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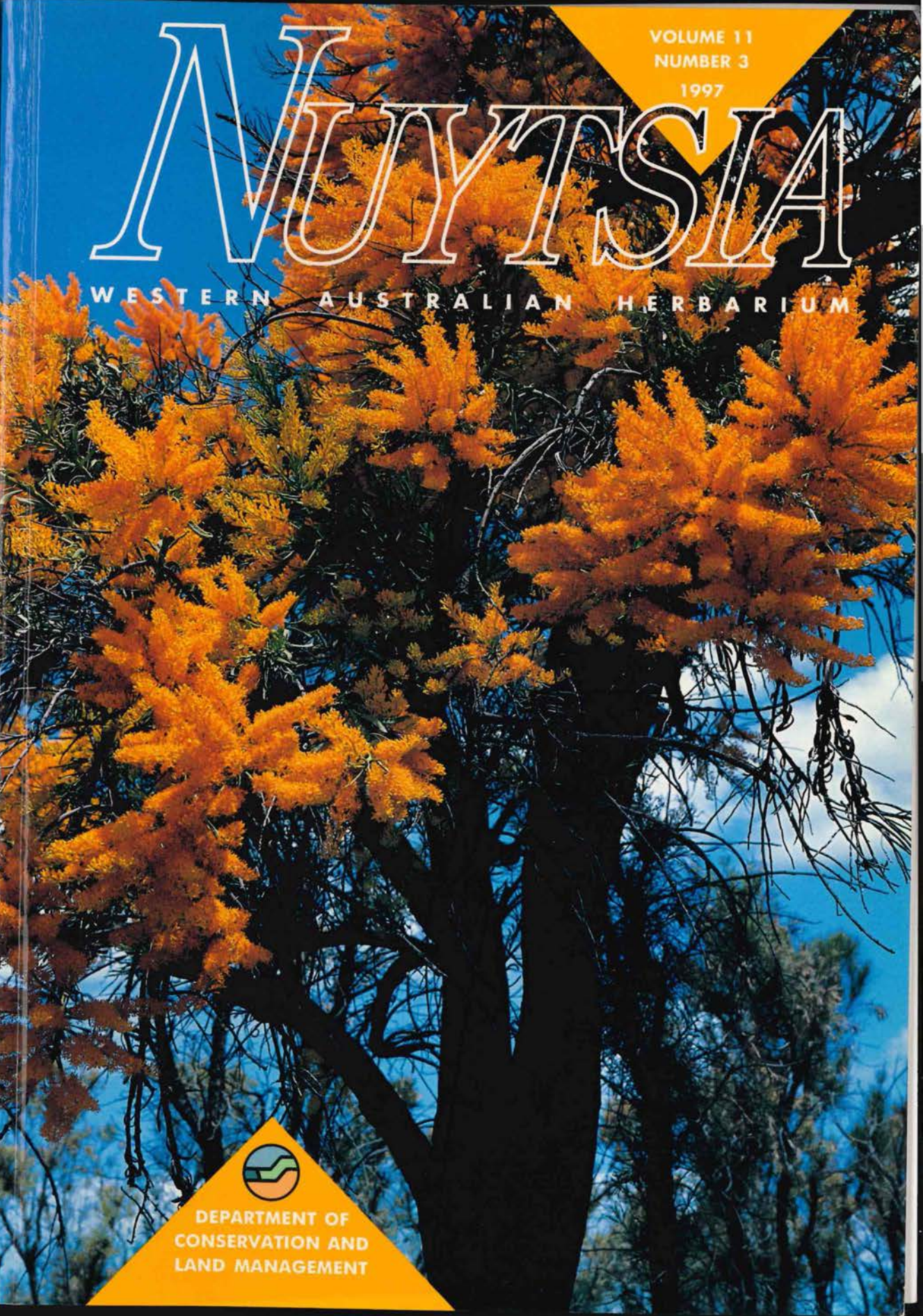

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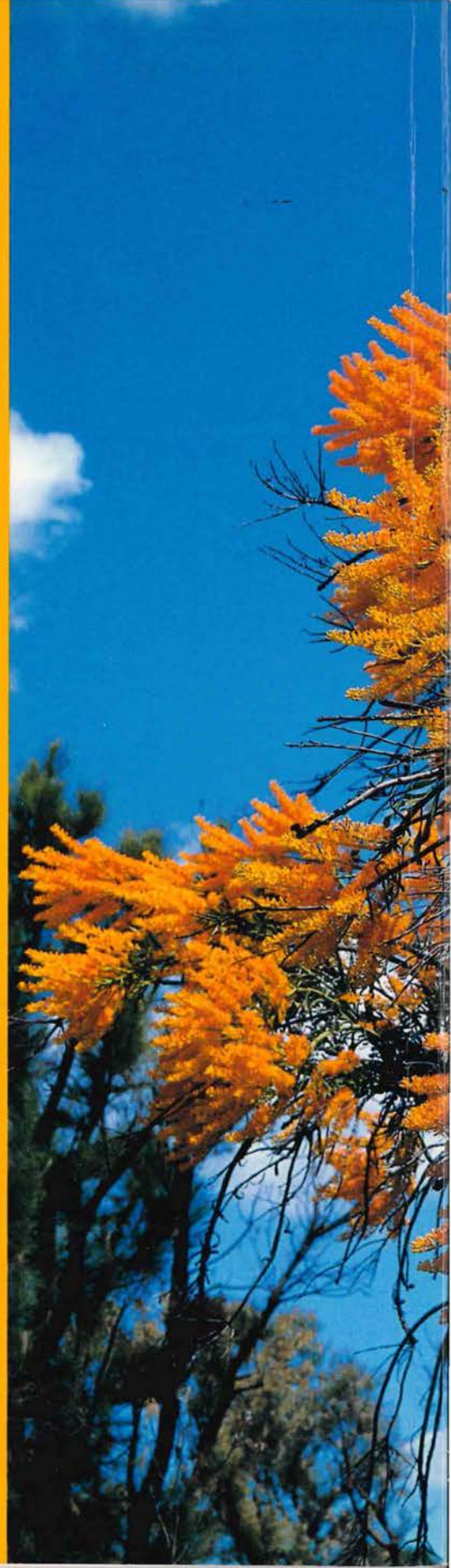

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Cover

*Nuytsia floribunda* (Labill.) R. Br. ex Fenzl (Loranthaceae) - the Western Australian Christmas Tree is one of the few arborescent mistletoes in the world. This endemic tree is a semi-parasite common in sandy soil from the Murchison River to Israelite Bay. The journal is named after the plant, which in turn commemorates Pieter Nuijts, an ambassador of the Dutch East India Company, who in 1627 accompanied the "Gulde Zeepard" on one of the first explorations along the south coast of Australia.

Cover design by Sue Marais

Photograph A.S. George

# *Goodenia katabudjar* (Goodeniaceae), a new species from south-west Western Australia

R.J. Cranfield and L.W. Sage

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

## Abstract

Cranfield, R.J. and Sage, L.W. *Goodenia katabudjar* (Goodeniaceae), a new species from south-west Western Australia. Nuytsia 11 (3): 297-299 (1997). A new species of *Goodenia* (Goodeniaceae) endemic to the Darling District, South West Botanical Province, *G. katatbudjar* Cranfield & Sage, is described and illustrated. A key to the species considered to be similar to *G. katabudjar* is provided and the differences between these are briefly noted.

## Introduction

A specimen collected late 1996 during a survey conducted by the authors was recognized as an unknown species of *Goodenia* Sm. (Goodeniaceae). Detailed examination found the species to be related to *Goodenia leptoclada* Benth. but with significant differences warranting its recognition as a new species.

## Taxonomy

**Goodenia katabudjar** Cranfield & Sage, *sp. nov.*

*Goodenia leptocladae* Benth. affinis sed foliis basalibus carentibus, sepalis longioribus, ovulis 8-10, differt.

*Typus*: Near Wandering [precise locality withheld], Western Australia, 13 December 1996, *L.W. Sage* 955 (*holo:* PERTH 04550137; *iso:* AD, CANB, K, MEL, NSW, US).

*Perennial sub-shrub* to 20 cm high, open, hirsute, branchlets simple or occasionally branched. *Leaves* alternate, ascending, subsessile; lamina ovate, 7-26 x 2-11 mm, entire, sericeous; apex obtuse. *Inflorescence* axillary to terminal, pedunculate, 1-flowered. *Pedicels* 2-7 mm long, glabrous; bracteoles 2 opposite, oblanceolate, 5-10 x 0.5-1.5 mm, hirsute, apex obtuse. *Flowers* pedicellate, bilabiate, 5-lobed, blue to pink (occasionally white), 12-16 x 8-14 mm. Sepals 5, free, linear, 5.5-7 x 0.5-0.75 mm, sericeous,

green, apex obtuse. *Corolla wings* flat, entire, 1.5-2 mm wide. *Stamens* 5, free; filaments linear, 3.2-3.5 x 0.5 mm; anthers basifixed, lanceolate, 1.3-1.4 x 0.4-0.5 mm, apiculate, longitudinally dehiscent. *Ovary* ovoid, 2.5-3.0 x 2 mm, ribbed; ovules 8-10, 0.6-0.7 x 0.4-0.5 mm. *Style* filiform, *c.* 6.5 x 0.7 mm; indusium 1.5-1.6 x 2.2-2.5 mm, hirsute. *Fruit* a subglobular carcerulus (Spjut 1994), *c.* 3 x 3 mm. *Seeds* 10, ovate, flat, body *c.* 1.7 x 1.1 mm, wing *c.* 0.2 mm wide, brown. (Figure 1)

*Other specimens examined.* WESTERN AUSTRALIA: Wandering area [precise locality withheld], 5 Dec. 1996, *R. Davies* 1685 (PERTH); 13 Dec. 1996, *L. W. Sage* 969 (PERTH).

*Distribution.* Known only from the type location and one other nearby population within the same proximity.

*Habitat.* Occurs in upland areas of open Wandoo woodland, near the margin of Jarrah woodlands.

*Conservation status.* This species is known from only two populations within the same reserve, both containing not more than a few hundred plants. Listed under CALM Conservation Codes for Western Australian Flora as Priority 2 (Poorly Known Taxa).

*Etymology.* The specific epithet is derived from the Nyoongar aboriginal dialect, *kata* meaning hill and *budjar* meaning ground. Referring to the low growth habit of the species and its association with hillside habitats.

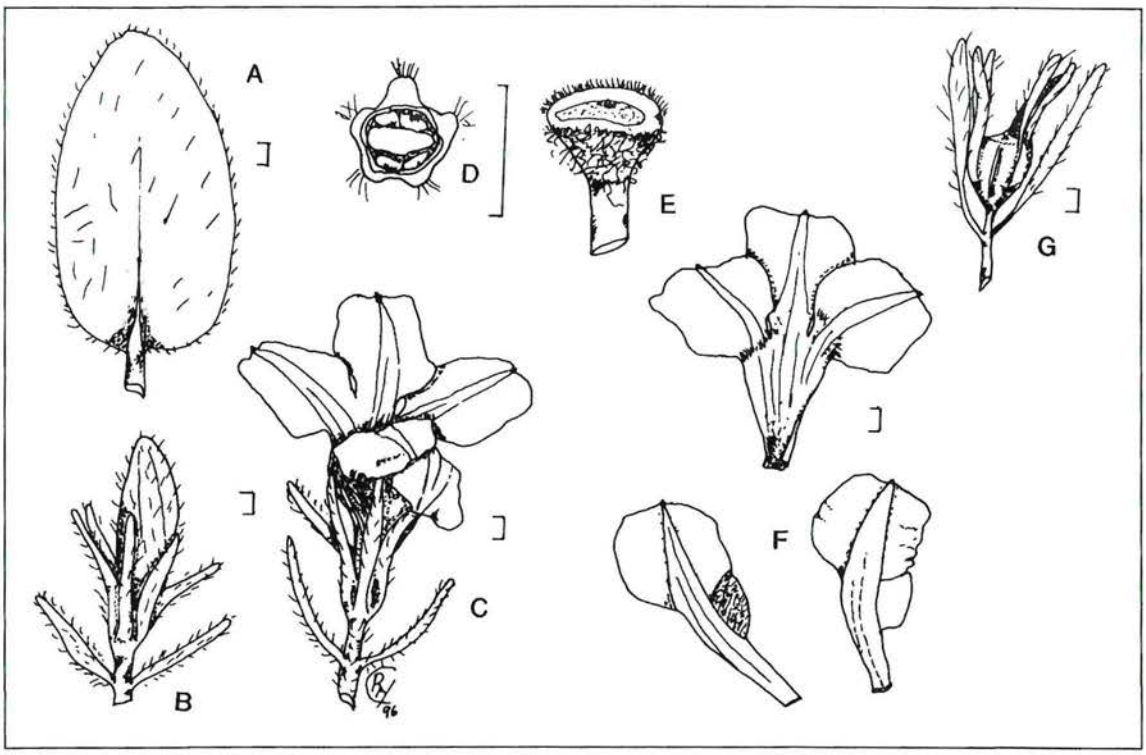


Figure 1. *Goodenia katabudjar* A - leaf; B - flower bud; C - flower; D - ovary; E - indusium; F - lower and upper petals; G - fruit. Drawn from *L.W. Sage* 955. Scale bars = 0.65 mm.

*Affinities*. *Goodenia katabudjar* is closely allied to *G. leptoclada* Benth. and to a lesser degree *G. eatoniana* F. Muell. *G. eatoniana* is a glabrous, glaucous sub-shrub, while *G. katabudjar* has hirsute stems and sericeous leaves. Characters separating *G. katabudjar* and *G. leptoclada* are shown in Table 1.

Table 1. Characters distinguishing *Goodenia katabudjar* from *G. leptoclada.*

| **Character** | ***G. katabudjar*** | ***G. leptoclada*** |
|---|---|---|
| basal leaves | absent | present |
| leaf margins | entire | mostly dentate |
| peduncle length | 2-7mm | 1-5mm |
| sepal length | 5.5-7.0mm | *c.* 3.0mm |
| ovule number | 8-10 | 4-5 |
| fruit diameter | *c.* 3mm | *c.* 2mm |
| distribution | central forest area | extreme south-west |

## Amendment to key

The *Goodenia* key in the "Flora of Australia" (Carolin 1992: 151), should be altered to read from couplet 19 in Group 1:

19 Corolla glabrous outside ..... **G. eatoniana**

19: Corolla hairy outside

19a Sepal length *c.* 3.0 mm; basal leaves present ..... **G. leptoclada**

19a: Sepal length 5.5-7.0 mm; basal leaves absent ..... **G. katabudjar**

## Acknowledgements

We are grateful to Paul Wilson for the Latin diagnosis.

## References

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# Taxonomic notes on *Boronia* species of north-western Australia, including a revision of the *Boronia lanuginosa* group (*Boronia* section *Valvatae*: Rutaceae)

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## Abstract

M.F. Duretto. Taxonomic notes on *Boronia* species of north-western Australia, including a revision of the *Boronia lanuginosa* group (*Boronia* section *Valvatae:* Rutaceae). Nuytsia 11(3): 301-346 (1997). The revision of *Boronia* (Rutaceae) in the Northern Territory, the Kimberley Region of Western Australia, and north-western Queensland is completed, and a key to all species is provided. The *B. lanuginosa* Endl. species group is characterized as those species with pinnate leaves, a calyx as large as or larger than the corolla, multiangular stellate hairs, and a pronounced ridge on the micropylar side of the seed. This clade comprises the *B. lanuginosa* species complex, *B. filicifolia* A. Cunn. ex Benth., *B. pauciflora* W. Fitzg. and five newly described species: *viz. B. decumbens* Duretto, *B. minutipinna* Duretto, *B. kalumburuensis* Duretto, *B. jucunda* Duretto and *B. tolerans* Duretto. The *B. lanuginosa* species complex has four available names and was analysed numerically using phenetic methods. Two taxa were identified in the analysis. *Boronia artemisiifolia* var. *wilsonii* F. Muell. ex Benth. is raised to specific status while *B. affinis* R. Br. ex Benth. and *B. artemisiifolia* F. Muell. are synonymized under *B. lanuginosa*. Additionally, *B. rupicola* Duretto is described, and *B. filicifolia, B. lanceolata* F. Muell., *B. lanuginosa* and *B. pauciflora* are lectotypified.

## Introduction

This paper is the second to discuss the systematics of *Boronia* Sm. (Rutaceae) for the "Top End" of the Northern Territory (NT) and the Kimberley Region of Western Australia (WA). The first, Duretto & Ladiges (1997), discussed the *B. grandisepala* F. Muell. group: those species with simple leaves and sepals as large as or larger than the petals. Here, the pinnate-leaved taxa with sepals as large as or larger than the petals are addressed. Cladistic analysis (Duretto 1995; Duretto & Ladiges in prep.) shows that these taxa form a monophyletic group characterized by the presence of multiangular stellate hairs, pinnate leaves (except *B. pauciflora*, which sometimes has juvenile leaves that are trifoliolate, but has simple mature leaves), sepals as large as or larger than the petals, and shiny seeds with a prominent ridge on the micropylar side. Weston *et al.* (1984) called this clade (less *B. pauciflora*) the *B. affinis* group, but for reasons outlined below, it is more appropriate for it to be known as the *B. lanuginosa* group. This clade belongs to *Boronia* section *Valvatae* (Benth.) Engl. and consists of three species complexes: the *B. lanuginosa* and *B. filicifolia* complexes, plus another undescribed species complex.

The *B. lanuginosa* species complex is found from King Sound (WA) to Wollogorang (NT) (Figure 1) and consists of an uncertain number of taxa. Morphological variation within the complex is analysed numerically, using phenetic methods. Leaf anatomy and ontogeny, and the taxonomic status of the four available names within the complex (*viz. B. affinis*, *B. artemisiifolia*, *B. artemisiifolia* var. *wilsonii*, and *B. lanuginosa*) are discussed.

The *B. filicifolia* species complex is endemic to the Kimberley Region and consists of four species that are morphologically and geographically distinct. Wheeler (1992) recognized a number of forms within *B. filicifolia* including the Mitchell River (and type) form and a Kalumburu form (*B. kalumburuensis*, see below). A third form, from the Osmond Plateau, is described below as *B. minutipinna*. *Boronia pauciflora* is also placed in this species complex (Duretto 1995; Duretto & Ladiges in prep.).

The third species complex consists of three rare species, *B. decumbens* (NT), *B. jucunda* (WA) and *B. tolerans* (NT), that are newly described below.

To complete the revision of *Boronia* in the Northern Territory and the Kimberley Region, taxa are lectotypified where necessary (including *B. lanceolata*) and *B. rupicola* is described as new. *Boronia lanceolata* and *B. rupicola* are more closely related to east coast members of *Boronia* section *Valvatae* than to other species in north-western Australia (Duretto 1995; Duretto & Ladiges in prep.). At the final stages of manuscript preparation a 1995 collection (*J.R.Clarkson* 10473) from north-west Queensland, near the Northern Territory border, came to the authors' attention. The specimen is of a previously unknown taxon that has affinities with *B. alulata* Benth. of Cape York (Duretto submitted; Duretto & Ladiges in prep.), and so will be described in a forthcoming paper that deals with Queensland members of *Boronia* section *Valvatae* (Duretto submitted). As this species is sympatric with *B. lanceolata* (in Queensland) it will be included in the key as *Boronia* aff. *alulata* (NW Qld, *Clarkson* 10473). All *Boronia* species found in the Northern Territory, the Kimberley Region, and north-west Queensland are placed in section *Valvatae*.

The Northern Territory and Kimberley floras are treated here as a single unit for a number of reasons. Firstly, apart from *B. lanceolata* and *B. rupicola*, cladistic analysis shows that all taxa form a monophyletic group defined by the following synapomorphies: the calyx being as large as or larger than the corolla, the antesepalous anther being significantly smaller than the antepetalous anther, and the filament shape (Duretto 1995; Duretto & Ladiges in prep.). Secondly, the boronias of this region are widely separated from the east coast, South Australian, and south-west Western Australian members of *Valvatae*. Thirdly, and finally, the region covering the "Top End" of the Northern Territory and the Kimberley region is often recognized as being a distinct biogeographic region or a number of closely related regions; that is, regions that share a recent history (see Specht 1958b; Kikkawa & Pearse 1969; Hnatiuk & Pedley 1985; Cowie & Finlayson 1986; Cracraft 1991; Dunlop & Webb 1991; Crisp *et al.* 1995; Duretto 1995; Duretto & Ladiges in prep.).

The boundaries for these biogeographic units, at least for *Boronia*, roughly correspond to the boundaries of three geological basins (as outlined by Plumb & Derrick 1975; Plumb *et al.* 1980; G.S.W.A. 1990): the McArthur River Basin which extends from Mt Isa (north-west Queensland) to the Arnhem Land Plateau and surrounds (northern and western NT); the Victoria River Basin, especially the north-western heavily faulted area, which includes an area from the western Northern Territory to the Ord River (WA); and, the Kimberley Basin including the neighbouring King Leopold and Halls Creek orogens or mobile plates. These basins are characterized by Precambrian sandstones.

## *Boronia lanuginosa* species complex

Endlicher (1837) described *B. lanuginosa* from material that was collected by Ferdinand Bauer and labelled King George's Sound. King George Sound is in south-western Australia, but Bauer had travelled with Matthew Flinders, on the "Investigator", around northern Australia (see Specht 1958a,b; Wilson 1975). Bentham (1863), who had not seen the type material of *B. lanuginosa*, applied this name to a south-western Western Australian species that is found growing around King George Sound (Wilson 1975). Later, Mueller (1859) described *B. artemisiifolia* (as *B. artemisifolia*) from material he collected while on Gregory's Northern Australian Expedition. Bentham (1863) used this later name (written as *B. artemisiaefolia*) in his "Flora Australiensis". Subsequently, and up until 1975, specimens of *Boronia* from northern Australia that had a dense indumentum, pinnate leaves and a large calyx have been called *B. artemisiifolia*, with orthographic variation. After studying type material of *B. lanuginosa,* Wilson (1975) realized Bentham's error and synonymized *B. artemisiifolia* with *B. lanuginosa*. He concluded that the type locality of *B. lanuginosa* was somewhere on the coast of Arnhem Land where Flinders' ship "The Investigator" had travelled on its second voyage. Robert Brown, who was on "The Investigator" with Bauer and Flinders, collected plant specimens from the islands of the Gulf of Carpentaria that are identical to the type material of *B. lanuginosa* (Wilson pers. comm.), strengthening Wilson's argument. The south-western Western Australian species that had previously been called *B. lanuginosa* is now known as *B. stricta* Bartl. (Wilson 1975).

Bentham (1863) described *B. affinis*, *B. filicifolia* and *B. artemisiifolia* var. *wilsonii* (presently synonymized under *B. lanuginosa*) from north-western Australia. The type material of *B. affinis* ("N. Australia. Islands of the Gulf of Carpentaria, and mainland opposite Groote Eylandt") was collected by Robert Brown while travelling with Matthew Flinders and Ferdinand Bauer on "The Investigator" in 1802-03. The main feature that has been used to distinguish *B. affinis* from *B. lanuginosa* is that *B. affinis* is glabrous or has a sparse indumentum while *B. lanuginosa* has a dense indumentum. There is much confusion surrounding the application of these two names.

Judging from present herbarium records and collections, *B. affinis* and *B. lanuginosa* are sympatric in the Northern Territory. *Boronia affinis* is considered to be rare, possibly endangered, and confined to the Northern Territory (Briggs & Leigh 1988 [not listed in Briggs & Leigh 1996]; Hnatiuk 1990) while *B. lanuginosa* (as currently circumscribed) is common and widespread from King Sound (WA) to Wollogorang Station (NT) (Figure 1).

*Boronia lanuginosa* has an ontogenetic sequence in leaf development from glabrous leaves, or leaves with a sparse simple and stellate indumentum, to leaves having a dense stellate indumentum, as has been observed in other members of section *Valvatae* (Duretto 1995; Duretto & Ladiges 1997, in prep.). Some specimens (e.g. *Dunlop* 5380; *Duretto* 500; *George* 13548; *Henshall* 1680; *Kenneally* 3025, 3075, 4455; *Wightman* 1374 *& Craven*; *Wolfe & Martin* 227) display this ontogenetic sequence. Many populations contain a variety of fertile forms that display varying degrees of hirsuteness (e.g. *Duretto* 477-481; 488-491; 503-504A; 522-524). Other populations, such as those in the Mt Cahill and Mt Basedow areas (Kakadu National Park), North Island (Gulf of Carpentaria) and the sand plains north of the Arnhem Land Plateau, consist of small plants that are glabrous or have a sparse indumentum and that are often determined as *B. affinis*. Interestingly, a range of hair densities, which is usually correlated with the density of hairs on the leaves, is also present on the abaxial surface of the perianth parts. This has led to some taxonomic confusion in the past.

Along with this indumentum variation *B. lanuginosa* shows some morphological and floral variation across its range. Plants collected from the northern and eastern areas of the Northern Territory (including

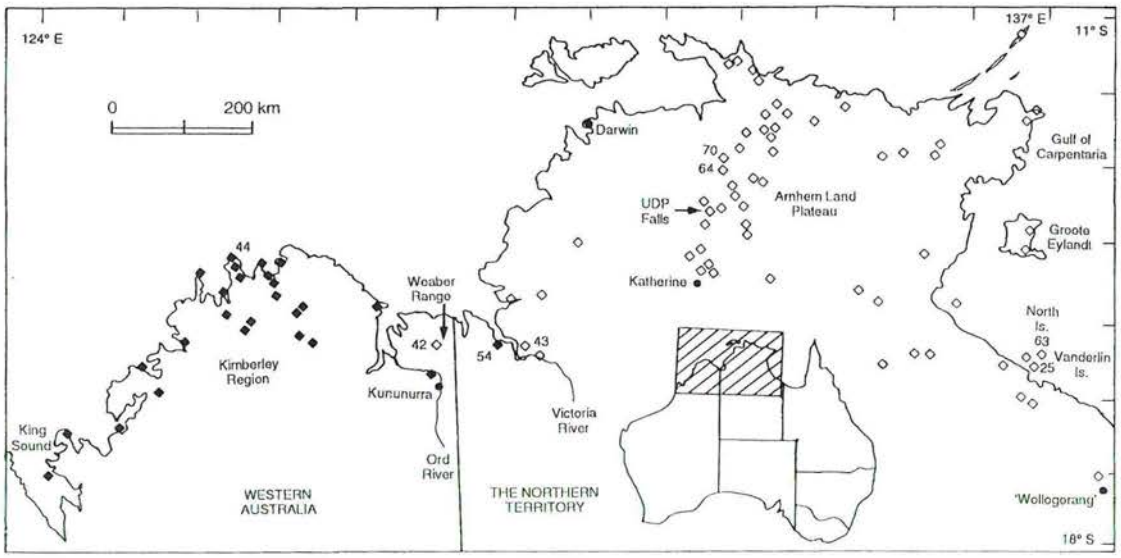


Figure 1. North-western Australia. Specimens used in analysis of *B. lanuginosa* species complex (25, 42-44, 54, 63, 64, 70); *B. lanuginosa*, Group A (◇); *B. wilsonii*, Group B (◆).

the islands of the Gulf of Carpentaria) have linear, revolute pinnae. Those collected south of UDP Falls (Kakadu National Park) to Nitmiluk National Park (NT) and west to the Weaber Range (WA) are similar but often have larger flowers. Kimberley plants have broad, recurved pinnae. Morphological variation within the complex is analysed numerically below, using phenetic methods.

## Materials and methods

### Material

Herbarium specimens were made available from AD, BRI, CANB, CBG, DNA, JCU, MBA, MEL, MELU, NSW, PERTH, QRS, TCD and WAU, cibachromes and slides were received from K, and slides were received from BM. Herbarium abbreviations follow Holmgren *et al.* (1990). These specimens were augmented with specimens from OSS (Office of the Supervisory Scientist, Kakadu National Park, NT) and material collected in the field during June and July of 1993.

### Leaf anatomy

The central portion of the leaves of all taxa was sectioned. Material was fixed in Mirsky's fixative (MAA) or 70% ethanol. If fresh material was not available, herbarium samples were re-hydrated by being placed in water with a small amount of detergent, brought to the brink of boiling, left simmering for one hour and soaked overnight before fixing in MAA. All fixed material was placed in 70% ethanol overnight, dehydrated through a graded ethanol series up to 100% ethanol, infiltrated with 100% LR-White (London Resin) through a resin/ethanol series, and polymerized at 60°C. Sections, 2 μm in thickness, were cut on a Reichert Ultracut ultra-microtome, stained with 0.05% toluidine blue solution (pH 4.4) and observed and photographed using an Olympus BHS compound microscope. Anatomical features are described in the taxonomic descriptions.

### Scanning electron microscopy

Trichomes (of leaves and stems) and seed surfaces of all taxa (where material was available) were surveyed using a Scanning Electron Microscope. Dry leaves, stems and seeds were mounted on stubs using double-sided or carbon tape with conductive carbon paint, coated with gold using an Edwards Sputter Coater S150B and examined and photographed at 5KV using a JEOL 840 Scanning Electron Microscope equipped with a lanthanum hexaboride filament. All photographs of seeds were taken of central areas on a lateral side, except where otherwise stated. Trichome and seed characters are described in the taxonomic descriptions.

## Phenetic analyses

### Characters

Seventeen characters (Table 1) were scored for 105 herbarium specimens (Tables 2, 3) that cover the entire geographic range of the *B. lanuginosa* species complex. Some collections were included more than once because they consisted of a number of plants with varying degrees of hirsuteness: *viz. Craven* 6705 (specimens 32 and 104), *Wightman* 1337 (specimens 71 and 72), and *Russell-Smith* 2861 (specimens 81-83). Scores are an average of five measurements (where five organs were available) and ratios are the

Table 1. Morphological characters used in scoring herbarium specimens.

Binary characters

1. Style glabrous/hirsute, 0/1
2. Leaves recurved/revolute, 0/1

Numeric characters

3. Length of petiole (mm)
4. Maximum leaflet number
5. Length of most proximal rhachis segment (mm)
6. Length of most distant rhachis segment (mm)
7. Length of terminal leaflet (TLL) (mm)
8. Width of terminal leaflet (TLW) (mm)
9. TLW/TLL
10. Length of lateral leaflet preceding the terminal leaflet (LLL) (mm)
11. LLL/TLL
12. Length of peduncle (mm)
13. Length of anthopodium (mm)
14. Length of sepal (SL) (mm)
15. Length of petal (PL) (mm)
16. PL/SL
17. Length of sepal on flower with mature fruit (mm)

Table 2. Data used in analysis of *B. lanuginosa* species complex. Principal collector given only. For quantitative characters mean values are given (see Table 1).

| Specimen | Collector & number (or date) | Herbarium & sheet number | Character 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Wilson 126 | DNA49945 | 0 | 1 | 0.8 | 7.0 | 3.0 | 4.0 | 9.8 | 1.7 | 0.18 | 8.0 | 0.83 | 0.5 | 2.0 | 7.0 | 5.0 | 0.71 | ? |
| 2 | Craven 3789 | DNA55101 | 0 | 1 | 0.6 | 7.0 | 1.1 | 3.0 | 8.5 | 2.0 | 0.24 | 6.2 | 0.73 | 1.0 | 3.0 | 5.0 | 3.0 | 0.60 | 7.0 |
| 3 | Hinz 110 | DNA43449 | 0 | 1 | 0.5 | 7.0 | 2.7 | 3.5 | 11.2 | 2.1 | 0.19 | 7.6 | 0.67 | 1.5 | 4.0 | 6.0 | 4.0 | 0.67 | ? |
| 4 | Knight 1450 | DNA339654 | 0 | 1 | 0.5 | 9.0 | 1.0 | 3.2 | 10.6 | 2.2 | 0.20 | 7.6 | 0.73 | 0.5 | 3.0 | 6.0 | 4.0 | 0.67 | 8.0 |
| 5 | Thomson 2474 | DNA84263 | 0 | 1 | 1.3 | 11.0 | 4.9 | 3.6 | 9.0 | 1.1 | 0.12 | 6.6 | 0.74 | 0.0 | 2.0 | 5.0 | 4.0 | 0.80 | 7.0 |
| 6 | Craven 5963 | CANB313896 | 0 | 1 | 0.6 | 9.0 | 1.5 | 2.3 | 8.8 | 1.2 | 0.15 | 7.6 | 0.87 | 0.0 | 2.0 | 6.0 | 4.0 | 0.67 | 8.0 |
| 7 | Russell-Smith 5220 | DNA47609 | 0 | 1 | 0.5 | 9.0 | 1.5 | 3.4 | 9.2 | 1.0 | 0.11 | 5.0 | 0.55 | 0.0 | 2.0 | 6.0 | 4.0 | 0.67 | 8.0 |
| 8 | Wightman 4283 | DNA50903 | 0 | 1 | 0.5 | 13.0 | 3.2 | 2.8 | 11.8 | 1.6 | 0.14 | 9.4 | 0.81 | 0.0 | 3.0 | 8.0 | 5.0 | 0.63 | ? |
| 9 | Lazarides 7928 | DNA52723 | 0 | 1 | 0.7 | 13.0 | 1.7 | 3.0 | 10.8 | 1.1 | 0.11 | 7.6 | 0.71 | 0.0 | 2.0 | 5.0 | 4.0 | 0.80 | 8.0 |
| 10 | Cleminson 261 | DNA79417 | 0 | 1 | 0.5 | 9.0 | 2.0 | 3.0 | 10.6 | 1.5 | 0.14 | 9.2 | 0.86 | 0.0 | 2.5 | 6.0 | 4.0 | 0.67 | 8.0 |
| 11 | Hinz 196 | DNA43177 | 0 | 1 | 0.5 | 7.0 | 2.2 | 2.8 | 10.4 | 1.0 | 0.10 | 7.6 | 0.73 | 0.0 | 2.0 | 6.0 | 5.0 | 0.83 | ? |
| 12 | Wightman 1374 | CANB352516 | 0 | 1 | 1.0 | 13.0 | 1.0 | 3.6 | 7.4 | 1.0 | 0.14 | 4.2 | 0.57 | 0.0 | 5.0 | 7.0 | 5.0 | 0.71 | 9.0 |
| 13 | Craven 2299 | CANB271721 | 0 | 1 | 0.6 | 7.0 | 1.7 | 3.0 | 10.2 | 1.0 | 0.10 | 8.4 | 0.85 | 0.0 | 5.0 | 7.0 | 5.0 | 0.71 | 12.0 |
| 14 | Lazarides 9042 | DNA19608 | 0 | 1 | 0.9 | 9.0 | 1.4 | 2.7 | 11.0 | 1.1 | 0.10 | 6.2 | 0.56 | 0.0 | 4.0 | 7.0 | 5.0 | 0.71 | 9.0 |
| 15 | Hinz 26 | DNA32735 | 0 | 1 | 1.3 | 17.0 | 2.4 | 3.2 | 6.2 | 1.1 | 0.19 | 4.0 | 0.66 | 0.0 | 1.0 | 5.0 | 4.0 | 0.80 | 6.0 |
| 16 | Clark 1344 | DNA34728 | 0 | 1 | 0.9 | 11.0 | 3.4 | 6.0 | 8.2 | 1.7 | 0.21 | 6.4 | 0.79 | 0.0 | 2.0 | 7.0 | 4.0 | 0.57 | 9.0 |
| 17 | Parker 908 | DNA11904 | 0 | 1 | 0.8 | 11.0 | 2.4 | 3.2 | 8.4 | 1.0 | 0.12 | 5.6 | 0.66 | 0.5 | 2.0 | 6.0 | 4.0 | 0.67 | 8.0 |
| 18 | Henshall 1680 | DNA54378 | 0 | 1 | 1.3 | 15.0 | 2.2 | 2.0 | 8.0 | 1.2 | 0.16 | 5.2 | 0.66 | 1.0 | 3.0 | 6.0 | 4.0 | 0.67 | 8.0 |
| 19 | Wightman 1615 | DNA23559 | 0 | 1 | 2.0 | 11.0 | 4.0 | 4.0 | 13.2 | 1.7 | 0.14 | 9.0 | 0.68 | 1.5 | 2.0 | 6.0 | 5.0 | 0.83 | 7.0 |
| 20 | Maconochie 860 | DNA85534 | 0 | 1 | 1.3 | 9.0 | 2.3 | 3.2 | 9.8 | 1.6 | 0.17 | 8.0 | 0.83 | 0.0 | 1.5 | 5.0 | 4.0 | 0.80 | ? |
| 21 | Pullen 9233 | DNA315385 | 0 | 1 | 0.8 | 9.0 | 2.4 | 3.0 | 7.4 | 1.5 | 0.22 | 4.8 | 0.66 | 0.0 | 3.0 | 5.0 | 4.0 | 0.80 | 7.0 |
| 22 | Jacobs 1587 | NSW244407 | 0 | 1 | 1.0 | 11.0 | 3.4 | 3.6 | 9.3 | 1.6 | 0.18 | 6.4 | 0.71 | 1.0 | 3.0 | 6.0 | 5.0 | 0.83 | 8.5 |
| 23 | Halford 84114 | DNA76573 | 0 | 1 | 1.1 | 15.0 | 2.8 | 3.5 | 6.8 | 1.3 | 0.20 | 5.2 | 0.76 | 1.0 | 1.5 | 5.0 | 4.0 | 0.80 | ? |
| 24 | Maconochie 2096 | DNA48271 | 0 | 1 | 0.8 | 11.0 | 1.2 | 3.7 | 7.2 | 1.3 | 0.18 | 4.4 | 0.61 | 0.0 | 4.0 | 5.0 | 4.0 | 0.80 | 7.0 |
| 25 | Reichenbach 3.vii.1955 | DNA40515 | 0 | 1 | 0.8 | 13.0 | 1.8 | 3.0 | 8.0 | 1.4 | 0.18 | 5.4 | 0.68 | 0.0 | 3.0 | 6.0 | 5.0 | 0.83 | 7.0 |
| 26 | Gallen 58 | DNA28469 | 0 | 1 | 0.5 | 13.0 | 2.3 | 3.4 | 10.0 | 2.1 | 0.23 | 7.0 | 0.72 | 1.0 | 1.0 | 7.0 | 5.0 | 0.71 | 7.0 |
| 27 | Hartley 13828 | DNA44421 | 0 | 1 | 0.7 | 11.0 | 1.8 | 3.6 | 9.2 | 1.8 | 0.20 | 6.0 | 0.66 | 1.0 | 2.0 | 5.0 | 4.0 | 0.80 | ? |
| 28 | Chappill 30.vi.1993 | MEL | 0 | 1 | 1.3 | 9.0 | 1.0 | 3.1 | 9.5 | 1.0 | 0.10 | 6.0 | 0.63 | 0.5 | 3.8 | 6.0 | 4.0 | 0.67 | 8.5 |
| 29 | Leach 2757 | BRI AQ462613 | 0 | 1 | 0.7 | 9.0 | 1.6 | 1.8 | 9.8 | 1.1 | 0.11 | 5.8 | 0.59 | 0.0 | 2.0 | 5.0 | 4.0 | 0.80 | 7.0 |
| 30 | Menkhorst 357 | MEL1582546 | 0 | 1 | 1.5 | 9.0 | 3.4 | 3.4 | 7.5 | 1.2 | 0.18 | 4.4 | 0.58 | 0.5 | 1.5 | 6.0 | 5.0 | 0.83 | 7.0 |
| 31 | Cowie 1165 | MEL1582645 | 0 | 1 | 0.5 | 9.0 | 2.1 | 5.0 | 12.8 | 0.8 | 0.06 | 8.6 | 0.70 | 0.5 | 2.0 | 6.0 | 4.0 | 0.67 | 7.0 |
| 32 | King 298 | DNA22700 | 0 | 1 | 0.5 | 11.0 | 0.9 | 2.8 | 9.8 | 1.0 | 0.11 | 8.4 | 0.86 | 0.0 | 4.0 | 10.0 | 8.0 | 0.80 | 11.0 |
| 33 | Fryxell 4222 | AD989251 | 0 | 1 | 0.5 | 11.0 | 1.0 | 2.6 | 10.2 | 1.0 | 0.10 | 7.0 | 0.69 | 0.0 | 4.0 | 10.0 | 8.0 | 0.80 | 12.0 |
| 34 | Craven 6705 | MEL626239 | 0 | 1 | 0.5 | 13.0 | 1.1 | 3.4 | 7.8 | 0.8 | 0.11 | 5.1 | 0.66 | 0.5 | 2.0 | 10.0 | 6.0 | 0.60 | 11.0 |
| 35 | Fryxell 4907 | DNA377233 | 0 | 1 | 0.3 | 11.0 | 0.9 | 3.6 | 16.0 | 1.0 | 0.07 | 13.0 | 0.82 | 0.0 | 4.0 | 5.0 | 4.0 | 0.80 | 10.0 |
| 36 | King 42 | DNA24457 | 0 | 1 | 0.4 | 17.0 | 0.7 | 3.0 | 11.4 | 1.0 | 0.10 | 7.4 | 0.68 | 0.0 | 2.0 | 6.0 | 4.0 | 0.67 | 10.0 |
| 37 | King 2.vi.1982 | DNA23248 | 0 | 1 | 0.4 | 15.0 | 1.2 | 2.4 | 7.2 | 1.0 | 0.14 | 5.8 | 0.81 | 0.0 | 2.0 | 6.5 | 5.0 | 0.77 | 10.0 |
| 38 | Byrnes 88 | DNA1034 | 0 | 1 | 0.6 | 13.0 | 1.6 | 4.4 | 12.0 | 1.0 | 0.08 | 7.8 | 0.66 | 0.0 | 2.0 | 7.0 | 5.0 | 0.71 | 13.0 |
| 39 | Barlow 558 | DNA20750 | 0 | 1 | 0.3 | 9.0 | 0.8 | 2.3 | 8.0 | 1.0 | 0.13 | 6.2 | 0.79 | 0.0 | 2.0 | 7.0 | 5.0 | 0.71 | 11.0 |
| 40 | Dunlop 8086 | DNA42635 | 0 | 1 | 0.5 | 11.0 | 1.4 | 1.4 | 7.4 | 1.0 | 0.14 | 6.6 | 0.90 | 0.0 | 4.0 | 7.0 | 6.0 | 0.86 | 12.0 |
| 41 | Lazarides 8426 | DNA56830 | ? | 1 | 0.5 | 15.0 | 0.5 | 1.9 | 5.2 | 0.8 | 0.15 | 4.8 | 0.94 | 1.0 | 2.0 | 7.0 | 6.0 | 0.86 | 8.0 |
| 42 | Clark 436 | DNA27360 | 0 | 1 | 0.2 | 13.0 | 1.2 | 2.2 | 5.8 | 1.0 | 0.18 | 5.0 | 0.86 | 0.0 | 2.0 | 5.0 | 4.0 | 0.80 | 8.0 |
| 43 | Dunlop 8216 | DNA42766 | 0 | 1 | 0.5 | 15.0 | 2.6 | 3.8 | 8.4 | 1.0 | 0.13 | 6.6 | 0.81 | 0.5 | 4.0 | 9.0 | 8.0 | 0.89 | 10.0 |
| 44 | Fryxell 4791 | DNA31055 | 0 | 0 | 1.2 | 11.0 | 1.6 | 1.8 | 6.4 | 2.1 | 0.35 | 4.0 | 0.63 | 0.0 | 3.0 | 6.0 | 4.0 | 0.67 | ? |
| 45 | George 13548 | CANB255846 | 1 | 0 | 3.0 | 19.0 | 3.0 | 2.9 | 5.2 | 1.9 | 0.40 | 3.2 | 0.62 | 0.0 | 3.0 | 6.0 | 4.0 | 0.67 | 7.0 |
| 46 | Fryxell 4600 | CANB377237 | 0 | 0 | 3.8 | 13.0 | 4.0 | 4.0 | 9.0 | 2.0 | 0.23 | 5.4 | 0.60 | 0.0 | 4.0 | 9.0 | 6.0 | 0.67 | 11.0 |
| 47 | Lazarides 6799 | DNA20749 | 0 | 0 | 2.0 | 13.0 | 4.0 | 3.0 | 10.8 | 3.8 | 0.36 | 5.0 | 0.46 | 0.0 | 4.0 | 5.0 | 4.0 | 0.80 | 7.0 |
| 48 | Willis 31.v.1984 | BRI AQ428115 | 0 | 0 | 2.0 | 13.0 | 5.4 | 4.2 | 9.4 | 4.1 | 0.44 | 6.6 | 0.70 | 0.0 | 3.0 | 6.0 | 4.0 | 0.67 | 7.0 |
| 49 | Kenneally 9682 | CANB367630 | 1 | 0 | 2.6 | 9.0 | 5.4 | 6.2 | 18.8 | 3.8 | 0.20 | 8.8 | 0.48 | 0.0 | 5.0 | 9.0 | 7.0 | 0.78 | 11.0 |
| 50 | Kenneally 8319 | CANB364052 | 1 | 0 | 1.9 | 13.0 | 3.4 | 3.3 | 11.8 | 3.2 | 0.28 | 6.6 | 0.57 | 0.0 | 5.0 | 7.0 | 6.0 | 0.86 | 9.0 |
| 51 | Fryxell 4685 | CANB377236 | 1 | 0 | 2.1 | 15.0 | 2.8 | 4.2 | 15.4 | 5.0 | 0.32 | 7.8 | 0.50 | 0.0 | 3.0 | 7.0 | 6.0 | 0.86 | 8.0 |
| 52 | Dunlop 5380 | DNA16746 | 1 | 0 | 2.2 | 15.0 | 5.0 | 4.6 | 13.8 | 3.6 | 0.27 | 8.6 | 0.62 | 0.0 | 3.0 | 5.0 | 4.0 | 0.80 | 8.0 |
| 53 | Fryxell 4002 | DNA31461 | 1 | 0 | 2.4 | 13.0 | 3.8 | 4.2 | 12.8 | 4.8 | 0.40 | 6.6 | 0.55 | 0.0 | 4.0 | 7.0 | 4.0 | 0.57 | 7.0 |
| 54 | Leach 2399 | BRI AQ1446448 | 1 | 0 | 2.0 | 15.0 | 2.2 | 1.8 | 4.0 | 2.0 | 0.53 | 3.4 | 0.85 | 0.0 | 3.5 | 5.0 | 5.0 | 1.00 | 7.0 |
| 55 | Chesterfield 245 | MEL1534491 | 1 | 0 | 1.5 | 9.0 | 3.0 | 3.4 | 11.4 | 4.0 | 0.36 | 8.0 | 0.71 | 0.0 | 4.0 | 7.0 | 6.0 | 0.86 | 8.0 |
| 56 | Forbes 2059 | MEL1534492 | 0 | 0 | 1.5 | 11.0 | 2.8 | 2.8 | 8.8 | 3.5 | 0.41 | 6.0 | 0.70 | 0.0 | 2.0 | 5.0 | 3.0 | 0.60 | 6.0 |

average of the individual ratios of the five organs measured. There are some problems associated with the use of ratios in phenetic analyses (see Duretto & Ladiges 1997 and references therein for discussion): here ratios are used as a means of quantifying and standardizing leaf shape (characters 9 and 11), and measuring the relative lengths of the sepals and petals (character 16).

Table 3. Data used in the phenetic analysis of the *B. lanuginosa* species complex, analysis 3, juvenile leaved plants only. Principal collector given only. For quantitative characters mean values are given (see Table 1).

| Specimen | Collector & number (or date) | Herbarium & sheet number | Character 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|
| 57 | Craven 3480 | DNA55102 | 6.0 | 5.0 | 0.83 | ? |
| 58 | Latz 10096 | DNA | 7.0 | 6.0 | 0.86 | 9.0 |
| 59 | Craven 5796 | DNA19609 | 6.0 | 5.0 | 0.83 | ? |
| 60 | Tidemann 13 | DNA51300 | 6.0 | 4.0 | 0.67 | ? |
| 61 | Russell-Smith 3072 | DNA43330 | 4.0 | 3.0 | 0.75 | 6.0 |
| 62 | Must 1041 | DNA4995 | 4.0 | 3.0 | 0.75 | 6.0 |
| 63 | Grinns 3 | DNA82012 | 6.0 | 4.0 | 0.67 | 8.0 |
| 64 | Craven 6311 | DNAS19618 | 6.0 | 5.0 | 0.83 | 6.0 |
| 65 | Wightman 2229 | DNA26585 | 6.0 | 4.0 | 0.67 | ? |
| 66 | Clark 1363 | DNA49016 | ? | ? | ? | 6.0 |
| 67 | Russell-Smith 2766 | DNA30067 | 6.0 | 5.0 | 0.84 | 8.0 |
| 68 | Smith 579 | DNA39890 | 6.0 | 5.0 | 0.84 | 7.0 |
| 69 | Clark 1178 | DNA34488 | 6.0 | 5.0 | 0.84 | 7.0 |
| 70 | Cowie 26.xi.1985 | DNA48810 | 5.0 | 4.0 | 0.80 | ? |
| 71 | Wightman 1337 | NSW244394 | 4.0 | 3.0 | 0.75 | 5.0 |
| 72 | Wightman 1337 | NSW244394 | 4.0 | 3.0 | 0.75 | 5.0 |
| 73 | Wightman 647 | DNA21610 | 5.0 | 4.0 | 0.80 | 5.0 |
| 74 | Clark 1529 | DNA34617 | 5.0 | 4.0 | 0.80 | 6.0 |
| 75 | Symon 7736 | DNA67794 | 5.0 | 3.0 | 0.60 | 6.0 |
| 76 | Maconochie 1482 | DNA35810 | 6.0 | 4.0 | 0.67 | 8.0 |
| 77 | Must 1018 | DNA4890 | 5.0 | 4.0 | 0.80 | 6.5 |
| 78 | Wightman 1981 | DNA26336 | 6.0 | 5.0 | 0.83 | 9.0 |
| 79 | Bowman 308 | DNA26280 | 7.0 | 4.0 | 0.57 | 7.0 |
| 80 | Wightman 1084 | DNA22555 | 5.5 | 4.0 | 0.73 | 8.0 |
| 81 | Russell-Smith 2861 | DNA29879 | 6.0 | 5.0 | 0.84 | ? |
| 82 | Russell-Smith 2861 | DNA29879 | 5.0 | 4.0 | 0.80 | 7.0 |
| 83 | Russell-Smith 2861 | DNA29879 | 5.0 | 4.0 | 0.80 | 7.0 |
| 84 | Wightman 1130 | DNA22554 | 5.0 | 4.0 | 0.80 | ? |
| 85 | Hartley 7.vi.1974 | DNA8233 | 5.0 | 5.0 | 1.00 | 5.0 |
| 86 | Wightman 3798 | DNA30364 | 5.0 | 5.0 | 1.00 | 5.0 |
| 87 | Latz 3462 | DNA36986 | 5.0 | 3.0 | 0.60 | 8.0 |
| 88 | Menkhorst 337 | DNA43605 | 5.0 | 4.0 | 0.80 | 6.0 |
| 89 | Craven 6063 | CANB313897 | 6.0 | 4.0 | 0.67 | ? |
| 90 | Muir 5976 | AD98904071 | 6.0 | 4.0 | 0.67 | ? |
| 91 | Muir 6057 | AD9890623 | 5.0 | 4.0 | 0.80 | 5.5 |
| 92 | Martensz AE583 | BRI [AQ151157] | 10.0 | 5.0 | 0.50 | 12.0 |
| 93 | Cowie 272 | DNA27078 | 10.0 | 7.5 | 0.75 | ? |
| 94 | Gittens 2612 | NSW244427 | 12.0 | 9.0 | 0.75 | 13.0 |
| 95 | Henry 896 | DNA49279 | 12.0 | 8.0 | 0.67 | ? |
| 96 | Bowman 383 | DNA37156 | 6.0 | 5.0 | 0.83 | 7.0 |
| 97 | Ollerenshaw 1594A | DNA50113 | 6.0 | 4.0 | 0.67 | 7.0 |
| 98 | Lazarides 8944 | DNA19605 | 6.0 | 4.0 | 0.67 | 9.0 |
| 99 | Brown 9.vii.1985 | DNA26772 | 5.0 | 4.0 | 0.80 | ? |
| 100 | Leach 2829 | DNA47633 | 7.0 | 5.0 | 0.71 | 8.0 |
| 101 | King 16.vi.1981 | DNA18842 | 7.0 | 5.0 | 0.71 | ? |
| 102 | Pullen 10602 | CANB264130 | 8.0 | 5.0 | 0.63 | 9.0 |
| 103 | Brooker 3149 | CANB259815 | 11.0 | 8.0 | 0.73 | 15.0 |
| 104 | Craven 6705 | DNA20963 | 8.0 | 6.0 | 0.75 | ? |
| 105 | King 45 | DNA20464 | 9.0 | 6.0 | 0.67 | 10.0 |

For numerical analyses (cladistic or phenetic) homologous features only should be compared. For example, comparing leaf measurements at different stages of development would be erroneous and results would be misleading. Also, as there is an ontogenetic sequence from glabrous to hirsute plants in the *B. lanuginosa* species complex, characters such as hair density are unusable. The phenetic analysis, outlined below, uses morphological data from mature plants (i.e. with a dense indumentum) only and, floral data from specimens with mature and/or juvenile foliage.

### Data analysis

All data sets were analysed using PATN (Belbin 1987) following the methodology outlined in Duretto (1995) and Duretto & Ladiges (1997). Data were range-standardized before Manhattan dissimilarity measures were calculated. For cluster analysis, both flexible UPGMA (unweighted pair group arithmetic averages) and flexible WPGMA (weighted pair group arithmetic averages) were utilized as fusion strategies. Data were ordinated in three dimensions using the multidimensional scaling, MDS, KYSP algorithm (Kruskal *et al.* 1973). The Hybrid option of Faith *et al.* (1987) was chosen. Twenty different random starting points were used for each analysis and the run with the lowest stress value is shown. Character correlations with the ordination vectors were calculated using the PCC function of PATN. Minimum spanning trees, MST, were also calculated. Three analyses were completed.

### Taxon descriptions

Descriptive terminology follows Theobald *et al.* (1979) and Hewson (1988) for hairs; Briggs & Johnson (1979) and Weston (1990) for inflorescence structure; and Murley (1951), Powell & Armstrong (1980), Barthlott (1984) and Duretto & Ladiges (1997) for seed surfaces. Conservation codes follow the format of Briggs & Leigh (1996) for all taxa, and that of the Western Australian Department of Conservation and Land Management for Western Australian taxa (Nuytsia 10, p. 471, 1996). Authority abbreviations are as given in Brummitt & Powell (1992).

### Specimen citation

In order to accord with the policy of the journal, specimen citations have been deliberately abbreviated to achieve less precision in order to protect taxa with conservation codes of E, V or K. A complete list of specimens seen is available from the author on request.

## Results of phenetic analysis

### Analysis 1 (specimens 1-56, characters 1-14)

The first analysis includes plants with mature (having a dense indumentum) foliage only, specimens 1-56, and characters 1-14. Two groups, A and B, are recognizable in the UPGMA (Figure 2) and WPGMA (not shown) classifications, ordination (Figure 3), and MST (Figure 4). Group A includes all specimens from the Weaber Range (WA) to "Wollogorang" (NT) (specimens 1-43) except specimen 54 (Figure 1). Group B includes all Kimberley specimens west of the Ord River (specimens 44-53, 55, 56) and specimen 54 from the lower Victoria River area (NT). In the MST (Figure 4), Groups A and B are linked by specimens 25 (and 17, 18, 21 etc) and 44 (and 45, 56 etc), which are from Vanderlin Island (Gulf of Carpentaria) and Bougainville Peninsula (Kimberley Region) respectively (Figure 1).

Characters that are highly correlated with the vectors in the ordination (Figure 3) are: characters 2, 3, 8, 11 for vector 1; 1, 4, 7 and 10 for vector 2; and, 12 for vector 3 (not shown). Group A is characterized by small petioles (character 3), fewer pinnae (character 4), and pinnae that are short (character 7), narrow (characters 8 and 9) and revolute (character 2). Group B is characterized by longer petioles, and longer, broader and recurved pinnae (Table 4).

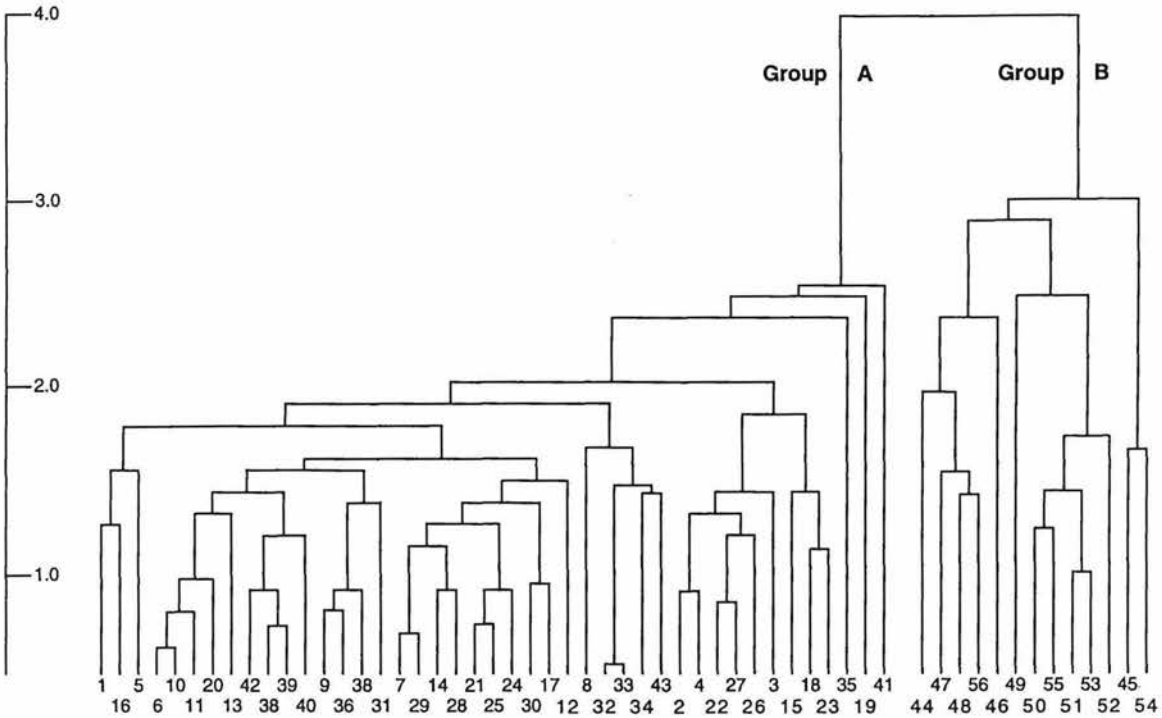


Figure 2. UPGMA classification, analysis 1, specimens 1-56.

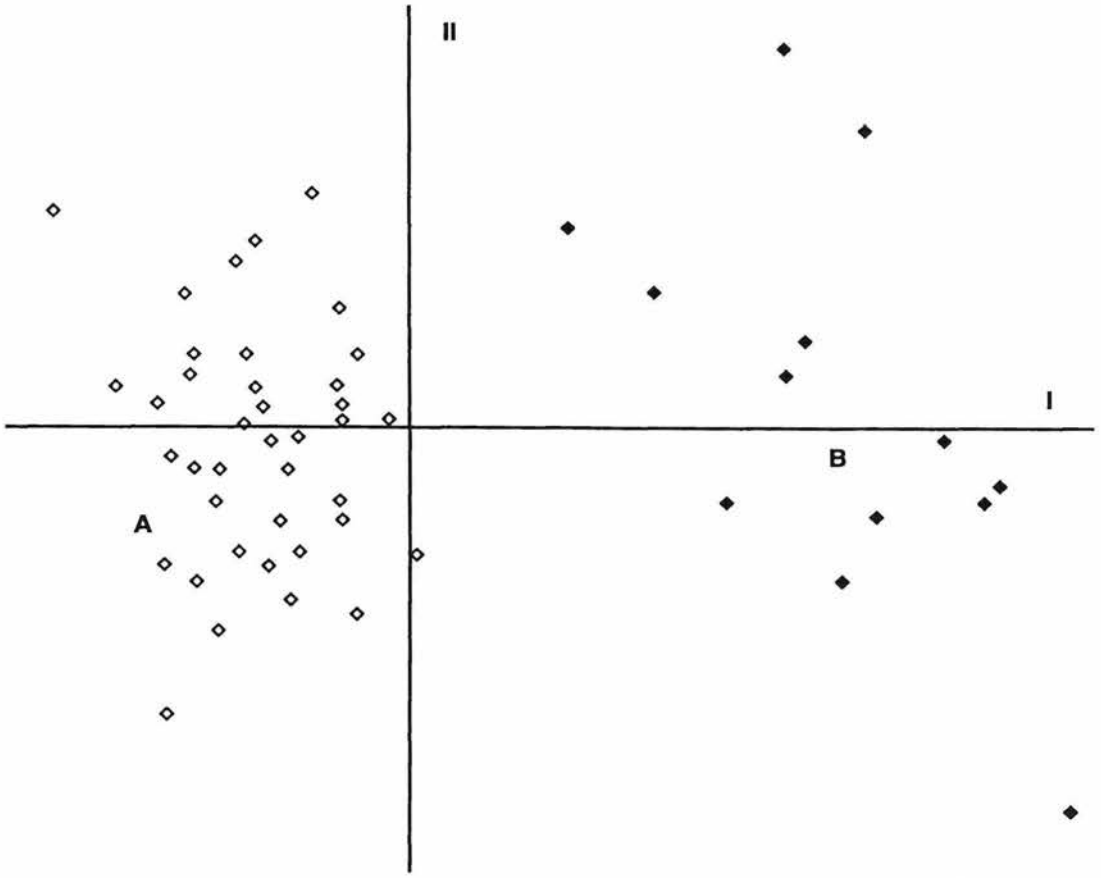


Figure 3. Ordination (KYSP), vectors 1 and 2, analysis 1, specimens 1-56. *Boronia lanuginosa*, Group A (◇); *B. wilsonii*, Group B (◆). Specimens referred to in text are numbered.

Table 4. Character ranges for Groups A and B. Means in brackets.

| | Character | Group A | Group B |
|---|---|---|---|
| 1 | Style glabrous/hirsute | 0 | 0 (38%) - 1 (62%) |
| 2 | Leaves recurved/revolute | 1 | 0 |
| 3 | Length of petiole (mm) | 0.2-2.0 (0.74) | 1.2-3.8 (2.2) |
| 4 | Maximum leaflet number | 7-17 (11.1) | 9-19 (13) |
| 5 | Length of most proximal rhachis segment (mm) | 0.5-4.9 (1.92) | 1.6-5.4 (3.5) |
| 6 | Length of most distant rhachis segment (mm) | 1.4-6.0 3.2 | 1.8-6.2 3.6 |
| 7 | Length of terminal leaflet (TLL)(mm) | 5.2-16.0 (9.3) | 4.0-18.8 (10.6) |
| 8 | Width of terminal leaflet (TLW)(mm) | 0.8-2.2 (1.3) | 1.9-5.0 (3.4) |
| 9 | TLW/TLL | 0.06-0.24 (0.15) | 0.2-0.53 (0.35) |
| 10 | Length of lateral leaflet preceding the terminal leaflet (LLL)(mm) | 4.0-13.0 (6.7) | 3.2-8.8 (6.2) |
| 11 | LLL/TLL | 0.55-0.94 (0.73) | 0.46-0.85 (0.61) |
| 12 | Length of peduncle (mm) | 0.0-1.5 (0.33) | 0.0 |
| 13 | Length of anthopodium (mm) | 1.0-5.0 (2.65) | 2.0-5.0 (3.6) |
| 14 | Length of sepal (SL) (mm) | 5.0-10.0 (6.36) | 5.0-9.0 (6.46) |

**Analysis 2 (specimens 1-43, characters 3, 5-7, 14)**

Two groups, A and B, were recognized in Analysis 1. Group A was re-analysed, that is specimens 1-43, and characters 3, 5-7 and 14 to see whether more groups were discernible. Uniform characters were deleted prior to re-analysis.

In the ordination plot of axes 1 and 2 (Figure 5) specimens from Katherine area, western Northern Territory and the Weaber Range loosely cluster together but are continuous with the other specimens. No distinct groups are discernible in either of the UPGMA or WPGMA classifications (not shown) or MST (not shown). Characters that are highly correlated with the vectors (Figure 5) are: 3 and 5 for vector 1; 6 and 16 for vector 2; and, 7 for vector 3 (not shown).

**Analysis 3 (specimens 1-43, 57-105, characters 14-17)**

The third analysis involved Group A and sympatric specimens with juvenile foliage, specimens 57-105, and floral characters (14-17) only. Two groups, A1 and A2, are recognizable in both the UPGMA

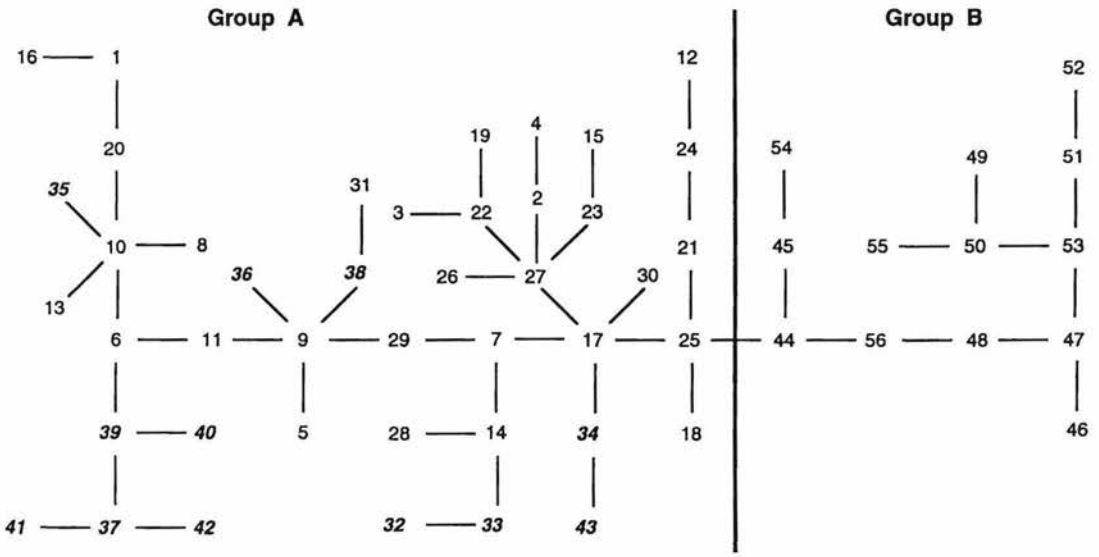


Figure 4. Minimum Spanning Tree, analysis 1, specimens 1-56.

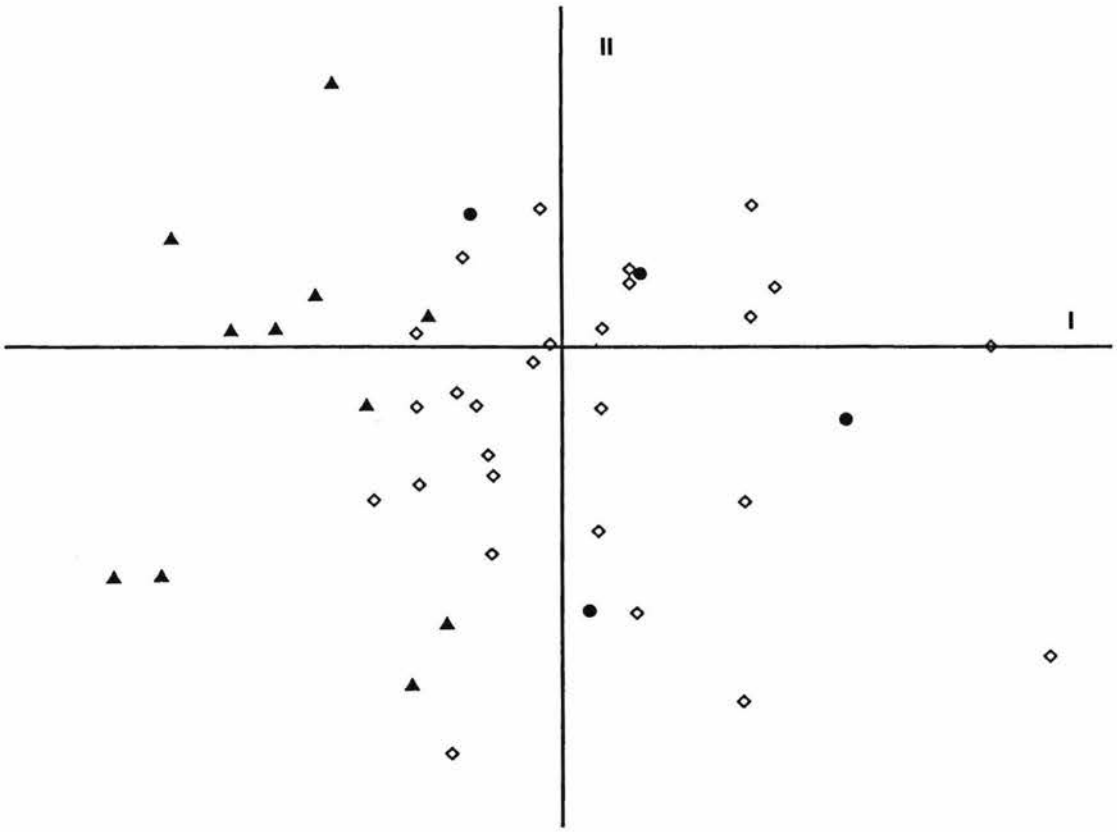


Figure 5. Ordination (KYSP), vector 1 verses 2, analysis 2, specimens 1-43. *Boronia lanuginosa*, Group A; specimens 1-27 - from the Gulf of Carpentaria, northern Arnhem Land to Jim Jim Falls (◇); specimens 28-31 - from UDP Falls to north of the Katherine area (●); specimens 32-43 - from the Katherine area and west to Weaber Range (▲).

(Figure 6) and WPGMA (not shown) classifications. Group A1 includes six of the 17 specimens collected in the Katherine area (32-34, 95, 104, 105), the UDP Falls specimens (92-94) and one of the Victoria River specimens (43). Group A2 includes the remainder of specimens collected in areas south and west of UDP Falls that are scattered amongst the specimens of typical *B. lanuginosa*. This pattern was repeated in the MST (not shown). As in Analysis 2, the specimens collected in areas south and west of UDP Falls loosely cluster together in the plot of vectors 1 and 2 but are continuous with the remaining specimens (not shown). Groups A1 and A2 differ mainly in sepal length (character 14; Figure 6). Glabrous specimens from Mt Basedow (64) and North island (63), and the almost glabrous specimen from Mt Cahill (70) cluster well within typical *B. lanuginosa* but away from each other in all analyses.

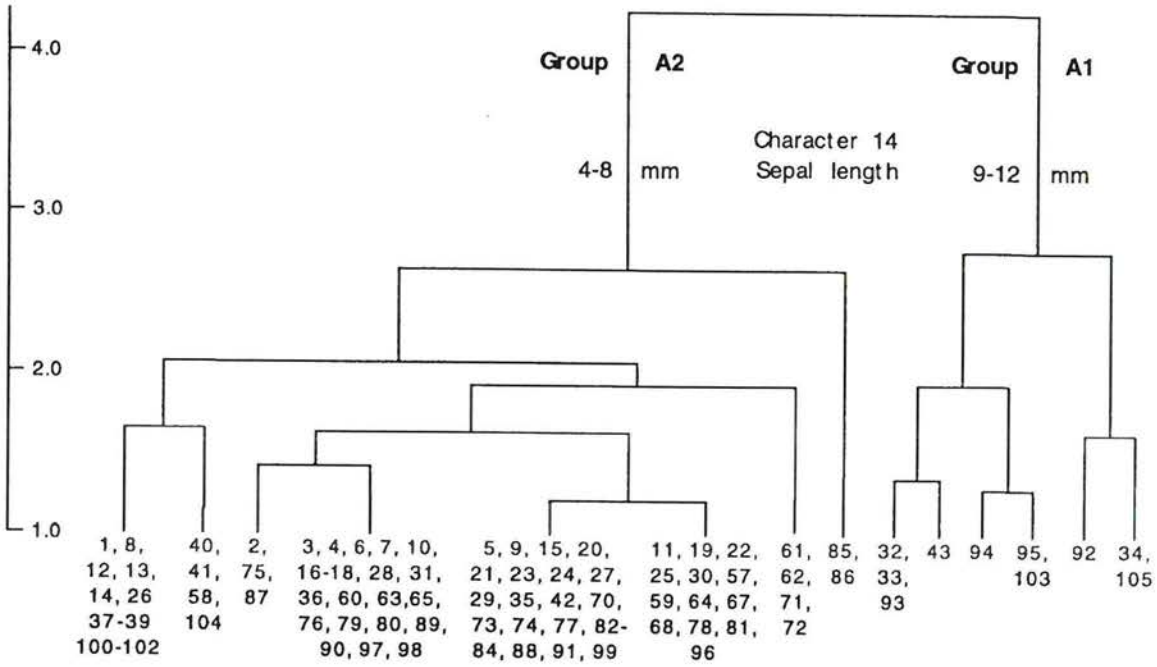


Figure 6. UPGMA classification, analysis 3, specimens 1-45, 55-105.

## Taxonomic interpretation and conclusions

On the basis of the above analyses (Figures 2-6) two taxa, corresponding to Groups A (specimens 1-43, 57-105) and B (specimens 44-56), are recognized at the specific level. Group A includes all Northern Territory and Weaber Range specimens (except specimen 54). Group B includes all Kimberley specimens (except 42) and a lower Victoria River specimen (54).

The types of *B. affinis* and *B. lanuginosa* represent extreme forms between which there are specimens with a grade of indumentum densities (Figure 7A-H, J). The anatomy of leaves (Figure 8) from seedlings, and glabrous and hirsute flowering plants are structurally similar. The type material for both taxa was collected from the same general area and collections made by Robert Brown possess varying degrees of hirsuteness. In fact, there are specimens of *B. lanuginosa* with dense indumentums collected by Brown at BM that originated from Vanderlin Island (Figure 1). This Island is one of the type localities of *B. affinis*. It would appear that Bentham (1863) described *B. affinis* from several of the less hirsute specimens that Brown collected. Here it is proposed that the type material of *B. affinis* and *B. lanuginosa* represent different ontogenetic stages of the same taxon, juvenile and mature respectively, and as

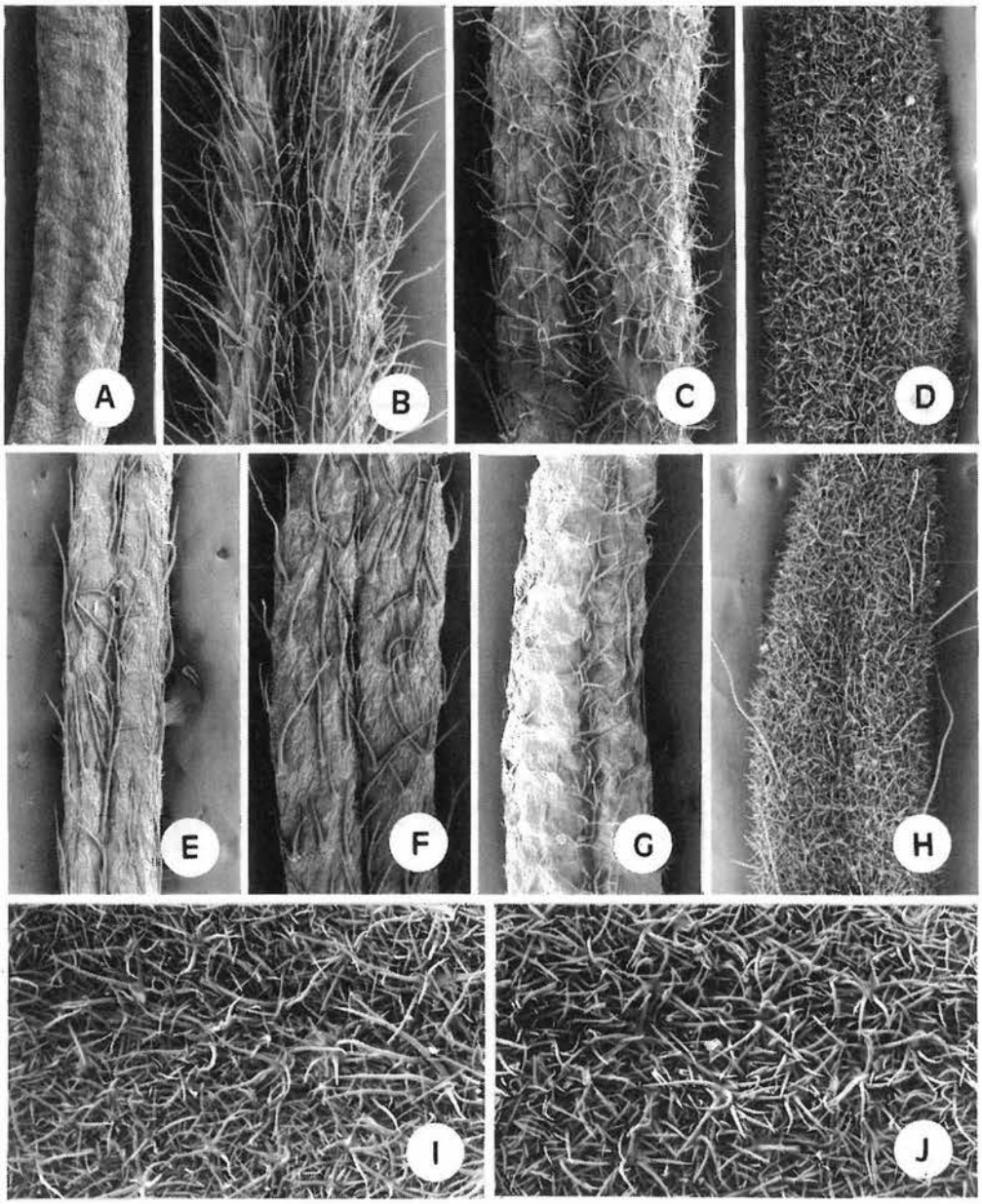


Figure 7. Scanning electron micrographs of hairs on adaxial leaf surfaces of the *B. lanuginosa* species complex A-H,J: The Northern Territory specimens (*B. lanuginosa*); I: Kimberley specimen (*B. wilsonii*). A - glabrous, lower leaf from a seedling (Mt Brockman, NT, *Duretto et al.* 444, MEL). B - higher leaf from a seedling with moderate indumentum of simple and stellate hairs (Mt Brockman, NT, *Duretto et al.* 444, MEL). C - leaf from a flowering plant with moderate indumentum, 40 cm tall (Borroloola area, NT, *Duretto* 499, MEL). D - leaf from a flowering plant, 1 m tall, with a dense stellate indumentum without simple hairs (Borroloola area, NT, *Duretto* 500, MEL). E - leaf with sparse indumentum from a flowering plant (Mt Cahill, NT, *Duretto* 449, MEL). F - leaf with sparse indumentum from a flowering plant (sand plains north of Arnhem Land Plateau, NT, *Duretto et al.* 414, MEL). G - leaf from a flowering plant, 1 m tall, with a sparse indumentum of simple and stellate hairs (Borroloola area, NT, *Duretto et al.* 504A, MEL). H - leaf from a flowering plant, 1 m tall, with a dense indumentum of stellate and simple hairs (Borroloola area, NT, *Duretto et al.* 503, MEL). I - leaf from a flowering plant, 1 m tall, with a dense stellate indumentum (Anjo Peninsula, WA, *Willis s.n.*, 31 May 1984, BRI). J - leaf from a flowering plant, 1 m tall, with a dense stellate indumentum (Borroloola area, NT, *Duretto* 500, MEL). Scales: x20 (A-H) and x550 (I-J).

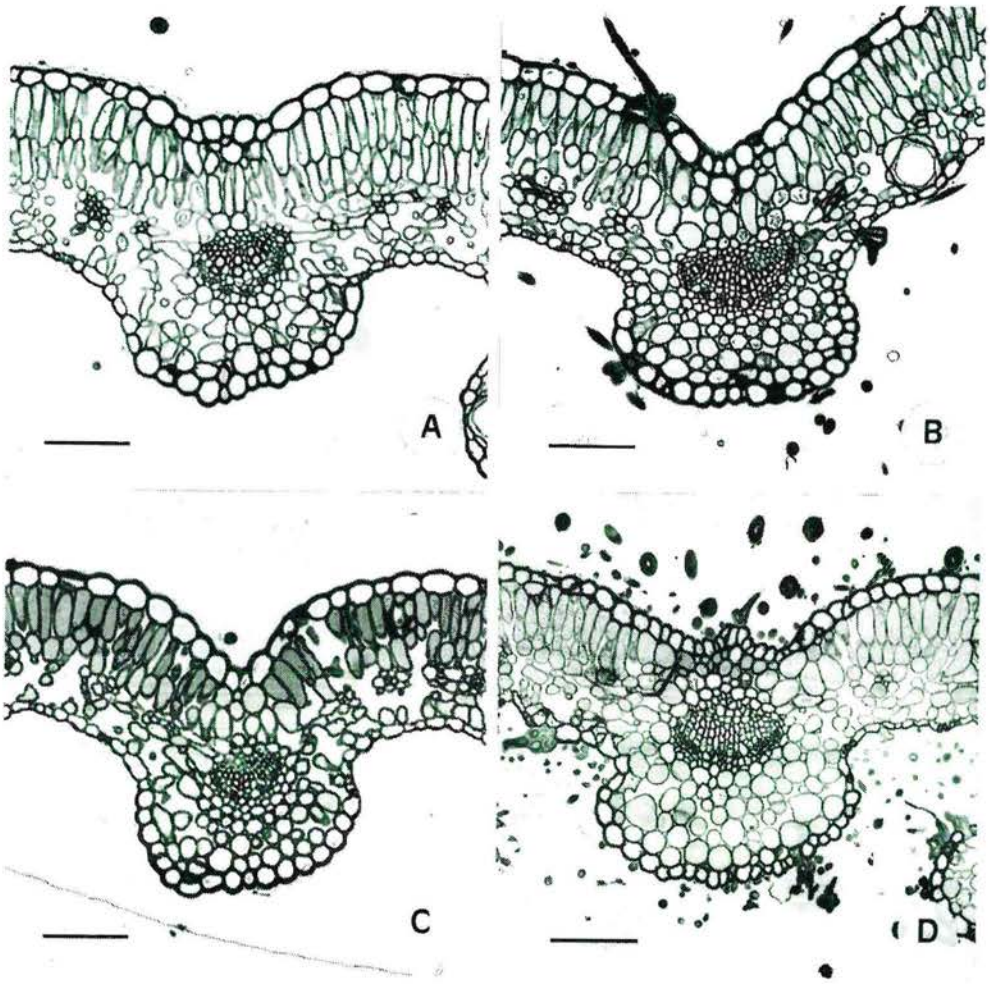


Figure 8. Light micrographs of transverse sections of leaves of *B. lanuginosa*. A - lower leaf from a seedling (*Duretto* 501, MEL). B - leaf from a flowering shrub with sparse indumentum (Borroloola area, NT, *Duretto et al.* 504A, MEL). C - leaf from a flowering shrub (Mt Cahill, NT, *Duretto* 448, MEL). D - leaf from a flowering plant with mature foliage (UDP Falls, NT, *Duretto et al.* 479, MEL). A-D - x 110. Scales: x100 (A-D); scale bar = 0.1 mm.

*B. lanuginosa* has priority, *B. affinis* is synonymized (see below). Group A contains specimens that are similar to the type material of *B. lanuginosa* and so retains that name. Group B corresponds to Bentham's taxon *B. artemisiifolia* var. *wilsonii,* which is raised to specific rank below.

Analyses 2 (Figure 5) and 3 (Figure 6) demonstrate that the glabrous specimens from Mt Basedow (64) and North Island (63), and the almost glabrous Mt Cahill specimen (70) do not warrant taxonomic recognition on the basis of floral data. Morphological data at present suggest that these populations are made up of small, possibly neotenous plants that may behave as annuals due to the present fire regime or the extended dry period of the "Top End" of the Northern Territory.

The hypothesis that the populations south and west of UDP Falls are distinct from typical *B. lanuginosa* is not supported by the data used in Analyses 2 and 3. As with indumentum density,

variation in floral size may be more complex than assumed in the analysis. Plants from the south and west of UDP Falls appear to have larger flowers on younger plants. Also, many of the leaves from these juvenile plants appear to be larger. The data (Tables 2, 3) were collected from plants at different stages of development, and so may not be directly comparable. This species complex requires seedling trials from a wide range of populations to determine whether any populations have significantly larger flowers and leaves at earlier stages of development. Leaves and flowers need to be measured and compared at specific nodes to assure homology. Seedling trials fell outside the scope of this project because seed was not readily available, and boronias are notoriously difficult to germinate. Other sources of data (e.g. oils, flavonoids, isoenzymes) may be required to resolve this problem.

If further work is completed, and the populations of *B. lanuginosa* south and west of UDP falls are shown to be distinct species, the name *B. artemisiifolia* should be reinstated. The type material of *B. artemisiifolia* is of this larger flowered form (see below). The boundary between the distributional areas of these taxa would approximately correspond to that of the two subspecies of *B. grandisepala*, and that of the related taxa *B. verecunda* Duretto and *B. xanthastrum* Duretto (Duretto 1995; Duretto & Ladiges 1997). Congruent patterns like these, and the diversity of boronias on the western escarpment of the Arnhem Land plateau (Duretto 1995; Duretto & Ladiges 1997, in prep.), make this region one of great biogeographical interest.

**Key to *Boronia* species in the Northern Territory, the Kimberley Region of Western Australia, and north-west Queensland.**

1. Sepals much smaller than petals ..... 2
1: Sepals equal to or larger than petals ..... 4
2. Leaves to 25-pinnate, margins strongly recurved; leaflets linear to narrowly elliptic, to 1 mm wide; sepals narrowly deltoid (NW Qld) ..... **B.** aff. **alulata** (NW Qld, *Clarkson* 10473)*
2: Leaves simple or 1-7 pinnate, margins flat; leaves and leaflets elliptic to oblanceolate, 1-27 mm wide; sepals ovate-deltoid (NW Qld, NT) ..... 3
3. Pendulous shrubs; leaves simple or pinnate, midrib not raised prominently abaxially; petals 2-2.5 mm long ..... 10. **B. rupicola**
3: Erect shrubs (rarely pendulous); leaves always simple, midrib prominently raised abaxially; petals usually greater than 3 mm long ..... 11. **B. lanceolata**
4. Leaves pinnate ..... 5
4: Leaves simple ..... 13
5. Juvenile leaves sometimes trifoliolate, mature leaves simple; leaves and pinnae glabrescent or glabrous, leaves and pinnae never linear ..... 6. **B. pauciflora**
5: Leaves 3-55-pinnate though first few leaves may be simple, sparsely to densely hirsute, pinnae often linear ..... 6
6 Leaves with more than 25 pinnae (on average) ..... 7
6: Leaves with less than 25 pinnae (on average) ..... 8
7. Terminal pinnae (1.5)3-8 mm long, lateral pinnae 0.5-5 mm long; anthopodium (2)6-21 mm long; sepal abaxial surface glabrous or with few hairs at base ..... 7. **B. filicifolia**
7: Terminal pinnae 1-3 mm long, lateral pinnae 0.5-1.5 mm long; anthopodium 1-6 mm long; sepal abaxial surface with a sparse indumentum ..... 9. **B. minutipinna**

8. Leaves sessile; pinnae linear-elliptic, margins flat or slightly recurved; plants glabrous or with a sparse simple/stellate indumentum ..... 9

8: Leaves petiolate; pinnae linear-elliptic to elliptic, margins flat to revolute; plants glabrous or with a sparse to dense stellate indumentum ..... 11

9. Branches obviously glandular; leaves trifoliolate (WA) ..... 5. **B. jucunda**

9: Branches not glandular; leaves with (3)5-7(9) pinnae (NT)

10. Plants decumbent, with a sparse to moderate simple indumentum (stellate hairs rare); margin slightly recurved ..... 3. **B. decumbens**

10: Plants erect, with a sparse stellate indumentum; margins flat ..... 4. **B. tolerans**

11. Sepals about the same size or slightly larger than petals, 3-5 mm long; anthopodium 7-24 mm long; plants with a sparse to moderate indumentum ..... 8. **B. kalumburuensis**

11: Sepals much larger than petals, (4)5-14 mm long; anthopodium 3-6(10) mm long; plants with a sparse to dense indumentum ..... 12

12. Pinnae linear, abaxial surface of lamina not usually visible as margins strictly revolute; sepals (4)5-14 mm long, glabrous or with a sparse to dense indumentum (NT, E Kimberley E of Ord River) ..... 1. **B. lanuginosa**

12: Pinnae elliptic to lanceolate, abaxial surface of lamina visible; sepals 5-9 mm long, always with a dense indumentum (Kimberley, W of Ord River, NT in the Victoria River area) ..... 2. **B. wilsonii**

13. Plants glabrous apart from flowers; stems purple and quadrangular; leaves glaucous ..... 14

13: Plants sparsely to densely hirsute; stems brownish and terete; leaves not glaucous ..... 15

14. Horizontal shrub growing perpendicular from vertical rock faces; leaves petiolate; sepals and petals 2.5-3 mm long ..... **B. viridiflora** *

14: Erect shrub, preferring ridge tops; leaves sessile; sepals 6-10 mm long; petals 4-5 mm long ..... **B. quadrilata** *

15. Sepals more or less equal to petals; leaves sometimes trifoliolate when juvenile (Kimberley) ..... **B. pauciflora**

15: Sepals much larger than petals; leaves always simple (NT) ..... 16

16. Hairs with prominent stalks, rays 0.5-1 mm long; fruits glabrous; plants usually less than 50 cm tall ..... 17

16: Hairs without prominent stalks, rays to 0.5 mm long; fruits hirsute; plants usually greater than 50 cm tall ..... 18

17. Hairs white and flexuous; new shoots pinkish to white; leaves narrowly elliptic; petal adaxial surface glabrous ..... **B. verecunda** *

17: Hairs yellow and straight; new shoots yellow; leaves elliptic; petal adaxial surface hirsute ..... **B. xanthastrum** *

18. Older stems with massive cork development; leaves with minute indumentum ..... **B. suberosa** *

18: Older stems without massive cork development; indumentum clearly visible ..... 19

19. Plants sprawling, with a moderate indumentum (rarely dense on the abaxial leaf surface); sepals less than 7 mm long before fruit matures ..... 20

19: Plants erect or sometimes spreading (then with a dense indumentum), with a moderate to dense indumentum; sepals greater than 7 mm long or, if less than then plant densely hirsute ..... 22

20. Peduncles to 4 mm long ..... **B. laxa** group *
20: Peduncles greater than 4 mm long ..... 21
21. Leaves lanceolate to ovate, most leaves much greater than 4 mm wide; rays of hairs not appressed ..... **B. prolixa** group *
21: Leaves narrowly elliptic, to 4 mm wide; rays of hairs appressed to leaves and stem ..... **B. amplectens** *
22. Plants grey in appearance with a very dense indumentum (leaf epidermis not visible) ..... **B. grandisepala** *
22: Plants with a moderate indumentum (leaf epidermis visible) ..... 23
23. Petals 3.5 mm long ..... **B. laxa** group *
23: Petals 4-4.5 mm long (5-6 mm with fruit) ..... **B. grandisepala** *

+Taxon to be discussed fully in Duretto (submitted), a paper dealing with Queensland species of *Boronia* section *Valvatae.*

* Taxa discussed fully in Duretto & Ladiges (1997) and not dealt with further here.

## Taxonomic descriptions

### *Boronia* section *Valvatae* (Benth.) Engl.

Section *Valvatae* has recently been revised (see Duretto 1995, submitted; Duretto & Ladiges in prep.). To avoid confusion a short description is given here.

*Inflorescence* axillary. *Sepals* valvate, persistent with mature fruit. *Petals* valvate, tip not inflexed, persistent with mature fruit. *Stamens* 8, all fertile; anthers glabrous. *Seed* elliptic in outline, adaxial surface flattened.

**1. Boronia lanuginosa** Endl., *In*: Endl. *et al.*, Enum. Pl. Hügel, 16 (1837). *Type:* 'King George's Sound' [probably Gulf of Carpentaria, the Northern Territory], *Ferd Bauer* (*lecto* (here designated): W *n.v.* (photo PERTH 1610171)).

[*Boronia artemisioides* F. Muell., Hookers J. Bot. 9: 196 (1857), *nom. inval.*, provisional name only.]

*Boronia artemisiifolia* F. Muell., Fragm. 1: 66 (1859) (as *B. artemisifolia*). *Type citation*: In plagis arenosis et rupestribus terrae Arnhem's Land et sinus Carpentaria Gulf. *Type*: In montibus rapid. fluvibus flum. Fitzmarie River [Northern Territory], October 1855, *F. Muell.* (*syn:* K *n.v.* (cibachrome & slide MEL), MEL); Sea Range [Northern Territory], December 1855, *F. Mueller* (*syn:* K *n.v.* (cibachrome & slide MEL), MEL); McAdam Range [Northern Territory], October 1855, *F. Muell.* (*syn*: BM *n.v.* (slides DNA, MEL), MEL, TCD (slide MEL)).

*Boronia affinis* R. Br. ex Benth., Fl. Austral. 1: 311 (1863). *Type citation*: N. Australia, Islands of the Gulf of Carpentaria, & mainland opposite Groote Eylandt [Northen Territory], 1802-1805, *R. Brown. Type:* Islands [North and Vanderlin Islands, Sir Edward Pellew Group] of the Gulf of Carpentaria and mainland opposite Groote Island [Northern Territory]), December 1802-January 1803, *R. Brown* No. 5293 (*syn:* BM *n.v.* (slides DNA, MEL), CANB 278461, K *n.v.* (cibachrome & slide MEL), MEL, NSW).

*Illustrations.* P.G. Wilson, Aust. Pl. 8: 200 (1975); K. Brennan, Wildfl. Kakadu 14, Figure 9 (1986) as *Boronia* sp.; J. Brock, Top End Native Plants, 99 (1988); J. Brock, Native Plants N. Aust. 99 (1993).

Erect, much branched *shrub* to 150 cm high; ontogenetic sequence in indumentum density on the branches, leaves, inflorescence and abaxial surfaces of the perianth parts: juvenile plants with a sparse simple and/or stellate indumentum and mature plants with a dense stellate indumentum throughout (Figure 7A-H, J). *Multiangular stellate hairs* sessile, with 2-15 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, white to faintly yellow, to 1 mm long. *Simple hairs* reflexed, 0.5-1(-2) mm long (Figure 7B, E-H). *Branches* terete to quadrangular, not obviously glandular, decurrencies absent, hair distribution even, little or no cork development. *Leaves* opposite decussate, imparipinnate, 11-27 pinnae, not becoming unifoliolate with age, 6-80 mm long, 5-50 mm wide; lamina discolourous, slightly paler beneath, dorsiventral, palisade mesophyll usually tightly packed, not obviously glandular, non-secretory glands scattered in mesophyll (Figure 8), epicuticular waxes absent; margins entire, revolute; midribs of leaflets and rachis segments impressed adaxially, prominently raised abaxially, tightly packed parenchyma between midvein and abaxial epidermis without secondary thickening (Figure 8); pinnae sessile, linear to narrowly elliptic, tip acute; terminal pinnae 5-26 mm long, 0.5-3 mm wide, midvein straight; lateral pinnae opposite or rarely subopposite, 4-26 mm long, 0.5-2 mm wide; rachis segments winged, triangular, distal end wider, 0.5-10 mm long, 1-1.5 mm wide; petiole not winged, 0.5-3 mm long; juvenile leaves larger than mature leaves, initially glabrous, becoming progressively more hirsute along stem. *Inflorescence* cymose, 1(3)-flowered; peduncle terete in cross section, absent to 1 mm long, non-woody and deciduous with flower; prophylls linear, minute to minutely unifoliolate, to 0.5 mm long, persistent; metaxyphylls absent or minute, persistent; anthopodium 4-10 mm long. *Flowers* white to deep pink. *Sepals* longer and wider than petals, ovate-deltoid, acute to acuminate, (4-5)7-14 mm long, 2-4 mm wide, enlarging to 8-15 mm long with fruit; adaxial surface densely and minutely pubescent sometimes becoming glabrous towards centre and base. *Petals* abaxial midrib not or slightly raised at base, 3-9 mm long, 1-2 mm wide, enlarging to 5.5-10 mm long and 1.5-2.5 wide with mature fruit; adaxial surface with a sparse to moderate simple or stellate indumentum, becoming glabrous towards base. *Stamens* with filaments bearing stiff simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.5-2 mm long, distal 0.5-1 mm prominently glandular; antepetalous filaments smooth, 1-1.5 mm long; anthers abaxial surface not or slightly frosty, antepetalous anthers much larger than antesepalous anthers, apiculum absent. *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style glabrous; stigma rounded, not or scarcely wider than style. *Cocci* with a moderate to dense simple and/or stellate indumentum, 4.5-6 mm long, 2-2.5 mm wide. *Seeds* elliptic in outline, adaxial side flattened and with prominent ridge, shiny, black, uniform in colour, 4-4.5 mm long, 2-2.5 mm wide, elaiosome (placental portion of endocarp) yellow-white; surface at magnification tuberculate to colliculate; tubercles and collicles, smooth, unfused, anticlinal walls ± visible, 6-55 μm across (Figure 9A,B). **Star Boronia, Engbajengbaja**

*Specimens examined (selected from c. 200 collections).* NORTHERN TERRITORY; DARWIN & GULF DISTRICT: Dhupuya Outstation road, 6 km N of Gove to Bulman River, Arnhem Land, 12°43'S, 135°32'E, 22 Sep. 1987, *M.J. Clark* 1363 (DNA); 18.4 km along Oenpelli-Gove track from Nabarlek turn off near Cooper Creek crossing, Arnhem Land, 12°12.32'S, 133°20.18'E, 13 June 1993, *M.F. Duretto* 410-7, *J. Chappill, G. Howell & K. Brennan* (MEL); Near Mt Brockman outlier on track to Radon Gorge, 12°44.68 S, 132°54.02 E, 15 June 1993, *M.F. Duretto* 441-4, *J. Chappill & G. Howell* (MEL); Mt Cahill, Kakadu National Park, SE of summit, 12°52.00'S, 132°42.27'E, 16 June 1993, *M.F. Duretto* 448-53, *J. Chappill & G. Howell* (MEL); Top of UDP Falls, Waterfall Creek, Kakadu National Park, 13°25.84'S, 132°25.03'E, 18 June 1993, *M.F. Duretto* 477-81 & *J. Chappill* (MEL); 42.4 km from Borroloola towards Wollogorang, 16°8.01'S, 136°36.70'E, 21 June 1993, *M.F. Duretto* 495-502 (MFD495-498, 501-502 - MEL; MFD499 - DNA, MEL; MFD500 - DNA, CANB, MEL); Fletcher Creek crossing, 43.8 km from Borroloola towards Wollogorang, 16°8.34'S, 136°37.32'E, 21 June 1993, *M.F. Duretto* 503-4A (MFD503 - MEL;

MFD504A - DNA, CANB, MEL); On track to Biddlecombe Cascades, Nitmiluk National Park, 14°15.60'S, 132°25.83'E, 28 June 1993, *M.F. Duretto* 522-4 & *G. Howell*, (MEL); Groote Eylandt, *F.R. Fosberg* & *R.C. Buckley* 62318, (BRI); 40 km W of Wollogorang, Calvert Hills road, 17°09'S, 137°41'E, 13 May 1974, *S. Jacobs* 1587 (CANB, NSW); Wessell Island, 11°13'S, 136°38E, 10 Oct. 1972, *P.K. Latz* 3462 (CANB, DNA, PERTH); *c.* 11 miles [17.6 km] SSW of Mt Gilruth, 13°11'S, 133°11'E, 28 Feb. 1973, *M. Lazarides* 7928 (CANB, DNA, MEL, NSW); 8 km E of Goyder River Crossing, 12°51'S, 135°05'E, *J.R. Maconochie* 1482 (DNA); 8 km NNE of Mt Evalyn, Kakadu National Park, 13°32'S, 132°56'E, 6 Apr. 1989, *Menkhorst* 337 (DNA, MEL); Murganella airstrip & surrounding vicinity, Murganella, Arnhem Land, 11°33'S, 132°55'E, 29 May 1988, *A.A. Muir* 5976 (AD, MEL); 8 km W of Roper Bar, 14°42'S, 134°27'E, 22 June 1977, *M.O. Parker* 908 (BRI, CANB, DNA, NSW); Groote Eylandt, 2 km SW of Umbakumba, 13°53'S, 136°48'E, *J. Russell-Smith* 2861 & *D. Lucas* (DNA); Nhulunbuy, Gove Peninsula, 12°10S, 136°46E, 21 Jan. 1988, *G.M. Wightman* 4283 (CANB, DNA).
VICTORIA RIVER DISTRICT: Victoria River, Gregory National Park, 15°28'S, 130°07'E, 7 Feb. 1986, *M. Clark* 436 & *G. Wightman* (DNA); 4 km W of Kodendong Valley, 14°39'S, 130°11'E, 13 May 1994, *I. Cowie* 4874 & *D.E. Albrecht* (DNA, MEL); 20 km S of Daly River Police Station (3 km S of Mt Boulder), 13°57'S, 130°42'E, 23 June 1985, *P.A. Fryxell, L.A. Craven & J. McD. Stewart* 4907 (CANB).
WESTERN AUSTRALIA; KIMBERLEY REGION: Limestone hills W of Weaber Range, *c.* 50 km N of Kununurra & *c.* 13 km NW of Point Springs, 8 Mar. 1978, *M. Lazarides* 8426 (CANB, DNA, PERTH).

*Possible hybrids.* Possible hybrids with *B. tolerans* are described under that species.

*Distribution.* Common and widespread throughout the "Top End" of the Northern Territory from Wollogorang to the Arnhem Land plateau and Cobourg Peninsula areas. Isolated collections have been made further west in the Macadam Range and Victoria River areas (NT) and the Weaber Range (WA). (Figure 1). *Boronia lanuginosa* has recently been collected from north-western Queensland (P.I. Forster pers. comm.).

*Habitat.* Found growing on sandstone and sands in open woodland and forest. Notes on the Weaber Range collection state that it was collected on limestone.

*Phenology.* Flowering material has been collected from January to September, and fruiting material from January to November.

*Conservation status.* Under no threat and found in a number of reserves though populations to the east and west are not protected.

*Etymology.* The specific epithet is derived from the Latin, *lanugo* - the down of plants, and refers to the dense indumentum on this species.

*Typification.* Endlicher (1837) cited only one specimen when describing *B. lanuginosa*: King George's Sound (Ferd. Bauer). A specimen matching this locality has been located at W by Wilson (1975). Despite the confusion surrounding the collection site (see earlier discussion, pp. 312, 314), this specimen is designated the lectotype.

*Affinities.* Mueller (1861: 179) thought that *B. artemisiifolia* (=*B. lanuginosa*) may be a form of *B. grandisepala*. Though closely related, these taxa are distinct, as Bentham (1863) concluded. *Boronia lanuginosa* is most closely related to *B. wilsonii* from which it can be distinguished by having narrower and longer leaflets, shorter anthopodia, and usually larger flowers.

*Notes.* Though *B. lanuginosa* is known from Western Australia (one collection), the Kimberley species referred to as *B. lanuginosa* by Green (1985), Hnatiuk (1990) and Wheeler (1992) is more than likely to be *B. wilsonii*.

White (1942), Hnatiuk (1990) and Henderson (1994) state that *B. lanuginosa* has been collected in the Cook district of Queensland. The collection cited by White, '*B. artemesiaefolia*: The Gorge, Mt Mulligan, *Dr. H. Flecker*, 2 Apr. 1934 (BRI)', and probably referred to by the others, is the first published record of an undescribed species that is sister to *B. alulata* (Duretto 1995, submitted; Duretto & Ladiges in prep.).

The Warnindilyakwa people of Groote Eylandt call *B. lanuginosa* Engbajengbaja, and use a preparation made from the leaves to treat headaches, body aches and pains, and chest colds (Levitt 1981). This is one of the few recorded uses of a member of section *Valvatae* by indigenous people.

**2. Boronia wilsonii** (F. Muell. ex Benth.) Duretto, *stat. nov.*

*Boronia artemisiifolia* var. *wilsonii* F. Muell. ex Benth., Fl. Austral. 1: 311 (1863) as *B. artemisiaefolia* var. *Wilsoni*. *Type:* Vansittart's Bay [Western Australia], 1819, *Alan Cunningham* 432, (*lecto* (here designated): PERTH 1610198; *isolecto:* BM *n.v.* (slides MEL, PERTH), K *n.v.* (cibachrome & slide MEL)). *Residual syntypes:* Victoria River, *Wilson* (*syn:* K *n.v.* (cibachrome & slide MEL), MEL); N.W. Coast, *Bynoe* (*syn*: K *n.v.* (cibachrome & slide MEL)).

*Illustration.* J.R. Wheeler, Fl. Kimb. 669, Figure 206 B1, B2 (1992) (as *B. lanuginosa*).

Erect, much branched *shrub* to 100 cm high; juvenile plants with a sparse simple and/or stellate-indumentum and mature plants with a dense stellate indumentum (Figure 7I). *Multiangular stellate hairs* sessile, with 4-12 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, white to faintly yellow, 0.05-0.1(0.25) mm long. *Simple hairs* reflexed, 0.5-2 mm long. *Branches* terete to quadrangular, not obviously glandular, decurrencies absent, hair distribution even, becoming glabrous with age, little or no cork development. *Leaves* opposite decussate, imparipinnate, 13-23 pinnae, not becoming unifoliolate with age, 17-34(61) mm long, 6-21 mm wide; lamina discolourous, paler beneath, dorsiventral, palisade mesophyll usually tightly packed (fresh material not available), not obviously glandular, non-secretory glands scattered in mesophyll, epicuticular waxes absent; margins entire, recurved to revolute; midribs of leaflets and rachis segments impressed adaxially, prominently raised abaxially, tightly packed parenchyma between midvein and abaxial epidermis without secondary thickening; pinnae sessile to subsessile, narrowly elliptic to elliptic or lanceolate, tip acute; terminal pinnae, 3-23 mm long, 1-6 mm wide, midvein straight; lateral pinnae opposite or rarely subopposite, 1.5-12 mm long, 1-4 mm wide; rachis segments winged, triangular, distal end wider, 2-6 mm long, 1-2.5 mm wide; petiole not winged, 0.5-7 mm long; juvenile leaves larger than mature leaves, initially glabrous, becoming progressively more hirsute along stem. *Inflorescence* cymose, 1(3)-flowered; peduncle absent; prophylls 0.5-1(9) mm long, to 4 mm wide, persistent; metaxyphylls absent or minute, persistent; anthopodium 3-7 mm long. *Flowers* cream to pink. *Sepals* longer and wider than petals, ovate-deltoid, acuminate, 5-9 mm long, 2-3 mm wide, enlarging to 6-10 mm long and 3-4.5 mm wide with fruit; adaxial surface with a dense stellate and simple indumentum near margins becoming sparse simple towards centre and glabrous towards base; abaxial surface with a dense stellate indumentum. *Petals* midvein not or slightly raised at base abaxially, 4-5 mm long, 1.5-2.5 mm wide, enlarging to 5.5-6 mm long with mature fruit; adaxial surface with a sparse simple indumentum, becoming glabrous towards base; abaxial surface with a dense stellate indumentum. *Stamens* with filaments bearing stiff simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective,

1.5-2 mm long, distal 0.5-1 mm prominently glandular; antepetalous filaments smooth, 1-1.5 mm long; anthers abaxial surface not or slightly frosty, antepetalous anthers much larger than antesepalous anthers; anther apiculum minute, glabrous. *Ovary* glabrous; style glabrous or rarely hirsute; stigma rounded, not or scarcely wider than style. *Cocci* with a moderate to dense simple and/or stellate indumentum, 4-5 mm long, 2-2.5 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black, uniform in colour, 3.5-4.5 mm long, 2-2.5 mm wide, elaiosome yellow-white; surface at magnification as with *B. lanuginosa* (see Figure 9A,B).

*Specimens examined (selected from c. 50 collections).* NORTHERN TERRITORY; VICTORIA RIVER DISTRICT: Victoria River area, 15°16'S, 129°35'E, 9 Mar. 1989, *G.J. Leach* 2399 & *C. Dunlop* (BRI, DNA). WESTERN AUSTRALIA; KIMBERLEY REGION: *c.* 50 km NE of Mitchell River Homestead, King Edward River, 14°47'S, 126°17'E, 23 Aug. 1978, *A.C. Beauglehole & E.G. Errey* B58912 E2612 (CANB, PERTH); Napier Broome Bay, West Governor Island, South Bay, 13°56'S, 126°41'E, 19 May 1984, *E.A. Chesterfield* 245 (CBG, DNA, MEL, NSW, PERTH); King Edward River, 14°54'S, 126°12'E, 1 Mar. 1980, *C.R. Dunlop* 5380 (DNA, PERTH); Napier Broome Bay, West Governor Island, South Bay, 13°57'S, 126°41'E, 19 May 1984, *S.J. Forbes* 2059 (MEL, NSW); Middle Springs, 18 km NW of Kununurra, 15°38'S, 128°40'E, 8 May 1985, *P.A. Fryxell & L.A. Craven* 4002 (AD, BRI, CANB, DNA, MEL, PERTH); Koolan Island, 16°07'S, 123°46'E, 2 June 1985, *P.A. Fryxell, L.A. Craven & J. McD. Stewart* 4600 (CANB, PERTH); Peninsula NE of Frederick Harbour at mouth of Hunter River [15°01'S, 125°23'E], 8 June 1985, *P.A. Fryxell, L.A. Craven & J. McD. Stewart* 4685 (PERTH); Base of Bougainville Peninsula, on E shore of Admiralty Gulf, 14°11'S, 126°10'E, 14 June 1985, *P.A. Fryxell, L.A. Craven & J. McD. Stewart* 4791 (DNA, CANB); Near junction of Drysdale River & Mogurnda Creek, Drysdale River National Park, 15°02'S, 126°55'E, 8 Aug. 1975, *A.S. George* 13548 (CANB, PERTH); Near Solea Falls, Drysdale River, Drysdale River National Park, 14°40'S, 127°E, 12 Aug. 1975, *A.S. George* 13745 (CANB, PERTH); Boiga Falls, Drysdale River National Park, 15°08'S, 127°06'E, 3 Aug. 1975, *K.F. Kenneally* 3025 (CANB, PERTH); *ibid*, 4 Aug. 1975, *K.F. Kenneally* 3075 (CANB, PERTH); Planigale Creek, Drysdale River National Park, 14°43'S, 126°54'E, 19 Aug. 1975, *K.F. Kenneally* 4455 (CANB, PERTH); Lachlan Island, Buccaneer Archipelago, 16°38'S, 123°29'E, 14 June 1982, *K.F. Kenneally* 8319 (CANB, PERTH); Steep Island of Raft Point at entrance to Doubtful Bay, 16°04'S, 124°28'E, 18 May 1988, *K.F. Kenneally* 9682 (CANB); Middle Springs, 18 km NW of Kununurra, 15°38'S, 128°40'E, 8 Mar. 1963, *M. Lazarides* 6799 (DNA, CANB, NSW, PERTH); Anjo Peninsula separating Napier Broome Bay & Vansittart Bay, *c.* 3.5 km SSW Sharp Point, 13°57'S, 126°31'E, 31 May 1984, *J.H. Willis s.n.* (BRI, CBG, MEL, NSW, PERTH); Kalumburu Mission, 14°17'S, 126°38'E, 7 Aug. 1970, *T.O. Wolfe & M. Martin* 227 (CANB).

*Distribution.* Restricted to the Kimberley Region and the adjacent islands, Western Australia, and from few collections from the lower Victoria River, the Northern Territory. Probably more widespread in the central Kimberley region than present collections suggest. (Figure 1)

*Habitat.* Found growing on sand, sandstone, quartzite and, rarely limestone.

*Phenology.* Flowering material has been collected from January to September, and fruiting material from March to September.

*Conservation status.* Common, widespread and under no immediate threat. Found in several reserves.

*Etymology.* This taxon was named in honour of Wilson who first sent specimens to Mueller.

*Typification.* Of the three specimens cited by Bentham (1863) when describing *B. artemisiifolia* var. *wilsonii,* the collection 'Vansittart's Bay, *Alan Cunningham* 432, 1819' housed at PERTH is in the best

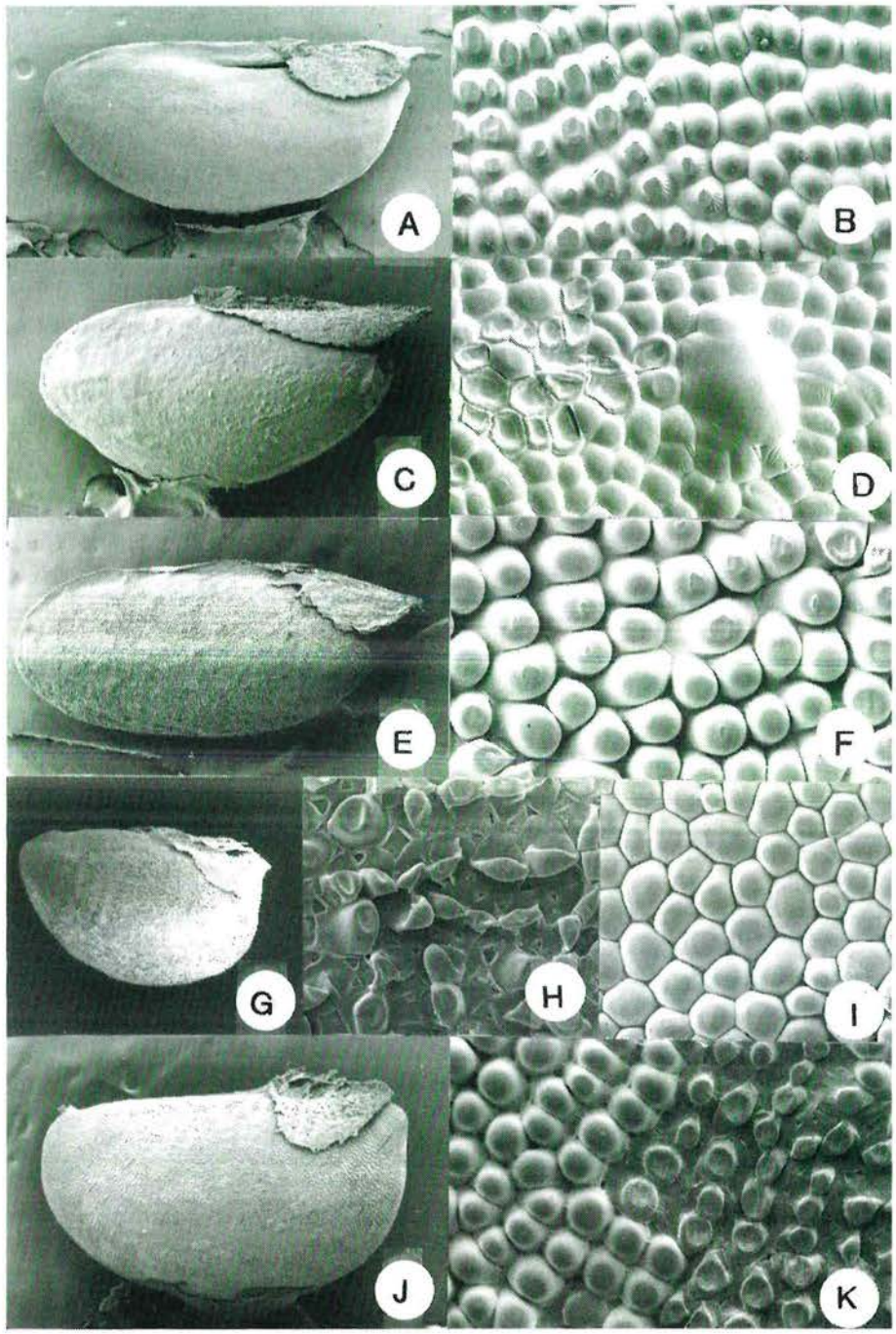


Figure 9. Scanning electron micrographs of seed surfaces. A,B - *B. lanuginosa* (*Chappill* 4783, MEL). C,D - *B. pauciflora* (*Symon* 7037, PERTH). E,F - *B. filicifolia* (*Fryxell* 4735 *et al.*, CANB). G-I - *B. rupicola* (G,H, *Craven* 6646, CANB; I, *Brennan* 2356, MEL). J,K - *B. lanceolata* (*Duretto* 446 *et al.*, MEL). Scales: x14 (A,C,E), x17 (G,J), x250 (B,D,H,I,K) and x300 (F).

condition and is chosen as the lectotype. It is of interest to note that Mueller annotated the K sheet of the Wilson collection from Victoria River as '*Boronia Wilsoni n. sp.*' suggesting that he thought it was distinct enough to warrant specific status. This collection is not chosen as the lectotype, though in good condition, as it is small and appears to be a plant with juvenile foliage.

*Affinities*. Closely related to *B. lanuginosa* from which it can be distinguished by the wider and usually shorter pinnae, longer anthopodia and usually smaller flowers.

*Notes*. Most collections from Drysdale River National Park (*George* 13548 [CANB 255846], *Kenneally* 3025, 3075, 4455) and a collection from Kalumburu (*Wolf & Martin* 227) are far less hirsute than other collections. These collections have what is presumed to be juvenile foliage. It is of note that George lodged two specimens of his number 13548 at CANB: the other, CANB 255847, has foliage with a dense indumentum like coastal plants adding some credence that *B. wilsonii* displays an ontogenetic sequence in indumentum density like *B. lanuginosa*.

The Western Australian species referred to as *B. lanuginosa* by Green (1985), Hnatiuk (1990) and Wheeler (1992) is probably *B. wilsonii*.

**3. Boronia decumbens** Duretto, *sp. nov.*

A *B. lanuginosa* Endl. habitu decumbenti, indumento sparso ad modicum, pilis stellatis paucis, et foliis sessilibus differt.

*Typus: c.* 70 km north-east of Pine Creek, El Sharana Rd, Northern Territory, 13°33'S, 132°18'E, 5 March 1985, *C. Dunlop* 6752 *& G. Wightman* (*holo:* CANB 363098; *iso:* DNA, MEL, NSW).

Decumbent, much branched *subshrub* to 10 cm high and 40 cm wide, regrowing from rootstock; with a sparse to moderate simple indumentum. *Multiangular stellate hairs* rare, sessile, with 2-6 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, white to faintly yellow, to 0.1 mm long. *Simple hairs* 0.5-2 mm long, reflexed (Figure 11A). *Branches* terete to slightly quadrangular, decurrencies absent, not obviously glandular (Figure 10B), hairs distributed evenly and becoming glabrous with age, little or no cork development. *Leaves* opposite decussate, imparipinnate, (3)5-7 pinnae, not becoming unifoliolate with age, sessile, 6-20 mm long, 8-25 mm wide; lamina discolourous, paler beneath, dorsiventral, palisade mesophyll usually tightly packed, not obviously glandular, scattered nonsecretory glands in mesophyll, epicuticular waxes absent; margins entire, flat to slightly recurved; midribs of leaflets and rachis segments sometimes impressed adaxially, not or slightly raised abaxially with tightly packed parenchyma between midvein and abaxial epidermis without secondary thickening; pinnae sessile, opposite, linear to narrowly elliptic, tip acute, attenuate; midribs of leaflets and rachis segments not or slightly raised abaxially, not impressed adaxially; terminal pinnae 6-12 mm long, 0.5-1 mm wide, midvein straight, larger than preceding lateral pinnae; lateral pinnae 4-11 mm long, 0.5-1 mm wide; rachis segments winged, triangular, distal end wider, 2-8 mm long, 0.5-1 mm wide. *Inflorescence* 1-flowered; peduncle absent; prophylls linear, minute to minutely unifoliolate, 0.5-2 mm long, persistent; metaxyphylls minute to 1 mm long, persistent; anthopodium 1-4 mm long. *Flowers* white to pink (Figure 10C). *Sepals* longer and wider than petals, deltoid, acute, 4-6 mm long, 1.5-3 mm wide, enlarging to 5.5-8 mm long and 2-4 mm wide with fruit; adaxial surface with a moderate simple indumentum and becoming glabrous towards the base; abaxial surface with a sparse simple indumentum. *Petals* abaxial midrib not or slightly raised at base, 3-5 mm long, 1-2 mm wide, enlarging to 4-5.5 mm long with mature fruit; adaxial surface with a sparse to moderate simple indumentum,

becoming glabrous towards base; abaxial surface with a sparse to moderate simple indumentum. *Stamens* with filaments bearing stiff simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.5 mm long, distal 0.5-1 mm prominently glandular; antepetalous filaments smooth, 1 mm long; anthers abaxial surface not frosty, antepetalous anthers much larger than antesepalous anthers; anther apiculum minute or large and erect, glabrous (Figure 10D,E). *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style glabrous; stigma rounded, not or scarcely wider than style. *Cocci* with a sparse to moderate simple and stellate indumentum, 5-6 mm long, 2-2.5 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black, uniform in colour, 4.5-5 mm long, 2 mm wide, elaiosome yellow-white; surface at magnification as with *B. lanuginosa.* (see Figures 9A,B). (Figure 10A-E)

*Other specimens examined.* NORTHERN TERRITORY; DARWIN & GULF DISTRICT: Pine Creek-Oenpelli road, 4 miles [6.4 km] E of Mary River, 15 Aug. 1968, *N. Byrnes* 786 (AD, DNA, PERTH); 48 miles [77 km] NE of Pine Creek on El Sharana road, 6 Jan. 1972, *N. Byrnes* 2473 (BRI, CANB, DNA); *c.* 5 miles [8 km] E of Mary River on Oenpelli-Pine Creek road, 14 May 1968, *R.C. Carolin* 6774 (PERTH); Moline Rockhole area, Kakadu Highway, 13°35'S, 132°15'E, 19 Mar. 1987, *M.J. Clark* 835 (DNA); Kakadu Highway near Jabiru turnoff, 13°35'S, 132°15'E, 19 Mar. 1987, *M.J. Clark* 1090 (DNA); Kakadu National Park, 13°34'S, 132°17'E, 20 Nov. 1991, *C.R. Dunlop* 8896 & *C. Wilson* (DNA, MEL); N of Waterfall Creek turnoff on Pine Creek-Oenpelli road, Kakadu National Park, 13°33'S, 132°17'E, 18 June 1993, *M.F. Duretto* 473-5, *J. Chappill & G. Howell* (MFD473 - MEL; MFD474 - CANB, DNA, MEL; MFD475 - DNA, MEL); E of Pine Creek-Oenpelli road towards Waterfall Creek, Kakadu National Park, 13°32'S, 132°17'E, 18 June 1993, *M.F. Duretto* 482, *J. Chappill & G. Howell* (MEL); Mary River Ranger Station, 13°33'S, 132°16'E, 1 July 1993, *M.F. Duretto* 548B-550, *J. Chappill & G. Howell* (MFD548B-549 - DNA, CANB, MEL; MFD550 - MEL); 41 miles [66 km] from Pine Creek to UDP Falls, 13°35'S, 131°43'E, July 1973, *C.H. Gittens* 2682 (DNA, NSW); *c.* 35 miles [56 km] NNE of Pine Creek township, 13°34'S, 132°16'E, 13 Mar. 1965, *M. Lazarides & Adams* 211 (CANB, DNA, MELU, NSW); Kombolgie Creek, Fern Gully, Fern Creek, 13°34'S, 132°18'E, Apr. 1993, *G.J. Leach* 3407 (BRI, PERTH); Kakadu National Park, 3 km SW of Mary River Ranger Station, 13°24'S, 132°05'E, 17 Apr. 1990, *A.V. Slee & L.A. Craven* 2494 (AD, CANB).

*Distribution.* Endemic to Kakadu National Park, north of the Mary River in an area around the Mary River Ranger Station and the Waterfall Creek turnoff on the Pine Creek-Oenpelli Road, in the Northern Territory. (Figure 12)

*Habitat.* Grows on deep sand or sandstone in eucalypt open woodland. Tolerates annual fires and many plants consist of a large number of small stems growing from a robust rootstock.

*Phenology.* Flowering material has been collected from November to August and fruiting material from March to August.

*Conservation Status.* A conservation code of 2RC+ is appropriate. Surveys are required to ascertain the full extent of this species as all known populations are near roads.

*Etymology.* The epithet alludes to the characteristic decumbent habit of this species.

*Affinities.* Most closely related to *B. tolerans* and *B. jucunda* from which it can be distinguished by the decumbent habit and few (if any) stellate hairs. These features and the sessile leaves also distinguish this species from *B. lanuginosa.*

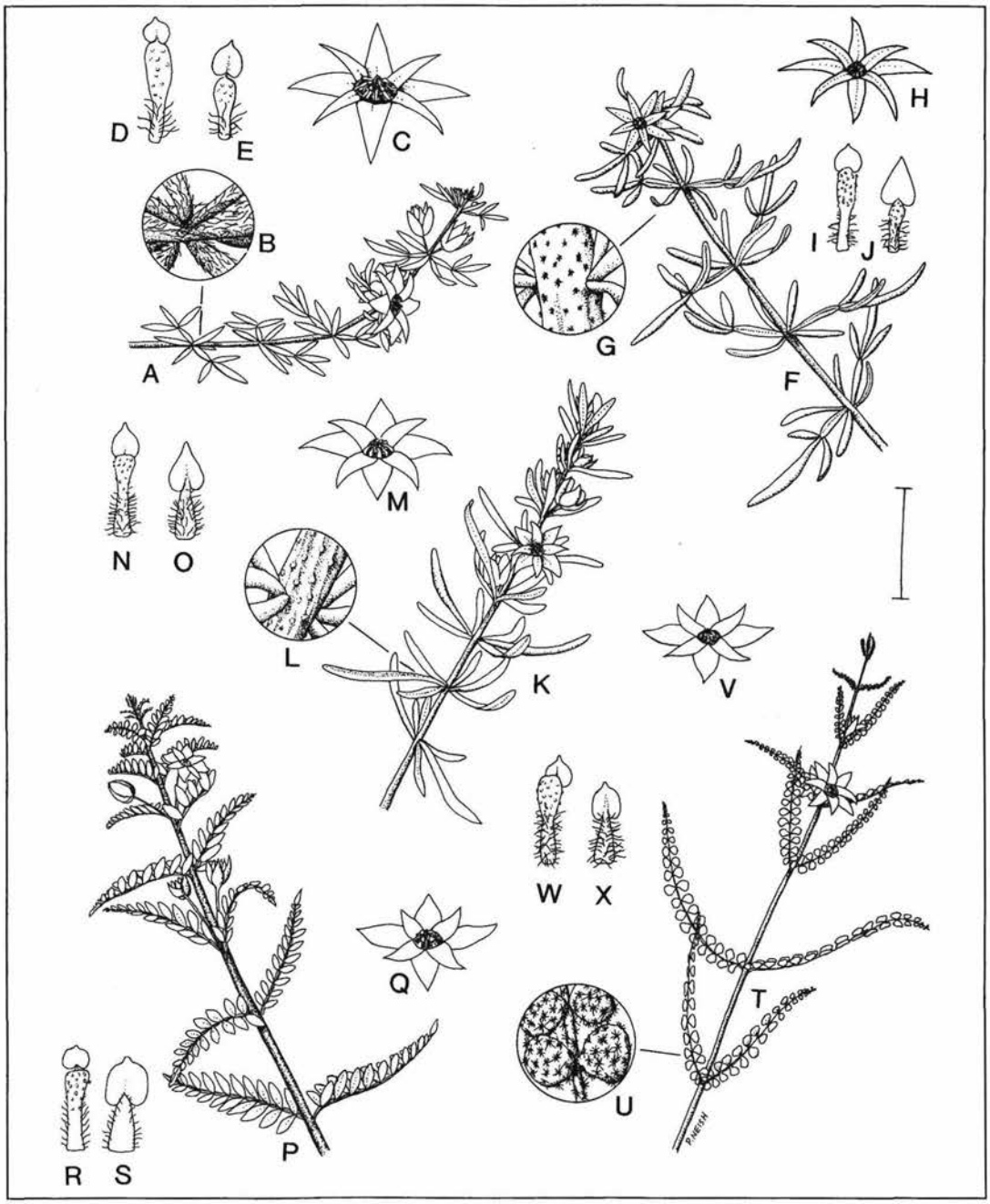


Figure 10. A-E - *B. decumbens* A - flowering branchlet; B - branchlet detail (A,B, holotype, *Dunlop* 6752, CANB); C - flower; D - abaxial view of antesepalous stamen; E - abaxial view of antepetalous stamen (C-E, *Duretto* 474, MEL). F-J - *B. tolerans* F - flowering branchlet; G - branchlet detail; H - flower; I - abaxial view of antesepalous stamen; J - abaxial view of antepetalous stamen (F-J, *holotype*, *Duretto* 516 *et al.*, MEL). K-O - *B. jucunda* K - flowering branchlet; L - branchlet detail (K,L, *holotype, Chesterfield* 214, MEL); M - flower; N - abaxial view of antesepalous stamen; O - abaxial view of antepetalous stamen (M-O, *Duretto* 509, MEL). P-S - *B. kalumburuensis* P, flowering branchlet; Q - flower; R - abaxial view of antesepalous stamen; S - abaxial view of antepetalous stamen (P-S, *holotype*, *Edwards* LAC9247, CANB). T-X - *B. minutipinna* T - flowering branchlet; U - leaf detail, adaxial surface; V - flower; W - abaxial view of antesepalous stamen; X - abaxial view of antepetalous stamen (T-X, *isotype, Cowie* 1911, MEL). Scale bars: 16 mm (A, F, K, P, T), 8 mm (C, H, M, Q, V) and 2 mm (D-E, I-J, N-O, R-S, W-X). This figure was prepared by Peter Neish for inclusion in "Flora of Australia" Vol. 26 (in prep.) and is reproduced here with the permission of the artist and ABRS.

*Notes*. Known as *Boronia* sp. 5 at OSS. One collection (*Duretto* 548) has flowers that are constructed of alternate whorls of perianth members and stamens on an elongated axis, with some flowers reaching three cm in length.

**4. Boronia tolerans** Duretto, *sp. nov.*

A *B. lanuginosa* Endl. indumento sparso et foliis sessilibus, a *B. jucunda* Duretto glandibus prominentibus in caulibus destitutis differt.

*Typus*: On track to and near Biddlecombe Cascades, Nitmiluk National Park, Northern Territory, 14°15'S, 132°26'E, 28 June 1993, *M.F. Duretto* 516, *J. Chappill & G. Howell* (*holo:* MEL; *iso:* DNA).

Erect, much branched *shrub* to 50 cm high. *Multiangular stellate hairs* sessile, 4-12 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, white to faintly yellow, 0.05-0.25(0.5) mm long (Figure 11B). *Simple hairs* reflexed, 0.5-1 mm long. *Branches* terete to slightly quadrangular, decurrencies absent, not obviously glandular (Figure 10G), with a sparse to moderate simple and stellate indumentum, hair distribution even, little or no cork development. *Leaves* opposite decussate, imparipinnate, with (1-3)5-7(9) pinnae, not becoming unifoliolate with age, sessile, glabrous to glabrescent, 7-50 mm long, 8-17 mm wide; lamina slightly discolourous, paler beneath, ± isobilateral, palisade mesophyll usually tightly packed, not obviously glandular, scattered nonsecretory glands in mesophyll, epicuticular waxes absent; margins entire, flat to slightly recurved; midribs of leaflets and rachis segments sometimes impressed adaxially, not or slightly raised abaxially with tightly packed parenchyma between midvein and abaxial epidermis without secondary thickening; pinnae opposite, linear to narrowly elliptic; terminal pinnae, 8-25 mm long, 1-2.5 mm wide, midvein straight; lateral pinnae 5-16 mm long, 1-2 mm wide; rachis segments winged, triangular, distal end wider, 2-10 mm long, 1-2 mm wide. *Inflorescence* 1-flowered, glabrous or with a sparse simple and stellate indumentum; peduncle absent; prophylls linear, minute, to 0.5 mm long, persistent; metaxyphylls absent or minute, persistent; anthopodium 1-2 mm long. *Flowers* white (Figure 10H). *Sepals* longer and wider than petals, ovate-deltoid, acute, 4-5 mm long, 1.5 mm wide, enlarging to 5.5-6 mm long and 2-2.5 mm wide with fruit; adaxial surface with a moderate and minute indumentum, becoming glabrous towards the base; abaxial surface glabrous or with a sparse indumentum. *Petals* abaxial midrib not or slightly raised at base, 3.5-4.5 mm long, 1 mm wide, enlarging to 5 mm long with mature fruit; adaxial surface with a sparse to moderate simple or stellate indumentum, becoming glabrous towards base; abaxial surface glabrous to glabrescent. *Stamens* with filaments bearing stiff simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.5 mm long, distal 0.5 mm prominently glandular; antepetalous filaments smooth, 1 mm long; anthers abaxial surface not or slightly frosty, antepetalous anthers much larger than antesepalous anthers; anther apiculum minute to large, erect, glabrous (Figures 10I-J). *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style glabrous; stigma rounded, not or scarcely wider than style. *Cocci* glabrous or with a sparse indumentum, 5-6 mm long, 2-3 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black, 4-4.5 mm long, 2-2.5 mm wide, elaiosome yellow-white; surface at magnification tuberculate to colliculate; surface at magnification as with *B. lanuginosa.* (see Figure 9A,B). (Figure 10F-J)

*Other specimens examined.* NORTHERN TERRITORY; DARWIN & GULF DISTRICT: On track to & near Biddlecombe Cascades, Nitmiluk National Park, 14°16'S, 132°26'E, 28 June 1993, *M.F. Duretto* 517-21, *J. Chappill & G. Howell* (MEL); Biddlecombe cascades, Katherine Gorge National Park, 16 June 1981, *S. King* (DNA); 3 km E of Biddlecombe cascades, Katherine Gorge National Park, 20 June 1981, *S. King* (DNA).

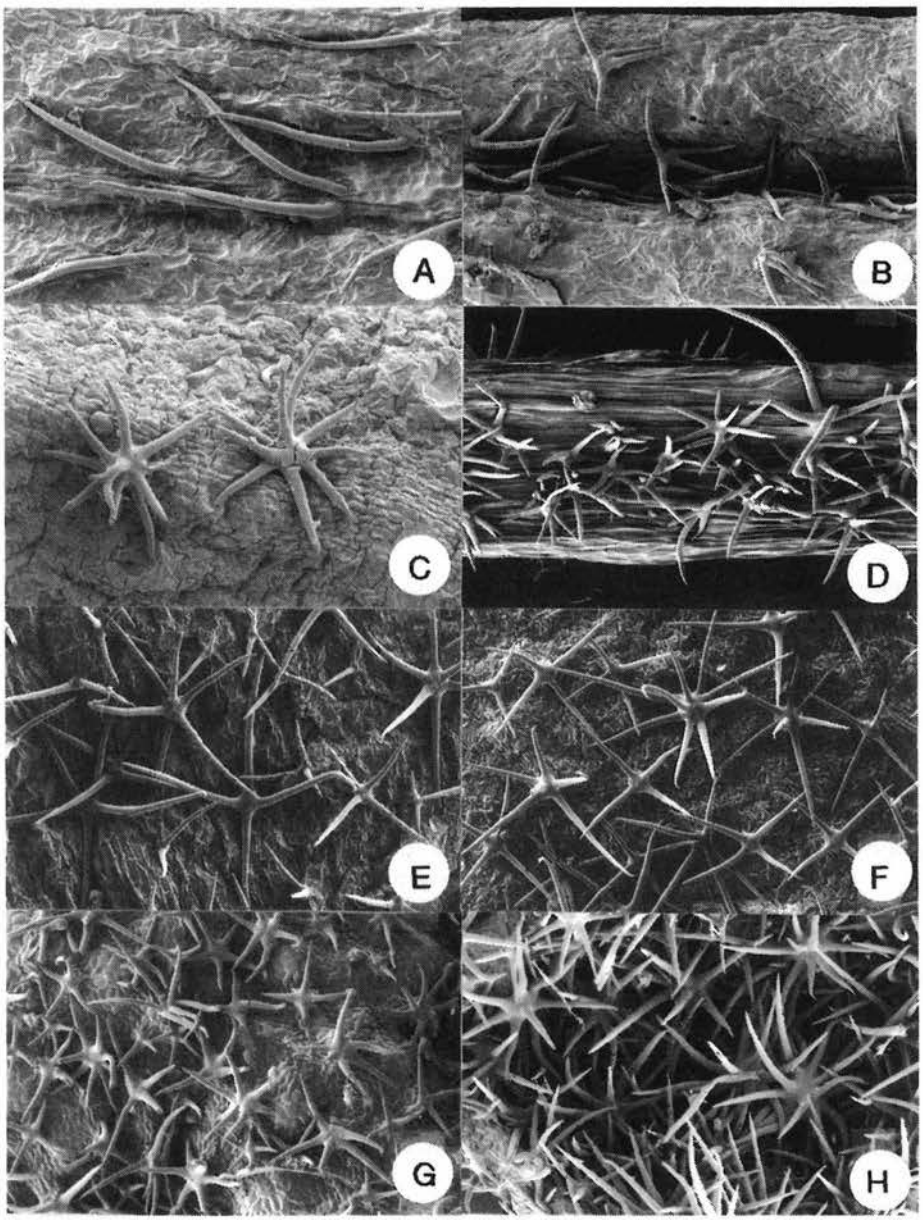


Figure 11. Scanning electron micrographs of hairs on adaxial (A,B, G) or abaxial (C, E,F, H) leaf surfaces, or stem (D). A - *B. decumbens* x55 (*Duretto* 473 *et al.*, MEL). B - *B. tolerans* x55 (*Duretto* 519 *et al.*, MEL). C - *B. jucunda* x130 (*Duretto* 509 *et al.*, MEL). D - *B. pauciflora* x80 (*Craven* 9212 *et al.*, CANB). E - *B. filicifolia* x55 (*Dunlop* 5262, CANB). F - *B. kalumburuensis* x55 (*Fryxell et al.* 4858, MEL). G,H - *B. minutipinna* G - x55, H - x80 (*Cowie* 1991, MEL).

*Possible hybrid. Boronia tolerans x B. lanuginosa* DARWIN & GULF DISTRICT: On track to & near Biddlecombe Cascades, Nitmiluk National Park, 14°16'S, 132°26'E, 28 June 1993, *M.F. Duretto* 525,526, (MFD525 - DNA, MEL; MFD526 - MEL).

*Distribution.* Occurs in a restricted area near Biddlecombe Cascades, Nitmiluk National Park, the Northern Territory. (Figure 12)

*Habitat.* Found growing on deep sand in a eucalypt woodland on the plateau top.

*Phenology.* Flowering and fruiting material collected in June.

*Conservation status.* A code of 2VC+ is appropriate as this species is only known, with certainty, from one small population near a walking track. This population is isolated from, but near, a hybrid swarm between *B. tolerans* and *B. lanuginosa*. *Boronia tolerans* could be in danger of genetic swamping by hybridization and introgression (see Rhymer & Simberloff 1996).

*Etymology.* The name is derived from the Latin, *tolerans* - tolerant, and is named in recognition of the great mental hardship suffered by Dr Greg Howell on the day this species was collected in the field.

*Affinities.* Closely related to *B. jucunda* from which it can be distinguished by having up to seven pinnae per leaf, and the smooth stems. Distinguished from *B. lanuginosa* by the sessile, isobilateral leaves with few hairs, and the smaller flowers.

*Notes.* One of two species in the *B. lanuginosa* species group that have isobilateral leaves, the other being *B. jucunda*.

Possible hybrids between *Boronia tolerans* and *B. lanuginosa* were observed near Biddlecombe Cascades in Nitmiluk National Park. Plants of *B. lanuginosa* (*Duretto* 522-4) and *B. tolerans* (*Duretto* 517-21) were growing beside sandstone outcrops and on nearby sandy flats respectively. Six putative hybrids (*Duretto* 525, 536) were growing in an intermediate habitat of sand with a large number of rocks and had flowers that were variously larger and hairier than those of *B. tolerans,* but smaller than those of *B. lanuginosa.* Flower and leaf morphology is variable in these plants as might be expected in a hybrid population. The leaves of one of the hybrids are dorsiventral with prominently raised abaxial midribs, which is similar to the leaf anatomy of *B. lanuginosa.* (Figure 8)

**5. Boronia jucunda** Duretto, *sp. nov.*

A *B. lanuginosa* Endl. indumento sparso et foliis sessilibus, isobilateralibus, a *B. tolerans* Duretto caulibus glandulosis manifeste differt.

*Typus*: Mabel Downs, Winnama Gorge, Kimberley Region, Western Australia, 17°11'S, 128°15'E, 14 May 1984, *E.A. Chesterfield* 214 (*holo*: MEL 1534494; *iso*: CBG 8503155, DNA 56026, NSW 166827, PERTH 1622609).

*Illustration.* J.R. Wheeler, Fl. Kimb. 669, Figure 206 D1-3 (1992) as *Boronia* sp. A.

Erect, much branched *shrub* to 50 cm high. *Multiangular stellate hairs* sessile, 4-12 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, 0.05-0.1 mm long

(Figure 11C). *Simple hairs* reflexed, 0.5-1 mm long. *Branches* slightly quadrangular, decurrencies absent, glandular (Figure 10L), with a sparse to moderate simple and stellate indumentum, hair distribution even, little or no cork development. *Leaves* opposite decussate, trifoliolate, not becoming unifoliolate with age, sessile, glabrous to glabrescent; pinnae discolourous, paler beneath, ± isobilateral, not obviously glandular, scattered nonsecretory glands in mesophyll, palisade mesophyll usually tightly packed, epicuticular waxes absent, linear to narrowly elliptic; margins entire, flat to slightly recurved; midribs of leaflets and rachis segments not or slightly raised abaxially with tightly packed parenchyma between midvein and abaxial epidermis without secondary thickening, sometimes impressed adaxially; terminal pinnae, 8-42 mm long, 1-3 mm wide, midvein straight; lateral pinnae 6-23 mm long, 1-2 mm wide. *Inflorescence* 1-flowered, glabrous or with a sparse simple and stellate indumentum; peduncle absent to 0.5 mm long, not woody, deciduous with flower; prophylls linear, minute, to 0.5 mm long, persistent; metaxyphylls absent or minute, persistent; anthopodium 0.5-3 mm long. *Flowers* white (Figure 10M). *Sepals* longer and wider than petals, ovate-deltoid, acute, 4-5 mm long, 1.5-2.5 mm wide, enlarging to 5.5-6 mm long and 2-2.5 mm wide with fruit; adaxial surface with a moderate stellate indumentum, becoming glabrous towards the base; abaxial surface glabrous or with a sparse indumentum. *Petals* abaxial midrib not or slightly raised at base, 3.5-4 mm long, 1 mm wide, not enlarging significantly with mature fruit; adaxial surface with a moderate simple or stellate indumentum, becoming glabrous towards base; abaxial surface glabrous or with a sparse simple and stellate indumentum. *Stamens* with filaments bearing stiff simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.5-2 mm long, distal 0.5-1 mm prominently glandular; antepetalous filaments smooth, 1 mm long; anthers abaxial surface not frosty, antepetalous anthers much larger than antesepalous anthers; anther apiculum minute to large, erect, glabrous (Figure 10N,O). *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style hirsute at base or for full length; stigma rounded, not or scarcely wider than style. *Cocci* with a sparse indumentum, 5.5-6 mm long, 3-3.5 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black, usually uniform in colour, rarely mottled, 4.5-5 mm long, 2-3 mm wide, elaiosome yellow-white; surface at magnification tuberculate to colliculate; surface at magnification as with *B. lanuginosa.* (see Figure 9A,B). (Figure 10K-O)

*Other specimens examined.* WESTERN AUSTRALIA, KIMBERLEY REGION: Escarpment edge, Winnama Gorge, 17°11'S, 128°15'E, 25 June 1993, *M.F. Duretto* 505-9 *& G. Howell* (MFD505 - DNA, MEL, PERTH; MFD506 - MEL; MFD507 & MFD509 - CANB, DNA, MEL, NSW, PERTH; MFD508 - DNA, MEL); Winnama Spring *c.* 17.5 km S of Turkey Creek, 17°11'S, 128°15'E, 15 May 1984, *J.H. Willis* (CBG, MEL, PERTH).

*Distribution.* Known only from the plateau top near Winnama Gorge, south-east Kimberley Region, Western Australia. (Figure 12)

*Habitat.* Found in open eucalypt woodland with a heathy/spinifex understorey on quartzite. The population is extensive and plants favour rockier areas away from grass especially along the gorge lip, but not on the gorge slope.

*Phenology.* Flowering material and fruiting material have been collected in May and June.

*Conservation status.* Known from a single large population. Winnama Gorge is used for recreation but disturbance is concentrated on the gorge bottom and the species is under no immediate threat. A conservation code of 2R is appropriate. Listed as a Priority 1 category on the Priority Flora List of the Department of Conservation and Land Management of Western Australia.

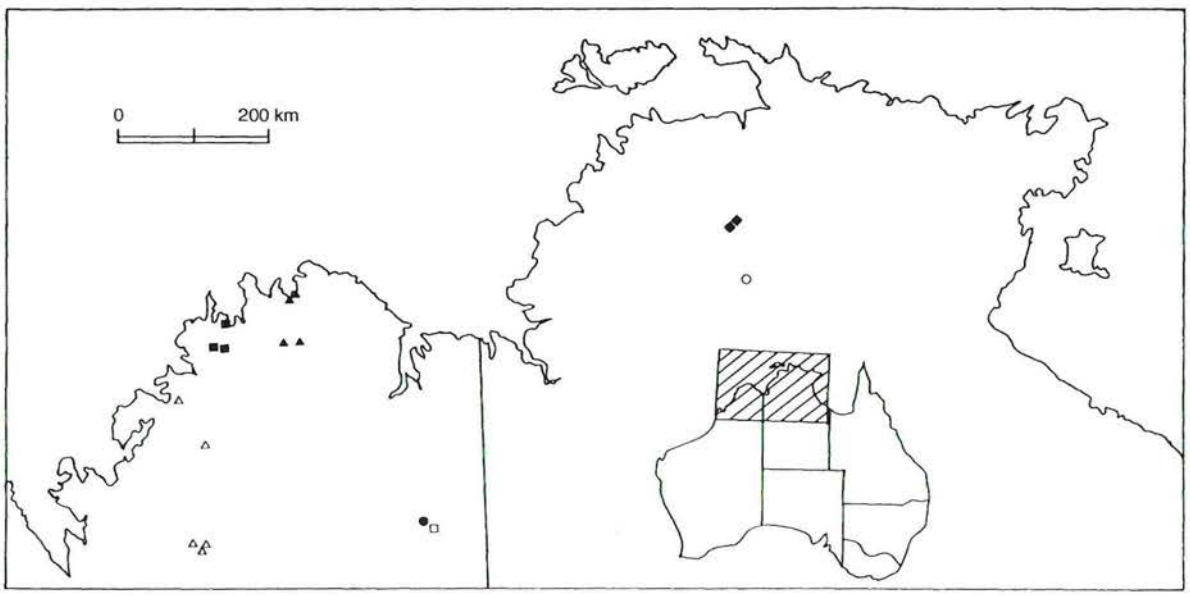


Figure 12. North-western Australia. Distribution of *B. decumbens* (◆); *B. jucunda* (●), *B. filicifolia* (■), *B. kalumburuensis* ( ▲ ); *B. minutipinna* ( □ ), *B. pauciflora* ( △ ) and *B. tolerans* ( ○ ).

*Etymology.* The epithet is derived from the Latin, *jucundus* - pleasing, and alludes to the pleasant smell of the leaves when crushed, unlike the leaves of most other members of section *Valvatae.*

*Affinities.* Closely related to *B. tolerans,* both species being unusual in having isobilateral leaves, but can be distinguished from *B. tolerans* by its trifoliolate leaves and prominently glandular stems. These features, plus its glabrescence, also distinguish this species from *B. lanuginosa, B. wilsonii,* and *B. decumbens.*

*Notes.* Called *B. ? pauciflora* in Forbes & Kenneally (1986) and Woirnarski (1992), and *B.* sp. A in Wheeler (1992).

**6. Boronia pauciflora** W. Fitzg., J. Proc. Roy. Soc. W. Austral. 3: 158 (1918). *Type:* Mount Broome, 1000 feet above the base, Western Australia, 17°21'S, 125°23'E, May 1905, *W. V. Fitzgerald* 825 (*lecto* (here designated): PERTH 1099701; *isolecto:* K *n.v.* (slide MEL, PERTH), NSW).

*Illustration.* J.R. Wheeler, Fl. Kimb. 669, Figure 206 C (1992).

Erect, much branched *shrub* to 60 cm high; glabrescent or with a sparse stellate indumentum throughout. *Multiangular stellate hairs* sessile, with 2-8 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, 0.1-0.2 mm long (Figure 11D). *Branches* quadrangular, decurrencies present, slightly glandular, with a sparse or rarely moderate stellate indumentum, hairs between decurrencies, becoming glabrous with age, little or no cork development.

*Leaves* opposite decussate, usually simple, juvenile leaves trifoliolate for few nodes; lamina of simple leaves and pinnae elliptic to lanceolate, tip acute, attenuate, discolourous, paler beneath, dorsiventral (fresh material not available), not obviously glandular, scattered nonsecretory glands in mesophyll, glabrescent with few scattered stellate and simple hairs, mainly on midrib, epicuticular waxes absent, trifoliolate leaves sessile, simple leaves petiolate, pinnae petiolate; margins entire, flat; midrib slightly impressed adaxially, raised abaxially, tightly packed parenchyma between midvein and abaxial epidermis with or without secondary thickening; simple leaves and terminal pinnae longer than lateral pinnae, midvein straight, 12-80 mm long, 2-12 mm wide; lateral pinnae 7-13 mm long, 2-4 mm wide; petiole not winged, 0.5-7 mm long; petiolule 1-2 mm long. *Inflorescence* cymose, 1(3)-flowered, glabrous or with a sparse stellate indumentum; peduncle absent; prophylls minute-minutely unifoliolate, to 1 mm long; metaxyphylls absent to 0.5 mm long; anthopodium 4-22 mm long. *Flowers* white to pink. *Sepals c.* same size as petals, ovate-deltoid, acute to acuminate, 2.5-4.5 mm long, 1-2 mm wide, enlarging to 4.5-5 mm long with fruit; adaxial surface with a sparse simple indumentum becoming glabrous towards base; abaxial surface glabrous to glabrescent. *Petals* midvein not raised abaxially, 2-4.5 mm long, 1-1.5 mm wide, scarcely enlarging with mature fruit; adaxial surface with a sparse to moderate stellate indumentum, becoming glabrous towards base; abaxial surface with a sparse stellate indumentum. *Stamens* with filaments bearing stiff simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 2 mm long, distal 1-1.5 mm prominently glandular; antepetalous filaments smooth, 1.5 mm long; anthers abaxial surface not or slightly frosty, antepetalous anthers much larger than antesepalous anthers; anther apiculum absent. *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style hirsute for full length; stigma rounded, not or scarcely wider than style. *Cocci* glabrous, 5-6 mm long, 2-2.5 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black but mottled, 4-4.5 mm long, 2-2.5 mm wide, elaiosome yellow-white; surface at magnification colliculate; collicules smooth, unfused or fused into amorphous units, somtimes collapsed, anticlinal walls ± visible, 10-55 µm across (Figure 9C,D).

*Other specimens examined.* WESTERN AUSTRALIA; KIMBERLEY REGION: Bold Bluff, King Leopold Ranges, 17°16'S, 125°15'E, 25 May 1971, *N. Byrnes* 2260 (CANB, DNA, PERTH); *c.* 10 km NE of Prince Regent River mouth, 15°26'S, 125°10'E, 27 May 1993, *L.A. Craven* 9212, *J. McD. Stewart & C.L. Brubaker* (CANB, DNA, E, L, MEL, PERTH); Foot of Bold Bluff, July 1967, *C.H. Gittens* 1443 (NSW); Leopold Range, towards base of Bold Bluff, 17°17'S, 125°25'E, 26 May 1971, *D.E. Symon* 7037 (MEL, PERTH); Edkins Range, *c.* 132 km from Mount Elizabeth homestead along the Walcott Inlet track, 16°02'S, 125°28'E, 1 May 1992, *I.R. Telford* 11627 (PERTH).

*Distribution.* Known from a few collections from the King Leopold Ranges, and two recent collections from the Edkins Range and Prince Regent River areas to the north, western Kimberley Region, Western Australia. (Figure 12)

*Habitat.* Found in rocky (sandstones and quartzites) areas with spinifex. The specimens collected from the Prince Regent River (*Craven* 9212 *et al.*) were part of regrowth after a spinifex fire the year before (collector's notes). It is of note that all plants were seedlings rather than older plants regrowing from a rootstock.

*Phenology.* Flowering and fruiting material has been collected between May and July.

*Conservation status.* Briggs & Leigh (1996) give *B. pauciflora* a conservation code of 3K, which is probably appropriate. Listed as a Priority 3 category on the Priority Flora List of the Department of Conservation and Land Management of Western Australia. Further surveys are required to ascertain the sizes of the three known populations and to determine the taxonomic status of the Prince Regent River population.

*Etymology.* The epithet is derived from the Latin, *paucus* - few and *flora* - flower, and presumably alludes to the few flowers found on the type material.

*Typification.* Fitzgerald (1918) cited only one of his own collections when describing *B. pauciflora*. The majority of Fitzgerald's collections are now lodged at BM, E, NSW and PERTH (Short 1990, 1993), and a large portion of his Kimberley material was received by PERTH via the Western Australian Museum (Kenneally 1986). Specimens matching the collection cited by Fitzgerald (1918) have been located at PERTH, K and NSW. As the PERTH specimen is in better condition than the other two seen, and it is unlikely that a better specimen exists elsewhere, it is chosen here as the lectotype.

*Affinities.* Fitzgerald (1918) thought *B. pauciflora* to be closely related to *B. grandisepala*, probably because both are simple-leaved. Weston *et al.* (1984) also suggested affinities between these two species when they combined them when scoring for their cladistic analysis of *Boronia* and *Boronella* Baill. A more detailed cladistic analysis of *Boronia* section *Valvatae* places this species sister to the *B. filicifolia* species group on a number of leaf, flower and seed characters (Duretto 1995; Duretto & Ladiges in prep.).

*Notes.* The Prince Regent River material (*Craven* 9212 *et al.*) differs from the King Leopold (type locality) and Edkins Ranges material in having a greater hair density on the branches, longer anthopodia (on average), less acuminate sepals, and less hirsute staminal filaments. Some of the Prince Regent River material has trifoliolate leaves, i.e. specimens lodged at A, CANB and MEL. The trifoliolate leaves are difficult to discern as the leaves are sessile, and the lateral pinnae are much smaller than the terminal pinnae. This variation, along with the disjunct distribution, could be used to support an argument for taxonomic recognition of the northern Prince Regent River population. It would be premature to do so, as the *Craven* 9212 collection from the Prince Regent River area consists of seedlings or young plants. That is, the variation seen may represent an ontogenetic developmental sequence and the plants may be displaying some juvenile features. It is suggested that the population be monitored and sampled over a period of years to determine whether or not the variation is genetic or ontogenetic.

The taxon referred to as *B. ? pauciflora* by Forbes & Kenneally (1986) and Woirnarski (1992) is *B. jucunda* (see above).

**7. Boronia filicifolia** A. Cunn. ex Benth., Fl. Austral. 1: 311 (1863). *Type:* Montague and York Sounds, N.W. Australia [Western Australia], 1820, *A. Cunningham* 220, third voyage of the "Mermaid" (*lecto* (here designated): K *n.v.* (cibachrome & slide MEL); *isolecto*: BM *n.v.* (slides MEL, PERTH)).

*Illustration.* J.R. Wheeler, Fl. Kimb. 669, Figure 206 A1, A2 (1992).

Erect, much branched *shrub* to 50 cm high; with a sparse to moderate stellate indumentum. *Multiangular stellate hairs* sessile, with 2-10 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, to 0.25 mm long (Figure 11E). *Branches* quadrangular becoming terete with age, not obviously glandular, decurrencies absent, hairs distributed evenly, becoming glabrous with age, little or no cork development. *Leaves* opposite decussate to subopposite, imparipinnate, (5)15-55 pinnae, not becoming unifoliolate with age, pinnae number gradually increasing along axillary branches, sessile or petiolate, (7-11)30-75 mm long, (3)6-12 mm wide; lamina discolourous, paler beneath, dorsiventral (fresh material not available), not obviously glandular, non-secretory glands scattered in mesophyll, epicuticular waxes absent; margin entire, flat to recurved; midribs of leaflets and rachis segments usually impressed adaxially, raised abaxially, tightly packed parenchyma between midvein and

abaxial epidermis without secondary thickening; pinnae acute, ± petiolate, petiolule 0-1 mm long; terminal pinnae lanceolate, longer than laterals, midvein straight, (1.5)3-8 mm long, 1-5 mm wide; lateral pinnae elliptic to rhombic, sometimes overlapping, opposite or rarely subopposite, 0.5-5(7) mm long, 0.5-3 mm wide; rachis segments winged, triangular, distal end wider, (0.5)2-7 mm long, 0.5-1 mm wide; petiole not winged, 0-2 mm long. *Inflorescence* cymose, 1(3)-flowered; peduncle absent; prophylls minute, persistent; metaxyphylls absent or minute, persistent; anthopodium glabrous or with sparse to moderate stellate indumentum, (2)6-22 mm long. *Flowers* white to pink. *Sepals c.* equal in size to petals, ovate-deltoid, acute, 2-3.5 mm long, 1.5-2 mm wide, not enlarging significantly with fruit; adaxial surface with a moderate stellate indumentum; abaxial surface glabrous or with a sparse stellate indumentum. *Petals* abaxial midrib not or slightly raised at base, 2.5-3.5 mm long, 1-1.5 mm wide, enlarging to 4 mm long with mature fruit; adaxial surface with a dense stellate indumentum, becoming glabrous towards base; abaxial surface glabrous or with a sparse stellate indumentum. *Stamens* with filaments bearing stiff bifid and some simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.5 mm long, distal 0.5 mm prominently glandular, most glands bearing a minute stellate hair; antepetalous filaments smooth, 1 mm long; anthers abaxial surface not or slightly frosty, antepetalous anthers much larger than antesepalous anthers; anther apiculum absent or present, minute or large and erect, glabrous or bearing few simple erect hairs. *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style hirsute for full length; stigma rounded, not or scarcely wider than style. *Cocci* glabrous to glabrescent, 5 mm long, 2-2.5 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black but mottled, 4 mm long, 2 mm wide, elaiosome yellow-white; surface at magnification tuberculate; tubercles smooth, unfused, anticlinal walls ± visible 6-55 µm across (Figure 9 E,F).

*Other specimens examined.* WESTERN AUSTRALIA; KIMBERLEY REGION: 6 km W of Mitchell River Falls, 14°49'S, 125°38'E, 29 Apr. 1993, *I. Cowie* 4346 & *C. Brubaker* (CANB, PERTH); Mitchell River, 14°50'S, 125°42'E, 22 Feb. 1980, *C.R. Dunlop* 5262 (CANB, DNA, NSW, PERTH); Along Mitchell River S of Mitchell Plateau, 14°47.57'S, 125°44'E, 10 June 1985, *P.A. Fryxell, L.A. Craven & J. McDStewert* 4735 (CANB, MEL, PERTH); Mitchell River Falls, Mitchell Plateau, 14°49'S, 125°41'E, 17 June 1976, *K.F. Kenneally* 5011 (PERTH); E side of Mindjau Creek, Port Warrender, Admiralty Gulf, 14°40'S, 125°56'E, 16 Jan. 1982, *K.F. Kenneally* 7763 (CANB, PERTH); *ibid,* 22 Jan. 1982, *K.F. Kenneally* 7903 (CANB, PERTH); Porosus Creek above confluence of fresh and salt water, Hunter River, 14°57'S, 125°24'E, 2 June 1992, *K.F. Kenneally* 11191 (PERTH); 300 m upstream of junction of tidal and fresh water interface, 14°59'S, 125°29'E, 10 Apr. 1992, *A.A. Mitchell & T. Willing* 2418 (PERTH).

*Distribution.* Occurs in the catchment area of the Mitchell River, and in the Port Warrender area, northern Kimberley Region, Western Australia. (Figure 12)

*Habitat.* Found in heath and open woodland on sandstones and quartzites.

*Phenology.* Flowering material has been collected from January to June, and fruiting material in June and July.

*Conservation status.* Briggs & Leigh (1996) gave this species a code of 3K, but a code of 2R is more appropriate. Listed as a Priority 2 category on the Priority Flora List of the Department of Conservation and Land Management of Western Australia.

*Etymology.* The specific epithet refers to the fern-like foliage of this species.

*Typification.* Bentham (1863) cited only one Cunningham collection when describing *B. filicifolia*: 'N. Australia. York and Montague Sounds, N.W. Coast.' A Cunningham collection was located at K, 'Montague and York Sound N. W. Australia, *A. Cunningham* 220, Sept. 1820', and another at BM, 'Shores of Montague and York Sounds, *A. Cunningham* 220, 1820'. These can be assumed to be duplicates and the K sheet, being superior, is chosen as the lectotype.

*Affinities. Boronia filicifolia* can be distinguished from *B. kalumburuensis* by the more numerous pinnae and by the glabrous to glabrescent cocci; and *from B. minutipinna* by the larger and more numerous pinnae, longer anthopodia and fewer hairs on the abaxial leaf surface.

*Notes.* In addition to the Mitchell River (type) and Kalumburu (*B. kalumburuensis*) variants of *B. filicifolia*, Wheeler (1992) noted a variant from Port Warrender in which the sepals were smaller than the petals. The Port Warrender collection (*Kenneally* 7763) does have smaller sepals (2-2.5 mm) than petals (2.5-3 mm), and also has much narrower pinnae than typical *B. filicifolia*. With more material and research the Port Warrender variant may prove to be distinct.

**8. Boronia kalumburuensis** Duretto, *sp. nov.*

A *B. filicifolia* A. Cunn. foliis pinnis paucis (15-27), sepalis largioribus (3.5-5 mm longis) et coccis hirsutis differt.

*Typus*: Outcropping sandstone immediately north of Kalumburu airstrip, Western Australia, 14°17'S, 126°37'E, 22 May 1993, *E.D. Edwards* LAC9247 (*holo*: CANB463023; *iso*: DNA, MEL234516, PERTH).

Erect, much branched *shrub* to 50 cm high; with a sparse to moderate stellate indumentum. *Multiangular stellate hairs* sessile, with 4-10 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, to 0.5 mm long (Figure 11F). *Branches* slightly quadrangular becoming terete with age, decurrencies absent, hairs distributed evenly, becoming glabrous with age, not obviously glandular, little or no cork development. *Leaves* opposite decussate, imparipinnate with 15-27 pinnae, not becoming unifoliolate with age, 8-40 mm long, 4-14 mm wide; lamina discolourous, paler beneath, dorsiventral (fresh material not available), not obviously glandular, non-secretory glands scattered in mesophyll, epicuticular waxes absent; margins entire, flat to recurved; midribs of leaflets and rachis segments usually impressed adaxially, raised abaxially with tightly packed parenchyma between midvein and abaxial epidermis without secondary thickening; pinnae acute, subsessile; terminal pinnae lanceolate, longer than laterals, midvein straight, 3-11 mm long, 1-3 mm wide; lateral pinnae opposite or rarely subopposite, elliptic, 1-9 mm long, 0.5-2.5 mm wide; rachis segments winged, triangular, distal end wider, 0.5-1.5 mm long, 0.5-1.5 mm wide; petiole not winged, 1-2 mm long; juvenile leaves larger than mature leaves, initially glabrous, becoming progressively more hirsute along stem. *Inflorescence* cymose, 1(-3)-flowered; peduncle absent; prophylls to 1 mm long, persistent; metaxyphylls absent or minute, persistent; anthopodium with a sparse to dense stellate indumentum, 7-24 mm long. *Flowers* white to pink (Figure 10Q). *Sepals* longer and wider than petals, ovate-deltoid, acute to acuminate, 3.5-5 mm long, 1.5-2.5 mm wide, enlarging to 5-6 mm long with fruit; adaxial surface with moderate stellate indumentum, sometimes along margins only; abaxial surface with a sparse stellate indumentum. *Petals* abaxial midrib not or slightly raised at base, 2.5-4 mm long, 1-2 mm wide, not enlarging significantly with mature fruit; adaxial surface with a sparse simple and stellate indumentum, becoming glabrous towards base; abaxial surface glabrous or with a sparse stellate indumentum. *Stamens* with filaments bearing stiff stellate and some simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.5 mm long, distal 0.5-1 mm prominently glandular; antepetalous filaments smooth, 1 mm long; anthers abaxial surface not frosty, antepetalous anthers much larger than

antesepalous anthers; anther apiculum absent or present, minute or large and erect, sometimes with few stiff simple hairs (Figures 10R-S). *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style hirsute at base or for full length; stigma rounded, not or scarcely wider than style. *Cocci* glabrescent or with a sparse stellate indumentum, 5-5.5 mm long, 2-2.5 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black but mottled, 4.5 mm long, 2.5 mm wide, elaiosome yellow-white; surface at magnification as with *B. filicifolia.* (see Figure 9E,F). (Figure 10P-S)

*Other specimens examined.* WESTERN AUSTRALIA; KIMBERLEY REGION: 3.6 km by road N of Kalumburu on road to Pago Mission, 14°16'S, 126°37'E, 1 May 1985, *T.E.H. Aplin* 867, *R.J. Cranfield & J.R. Wheeler* (PERTH); 2 km N of Kalumburu, 14°16'S, 126°37'E, 25 May 1993 *I. Cowie & Brubaker,* (CANB, PERTH); Sandstone outcrop adjacent to river, 14°50'S, 126°30'E, 24 July 1984, *S.J. Forbes* 2722 (MEL); *c.* 10 km N of Kalumburu Mission, 14°11'S, 126°40'E, 14 May 1983, *P.A. Fryxell & L.A. Craven* 4131 (CANB, DNA, MEL, PERTH); Theda Station near Homestead on banks of Morgan River, 14°49'S, 126°43'E, 18 June 1985, *P.A. Fryxell, L.A. Craven & J. McDStewert* 4858 (CANB, MEL, PERTH); 4 km N of Kalumburu, 14°17'S, 126°37'E, 24 June 1978, *A.S. George* 15199 (CANB, MEL, NSW, PERTH); Quartzite outcrop between Kalumburu Mission & Longini Landing, 14°16'S, 126°37'E, 26 May 1975, *D.E. Symon* 10184 (AD, CANB, PERTH).

*Distribution.* Endemic to the Kalumburu area, north Kimberley Region, Western Australia (Figure 12).

*Habitat.* Grows mainly on sandstones and quartzites.

*Phenology.* Flowering and fruiting material has been collected from May to July.

*Conservation status.* The appropriate conservation code for this species is 2RC-. Listed as a Priority 3 category on the Priority Flora List of the Department of Conservation and Land Management of Western Australia.

*Etymology.* The epithet refers to the major community in the area where this species is found, Kalumburu.

*Affinities.* Related to *B. filicifolia* and *B. minutipinna* from which it can be distinguished by the smaller number of pinnae and hirsute cocci, and from *B. wilsonii* by the sparse to moderate indumentum, much longer anthopodia, and smaller and less hirsute flowers.

**9. Boronia minutipinna** Duretto, *sp. nov.*

A *B. filicifolia* A Cunn. ex Benth. foliis pinnis paucioribus (17-35) et minoribus (0.5-2 mm longis), et anthipodiis brevioribus (1-6 mm longis) differt.

*Typus*: Osmond Plateau, Western Australia, 17°16'S, 128°22'E, 19 July 1991, *I. Cowie* 1991 (*holo*: CANB 412831; *iso*: DNA 59392, MEL 229246, PERTH 1881515).

Erect, much branched *shrub* to 50 cm high; with a moderate to dense stellate indumentum throughout. *Multiangular stellate hairs* sessile, with 6-15 rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, 0.1-0.25(0.5) mm long (Figures 11G,H). *Branches* slightly quadrangular becoming terete with age, decurrencies absent, not obviously glandular, hairs distributed evenly, becoming glabrous with age, little or no cork development. *Leaves* opposite decussate, imparipinnate, 17-35 pinnae, not becoming unifoliolate with age, pinnae number gradually increasing

along axillary branches, sessile, 5-34 mm long, 2-4 mm wide; lamina discolourous, paler beneath, dorsiventral (fresh material not available), not obviously glandular, scattered nonsecretory glands in mesophyll, epicuticular waxes absent; adaxial surface with moderate stellate indumentum (Figures 10U, 11G); abaxial surface with a moderate to dense stellate indumentum (Figure 11H); margins entire, flat to recurved; midribs of leaflets and rachis segments raised abaxially, with tightly packed parenchyma between midvein and abaxial epidermis without secondary thickening; pinnae acute, petiolule *c.* 0.5 mm long; terminal pinnae elliptic, longer than but the same width as laterals, 1-2 mm long, midvein straight, 0.5-1.5 mm wide; lateral pinnae rhombic, overlapping, opposite or rarely subopposite, 0.5-1.5 mm long, 0.5-1.5 mm wide; rachis segments winged, oval shaped, 0.5-12 mm long, 0.5-1.5 mm wide. *Inflorescence* 1-flowered, with a moderate stellate indumentum; peduncle absent; prophylls to 1 mm long, minute, persistent; metaxyphylls absent or minute, persistent; anthopodium 1-6 mm long. *Flowers* white to pink (Figure 10V). *Sepals* longer and wider than petals, deltoid, acute, 3-4 mm long, 1.5-2 mm wide, enlarging to 3.5-5 mm long with fruit; adaxial surface with a sparse simple and stellate indumentum; abaxial surface with a sparse stellate indumentum. *Petals* midrib not raised abaxially, 2.5-3 mm long, 1-1.5 mm wide, enlarging to 4-4.5 mm long with mature fruit; adaxial surface with a moderate to dense stellate indumentum, becoming glabrous towards base; abaxial surface with a sparse to moderate stellate indumentum. *Stamens* with filaments bearing stiff bifid or stellate hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.5-2 mm long, distal 0.5 mm prominently glandular; antepetalous filaments smooth, 1 mm long; anthers abaxial surface not frosty, antepetalous anthers much larger than antesepalous anthers; anther apiculum present, minute or large and erect; glabrous (Figures 10W,X). *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; style glabrous or hirsute at base; stigma rounded, not or scarcely wider than style. *Cocci* (mature not seen) with a moderate stellate and simple indumentum, 6 mm long, 2.5 mm wide. *Seed* not seen. (Figure 10T-X)

*Specimens seen.* Known from the type material only.

*Distribution.* Known from the Osmond Plateau, south-east Kimberley Region, Western Australia. (Figure 12)

*Habitat.* Found growing in sand amongst boulders (collector's notes).

*Phenology.* Flowering and fruiting material was collected in July.

*Conservation status.* As the species is known only from the type collection a code of 1K is appropriate. Listed as a Priority 2 category on the Priority Flora List of the Department of Conservation and Land Management of Western Australia.

*Etymology.* The epithet is derived from the Latin, *minutas* - small and *pinnae* - wings and alludes to the small pinnae of the leaves.

*Affinities.* Closely related to *B. filicifolia* from which it can be distinguished by having smaller and fewer pinnae, the abaxial surface of the leaves having a moderate to dense indumentum, smaller anthopodia, and perianth parts with a sparse indumentum.

**10. Boronia rupicola** Duretto, *sp. nov.*

A aliis speciebus *Boroniae* sectionis *Valvatarum* (Benth.) Engl. habitu pendulo, floribus parvis flavo-virentibus, et foliis planis differt.

*Typus*: 18 km south-east of Jabiru, outlier of main Plateau, Northern Territory, 12°48'S, 132°55'E, 30 March 1981, *L.A. Craven* 6646 (*holo*: CANB 338121; *iso*: A, AD, BRI, CANB 338122, DNA *n.v.*, E, L, MEL).

Pendulous *subshrub* to 40 cm long, capable of regrowing from rootstock, glabrous or with a dense stellate indumentum. *Multiangular stellate hairs* mostly sessile but occasionally stalked, with 10-20+ rays; rays firm, straight, smooth, glossy, unfused, unicellular, epidermal in origin, white to faintly yellow, to 0.05(0.1) mm long (Figure 14A-C). *Simple hairs* (mainly on adaxial surface of leaves) erect, 0.01-0.02 mm long (Figure 14A). *Branches* brittle, quadrangular, decurrencies absent, not glandular, hairs distributed evenly, becoming glabrous with age, little or no cork development. *Leaves* opposite decussate, simple, unifoliolate or imparipinnate, 1-7 pinnae, becoming simple with age, 5-15 mm long, 1-4 mm wide; lamina strongly discolourous, paler beneath, dorsiventral, not obviously glandular, scattered nonsecretory glands in mesophyll, palisade mesophyll tightly packed, epicuticular waxes absent; pinnae and simple leaves elliptic to oblanceolate, sessile to subsessile, tip obtuse, base attenuate to obtuse, margin entire and flat; midrib not raised significantly abaxially, tightly packed parenchyma with secondary thickening between midvein and abaxial epidermis; adaxial surface smooth, glabrous or with a sparse indumentum with multiangular stellate hairs and minute erect simple hairs (Figure 14A); abaxial surface glabrous or with a dense indumentum made up of a heterogenous layer of two hair types: a sparse to moderate layer of multiangular hairs (some stalked) and a dense layer of smaller planer stellate hairs (Figure 15B,C); terminal pinnae longer than preceding laterals but shorter than other laterals, midrib straight, 7-10 mm long, 1-3 mm wide; lateral pinnae opposite, 4-10 mm long, 1-3 mm wide; rachis segments winged, oval or triangular with distal end wider, 4-7 long 0.5-1 wide; petiole 1.5-7 mm long. *Inflorescence* cymose, 1(3)-flowered, with a dense stellate indumentum; peduncle terete in cross section, non woody and deciduous with flower, 0.5-1 mm long; prophylls persistent, linear to minutely unifoliolate, 1-6.5 mm long, 0.5-1.5 mm wide, indumentum as leaves; metaxyphylls persistent, minute to 0.5 mm long; anthopodium 0.5-3 mm long. *Flowers* yellow-green (Figure 13C,D). *Sepals* ovate-deltoid, acute to slightly acuminate, much shorter and narrower than petals, 1-1.5 mm long, c. 1 mm wide, not enlarging significantly with fruit; adaxial surface with a sparse simple indumentum, becoming glabrous towards base; abaxial surface with a sparse to dense stellate indumentum. *Petals* midvein slightly raised abaxially, 2-2.5 mm long, 1.5 mm wide, not enlarging significantly with mature fruit; adaxial surface with a sparse simple indumentum, becoming glabrous towards base; abaxial surface with a sparse to dense stellate indumentum. *Stamens* with filaments clavate, tapering to anther connective, with stiff simple hairs abaxially and on margins below glandular tip; antesepalous filaments 1.5 mm long, distal 0.5 mm prominently glandular; antepetalous filaments smooth or slightly glandular distally, 1 mm long; anthers all equal, abaxial surface not frosty; anther apiculum absent or present, glabrous, erect (Figure 13E,F). *Disc* entire, glabrous, not surrounding base of filaments. *Ovary* glabrous; style hirsute at base; stigma rounded, not or scarcely wider than style (Figure 13G). *Cocci* glabrous to moderately hirsute, 3.5 mm long, 2 mm wide (Figure 13D). *Seeds* black or grey, shiny or dull, adaxial side with or without minute ridge, 2-3 mm long, 1-1.5 mm wide; elaiosome yellow-white; testa surface at magnification ± tuberculate; tubercles unicellular, smooth, anticlinal walls ± visible, often collapsed, 6-55 µm across (Figure 9G-I). (Figure 13)

*Other specimens examined.* NORTHERN TERRITORY; DARWIN & GULF DISTRICT: Baroalba Creek, 31 Mar. 1990, *K. Brennan* 142 (OSS); Tin Camp Creek, 6.5 km WNW of Myra Falls, *c.* 12°27'S, 133°17'E, 17 Apr. 1993, *K. Brennan* 2269 (OSS); 11.5 km ESE of Nabarlek, *c.* 12°20'S, 133°26'E, 13 June 1993, *K. Brennan* 2356 (MEL, OSS); *c.* 17 km SE of Jabiru, 12°47.5'S, 132°57.5'E, *L.A. Craven* 6581 (CANB); Radon Gorge, Mt Brockman, 12°45'S, 132°54'E, 21 Apr. 1980, *C.R. Dunlop* 5455 (DNA, NSW); Tin Can Creek *c.* 20 miles [32 km] S of Nabarlek Mining Camp, 12°28'S, 133°15'E, 30 May 1973, *T.G. Hartley* 13819 (CANB, DNA); Nabarlek, 12°22'S, 133°23'E, 11 July 1989, *Hinz* 565 (DNA); Gulungul Creek, mouth of Radon Gorge, 4 km WSW of Mt Brockman, Kakadu National Park, 12°45'S, 132°55'E, 21 June 1980, *I.R. Telford* 7931 & *J.W. Wrigley* (CBG); 6.5 km SSW of Mt Brockman, Kakadu National Park, 12°48'S, 132°56'E, 23 Apr. 1980, *I.R. Telford* 8058 & *J.W. Wrigley* (CANB, CBG).

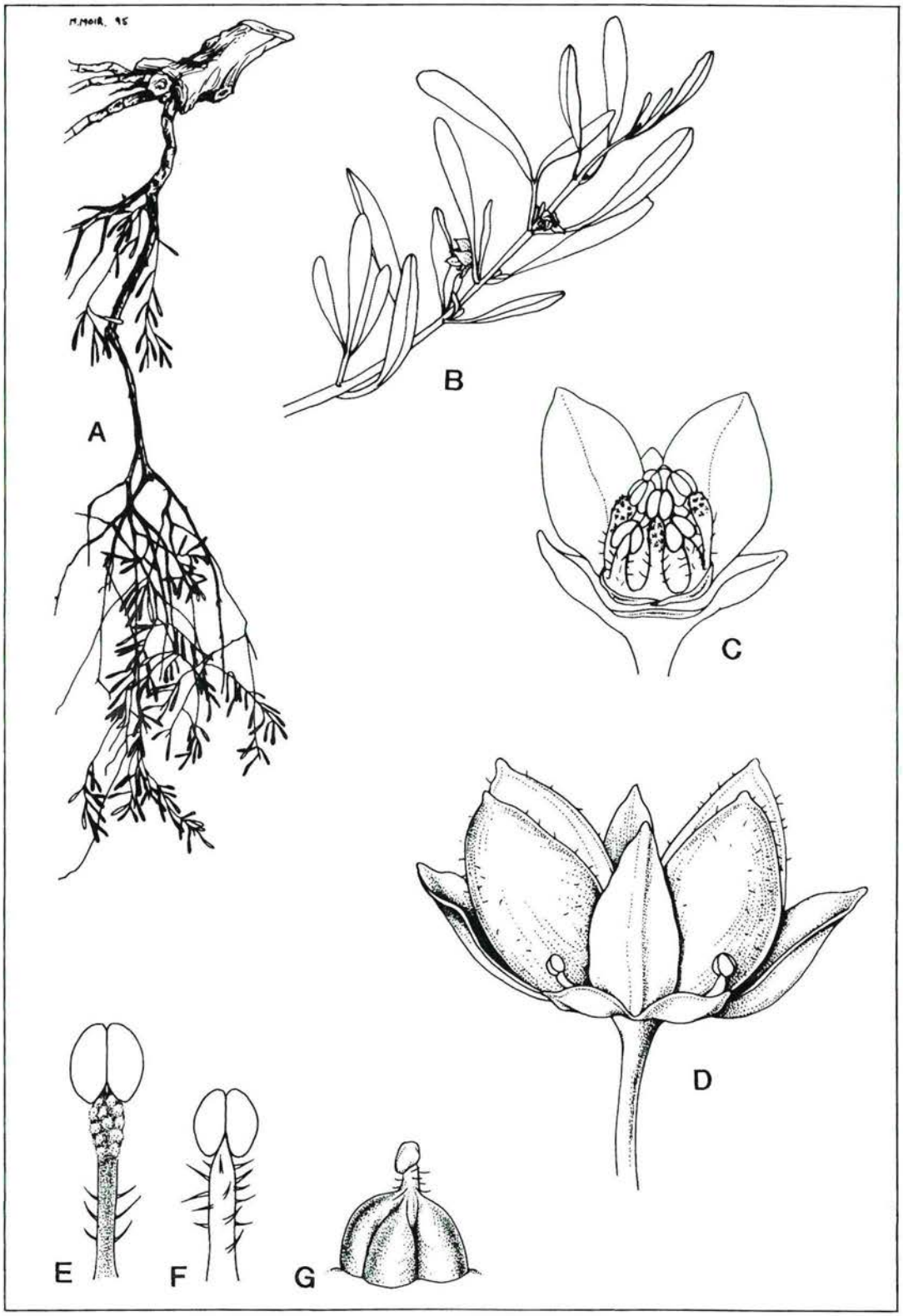


Figure 13. *Boronia rupicola* A - habit (x0.5). B - habit (x3). C - flower, one sepal and two petals removed (x10). D - fruiting flower (x10). E - antesepalous stamen (x20). F - antepetalous stamen (x20). G - gynoecium (x20). Drawn from *L.Craven* 6646 *(isotype*, MEL 338122) (A,B), and *K.Brennan* 2356 (MEL) (C-G). Drawing prepared by Mali Moir.

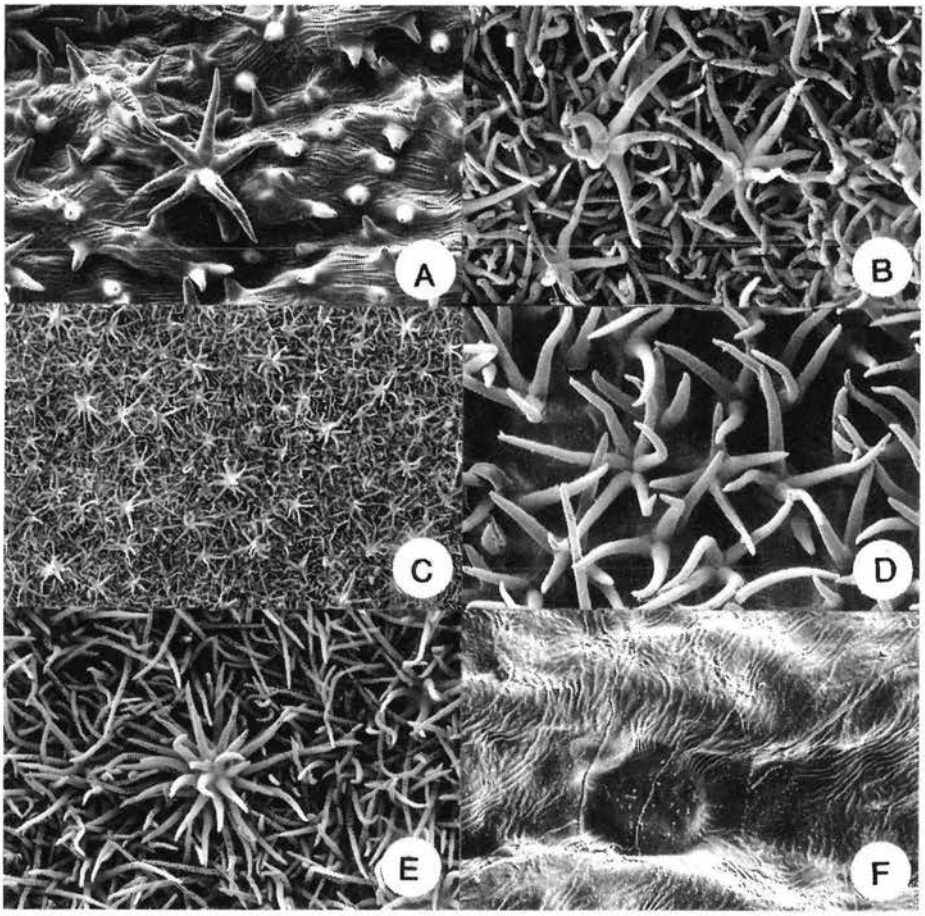


Figure 14. Scanning electron micrographs of leaf surfaces. A-C *B. rupicola*: A - adaxial surface, x250 (*Craven* 6646, CANB); B,C - abaxial leaf surface, B - x250, C - x55 (*Brennan* 2356, MEL). D-F *B. lanceolata*: D - hirsute adaxial surface, x350; E - abaxial surface, x200 (D,E, *Fryxell et al.* 4916, MEL); F - glabrous adaxial surface, x350 (*Weber* 10087, MEL).

*Distribution.* Known only from the Mt Brockman outlier (Kakadu National Park) and around the Nabarlek mining lease (Arnhem Land), the Northern Territory. (Figure 15A)

*Habitat.* Pendulous shrub found exclusively on vertical sandstone surfaces.

*Phenology.* Flowering and fruiting material collected from March to July.

*Conservation status.* Briggs & Leigh (1996) gave this species a conservation code of 2RC- for both the Nabarlek (their *B. sp. 5*) and Mt Brockman (their *B. sp. 6*) populations: the appropriate code for *B. rupicola* is 2RC-. Neither population is under immediate threat as the species is found in rugged and isolated terrain. Any developments in either area, such as tourism or mining, should be monitored as the habitat of this species is fragile.

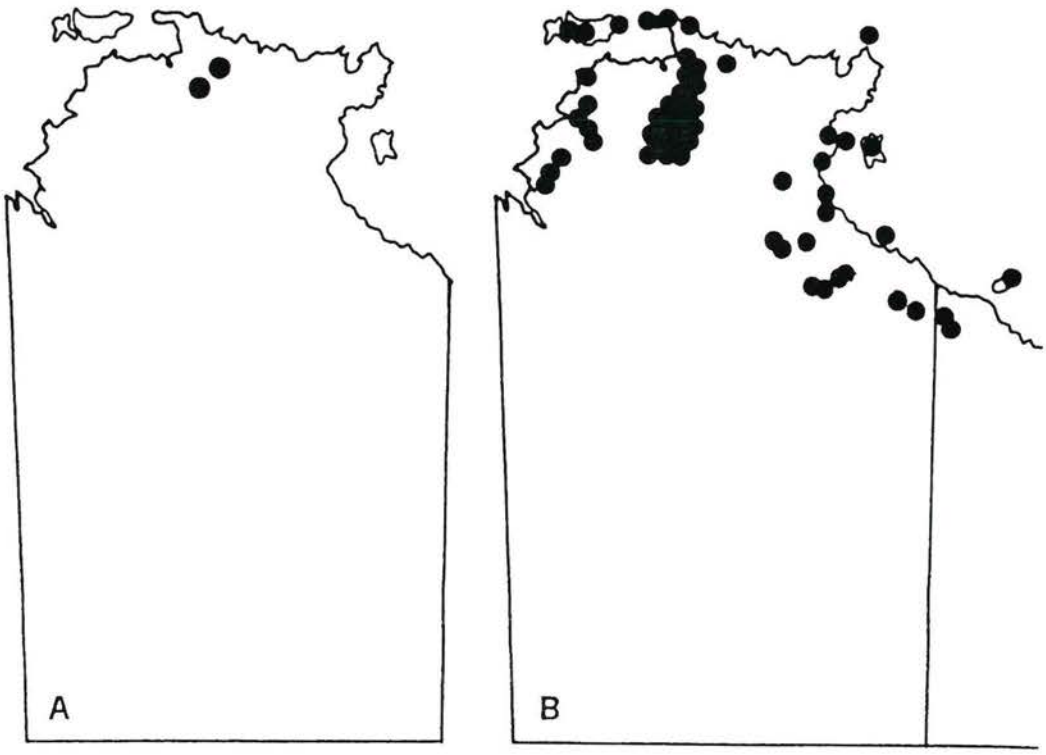


Figure 15. The Northern Territory and north-west Queensland. Distribution of: A - *B. rupicola*; B - *B. lanceolata*.

*Etymology.* The epithet is derived from the Latin, *rupestris* - rocky and *incola* - inhabitant, and alludes to the specialised habitat of this species.

*Affinities.* The taxonomic position of this species within section *Valvatae* is unresolved but certainly isolated. Cladistic analysis of section *Valvatae* (Duretto 1995, Duretto & Ladiges in prep.) places this species with the '*B. ledifolia* (Vent.) J.Gay ex DC. group' of Weston (1990). It is one of three species of *Boronia* that colonizes vertical rock faces in the north-west portion of the Arnhem Land plateau. *Boronia rupicola* can be distinguished from these other species by its sepals being much smaller than its petals, pendulous habit and compound leaves (though these are not always present). The last two characters also distinguish it from *B. lanceolata*, the only other species in the region with sepals much smaller than the petals.

*Notes.* Called *B. sp.* 1 at OSS, A44419 (Nabarlek) and DNA17279 (Radon Gorge) in Leach *et al.* (1992), and *B. sp. 5* (Nabarlek; *T.G. Hartley* 13819) and *B. sp. 6* (Radon Gorge; *C.R. Dunlop* 5455) in Briggs & Leigh (1996). Both glabrous (e.g. *Craven* 6581 and *Hartley* 13819) and hirsute plants (e.g. *Craven* 6646 and *Hinz* 565) have been collected from the Nabarlek and Mt Brockman areas. The two taxa listed by Leach *et al.* (1992) and Briggs & Leigh (1996) are based on glabrous (*viz.* A44419 and *B. sp. 5*) and hirsute (*viz.* DNA17279 and *B. sp. 6*) specimens. Some obviously old plants, e.g. *Craven* 6581 (CANB 338126) are glabrous, and so being glabrous does not appear to be a juvenile condition. Glabrous plants of normally

hirsute taxa of section *Valvatae* do occur (Duretto 1995). Detailed population surveys are required to determine the taxonomic importance, if any, of hair density in this species.

**11. Boronia lanceolata** F. Muell., Fragm. 1: 66 (1859). *Type*: M'Adam [Macadam] Ranges, [Northern Territory], *F.v.Mueller,* Oct 1855 (*lecto* (here designated): K *n.v.* (cibachrome & slide MEL); *isolecto:* MEL). *Residual syntypes:* Arnhem Land, *F.v.Mueller* (*syn:* K *n.v.* (cibachrome & slide MEL), MEL); Point Efingstone, *F. Mueller* (*syn:* MEL).

*Illustration.* K. Brennan, Wildfl. Kakadu 34 (1986).

Erect, rarely pendulous, much branched *shrub* to 250(400) cm high, with a moderate to dense stellate indumentum. *Multiangular stellate hairs* sessile, with 10-25+ rays; rays unicellular, epidermal in origin, unfused, firm, straight, not appressed, glossy, smooth, white to faintly yellow, to 0.1 mm long (Figure 14D,E). *Branches* terete, not glandular, little or no cork development, without decurrencies, with a dense stellate indumentum, hair density even around stem, becoming glabrous with age. *Leaves* opposite decussate, rarely subopposite or in whorls of three, simple (juvenile and mature), 8-90 mm long, 3-27 mm wide; lamina strongly discolourous, paler beneath, narrowly elliptic to elliptic-lanceolate, acute, ± slightly mucronate, cuneate to obtuse, dorsiventral, not obviously glandular, scattered nonsecretory glands in mesophyll, palisade mesophyll usually tightly packed, epicuticular waxes absent; margins entire, flat to slightly recurved; adaxial surface glabrous-glabrescent (hairs along midrib only; Figure 14F) or with a dense stellate indumentum (Figure 14D); abaxial surface with a dense indumentum of a heterogenous layer of two hair types: a sparse to moderately dense layer of multiangular stellate hairs, and a dense layer of smaller planer, stellate hairs (Figure 14E); midrib impressed adaxially, raised prominently abaxially, tightly packed parenchyma cells between midvein and abaxial epidermis with secondary thickening; petiole 3-16 mm long; juvenile leaves with a sparse to moderate indumentum, indumentum becoming more dense on progressive nodes, the multiangular stellate hairs appearing before the planer, stellate hairs. *Inflorescence* cymose, often appearing umbellate, 3-7(15)-flowered, with a dense stellate indumentum; peduncle slightly flattened to terete in cross section, non woody and usually deciduous, 0.5-9 mm long; prophylls minutely unifoliolate, persistent, 0.5-6 mm long, to 4 mm wide; metaxyphylls persistent, minute to 0.5 mm long; anthopodium 0.5-5 mm long. *Sepals* shorter and narrower than petals, ovate-deltoid, acuminate, 1-3 mm long, 1-2 mm wide, not enlarging significantly with fruit; adaxial surface glabrous to glabrescent with few stellate hairs near tip; abaxial surface with a dense stellate indumentum. *Petals* abaxial surface with prominently raised midrib, pink or white, 2-5.5 mm long, 1.5-3 mm wide, enlarging to 2.5-7 mm long and 2-4 wide with mature fruit; adaxial surface with a sparse to moderate simple or stellate indumentum, becoming glabrous towards base; abaxial surface with a moderately-dense stellate indumentum, rays of hairs usually firm, glossy and straight. *Stamens* with filaments clavate, tapering to anther connective, glabrous or rarely bearing few stiff simple hairs abaxially or along margins below glandular tip; antesepalous filaments 2-2.5 mm long, distal 0.5 mm prominently glandular; antepetalous filaments slightly to strongly glandular distally, 1-1.5 mm long; anthers all equal, abaxial surface not frosty; anther apiculum absent or rarely minute, glabrous. *Disc* entire, not surrounding base of filaments, glabrous. *Ovary* glabrous; styles glabrous; stigma rounded, not or scarcely wider than style. *Cocci* glabrous with occasional stellate hair along suture, 3-4 mm long, 2-2.5 mm wide. *Seeds* without ridge on adaxial side, shiny but sometimes dull, black or grey, 2-3 mm long, 1.5-2 mm wide, 2-4 mm long, 1.5-2.5 mm wide; elaiosome yellow-white; surface at magnification tuberculate; tubercles unicellular, surface smooth to wrinkled, often collapsed, anticlinal walls ± visible, 6-55 µm across (Figure 9J,K).

*Specimens examined (selected from c. 200 collections).* NORTHERN TERITORY; DARWIN & GULF DISTRICT: Channel Island, Darwin Harbour, 12°34'S, 130°52'E, 3 Feb. 1972, *N. Byrnes* 2376 (DNA);

Sandstone plateau near Glyde River, Macarthur River area, 16°27'S, 136°10'E, 29 May 1976, *L.A. Craven* 3910 (CANB, DNA); Deaf Adder Gorge, 22 Apr. 1980, *C.R. Dunlop* 5475 (CBG, DNA); Bloomfield Springs, Mary River, Kakadu National Park, 15 Sep. 1987, *C.R. Dunlop* 7084 & *Wightman* (DNA); Just before Koongarra saddle, on track to mine site, Kakadu National Park, 12°50.73 S, 132°51.40'E, 16 June 1993, *M.F. Duretto* 446, *J. Chappill & G. Howell* (BRI, DNA, MEL); Saddle/ridge above side creek, just downstream & W of plunge pool, Barramundi Gorge, Kakadu National Park, 13°19.15'S, 132°26.13'E, 18 June 1993, *M.F. Duretto* 463, *J. Chappill & G. Howell* (MEL); Ikoymarrawa Lookout, *c.* 9 km W of Mary River crossing on Jabiru road, Kakadu National Park, 13°34.61 S, 132°15.34'E, 29 June 1993, *M.F. Duretto* 533-7, *J. Chappill & G. Howell* (MFD533-535, 537 - MEL; MFD536 - DNA, MEL); E end of Melville Island, 1.5 km N of Soldier Point, 11°28'S, 131°32'E, 25 June 1985, *P.A. Fryxell, L.A. Craven & J. McD.Stewart* 4916 (CANB, DNA, MEL); Cox River Station, 15°50'S, 134°43'E, 9 July 1977, *T.S. Henshall* 1678 (CANB); 16 km S of Twin Falls, 13°28'S, 132°46.5'E, 5471-592109, 24 May 1980, *M. Lazarides* 8960 (CANB, DNA, NSW); Wilgran Island, English Company Islands, 11°45'S, 136°37'E, 24 July 1992, *G.J. Leach* 3072 (CANB); Butterfly Gorge, Katherine Gorge, 14°19'S, 132°28'E, 4 Aug. 1983, *D.J. Nelson* 2645 (DNA); Adjacent to Round Jungle, Kakadu National Park, 13°18'S, 132°38'E, 30 Apr. 1987, *J. Russell-Smith* 2158 & *D. Lucas* (CANB, DNA); Deaf Adder Gorge, 13°07'S, 132°56'E, 22 Apr. 1980, *I.R. Telford* 7999 & *J.W. Wrigley* (CBG, DNA, NSW); Ngarradj Warde Jobkeng, SW of Cahills Crossing, East Alligator River, 12°27'S, 132°56'E, 18 Apr. 1983, *H.S. Thompson* 286 (AD, CBG, MEL); Moline Rock Holes, 9 km NE of Mary River on Pine Creek-El Sharana road, 13°32'S, 132°12'E, 8 May 1983, *K.L. Wilson* 5217 (DNA, NSW).

VICTORIA RIVER DISTRICT: Vicinity of Woolaning Homestead, 13°06'S, 130°40'E, *L.A. Craven & C. Dunlop* 6686 (CANB, DNA); Candy Rock Range, *c.* 23 km ESE of Daly River police station, 13°50'S, 130°54'E, 23 June 1985, *P.A. Fryxell, L.A. Craven & J. McD.Stewart* 4897 (CANB).

QUEENSLAND; BURKE DISTRICT: Amphitheatre, *c.* 27 km N of Musselbrook Mining Camp, 18°21'S, 138°09'E, 12 June 1995, *J.R. Clarkson* 10483 (MEL); 3 miles [4.8 km] W of Westmoreland Station, 17°20'S, 138°13'E, 5 June 1948, *R.A. Perry* 1351 (BRI, CANB, DNA); Appel Channel, Mornington Island, Wellesly Islands, Gulf of Carpentaria, 16°29'S, 139°34'E, June 1963, *N.B. Tindale & P. Aiken* (AD).

*Distribution.* Found from Mornington Island and Westmoreland, north-west Queensland, to the Macadam Ranges and the Tiwi Islands, the Northern Territory, including the nearby islands in the Gulf of Carpentaria and off Arnhem Land. (Figure 15B)

*Habitat.* A denizen of the sandstone monsoon forest, woodland and heath communities (Brennan 1986; pers. obs.).

*Phenology.* Flowering and fruiting material has been collected from May to February.

*Conservation status.* Widespread, well represented in conservation reserves (though not in far western or far eastern Northern Territory, or in Queensland), and not under immediate threat.

*Etymology.* The specific epithet refers to the lanceolate leaves (Bailey 1883).

*Typification.* Mueller (1859) did not cite any specimens when he described *B. lanceolata* and it can be assumed that the description was based on material he had collected on Gregory's 1855-56 expedition to northern Australia. Bentham (1863) cites three specimens of *B. lanceolata* (*viz.*: Islands of Gulf of Carpentaria, *R. Brown*; Port Essington, *Armstrong & Leichardt*; Stoney places in Arnhem Land and Carpentaria, *F. Mueller*). Specimens matching some of these localities have been located at K and MEL. Of these, Mueller would have definitely seen only his own collection before 1859, and so only this specimen can be confidently called a syntype. In addition, other Mueller collections (Point Effington,

*F. Mueller* [MEL]; M'Adam Range, Oct 1855, *F. Muell.* [K, MEL]) have been located. This material had obviously been seen by Mueller before the description of *B. lanceolata* and so are also syntypes. As the M'Adam Range (now called Macadam Range) specimen lodged at K is in the best condition, it is chosen as lectotype.

*Affinities. Boronia lanceolata* is not easily confused with any other species over its range, being more closely related to presently undescribed species from central Queensland. It can be distinguished from other Northern Territory and north-western Queensland species by the sepals being significantly smaller than the petals, and by the simple leaves having a prominently raised midrib on the abaxial surface. It is distinguished from other large, simple-leaved members of *Boronia* section *Valvatae* (eastern Queensland, New South Wales and Victoria) by the small flowers and glabrous to glabrescent staminal filaments.

*Notes. Boronia lanceolata* is the most common and widespread *Boronia* in the Northern Territory and north-west Queensland. It is a variable taxon; leaves range from small to very large, and from broadly lanceolate-elliptic to narrowly elliptic, and the flowers, fruit and seed also show significant variation in size. Some collections from between Twin Falls and Moline Rock Hole, Kakadu National Park, (e.g. *Duretto* 533-7 *et al.*, *Wilson* 5217) have very narrow, but long leaves. Other collections in this area (e.g. from Barramundi Gorge and UDP Falls) have the more 'typical' elliptic or lanceolate leaf. Moderately narrow-leaved specimens have also been collected from Melville Island (*Fensham* 126 & 244), Darwin (*Byrnes* 2376), Round Jungle (*Russell-Smith* 2158 *& D. Lucas*), Twin Falls (*Lazarides* 8960), Bloomfield Springs (*Dunlop* 7084 *& Wightman*), and Katherine Gorge (*Nelson* 2645). The very narrow-leaved variant and a very large-leafed variant (north-west Arnhem Land plateau) represent extreme conditions between which there is a continuous grade and so no taxonomic limits could be placed confidently on any of these 'forms'. Plants are usually erect but two collections from Deaf Adder Gorge (*Telford* 7999 *& Wrigley* and *Dunlop* 5475) are from pendulous plants (collectors' notes). These plants also have small flowers, but are otherwise very similar to typical *B. lanceolata.*

Leaves of the majority of plants have a glabrous adaxial surface (Figure 14F), but the leaves of a significant percentage of plants have a dense indumentum on the adaxial surface (Figure 14D). Mueller labelled some of these specimens at MEL as '*Boronia velutina*' (an unpublished name used on several specimens including the K specimen 'Arnhem Land, F.v.Mueller') and is probably referring to this phenomenon. The glabrous and hirsute forms are broadly sympatric, but rarely occur in the same population (pers. obs.), though both 'forms' co-exist in the Barramundi Gorge population (*Duretto* 463, 469-472). Scanning electron microscopy of adaxial leaf surfaces revealed that as the epidermis is continuous and unbroken on the glabrous adaxial surface, the glabrous nature of some of these leaves is not due to deciduous hairs (Figure 14F). This feature does not appear to be of any taxonomic significance.

The almost bewildering variety found within *B. lanceolata* may be owing to the diverse environments and communities this taxon inhabits. Unlike the other boronias of the Northern Territory, *B. lanceolata* inhabits a wide variety of communities, from wattle scrub and heath in exposed areas of the plateau surface, to monsoon forests in sheltered gorges. It is also mesic, while the other taxa are more sclerophyllous. It is interesting to note that most of the morphological variation is found within Kakadu National Park between the Mt Brockman/Deaf Adder Gorge area and Katherine Gorge, Nitmiluk National Park, an area that is also problematic in populations of *B. grandisepala* (Duretto 1995; Duretto & Ladiges 1997) and *B. lanuginosa* (see above). *Boronia lanceolata* may have undergone some incipient speciation during the last glacial period when the area was much drier, and populations probably more isolated. Further studies, involving extensive collecting in these areas and utilising data from sources

such as oils, flavonoids and isoenzymes, as well as morphology, are needed to ascertain whether this variation has any taxonomic significance.

Occasionally the leaves of *B. lanceolata* are arranged in whorls of three instead of the normal condition in *Boronia*, opposite and decussate (e.g. *Dunlop* 4712, *Fensham* 869). This is not unusual in plants with opposite decussate leaves (A.N. Drinnan pers. com.) and has also been observed in other boronias, such as *B. rosmarinifolia* A. Cunn. ex Endl. (Duretto 1995). Usually the secondary branches have the normal opposite decussate condition.

Bailey (1899) referred a north Queensland specimen, 'Cave Creek, WE Armit (FvM.)', to *B. lanceolata*. Collections from this locality have been located at MEL (in Mueller's herbarium) and can be confidently assigned to *B. bowmanii* F.Muell. (these specimens are annotated as *B. lanceolata* var. *pinnata*, an unpublished name). Hnatiuk (1990) states that *B. lanceolata* has been collected in the North Kennedy and Cook Districts of Queensland. The Cook District record is probably referring to Bailey (1899). The North Kennedy record may be due to one or two undescribed species of *Boronia* from the humid Wet Tropics (both with large, simple leaves which will be described in a later paper) that have been incorrectly assigned to *B. lanceolata*.

Some novel alkaloids have been isolated from *B. lanceolata* by Ahson *et al.* (1993) and shown to be similar to those of *B. ternata* Endl., the only other member of *Valvatae* sampled.

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# *Drosera paradoxa* (Droseraceae), a new species from northern Australia

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## Abstract

Lowrie, A. *Drosera paradoxa* (Droseraceae), a new species from northern Australia. Nuytsia 11 (3): 347-351 (1997). The new species *D. paradoxa* Lowrie is described and illustrated. It occurs in tropical northern Australia and belongs in *Drosera* sect. *Lasiocephala* Planchon.

## Introduction

A new species of carnivorous plant from the Kimberley region of Western Australia and the Northern Territory is described and illustrated. It is a member of *Drosera* subgen. *Drosera,* sect. *Lasiocephala* Planchon (Droseraceae) and brings the total number of named species in the section to 14. Lowrie (1996) gives a key to the other 13 species currently recognized in this section of *Drosera* L.

## Taxonomy

### Addition to key to section *Lasiocephala*

An additional couplet needs to be added to the end of the key to section *Lasiocephala* (Lowrie 1996) to accommodate the new species.

12 Inflorescence (including scape) glabrous ..... **D. broomensis**

12 Inflorescence (including scape) covered with woolly hairs ..... 13

13 Plants with clump-forming perennial stock giving rise to one or more leafy rosettes; petiole 0.4-0.8 mm wide in the centre ..... **D. petiolaris**

13 Plants with perennial, erect, woody stem up to 30 cm tall with a solitary terminal leafy rosette; petiole 0.2-0.4 wide in the centre ..... **D. paradoxa**

**Drosera paradoxa** A. Lowrie, *sp. nov.*

*Droserae petiolaris* affinis sed petiolis in centro 0.2-0.4 mm latis, rosullis foliaceis solitariis, foliis veteribus infra rosellam caducis; caulibus erectis soli deest etiam in plantis juvenilibus; caule in plantis maturissimis erecto ad 30 cm alto crasso lignaceo, foliis veteribus desunt, inflorescentia congesta, floribus 50-70 vel ultra.

*Typus*: Wren Creek, on road to Pantijan from Peter Lacy's camp on a tributary of Bachsten Creek, Western Australia, 16° 01' 32" S, 125° 14' 55.7" E, 1 August 1996, *A. Lowrie* 1514 (*holo*: PERTH 04680502; *iso*: MEL).

A fibrous-rooted *perennial herb*; stem woody, erect, short at first but with age up to 30 cm tall *c.* 1.5 mm diam., with a terminal active solitary leafy rosette, the leaves below the terminal rosette caducous; indumentum of white hairs, which are minutely spurred along their length, present on the petioles, lamina abaxial surface, inflorescence, scape and sepals in varying densities. *Leaves* of the rosette varying from erect (new inner ones) to horizontal (older outer ones); petiole linear, commonly 20-35 mm long at flowering, 0.4-0.6 mm wide near base, 0.2- 0.4 mm wide in the centre, narrowed to 0.1-0.15 mm wide at the base of the lamina, sparsely hairy; lamina sub-orbicular, 2.5-3 mm wide, 2-3 mm long, adaxial surface with insect catching glands positioned around the margins and smaller glands within, abaxial surface sparsely hairy. *Inflorescences* 1-5 arising from and/or below the leafy rosette (often rust-coloured), 20-40 cm long (including scape), densely hairy; raceme crowded, with 50-70 or more flowers; pedicels 0.5-1.5 mm long, pendulous in fruit. *Sepals* elliptic, oblong or oblanceolate, 2-3.5 mm long, 0.8-1 mm wide, abaxial surface hairy. *Petals* pink or white, with or without a red centre, or cerise, obovate, 4-12 mm long, 2.7-11 mm wide. *Stamens* 2-3 mm long. *Ovary* obovoid, *c.* 0.5 mm long, *c.* 0.7 mm diam. at anthesis, carpels 3. *Styles* 3, *c.* 1.1 mm long (including stigmas), divided into many branching segments in the upper portion, with each segment terminating in a clavate stigma. *Fruit* obovoid 0.7-0.8 mm long, 0.7-0.8 mm diam., containing *c.* 15 seeds. *Seeds* black, ellipsoid, reticulate, 0.3-0.35 mm long, *c.* 0.2 mm diam. (Figure 1)

Other specimens examined. NORTHERN TERRITORY: Deaf Adder Gorge, Kakadu, 24 Feb. 1977, *R. E. Fox* 2566 (DNA); 3 km SE of Jim Jim Falls, Arnhem Land, 24 Mar. 1984, *D. L. Jones* 1519 (DNA); Waterfall Creek, Kakadu, 4 Aug. 1993, *F. Rivadavia* 236 (PERTH).

WESTERN AUSTRALIA: 62 km N of Beverley Springs homestead, 22 Dec. 1992, *R. L. Barrett* 412 (PERTH); Bachsten Creek camp, 30 km E of Pantijan, W Kimberley, July 1994, *M. Hancock* 19 (PERTH); King Edward River crossing on road to Mitchell Plateau, 24 June 1994, *A. Lowrie* 993 (DNA, MEL, PERTH); Ngoollalah Creek crossing on Kalumburu road 12 km N of turn off to King Edward River, 26 June 1994, *A. Lowrie* 1005, 29 Sep. 1995, *A. Lowrie* 1344 (DNA, MEL, PERTH); Garlcarinangui Creek on road to Pago Mission, 26 June 1994, *A. Lowrie* 1015 (DNA, MEL, PERTH); Unamon Creek on road to Pago Mission, 26 June 1994, *A. Lowrie* 1023 (DNA, MEL, PERTH); Pago Mission ruins, 26 June 1994, *A. Lowrie* 1024 (DNA, MEL, PERTH); headwaters of the Hann River, Mt Elizabeth, 14 June 1995, *A. Lowrie* 1304 (DNA, MEL, PERTH); Creek crossing at 16° 3' 46" S, 125° 23' 38" E, on road to Beverley Springs from Bachsten Creek, 2 Aug. 1996, *A. Lowrie* 1523 (DNA, MEL, PERTH); first creek crossing N of Honeymoon Beach turn off on Kalumburu-Pago road, 4 July 1997, *A. Lowrie* 1769 & 1770 (DNA, MEL, PERTH); Noseda Creek, E end of Napier Broome Bay, 28 Mar. 1993, *A. A. Mitchell* 2971 (PERTH, BROOME).

*Distribution. Drosera paradoxa* is widely distributed from the west and north coasts of the Kimberley inland to Beverley Springs in Western Australia and eastwards to Arnhem Land and Kakadu National Park in the Northern Territory.

*Habitat. Drosera paradoxa* grows in skeletal sandy soils over sandstone pavement on the banks as well as in the beds of seasonally dry creeks; in the cracks of sandstone pavements as well as amongst sandstone boulders. The habitats of *D. paradoxa* are commonly covered with a considerable depth of fast-flowing water in March-April during the wet season.

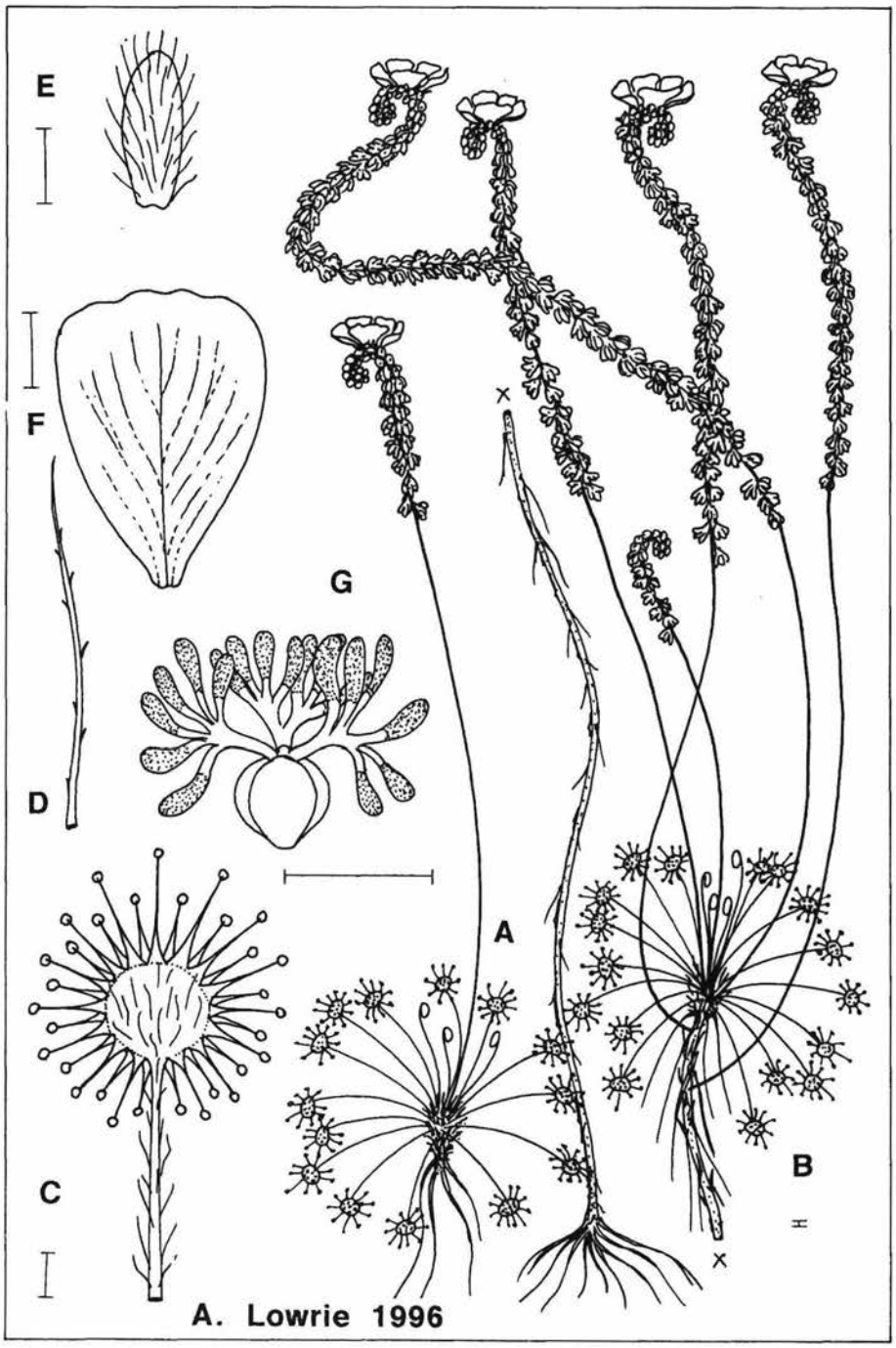


Figure 1. *Drosera paradoxa* A - habit of young plant; B - habit of plant many seasons' old; C - leaf; D - hair found on petioles, abaxial lamina surface, scape and sepals, enlarged; E - sepal; F - petal; G - gynoecium. Scale bars = 1 mm. Drawn from *A. Lowrie* 1514.

*Flowering Period.* July-September (during the dry season).

*Conservation status. Drosera paradoxa* is a common species in Western Australia and the Northern Territory and is currently not under threat.

*Etymology.* The epithet, *paradoxa* from the Greek - *paradoxos,* refers to this species complicated and secretive growth cycle which was only revealed after extensive studies on many occasions in the field, often under difficult, dangerous and uncomfortable circumstances in both the wet and dry seasons from 1993-1997.

*Affinities.* The closest relative to *Drosera paradoxa* appears to be *D. petiolaris* R. Br. whose distinguishing characters are given in parenthesis. *D. paradoxa* is distinguished by having an erect woody stem up to 30 cm tall with a solitary terminal leafy rosette (clump-forming perennial stock giving rise to one or more leafy rosettes) bearing leaves with extremely narrow petioles 0.2-0.4 mm wide in the centre (0.4-0.8 mm wide in the centre); old leaves below the terminal rosette soon caducous (basal portions of spent leaves persisting); and inflorescence 50-70-flowered or more, crowded, up to 40 cm long including the scape (inflorescence 10-25-flowered, not crowded, up to 20 cm long including the scape).

*Notes.* The early field observations of *Drosera paradoxa* presented a paradox. *D. paradoxa* appeared to be an annual after seedling populations were observed at a number of locations where mature plants had occurred the previous season; habitats were found where only very tall woody-stemmed flowering specimens were present; and at other locations rosetted plants without woody stems occurred. It was only after many field observations that these various forms of *D. paradoxa* were shown to be only stages of its perennial growth cycle.

In an exceptionally good wet season the habitats of *Drosera paradoxa* can be scoured free of most vegetation. I observed the results of an event such as this at the King Edward River crossing in the Kimberley region in July 1997. At this location the entire population of *D. paradoxa* (*A. Lowrie* 993) which I had studied each year between 1994-1996 had been washed away by flood waters. Observations however, showed that the renewal of this population had already begun with the discovery of many *D. paradoxa* seedlings 1-2 cm in diam. on the bare soil of the river's floodway margins. Clearly it is only specimens securely anchored to the soil against the ravages of fast flowing flood waters over many wet seasons that produce tall erect woody stems.

A possible new species with an erect growth habit similar to that of *Drosera paradoxa* has recently been discovered in a remote region of the Kimberley. This new taxon differs from *D. paradoxa* by only attaining a height of *c.* 5 cm, its fewer, shorter leaves and its metalic-orange flowers. Further examination of this taxon in the field as well as cultivation is needed to determine whether it warrants specific status.

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companionship in the field; Paul Wilson for his assistance with the Latin diagnosis; Barbara Rye for her comments and the staff at the Western Australian Herbarium.

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Lowrie, A. (1996). New species in *Drosera* section *Lasiocephala* (Droseraceae) from tropical northern Australia. Nuytsia 11: 55-69.

# A taxonomic review of *Stylidium* subgenus *Forsteropsis* (Stylidiaceae)

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## Abstract

Lowrie, A. and Kenneally, K.F. A taxonomic review of *Stylidium* subgenus *Forsteropsis* (Stylidiaceae). Nuytsia 11 (3): 353-364 (1997). Three new species of *Stylidium* Willd. (Stylidiaceae) from south-west Western Australia, *Stylidium leeuwinense*, *S. marradongense* and *S. semaphorum* Lowrie & Kenneally are described and illustrated. Descriptions and illustrations of *S. imbricatum* Benth. and *S. preissii* (Sond.) F. Muell. are provided for comparison and to complete this review of *Stylidium* subgenus *Forsteropsis* (Sond.) Mildbr.

## Introduction

This paper presents a taxonomic review of *Stylidium* subgenus *Forsteropsis* (Stylidiaceae) which comprises five species of triggerplant from south-western Australia including three new species described here. All members of this subgenus of *Stylidium* Willd. are characterized by being plants with tightly appressed leaves spirally arranged around the stems. They are referred to under the common names Lizard Triggerplant for *S. preissii* and Tile-leaved Triggerplant for *S. imbricatum* (Erickson 1958) as well as for the three new species.

## Taxonomy

***Stylidium* subgenus *Forsteropsis*** (Sond.) Mildbr. (Mildbraed 1908: 31,33). - *Forsteropsis* Sond. (Sonder 1845: 393). *Type: Forsteropsis preissii* Sond. [= *Stylidium preissii* (Sond.) F. Muell.]

*Stylidium* ser. *Imbricatae* Benth. (Bentham 1869: 21). *Type: Stylidium imbricatum* Benth.

### Key to species of subgenus *Forsteropsis*

1 Flowers in umbellate racemes. Stigma round, cushion-shaped ..... **S. preissii**
1: Flowers in spike-like racemes. Stigma conical, capitate ..... 2
2 Hypanthium glabrous ..... 3
2: Hypanthium glandular ..... 4

3 Leaves with a long apical point. Sepals obovate ..... **S. imbricatum**
3: Leaves lacking an apical point. Sepals ovate ..... **S. leeuwinense**
4 Sepals ovate, apex acute. Corolla lacking throat appendages ..... **S. marradongense**
4: Sepals narrowly ovate with apical mucro. Corolla with throat appendages ..... **S. semaphorum**

**Stylidium imbricatum** Benth. (Bentham 1837: 73). *Type:* Interior of King George Sound, [Western Australia], *Huegel* (*holo*: K; *iso*: fragment attached to Harvey, King George Sound, MEL 710000).

*Perennial herb*, with erect divided stems covered with appressed, tile-like leaves spirally arranged around the stem. *Leaves* basifixed, green, ovate-elliptic, 1.5-1.8 mm long, 0.6-0.8 mm wide, with silvery white mucro 0.6-0.8 mm long, pilose at the base, hyaline margins silvery white, dentate-laciniate. *Racemes* terminal, spike-like; pedicels 1.5-2 mm long; bracts silvery white, *c.* 3 mm long, fringed; bracteoles similar, *c.* 2 mm long. *Hypanthium* obovoid at anthesis, *c.* 2.5 mm long, *c.* 1 mm wide, glabrous. *Sepals* free to base, obovate, *c.* 2 mm long, glabrous; hyaline margin silvery white, fringed. *Corolla* reddish violet, with laterally-paired lobes; anterior lobes *c.* 4.5 mm long, *c.* 3 mm wide; posterior lobes *c.* 4.5 mm long, *c.* 3 mm wide. *Labellum* subulate, reddish and black at the base, *c.* 2.9 mm long, *c.* 0.7 mm wide, margins bearing long hair-like stalked glands, with 2 basal acicular appendages; appendages *c.* 1.5 mm long, reddish maroon, the margins bearing a few long hair-like stalked glands; boss ovate, white, smooth, *c.* 0.7 mm long, *c.* 0.5 mm wide. *Throat appendages* 8, the 2 near the labellum *c.* 0.5 mm, the next 2 *c.* 1 mm and the 4 remaining ones *c.* 0.7 mm long. *Gynostemium* column *c.* 8 mm long; anthers black, pollen pale yellow; stigma conical, capitate. (Figure 1)

*Selected specimens examined.* WESTERN AUSTRALIA: Porongurup Range, Apr. 1939, *W.E. Blackall* (PERTH); Baby Barnett Hill, 34° 24' S, 117° 51' E, 20 Apr. 1980, *R.J. Cranfield* 1425 (PERTH); Stirling Range, N of Albany, May, *R. Erickson s.n.* (PERTH); Base of Mt Toolbrunup, Stirling Range, 23 Apr. 1923, *C.A. Gardner s.n.* (PERTH); Above Mondurup, Stirling Range, 4 May 1964, *C.A. Gardner* 14711 (PERTH); Foot of N side of Bluff Knoll, Stirling Range, 1 June 1958, *A.S. George s.n.* (PERTH); 2 miles [3.2 km] W of Karribank on Porongurups road, 28 Oct. 1966, *S.H. James s.n.* (PERTH); 2 km SE of Ellen Peak, Stirling Range, 11 May 1982, *G.J. Keighery* 4949 (PERTH); Mondorup Peak, 0.5 km up from road, Stirling Range, 34° 24' S 117° 49" E, 19 Apr. 1994, *K.F. Kenneally* 11443 (BRI, CB, DNA, MEL, PERTH); On South Coast Highway, 4.7 km NE of Cheynes Beach turn-off, E of Manypeaks, 2 May 1991, *A. Lowrie* 583 (PERTH); Cheyne Beach, 20 Apr. 1960, *G. Starkie s.n.* (PERTH); 6.9 miles [11 km] NNE of Cheynes Beach turn-off on Highway 1, 22 Mar. 1970, *M.D. Tindale* 315 & *B.R. Maslin* (K); Chester Pass, Stirling Range, 4 Sep. 1947, *J.H. Willis* 12 (PERTH).

*Distribution.* Stirling Range National Park, Porongurup Range and south-east to Cheynes Beach.

*Habitat.* Grows in laterite soils often mixed with a little white sand.

*Flowering period.* April-May.

*Conservation status.* Not considered to be at risk.

*Affinities. Stylidium imbricatum* is distinguished from all other members of subgenus *Forsteropsis* by having obovate sepals.

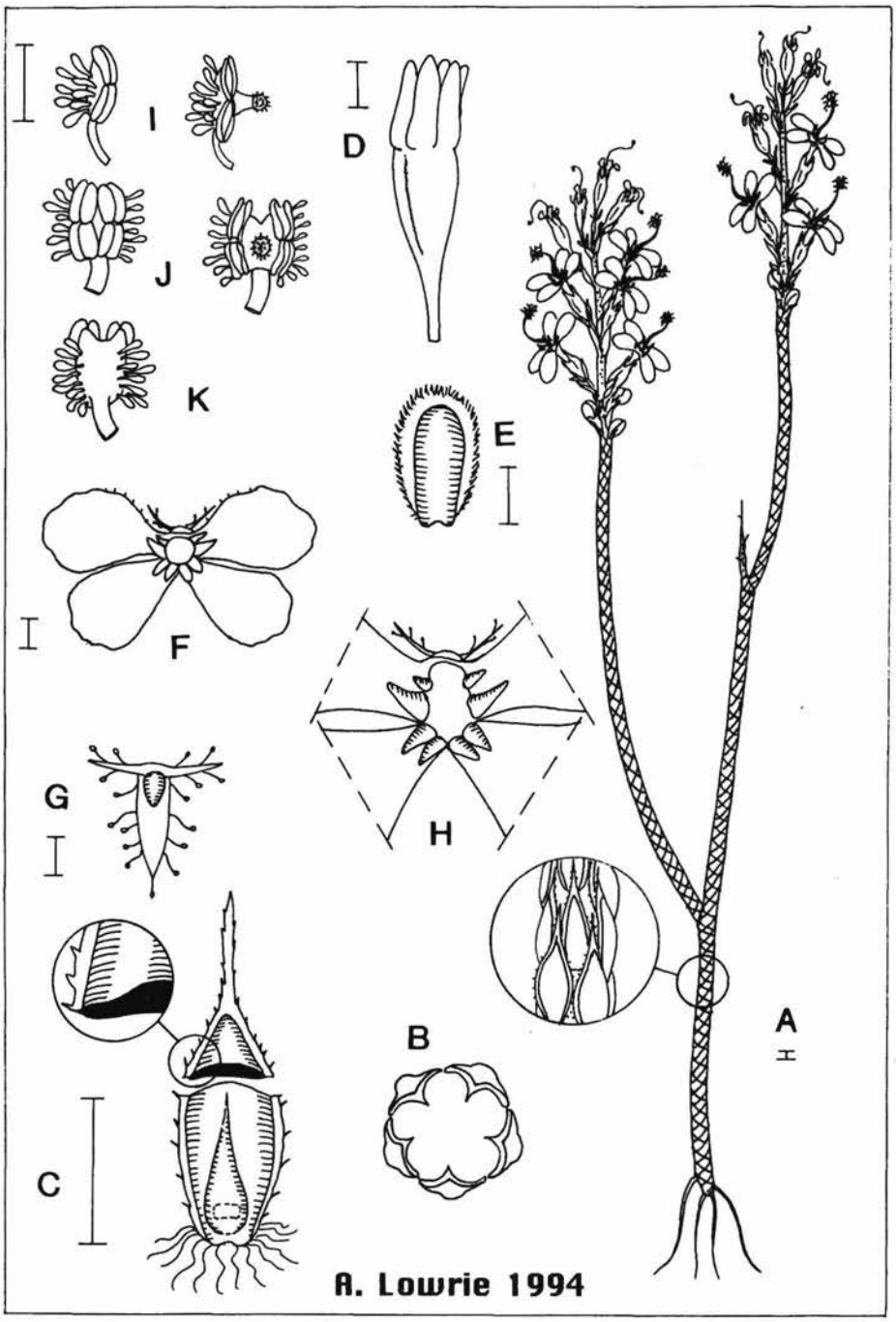


Figure 1 *Stylidium imbricatum* A - habit of flowering plant; B - section of stem showing spirally arranged leaves; C - leaf, enlarged section left; D - hypanthium; E - sepal; F - corolla; G - labellum; H - throat appendages; I - lateral view of gynostemium tip (with conical, capitate stigma at right); J - front view of gynostemium tip (with stigma grown out, right); K - back of gynostemium tip. Scale bar for all = 1 mm. Drawn from *A. Lowrie* 583.

**Stylidium leeuwinense** Lowrie & Kenneally, *sp. nov.*

*S. imbricato* Benth. affinis sed sepalis subulatis, foliis acumene apicali absenti atque foliis quatuor circum caulem dispositis differt.

*Typus:* South corner of the intersection of Scott River Rd and Govenor Broome Rd, *c.* 0.5 km north of Brennans Ford on the Scott River, Western Australia, 34° 17' S, 115° 25' E, 26 May 1996, *A. Lowrie* 1465 (*holo:* PERTH 04431170; *iso:* MEL).

*Perennial herb*, with erect divided stems covered with appressed, tile-like leaves spirally arranged around the stem. *Leaves* basifixed, green, lanceolate, 2.5-3.5 mm long, 0.5-0.8 mm wide, acute, without an apical mucro, pilose at the base, hyaline margins silvery white, dentate-laciniate. *Racemes* terminal, spike-like, flowers almost sessile; bracts silvery white, *c.* 3 mm long, fringed; bracteoles similar, *c.* 2.5 mm long. *Hypanthium* obovoid at anthesis, *c.* 2.5 mm long, *c.* 1 mm wide, glabrous. *Sepals* free to base, ovate, *c.* 1.5 mm long, glabrous; hyaline margin silvery white, serrate, surrounding a subulate body. *Corolla* reddish purple, with laterally-paired lobes; anterior lobes *c.* 4 mm long, *c.* 2.2 mm wide; posterior lobes *c.* 3 mm long, *c.* 1.8 mm wide. *Labellum* lanceolate, maroon, *c.* 3 mm long, *c.* 0.5 mm wide, margins bearing long white hair-like stalked reddish glands, with 2 basal acicular appendages; appendages *c.* 1.5 mm long, the margins bearing a few long hair-like stalked glands; boss ovate, white, smooth, *c.* 0.5 mm long, *c.* 0.3 mm wide. *Throat appendages* 8, the longest ones *c.* 1.5 mm long. *Gynostemium* column *c.* 7 mm long; anthers maroon, pollen pale yellow; stigma conical, capitate. (Figure 2)

*Other specimens examined.* WESTERN AUSTRALIA: Nut Rd and Ficifolia Rd junction, Walpole-Nornalup National Park, 3 Oct. 1988, *A.R. Annels* 261 (PERTH); Walpole-Nornalup National Park, 35° 14' 00"S, 116° 52' 30" E, 31 May 1989, *A.R. Annels s.n.* (PERTH); 200 m S of Milyeannup Coast Road, 1.7 km NE of intersection with Roberts Rd, 4 Apr. 1991, *N. Gibson & M. Lyons* 1118 (PERTH); Scott River sand plain, 18 Apr. 1976, *S.D. Hopper* 2294 (PERTH); Chester block, Augusta to Nannup, 34° 11' S, 115° 20' E, 26 May 1992, *G.J. Keighery* 13451 (PERTH); Quarram, 23 miles [36.8 km] W of Denmark, 31 July 1953, *R. Melville* 4461 & *R.D. Royce* (K, MEL, NSW, PERTH); Near Mt Lindsay, 1879, *Muir s.n.* (MEL, PERTH); Between Bow and Denmark Rivers, 20 Apr. 1960, *G. Starkie s.n.* (PERTH); Shannon River, 9 Apr. 1979, *Survey team* 1555 (PERTH).

*Distribution.* Coastal regions between Augusta and Denmark.

*Habitat.* Occurs in black sandy soil on swampy heathland.

*Flowering period.* February-May.

*Conservation status.* CALM Conservation Codes for Western Australian Flora: Priority Three. Although extending over a wide distribution, *Stylidium leeuwinense* is known from relatively few locations with small populations. The type location is situated near an active mining lease. This population could be threatened with extinction if sand mining and associated activities were undertaken at the site before a management plan for the species was in place.

*Etymology.* The epithet, *leeuwinense* refers to the Cape Leeuwin region in south-west Western Australia which is the type location for this species.

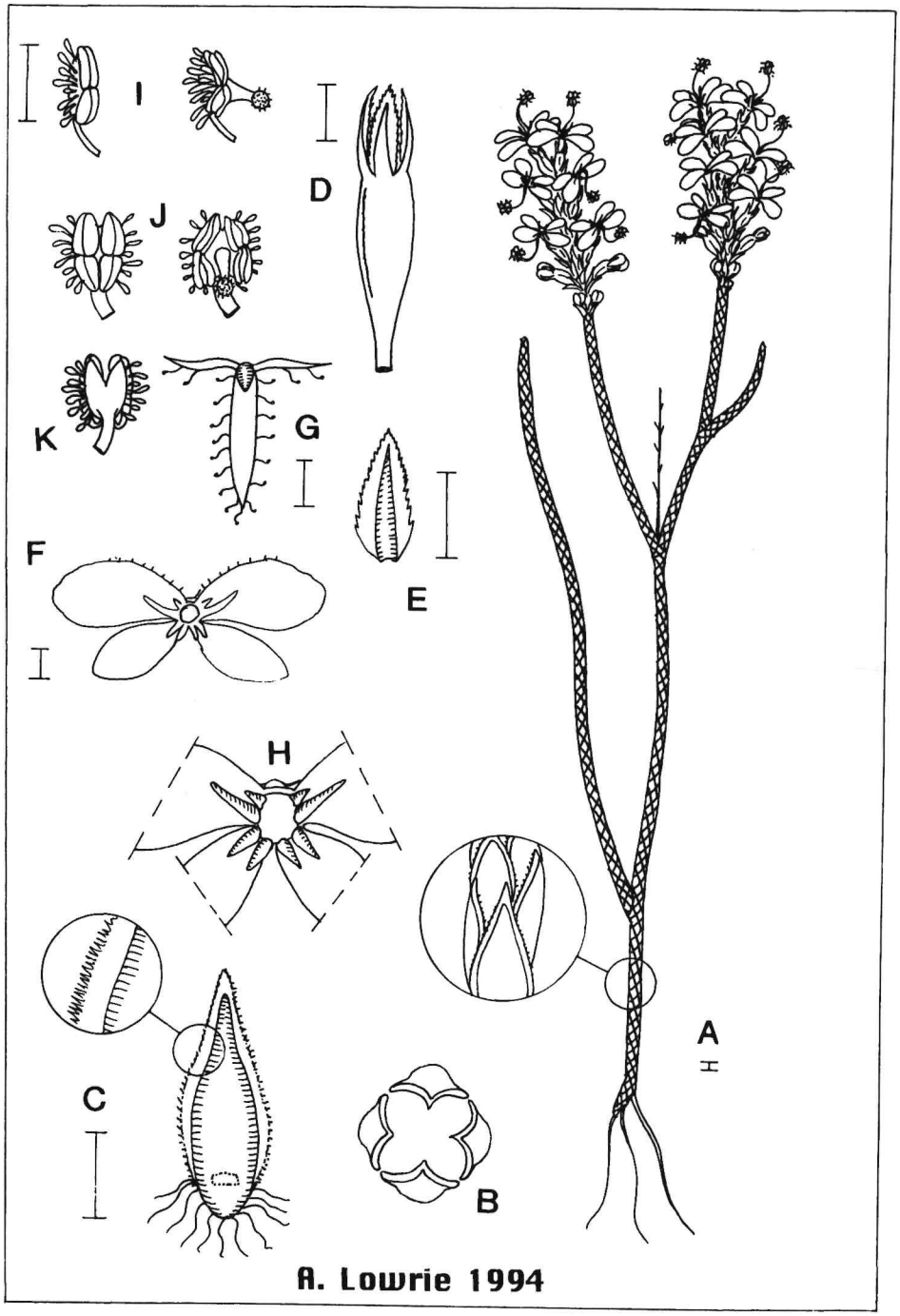


Figure 2. *Stylidium leeuwinense* A - habit of flowering plant; B - section of stem showing spirally arranged leaves; C - leaf, enlarged section left; D - hypanthium; E - sepal; F - corolla; G - labellum; H - throat appendages; I - lateral view of gynostemium tip (with conical, capitate stigma at right); J - front view of gynostemium tip (with stigma grown out, right); K - back of gynostemium tip. Scale bar for all = 1 mm. Drawn from *A. Lowrie* 1465.

*Affinities. Stylidium leeuwinense* is distinguished from *S. preissii* by its spike-like racemes and from all other species in subgenus *Forsteropsis* by having leaves without an apical mucro.

**Stylidium marradongense** Lowrie & Kenneally, *sp. nov.*

*S. imbricato* Benth. affinis sed sepalis ovatis, corolla appendicibus faucis absentibus differt.

*Typus:* south end of Tunnel Rd, Marradong, Western Australia, 32° 55' S, 116° 28' E, 14 October 1993, *A. Lowrie* 807 (*holo*: PERTH 04431189; *iso*: MEL).

*Perennial herb*, with erect divided stems covered with appressed, tile-like leaves spirally arranged around the stem. *Leaves* basifixed, green, lanceolate, 1.5-2 mm long, 0.5-0.8 mm wide, with apical silvery white mucro 0.7-1.5 mm long, pilose at the base, hyaline margins silvery white, dentate-laciniate. *Racemes* terminal, spike-like; pedicels 1-1.5 mm long; bracts silvery white, *c.* 3.5 mm long, fringed; bracteoles similar, *c.* 2.5 mm long. *Hypanthium* obovoid at anthesis, *c.* 3.5 m long, *c.* 1.5 mm wide, glandular. *Sepals* free to base, ovate, *c.* 2 mm long, acute, upper half glabrous, lower half glandular; hyaline margin silvery white, fringed. *Corolla* white or various shades of pink, with laterally-paired lobes; anterior lobes *c.* 5 mm long, *c.* 3 mm wide; posterior lobes *c.* 5 mm long, *c.* 2.5 mm wide. *Labellum* ovate, white, *c.* 1.5 mm long, *c.* 0.6 mm wide, margins bearing long hair-like stalked glands, with 2 basal subulate appendages; appendages *c.* 0.6 mm long, glabrous; boss narrowly ovate, white, smooth, *c.* 0.7 mm long, *c.* 0.3 mm wide. *Throat* yellow, bordered by prominent reddish markings, without appendages. *Gynostemium* column *c.* 7.5 mm long; anthers maroon, pollen greyish white; stigma conical, capitate. (Figure 3)

*Other specimens examined.* WESTERN AUSTRALIA: Tunnel Rd, Worsley mine site, 10 km S of Boddington, 26 Sep. 1982, *K.J. Atkins* KA210 (PERTH); Junction of Fletcher Rd and Tunnel Rd, Boddington, 32°37' S, 116°29' E, 14 Oct. 1993. *K.F. Kenneally* 11396 (BRI, CANB, K, MEL, NSW, PERTH); Gully near Mt Saddleback, Marradong, 13 Nov. 1904, *A. Morrison* 14181 (K, PERTH).

*Distribution.* Occurs from Mt Saddleback to Marradong.

*Habitat.* In laterite soils in open Jarrah forest (*Eucalyptus marginata*) with *Banksia grandis, Dryandra sessilis* and *Persoonia longifolia.*

*Flowering period.* October.

*Conservation status.* CALM Conservation Codes for Western Australian Flora: Priority One. *Stylidium marradongense* is only known from a few locations. The small population at the type location, which is situated within an active bauxite mining lease, could be threatened with extinction if mining and related activities were commenced before a management plan for the species was in place.

*Etymology.* The epithet, *marradongense* refers to the Marradong region in south-west Western Australia where this species occurs.

*Affinities. Stylidium marradongense* and *S. preissii* both lack throat appendages. *S. marradongense* is distinguished from *S. preissii* by having leaves with an apical mucro, terminal spike-like racemes and conical, capitate stigmas.

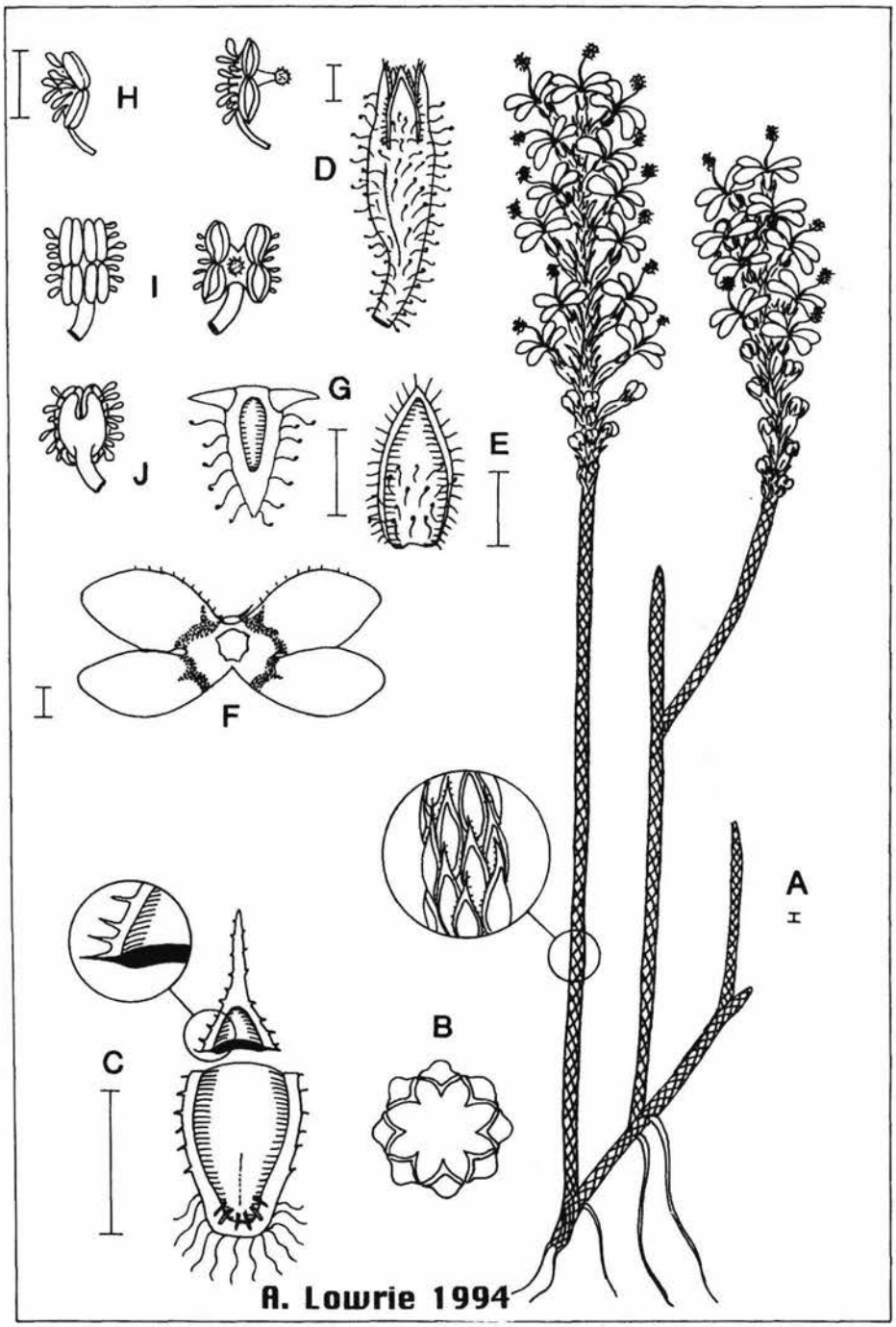


Figure 3. *Stylidium marradongense* A - habit of flowering plant; B - section of stem showing spirally arranged leaves; C - leaf, enlarged section left; D - hypanthium; E - sepal; F - corolla; G - labellum; H - lateral view of gynostemium tip (with conical, capitate stigma at right); I - front view of gynostemium tip (with stigma grown out, right); J - back of gynostemium tip. Scale bar for all = 1 mm. Drawn from *A. Lowrie* 807.

**Stylidium preissii** (Sond.) F. Muell. (Mueller 1863: 122). - *Forsteropsis preissii* Sond. (Sonder 1845: 383). *Type:* Cape Riche, [Western Australia], 22 November 1840, *L. Preiss* 438 (*holo:* MEL 709983; *iso:* LD, MEL).

*Perennial herb*, with short erect branching stems covered with appressed, tile-like leaves spirally arranged around the stem. *Leaves* basifixed, green, broadly trullate, *c.* 1.9 mm long, *c.* 1 mm wide, acute, with silvery white hyaline margins, fringed at base and ciliate above. *Racemes* umbellate; flowers almost sessile; bracts and bracteoles similar, silvery white, *c.* 2.4 mm long. *Hypanthium* obovoid at anthesis, *c.* 2.5 mm long, *c.* 1.2 mm wide, glabrous. *Sepals* 2 joined almost to the apex, 3 free to base, ovate, *c.* 3 mm long, glabrous; hyaline margin silvery white, serrate, surrounding a subulate body. *Corolla* white, pale or dark pink, with laterally-paired lobes; anterior lobes *c.* 6 mm long, *c.* 5 mm wide; posterior lobes *c.* 6 mm long, *c.* 3.5 mm wide. *Labellum* ovate, white, *c.* 2.5 mm long, *c.* 2.2 mm wide, margins dentate, each tooth bearing a long stalked gland; boss narrowly ovate, white, smooth, *c.* 0.9 mm long, *c.* 0.25 mm wide. *Throat* without appendages. *Gynostemium* column strap-like, hinged below the anthers, with a dilated cunabulum where the anthers or stigma rest in the set position above the sensitive torosus, *c.* 5 mm long; anthers lilac, pollen white; stigma round, cushion-shaped. (Figure 4)

*Selected specimens examined.* WESTERN AUSTRALIA: Branch Circus and Hammond Rds, Jandakot, 9 Nov. 1965, *J.C. Anway* 542 (MEL, NSW, PERTH); Cape Le Grande, 5 Nov. 1967, *Carlquist* 4013 (M, NSW, PERTH), 4031 (NSW); Beenyup Rd, *c.* 1 mile [1.6 km] S of Jandakot Siding, 27 Oct. 1963, *A.S. George* 5295: NE of Jerramungup, 30 Oct. 1965, *A.S. George* 7024 (PERTH); 29.3 km NE of Manypeaks, 9 Dec. 1986, *A. Lowrie s.n.* (PERTH); Turn-off to Hellfire Bay, Cape Le Grand National Park, 8 Dec. 1990, *A. Lowrie s.n.* (PERTH); On the corner of Stockyard Rd and Merivale Rd, E of Esperance, 28 Nov. 1993, *A. Lowrie* 844 (PERTH); At the junction of Hellfire Bay Rd and Lucky Bay Rd, Cape Le Grand National Park, E of Esperance, 28 Nov. 1993, *A. Lowrie* 847 (PERTH); On Cape Le Grand Rd, 2.4 km S of Merivale Rd, E of Esperance, 29 Nov. 1993, *A. Lowrie* 851 (PERTH); From the Fitzgerald Range to Cape Le Grande, 1867, *Maxwell s.n.* (K); N side of Woogenellup North Rd from the junction with Chester Pass Rd, 13 Dec. 1992, *F.H. & M.P. Mollemans* 4393 (PERTH); Balladonia Rd, S of Mt Ragged on western boundary of Cape Arid National Park, 29 Nov. 1971, *R.D. Royce* 9905 (PERTH); *c.* 50 km W of Israelite Bay, *E. Wittwer* W1900, 17 Nov. 1976 (PERTH).

*Distribution.* Bremer Bay to Israelite Bay with disjunct populations at Jandakot.

*Habitat.* Grows in white silica sand in open heathland.

*Flowering period.* November-December.

*Conservation status.* Not considered to be at risk at locations along the south coastal region. However, the disjunct Jandakot populations (*J.C. Anway* 542 and *A.S. George* 5295) are presumed to be extinct owing to urban development. There is an urgent need of further survey to establish if other populations exist within the Perth region.

*Affinities. Stylidium preissii* is distinguished from all other members of subgenus *Forsteropsis* by having a strap-like gynostemium column, hinged below the anthers, with a dilated cunabulum where the anthers or cushion-shaped stigma rest in the set position above the sensitive torosus.

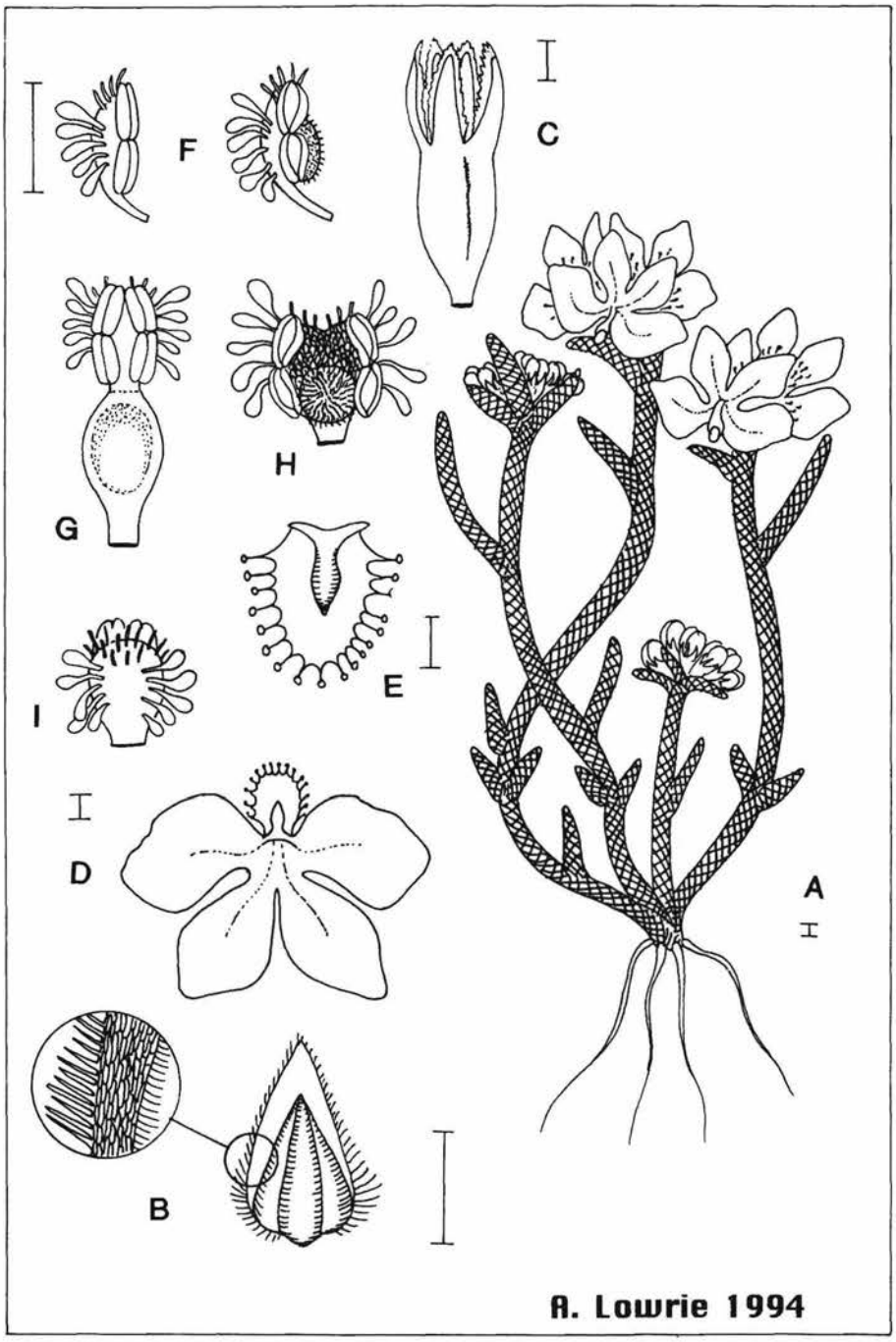


Figure 4. *Stylidium preissii* A - habit of flowering plant; B - leaf, enlarged section left; C - hypanthium; D - corolla; E - labellum; F - lateral view of gynostemium tip (with cushion-like stigma at right); G - adaxial view of gynostemium, anthers at the apex with clavate moniliform hairs along the margins, showing hinged portion (dotted) immediately below the anthers and the dilated cunabulum that the anthers fold upon when the gynostemium is in the set position; H - front view of gynostemium tip with stigma grown out; I - back of gynostemium tip. Scale bar for all = 1 mm. Drawn from *A. Lowrie s.n.* 9 Dec. 1986.

**Stylidium semaphorum** Lowrie & Kenneally, *sp. nov.*

*S. imbricato* Benth. affinis sed sepalis anguste ovatis et apicaliter mucronatis differt.

*Typus:* Great Northern Highway [precise locality withheld], Western Australia, 4 October 1993, *A. Lowrie* 804 (*holo:* PERTH 04431197; *iso:* MEL).

*Perennial herb*, with erect divided stems covered with appressed, tile-like leaves spirally arranged around the stem. *Leaves* basifixed, green, narrowly ovate, 2-2.3 mm long, 0.5-0.7 mm wide, with silvery white apical mucro 1.2-2 mm long, pilose at the base, hyaline margins silvery white, dentate-laciniate. *Racemes* terminal, spike-like; pedicels 1.5-2.5 mm long; bracts silvery white, fringed, *c.* 2.5 mm long, with *c.* 1.5 mm long mucro; bracteoles similar, *c.* 2 mm long, with *c.* 0.7 mm long mucro. *Hypanthium* obovoid at anthesis, *c.* 2.5 mm long, *c.* 1 mm wide, glandular. *Sepals* free to base, narrowly ovate, *c.* 2.5 mm long, mostly glabrous except for the base; hyaline margin silvery white, fringed, with a short brownish apical mucro. *Corolla* pale pink, rarely white, with laterally-paired lobes, but these appearing vertically paired in relation to the plant, with the lower lobes (a combination of an anterior and posterior lobe) placed together to provide an insect pollinator's landing platform, the upper lobes spread apart in a semaphore-like arrangement; anterior lobes *c.* 5 mm long, *c.* 2.3 mm wide; posterior lobes *c.* 5 mm long, *c.* 2.3 mm wide. *Labellum* subulate, reddish, *c.* 2.5 mm long, *c.* 0.5 mm wide, margins bearing long hair-like stalked glands, with 2 basal subulate appendages; appendages *c.* 0.8 mm long, papillose; boss narrowly ovate, white, smooth, *c.* 0.9 mm long, *c.* 0.3 mm wide. *Throat appendages* 6, the 2 near the labellum pink and *c.* 0.7 mm long, the remaining 4 white and *c.* 0.4 mm long, followed by 4 dark pink throat markings. *Gynostemium* column *c.* 5 mm long; anthers dark brown, pollen white; stigma conical, capitate. (Figure 5)

*Other specimens examined.* WESTERN AUSTRALIA: Great Northern Highway, 21 Oct. 1966, *R. Erickson s.n.* (PERTH); Great Northern Highway, 31 Aug. 1991, *A. Lowrie* 298 (PERTH), 28 Sep. 1991, *A. Lowrie* 333 (PERTH), 11 Oct. 1996, *A. Lowrie* 1355 (PERTH).

*Distribution.* Known only from the type location.

*Habitat.* Grows in laterite gravel soils with *Dryandra sessilis,* on a hill summit, within a CALM Nature Reserve.

*Flowering period.* September-October.

*Conservation status.* CALM Conservation Codes for Western Australian Flora: Priority Two. *Stylidium semaphorum* is known from only one small population within a nature reserve.

*Etymology.* The specific epithet *semaphorum* is from the Greek *sema* - sign and *phoros* - bearing and alludes to the signalling method of sending messages by semaphore, whereby a person holding a flag in each hand angles the flags to code positions to relay visual messages. The upper corolla lobes of *Stylidium semaphorum* are displayed like a flag-like semaphore signalling its position to attract pollinators from their flight paths. It is interesting to note that the upper lobes of the corolla are positioned in a V-shape which is the semaphore code for "U" and "attention".

*Affinities. Stylidium semaphorum* is distinguished from all other members of subgenus *Forsteropsis* by having sepals with a short brownish apical mucro.

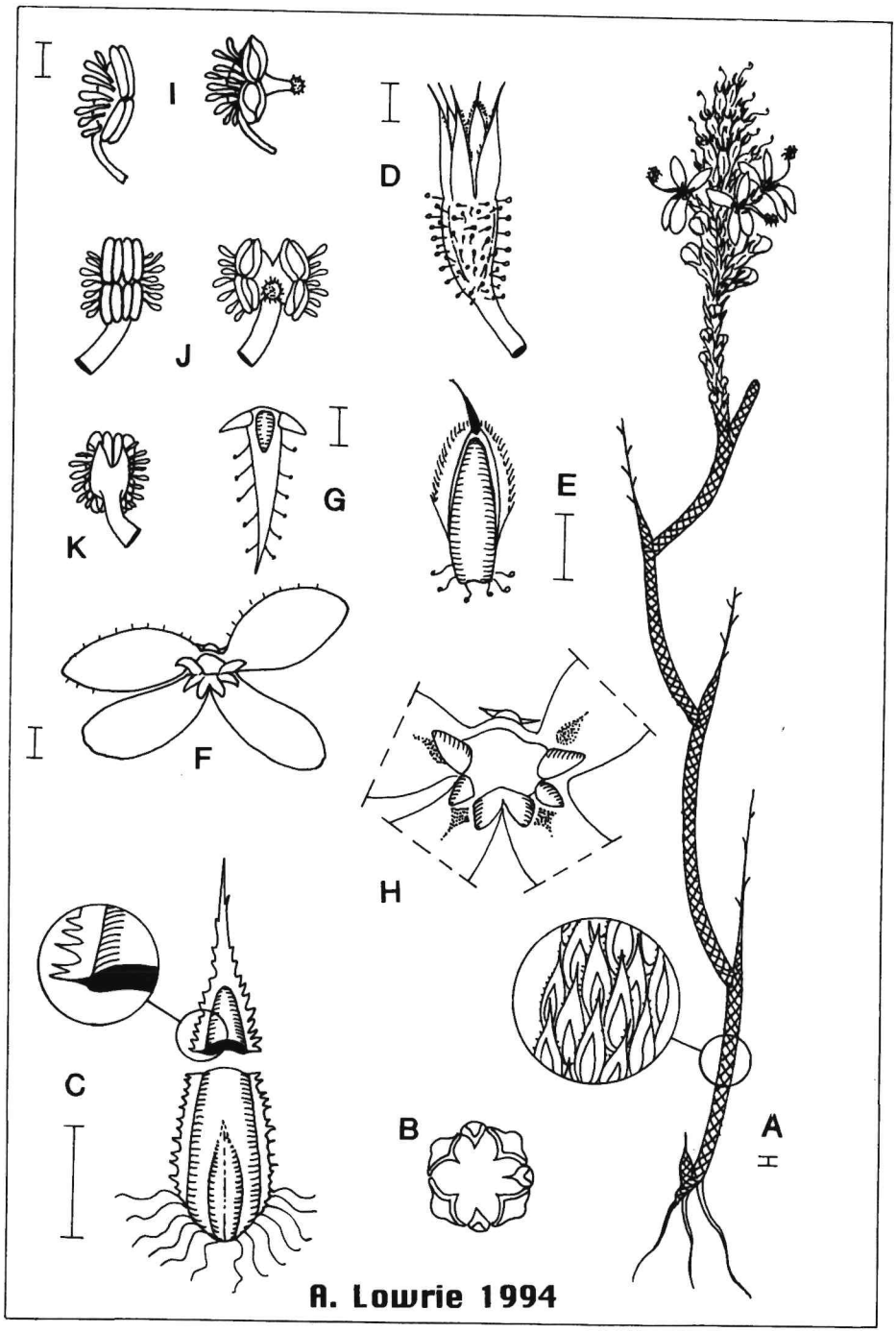


Figure 5. *Stylidium semaphorum* A - habit of flowering plant; B - section of stem showing spirally arranged leaves; C - leaf, enlarged section left; D - hypanthium; E - sepal; F - corolla; G - labellum; H - throat appendages; I - lateral view of gynostemium tip (with conical, capitate stigma at right); J - front view of gynostemium tip (with stigma grown out, right); K - back of gynostemium tip. Scale bar for all = 1 mm. Drawn from *A. Lowrie* 804.

## Acknowledgements

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# A taxonomic revision of the *Eucalyptus striaticalyx* group (*Eucalyptus* series *Rufispermae*: Myrtaceae)

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## Abstract

D. Nicolle. A taxonomic revision of the *Eucalyptus striaticalyx* group (*Eucalyptus* series *Rufispermae*: Myrtaceae). Nuytsia 11 (3): 365-382 (1997). A taxonomic revision of *Eucalyptus striaticalyx* W. Fitzg. *sens. lat.* has been undertaken based on morphological characteristics observed through field studies, herbarium research and seedling trials. *E. striaticalyx* W. Fitzg. subsp. *striaticalyx*, from the northern goldfields and *E. clelandii* F. Muell. from the central goldfields of Western Australia are treated and new taxa are described here as *E. striaticalyx* subsp. *delicata* Nicolle & P.J. Lang, restricted to a couple of lunette systems in the northern goldfields of Western Australia, *E. gypsophila* Nicolle, widespread in the Great Victoria Desert of Western Australia and South Australia, with remnant populations extending to the Gascoyne Region of Western Australia, *E. repullulans* Nicolle from the Pilbara area of Western Australia, and *E. canescens* Nicolle (with subsp. *canescens* and subsp. *beadellii* Nicolle), apparently endemic to the southern Great Victoria Desert of South Australia. Keys, maps and representative illustrations for all the described species are provided.

## Introduction

*Eucalyptus* series *Rufispermae* Maiden (Myrtaceae) is one of the largest series in the eucalypts, with many undescribed and poorly known taxa, particularly in Western Australia, where the series is best represented in terms of species numbers and diversity. One of the most complex species in the series has been *Eucalyptus striaticalyx sens. lat.*, which has a widespread distribution in remote parts of southern Australia and exhibits great morphological variation across its distribution. Three new species and two new subspecies are here described based on field studies, herbarium research and seedling trials. Field studies have proved most useful in revising the *E. striaticalyx* group as features such as habit, bark type, leaf colour etc. are rarely mentioned on herbarium sheets. I have undertaken seven separate field trips through the Great Victoria Desert in the last four years, where plants attributed to *E. striaticalyx* are widely represented. Through ongoing seedling trials of all the closely related *Eucalyptus* species it has been found that seedlings within series *Rufispermae* as a whole are similar and generally not useful for distinguishing between taxa, unlike those of many other series within the eucalypts. *E.* ser. *Rufispermae* is equivalent to Pryor & Johnson's (1971) informal *E.* ser. *Dumosae* within *E.* section *Dumaria*.

*Eucalyptus striaticalyx* was described by Fitzgerald (1904) from specimens he collected in 1903 at Millys Soak, near Cue in the northern goldfields of Western Australia. *E. striaticalyx* is dominant around Millys Soak where it forms a rough-barked tree much larger than any other plants for many kilometres around.

The only other taxon of those treated here that has been previously described is *E. clelandii*. Maiden described *Eucalyptus goniantha* var. *clelandii* in 1911 from specimens he collected at Goongarrie, also in the northern goldfields and one year later Maiden raised it to specific rank, and appeared to dissociate it from the unrelated *E. goniantha* Turcz. Around Goongarrie, *E. clelandii* grows as a single-stemmed tree with a blackbutt and small pruinose buds and fruits.

Lang (1983), in his Ph.D. Thesis on the series *Rufispermae,* recognized much of the variation within *E. striaticalyx* and *E. clelandii* but suggested they be sunk under *E. dumosa* A. Cunn. ex Oxley (i.e. *E. dumosa* subsp. *dumosa* and subsp. *clelandii* respectively). This suggestion was never taken up by eucalypt taxonomists. However, potential new taxa were recognized by Lang and are treated here as *E. canescens* (Lang's PCVH) and *E. gypsophila* in part (Lang's PMAR and PSL). Since Lang's work, no other work has been done on the taxonomy of *E. striaticalyx*.

## Eucalyptus striaticalyx group

The *E. striaticalyx* group is geographically distinct from other taxa of series *Rufispermae*, occurring in drier, more inland areas than the rest of the series and includes the only species in the series known to occur in the tropics (*E. repullulans*). It extends from the Pilbara area of Western Australia south-east to near Ceduna in South Australia. Distribution maps for all the taxa are given in Figures 1 and 2.

The taxa treated here together form a somewhat arbitrary group of closely related taxa within the *Rufispermae*. They can be loosely defined within the series by the combination of inland arid habitat, small tree or mallee habit, dull to slightly glossy adult leaves, 7- 15- flowered inflorescences, peduncles to 23 mm long, pedicels 2-8 mm long, buds with a lightly to heavily ribbed operculum and cupular to cylindrical, smooth to ribbed fruits with a prominent operculum scar and descending disc.

### Key to the species

1. Bark smooth throughout. Hamersley Ranges only ..... **4. E. repullulans**
1. Bark rough, at least on lower stem(s). Gascoyne area of Western Australia to near Ceduna in South Australia, absent from the Hamersley Ranges ..... 2
2. Tree. Operculum conical to beaked
3. Erect tree with rough bark for 0.5-2 m only. Buds and fruits pruinose ..... **1. E. clelandii**
3. Erect to depauperate tree with rough bark to branches. Buds and fruits not pruinose ..... **2. E. striaticalyx**
2. Mallee. Operculum hemispherical to conical ..... 4
4. Fruit 6-10 mm long. Adult leaves mostly broad-lanceolate to ovate, 18-25 mm wide ..... **3. E. gypsophila**
4. Fruit 10-16 mm long. Adult leaves lanceolate to broad-lanceolate, 22-55 mm wide ..... **5. E. canescens**

**1. Eucalyptus clelandii** (Maiden) Maiden, Crit. Revis. *Eucalyptus* 2: 189 (1912).- *E. goniantha* Turcz. var. *clelandii* Maiden, Proc. W. Austral. Nat. Hist. Soc. 3: 176 (1911). *Type*: Goongarrie, Western Australia, September 1909, *J.H. Maiden* (*lecto*: NSW, *fide* J.H. Maiden, Crit. Revis. *Eucalyptus* 2: 190 (1912); *isolecto:* K, L, PERTH 01377140).

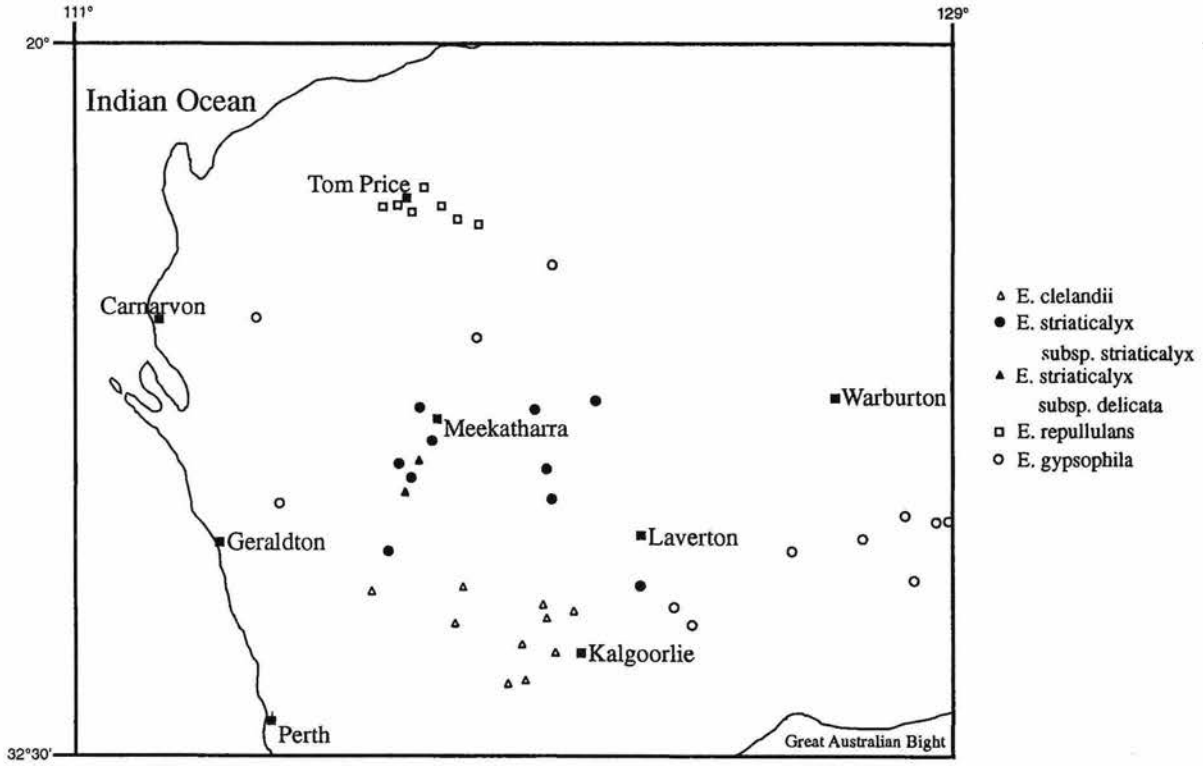



Figure 1. Distribution of the *Eucalyptus striaticalyx* group in Western Australia.

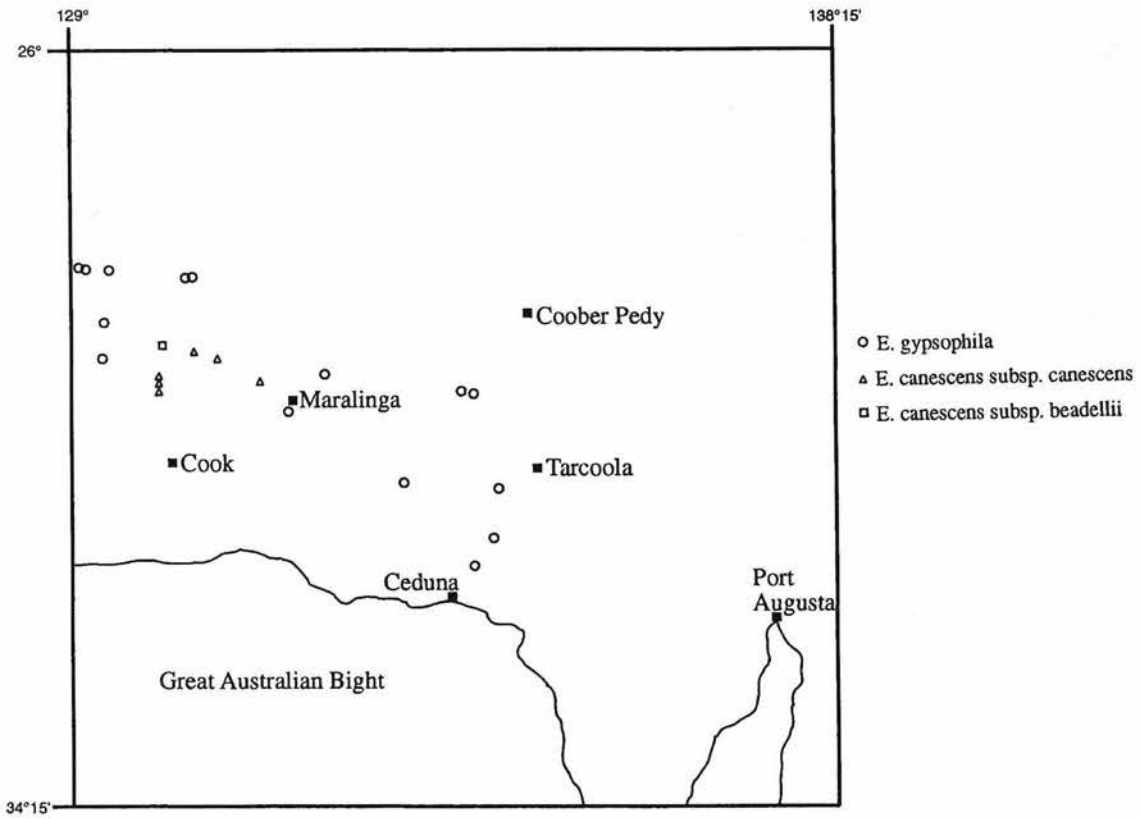



Figure 2. Distribution of the *Eucalyptus striaticalyx* group in South Australia.

Distinguished within the *E. striaticalyx* group by the combination of erect tree habit, persistent rough basal bark (blackbutt) then smooth above, pruinose twigs, buds and fruits, narrow-lanceolate to lanceolate leaves, small buds with a ribbed, beaked operculum and small slightly ribbed fruits.

Small, erect-stemmed *tree* 6-12 m tall; lignotubers not recorded. Rough *bark* persistent at base to 0.5-2 m, rough, thick, sub-fibrous, dark grey to almost black, then smooth, tan or pink-grey over cream to light grey thereafter, decorticating in ribbons. *Branchlets* pruinose; pith glands present. *Cotyledons* reniform; seedling leaves opposite for 3-6 pairs, petiolate, ovate, pruinose. *Adult leaves* alternate, petiolate, narrow-lanceolate to lanceolate, 60-150 mm long, 10-25 mm wide, concolorous, dull, blue-green to grey-green; reticulation dense with many irregular, intersectional oil glands; lateral veins at 35°-55° from midrib. *Inflorescences* axillary, unbranched, 7-11-flowered; peduncle terete, 6-20 mm long; pedicels 2-5 mm long. *Buds* 8 -11 mm long, 4-6 mm diam., pruinose; hypanthium cupular, smooth to ribbed; operculum equal to or wider than hypanthium, ribbed, beaked, apiculate. *Stamens* strongly inflexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* creamy white. *Ovules* in 4 vertical rows. *Fruits* pruinose, cupular to slightly campanulate, smooth to slightly ribbed, 4-8 mm long, 5-7 mm diam.; operculum scar ascending, 1-2 mm wide; disc level to descending, 2-3 mm wide; valves (3)4, at rim level to exserted. *Seeds* compressed ovoid, 1.2-2 mm long, glossy, dark red-brown, reticulum shallow to moderate; chaff glossy brown to dark red-brown. (Figure 3)

*Selected specimens examined* (west to east). WESTERN AUSTRALIA: 6.3 km E of Die Hardy Range road on Diemals - Menzies road, 29°44'S, 119°40'E, 16 Oct. 1984, *I. Brooker* 8696 (AD, CANB, PERTH); 64 km SW of Paynes Find, 29°28'S, 117°12'E, 18 Oct. 1984, *I. Brooker* 8716 (AD, CANB, PERTH); 14.5 km by road NE of road to Mt Gibson Homestead on Highway 95, 9 July 1978, *P.J. Lang* 1486, 1487 (AD); 1.3 km by road W of Bulla Bulling on Southern Cross-Coolgardie road, 11 July 1978, *P.J. Lang* 1514 (AD); 4.9 km by road NW of Coolgardie on Great Eastern Highway, 12 July 1978, *P.J. Lang* 1519, 1520 (AD); Rise immediately N of Arrow Lake (26.3 km by road N of Kalgoorlie on road to Menzies), 12 July 1978, *P.J. Lang* 1529 (AD); 5.9 km by road N of Goongarrie on road to Menzies, 12 July 1978, *P.J. Lang* 1530 (AD); 3.7 km by road S of Goongarrie on Kalgoorlie to Menzies road, E side, 13 July 1978, *P.J. Lang* 1543 (AD); N of Coolgardie, 30°12'23"S, 120°37'54"E, 15 Dec. 1992, *D. Nicolle* 333 (AD); Near Mt Gibson Homestead, 29°31'57"S, 117°09'52"E, 19 Sep. 1995, *D. Nicolle* 1559 (AD, CANB, PERTH); S of Diemals, 29°46'25"S, 119°18'17"E, 20 Sep. 1995, *D. Nicolle* 1565 (AD).

*Intergrades. E. clelandii - E. striaticalyx* subsp. *striaticalyx:* WESTERN AUSTRALIA: 2 km N of Mount Magnet Township on road to Meekatharra, creekside, Mount Magnet Golf Course, 8 Dec. 1978, *P.J. Lang* 1476 (AD); SW of Youanmi, 28°36'15"S, 118°47'40"E, 19 Sep. 1995, *D. Nicolle* 1553 (AD, CANB).

*Distribution and habitat.* Endemic to the goldfields of Western Australia from Mount Gibson Homestead north-east of Wubin, east to Menzies and Kalgoorlie. *E. clelandii* occurs on plains and low stony rises, sometimes in pure stands. The soils are red-brown loams, often over greenstone or on rises of lateritic ironstone. Associated species include *E. campaspe, E. celastroides* subsp. *celastroides, E. loxophleba* subsp. *supralaevis, E. ravida, E. salmonophloia, E. salubris* and *E. yilgarnensis*, with a sparse understorey, often dominated by chenopods. (Figure 1)

*Flowering period.* August to February.

*Conservation status.* Widespread and locally common and not considered to be at any risk.

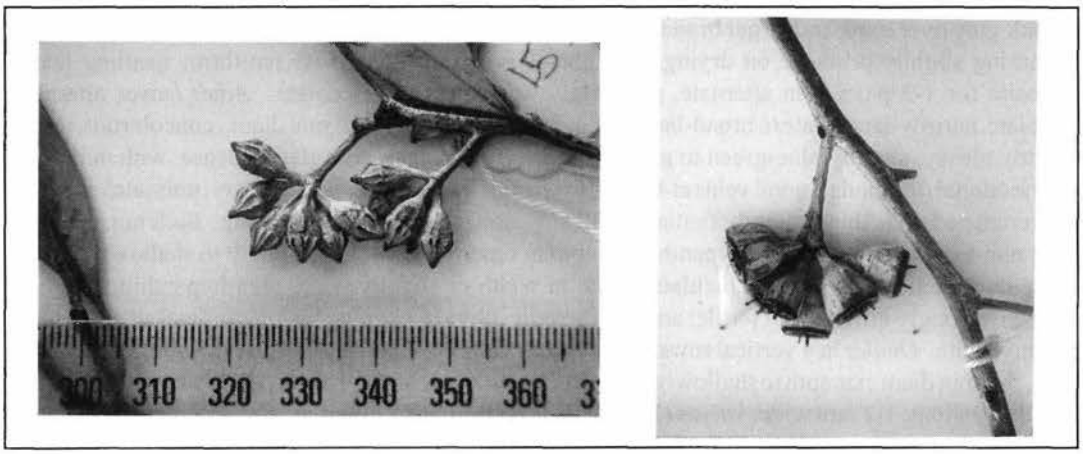



Figure 3. *Eucalyptus clelandii* buds and fruits (life size, from *D. Nicolle* 1559).

*Notes.* The western populations of *E. clelandii*, around Mount Gibson Station were once thought to be an outlier from the more eastern populations (Brooker & Kleinig 1990), however, more recent collections from east, south and west of Diemals Homestead show its distribution to be more continuous, with the Mount Gibson populations forming the westerly extremity of its distribution. In the south-west of its distribution, *E. clelandii* is replaced by *E. sheathiana* Maiden, differing in its variable tree or mallee habit, absence of basal rough bark and less ribbed, conical to hemispherical operculum. In the south-east *E. clelandii* is replaced by *E. polita* Brooker & Hopper, differing in the absence of rough basal bark, smaller leaves and smaller, generally non-pruinose and less ribbed buds and fruits. Intermediate forms (probably intergrades) between *E. clelandii* and *E. polita* or *E. sheathiana* are very uncommon but not unknown, where their distributions adjoin. (These intergrades can be recognized by their intermediate stem, leaf, bud and fruit morphology, and usually do not develop the characteristic blackbutt seen in *E. clelandii.*)

North of the distribution of *E. clelandii,* intergrades between *E. clelandii* and *E. striaticalyx* subsp. *striaticalyx* occur and can be distinguished from *E. clelandii* by their more crooked stature, finer textured, lighter coloured rough bark occurring further up the trunk and the slightly pruinose twigs, buds and fruits.

In the south-east of its distribution, *E. clelandii* may morphologically approach *E. lesouefii* Maiden, but the two species are usually well defined and easily separated, *E. lesouefii* having glossy, green adult leaves (dull, blue-green in *E. clelandii*) and larger, more prominantly ribbed buds and fruits than *E. clelandii.*

**2. Eucalyptus striaticalyx** W. Fitzg., J.W.Austral. Nat. Hist. Soc. 1: 20-21 (1904). *Type*: Millys Soak, Western Australia, September 1903, *W. V. Fitzgerald* (*lecto*: PERTH 01394584, here designated; *isolecto:* E, NSW, PERTH 01394592).

Distinguished within the *E. striaticalyx* group by the combination of habitat along drainage lines or salt lakes, tree habit, persistent rough bark over lower half to all of trunk, non-pruinose twigs, leaves, buds and fruits, dull to slightly glossy, blue-green to grey-green lanceolate to narrow-lanceolate leaves, slightly ribbed, small to medium-sized buds with a beaked operculum and small to medium, smooth fruits.

*Tree*, 5-12 m tall; lignotubers not recorded. Rough *bark* persistent, sub fibrous and flaky, grey-brown to dark grey over trunk and larger branches, then smooth and cream. *Branchlets* not pruinose or rarely becoming slightly pruinose on drying, pith glands present. *Cotyledons* reniform; seedling leaves opposite for 1-3 pairs then alternate, petiolate, ovate to broad-lanceolate. *Adult leaves* alternate, petiolate, narrow-lanceolate to broad-lanceolate, 70-160 mm long, 7-25 mm diam., concolorous, dull to slightly glossy, slightly blue-green to grey-green, never pruinose; reticulation dense, with numerous intersectional oil glands, lateral veins at 40°-50° from midrib. *Inflorescences* axillary, unbranched, 7-13-flowered; peduncle thick, slightly flattened, 8-23 mm long; pedicels 2-5 mm long. *Buds* not pruinose, 6-12 mm long, 3-7 mm diam.; hypanthium cupular, tapering to pedicel, smooth to shallowly ribbed; operculum conical to beaked, apiculate, equal in width or slightly wider than hypanthium, ribbed. *Stamens* strongly inflexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* creamy white. *Ovules* in 4 vertical rows. *Fruits* non-pruinose, cupular to shortly cylindrical, 5-10 mm long, 5-9 mm diam., smooth to shallowly ribbed; operculum scar conspicuous, ascending, 1-2 mm wide; disc descending, 1-3 mm wide; valves (3)4, at rim level to slightly exserted. *Seeds* compressed-ovoid, 1.5-2.5 mm long, glossy, dark red-brown, reticulum fine to medium; chaff glossy orange to red-brown.

*Notes. E. striaticalyx* is typically a single-stemmed tree, however, many populations have in the past been periodically cut for the pastoral and mining activities in the area. This is most evident at the type location, where the population, upon first appearance, may appear to be a mixture of trees and large multi-stemmed tree-mallees (plants of tree proportion and thick stem diameter but with more than one stem arising from ground level as in a typical mallee). On closer inspection, the tree-mallee individuals have evidence of being cut approximately 0.5-1 metre above ground level, not just once, but in most cases two or three times. Only trees with curved or somewhat wavy stems have been left, presumably the poorer trees unsuitable for timber. *E. striaticalyx* is the dominant tree wherever it occurs and is substantially taller than any other surrounding vegetation for many kilometres. Therefore it seems that the original habit of this taxon has been altered due to lopping for posts and rails in fencing and props and beams in mining. Plants of a younger cohort at the type locality (less than about 20 years old) all show the tree form, most trees with straight stems with few side branches. This induced tree-mallee form is seen at its best at Millys Soak. At least some plants at many sites for this taxon have been cut earlier this century. This induced tree-mallee habit is not seen in *E. clelandii* to any great extent, possibly because it occurs in a more wooded habitat where other species such as *E. salmonophloia* and *E. melanoxylon* would be the preferred timber species.

*E. striaticalyx* differs from *E. gypsophila*, to which it is most closely related, in its larger, tree habit, its more extensive persistent bark, its consistently non-pruinose buds and fruits and its more pointed operculum.

Rare intergrading populations with *E. clelandii* to the south of its distribution and with *E. gypsophila* to the east of its distribution are known.

The common names Kopi Mallee and Cue York Gum have been applied to this species. The name Cue York Gum, in the strict sense, refers only to *E. striaticalyx*. The name refers to the type locality near Cue and its tree habit like that of the unrelated York Gum, *E. loxophleba*. The common name Kopi Mallee, which contradicts Cue York Gum in terms of habit would be more correctly applied to *E. gypsophila*.

There are two subspecies.

1. Crown not noticeably pendulous, leaves lanceolate to broad-lanceolate, mostly 12-25 mm wide ..... 2a. subsp. **striaticalyx**
1. Crown noticeably pendulous, leaves narrow-lanceolate, mostly 7-14 mm wide ..... 2b. subsp. **delicata**

**2a. Eucalyptus striaticalyx** W. Fitzg. subsp. **striaticalyx**

Distinguished from subsp. *delicata* by its more robust form; its more extensive rough bark; its lanceolate to broad-lanceolate adult leaves, 70-160 mm long by 12-25 mm wide; its larger buds and fruits (buds 8-12 mm long and 4-7 mm diam.; fruits 7-10 mm long and 7-9 mm diam.); and the crown, which is not notably pendulous. (Figure 4)

*Selected specimens examined (north to south).* WESTERN AUSTRALIA: 42 km W of Meekatharra on Belele road, 26°26'S, 118°04'E, 29 Aug. 1984, *I. Brooker* 8643 (AD, CANB, PERTH); 67 km from Paynes Find on Yalgoo Road, 28°57'S, 117°11'E, 24 Nov. 1986, *K. Hill* 2584 & *L.A.S. Johnson* (CANB, PERTH, MELB, NSW, CBG); Millys Soak, 15 km due N of Cue, 9 July 1978, *P.J. Lang* 1481, 1482, 1483, 1484, 1485 (AD); Lake Miranda, N of Leinster, 27°41'22"S, 120°32'41"E, 5 Oct. 1993, *D. Nicolle* 546 (AD); Between Leonora and Leinster, 28° 17' 31"S, 121° 08' 02"E, 17 Sep. 1995, *D. Nicolle* 1544 (AD); WNW of Meekatharra, 26°28'14"S, 118°06'19"E, 18 Sep. 1995, *D. Nicolle* 1545 (AD, CANB); Millys Soak, N of Cue, 27° 17' 10"S, 117°55'44"E, 18 Sep. 1995, *D. Nicolle* 1548 (AD, CANB, PERTH).

*Intergrades.* *E. striaticalyx* subsp. *striaticalyx* - *E. clelandii* intergrades are cited under the latter. *E. striaticalyx* subsp. *striaticalyx* - *E. gypsophila*: WESTERN AUSTRALIA: 22.1 km E of junction S side of Lake Minigwal, 25 June 1987, *I. Brooker* 9673 (CANB, PERTH); 3 km E of Mt Cleaver, 26°32' S, 120°31'E, 5 May 1978, *L.A. Craven* 5397 (CANB, PERTH); NE of Laverton, 28°25' 10"S, 123°15' 18"E, 17 Sep. 1995, *D. Nicolle* 1543 (AD, CANB).

*Distribution and habitat.* Endemic to the northern goldfields of Western Australia, from north-west of Meekatharra south-west towards Mongers Lake and north-east to Lake Carnegie with a more outlying population around Lake Minigwal in the south-east of its distribution where it grades into *E. gypsophila*. Although the total distribution is fairly wide, subsp. *striaticalyx* occurs in very scattered populations. Individual populations may be large, especially where it occurs around salt lakes, and it is usually the dominant plant where it occurs (eg. Lake Way, Lake Miranda). It always grows immediately around salt lakes or in broad, shallow drainage lines in fairly flat country. The soil is usually powdery red-brown or brown loams over white calcareous loams. It almost always occurs in pure stands often with *Selenothamnus* or a sparse chenopod understorey, although in the north-west of its range it is sometimes associated with *E. victrix* and near Lake Minigwal with *E. salicola*. (Figure 1)

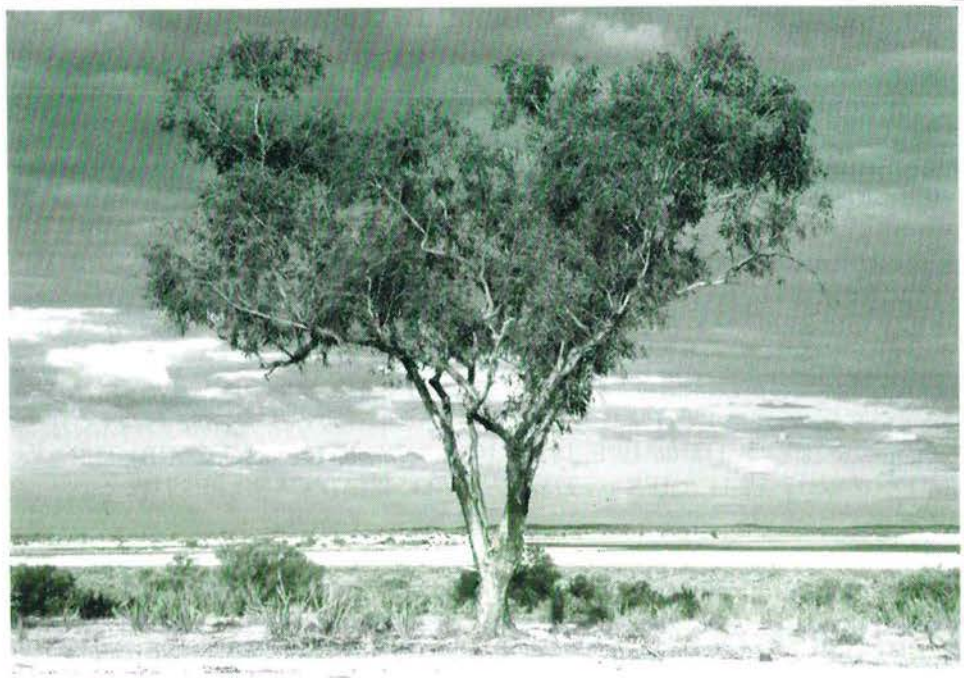
*Flowering period.* Poorly known.

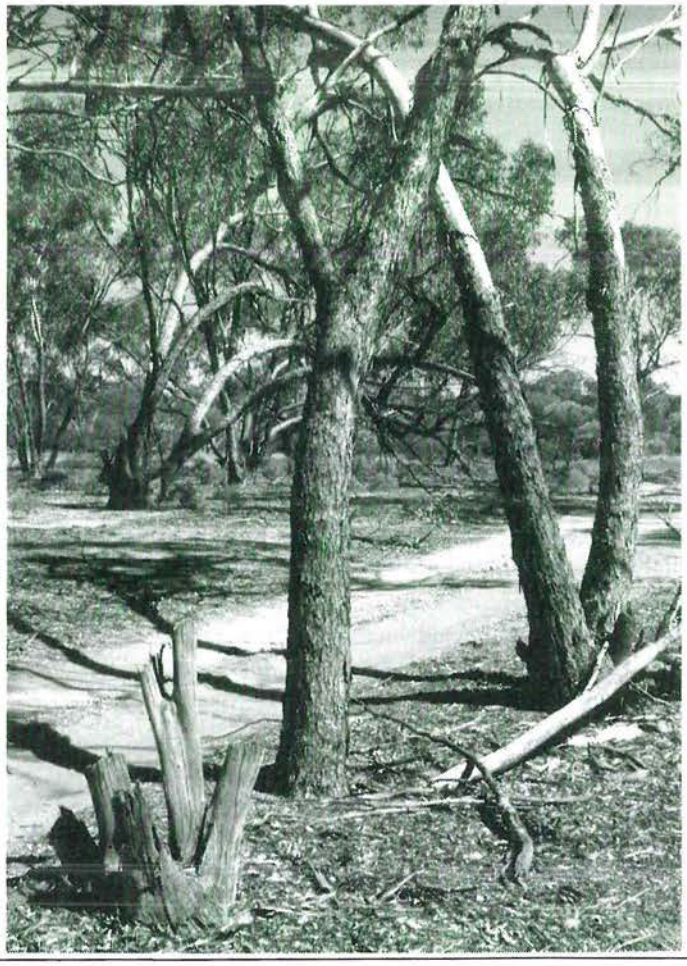
*Conservation status.* Although occurring over a large range, populations are widely scattered and this subspecies is not common (although usually locally dominant). It is not known to occur in any conservation reserves and many populations have suffered disturbance as mentioned above.

*Notes.* *E. striaticalyx* subsp. *striaticalyx* is more common and widespread than subsp. *delicata*. It is more robust in form and has larger adult leaves, buds and fruits than subsp. *delicata*.

**2b. Eucalyptus striaticalyx** subsp. **delicata** Nicolle & P.J. Lang, *subsp. nov.*

A subspecie typica habitu fruticoso, foliis angustioribus, alabastris et fructibus minoribus, ramulis et foliis adultis pedulis differt.





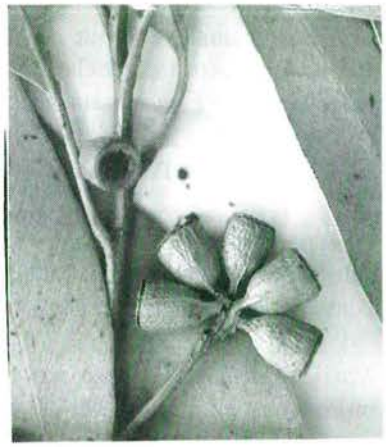


Figure 4. *Eucalyptus striaticalyx* subsp. *striaticalyx* habit and bark of specimens at Millys Soak, Western Australia (note the single-stemmed uncut tree with multi-stemmed trees that have been cut for timber on either side), and fruits (life size, from *D. Nicolle* 1548).

Distinguished from subsp. *striaticalyx* by its poorer, depauperate tree habit; its less extensive rough bark; its narrow-lanceolate adult leaves, 70-160 mm long by 7-14 mm wide; its smaller buds and fruits (buds 6-11 mm long by 3-4 mm diam.; fruits 5-9 mm long by 5-7 mm diam.); and the notably pendulous branchlets.

*Typus*: Lake Annean, South of Meekatharra, Western Australia, 26° 53' 59"S, 118° 16' 25"E, 18 September 1995, *D. Nicolle* 1547 (*holo:* PERTH; *iso:* CANB).

*Selected specimens examined.* WESTERN AUSTRALIA: Lake Austin, 12 Aug. 1965, *I. Brooker* 1996, 1997, 1998 (PERTH); 72.5 km by road NNE of Cue towards Meekatharra, Lake Annean - kopi dune east of road, 8 Dec. 1978, *P.J. Lang* 1478, 1479 (AD); Lake Annean, S of Meekatharra, 26° 53' 59"S, 118° 16'25"E, 18 Sep. 1995, *D. Nicolle* 1546 (AD, CANB).

*Distribution and habitat.* Restricted to immediately around Lake Annean and Lake Austin in the northern goldfields of Western Australia. It occurs in open, pure stands on gypseous low dunes (lunettes) beside salt lake systems. These dunes support very little vegetation, mostly *Selenothamnus*, apart from this taxon. The dunes consist of very calcareous fine white to brown powdery silt-loams. The habitat is similar to that occupied by *E. striaticalyx* subsp. *striaticalyx,* but is somewhat harsher, indicated by the very sparse vegetation covering the ground and the depauperate nature of the trees. (Figure 1)

*Flowering period.* Not known.

*Conservation status.* Of restricted distribution and not known to occur in a conservation reserve. It is locally dominant where it occurs although seedling regeneration is not apparent. Listed as Priority 1 by the Department of Conservation and Land Management.

*Etymology.* From the Latin *delicata* - meaning delicate or soft, referring to its pendulous crown of narrow leaves and small buds and fruits compared to the type subspecies.

*Notes.* This is a distinctive subspecies of *E. striaticalyx,* notable because of its depauperate form, narrow leaves and noticeably pendulous branchlets compared to subsp. *striaticalyx*. It occupies a similar but harsher habitat to subsp. *striaticalyx*, being the only plant of significant size where it grows with a very sparse understorey of few species. *E. striaticalyx* subsp. *delicata* occurs within the general distribution of *E. striaticalyx* subsp. *striaticalyx*, however, the two subspecies are not known to grow in mixed stands. Although this subspecies is of restricted distribution, it is well represented in herbaria although many specimens are poor and consist mainly of stem and leaf material, with most collections coming from around Lake Annean.

**3. Eucalyptus gypsophila** Nicolle, *sp. nov.*

*Affinis E. striaticalyci* sed characteribus sequentibus distinguitur: habitu pluricauli ("mallee"), cortice fibroso in dimidio inferiore, ramulis variabile glaucis, alabastris fructibusque et operculis hemispherical vel acutis differt.

Distinguished within the *E. striaticalyx* group by the combination of mallee habit, persistent rough bark on lower half of stems, variably pruinose twigs, buds and fruits, blue-green to grey-green lanceolate leaves, slightly ribbed, medium-sized buds with a conical to hemispherical operculum and medium-sized smooth to striated fruits.

*Typus:* Northern part of Yumbarra Conservation Park, South Australia, 31°39'28"S, 133°46'43"E, 22 July 1995, *D. Nicolle* 1405 (*holo*: PERTH; *iso*: AD).

*Mallee*, 3-6 m tall; lignotubers present. Rough *bark* persistent, sub-fibrous and flaky, grey-brown to dark grey over tan for 1-3 m (lower half of stems), then smooth, tan to grey over cream to grey. *Branchlets* sometimes pruinose, pith glands present. *Cotyledons* reniform; seedling leaves opposite for 1-3 pairs then alternate, petiolate, ovate, blue-grey, usually pruinose. *Adult leaves* alternate, petiolate, broad-lanceolate to lanceolate, 90-130 mm long, 18-25 mm wide, concolorous, dull, blue-green to blue-grey, occasionally slightly pruinose; reticulation dense, with numerous intersectional oil glands, lateral veins at 40°-60° from midrib. *Inflorescences* axillary, unbranched, 7-11-flowered, peduncles thick, terete, 4-18 mm long; pedicles 2-4 mm long. *Buds* sometimes pruinose, 7-12 mm long, 5-7 mm diam.; hypanthium cupular, tapering to pedicel, smooth; operculum hemispherical to conical, apiculate to rounded, equal in width or very slightly wider than hypanthium, almost smooth to lightly ribbed. *Stamens* strongly inflexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* creamy white. *Ovules* in 4 vertical rows. *Fruits* sometimes pruinose, cupular to shortly cylindrical, 6-10 mm long, 6-11 mm diam., smooth to slightly ribbed; operculum scar sometimes conspicuous, ascending to level, 1-2 mm wide; disc level to descending, 2-3 mm wide; valves (3)4, around rim level. *Seeds* compressed ovoid to compressed spherical, 1.2-2.5 mm long, glossy, dark tan-brown to red-brown, reticulum shallow to medium; chaff glossy, tan to red-brown. (Figure 5)

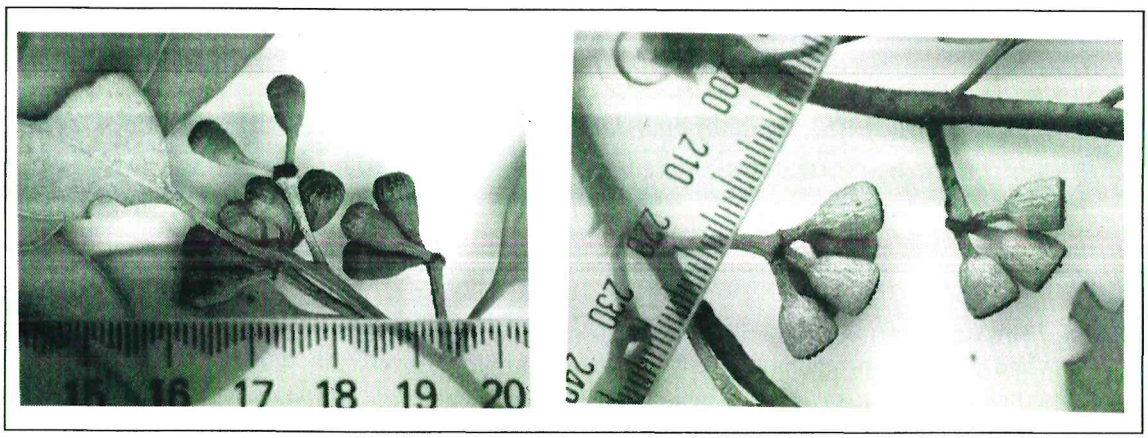



Figure 5. *Eucalyptus gypsophila* buds and fruits (life size, from *D. Nicolle* 1405).

*Selected specimens examined* (west to east). WESTERN AUSTRALIA: 62 km S of Neale Junction, Great Victoria Desert, 28°45'S, 125°48'E, 12 May 1984, *I. Brooker* 8563 (AD, PERTH); *c.* 1 km E of Tallering Peak, 50 km NNE of Mullewa, 17 Aug. 1983, *S.D. Hopper* 3136 (PERTH); Savory Creek, Keartland District, 23°41'S, 121°36'E, 12 June 1984, *G.J. Morse* 127 (CANB, PERTH); 179 km W of intersection of Cook to Vokes Hill road and Oak Valley to Tjuntjunjara road, 29°34'17"S, 128°23'42"E, 27 Sep. 1993, *D. Nicolle* 499 (AD, CANB); Track S of Lake Minigwal, 29°52'06"S, 123°06'18"E, 30 Sep. 1993, *D. Nicolle* 525 (AD); Ann Beadell Highway, just W of Serpentine Lakes, 28°30'35"S, 128°59'40"E, 16 Sep. 1995, *D. Nicolle* 1520 (AD, CANB); Ann Beadell Highway, just W of Serpentine Lakes, 28°30'53"S, 128°57'38"E, 16 Sep. 1995, *D. Nicolle* 1521 (AD); Ann Beadell Highway, E of Neale Junction, 28°19'58"S, 127°20'44"E, 16 Sep. 1995, *D. Nicolle* 1529 (AD, CANB); Tallering Peak, 28°15'35"S, 115°39'29"E, 18 Sep. 1995, *D. Nicolle* 1550 (AD, CANB, PERTH, NSW); 26 km NNW of Queen Victoria Spring, Queen Victoria Spring Nature Reserve, 30°15'S, 123°24'E, 26 May 1990, *D.J. Pearson* 810 (PERTH).

SOUTH AUSTRALIA: 29 km N of Watson towards Maralinga, 10 Mar. 1984, *I. Brooker* 8470 (AD); Vokes Corner - north-west plains, 17 July 1972, *N.N. Donner* 3905 (AD, NBG, CANB, SI, TI, TAI, LIS); E of Serpentine Lakes, 21 July 1979, *T. Dennis* 205 (AD); 117 km N of Hughes Station 52, 12 July 1967, *J. Johnson s.n.* (AD); E side of lake with centre at 29° 48' 30"S, 132° 54' 50"E, W of Dingo Flat gate, Commonwealth Hill Station, 12 July 1981, *F. Mollemans* 809 (AD, CANB, PERTH); Tarcoola to Ceduna track, 31° 13' 14"S, 133° 59' 11"E, 22 July 1995, *D. Nicolle* 1400 (AD); Vokes Hill Junction, Ann Beadell Highway, 28° 33' 55"S, 130° 41' 12"E, 15 Sep. 1995, *D. Nicolle* 1515 (AD, CANB); Serpentine Lakes, 28° 29' 59"S, 129° 01' 54"E, 15 Sep. 1995, *D. Nicolle* 1519 (AD, CANB); 40 km NE of Maralinga, 15 Nov. 1972, *R.C. Shearer* 67 (AD); *c.* 155 km N of Hughes, 16 Feb. 1972, *R.C. Shearer* 137 (AD); 10 km S of Mt Christie Siding on new track, 30° 37' 54"S, 133° 14' 49"E, 17 Oct. 1987, *D.E. Symon s.n.* (AD, CANB); 3.28 km E of Western Australian Border on track from Serpentine Lakes, 30 July 1979, *L.D. Williams s.n.* (AD).

*Intergrades. E. gypsophila - E. striaticalyx* intergrades are cited under the latter.
*E. gypsophila - E. canescens* subsp. *canescens*: SOUTH AUSTRALIA: Cook road, *c.* 75 km WSW of Lake Maurice (station 39), 29 June 1967, *J. Johnson s.n.* (AD); Maralinga to Oak Valley road, 29° 27' 31"S, 130° 48' 47"E, 14 Sep. 1995, *D. Nicolle* 1503 (AD); Cook to Vokes Hill road, 28° 50' 15"S, 130° 29' 03"E, 15 Sep. 1995, *D. Nicolle* 1509 (AD, CANB); Cook to Vokes Hill road, 28° 36' 43"S, 130° 37' 32"E, 15 Sep. 1995, *D. Nicolle* 1512 (AD); W of Lake Maurice, 27 May 1970, *S. Reid & J. Johnson s.n.* (AD).
*E. gypsophila - E. dumosa sens. lat.*: SOUTH AUSTRALIA: Koongawa water reserve adjoining S side of Eyre Highway, 33° 10'S, 135° 23'E, 8 Feb. 1978, *P.J. Lang* 1227 (AD); NE of Wirrulla, 32° 22' 16"S, 134° 53' 34"E, 13 Sep. 1995, *D. Nicolle* 1489 (AD); SW of Yardea in sand dunes between Gawler Ranges, 32° 30' 37"S, 135° 21' 23"E, 15 Feb. 1996, *D. Nicolle* 1679 (AD, CANB); 49.1 km N of Minnipa towards Yardea, 32° 32'S, 135° 23'E, 28 Oct. 1978, *L.D. Pryor & J.D. Briggs* 209 (AD).

*Distribution and habitat.* Widespread and relatively frequent in the Great Victoria Desert of Western and South Australia, scattered from east of Laverton and Queen Victoria Spring in Western Australia to the western edge of the Gawler Ranges in South Australia. It grows on red sand over shallow powdery limestone throughout most of its range, often near or around salt or playa lakes. At the extreme south-east of its range, near the Gawler Ranges, it grows on low orange sand dunes near small salt lakes with *E. concinna*. There are also a number of disjunct occurrences to the north-west of its main distribution, possibly remnant populations from the past when it may have been more common there. The most disjunct population, apparently a remnant, occurs at Tallering Peak, north-east of Geraldton in Western Australia, where about 50 mallees grow on a rocky breakaway of quartz and ironstone in low open shrubland. This habitat is typical of these disjunct north-western populations but differs from the more sandy soils in which it grows in Great Victoria Desert, however these mallees are morphologically identical to *E. gypsophila* in the Great Victoria Desert. Similar remnant populations of *E. gypsophila* occur in the Kennedy Ranges, near Marymia and at Savoury Creek. On sand dunes where the Great Victoria Desert enters into the western Gawler Ranges, *E. gypsophila* intergrades into the northern Eyre Peninsula form of *E. dumosa*. Commonly associated species in the Great Victoria Desert include *E. eucentrica, E. gongylocarpa, E. concinna, E. eremicola* and *E. youngiana* with a *Triodia* understorey. (Figures 1,2)

*Flowering period.* Not known.

*Conservation status. E. gypsophila* is widespread and well represented in conservation reserves such as Neale Junction Nature Reserve in Western Australia and Unnamed Conservation Park and Yumbarra Conservation Park in South Australia. The isolated Tallering Peak population is small and may be under threat from proposed iron-ore mining activity in the area.

*Etymology.* From the Greek *gypsos* - of gypsum or white plaster, and *philos* - meaning loving, referring to its common occurrence on gypseous sand dunes around playa lakes.

*Notes and affinities.* By far the most widespread taxon in the *E. striaticalyx* group, with populations representing the most easterly (west of the Gawler Ranges) and westerly (Kennedy Ranges) boundaries for this group. This taxon is also the most variable taxon described here, perhaps a reflection of its large distribution. Its most variable feature appears to be pruinosity, sometimes present on the twigs, buds and fruits. The pruinosity of branchlets in *E. gypsophila* follows somewhat of a geographical pattern, with the remnant western populations consistently being distinctly pruinose, however in the Great Victoria Desert this pattern breaks down with pruinose and non-pruinose populations occurring apparently at random, although usually less pruinose than western populations except where adjoining the distribution of *E. canescens* subsp. *canescens*.

**4. Eucalyptus repullulans** Nicolle, *sp. nov.*

Affinis *E. striaticalyci* sed characteribus sequentibus distinguitur: habitatione saxosa, habitu pluricauli ("mallee"), cortice deciduo et ramulis glaucis, alabastris fructibusque glaucis differt.

Distinguished within the *E. striaticalyx* group by the combination of its harsh, rocky habitat, mallee habit, smooth bark, pruinose twigs, buds and fruits, lanceolate leaves, medium-sized, lightly ribbed buds and fruits and conical to beaked operculum.

*Typus:* Near summit of Mt Nameless, near Mt Tom Price, Hamersley Ranges, Western Australia, 22° 43' 16"S, 117° 45' 41"E, 29 November 1994, *D. Nicolle* 1192 (*holo:* PERTH; *iso:* AD, CANB).

*Illustrations.* Habit, bark, buds and fruits in Brooker & Kleinig (1994: 225) as *E. striaticalyx*; buds and fruits in Chippendale (1968:48) as *E. striaticalyx*.

Slender-stemmed *mallee* 3-5 m tall, forming lignotubers. *Bark* smooth throughout (a little persistent rough bark may be present at extreme base), light grey, pink and pinkish-tan over cream. *Branchlets* sometimes pruinose; pith glands present. *Cotyledons* reniform; seedling leaves opposite for 3-6 pairs, petiolate, ovate, 20-45 x 9-22 mm, discolorous, dull to slightly glossy, green, petioles and juvenile new growth pruinose. *Adult leaves* alternate, petiolate, narrow-lanceolate to lanceolate (to broad-lanceolate), 70-125 mm long, 12-30 mm wide, concolorous, dull, blue-green, sometimes slightly pruinose; reticulation dense, with numerous intersectional oil glands, lateral veins at 40°-60° from midrib. *Inflorescences* axillary, unbranched, 7-9-flowered; peduncle terete to angular, 12-14 mm long; pedicels 2-4 mm long. *Buds* 7-11 mm long, 5-6 mm diam., pruinose; hypanthium smooth or weakly ribbed; operculum equal to or wider than hypanthium, ribbed, conical, rounded or apiculate. *Stamens* strongly inflexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* creamy white. *Ovules* in 4 vertical rows. *Fruits* pedicellate, cupular to slightly campanulate, smooth to weakly ribbed, usually pruinose, 6-9 mm long, 6-9 mm diam.; operculum scar 1 mm wide, ascending or level; disc descending; valves 3 or 4, slightly below rim level to slightly exserted. *Seeds* compressed-ovoid to compressed-spherical, 1.2-2 mm long, glossy, orange-brown to red-brown, reticulum fine to medium; chaff glossy, tan to brown. (Figure 6)

*Etymology.* From the Latin *repullulans* - sprouting again, referring to the mallee habit, in contrast to *E. striaticalyx*.

*Selected specimens examined* (west to east). WESTERN AUSTRALIA: Mount Tom Price township at Mrs L. Mattiske residence, 22°45'S, 117°46'E, 10 Aug. 1980, *C.D. Boomsma* 669, 670 (AD); 28 km W of rail crossing, N of Newman on Packsaddle road, 23°14'S, 119°33'E, 6 July 1983, *I. Brooker* 8207 (CANB, PERTH); Haulpak Track, N of Mt Meharry, 22°50'S, 118°35'E, 7 July 1983, *I. Brooker* 8217 (CANB, PERTH); 18.3 km from Tom Price towards Paraburdoo, 22°50'S, 117°47'E, 9 July 1983, *I. Brooker* 8240 (CANB, PERTH); SW of Tom Price, Hamersley Ranges, 22°37'50"S, 117°36'56"E, 29 Nov. 1994, *D. Nicolle* 1188 (AD, CANB); 2.2 km NE of Dinner Hill, Karijini National Park, Hamersley Ranges, 22°36'15"S, 118°18'53"E, 23 May 1991, *S. Van Leeuwen* 765 (CANB, PERTH).

*Distribution and habitat.* Known only from the Hamersley Ranges in the Pilbara area, where it occurs as scattered populations in shallow skeletal soils on the slopes and summits of prominant mountains (eg. Mt Nameless, Mt Bruce, Mt Meharry and Mt Robinson) and the surrounding undulating areas, in open mallee shrubland. Recorded associated taxa are *Eucalyptus socialis*, *E. gamophylla*, *E. kingsmillii* subsp. *kingsmillii*, *E. pilbarensis*, *E. trivalvis*, *E. leucophloia*, *E.* aff. *lucasii*, *Corymbia hamersleyana*, *C. ferriticola* subsp. *ferriticola*, and *Acacia* spp. with a *Triodia* ground cover. (Figure 1)

*Flowering period.* Not known.

*Conservation status.* The scattered populations are at little risk from any activity in the area and the taxon has been recorded in Karijini National Park. This subspecies recovers vigorously following fire.

*Notes. E. repullulans* is geographically isolated from all other taxa in extra-codical section *Dumaria* (Pryor & Johnson 1971) and occurs in a habitat unlike that of other taxa in the *E. striaticalyx* group. Herbarium specimens appear very similar to *E. gypsophila*, however the habitat, habit and bark characteristics readily distinguish the two species. This taxon is poorly represented in herbaria and habit and bark have rarely been accurately recorded on herbarium specimens.

A specimen (*D. Symon* 8403), collected in the Wingelina nickel area of the Blackstone Range in Western Australia may be this taxon but, as bark characteristics are not noted, it is indistinguishable from *E. gypsophila*. The "lower slopes of low hills" habitat for this specimen matches that of *E. repullulans* and it is said to be a "graceful mallee, ends of branches sometimes drooping". Further field investigation will resolve its determination.

**5. Eucalyptus canescens** Nicolle, *sp. nov.*

Affinis *E. striaticalyci* sed characteribus sequentibus distinguitur: habitatione arenacea, habitu fruticoso ("mallee"), alabastris majoribus; fructibus costatis et majoribus; foliis adultis latioribus; ramulis, alabastris et fructibus non-pruinosis vel pruinosis et operculis haemisphericis differt.

Distinguished within the *E. striaticalyx* group by the combination of its occurrence on red sand, effuse mallee habit, persistent rough bark, broad-lanceolate to ovate adult leaves, large, ribbed buds with a hemispherical operculum and large fruits with 4 or 5 valves.

*Typus:* Just south of Oak Valley, north of Cook, South Australia, 29°24'55"S, 130°43'52"E, 14 September 1995, *D. Nicolle* 1504 (*holo:* PERTH; *iso:* AD, CANB).

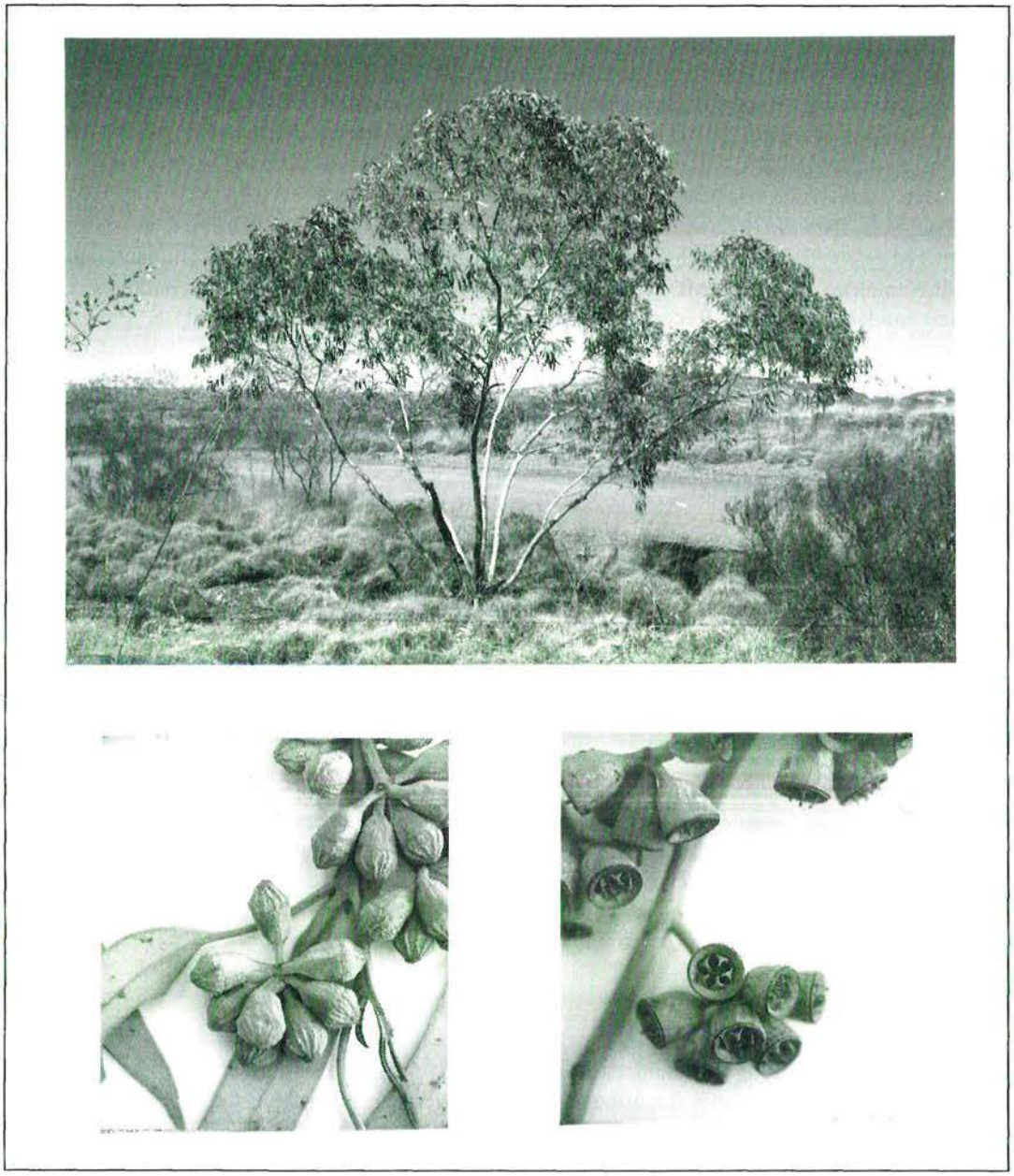


Figure 6. *Eucalyptus repullulans* habit of mallee from south-west of Tom Price, Hamersley Ranges, Western Australia, with buds and fruits (life size, from *D. Nicolle* 1192).

*Mallee* 2-6 m tall, forming lignotubers. Rough *bark* persistent, thick and flaky, brown to grey over red-brown to yellow-brown over stems to about 5 cm diameter. *Branchlets* not pruinose in subsp. *beadellii* or strongly pruinose in subsp. *canescens*; pith glands present. *Cotyledons* reniform; seedling leaves opposite for 1-3 pairs then alternate, petiolate, ovate, to 35 x 23 mm. *Adult leaves* alternate, petiolate, elliptic or ovate to broad-lanceolate (to lanceolate), 45-115 mm long, 22-55 mm wide, concolorous, dull, blue-grey to grey and usually pruinose in subsp. *canescens*, or dull to slightly glossy, green in subsp. *beadellii*; reticulation dense, with numerous intersectional oil glands, lateral veins at 35°-55° from midrib. *Inflorescences* axillary, unbranched, 7-flowered; peduncle thick, terete to slightly flattened, 8-18 mm long; pedicels thick, tapering to fruit, 2-8 mm long. *Buds* strongly pruinose in subsp. *canescens*, not pruinose in subsp. *beadellii*, pyriform to ovoid to somewhat mushroom-shaped, 11-16 mm long, 8-11 mm diam.; hypanthium tapering to pedicel, obconical to cupular, smooth to ribbed; operculum hemispherical, apiculate to rounded, equal in width or wider than hypanthium, ribbed. *Stamens* strongly inflexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* creamy white. *Ovules* in 4 vertical rows. *Fruits* pruinose, especially when young in subsp. *canescens*, not pruinose in subsp. *beadellii*, broadly obconical to cupular to shortly cylindrical, 10-16 mm long, 9-14 mm diam., smooth to strongly ribbed; operculum scar conspicuous, ascending to level, 1-3 mm wide; disc level to descending, 1-4 mm wide; valves 4 or 5, at or just below rim level. *Seeds* strongly compressed-ovoid, 2-4 mm long, glossy, red-brown, reticulum fine to medium; chaff glossy, orange-brown.

*Etymology.* From the Latin *canescens* - grey or becoming grey, referring to the grey general appearance of the type subspecies, caused by the greyish adult leaves and pruinose branchlets, buds and fruit.

*Notes and affinities.* To the north and east of its distribution, *E. canescens* is replaced by E. *gypsophila* and the two species intergrade in the area around Wyola Lake to Lake Maurice. This species is low-growing and has the broadest leaves and largest buds and fruits of those treated here. Both subspecies therefore have horticultural appeal.

There are two subspecies:

1. Twigs, buds and fruits strongly pruinose, adult leaves greyish ..... 5a. subsp. ***canescens***
1. Twigs, buds and fruits not pruinose, adult leaves green ..... 5b. subsp. ***beadellii***

**5a. Eucalyptus canescens** Nicolle subsp. **canescens**

Distinguished from subsp. *beadellii* in its strongly pruinose twigs, buds and fruits, the blue-grey, often pruinose adult leaves and the more cupular, ribbed fruits. (Figure 7)

*Selected specimens examined.* SOUTH AUSTRALIA: 232 km N of Cook, 28 Aug. 1986, *I. Brooker* 9427 (AD); 131 km N of Cook on road to Vokes Hill, 20 Aug. 1979, *T.E. Dennis* 188 (AD); 131 km N of Cook on road to Vokes Hill, 20 Aug. 1979, *T.E. Dennis* 189 (AD); 191 km N of Cook on road to Vokes Hill, 20 Aug. 1979, *T.E. Dennis* 191 (AD); 29°31'S, 130°08'E, 16 Aug. 1980, *T.E. Dennis* 213 (AD); Cook road, about 75 km WSW of Lake Maurice, 29 June 1967, *J. Johnson* (AD); Cook-Vokes Hill road, Great Victoria Desert, 29° 30' 42"S, 130° 18' 56"E, 5 Dec. 1992, *D. Nicolle* 108 (AD, CANB, PERTH); Cook to Vokes Hill road, Great Victoria Desert, 29° 33' 49"S, 130° 08' 22"E, 26 Sep. 1993, *D. Nicolle* 487 (AD, CANB); Maralinga-Oak Valley road, 29° 52' 00"S, 131° 15' 38"E, 14 Sep. 1995, *D. Nicolle* 1499 (AD, CANB); Maralinga-Oak Valley road, 29° 48' 40"S, 131° 10' 00"E, 14 Sep. 1995, *D. Nicolle* 1501 (AD, CANB); about 135 km N of Cook on Cook-Vokes Hill road, 29° 35'S, 130° 07'E, 18 Aug. 1980, *D.E. Symon* 12236 (AD, FRI); Cook-Vokes Hill road, N of Nullarbor Plain, 29° 32'S, 130° 09'E, 20 Aug. 1980, *D.E. Symon* 12255 (AD, FRI, NSW); About 130 km N of Cook along Cook-Vokes Hill road, 29° 36'S, 130° 08'E, 19 Aug. 1980,

*J.Z. Weber* 6316 (AD); 121 km W of N of Cook, 29°32.5'S, 130°75'E, 18 July 1979, *L.D. Williams* 10492 (AD).

*Intergrades.* *E. canescens* subsp. *canescens* - *E. gypsophila* intergrades are cited under the latter.

*Distribution and habitat.* Known from the Ooldea Range, part of the Barton Dune system in the southern part of the Great Victoria Desert, immediately north of the Nullarbor Plain, from north-west of Cook to near Maralinga. It is common on the track north of Cook. Endemic to South Australia. It occurs on sand dunes or sand plains in red sand, sometimes with limestone rubble present. Associated taxa include *E. pimpiniana, E. concinna, E. eremicola, E. eucentrica* and *E. eucentrica-E. wyolensis* intergrades. (Figure 2)

*Flowering period.* Not known.

*Conservation status.* Endemic to the Maralinga Aboriginal Lands where it is scattered but locally common and not considered to be at risk. *E. canescens* subsp. *canescens* - *E. gypsophila* intergrades have been recorded in Unnamed Conservation Park as has *E. gypsophila,* but *E. canescens* (subsp. *canescens* and subsp. *beadellii* have not).

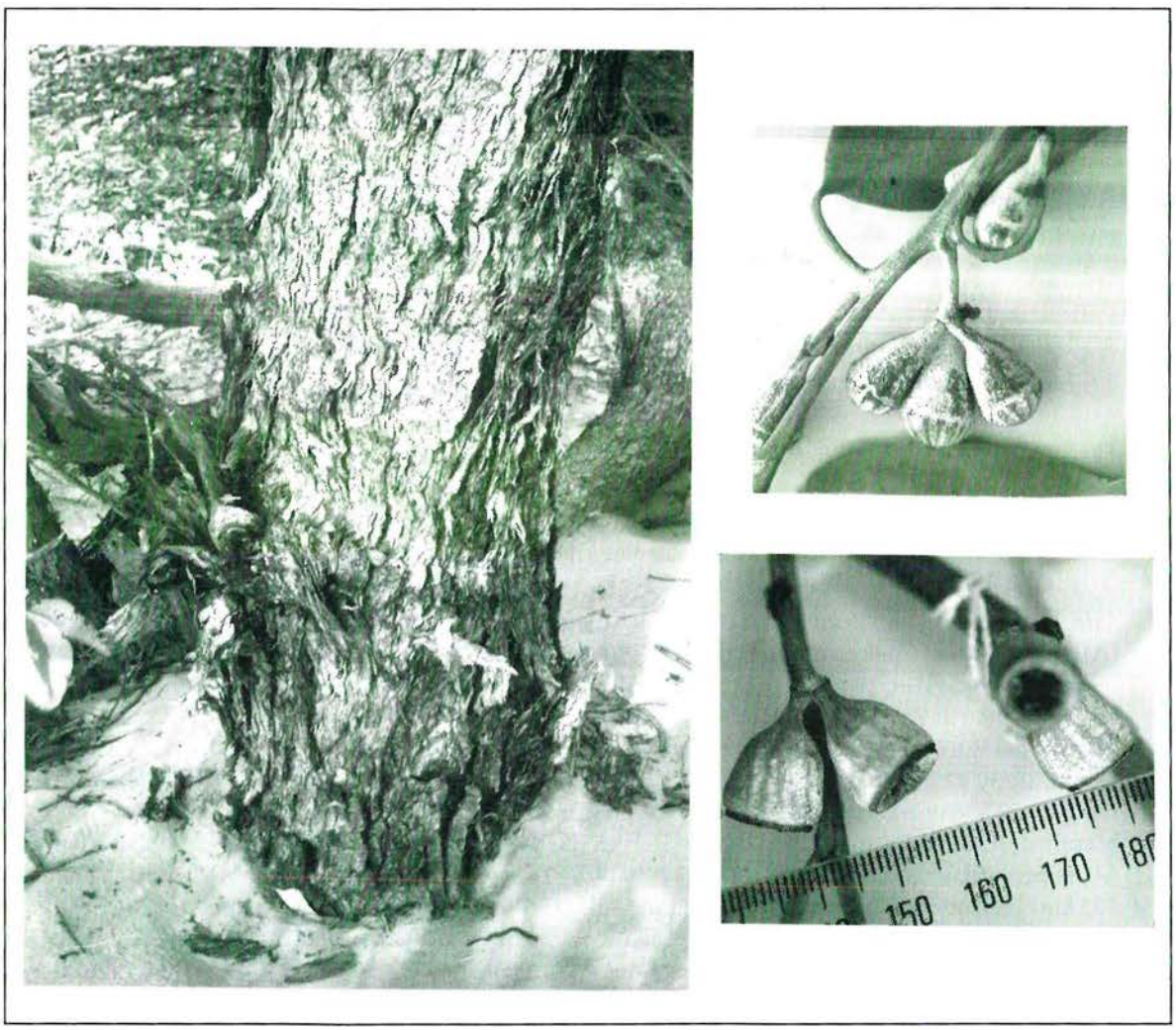



Figure 7. *Eucalyptus canescens* subsp. *canescens* lower bark on mallee north of Cook, South Australia (*D. Nicolle* 487), buds and fruits (*D. Nicolle* 1504).

*Notes and affinities.* Herbarium specimens of *E. canescens* subsp. *canescens* are somewhat similar to *E. cretata* Lang & Brooker of central Eyre Peninsula, from which it differs in its smaller stature, persistent, rough bark (smooth in *E. cretata*), consistently dull, ovate to broad-lanceolate adult leaves (maturing glossy and lanceolate in *E. cretata*), larger buds and fruit (fruit 6-8 mm long and 6-8 mm diam. in *E. cretata*) and consistently hemispherical operculum (rounded to beaked in *E. cretata*). *E. canescens* subsp. *canescens* is particularly ornamental and would merit cultivation in arid areas. Hybrids are known with *E. concinna* Maiden & Blakely and *E. eucentrica* Johnson & Hill. A specimen of the intersectional hybrid *E. eucentrica* x *E. canescens* subsp. *canescens* constitutes the type material of *E. yumbarrana* Boomsma subsp. *striata* Boomsma.

**5b. Eucalyptus canescens** subsp. **beadellii** Nicolle, *subsp. nov.*

A subspecie typica characteribus sequentibus distinguitur: foliis adultis latioribus et viridibus; ramulis, alabastris fructibusque non-pruinosis differt.

Distinguished from subsp. *canescens* in the non-pruinose twigs, buds and fruits, the dull to slightly glossy, green adult leaves and the more obconical, almost smooth fruits. (Figure 8)

*Typus:* Junction of Cook to Vokes Hill road and Oak Valley to Tjuntjunjara road, Great Victoria Desert, South Australia, 29° 20' 00"S, 130° 11' 50"E, 26 September 1993, *D. Nicolle* 489 (*holo:* PERTH; *iso:* CANB).

*Selected specimens examined.* SOUTH AUSTRALIA: Just E of Cook to Vokes Hill road on Oak Valley road, Great Victoria Desert, 29° 15'S, 129° 55'E, 20 Aug. 1980, *T. Dennis* 220 (AD, FRI); 29° 20' 07"S, 130° 13' 15"E, 14 Sep. 1995, *D. Nicolle* 1506 (AD, CANB).

*Distribution and habitat.* Of very restricted occurrence, known only in the vicinity of the junction of the Cook to Vokes Hill track and the Oak Valley track, north of Cook. Here it is part of a mallee community in deep red sand in level country. Associated species include *E. wyolensis, E. concinna, E. eucentrica, E. pimpiniana* and *E. yumbarrana* with an understorey mainly of *Triodia*. (Figure 2)

*Flowering period.* Not known.

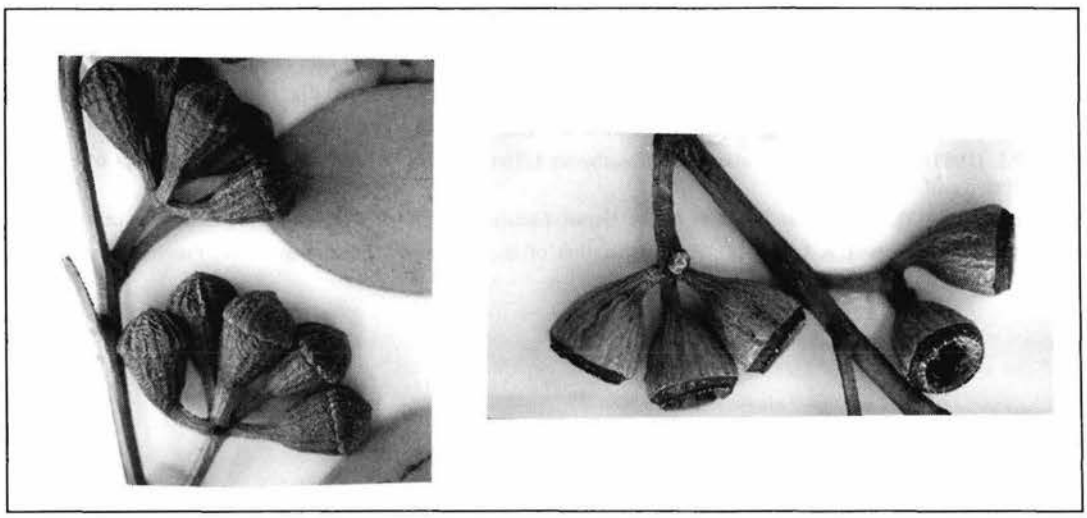


Figure 8. *Eucalyptus canescens* subsp. *beadelii*, buds and fruits (life size, from *D. Nicolle* 489 the *Type*).

*Conservation status.* By far the rarest taxon in the *E. striaticalyx* group, with a known distribution of only a few square kilometres. It is likely that it occurs elsewhere in such a large, remote area of similar habitat. The entire known populations occur within Maralinga Aboriginal land. The mallees recover well from fire through coppice shoots from the lignotuber and the taxon is currently under no threat. The status code 2R is suggested using criteria of Briggs & Leigh (1989).

*Etymology.* The epithet commemorates Len Beadell (1923 - 1995), who surveyed over 5000 km of roads to open up the Great Victoria, Gibson and Great Sandy Deserts to present day travellers and botanists. These roads are still the only access to much of these areas today.

*Notes and affinities.* No other taxa from series *Rufispermae* occur within the distribution of *E. canescens* subsp. *beadellii*, however, subsp. *canescens* occurs to the east and south and *E. gypsophila* mainly to the north. The large club-shaped buds are conspicuous when mature. The distribution and habitat roughly matches that of the rare *E. wyolensis* Boomsma, although *E. wyolensis-E. eucentrica* intergrades occur westwards almost to the Western Australian border. *E. canescens* subsp. *beadellii* has the same gross morphology as subsp. *canescens* but differs in the dull to slightly glossy, green adult leaves and the non-pruinose twigs, buds and fruits.

## Acknowledgements

Thanks must go to Ian Brooker for checking the manuscript and much helpful advice and discussions. Peter Lang gave much helpful advice and is co-author of *E. striaticalyx* subsp. *delicata*. I would also like to thank Martin Oleary and John Jessop for continuing support and access to the State Herbarium. Thanks also to Malcolm French for bringing the Tallering Peak population of *E. gypsophila* to my attention. The Maralinga Tjarutja provided support by allowing access within their lands.

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# A synopsis of the annual species of Cyperaceae from central and southern Western Australia

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## Abstract

Rye, B.L. A synopsis of the annual species of Cyperaceae from central and southern Western Australia. Nuytsia 11 (3): 383-423 (1997). A synopsis, keys and distribution maps are provided for all the annual species of Cyperaceae known from the Eremaean and South West Botanical Provinces of Western Australia. Selected species are illustrated. Some taxa are of conservation significance, including about six species each known from only one collection.

## Introduction

The recent account of the family Cyperaceae in "Flora of the Kimberley Region" (Rye 1992) gives keys, descriptions and illustrations for species occurring in the Northern Botanical Province of Western Australia. For regions south of the Kimberley, there is no recent comprehensive treatment of the family, although there are keys available for most of the species belonging to *Fimbristylis* (Latz 1990) and genera related to *Scirpus* L. (Wilson 1981). The key to south-western Cyperaceae published by Blackall & Grieve (1954) has never been revised.

In order to determine which species of Cyperaceae from the less well documented areas of Western Australia should be placed on the Declared Rare and Priority Flora List, herbarium specimens from the Eremaean and South West Botanical Provinces were surveyed. Among the numerous perennials in the family, the proportion of species likely to be at risk of extinction seemed very small in comparison with many other plant families. Annual species of Cyperaceae appeared to be more in need of attention. Nine new annual taxa, nearly all in the genus *Schoenus*, were distinguished as a result both of this survey and recent curation by Karen Wilson (NSW). Three of these were named and described (Rye 1997); the others were allocated phrase names but considered to be too poorly known to name formally. Since then, a further new annual taxon has been discovered and given the phrase name *Schoenus* sp. *Waroona* (*G.J. Keighery* 12235).

This paper provides a synopsis, keys and distribution maps for the annual species of Cyperaceae occurring in the Eremaean and South West Botanical Provinces of Western Australia. As a further aid to identification of these plants, previously published illustrations are cited and new illustrations provided where required.

About half of the 156 species included in the Kimberley flora are annuals, including several genera that do not occur elsewhere in Western Australia. In the south-west most species are perennial; for example, in the area covered by "Flora of the Perth Region" less than a quarter of the species are annuals (Rye 1987). Many of the annual species are small and inconspicuous, as well as being absent altogether for part of each year, so tend to be poorly collected. Since the Perth regional flora was completed, eight additional annual species have been recorded in that region.

In many of the perennial species, maximum fruit set has been reduced to one or two nuts per spikelet, and vegetative spread by rhizomes is of great importance. Annual species need to produce a good seed crop each year to ensure future generations and almost invariably produce larger numbers of nuts per spikelet or condensed spike. Since fruiting quickly follows flowering in annuals, flowering and fruiting generally occur in the same months. The flowering and fruiting periods given here apply only to specimens collected in the study area, as do any measurements and other descriptions.

## Distribution patterns and new records

Most species of Cyperaceae have wide distributions, often extending to other states of Australia and overseas. The annual species occur mainly in seasonally damp habitats, including the margins of watercouses, low-lying flats and rock crevices. Of the 48 named native species included here, 13 are endemic to the south-west and one to the Pilbara area of Western Australia. Five species (*Fimbristylis ammobia*, *Fuirena incrassata, F. nudiflora*, *Isolepis australiensis* and *Schoenus centralis*) are known from less than five localities in this State but have been collected more frequently from other parts of Australia, while the remaining species have been widely collected both in Western Australia and outside the State. The Western Australian distributions of all the species are shown in Figures 1-18, with each symbol indicating the presence of the taxon in a quarter degree latitude by quarter degree longitude area.

The number of named annual species recorded for Western Australia since the publication of the census and its most recent supplement (Green 1985, 1988) has increased by seven. Curation of the PERTH collection by Karen Wilson has led to the addition of the two native species *Fuirena incrassata* and *Isolepis australiensis* and the introduced species *Isolepis hystrix*. A further four species, named since the last supplement of the census, are *Fimbristylis simulans* (Latz 1990), *Schoenus badius, S. plumosus* and *S. variicellae* (Rye 1997).

One species previously recorded (Wilson 1981) for Western Australia, but now excluded, is *Isolepis platycarpa* (S.T. Blake) Soják. This species occurs in South Australia, New South Wales, Victoria, Tasmania and New Zealand, and might prove to be more widespread, but there are currently no specimens known to have been collected from Western Australia.

The descriptions given for all the annual species included in "Flora of the Perth Region" (Rye 1987) are accurate except that the one given under the name *Schoenus odontocarpus* actually applies to the new species *S. variicellae*. At the time the flora treatment was prepared, no specimens of true *S. odontocarpus* from the Perth region had been seen, but some have since been incorporated in the collection at PERTH. Other newly recorded native species for the region are *Isolepis congrua, I. hookeriana, Schoenus humilis, S. plumosus, S.* sp. *Bullsbrook* (*J.J. Alford* 915) and *S.* sp. *Waroona* (*G.J. Keighery* 12235). There is also one additional naturalized species, *Isolepis hystrix*.

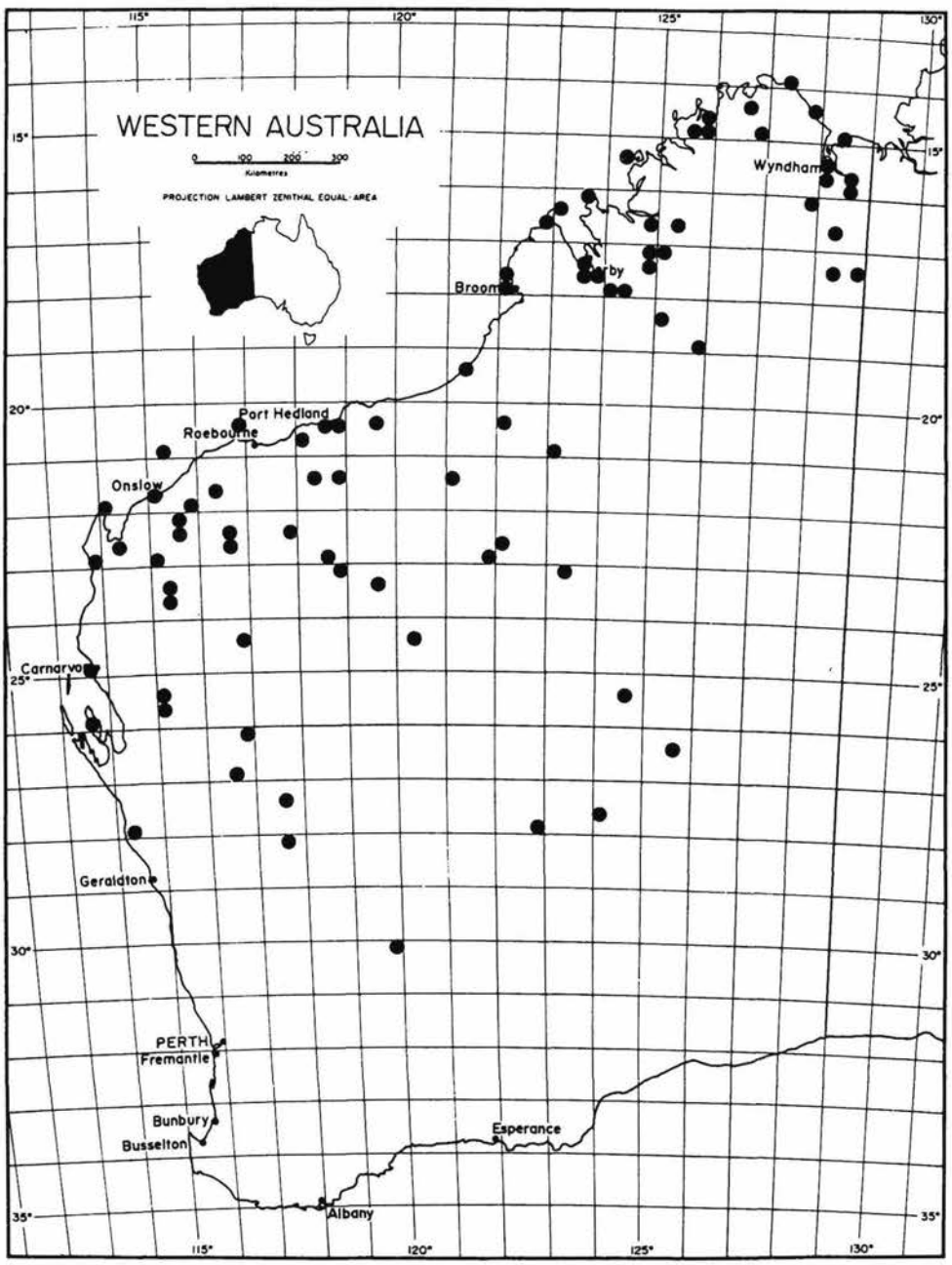


Figure 1. Distribution of *Bulbostylis barbata* in Western Australia.

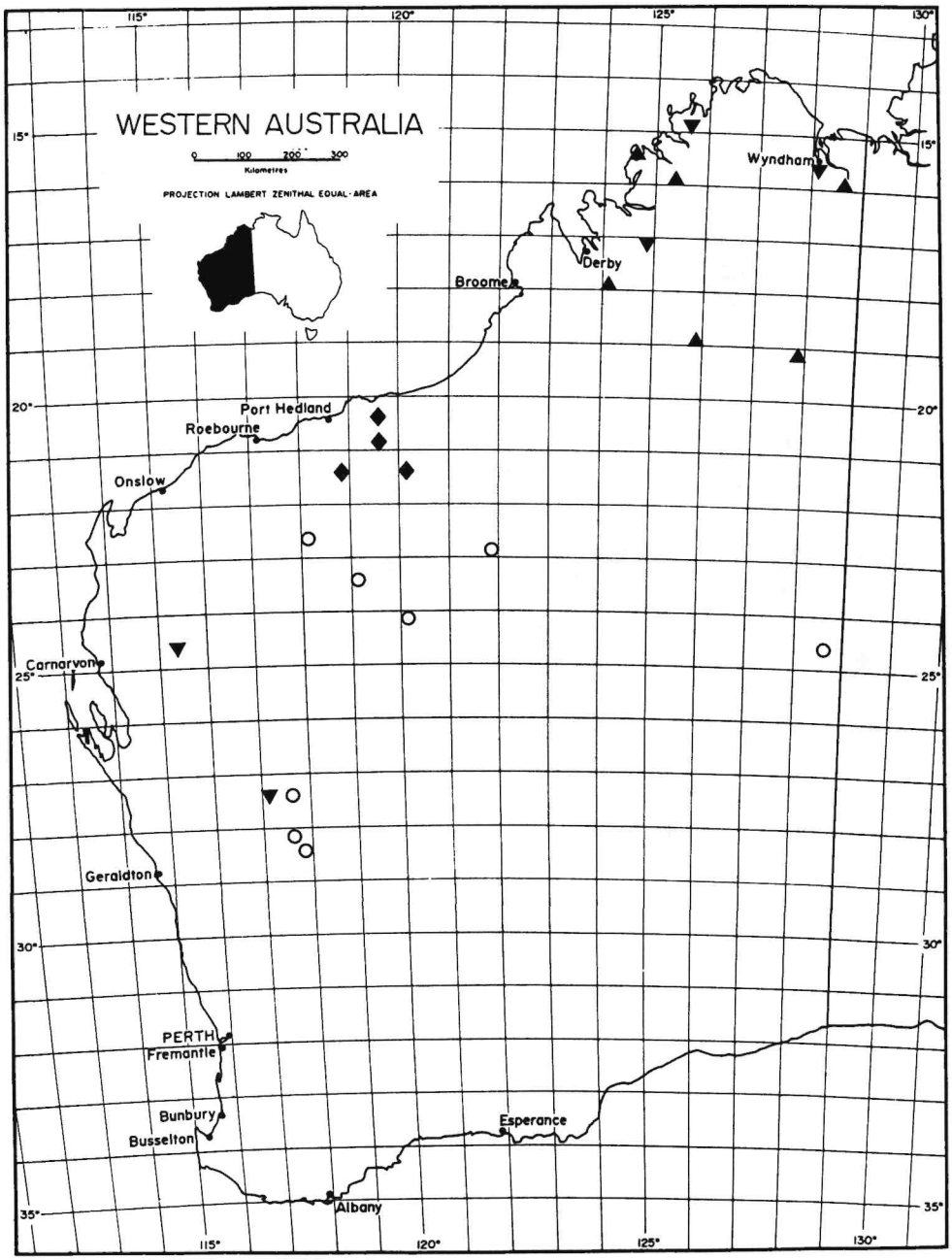


Figure 2. Full distribution of *Bulbostylis burbidgeae* ◆, and Western Australian distribution of *Bulbostylis turbinata* ○, atypical variant of *Cyperus castaneus* ▲ and typical variant of *Cyperus castaneus* ▼ .

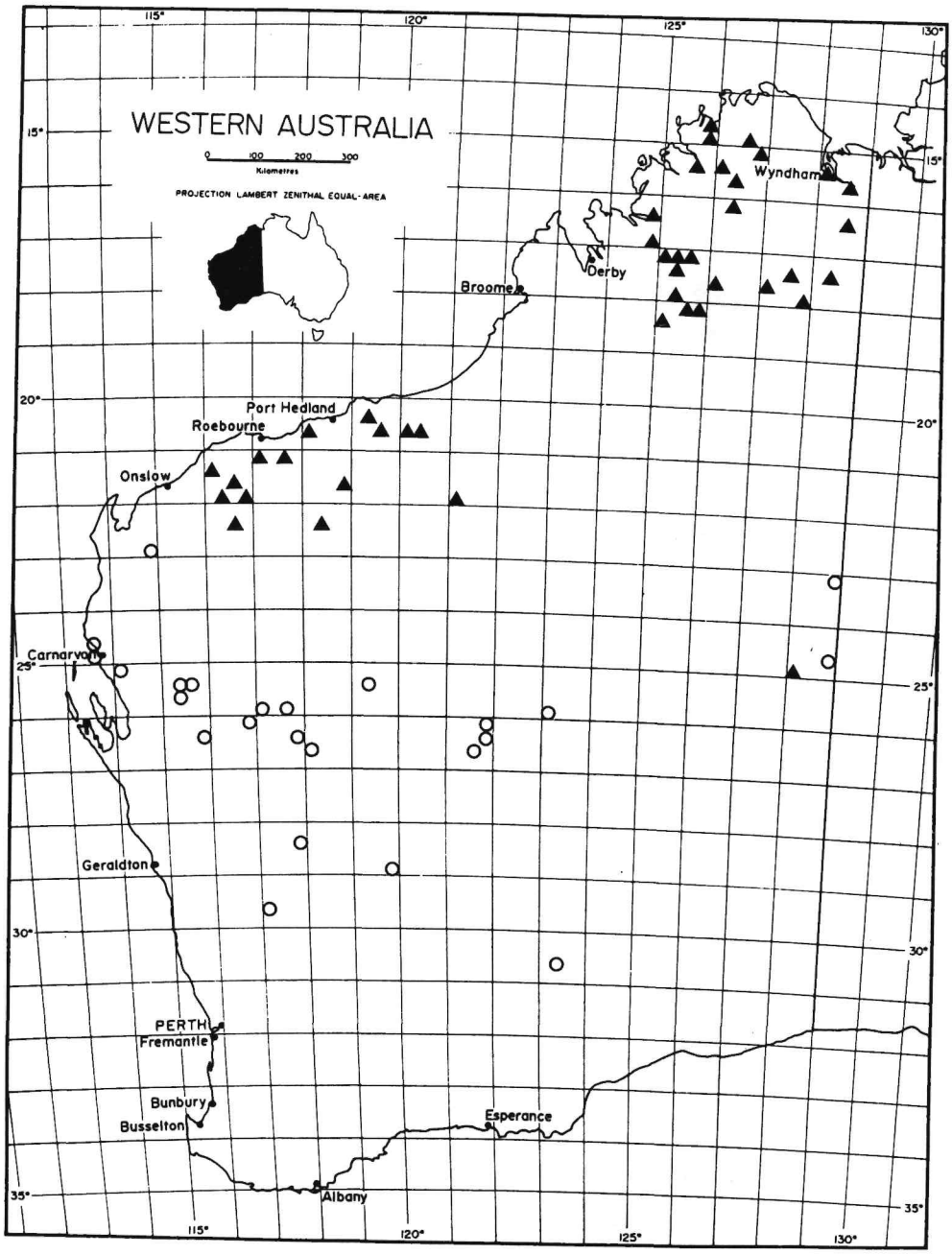


Figure 3. Western Australian distribution of *Cyperus difformis* ▲ and *Cyperus rigidellus* ○.

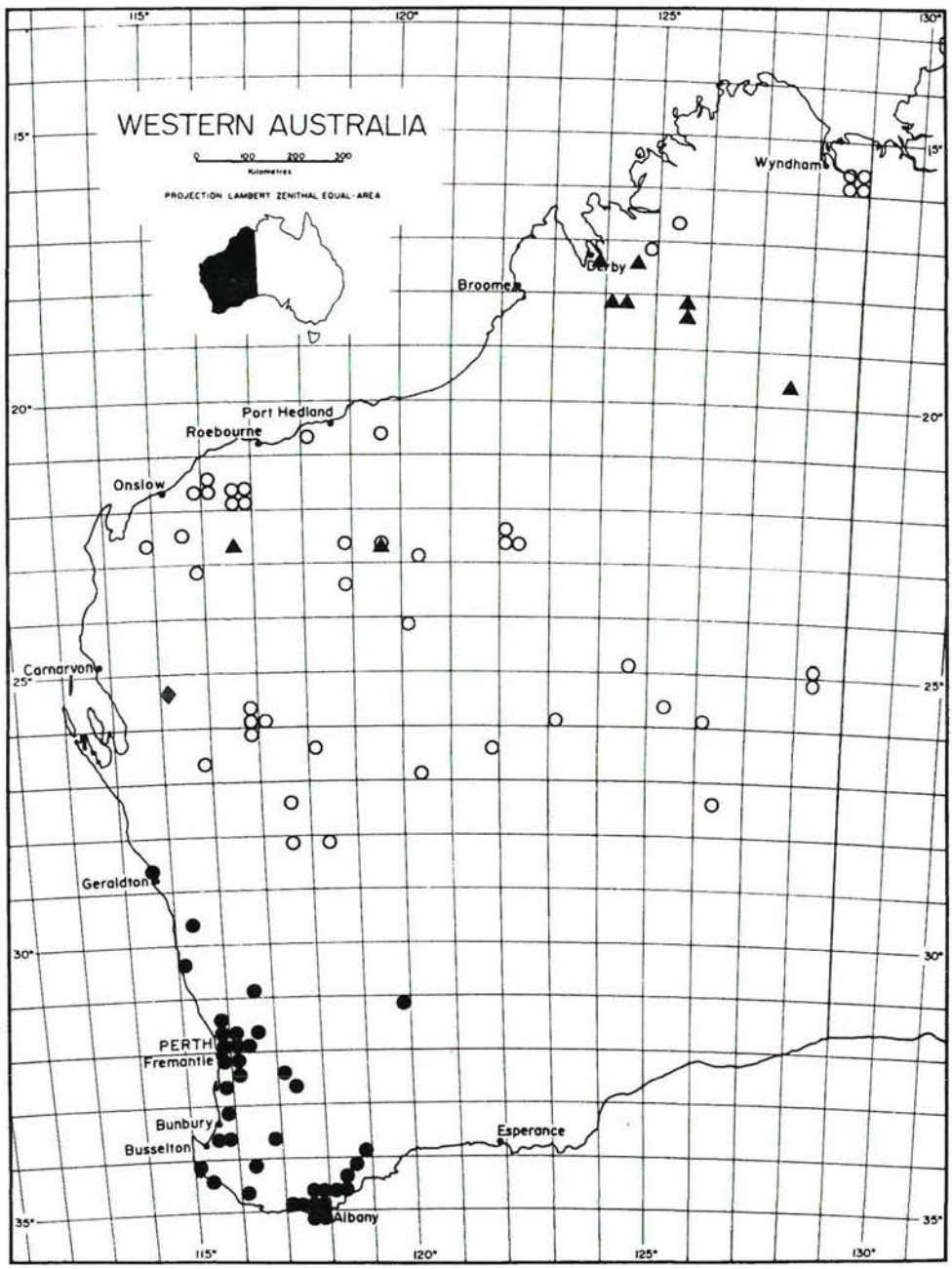


Figure 4. Western Australian distribution of *Cyperus hamulosus* ◆, *Cyperus iria* ○, *Cyperus pygmaeus* ▲ and *Cyperus tenellus* ●.

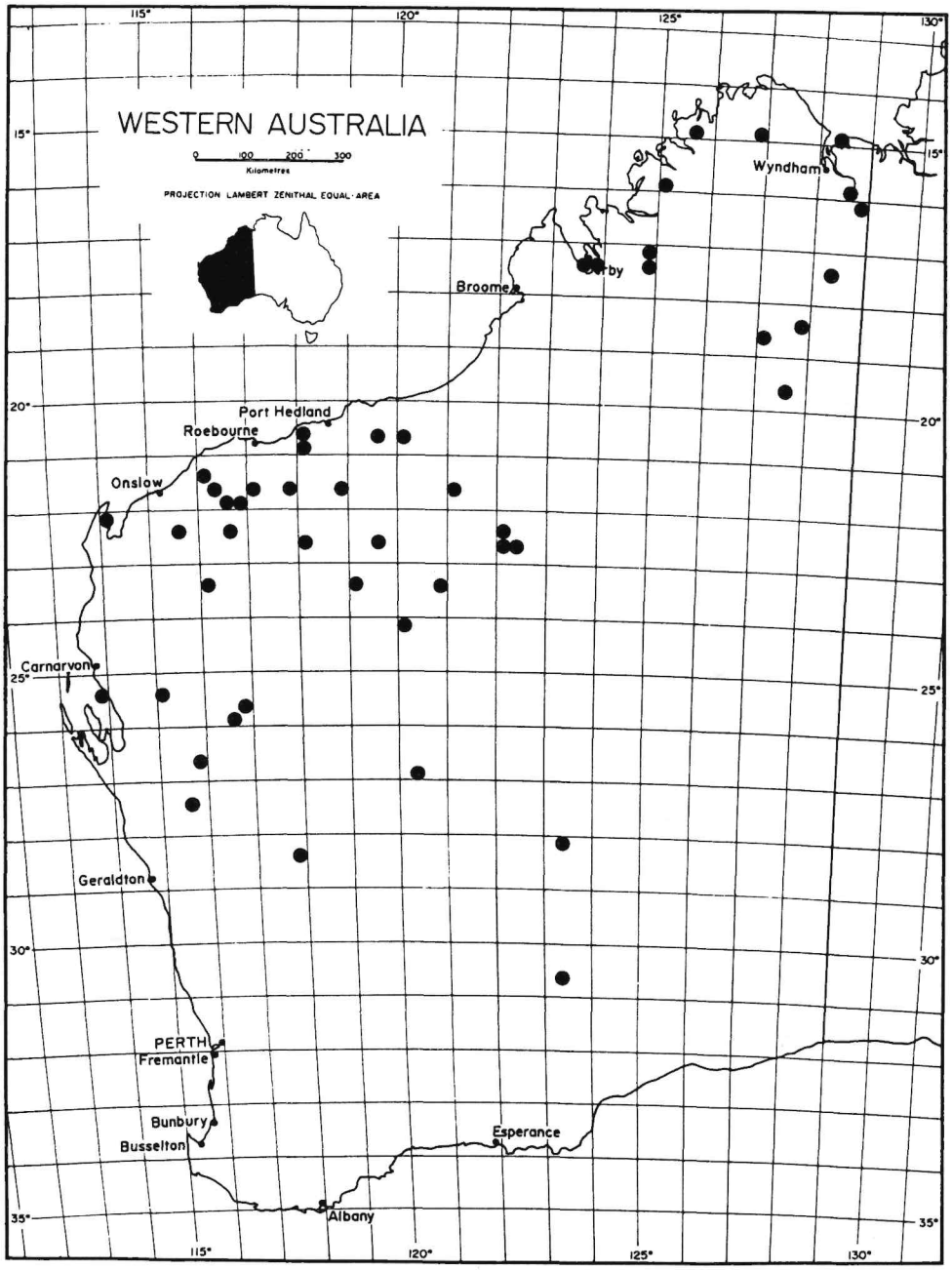


Figure 5. Distribution of *Cyperus squarrosus* in Western Australia.

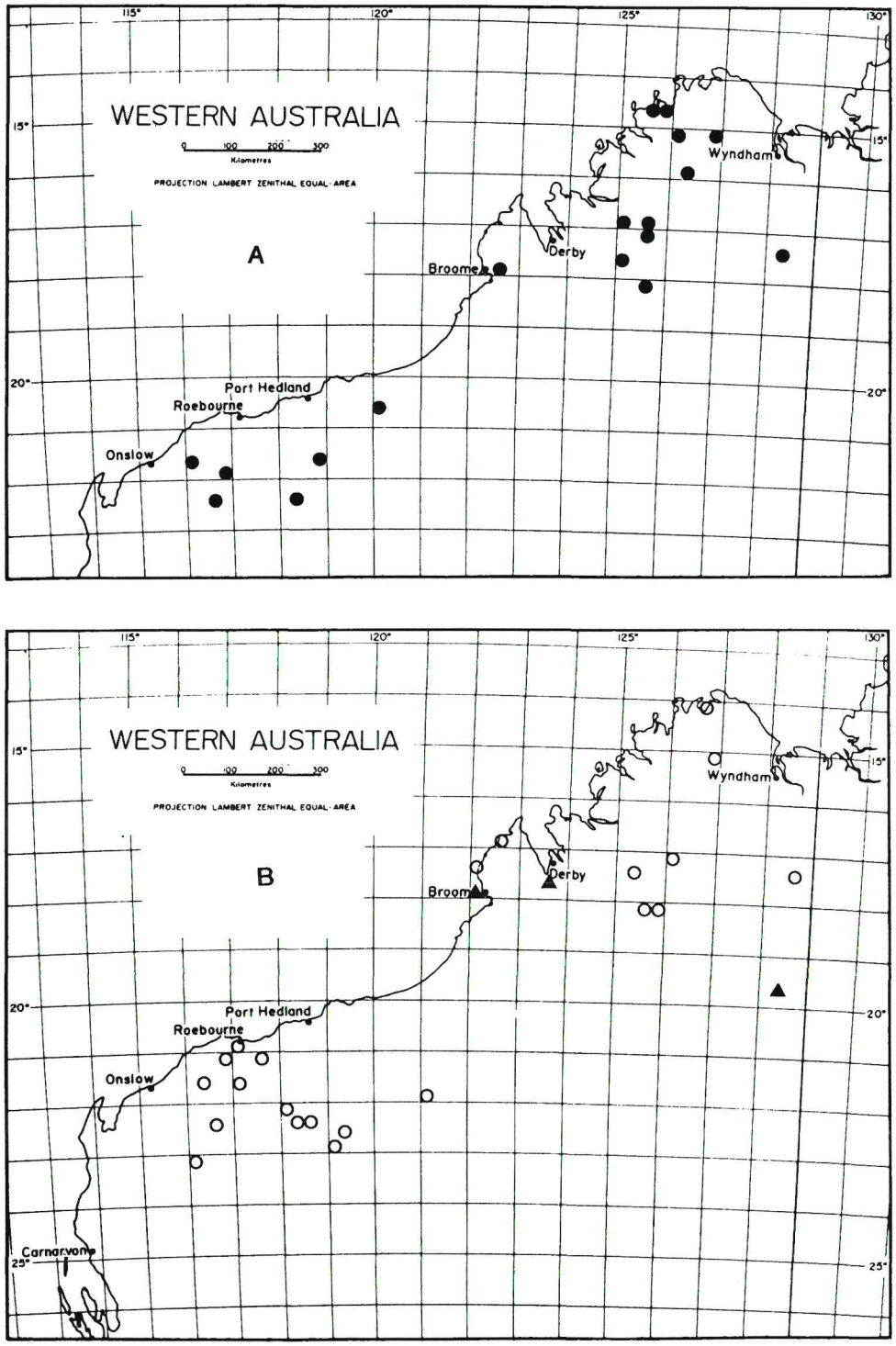


Figure 6. Distribution in Western Australia. A - *Eleocharis atropurpurea*; B - *Eleocharis geniculata* ○ and *Fimbristylis ammobia* ▲ .

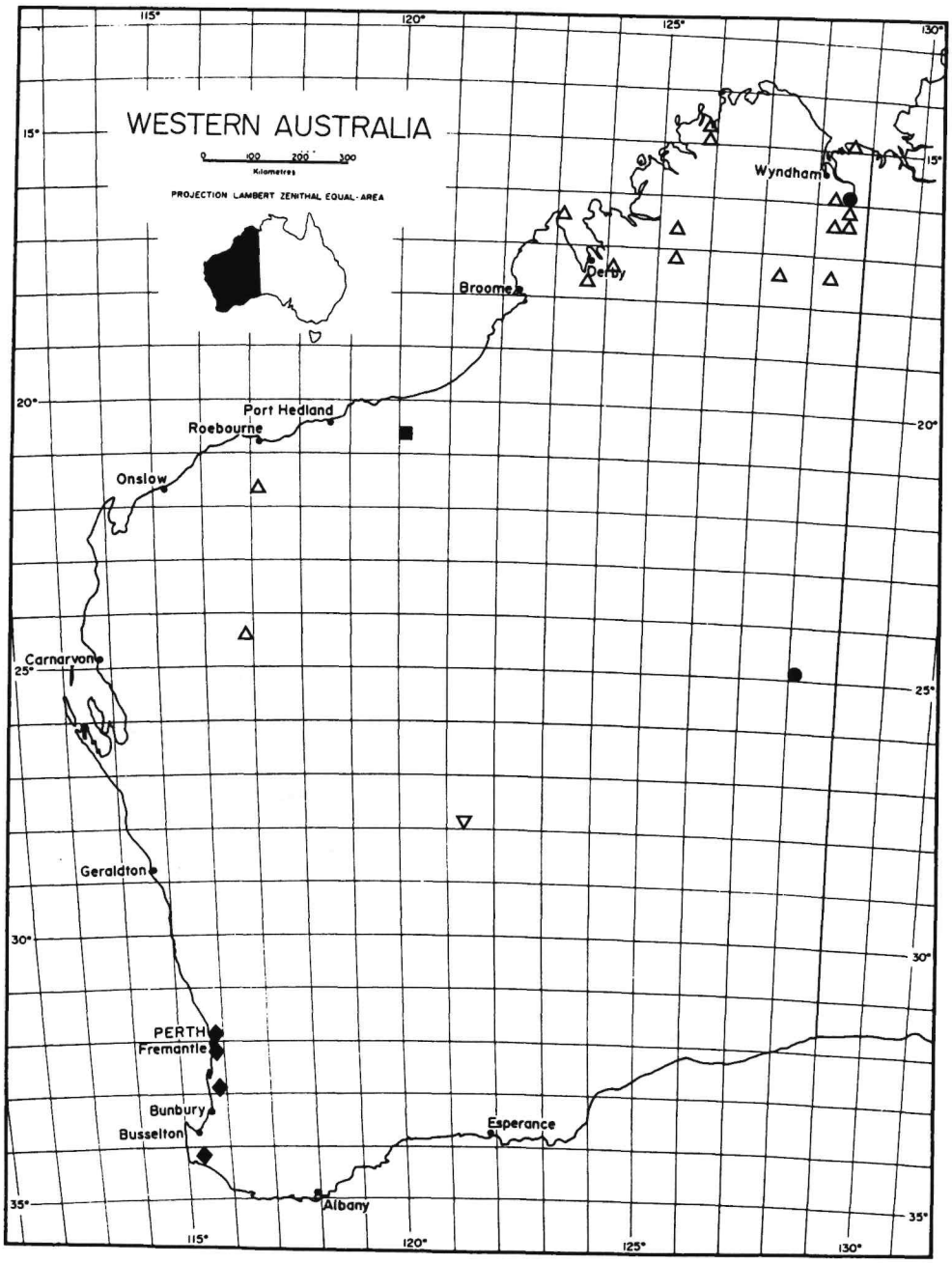


Figure 7. Western Australian distribution of typical variant of *Fimbristylis depauperata* △ , *Fimbristylis velata* ◆ and *Fuirena nudiflora* ● and full distribution of atypical variant of *Fimbristylis depauperata* ▽ , and *Fimbristylis* sp. *Shay Gap* ■ .

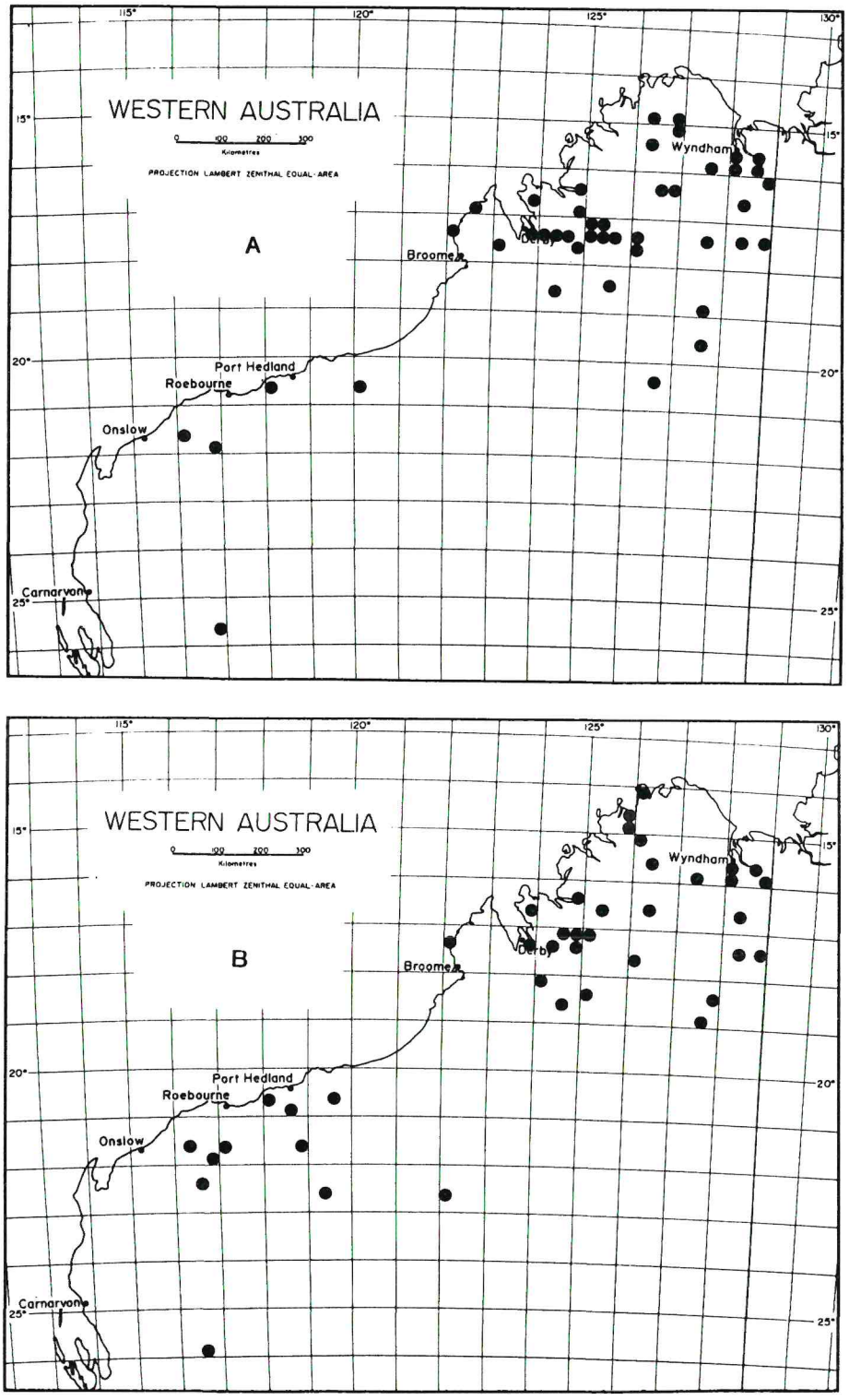


Figure 8. Distribution in Western Australia. A - *Fimbristylis littoralis*; B - *Fimbristylis microcarya*.

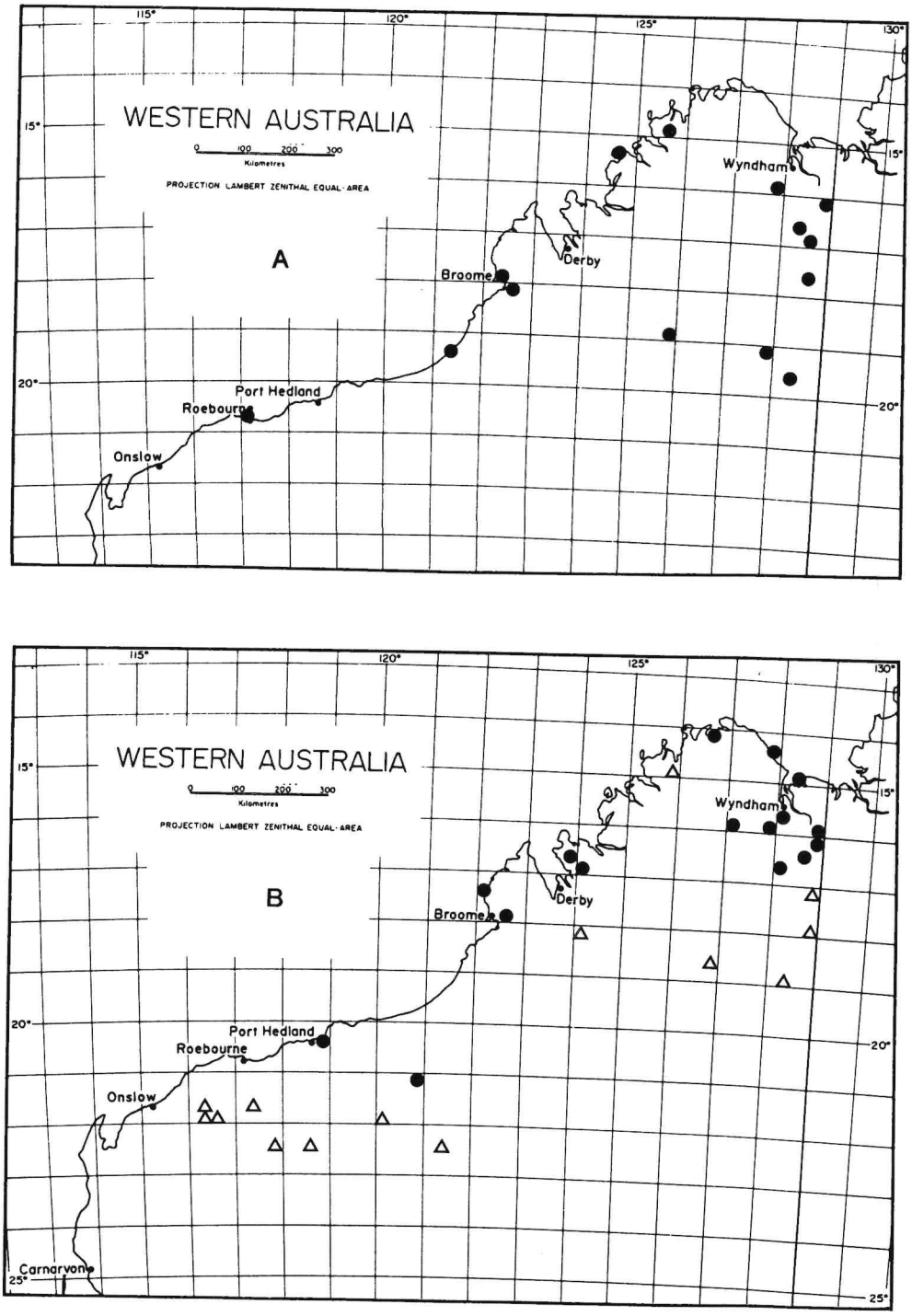


Figure 9. Distribution in Western Australia. A - *Fimbristylis oxystachya*; B - *Fimbristylis rara* ● and C - *Fimbristylis simulans* △ .

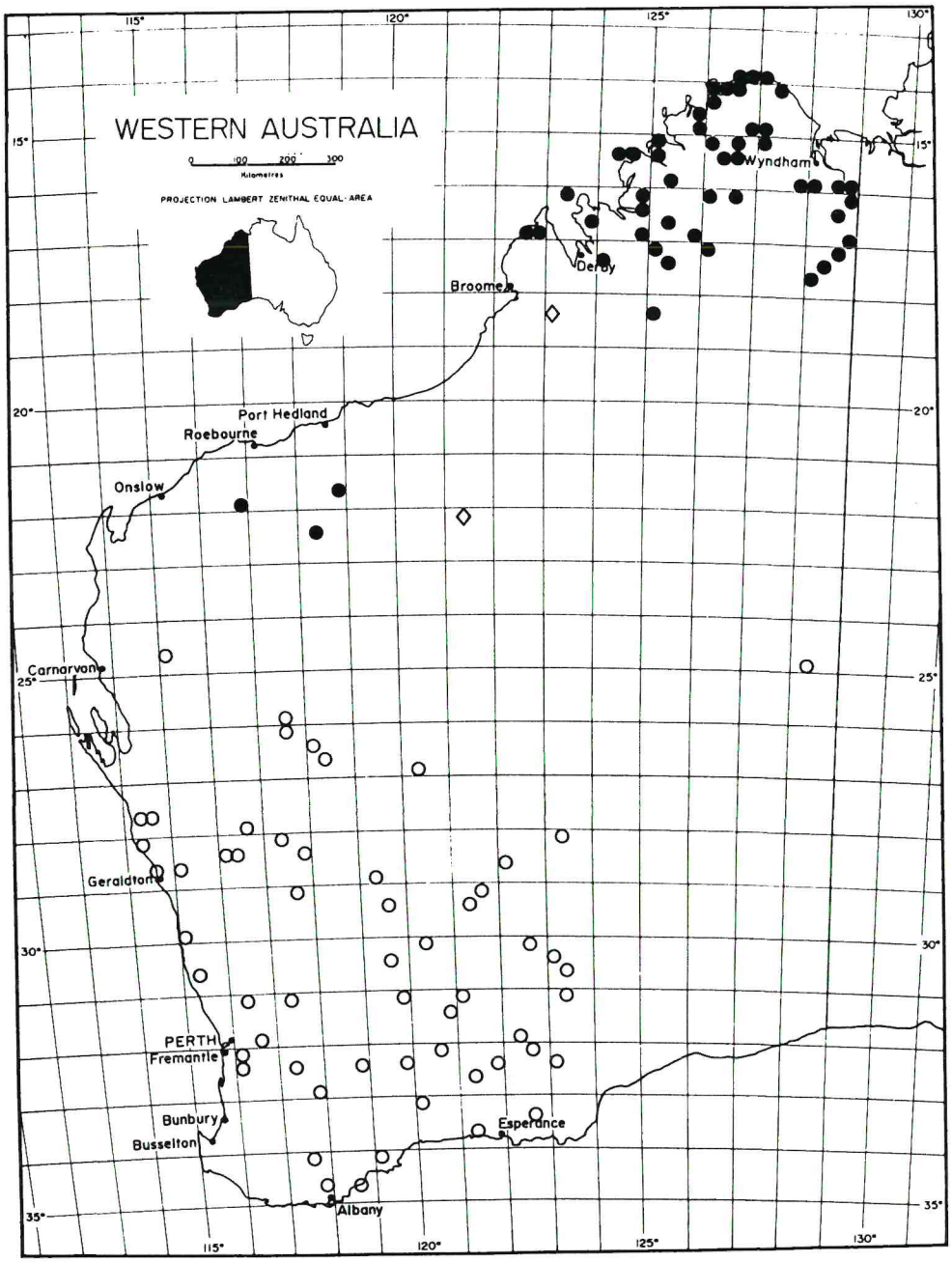


Figure 10. Western Australian distribution of *Fuirena ciliaris* ●, *Fuirena incrassata* ◇ and *Isolepis congrua* ○.

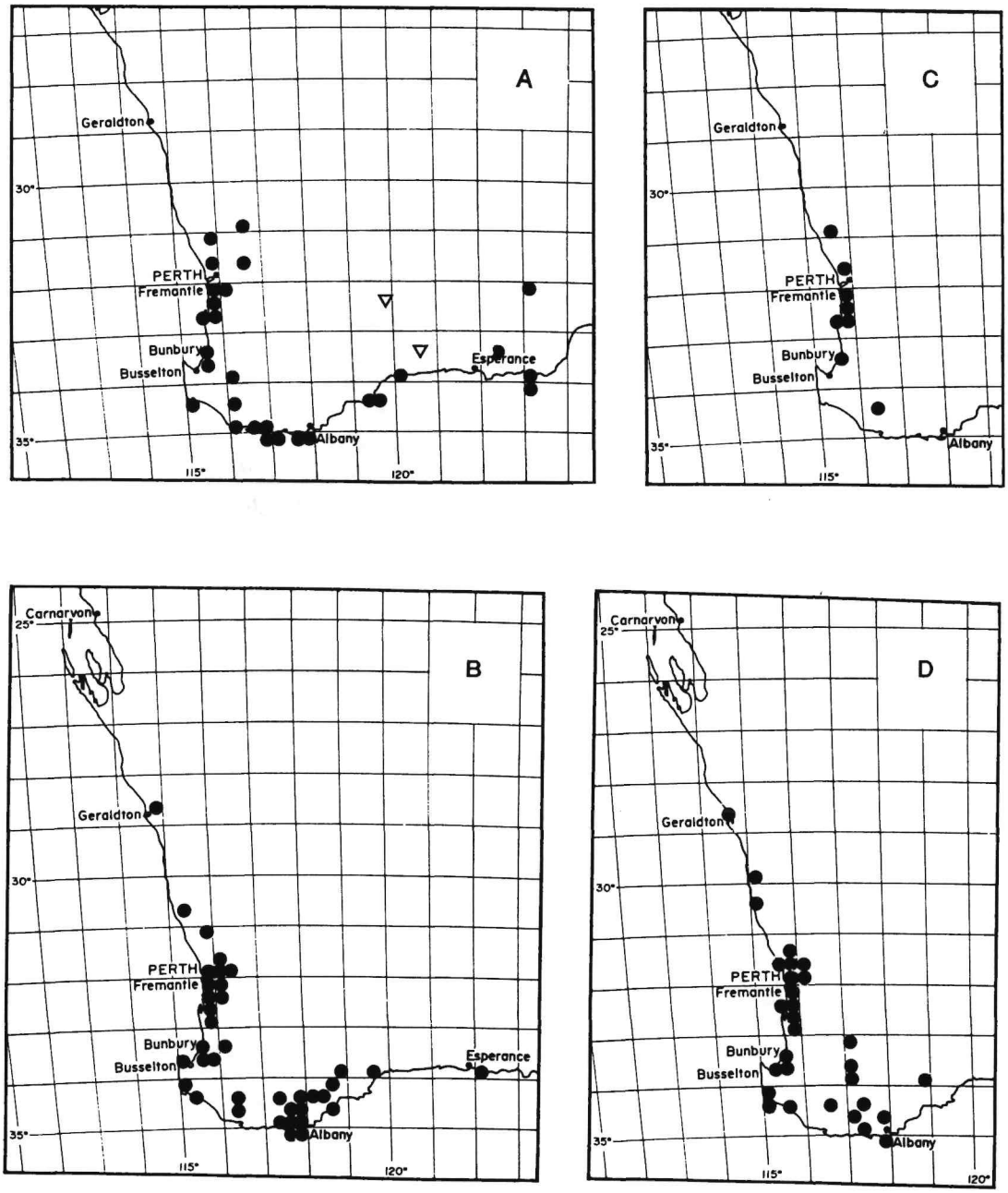


Figure 11. A - Western Australian distribution of *Isolepis australiensis* ▽ and *Isolepis cernua* ● ; full distribution of B - *Isolepis cyperoides,* C - *Isolepis oldfieldiana,* and D - *Isolepis setiformis.*

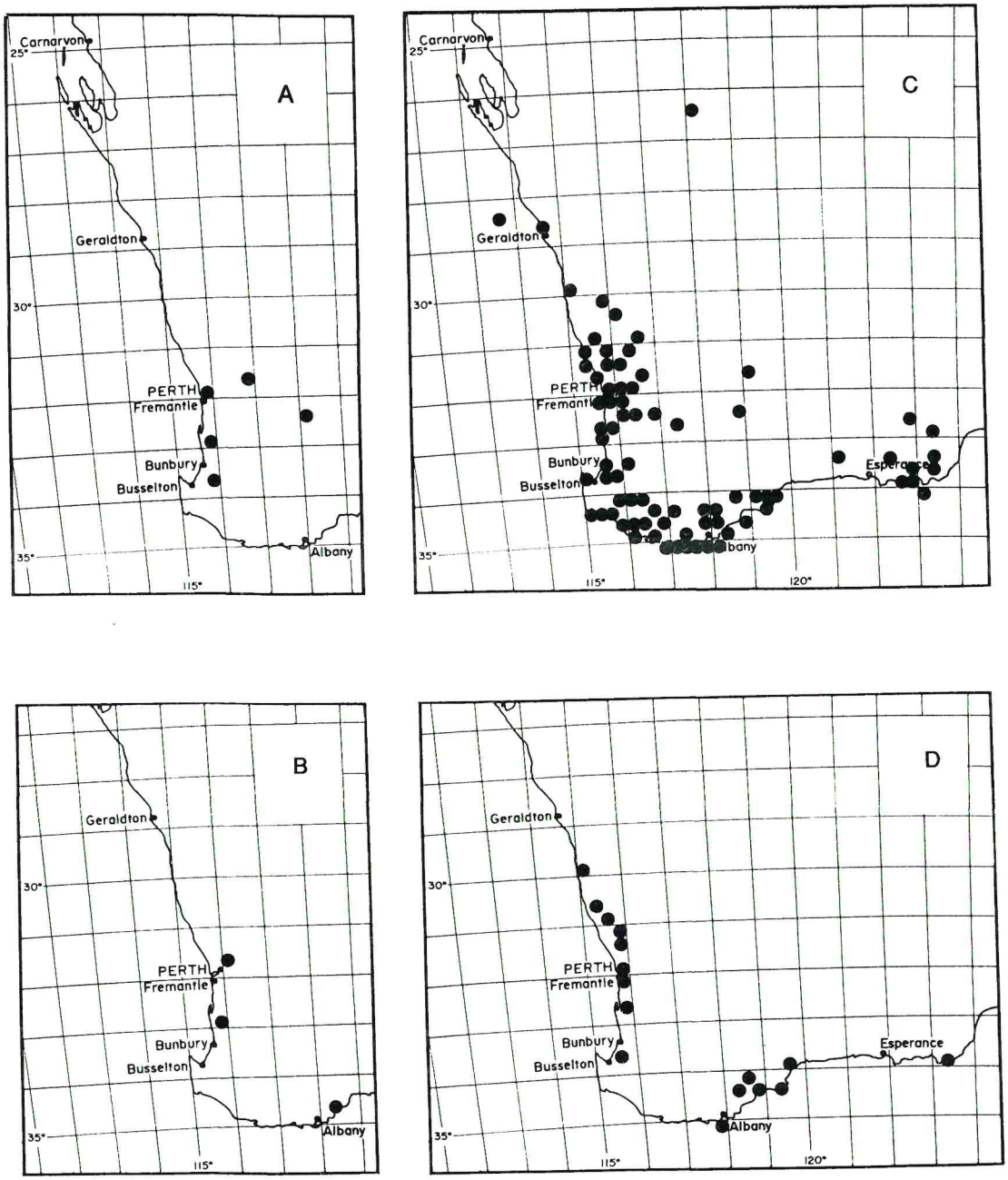


Figure 12. Distribution in Western Australia. A - *Isolepis hookeriana*; B - *Isolepis hystrix*; C - *Isolepis marginata*; D - *Isolepis stellata*.

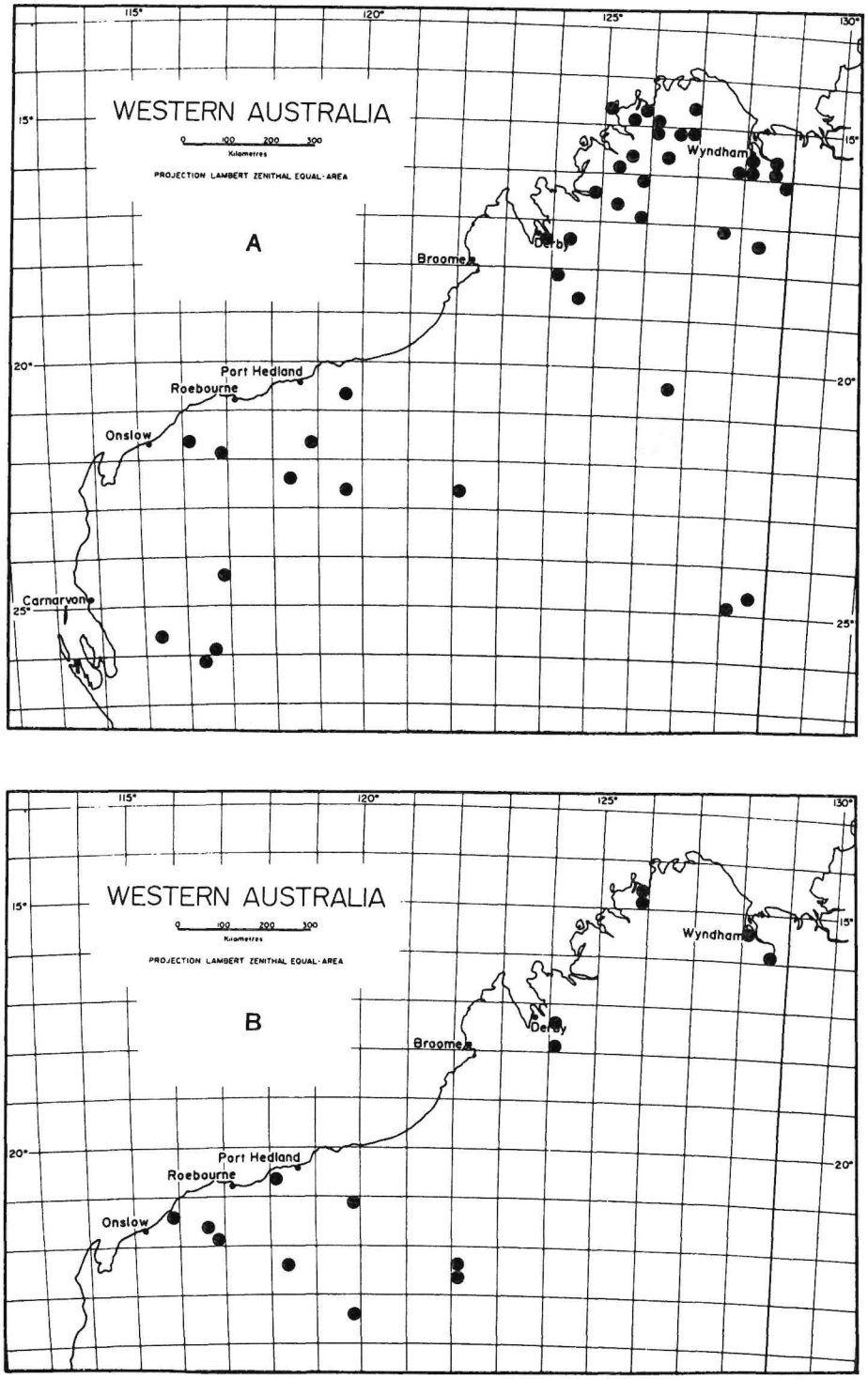


Figure 13. Distribution in Western Australia. A - *Lipocarpha microcephala*; B - *Schoenoplectus laevis*.

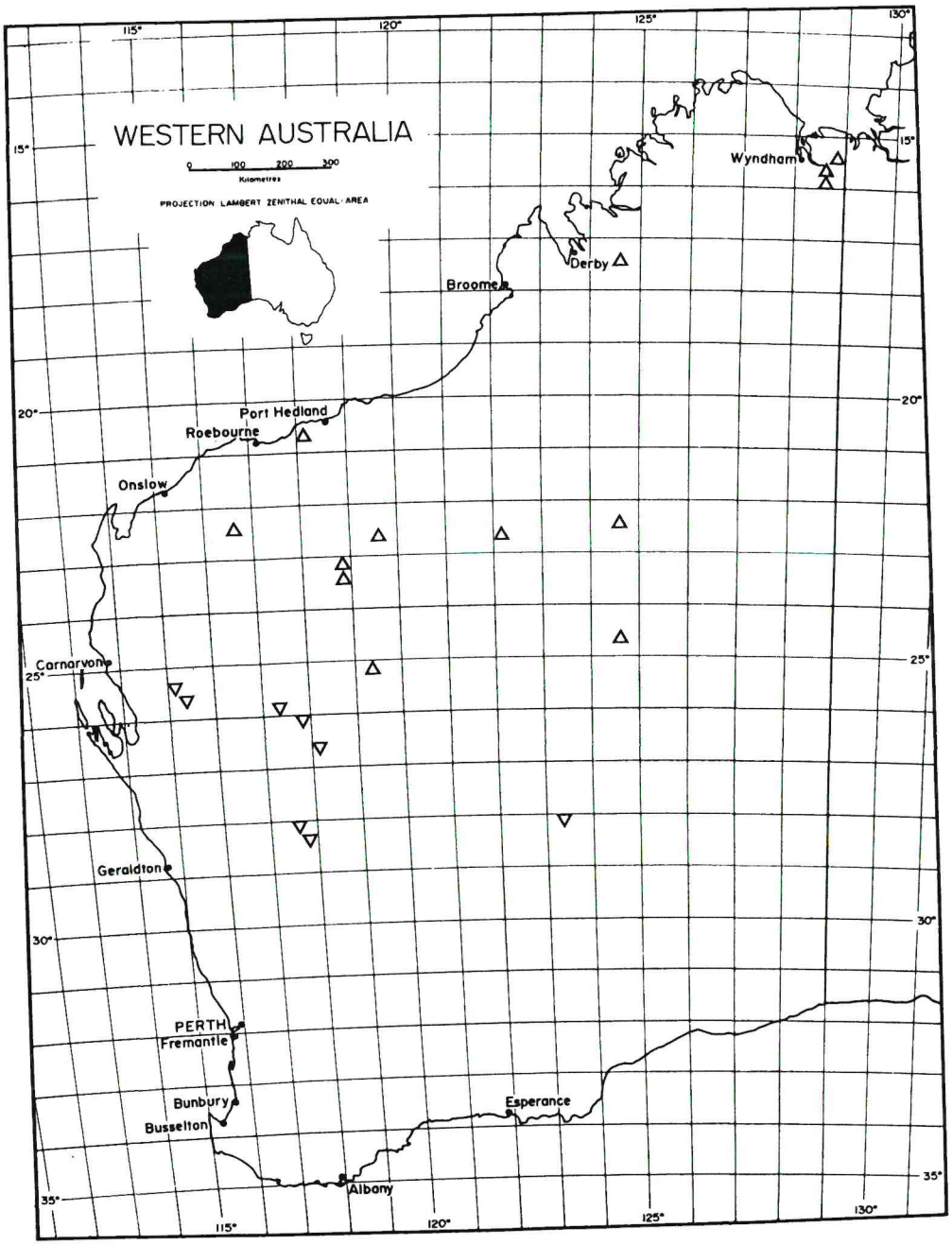


Figure 14. Distribution of *Schoenoplectus dissachanthus* in Western Australia, typical variant △ and trimerous variant ▽ .

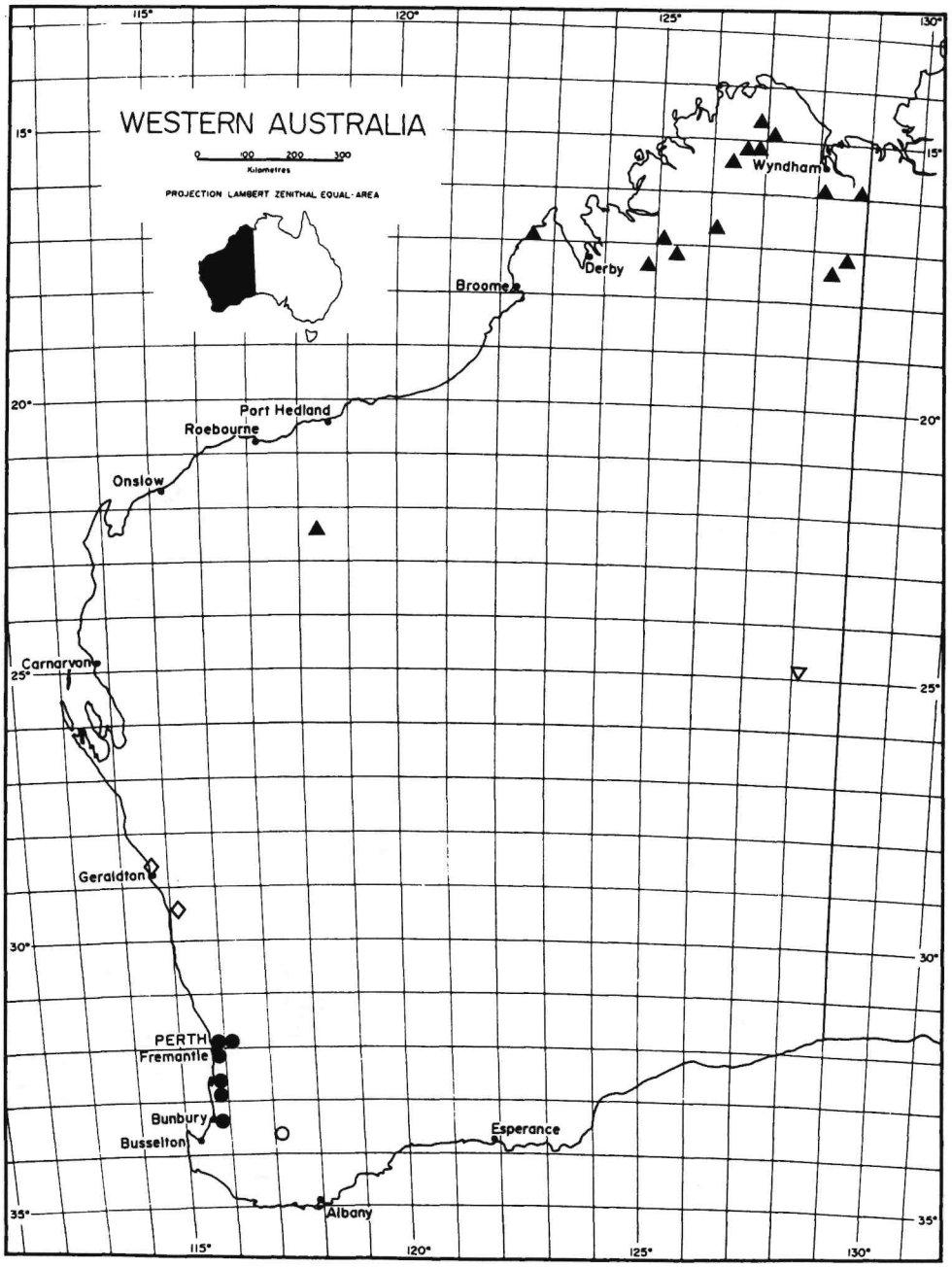


Figure 15. Western Australian distribution of *Schoenoplectus lateriflorus* ▲ and *Schoenus centralis* ▽ and full distribution of *Schoenus badius* ◇ , inland variant of *Schoenus capillifolius* ○ and typical variant of *Schoenus capillifolius* ● .

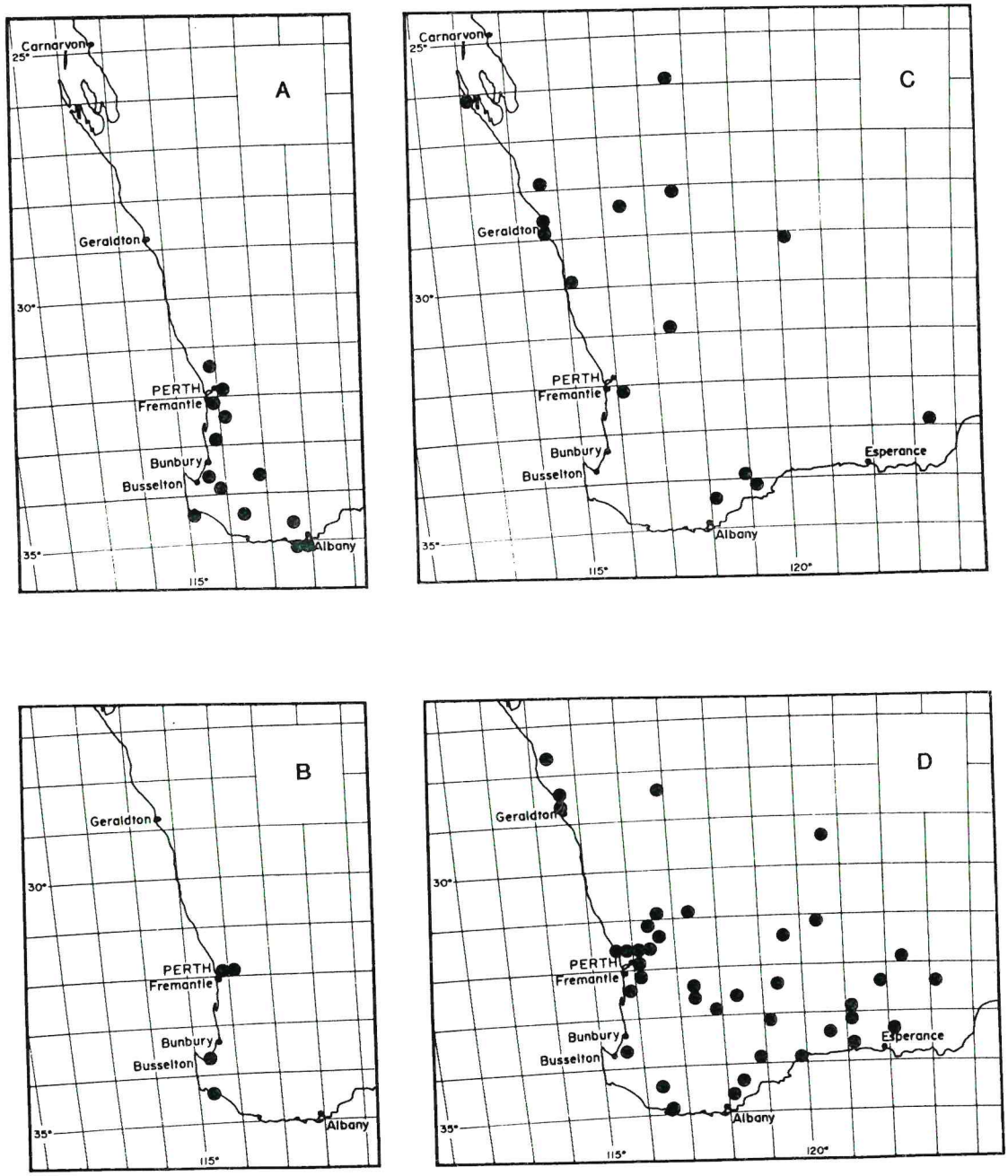


Figure 16. A - Western Australian distribution of *Schoenus discifer*; B - full distribution of *Schoenus elegans*; C - full distribution of *Schoenus humilis*; D - Western Australian distribution of *Schoenus nanus*.

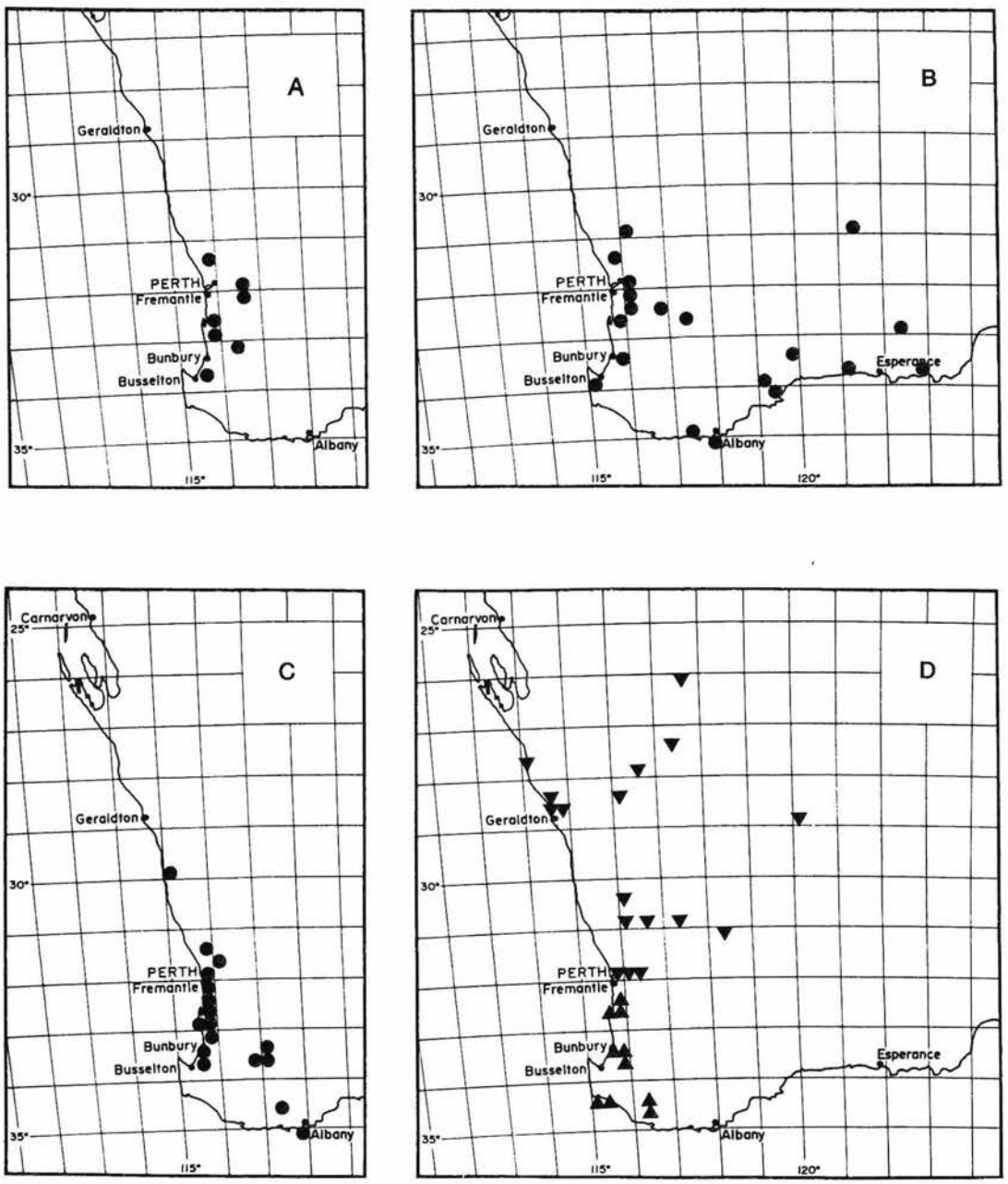


Figure 17. Geographical distribution. A - *Schoenus natans*; B - *Schoenus odontocarpus*; C - *Schoenus plumosus*; D - *Schoenus variicellae*, typical variant ▼ and southern variant ▲ .

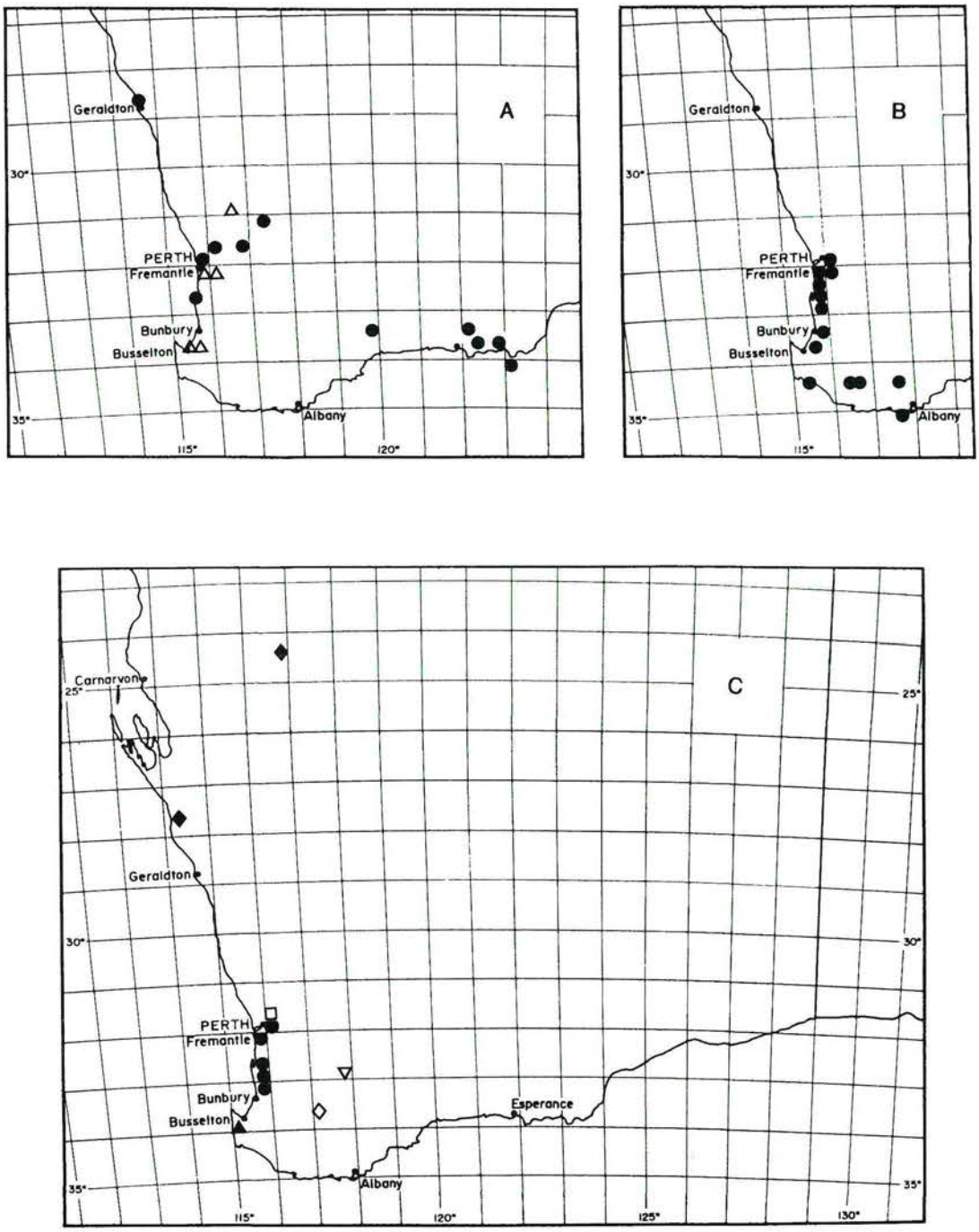


Figure 18. A - Full distribution of *Schoenus pennisetis* △ and Western Australian distribution of *Schoenus sculptus* ● ; B - Western Australian distribution of *Schoenus tenellus*; C - full distribution of *Schoenus* sp. *Beaufort* ◇ , *Schoenus* sp. *Bullsbrook* □ , *Schoenus* sp. *Harrismith* ▽ , *Schoenus* sp. *Jindong* ▲ , *Schoenus* sp. *Kalbarri* ◆ and *Schoenus* sp. *Waroona* ● .

## Key to genera

1. Style thickened at the base, articulate above or below the enlarged base
   2. Style articulate at summit of ovary, fully deciduous, the thickened base acutely angled or very compressed at summit. Nut usually either tuberculate and 3-angled or smooth and biconvex; perianth absent ..... **FIMBRISTYLIS**
   2. Style articulate at the top of an enlarged button-like to almost spherical base, which is persistent on the nut. Nut not tuberculate, if biconvex then with perianth bristles present
      3. Leaves reduced to the sheath, glabrous. Spikelet solitary, ovoid to globular. Style 2-branched. Nut biconvex, surrounded by 6-8 perianth bristles ..... **ELEOCHARIS**
      3. Leaves with a definite blade, hairy near orifice of sheath. Spikelets usually 2 or more together, cylindric to ovoid, usually narrowly ovoid. Style 3-branched. Nut 3-angled, the perianth absent ..... **BULBOSTYLIS**
1. Style not or scarcely thickened at base, continuous with ovary (i.e. not articulate) but usually breaking a little above the base leaving a 'point' at summit of nut
   4. Stems with a few nodes (each with one leaf) scattered between the base of the plant and the base of the inflorescence, terrestial. 'Spikelets' (actually probably condensed spikes of many 1-flowered spikelets in this genus) squarrose, the awns hairy ..... **FUIRENA**
   4. Stems with leaves all borne towards base of plant unless aquatic. Spikelets either not squarrose or with glabrous awns
      5. Spikelets strongly compressed and with distichous glumes in all species except *Cyperus hamulosus*, which has spiro-distichous glumes and a distinct curry-like smell when dried
         6. Spikelet axis prominently flexuose at maturity and curved over each nut. Perianth conspicuous, minute or absent ..... **SCHOENUS**
         6. Spikelet axis straight or flexuose but not prominently curved over each nut. Perianth absent ..... **CYPERUS**
      5. Spikelets not compressed, the glumes spirally arranged, with no curry-like smell
         7. Nut 3-angled, elongate (more than twice as long as wide), much longer than the style, enclosed in 2 translucent scales, lacking bristles ..... **LIPOCARPHA**
         7. Nut 2- or 3-angled, compact (less than twice as long as wide), shorter or longer than style but not greatly exceeding it, lacking scales, sometimes surrounded by up to 7 perianth bristles
            8. Main involucral bract prominent and stem-like, 40-120 mm long. Nut transversely ridged or smooth. Distributed in the Northern and Eremaean Botanical Provinces extending south to near Mount Magnet ..... **SCHOENOPLECTUS**
            8. Main involucral bract inconspicuous to prominent, 1-30 mm long. Nut smooth or reticulate-patterned. Distributed in the south-west, with *I. congrua* extending north to Lyons River Station and Rawlinson Range ..... **ISOLEPIS**

## Synopsis and keys to species

**Bulbostylis** Kunth

1. Spikelets usually few to many in a head, rarely solitary. Stamens 1(2) ..... **B. barbata**
1. Spikelets in a simple umbel or rarely solitary. Stamens 3
   2. Involucral bracts long, at least one exceeding inflorescence, hairy. Glumes with hairs *c.* 0.3 mm long; apical mucro 1.5-2 mm long. Nut not transversely ridged ..... **B. burbidgeae**
   2. Involucral bracts all shorter than inflorescence or rarely the basal one longer, subglabrous or with minute hairs. Glumes subglabrous or with hairs less than 0.1 mm long; apical mucro less than 0.5 mm long. Nut transversely ridged ..... **B. turbinata**

**Bulbostylis barbata** (Rottb.) C.B. Clarke - occurs from the coast to far inland, in a variety of damp habitats, including shallow soil over rock or in rock crevices, the margins of watercourses and low-lying flats. Widespread in the northern half of Western Australia, extending from the far north of the Kimberley Region around the coast to Kalbarri National Park in the South West Botanical Province, south to Hunt Range in the South-western Interzone and inland to near Gahnda Rockhole (east of Warburton) in the Eremaean Botanical Province. Also occurs in Northern Territory, South Australia, Queensland and New South Wales. Widely distributed in warm parts of the world. Flowers and fruits: mainly February-September. Plants 20-350 mm high; stems 0.2-0.6 mm diam. *Bulbostylis eustachii* J.M. Black, *Fimbristylis barbata* (Rottb.) Benth., *Scirpus barbatus* Rottb. (Jessop & Weber 1986: Figure 923A; Rye 1992: Figure 311B; Sharp 1989: Figure 43A; Wilson 1994: 381)

**Bulbostylis burbidgeae** K.L. Wilson - apparently endemic to the Eremaean Botanical Province of Western Australia, recorded from the base of cliffs or associated with granite outcrops, on Mulyie Station, Gorge Range, Abydos-Woodstock Reserve and Mt Edgar Station. Flowers and fruits: March, June-August. Plants 30-200 mm high; stems 0.2-0.4 mm diam. **Priority 3** (Figure 19A-C)

**Bulbostylis turbinata** S.T. Blake - occurs along watercourses, in depressions, rockholes and other damp habitats in the Eremaean Botanical Province, extending from Karijini National Park south to near Mount Magnet and east to Walter James Range. Also occurs in Northern Territory, Queensland and possibly South Australia. Flowers and fruits: February-April. Plants 50-150 mm high; stems 0.2-0.6 mm diam. (Jessop & Weber 1986: Figure 923B; Latz & Wilson 1981: Figure 640)

**Cyperus** L.

*Note.* The two species keyed first, *C. hamulosus* and *C. squarrosus*, belong to a different species group from the other species included here and might be better placed in a distinct genus as discussed by Wilson (1981: 171).

1. Plants with a distinct curry-like smell when dried. Spikelets either terete (the glumes spirally arranged) or squarrose with points (0.5)0.7-1.2 mm long
   2. Spikelets more or less terete; glumes spiro-distichous, with 1 or 2 prominent veins on each side and a recurved mucro 0.3-0.4 mm long ..... ***C. hamulosus**
   2. Spikelets flat; glumes distichous, with 2-4 prominent veins on each side and a prominently recurved mucro (0.5)0.7-1.2 mm long ..... **C. squarrosus**

1. Plants lacking a curry-like smell. Spikelets flat (the glumes distichous), not squarrose but sometimes with points 0.2-0.3(0.4) mm long
   3. Stems filiform, 0.1-0.2 mm diam., with a solitary spikelet or 2-4 spikelets in a pseudo-lateral cluster. Occurs in the South West Botanical Province ..... ***C. tenellus**
   3. Stems slender to robust, 0.2-2.5 mm diam., with usually many spikelets in a simple or compound umbel of clusters or in a head, the inflorescence rarely reduced to a single cluster of spikelets or solitary spikelet. Occurs in the Northern and Eremaean Botanical Provinces
      4. Stamens 3 or (in *C. iria*) sometimes 2. Nut 1.2-2.5 mm long
         5. Glumes 2-4 mm long, mucronate. Fruiting axis narrowly to broadly winged. Anthers 3, 0.3-0.5 mm long ..... **C. rigidellus**
         5. Glumes 1.3-1.7 mm long, emarginate. Fruiting axis not winged. Anthers 2 or 3, 0.2-0.3 mm long ..... **C. iria**
      4. Stamens 1 or 2. Nut 0.5-1 mm long
         6. Spikelets in a dense head surrounded by 3 or more long involucral bracts greatly exceeding inflorescence. Anthers 0.3-0.5 mm long ..... **C. pygmaeus**
         6. Spikelets in a lateral or stellate cluster or in multiple clusters arranged in umbels, sometimes subtended by 1(2) long bracts greatly exceeding inflorescence. Anthers 0.1-0.3 mm long
            7. Spikelets 3-8 mm wide. Glumes *c.* 0.6 mm long, almost truncate. Nut broadly elliptic-obovate in outline ..... **C. difformis**
            7. Spikelets 1-1.5 mm wide. Glumes 0.7-1.5 mm long, with a mucro exceeding the membranous sides. Nut obovate in outline ..... **C. castaneus**

**Cyperus castaneus** Willd. - fairly widespread in the Kimberley Region from Kunmunya Hill southwards, with three records from claypans and other damp habitats in the Eremaean Botanical Province at Wolf Creek Crater, Towrana Station and near Mount Magnet. Also occurs in Northern Territory, Queensland, New South Wales and from India east to Indonesia. Flowers and fruits: February-April, July. Plants 0.01-0.05 m (10-50 mm) high; stems 0.2-0.4 mm diam. There are two named varieties, which apparently intergrade (K.L. Wilson pers. comm.) and are no longer recognized. The typical variety occurs throughout the range of the species. The other variety, distinguished by its smaller glumes with a shorter mucro and smaller nuts, is apparently restricted to northern Australia. *Cyperus castaneus* var. *brevimucronatus* Kük. (Figure 19D-F; Latz & Wilson 1981: Figure 637K; Sharp 1989: Figure 46F)

**Cyperus difformis** L. - occurs mainly along watercourses. Extends from near Wyndham in the Kimberley Region south-east to Duck Creek Station in the Eremaean Botanical Province, with an isolated record far inland at Rawlinson Range. Also occurs in Northern Territory, South Australia, Queensland, New South Wales, Victoria and from southern Europe and Africa east to Japan and the western Pacific islands. Flowers and fruits: mainly May-September, also recorded February. Plants 0.15-0.6 m high; stems 1.0-2.8 mm diam. (Jessop & Weber 1986: Figure 927J, 928A; Latz & Wilson 1981: Figure 637D; Rye 1992: Figure 313B; Sharp 1989: Figure 46D)

***Cyperus hamulosus** M. Bieb. - naturalized in Western Australia, recorded from the edge of a lake on Towrana Station in the Eremaean Botanical Province. Also naturalized in Northern Territory, South Australia and Victoria. Native to Africa and central Asia. Flowers and fruits: April-May. Plants *c.* 0.05 m (50 mm) high; stems *c.* 0.4 mm diam. *Mariscus hamulosus* (M. Bieb.) S.S. Hooper, *Scirpus hamulosus* (M. Bieb.) Steven (Jessop & Weber 1986: Figure 927P; Latz & Wilson 1981: Figure 638M)

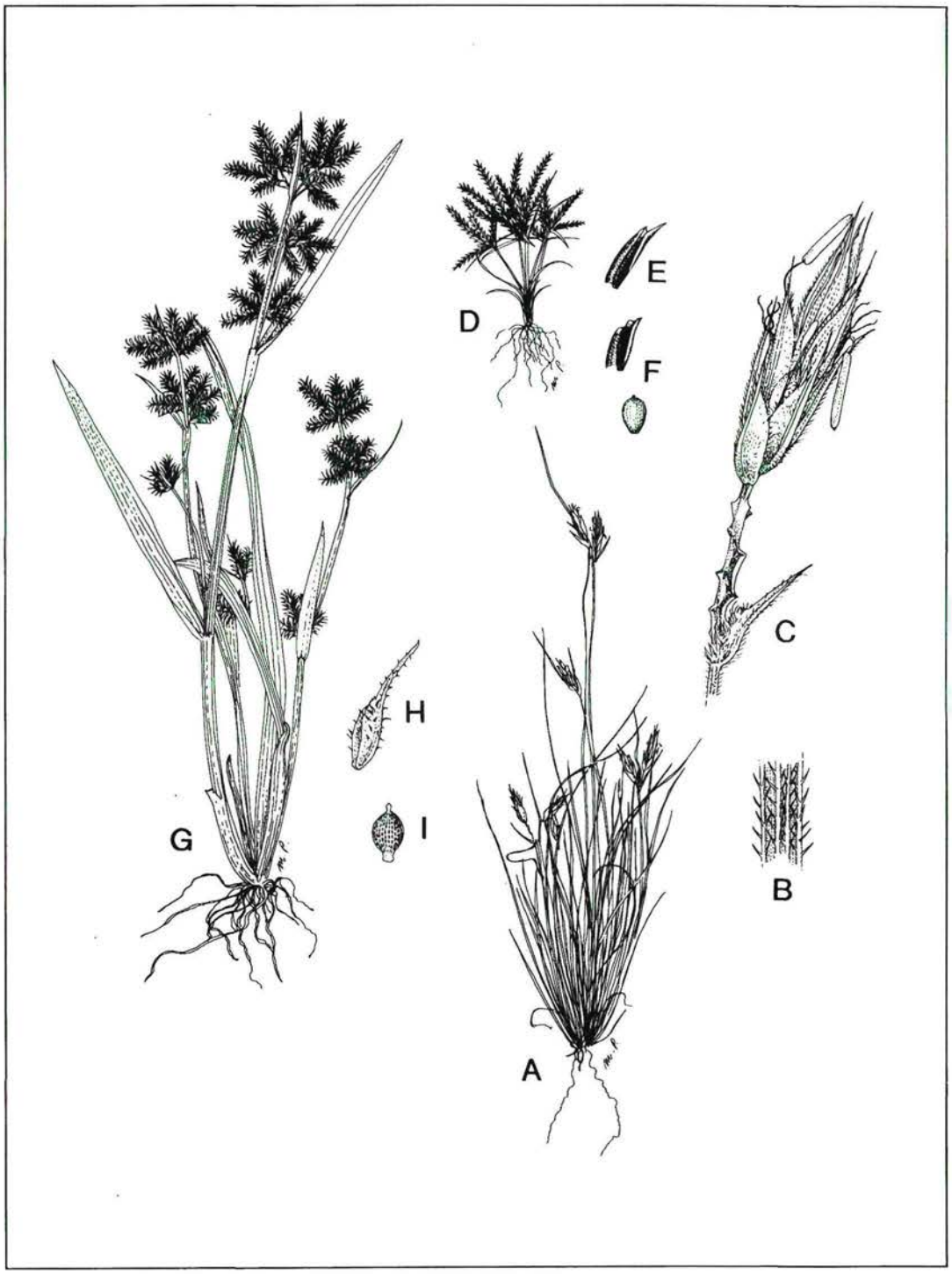


Figure 19. A-C *Bulbostylis burbidgeae* A - whole flowering plant (x1), B - stem (x1), C - spikelet (x6); D-F *Cyperus castaneus* D - whole plant of typical variant (x1), E - glume of typical variant (x10), F - glume and nut of atypical variant (x10); G-I *Fuirena nudiflora* G - whole plant (x1), H - glume (x10), I - nut (x10). Drawn from *N.T. Burbidge* 1102 (A-C), *R.J. Cranfield* 2084 (D,E), *G.W. Carr* 3600 & *A.C. Beauglehole* 47378 (F), *A.S. George* 8801 (G-I).

**Cyperus iria** L. - occurs in claypans, along drainage lines and watercourses and in other damp habitats. Extends from Kununurra in the Kimberley Region south-west to Yanrey Station (south of Onslow) and near Mount Magnet and inland to Rawlinson Range in the Eremaean Botanical Province. Also occurs in Northern Territory, South Australia, Queensland, New South Wales and from tropical Africa through southern Asia to Japan. Flowers and fruits: February-August. This species might sometimes be perennial. Plants 0.05-0.7 m high; stems 0.2-2.5 mm diam. (Jessop & Weber 1986: Figure 927R, 928D; Latz & Wilson 1981: Figure 637J; Rye 1992: Figure 314A; Sharp 1989: Figure 45D)

**Cyperus pygmaeus** Rottb. - Occurs along watercourses and in claypans in two main areas, one extending from Derby in the Kimberley Region south-east to Sturt Creek in the far north of the Eremaean Botanical Province. The other area is in the Pilbara, with three records from Billiluna Station, Duck Creek and Roy Hill Station (north of Newman). Also occurs in Northern Territory, South Australia, Queensland, New South Wales, Victoria and from the Mediterranean region and southern Africa through southern Asia to the Philippines and New Guinea. Flowers and fruits: July-August. Plants *c.* 0.05 m (50 mm) high; stems 0.7-1.4 mm diam. *Cyperus michelianus* subsp. *pygmaeus* (Rottb.) Asch. & Graeb. (Jessop & Weber 1986: Figure 927V; Latz & Wilson 1981: Figure 637M; Sharp 1989: Figure 46P)

**Cyperus rigidellus** (Benth.) J.M. Black - occurs along watercourses, on floodplains, in claypans and other damp habitats, extending from Uaroo Station and Carnarvon east to Walter James Range in the Eremaean Botanical Province and south-east to Cundeelee in the South-western Interzone, with a single record from Geraldton in the South West Botanical Province. Also occurs in Northern Territory, South Australia, Queensland, New South Wales and Victoria. Flowers and fruits: April-October. A species in need of further study, with several variants; it is sometimes perennial. Plants 0.05-0.4 m high or rarely smaller; stems 0.5-1.3 mm diam. *Cyperus gracilis* var. *rigidellus* Benth., *C. subpinnatus* Kük., *C. subpinnatus* var. *subrigidellus* Kük., *Mariscus rigidellus* (Benth.) C.B. Clarke (Jessop & Weber 1986: Figure 927W, 928F; Sharp 1989: Figure 47F; Wilson 1991: Figure 30a-f)

**Cyperus squarrosus** L. - occurs along watercourses, drainage lines, in claypans and other damp habitats. Extends from the north of the Kimberley Region south-west to Edagee Station and near Mount Magnet in the Eremaean Botanical Province and south to Cundeelee Mission in the South-western Interzone. Also occurs in Northern Territory, South Australia, Queensland, New South Wales, Victoria, North and South America, Africa and southern Asia. Flowers and fruits: February-August. Plants 0.03-0.25 m high; stems 0.3-1.4 mm diam. *Cyperus aristatus* Rottb., *Mariscus squarrosus* (L.) C.B. Clarke (Jessop & Weber 1986: Figure 927Y; Latz & Wilson 1981: Figure 638L; Rye 1992: Figure 314B; Sharp 1989: Figure 46H)

***Cyperus tenellus** L.f. - naturalized on the margins of swamps, rockpools on granite, and in other damp habitats, extending around the coast from near Geraldton to near Green Range in the South West Botanical Province and inland to Mt Clara (east of Southern Cross) in the South-western Interzone. Also naturalized in South Australia, New South Wales, Victoria, Tasmania and New Zealand. Apparently native to South Africa. Flowers and fruits: mainly September-November. Plants 0.02-0.12 m (20-120 mm) high; stems 0.1-0.2 mm diam. *Eucyperus tenellus* (L.f.) Palla (Jessop & Weber 1986: Figure 927Z; Wilson 1994: Figure 61e,f)

**Eleocharis** R. Br.

1. Glumes 0.8-1.5 mm long, becoming patent in fruit. Anthers 0.2-0.4 mm long ..... **E. atropurpurea**
1. Glumes 1.5-2 mm long, appressed to antrorse. Anthers 0.5-0.7 mm long ..... **E. geniculata**

**Eleocharis atropurpurea** (Retz.) Kunth - occurs along watercourses and around swamps and lakes, extending from Mitchell Plateau and Drysdale River National Park in the Kimberley Region south-west to Duck Creek Station in the Pilbara area of the Eremaean Botanical Province. Also occurs in Northern Territory, Queensland and widely distributed in warm regions of the world. Flowers and fruits: April-August. Plants 0.03-0.1 m high; stems 0.1-0.3 mm diam. *Eleocharis atropurpurea* var. *setiformis* Benth., *Scirpus atropurpureus* Retz. (Rye 1992: Figure 310E)

**Eleocharis geniculata** (L.) Roem. & Schult. - occurs along watercourses, commonly on the margins of permanent pools. Extends from the far north and east of the Kimberley Region south-west to Harding River in the Eremaean Botanical Province. Also occurs in Northern Territory, South Australia, Queensland, New South Wales and widespread in warm regions of the world. Flowers and fruits: mainly May-October, also January-February. Many specimens appear to be perennial, others apparently annual. Plants 0.1-0.4 m high; stems 0.3-1 mm diam. *Eleocharis capitata* R.Br., *E. caribaea* (Rottb.) S.T. Blake, *Scirpus caribaeus* Rottb., *S. geniculatus* L. (Jessop & Weber 1986: Figure 930C; Rye 1992: Figure 310I; Sharp 1989: Figure 42F; Wilson 1993: 376)

**Fimbristylis** Vahl

1. Style flat, 2-branched. Nut biconvex, neither tuberculate nor transversely ridged
   2. Stamen 1. Style base with very long reflexed hairs ..... **F. velata**
   2. Stamens (2)3. Style base glabrous or ciliolate ..... **F. depauperata**
1. Style triquetrous, 3-branched. Nut 3-angled in cross-section, usually either tuberculate or transversely ridged (except in *F. microcarya*, which often has a smoother nut)
   3. Spikelet solitary, compressed, the glumes distichous at first. Nut *c.* 2.5 mm long ..... **F. oxystachya**
   3. Spikelets 1-many, more or less terete, the glumes spirally arranged. Nut 0.6-1.5 mm long
      4. Inflorescence of 1 or rarely 2 or 3 spikelets, simple. Glumes 2.5-5 mm long. Nut 1-1.5 mm long, if 1-1.2 mm long then with prominent transverse ridges
         5. Glumes 2.5-3 mm long. Nut with 7-10 prominent transverse ridges ..... **F. ammobia**
         5. Glumes 4-5 mm long. Nut longitudinally 3-ridged, tuberculate towards apex ..... **F. simulans**
      4. Inflorescence of (3)4-many spikelets, simple, compound or decompound. Glumes 1-2.5 mm long. Nut 0.6-1 mm long, not transversely ridged
         6. Glumes 2-2.5 mm long. Stamens 3. Style ciliate along the angles of undivided portion
            7. Glumes fairly broad, each side 0.5-0.6 mm wide. Anthers 0.5-0.6 mm long .. **F. sp. Shay Gap**
            7. Glumes very broad, each side 1-1.2 mm wide. Anthers 1.2-1.7 mm long ..... **F. rara**
         6. Glumes 1-1.5(2) mm long. Stamens 1 or 2. Style glabrous on undivided portion
            8. Spikelets obtuse; axis (visible after fruits shed) slightly winged. Anthers 0.4-0.8 mm long ..... **F. littoralis**
            8. Spikelets acute; axis (visible after fruits shed) prominently winged. Anthers 0.2-0.4 mm long ..... **F. microcarya**

**Fimbristylis ammobia** Latz - occurs from Broome to Derby in the Kimberley Region, with a single record from red sand on Yaramin Station (east of Sturt Creek) in the Eremaean Botanical Province. Also occurs in Northern Territory. Flowers and fruits: July. Plants 0.1-0.2 m high; stems *c.* 0.5 mm diam. (Latz 1979: Figure 2; Latz & Wilson 1981: Figure 636A-D; Rye 1992: Figure 316A)

**Fimbristylis depauperata** R. Br. - fairly widespread in the Kimberley Region, extending from Mitchell Plateau south-west to One Arm Point and near Derby, east to Long Spring and south-east to Bungle Bungle Range, with isolated records in the Eremaean Botanical Province from drainage lines in Chichester Range National Park and at Mt Augusta. Also occurs in Northern Territory, Queensland, Lesser Sunda Island, South Moluccas and New Guinea. Flowers and fruits: March-April, August. Plants 0.1-0.3 m high; stems 0.4-1 mm diam. *Fimbristylis dichotoma* subsp. *depauperata* (R. Br.) Kern, *F. dichotoma* f. *depauperata* (R. Br.) Ohwi, *F. diphylla* var. *depauperata* (R. Br.) C.B. Clarke, *F. spirostachya* F. Muell., *Iria depauperata* (R. Br.) Kuntze (Rye 1992: Figure 315F; Sharp 1989: Figure 43V)

**Fimbristylis littoralis** Gaudich. - extends from Drysdale River National Park in the Kimberley Region south to Southesk Tablelands and south-east to Erong Springs Station in the Eremaean Botanical Province, recorded along watercourses. Also occurs in Northern Territory, Queensland and widespread in the tropics. Flowers and fruits: February-July. Plants 0.05-0.4 m high; stems 0.5-1.4 mm diam. (Rye 1992: Figure 318C)

**Fimbristylis microcarya** F. Muell. - occurs along watercourses and drainage lines, with one record from a claypan. Extends from the far north of the Kimberley Region south-west to Milly Milly Station (near upper Murchison River) in the Eremaean Botanical Province. Also occurs in Northern Territory and Queensland. Flowers and fruits: February-August. Plants 0.05-0.4 m high; stems 0.4-1.2 mm diam. Most specimens have only 1 stamen in each flower but the specimen from Milly Milly Station (*R.J. Cranfield* 5324) has 2 stamens. *Fimbristylis autumnalis* var. *microcarya* (F. Muell.) Kük., *F. complanata* var. *microcarya* (F. Muell.) C.B. Clarke, *Iria microcarya* (F. Muell.) Kuntze (Rye 1992: Figure 318D; Sharp 1989: Figure 43Q)

**Fimbristylis oxystachya** F. Muell. - extends from Mitchell Plateau in the Kimberley Region south-west to near Roebourne and south-east to Yaramin Station (east of Sturt Creek) in the Eremaean Botanical Province, occurring in red sand. Also occurs in Northern Territory and Queensland. Flowers and fruits: April-July. Plants 0.2-0.35 m high; stems 0.5-0.7 mm diam. *Iria oxystachya* (F. Muell.) Kuntze (Rye 1992: Figure 316H)

**Fimbristylis rara** R. Br. - extends from the far north of the Kimberley Region south-west to near Port Hedland and to a claypan near upper Oakover River in the Eremaean Botanical Province. Also occurs in Northern Territory and Queensland. Flowers and fruits: May. Plants 0.05-0.35 m high; stems 0.5-0.8 mm diam. (Rye 1992: Figure 317I)

**Fimbristylis simulans** Latz - extends from Mitchell Plateau in the Kimberley Region south-west to Hamersley Range and south-east to Yaramin Station (east of Sturt Creek) in the Eremaean Botanical Province, occurring in rock crevices and in skeletal sand over a variety of rock types. Also occurs in Northern Territory. Flowers and fruits: February-August. Plants 0.1-0.3 m high; stems 0.2-0.4 mm diam. (Latz 1990: Figure 2G-I; Rye 1992: Figure 316N)

**Fimbristylis velata** R. Br. - occurs along watercourses and in other damp habitats in the South West Botanical Province, extending from Ellen Brook south to Medina, with an isolated record from Blackwood

River. Also occurs in Northern Territory, South Australia, Queensland, New South Wales, Victoria and from Asia to Polynesia. Flowers and fruits: December-May. Plants 0.04-0.15 m high; stems 0.4-0.6 mm diam. *Fimbristylis squarrosa* var. *esquarrosa* Makino, *F. squarrosa* var. *velata* (R. Br.) Cheeseman, *Iria velata* (R. Br.) Kuntze (Sharp 1989: Figure 43M; Wilson 1993: 378)

**Fimbristylis** sp. **Shay Gap** (*K.R. Newbey* 10293) - apparently endemic to the Eremaean Botanical Province of Western Australia, known from a single collection from sandy soil on a drainage line near Shay Gap. Flowers and fruits: June-July. Plants *c.* 0.15 m high; stems *c.* 0.7 mm diam. **Priority 1**

**Fuirena** Rottb.

1. Perianth absent. Stamen 1 ..... **F. nudiflora**
1. Perianth consisting of 3 bristles and 3 prominently clawed scales. Stamens usually 3 (but sometimes hidden)
   2. Perianth scales prominently 3-veined but otherwise unthickened throughout the body, with a shallow lobe or tooth on each side of a thickened incurved apical point, the apical point *c.* 0.2 mm long ..... **F. ciliaris**
   2. Perianth scales prominently 3-veined in basal part and prominently thickened in distal part of body, the apex broadly obtuse and with a slender awn *c.* 0.6 mm long ..... **F. incrassata**

**Fuirena ciliaris** (L.) Roxb. - widespread in the Kimberley Region. Occurs along watercourses in the Hamersley Ranges and along Yule River in the Eremaean Botanical Province. Also occurs in Northern Territory, Queensland, New South Wales and from tropical Africa north-east to Japan. Flowers and fruits: April-August. Plants 0.1-0.35 m high; stems 0.5-1.2 mm diam. *Fuirena glomerata* Lam., *Scirpus ciliaris* L. (Kern 1974: 32; Latz & Wilson 1981: Figure 642; Sharp 1989: Figure 42A; Wilson 1993: 369)

**Fuirena incrassata** S.T. Blake - one record from Edgar Range in the far south of the Kimberley Region and another from Googhenama Rockhole on upper Oakover River in the Eremaean Botanical Province. Also occurs in Northern Territory, Queensland and New South Wales. Flowers and fruits: May-August. Plants 0.1-0.3 m high; stems 0.7-1.7 mm diam. This species is widespread but uncommon across northern Australia and has been included on the Priority Flora List for Western Australia. It is probably poorly collected rather than at risk; it is easily overlooked because it resembles its common relation *F. ciliaris*. **Priority 3** (Sharp 1989: Figure 42B; Wilson 1993: 369)

**Fuirena nudiflora** S.T. Blake - one record from near Kununurra in the Kimberley Region, and one record from a rocky creek bed in a valley of Rawlinson Range in the Eremaean Botanical Province. Also occurs in Northern Territory and Queensland. Flowers and fruits: June. Plants 0.05-0.2 m high; stems 0.3-1.0 mm diam. Like the previous species, *F. nudiflora* has been included on the Priority Flora List for Western Australia, although it has a large range in Australia. It is probably poorly collected, perhaps mostly overlooked because of its much more common relation, *F. ciliaris*. **Priority 1** (Figure 19G-I)

**Isolepis** R. Br.

1 Glumes 2.3-3.7 mm long. Style branches 2. Nut very compressed, shallowly biconvex, 1.4-1.8 mm long
   2. Spikelets 1-5, 1.5-2.5 mm diam. at first, up to 3.5 mm diam. in fruit. Glumes with a short or long, rather straight mucro. Nut usually broadly obovate to broadly elliptic but sometimes almost circular in outline ..... **I. cyperoides**

2. Spikelet 1, 3-4 mm diam. at first, up to 5 mm diam. in fruit. Glumes with a short incurved mucro. Nut almost circular in outline ..... **I. oldfieldiana**

1. Glumes 1.0-2.1 mm long. Style branches 3 except in most *I. setiformis* specimens. Nut circular in cross-section to compressed 3-angled or plano-convex in cross-section, 0.4-1.3 mm long

3. Nut circular in cross-section, prominently reticulate-patterned ..... **I. hookeriana**

3. Nut 3-angled to plano-convex in cross-section, smooth to minutely patterned

4. Spikelets either prominently angular or squarrose, with boat-shaped or awned glumes

5. Spikelets squarrose, each glume with an awn at least as long as its body Stamens 1 or 2 ..... ***I. hystrix**

5. Spikelets angular, not squarrose, with rigid boat-shaped incurved glumes. Stamens 3 ..... ***I. marginata**

4. Spikelets more or less smoothly terete, not squarrose, with glumes more or less convex on abaxial surface

6. Stamens 2 or 3; anther 0.7-1.3 mm long. Nut with abaxial angle absent or obtuse

7. Flowers usually all with 3 stamens and a 3-branched style, rarely some flowers of the spikelet with a 2-branched style. Nut usually 3-angled ..... **I. cernua**

7. Flowers all with 2 stamens and a 2-branched style or sometimes some flowers of the spikelet with a 3-branched style. Nut usually biconvex ..... **I. setiformis**

6. Stamens 1(2); anther 0.2-0.3 mm long. Nut with abaxial angle acute

8. Spikelets 1-4(6), forming an open or irregularly shaped cluster, some spikelets often protruding further than others. Glumes with a keel 0.15-0.2 mm wide on each side of midvein. Nut 0.4-0.6 mm long

9. Glumes 0.8-1.2 mm long, with hyaline margins more or less reaching the scarcely pointed apex ..... **I. australiensis**

9. Glumes (1.2)1.4-2 mm long, with hyaline margins tapering below a distinct apical point ..... **I. congrua**

8. Spikelets 3-8, in a dense globular cluster. Glumes with a broad keel *c.* 0.3 mm wide on each side of midvein. Nut 0.6-0.7 mm long ..... **I. stellata**

**Isolepis australiensis** (Maiden & Betche) K.L. Wilson - occurs in the South West Botanical Province of Western Australia, recorded from sandy clay beside a pool near Lake Cronin (east of Hyden) and from near Coujinup Hill (north-east of Ravensthorpe). Also occurs in Northern Territory, South Australia, Queensland, New South Wales, Victoria and possibly New Zealand. Flowers and fruits: June, September. Plants 30-55 mm high; stems 0.2-0.3 mm diam. *Scirpus australiensis* (Maiden & Betche) S.T. Blake, *S. cernuus* var. *australiensis* Maiden & Betch **Priority 2** (Jessop & Weber 1986: Figure 934A; Wilson 1994: Figure 63c,d)

**Isolepis cernua** (Vahl) Roem. & Schult. - commonly occurs in winter-wet depressions or associated with granite, in sand or clay soils, mainly in the South West Botanical Province, extending around the coast from north of Gingin to Cape Arid National Park and inland to Wongan Hills, Manjimup and Kau Rocks (north-east of Esperance), with a single record from the South-western Interzone north-east of Newman Rock (east of Frazer Range). Also occurs in South Australia, Queensland, New South Wales, Victoria,

Tasmania and most regions of the world. Flowers and fruits: August-March. Plants 20-200(300) mm high; stems 0.2-0.6 mm diam. Annual or apparently annual specimens are much less common than perennial ones, and a particularly robust perennial variant from the south coast has been named *Scirpus psammophilus* S.T. Blake. There may be two or more species or infra-specific taxa included here, with one species or variant being distinguished by having a black (rather than brown) nut; the variation in this complex needs further study throughout the world. *Scirpus cernuus* Vahl (Jessop & Weber 1986: Figure 934B; Sharp 1989: Figure 41L; Wilson 1994: Figure 65a-c)

**Isolepis congrua** Nees - commonly associated with granite outcrops, also in other damp locations such as the margins of watercourses and winter-wet depressions. Widespread in the South West Botanical Province (except for the extreme south-west corner), South-western Interzone and adjacent parts of the Eremaean Botanical Province, extending from Lyons River Station and Kalbarri south-east to Porongurup Range National Park and east to Dadyum Rockhole (east of Laverton), with an isolated record from Rawlinson Range. Also occurs in Northern Territory, South Australia, New South Wales and Victoria. Flowers and fruits: July-October. Plants 15-180 mm high; stems 0.15-0.35 mm diam. *Scirpus congruus* (Nees) S.T. Blake (Jessop & Weber 1986: Figure 934C; Wilson 1994: Figure 63e,f)

**Isolepis cyperoides** R. Br. - endemic to the South West Botanical Province, occurring in clay in winter-wet depressions and other damp habitats, extending around the coast from near Nanson (north of Geraldton) to near Cape Le Grand National Park and inland to Stirling Range. Flowers and fruits: mainly September-February. Plants (when apparently annual) 35-150 mm high, more commonly perennial and up to 300 mm high; stems 0.3-1.3 mm diam. Closely related to *I. oldfieldiana*, which has broader, usually more obtuse spikelets. *Scirpus brunonianus* S.T. Blake, *S. cyperoides* (R. Br.) Spreng. (Figure 20A,B)

**Isolepis hookeriana** Boeck. - occurs in the South West Botanical Province, recorded on winter-wet flats in sandy clay, known from at least five scattered localities extending from Meenaar south to Lowden (possibly also Stirling Range) and east to near Corrigin. Also occurs in South Australia, Queensland, New South Wales, Victoria and Tasmania. Flowers and fruits: September-November. Plants 30-150 mm high; stems 0.1-0.25 mm diam. Although this species is widespread, it appears to be uncommon, with few plants at each population (K.L. Wilson pers. comm.) *Scirpus calocarpus* S.T. Blake, *S. hookerianus* (Boeck.) S.T. Blake **Priority 3** (Jessop & Weber 1986: Figure 934E; Sharp 1989: Figure 41E; Wilson 1994: Figure 64a,b)

***Isolepis hystrix** (Thunb.) Nees - naturalized in the South West Botanical Province, recorded from winter-wet flats in the Waroona area and near Green Range (north-east of Albany). Also naturalized in South Australia, New South Wales and Victoria. Native to South Africa. Flowers and fruits: November. Plants *c.* 25 mm high; stems 0.3-0.4 mm diam. *Scirpus hystrix* Thunb. (Jessop & Weber 1986: Figure 934F)

***Isolepis marginata** (Thunb.) A. Dietr. - commonly occurs in shallow soil over granite, limestone or other types or rocks, also in winter-wet depressions and other damp habitats. Widespread in the South West Botanical Province, extending around the coast from Abrolhos Islands to Recherche Archipelago and inland into the South-western Interzone near Mt Hampton (south of Southern Cross) and Mt Willgonarinya (south of Balladonia), with an isolated record from Belele Station in the Eremaean Botanical Province. Probably naturalized in Australia. Also occurs in South Australia, New South Wales, Victoria, Tasmania and New Zealand. Native to South Africa. Flowers and fruits: mainly August-December, also January-February. Plants 15-220 mm high; stems 0.2-0.5 mm diam. *Isolepis cartilaginea* R. Br., *Scirpus marginatus* Thunb. (Jessup & Weber 1986: Figure 934H, 935A; Wilson 1994: Figure 65j-l)

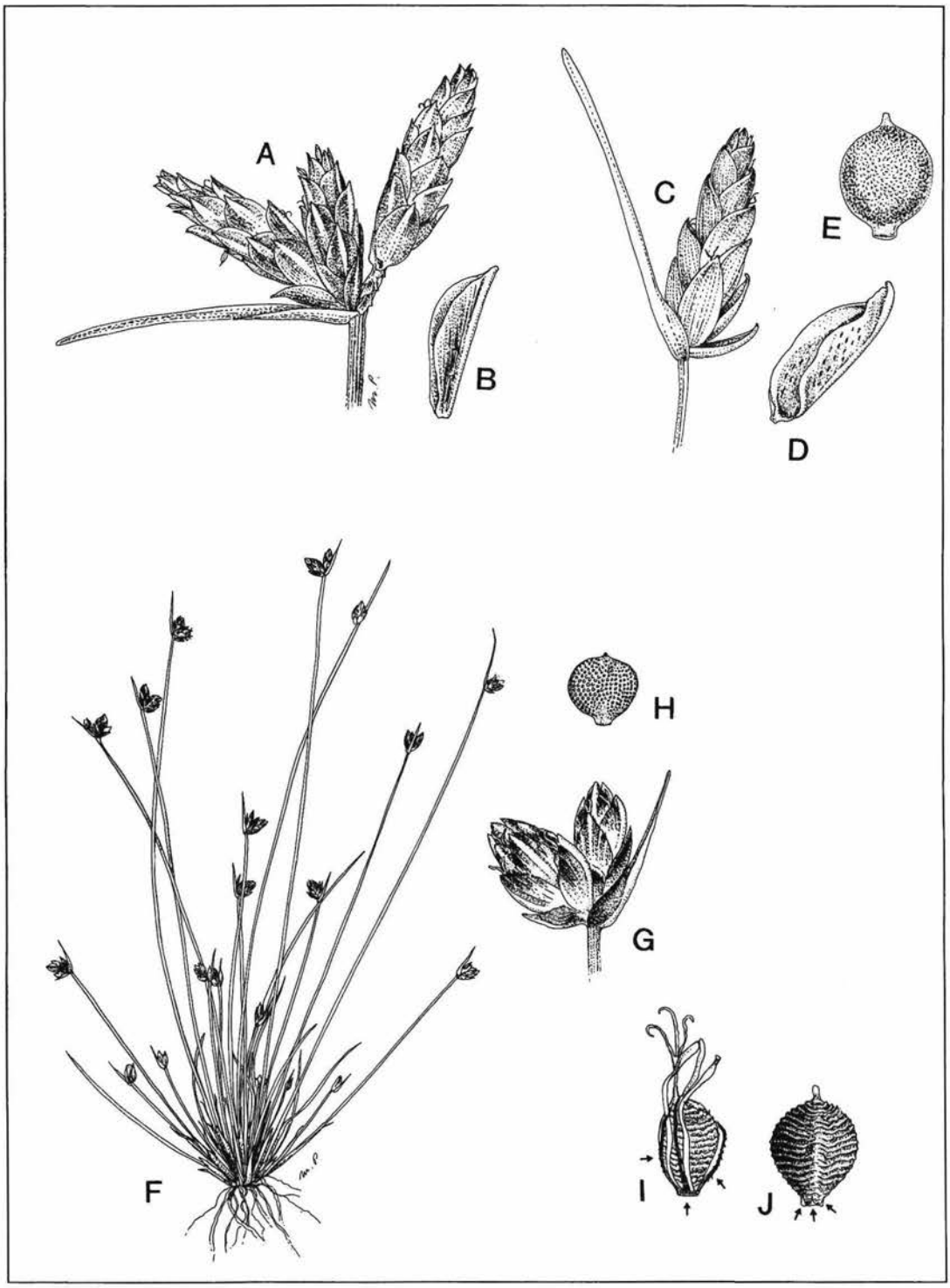


Figure 20. A,B *Isolepis cyperoides* A - inflorescence (x4), B - glume (x10); C-E. *Isolepis oldfieldiana* C - inflorescence (x4), D - glume (x7), E - nut (x10); F-H *Isolepis setiformis* F - whole plant (x1), G - inflorescence (x6), H - nut (x10); I,J Trimerous variant of *Schoenoplectus dissachanthus* I - young nut with three stamen filaments, 3-branched style and fairly long perianth segments (arrowed) (x10), J - mature nut with very reduced perianth segments (arrowed) (x10). Drawn from *M. Koch* 1790 (A,B), *S.T. Blake* 17995 (C,D), *G.J. Keighery* 11366 (E), *R.J. Cranfield* 1410 (F,G), *K.F. Kenneally* 5857 (H), *N.H. Speck* 639 (I) and *R.J. Cranfield* 2171 (J).

**Isolepis oldfieldiana** (S.T. Blake) K.L. Wilson - endemic to the South West Botanical Province, occurring in clay or sandy clay in winter-wet depressions, extending from near Dandaragan south to Perup River (near Manjimup). Flowers and fruits: August-October, also recorded February. Plants (when apparently annual) 20-70 mm high; stems 0.3-1.1 mm diam. Perennial plants more common, up to 350 mm high. *Scirpus brizoides* Benth., *S. oldfieldianus* S.T. Blake (Figure 20C-E)

**Isolepis setiformis** (S.T. Blake) K.L. Wilson - endemic to Western Australia, occurring mainly in the South West Botanical Province in winter-wet depressions and other damp habitats, commonly in clay or sandy clay. Extends around the coast from Dirk Hartog Island in the Eremaean Botanical Province south to Albany and inland to Highbury (south of Narrogin). Flowers and fruits: mainly September-February. Plants 20-350 mm high, the smaller ones sometimes apparently annual; stems 0.2-0.5 mm diam. Closely related to *I. cernua*; the differences between the two taxa are not clear and possibly no greater than differences between some of the variants presently included within *I. cernua* (see note under that species). *Scirpus arenarius* var. *setiformis* Benth., *S. setiformis* S.T. Blake (Figure 20F-H)

**Isolepis stellata** (C.B. Clarke) K.L. Wilson - occurs in the South West Botanical Province, in clay or sandy clay in winter-wet depressions and other damp habitats. Extends around the coast from Lake Indoon south to Capel and from Albany east to Cape Arid National Park and inland to Stirling Range. Also occurs in South Australia, New South Wales, Victoria and Tasmania. Flowers and fruits: mainly October-January. Plants 20-90 mm high; stems 0.2-0.4 mm diam. *Scirpus stellatus* C.B. Clarke (Jessop & Weber 1986: Figure 934L, 935C; Wilson 1994: Figure 66d,e)

**Lipocarpha** R. Br.

**Lipocarpha microcephala** (R. Br.) Kunth - commonly occurs along watercourses, also recorded from drainage lines, rockholes and claypans. Extends from the far north of the Kimberley Region south-west to Byro Station in the Eremaean Botanical Province and south to Rawlinson Range in the Eremaean. Also occurs in Northern Territory, South Australia, Queensland, New South Wales, Victoria and north to Japan. Flowers and fruits: March-August. Plants 0.05-0.4 m high; stems 0.3-0.9 mm diam. *Hypaelyptum microcephalum* R. Br., *Rikliella australiensis* J. Raynal, *Scirpus dietrichiae* Boeck., *S. squarrosus* var. *dietrichiae* (Boeck.) Benth. (Jessop & Weber 1986: Figure 937; Latz & Wilson 1981: Figure 641; Rye 1992: Figure 311G; Sharp 1989: Figure 41O,42D; Wilson 1994: Figure 62a-c)

**Schoenoplectus** Palla

1. Nut smooth, 2-faced (biconvex or almost plano-convex), without perianth bristles ..... **S. laevis**
1. Nut transversely ridged, 2- or 3-faced, sometimes surrounded by minute to prominent perianth bristles
   2. Spikelets with dark reddish brown portions. Glumes minutely ciliolate or minutely denticulate towards apex; mucro distinctly thickened, usually dark red-brown. Perianth absent. Anthers 0.4-0.5 mm long ..... **S. lateriflorus**
   2. Spikelets lacking reddish colouring. Glumes glabrous and entire; mucro slender or sometimes scarcely developed, green or yellowish. Perianth of 3-7 (usually 6) long to very reduced bristles. Anthers *c.* 0.7 mm long ..... **S. dissachanthus**

**Schoenoplectus dissachanthus** (S.T. Blake) J. Raynal - occurs along watercourses, around rockpools and in claypans, extending from Weaber Plain in the Kimberley Region south-west to near Mount Magnet. Also occurs in Northern Territory, South Australia, Queensland, New South Wales and

Victoria. Flowers and fruits: April-October. Plants 0.07-0.35 m high; stems 0.7-1.4 mm diam. There are two main variants, which slightly overlap in range and intergrade.

typical variant - extends from the Kimberley Region south-west to Duck Creek and Three Rivers Station in the Eremaean Botanical Province. Also occurs in Northern Territory, South Australia, Queensland, New South Wales and Victoria. Flowers all or mostly with 2 stamens and a 2-branched style. Nut usually biconvex or plano-convex, usually surrounded by up to 7 (usually 6) medium-sized to long perianth bristles, rarely with bristles very reduced or absent. *Scirpus dissachanthus* S.T. Blake (Jessop & Weber 1986: Figure 938A; Rye 1992: Figure 319A; Wilson 1993: 368)

trimerous variant - extends from Towrana Station south-south-east to Dadyun Rockhole (east of Laverton) in the Eremaean Botanical Province. Also occurs in Northern Territory. This variant occurs further south than the typical variant in Northern Territory (Latz & Wilson 1981: 512) and also in Western Australia. Flowers all or mostly with 3 stamens and a 3-branched style. Nut usually 3-angled, surrounded by 3-6 long to very reduced perianth bristles, the bristles often so short that they appear to be absent. (Figure 20I,J)

**Schoenoplectus laevis** (S.T. Blake) J. Raynal - occurs along watercourses and around rock pools, extending from Mitchell Plateau and Wyndham in the Kimberley Region south-west to near Robe River and Newman in the Pilbara area of the Eremaean Botanical Province. Also occurs in Northern Territory, Queensland and New South Wales. Flowers and fruits: February-August. Plants 0.1-0.5 m high, with stems 0.5-1.3 mm diam. *Scirpus laevis* S.T. Blake (Rye 1992: Figure 319B; Wilson 1993: 368)

**Schoenoplectus lateriflorus** (J.F. Gmel.) Lye - occurs in the Kimberley Region from Drysdale River National Park south-west to Beagle Bay Mission and south-east to Osmond Range, with an isolated occurrence in the Pilbara area of the Eremaean Botanical Province, recorded several times by a watercourse at a single locality in the Hamersley Ranges. Also occurs in Northern Territory, Queensland and from India to southern China and the Philippines. Flowers and fruits: July-August. Plants usually 0.1-0.4 m high; stems 0.5-1.1 mm diam. *Schoenoplectus supinus* subsp. *lateriflorus* (J.F. Gmel.) T. Koyama, *Scirpus lateriflorus* J.F. Gmel. (Rye 1992: Figure 319C)

**Schoenus** L.

*Note for use of key.* The number of rows of cells on the surfaces of the nut does not include any rows of cells on the ridges, only those between the ridges. It varies from surface to surface on each nut and between nuts of the same plant, so where the ranges given have one number in common (e.g. 3-5 rows versus 5-7 rows) there is actually no overlap as neither choice will have 5 rows of cells consistently on all surfaces of the nut.

1. Perianth segments absent or minute (much shorter than nut)
2. Spikelets 1-6 per stem in an interrupted spike, each node usually with 1spikelet. Nut with many rows of narrowly oblong cells on each surface (with parts of the rows tending to become black at maturity, forming black stripes or patches) or smooth
3. Largest glume 4-6 mm long, shiny. Nut *c.* 1.5 mm long ..... **S. discifer**
3. Largest glume 2-3.5 mm long, usually dull. Nut *c.* 0.8 mm long

4. Aquatic or semi-aquatic plant 35-110 mm high, with very slender lax leaves. Spikelets at 2-6 nodes per stem; lowest bract 3-6 mm long ..... **S. tenellus**

4. Tiny terrestrial plant 15-55 mm high, with firm leaves. Spikelets at 1-4 nodes per stem; lowest bract 10-25 mm long ..... **S.** sp. **Waroona**

2. Spikelets several to many in a terminal cluster on each stem or in several pairs or clusters, sometimes also with solitary spikelets at some nodes. Nut with few to many rows of almost isodiametric or transversely elongate cells on each surface.

5. Nut 3-horned, with each of the 3 ridges shortly produced at the summit into a small rounded projection

6. Spikelets 4-6-flowered, with 1 empty basal glume. Nut 1.1-1.5 mm long, with *c.* 10 rows of cells on each surface and a prominent apical beak. Occurs in central Australia ..... **S. centralis**

6. Spikelets 2-5-flowered, with 2(3) empty basal glumes. Nut 0.6-1.0 mm long, with 3-7 rows of cells on each surface and a small apical point. Occurs in south-western Australia

7. Floral glumes (2.5)3-4 mm long. Anthers 1.2-2.4 mm long. Nut with 3-5 rows of cells on each surface, the central row(s) usually with very large cells ..... **S. variicellae**

7. Floral glumes 1.5-2.5 mm long. Anthers 0.5-0.8 mm long. Nut with 5-7 rows of cells of relatively uniform size on each surface ..... **S. odontocarpus**

5. Nut not horned, with each of the 3 ridges smoothly rounded at the summit

8. Nut with a prominent beak a quarter to a third as long as body of nut, with 3 or 4(5) rows of cells on each surface, the central rows with large almost isodiametric cells ..... **S. sculptus**

8. Nut with beak or apical point less than a quarter as long as the body of nut, with 4-16 rows of cells on each surface, the central rows with cells either small or transversely narrowly oblong

9. Anthers 0.5-1.5 mm long

10. Mature upper glumes 5-6 mm long. Anthers over 1 mm long. Nut with 12-16 rows of cells on each surface ..... **S.** sp. **Jindong**

10. Mature upper glumes 3.5-4.5 mm long. Anthers less than 1 mm long. Nut with 5-7 rows of cells on each surface ..... **S.** sp. **Harrismith**

9. Anthers 2.5-3.5 mm long

11. Glumes with apex similar in colour to remainder of glume. Nut with 6-8 rows of cells on each surface, all rows with square to transversely oblong cells ..... **S.** sp. **Kalbarri**

11. Glumes deeply coloured at apex but not elsewhere. Nut with 4-6 rows of cells on each surface, all or at least the central rows with transversely narrowly oblong cells ..... **S. elegans**

1. Perianth segments well developed, about half as long as to exceeding nut, hair-like to plumose

12. Spikelets solitary (sometimes basal and largely hidden by the leaves) or rarely 2 superposed per stem, 1- or 2-flowered

13. Plants with tufted leaves around elongate basal spikelets, rarely also with erect emergent non-leafy stems bearing exposed spikelets. Basal spikelets 1(2)-flowered, with glumes 4-10 mm long; exposed spikelets 1 or 2 per stem, 2- or 3-flowered, with glumes 2.5-4.5 mm long ..... **S. capillifolius**

13. Plants with long lax leafy aquatic stems with terminal spikelets. Basal spikelets absent; exposed spikelets solitary, 2-flowered, with glumes 3-4 mm long ..... **S. natans**

12. Spikelets either 3 or more per stem or with 3 or more flowers

14. Nut with a fine reticulate pattern of many (over 10) rows of cells or papillae on each surface, or sometimes appearing smooth

15. Semi-aquatic plants with leaves much more slender and lax than the stems. Spikelets solitary or rarely 2 per stem, 2.5-3.5 mm long ..... **S.** sp. **Beaufort**

15. Terrestrial plants with leaves similar in width to the stems. Spikelets several per stem, 4-6 mm long ..... **S. pennisetis**

14. Nut more obviously reticulate-patterned, with 3-8 rows of cells on each surface

16. Nut with 3-5 rows of cells on each surface, the cells of the central row(s) large, usually much larger than the rest

17. Spikelets borne at 2-many levels up each stem, with often only one spikelet at each level. Floral glumes (3.5)4-5.5 mm long ..... **S. plumosus**

17. Spikelets all borne in a terminal cluster on each stem. Floral glumes 1.5-3 mm long ..... **S. nanus**

16. Nut with 5-8 rows of medium-sized cells on each surface

18. Perianth segments hair-like in distal half and with long antrorse hairs in basal half. Nut 3-lobed about a small pointed apex ..... **S. badius**

18. Perianth segments hair-like or plumose throughout. Nut tapering to the beaked apex, not lobed

19. Perianth segments hair-like ..... **S. elegans**

19. Perianth segments plumose

20. Floral glumes 6-7 mm long. Anthers *c.* 3 mm long. Nut shed with the perianth segments attached ..... **S.** sp. **Bullsbrook**

20. Floral glumes 2.5-5 mm long. Anthers usually 0.4-1 mm long. Nut shed leaving perianth attached to plant ..... **S. humilis**

**Schoenus badius** Rye - endemic to the South West Botanical Province, recorded from Moresby Range and near Mt Adams (east of Dongara) in damp habitats. Flowers and fruits: August-September. Plants 50-120 mm high; stems *c.* 0.3 mm diam. **Priority 2** (Rye 1997: Figure 1A-C)

**Schoenus capillifolius** D.A. Cooke - endemic to the South West Botanical Province, aquatic or semi-aquatic, usually submerged in swamps, rooted in clay. Occurs on the coastal plain from the Upper Swan area of Perth south to Waterloo, also recorded inland near Beaufort River. Flowers and fruits: September-November. This species sometimes appears to have stolons connecting the tufted plants so may be perennial in some or most cases. There are two variants. **Priority 2**

typical variant - extends from Upper Swan south to Waterloo. Fully or partially submerged tufted plants with very slender lax leaves 20-115 mm long with a blade 0.1-0.2 mm wide, and basal 1-flowered spikelets with a solitary stamen. (Figure 21A)

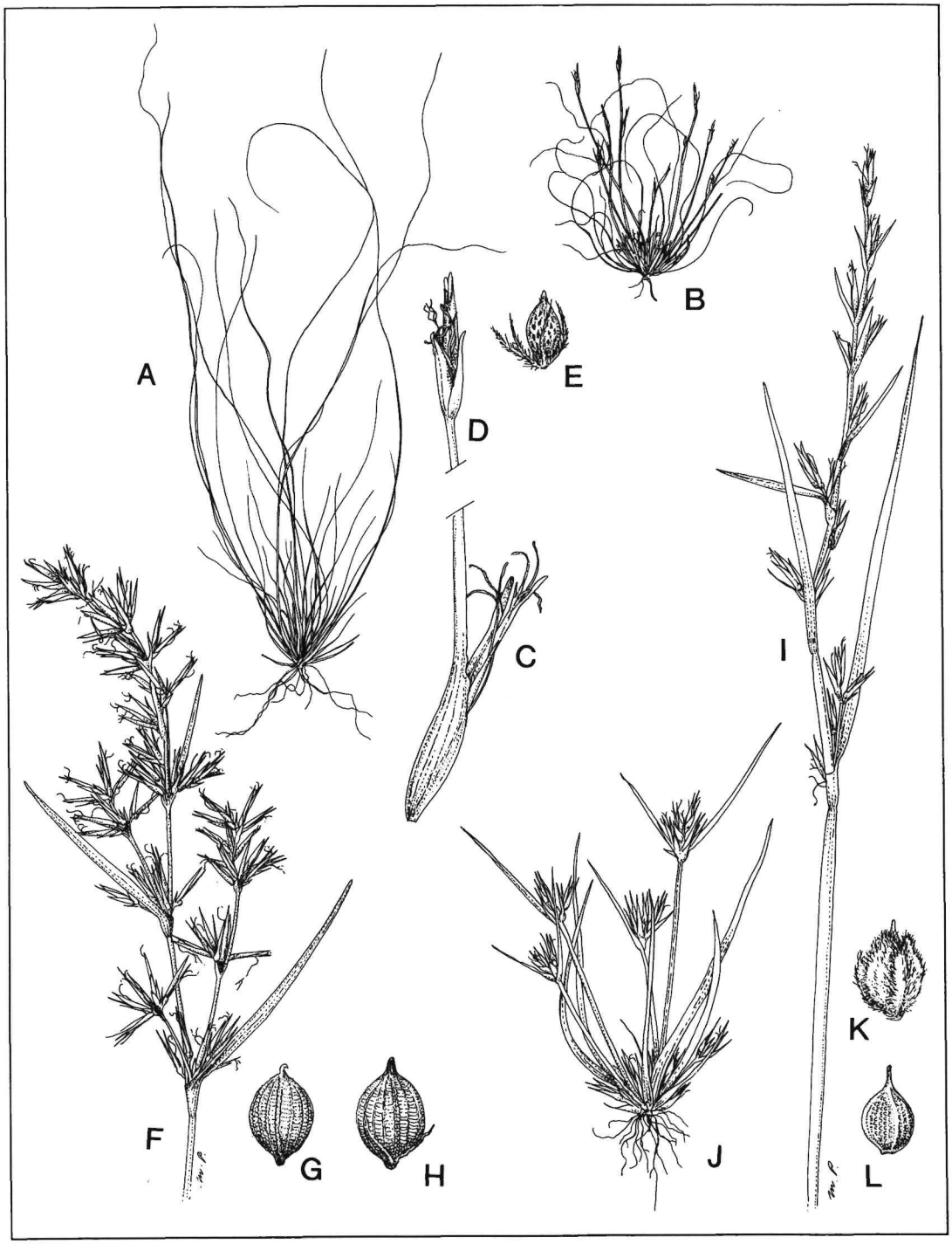


Figure 21. A - Typical variant of *Schoenus capillifolius*, whole plant (x1); B-E Inland variant of *Schoenus capillifolius* B - whole plant (x1), C - basal spikelet (x7), D - aerial spikelet (x5), E - nut with perianth segments, from aerial spikelet (x8.5); F-H *Schoenus elegans* F - inflorescence (x1), G - nut without perianth (x13); H nut and perianth segments (x13); I-L *Schoenus humilis* I - stem from large variant (x1), J - whole plant of small variant (x1), K - nut with perianth segments (x10), L - nut (x10). Drawn from *A. Kelly & A. Spooner* 90/63 (A), *G.J. Keighery* 6291A (B-E), *J. Seabrook* 437 (F,G), *G.J. Keighery* 1905 (H), *G.J. Keighery* 3307 (I) and *A.S. George* 11610 (J-L).

inland variant - known only from Beaufort River (*G.J. Keighery* 6291A, 6377). Partially submerged plants 30-40 mm high with firm stems 0.3-0.4 mm wide and with 2- or 3-flowered exposed spikelets present in addition to the longer basal spikelets. The nut is inconspicuously patterned with many rows of narrowly oblong cells. (Figure 21B-E)

**Schoenus centralis** Latz - recorded from a rocky creek bed in a valley in Rawlinson Range in the Eremaean Botanical Province. Also occurs in Northern Territory. Flowers and fruits: July. Plants commonly 110-200 mm high; stems 0.7-1.0 mm diam. A specimen from Northern Territory is *c.* 400 mm high. **Priority 1** (Latz 1979: Figure 4; Latz & Wilson 1981: Figure 635)

**Schoenus discifer** Tate - occurs on the margins of winter-wet depressions in the South West Botanical Province, extending around the coast from near Gingin south to Scott National Park and south-east to Albany. Also occurs in South Australia. Flowers and fruits: September-December. Plants 20-80 mm high; stems 0.5-1.1 mm wide. (Jessup & Weber 1986: Figure 939F)

**Schoenus elegans** S.T. Blake - habitat unknown except for one record from very shallow wet sandy soil over ironstone. Endemic to the South West Botanical Province, extending from Bayswater and Helena Valley (Perth) south to Scott River. Flowers and fruits: October-November. Plants 50-300 mm high; stems 0.5-1.5 mm diam. Some specimens lack a perianth and others have hair-like bristles which may be very short or about half as long as the nut. Most plants are 150-300 mm high but plants collected from Scott River (*G.J. Keighery* 1905) are only *c.* 55 mm high. (Figure 21F-H)

**Schoenus humilis** Benth. - endemic to the South West Botanical Province, occurring in a variety of damp habitats including the margins of watercourses and lakes and on granite. Extends from Dirk Hartog Island and Moorarie Station (upper Murchison River) south-east to near Stirling Range and Ponier Rock (south of Balladonia). Flowers and fruits: August-November. Plants 30-200 mm high; stems 0.5-1.4 mm wide. Very variable in habit, varying from large specimens with many spikelets borne singly or in small clusters along the stems (e.g. *G.J. Keighery* 3307) to very small specimens with basal spikelets and a cluster of terminal spikelets as in a specimen from a salt lake on Dirk Hartog Island (*A.S. George* 11610). A specimen from Wattle Grove (*R. Coveny* 8261) has unusually large glumes. (Figure 21I-L)

**Schoenus nanus** (Nees) Benth. - occurs commonly in clay soils in winter-wet depressions towards the coast, but more commonly on granite outcrops or sheets inland. Widespread in the South West Botanical Province, from Kalbarri National Park to the south coast and south-west to Mt Burdett, also extending inland to Yellowdine (east of Southern Cross), near Lake Cowan and Boingaring Rock (west of Balladonia) in the South-western Interzone. Also occurs in South Australia and Victoria. Flowers and fruits: August-November. Plants 10-80 mm high; stems 0.2-0.4 mm diam. *Chaetospora nana* Nees (Jessop & Weber 1986: Figure 939J; Wilson 1994: Figure 53j)

**Schoenus natans** (F. Muell.) Benth. - endemic to the South West Botanical Province, aquatic, fully submerged in small pools in seasonally wet flats or larger swamps, extending along the coastal plain from near Gingin south to Ludlow and inland to swamps near the upper reaches of Helena and Darkin Rivers and on Collie Plain. Flowers and fruits: August-November. Plants with very slender lax stems and leaves 75-250 mm long; stems *c.* 0.1 mm diam. *Chaetospora natans* F. Muell. **Declared Rare** (Figure 22A-C)

**Schoenus odontocarpus** F. Muell. - occurs mainly on granite outcrops or slabs inland and in winter-wet depressions on the coastal plain. Endemic to the south-west of Western Australia, occurring in the South West Botanical Province from Gillingarra south to Wicher Range and Albany, south-east to Howick Hill, and east (inland) to Wallaroo Rock in the South-western Interzone. Flowers and fruits: August-November. Plants 20-95 mm high; stems 0.15-0.3 mm diam. (Rye 1997: Figure 1D,E)


Figure 22. A-C *Schoenus natans* A - whole plant (x1), B - spikelet (x8), C - nut with perianth segments (x10); D-F *Schoenus pennisetis* D - whole plant (x1), E - spikelet (x8), F - nut with perianth segments (x10); G-J *Schoenus tenellus* G - whole plant (x1), H - fruiting spikelet (x8), I - fruiting axis (x8), J - nut (x14). Drawn from *B.J. Keighery & N. Gibson* 015 (A,B), *B.J. Keighery & N. Gibson* 019 (C), *G.J. Keighery* 9183 (D,E), *A. Kelly & A. Spooner* 90/116 (F), *G.J. Keighery* 3594 (G) and *H. Butler* Oct. 1948 (H-J).

**Schoenus pennisetis** S.T. Blake - endemic to the South West Botanical Province, recorded from Wongan Hills and from sandy clay in winter-wet depressions on the eastern side of the coastal plain in Perth suburbs and near Ruabon (south of Capel). Flowers and fruits: August-December. Plants 70-130 mm high; stems 0.2-0.4 mm diam. **Priority 1** (Figure 22D-F)

**Schoenus plumosus** Rye - occurs on the margins of winter-wet depressions and watercourses and in other damp habitats. Endemic to the South West Botanical Province, extending from Lake Indoon south to near Capel and south-east to Albany. Flowers and fruits: September-November. Plants 70-180 mm high; stems 0.5-1.2 mm diam. (Rye 1997: Figure 1J-M)

**Schoenus sculptus** (Nees) Boeck. - occurs in the South West Botanical Province from near Geraldton south to near Mandurah and south-east to Recherche Archipelago. Recorded mainly in winter-wet depressions in the western part of its range from Howatharra Hill Reserve south to Mandurah and inland to Meenaar. Recorded on granite, low-lying flats and salt lake margins in the eastern area from Lake King east to Recherche Archipelago. Also occurs in South Australia and Victoria. Flowers and fruits: September-November. Plants 20-100 mm high; stems 0.4-0.9 mm diam. The western specimens are larger and apparently more erect than the eastern specimens. *Elynanthus sculptus* Nees (Jessop & Weber 1986: Figure 939M; Wilson 1994: Figure 53k)

**Schoenus tenellus** Benth. - endemic to the South West Botanical Province, usually partially submerged near the margins of pools on claypans, also recorded from one sandy swamp. Extends from Upper Swan south to Scott River and south-east to Albany. Flowers and fruits: September-December. Plants 35-110 mm high; stems 0.2-0.4 mm diam. *Schoenus fluitans* var. *tenellus* (Benth.) Kük. (Figure 22G-J)

**Schoenus variicellae** Rye - occurs mainly in clay soils in winter-wet depressions or associated with laterite or granite. Endemic to Western Australia, occurring mainly in the South West Botanical Province from Kalbarri National Park south to the Scott River area and Perup River, also extending inland to Koonmara Station in the Eremaean Botanical Province and to Walling Rock Station in the South-western Interzone. Flowers and fruits: August-November. Plants 30-160 mm high; stems 0.3-0.4 mm diam. A variant from the southern part of the species range has shorter anthers than the typical variant. (Rye 1997: Figure 1G-I)

**Schoenus** sp. **Beaufort** (*G.J. Keighery* 6291B) - endemic to the South West Botanical Province, semi-aquatic, known from a single collection, in a winter-wet claypan near Beaufort River, north of Kojonup. Flowers and fruits: October. Plants *c.* 40 mm high; stems 0.2-0.3 mm diam. **Priority 1**

**Schoenus** sp. **Bullsbrook** (*J.J. Alford* 915) - endemic to the South West Botanical Province, known from a single collection from sandy soil over clay, in a winter-wet depression, on a nature reserve near Bullsbrook, north of Perth. Flowers and fruits: October-November. Plants *c.* 140 mm high; stems *c.* 0.7 mm diam. **Priority 2**

**Schoenus** sp. **Harrismith** (*G.J. Keighery* 6475) - endemic to the South West Botanical Province, known from a single collection from a winter-wet flat near Harrismith. Flowers and fruits: October. Plants *c.* 120 mm high; stems 0.8-1.2 mm diam. **Priority 1**

**Schoenus** sp. **Jindong** (*R.D. Royce* 2485) - endemic to the South West Botanical Province, known from a single collection from the bank of a stream at Jindong, south of Busselton. Flowers and fruits: October-November. Plants *c.* 100 mm high; stems *c.* 0.8 mm diam. **Priority 1**

**Schoenus** sp. **Kalbarri** (*K.R. Newbey* 9352) - recorded from sandy soil along drainage lines or watercourses. Endemic to Western Australia, known from a single collection from Kalbarri National Park in the north of the South West Botanical Province. Another specimen possibly belonging to the same species is from Mt Augustus in the Eremaean Botanical Province. The Mt Augustus specimen (*K.R. Newbey* 11692) shows a number of differences in overall appearance, glumes and patterning on the nut surface but appears to occur in the same habitat. Flowers and fruits: August-October. Plants *c.* 90 mm high; stems *c.* 1 mm diam. Apparently related to *Schoenus elegans*. **Priority 2**

**Schoenus** sp. **Waroona** (*G.J. Keighery* 12235) - endemic to the South West Botanical Province, extending from eastern suburbs of Perth south to near Harvey. Occurs in clay or sandy clay on winter-wet flats on the eastern side of the coastal plain. Flowers and fruits: October-November. Plants 15-30 mm high; stems 0.35-0.6 mm wide. Closely related to *S. discifer* and *S. tenellus* but a smaller plant than both these species and with shorter anthers. **Priority 3**

## Discussion

Of all the genera included here, only *Bulbostylis* and *Lipocarpha* are fully covered for Western Australia. The other genera have perennial members and some also have annual members from the Kimberley Region that do not extend into the study area. Some small perennial species, such as *Eleocharis pusilla* R. Br. and *Schoenus latitans* S.T. Blake, could easily be mistaken for annual species, but true annuals can generally be distinguished readily by their shallow multi-rooted base with no rhizome or bulbs. Most perennial species have a short to long rhizome connecting the densely clustered to scattered bases of the stems.

There is some overlap between the annuals and perennials as a few species appear to vary in lifeform according to the environmental conditions or according to their variant. For example, *Cyperus rigidellus*, *Eleocharis geniculata* and four of the *Isolepis* species (*I. cernua, I. cyperoides, I. oldfieldiana* and *I. setiformis*) appear to be perennial more often than annual. *Cyperus polystachyos* Rottb. is often described as being either annual or perennial, but is usually a robust perennial. This species is native in the Kimberley Region and other tropical or subtropical areas and has become naturalized in the South West Botanical Province, recorded from lawns, drains, swamps and other damp habitats in the Perth and Bunbury areas. It was not included here because all the naturalized specimens examined were perennial.

It is unlikely that all annual taxa occurring in the study area have been covered here. Some Western Australian species presently known only in the Kimberley Region might eventually be collected further south, and some new taxa may still be awaiting discovery. A possible new species in *Fimbristylis* is the southernmost specimen ( *E.M. Mattiske & D. True* 12/105) of those included under *F. depauperata*, which is quite atypical. This taxon is known from incomplete material and could possibly be perennial.

Five named Western Australian endemics (*Bulbostylis burbidgeae, Schoenus badius, S. capillifolius*, *S. natans* and *S. pennisetis*) and all of the taxa known by phrase names are currently included on the Declared Rare and Priority Flora List. In view of the usually wide distributions of other members of the family, it is likely that additional populations of at least some of these taxa will be discovered over fairly wide distributions. The small inconspicuous nature of these plants would certainly have contributed to the paucity of collections, although there is no doubt that they are much rarer than their frequently collected relatives. It is intended that, as the new taxa become known from multiple collections, they will be described and illustrated.

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Nuytsia 11(3):425-427(1997)



# SHORT COMMUNICATIONS

## *Digitaria aequiglumis* (Poaceae), a new weed for Western Australia

### Introduction

*Digitaria* Haller is a cosmopolitan genus represented in Western Australia by 15 indigenous and four introduced species. In early 1996, the first author collected a weedy *Digitaria* (*Lepschi & Lally* 2486) on the northern outskirts of Perth which did not match any *Digitaria* species so far recorded from Western Australia. Subsequent examination of the collection by the second author revealed the plant to be *D. aequiglumis* (Hackel & Arechav.) Parodi, a South American species sparingly naturalized in eastern and southern Australia (Webster 1984).

*Digitaria aequiglumis* is superficially similar to the two most common introduced *Digitaria* species in Western Australia, *D. ciliaris* (Retz.) Koeler and *D. sanguinalis* (L.) Scop., and could easily be confused with either taxon. The purpose of this note is to draw attention to the presence of *D. aequiglumis* in this state to allow the recognition of any further occurrences of this species.

**Digitaria aequiglumis** (Hackel & Arechav.) Parodi, Rev. Fac. Agron. Vet. 4:47 (1922). *Panicum aequiglume* Hackel et Arechav., Anal. Mus. Nac. Montevideo 1: 113 (1894).

Detailed descriptions of *D. aequiglumis* may be found in Vickery (1961), Webster (1984, 1987), Jessop (1986) and Jacobs & Wall (1993). The species is illustrated in the latter two references, as well as in Henrard (1950).

*Specimen examined.* WESTERN AUSTRALIA: 6.2 km N of Swan River crossing on Great Northern Highway, *c.* 7.5 km S of Bullsbrook, 27 Jan. 1996, *B.J. Lepschi & T.R. Lally* 2486 (BRI, CANB, PERTH).

*Distribution.* Native to southern South America, introduced into Europe and Australia, where it is naturalized in urban Adelaide and Sydney (Webster 1984). Within Western Australia known from one site on the northern outskirts of Perth.

*Habitat. Lepschi & Lally* 2486 was collected growing in brown sandy-loam on a roadside, in association with *D. ciliaris*, *D. sanguinalis* (*Lepschi & Lally* 2487), *Euphorbia* sp., *Sonchus oleraceus* and other weedy grasses and herbs. Plants of *D. aequiglumis* appeared to be confined to drier sites on the road verge, whereas *D. ciliaris* and *D. sanguinalis* occupied not only these areas but also moist soil in a shallow drainage ditch running parallel to the road.

*Notes.* As mentioned above, *D. aequiglumis* is superficially similar to the weedy *D. ciliaris* and *D. sanguinalis*. *Digitaria aequiglumis* may be distinguished from these species by the following key, which may be inserted into the key in Bennett (1987):

p. 955 rewrite lead 3 as follows:

3. Lower glume absent, upper glume subequal to lemma. Primary inflorescence branches unwinged ..... ***D. aequiglumis**

3. Lower glume present (though may be as little as 0.1 mm long in *D. sanguinalis*), upper glume shorter than lemma. Primary inflorescence branches winged

4. Upper glume 1/3 to 1/2 as long as lemma. Lower lemma scabridulous ..... ***D. sanguinalis**

4. Upper glume 1/2 to 3/4 as long as lemma. Lower lemma puberulous or sericeous and densely long-ciliate ..... ***D. ciliaris**

The indigenous *D. bicornis* (Lam.) Roem. & Schult., also resembles *D. aequiglumis*, but this taxon is confined to tropical areas in Australia (Webster 1984) and is unlikely to be found in association with *D. aequiglumis*. *D. bicornis* may be distinguished from *D. aequiglumis* by characters of the inflorescence and spikelets (see Webster 1984).

A feature of plants in the population represented by *Lepschi & Lally* 2486 is their distinctive pale green colour (both in life and when dried), and the first author was easily able to distinguish individuals of *D. aequiglumis* from *D. ciliaris* and *D. sanguinalis* (both darker purplish-green), on this character alone at the above locality. This is not specifically noted by any other authors (see above), although Vickery (1961) describes the spikelets in this species as "light green". Further observations on live and dried material are required to determine whether plant colour can be used as an aid to the identification of this taxon.

How *D. aequiglumis* arrived in Western Australia is unknown, but given the locality of *Lepschi & Lally* 2486, introduction *via* road traffic from eastern Australia seems likely. *Digitaria aequiglumis* does not appear to be a particularly aggressive or successful weed in areas where it is naturalized in eastern Australia, but its weed potential in Western Australia is unknown. Other species of *Digitaria* (e.g. *D. ciliaris* and *D. sanguinalis*) are important weeds in Australia and elsewhere (Kleinschmidt and Johnson 1977, Muenscher 1980, Wilson *et al.* 1995).

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# Brief notes on the genus *Crowea* (Rutaceae)

A treatment of the genus *Crowea* (Rutaceae) for Volume 26 of the "Flora of Australia" has been submitted. This paper describes a new subspecies included in that treatment and explains the nomenclatural decision that was taken with regard to the use of one of the varietal names.

## **CROWEA** Sm.

**Crowea angustifolia** Sm. in Rees, Cyclo. 10: n. 2 (1808). *Type*: King George Sound, Western Australia, 1803, *A. Menzies* (*holo*: LINN).

*Crowea angustifolia* Turcz., *Bull. Soc. Nat. Moscou* 22/2: 13 (1849). *Type*: Western Australia, *J. Drummond* 3rd coll. n. 12 (*holo*: KW; *iso*: K, MEL 4548, NSW 69928, TCD).

*Notes.* Archibald Menzies, the collector of the type of *C. angustifolia* Sm., visited King George Sound in August 1791 with George Vancouver. The date on the herbarium sheet in herb. LINN is therefore incorrect if it refers to the year in which it was collected.

**Crowea angustifolia** Sm. var. **platyphylla** Benth., Fl. Austral. 1:330(1863) as *C. angustifolia* Turcz. var. *platyphylla*. *Type*: Near the Franklin River [i.e. Frankland River], Western Australia, *G. Maxwell* (*iso*: MEL4549).

*Crowea dentata* Benth., Fl. Austral. 1: 330 (1863) - *Crowea angustifolia* Sm. var. *dentata* (Benth.) Paul G. Wilson, Nuytsia 1: 16 (1970). *Type*: King George Sound, Western Australia, *W. Baxter (holo*: K).

*Notes.* The names *Crowea angustifolia* Sm. and *C. angustifolia* Turcz. are taxonomic synonyms and also homonyms since they are based on different types.

Wilson (1970) recognized that *C. angustifolia* Turcz. var. *platyphylla* Benth. represented a variety distinct from the typical variety. He considered that the name was incorrect since the varietal epithet was attached to an illegitimate species name. Since he assumed that it would create a later homonym if the epithet were transferred to *C. angustifolia* Sm. he made the new combination *C. angustifolia* Sm. var. *dentata* (Benth.) Paul G. Wilson. However, as has been pointed out by Chapman (1991), this action was incorrect since homonyms have to be based on different types; in this case the types are the same whether the varietal epithet *platyphylla* is attached to the name *C. angustifolia* Sm. or to the name *C. angustifolia* Turcz.

I have therefore decided to 'correct' Bentham's combination by assuming that he had inadvertently provided the wrong bibliographic citation for the species name. This action appears to be sanctioned under article 33.3 of the International Code of Botanical Nomenclature (Tokyo Code).

**Crowea exalata** F. Muell., Trans. Philos. Soc. Victoria 1: 11 (1855). *Type:* Mitta Mitta River, Victoria, February 1854, *F. Mueller* (*lecto:* MEL 4410) *fide* Wilson, Nuytsia 1: 119 (1970).

**Crowea exalata** F. Muell. subsp. **exalata**

*Leaves* narrow-spathulate or narrow-elliptic, 15-30 x 2 mm to 50 x 6 mm, flat or with recurved margin, glabrous or sparsely puberulous. *Petals* 6-12 mm long. *Anther appendage* densely bearded.

*Distribution.* Far south-east Queensland south to eastern Victoria.

**Crowea exalata** subsp. **revoluta** Paul G. Wilson, *subsp. nov.*

Folia lineari-spathulata vel revoluta teretiaque, 10-15 mm longa, ca 1 mm lata, glabra vel sparse puberula. Petala 6-9 mm longa. Appendix staminalis modice barbata.

*Typus*: 1 mile [1.6 km] north of Lightning Hill near Eaglehawk, Victoria, 18 December 1916, *D.L. Paton* (*holo*: MEL 4413).

*Leaves* linear-spathulate to revolute and terete, 10-15 mm long, *c.* 1 mm wide, glabrous or sparsely puberulous. *Petals* 6-9 mm long. *Staminal appendage* moderately bearded.

*Additional specimens examined.* VICTORIA: Kamarooka State Park, *A.C. Beauglehole* 69683 (MEL); Gobarup Flora Reserve, *A.C. Beauglehole* 68932 (MEL); Eaglehawk, *W.K. Bissill* 4 (MEL); St Arnaud, May 1951, *L.G. Dale* (MEL); 1 mile [1.6 km] north of Blue Jacket Reservoir, 3 Apr. 1961, *W. Perry* (MEL); Reservoir on Lightning Hill Road, 12 July 1947, *F. Robbins* (MEL); Bendigo, 20 Jan. 1940, *A.J. Tadgell* (MEL).

*Distribution.* Found in central Victoria between Bendigo and Kamarooka, also at St Arnaud.

*Habitat.* Found in 'Whipstick Scrub', a mallee community on ironstone ridges with clay and gravelly soils (Conn 1993).

*Notes. Crowea exalata* ranges from south-east Queensland to central Victoria. A number of regional variants occur but most of these are recorded from only a small area and their distinguishing characters are relatively insignificant. However, the subspecies described above is distributed over a considerable area where it is constant in its flower and leaf morphology.

*Crowea exalata* subsp. *revoluta* is the most western variant of *C. exalata*; it appears to grade to the east into the typical variant of subsp. *exalata.*

## References

Chapman, A.D. (1991). "Australian Plant Name Index." Australian Flora and Fauna Series Number 12. (Australian Government Publishing Service: Canberra.)

Conn, B.J. (1993). *In:* Foreman, D.B. & Walsh, N.G. "Flora of Victoria." Vol. 1. (Inkata Press: Melbourne.)

Wilson, Paul G. (1970). A taxonomic revision of the genera *Crowea*, *Eriostemon* and *Phebalium* (Rutaceae). Nuytsia 1: 5-155.

**Paul G. Wilson**

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## CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA

**R: Declared Rare Flora - Extant Taxa** (= Threatened Flora = Endangered + Vulnerable)

Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee.

**X: Declared Rare Flora - Presumed Extinct Taxa**

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee.

**1: Priority One - Poorly Known Taxa**

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

**2: Priority Two - Poorly Known Taxa**

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

**3: Priority Three - Poorly Known Taxa**

Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.

**4: Priority Four - Rare Taxa**

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

## Referees for Volume 11

The assistance of referees in providing expert review of papers submitted to *Nuytsia* is gratefully acknowledged. The external referees consulted for Volume 11 are listed below. Each paper was also refereed internally by *Nuytsia* Committee members or other staff members of the Department of Conservation and Land Management.

Bean, A.R.
Conn, B.J.
Crisp, M.D.
George, A.S.
Dodd, J.
Haegi, L.
Hopper, S.D.
Hill, K.D.
Jessup, L.W.
Lepschi, B.J.
Makinson, R.O.
Marchant, N.G.
Morrison, D.A.
Munir, A.A.
Pedley, L.
Simon, B.K.
Thiele, K.R.
Thomson, B.G.
Walsh, N.G.
Weston, P.H.
Wilson, K.L.
Wilson, Paul G.
Wilson, Peter H.

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## Notes for Authors

The aim of *Nuytsia* is to publish original papers on systematic botany with preference given to papers relating to the flora of Western Australia. All papers are refereed and the Editorial Advisory Committee reserves the right to reject papers. Opinions expressed by authors are their own and do not necessarily represent the policies or views of the Department of Conservation and Land Management.

After final acceptance of papers, authors are requested to provide discs readable directly by IBM computer or internet attachments. Wherever possible, the MS-WORD software should be used. Original figures should not be lettered but accompanied by copies indicating lettering. Page proofs will be forwarded to authors for checking. Twenty reprints of each paper will be provided free of charge; no additional copies may be ordered.

Style and layout should follow recent numbers of *Nuytsia*. Within a paragraph two spaces are required between sentences; after colons, semicolons, commas and dashes a single space is required. Italics should be used for formal taxonomic names, from the genus level down to the lowest infraspecific categories, and for collectors' names when citing specimens. Incidental Latin words in the text should be italicized but not the Latin diagnosis.

*Title.* Should include the family name of the genera or species treated, but not authorities. New taxa should be named if not too numerous. The type of paper (e.g. revision, synopsis) and geographic area of study should be given where appropriate.

*Structure of papers.* Authors are encouraged to use the conventional structure of scientific papers, especially when a complete study, such as a revision, is being reported.

(1) *Abstract.* Should be indented and commence with bibliographic information. New taxa, combinations and names should be listed with their authorities. The major contents of the paper should be concisely summarized but no additional material given.

(2) *Introduction.* Should give some background information and state the purpose of the paper.

(3) *Methods* or *Materials and methods*. May include the method of drawing up the description from specimens, extent of search for types and discussion of concepts of taxonomic categories.

(4) *Results* or *Taxonomy* or *Taxonomic treatment* or various alternative headings as appropriate to the data being presented in the paper.

(5) *Discussion.* A discussion section should be considered, which would include some or all of the following: a summary of the findings emphasizing the most significant; interpretation of the results in the light of other relevant work; statement of new problems which have arisen; advising of aspects which are to be followed up; suggestion of topics which others might usefully pursue; prediction and speculation.

*Short Communications.* These are short concise contributions, usually with few or no main headings. They lack an abstract and authors' names and addresses are placed at the end.

*Headings*. All headings should be mainly in lower case, major headings centred and bold, secondary headings (where required) left-justified and bold, and minor headings left-justified and italicized.

*Keys.* May be either indented (e.g. Nuytsia 11: 94) or bracketed (e.g. Nuytsia 11: 55-56). Indented keys involving more than nine levels of indentation should be avoided. Where a key is indented, tabs should be used and not space bars.

*Species treatments.* Use of certain named paragraphs, or sets of paragraphs, for matter following the descriptions is encouraged. The desired sequence and examples of commonly used headings are shown below. Italicized headings should be followed by text on the same line.

(1) Taxon name (in bold) and authority. For previously published taxa this should be followed by the reference, nomenclatural synonyms (if any) and *Type:* heading with full type details.

(2) Other synonyms with their type details, significant manuscript or phrase names. Recent papers should be consulted for examples of an appropriate format for citing synonyms.

(3) Latin diagnoses (for new taxa - not indented).

(4) *Typus:* (for new taxa - not indented).

(5) English description (indented).

(6) *Other specimens examined* or *Selected specimens examined.*

(7) *Distribution.*

(8) *Habitat.*

(9) *Phenology* or *Flowering period.*

(10) *Conservation status.* Department of Conservation and Land Management Conservation Codes for Declared Rare and Priority Flora should be cited for any endangered or rare Western Australian plants.

(11) *Etymology.*

(12) *Typification.*

(13) *Affinities.*

(14) *Notes* or *Discussion* or *Comments.*

*Threatened species.* The Department of Conservation and Land Management has a policy not to publish precise locality data for threatened species. When describing threatened taxa authors are therefore requested to use generalized localities accompanied by the bracketed statement [precise locality withheld].

*Standard abbreviations.* When abbreviations are used, the following standards should be followed.

(1) Author abbreviations. Follow Brummitt, R.K. & Powell, C.E. (1992). "Authors of Plant Names." (Royal Botanic Gardens: Kew.).

(2) Book titles. These should not be abbreviated in the references but any literature citations in the text should follow Green, J.W. (1985). "Census of the Vascular Plants of Western Australia." Edn 2. pp. 20-24. (Department of Agriculture: Perth.). A more complete list of book title abbreviations is given in Stafleu, F.A. & Cowan, R.S. (1976-83). "Taxonomic Literature." Edn 2. (Bohn, Scheltema & Holkema: Utrecht.), but capital initial letters need to be used in *Nuytsia.*

(3) Journal titles. Follow Lawrence, G.H.M. *et al.* (1968). "B-P-H. Botanico-Periodicum-Huntianum." (Hunt Botanical Library: Pittsburgh.)

(4) Dates and directions. Generally should not be abbreviated except under the *Specimens examined* section. In that section, dates should be written in full only if they have less than five letters (e.g. July), otherwise should be shortened to the first three letters and a stop (e.g. Oct.), while compass directions should be abbreviated to capital letters with no stops (e.g. N and SSW).

(5) Other abbreviations. Standard abbreviations for measurements (e.g. mm), Latin abbreviations (e.g. *c.*, *nom. illeg.*), mountains and roads (e.g. Mt Koscuisko, Brooke Rd) are used in *Nuytsia.* Other abbreviations, especially ones that are ambiguous (e.g. Pt), should be avoided.

*Figures.* Numbers should follow a single sequence including maps.

*References.* Citation of references in the text should give the author's surname and date (e.g. Smith 1963) and full details should be given in the reference section. This format is also recommended to replace the traditional abbreviations for references listed under taxonomic names, for example using Benth. (Bentham 1878: 234) rather than Benth., Fl. Austral. 7: 234 (1878).