*, 24 Nov 1939 (NSW 6225, CANB, CBG, K, LE, MO); Clarence, *Burgess*, 26 Oct 1962 (CBG).

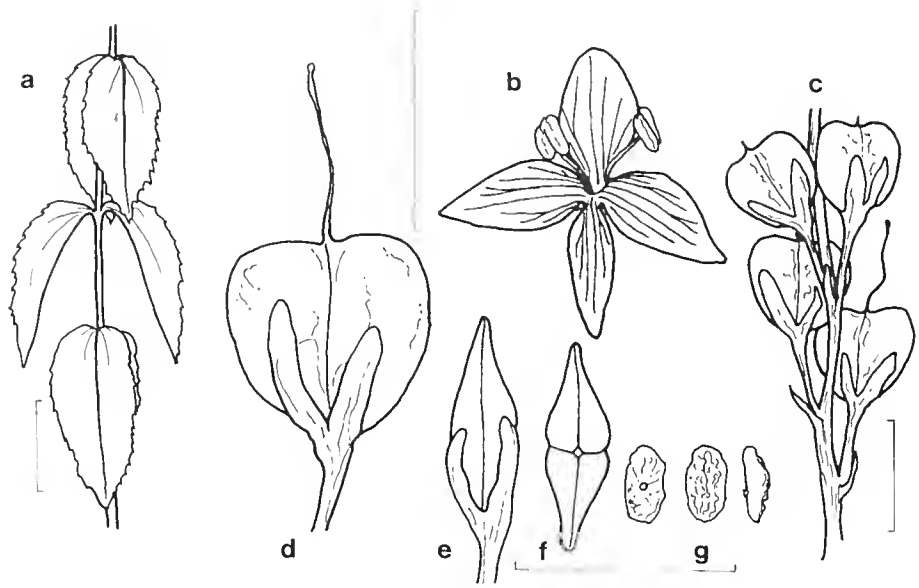

Figure 17. *D. blakelyi*. **a**, leafy branch; **b**, leaf; **c**, corolla with stamens; **d**, part of fruiting inflorescence; **e–g**, capsule with calyx – lateral, abaxial and apical views; **h**, seeds – adaxial, abaxial and side views; a–c from *Briggs 1410a*; d–h *Blakely & Buckingham NSW 6221* (holotype). Scale bars: a–b = 2 cm, c = 5 mm, d = 2 mm, e–h = 2.5 mm.

7. Derwentia arcuata *B. Briggs & Ehrend.*, **sp. nov.**

A *D. blakelyi* capsula ellipsoidea, minus compressa, non emarginata, et a *D. perfoliata* foliis recurvis sectione transversa V-formibus, semper dentatis, differt.

Type: New South Wales: Northern Tablelands: Biscuit Ck, 7 1/2 miles [12 km] NW of Ebor, *N.C. Ford*, 10 Jan 1958; holo NSW 42793.

Vegetative parts, calyx, and ovary glabrous and glaucous. *Stems* several from a narrow woody rootstock or from elongated underground rhizomes, mostly erect and unbranched below the inflorescence, at first herbaceous, becoming softly woody, often ± prostrate at the base, 30–75 cm long, terete, 1.8–4 mm diam., the longest internodes 1.5–6 cm long; each stem flowering in only one season, commonly continuing growth above the nodes subtending the lateral racemes but not flowering again before dying back to the base. *Leaves* sessile, usually recurved and V-shaped in transverse section, ovate to narrow-ovate, 32–90 mm long, 10–45 mm broad, leaf

index 1.5–3.5, with 6–15 coarse spreading or antrorse teeth on each side, dentation index 1.06–1.2, usually with 7 nerves from near the base and 1–2 on the midrib, the base cordate or cuneate, the apex acute, the margin thickened. *Racemes* single or usually opposite at each of 1–4(–6) upper nodes, floriferous portion (3–)9–35 cm long, with (8–)20–85 flowers; the peduncle 4–12 cm long. *Bracts* linear, acute, 2–4 mm long. *Pedicels* 3–5 mm long in fruit. *Calyx* lobes linear or narrow-elliptic, acute, 4–5 mm long and 0.8–1.2 mm broad in fruit. *Corolla* lilac, 9.5–11 mm long, with rather long (c. 1 mm) hairs in the throat; adaxial lobe elliptic, obtuse or subacute, 5–7 mm broad; abaxial lobe narrow-ovate, subacute, 2.5–3.5 mm broad. *Stamen* filaments 4.5–6.5 mm long; anthers 1.5–2 mm long. *Ovules* in 2 irregular vertical rows. *Capsules* glabrous, glaucous, ellipsoidal, obtuse or truncate, slightly compressed, (4.5–)6–9.5 mm long, 3–5 mm broad, 2.2–2.8 mm thick, dehiscing by a septicidal split and eventually splitting to the base septicidally and 1/4–1/2 of the distance to the base loculicidally; style glabrous, persistent or the upper part deciduous, the basal 0.5 mm thickened and splitting longitudinally at dehiscence. *Seeds* 4–20, ovoid but irregular in outline, the margin undulate, 1–2 mm long, c. 1 mm broad. (Figs. 4e, f, 18).

DISTRIBUTION AND HABITAT: Northern Tablelands of New South Wales, and extending to closely adjacent areas of the North Western Slopes. Usually in eucalypt woodland, often on shallow soil with rock outcrops, on basalt and granite, 750–1600 m alt. (Fig. 19).

The epithet is derived from the Latin *arcuatus*, curved, like a bow, referring to the recurved leaves.

This species was included, with a brief English description and illustration, as '*Parahebe arcuata*' Briggs et Ehrendorfer [ined.] in Beadle (1984). It was referred to as '*Parahebe* sp. F' in Jacobs & Pickard (1981).

SELECTED SPECIMENS: NEW SOUTH WALES: Northern Tablelands: Lower slopes of Mt Capoompeta, c. 12 miles [19 km] NE of Deepwater, *Constable*, 24 Aug 1966 (NSW 99813); 3.1 km ENE of Emmaville, *Coveny 14643, Makinson & Quirico*, 12 Oct 1990 (NSW, BRI); Tent Hill, *Clelaud* (AD); Glen Elgin–Dundee, *Gray 3842*, Jan 1956 (CANB); Mt Mitchell, *Beckler* (MEL); Pheasant Mtn, vicinity of Backwater, *Gray 3465*, 16 Apr 1956 (CANB); top of range near Backwater, *Blakely, McKie & Boorman*, 29 Oct 1929 (NSW 6213); Ben Lomond, *Maiden*, Dec 1899 (NSW 6218); 6 miles [9.6 km] E of Guyra, *Trapnell A90*, 19 Apr 1961 (K); Bald Hills to Guy Fawkes and the summit of Round Mtn, *Maiden*, Dec 1893 (NSW 6217); Guy Fawkes, *Boorman*, Dec 1909 (NSW 6216); Ebor Falls, *Wissuan*, Jan 1967 (NSW 96037); Armidale, 6 miles [9.6 km] Glen Innes Rd, *Stopford*, 7 Nov 1908 (BM); Serpentine R., 30 miles [50 km] ENE of Armidale, *Davis*, 4 Jan 1941 (NSW 22324); Bullock Ck, *Williams*, 4 Jun 1967 (NE, CHR, NSW 96611); Snowy Ra., Cathedral Rock Natl Park, Native Dog Ck, *Telford 10772*, 2 Jan 1989 (CBG, AD, NSW); Gara R., 9 miles [14.5 km] E of Armidale, *Williams*, Aug 1959 (NE); University of New England grounds, Armidale, *Piesse*, 26 Oct 1959 (NE); Armidale, *Stopford*, 1907 (BM); Moona Plains, Walcha, *Crawford*, Nov 1898 (NSW 6219); Moona, *Crawford*, Feb 1885 (MEL 21587); head of Macleay R., *Betche*, (NSW 6212); New England, *Moore*, c. 1867 (K), 1868 (BM). North Western Slopes: Howell, *Boorman*, June 1904 (NSW 6215); Tingha, *Cambage 973*, 14 Oct 1903 (NSW 6214).

8. *Derwentia perfoliata* (R. Br.) Raf.

Rafinesque (1836: 55).

BASIONYM: *Veronica perfoliata* R. Br. (Brown 1810: 434).

TYPE: NEW SOUTH WALES: Central Tablelands: 'Nova Cambria Australis, Blue Mountains', *E.F. Barrallier*, 1802; lecto BM, photo NSW. From the two sheets of the collection in BM, the left-hand specimen on the sheet marked 'Specimen selected by Brown "for the public collection" ' is selected as lectotype.

Parahebe perfoliata (R. Br.) B. Briggs & Ehrend. (1968: 742).

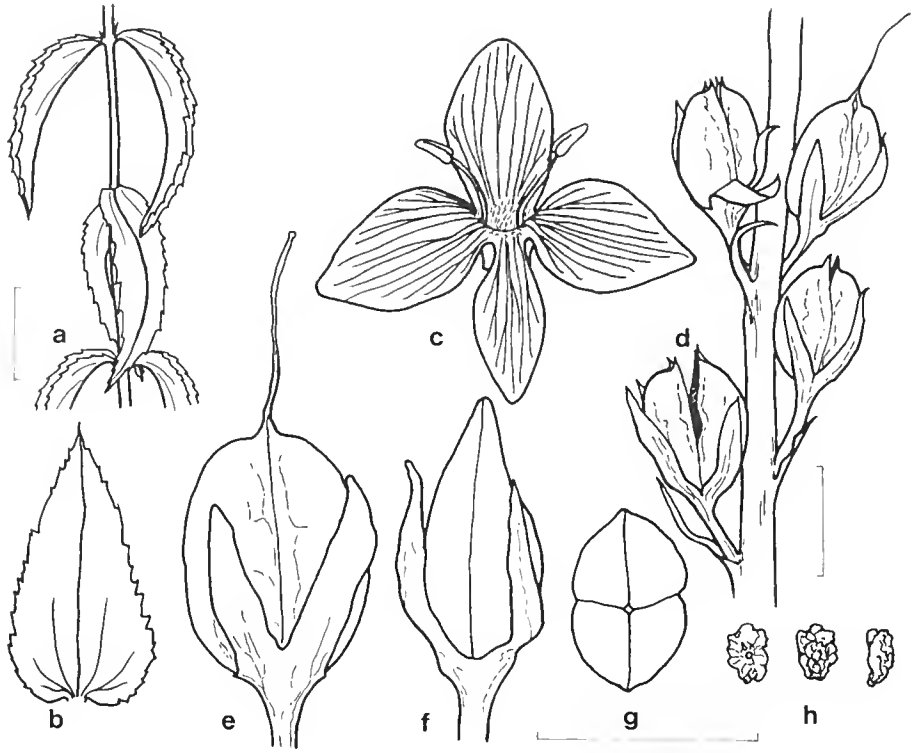

Figure 18. *D. arcuata*. **a**, leafy branch; **b**, corolla with stamens; **c**, part of fruiting inflorescence; **d–f**, capsule with calyx – lateral, abaxial and apical views; **g**, seeds – adaxial, abaxial and side views; a–f from *Ford NSW 42793* (holotype); g MEL 21587. Scale bars: a = 2 cm, b = 5 mm, c = 2 mm, e–g = 2.5 mm.

Veronica imperfoliata Benth. in Candolle (1846: 463). Type: New South Wales: Central Tablelands: Blue Mountains, New Holland, *R. Cunningham*; holo K.

Softly woody shrub 0.3–1.2 m tall, vegetative parts and calyx glabrous and glaucous; the stems, the margins and the nerves of the leaves, and the calyx margins often red-purple. *Stems* several or numerous, from a narrow woody rootstock or usually the basal 10–30 cm of the stems prostrate and subterranean (and with adventitious roots) forming ramifying clumps connected by woody rhizomes. *Stems* mostly erect and unbranched below the inflorescence, rarely with leafy lateral shoots bearing both terminal and lateral racemes, at first herbaceous but becoming softly woody, 30–120 cm long, terete, 2–4 mm diam., the longest internodes (1.5–)3–7 cm long, each stem flowering in only one season before dying back to the base. *Leaves* opposite or rarely in whorls of 3, sessile, coriaceous, ovate or broad-ovate or less often very narrow-ovate, (16–)25–55(–75) mm long, (6–)15–40(–65) mm broad, entire or crenulate or with up to 10(–20) shallow or coarse acute teeth on each side, the base perfoliate or cordate or cuneate, the apex acute or acuminate, leaf index 1.06–8, dentation index 1–1.3, the margin thickened, with (3–)5–9 nerves from near the base. *Racemes* single or opposite at each of 3–6 upper nodes, floriferous portion, 10–45 cm long, with (9–)25–70(–130)

flowers; the peduncle 5–12 cm long. *Bracts* linear, subacute, 2–5 mm long, 0.5–1 mm broad. *Pedicels* (3–)5–12 mm long in fruit. *Calyx lobes* linear, subacute, 3–5 mm long, 0.5–1 mm broad. *Corolla* 7–12 mm long, blue or purplish blue, the throat with hairs 0.5–1 mm long; adaxial lobe ovate or broad-ovate, obtuse, 4.5–8 mm broad; abaxial lobe elliptic or ovate, acute, 2.5–3.5 mm broad. *Stamen* filaments purplish-blue or white, 2.5–5 mm long; anthers white or pale yellow, 1.5–3 mm long. *Ovules* crowded on a narrow vertical placenta. *Capsules*, not glossy, narrow- or broad-ovoid, obtuse or acute, usually scarcely compressed, 4.5–8.5 mm long, 2.8–3.5 mm broad, 2.2–3.5 mm thick, glabrous, dehiscing by a septicidal split which eventually reaches almost to the base and a loculicidal split for c. 1/2 the distance to the base; style 4–6 mm long, usually persistent, the basal 1–1.5 mm usually thickened and splitting longitudinally with the capsule. *Seeds* 6–12, 1–2 mm long, c. 1 mm broad. *Chromosome number* (Fig. 1g): *n*=20. (Fig. 4f, 20).

DISTRIBUTION AND HABITAT: In New South Wales on the South Coast, Central and Southern Tablelands and the Western Slopes, in Victoria in montane areas as far west as c. 144° E (Brisbane Ranges). The species is more common above 500 m alt. than at low altitudes and extends to about 1750 m alt. In eucalypt forests and woodland, alpine meadows, heath, and on rock screes; on a wide range of rock types but usually on shallow skeletal soil. It is reported from granite, shale, sandstone, limestone, and serpentine areas. It commonly adjoins *P. derwentiana* but occurs in drier sites; for example the latter may be on deeper soil or in shaded sites while *P. perfoliata* grows on adjacent steep, exposed rocky slopes. This wide ecological range contrasts with reports that it was considered 'a sure indicator of gold', a view which was associated with its common name 'Diggers' Speedwell'. The species shows great variation in leaf shape and in this it exhibits some geographic regularity. Plants in drier regions mostly have narrower leaves than those in moister and cooler areas. (Fig. 19).

Richardson & Barnsley (1991) record a putative hybrid *D. derwentiana* x *D. perfoliata* as a self-sown plant in the Australian National Botanic Gardens at Canberra. This plant shows about 70% of visually normal pollen grains, a somewhat lower percentage than observed in the relevant species, and has well-developed capsules. Its very broad ovate-deltoid leaves that have numerous shallow teeth, together with the shape of corolla lobes and the widely spaced flowers, suggest such a hybrid ancestry. No hybrids between these or other *Derwentia* species have been recorded in the wild, but ecological differences generally separate the parental species (with *D. perfoliata* in drier sites), despite broad geographic overlap. The plant has some similarities to *D. derwentiana* subsp. *maideniana*, but Richardson and Barnsley are probably correct in ascribing its origin to interspecific hybridisation.

SELECTED SPECIMENS: NEW SOUTH WALES: South Coast: Belowra, 40 km W of Narooma, *Briggs 3096*, 16 Dec 1969 (NSW, CANB); near Mt Imlay trig, *Taylor 224 & James*, 15 Feb 1984 (NSW, MEL). Central Tablelands: Cherry Tree Hill, near Ilford, *Ehrendorfer 8801, Briggs & Johnson*, 23 Oct 1966 (NSW 98357, AD, CANB, CHR, MO); Running Stream near Ilford, *Burgess*, 13 Apr 1963 (CBG); dry rocky summits of hills in the country on the west of the Blue Mountains – Bathurst etc., *A. Cunningham*, April 1817 (K); 3 km S of Lithgow, *Briggs 1004 & Johnson*, 26 Nov 1966 (NSW); Mt Victoria, *Fletcher*, 5 Jan 1892 (NSW 6103); Gibbergunyah Ck, Mittagong, *Constable 6722*, 20 Feb 1966 (NSW, K); 3 km N of Wombeyan Caves, *Briggs 1113 & Johnson*, 29 Nov 1966 (NSW, AD, K, MEL); summit of 'The Gib', Bowral, *Rodway*, 15 Dec 1935 (NSW 22331); Black Bobs Ck, 7 miles [11 km] SW of Moss Vale, *Burgess*, 29 May 1962 (CBG). Southern Tablelands: Currockbilly Mtn, near Braidwood, *Boorman*, Dec 1915 (NSW 6101); Black Mtn, *Beeton*, 2 Dec 1964 (CBG); Mt Franklin, ACT, *Gauba*, 2 Nov 1949 (GAUBA); Gingera gate, Brindabella Ra., *Canning 639*, Jan 1968; below Mt Gingera, ACT, *Ford*, 16.1.1954 (NSW 26567); between Pryors Hut and Mt Ginni, Brindabella Ra., *Coveny 11543 & Hind*, 19 Jan 1983 (NSW, CANB, BRI); Tinderry Mtns, 12 km E of Michelago, *Briggs*, 26 Dec 1965 (NSW 89773, AD, CBG); near Big Badja Hill, Kybeyan Ra., *Coveny 2824 & Pickard*, 15 Mar 1970 (NSW, AD, CHR, K, L, LE, MEL, MO); above Tuross Falls,

Fairley-Cunninghame, 26 Dec 1967 (NSW); 3 km W of Tuross Falls, *Johnson*, 5 Jan 1968 (NSW 85491); Sawpit Ck, Mt Kosciusko, *Maiden*, Jan 1898 (NSW 6114). Central Western Slopes: Upper Meroo R., 14 miles [22.5 km] SW of Mudgee, *Johnson & Constable*, 13 Aug 1950 (NSW 16199); Ardlethan, *Boorman*, Nov 1917 (NSW 6130); Harvey Ranges, Peak Hill, *Boorman*, Nov 1905 (NSW 6120). South Western Slopes: Burrinjuck, *Boorman*, Feb 1911 (NSW 6098, RSA, US). VICTORIA: Riverina: Chiltern, *Williamson*, Nov 1904 (MEL). Midlands: S side of Granya Gap, *Rodd 606*, 16 Apr 1968 (NSW); Avoca, *Walter*, Oct 1888 (MEL); N end of Brisbane Ra., c. 10 miles [16 km] NW of Balliang, *Melville 71.836*, 21 Oct 1971 (K, NSW); Brisbane Ranges, Stony Ck Picnic Reserve, *Conn 2494 & Foreman*, 16 Nov 1986 (NSW, G, L, MEL, MO, PE, W). Eastern Highlands: Howqua R., *Whaite*, 11 Jan 1949 (NSW 7655); Wellington R., Gippsland, *Lucas*, Dec 1890 (NSW 6108); SE of Tali Karng near The Sentinels, *Muir 2999*, 1 Jan 1964 (MEL). Snowfields: Mt Buffalo, *Walter*, Nov 1891 (BRI); Suggan Buggan Ra., 4 miles [6.4 km] N of Suggan Buggan, *Coveny 2760 & Pickard*, 12 Mar 1970 (NSW, MEL, BRI); Little R., Wulgulmerang, *Melville 3013 & Wakefield*, 20 Jan 1953 (K, NSW); W Tree Ck, Murrindal, 13 miles [21 km] N of Buchan, *Constable 5368*, 30 Oct 1964 (NSW).

Figure 19. Distribution of *D. blakelyi* (▲), *D. arcuata* (■), *D. perfoliata* (●). The dotted line shows the 610 m (c. 2000 ft) contour.

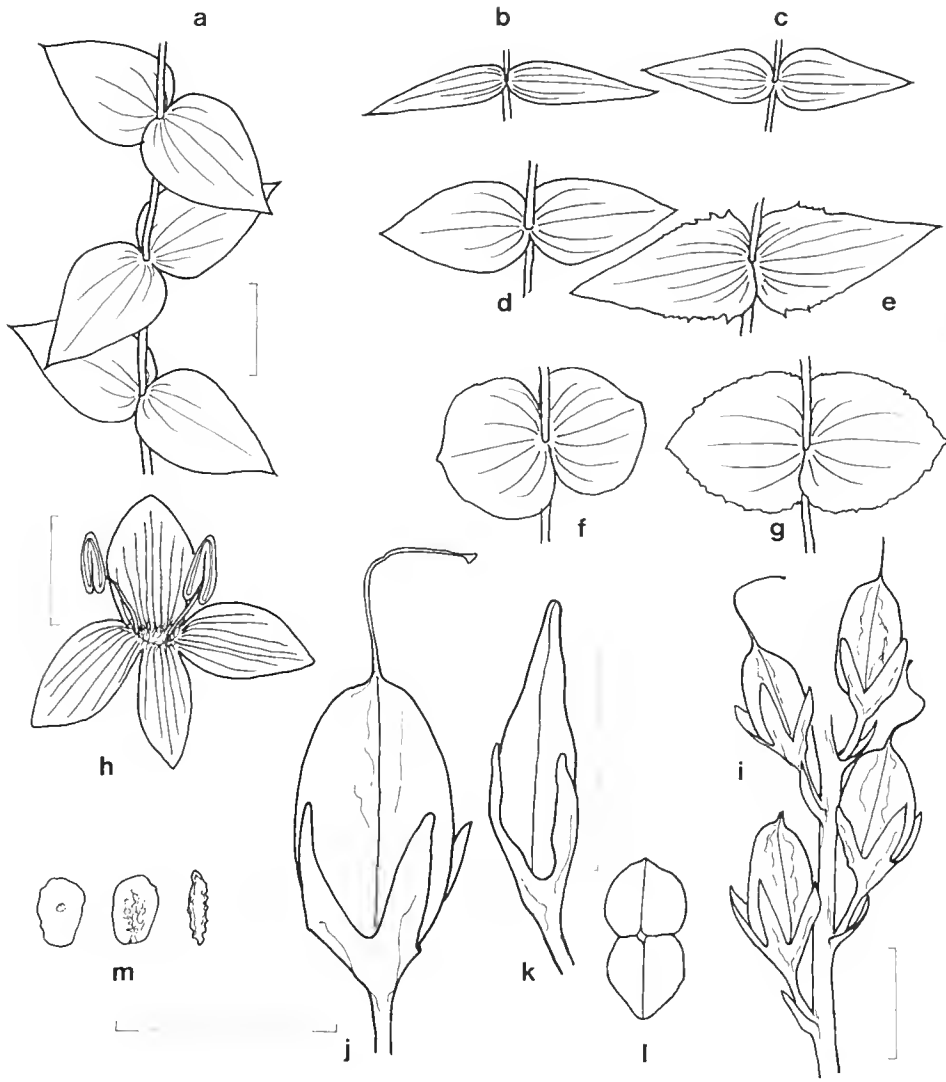

Figure 20. *D. perfoliata.* **a**, leafy branch; **b–g**, variation in leaf shape; **h**, corolla with stamens; **i**, part of fruiting inflorescence; **j–l**, capsule with calyx – lateral, abaxial and apical views; **m**, seeds – adaxial, abaxial and side views; a and i–m *Briggs NSW 89773*; b NSW 6131; c *Fairley-Cunninghame NSW 98358*; d NSW 989773; e *Briggs 1004 & Johnson*; f *Ford NSW 26567*; g *Canning 639*. Scale bars: a–g = 2 cm, h = 5 mm, i = 2 mm, j–m = 2.5 mm.

Acknowledgements

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SHORT COMMUNICATION

Neotypification of *Macrozamia mountperriensis* (Zamiaceae), with notes on its distribution

Macrozamia mountperriensis Bailey was recently reinstated at specific level (Jones 1991) having been placed in the synonymy of *M. miquelii* (A. DC.) F. Muell. by Johnson (1961). As noted by Forster (1988) no type material of *M. mountperriensis* is extant at the Queensland Herbarium (BRI) and neotypification is necessary for the name of this taxon.

Macrozamia mountperriensis *Bailey*, Syn. Queensland Fl., Suppl. I: 50 (1886). *M. tridentata* subsp. *mountperriensis* (Bailey) Schuster in Engler, Pflanzenr. IV(i): 89 (1932) [as 'mountperryensis'].

TYPE: QUEENSLAND: Burnett District: 'Mount Perry' [J. Keys] (holo BRI n.v. & presumed lost).

NEOTYPE (here designated): QUEENSLAND: Burnett District: adjacent to Schuh Lookout, c. 3 km west of Mt Perry beside road to Monto, *D.L. Jones 6340 & B.E. Jones*, 29 August 1990 (neo CBG; isoneo BRI, CBG, NSW).

NOTES: A detailed description of *Macrozamia mountperriensis* was provided by Bailey (1886) who stated that the species was found at Mount Perry. Although no collector of the type is indicated, it is most likely that this was James Keys who sent many plants to Bailey (Forster 1988). James Keys resided at Mount Perry between 1 January 1880 and 30 June 1887 and it may be assumed that he collected the material of *Macrozamia* between 1884 and 1886, as Bailey (1884) does not mention the genus, and Keys (1886) mentions it twice. The precise locality of Keys' collection of *Macrozamia* in the Mount Perry district is unclear. Although nearly all of his collections from the area are labelled as Mount Perry, it is unlikely that they all originated either from the immediate vicinity of the township or the mountain of the same name (Forster 1988). Keys (1886: 43) noted that 'On the low ground and the hilly country, the chief plants of interest are the cycads and macrozamias'.

The species is common in many areas in close proximity to both the township and mountain named Mount Perry. The collection selected as neotype of the name is appropriate not only for its close agreement with Bailey's (1886) description, but also for its undoubted location within the area of James Keys' collecting activities.

DISTRIBUTION: Restricted to the eastern–central Burnett and western–central Wide Bay pastoral districts in south-east Queensland. *M. mountperriensis* was stated by Jones (1991) to be common in the Mount Perry area, and while this is true, it is also common south to the Biggenden area and east to Aramara (Forster et al. 1991 [sites 43–44, 46–47, 55–56, 66, 70 as *M. miquelii*].

ECOLOGY: Plants grow in araucarian microphyll vineforest (Forster et al. 1991) on volcanic soils or in adjacent open eucalypt forest on stony soils.

SELECTED SPECIMENS EXAMINED: QUEENSLAND: Burnett District: 2 km SW of Boolbunda Rock, *Forster 2423*, May 1986 (BRI); 6.9 km from Mt Perry on Eidsvold road, *Hill 3804 & Stanberg*, Sep 1990 (BRI ex NSW); Mt Perry, *Cameron [AQ142068]*, Dec 1911 (BRI); Goodnight Scrub, 18.2 km from Mt Perry – Gayndah road, *Hill 3806 & Stanberg*, Aug 1990 (BRI ex NSW); Goodnight Scrub, c.

65 km SW of Bundaberg, *Smith 9845*, June 1957 (BRI); Kalliwa Creek area, Goodnight Scrub S.F., *Forster 2771*, Dec 1986 (BRI). Wide Bay District: Booyal, *Animal Health Stn. F1676*, July 1954 (BRI); Booyal – Wallaville road, *Walter [AQ142060]*, Mar 1961 (BRI); Stony Creek, 4 km E of Didcot, *Forster 1966*, Dec 1984 (BRI); Farrel's Scrub, Deep Creek road, *Forster 9128*, Oct 1991 (BRI, CBG, MEL); Biggenden, *White 7255*, Oct 1930 (BRI); State Forest 1294 Brooweena, Compartment 12, *Forster 9343 & Machin*, Jan 1992 (BRI, MEL); North Aramara, *Blake 19258*, Mar 1954 (BRI).

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SHORT COMMUNICATION

Cheilanthes nudiuscula (R. Brown) T. Moore, previously *C. hirsuta* (Poiret) Mett.

Since our recent publication on the genus *Cheilanthes* in Australia (Chambers & Farrant 1991), Alan R. Smith (1991), in a review of S.B. Andrews' *Ferns of Queensland* (1990), has correctly pointed out that *Cheilanthes hirsuta* (Poiret) Mett. is 'a later homonym for *C. hirsuta* Link, a Mexican species'.

The Australian species was first described as *Pteris hirsuta* by Poiret (1804: 719) and later transferred to *Cheilanthes* by Mettenius (1858: 69). However, the name *Cheilanthes hirsuta* had already been applied by Link (1833: 40–41) to a Mexican species, so the use of this name by Mettenius was illegitimate, being a later homonym. Another name, *Cheilanthes nudiuscula* (R. Brown) T. Moore, is available.

The epithets *hirsuta* and *nudiuscula* suggest very different conditions of hairiness, and the species does show great variation in this feature. At one extreme of the variation found in the species are specimens with a glabrous upper pinnule surface and only a sparse cover of medium length hairs (1–4 cells) on the lower pinnule surface. Most specimens have sparse, medium length hairs on the upper pinnule surface and moderately dense, medium length hairs on the lower pinnule surface and rhachis. Although the specific epithet means 'somewhat naked', the type specimen of *C. nudiuscula* has a moderately dense cover of hairs on the upper pinnule surface and a dense cover of hairs on the lower pinnule surface, which places it at the other extreme of the variation found within this species. In addition, this type specimen has elongated triangular pinnules, which are less common in the species than oblong, rounded pinnules, but which still fit within our accepted range of variation for the species.

Cheilanthes nudiuscula *(R. Brown) T. Moore*, Ind. Fil.: 249 (1860)

BASIONYM: *Pteris nudiuscula* R. Brown, Prodr. Fl. Nov. Holl.: 155 (1810).

Cheilanthes tenuifolia subsp. *nudiuscula* f. *glabrata* Domin, Biblioth. Bot. 85: 142 (1915).

HOLOTYPE (Quirk et al. 1983: Figure 26): NORTHERN AUSTRALIA: Coast 'T' [Tropical: the coast of Queensland and the Northern Territory westward to Arnhem Bay], *R. Brown 60*, 1802-5 (BM).

SYNONYMY: *Pteris hirsuta* Poiret, Encycl. 5: 719 (1804). *C. hirsuta* (Poiret) Mettenius, Farngatt. 3: 69 (1858), *nom. illeg.*, non Link (1833). HOLOTYPE: unknown locality and date, *P. Sonnerat* (P-LA, photo seen).

C. tenuifolia subsp. *nudiuscula* f. *pubescens* Domin, Biblioth. Bot. 85: 142 (1915). LECTOTYPE (Chambers & Farrant 1991): QUEENLAND: Picnic Hill, Russel [Russell] R., *K. Domin 313* (PR).

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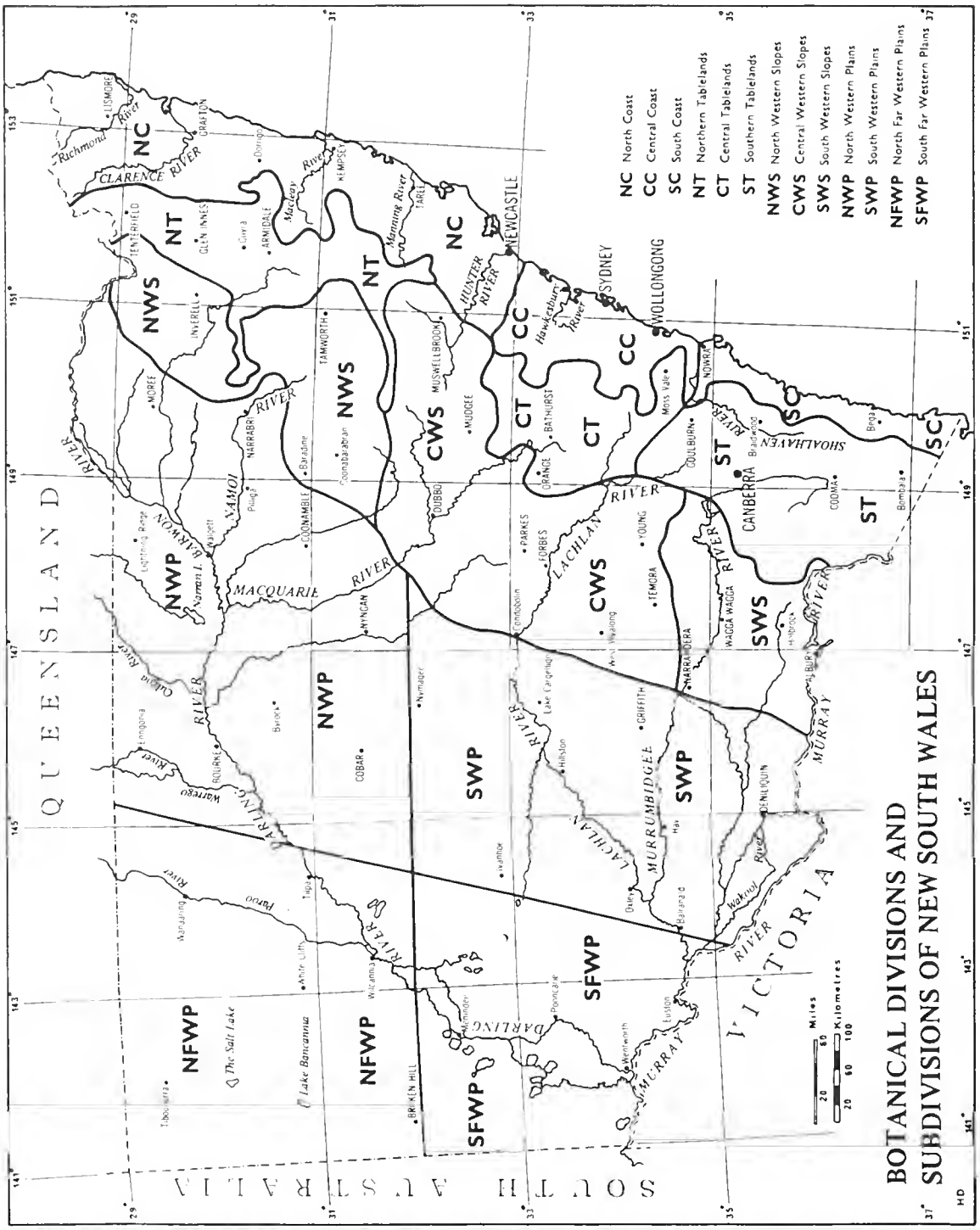

For explanation and description of the Botanical Divisions and Subdivisions of New South Wales see Anderson, R. H. (1961). Introduction. *Contr. New South Wales Natl. Herb. Fl. New South Wales* Nos 1–18, pp. 1–15.

CONSERVATION CODES APPLIED TO RARE AND THREATENED SPECIES

The codes used in this journal follow J. Briggs & J. Leigh (1988) *Rare or threatened Australian plants* 1988 Revised Edition. Australian National Parks & Wildlife Service, Special Publication no. 14.

Distribution categories

1 species known from type collection only

2 species with a very restricted distribution in Australia and with a maximum geographic range of less than 100 km

3 species with a geographic range of at least 100 km but occurring only in small populations (often restricted to highly specific and localised habitats)

\+ species also occurs naturally outside Australia

Conservation categories

X presumed extinct (not found in recent years)

x presumed extinct within a particular region

E endangered: species in serious risk of disappearing from the wild within 10–20 years

V vulnerable: species not presently endangered but at risk over 20–50 years

R rare: species that are rare in Australia but not endangered or vulnerable

K poorly known: species that are suspected of being at risk but data are inadequate;

k poorly known in Western Australia by the criteria of the Western Australian Dept of Conservation and Land Management

Reservation categories

C species known to be present within a national park or other proclaimed reserve;

a adequately reserved, with at least 1000 plants known to occur in reserves;

i inadequately reserved, with fewer than 1000 plants known from reserves;

\- adequacy of reservation unknown

t total known populations are in reserves

Taxonomic category

? taxonomic status is uncertain

NOTICE TO AUTHORS

Telopea is published twice-yearly, in March and September. Preference will be given to papers relating to the flora of New South Wales. Brief papers may be published as Short Communications (see previous issues for format).

Deadlines for the submission of papers are **1 June** (for the March issue the following year) and **1 November** (for the following September issue). Authors are expected to have had their papers peer-reviewed before submission. All papers will be refereed. Two copies of the manuscript should be submitted along with originals of photographs and clear photocopies of all other figures. The full postal address (plus telephone and fax numbers) of the author who will check the proofs and receive correspondence should be included. Once a paper has been accepted for publication the author should provide the paper on a computer disk along with final artwork. The disk should be in IBM compatible (MS-DOS) or Macintosh format and clearly labelled with the word processing program used and the file name(s).

General formatting requirements • Text should be flush left. This applies also for abstracts, headings, keys and reference lists. Headings should be in upper and lower case, and not underlined. • Use only a single space after *all* punctuation marks including fullstops. • Insert a space between a numeral and unit of measurement, e.g. 3 mm, but no space between initials, e.g. L.A.R. Haegi, or between a hyphen and associated numerals, e.g. 5.2-6 mm or between extreme measurements and ranges e.g. (10-)25-35(-90). • Do not use the spacebar to indent or tabulate. Underline, in preference to italics, and use single quote marks before double.

Organisation of the paper The title should be explicit and descriptive of the content. Include the family name and broad geographic region where appropriate. Abstracts (except for Short Communications) should be included. Check most recent issue for format. Bracketed keys are preferable especially for long keys, but indented keys are acceptable. Long indented keys should be divided into groups. When giving authors of botanical names follow the forms in the Kew Draft Index of Author Abbreviations. But note unabbreviated use in references below.

Types Cite details in full, giving details from protologue and from specimen label separately if there are important differences. Type citations should be in a consistent format, e.g: Type: New South Wales: North Western Plains: 10 km W of Moree (29°08' S 129°48' E), *B. Wiecek 1250*, 2 Jan 1989; lecto NSW (Weston 1990: 21); isolecto K, MO.

Selected specimens Cite no more than 20 (except for very widely distributed species) and arrange by Botanical Divisions. Use accepted format: locality, collector & number, date (herbarium code plus institutional number if there is no collector's number) and omit the initials of collectors, unless confusion is likely. Only latitudes and longitudes on the original labels should be included. Give dates in the following format: 12 Jan 1987, 2 June, 30 July, 10 Dec etc.

References In formal taxonomic citations use the fully abbreviated (Harvard) form: author (year: page) e.g. Bentham (1878: 234). The traditional ± abbreviated form, e.g. Bentham, Fl. Austral. 7: 234 (1878), may be used in shorter papers. Authors' names in these citations should be given unabbreviated. References to books published before 1900 need not include the publisher and place of publication, but be consistent.

Index to taxa This is useful if the paper is large and deals with many species and synonyms. The author should prepare the basic alphabetic listing including all names in recent use.

Illustrations/maps/photos • In general figures should be drawn one and a half times the final printed size. Check that line thickness and evenness, and labelling size are suitable for the final reproduction size and that maps show their context clearly (by lat/longs or an inset map) and that relevant place names in the text (but not for cited specimens) are shown. • Submit line drawings as bromide (Repromaster) copies with the final manuscript. • Photos should be unmounted, good-quality gloss prints. Do not label photos. • Labelling that is part of an illustration, e.g. place names on a map, should be added in Helvetica font by the person preparing the illustration. • Bar scales on the figure are preferable to numerical scales in the caption. Any magnification levels in the caption should refer to the size of the submitted original figure (not anticipated final size). • Bear in mind the shape of the final printed page and that the maximum final size of the illustration is 205 mm high x 125 mm wide, but preferably less to leave space for a caption on the same page.

Captions Use lower case letters for the parts of a figure e.g. Figure 1. *Jacksonia michaeliana*. a, stem tissue (x 10); b, calyx lobes (x 0.5). (a from holotype; b from *Barson 234*.)

Tables should preferably be portrait rather than landscape shape. They should be typed as separate files.

More detailed instructions are available on request from the editors.

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