JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 10 1987

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 10 Part 1

13 March, 1987

Instructions to Authors

Topics

Papers will be accepted in the following categories:
(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

Copy

Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of generic or lower rank must be underlined.

The print area for illustrations is 18 x 13 cm (excluding captions). Half-tone material should be submitted this size if possible, but will be reduced by the printers, if necessary.

Reprints

50 copies of reprints will be provided for each paper. Additional reprints may be purchased at cost.

Layout

The pattern of the paper should generally be:
(i) Title; (ii) Author and Address; (iii) Abstract (except for short papers); (iv) Introduction and subject matter; (v) Acknowledgements; (vii) References.

References

Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

Text references to specimens should be italicized, for example *Kock 276.*

Indices

When required, follow the pattern on, for example, p. 106 of vol. 1, pt. 2.

Recommendations on taxonomic papers

Synonymy

Authors are requested to include in the synonymy only references to publications containing information additional to that to be published in the paper being submitted. Within this section journal and book titles must be consistently abbreviated. B-P-H journal abbreviations and book titles abbreviated in a similar way are desirable. Authors of references cited in the synonymy should preferably be abbreviated according to the 'Index of Author Abbreviations' compiled and published by Royal Botanic Gardens, Kew (1980). References may be cited as:

Benth., *Fl. Austral.* 4: 111 (1868) OR

Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

All correspondence concerning the journal should be addressed to:

The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

ISSN 0313-4083

J. Adelaide Bot. Gard. 10(1): 1-30 (1987)

A TAXONOMIC REVISION OF THE AUSTRALIAN SPECIES OF *HYPOLEPIS*

P.J. Brownsey

National Museum of New Zealand,
Private Bag, Wellington, New Zealand

and

R.J. Chinnock

State Herbarium, Botanic Gardens, North Terrace,
Adelaide, South Australia 5000

Abstract

Eight species and two hybrid combinations within the fern genus *Hypolepis* Bernh. are recognised in Australia (including Norfolk Island and Lord Howe Island). The name *H. punctata* (Thunb.) Mett. ex Kuhn is shown to have been misapplied, and material previously referred to this species is described as *H. glandulifera*, sp. nov. Two species, *H. muelleri* and *H. rugosula*, are regarded as endemic. Three species, *H. dicksonioides*, *H. distans* and *H. amaurorachis*, are shared with New Zealand; *H. amaurorachis* is shown to be an earlier name for both *H. australis* and the recently described *H. subantarctica*. Two species, *H. elegans* and *H. glandulifera*, extend into the Pacific but not to New Zealand, and one, *H. tenuifolia*, has a wide distribution in the Indo-Malesian region. Chromosome numbers are newly reported for four species, including n = 49 in *H. muelleri*, a number not previously recorded in the genus.

Introduction

This paper forms part of an ongoing revision of *Hypolepis* in the Old World. Brownsey (1983) published some observations on the cytological evolution of the genus as a whole together with some ideas on the relationships of the dennstaedtioid ferns. This was followed by a taxonomic revision of the New Zealand species of *Hypolepis* (Brownsey & Chinnock, 1984). The present paper deals with species in Australia, and a subsequent paper will treat those of Malesia and the Pacific.

A review of the existing literature on *Hypolepis* and the treatment of the genus since it was first established by Bernhardi in 1805 have already been provided by Brownsey & Chinnock (1984). That publication also indicated the important taxonomic characters for distinguishing *Hypolepis* from related genera, and for delimiting individual species.

In Australia, just three species were recognised until the 1940s — *H. punctata*, *H. rugosula* and *H. tenuifolia* (Bentham, 1878; Bailey, 1902), of which only *H. rugosula* was actually described from this country (Labillardière, 1806 — as *Polypodium rugosulum*). However, the true diversity of *Hypolepis* in Australia became more apparent with the description of two new species, *H. muelleri* and *H. australis*, and the re-definition of *H. rugosula*, by Wakefield (1943, 1955, 1956). A sixth species was added when Chinnock (1976) reported the occurrence on King Island, Tasmania, of *H. distans*, a species previously thought to be endemic to New Zealand. Brownsey & Chinnock (1984) accepted *H. dicksonioides*, a taxon first described from Norfolk Island by Endlicher (1833) as *Cheilanthes dicksonioides*, but not generally recognised by subsequent authors. In the present paper, the validity of *H. elegans*, first described by Carruthers (in Seemann, 1873) from Fiji, New Hebrides and Lord Howe Island, is also accepted and plants previously referred to *H. punctata* are distinguished as a new species, *H. glandulifera*. *Hypolepis amaurorachis* is shown to be an earlier name for both *H. australis* and the recently described *H. subantarctica* from New Zealand. In all, seven species are recognised from the eastern States of Australia, with one extending to Norfolk Island and another to Lord Howe Island; the eighth species is confined to Norfolk Island. Only *H. muelleri* and *H. rugosula* are thought to be endemic to the Australian region.

A summary of the critical characters for distinguishing the species is given in Table 1.

Materials and Methods

This revision of Australian species of *Hypolepis* is based on examination of over 1000 herbarium sheets together with field observations in several different parts of the country. Morphological measurements and distribution maps are based on material in AD, BRI, CANB, HO, MEL, NSW, PERTH and WELT. Only selected lists of material examined are given, but sheets in the above herbaria have been appropriately annotated. Selected material (mostly of type status) from B, BM, CHR, E, FI, K, and W has also been examined.

Measurements given here for all characters (except spores) indicate the full size range observed in the above material; figures in brackets indicate exceptional values found in odd specimens. The figures relating to spores are measurements of the exospore made from spores mounted in gum chloral. The approximate range of mean values to the nearest 1 μm (based on a sample of 20 spores) for a specified number of collections is given for each species, the figures in brackets indicating the extreme sizes of individual spores.

Meiotic chromosome preparations were obtained by fixing young sporangia and staining according to the method described by Manton (1950, pp. 295-296). Material which has been examined cytologically is listed immediately after the chromosome number. Voucher specimens are deposited in WELT.

Frond shape has been illustrated by silhouettes made from dried specimens, and pinnules and hairs by *camera lucida* drawings of lightly pressed specimens. Photographs of spores were taken on an ETEC Autoscan Scanning Electron Microscope.

Herbarium abbreviations follow Holmgren et al. (1981); author abbreviations are those proposed by Kew (Halliday et al., 1980); serials are abbreviated according to Botanico Periodicum Huntianum and monographs according to Stafleu & Cowan (1976-1985).

HYPOLEPIS

Hypolepis Bernh., Neues J. Bot. (1 (2): 34 (1805).

Type species: *Hypolepis tenuifolia* (Forst. f.) Bernh. ex C. Presl, Tent. Pterid. 162 (1836).

Diagnosis

Terrestrial ferns; rhizomes long-creeping, solenostelic; fronds often large, bipinnate or more compound; veins free; scales absent; hairs present on at least some part of lamina, rachis, stipe or rhizome, often abundant, glandular or non glandular, sometimes modified on stipe and rachis into recurved spines; sorus ± round, ranging in position from marginal and terminal on a vein to submarginal and not quite terminating the vein; indusium a reflexed laminal flap, sometimes well-developed protecting the marginal sorus, more usually only partially reflexed, occasionally totally lacking in species with submarginal sori; spores monolete; chromosome number n = 28, 29, (39?), 49, 52, 98, 104 (Brownsey 1983).

	H. distans	*H. amaurorachis*	*H. rugosula*	*H. muelleri*	*H. glandulifera*	*H. elegans*	*H. dicksonioides*	*H. tenuifolia*
Stipe diameter	0.7-1 mm	1-3.5 mm	2-5 mm	1.5-5 mm	3-10 mm	4-8 mm	(2) 5-15 mm	3.5-10 mm
Colour of stipe and rachis	Red-brown almost to apex	Mostly dark red-brown, becoming green near apex	Mostly red-brown, becoming yellow-brown near apex	Red-brown at very base, but mostly yellow-brown	Chestnut-brown at base, but mostly yellow-brown	Dark chestnut-brown below, becoming yellow-brown or green near apex	Dark chestnut-brown below, becoming yellow-brown or green near apex	Dark chestnut-brown below, becoming yellow-brown or green at apex
Hairs on upper stipe and rachis	Almost glabrous, a few scattered pale brown hairs	Abundant, colourless and pale brown, glandular hairs (to 2 mm)	Abundant, colourless and red-brown, glandular and non-glandular hairs (to 2 mm)	Sparse colourless and red-brown, non glandular hairs (to 1 mm)	Dense, fine, colourless and brown-tinged, glandular and non-glandular hairs (to 1 mm)	Abundant, colourless and brown-tinged, non-glandular hairs (to 1 mm)	Abundant, colourless, glandular and non-glandular hairs (to 5 mm)	Abundant, colourless, glandular and non-glandular hairs (to 5 mm)
Lamina	2-(3)-pinnate Narrowly elliptic to ovate (15)25-35 x 9-12 cm	2-3-pinnate Narrowly ovate to ovate 15-55 x 10-35 cm	2-3(4)-pinnate Ovate to broadly elliptic 35-115 x 20-60 cm	1-3-pinnate Rhombic to broadly ovate 20-100 x 15-70 cm	2-4-pinnate Broadly ovate or broader than long 45-180 x 40-150 cm	2-4(5)-pinnate Broadly ovate or broader than long 40-100 x 45-80 cm	2-4(5)-pinnate Broadly ovate to broadly elliptic (20)35-135 x (15) 35-110 cm	2-4(5)-pinnate Broadly ovate to broadly elliptic 25-200 x 28-140 cm
Hairs on underside of lamina	Virtually glabrous	Dense, colourless, glandular and non-glandular hairs on margins and all surfaces, 0.3-0.7(1) mm	Abundant, colourless and red-brown, glandular and non-glandular hairs on veins and midribs, 0.3-1 mm	Abundant, colourless, stiff, slightly curved, non-glandular hairs on veins and midribs, 0.3-0.8 mm	Dense, fine, colourless and brown-tinged, glandular and non-glandular hairs on all surfaces, 0.1-1 mm	Abundant, colourless and brown-tinged, stiff, curved, sharply pointed, non-glandular hairs on veins and midribs, to 1 mm	Abundant, colourless, glandular and non-glandular hairs on veins and midribs, 0.2-1(1.5) mm	Dense, fine, colourless, glandular and non-glandular hairs, 0.1-0.8(1) mm
Soral hairs	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent
Soral protection	Reflexed, incised membranous flap	Slightly reflexed, green laminal flap with a few short hairs	Unprotected, or with slightly reflexed, green laminal flap with a few short hairs	Unprotected	Unprotected, or with slightly reflexed, green laminal flap	Well-developed, reflexed, membranous flap	Well-developed, reflexed, incised, tapering, mostly green flap often bearing a few glandular hairs on margin	Well-developed, reflexed, incised, broad, membranous flap sometimes bearing a few glandular hairs on upper surface
Spore size	(34)37-38(43) x (21)24-25(27) μm	(29)32-34(38) x (18)20-22(26) μm	(34)37-40(42) x (21)24-27(29) μm	(29)31-34(37) x (18)20-23(25) μm	(31)33-35(37) x (20)21-26(29) μm	(24)26-28(31) x (16)17-19(21) μm	(36)38-40(44) x (20)24-26(28) μm	(30)33-36(39) x (17)20-23(25) μm
Chromosome number	n = 28 (in N.Z.)	n = 52 (in N.Z.)	n = c. 104	n = 49	n = 52	Unknown	n = 104 (in N.Z.)	n = 52

Table 1. Summary of the most important characters for distinguishing Australian species of *Hypolepis*.

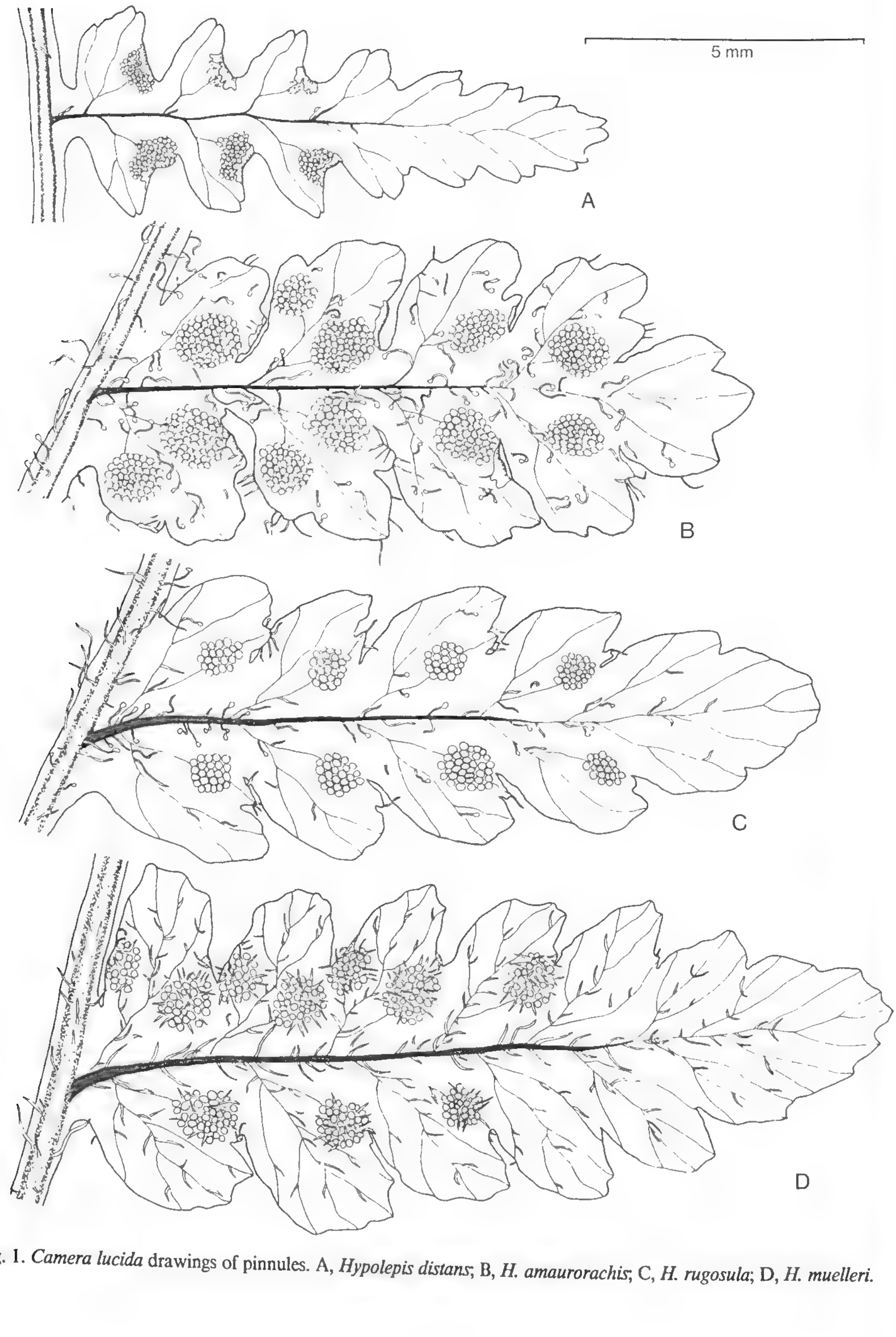


Fig. 1. *Camera lucida* drawings of pinnules. A, *Hypolepis distans*; B, *H. amaurorachis*; C, *H. rugosula*; D, *H. muelleri*.

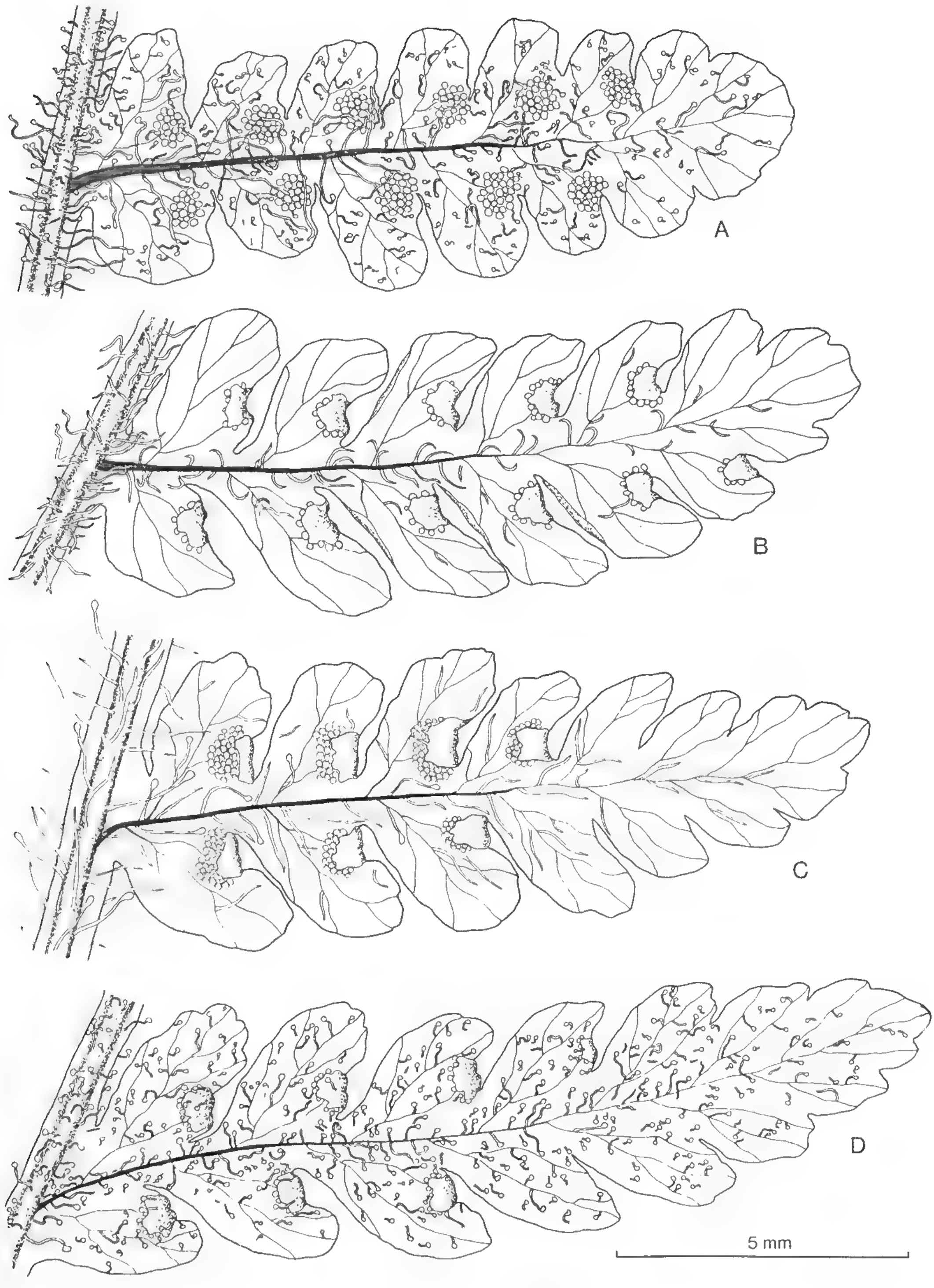


Fig. 2. *Camera lucida* drawings of pinnules. A, *Hypolepis glandulifera*; B, *H. elegans*; C, *H. dicksonioides*; D, *H. tenuifolia*.

Key to Australian species of *Hypolepis*

1. Veins of ultimate pinnules reaching margin at a small sinus (Fig. 1A); lowest pair of primary pinnae arising at c. 90° to rachis, bearing secondary pinnae of approximately equal length .... 1. *H. distans*

Veins of ultimate pinnules never ending in a sinus (Figs 1B-D, 2A-D); lowest pair of primary pinnae arising at 20-80° to rachis, bearing secondary pinnae which decrease markedly in length along the primary pinnae *2*

2. Sporangia protected by well-developed, reflexed, at least partially membranous indusium *3*

Sporangia unprotected, or protected only by a slightly reflexed, green segment of the lamina *5*

3. Glandular hairs absent from frond .... 6. *H. elegans*

Glandular hairs abundant on frond *4*

4. Hairs on lamina undersurface fine, 0.1-1 mm long; indusial flap mostly membranous, broad, sometimes bearing glandular hairs on upper surface; spores 33-36 x 20-23 μm .... 8. *H. tenuifolia*

Hairs on lamina undersurface stouter, 0.2-1.5 mm long; indusial flap mostly green, tapering, often bearing glandular hairs on margin; spores 38-40 x 24-26 μm .... 7. *H. dicksonioides*

5. Hairs present in sorus; glandular hairs always absent from frond .... 4. *H. muelleri*

Hairs absent from sorus; glandular hairs usually present on frond *6*

6. Stipes mostly yellow-brown, 3-10 mm diameter; laminae quadripinnate, 45-180 x 40-150 cm, densely covered in fine colourless hairs (Fig. 8) .... 5. *H. glandulifera*

Stipes mostly red-brown, 1-5 mm diameter; laminae tripinnate (rarely quadripinnate), 15-115 x 10-60 cm, more sparsely covered in stout, colourless or red-brown hairs (Figs 3B, 5) *7*

7. Laminae 15-55 x 10-35 cm, bearing mostly colourless hairs on underside; spores 32-34 x 20-22 μm .... 2. *H. amaurorachis*

Laminae 35-115 x 20-60 μm, bearing both colourless and red-brown hairs on underside; spores 37-40 x 24-27 μm .... 3. *H. rugosula*

1. **Hypolepis distans** Hook., Sp. Fil. 2: 70, t. 95c (1852).

Lectotype: *W. Colenso 1782*, [Hutt Valley, New Zealand], no date (K; chosen by Brownsey & Chinnock 1984).

Description (Figs 1A, 3A, 13A)

Rhizome long-creeping, 1-2.5 mm diameter, abundantly covered in dark red-brown hairs 2-3.5 mm long. *Stipes* 5-10 cm long, 0.7-1 mm diameter, dark red-brown, bearing a few scattered red-brown hairs at base. *Laminae* narrowly elliptic to elliptic or ovate, (15-) 25-35 x 9-12 cm, rather stiff and harsh to the touch, bipinnate at apex to almost tripinnate at base. Rachises dark red-brown, becoming paler only at the very apex, bearing scattered pale brown non-glandular hairs. *Primary pinnae* in 20-40 pairs, opposite or subopposite, arising at c. 90° to rachis, the longest at or below middle 5-7 x 1.7-2.5 cm, narrowly ovate or triangular, midrib narrowly winged throughout; lowest pair orientated at 90° to plane of frond in largest specimens. *Secondary pinnae* sessile or shortly stalked, ovate to narrowly ovate, the longest 0.8-1.3 x 0.4-0.5 cm, doubly serrate with 3-9 primary serrations on each side of longest secondary pinna; those on lower primary pinnae ± equal in length, only decreasing in size towards the very apex of each pinna. *Veins* reaching margin at a sinus (emarginate). Hairs virtually absent on upper surface of frond, a few scattered pale-brown non-glandular hairs on underside of lamina veins and pinna midribs. *Sori* ± ovate, marginal, protected by reflexed incised membranous flaps, lacking hairs amongst sporangia. *Spores* appearing dark brown under light microscope with reticulate perispores lacking obvious projections, (34-) 37-38 (-43) x (21-) 24-25 (-27) μm (1 population).

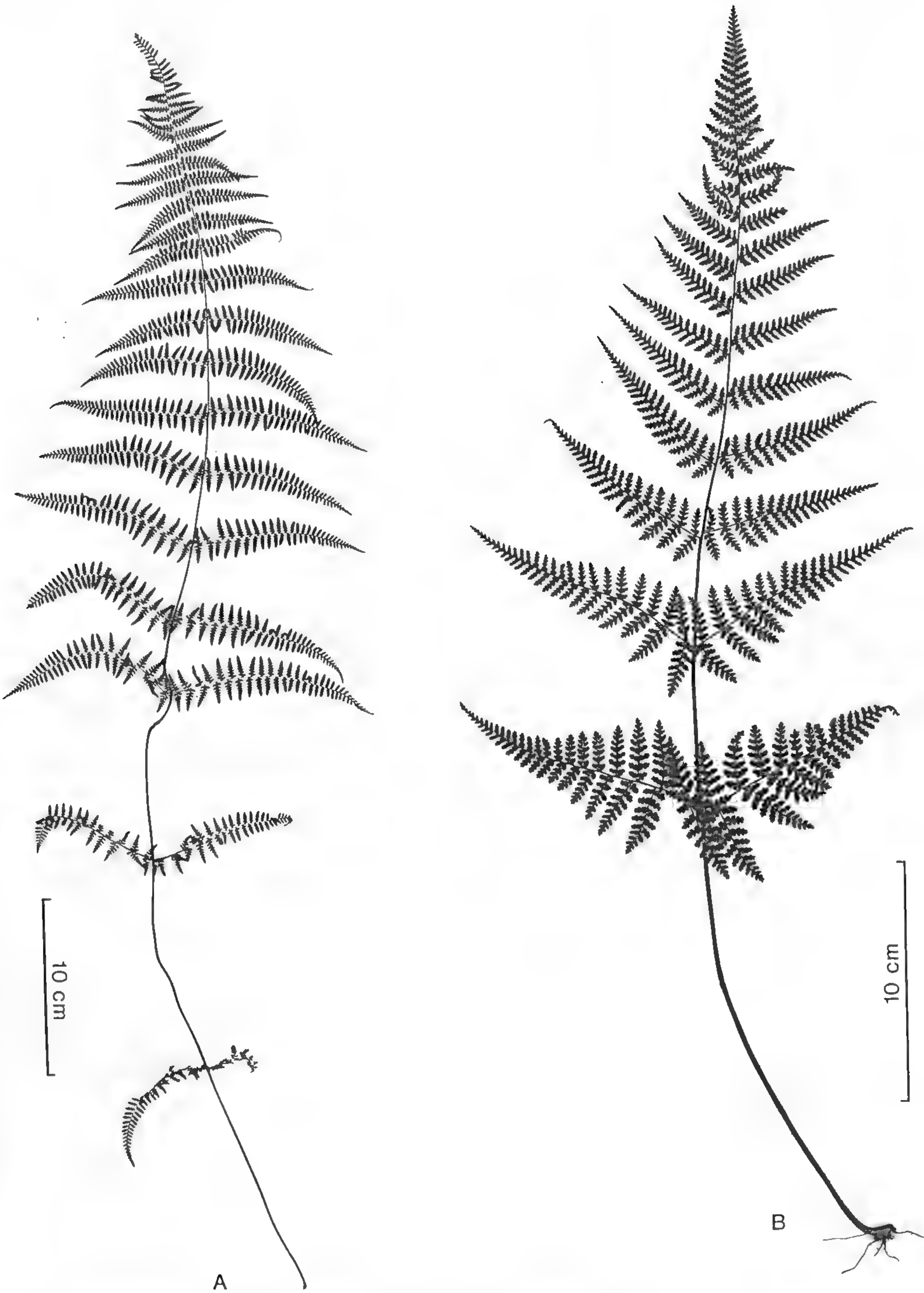


Fig. 3. Silhouettes of fronds of A, *Hypolepis distans* (x¼) and B, *H. amaurorachis* (x$^1/_3$).

Chromosome number

No chromosome number has been obtained from Australian material, but Brownsey & Chinnock (1984) recorded n = 28 in 5 populations from New Zealand, the evolutionary significance of which is discussed fully by Brownsey (1983). The larger size of the spores in Australian as compared with New Zealand material (37-38 x 24-25 μm cf. 31-34 x 19-21 μm) suggests the possibility of a higher chromosome number which should be investigated.

Distribution (Fig. 4)

In Australia, this species is known only from scattered localities in the north-east of King Island, from where it was first recorded by Chinnock (1976). It occurs also in New Zealand and the Chatham Islands (Brownsey & Chinnock, 1984).

Specimen examined

TASMANIA: *P.F. Barnett s.n.*, King Is., 4 km S of Penny's Lagoon, iv. 1973 (AD 97529194, MEL 77350, NSW P10101).

Ecology

On King Island, *H. distans* grows under *Melaleuca squarrosa/Leptospermum scoparium* scrubland bordering swampy ground, usually in organic material at the base of *Todea barbara* and *Restio tetraphyllus*. This habitat is comparable to that in New Zealand where it grows on humus or decomposing logs.

Notes

Hypolepis distans can be distinguished immediately from all other species by its relatively long, narrow frond, the pinnae arising in opposite or subopposite pairs at right angles to the rachis, the veins ending in emarginations (Fig. 1A), the thin, highly polished, rather brittle stipe and the dark brown spores with virtually no perispore projections (Fig. 13A).

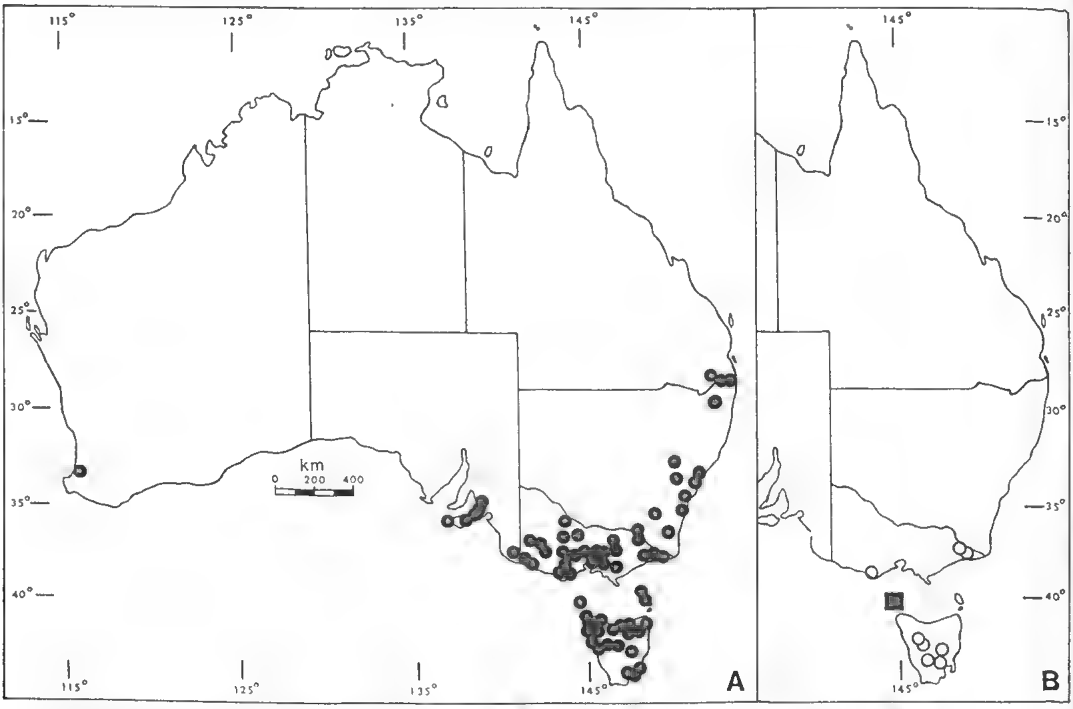


Fig. 4. Australian distributions of A, *Hypolepis rugosula* ●; B, *H. amaurorachis* ○ and *H. distans* ■.

2. **Hypolepis amaurorachis** (Kunze) Hook., Sp. Fil. 2:62 (1852).

Cheilanthes amaurorachis Kunze, Linnaea 23: 242, 306 (1850).

Lectotype: *G. Kunze s.n.*, Hort. Lips. ex Tasmania (B 74521, here chosen).

Hypolepis australis Wakef., Victorian Naturalist 72: 95 (1955).

Holotype: *N.A. Wakefield 107*, Arte R., Victoria, Australia, 23.iii. 1941 (MEL 1512588).

Hypolepis subantarctica Brownsey et Chinnock, New Zealand J. Bot. 22: 57 (1984).

Holotype: *D.R. Given s.n.*, Campbell Is., New Zealand, cultivated at CHR as G11407 (WELT P11518; isotypes AK, CHR).

Description (Figs 1B, 3B, 13B)

Rhizome long-creeping, 2-2.5 mm diameter, covered in red-brown hairs. *Stipes* 7-23 (-45) cm long, 1-3.5 mm diameter, dark red brown, bearing abundant colourless or pale brown glandular hairs up to 2 mm long. *Laminae* narrowly ovate to ovate, 15-55 x 10-35 cm, bipinnate at apex, tripinnate at base. *Rachises* dark red-brown at base becoming paler above and often green at apex, densely covered in colourless or pale-brown glandular hairs up to 1.5 mm long. *Primary pinnae* in 15-30 pairs + pinnatifid apex, opposite or alternate, the longest below the middle 5-20 x 2-9 cm; upper ones parallel-sided or narrowly ovate, lower ones ovate or narrowly ovate. *Secondary pinnae* ovate to ± parallel-sided, the longest 0.5-4.5 x 1-2 cm, those on the lower primary pinnae decreasing markedly in length along the pinnae. *Tertiary pinnae* up to 0.6 x 1 cm, deeply incised on larger specimens, bearing 1-3 pairs of sori. *Veins* reaching margin at a tooth apex. *Hairs:* colourless glandular hairs (0.3-0.7 mm on laminae, up to 1 mm on midribs) interspersed with a few bristly colourless hairs densely covering both surfaces of lamina, lamina margins, and pinna midribs and costae. *Sori* round, originating away from margin, protected by partially reflexed lamina segments which often bear a few short hairs, lacking hairs amongst sporangia. *Spores* very pale under light microscope, perispores of inter-connecting flattened projections, (29-) 32-34 (-38) x (18-) 20-22 (-26) μm (7 populations).

Chromosome number

No chromosome number has been obtained from Australian material, but Brownsey & Chinnock (1984) recorded n = 52 from one population of this species (as *H. subantarctica*) from Campbell Island, New Zealand.

Distribution (Fig. 4)

Southern Victoria, Tasmania.

Outside Australia, this species occurs only in New Zealand in Fiordland, and on Auckland and Campbell Islands (Brownsey & Chinnock, 1984).

Representative specimens (18 specimens seen)

VICTORIA: *A.C. Beauglehole 41125*, Gable End, 4 km SW of Mt Wellington, 8.i.1973 (AD, MEL); *W. Forsyth s.n.*, Bonang, v.1908 (NSW P10051); *N.A. Wakefield 4865*, Reedy R., East Gippsland, 14.i.1959 (MEL); *N.A. Wakefield & J.H. Willis s.n.*, Upper Calder R., Otway Ranges, 19.xi.1955 (NSW P10099).

TASMANIA: *P.J. Brownsey s.n.*, Myrtle Forest Gully, Mt Wellington, 3.viii. 1981 (WELT P12245); *P.J. Brownsey s.n.*, Betts Falls Track, Mt Wellington, 3.viii.1981 (WELT P12246); *A.M. Gray s.n.*, Godkin Ridge, Cleveland Track, SE of Luina, 21.vii.1979 (HO 31126); *A.M. Gray s.n.*, L. King William, Guelph Basin, 19.vii.1975 (HO 27402); *J. Somerville s.n.*, Surprise V., nr Mt Arrowsmith, 14.i.1941 (HO 1151); *Stuart s.n.*, Mt d'Laperouse, 1.iii.1857 (MEL 1512585-6).

Ecology

Hypolepis amaurorachis is an uncommon species in Australia, as it also is in New Zealand, being confined to cool upland streambeds and wet forest situations in southern Victoria and Tasmania. It grows on damp ground, on rotten logs and occasionally in moist rock crevices, usually as scattered individual plants. It has been recorded at an altitude up to 750 m.

Notes

Hypolepis amaurorachis can be distinguished from most other species by its red-brown stipe and rachis, abundant glandular hairs and absence of both soral hairs and a well-developed indusium. However, it is very closely related to *H. rugosula* and distinguished only by its smaller frond (15-55 x 10-35 cm cf. 35-115 x 25-60 cm), more densely hairy laminae, mostly colourless hairs, more finely dissected pinnae and smaller spores (32-34 x 21-22 *µm* cf. 37-40 x 24-27 *µm*). The difference in spore size almost certainly reflects a difference in chromosome number, but this has yet to be determined conclusively in Australian material. New Zealand material of *H. amaurorachis* is tetraploid with n = 52, whilst Australian *H. rugosula* is octoploid with n = c. 104.

The two species have somewhat different habitats, *H. amaurorachis* being confined to cool, wet, forest situations, whereas *H. rugosula* is often found in more open places. Nevertheless, in parts of Tasmania and Victoria the two occur together in several localities where they probably hybridise, although this remains to be confirmed.

Hypolepis amaurorachis has until now been known in Australia as *H. australis*, a name first used by Wakefield (1955). However, the taxon was actually first described as *Cheilanthes amaurorachis* by Kunze (1850) from material in cultivation at Leipzig originally collected in Tasmania. Hooker (1858) transferred the species to the genus *Hypolepis* but, since then, the name has been almost completely ignored by Australian botanists. The original description from cultivated material was not entirely adequate, and the destruction of Kunze's herbarium at LZ left little chance for modern botanists to trace the attribution of the name. However, very recently, an authentic specimen comprising two fronds has been located at B (photo WELT). The morphology and spore size indicate clearly that the two fronds belong to the species previously known as *H. australis*, and not to the more widespread *H. rugosula*, as might have been expected. Their Tasmanian origin is consistent with this finding. Since the name *H. amaurorachis* predates *H. australis* by almost a century it must take precedence. The recently described *H. subantarctica* from New Zealand (Brownsey & Chinnock, 1984) must also be reduced to synonymy, being in every way identical to the Australian plant.

3. **Hypolepis rugosula** (Labill.) J. Smith, Comp. Bot. Mag. New Ser. 2: 8 (1846) as "rugulosa". — *Polypodium rugosulum* Labill., Nov. Holl. P1. 2: 92, t. 241 (1807). — *Phegopteris rugosula* (Labill.) Fée, Gen. Fil. 243 (1852). — *Polypodium punctatum* var. *rugosulum* (Labill.) Hook. et Baker, Syn. Fil. 312 (1868) as "rugulosum". — *Dryopteris punctata* subsp. *rugosula* (Labill.) C. Chr., Ind. Fil. 287 (1905). — *Dryopteris punctata* var. *rugosula* (Labill.) Domin, Biblioth. Bot. 85: 41 (1913).

Lectotype: J.J. Labillardière s.n., [van Diemen's Land], no date (FI, here chosen).

Description (Figs 1C, 5, 13C)

Rhizome long-creeping, 2-3 mm diameter, densely covered in red-brown hairs up to 2 mm long. *Stipes* 10-95 cm long, 2-5 mm diameter, red brown at base, chestnut-brown above, covered at base in red-brown hairs similar to those of rhizome, sparsely hairy above, slightly rough. *Laminae* ovate, broadly ovate or broadly elliptic, 35-115 x 20-60 cm, bipinnate at apex, tri- or quadripinnate at base. *Rachises* chestnut-brown at base, yellow-brown at apex, covered in colourless and red-brown non-glandular and usually also glandular hairs up to 1.5 mm long,

Fig. 5. Silhouette of a frond of *Hypolepis rugosula*.

densely so on upper surface. *Primary pinnae* in 20-30 pairs, opposite or subopposite, the longest at or near the base 13-55 x 5-25 cm, upper ones narrowly triangular or narrowly ovate, basal ones ovate. *Secondary pinnae* narrowly ovate or ovate, the longest 3-15 x 1.2-5 cm, those on the lower primary pinnae decreasing markedly in length along the midribs, the midribs narrowly winged. *Tertiary pinnae* ± parallel-sided, obtuse or acute, the longest 0.7-4 x 0.3-1.5 cm, divided on larger fronds almost to the midrib into quaternary pinnae up to 0.9 x 0.4 cm. *Veins* reaching margin at tooth apices. *Hairs:* colourless and red-brown non-glandular and usually also glandular hairs on underside of lamina veins and pinna midribs, 0.3-1 mm long, the red-brown hairs generally slightly longer than the colourless ones and more common on the midribs; similar but denser hairs on the upper surfaces; short non-glandular hairs sometimes present on the lamina margins adjacent to sori, but otherwise usually absent. *Sori* round, originating away from margin, unprotected or protected only by partially reflexed lamina segments, lacking hairs amongst sporangia. *Spores* very pale under light microscope, perispores of flattened inter-connecting projections, (34-) 37-40 (-42) x (21-) 24-27 (-29) μm (7 populations).

Chromosome number

n = c.104 (Fig. 14D)

P.J. Brownsey s.n., Aire R., Otway Range, Victoria, 5.x.1985 (WELT P13649).

Distribution (Fig. 4)

Western Australia, South Australia, southern Queensland, New South Wales, Victoria and Tasmania.

Endemic; possibly introduced to Western Australia from the eastern States.

New Zealand plants referred to *H. rugosula* by Allan (1961) belong to one of three species, *H. rufobarbata* (Col.) Wakef., *H. lactea* Brownsey & Chinnock and *H. amaurorachis*, or to the hybrid *H. ambigua* × *rufobarbata* (Brownsey & Chinnock 1984, p. 72).

Representative specimens (131 specimens seen)

WESTERN AUSTRALIA: *A.R. Annels s.n.*, Parwill Well, W of Manjimup, viii. 1982 (PERTH).

SOUTH AUSTRALIA: *R. Bates 2650*, 3 km NE of Marshes Swamp, Glencoe, 6.iii. 1977 (AD); *P.J. Brownsey s.n.*, nr Mt Compass, S of Adelaide, 30.vii.1981 (WELT P12242); *R. Schodde 528*, Kangaroo Is., 8 km E of Cape Borda, 29.xii.1957 (CANB, AD); *I.B. Wilson 1002*, Mt Edward, 5.ix.1969 (AD).

QUEENSLAND: *P. Grimshaw s.n.*, South Bald Rock, Girraween Nat. Park, 28.v.1978 (BRI 339960-1); *J. Shirley s.n.*, Roberts Plateau (BRI 114678); *C.T. White s.n.*, MacPherson Range, xii.1918 (BRI 114683, NSW P4234).

NEW SOUTH WALES: *E.F. Constable s.n.*, Mt Tambo Limb, 12.xii.1948 (NSW P5608); *E.F. Constable s.n.*, Mt Spirabo, 20 km SSE of Tenterfield, 7.v.1961; *R. Coveny 9190 & S.K. Roy*, below Govett's Leap, Blackheath, 15.iii.1977 (NSW); *M. Gray 5459*, Two Sticks Rd, Blue Range, 21.v.1964 (CANB); *N.A. Wakefield 179*, Wonboyn Rd, 11.i.1942 (MEL); *E. Yauba s.n.*, Devils Creek, 13.i.1950 (MEL 77351).

VICTORIA: *A.C. Beauglehole 38232*, Rosedale Shire, 5 miles SW of Gormandale, 16.iii.1972 (MEL); *A.C. Beauglehole 41430*, East Gippsland, Nunniong Plateau, Diggers Hole Track, 10.ii.1973 (MEL); *R.J. Chinnock P812*, Otway Range, Turtin's Track, 5km W of Hains Junction, 31.xii.1973 (MEL); *J.H. Willis s.n.*, Mt Buffalo Nat. Park, track to Monolith, 21.ii.1963 (MEL 47078, 50286); *J.H. Willis s.n.*, Smythesdale Forest, 20 km SW of Ballarat, 7.i.1974 (MEL 504735).

TASMANIA: *P.J. Brownsey s.n.*, Myrtle Forest Gully, Collinsvale, 3.viii.1981 (WELT P12243); *P.J. Brownsey s.n.*, Serpentine Dam, Gordon R. road, 6.viii.1981 (WELT P12244); *I.D. Cameron s.n.*, Tarra Ck, King Is., 6.iii.1966 (HO 27125-6); *R.J. Chinnock P984*, Mackintosh R., 1.4 km N of Tullah, 30.i.1974 (AD, HO); *D.I. Morris 7845*, Flowery Gully, Tamar, 30.xi.1978 (HO).

Ecology

Hypolepis rugosula is found most frequently in streambeds, damp gullies, along drainage ditches and in swampy ground, usually in clearings, forest margins or open situations, on soil or sometimes on rock. On disturbed soils or swampy ground it can form extensive colonies, but it is usually restricted to small patches. It grows at higher altitudes and produces fronds of smaller dimensions in the northern part of its range, and has been recorded up to 1400 m altitude.

Notes

Hypolepis rugosula can be distinguished from most other species by its red-brown stipe and rachis, absence of soral hairs and absence of a well-developed indusium. Normally it has colourless and red-brown glandular hairs on the underside of the laminae and costae, but sometimes these are very sparse or even replaced altogether by non-glandular hairs. In Australia, it can only be confused with *H. amaurorachis* whose characteristics are given above (p. 10). Its close relationship to the New Zealand *H. ambigua* has been discussed elsewhere (Brownsey & Chinnock, 1984, p. 72).

4. **Hypolepis muelleri** Wakef., Victorian Naturalist 60: 42, t. 2 (1943).

Holotype: *N.A. Wakefield 114*, Mt Drummer, East Gippsland, Victoria, Australia (MEL 1511490-1).

Description (Figs 1D, 6, 13D)

Rhizome subterranean, long-creeping, 1.5-5 mm diameter, sparsely covered in red-brown hairs up to 1 mm long. *Stipes* 12-80 (-100) cm long, 1.5-5 mm diameter, red-brown at very base, yellow-brown above, covered in red-brown hairs similar to those of rhizome at base, ± glabrous above, smooth, often producing roots at base. *Laminae* rhombic, ovate or broadly ovate, 20-100 (-150) x 15-70 cm, pinnate at apex, tripinnate to almost quadripinnate below, generally rather coriaceous. *Rachises* yellow-brown throughout, sparsely covered in colourless or red-brown non-glandular hairs up to 1 mm long. *Primary pinnae* in 15-30 pairs, opposite or subopposite, the longest at or near the base 13-45 x 6.5-28 cm, upper ones narrowly triangular, basal ones triangular to broadly triangular. *Secondary pinnae* narrowly ovate or ± parallel-sided, often with midribs narrowly winged, the longest 3.5-15 x 1.2-5 cm, those on the lower primary pinnae decreasing markedly in length along the midribs. *Tertiary pinnae* ovate or ± parallel-sided, obtuse to acute, the longest 0.6-2.5 x 0.3-1 cm. *Veins* reaching margin at tooth apices. *Hairs:* glistening, colourless, or sometimes brown-tinged, non-glandular, stiff, often slightly curved, on underside of lamina veins and pinna midribs, 0.3-0.8 mm long; similar, but generally slightly shorter hairs also on upper surfaces; occasional very short hairs present on lamina margins, but usually absent. *Sori* round, often absent from lower 2 pairs of pinnae, originating away from margin, unprotected, short hairs (0.2-0.5 mm long) intermixed with sporangia. *Spores* very pale under light microscope, perispores of inter-connecting flattened projections, (29-) 31-34 (-37) x (18-) 20-23 (-25) μm (6 populations).

Chromosome number

n = 49 (Fig. 14A)

R.J. Chinnock 5851 & P.J. Brownsey, nr Pomona, 1 km E of Bruce Highway, Queensland, 19.x.1982 (WELT P11639, AD 98304275).

A chromosome number of n = 49 has not previously been reported in *Hypolepis,* but is not totally unexpected since n = 98 has been consistently recorded for Japanese material of *H. punctata* (Kurita, 1967, 1972; Mitui, 1975, 1976). Kurita (1972) also reported n = 98 in an unknown species cultivated in the Koishikawa Botanical Garden, reputedly of Australian origin. The occurrence of n = 49 and n = 98 is evidence of another aneuploid line within *Hypolepis,* this one presumably being derived from species with n = 52. Brownsey (1983) has already demonstrated one aneuploid line linking American *H. nigrescens* (n = 29) and Australasian *H. distans* (n = 28) to a probable base number of n = 26 in the genus.

Fig. 6. Silhouette of a frond of *Hypolepis muelleri*.

It is evident from Figure 14A that some bivalents in *H. muelleri* are considerably bigger than the others, suggesting that reduction in chromosome number may have resulted from chromosomal fusion.

Distribution (Fig. 7)

Queensland, New South Wales, Victoria and north-western Tasmania.

Endemic.

Representative specimens (124 specimens seen)

QUEENSLAND: *M.S. Clemens s.n.*, Mt Coolum, Moreton District, iii.1945 (K); *D.A. Goy & L.S. Smith 632*, Stony Creek, nr Bundaberg, 2.i.1939 (BRI); *D.A. Goy & L.S. Smith 497*, Mt Glorious, Moreton District, 19.vi.1938 (BRI); *L.S. Smith 352*, Sunnybank, Moreton District, 15.ii.1938 (BRI); *N.A. Wakefield 408*, MacPhersons Ck, 26.vi.1942 (MEL).

NEW SOUTH WALES: *M.P. Austin 180*, Kioloa State Forest, c. 9 km NNE of Darras, 23.vii.1973 (CANB); *P.J. Brownsey & R.J. Chinnock s.n.*, Nerrigundah, W of Bodalla, 15.viii.1981 (WELT P12240); *P.J. Brownsey & R.J. Chinnock s.n.*, E. Kangaloon, nr Robertson, junction of Tourist Rd & Moresby Hill Rd, 16.viii.1981 (WELT P12239); *E.F. Constable s.n.*, Upper Cordeaux Dam, 2.v.1957 (NSW P7629); *M. Gray 5658*, Lane Cove Road, Lane Cove Nat. Park, 31.ii.1964 (CANB); *E. Yauba s.n.*, Devil's Creek, 13.i.1950 (NSW P10112).

VICTORIA: *P.J. Brownsey & R.J. Chinnock s.n.*, East Gippsland, Colquhoun State Forest, Torloo Arm Bridge, nr Nowa Nowa, 12.viii.1981 (WELT P12241); *F. Mueller s.n.*, banks of Latrobe, v.1853 (MEL 47058); *F. Mueller s.n.*, forests of Dandenong, ii.1875 (MEL 47063); *N.A. Wakefield 112*, Thurra R., 9.iii.1941 (MEL); *J.H. Willis s.n.*, East Gippsland, Wingan Inlet, nr Ram Head, 30.xii.1951 (MEL 47050).

TASMANIA: *P. Barnett s.n.*, King Is., NE of Mt Counsel, 4.v.1969 (MEL 77352); *M. Cameron s.n.*, Dinosaur Park, Launceston, 10.iii.1981 (HO 39669); *M. Garnett s.n.*, Tin Hut Creek, Fraser Road, WSW of Anson's Bay, 18.vi.1983 (HO 90018).

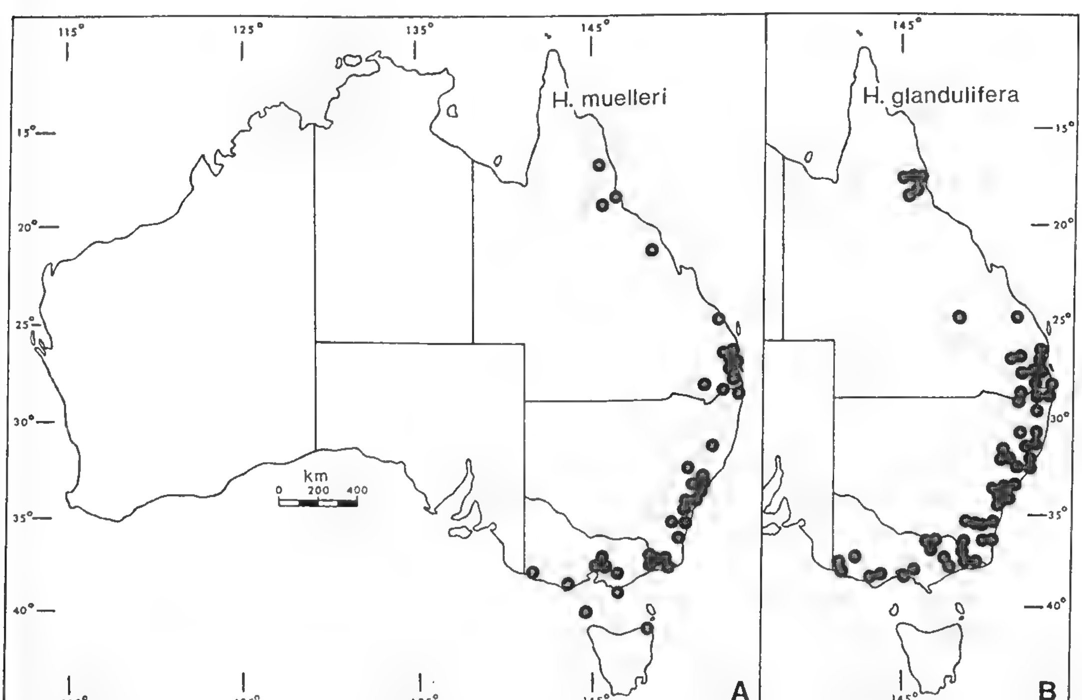


Fig. 7. Australian distributions of A, *Hypolepis muelleri* and B, *H. glandulifera*.

Ecology

Hypolepis muelleri frequently grows along creek banks and drainage channels on damp ground in otherwise rather dry, shaded sclerophyll forest. It also occurs on swampy ground in more open country, and often forms dense clumps or colonies in disturbed areas by virtue of its spreading habit. It has been recorded from sea-level to 850m.

Notes

Hypolepis muelleri is a very distinctive species with rather firm, harsh fronds, short, sharp, slightly curved, non-glandular hairs on the lamina under-surface, no indusium and, unlike any other Australian species, short non-glandular hairs amongst the sporangia in the sorus. This characteristic morphology is combined with the unusual chromosome number of n = 49 and may, in part, be the result of aneuploid evolution from the main *Hypolepis* line with n = 52. The relationship of *H. muelleri* to Japanese material of *H. punctata* with n = 98 obviously warrants further investigation.

5. **Hypolepis glandulifera** Brownsey et Chinnock, sp. nov.

Polypodium punctatum auctt. non Thunb. (1784): Benth., Fl. Austral. 7: 764 (1878); F.M. Bail., Queensland Fl. 1982 (1902).

Dryopteris punctata auct. non C. Chr. (1905): Domin, Biblioth. Bot. 85: 40 (1913).

Hypolepis punctata auctt. non Mett. ex Kuhn (1868): Wakef., Pap. Proc. Roy. Soc. Tasmania 91: 160 (1957); Willis, Handbk. Pl. Victoria 21 (1962, 1970); Tindale in Beadle et al., Fl. Sydney Region 64 (1972); Wakef., Ferns Victoria & Tasmania 27 (1975); Jones & Clemesha, Austral. Ferns & Fern Allies 198 (1976); *ibid* edn 2: 150 (1981).

Rhizoma subterraneum, repens, 4-8 mm diametro, pilis multis rufescentibus usque ad 0.5 mm longos. *Stipes* 40-120 cm longus, 3-10 mm diametro, basi castaneus, apice fulvus, basi pilis multis rufescentibus, apice pilis sparsis, leviter asper, saepe basi radicibus. *Lamina* late ovata vel latior quam longior, 45-180 x 40-150 cm, apice bipinnata, basi quadripinnata. *Rhachis* fulva, pilis multis tenuibus hyalinis vel ferrugineis glanduliferis setosisque usque ad 1 mm longos. *Pinnae primariae* 20-30- jugatae, oppositae vel suboppositae, longissimae prope basin repertae 24-65 x 10-48 cm, superiores anguste ovatae vel anguste triangulatae, infimae ovatae. *Pinnae secundariae* ± lineares, anguste ovatae vel anguste triangulatae, longissimae 6-25 x 2-11 cm. *Pinnae tertiariae* ± lineares, 1-6 x 0.4-2 cm. *Pinnae quaternariae* obtusae vel acutae, 0.1-1 cm longae, interdum profunde incisae. *Venae* marginem in apicibus dentium attingentes. *Paginae* inferiores venaeque laminarum pilis multis 0.1-1 mm longis tenuibus hyalinis glanduliferis, pilis sparsis setosis interspersis, dense vestitae; costae pinnarum pilis similaribus hyalinis ferrugineisque dense vestitae; paginae superiores praeter costas pilis similaribus sparsis vestitae; margines laminarum pilis rarissimis. *Sori* rotundi, in pinnulis ultimis, procul a margine exorientes, sine pilis, non obtecti vel reflexis pimularum marginibus partim obtecti. *Sporae* pallidae, perisporae projecturis complanatis interconnexis, (31-) 33-35 (-37) x (20-) 21-26 (-29) μm.

Holotype: *R.J. Chinnock 5646 & P.J. Brownsey*, Millaa Millaa Falls, NE of Millaa Millaa, Queensland, 10.x.1982 (WELT P11585; isotypes AD, CBG, NT).

Etymology

The specific epithet refers to the dense covering of fine, sticky, glandular hairs on the fronds of this plant.

Description (Figs 2A, 8, 13E)

Rhizome subterranean, long-creeping, 4-8 mm diameter, densely covered in a felt of soft red-brown hairs up to 0.5 mm long. *Stipes* 40-120 cm long, 3-10 mm diameter, chestnut-brown at base, yellow-brown above, densely covered in hairs similar to those of rhizome at base, sparsely hairy above, slightly rough, often producing roots at the very base. *Laminae* broadly ovate or slightly broader than long, 45-180 x 40-150 cm, bipinnate at apex, quadri-pinnate at base. *Rachises* yellow-brown throughout, densely covered in fine colourless or brown-tinged glandular and non-glandular hairs up to 1 mm long. *Primary pinnae* in 20-30

Fig. 8. Silhouette of a frond of *Hypolepis glandulifera*.

pairs, opposite or subopposite, the longest at or near the base 24-65 x 10-48 cm, upper ones narrowly ovate or narrowly triangular, the lower ones ovate. *Secondary pinnae* ± parallel-sided to narrowly ovate or narrowly triangular, the longest 6-25 x 2-11 cm. *Tertiary pinnae* ± parallel-sided, 1-6 x 0.4-2 cm. *Quaternary pinnae* obtuse to acute, 0.1-1 cm long, themselves deeply divided on largest fronds. *Veins* reaching margin at tooth apices. *Hairs:* fine colourless glandular hairs, interspersed with a few non-glandular hairs, densely covering underside of laminae, lamina veins and pinna midribs, with some similar brown-tinged hairs mostly on the midribs, 0.1-1 mm long; similar hairs on upper surfaces but less dense except on the midribs; hairs very rare on the lamina margins. *Sori* round, originating away from margin, unprotected, or protected only by partially reflexed lamina segments, lacking hairs amongst sporangia. *Spores* very pale under light microscope, perispores of inter-connecting flattened projections, (31-) 33-35 (-37) x (20-) 21-26 (-29) μm (6 populations).

Chromosome number

n = 52 (Fig. 14C)

R.J. Chinnock 5646 & P.J. Brownsey, Millaa Millaa Falls, NE of Millaa Millaa, Queensland, 10.x.1982 (AD 98303163, WELT P11585).

Distribution (Fig. 7)

Queensland, New South Wales, Victoria.

Outside Australia this species ranges from southern India and Sri Lanka, through Indonesia to Papua New Guinea and New Caledonia.

Representative specimens (125 specimens seen)

QUEENSLAND: *S.T. Blake 21408*, Mt Roberts, Lamington Nat. Park, 5.xi.1960 (BRI); *R.J. Chinnock 5666 & P.J. Brownsey*, Lamin's Hill, 3 km S of Butcher's Ck School, nr Malanda, 11.x.1982 (AD, BRI, WELT); *R.J. Chinnock 5770 & P.J. Brownsey*, summit Mt Bellenden Ker, 14.x.1982 (AD, WELT); *A.W. Dockrill 246*, The Crater, Atherton, 26.viii.1971 (BRI); *T. Pentzcke s.n.*, Daintree R., 1882 (MEL 47093).

NEW SOUTH WALES: *P.J. Brownsey & R.J. Chinnock s.n.*, S slope Mt Dromedary, nr Narooma, 14.viii.1981 (WELT P12247); *P.J. Brownsey & R.J. Chinnock s.n.*, E. Kangaloon, nr Robertson, junction of Tourist Rd & Moresby Hill Rd, 16.viii.1981 (WELT P12248); *E.F. Constable s.n.*, St Helena, 4 miles S of Springwood, 29.xi.1960 (NSW P8396); *M. Gray 5305*, Fitzroy Falls, 28.xi.1962 (CANB); *R. Schodde 1170*, Hurdle Ck, Mt Tidbinbilla, 5.vi.1960 (CANB); *N.A. Wakefield 111*, Dorrigo, 3.i.1941 (MEL).

VICTORIA: *W.R. Archer s.n.*, Mornington Peninsula, off Main Ck, Baldry's Crosing, 23.vi.1979 (MEL 558302); *A.C. Beauglehole 43713 & D.G. Cameron*, Upper Edi Rd, 27 km SW of Myrtleford, 3.xii.1973 (MEL); *A.C. Beauglehole 41792*, Tea Kettle Ck, trib. of Stokes R., 8 miles SW of Digby, 28.iii.1953 (MEL); *P.J. Brownsey & R.J. Chinnock s.n.*, 13 km up Glen Arte Rd off Prince's Highway, 13.viii.1981 (WELT P12249); *N.A. Wakefield 108*, Gipsy Pt, 19.xii.1941 (MEL).

Ecology

In Australia, *H. glandulifera* characteristically grows in extensive colonies that shade out other vegetation. It is best developed in humid, shaded forest situations growing on disturbed soils along creek banks, swamps and roadsides, but it occurs also in clearings, on forest margins, and on cleared hillsides where the fronds are generally shorter, harsher and less sticky. It has been recorded at an altitude up to 1600 m.

Notes

Hypolepis glandulifera is distinguished by its large, quadripinnate fronds, yellow-brown stipes, abundant fine glandular hairs on the laminae and the absence of both soral hairs and a well-developed indusium. It has been known previously in Australia as *H. punctata* (Thunb.) Mett. ex Kuhn. However, the type specimen of *H. punctata* is from Japan and, although fragmentary and over-mature (see Brownsey & Chinnock, 1984, fig. 21), relates to a species or species-aggregate extending from Korea in the north to Sumatra in the south, westwards into China and the Himalayas. Compared with Australian *H. glandulifera,* Asian material of *H. punctata* has a smaller frond, is only tripinnate at the base, has a generally sparser covering of hairs on the lamina undersurface, and often has some hairs on the lamina margins. Japanese material is also known to be chromosomally distinct with n = 98 compared with n = 52 in *H. glandulifera.*

Plants morphologically similar to the Australian species, and with the same habit of growing in extensive colonies, are found from southern India and Sri Lanka, through Indonesia and Papua New Guinea to New Caledonia, where it is apparently rare. Sri Lankan material has the same chomosome number, reported as n = 51-53 by Manton & Sledge (1954). It seems that these plants have never been recognised as a distinct species before, having always been included within *H. punctata.* It is just possible that the name *Cheilanthes resistens* Kunze used for southern Indian material applies to this species, but, despite an exhaustive search, no type specimen has been located. Without authentic material the correct application of this name is impossible to determine.

Plants in New Zealand previously referred to *H. punctata* belong to other species, as described by Brownsey & Chinnock (1984, p. 72).

6. **Hypolepis elegans** Carruth. in Seemann, Fl. Vitiensis 347 (1873).

Lectotype: *J. MacGillivray 108*, Aneiteum, New Hebrides, ii.1860 (BM, here chosen; isolectotype E).

Description (Figs 2B, 9, 13F)

Rhizome long-creeping, up to 5 mm diameter, covered with pale-brown hairs. *Stipes* 30-95 cm long, 4-8 mm diameter, dark chestnut-brown at base, lighter above, densely covered at base with fine colourless non-glandular hairs up to 0.5 mm long, sparsely hairy above, slightly rough. *Laminae* broadly ovate or broader than long, 40-100 x 45-80 cm, bipinnate at apex, 4-5-pinnate at base. *Rachises* chestnut-brown at base, yellow-brown or green at apex, covered in colourless or brown-tinged non-glandular hairs up to 1 mm long, densely so on upper surface. *Primary pinnae* in 20-25 pairs, opposite or subopposite, the longest at or near the base 28-70 x 20-50 cm, upper ones narrowly ovate or narrowly triangular, the lower broadly ovate. *Secondary pinnae* narrowly triangular or narrowly ovate to ovate, the longest 13-35 x 4-18 cm. *Tertiary pinnae* ± parallel-sided to narrowly ovate or narrowly triangular, the longest 2.5-11 x 0.8-5 cm. *Quaternary pinnae* obtuse or acute, 0.4-3 x 0.2-1.2 cm, divided to midrib in largest specimens to form segments up to 0.7 cm long, the ultimate segments regardless of degree of dissection often sickle-shaped. *Veins* reaching margin at tooth apices. *Hairs:* colourless or brown-tinged, stiff, curved, sharply pointed, non-glandular, up to 1 mm long, on both surfaces of lamina veins and pinna midribs; absent from margins. *Sori* round or ovate, originating at margin, protected from earliest stages by obvious reflexed incised membranous flaps, lacking hairs amongst sporangia. *Spores* very pale under light microscope, perispores of inter-connecting flattened projections, (24-) 26-28 (-31) x (16-) 17-19 (-21) μm (3 populations).

Chromosome number

Unknown.

Distribution (Fig. 10)

In Australia, *H. elegans* is known only from Lord Howe Island and from three mainland collections: from the Atherton Tableland, Richmond River, and Wilsons Promontory. A few early specimens (e.g. MEL 47074) suggest that it may once have occurred on Norfolk Island, but it has not been collected there in recent years, and the localities may have been confused.

Outside Australia, the species extends from New Ireland and the Solomon Islands through the New Hebrides and New Caledonia to Fiji, Samoa and Rapa.

Fig. 9. Silhouette of a frond of *Hypolepis elegans*.

Representative specimens (32 specimens seen)

QUEENSLAND: *L.S. Smith 10854*, Laurensons and Johnsons, near Lamond's Hill, 17 km S of Malanda, 9.ix.1959 (BRI).

NEW SOUTH WALES: *C. Fraser s.n.*, Richmond R. (NSW P5493, P6025).

LORD HOWE ISLAND: *R.E. Beever 78139*, track to Boat Harbour, 29 viii. 1981 (WELT); *R.E. Beever 78140-2*, Goat House Track, 31.viii.1981 (WELT); *R.J. Chinnock s.n.*, nr Mountain Inn, 5.xii.1968 (NSW P10094); *W.R.B. Oliver s.n.*, Mt Lidgbird, 5.xi.1913 (WELT P1493); *W.R.B. Oliver s.n.*, Transit Hill, 16.xi.1913 (WELT P12224); *W.R.B. Oliver s.n.*, Little Slope, 11.xi.1913 (WELT P12225); *A. Rodd 1713*, Malabar, 19.iii.1971 (NSW).

VICTORIA: *J.W. Audas & P.K.M. St John s.n.*, Wilson's Promontory, x.1909 (AD 97114319).

Ecology

On Lord Howe Island, *H. elegans* grows in damp forest situations in the undergrowth, in canopy gaps and along water courses. It has been recorded up to 300 m altitude. The single Queensland specimen was collected in "gallery rainforest".

Notes

Hypolepis elegans is easily recognised by its large fronds, thick stipes, conspicuously reflexed indusia and the slightly curved, non-glandular hairs on the laminae. In its general habit and proportions it is similar to both *H. dicksonioides* and *H. tenuifolia*, but lacks the glandular hairs of those species.

It is almost certainly the only species of *Hypolepis* occurring on Lord Howe Island today. Early accounts (e.g. Oliver, 1917) referred to it as *H. tenuifolia* but these were misidentifications.

Hypolepis elegans was first described by Carruthers in Seemann's Flora Vitiensis based on collections from Fiji, New Hebrides and Lord Howe Island. MacGillivray's specimen from Aneiteum in the New Hebrides is chosen here as the lectotype because it is more complete than any of the others.

Fig. 10. Distribution of *Hypolepis elegans* (●) in Australia (A) and on Lord Howe Island (B).

7. **Hypolepis dicksonioides** (Endl.) Hook., Sp. Fil. 2: 61 (1852).

Cheilanthes dicksonioides Endl., Prodr. Fl. Norfolk. 15 (1833).

Lectotype: *F. Bauer s.n.*, Norfolk Island, no date (W, on 4 sheets; chosen by Brownsey & Chinnock, 1984).

Hypolepis endlicheriana C. Presl, Tent. Pterid. 162 (1836), nom. nov. pro *Cheilanthes dicksonioides* Endl.

Cheilanthes pellucida Col., Tasm. J. Nat. Sci. 2:173 (1845).

Hypolepis tenuifolia var. pellucida (Col.) Hook., Sp. Fil. 2:60, t. 90a (1851).

Lectotype: *W. Colenso s.n.*, E. coast. New Zealand, no date (WELT P3224; chosen by Brownsey & Chinnock, 1984).

Description (Figs 2C, 11, 13G)

Rhizome long-creeping, (3-) 4-8 mm diameter, densely covered in pale brown hairs near growing apex, elsewhere more scattered hairs becoming red-brown. *Stipes* (9-) 20-100 cm long, (2-) 5-15 mm diameter, dark chestnut-brown at base, pale chestnut or yellow-brown above, bearing red-brown hairs at very base, replaced by colourless glandular and non-glandular hairs above (up to 5 mm long on uncoiling fronds); two dark, prominent, vertical bands on opposite sides of stipe. *Laminae* broadly ovate or broadly elliptic, (16-) 35-135 x (12-) 35-110 cm, bipinnate at apex, 4-5-pinnate at base. *Rachis* yellow-brown at base, green at apex, bearing colourless glandular and non-glandular hairs (up to 3 mm long). *Primary pinnae* in 15-30 pairs, opposite or subopposite, the longest at or near the base (11-) 20-70 x (7-) 14-45 cm; upper ones narrowly ovate, lower ones ovate. *Secondary pinnae* ovate, (4.5-) 7-30 x 3-15 cm, those on the lower pinnae decreasing markedly in length along the pinnae. *Tertiary pinnae* ovate, (1.6-) 2-8 x (0.7-) 1-3.5 cm, midrib winged. *Quaternary pinnae* narrowly ovate, 0.7-1.6 x 0.2-0.6 cm, shallowly incised on smaller specimens, divided into 4-5 pairs of ultimate segments on larger specimens. *Veins* reaching margin at a tooth apex, or sometimes ending just short of margin. *Hairs*: stout, colourless, glandular and non-glandular, on midribs and veins of both lamina surfaces but absent from margins, 0.2-1 mm long on lamina surfaces, up to 1.5 mm on midribs. *Sori* round or ovate, protected from earliest stages by reflexed, incised, tapering flaps that are green at base and membranous at apex, often bearing a few glandular hairs on margin, 0.3-0.8 mm wide; lacking hairs amongst sporangia. *Spores* very pale under light microscope, perispores of inter-connecting flattened projections, (36-) 38-40 (-44) x (20-) 24-26 (-28) μm (3 populations).

Chromosome number

No chomosome number has been obtained from Norfolk Island material, but Brownsey & Chinnock (1984) recorded n = 104 from three New Zealand populations of this species.

Distribution (Fig. 12)

This species is known with certainty only from Norfolk Island, the Kermadec Islands and parts of New Zealand (Brownsey & Chinnock, 1984), although it is now thought that it may also occur at altitudes above about 1000 m on Tahiti and the Marquesas Islands in the eastern Pacific. A few early specimens (e.g. MEL 47094) suggest that it may once have been present on Lord Howe Island, but it has not been collected there in recent years. The possibility that it may also occur naturally on the mainland of Australia should not be overlooked.

The species does occur in the Mount Lofty Ranges of South Australia from where it has been erroneously recorded as *H. punctata* (Black, 1978). However, these populations are believed to have been introduced.

Fig. 11. Silhouette of a frond of *Hypolepis dicksonioides*.

Representative specimens (12 specimens seen)

NORFOLK ISLAND: *F.C. Allen s.n.*, Mt Pitt, 1943 (CHR 229325); *R.J. Chinnock NK 49*, near Mt Pitt summit, 7.xii.1971 (AD); *R.J. Chinnock NK 50*, road above Ball Bay, 7.xii.1971 (AD); *P.S. Green 1396*, Mt Bates, 28.x.1963 (NSW); *Metcalfe s.n.*, (WELT P11538-9); *Robinson s.n.*, 1884 (MEL 47045).

PHILIP ISLAND: *R.J. Chinnock 5928*, Long Valley, 13.i.1984 (AD).

Ecology

Hypolepis dicksonioides can be found at all altitudes on Norfolk Island occurring on exposed clay banks, along forest margins and tracks or on stream banks in open situations. The more robust forms occur in wetter sites and fronds to 3 metres long were recorded at Ball Bay (*Chinnock NK 50*) while depauperate plants with sporogenous fronds 25 cm long were found on dry clay banks near Mt Pitt summit (*Chinnock NK 49*).

On Philip Island this species is an important pioneer fern, which, with *Pteris tremula* R. Br., forms dense thickets amongst rocks and along erosion channels in the upper part of "Long Valley".

Notes

The difficulty of distinguishing *H. dicksonioides* and *H. tenuifolia* in the Pacific and Australasian regions has been discussed in detail elsewhere (Brownsey & Chinnock, 1984, p. 67). Both are large ferns recognisable by their thick stipes, glandular hairy fronds and the presence of well-developed reflexed indusia protecting the sori. *Hypolepis dicksonioides* generally has longer, stouter, glandular hairs on the laminae (0.2-1.5 mm cf. 0.1-1 mm), and rather shorter, broader pinnules with more rounded tips than *H. tenuifolia* which has longer, narrower, more tapering pinnules. Those of *H. tenuifolia* tend to arise from the midribs at more acute angles. The indusia in *H. dicksonioides* are mostly green and only partially membranous, 0.3-0.8 mm wide, tend to taper towards the apex and often have glandular hairs on the margins. Those of *H. tenuifolia* are totally membranous, broad or almost hooded, 0.5-1.2 mm wide and often bear a few glandular hairs on the upper surface.

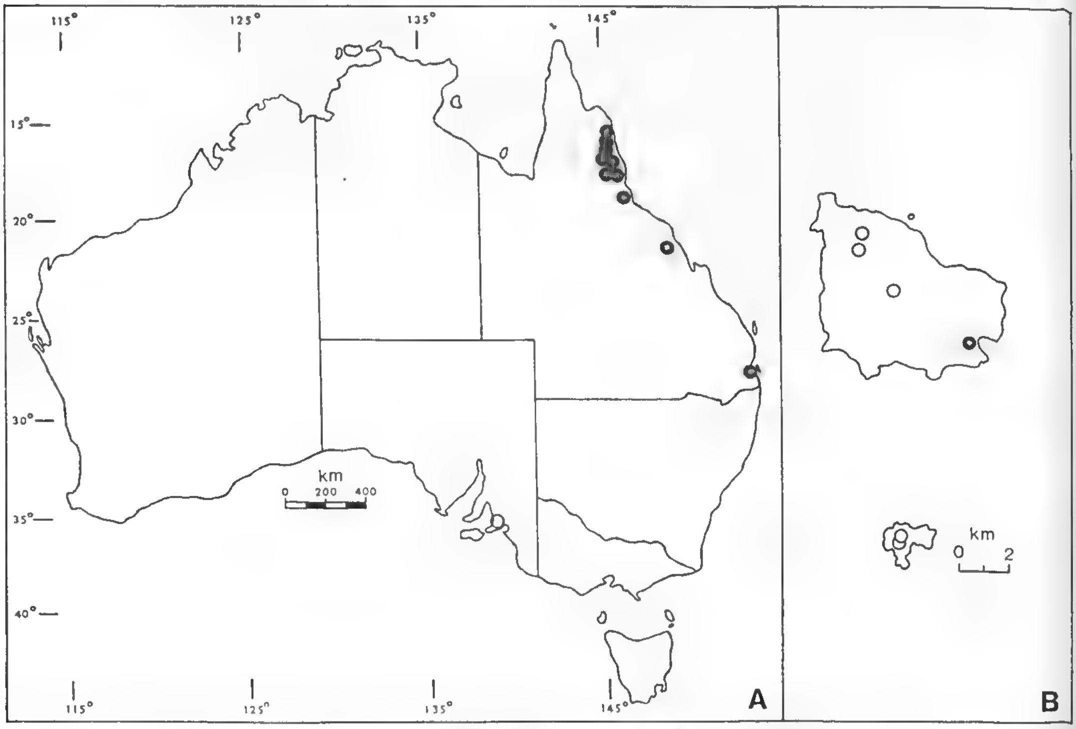


Fig. 12. Distribution of *Hypolepis dicksonioides* (○) and *H. tenuifolia* (●) in Australia (A) and on Norfolk and Philip Islands (B).

Brownsey & Chinnock (1984) noted a difference in chromosome number between *H. tenuifolia* from Samoa with n = 52 and *H. dicksonioides* from New Zealand with n = 104. An additional chromosome count of n = 52 from *H. tenuifolia* in Queensland is reported here (Fig. 14B), but no chromosome count has yet been made from Norfolk Island material. Further cytological investigation of Australian plants is clearly necessary, but we believe that *H. tenuifolia* is a tetraploid species ranging through tropical latitudes from Queensland to Pitcairn Island, and that *H. dicksonioides* is an octoploid species confined in the south-west Pacific region to Norfolk Island, the Kermadec Islands and New Zealand, and in the eastern Pacific to higher altitudes in Tahiti and the Marquesas Islands.

H. dicksonioides is certainly the only species of the genus occurring commonly on Norfolk Island today. Records of *H. punctata* (Turner, Smithers & Hoogland, 1968) are based on misidentifications, but one recent collection from Ball Bay (*Sykes 106,* 29.x.1971, CHR) has very membranous indusia suggesting that occasional plants of *H. tenuifolia* may also occur.

H. dicksonioides is closely related to *H. alpina* (Bl.) Hook., a species occuring at high altitudes in the Malesian region which will be discussed in more detail in a subsequent paper.

8. **Hypolepis tenuifolia** (Forst. f.) Bernh. ex C. Presl, Tent. Pterid. 162 (1836).

Lonchitis tenuifolia Forst. f., Prodr. 80 (1786) — *Cheilanthes arborescens* Sw., Syn. Fil. 129 (1806), nom. nov. pro *Lonchitis tenuifolia* Forst. f. — *Phegopteris tenuifolia* (Forst. f.) Keys., Polyp. Herb. Bunge. 51 (1873).

Lectotype: *J.R. & G. Forster s.n.*, Insulae Oceani Pacifici, no date (BM, here chosen).

Description (Figs 2D, 13H)

Rhizome long-creeping, 3-10 mm diameter, densely covered in pale brown hairs near growing apex, elsewhere more scattered hairs becoming red-brown. *Stipes* 40-170 cm long, 3.5-10 mm diameter, dark chestnut-brown at base, pale chestnut or yellow-brown above, bearing red-brown hairs at very base, replaced by colourless glandular and non-glandular hairs above (up to 5 mm long on uncoiling fronds); two dark prominent vertical bands on opposite sides of stipe. *Laminae* broadly ovate or broadly elliptic, 25-200 x 28-140 cm, bipinnate at apex, 4-5-pinnate at base. *Rachis* yellow-brown at base, green at apex, bearing colourless glandular and non-glandular hairs (up to 2 mm long). *Primary pinnae* in 10-30 pairs, opposite or subopposite, the longest at or near base 16-100 x 11-50 cm; upper ones narrowly ovate to ovate, lower ones ovate. *Secondary pinnae* ovate, 7-35 x 3.5-15 cm, those on the lower pinnae decreasing markedly in length along the pinnae. *Tertiary pinnae* ovate, 2-17 x 1-6 cm, midrib winged. *Quaternary pinnae* narrowly ovate, 0.5-3.5 x 0.2-1.2 cm, shallowly incised on smaller specimens, divided into ultimate segments up to 0.6 cm long on larger specimens. *Veins* reaching margin at a tooth apex, or sometimes ending just short of margin. *Hairs*: fine, colourless glandular and non-glandular hairs densely covering both lamina surfaces, veins and midribs but absent from margins, 0.1-0.8 mm long on lamina surfaces, up to 1 mm on midribs. *Sori* round or ovate, protected from earliest stages by reflexed, incised, rather broad, membranous flaps which bear occasional glandular hairs on the upper surface, 0.5-1.2 mm wide; lacking hairs amongst sporangia. *Spores* very pale under light microscope, perispores of inter-connecting flattened projections, (30-) 33-36 (-39) x (17-) 20-23 (-25) μm (7 populations).

Chromosome number

n = 52 (Fig. 14B)

R.J. Chinnock 5793 & P.J. Brownsey, N. Johnson R., 19 km SW of Russell R. Bridge on Innisfail-Cairns Rd, Queensland, 16.x.1982 (AD, WELT).

A count of n = 52 from Queensland material of *H. tenuifolia* confirms the suggestion made by Brownsey & Chinnock (1984, p. 72) that there is a ploidy difference between this species and the very closely related *H. dicksonioides* from New Zealand and Norfolk Island which has n = 104.

Samoan material of *H. tenuifolia* also has n = 52 (Manton & Vida, 1968).

Distribution (Fig. 12)

In recent years *Hypolepis tenuifolia* has been collected only from localities in the Atherton Tableland region of north Queensland, from Dalrymple Heights further south, and from Norfolk Island. Two early collections were made from the Brisbane area. The species has also been recorded from Lord Howe Island (e.g. Oliver, 1917) but these records refer to plants of *H. elegans*.

Outside Australia, *H. tenuifolia* ranges across the Pacific in tropical latitudes from New Caledonia through Fiji, Tonga, Samoa, the Cook Islands, Society Islands, and Austral Islands to Rapa, Mangareva and Pitcairn Island. It also occurs further north in Papua New Guinea and parts of S.E. Asia.

New Zealand plants referred to *H. tenuifolia* by Allan (1961) belong to either *H. ambigua* Brownsey & Chinnock or to *H. dicksonioides* (Brownsey & Chinnock 1984, p. 67).

Representative specimens examined (24 specimens seen)

QUEENSLAND: *F.M. Bailey s.n.*, Mulgrave R., vi-vii.1889 (BRI 114714); *F. Burtt s.n.*, Enoggera, Brisbane, x.1912 (BRI 114715); *R.J. Chinnock 5793 & P.J. Brownsey*, 19.3 km SW of Russell R. bridge on Innisfail-Cairns Road, 16.x.1982 (WELT); *M.S. Clemens s.n.*, Dalrymple Heights, viii-xi.1947, ix-x.1947 (K, BRI 142708, 139468); *A.W. Dockrill 1299*, State Forest Rd 675, E. Mulgrave, 7.x.1976 (BRI); *M.J. Manski s.n.*, Edge Hill, Cairns (BRI 12641); *P.R. Messmer s.n.*, Big Tableland, nr Cooktown, 24.vii.1952 (NSW P8528); *P.R. Messmer s.n.*, Stuarts Ck, Daintree R., 10.viii.1952 (NSW P2825); *L.S. Smith 3768*, Emerald Creek, 8 km N of Danbulla, 15.viii.1948 (BRI); *C.T. White s.n.*, Atherton, i.1918 (BRI 114718, 257772).

NORFOLK ISLAND: *Backhouse s.n.*, 4.iii.1835 (BM); *W.R. Sykes 106*, Ball Bay, 29.xi.1971 (CHR).

Ecology

This is a rare species collected only occasionally from Queensland and Norfolk Island. Few details of its preferred habitat are known, but it may favour disturbed soils in open situations near streams in rainforest. It has been recorded up to 1000 m altitude.

Notes

The characteristic features of *H. tenuifolia* and its distinction from *H. dicksonioides* are discussed above (p. 24). The morphological range and distribution of this species in Australia require further investigation.

Excluded taxon

Hypolepis tenuifolia var. *hirsuta* C. White et Goy, Victorian Naturalist 54: 148 (1938).

Holotype: *C.T. White 10702*, Mt Spurgeon, Cook District, north Queensland, ix.1936 (BRI 210974-5).

The type specimen has been re-identified by D.A. Smith as *Culcita villosa* C. Chr., a species described from Papua New Guinea with a distribution extending to Indonesia and Australia. It is rare and localised in tropical Australia (Jones & Clemesha, 1981).

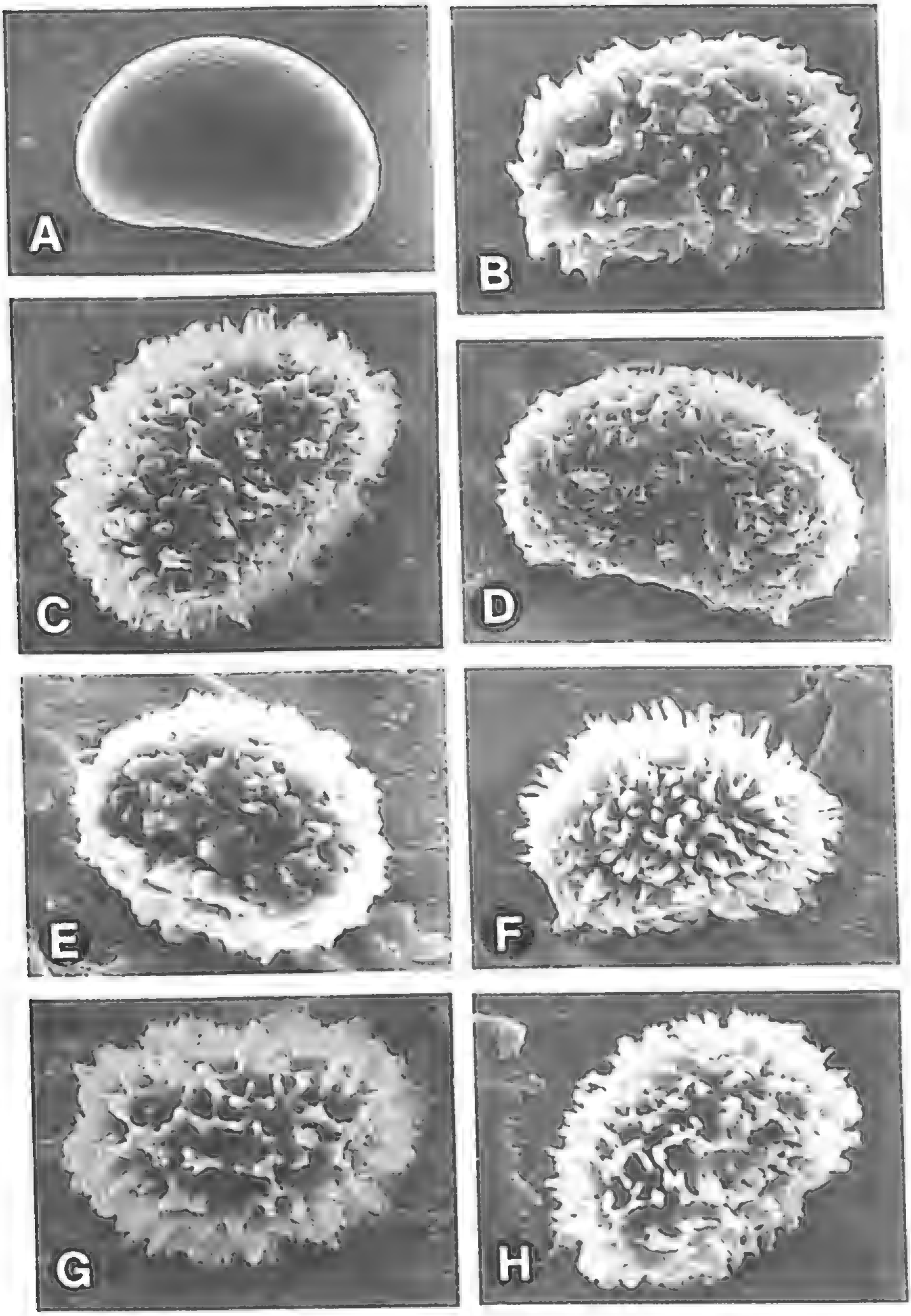


Fig. 13. Scanning electron micrographs (x1200) of spores. A, *Hypolepis distans*; B, *H. amaurorachis*; C, *H. rugosula*; D, *H. muelleri*; E, *H. glandulifera*; F, *H. elegans*; G, *H. dicksonioides*; H. *H. tenuifolia*.

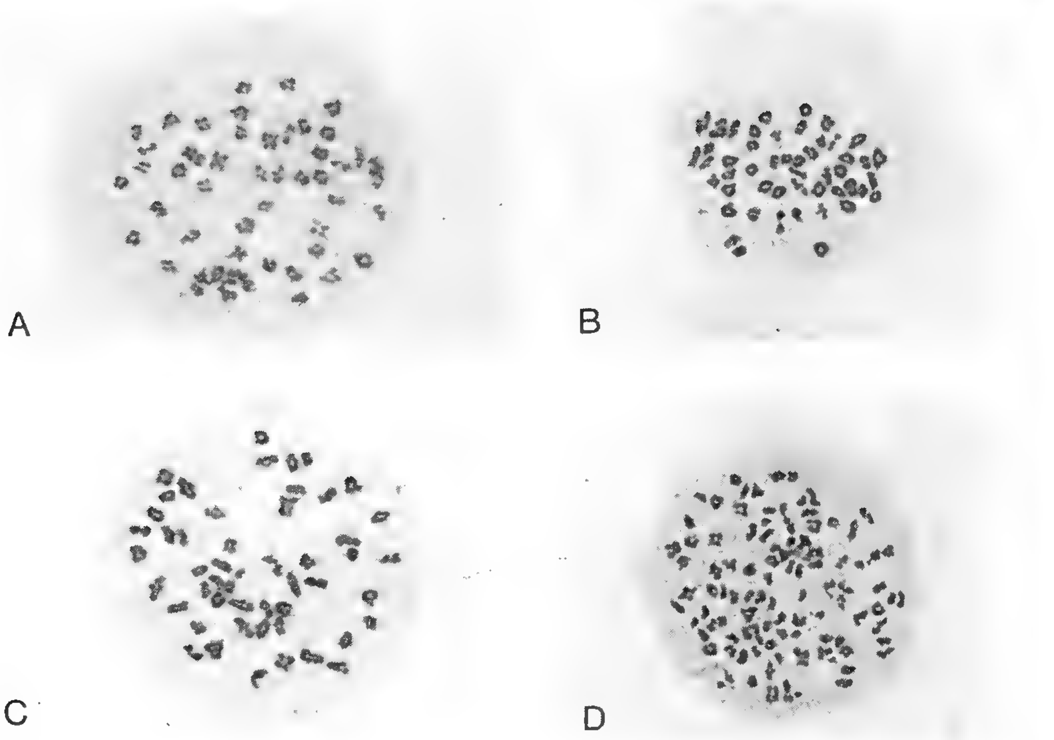


Fig. 14. Permanent acetocarmine preparations of diakinesis (x1000). A, *Hypolepis muelleri*, Pomona, Queensland, showing 49 bivalents; B, *H. tenuifolia*, North Johnson River, Queensland, showing 52 bivalents; C, *H. glandulifera*, Millaa Millaa Falls, Queensland, showing 52 bivalents; D, *H. rugosula*, Otway Ranges, Victoria, showing c. 104 bivalents.

Hybrids

As in other genera of ferns, plants of *Hypolepis* with aborted spores and with morphological characteristics inconsistent with any known species are assumed to be of hybrid origin. In the course of this investigation, a few herbarium specimens with these attributes have been found. The small number of such specimens suggests that hybridism between Australian species is uncommon, and, since we have had no personal experience of hybridism in the field, it is difficult to be certain of the parentage of these putative hybrids.

There is reasonably good morphological evidence for the combination *H. muelleri* x *rugosula*, but that for a second combination, *H. muelleri* x *glandulifera*, is much less certain. A third combination, *H. amaurorachis* x *rugosula* has not been found, but since the two parent species are known to grow in the same areas and are closely related, hybrids between them can be anticipated. Further study of any putative *Hypolepis* hybrids in the wild is clearly desirable.

Hypolepis muelleri x rugosula

Specimens examined

QUEENSLAND: *P. Grimshaw s.n.*, South Bald Rock, Girraween Nat. Park, 28.v.1978 (BRI 339959).
NEW SOUTH WALES: *S. Clemesha s.n.*, Perry's Lookout, Blackheath, 8.ii.1973 (AD, NSW).

VICTORIA: *W.R. Archer s.n.*, Mornington Peninsula, Nepean State Park, trib. of Main Ck nr junction with Lightwood Ck, 13.v.1979 (MEL 1515069); *A.C. Beauglehole 43682*, Mt Porepunkah, 7.2 km NNE of Bright, 29.xi.1973 (MEL 522651); *A.C. Beauglehole 15879*, Victoria Range, E side of Castle Rock, upper reaches of Deep Ck, 6.xi.1966 (MEL 522678); *A.C. Beauglehole 41630*, Rosedale Shire, Holey Plains, Merrimans Creek, 11.iii.1973 (MEL 522692); *A.C. Beauglehole 41332*, Nunniong Plateau, Little Reedy R. W of junction with Reedy R., 2.ii.1973 (MEL 522685); *R. Melville 3842*, Kallista, Clematis Gully, 11.v.1953 (MEL 47077, BRI 56160).

Notes

This hybrid is intermediate in morphology between the two parent species and can be recognised by the combination of reddish brown stipes characteristic of *H. rugosula* together with occasional hairs in the sorus, typical of *H. muelleri*. The hairs on the remainder of the laminae are sharp and slightly curled as in *H. muelleri*, but rather longer than is usual in that species. Glandular hairs are generally absent. In a few specimens, the sporangia, as well as the spores, are aborted.

Manton & Sledge (1954, p. 149) reported a chromosome count of 2n = c. 150 from an Australian plant of *Hypolepis* collected by R. Melville. It had "about half a dozen pairs and nearly 140 univalents" at meiosis, and the spores were aborted. This was evidently a plant of hybrid origin, presumably derived from parental species with n = approximately 50 and 100 respectively. It is virtually certain the plant was a hybrid between *H. muelleri* and *H. rugosula* — the former having a chromosome number of n = 49 and the latter n = 104 (Fig. 14). Specimens of this hybrid collected by Melville are in BRI and MEL (cited above).

Hypolepis muelleri x glandulifera

Specimens examined

VICTORIA: *H.I. Aston 589*, Dandenong Ranges, c. 1 km E of Belgrave, near Hardy Ck at Belgrave-Gembrook rail crossing, 2.viii.1960 (MEL 77353); Dunip Ck (MEL 47104).

Notes

Neither of these specimens is a complete frond, each lacking the stipe and lower pinnae, so that their parentage is difficult to determine. However, the fronds are more highly dissected than those of the previous combination, the lamina hairs longer and more numerous, and the soral hairs more numerous. This would be consistent with the suggested parentage, *H. muelleri* x *glandulifera*.

Acknowledgements

We are grateful to Dr R.E. Beever, Auckland for specimens of *Hypolepis elegans* from Lord Howe Island, to Dr A.E. Orchard for assistance with field work in Tasmania, to Mr P. Barnett for collection of herbarium and cytological specimens and for assistance with field work in the Otway Ranges, to Professor J.D. Lovis for his comments on the manuscript and to the Curators of the following herbaria who have sent material on loan: B, BM, BRI, CANB, CHR, E, FI, HO, K, MEL, NSW, PERTH and W. Mr G.H. Bell, Adelaide took the scanning electron micrographs of spores and other photographic work was done at the National Museum, Wellington by Mr W.N. Wilson and Mr M.A. Strange.

References

Allan, H.H. (1961). "Flora of New Zealand", vol. 1. (Govt Printer: Wellington).
Bailey, F.M. (1902). "The Queensland flora", part VI. (Diddams: Brisbane).
Bentham, G. (1878). "Flora Australiensis", vol. 7. (Reeve: Ashford).
Black, J.M. (1978). "Flora of South Australia", part 1, edn. 3 (Govt. Printer: Adelaide).

Brownsey, P.J. (1983). Polyploidy and aneuploidy in *Hypolepis*, and the evolution of the Dennstaedtiales. *American Fern J.* 73: 97-108.
Brownsey, P.J. and Chinnock, R.J. (1984). A taxonomic revision of the New Zealand species of *Hypolepis. New Zealand J. Bot.* 22: 43-80.
Chinnock, R.J. (1976). Notes on *Hypolepis distans* Hook. and *Doodia aspera* R. Br. *New Zealand J. Bot.* 14: 113.
Endlicher, S.L. (1833). "Prodromus florae Norfolkicae". (Beck: Vienna).
Halliday, P., Meikle, R.D., Story, J. and Wilkinson, H. (1980). "Draft index of author abbreviations compiled at the Herbarium, Royal Botanic Gardens, Kew". (HMSO: Basildon).
Holmgren, P.K., Keuken, W. and Schofield, E.K. (1980). Index herbariorum, Part I. The herbaria of the world. *Regnum Vegetabile* 106: 1-452.
Hooker, W.J. (1858). "Species filicum", vol II. (Pamplin: London).
Jones, D.L. and Clemesha, S.C. (1981). "Australian ferns and fern allies", edn 2. (Reed: Sydney).
Kunze, G. (1850). Index filicum adhuc, quantum innotuit, in hortis Europaeis cultarum. *Linnaea* 23: 209-407.
Kurita, S. (1967). Chromosome numbers of Japanese species of Pteridophyta. *Ann. Rep. Foreign Students College, Chiba Univ.* 2: 41-56.
Kurita, S. (1972). Chromosome numbers of some Japanese ferns (8). *Ann. Rep. Foreign Students College, Chiba Univ.* 7: 47-53.
Labillardière, J.J. (1806). "Novae Hollandiae plantarum specimen", vol. 2. (Huzard: Paris).
Manton, I. (1950). "Problems of cytology and evolution in the Pteridophyta". (Cambridge University Press: Cambridge).
Manton, I. and Sledge, W.A. (1954). Observations on the cytology and taxonomy of the pteridophyte flora of Ceylon. *Phil. Trans., B.* 238: 127-185.
Manton, I. and Vida, G. (1968). Cytology of the fern flora of Tristan da Cunha. *Proc. Roy. Soc. London, B.* 170: 361-379.
Mitui, K. (1975). Chromosome numbers of Japanese pteridophytes. *Bull. Nippon Dental College, Gen. Ed.* 4: 221-271.
Mitui, K. (1976). Chromosome studies on Japanese ferns (5). *Bull. Nippon Dental College, Gen. Ed.* 5: 133-140.
Oliver, W.R.B. (1917). The vegetation and flora of Lord Howe Island. *Trans. New Zealand Inst.* 49: 94-161.
Seemann, B. (1873). "Flora Vitiensis". (Reeve: London).
Stafleu, F.A. and Cowan, R.S. 1976-1985. Taxonomic literature, vols I-V. 2nd Ed. *Regnum Vegetabile* 94: 1-1136; 98: 1-991; 105: 1-980; 110: 1-1214; 112: 1-1066.
Turner, J.S., Smithers, C.N. and Hoogland, R.D. (1968). "The conservation of Norfolk Island". (Australian Conservation Foundation: Melbourne).
Wakefield, N.A. (1943). A new species of *Hypolepis. Victorian Naturalist* 60: 42-43.
Wakefield, N.A. (1955). Flora of Victoria: new species and other additions — 5. *Victorian Naturalist* 72: 92-95.
Wakefield, N.A. (1956). New combinations in some Australasian ferns. *Victorian Naturalist* 72: 159-160.

J. Adelaide Bot. Gard. 10(1): 31-79 (1987)

A TAXONOMIC REVISION OF THE GENUS *VITEX* L. (VERBENACEAE)* IN AUSTRALIA

Ahmad Abid Munir

State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

A taxonomic revision of *Vitex* in Australia is presented. The following eight species are recognised: *V. acuminata, V. benthamiana, V. glabrata, V. helogiton, V. melicopea, V. rotundifolia, V. trifolia* and *V. velutinifolia. V. velutinifolia* (from Western Australia) is described as new. *V. melicopea* and *V. helogiton* are reinstated, with *V. helogiton* being recorded from Australia for the first time. *V. rotundifolia* is reinstated as the oldest valid name for the 1-foliolate species previously often named *V. ovata, V. trifolia* var. *ovata, V. trifolia* var. *unifoliolata, V. trifolia* var. *simplicifolia* or *V. trifolia* subsp. *littoralis. V. trifolia* var. *bicolor* is placed in synonymy of *V. trifolia* var. *trifolia.* The following four species are typified: *V. acuminata, V. benthamiana, V. helogiton* and *V. melicopea.* A range of material of the non-endemic species was examined from Malesia.

Affinities and distribution are considered for each species. A key to the species is provided and a detailed description of each species is supplemented by a habit sketch of a flowering branch and analytical drawings of the flower.

Taxonomic History of the Genus

The genus *Vitex* was described by Linnaeus (1753) with four species, *V. agnus-castus, V. trifolia, V. negundo* and *V. pinnata.* The syntypes of the first named species came from Sicily and Naples, the second and third from India, and the fourth type from Ceylon. The genus was placed together with *Clerodendrum, Gmelina* and a few other genera of present Verbenaceae in "Didynamia Angiospermia", where it was retained by Murray (1774), Reichard (1778), Loureiro (1793), Schreber (1791), Gmelin (1792), Persoon (1797, 1807), Willdenow (1800), Link (1822), Lamarck & Poiret (1823), Sprengel (1825), Roxburgh (1832), Dietrich (1842) and a few others. De Jussieu (1759) placed it in "Verbenae" which was later accepted for the genus by Adanson (1763) and Reichenbach (1828). The latter, however, referred *Vitex* and other related genera to the Labiatae. Gleditsch (1764) recorded it in section "Petalostemonum" and Scopoli (1777) in the tribe "Personatae". The latter was accepted for the genus by Giseke (1792) and Batsch (1802). Gaertner (1788) recorded it in "Centuria Quarta", de Jussieu (1789) in "Vitices", Necker (1790) in his "Chasmatophytum" and Ventenat (1799) under "Pyrenaceae". Ventenat's proposed family was later accepted for the genus by Dumortier (1822). In 1805, Jaume Saint-Hilaire, proposed the family Verbenaceae for *Vitex* and other related genera. The family Verbenaceae was accepted for this genus by de Jussieu (1806), Robert Brown (1810), Kunth (1823), Blume (1826), Lindley (1847), F. Mueller (1862), Bentham (1870), Bentham & Hooker (1876), Briquet (1895), Bailey (1883, 1901), H.J. Lam (1919), Gardner (1931) and by the majority of other botanists.

Dumortier (1829) divided the Verbenaceae into two tribes: Verbeneae and Viticeae, with *Vitex* in the tribe Viticeae. This tribe was accepted for the genus by Bartling (1830), Spach (1840), Schauer (1847), Miquel (1858), Bentham (1870), Bentham & Hooker (1876), Bailey (1883, 1901, 1913), C.B. Clarke (1885), Durand (1888), King & Gamble (1909), Ewart & Davies (1917), Dop (1928), Fletcher (1938), Lemée (1943) and others. In 1838, Endlicher divided the family into three tribes: Lippieae, Lantaneae and Aegiphileae, with *Vitex* in the tribe Lantaneae. This tribe was accepted for the genus by Meisner (1840), Brongniart (1843),

*The present treatment of the genus *Vitex* is the fifth in the series of taxonomic revision in the family Verbenaceae in Australia (See Munir, 1982, 1984a, 1984b, 1985).

Dietrich (1843) and Walpers (1845). Schauer (1847) re-classified the Verbenaceae into three tribes: Verbeneae, Viticeae and Avicennieae, with *Vitex* in the tribe Viticeae. He subdivided the tribe Viticeae into three subtribes: Symphoremeae, Caryopterideae and Viticeae, with *Vitex* in the subtribe Viticeae. Schauer (1847) also split the genus into three sections: *Euagnus*, *Pyrostoma* and *Chrysomallum*, based chiefly on the shape of their calyces, the presence or absence of calyx-teeth and the type of inflorescence i.e. axillary or terminal. Later, the subtribe Viticeae was accepted for the genus by Miquel (1858) and Bentham (1870). C.B. Clarke (1885) split the genus into two subgenera: *Euagnus* and *Glossocalyx*, and Dop (1928) into two groups: *Terminales* and *Axillares*, with the former group divided into two subgroups: *Longibracteatae* and *Brevibracteatae.*

In 1895, Briquet re-classified the Verbenaceae and upgraded the tribe Viticeae to a subfamily Viticoideae. The latter consisted of four tribes: Callicarpeae, Tectoneae, Viticeae and Clerodendreae, with *Vitex* in the tribe Viticeae. This classification was adopted by Dalla Torre & Harms (1904), H.J. Lam (1919), Gardner (1931), Junell (1934), Moldenke (1959, 1971) and Melchior (1964). In the same treatment, Briquet (1895) subdivided the genus *Vitex* into four sections: *Agnus-castus*, *Pyrostoma*, *Chrysomallum* and *Glossocalyx*, each characterised chiefly by the shape of their calyces and the size of calyx-lobes. He further subdivided the section *Agnus-castus* into three subsections: *Terminales*, *Axillares* and *Glomerulosae*. These sections and subsections were adopted by Dalla Torre & Harms (1904). In 1904, Post & Kuntze divided the genus *Vitex* into four sections namely *Lagondium* (Rumpf) Kuntze, *Pyrostoma* (Mey) Schauer, *Chrysomallum* (Thou.) Schauer and *Glossocalyx* C.B. Clarke. He further subdivided the section *Lagondium* into three subsections: *Mailelou* (Adans.) Kuntze, *Limia* Endl. and *Glomerovitex* Kuntze. The majority of botanists, however, have not divided the genus into sections and subsections, but have retained it in the Verbenaceae without reference to any subfamily or a tribe. In the present revision, Briquet's (1895) classification of the Verbenaceae is followed in retaining *Vitex* in the tribe Viticeae. The subgeneric sections and subsections proposed for the genus, however, are not accepted because of the unreliability of the characters used.

Australian History of the Genus

The first Australian records of *Vitex* were made by Robert Brown (1810) from northern Queensland and north of the Northern Territory, when he recognised five species: *V. ovata* Thunb., *V. trifolia* L., *V. acuminata* R. Br., *V. glabrata* R. Br. and *V. macrophylla* R. Br. Of these, *V. acuminata*, *V. glabrata* and *V. macrophylla* were newly described, with *V. macrophylla* later found to be synonymous with *Gmelina dalrympleana* (F. Muell.) H.J. Lam. Of the remaining two species, *V. ovata* was later found to be a synonym of *V. rotundifolia* L.f. In 1847, Schauer recorded all of Robert Brown's new *Vitex* species from Australia under "Species non satis notae". He did not elaborate on their short original descriptions, nor cite any plant collections from Australia. In addition, he described from Australia *V. trifolia* and two new species: *V. cunninghamii* Schauer and *V. lignum-vitae* A. Cunn. ex Schauer. Later, *V. cunninghamii* was found to be conspecific with *V. glabrata* R. Br. and *V. lignum-vitae* as belonging to the genus *Premna* L. F. Mueller (1862) recorded two *Vitex* species namely *V. leichhardtii* F. Muell. and *V. lignum-vitae* A. Cunn. ex Schauer. Of these, *V. leichhardtii* was described as a new species from New South Wales, but it was later found to belong to the genus *Gmelina* L. In 1864, F. Mueller recorded from Queensland two more *Vitex* species: *V. dalrympleana* F. Muell. and *V. macrophylla* R. Br. Of these, *V. dalrympleana* was described as a new species, but this too was later found to belong to the genus *Gmelina*. In fact both *V. macrophylla* and *V. dalrympleana* are now synonyms of *Gmelina dalrympleana* (F. Muell.) H.J. Lam. About a year later, F. Mueller (1865) listed from Australia five *Vitex* species of which *V. melicopea* F. Muell. and *V. tracyana* F. Muell. (= *Premna tracyana* F. Muell.) were newly described from Queensland. The latter was subsequently identified as

Clerodendrum tracyanum (F. Muell.) Benth. F. Mueller (1868, 1875) listed respectively four and three *Vitex* species, previously described from Australia by Robert Brown and F. Mueller himself.

In 1870, Bentham published a detailed account of the Australian Verbenaceae, and listed four *Vitex* species: *V. trifolia* L., *V. lignum-vitae* A. Cunn. ex Schauer, *V. acuminata* R. Br. and *V. glabrata* R. Br. He relegated *V. melicopea* F. Muell. to the synonymy of *V. acuminata* R. Br., and described under *V. trifolia* three new varieties: var. *obovata*, var. *acutifolia* and var. *parviflora*. Subsequently, the occurrence of these species in Australia was recorded by F. Mueller (1882, 1889), Bailey (1883, 1901, 1913) and Ewart & Davies (1917). Maiden (1889) listed *V. acuminata* and *V. lignum-vitae* from Queensland and New South Wales, and Domin (1929) recorded from Queensland four species namely *V. trifolia* L., *V. ovata* Thunb., *V. benthamiana* Domin and *V. petiolaris* Domin. In this list, *V. benthamiana* and *V. petiolaris* were respectively described as a new name and as a new species. The latter species was subsequently found to be synonymous with *V. trifolia* L. Anderson (1947) listed three *Vitex* species from New South Wales namely *V. trifolia*, *V. glabrata* and *V. lignum-vitae*. In this publication the name *V. glabrata* seems to be a misidentification of another taxon because *V. glabrata* does not occur in New South Wales. All above named taxa described by Robert Brown, Schauer, F. Mueller and Domin were later recorded for Australia by Moldenke (1959, 1971, 1980).

VITEX L.

Vitex L., Sp. Pl. 2 (1753) 638; Gen. Pl. edn 5 (1754) 285; Lour., Fl. Cochin. 2 (1790) 389; Willd., Sp. Pl. edn 4, 3 (1800) 390; R. Br., Prod. Fl. Nov. Holl. (1810) 511; Spreng., Syst. Veg. 2 (1825) 756; Blume, Bijdr. Fl. Ned. Ind. (1826) 812; Bartling, Ord. Nat. Pl. (1830) 180; Roxb., Fl. Ind. edn 2, 2 (1832) 69; Endl., Gen. Pl. 1 (1838) 635; Walp., Rep. Bot. Syst. 4 (1845) 82; Schauer in A. DC., Prod. 11 (1847) 682; Miq., Fl. Ned. Ind. 2 (1858) 858; Seemann, Fl. Viti. (1866) 190; Benth., Fl. Aust. 5 (1870) 66; Benth. & Hook. f., Gen. Pl. 2 (1876) 1135, 1154; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; Bailey, Synop. Qld Fl. (1883) 379; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 583; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 170; Bailey, Qld Fl. 4 (1901) 1179; Bailey, Comp. Cat. Qld Pl. (1913) 386; H.J. Lam, Verbenac. Malay. Arch. (1919) 164; Bull. Jard. Bot. Ser. 3, Vol. 3 (1921) 47; Ridley, Fl. Mal. Penin. 2 (1923) 630; C. Gardner, Enum. Pl. Aust. Occ. 3 (1931) 112; Lecomte, Fl. Gén. Indo-Chine 4 (1935) 820; Lémée, Dict. Gen. Pl. Phan. 8b (1943) 656; Mold., Résumé Verbenac. etc. (1959) 232, 233, 248, 250, 251, 276, 285, 302, 309, 319, 321, 335, 341, 342, 355, 356, 379, 393, 395-399, 409, 424; N. Burb., Dict. Aust. Pl. Gen. (1963) 306; Backer & Bakh. f., Fl. Java 2 (1965) 604; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 6, 7, 10, 385, 386, 420, 423, 426, 469, 472, 491, 534, 548, 549, 570, 572, 573, 602, 603, 614, 615, 617, 644, 648, 709, 710, 735, 739-744, 758, 789, 791, 794; Baines, Aust. Pl. Gen. (1981) 395; Mold., Phytologia 48 (1981) 413; Phytologia 49 (1981) 161; Phytologia 51 (1982) 212, 246 p.p. excl. syn. *Viticipremna* H.J. Lam; Phytologia 52 (1982) 132; Mold. in Dassan. & Fosberg, Fl. Ceylon 4 (1983) 348.

Lectotype: *V. agnus-castus* L., Sp. Pl. 2 (1753) 638 (vide N.L. Britten et P. Wilson, Scient. Surv. Porto Rico 6 (1925) 149).

Allasia Lour., Fl. Cochinch. edn 2, 1 (1793) 107.
Type: *A. payos* Lour., loc. cit. (1793) 107.

Nephrandra Willd. in Cothen., Disp. Veg. (1790) 8.
Type: *N. dubia* Willd. loc. cit. (1790) 8.

Tripinna Lour., Fl. Cochinch. edn 2, 2 (1793) 476.
Type: *T. tripinnata* Lour. loc. cit. (1793) 476.

Chrysomallum Thouars, Gen. Nov. Madag. (1806) 8.
Type: *C. madagascariense* Thou. ex Steud., Nom. Bot. edn 1 (1821) 194.

Tripinnaria Pers., Synop. Pl. 2 (1806) 173.
Type: *T. cochinchinensis* Pers., loc. cit. (1806) 173.

Pyrostoma G.F.W. Mey., Prim. Fl. Esseq. (1818) 219.
Type: *P. ternatum* G.F.W. Mey. loc. cit. (1818) 220.

Wallrothia Roth, Nov. Pl. Sp. (1821) 317, nom. illeg., non Spreng (1815); Bocq., Rev. Verbenac. (1863) 181, sphalm. "*Walrothia*".
Syntypes: *W. articulata* Roth loc. cit. (1821) 317; *W. leucoxylon* Roth loc. cit. (1821) 319.

Ephialis Banks & Sol. ex Cunn., Ann. Nat. Hist. Ser. 1, 1 (1838) 461.
Type: *E. pentaphylla* Banks & Sol. ex Cunn. loc. cit. (1838) 461.

Ephiélis Banks & Sol. ex Angely, Cat. Estat. Gen. Bot. Fan. 17 (1956) 6, nom. illeg., orthographical variant.
Type: as for *Ephialis* Banks & Sol. ex Cunn.

Psilogyne A. DC., Biblioth. Univers. Genév. 17 (1838) 132.
Type: *P. viticifolia* A. DC. loc. cit. (1838) 132.

Casarettoa Walp., Rep. Bot. Syst. 4 (1845) 91.
Syntypes: *C. mollissima* Walp. loc. cit. (1845) 91; *C. diversifolia* Walp. loc. cit. (1845) 92.

?*Macrostegia* Nees in A. DC., Prod. 11 (1847) 218, non Turcz.
Type: *M. ruiziana* Nees loc. cit. (1847) 218.

Agnus-castus Carr., Rev. Hort. 42 (1871) 415.
Syntypes: *A. incisa* Carr. loc. cit. (1871) 415; *A. negundo* Carr. loc. cit. (1871) 415.

Shrubs or trees. *Stem* and branches almost terete or obscurely tetragonal, main trunk often with fissured flaky bark. *Leaves* opposite, usually of 3-5 digitate leaflets, rarely reduced to 2 or a single leaflet as in *V. rotundifolia* L., exstipulate, reticulate-veined, unicostate, petiolate or sessile. *Inflorescence* cymose, compound and often much branched, terminal or axillary, usually pedunculate. *Flowers* small, complete, zygomorphic, bisexual, hypogynous; bracts small, narrow. *Calyx* of 5 fused sepals, persistent, tubular or somewhat campanulate, variously toothed or truncate, accrescent. *Corolla* of 5 fused petals, deciduous, tubular below, 2-lipped above, 5-lobed; upper lip 2-lobed, lower 3-lobed, the middle lobe of the lower lip larger and longer than the others; tube usually villous within, often pubescent without. *Stamens* 4, didynamous, exserted, alternate with the corolla-lobes, epipetalous, inserted about the middle of the corolla-tube; filaments filiform, usually villous towards the base; anthers dorsifixed, oblong or elliptic, 2-lobed, lobes parallel or divergent. *Ovary* bicarpellary, syncarpous, 4-celled, with one ovule in each cell, attached to an axile placenta at or about the middle; style filiform, glabrous, with 2 short stigmatic lobes. *Fruit* a small succulent drupe, with endocarp separating into 4 hard one-seeded pyrenes. *Seeds* exalbuminous.

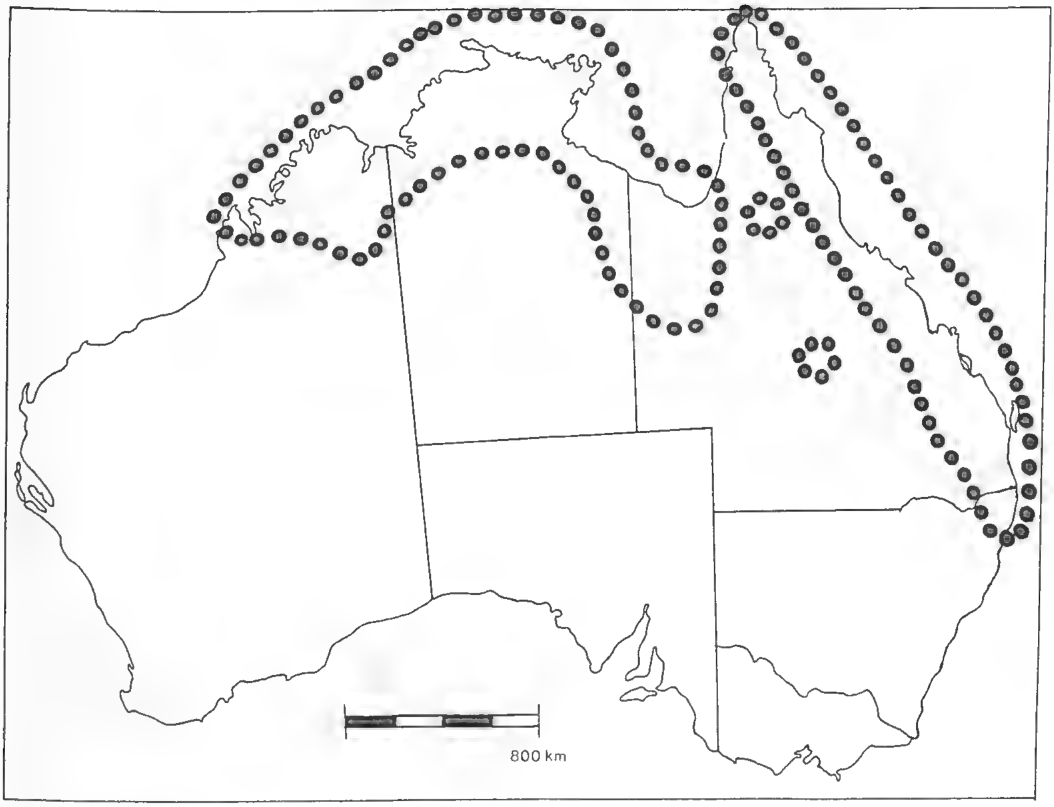
Number of species: World: ±250; Australia: 8.

Derivation of name

The generic name is derived from a name used by Pliny for the chaste tree or Abraham's balm (*V. agnus-castus* L.), the type species of the genus.

Distribution (Map 1)

The genus *Vitex* is widely distributed in the tropical and subtropical regions of Australia, Asia, Africa, with a few South American species, and at least one species extending to southern Europe. So far, it has not been recorded from northern Europe, North America, central and southern Australia, except in cultivation.



Map 1. Distribution of the genus *Vitex* L. in Australia.

Of the eight Australian species, five are endemic in Australia and the other three are widespread in Malesia and other parts of Asia. The distribution of at least two of these species (*V. trifolia* L. and *V. rotundifolia* L.f.) extends to East Africa, India, southern China, Japan and the Hawaiian Islands. *V. helogiton* is the third most widespread species occuring from Papua New Guinea and Indonesia to the Philippines, and extending southwards to northern Australia.

Comments

Very few botanists have attributed the name *Vitex* to Tournefort, rather than to Linnaeus, who merely adopted it. In some publications, Briquet's (1895) division of *Vitex* into sections and subsections has been erroneously attributed to Dalla Torre & Harms (1904), who simply adopted Briquet's classification of the Verbenaceae.

Affinities

Vitex is closely related to *Viticipremna* in its leaves being digitate; calyx persistent, accrescent; corolla-tube short and cylindrical, villous inside; stamens didynamous; style with short bifid stigma; fruit a drupe with one 4-celled pyrene. Nevertheless, *Vitex* can easily be identified by its 5-lobed corolla and calyx often 5-toothed. *Vitex* is also closely allied to *Premna* in having cymose inflorescence, zygomorphic flowers, 2-lipped corolla with a short cylindrical tube, didynamous stamens and drupaceous fruit. However, *Premna* can readily be distinguished by its leaves being simple and corolla 4-lobed.

There are a few characters common to *Vitex* and *Gmelina*. Both have a persistent accrescent calyx, 2-lipped corolla with 5 lobes and a short cylindrical tube, didynamous stamens and drupaceous fruit. The latter, however, may easily be distinguished by its leaves being simple and stigma unequally 2-lobed. In Australia, the flowers and fruit in *Gmelina* are much larger than those of *Vitex*.

Key to the Species

1a. Leaves densely hairy below or on both surfaces 5

b. Leaves glabrous excepting a few hairs on nerves 2

2a. Inflorescence axillary towards the ends of branches; cymes lax, arranged in a dichotomously branched thyrse; calyx and corolla not glandular outside; filaments glandular, villous towards the base 4

b. Inflorescence terminal; cymes arranged in a pyramidal thyrse; calyx and corolla glandular outside; filaments not glandular, glabrous in the upper half, villous towards the base 3

3a. Leaflets dark-brown to orange-brown when dry, densely glandular-dotted underneath; calyx brownish when mature and dry; ovary glandular and hairy at the top (Qld) .... 1. *V. melicopea*

b. Leaflets greenish-grey or dull brownish-grey when dry, not glandular; calyx dull brownish-grey when mature and dry; ovary not glandular, glabrous (north Qld, N.T. & W.A.) .... 2. *V. acuminata*

4a. Leaflets broadly elliptic or subrotund, obtuse or retuse, obliquely rounded at the base; ovary glabrous (west Qld, N.T., W.A. & extra Austral.) .... 3. *V. glabrata*

b. Leaflets narrowly elliptic-lanceolate, narrowing towards both ends; ovary villous at the top (north Qld & extra Austral.) .... 4. *V. helogiton*

5a. Procumbent shrub on sandy sea-shores; stem creeping, rooting at nodes; leaves mostly 1-foliolate, rotund or rotund-obovate, pubescent-tomentulose all over, usually sessile, sometimes with a petiole 1-5 (-10) mm long (Qld, N.T., W.A. & extra Austral.) .... 5. *V. rotundifolia*

b. Erect shrubs or small trees along the coast or inland; stems neither creeping nor rooting at nodes; leaves mostly 3-5-foliolate, sometimes 1-2-foliolate; leaflets lanceolate, elliptic-lanceolate, ovate or oblanceolate, glabrescent or greyish-velutinous above, petiolate, petiole 10-60 mm long 6

6a. Leaflets greyish-velutinous all over; ovary villous at the top, not glandular (north W.A.) .... 6. *V. velutinifolia*

b. Leaflets glabrescent above, greyish-tomentose or pubescent beneath; ovary glabrous, glandular 7

7a. Leaflets narrow-lanceolate, rostrate-acuminate, narrowing towards the base, mostly up to 2 cm broad; lateral nerves on ventral surface hidden by dense indumentum; fruit 3-4 mm diameter (west Qld) .... 7. *V. benthamiana*

b. Leaflets oblong-elliptic, ovate-lanceolate or oblanceolate, up to 5 cm broad; lateral nerves on ventral surface distinct; fruit 4-6 mm diameter (north-east N.S.W., Qld, N.T., W.A. & extra Austral.) .... 8. *V. trifolia*

8a. Tall shrub or a tree; leaves 3-5-foliolate; leaflets (all or at least the terminal one) always petiolulate, oblong-elliptic or ovate-lanceolate, acute or subacuminate (north-east N.S.W., Qld & extra Austral.) .... 8a. *V. trifolia* var. *trifolia*

b. Dwarf, erect or subprostrate shrub; leaves mostly 3-foliolate, sometimes 1- and 3-foliolate; leaflets always sessile, elliptic to oblanceolate, obtuse or subacuminate (Qld, N.T., ?W.A. & extra Austral.) .... 8b. *V. trifolia* var. *subtrisecta*

1. **Vitex melicopea** F. Muell., Fragm. Phyt. Aust. 5 (1865) 35, 213; Fragm. Phyt. Aust. 6 (1868) 152; Bailey, Qld Fl. 4 (1901) 1180, pro syn.; Mold., Fifth Summary Verbenac. etc. 2 (1971) 722, pro syn.

Lectotype: *J. Dallachy 314*, Rockhampton, Queensland, Australia, 7.vii.1863 (K, lectotype designated here!; MEL 97900, MEL 97912 — isolectotypes!).

V. acuminata R. Br.: Benth., Fl. Aust. 5 (1870) 67, p.p. quoad descr. of leaves & fruit, and spec. J. Dallachy from Rockhampton, Qld; Bailey, Qld Fl. 4 (1901) 1180, p.p. quoad descr. of leaves & fruit, and spec. J. Dallachy from Rockhampton, Qld; Francis, Aust. Rain-For. Trees (1951) 373, p.p. quoad descr. leaves & fruit, and loc. Gympie, Qld.

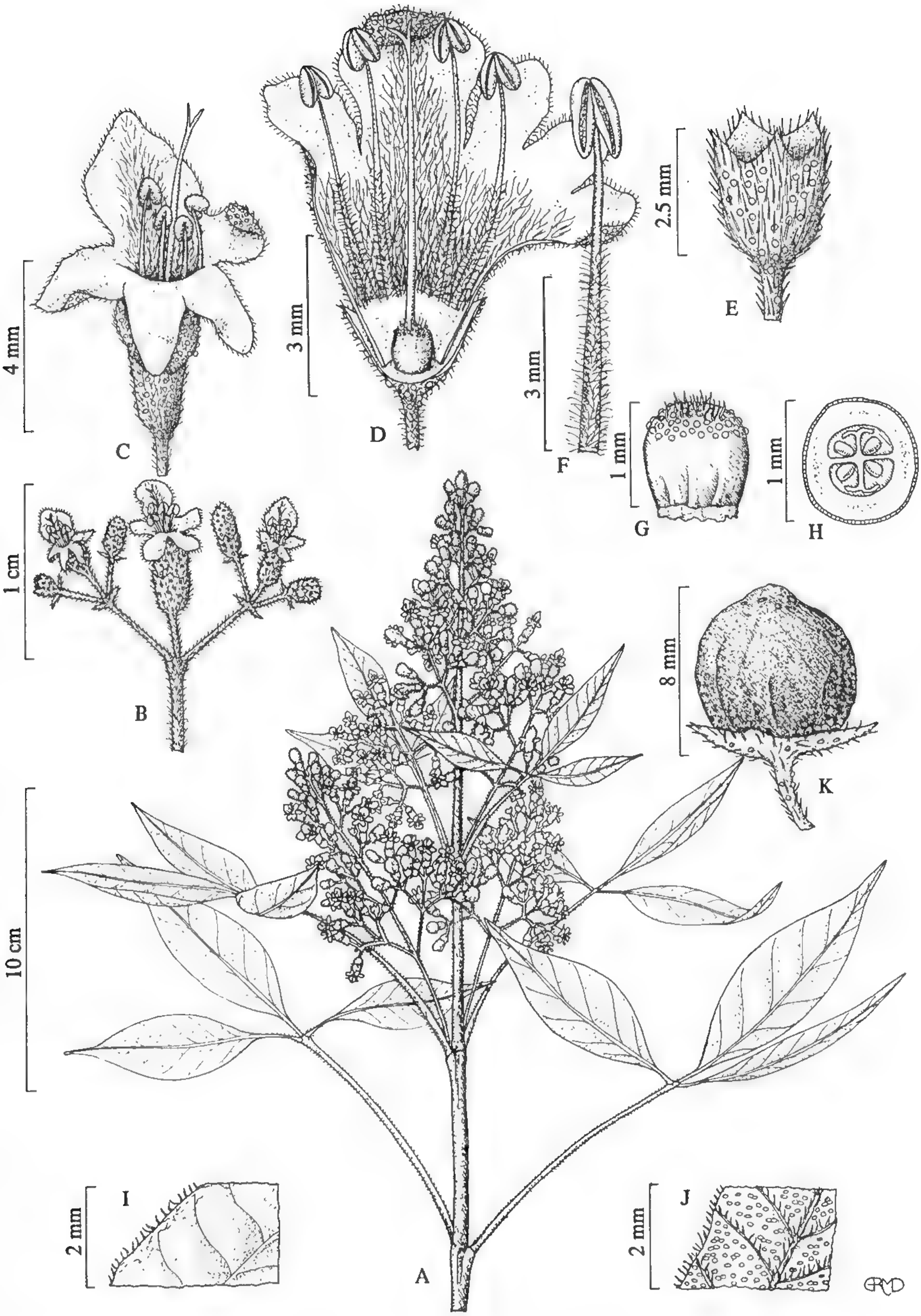


Fig. 1. *Vitex melicopea* F. Muell. (A-J, *T. Stanley & E. Ross 78114*: BRI; K, *A. Thozet 74*: MEL)

Typification

V. melicopea is based on three (syntype) collections, one by J. Dallachy (no. 314) and two by A. Thozet (nos 74 & 347), all from Rockhampton, Queensland. The collection by J. Dallachy consists of at least three duplicates, and both the collections by A. Thozet comprise at least two duplicates. With the exception of one Dallachy's duplicate at Kew, all other syntypes are in Herb. MEL. Since the author did not choose a type, it is, therefore, proposed to select a lectotype for this species. Annotations by F. Mueller indicate that he did examine all syntypes. Of these, the one in Herb. K is the only specimen annotated in F. Mueller's handwriting as "*Vitex melicopea* F. Mueller". The specimen is particularly complete and well preserved and is selected here as the lectotype.

Description (Fig. 1)

Tall shrub or tree (3-) 5-18 (-24.5) m tall. *Stem* 15-50 cm diameter, bark yellowish-brown, finely cracked longitudinally; branchlets densely greyish-pubescent. *Leaves* 3- or rarely 5-foliolate; leaflets shortly petioluled or the laterals sometimes almost sessile, lanceolate or narrowly elliptic-lanceolate, entire, acuminate, tapering at both ends, (2.5-) 4-10 (-14) cm long, (1-) 2-4 (-5.5) cm broad, chartaceous, dark-brown to orange-brown above, paler and densely glandular-dotted underneath, glabrous excepting puberulous midrib and main veins underneath and a few sparse hairs on margins; pairs of nerves 8-12 (-14); petioles greyish-pubescent, (2-) 3-6 (-9) cm long; petiolules greyish-pubescent, (2-) 5-10 (-14) mm long, sometimes absent. *Inflorescence* terminal, cineraceous-pubescent, 8-18 cm long, 7-20 cm wide; cymes pedunculate, in loosely branched thyrse, arranged in more or less pyramidal-shaped outline; lateral primary peduncles pubescent, 1.5-3 cm long. *Flowers* shortly pedicellate; pedicels pubescent, 1-2 mm long; bracts linear-lanceolate, ± 1 mm long. *Calyx* brownish, tubular, minutely 5-toothed at the top, pubescent and glandular outside, glabrous within, lobes distinct, ± 0.5 mm long; tube cylindrical, 1.5-2.5 mm long, 1.5-2 mm diam. *Corolla* "bluish-mauve", 5-lobed in the upper half, tubular below, pubescent and densely glandular outside, villous inside the tube with hairs extending to the large anterior lobe of the lower lip; the anterior lobe broadly elliptic or almost orbicular in outline, 3-4 mm long, 3-5 mm broad; the lateral lobes ovate or broadly oblong-ovate, 2.5-3 mm long, 1.5-2.5 mm broad at the base; the two lobes of the upper lip ovate, 2-2.5 mm long, 1.5-2 mm broad at the base; tube more or less cylindrical, enlarging gradually upwards, about twice the length of the calyx, 3.5-4.5 mm long, 2-3 (-3.5) mm broad at the top. *Stamens* exserted, connate to the lower half of the tube; filaments filiform, glabrous above, villous in the lower half, the anterior pair 5-6.5 mm long, the lateral pair 4-5.5 mm long; anthers more or less elliptic-oblong or almost orbicular in outline, ± 1 mm long, nearly as broad, lobes oblong, free and divergent in the lower half. *Ovary* globose, glandular at the top, often with a few hairs between the glands, glabrous in the lower half, 1-1.5 mm diam.; style exserted, glabrous, filiform, 7-9 mm long; stigma 2-fid. *Fruit* globular or somewhat ellipsoid, glabrous, sometimes with a few glands and hairs at the top, 4-9 (-10) mm long, (3.5-) 4.5-10 (-12) mm diam., shining, brick-red to brown when fresh, turning black when mature and dry; accrescent calyx expanding 4-5 mm diam.

Representative specimens (collections seen: Australian 36, non-Australian 0)

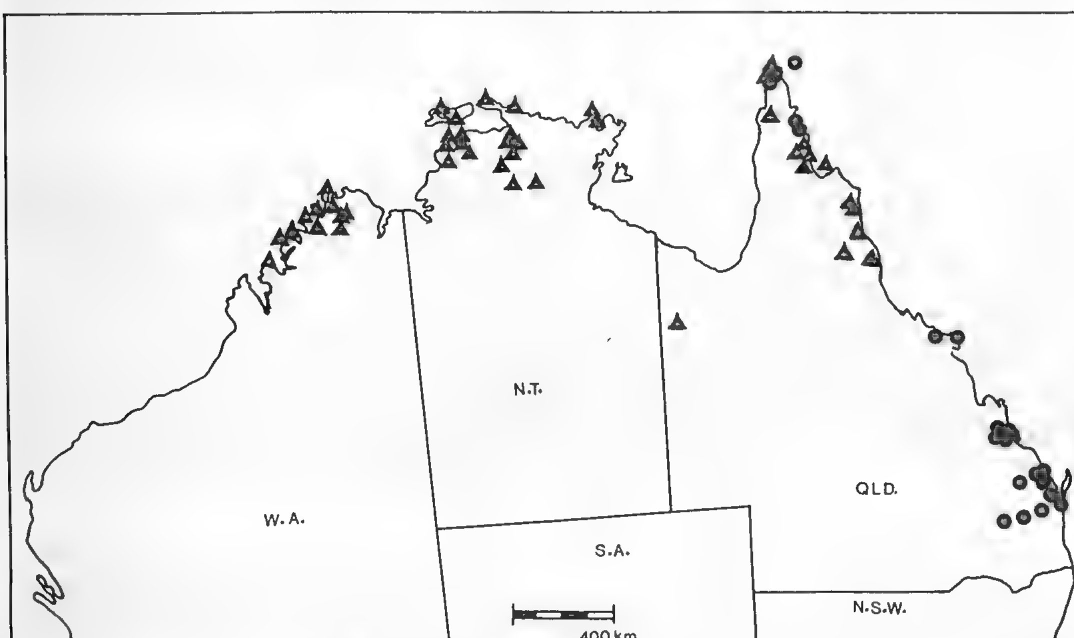
AUSTRALIA: QUEENSLAND: *Anderson 2101*, 25 km N of Rockhampton, 11.xi.1980 (BRI); *Bailey s.n.*, Bundaberg, undated (BRI 267604); *Bailey s.n.*, Rockhampton, undated (BRI 267608); *Bailey 301*, loc. cit., undated (BRI 267610); *Bailey 715*, Mt Perry, undated (BRI 267607); *Cameron 2215*, Horn Island, Torres Strait, 27.vii.1975 (QRS); *J. Dallachy 314*, Rockhampton, 7.vii.1863 (K, lectotype, MEL 2 spec., isolectotypes); *Dietrich 701 & 1773*, loc. cit., undated (MEL); *Fitzalan s.n.*, Mount Dryander, undated (MEL 97901); *Fitzalan s.n.*, Port Denison, undated (MEL 97902); *Fitzalan s.n.*, Mt Elliot, undated (MEL 97903); *Flecker 6562*, Fairyland, 13.i.1940 (QRS); *Helms 10*, Childers, 7.vi.1899 (BRI); *Henderson H2624*, Glastonbury, ca 25 km WSW of Gympie, 1.v.1978 (BRI); *Hyland 2771*, Claudie River, 2.i.1973 (QRS); *Hyland 10222*, near Lockerbie, 31.i.1980 (AD, QRS); *Jones 881*, The Caves, 25 km N of Rockhampton, 7.xi.1957 (JCT); *Kajewski s.n.*, Mt Bauple, 43 km N from Brisbane, -.xii.1922 (MEL 890); *Kajewski 55*, loc. cit. 19.i.1928 (BRI); *Michael 3013*, East Wooroolin, -.ii.1947 (BRI); *O'Shanesy 22*, Rockhampton, 15.vii.1867 (MEL); *Smith 4117*, Bingera, 26.x.1948 (BRI, L); *Smith 12561*, Red Island Point, ca 25 km SW of Cape York, 28.x.1965 (BRI, L, LAE 2 spec.); *Stanley & Ross 78114*, ca 2 km from Dundowran Beach on road to Harvey Bay, 14.xi.1978 (BRI); *Thozet 74*, Rockhampton, undated (MEL 2 spec., syntypes). *Thozet 347*, loc. cit., undated (MEL 2 spec., syntypes); *?Thozet s.n.*, loc. cit., undated (L 402530, MEL 97895-MEL 97899, MEL 97908, MEL 97909, possible syntypes); *Webb 435*, loc. cit., 27.xii.1944 (JCT); *Webb s.n.* (bulk sample no. 5362), Milman, undated (CANB); *White 1191*, Red Island Point, Cape York, xi.1955 (BRI).

Distribution (Map 2)

V. melicopea is endemic to Australia where it is known to occur chiefly in the tropical region of Queensland. The main distribution is along the east-coast mainly in the area between Brisbane and Townsville, and further north between McIlwraith Range and the tip of Cape York Peninsula. It has also been recorded from at least two off-shore islands in the Torres Strait. From inland, a few localities are reported from about 300 km north-west of Brisbane. In Cape York area, the distribution is found overlaping with *V. acuminata* R. Br.

Comments

Bentham (1870) erroneously recorded *V. melicopea* as a synonym of *V. acuminata* R. Br., in spite of distinct differences in their leaves and flowers. This was later accepted by F. Mueller (1875, 1882, 1889), Bailey (1883, 1890, 1901, 1913), Francis (1951) and others. Since the reduction of *V. melicopea* to a synonym, all collections belonging to this species have been misidentified as *V. acuminata* R. Br. It seems that Bentham did not give much importance to the distinctive characters in the leaves and flowers of these species. As a result, his description of *V. acuminata* is found to include some characters which are distinctive of *V. melicopea*. During present investigations, therefore, *V. melicopea* is found to differ from *V. acuminata* by its brownish leaves being always gland-dotted underneath, filaments much more prominently villous in the lower half and ovary distinctly glandular and hairy on top. In view of these differences, *V. melicopea* is resurrected here to its distinct specific status. Superficially, both these species have more or less the same aspect, but the above mentioned characters can easily distinguish between the two. From a distribution view point, *V. melicopea* occurs chiefly in



Map 2. Distribution of *V. melicopea* ●, *V. acuminata* ▲.

southern Queensland while *V. acuminata* is found in northern Queensland, extending westwards to the tropics of the Northern Territory and Western Australia.

The following collections from Rockhampton, now preserved in Herb. L and MEL, have no collector's number, collection number or collecting date. It seems, that they possibly belong to A. Thozet's type collections of this species. They match more closely the type material than any other collection at hand. All these unnumbered specimens are recorded here as possible syntypes: L402530, MEL97895-MEL97899, MEL97908 and MEL97909.

The leaves in *V. melicopea* are mostly 3-foliolate, rarely 5-foliolate. In the latter situation, the leaflets are almost always sessile.

Affinities

V. melicopea is closely allied to *V. acuminata* in its leaves being glabrous and more or less similarly shaped; inflorescence terminal, pyramidal; calyx and corolla glandular and pubescent outside; stamens and style exserted, and filaments villous towards the base. However, *V. melicopea* may easily be distinguished by its bark of the stem being yellowish-brown; leaflets dark-brown to orange-brown when dry, densely gland-dotted underneath; calyx brownish when mature and dry; ovary glandular and with a few hairs at the top.

2. **Vitex acuminata** R. Br., Prod. Fl. Nov. Holl. (1810) 512; Walp., Rep. Bot. Syst. 4 (1845) 86; Schauer in A. DC., Prod. 11 (1847) 695; F. Muell., Fragm. 5 (1865) 34; Fragm. 6 (1868) 153; Benth., Fl. Aust. 5 (1870) 67, p.p., excl. syn. *V. melicopea* F. Muell., & Dallachy Coll. Rockhampton; F. Muell., Fragm. 9 (1875) 5; Syst. Cens. Aust. Pl. 1 (1882) 103; Bailey, Synop. Qld Fl. (1883) 379; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Bailey, Cat. Indig. Nat. Pl. Qld (1890) 35; Briq. in Engl. & Prantl, Nat. Pflanzenfam. 4, 3a (1895) 172; Bailey, Qld Fl. 4 (1901) 1180, p.p., excl. syn. *V. melicopea* F. Muell., & Dallachy Coll. Rockhampton; Comp. Cat. Qld Pl. (1913) 386, fig. 362; Ewart & O.B. Davies, Fl. N. Terr. (1917) 237; C. Gardner, Enum. Pl. Aust. Occ. part 3 (1931) 112; Francis, Aust. Rain-For. Trees (1951) 373, p.p., exclud. description of leaves & fruit, and locality Gympie; Mold., Résumé Verbenac. etc. (1959) 211; Mold., Phytologia 16 (1968) 491; Beard, Descrip. Cat. W. Aust. pl. edn 2 (1970) 113; Mold., Fifth Summary Verbenac. etc. 1 (1971) 349; Phytologia 34 (1976) 280, excl. syn.; Phytologia 44 (1979) 223; Sixth Summary Verbenac. etc (1980) 339; Phytologia 45 (1980) 479.

Lectotype: *R. Brown s.n.*, "North coast" (possibly Cape York Peninsula), Queensland, Australia, 1802-1805 (MEL582922, lectotype designated here!; BM (J.J. Bennett no. 2320), CANB251255, K — isolectotypes!).

Typification

V. acuminata is based on Robert Brown's collection from "North coast" of Queensland consisting of at least 4 duplicates. All duplicates were annotated by Robert Brown and certainly used by him in preparing the original diagnosis of this species. Since he did not choose any one specimen as a type, it is, therefore proposed to select a lectotype for this name. Of all the syntypes, a duplicate in Herb. MEL (MEL582922) is particularly complete and well preserved and chosen here as the lectotype of this species.

Description (Fig. 2)

Tall shrub or tree (2-) 4-18 (-25) m high. *Stem* 10-60 cm diameter, with outer bark pale or light grey, fissured and flaky; branchlets more or less quadrangular, hoary-pubescent. *Leaves* 3- or rarely 5-foliolate; leaflets mostly petiolulate, the lateral sometimes sessile, elliptic-lanceolate, elliptic-ovate or oblong-ovate, entire, mostly acuminate, cuneate at the base, (3-) 5-10 (-15) cm

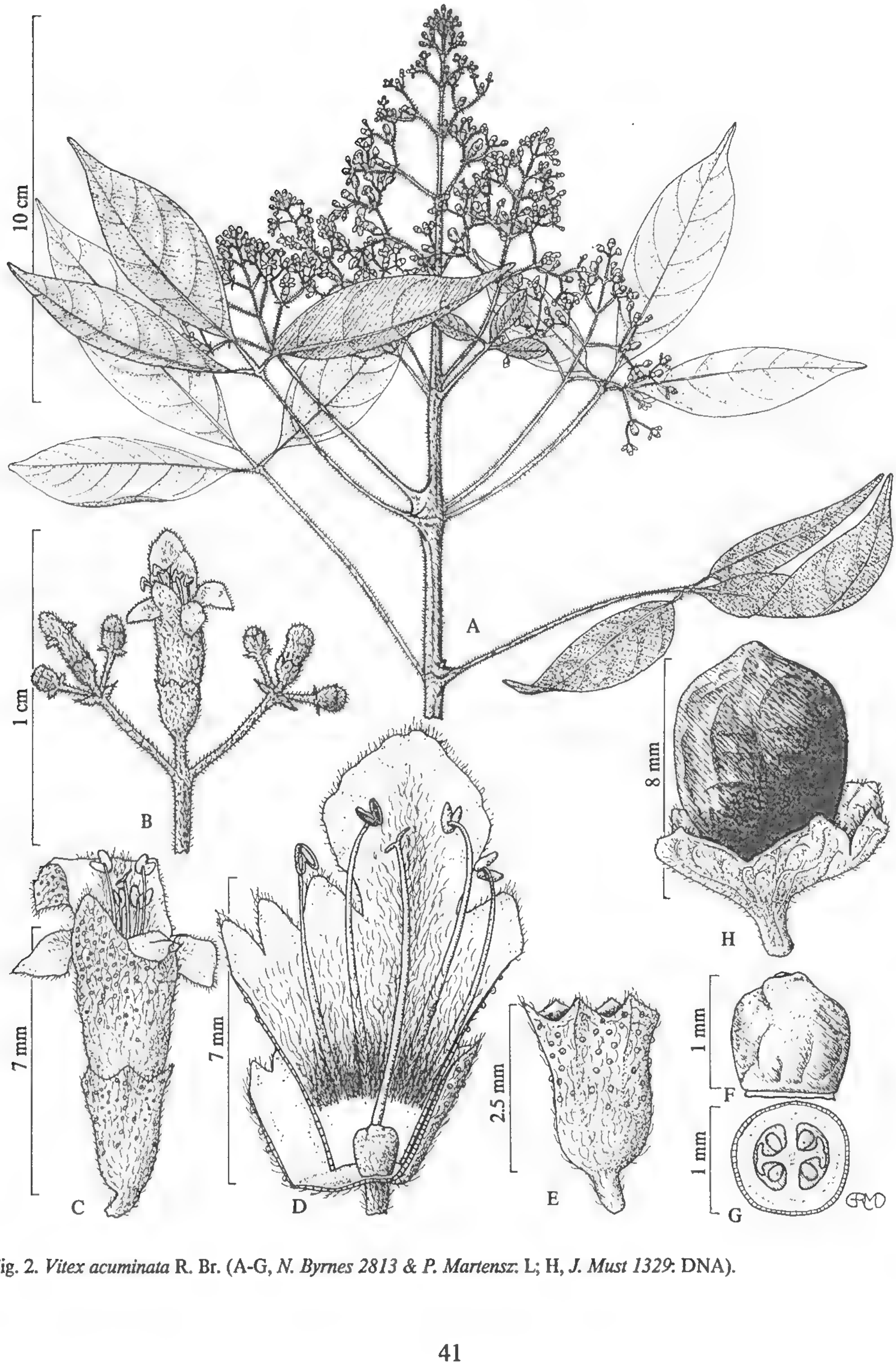


Fig. 2. *Vitex acuminata* R. Br. (A-G, *N. Byrnes 2813 & P. Martensz*: L; H, *J. Must 1329*: DNA).

long, (2-) 3-5 (-6.5) cm broad, chartaceous, greenish-grey or dull brownish-grey and glossy above, glabrous excepting some hairs on and near the midrib; pairs of nerves 8-12; petioles minutely pubescent, (3-) 4-10 (-14) cm long; petiolules greyish-pubescent, (3-) 5-15 (-20) mm long. *Inflorescence* terminal or in the upper axils, hoary-pubescent, 6-12 (-15) cm long, 8-10 (-14) cm wide; cymes pedunculate, in loose thyrse, more or less pyramidal in outline; lateral primary peduncles (1-) 2-5 cm long; flowers pedicellate; pedicels pubescent, 1-2 mm long; bracts linear-lanceolate, about 1 mm long. *Calyx* tubular, more or less cylindrical, minutely 5-toothed at the top, pubescent and sparsely glandular outside, glabrous within, 2-3 mm long, 1.5-2 mm diam. *Corolla* blue or pale mauve with a creamy throat, 5-lobed in the upper half, tubular below, pubescent and glandular outside, villous inside the tube, with hairs extending to the large anterior lobe of the lower lip; the anterior lobe broadly ovate, elliptic-oblong or almost orbicular in outline, 3-5 mm long, 2.5-5 (-6) mm broad; the two lateral lobes more or less oblong-ovate, 2.5-3.5 (-4) mm long, 2-3.5 mm broad at the base; the two lobes of the upper lip oblong-ovate, 2-3 mm long, 1.5-2.5 mm broad at the base; tube more or less cylindrical with gradual dilation upwards, about twice as long as the calyx, 5-6.5 mm long, 3-4.5 mm broad at the top end. *Stamens* exserted, connate to about the middle of the corolla-tube; filaments filiform, glabrous above, villous in the lower half, the anterior pair 6.5-8 (-9) mm long, the lateral pair 6-7 (-7.5) mm long; anthers more or less elliptic-oblong or almost orbicular in outline, about 1 mm long, nearly as broad, lobes oblong, free and divergent in the lower half. *Ovary* globular, glabrous, non-glandular, about 1 mm diam.; style exserted, glabrous, filiform, 8-11 mm long; stigma distinctly 2-fid. *Fruit* globular-ellipsoid or somewhat obovoid, glabrous, 4.5-8 (-10) mm long, (3-) 4-7 (-8) mm diam., "dark purple when ripe", turning black when mature and dry.

Representative specimens (collections seen: Australian 66, non-Australian 0)

AUSTRALIA: QUEENSLAND: *R. Brown s.n.*, north coast, loc. incert., 1802-1805 (BM J.J. Bennett no. 2320, CANB251255, K, MEL582922); *Cameron 20265*, Prince of Wales Island, Torres Strait, 8.ii.1975 (QRS); *Hyland 3768*, Claudie River, 20.vii.1978 (QRS); *Hyland 7515*, Oliver River, 14.ix.1974 (BRI, QRS); *Perry 1052*, near Undilla Station, 28.iv.1948 (NT); *Persieh 1001 & 1002*, Endeavour River, -1883 (MEL); *Webb 3112*, Dinner Creek on Coen-Port Stewart Rd, -xi.1956 (BRI); *Webb & Tracy 6644*, Miriwinni near Mt Bartle Frere, -1962 (BRI, CANB); *Webb & Tracy 6992*, Bamaga, tip of Cape York Peninsula, -1962 (BRI, CANB); *Webb & Tracy 9052*, Shipton Flat between Roseville & Mt Finnegan, SW of Cooktown, 15.v.1969 (BRI, CANB); *Webb & Tracy 11183*, Sweet Creek on Cook Highway between Cairns and Mossman, undated (BRI, CANB).

NORTHERN TERRITORY: *Bleeser 533*, Darwin, -xi.1929 (MEL, NSW); *Byrnes 556*, Lee Point, Darwin, 13.ii.1968 (DNA, NT); *Byrnes 2813 & Martensz s.n.*, Cannon Hill, 1.xi.1972 (CANB, DNA, K, L, NT); *Craven 2344*, N side of Mt Brockman, 21.ii.1973 (A, CANB, L, LAE, NT); *Dunlop 3101*, Wagait Reserve, 16.i.1973 (CANB, DNA, FRI-DWN, NT); *Dunlop 3836*, Warangaiyu Lagoon, Elcho Island, 3.vii.1975 (CANB, DNA, NT); *Lazarides & Adams 282*, 9 miles NNE of Darwin, 2.iii.1965 (B, BRI, CANB, E, K, L, NSW, NT, P, US); *Maconochie 549*, East Point, Darwin, 13.ii.1968 (NT); *Martensz & Schodde AE354*, Koolpin Creek Gorge, S of El Sharana, 16.i.1973 (BRI, CANB, K, L, MO, NT); *McKean B829*, Deaf Adder Creek, 18.xi.1972 (CANB, DNA, K, NT); *Must 1329*, Berry Creek, 9.xii.1974 (BRI, CANB, DNA, NT); *Stocker 267*, Banjo Beach, Melville Island, -i.1966 (BRI, DNA, NT); *Swinbourne 686*, Canopy Rock, Mountain Valley Station, 25.iii.1963 (CANB, NT); *Telford 7987 & Wrigley*, Kakadu National Park, Deaf Adder Gorge, 22.iv.1980 (CBG); *Webb & Tracy 12541*, near Cahills Crossing, East Alligator River, -.v.1978 (BRI).

WESTERN AUSTRALIA: *Beard 7034*, Mitchell Plateau, N Kimberley, xii.1974 (DNA, PERTH); *Crawford 12*, Kalumburu, 31.xii.1973 (PERTH); *George 12701*, Mt Trafalgar, Prince Regent River, 26.viii.1974 (PERTH); *George 14131*, Forest Creek near Drysdale River, 21.viii.1975 (PERTH); *Wilson s.n.*, Careening Bay, S of Coronation Island, 25.v.1972 (PERTH); *Wilson 10856*, Augustus Island, Bonaparte Archipelago, 18.v.1972 (PERTH).

Distribution (Map 2)

V. acuminata is endemic to Australia where its main distribution is in the tropics of northern Queensland, Northern Territory and Western Australia. In Queensland, it is known chiefly from the eastern and northern coastal areas of Cape York Peninsula. From offshore islands, it has been recorded from Horn Island and Prince of Wales Island in the Torres Strait. One collection, reportedly from near Undilla Station, is outside the main distribution area.

In the Northern Territory, the main distribution is in the Darwin area extending southwards to Daly River and eastwards to Mary River. A fair number of collections have also come from the area between Oenpelli Mission Station and El Shirana Mining township. It has also been reported from at least three different locations along the north coast of Arnhem Land. Other than the mainland, it is known to occur only on Melville Island.

Distribution in Western Australia is in the Kimberley region where it seems restricted between latitude 13° and 17°S and longitude 123° and 127°E. It has mainly been recorded from along Drysdale River extending westwards to the coastal areas. The only offshore records of this species have come from Augustus Island and Koolan Island.

Comments

Bentham (1870) described the leaflets of this species as "paler and usually glandular-dotted underneath". In fact these are not characters of *V. acuminata* because the leaflets in this species are free of glands and similar in colour above and below. It appears from the specimens cited, that Bentham erroneously incorporated into this species a few specimens belonging to *Vitex melicopea* F. Muell. and *Viticipremna queenslandica* Munir. The leaflets of both these species are found to be densely covered underneath with yellowish glands that give them a paler look. Of the two Dallachy collections cited by Bentham under the species, the one from Rockhampton is the type of *Vitex melicopea* and the other from Rockingham Bay belongs to *Viticipremna queenslandica.* Apparently Bentham disregarded the leaf and flower-characters while reducing *V. melicopea* to synonymy with *V. acuminata.*

Francis (1951) recorded this species from Gympie, Queensland. In fact, *V. acuminata* does not occur anywhere south of the Atherton Tableland. From the description provided and the specimens annotated by Francis himself, it seems that he too considered *V. acuminata* and *V. melicopea* as one species. The records of *V. acuminata* from Rockhampton, Gympie and Brisbane areas, therefore, have been based on the misidentification of *V. melicopea* specimens as this species. In fact, *V. melicopea* is known to occur commonly around Rockhampton and other south-eastern parts of Queensland. Francis (1951) described the fruit as "red, globose, about half an inch in diameter". This seems to have been taken from *V. melicopea* or *V. glabrata* R. Br. The fruit in *V. acuminata* is dark purple, globular-ellipsoid, 4.5-8 (-10) mm long, (3-) 4-7 (-8) mm in diameter.

A collection by P.G. Wilson 10856 (PERTH) from Augustus Island, Western Australia is reported to have "pale yellow" flowers. The collection has been correctly identified as *V. acuminata* but the given flower-colour seems unusual. The flower-colour recorded by most other collectors is blue or pale mauve.

The largest leaves are noticed in the collections from areas receiving high rainfall averaging 1.7-4 m annually. The leaves in some juvenile specimens are found to be irregularly toothed or lobed.

Some overseas collections, without flowers or fruit, have been identified as this species. In general appearance they seem nearer to *Viticipremna* but due to lack of flowers they cannot be positively identified. Material of *V. acuminata* has also been misidentified and distributed in some herbaria as *V. glabrata* R. Br.

Bailey (1888) described this species as having close-grained brown wood suitable for cabinet-work. According to Webb (1948) this species is suspected of causing mortalities in dairy stock at Kingaroy.

Affinities

V. acuminata is closely related to *V. melicopea.* For details see "Key to the Species" and "affinities" under the latter. *V. acuminata* has also several characters common with *V. glabrata.* Both species have glabrous leaves, exserted stamens and style, and a glabrous ovary. However, *V. glabrata* can easily be identified by its leaflets being broadly elliptic or subrotund, obtuse or retuse, obliquely rounded at the base; inflorescence axillary, lax, dichotomously branched; calyx and corolla not glandular outside and filaments distinctly glandular.

3. **Vitex glabrata** R. Br., Prod. Fl. Nov. Holl. (1810) 512; Benth., Fl. Aust. 5 (1870) 68, p.p., excl. spec. Qld; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103, p.p. quoad spec. N. Aust.; Sec. Syst. Cens. Aust. Pl. 1 (1889) 173, p.p., quoad spec. N. Aust.; Schumann in Schumann & Hollr., Fl. Kais.-Wilh. Land (1889) 121, p.p., excl. *Hollrung 672 & 708*; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 172; Bailey, Qld Fl. 4 (1901) 1180, p.p., excl. spec. Qld; Ewart & O.B. Davies, Fl. N. Territory (1917) 238; W. Fitzg., Journ. & Proc. Roy. Soc. W.Aust. 3 (1918) 202; H.J. Lam, Verbenac. Malay. Arch. (1919) 203, p.p., quoad syn. *V. cunninghamii* Schauer, & Distrib. N. Aust. & W. Aust.; H.J. Lam & Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 62, p.p., quoad spec. N. & W. Aust.; Dop, Fl. Gen. Ind-Chine 4 (1935) 840, p.p., quoad spec. N. & W. Aust.; Specht in Specht & Mountford, Recd Amer.-Aust. Sc. Exped. (Bot.) Arnhem Land (1958) 292, p.p., excl. Qld & N.G.; Mold., Résumé Verbenac. etc (1959) 211, p.p., excl. pl. Qld; Mold., Fifth Summary Verbenac. etc. 1 (1971) 349 & 716, p.p., excl. Qld; Mold., Phytologia 44 (1979) 493, p.p., quoad spec. N & W. Aust.; Sixth Summary Verbenac. etc (1980) 339, p.p., excl. Qld; Phytologia 45 (1980) 483, p.p., quoad spec. N. & W. Aust.; Mold., Phytologia 48 (1981) 458, p.p., quoad *Lazarides 7986* ex N.T.; Phytologia 49 (1981) 166, p.p., excl. spec. ex Qld & N.S.W.; Phytologia 51 (1982) 254, p.p., quoad spec. ex N.T.

Lectotype: *R. Brown s.n.* (J.J. Bennett no. 2319), Groote Eylandt, Northern Territory, Australia, -1803 (MEL97917, lectotype designated here!; BM, MEL97916 — isolectotypes!).

V. cunninghamii Schauer in A. DC., Prod. 11 (1847) 691; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 172; F. Muell., Fragm. 6 (1968) 153, p.p., excl. spec. ex Qld.

Type: *A. Cunningham 256*, Careening Bay, north-west coast, Western Australia, -.ix.1820 (G-DC!, K 2 spec.!, MEL 2 spec.! — syntypes).

Typification

V. glabrata is based on Robert Brown's collection (s.n., *J.J. Bennett no. 2319*) from Groote Eylandt consisting of at least 3 duplicates. All duplicates were possibly used by Robert Brown in preparing the protologue of this species. Since he did not choose any one specimen as a holotype, it is proposed to select a lectotype for this name. Of all the available syntypes, a duplicate preserved in Herb. MEL (MEL97917) is the only one annotated by the author himself. The specimen is particularly complete and well preserved and chosen here as the lectotype for this species.

Description (Fig. 3)

A tall shrub or tree (3-) 5-9 (-12) m high. *Stem* 15-40 cm diameter, bark brownish-grey, finely fissured; branchlets obtusely quadrangular, more or less fulvous-pubescent, becoming glabrescent. *Leaves* 3-5-foliolate; leaflets broadly elliptic, subobovate or sometimes subrotund, obtuse or retuse at the apex, sometimes obtusely acuminate, obliquely rounded at the base, (3-) 5-16 (-21) cm long, (2-) 3.5-8 (-13) cm broad, chartaceous or membranous, brownish or somewhat blackish-brown when dry, glabrous excepting minute pubescence on the midrib and main nerves underneath, glossy above, dull below; pairs of nerves 6-15 (-17); petioles glabrous or somewhat pubescent when young, (3-) 5-10 (-15) cm long; petiolules glabrous, somewhat pubescent when young, 1-3 (-5) cm long, rarely absent. *Inflorescence* axillary, lax, almost always shorter than the leaf, minutely pubescent, (8-) 10-18 (-23) cm long, 8-18 cm wide; cymes slender, very loose and dichotomously branched, primary peduncle puberulous but becoming glabrous, (2-) 3-7 (-9.5) cm long. *Flowers* pedicellate, rather small; pedicels

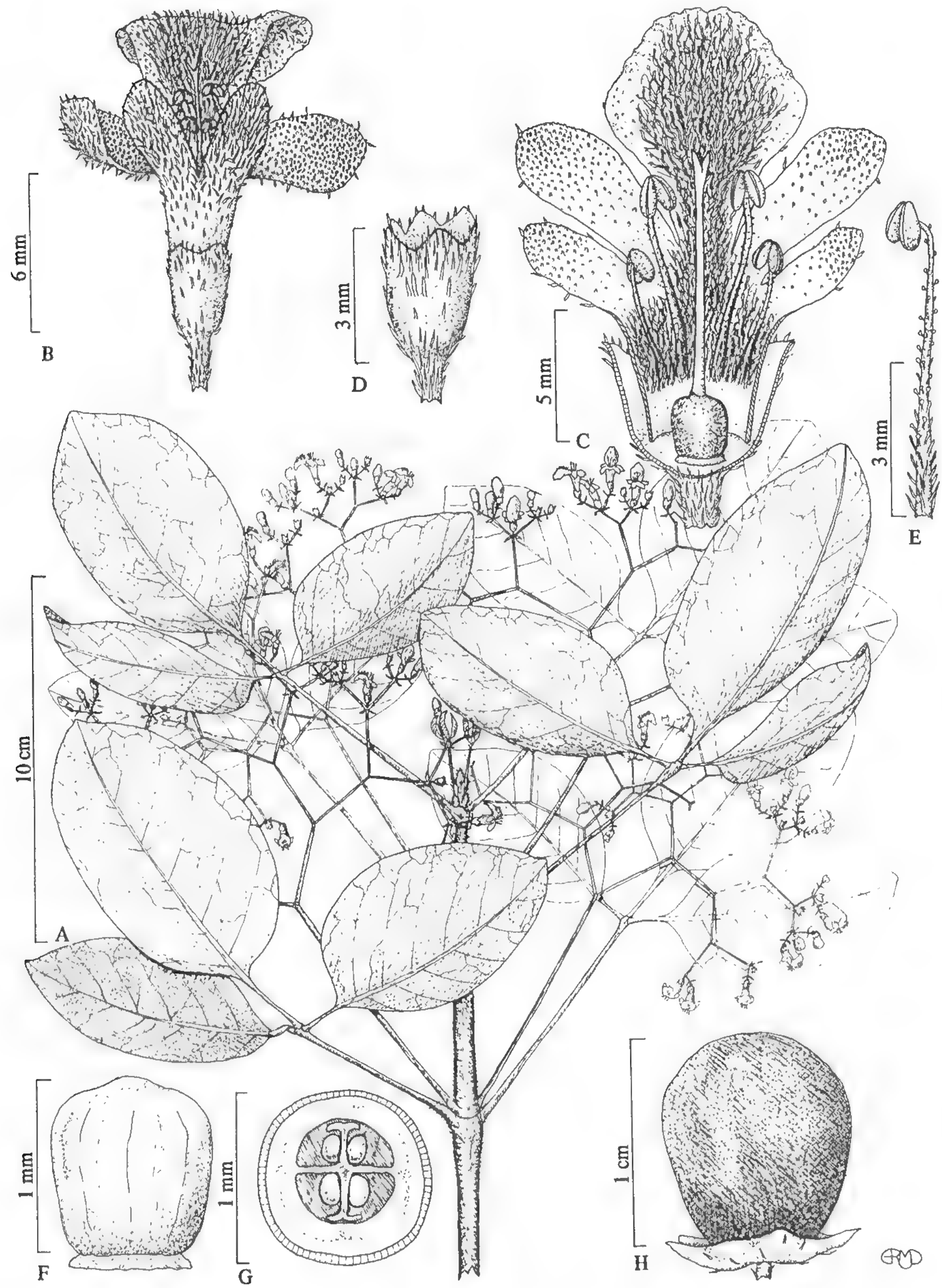


Fig. 3. *Vitex glabrata* R. Br. (A-G, *C. Dunlop 3598*: NT; H, *C. Dunlop & G. Wightman 322*: DNA).

pubescent, 1-3 mm long; bracts small, caducous, 2-3 mm long; bracteoles 2, minute, lanceolate, ± 0.5 mm long. *Calyx* cupuliform, tubular, with 5 minute teeth at the top, minutely and appressedly pubescent outside, glabrous within; lobes ± 0.5 mm long; tube more or less cylindrical, 2-3 mm long, 1.5-2 mm diam. *Corolla* cream-white with a purple tinge especially on the inside of the mid-lower lobe, 5-lobed (2-lipped) in the upper half, tubular below, pubescent but non-glandular outside, glabrous within near the base of the tube, otherwise densely villous within the tube with hairs extending to the large anterior lobe of the lower lip, the smaller lobes papillose within; the large anterior lobe pink, nearly as long as the tube, broadly elliptic-obovate or almost orbicular in outline, 3.5-6 (-8) mm long, 3-4.5 (-5) mm broad; the lateral lobes of the lower lip elliptic-ovate or oblong-ovate, 2.5-3 (-4) mm long, 2-3 (-3.5) mm broad at the base; the two lobes of the upper lip more or less broadly ovate or almost orbicular in outline, 2-3 (-3.5) mm long, 1.5-2 (-3) mm broad at the base; tube more or less cylindrical, about twice as long as the calyx, 4-6 mm long, 1.5-2.5 mm diam. at the top. *Stamens* exserted, connate to the tube; filaments filiform, villous in the lower half, glandular in the upper half, somewhat broadened below, the anterior pair 5-7.5 mm long, the lateral pair 3.5-5.5 mm long; anthers more or less orbicular in outline, ± 0.5 mm long, nearly as broad, lobes free and divergent in the lower half. *Ovary* globose, glabrous, 1-1.5 mm diam.; style exserted, glabrous, filiform, 5-8 mm long, stigma shortly 2-fid. *Fruit* obovoid or somewhat ellipsoid, glabrous, 5-10 (-13) mm long, 5-9 mm diam., dark purple when mature, turning black when dry; accrescent calyx expanding, 5-7 (-9) mm diam.

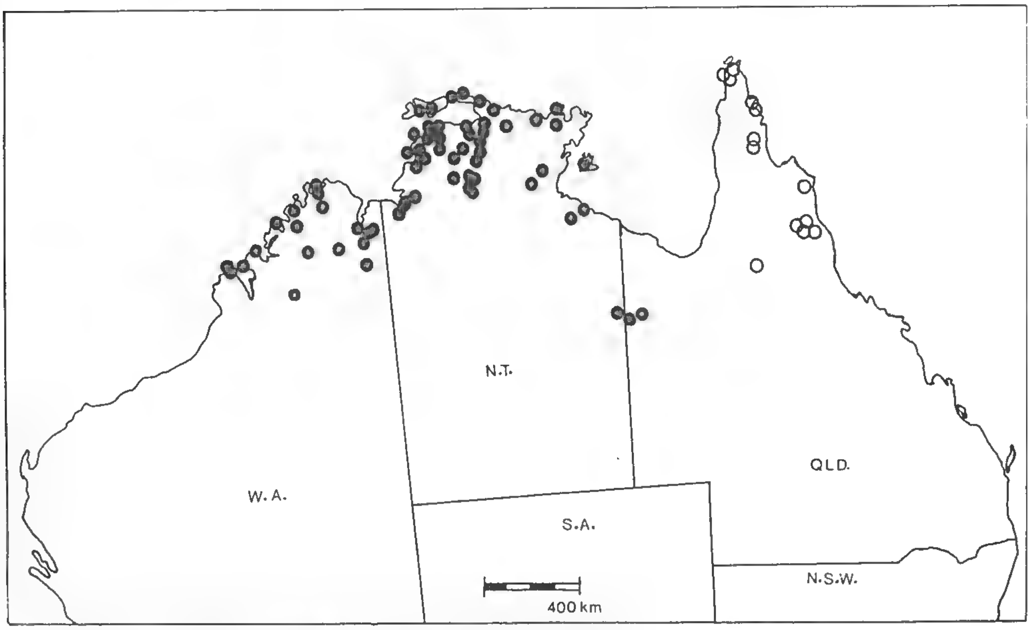
Representative specimens (collections seen: Australian 104, non-Australian 0)

AUSTRALIA: NORTHERN TERRITORY: *Adam 872*, Wyndham Road, ca 13 miles SW of Katherine, 7.ii.1974 (BRI, CANB, K, L, NT, NSW, US); *Blake 17100*, South Alligator River, 30.ix.1946 (BRI); *R. Brown s.n.* (J.J. Bennett no. 2319), Groote Eylandt, 1803 (BM, MEL 2 spec., syntypes of *V. glabrata*); *Craven 3887*, McArthur River Area, 12.ii.1976 (CANB); *Dittrich s.n.*, from Herbert River to Carpentaria, 1886 (AD, MEL); *Dunlop 3980*, Melville Island, 15.xii.1975 (DNA, NT); *Holtze s.n.*, Port Darwin, 1883 (MEL97918); *Latz 3298*, Wessel Island, 30.ix.1972 (BRI, CANB, NT, PERTH); *Lazarides 7946*, ca 7 miles W of Mt Gilruth, 2.iii.1973 (CANB, L, NT); *Lazarides 282*, 9 miles NNE of Darwin, 20.iii.1965 (B, BRI, CANB, E, K, L, NSW, NT, P, US); *Martensz AE717*, ca one mile WSW of Cannon Hill, 4.ii.1973 (CANB, K, NT); *Martensz & Schodde AE380*, El Sharana Mining Camp vicinity, 17.i.1973 (CANB, L, NT); *F. Mueller s.n.*, Fitzmaurice River, x.1855 (MEL97931); *F. Mueller s.n.*, Liverpool River, 2.x.1867 (MEL97935); *Must 1097*, Lookback Billabong, Elizabeth Downs, 19.x.1972 (CANB, DNA, K, L, NT); *Parker 529*, Yarrawonga area, 7.xi.1974 (DNA, K, L, NE, NT); *Rankin 1531*, Whitestone Creek area, 18.x.1978 (CANB, DNA, NE, NSW); *Schodde AE18*, Harrys Cave, S Mt Brockman Range, 3.xi.1971 (CANB, DNA, K, NT); *Specht 1076*, Oenpelli, 27.ix.1948 (AD, BRI, CANB, L, MEL, PERTH); *Webb & Tracey 12538*, Woolaning-Channel Pt Road, N of Daly River, -v.1978 (BRI); *Webb & Tracey 12549*, western gully of Mt Douglas west, -v.1978 (BRI); *Webb & Tracey 12556*, Ginger Palmer's Camp, Fright Point, E of Darwin, -v.1978 (BRI); *Wightman 1115*, Murgenella, 10.ii.1984 (DNA); *Wightman & Dunlop 322*, Channel Point, 25.xi.1982 (DNA); *Wilson 180*, Maude Creek, Goldfield area, 12 miles E of Katherine, 23.i.1965 (CANB, K, L, NSW, NT, US).

WESTERN AUSTRALIA: *Beard 8357*, W of Mitchell River, near Mitchell Plateau, north-western Kimberley, 22.ii.1978 (PERTH); *Crawford 13*, Kalumburu, 31.xii.1973 (PERTH); *Cunningham 256*, Careening Bay, NW coast -ix.1820 (G-DC, K 2 spec., MEL 2 spec., syntypes of *Vitex cunninghamii* Schau.); *Fitzgerald 1649*, Dillon Springs, E Kimberley, -x.1906 (NSW145233, PERTH); *Froggat s.n.*, Kings Sound, 1888 (MEL97922); *Kenneally 6649*, on western side of Mitchell Plateau, 17.v.1978 (CANB, PERTH); *Mackenzie 691101*, between King River Pumping Stn and Kununurra, 1.xi.1969 (CANB); *Rust 46K*, Karunjie Stn, -.x.1954 (CANB, PERTH); *Speck 4858*, 48 miles SSE of Kalumburu Mission, 1.ix.1954 (CANB); *Telford & Butler 6183*, Carson Escarpment, 36km E of new Theda Homestead Gorge near Wonjarring, Glider Gorge, 27.vii.1977 (CBG).

Distribution (Map 3)

V. glabrata is known chiefly from the tropics of the Northern Territory and Western Australia. In the Northern Territory most localities are to the north of latitude 15°S where the majority of collections came from the areas around Darwin, Katherine, the Alligator River and from within Arnhem Land. A few localities from south of latitude 15°S are reported from near the Victoria and McArthur Rivers. One collection from between the Herbert River and the Gulf of Carpentaria was collected by Lieut. Dittrich during 1886. Since then, this species has never been recollected from that area. From offshore islands of the State, it has been recorded from Groote Eylandt in the Gulf of Carpentaria and from Melville Island, north of Darwin.



Map 3. Distribution of *V. glabrata* ●, *V. helogiton* ○.

In Western Australia, the main distribution is in the Kimberley region, mostly to the north of the Fitzroy and Ord Rivers. Within this region, the northern-most locality is near Kalumburu Mission Station and the southern-most near Oscar Range along the Northern Highway. Outside the Kimberlies, this species has been recorded from Lombadina Mission and the coastal areas of King Sound Bay.

The occurrence of *V. glabrata* in Queensland has not been confirmed by any collection. It was recorded from that State by Bentham (1870), F. Mueller (1882, 1889), Bailey (1901, 1913), H.J. Lam (1919), Moldenke (1959, 1971, 1980) and others. All these records were based on misidentification of the closely related species *V. helogiton* which has similar lax axillary inflorescences and several flower-characters in common with *V. glabrata*. Almost all collections from Queensland and several from Papua New Guinea, Indonesia and the Philippines hitherto misidentified by others as "*V. glabrata*" are being referred here to *V. helogiton*.

It seems that *V. glabrata* R. Br. is endemic to the northern part of Northern Territory and Western Australia, although it may occur in the border region of northern Queensland. The following two collections, gathered just across the border from Queensland, may possibly belong to *V. glabrata*: *Listang 336* (BRI) from near Camooweal and *Perry 1052* (BRI, CANB) from Undilla Station. These specimens are without flowers or fruits, but the shape and texture of their leaflets are nearest to *V. glabrata*.

Comments

Bentham's concept of *V. glabrata* and its distribution range was accepted by F. Mueller (1882, 1889), Bailey (1901, 1913) and others. F. Mueller (1865) recorded it from New South Wales by misidentification of a cultivated specimen of the New Zealand *V. lucens* T. Kirk as *V. glabrata*. For the first time, Schumann (1889, 1901) reported *V. glabrata* from New Guinea by identifying two Hollrung's collections (nos. 672 & 708) as *V. glabrata*. Subsequently, however, Schumann (1905) recognised both the above Hollrung's collections as distinct from *V. glabrata* and thus described them as a new species *V. helogiton* Schumann.

H.J. Lam (1919, 1921) recorded *V. helogiton* and a few other names as synonyms of *V. glabrata*, and gave its distribution from northern Australia to all over Malesia, Indochina and India. Lam's (1919) distribution range for *V. glabrata* was accepted by Merrill (1923), Burkill (1966) and Moldenke (1959, 1971, 1980). He regarded *V. glabrata* and *V. helogiton* as conspecific because superficially both species appear to be one and the same taxon. They have similar axillary inflorescences, and apart from the villous ovary apex in *V. helogiton*, all flower-characters of both the species are almost the same. Apparently, H.J. Lam (1919, 1921) did not examine the type of *V. glabrata* nor any Australian collection of this species from Northern Territory or Western Australia.

In the course of present investigations, *V. helogiton* was found to be a distinct species, differing from *V. glabrata* by its leaflets being generally lanceolate, acuminate, cuneate towards the base and ovary always hairy (villous) on top. The leaflets of *V. helogiton* often turn from deep dark-brown to almost black when dry. H.J. Lam's (1919) description of *V. glabrata* and the specimens cited by him mostly belong to *V. helogiton*. His concept of *V. glabrata*, which in fact mainly comprises *V. helogiton*, was widely accepted by others. Since 1919 the name *V. glabrata* has therefore been often misapplied to all non-Australian and Queensland material of *V. helogiton*.

Anderson (1947) recorded *V. glabrata* from the northern subdivision of New South Wales, but the author admits that he has seen no specimens of this species. It is not clear whether this record was based on a misidentification of a different species or perhaps on F. Mueller's records of *V. glabrata*.

The present author has seen no cultivated *V. glabrata* from outside Australia. However, the reported cultivation of this species in Java, Madagascar and Mauritius possibly refers to *V. helogiton*.

Material of *V. glabrata* has been misidentified and distributed in some herbaria as *V. acuminata* R. Br. and/or *V. quinata* (Lour.) F.N. Will.

Affinities

V. glabrata is nearest to *V. helogiton* in its leaves being glabrous; inflorescence axillary, lax and dichotomously branched; calyx and corolla not glandular outside and filaments distinctly glandular, villous towards the base. Nevertheless, *V. glabrata* may readily be distinguished by its leaflets being broadly elliptic, subrotund, obtuse or retuse, obliquely rounded at the base, and ovary glabrous all over. The leaflets in *V. helogiton* are elliptic-lanceolate, gradually narrowing towards both ends and ovary villous at the top. There are several characters in common between *V. glabrata* and *V. acuminata* (for details see "affinities" under the latter and "key to the species" as well).

4. **Vitex helogiton** Schumann in Schumann & Lauterb., Nachtr. Fl. D. Südsee (1905) 369.

Type: *M. Hollrung 672*, Augusta Station, Kaiser Wilhelms Land (i.e. Papua New Guinea), -viii.1887 (B, holotype n.v., and probably destroyed). See typification.

V. pentaphylla Merr., Philipp. J. Sci. (Bot.) 4 (1909) 320; Hall. f., Meded. Rijks-Herb. Leid. no. 37 (1918) 54.

Type: *Whitford & Hutchinson F.B. No. 9490*, Siocon River, dist. of Zamboanga, Mindanao, Philippines, -ii.1908 (PNH, syntype n.v.); *Hutchison F.B. No. 11245*, loc. cit., iii.1908 (PNH, syntype n.v.).

V. nitida Merr., Philipp. J. Sci. (Bot.) 7 (1912) 343; H.J. Lam, Verbenac. Malay. Arch. (1919) 194.

Type: *Klemme F.B. No. 19546*, Tanob, Prov. of Misamis, Mindanao, Philippines, 7.v.1911 (K!, PNH n.v. — syntypes).

V. bombacifolia Wall. Cat. (1828) no. 1749, nom. nud.

V. pallida Wall. Cat. (1828) no. 1751, nom. nud.

V. leucoxylon auct. non Linn. f.: sensu Schauer in A. DC., Prod. 11 (1847) 692 p.p.; sensu Kurz, For. Fl. Burma 2 (1877) 273; Gamble, Man. Ind. Timb. (1881) 298.

V. glabrata auct. non R. Br.: sensu Benth., Fl. Aust. 5 (1870) 68 p.p. excl. syn. *V. cunninghamii* Schauer & Pl. extra N. Aust.; sensu F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103, p.p., quoad loc. Qld; sensu Bailey, Synop. Qld Fl. (1883) 380, p.p., quoad loc. Cape York & Gilbert River; sensu C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 588, p.p., excl. syn. *V. cunninghamii* Schauer; sensu F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173, p.p., quoad loc. Qld; sensu Schumann & Hollr., Fl. Kais.-Wilh. Land (1889) 121, p.p., quoad *Hollrung 672 & 708*; sensu Bailey, Qld Fl. 4 (1901) 1180, p.p., excl. syn. *V. cunninghamii* Schauer & Pl. extra N.T.; sensu Schumann & Lauterb., Fl. D. Schutzgeb. Südsee (1901) 523, p.p., quoad *Hollrung 672 & 708*; sensu Bailey, Comp. Cat. Qld Pl. (1913) 386, p.p., quoad loc. Cooktown; sensu Hall. f. in Meded. Rijks-Herb. 37 (1918) 54, p.p., quoad pl. extra-Aust.; sensu H.J. Lam, Verbenac. Malay. Arch. (1919) 203, p.p., excl. syn. *V. cunninghamii* Schauer & loc. N & W. Aust.; sensu H.J. Lam & Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 62, p.p., excl. syn. *V. cunninghamii* Schauer & loc. N. Aust.; sensu Bakh. & H.J. Lam, Bull. Jard. Bot. Ser. III, 4 (1922) 285, p.p., quoad pl. extra-Aust.; sensu Merr., Enum. Philipp. Fl. Pl. 3 (1923) 394, p.p., quoad pl. extra-Aust.; sensu Ridley, Fl. Mal. Penin. 2 (1923) 634, p.p., excl. pl. extra-Aust.; sensu Dop, Bull. Soc. Hist. Natur. 57 (1928) 207 & 209, p.p., quoad pl. extra-Aust.; sensu Dop in Lecomte, Fl. Gen. Indo-Chine 4 (1935) 840, p.p., excl. syn. *V. cunninghamii* Schauer, *V. pentaphylla* Merr. & loc. Aust.; sensu Fletcher, Kew Bull. no. 10 (1938) 435, p.p., excl. loc. N. Aust.; sensu Specht in Specht & Mountford, Recd Amer.-Aust. Sc. Exped. (Bot.) Arnhem Land 3 (1958) 292, p.p., quoad Pl. Qld & extra-Aust.; sensu Mold., Résumé Verbenac. etc. (1959) 211 excl. N.T., 225, 283-287, p.p., quoad pl. Qld & extra-Aust.; sensu Backer & Bakh. f., Fl. Java 2 (1965) 605, p.p., quoad Pl. extra-Aust.; sensu Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 374, 603, 718, 720-22, 724, 725, p.p., quoad Pl. extra-Aust., excl. Pl. N.T. & W.A.; sensu Mold., Sixth Summary Verbenac. etc. (1980) 339, 366, 457 & 458, p.p., quoad Pl. extra-Aust., excl. Pl. N.T. & W.A.; sensu Mold., Phytologia 45 (1980) 483, p.p., excl. syn. *V. cunninghamii* Schauer; sensu Mold., Phytologia 49 (1981) 166, p.p., excl. pl. N.T. & W.A.; sensu Mold., Phytologia 48 (1981) 458, p.p., quoad pl. extra-Aust.; sensu Mold., Phytologia 51 (1982) 254, p.p., quoad pl. extra-Aust.; sensu Mold., Phytologia 52 (1982) 134, p.p., quoad Pl. extra-Aust.

Typification

The type of *V. helogiton* was not available for examination. According to Stafleu & Cowan (1979), "the type specimens of *Die Flora der deutschen Schutzgebiete* in der Südsee were in B". If the holotype of *V. helogiton* was destroyed during the Second World War, it must be investigated whether isotypes are extant. Alternatively, a neotype should be selected, and *Hollrung 708* should be taken into consideration because *Hollrung 672* and *Hollrung 708* were seen and cited by K. Schumann (1901) and annotated by him as one and the same species. A duplicate of *Hollrung 708* is preserved in Herb. MEL. The specimen is particularly complete and well preserved and should be taken into consideration as a candidate for the neotype if no isotype can be traced. Dr J. Hrynkiewicz has informed me (Pers. Comm. dated 22.xi.1984) that there is no duplicate of *Hollrung 672* extant in Herb. WRSL.

Description (Fig. 4)

A large shrub or a tree (3-) 5-20 (-30) m high. *Stem* 15-60 cm diameter, bark light brown or grey, flaky, narrowly fissured; branchlets somewhat 4-angled, the young parts pubescent, the growing parts turning black when dry. *Leaves* 3-5-foliolate; leaflets narrowly elliptic, elliptic-lanceolate, rarely elliptic-ovate, acuminate at the apex, cuneate towards the base, (3-) 5-17 (-22) cm long, (2-) 3-7 (-9) cm broad, chartaceous or membranaceous, glabrous and shining above, slightly pubescent on the midrib and main nerves underneath, dark brown, often turning black when dry, non-glandular; pairs of nerves 6-15; petioles puberulous but becoming glabrous, (3-) 5-12 (-16) cm long; petiolules puberulous, sometimes becoming glabrescent, 5-20 (-30) mm long, rarely absent. *Inflorescence* axillary, in the axil of upper leaves, lax, shorter than the leaf, minutely puberulous; cymes pedunculate, dichotomously branched, few flowered, 6-15 (-22) cm long, 6-8 (-12) cm wide; primary peduncles puberulous, later becoming glabrous, (2-) 4-7 (-10) cm long. *Flowers* pedicellate, rather small; pedicels pubescent, 1-3 (-4) mm long, often with 2 minute opposite bracteoles at the base. *Calyx* cupuliform, regularly

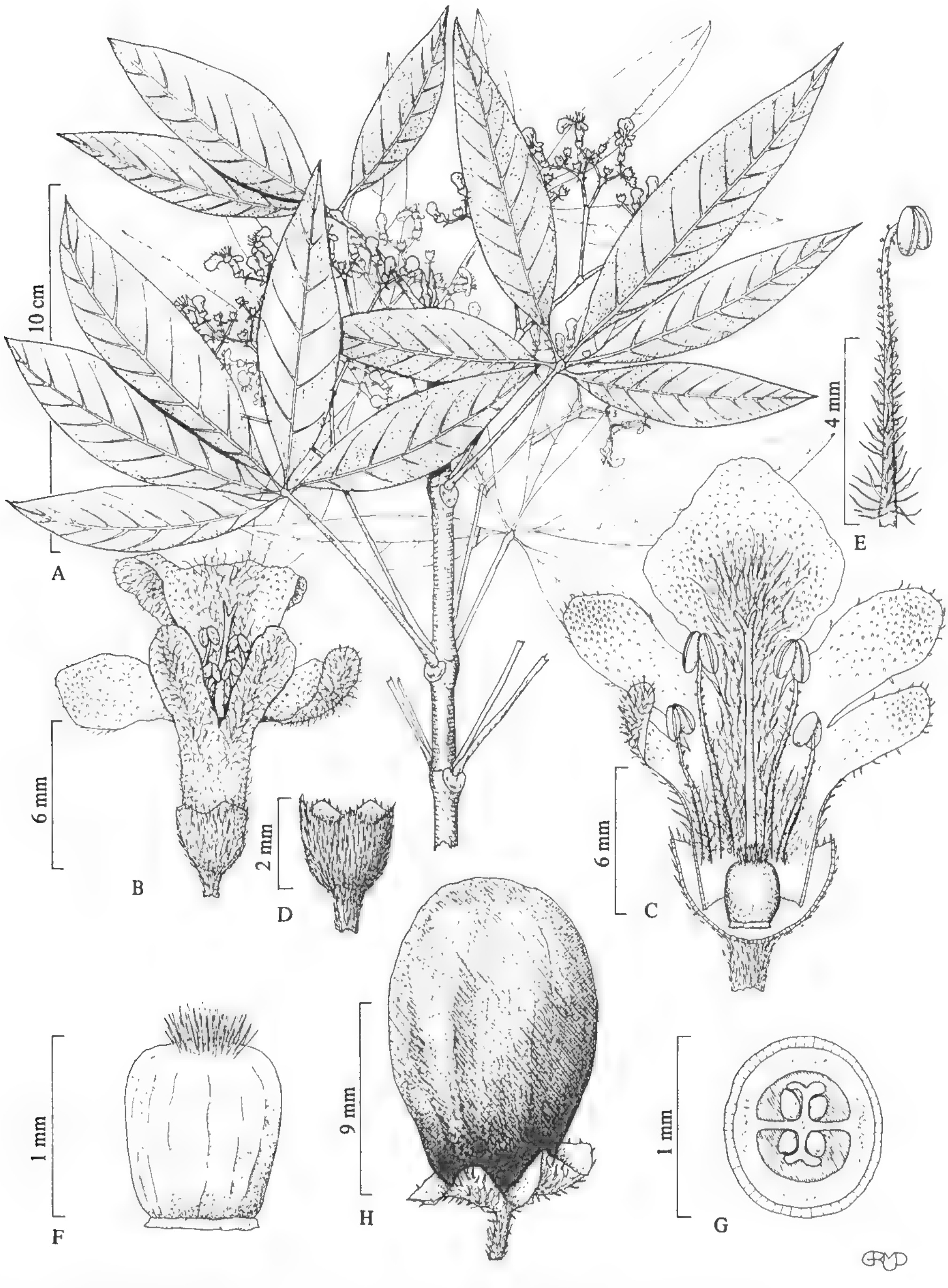


Fig. 4. *Vitex heligoton* Schumann. (A-G, *B. Hyland 12381*: QRS; H, *B. Hyland 11558*: QRS).

5-toothed at the top, pubescent outside, glabrous within; lobes small, broadly ovate, acute or acuminate, ± 0.5 mm long; tube more or less cylindrical, 2-3 mm long, 1.5-2 mm diam. *Corolla* "white", "purplish-white" or "creamy purple", 2-lipped, 5-lobed in the upper half, tubular below, pubescent but non-glandular outside, densely villous inside the tube with hairs extending to the large midlobe of the lower lip within, the smaller lobes somewhat papillose within; the large middle lobe of the lower lip broadly elliptic-obovate or almost orbicular in outline, 5-8 mm long, 4-6 mm broad; densely villous on the median portion inside; the lateral lobes of the lower lip oblong or oblong-ovate, 3-4 mm long, 2-3 mm wide at the base; the two lobes of the upper lip more or less elliptic-ovate, 3-3.5 mm long, 2-2.5 mm broad at the base; tube more or less cylindrical, inflated upwards, at least twice as long as the calyx, 5-7 mm long, 2-3 mm diam. at the top. *Stamens* exserted, connate to the corolla tube; filaments filiform, villous in the lower half, glandular in the upper half, somewhat broadened below, anterior pair 7-8 mm long, the lateral pair 6-7 mm long; anthers more or less orbicular in outline, ± 0.5 mm long, nearly as broad, lobes free and divergent in the lower half. *Ovary* ovoid-globose, villous at the top, glabrous below ± 1 mm diam.; style exserted, glabrous, filiform, 7-10 mm long, stigma shortly 2-fid. *Fruit* obovoid or oblong-obovoid, rounded at the apex, glabrous, 8-15 (-20) mm long, 6-10 (-12) mm diam., pinkish-purple when mature, turning black when dry; accrescent calyx somewhat saucer-shaped, 6-8 mm diam.

Representative specimens: (collections seen: Australian 26; non-Australian 15)

AUSTRALIA: QUEENSLAND: *Blake 14728*, Georgetown, 23.xi.1942 (BRI); *Bouel 2*, Endeavour River, -i.1881 (MEL); *Cameron 20327*, Prince of Wales Island, Torres Strait, 9.ii.1975 (QRS); *Daemel s.n.*, Cape York, -x.1866 (MEL97927, MEL582917-MEL582919); *Daintree s.n.*, Gilbert River, 1869 (MEL97936); *Flecker 1137*, Hodkinson River, 15.xii.1936 (QRS); *Flecker 6502*, Thornborough & Mt Mulligan, 30.xi.1939 (BRI); *Hyland 2469*, Lockerbie, Cape York Peninsula, 30.xi.1962 (BRI); *Hyland 11558*, Packer's Creek, 22.i.1982 (QRS); *Hyland 11760*, Parish of Kesteyen, Timber Reserve 14, 23.iii.1982 (QRS); *Moriarty 2561*, Leichhardt Creek, ca 4 km W of Mt Molloy, 9.xii.1978 (AD); *Smith 11976*, 2 miles NNW of Coen, on banks of Coen River, 16.x.1962 (BRI, L); *Smith 12415*, Bamaga Mission, 11.2 km SW of Cape York, 24.x.1965 (CANB, L); *Smith 12623*, between Somerset, ca 13 km SE of Cape York, 30.x.1965 (BRI); *Sparvell 6502*, Mareeba, 26.xi.1940 (QRS).

PAPUA NEW GUINEA: *Brass 8464*, Penzara, between Morehead and Wassi Kussa Rivers, Western division, -xii.1936 (A, BRI, CANB, LAE); *Henty & Foreman NGF 49346*, Morehead River, near station, 9.xi.1972 (A, BISH, BO, BRI, CANB, K, L, LAE, PNH, SING, SYD, US); *Hollrung 708*, Augusta Station, 1887 (B n.v., MEL!); *Katik NGF 37970*, Gogol Timber Area, Madang subdistrict, 18.x.1973 (A, BISH, BO, BRI, CANB, E, FI, K, L, LAE, M, PNH, QRS, SING, SYD, US); *Katik NGF 46595*, Enesil Village near Gogol River, 14.x.1969 (A, BISH, BO, BRI, CANB, K, L, LAE, PNH, SING, SYD, US); *Robbins 1730*, Nubia, Madang District, 16.ix.1958 (CANB, LAE).

IRIAN JAYA: *Koorders 27046*, Banjumas, Java, 20.i.1897 (K, MEL); *Koorders 28170*, Semarang, Java, 15.vi.1897 (B, BRI, K). *Lam 1144*, Meervlakte, Irian Jaya, 18.ix.1920 (BO, BRI); *Lorenzo BW7257*, Andai near Manokwari, 27.viii.1958 (BO, CANB, L); *Schram BW2748*, Hollandia, Irian Jaya, 28.iii.1956 (BO, CANB, L); *Schram BW7986*, Sanggang, Manokwari, Irian Jaya, 10.xii.1958 (BO, BRI, L); *Backer 27850*, Kangean, 1925 (BO, L).

PHILIPPINES: *Sulit PNH 12507*, Iraan Mountains Aborlan, Palawan, -v-vi.1950 (PNH); *Klemme FB19546*, Tangob, Misamis Prov., Mindanao, 7.v.1911 (K!, PNH n.v, syntype of *V. nitida* Merr.).

Distribution (Map 3)

In Australia, *V. helogiton* is chiefly known from the tropical areas of northern Queensland. The main distribution is in the coastal parts of the Cape York Peninsula, particularly north of latitude 17°S. Further south, a few collections were reportedly gathered from west of Georgetown along the Gilbert River. So far, its occurrence further inland in Queensland is not known. From off-shore islands, it has been recorded from the Prince of Wales Island in Torres Strait.

Collections from outside Australia have been examined from Papua New Guinea, Irian Jaya, Indonesia and the Philippines.

Comments

V. helogiton is recorded here for the first time from Australia. It was described by K. Schumann (1905) who had earlier (1889, 1901) identified its type as *V. glabrata* R. Br. In 1909, a conspecific collection from Mindanao Island in the Philippines was described by E.D. Merrill as a new species *V. pentaphylla*. Regarding the affinity of his new taxon, Merrill (1909) noted that "this species is most closely allied to *Vitex littoralis* Dcne.; but is at once distinguishable by its five leaflets which are not at all glandular beneath". A few years later, a different collection of the same species from the above named island was described by Merrill (1912) as another new *Vitex* species named *V. nitida*. In the protologue, he commented that it was "A species well characterised by its 3- and 5-foliolate leaves, the lower two leaflets, when present, much reduced, its axillary, peduncled cymes, truncate calyx, and densely pubescent corolla. It is most closely allied to *Vitex pentaphylla* Merr., but is apparently sufficiently distinct from that species".

In 1919, H.J. Lam reduced *V. pentaphylla* and *V. helogiton* to synonymy under *V. glabrata*, but with some reluctance he retained *V. nitida* as a distinct species. Under *V. nitida*, H.J. Lam (1919) remarked that "this species belongs possibly to the subsection *Axillares*, for it is not clear from Merrill's description whether there are only axillary cymes forming together a terminal (pseudo-terminal) panicle, or if also a real terminal panicle is present". A few years later, Merrill (1923) reduced both his species *V. pentaphylla* and *V. nitida* to synonymy under *V. glabrata*, without any mention of *V. helogiton*. Subsequently, Moldenke (1959, 1971, 1980) recorded *V. helogiton*, *V. pentaphylla* and *V. nitida* as synonyms of *V. glabrata*. Apparently, none of these authors seem to have examined the type of *V. glabrata*, because their description of *V. glabrata* is found to be that of *V. helogiton*.

During present investigation, *V. glabrata* is found restricted chiefly to the northern parts of the Northern Territory and Western Australia. The distribution range of *V. helogiton* is found to extend from northern Queensland in Australia to all over Malesia and from India to Indochina. Superficially, both *V. glabrata* and *V. helogiton* have more or less the same aspect. Both have similar looking leaves, axillary inflorescence, almost identical flowers with exserted stamens and style. The leaflets in *V. helogiton*, however, often turn blackish when dry, and are cuneate towards the base, ovary villous on top and fruit somewhat larger [8-15 (-20) by 6-10 (-12) mm] than that of *V. glabrata*. In view of these differences, *V. helogiton* is reinstated here as a distinct species. All references of *V. glabrata* from outside Australia were based on misidentification of plants belonging to *V. helogiton*. Therefore, of the synonyms recorded by other authors under *V. glabrata* only *V. cunninghamii* Schauer belongs to this species. All the rest are found to belong to *V. helogiton* Schumann.

According to collecting notes by *Bouel 2* (MEL) and others, the fruit of this species "is very good to eat".

Affinities

V. helogiton is very closely related to *V. glabrata* in its leaves being glabrous; inflorescence axillary, lax, dichotomously branched; calyx and corolla not glandular outside; filaments distinctly glandular, villous towards the base. For the distinguishing characters and more detail see "key to the species" and "affinities" under *V. glabrata*. There are a few characters common to *V. helogiton*, *V. melicopea* and *V. acuminata*. (For detail see "key to the species").

5. **V. rotundifolia** L. f., Suppl. Pl. Syst. Veg. (1782) 294; Sasaki, List. Pl. Formos. (1928) 353, 354; Hara, Outline Phytogeogr. Jap. (1959) 56; Mold., Phytologia 8 (1961) 86; Chippendale, Proc. Linn. Soc. N.S.W. 96 (1972) 256; Baines, Aust. Pl. Gen. (1981) 393.

Type: *Thunberg s.n.*, in Japan, undated (LINN, Herb. Smith, microfiche!).

V. ovata Thunb., Fl. Jap. (1784) 257; Willd., Sp. Pl. 3 (1800) 390; Pers., Syn. Pl. 2 (1806) 143; R. Br., Prod. Fl. Nov. Holl. (1810) 511; Spreng., Syst. Veg. 2 (1825) 756; Hook. & Arn., Bot. Beech. Voy. (1841) 206, 268, t. 47; Walp., Rep. Bot. Syst. 4 (1845) 82; Sieb. & Zacc., Abh. Akad. Muench. 4 (1846) 152; Merr., Govt. Lab. Publ. Philip. 6 (1904) 17; Bur. Gov. Lab. no. 27 (1905) 68; Rev. Iden. Sp. Blan. Fl. Filip. (1905) 68; Philip. J. Sc. 1, Suppl. 1 (1906) 121; Philip. J. Sc. Bot. 3 (1908) 297, 432; Wilson, J. Arn. Arb. 1 (1920) 186; Chung, Mem. Sc. Soc. China 1 (1924) 227; Domin, Biblioth. Bot. 89 (1929) 560; Corner, Gard. Bull. Str. Settle. 10 (1940) 258; M.R. Hend., Malay. Wild. Fl. part 2 (1950) 387, f. 357; Specht, Recd Amer.-Aust. Sc. Exped. (Bot.) Arnhem Land 3 (1958) 292; Backer & Bakh. f., Fl. Java 2 (1965) 604; St. John, Phytologia 39 (1978) 317; Chippendale, Proc. Linn. Soc. N.S.W. 96 (1972) 256.

Type: "Crescit in littore Papenberg et Satsuma E. Macao Chinae missa quoque mihi fuit a Dn. P.I. Bladh", (UPS, microfiche!).

V. repens Blanco, Fl. Filip. edn 1 (1837) 513.

Type: Philippines, loc. incert. (n.v.).

V. trifolia L. var. *simplicifolia* Cham., Linnaea 7 (1832) 107, [as "β. simplicifolia"]; Shirasawa, Bull. Coll. Agric. Tokyo 2 (1895) 270; H.J. Lam, Verbenac. Malay. Arch. (1919) 182; Hosokawa, Trans. Nat. Hist. Soc. Formos. 23 (1933) 233; Degener, New Illust. Fl. Haw. Isl. (1946) Fam. 315; Meeuse, Blumea 5 (1942) 73; Merr., Pl. Life Pac. World, repr. edn (1946) 32, 37, 47 & f. 46; Mold., Phytologia 6 (1958) 183-192 & 197; Résumé Verbenac. etc. (1959) 211, 212, 226, 379, 380, 387, 388; Phytologia 8 (1961) 86-88; Neal, Gard. Haw. (1965) 728; Ohwi, Fl. Jap. (1965) 765; Mold., Phytologia 17 (1968) 54-56 & 114-117; Fifth Summary Verbenac. etc. 1 & 2 (1971) 349, 351, 353, 375, 709, 712, 725, 727-730, 792; Huang, Pollen Fl. Taiwan (1972) 244, t. 163, f. 15-17; Mold., Phytologia 25 (1973) 235; M.R. Henderson, Malay. Wild Fl. Dict. 1 (1974) 387; Mold., Phytologia 34 (1976) 266, 268; Phytologia 41 (1979) 302; Sixth Summary Verbenac. etc. (1980) 339-341, 343, 368, 459; Mold., Phytologia 52 (1982) 141; Mold., Phytologia 51 (1982) 352; Manilal & Sivar., Fl. Calicut (1982) 229; Sivar. & Manilal, J. Econ. & Taxon. Bot. 3 (1982) 816; Mold., Phytologia 52 (1982) 184; Mold. in Dassan & Fosb., Fl. Ceylon 4 (1983) 382.

Type: *Collector undesignated s.n.*, from sandy shores near Cavite, Luzon, Philippine Islands, undated (possibly in Herb. B, n.v.). Perhaps destroyed during the war.

V. trifolia L. var. *unifoliolata* Schauer in A. DC., Prod. 11 (1847) 683; Mann, Proc. Amer. Acad. Arts 7 (1867) 194; Engl., Bot. Jahrb. 6 (1885) 66; Maxim. in Mél. Biol. 12 (1886) 514; Bull. Acad. Sc. St. Petersb. 31 (1887) 82; H.J. Lam, Verbenac. Malay. Arch. (1919) 182; Bull. Jard. Bot. Buitenz. Ser. III, 3 (1921) 53; Bakh. & H.J. Lam, Bull. Jard. Bot. Buitenz. Ser. III, 4 (1922) 285; Dop, Bull. Soc. Hist. Natur. 57 (1928) 206, sphalm. var. *unifoliata*; P'ei, Mem. Sc. Soc. China 1 (1932) 100; Dop in LeComte, Fl. Gen. Indo-Chine 4 (1935) 835, sphalm. var. *unifoliata*; Mold., Phytolgia 6 (1958) 184.

Syntypes: *Sieber s.n.*, Mauritius (G-DC, n.v.); *Chamisso s.n.*, in littoribus arenosis Luconiae ad Cavite (probably B, n.v.); *Meyen s.n.*, Syng-moon (n.v.); *Millet s.n.*, *Vachell 174*, Canton, China (n.v.); *Thunberg s.n. & Goering s.n.*, Japan (n.v.); *R. Brown s.n.*, Novae Hollandia (BM!); *Macrae s.n.*, in ins. Oweehe (n.v.).

V. trifolia L. var. *obovata* Benth., Fl. Aust. 5 (1870) 67; Bailey, Synop. Qld Fl. (1883) 379; Cat. Indig. & Natur. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1179; Comp. Cat. Qld Pl. (1913) 386.

Syntypes: *A. Cunningham 217*, Snapper Island, Queensland, -v.1819 (BM, K, MEL 4 spec.); *A. Cunningham 216*, Goulburn & Sims Islands, Northern Territory, 1818 (BM, K, MEL).

V. trifolia var. *unifoliata* Miq., Cat. Mus. Bot. Lugd.-Bat. (1870) 70, probably misspell. of Schauer's *unifoliolata*; Fawcett, Natur. Wond. E. Arch. (1885) 514; Hillebr., Fl. Haw. Isl. (1888) 342; Kawakami, List Pl. Formos. (1910) 85; Mold., Suppl. List Invalid Names (1941) 11; Phytologia 6 (1958) 184; Phytologia 17 (1968) 54, sphalm. var. "*unifolia*".

Type: n.v., probably the same as for var. *unifoliolata* Schauer.

V. agnus-castus L. h *ovata* Kuntze, Rev. Gen. Pl. 2 (1891) 510, 511; Hara, Enum. Sperm. Japan 1 (1948) 190.

Type: "Anam: Turong" (n.v.). This taxon seems to have been based on *V. ovata* Thunb. Therefore, the type should be as for *V. ovata* Thunb.

V. trifolia L. var. *ovata* (Thunb.) Makino, Bot. Mag. Tokyo 17 (1903) 92; Merr., Sp. Blanc. (1918) 332; Enum. Philip. Fl. Pl. 3 (1923) 397; Merr. in Ling., Sc. J. 5 (1927) 158; Fletcher, Kew Bull. (1938) 432; Mold., Alph. List Invalid Names Suppl. 1 (1947) 29.

Type: As for *V. ovata* Thunb.

V. trifolia L. var. *repens* Ridley, Fl. Malay Penin. 2 (1923) 631.

Syntypes: *Watson*, Kuantan, Malaya (K, SING, n.v.); *Ridley*, Kelantan, Malaya (K, SING, n.v.).

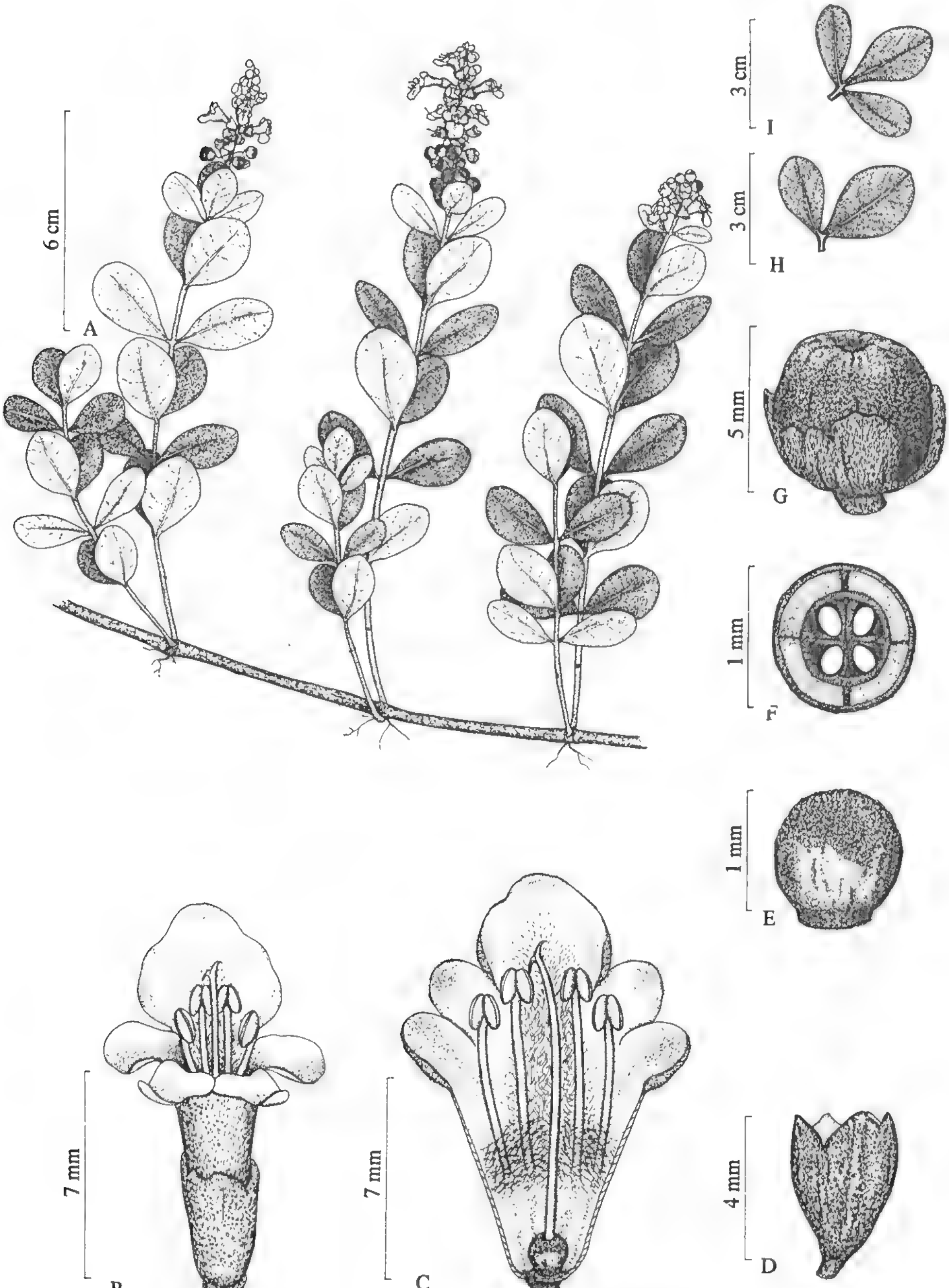


Fig. 5. *Vitex rotundifolia* L. f. (A-G, *W.T. Jones 1500*: CANB; H-I, *N.B. Byrnes 1018*: AD).

V. trifolia L. subsp. *littoralis* Steenis, Blumea 8 (1957) 516; Balgooy, Pac. Pl. Areas 3 (1975) 276.

Type: *S. Bloembergen 3894*, interior east of Wonreli, Secondary Country, beach-shore. Kisar, Lesser Sunda Islands, Indonesia, 22.iv.1939 (L, holotype!, BO, BRI, isotypes!).

V. trifolia L. sensu Miq., Fl. Ind. Bat. 2 (1856) 859, p.p., quoad descrip. and syn. *V. repens* Blanco, *V. ovata* Thunb. and var. *unifoliolata* Schauer; sensu Benth., Fl. Hongk. (1861) 273, p.p., quoad syn. *V. ovata* Thunb. and var. *unifoliolata* Schauer; sensu Seemann, Fl. Vit. part 5 (1866) 190, p.p., quoad syn. *V. ovata* Thunb. and *V. repens* Blanco; sensu F. Muell., Fragm. Phytogr. Aust. 6 (1868) 152, p.p., quoad syn. *V. ovata* Thunb.; sensu C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 583, p.p., quoad syn. *V. ovata* Thunb. and *V. repens* Blanco; sensu Bailey, Qld Woods (1888) 92, p.p., quoad descrip.; sensu Forbes & Hemsl., J. Linn. Soc. 26 (1890) 258, p.p., quoad syn. *V. ovata* Thunb. and var. *unifoliolata* Schauer; sensu Hall. f., Meded. Rijks-Herb. Leid. no. 37 (1918) 40, p.p., quoad syn. var. *obovata* Benth., var. *simplicifolia* Cham. and var. *unifoliolata* Schauer; sensu Gamble, Fl. Pres. Madr. (1924) 1101-1102, p.p., quoad descrip.; sensu Pope, Man. Wayside Pl. Haw. (1968) 195.

Description (Fig. 5)

A prostrate shrub on sandy sea-shores, 10-40 (-90) cm high, spreading to about 10 m diameter. *Stem* procumbent or creeping, rooting at the nodes with silky-tomentose young branches. *Leaves* mostly 1-foliolate, rarely a few sub-2-foliolate or 3-foliolate, sessile or shortly petiolate, obovate-oval, broadly oblong-elliptic, orbicular or obovate-spathulate, (1.5-) 3-5 (-6) cm long, (1-) 2-3 (-3.5) cm broad, rounded at both ends or sometimes abruptly subacuminate at the apex, attenuate at the base, usually pale dull-green, pubescent above, velutinous- or silky-tomentulose below; pair of nerves 4-6; petiole tomentulose, 1-5 (-10) mm long. *Inflorescence* mostly abbreviated terminal thyrse borne on small side-branches, densely tomentulose, 3-10 (-13) cm long, 1-2.5 cm wide; cymes shortly pedunculate, usually branched, arranged in a pyramidal panicle, lateral primary peduncles absent or 1-5 mm long; flowers shortly pedicellate; pedicels densely glandular and tomentulose, 0.5-2 mm long; bracteoles linear, 1-2.5 mm long. *Calyx* cyathiform, glandular and silky-tomentulose outside, glabrous within, 5-ribbed outside, with 5 short teeth at the top; teeth 0.5-1 mm long, 1-1.5 mm broad at the base; tube cylindrical, 3-4 mm long, 2-3 mm diam. at the top. *Corolla* hypocrateriform, varying from purplish-mauve to lilac-blue, 2-lipped and 5-lobed above, tubular below, glandular and silky-tomentulose outside, villous inside the tube and on the lower half of the large anterior lobe of the lower-lip, glabrous near the base of the tube; the anterior lobe broadly elliptic or almost orbicular in outline, glabrous in the upper inner half and along the periphery outside, 3-5 (-6) mm long, 3-5 mm broad; the two lateral lobes more or less oblong-elliptic or elliptic-ovate, 2-3 (-4) mm long, 1.5-3 (-3.5) mm broad at the base; the two lobes of the upper lip oblong-ovate, 2-3 (-4) mm long, 1.5-3 (-3.5) mm broad; tube cylindrical below, gradually enlarged upwards, almost twice the length of the calyx, 4-7 mm long, 2-4 mm broad at the top. *Stamens* exserted, connate to the corolla-tube; filaments filiform, glabrous above, villous near the base, the anterior pair 7-9 mm long, the lateral pair 6.5-8 mm long; anthers elliptic-oblong in outline, ± 1 mm long, lobes oblong, free and divergent in the lower half. *Ovary* globose, glabrous, densely glandular all over, 1-1.5 mm diam.; style exserted, glabrous, filiform, 8-12 mm long; stigma shortly 2-lobed. *Fruit* globose, green when fresh, becoming dark-brown when dry, glabrous, glandular all over, 4-5.5 mm long, 5-6.5 mm diam.; fruiting calyx glandular and tomentulose outside, glabrous within, 5-denticulate, 5-6.5 mm diam.

Representative specimens (collections seen: Australian 124, non-Australian 26)

AUSTRALIA: QUEENSLAND: *Banfield s.n.*, Brammo Bay, Dunk Island, 1914 (BRI267720); *Barnard 2*, Townsville, 8.vi.1941 (CANB, MEL); *Blake 11250*, Nielson Park - Bargara, near Bundaberg, 25.iv.1936 (BRI, CANB, MO); *Brass 1919*, Port Douglas, 13.i.1932 (BRI); *Clements 5*, Rockhampton, -iv.1917 (BRI); *Cunningham 217*, Snapper Island, -v.1819 (BM, K, MEL, syntype of *V. trifolia* var. *obovata* Benth.); *Domin 8162 & 8163*, near Russel River, -i.1910 (PR); *Hyland 7397*, Bathurst Bay, 28.viii.1974 (BRI, L, QRS); *McDonald & Batianoff 1291*, Dalrymple Beach, 10 km S of Mackay, 6.iv.1975 (BRI); *F. Mueller s.n.*, Bloomfield River, -1885 (MEL97997); *Kratzing PO1444*, ca 6 km N of Karumba, 15.vii.1974 (BRI, CBG, L); *Persieh 281*, Endeavour River, 1882 (MEL98041); *Reilley s.n.*, Haughton River, 1891 (MEL97973); *Peiniger 10830*, Cairns, 14.iii.1947 (QRS); *Smith 11014*, Bloomfield Beach, ca 1.6 km N of Bloomfield River, 4.ix.1960 (BRI, L); *Stoddart 4189*, Sinclair Island, 8.viii.1973 (BRI, L);

Stoddart 4756, Turtle Island III, 3.x.1973 (BRI, L); *Telford 2022*, Forrest Beach, E of Ingham, 25.v.1970 (BRI, CBG); *Tindale s.n.*, Wellesley Islands & Mornington Island, 31.v.1963 (AD 2 spec., BRI); *Webb & Norris 3079*, Bramston Beach, -xi.1956 (BRI); *Webster & Tracy 18969*, Dunes near the mouth of Harley's Creek, 12.x.1973 (NSW); *Wrigley & Telford 1435*, Quarantine Bay, S of Cooktown, 19.vi.1972 (CBG).

NORTHERN TERRITORY: *Byrnes 291*, Casuarina Beach, Darwin, 24.i.1968 (L, NT); *Chippendale 8235*, 3 miles S Danger Point, Cobourg Peninsula, 21.vii.1961 (AD, BRI, CANB, L, MEL, NT, PERTH); *Craven 3824*, Sir Edward Pellew Group, E side of South West Island, 11.ii.1976 (BRI, CANB, L, NT, PERTH); *A. Cunningham 216*, Goulburn & Sims Islands, 1818 (BM, K, MEL, syntype of *V. trifolia* L. var. *obovata* Benth.!); *Dunlop 2920*, Maria Island, Gulf of Carpentaria, 22.vii.1972 (NT); *Latz 3280*, Wessel Islands, 28.ix.1972 (CANB, MO, NT); *Perry 1223*, 60 miles N of Wollogorang Station, 3.vi.1948 (BRI, CANB, MEL, NT); *Specht 677*, Yirrkala, 19.vii.1948 (AD, BRI, CANB, L, MEL); *Wightman 1097*, Brogden Point, Murganella, 10.ii.1984 (DNA).

WESTERN AUSTRALIA: *Gulliver 16*, Kimberley, 1875 (MEL98022); *Wilson 11279*, Anjo Peninsula, N coast of W.A., 2.vii.1973 (CANB, PERTH).

PAPUA NEW GUINEA: *Reedy s.n.*, Ratau River, SW of Daru, undated (MEL97875).

INDONESIA: *Bloembergen 3894*, Lesser Sunda Isl. Kisar, 22.iv.1939 (BO, BRI, L).

NEW CALEDONIA: *Schlechter 15548*, [Auf den Bergen bei] Oubatche, 23.xii.1902 (L).

POLYNESIA: *Fosberg 11981*, Moerai, Rurutu Isl., 29.viii.1934 (BISH, L).

HAWAIIAN ISLANDS: *Royen 10192*, Oahu, below Airfield Beach Park, 22.x.1907 (BISH, L).

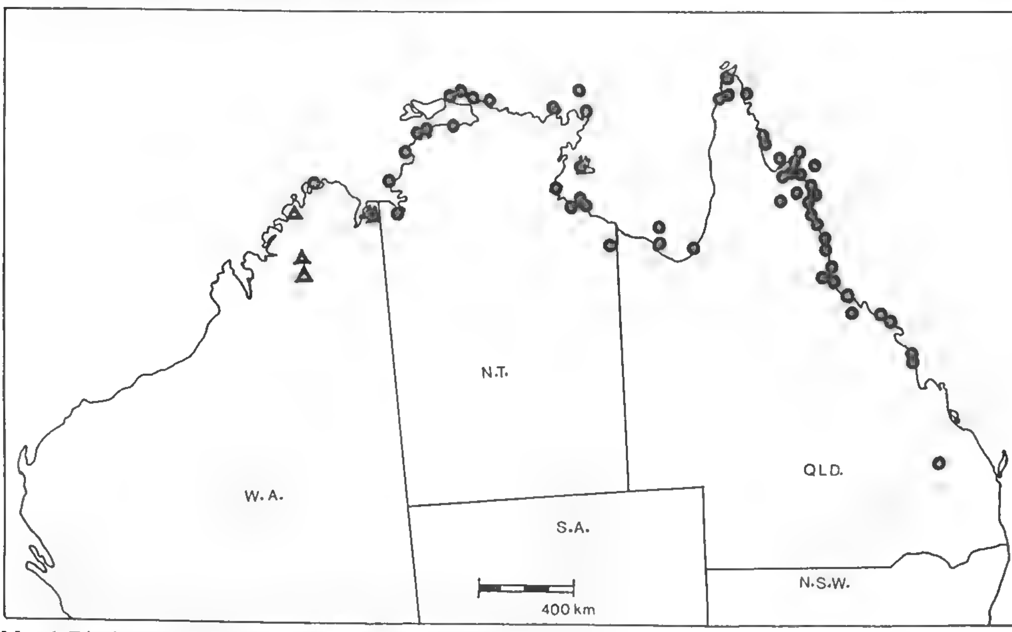
MALAYA: *Burkill 2255*, near Endau, Johore, 3.vi.1960 (K, SING).

PHILIPPINES: *Ramos 7467*, Cagayan Prov., Luzon, -iii.1909 (MEL, PNH).

HONG KONG: *Tsiang Ying 669*, way to Hom Tin, Lantao Island, 20.vi.1928 (BRI).

Distribution (Map 4)

In Australia, *V. rotundifolia* is found in the coastal areas of Queensland, Northern Territory and Western Australia. In Queensland, the distribution is mainly along the coast from Bundaberg northwards to the tip of Cape York Peninsula, and along the Gulf of Carpentaria coast it has been collected from near Mapoon Mission Station and Karumba. It has also been reported from several off-shore islands along the east coast and in the Gulf of Carpentaria. The east coast islands are mainly along the Great Barrier Reef and in the Gulf it has been recorded from Mornington Island and Sweers Island.



Map 4. Distribution of *V. rotundifolia* ●, *V. velutinifolia* ▲.

Distribution in the Northern Territory is chiefly along the northern and north-western coast. Most collections from northern coastal areas came from Cobourg Peninsula, Napier Peninsula and Gove Peninsula. Along the north-west coast, the majority of known localities are between Darwin and Victoria River. From the Gulf of Carpentaria, this species has been recorded from Groote Eylandt and the Sir Edward Pellew Group of Islands.

In Western Australia, it has been recorded from the north-coast of the Kimberley region. So far, it is known to occur only near Kalumburu Mission and Anjo Peninsula, but further exploration would probably reveal its occurrence in other parts of tropical Australia. So far, this species has not been collected from the interior of Australia.

Collections from outside Australia have been examined from Papua New Guinea, Lesser Sunda Island (Indonesia), New Caledonia, Polynesia, Hawaiian Islands, Malaya, Philippines and Hong Kong. In addition to this, the distribution of this taxon has been recorded by Moldenke (1971, 1980) from Brazil, Mauritius, Reunion, Bangladesh, Sri Lanka, Andaman Islands, China, Taiwan, Japan, Ryukyu Islands, Korea, Indochina, Thailand, Borneo, Sarawak, New Hebrides and Fiji. Sivarajan & Manilal (1982) reported it from South India.

In Australia, *V. rotundifolia* is reportedly grown in Queensland and Western Australia. Moldenke (1980) recorded its cultivation in England, Florida, Germany, Hawaiian Islands, Hong Kong, Java, Johnston Island, Maryland and New York.

Comments

The status of this taxon has been disputed by various taxonomists. Some considered it as a distinct species, while others regarded it as a subspecies or a variety of *V. trifolia* L. Linnaeus f. (1782) initially described it as a new species *V. rotundifolia.* Later, it was described by Thunberg (1784) as *V. ovata* Thunb., and by Blanco (1837) as *V. repens* Blanco. Subsequently, von Chamisso (1832) described it as var. *simplicifolia* of *V. trifolia.* In his revision of the Verbenaceae, Schauer (1847) regarded it also as a var. *β unifoliolata* of *V. trifolia.* Afterwards, Makino (1903) named it *V. trifolia* var. *ovata* (Thunb.)Makino, Ridley (1930) called it *V. trifolia* var. *repens* Ridley and Bentham (1870) by yet another varietal name *V. trifolia* var. *obovata* Benth.

This evaluation as a variety was maintained by Bailey (1901), H.J. Lam (1919), H.J. Lam & Bakhuizen (1921), Merrill (1923), Meeuse (1942), Moldenke (1971, 1980, 1983) and several other botanists. On the other hand, it has been treated as a distinct species by Walpers (1845), Merrill (1905), Corner (1939), and following him by Backer & Bakhuizen (1965). To justify the varietal rank of this taxon, Ridley (1930) said that when plants of *V. ovata* are grown inland they develop into bushes like *V. trifolia,* so that the distinction between them would appear to be due to external factors and not to hereditary. He further claimed to have seen it change (from the typical prostrate habit with runner-like branches, and obovate, small, simple leaves) into normal *V. trifolia* after transplantation to the Botanic Gardens, Singapore.

To test Ridley's statement, Corner (1939) collected seeds from typical plants of *V. ovata* on the coastal sand-dunes of Pahang State in Malaysia. He raised and grew ten plants in fairly good, not sandy, soil in the Nursery at the Botanic Gardens, Singapore, where plants of *V. trifolia* and *V. negundo* L. were also growing. The ten plants developed without exception into typical *V. ovata* without change in their habit. "Their branches reached one meter high then flopped over and rooted at the ends or turned up again in the manner of bramble (Rubus)". Their leaves, inflorescence and flowers were typical of *V. ovata.* According to Corner (1939), therefore, *V. ovata* does not turn into *V. trifolia* when grown inland. Further, on the coast of Perak in Malaysia, Corner found a few old plants of *V. trifolia* growing in open sandy scrub. These plants of *V. trifolia* were upright, 2-3 metres high, with a woody trunk over 1 m high and 7.5 cm thick. Their branches were never creeping or rooting at the nodes, leaves trifoliolate, and inflorescence and flowers were typical of *V. trifolia.* From these facts, Corner refuted the concept of the conspecificity of *V. ovata* and *V. trifolia*, and regarded them as two distinct species. In addition, he said he had found no intermediates between *V. ovata* and *V. trifolia*. In his opinion, the floral characteristics of *V. ovata* have been overlooked and incorporated in the description of *V. trifolia*. Corner (1939) maintained the name *V. ovata* Thunb. for this taxon, and assumed to have found differences with *V. trifolia* in the corolla, fruiting calyx, and the fruit.

According to van Steenis (1957), "the only characteristics holding are vegetative in nature, viz. the typical prostrate, rooting, runner-like branches, and the obovate, small, simple leaves, and geographic: its exclusive growth on the sandy beach". In his opinion, it is a clear-cut "ecological (littoral) race", exclusive of the *V. trifolia* population. He therefore named it subsp. *littoralis* Steenis of *V. trifolia*. Van Steenis tried to verify Corner's assumed differences between *V. ovata* and *V. trifolia* in the calyx, corolla and the fruit. However, he could not corroborate Corner's statement from any specimen of this taxon in Herb. L.

Modern taxonomists are divided among those who regard it as a species, a subspecies, or a variety. During present investigations, Corner's finding refuting the conspecificity of *V. ovata* and *V. trifolia* is accepted. It is considered here as a distinct species, but the name *V. ovata* is placed in the synonymy of *V. rotundifolia* L.f. which is the earliest valid name for this species. The calyx, corolla and the fruit of *V. rotundifolia* (= *V. ovata* Thunb.) appear similar to those of *V. trifolia*, and inflorescences of *V. rotundifolia* are smaller than the average size in *V. trifolia*, and are borne on small side-branches.

In the "New Illustrated Flora of the Hawaiian Islands", the calyx of this taxon (under the name *V. trifolia* var. *simplicifolia* Cham.) was erroneously described by Degener (1946) as being "silky tomentose within and glabrous without", and "ovary pulverulent". In fact, the calyx in this taxon is glabrous within and tomentose outside, and the ovary glandular all over.

V. rotundifolia is a widespread and variable species found mostly on sandy sea-shores and on sand-dunes. In view of its common occurrence near the sea-shores, it is popularly called "Beach Vitex", and because of its creeping habit some people call it "Creeping Vitex". According to collectors' field notes, this species growing in the sand becomes very deep-rooted, but on account of the looseness of the ground, their roots may be easily grubbed and pulled. Backer & Bakhuizen (1965) state that the main stem is often entirely buried in the sand from which only the flowering branchlets emerge.

The dispersal of this species takes place by various means. According to Ridley (1930), "the small drupe with its light corky pericarp is found in river- and beach-drift. The wide distribution is ascribed to dispersal by sea-currents but also dispersal by pigeons may play a role locally".

The plant is of considerable value as a sand-binder to prevent beach erosion.

Affinities

Amongst Australian *Vitex* species, *V. rotundifolia* is most closely related to *V. trifolia*. In both species, leaves are always tomentulose underneath, the inflorescence terminal and pyramidal in outline, and flowers and fruit with most characters similar. However, *V. rotundifolia* may readily be identified by its procumbent habit, sandy sea-shore habitat; stem creeping and rooting at the nodes; leaves mostly 1-foliolate, rounded to rounded-obovate in outline, pubescent-tomentulose all over, usually sessile, sometimes with a short petiole of 1-5 (-10) mm long.

V. rotundifolia has a few characters common with *V. velutinifolia*. Both species have tomentose leaves, terminal inflorescence, similar flowers and nearly similarly shaped fruit. The latter, however, can easily be distinguished by its erect habit; stem neither creeping nor rooting at the nodes; leaves 3-foliolate; leaflets narrowly elliptic-lanceolate, usually petiolulate; ovary non-glandular and villous at the top.

6. **Vitex velutinifolia** Munir, sp. nov.

Frutex vel arbor 3-8 m alta. *Ramuli* aliquantum 4-angulati dense cinerascenti-tomentosi vel velutini. *Folia* 3-foliolata rare 1-foliolata; foliola plerumque petiolulata elliptico-lanceolata vel anguste ovato-lanceolata integra acuminata basi cuneata (3-) 4.5-7.5 (-9) cm longa (1.5-) 2-3.5 (-4.5) cm lata chartacea omnino cinerascenti-velutina. *Inflorescentia* terminalis cinerascenti-tomentosa; cymae pedunculatae in ambito plus minusve pyramidalis. *Flores* fere sessilis vel breviter pedicellati; pedicelli 0.5-3 mm longi. *Calyx* tubularis aliquantum cupulatus 5-dentatus extra glandifer et dense cinerascenti-tomentosus intra glaber. *Corolla* pallido-malvina vel caerulea 2-labiata apice 5-lobata subter tubularis extra pubescens glandiferque intra tubo villosa lobo antico elliptico-oblongo lobis aliis oblongo-ovatis. *Stamina* exserta; filamenti filiformes in dimidio inferiore villosi; antherae in ambito ellipticae vel orbiculares. *Ovarium* globulum apice villosum; stylus exsertus glaber filiformis; stigma 2-fida. *Fructus* globulo-ellipsoideus glaber 5-7 mm longus ubi maturatus purpureo-ater.

Type: *M. Lazarides 8471*, The Gorge, Station Creek, 35km north-north-east of Carlton Hill Homestead, north-eastern Kimberley, Western Australia, 11.iii.1978 (CANB, holotype; NT, PERTH — isotypes).

Description (Fig. 6)

Shrub or tree 3-8 m high. *Stem* with bark smooth in the upper part, slightly fissured in the lower part, mottled dark and pale grey; branchlets somewhat 4-angled, densely greyish-tomentose or velutinous. *Leaves* 3-foliolate, rarely 1-foliolate, petiolate; leaflets usually petiolulate, the lateral sometimes subsessile, elliptic-lanceolate or narrowly ovate-lanceolate, entire, mostly acuminate, cuneate at the base, (3-) 4.5-7.5 (-9) cm long, (1.5-) 2-3.5 (-4.5) cm broad, chartaceous, somewhat glossy and dark-green above, olive-green below, greyish-velutinous all over; pairs of nerves 6-9; petioles greyish-tomentose or velutinous, (1.5-) 2-4 (-5.5) cm long; petiolules greyish-tomentose, (2-) 3-8 (-10) mm long. *Inflorescence* terminal, greyish-tomentose, 7-15 cm long, 7-10 cm wide; cymes pedunculate, in lax thyrsoid panicles, more or less pyramidal in outline; lateral primary peduncles 1-3.5 cm long; flowers almost sessile or shortly pedicellate; pedicels greyish-tomentose, 0.5-3 mm long; bracts linear-lanceolate, ± 1 mm long. *Calyx* tubular, somewhat cup-shaped, 5-toothed at the top, sparsely glandular and densely greyish-tomentose outside, glabrous inside, ± 2 mm long, 2-2.5 mm diam. at the top end; teeth ± 0.5 mm long, 0.5-1 mm broad at their base. *Corolla* pale-mauve or blue, 2-lipped, 5-lobed in the upper half, tubular below, pubescent and glandular outside, villous inside the tube with hairs extending to the large anterior lobe of the lower lip; the anterior lobe broadly elliptic-oblong or almost orbicular in outline, 4-6 mm long, nearly as broad; the two lateral lobes of the lower lip more or less oblong-ovate, obtuse, 2.5-3 (-3.5) mm long, 2.5-3 mm broad at the base; the two lobes of the upper lip more or less ovate, obtuse, 2-3 mm long, 2-2.5 mm broad at the base; tube cylindrical near the base, abruptly dilating upwards above the calyx, at least twice the length of the calyx, 4.5-5.5 mm long, 4-5 mm broad at the top. *Stamens* exserted, connate to the lower part of the corolla-tube; filaments filiform, villous excepting the top end, the anterior pair 7-8 mm long, the lateral pair 6-7 mm long; anthers more or less elliptic or almost orbicular in outline, ± 1 mm long, nearly as broad, lobes oblong, free and divergent in the lower half. *Ovary* globular, villous at the top, glabrous elsewhere, non-glandular, 1-2 mm diam.; style exserted, glabrous, filiform, 9-10 mm long; stigma distinctly 2-fid. *Fruit* globular-ellipsoid, glabrous, 5-7 mm long, 4-6 mm diam., purple-black when ripe.

Specimens examined

AUSTRALIA: WESTERN AUSTRALIA: *Done 342*, Camp Creek, Mitchell Plateau, 14° 53′S, 125° 45′E, 18.x.1980 (DNA); *Dunlop 6035 & Done*, Manning Gorge, Mt Barnett Station, 16° 39′S, 125° 55′E, 10.x.1981 (AD, DNA); *Lazarides 8471*, The Gorge, Station Creek, 35 km NNE of Carlton Hill Homestead, north-eastern Kimberley, 11.iii.1978 (CANB, holotype; NT, PERTH, isotypes).

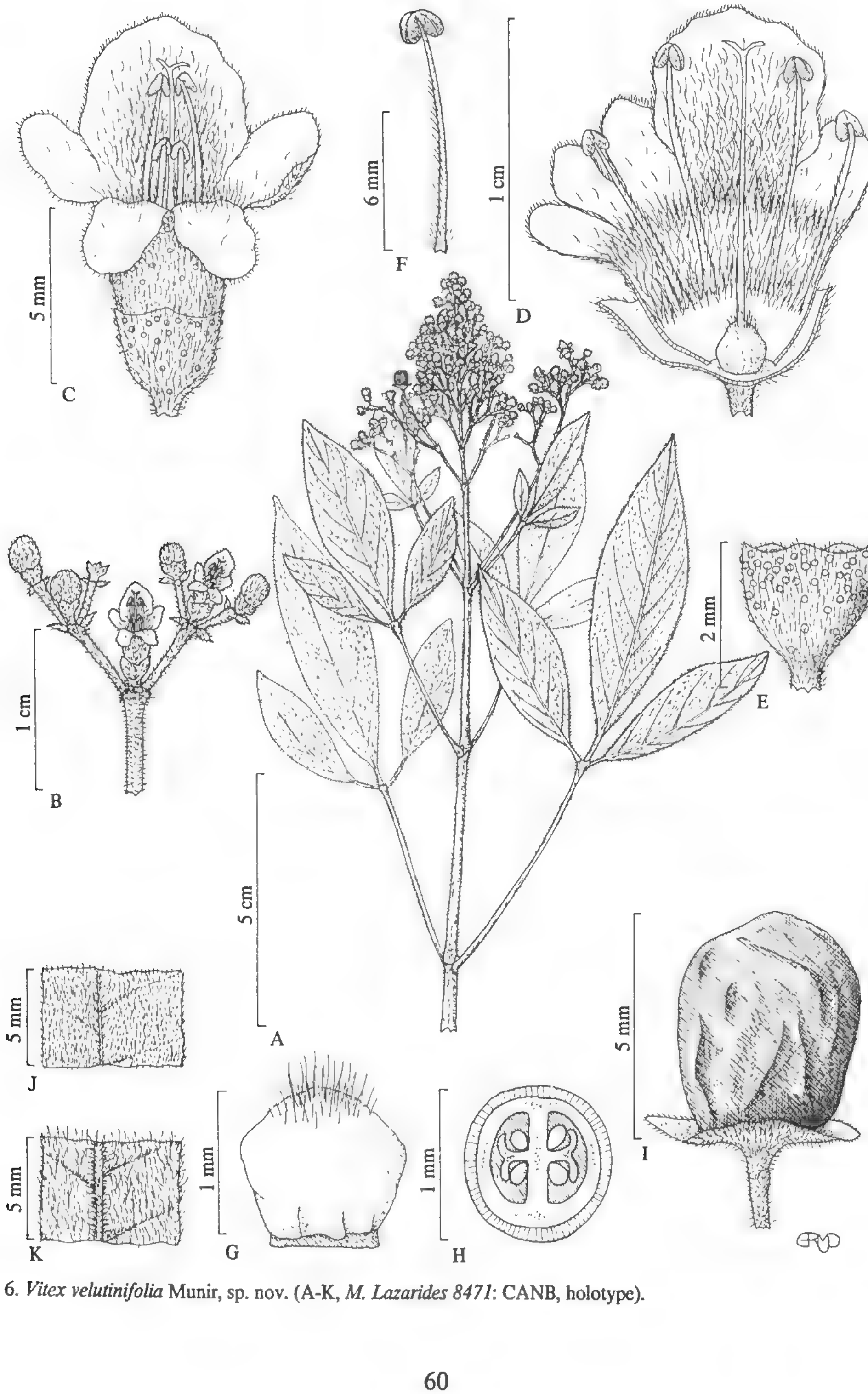


Fig. 6. *Vitex velutinifolia* Munir, sp. nov. (A-K, *M. Lazarides 8471*: CANB, holotype).

Distribution (Map 4)

V. velutinifolia is endemic to northern Western Australia where it is known to occur in the tropics of the Kimberley region. So far, it has been recorded only from four disjunct localities to the north of latitude 18°S.

Comments

This species has been misidentified as *V. acuminata* R. Br. which has more or less similarly shaped leaves and a terminal inflorescence. The latter, however, may readily be identified by its leaves, stamens and ovary being glabrous. In the two paratype collections cited here, some ovaries appear to be almost glabrous. It seems that the villous hairs on top of the ovary were possibly shed at a relatively younger stage. In the holotype, however, the hairs were noticed on the fully developed ovary.

Stamens are inserted towards the base of the corolla-tube and their filaments are hairy only on the side facing away from the wall of the corolla-tube.

The leaves are mostly 3-foliolate, but in *C. Done 342* (DNA) and *C.R. Dunlop 6035 & C. Done* (AD, DNA) both 3-foliolate and (a few) unifoliolate leaves were observed.

Affinities

V. velutinifolia is closely allied to *V. acuminata* in its leaves being elliptic-lanceolate; inflorescence terminal, pyramidal; calyx and corolla pubescent and glandular outside; fruit globular-ellipsoid, dark-purple when ripe. However, *V. velutinifolia* may easily be identified by its leaflets being greyish-velutinous all over and ovary villous at the top. *V. velutinifolia* is also near to *V. rotundifolia* in having tomentose leaves, terminal inflorescence and similar flowers. For distinguishing characters see "affinities" under the latter.

There are a few characters common between *V. velutinifolia* and *V. trifolia*. The latter, however, differs by its leaflets being glabrescent above, and ovary densely glandular and glabrous.

7. **Vitex benthamiana** Domin, Biblioth. Bot. 89 (1929) 560, fig. 182; Fedde & Schust., Just's Bot. Jahresber. 56 (1937) 286; Mold., Pl. Life 2 (1948) 50; Résumé Verbenac. etc. (1959) 211, 390; Phytologia 5 (1956) 355; Phytologia 8 (1961) 21-43; Phytologia 15 (1967) 228; Fifth Summary Verbenac. etc. 1 & 2 (1971) 349, 729, 730; Phytologia 44 (1979) 390; Phytologia 45 (1980) 481; Sixth Summary Verbenac. etc. (1980) 339, 588; Phytologia 51 (1982) 217.

Type: *K. Domin 8164*, on arid hills near Cloncurry, Queensland, Australia, -ii.1910 (PR!, lectotype here designated); *K. Domin 8165 & 8166*, loc. cit. ii.1910 (PR, syntypes!).

V. trifolia L. var. *parviflora* Benth., Fl. Aust. 5 (1870) 67, p.p., excl. spec. from Moreton Bay; Bailey, Synop. Qld Fl. (1883) 379; Schumann & Hollr., Fl. Kais. Wilh. Land (1889) 121, p.p., excl. Hollrung n.486; Bailey, Cat. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1179; Comp. Cat. Qld Pl. (1913) 386; Wangerin, Justs Bot. Jahresber. 56 (1936) 668; Fedde & Schust., Justs Bot. Jahresber. 56 (1937) 286.

Type: *W. Landsborough s.n.*, on Gulf of Carpentaria possibly near Albert River, Queensland, Australia, -ii.1862 (MEL98012), syntype of *V. benthamiana* Domin.

V. agnus-castus auct. non L.: sensu Wangerin, Just's Bot. Jahresber. 56 (1936) 668, p.p., quoad syn. *V. benthamiana* Domin.

Typification

V. benthamiana is based on two (syntype) collections, one by K. Domin himself from Cloncurry and another by W. Landsborough from near the Gulf of Carpentaria. Both

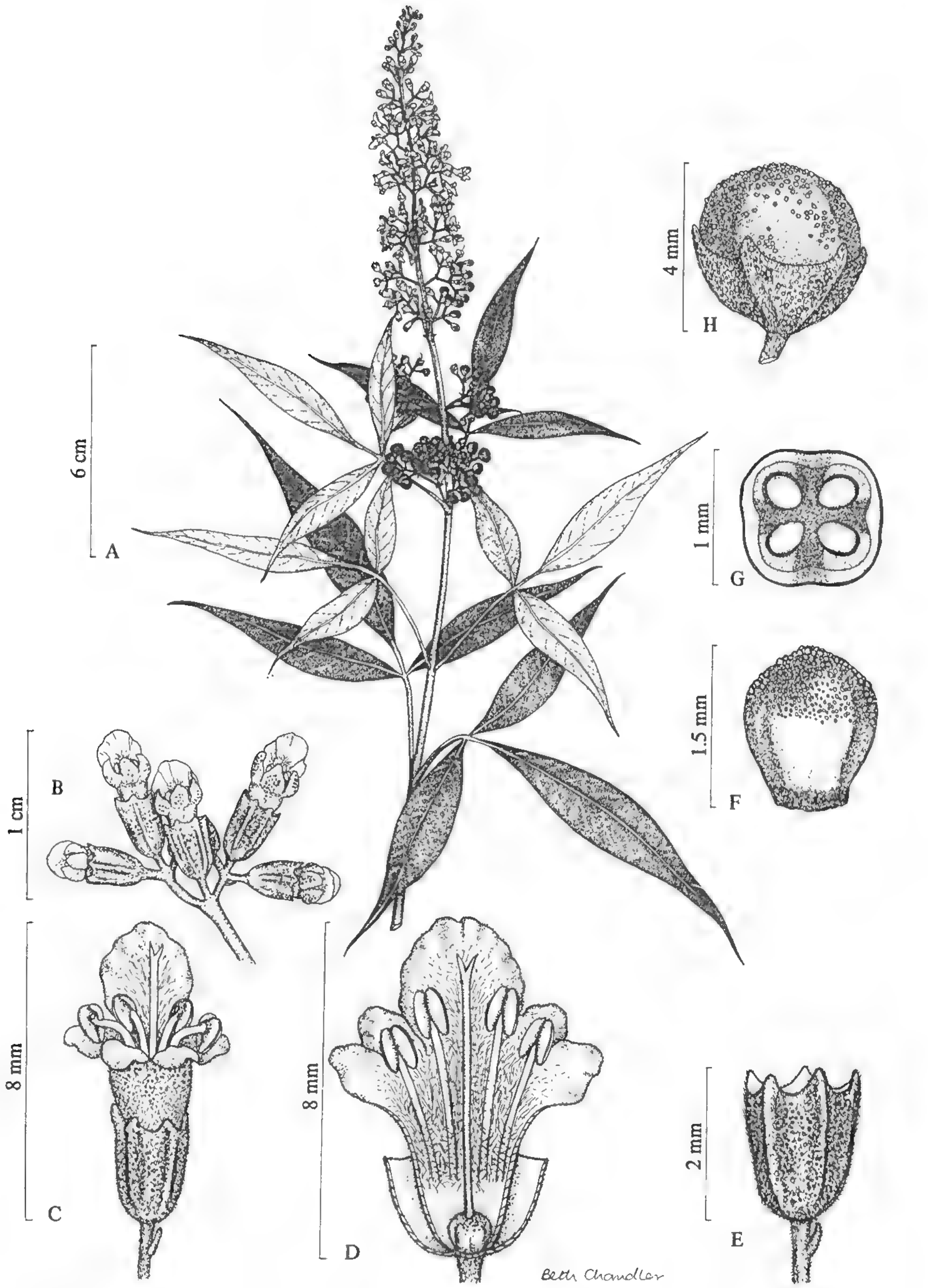


Fig. 7. *Vitex benthamiana* Domin (A-H, *R.A. Perry 1061*: AD).

collections come from Queensland, with the former comprising at least three duplicates and the latter only one. Since the author did not choose a type, it is, therefore, proposed to select a lectotype for this species. Of these, a duplicate of Domin's own collection (*Domin 8164*: PR) is particularly complete and well preserved and is selected here as the lectotype.

Description (Fig. 7)

Shrub or small tree 1.5-4.5 m high. *Stem* erect, branched, cylindrical, striate, densely pubescent. *Leaves* mostly 3-foliolate, rarely a few 1-foliolate, petiolate; leaflets narrow lanceolate, rostrate-acuminate at the apex, cuneate towards the base, (2-) 3-10 (-13.5) cm long, (0.7-) 1-1.8 (-2.3) cm broad, entire, membranous, glabrescent and dark-green above, very densely greyish-silvery pubescent beneath, the lateral nerves concealed by the dense indumentum underneath, the terminal leaflet usually petiolulate the lateral leaflets always sessile; petioles greyish-pubescent, 1-3 (-4) cm long; petiolules greyish-pubescent, 1-10 (-15) mm long. *Inflorescence* terminal, cinereous-pubescent, (4-) 6-20 (-31) cm long, 3-10 cm wide; cymes pedunculate, usually branched, arranged into pyramidal panicles; the lateral primary peduncles 3-10 mm long; flowers sessile or on a short pedicel of up to 1 mm long. *Calyx* more or less cyathiform, minutely 5-toothed at the top, 5-ribbed, densely glandular and mealy-puberulent outside, glabrous within, 2-3 mm long, 1.5-2 mm broad at the top; teeth ± 0.5 mm long, nearly as broad. *Corolla* pinkish-lilac or light-mauve, 2-lipped of 5 lobes above, tubular below, glandular and silky-tomentulose outside, villous inside the tube and at the lower inner half of the large anterior lobe of the lower lip, glabrous near the base of the tube; anterior lobe broadly elliptic or orbicular, glabrous in the upper inner half and along the periphery outside, 2-4 mm long, 2-3.5 mm broad; the two lateral lobes more or less ovate, 1.5-2 mm long, 1.2-1.8 mm broad at the base; the two lobes of the upper lip ovate, (1-) 1.5-2 mm long, (1-) 1.5-2 mm at the base; tube more or less cylindrical, about twice as long as the calyx, gradually dilated upwards, (3-) 4-5 mm long, 1.5-2.5 mm wide at the top. *Stamens* exserted, connate to the inside of the corolla-tube; filaments filiform, glabrous above, villous in the lower part, the anterior pair (3.5-) 4-5 (-6) mm long, the lateral pair (3-) 3.5-4.5 (-5) mm long; anthers more or less elliptic-oblong in outline, ± 1 mm long, lobes oblong, free and divergent in the lower half. *Ovary* globose, glabrous, glandular all over, ± 1 mm diam.; style exserted, glabrous, filiform, 6-8 mm long, shortly 2-fid at the apex. *Fruit* globose, glabrous, glandular all over, 3-4 mm diam., purplish, ultimately black; fruiting calyx glandular and mealy-puberulent outside, glabrous within, distinctly 5-denticulate, 3.5-4.5 mm diam.

Specimens examined

AUSTRALIA: QUEENSLAND: *Bailey s.n.*, Sweers Island, -.vi.1901 (BRI267704); *Beamount & Bushoff 7051*, 6-7 miles S of Mary Kathleen, 12.iv.1971 (BRI, CANB); *Blake 6347*, Cloncurry, 23.vi.1934 (BRI, MO, NT); *Cambage 3952*, Quamby, NNW of Cloncurry, 30.viii.1913 (NSW); *Cole & Provan 181*, bed of Cabbage Tree Creek, N of Little Eva Mine, 19.iv.1962 (BRI); *Dittrich s.n.*, vicinity of Nicholson River, -.vii.1986 (BRI); *Domin 8164*, near Cloncurry, -.ii.1910 (PR, lectotype); *Domin 8165 & 8166*, loc. cit., -.ii.1910 (PR, syntypes. See comments); *Everist & Smith 213*, loc. cit., 6.ii.1937 (BRI); *Farrell 347*, 5 km E of Mary Kathleen, 27.iii.1976 (BRI); *Gittins 775*, Mammoth Mines, -.v.1963 (NSW); *Halliday 428*, c. 55 km W of Cloncurry on road to Mt Isa, 7.iv.1975 (AD, AK); *Landsborough s.n.*, on Gulf of Carpentaria, possibly from Albert River, -.ii.1862 (MEL98012, syntype!); *Lestang 9397*, Adels Grove, -.iii.1945 (BRI, QRS); *MacGillivray 2217*, western Queensland, -.viii.1928 (BRI); *F. Mueller s.n.*, Albert River, undated (MEL894, MEL98002, MEL98003); *Perry 1061*, 6 miles E of Undilla Station, 28.v.1948 (AD, BRI, CANB, NT, PERTH); *Thozet 104*, between Burketown and Flinders River, undated (MEL98011); *Trapnell & Williams 106*, 1.6 km E of Burketown Wharf, 17.viii.1973 (BRI).

Distribution (Map 5)

V. benthamiana seems to be endemic to Australia where the main distribution is in the north-western part of Queensland. The major distribution is chiefly to the south of the Gulf of Carpentaria where it seems restricted between latitude 17° and 21°S, and longitude 138° and 141°E. Most northern localities are in the coastal area north of Burketown. In the south it has been recorded chiefly from areas around Cloncurry and Mt Isa. Besides, a few collections from near the Northern Territory border. From within the Gulf of Carpentaria it has been reported only from Sweers Island. So far, the occurrence of this species in the Northern Territory has not been confirmed.

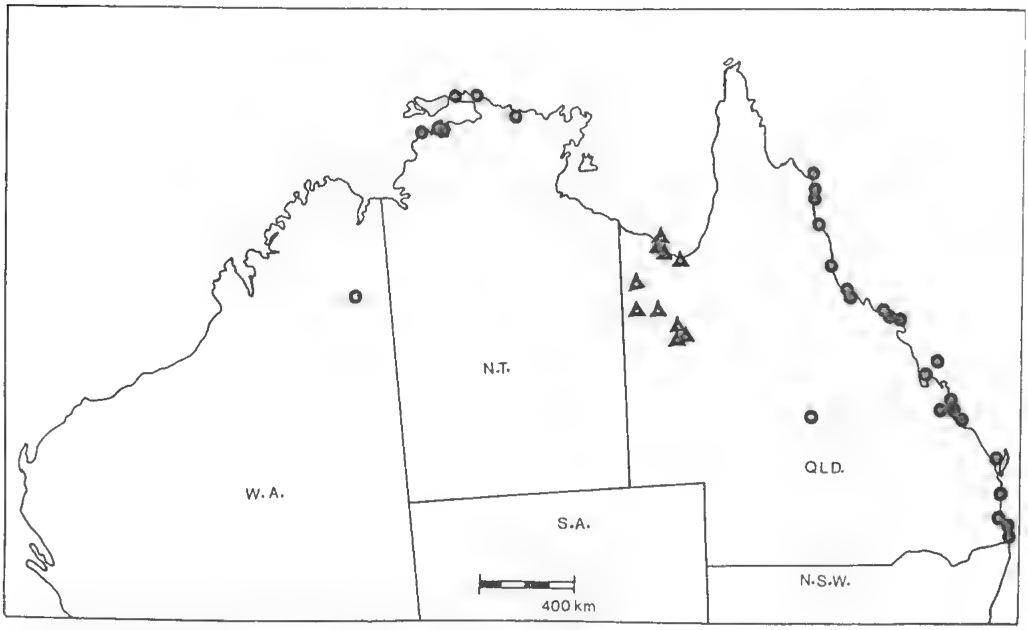
Comments

Bentham (1870) published this taxon as a var. *parviflora* of *V. trifolia*, and described the number of "leaflets 5 or sometimes 3 to each leaf". According to present studies, however, the leaves of this taxon are mostly 3-foliolate, rarely a few 1-foliolate. It appears that perhaps Bentham included in var. *parviflora* some collections belonging to the typical variety. He did not cite any specimen with the description, therefore, it is difficult to positively identify those specimens which caused Bentham to record up to 5 leaflets to each leaf of this taxon.

One of the syntypes of *V. benthamiana*, collected by Landsborough in 1862, was reported by Bentham (1870) and Domin (1929) as having come from "Northern Australia, on the Gulf of Carpentaria". Moldenke (1959, 1971, 1980) recorded "Northern Australia" as Northern Territory where this species does not occur. In fact, Landsborough's collection on the Gulf of Carpentaria came from Albert River in Queensland.

Domin's syntype collection from Cloncurry, Queensland, comprises three duplicates, each with a different number. In the present work, all three numbers (*Domin 8164*, *Domin 8165* & *Domin 8166*) are considered as belonging to one and the same collection. The different numbering seems to apply to different herbarium sheets and should not, therefore, be taken as different collections. Domin (1929) did not cite any of these numbers in the protologue but he recorded only the locality and collecting date.

Several collections of *V. benthamiana* and *V. trifolia* var. *trifolia* are found identified by others as *V. negundo* L. The occurrence of *V. negundo* in Australia has not been confirmed by any collection. The small flowers of *V. negundo* do look like those of *V. benthamiana*, but the latter differs by the shape and colour of its leaves, disposition of inflorescence and the flower characters.



Map 5. Distribution of *V. benthamiana* ▲, *V. trifolia* var. *subtrisecta* ●.

Affinities

V. benthamiana is nearest to *V. trifolia* in its leaflets being glabrescent above, greyish-tomentose below; inflorescence terminal, pyramidal; flowers almost identical in all major characters; ovary densely glandular and glabrous; fruit globose. Nevertheless, *V. benthamiana* may readily be distinguished by its leaflets being narrow-lanceolate, rostrate-acuminate, narrowing towards the base, generally up to 2 cm broad; lateral nerves beneath hidden by dense indumentum; fruit small, 3-4 mm in diameter. Fruit in *V. trifolia* is 5-6 mm in diameter.

There are several characters in common between *V. benthamiana* and *V. negundo* L. Both have more or less similarly shaped leaflets, terminal inflorescence, small flowers with calyx and corolla glandular and pubescent outside, stamens and style exserted, and ovary glabrous and glandular. However, *V. negundo* may easily be distinguished by its leaves being 3-5-foliolate; leaflets sometimes coarsely and obtusely serrate in the middle, their primary lateral nerves quite prominent underneath; inflorescence narrow and much less branched; calyx-lobes longer and narrower than those of *V. benthamiana*; fruit obovoid to oblong-obovoid. The fruit in *V. benthamiana* is always globose.

8. **Vitex trifolia** L., Sp. Pl. edn 1, 2 (1753) 638; Willd., Sp. Pl. 3 (1800) 392; R. Br., Prod. Fl. Nov. Holl. (1810) 511; Sprengel, Syst. Veg. 2 (1825) 757; Blume, Bijdr. Fl. Ned. Ind. (1926) 812; Cham., Linnaea 7 (1832) 107; Roxb., Fl. Ind. 3 (1832) 69; D. Dietr., Synop. Pl. 3 (1843) 611; Schauer in A. DC., Prod. 11 (1847) 683; Miq., Fl. Ind. Bat. 2 (1858) 859; F. Muell., Fragm. 3 (1862) 59; Benth., Fl. Aust. 5 (1870) 66; F. Muell., Fragm. 9 (1875) 5; Bailey & Ten.-Woods, Proc. Linn. Soc. N.S.W. (1880) 174; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; Maxim., Bull. Soc. Acad. Sc. St. Petersb. 31 (1886) 82; Schumann in Schumann & Hollr., Fl. Kais. Wilh. Land (1889) 121; Hemsley, J. Linn. Soc. (Bot.) 30 (1894) 187, 206; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 172; Merr., Fl. Manila (1912) 404; Merr., Enum. Philip. Fl. Pl. 3 (1923) 397; Ridley, Fl. Mal. Penin. 2 (1923) 630; Dop, Bull. Soc. Hist. Natur. 57 (1928) 206; Domin, Biblioth. Bot. 89 (1929) 560; Dop in Lecomte, Fl. Gén. Indo-Chine 4 (1935) 834; Fletcher, Kew Bull. (1938) 432; R. Henderson, Trees N.S.W. (1947) 273; Mold., Phytologia 6 (1958) 165, 174; Résumé Verbenac. etc. (1959) 211, 249, 250, 302, 335, 379, 380, 384, 385, 389-391, 423; Baker & Bakh.f., Fl. Java 2 (1965) 604; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 349, 375, 421, 534, 602, 710-712, 719, 720, 723, 729-732; Chippendale, Proc. Linn. Soc. N.S.W. 96 (1972) 256; Balg. & de Vogel, Pac. Pl. Area 3 (1975) 276; Mold., Sixth Summary Verbenac. etc. (1980) 339-343, 367, 405, 413, 423, 431, 436, 456, 458, 460; Jacobs & Pickard, Pl. N.S.W. (1981) 210; Mold., Phytologia 51 (1982) 330.

Type: Collector not known, Herb. Linnaeus 811/7, India, loc. incert. undated (LINN, microfiche!).

Small tree or shrub, sometimes decumbent and low. *Branches* obscurely quadrangular, minutely grey-tomentose. *Leaves* very variable, simple, 2-, 3- or 5-foliolate, petiolate; leaflets ovate-lanceolate, obovate-spathulate or oblong-elliptic, sessile or the central 1-3 leaflets petiolulate, often pubescent on both sides, but usually becoming nearly glabrous on the upper side at least when old. *Inflorescence* terminal, grey-tomentose; cymes opposite, pedunculate, forming short panicles, either simple and spike-like or slightly branched, the floral leaves reduced to small bracts. *Flowers* almost sessile or shortly pedicellate. *Calyx* obscurely 2-lipped, with 5 small teeth at the top or almost truncate, 5-ribbed, greyish-tomentose and white-glandular outside, glabrous within, 2-4 mm long, 1.5-3 mm wide, cup-shaped. *Corolla* 2-lipped, hypocrateriform, pubescent and glandular outside, villous inside the tube; tube nearly twice as long as the calyx; the 4 upper lobes short, the lowest twice as large and often as long as the tube. *Stamens* exserted, connate to the corolla-tube; filaments filiform, glabrous above, villous near the base, 3-6 mm long. *Ovary* globose, glandular-dotted in the upper, glabrous in the lower part, 2-celled, with 2 ovules in each cell; style exserted, glabrous, filiform, 5-8 mm long, with stigma shortly 2-fid. *Fruit* globular, glandular, up to 6 mm diam.; fruiting calyx cupuliform, 5-6 mm long and wide, cinereous-puberulent outside, entire or irregularly 5-denticulate.

Distribution

A widespread species from Afghanistan to India, Bangladesh and eastward through Burma, Malaysia, Indonesia, Papua New Guinea, northern Australia, New Caledonia, Fiji and Polynesia, north into the Hawaiian Islands, southern China, the Philippines, and Japan and westward to Mauritius, Madagascar, and Natal.

8a. **Vitex trifolia** L. var. **trifolia**. Sims, Curtis Bot. Mag. 47 (1820) t. 2187; Walp., Rep. Bot. Syst. 4 (1845) 83, p.p., excl. syn. *V. ovata* Thunb.; Seemann, Fl. Viti 5 (1866) 190, p.p., excl. syn. *V. ovata* Thunb. & *V. repens* Blanco; F. Muell., Fragm. 6 (1868) 152, p.p., excl. syn. *V. ovata* Thunb.; Bailey, Synop. Qld Fl. (1883) 379, p.p., excl. var.; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 583, p.p., excl. syn. *V. ovata* Thunb.; Bailey, Cat. Indig. & Nat. Pl. Qld (1890) 35, p.p., excl. var.; Forbes & Hemsley, J. Linn. Soc. Bot. 26 (1890) 258, p.p., excl. syn. *V. ovata* Thunb.; Collett & Hemsley, J. Linn. Soc. Bot. 28 (1891) 110, p.p., excl. var.; Bailey, Qld Fl. 4 (1901) 1179, p.p., excl. var.; Comp. Cat. Qld. Pl. (1913) 386, p.p., excl. var.; Ewart & Davies, Fl. N. Terr. (1917) 238, p.p., quoad spec. Henne; H.J. Lam, Verbenac. Malay. Arch. (1919) 180, p.p., excl. syn. *V. repens* Blanco & *V. rotundifolia* L. f.; E. Wilson, J. Arn. Arb. 1 (1920) 186 as "*V. trifoliolata*"; H.J. Lam & Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 52, p.p., excl. var. *rotundifolia* L. f.; Mold. in Dassan. & Fosb., Fl. Ceylon 4 (1983) 378.

V. trifolia L. var. *bicolor* (Willd.) Mold., Known Geogr. Distrib. Verbenac. edn 2 (1942) 79; Phytologia 6 (1958) 174-180; Résumé Verbenac. etc. (1959) 211, 212, 226, 380, 381, 384, 387-389; Phytologia 8 (1961) 84-86; Phytologia 17 (1968) 51-53; Fifth Summary Verbenac. etc. 1 & 2 (1971) 349, 351, 352, 375, 711, 712, 714, 719, 723-725; Phytologia 51 (1982) 345; in Dassan. & Fosb., Fl. Ceylon 4 (1983) 386.

Type: Herb. Willdenow 11709. Habitat in India orientali, undated. A cultivated specimen from Botanical Garden at Berlin (B-W, microfiche!).

V. trifolia L. var. *trifoliata* Cham., Linnaea 7 (1832) 107; Mold., Phytologia 6 (1958) 165, pro syn.

Type: As for *V. trifolia* L. var. *trifolia*.

V. trifolia L. var. *trifoliolata* Schauer in A. DC., Prod. 11 (1847) 683; H.J. Lam, Verben. Malay. Archip. (1919) 182; H.J. Lam & Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 53; Mold., Prelim. Alph. List Invalid Names (1940) 52; Phytologia 8 (1961) 83.

Type: As for *V. trifolia* L. var. *trifolia*.

V. bicolor Willd., Enum. Hort. Berol. 2 (1809) 660; Schauer in A. DC., Prod. 11 (1847) 683; Miq., Fl. Ind. Bat. 2 (1858) 860; Hall. f., Meded. Rijk-herb. Leid. no. 37 (1918) 42.

Type: Herb. Willdenow 11709. Habitat in India orientali, undated. A cultivated specimen from Botanical Garden at Berlin (B-W, microfiche!).

V. agnus-castus L. var. *trifolia* (L.) Kurz, For. Fl. Burma (1877) 270, based on *V. trifolia* L.; Kuntze, Rev. Gen. Pl. 2 (1891) 510, 511; Mold., Alph. List Invalid Names (1942) 52.

Type: As for *V. trifolia* L.

V. integerrimis Mill., Gard. Dict. edn 8 (1768) *Vitex* no. 3.

Type: India, undated (BM, n.v.).

V. trifolia L. var. *acutifolia* Benth., Fl. Aust. 5 (1870) 67; Bailey, Synop. Qld Fl. (1883) 379; Qld Fl. 4 (1901) 1179; Comp. Cat. Qld Pl. (1913) 386.

Syntypes: R. Brown s.n. (J.J. Bennett No. 2321), along the coast from Cape York to Moreton Bay, Queensland, 1802-1805 (BM, K).

V. variifolia Salisb., Prod. Stirp. Hort. Allert. (1796) 107.

Type: John Ger Koening, loc. incert, undated (BM, n.v.).

V. negundo L. var. *bicolor* (Willd.) H.J. Lam, Verben. Malay. Archip. (1919) 191; H.J. Lam in Bot. Jahrb. 59 (1924) 27; Mold., Phytologia 17 (1968) 51; Corner, Gard. Bull. Str. Settlem. 10 (1939) 258.

Type: As for *V. bicolor* Willd.

V. petiolaris Domin, Biblioth. Bot. 89 (1929) 561.

Type: *Domin 8167*, Cairns, northern Queensland, Australia, -.xii.1909 (PR, holotype!).

V. iriomotensis Ohwi, Acta Phytotax. Geobot. 7 (1938) 29.

Type: n.v., possibly in TO.

V. ternifolia Hort. ex Mold., Phytologia 6 (1958) 174.

Type: n.v., whereabouts not known.

V. negundo auct. non L. sensu C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 583, p.p., quoad syn. *V. bicolor* Willd.; P'ei, Mem. Sc. Soc. China 1 (1932) 101, p.p., quoad syn. *V. bicolor* Willd. & *V. negundo* L. var. *bicolor* (Willd.) H.J. Lam.; sensu Mosam., Sc. Rep. Kanaz. Uni. Biol. 4 (1955) 49; sensu Court, Cat. Liv. Pl. CBG (1980) 81; sensu Munir in Morley & Toelken (eds), Fl. Pl. Aust. (1983) 287, fig. 175.

V. triphylla auct. non L.: sensu Royle, Ill. Bot. Himal. (1839) 299; Mold., Alph. List Inval. Names Suppl. 1 (1947) 29.

Description (Fig. 8)

Shrub or small tree to 6.5 m tall. *Stem* to 25 cm diam. at breast height, branched from near the base, with bark smooth or finely checked, light-brown. *Leaves* mostly 3- or 5-foliolate, sometimes 1-3-foliolate or only 1-foliolate (i.e. undivided); leaflets subequal in size or the 2 lateral ones much smaller, oblong-elliptic or ovate-lanceolate, (2-) 3-8 (-13) cm long, (1-) 2-4 (-5) cm broad, acute or short-acuminate towards the apex, varying to obtuse, rounded or somewhat emarginate, cuneate-attenuate or somewhat rounded at the base, entire, membranous, glabrescent and rich dark-green above, usually turning black in drying, densely greyish- or white-tomentose beneath, the central 1-3 leaflets usually petiolulate, the lateral ones usually sessile or subsessile; petioles greyish-pubescent, 5-60 mm long; petiolules greyish-pubescent, 1-15 (-20) mm long. *Inflorescence* with a few cymes in the upper-most leaf-axils, cinereous or sordid-puberulent throughout, (3-) 5-18 (-25) cm long, 4-8 cm wide; cymes arranged into a pyramidal thyrse; the lateral primary peduncles 1-5 cm long. *Corolla* varying from blue to lavender, purple, mauve or violet; the anterior lobe broadly elliptic or almost orbicular, glabrous along the outside periphery, 3-5 mm long, 3-6 mm broad; the two lateral lobes more or less oblong-ovate, obtuse, (1.5-) 2-3 mm long, (1.3-) 1.5-2.5 mm broad at the base; the two lobes of the upper lip oblong-ovate, obtuse, 1-2.5 mm long, 1-2 (-2.5) mm broad at the base; tube nearly cylindrical, about twice the length of the calyx, 4-6 mm long, 2-3 mm wide at the top end. *Fruit* 4-6 mm diameter, at first green, then yellowish-reddish, finally blue or black.

Representative specimens (collections seen: Australian 125, non-Australian 124)

AUSTRALIA: QUEENSLAND: *Adams 20046*, Dunk Island, Coconut Bay, 11.x.1959 (BRI); *Bancroft 66*, Palm Islands, undated (BRI267708); *Bäuerlen 28*, Thursday Island, 30.vi.1885 (MEL); *Betche s.n.*, Cairns, -.viii.1901 (NSW145207); *Boorman s.n.*, Brisbane, -.iv.1899 (MEL98004); *R. Brown s.n.* (J.J. Bennett no. 2321), East and North Coast, 1802-1805 (K, MEL97989); *Cameron 20425*, Prince of Wales Island, Torres Strait, 16.ii.1975 (QRS); *Cunningham 218*, Endeavour River, -.1819 (MEL); *Dallachy s.n.*, Moreton Bay, -.vii.1865 (MEL98014); *Dallachy s.n.*, Rockingham Bay, 31.xii.1870 (MEL98038, MEL97968, MEL97969); *Domin 8167*, Cairns, -.xii.1909 (PR, holotype of *V. petiolaris* Domin); *Fitzalan s.n.*, Trinity Bay, 1882 (MEL98032); *Heatwole s.n.*, ca 19 km N of Townsville, 4.iii.1971 (BRI149532-33); *Hubbard 2967*, Wellington Point near Brisbane, 8.v.1930 (BRI, K); *Hyland*

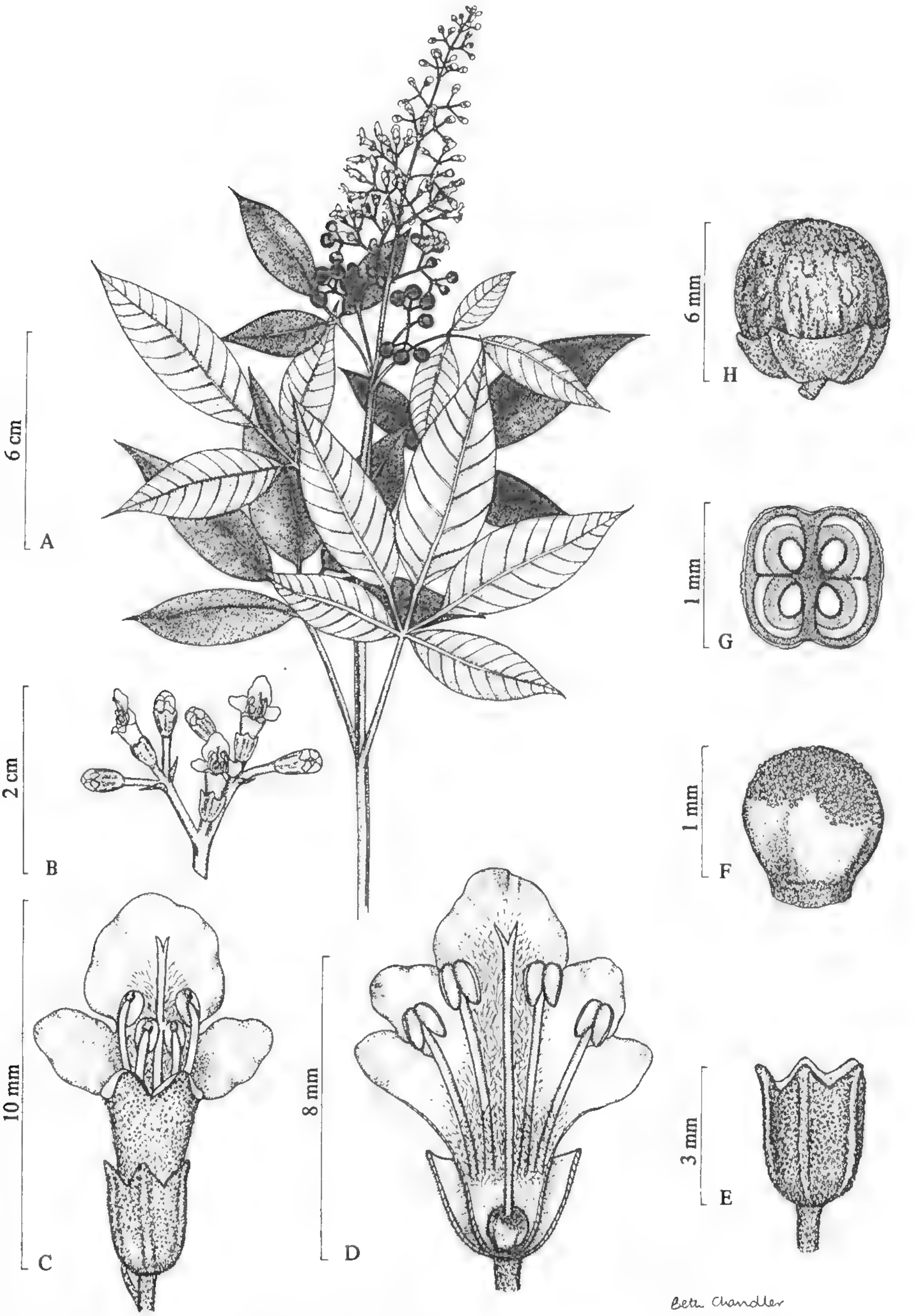


Fig. 8. *Vitex trifolia* L. var. *trifolia* (A-H, *B. Labler 91*: BRI).

03871, between Mission Beach and Bingil Bay, -.vii.1966 (BRI, L 2 spec.); *Johnson s.n.*, Harvey's Creek, 1892 (MEL97958); *Jones 3854*, Airlie-Proserpine, 17.viii.1968 (CANB); *Ladbrook s.n.*, Johnstone River, -.xi.1917 (BRI267702, NSW145216); *Leichhardt s.n.*, Brisbane River, 6.vii.1843 (NSW145211); *F. Mueller s.n.*, Fitzroy River, Rockhampton, undated (MEL893, MEL98016); *Ollerenshaw & Kratzing 1363*, ca 62 km NE of Doomadgee on Burketown Rd, 12.vii.1974 (BRI, CBG, L); *O'Shanesy 92*, Rockhampton, undated (MEL97982); *Porter 53*, South Percy Island, 140 km SE of Mackay, 27-31.vi.1980 (BRI); *Sharpe 1590 & 1747*, Hinchinbrook Island, 11.viii.1975 (BRI 2 spec.); *Specht L.I. 188*, Lizard Island, 24.xii.1974 (BRI); *Stoddart 4322*, Low Isles, Green Ant Island, 27.viii.1973 (BRI); *Stoddart 4411*, West Hope Island, 2.ix.1973 (BRI, L); *Telford 1770*, Shoal Point, near Mackay, 19.v.1970 (CBG); *White 10167*, Hayman Island, 12.vi.1934 (BRI, NY); *Wrigley & Telford 1434*, Quarantine Bay, S of Cooktown, 19.vi.1972 (CBG 2 spec., L).

NEW SOUTH WALES: *Boorman s.n.*, Tweed Heads, 24.ii.1914 (NSW145205); *Fawcett s.n.*, Richmond River, 1878 (MEL98015); *Hodgkinson s.n.*, loc. cit., -.1874 (MEL97914); *Tanner 3*, near Lismore, -.vi.1914 (NSW145204).

PAPUA NEW GUINEA: *Brass 859*, Port Moresby, 29.xii.1925 (A, BRI); *Isles & Croft NGF32225*, Ott Island, New Britain, 20.v.1973 (A, BISH, BRI, CANB, E, K, L, M, PNH, NSW, US); *Hollrung 486*, Constantine Harbour, 1886 (B n.v., MEL).

TONGA ISLANDS: *Crosby 142*, Vavau Islands, -.vi.1891 (MEL).

SAMOA: *Whitmee 50*, loc. incert., undated (MEL).

NEW HEBRIDES: *Campbell s.n.*, Aneityum Island, undated (MEL97861).

NEW CALEDONIA: *Schodde 5272*, Marine Drive, Anse Vata, Noumea, 19.i.1968 (A, AD, CANB, L, P).

FIJI: *Bryan f. 208*, Suva Bay, 25.vi.1924 (L); *Parks 20857*, Ellington, -v.-vii.1927 (L, UC).

INDONESIA: *Dali 7732*, W of Mt Hondja, Java, 26.ix.1957 (BO, L); *Sauveur 216*, Timor, Tandajung Ela, undated (A, K, L); *Vogel 4212*, Obi Isl., N Moluccas, 22.xi.1974 (BO, L).

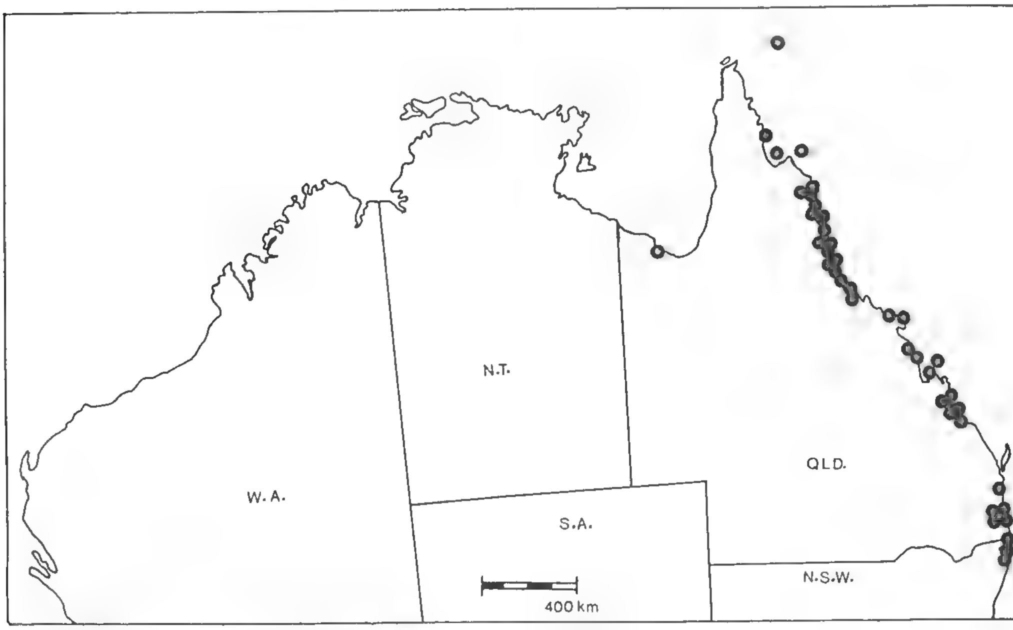
MALAYSIA: *Caudra A.1228*, Maruda, Kudat, Telaga, Sabah, 23.ii.1948 (BO, K); *Purseglove 5015*, Telok Lakei, Bako National Park, 20.v.1956 (L, SING).

PHILIPPINES: *Conklin s.n.*, Mt Yagaw, Mansalay, Mindora, 4.v.1953 (PNH17492); *Edano s.n.*, Panay, Capiz Prov., -x-xi.1925 (BRI267709, PNH 46232).

Distribution (Map 6)

In Australia, *V. trifolia* var. *trifolia* is found only in New South Wales and Queensland. The localities in New South Wales are in the far north-eastern part of the state where it mostly occurs in the area known as the "Macpherson-Macleay Overlap". The known localities are restricted between 28° and 29°S and between 153° and 154°E. In Queensland, the distribution is chiefly in the tropical region of the east-coast with scarcely any locality deep inland. It has been reported from most off-shore islands along the east-coast, and from several major islands in the Torres Strait. So far, it has not been recorded from the west-coast of Cape York Peninsula where it is likely to occur. From the Gulf of Carpentaria region, it has been collected only from about 62 km north-east of Doomadgee on the Burketown Road. It's occurrence in the Northern Territory was based by others on misidentification of its non-typical varieties as var. *trifolia.*

Collections from outside Australia have been examined from Papua New Guinea, Tonga Islands, Samoa, New Hebrides, New Caledonia, Fiji, Cook Islands, Indonesia, Malaysia, Philippines and India. According to Moldenke (1983), "this is a widespread species from Afghanistan to India, Bangladesh and eastward through Burma, Malaya, Indonesia, New Guinea, northern Australia, and New Caledonia, north into southern China, the Philippines, and Japan, and westward to Mauritius, Madagascar and Natal". Due to relegation of var. *bicolor* to a synonym of the typical variety, the above distribution range further extends westward to Tanzania, and eastward to the Pacific Islands including the Hawaiian Islands. According to Moldenke (1971), this species has been cultivated in Australia, Belgium, California, China, Cochinchina, Cuba, Florida, France, India, Java, Johnston Island, Kenya, Maryland, Mauritius, Netherlands, New Hebrides, New York, Reunion, South Africa, Sumatra and Thailand. All these may not necessarily belong to the typical variety.



Map 6. Distribution of *V. trifolia* var. *trifolia* ●.

Comments

The examination of a range of collections, and the types of var. *trifolia* and var. *bicolor* has shown that this species is very polymorphic. The type specimens in Herb. LINN on which this species was based have strictly 3-foliolate discolourous leaves which are distinctly petiolate and their terminal leaflet always petiolulate. The apices of most of their leaflets are long-acuminate. As in the type variety, the leaves on the type specimen of var. *bicolor* (in Herb. B-W) are also discolourous and long-petiolate, with terminal leaflets always petiolulate and most leaflets have a narrow acuminate apex. Nevertheless, the leaves of the var. *bicolor* type are found to be mostly 5-foliolate with a few towards the apex 3-foliolate. The number of leaflets in a leaf seems to be the basis of separating these two varieties with var. *trifolia* mostly 3-foliolate and var. *bicolor* mostly 5-foliolate. There is no other character in the literature which could help to identify these two very closely allied varieties.

During present investigations, a range of *V. trifolia* collections from Australia and overseas have been examined. Their leaves, when dried, are all deep dark- or black-coloured above, greyish or white matted tomentose beneath. The polymorphic nature of this species became evident by observing 1-, 3-, 4- and 5-foliolate leaved specimens identified as *V. trifolia* or *V. trifolia* var. *bicolor*. In some collections, a few 2-foliolate leaves were also observed. Some collections have undivided leaves, some 1-3-foliolate and others 3-5-foliolate with a few undivided as well. In fact, very few specimens have strictly 3-foliolate or only 5-foliolate leaves. There appears to be so much intergradation or transition from 1- to 3-foliolate or 3- to 5-foliolate leaved on the same collection that it is not possible to draw a line between the two taxa. Therefore, in the present revision only var. *trifolia* is retained with var. *bicolor* relegated to its synonymy. The only other varieties of *V. trifolia* recognised from Australia were var. *simplicifolia* and var. *subtrisecta*. In both these varieties the leaves are not discolourous (or two-coloured) and their leaflets or undivided leaves are found to be mostly sessile with a cuneate base. The leaflets in var. *trifolia* and var. *bicolor* are mostly almost rounded or occasionally somewhat truncate at the base.

Material of *V. trifolia* var. *trifolia* has been widely misidentified and distributed in herbaria as *V. trifolia* var. *bicolor* (Willd.) H.J. Lam or *V. negundo* L. The latter has often been considered a closely allied species differing by its calyx being acutely dentate or lobed, leaves 5-foliolate, leaflets petiolulate and lanceolate, and cymes slightly lax to dense.

A few specimens have been identified as *V. trifolia* var. *variegata* Mold. The occurrence of this variety in Australia is improbable and the specimens identified as this variety do not agree with the available descriptions of this taxon.

It has been mentioned under "distribution", that, in Australia, *V. trifolia* var. *trifolia* occurs mainly in Queensland with only a few records from the far north-eastern tip of New South Wales. However, Moldenke (1959, 1971) recorded this variety from the Northern Territory and Western Australia, apparently misidentifying the material of other species and varieties as var. *trifolia*.

Backer & Bakhuizen (1965) suggest that in Java *V. trifolia* L. hybridises naturally with what they call *V. paniculata* Lam., and they assert that in Java the plant flowers throughout the year. It is reported to grow from sea level to 1100 m altitude and is found in periodically very desiccated localities. In some areas, this species has been cultivated as a hedge plant.

Kurz (1877) regarded *V. agnus-castus* L. and *V. trifolia* L. as conspecific, adopting the former epithet. In fact, *V. agnus-castus* is a distinct species, differing from *V. trifolia* by its leaves being always 3-5 (sometimes 7 or 9) -foliolate; leaflets much narrower, tapering towards both ends, sessile or very shortly petiolulate; panicles interrupted, with subsessile, opposite, globose cymes.

H.J. Lam (1919) and Moldenke (1983) recorded the corolla-tube of *V. trifolia* as 0.85-1.3 cm long, and the calyx 4-5 mm long. These measurements are much longer than those for Australian plants seen by the present author.

V. trifolia is sometimes referred to as "*V. trifoliata*", "*V. trifoliolata*" or "*V. triphylla*" without any reference to look up these names and their status. All these names are only orthographic variance of *V. trifolia*.

There are many more names attributed to this taxon than are recorded here in the synonymy.

Affinities

Of Australian *Vitex* species, *V. trifolia* is nearest to *V. rotundifolia*. Both these species have their leaves (or leaflets) greyish-tomentulose underneath; inflorescence terminal, pyramidal in outline; flowers almost identical in their major characteristics, ovary glabrous and glandular all over, and fruit globular, glabrous and glandular even after drying. *V. rotundifolia*, however, can easily be indentified by its procumbent habit and sandy sea-shore habitat; stem creeping and rooting at nodes; leaves mostly 1-foliolate, rotund or rotund-obovate, pubescent-tomentulose all over, sessile or sometimes with a short petiole 1-5 (-10) mm long. The leaves in *V. trifolia* are 3-5-foliolate, rarely 1-foliolate, always petiolate and glabrescent above; stem never rooting at the nodes.

There are several characters common to *V. trifolia* and *V. velutinifolia*. For similarities and differences see "key to the species" and "affinities" under the latter.

8b. **V. trifolia** L. var. **subtrisecta** (Kuntze) Mold., Phytologia 8 (1961) 88; Neal, Gard. Hawaii (1965) 727; Pope, Man. Wayside Pl. (1968) 195, 196, t. 111; Mold., Phytologia 17 (1968) 117; Fifth Summary Verbenac. etc. 1 & 2 (1971) 349, 351-353, 375, 712, 727, 729, 792; Backer, Atlas 220 Weeds (1973) t. 521; Walker, Fl. Okin. & South Ryuk. (1976) 893; Mold., Sixth Summary Verbenac. etc. (1980) 339-343, 368, 459; Siv. & Mani., J. Econ. Taxon. &

Bot. 3 (1982) 816; Mani & Siv., Fl. Calicut (1982) 229; Mold., Phytologia 52 (1982) 188; Mold. in Dassan. & Fosb., Fl. Ceylon 4 (1983) 385.

Type: *Kuntze 5817*, from the Willisgebirge in Java, Indonesia, ?2.viii.1875 (NY, holotype!).

V. agnus-castus L. var. *subtrisecta* Kuntze, Rev. Gen. Pl. 2 (1891) 510, 511, basionym; Mold., Phytologia 6 (1968) 165.

V. rotundifolia L. f. var. *heterophylla* Makino, Ill. Fl. Nipp. (1940) 186; Makino & Hara, Enum. Sperm. Jap. 1 (1948) 191; Walker, Fl. Okin. & S. Ryuk. (1976) 894.

Type: Japan, n.v.

V. trifolia L. var. *heterophylla* (Makino) Mold., Phytologia 3 (1949) 178; Phytologia 6 (1958) 180-183; Résumé Verbenac. etc. (1959) 185, 189, 191, 195, 198, 200, 202, 206, 207, 211, 226, 380, 388, 390.

Type: As for *V. rotundifolia* L.f. var. *heterophylla* Makino.

V. trifolia L. var. *subincisa* Kuntze ex Mold., Phytologia 8 (1961) 88.

Type: n.v.

V. rotundifolia L.f. form. *heterophylla* (Makino) Kitamura in Kitamura & Murata, Acta Phytotax. Geobot. 25 (1972) 34.

Type: As for *V. rotundifolia* L.f. var. *heterophylla* Makino.

V. trifolia sesnu C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 583, p.p.; Gamb., Fl. Pres. Madr. (1924) 1101-1102, p.p.

Diagnosis (Fig. 9)

Dwarf, erect or subprostrate shrub 0.5-3 m tall, with leaves both 1-foliolate and 3-foliolate interspersed on branchlets; petioles up to 25 mm long. *Leaflets* sessile, elliptic to oblanceolate, obtuse or shortly acuminate at the apex; the terminal leaflet much larger than the laterals, cuneate at the base, up to 9 by 4 cm; lateral leaflets elliptic-obtuse, oblique at the base. *Inflorescence* of densely tomentose thyrse, with flowers purplish-mauve or pale-blue. Fruit subglobose, glabrous, glandular all over.

Representative specimens (collections seen: Australian 58, non-Australian 41)

AUSTRALIA: QUEENSLAND: *Bailey s.n.*, Dalrymple Islet, undated (HO); *Blake 22596*, Curtis Island, south-end, 29.iii.1966 (BISH, BRI, CANB, K, MO, SP); *Couper 961*, Barron River, Mareeba, 28.x.1935 (QRS); *Craig 028216*, Noosa Heads, 10.xii.1968 (CBG); *Dallachy s.n.*, Edgecumbe Bay, 14.vi.1863 (MEL98008); *Dallachy s.n.*, Rockingham Bay, 24.xii.1869 (MEL97995, MEL97996); *Domin 8161*, Emu Park, near Rockhampton, -.iii.1910 (PR); *Fitzalan s.n.*, Port Denison, undated (MEL97970, MEL98006, MEL98009, MEL98013); *Fosberg 54993*, Lizard Island, Great Barrier Reef, S side, 26.vi.1973 (BRI, L); *Johnson s.n.*, Cleveland Bay, 1876 (MEL98019); *L. Johnson 42326*, Coolangatta Beach, 13.vi.1957 (NSW); *Macgillivray s.n.*, Saddleback Island, -xii-1.1932-3 (BRI); *Persieh 168*, Endeavour River, undated (MEL97972); *Telford 1723*, Yeppoon, 17.v.1970 (CBG); *Telford 5500*, 15 km SE of Gladstone, 3.vi.1977 (CBG); *Williams 79063*, Wild Duck Island, 29.xi.1979 (BRI); *Woods 12*, 6th Isl. of Northumberland Group of Islands, -.xi.1873 (MEL98021).

NORTHERN TERRITORY: *Allen s.n.*, near Darwin, 29.ix.1929 (MEL97976); *Chippendale 8162*, near Mountnorris Bay, Cobourg Peninsula, 17.vii.1961 (AD, BRI, CANB, MEL, NT, PERTH); *Gressitt 3675*, Maningrida, 1961 (BRI); *Landsborough s.n.*, Gulf of Carpentaria, undated (MEL98010); *Lazarides & Adams 285*, Casuarina Beach near Lee Point, 9 miles NNE of Darwin, 20.iii.1965 (BRI, CANB, E, K, L, NSW, NT, US); *Rankin 1455*, 2 km NW of Lake Finnis on Woolner Station, 4.x.1978 (BRI, CANB, DNA, K, NT); *Specht 42*, Nightcliff, Darwin, 23.iii.1948 (AD, BRI, L, MEL, NSW).

WESTERN AUSTRALIA: *Thompson s.n.*, R.C. Presbytery, Carnarvon, 10.ix.1964 (PERTH); *Done 374*, Halls Creek area, 21.xi.1980 (DNA).

PAPUA NEW GUINEA: *Henty 11514*, Nadzab, near Lae, Morobe district, 4.viii.1959 (BRI, CANB, LAE); *Schodde & Craven 4544*, Tapala village environs, Malalaua River near mouth of Tauri River, Gulf district, 27.ii.1966 (A, BO, BRI, CANB, G, K, L, LAE, PNH, US).

INDONESIA: *Iwatsuki, Murata, Dransfield & Saerudin 1523*, Atjeh enroute from Takingeun to Isak, Sumatra, 2.ix.1971 (BO, K, KYO, L); *Rahmat Si Toroes 910*, Hoeta Padang, Asahan, 1-6.v.1928 (BO, L, MICH).

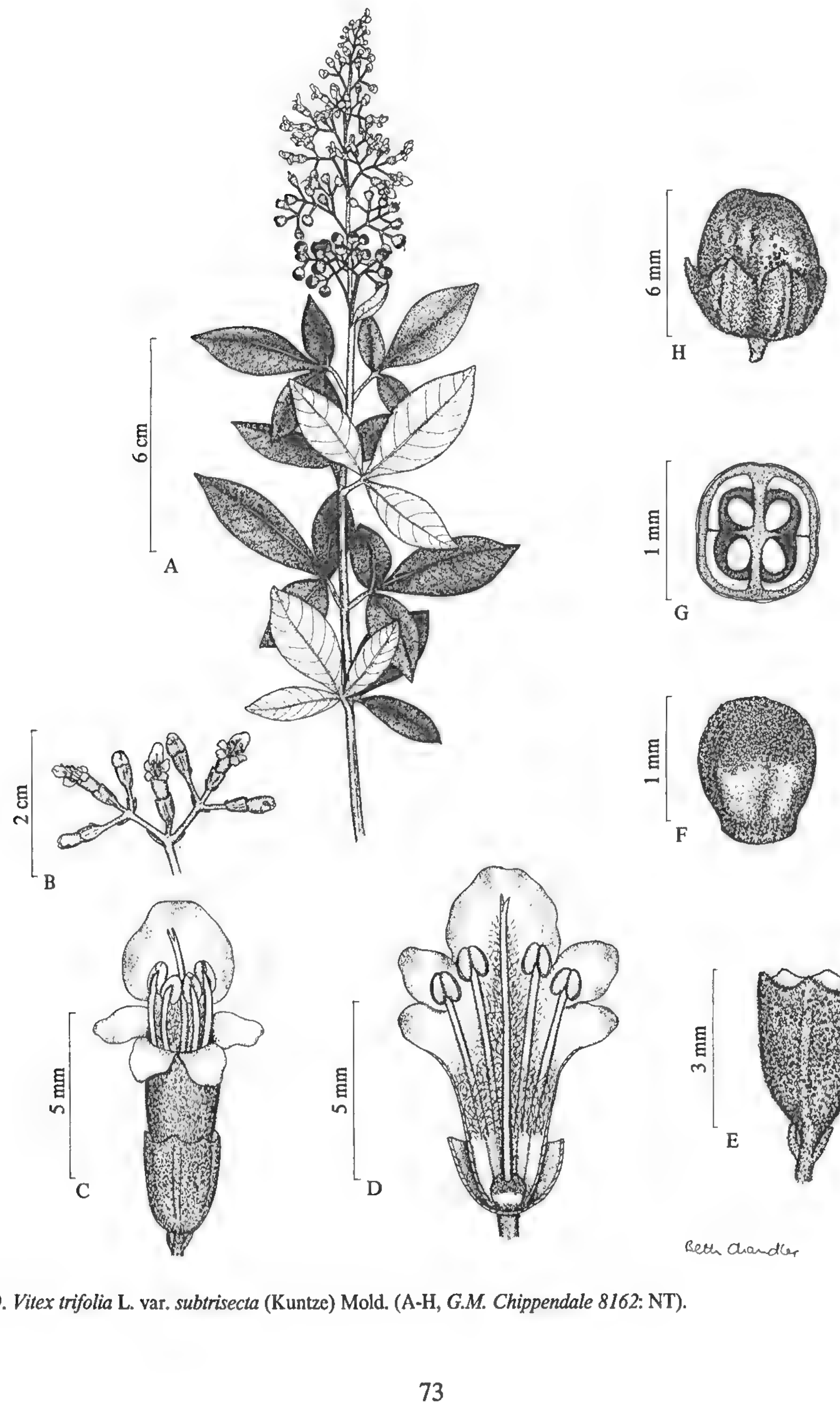


Fig. 9. *Vitex trifolia* L. var. *subtrisecta* (Kuntze) Mold. (A-H, *G.M. Chippendale 8162*: NT).

IRIAN JAYA: *Royen & Sleumer 8249*, near Anjai, Vogelkop Peninsula, 13.xii.1961 (BO, BRI, CANB, L).

PHILIPPINES: *Canicosa s.n.*, Kinamaligan, Calauag Quezon Prov., Luzon, 4.v.1949 (PNH9784).

MALAY PENINSULA: *Corner 33492*, Kuala Brang, State of Trengganu, 29.iv.1937 (SING).

FIJI: *Smith 7088*, east of Wainimbuka River in vicinity of Ndakuivuna, Tailevu, Viti Levu, 14-26.iv.1953 (BISH, L, US).

NEW CALEDONIA: *Däniker 2417*, Loyalitätsinseln, 15.xi.1925 (L, Z).

MICRONESIA: *Stone 4728*, OSIR Road, Apra Harbour, Guam, 3.iii.1963 (L).

HAWAIIAN ISLANDS: *Spence 151*, along Highway 56 north of Kapaa, Kauai, 13.iv.1973 (BISH, L).

CHINA: *Yip 357*, Guangzhou, Guangdong, 25.vi.1981 (AD, IBSC).

Distribution (Map 5)

In Australia, *V. trifolia* var. *subtrisecta* is found chiefly in Queensland and Northern Territory with only two disjunct localities in Western Australia. In Queensland, the distribution is along the east-coast particularly in the area between the Gold Coast and Cooktown. So far, it has not been reported from the upper half of the Cape York Peninsula or any area along the Gulf of Carpentaria. A few collections are known from off-shore islands along the east-coast and at least one from the Dalrymple Islet in the Torres Strait.

In the Northern Territory, this taxon is found in the northern part of the state where the known localities are restricted between 11° and 13°S and between 130° and 135°E. Most localities, however, are in the Darwin region with only two records from the northern coast. So far it has not been reported from inland or from any off-shore island of the Northern Territory.

There are only two known localities in Western Australia. One near Halls Creek south of the Kimberley region and the other from Carnarvon along the North West Coastal Highway. Further exploration in the Kimberley region might reveal its occurrence in that part of Western Australia.

Collections from outside Australia have been examined from southern China, Taiwan, Malesia, Melanesia, Micronesia and the Hawaiian Islands. According to Moldenke (1983), the distribution range of this variety extends "from India, Ceylon, the Andaman Islands, Burma, Thailand, Malaya, and Indo-China north to southern China and Japan, west to the Mascarene Islands and Madagascar, east through the Ryukyu and Philippine Islands to Indonesia, the Lesser Sunda Islands, New Guinea, New Caledonia, Fiji, and Polynesia".

In Australia, var. *subtrisecta* is cultivated in several towns and cities of Queensland, Northern Territory and Western Australia. Outside Australia, Moldenke (1980) recorded its cultivation (mainly as a hedge plant) in the Bahamas, Baker Island, Belgium, China (Hainan Island), U.S.A. (Florida, Hawaiian Islands & New York), India, Indonesia (Java & Sumatra), Johnston Island, Marshall Islands, Papua New Guinea, Malaysia (Penang), Singapore and Sri Lanka.

Comments

The type of var. *subtrisecta* came from Java where the occurrence of this variety has been reported by Moldenke (1971, 1980, 1983) and Sivarajan & Manilal (1982). Nevertheless, this variety was not recorded in the "Flora of Java" by Backer & Bakhuizen (1965). It seems, that similar to a few other authors, they may have identified this variety as the typical form of the species.

During present investigations, var. *subtrisecta* is found to be very variable, with its leaves commonly 1-, 2-, and 3-foliolate, or a few leaflets more or less binary. According to collector's field notes, it generally occurs in the littoral belt close to mangrove formations, along the river banks, and inland to several hundred meters in altitude.

A few collections with somewhat variegated leaves have been identified as var. *variegata*. Almost all of them came from garden cultivation. Most of these specimens have leaves with a variegation of somewhat greyish speckles. Their leaf-shape and flower-characters, however, are similar to those of var. *subtrisecta*. So far, the variegate-leaved form does not grow naturally in Australia.

According to Moldenke (1971), more work is badly needed on means of distinguishing the present subdivision of *V. trifolia* and several other taxa of the Verbenaceae. Under the "Statement of Policies", Moldenke expressed his doubt on the true status of var. *simplicifolia* and var. *subtrisecta*. In fact, the infraspecific complex of *V. trifolia* seems to have several names apparently referred to variants of the same taxon. A broader concept of the infraspecific taxa may possibly lead to reducing at least a few names to the level of variety or form.

In var. *subtrisecta*, the glands all over the ovary and fruit seem more consistently prominent than those in the typical form of the species.

Affinities

As mentioned for var. *trifolia*, typical variety, var. *subtrisecta* is also allied to *V. rotundifolia* in having similar indumentum on the lower surface of its leaflets, similar inflorescence, flowers and fruit. Nevertheless, var. *subtrisecta* can readily be distinguished by its leaves being distinctly petiolate, mostly 3-foliolate, sometimes 1-3-foliolate; leaflets sessile, elliptic or oblanceolate, obtuse or subacuminate and glabrescent above. The leaves in *V. rotundifolia* are mostly sessile, rotund-obovate, and tomentulose all over.

Acknowledgements

The author is grateful to Dr J.P. Jessop for comments on the draft of this manuscript and for translating into Latin the diagnosis of the new species; to Dr H.N. Moldenke for supplying references relevant to this work; to Mr G.R.M. Dashorst for preparing figures 1-4 & 6; to Mrs Beth Chandler for preparing figures 5 & 7-9; Miss M. Eadsforth for typing the manuscript.

Thanks are also due to the Directors/Curators of the following herbaria for the loan of herbarium specimens: A, ADW, BISH, BM, BO, BRI, CANB, CBG, DNA, E, G, HO, JCT, K, Kings Park Perth, L, LAE, MEL, M, MO, NSW, NT, NY, P, PERTH, PNH, PR, QRS, SING, SYD, US, Z.

References

Adanson, M. (1763). "Familles des Plantes". Vol. 2:195-201. (Vincent: Paris).

Anderson, R.H. (1947). *Vitex*. "The Trees of New South Wales". (Govt Printer: Sydney).

Backer, C.A. & Bakhuizen van den Brink, R.C. (1965). Verbenaceae. "Flora of Java". Vol. 2:594-614. (N.V.P. Noordhoff: Groningen).

Bailey, F.M. (1883). Verbenaceae. "A Synopsis of the Queensland Flora". 375-381. (J.C. Beal, Govt Printer: Brisbane).

Bailey, F.M. (1888). Verbenaceae. "Queensland Woods". Edn 2:90-93. (Queensland Commission: Brisbane).

Bailey, F.M. (1890). Verbenaceae. "Catalogue of the indigenous and naturalised plants of Queensland". 35-36. (Govt Printer: Brisbane).

Bailey, F.M. (1901). Verbenaceae. "The Queensland Flora". Part 4:1164-1185. (H.J. Diddams & Co.: Brisbane).

Bailey, F.M. (1913). Verbenaceae. "Comprehensive Catalogue of Queensland Plants". 381-387. (Govt Printer: Brisbane).

Bartling, F.G. (1830). "Ordines naturalis Plantarum". (Dietrich: Goettingen).

Batsch, A.J.G.K, (1802). "Tabula affinitatum Regni vegetabilis". (Landes-Industrie Comptoir: Weimar).

Bentham, G. (1870). Verbenaceae. "Flora Australiensis". Vol. 5:31-70. (L. Reeve & Co.: London).

Bentham, G. & Hooker, J.D. (1876). Verbenaceae. "Genera Plantarum". Vol. 2:1131-1160. (L. Reeve & Co.: London).

Blanco, F.M. (1837). Didynamia Angiospermia. "Flora des Filipinas Segun el Sistema sexual de Linneo". 484-519. (D. Candido Lopez: Manila).

Blume, C.L. (1826). Verbenaceae. "Bijdragen tot de flora van Nederlandsch Indie". 807-822. (Lands Drukkerij: Batavia).

Briquet, J. (1895). Verbenaceae. In Engler, A. & Prantl, K. "Die natrülichen Pflanzenfamilien". Part 4, 3a:132-182. (Wilhelm Engelmann: Leipzig).

Brongniart, A.T. (1843). "Enumeration des Generes de Plantes cultives au Museum d'histoire naturelle de Paris". (Fortin, Masson & Co.: Paris).

Brown, R. (1810). Verbenaceae. "Prodromus Florae Novae Hollandiae et Insulae Van-Diemen". 510-514. (Richard Taylor & Co.: London).

Burkill, I.H. (1966). "A Dictionary of the economic products of the Malay Peninsula". Vol. 2:2277-2282. (Ministry of Agriculture and Co-operatives: Kuala Lumpur).

Chamisso, L.A. (1832). De Plantis in Expeditione Romanzoffiana et in Herbariis Regiis Observatis disserere pergitur. *Linnaea* 7:105-115.

Clarke, C.B. (1885). Verbenaceae. In Hooker, J.D. "The Flora of British India". Vol. 4:560-604. (L. Reeve & Co.: Ashford).

Corner, E.J.H. (1939). Notes on the Systematy and Distribution of Malayan Phanerogams III. *Gard. Bull. Str. Settle. Singapore* 10:239-260.

Dalla Torre, C.G. & Harms, H. (1904). Verbenaceae. "Genera Siphonogamarum ad Systema Englerianum Conscripta". 429-434. (Wilhelm Engelman: Leipzig).

Degener, O. (1946). Verbenaceae. "New Illustrated Flora of the Hawaiian Islands". Family 315. (O. & I. Degener: Honolulu).

Dietrich, D.N.F. (1842). Didinamia Angiospermia. "Synopsis Plantarum". Vol. 3:600-620. (B.F. Voight: Weimar).

Domin, K. (1929). Beiträge zur Flora und Pflanzengeographie Australiens. *Biblioth. Bot.* 89(vi):551-562.

Dop, P. (1928). Les *Vitex* de L'Indochine. *Bull. Soc. Hist. Natur. Toulouse.* 57:197-211.

Dumortier, B.C.J. (1822). "Commentationes botanicae". 60. (J. Casterman: Tournay).

Dumortier, B.C.J. (1829). Verbenaceae. "Analyse des Familles des Plants". 22 (J. Casterman: Tournay).

Durand, Th. (1888). Verbenaceae. "Index Generum Phanerogamorum". 319-322. (Dulau & Co.: London).

Endlicher, S.L. (1838). Verbenaceae. "Genera Plantarum Secundum Ordines Naturales Disposita". Vol. 1:632-639. (Fr. Beck: Vienna).

Ewart, J. & Davies O.B. (1917). Verbenaceae. "Flora of the Northern Territory". 235-239. (McCarron, Bird & Co.: Melbourne).

Fletcher, H.R. (1938). The Siamese Verbenaceae. *Kew Bull.* 1938:401-445.

Francis, W.D. (1951). Verbenaceae. "Australian Rain-Forest Trees". 367-373. (Forestry and Timber Bureau: Sydney).

Gaertner, J. (1788). "De Fructibus et Seminibus Plantarum". Vol. 1:266-275. (G.H. Schramm: Tübingen).

Gardner, C.A. (1931). Verbenaceae. "Enumeratio Plantarum Australiae occidentalis". Part 3:111-113. (Govt Printer: Perth).

Giseke, P.D. (1792). "Caroli a Linne .... Praelectiones in Ordines Naturales Plantarum". (B.G. Hoffmann: Hamburg).

Gleditsch, J.G. (1764). "Systema plantarum a Staminum situ, etc." (Haude & Spencer: Berlin).

Gmelin, J.F. (1792). "Caroli a Linne .... Systema Naturae etc". (B.E. Beer: Leipzig).

Jaume Saint-Hilaire, J.H. (1805). Verbenaceae. "Exposition des Familles naturelles et de la Germination des Plantes". Vol. 1:245-253. (Treuttel et Würtz: Paris).

Junell, S. (1934). Zur Gynäceummorphologie und Systematik der Verbenaceen und Labiaten. *Symb. Bot. Ups.* 4:1-219.

Jussieu, A. de (1759). "Ordines naturales in Ludovici XV Horto Trianonensi Dispositi Anno". (Bibl. Centr.: Paris).

Jussieu, A.L. de (1789). Vitices. "Genera Plantarum secundum Ordines naturalis disposita". 106-110. (Viduam Herissant & T. Barrois: Paris).

Jussieu, A.L. de (1806). Sur la Famille des Plantes Verbenacees. *Ann. Mus. Hist. Nat. Paris.* 7:63-77.

King, G. & Gamble, J.S. (1909). Verbenaceae. "Material for a Flora of the Malayan Peninsula". Vol. 4:1004-1079. (W. Newman & Co.: London).

Kunth, C.S. (1823). Verbenaceae. "Synopsis Plantarum". Vol. 2:40. (F.G. Levrault: Paris).

Kurz, S. (1877). Verbenaceae. "Forest Flora of British Burma". Vol. 2:25-276. (Govt Printing: Calcutta).

Lam, H.J, (1919). "The Verbenaceae of the Malayan Archipelago'. (M. De Waal: Groningen).

Lam, H.J. (1921). In Lam, H.J. & Bakhuizen van den Brink, R.C. Revision of the Verbenaceae of the Dutch East-Indies and surrounding Countries. *Bull. Jard. Bot. Buitenz.* Ser. III, 3:1-116.

Lamarck, J.B.A.P. de (1823). "Tableau Encyclopédique et Methodique". Vol. 3:56. (Chez Pancoucke: Paris).

Lemée, A. (1943). Verbenaceae. "Dictionnaire descriptif et synonymique des Generes de Plantes Phanerogames". Vol. 8b:650-657. (Imprimerie Commerciale et Administrative: Brest).

Lindau, G. (1895). Acanthaceae. In Engler, A. & Prantl, K. "Die natürlichen Pflanzenfamilien". Part 4, 3a:274-354. (Wilhelm Engelmann: Leipzig).

Lindley, J. (1847). "The Vegetable Kingdom". Edn 2. (Bradbury & Evans: London).

Link, J.H.F. (1822). Didynamia Angiospermia. "Enumeratio Plantarum Horti Regii Berolinensis altera". Part 2. (G. Reimer: Berlin).

Linnaeus, C. (1753). Didynamia Angiospermia. "Species Plantarum". Edn 1, vol. 2:602-609. (Laurentius Salvius: Stockholm).

Linnaeus, C. von fil. (1781). "Supplementum Plantarum. etc". (Impensis Orphanotropei: Braunschweig).

Loureiro, J. de (1793). Didynamia Angiospermia. "Flora Cochinchinensis". Edn 2, vol. 2:455-478. (Haude & Spencer: Berlin).
Maiden, J.H. (1889). "The useful native Plants of Australia including Tasmania". (Turner & Henderson: Sydney).
Makino, T. (1903). Observations on the Flora of Japan. *Bot. Mag. Tokyo* 17:85-92.
Meeuse, A.D.J. (1942). Notes on Javanese Verbenaceae. *Blumea* 5:66-80.
Meisner, C.F. (1840). Verbenaceae. "Plantarum vascularium Genera secundum Ordines naturalis digesta . . . .". Vol. 1. "Tabulis Diagnosticis". 290-292. Vol. 2. "Commentarius". 197-200. (Libraria Weidmannia: Leipzig).
Melchior, H. (1964). Tubiflorae. In Melchior, H. "Engler's Syllabus der Pflanzenfamilien". Edn 12, vol. 2:424-471. (Borntraeger Borthers: Berlin).
Merrill, E.D. (1905). Verbenaceae. "A review of the identifications of the species described in Blanco's Flora of de Filipinas". 67-69. (Bureau of Public Printing: Manila).
Merrill, E.D. (1909). New or Noteworthy Philippine Plants VII. *Philipp. J. Sci.* 4:247-330.
Merrill, E.D. (1912). New or Noteworthy Philippine Plants IX. *Philipp. J. Sci.* 7:259-358.
Merrill, E.D. (1923). Verbenaceae. "An Enumeration of Philippine Flowering Plants". Vol. 3:380-408. (Bureau of Printing: Manila).
Miquel, F.A.W. (1858). Verbenaceae. "Flora Indiae Batavae". Vol. 2:85-913. (C.G. van der Post: Amsterdam).
Moldenke, H.N. (1959). "A Résumé of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". (H.N. Moldenke: Mountain, New Jersey).
Moldenke, H.N. (1971). "A fifth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World etc". Vol. 1 & 2. (H.N. Moldenke: Wayne, New Jersey).
Moldenke, H.N. (1980). "Phytologia Memoirs. II. A sixth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Chloanthaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World etc". (H.N. & A.L. Moldenke: Plainfield, New Jersey).
Moldenke, H.N. & Moldenke, A.L. (1983). Verbenaceae. In Dassanayake, M.D. & Fosberg, F.R. "A Revised Handbook to the Flora of Ceylon". Vol. 4:196-487. (Amerind Publishing Co. Pvt. Ltd.: New Delhi).
Mueller, F.v. (1862). "Fragmenta Phytographiae Australiae". Vol. 3. (Govt Printer: Melbourne).
Mueller, F.v. (1864). "Fragmenta Phytographiae Australiae". Vol. 4. (Govt Printer: Melbourne).
Mueller, F.v. (1865). "Fragmenta Phytographiae Australiae". Vol. 5. (Govt Printer: Melbourne).
Mueller, F.v. (1868). "Fragmenta Phytographiae Australiae". Vol. 6. (Govt Printer: Melbourne).
Mueller, F.v. (1875). "Fragmenta Phytographiae Australiae". Vol. 9. (Govt Printer: Melbourne).
Mueller, F.v. (1882). Verbenaceae. "Systematic Census of Australian Plants". Part 1. Vasculares: 102-103. (McCarron, Bird & Co.: Melbourne).
Mueller, F.v. (1889). Verbenaceae. "Second Systematic Census of Australian Plants". Part. 1. Vasculares: 171-173. (McCarron, Bird & Co.: Melbourne).
Munir, A.A. (1982). A taxonomic Revision of the Genus *Callicarpa* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 6(1):5-39.
Munir, A.A. (1984a). A taxonomic Revision of the Genus *Premna* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7(1):1-43.
Munir, A.A. (1984b). A taxonomic Revision of the Genus *Gmelina* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7(1):91-116.
Munir, A.A. (1985). A taxonomic Revision of the Genus *Viticipremna* H.J. Lam (Verbenaceae). *J. Adelaide Bot. Gard.* 7(2):181-200.
Murray, J.A. (1774). "Caroli a Linne . . . . Systema Vegetabilium etc.". (J.C. Dieterich: Göttingen).
Necker, N.J. de (1790). "Elementa Botanica Genera genuina, Species naturales omnium Vegetabilium . . . .". (Societas Typographica: Neowedae ad Rhenum).
Persoon, C.H. (1797). "Caroli a Linne Systema Vegetabilium etc.". (J.C. Dieterich: Göttingen).
Persoon, C.H. (1807). Didynamia Angiospermia. "Synopsis Plantarum". Vol. 2:138-182. (J.G. Cotta: Tübingen).
Post, T.V. & Kuntze, O. (1904). "Lexicon Generum Phanerogamorum". (Duetsche Verlags-Anstalt: Stuttgart).
Reichard, J.J. (1778). Didynamia Angiospermia. "Linne's Genera Plantarum". Edn 7. (Varrentrapp: Frankfurt).
Reichenbach, H.G.L. (1828). Labiatae. "Conspectus Regni vegetabilis Per Gradus naturales evoluti". Part 1:115-117. (Carolus Cnobloch: Leipzig).
Ridley, H.N. (1930). "The Dispersal of Plants throughout the World". (L. Reeve & Co.: Ashford, Kent).
Roxburgh, W. (1832). Didynamia Angiospermia. "Flora Indica". Edn 2, vol. 3:1-116. (W. Thacker & Co.: Serampore, Calcutta).
Schauer, J.C. (1847). Verbenaceae. In De Candolle, A., "Prodromus Systematis naturalis Regni Vegetabilis". Vol. 11:522-700. (Victoris Masson: Paris).
Schreber, J.C.D. (1791). "Caroli a Linne Genera Plantarum . . . .". Edito Octava. Post Reichhardianam Secunda, prioribus longe auctior atque emendatior". (Warrentrapp et Wenner: Frankfurt a/M).
Schumann, K. & Hollrung, M. (1889). Verbenaceae. "Die Flora von Kaiser Wilhelms Land". 118-122. (Asher & Co.: Berlin).
Schumann, K. & Lauterbach, K. (1901). Verbenaceae. "Die Flora der Deutschen Schutzgebiete in der Südsee". 521-527. (Borntraeger Brothers: Leipzig).

Schumann, K. & Lauterbach, K. (1905). Verbenaceae. "Nachträge zur Flora der Deutschen Schutzgebiete in der Südsee". 369-373. (Borntraeger Brothers: Leipzig).
Sivarajan, V.V. & Manilal, K.S. (1982). Notes on some interesting Species of Verbenaceae from South India. *J. Econ. Tax. Bot.* 3:813-817.
Spach, E. (1840). "Histoire Naturelle des Vegetaux Phanerogams". Vol. 9:225-243. (Librarie Encyclopedique de Roret: Paris).
Sprengel, K. (1825). Didynamia Angiospermia. "Caroli a Linnaei .... Systema Vegetabilium". Edn 16, vol. 2:747-765. (Dietrich: Göttingen).
Stafleu, F.A. & Cowan, R.S. (1979). "Taxonomic Literature". Vol. 2. (Bohn, Scheltema & Holkema: Utrecht).
Steenis van C.G.G.J. (1957). Miscellaneous botanical Notes VIII. *Blumea* 8:514-517.
Thunberg, C.P. (1784). Didynamia Angiospermia. "Flora Japonica". 251-258. (Müller: Leipzig).
Ventenat, E.P. (1799). Pyrenaceae. "Tableau du Régne Végétal". Vol. 2:315-324. (Imprimerie de J. Drisonnier: Paris).
Walpers, W.G. (1845). Verbenaceae. "Repertorium Botanices Systematicae". Vol. 4:3-134. (Fr. Hofmeister: Leipzig).
Willdenow, C.L. (1800). Didynamia Angiospermia. "Caroli a Linne Species Plantarum etc.". Edn 4, vol. 3, part 1:2-403. (G.C. Nauk: Berlin).

Index to Scientific Names

Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked refer to figures and maps.

J. Adelaide Bot. Gard. 10(1): 81-90 (1987)

THE NATURALISED FLORA OF SOUTH AUSTRALIA 1. THE DOCUMENTATION OF ITS DEVELOPMENT

P.M. Kloot

South Australian Department of Agriculture,
GPO Box 1671, Adelaide, South Australia 5001

Abstract

Intensive library and archival searches yielded considerably more sources of information concerning the naturalisation of alien plants in South Australia than had been documented hitherto. The material is reviewed chronologically, and its value and the difficulties of its interpretation are discussed. The sources include herbarium specimens, botanical, agricultural and other literature, and records of Parliament and its Select Committees associated with the consideration of noxious weeds legislation.

Introduction

The naturalisation of alien plants started with the advent of Europeans to South Australia and has continued to the present. However there appears to be little documentation of the process, particularly in earlier years. Three studies of the naturalised flora of South Australia were known from last century (Michael, 1972), apart from material scattered throughout the "Flora Australiensis" (Bentham, 1863-1878).

The first was a pamphlet by Schomburgk (1879) which was revised and expanded a decade later (Schomburgk, 1889). This has been reprinted, annotated and discussed by this writer (Kloot, 1980). The second publication was a list of introduced plants collected by Tepper in the vicinity of Ardrossan, Yorke Peninsula during 1878 and 1879 (Tepper, 1880). The third was Tate's (1883a) paper on the natural history of Kangaroo Island in which he included a section on alien plants.

An intensive search for further materials revealed considerably more than those noted by Michael. The additional sources are reviewed and assessed here. Subsequently, the information obtained from them was analysed (Kloot, 1985a, 1987a, b) as part of an intensive study of the development of the South Australian naturalised flora.

At this point, some key words are defined as used in these papers. The definitions are in terms of the South Australian flora and where the terms are applied to that of other regions they are used analogously. Where the words are cited from other writers their meanings may be different.

Acquired species — species originating in other regions of the world, whose presence in South Australia, or southern Australia generally seem to be independent of Man and his activities and preceded European contact (Kloot, 1984), although the process undoubtedly is still proceeding.

Adventive — A plant that is persisting without, or in spite of, human intervention at one or few separate locations, generally for less then 25 years. Generally reproducing only sparingly.

Alien Plant — A species that has reached South Australia in active or passive association with Man, usually in historical times. This means that it arrived after European penetration, which is taken to be 1802.

Casual — A plant that does not persist for more than, say two years, without constant fresh introductions (cf. Tutin *et al.*, 1964-80).

Established — The final stage of naturalisation (q.v.) where an alien plant is widespread over large parts of the State or locally abundant in one or more regions, and generally reproducing freely. Where the distribution is very restricted, the plant should have persisted for at least 25 years (cf. Tutin *et al.*, 1964-80). Mueller's (1853) definition of such a species as one that has spread "beyond the possibility of extirpation" is still a useful perspective. Many authors use the word "naturalised" synonymously with "established" as defined here.

Extinct — No definite records are available of the plant's presence in South Australia since 1950.

Naturalisation — The process by which alien plants are assimilated into the local flora. Three successive stages which merge into each other are recognized, viz. casual (q.v.), adventive (q.v.) and established (q.v.). Hence a **naturalised** species is one that is growing spontaneously, i.e. without, or in spite of, human intervention.

A successfully established plant would have passed from being a "casual", to being an "adventive" and then to being "established". The time scale would depend upon the individual species. A given species may be established in part of the State but merely casual in another area to which it is less adapted.

Volunteer — A species, particularly in an agricultural context, that grows without being deliberately sown by the land manager, in contrast to intentionally *planted* or *sown* species.

Weed — A perjorative, non-biological term expressing the user's perception that the plant concerned has no good properties or possesses deleterious properties. **Weediness** refers to a variable range of characteristics that ensure the persistence of unwanted plants (cf. Baker, 1974). The same characteristics are generally regarded favourably if they are found in desirable plants and are responsible for their persistence.

Sources

In documenting the alien flora, it is necessary to use every reference that can be located. The assessment of the reliability of such material and its interpretation depends heavily on the observer's "taxonomic nous" (Michael, 1972). The records and references may be graded according to reliability, as follows:

1. Herbarium specimens.

2. Records and observations of competent botanists, agriculturalists, and horticulturalists.

3. Detailed observations and comments about specific situations in non-technical literature, e.g. evidence of Select Committees and the survey of *Oxalis pes-caprae* undertaken in 1899-1900 by the Central Agricultural Bureau.

4. Passing references by various observers incidental to the intent of the writing.

Some difficulties encountered in assessing this material include:

1. Ambiguous, illegible or incomplete vouchers on herbarium specimens, particularly early collections.

2. The recognised authorities at different times identified material, usually consistently, but incorrectly according to later determinations. A common mistake was to identify plants as a northern European species rather than as one from the Mediterranean, e.g. *Adonis annua* in error for *A. microcarpus* (Kloot, 1976), *Hordeum murinum* for *H. leporinum* (Cocks *et al.*, 1976). Also, there was much variation between the botanical nomenclature used in the past, and that used currently. These uncertainties were largely overcome by an intensive study of all names used for alien plants by earlier workers and relating them to current nomenclature.

3. Weeds were known by many common names, particularly in the past. Some were extremely localised in their use. The author has personal knowledge of at least six local names for *Pentzia suffruticosa* that were in use in the Mallala area as late as the mid-1970s. One or two names were restricted to about a dozen properties each. Unravelling this uncertainty was greatly aided by publications of Department of Agriculture Officers who added botanical names to the common names recognized by farmers.

An intensive search was made of herbarium, literary and archival material to find further evidence of the time and circumstances surrounding the naturalisation of the species of the South Australian naturalised alien flora. The results of these investigations will be published separately.

Herbarium Specimens

There are about 200 herbarium specimens of alien plants collected in South Australia from the period prior to 1879, almost all of which are lodged at MEL. They were collected mostly by Behr, Blandowski and Mueller, and have been listed and discussed previously (Kloot, 1983). In the majority of cases the material is sufficient for confident determination and it is reassuring to discover that names were applied consistently and largely correctly. The correctness of the names applied to these specimens increases one's confidence in the names used in the literature of that time. Errors seem to be those that were commonly made e.g. *Arenaria serpyllifolia* in error for *A. leptoclados*, *Malva verticillata* in error for *M. parviflora*.

Up to the end of 1878, 97 species of the present naturalised flora had been collected in South Australia for the first time (Kloot, 1987a). However, only six, *Solanum nigrum* — 1869, *Echium plantagineum* — 1870, *E. italicum* and *Dittrichia graveolens* — 1876, *Trifolium tomentosum* — 1877 and *Veronica arvensis* — 1878, are from the period between the departure of Mueller and his colleagues and the advent of Tate and Tepper, which demonstrates the dearth of botanical activity in South Australia at that time (Kloot, 1980, 1983).

After 1879 R. Tate, Professor of Natural History in the University of Adelaide and J.G.O. Tepper (Kraehenbuehl, 1969) began extensive collections and descriptions of the South Australian flora including the introduced species. Tate's botanical specimens were the foundation of the Tate Herbarium that was built up in the University of Adelaide. Tate collected many specimens of naturalised plants including a number of first records. He made a number of specific collecting trips such as his survey of Kangaroo Island (Tate, 1883a), his travels to Eyre (Tate,1888) and Yorke Peninsulas (Tate, 1890b), and to the South-east (Tate, 1883b).

Tepper made extensive collections from various parts of the State (Kraehenbuehl, 1969). Much of his material is found in Melbourne for he sent specimens to Mueller for confirmation. Some specimens were incorporated in the Tate Herbarium but much of his collection was passed through private hands, the Field Naturalists' Society of South Australia and the South Australian Museum. It is now housed in the State Herbarium, Adelaide (Kraehenbuehl, 1969). A lot of this material has been poorly curated and has either deteriorated completely or is in a poor state.

Tepper made particularly comprehensive collections from Ardrossan (Tepper, 1880) and Clarendon where he was stationed at different times as a school teacher. He seemed to collect naturalised plants routinely and is associated with a number of first records for the State.

Although R. Schomburgk, the Director of the Adelaide Botanic Gardens wrote about introduced plants (Kloot, 1980) there appears to be no extant specimens of aliens collected by him.

In the 1870s and 1880s, Mrs Wehl, Mueller's sister, collected widely and included naturalised plants in her collection. In the mid-1890s Miss J.L. Hussey (Kraehenbuehl, 1981) collected intensively in the Port Elliot area and added many records of naturalised plants. Because they sent their collections to Mueller both of these ladies' collections are at MEL!, although odd specimens have appeared elsewhere.

From 1902, J.M. Black amassed collections particularly from Adelaide and the Mt Lofty Ranges. He adopted a characteristic technique of mounting all his specimens of one species in a single folder to which he attached his drawings and notes about that species. He only started a second folder when he could not fit any more in the first. In later years, he seemed to modify his approach, at least on occasions, and only included one specimen per folder. The diagrams were usually the basis of those used in his books and papers. His annotations provide a rich source of details about the local names, introduction, distribution, economic effects and farmer attitudes towards naturalised plants. He received many specimens from relatives, friends and members of the general public and these are all available at AD where they have been remounted, individually where possible, but still preserving Black's notes and drawings. In some cases he sent specimens of naturalised plants to Kew, Paris or Washington for confirmation of identity. Black's efforts markedly lifted the number of known alien plants and culminated in his handbook of naturalised alien plants (Black, 1909).

From 1909 to his death in 1951 Black dominated South Australian taxonomic botany. He continued to build his collection but from the early 1920s he relied increasingly on others, his own collections being confined to the immediate vicinity of his home. J.B. Cleland collected very widely throughout the State but particularly from the Victor Harbor-Encounter Bay area where he regularly holidayed.

About 1930 the herbarium at the Waite Institute (ADW) was established. It was well-endowed with naturalised species and had a disproportionate share of the first collections for the State. It contained many specimens of plants introduced by the Waite Institute as potential crop and fodder plants and these specimens antedate the first records of the plants as established species. In 1985 this collection was placed on permanent loan in the State Herbarium (AD).

The Tate Herbarium was enriched by T.G.B. Osborne and other staff of the Botany Department at the University of Adelaide, but as far as introduced species are concerned, it became unimportant after the establishment of the Waite Herbarium and a shift in emphasis within the Botany Department to intensive studies of the ecology of native communities by J.G. Wood and others. After the re-establishment of the State Herbarium the Tate Herbarium was lodged there on permanent loan and incorporated into the main collection. Generally, the material has been well-curated and is in good condition.

In 1955 the State Herbarium (AD) was re-established and since then has absorbed many collections by its own staff and others, which have included introduced plants as a matter of course.

Literature records

Early literature

This study has revealed that there is far more early material available than previously suggested (Michael, 1972). The following source material was located by this writer:

a. Behr (1847, 1851, 1891) — covering the period 1844 — 1849.

b. McEwin (1847) — contemporaneous.

d. Mueller (1850, 1853, 1858-82) — covering the period 1847 — 1852.

d. Francis (1855) — contemporaneous.

e. "Flora Australiensis" (Bentham, 1863-78) — with regard to the naturalised flora of South Australia, the records are largely those of Mueller and others up to 1853 with scattered later records particularly in the last volume.

These sources have been discussed in detail already (Kloot, 1983), apart from McEwin's article from which a number of species were mentioned in passing. The different treatment accorded McEwin's article, in spite of his training as a landscape gardener and his considerable ability as a botanist (Pascoe, 1901), was justified because his comments were general and not supported by any collections that could be considered as voucher specimens for his paper. Apart from "want of leisure", he was also lacking a "good work on the Flora of Britain", which handicapped his investigations in these matters (McEwin, 1847). Further species noted in his article will be mentioned below.

The general press, reflecting the interests of a largely agricultural society, made passing references to the occurrence of weeds and the problems they caused. Later came the establishment of more specialised publications catering for the agricultural and horticultural community. Prior to 1880 these were the short-lived "South Australian Horticulturalist" (1856), "Farm and Garden" (1858-1863) and "Garden and Field"(1875-1940). Albert Molineux (1832-1909) was an astute and reliable observer whose local experience reached back to 1839. He was a key figure in the agricultural press, being the first editor of "Garden and Field". He also made substantial contributions to later publications. His articles and notes on weeds bear a ring of authority and in all cases where cross-checking is possible, his comments are vindicated.

The earliest definite record in the literature of an alien plant other than as a crop is that of *Verbena officinalis* growing on the banks of the Torrens River in 1837 (Kloot, 1985b). *Datura stramonium* and *Silene gallica* are reputed to have been introduced by 1839 and 1840 respectively, and *Avena fatua* is claimed to have been introduced in the first cereal seed imported (Kloot, 1985b). In the Gardener and Farmer's Calendar for 1839 (Stevenson, 1838), the notes for August include "check the growth of weeds". For December the advice is, *inter alia,* "Free the garden from weeds before they drop their seed". Such comments are frustrating because they give no idea as to what the species were, but I suggest that they would have been the same species introduced in other places by Europeans (Kloot, 1985b). These weeds would have arrived in contaminated seed, contaminated soil around potted plants, or from propagules attached to implements.

Arctotheca calendula and *Cirsium vulgare* were both recorded as established in 1841, *Onopordum acaulon* had escaped by 1845 and *Ricinus communis* was growing on a rubbish heap by the mid-1840s (Kloot, 1983). *Oxalis pes-caprae* appears to have been troublesome by 1855 (Kloot 1983). *Trifolium repens* was noted as naturalised in gullies of the Adelaide Hills in 1859 (Farm & Garden *1*: 207). *Marrubium vulgare* was observed to be growing densely near Bullaparinga (near Second Valley) in 1850 (Yelland, 1970).

McEwin's (1847) article is only of limited value for the reasons mentioned earlier. Apart from the species that were noted by Kloot (1983), he also recorded, *inter alia*, the following species: *Rumex crispa* (i.e. *R. crispus*), *Areneria rubra* (i.e. *Spergularia rubra*), *Stellaria graminea* (prob. *S. palustris*) and *Erodium* (*E. cicutarium* and *E. moschatum*). As all these species were collected by Mueller (Kloot, 1983), McEwin's implication that they were successfully established seems well-founded. Other references are too vague, e.g. "*Senecio* — very similar to *S. vulgaris*", or involve confusion between native and introduced taxa, e.g. *Oxalis, Geranium.*

In his lecture on "Pasture Grasses", Francis (1859) mentioned that brome grasses (*Bromus* spp.) and barley grass (*Hordeum glaucum*) were troublesome to stock, which implies that already they were well-established by that time. Mueller had noted weedy *Bromus* spp. about Adelaide in 1847 and had collected *H. glaucum* in 1848 (Kloot, 1983).

References to *Dittrichia graveolens* as stinkweed or stinkwort are found in the popular press of the period as it spread very quickly throughout the cropping areas. The most complete account of its introduction, establishment and initial spread in the 1860s was written some time later by Grassby. This account was preserved by Maiden (1920). Considering Grassby's fairly definite dating of this plant's establishment near Balhannah to be within a year or two of 1865, it is startling that the earliest extant herbarium specimen is from 1876, and it indicates the necessity to cross-check data wherever possible.

During the period to 1879, most references to weeds or weed control in the agricultural press were general, without mentioning particular species. However, this changed completely by the 1880s with the rise of the Agricultural Bureaux.

Schomburgk (1870, 1889) contributed a short treatise on the naturalised alien plants of South Australia. This pamphlet is a disappointing source of reliable information about the subject (Kloot, 1980).

Another source of information is the series of annual reports of the Director of the Adelaide Botanic Gardens (Schomburgk, 1867 *et seq.*) in which he wrote of the major weed problems encountered in the Garden or in the adjacent parkland (Botanic Park).

Tepper's (1880) paper on the flora about Ardrossan is of interest because it was a systematic analysis of the flora of one part of the settled areas and because it was the first paper to consider alien plants as a group by itself. Tepper in common with other authors of that period considered a number of species to be native which we now know to be introduced and also used names of aliens erroneously for native species (Kloot, 1980).

Voucher specimens which were identified or confirmed by Mueller, still exist for the paper although many have deteriorated completely. The remaining material is housed at AD! and it is possible to realise Tepper's errors in determining *Nicotiana glauca* as *N. suaveolens*, and in his application of the names *Sagina apetala* and *Spergularia rubra* to native Caryophyllaceae. However it must be stated that most of the remaining material appears to be correctly identified.

His list, which includes 30 alien species, does not actually record any first records for South Australia, although for many species it remains a first record for Yorke Peninsula.

Tate (1883a), in his pioneering study of the Kangaroo Island flora, examined the relationships between the island flora and that of the mainland, other parts of Australia and other parts of the world. He listed the "extra-Australian" species found on the island and these are a mixture of alien, acquired (Kloot, 1984) and mis-identified native species. He also commented on the "alien plants" *per se.*

A total of 51 naturalised alien species can be identified from his paper, but voucher specimens for many of them are missing. Those that are still extant are in good condition and provide a valuable supplement to the remainders of Tepper's collection.

However, there are no first records for South Australia and there is considerable overlap with the species listed by Tepper (1880), which suggests that a number of common weeds were already widespread by this period.

Journals and periodicals

In 1875 the "Garden and Field" was launched edited by Albert Molineaux. This journal provided a forum for the exchange (and permanent record) of much agricultural and botanical information relevant to this study. Many first records were obtained from that publication.

The Royal Society of South Australia was originally formed as the Philosophical Society in 1853. Records of meetings and activities were printed in the daily press until 1877 when the publication of the "Transactions and Proceedings" commenced. Apart from many scientific papers, the minutes of the meetings and records of excursions provided much material for this study. In 1883 the Field Naturalist's Section of the Royal Society was formed and for many years its records were published as a supplement to the Royal Society volume. Eventually its own journal the "South Australian Naturalist" was established in 1919. All these provide further sources for first records.

Under the influence of Albert Molineux the Central Agricultural Bureau was founded in 1888. At the outset its records were published in the "Garden and Field", but later in the same year the "Journal of the Bureau of Agriculture of South Australia" was established as a separate organ. Molineux, beside being General Secretary of the Bureau was the Editor of the Journal. The Journal ceased publication in 1897 when the "Journal of Agriculture" was launched. Details of plant specimens sent for identification and other information contained in these publications are a rich source of information about the introduction and spread of weeds.

Because of the more abundant literature and the availability of herbarium specimens, records may be cross-checked and consequently their reliability is greatly enhanced.

Black's writings

Black (1909) sought to complement Tate's (1890a) handbook of the native flora by producing a work on naturalised aliens. The species were systematically arranged and a description was provided for each species together with distribution and economic notes. The book was well-illustrated with Black's own drawings. The book was a milestone in South Australian botany and indeed Australian botany. It was the first Colonial or State flora that was not based on the "Flora Australiensis" (Bentham, 1863-1878) and the book was the basis of the first two editions of Black's Flora of South Australia (Black 1922-28; Black 1943-52; Robertson, 1957).

Black's Flora included naturalised aliens with the native species. The records are supported by Black's own specimens now at AD! In general, Black's earliest literature reference regarding the later established species is generally to his long-running series of "Additions to the Flora of South Australia" published in the "Proceedings of the Royal Society of South Australia" between 1907 and 1951.

Eichler's supplement (1965) retained the format which was continued into the third edition of the first volume (Jessop, 1978) but it has finally been abandoned.

Department of Agriculture publications

Apart from its journal, various scientific and extension reports, papers, pamphlets and bulletins also provide information on the introduction and establishment of alien plants. Thus the earliest Annual Reports for 1882 and 1883 *inter alia* list many species being tested for fodder at Roseworthy. As some of these species, such as *Ulex europaeus* and *Plantago lanceolatus* are not considered suitable for such purposes nowadays such records provide an insight to their earlier novel uses. Andrew (1916) reports on pasture and crop seed contamination by weeds which have been continued by subsequent reports of the Seed Testing Laboratory. There has been a steady production of literature on weeds and their management and also on plant introduction e.g. pasture species for alkaline (French and Young, 1962) and saline areas (Matheson, 1968; MacPhie, 1973).

Much Departmental work, particularly up to the 1950s, was done by or in collaboration with the Waite Agricultural Research Institute. Indeed much of the early work of that Institute was published in Departmental media.

There also exists further records contained in Departmental files and dockets. As an example, a study of the relevant dockets by this writer revealed the history of the introduction of *Spartina* x *townsendii* which was passed on to K.G. Boston and included in his comprehensive treatment of that plant in Australia (Boston, 1981).

Noxious weeds legislation

In the twentieth century, by the time that a weed had spread so extensively that proclamation was being considered, records and herbarium specimens were available which diminished the importance of evidence to Parliamentary Committees or the records of

Table 1 — *South Australian Noxious Weeds Legislation*

Short Title	Purpose	Associated papers
Thistle Act, 1851	An Act for preventing further spread of the Scotch thistle	S.A. Parl. Paper No. 19/1851
Thistle and Burr Act, 1862	An Act for preventing the further spread of Scotch thistle, variegated thistle and Bathurst bur.	S.A. Parl. Paper No. 205/1862
Thistle and Burr Act, 1887	An Act for amending No. 26 of 1862 and for preventing the further spread of star thistle.	S.A. Parl. Paper No. 102/1887

The following Acts dealt with administrative matters but do not provide information relevant to this study not available from other sources.

Noxious Weeds Destruction Act, 1891

Destruction of African Boxthorn Act, 1925

Noxious Weeds Act, 1931-1939

Local Government Act, 1934-1976

Noxious Weeds Act, 1956

Pest Plants Act, 1975

Parliamentary Debates as bases for historical investigation of weeds. For last century however, such documents are very useful sources (Table 1). Much of the information is anecdotal but the 1862 Report is especially valuable because of G.W. Francis' evidence and his drawings of the various species that were under consideration.

The Thistle Act, 1851, was the first noxious weeds legislation to be enacted in Australia. From the Parliamentary debate, the report of the Select Committee and the wording of the Act itself, it is possible to determine which species were included in the legislation. In the Act the expression "plants commonly known in this Province as the Scotch Thistle", or some variation, keeps recurring. The last clause, which is purely interpretative, states" . . . 'Plants commonly known in this Province as the Scotch Thistle', shall be held to mean and include (in addition to all other plants so commonly known), the variegated thistle, and the plants commonly known by the botanical names of 'Carduus Marianus', and of 'Carduus benedictus' . . .".

It must be stated quite firmly that the real Scotch thistle (*Onopordum acanthium*) is not the weed being considered. This species has always been uncommon in South Australia. Spear thistle (*Cirsium vulgare*) was very widespread in the settled areas of South Australia having been introduced in 1841 (Kloot, 1983) and this weed was generally known as "Scotch thistle". However, the clause . . . "all other plants so commonly known" . . . potentially includes many more species for almost all of the purple-flowered thistles are called, at times, "Scotch thistle". This was particularly common last century. The specific inclusion of variegated thistle (*Silybum marianum*, syn. *Carduus marianus* and in error, *C. benedictus*) which is readily distinguished from other thistles by its characteristic leaf marking, effectively extends the scope of the Act to cover all purple-flowered thistles present at that time (Kloot, 1983).

The enactment of the 1851 Thistle Act is proof that both *Cirsium vulgare* and *Silybum marianum* were well-established, aggressive weeds by that time, for the preamble to that Act states clearly: "Whereas great injury and loss have been and are occasioned to the cultivated and waste lands of this Province, by the spread of the plants known as the Scotch Thistle . . .".

In the 1862 Act, the only addition was Bathurst burr (*Xanthium spinosum*). According to evidence presented to the Select Committee investigating the matter, this pest had only been observed for the first time about 1850, so at the time of the earlier Act, *X. spinosum* would only have been a minor weed. Apparently it was confined to roadsides and stock reserves within the agricultural area but when it reached the interior, it spread with alarming rapidity. Whilst the thistles were agricultural weeds, Bathurst burr was held to be "as dangerous a weed as the sheep farmers have to contend with".

No further legislative action was taken until 1887. From the Evidence to the Select Committee enquiring into the Bill and other records it is quite clear that the "star thistle" of this Act was the plant now called saffron thistle (*Carthamus lanatus*). This weed was spreading throughout the northern cereal areas and causing havoc in crops, particularly at harvesting.

It is also clear from references to a purple flowered star thistle in the south-east and the yellow flowered "star thistle" in the north, that witnesses before the Select Committee from each of these areas were referring to *Centaurea calcitrapa* and *Carthamus lanatus* respectively.

The later legislation only dealt with administrative changes but did not provide any information relevant to this study not available from other sources.

Conclusion

The material reviewed here yielded considerable information about the development of the naturalised flora of South Australia. Earlier writers underestimated the amount of material available and it is likely that further investigations may reveal more details. Diaries and letters of early settlers are likely to be rewarding. At present there are still many frustrating gaps in our knowledge, particularly concerning the unintentionally-introduced species.

A number of likely horticultural introductions are obscured by nomenclatural confusion, and the locating of old catalogues and plant lists may assist in clarifying such cases.

From the records mentioned here a checklist of the naturalised alien flora of South Australia was compiled (Kloot, 1986).

Acknowledgements

I am deeply indebted to the staff of the libraries of the Adelaide Botanic Garden, the National Herbarium Melbourne, the State Library, Adelaide, and the Public Library, Melbourne for assistance with the literary research reported here. Mr. D.E. Symon, formerly of the Waite Agricultural Research Institute, provided much advice on the manuscript for which I am most grateful.

References

Andrew, H.W. (1916). Seed imported from abroad into South Australia. *J. Agric. S. Aust.* 20: 103-115

Baker, H.G. (1974). The evolution of weeds. *Ann. Rev. Ecol. & Syst.* 5: 1-24.

Behr, H.H. (1847). Südaustralische Pflanzen I. Ueber die Verhältnisse der südaustralischen Flora im Allgemeinen. *Linnaea* 20: 545-558.

Behr, H.H. (1851). On the character of the South Australian flora in general. *Hooker's J. Bot. Kew Gard. Misc.* 3: 129-134.

Behr, H.H. (1891). Botanical reminiscences. *Zoe* 2: 2-6.

Bentham, G. (1863-78). "Flora Australiensis", 7 vols. (Reeve: Ashford).

Black, J.M. (1909). "The Naturalised Flora of South Australia". (privately printed: Adelaide).

Black, J.M. (1922-28). "Flora of South Australia", 4 vols, 1st edn. (Govt Printer: Adelaide).

Black, J.M. (1943-52). "Flora of South Australia", 3 vols, 2nd edn. (Govt Printer: Adelaide).

Boston, K.G. (1981). The introduction of *Spartina townsendii* (s.l.) to Australia. *Melb. State Coll. Occ. Papers* 6.

Cocks, P.S., Boyce, K.G. & Kloot, P.M. (1976). The *Hordeum murinum* complex in Australia. *Aust. J. Bot.* 24: 651-662.

Eichler, H. (1965). "Supplement to J.M. Black's Flora of South Australia". (Govt Printer: Adelaide).

Francis, G.W. (1855). Letter to W.J. Hooker, reproduced in B.J. Best (1966), "The Life and Times of George William Francis", (privately printed: Adelaide).
Francis, G.W. (1859). Pasture grasses. *Farm & Garden* 1: 27.
French, R.J. & Young, G.J. (1962). Pastures for Upper Eyre Peninsula. *J. Agric. S. Aust.* 65: 382-386.
Jessop, J.P. (1978). "Flora of South Australia", vol. 1, 3rd edn. (Govt Printer: Adelaide).
Kloot, P.M. (1976). The species of *Adonis* L. naturalized in Australia. *Muelleria* 3: 200-207.
Kloot, P.M. (1980). Dr Richard Schomburgk's "Naturalized Weeds" (1879). *J. Adelaide Bot. Gard.* 2: 195-220.
Kloot, P.M. (1983). Early records of alien plants naturalised in South Australia. *J. Adelaide Bot. Gard.* 6: 93-131.
Kloot, P.M. (1984). The introduced elements of the flora of southern Australia. *J. Biogeogr.* 11: 63-78.
Kloot, P.M. (1985a). Studies in the alien flora of the cereal rotation areas of South Australia. Ph.D. Thesis, University of Adelaide.
Kloot, P.M. (1985b). Plant introductions to South Australia prior to 1840. *J. Adelaide Bot Gard.* 7: 217-231.
Kloot, P.M. (1986). Checklist of the introduced species naturalised in South Australia. *S.A. Dept. Agric. Tech. Paper* No. 14.
Kloot, P.M. (1987a). The naturalised flora of South Australia 2. Its development through time. *J. Adelaide Bot. Gard.* 10: 91-98.
Kloot, P.M. (1987b). The naturalised flora of South Australia 3. Its characteristics. *J. Adelaide Bot Gard.* 10: 99-111.
Kraehenbuehl, D.N. (1969). The life and works of J.G.O. Tepper, F.L.S. *S. Austr. Natural.* 44: 23-42.
Kraehenbuehl, D.N. (1981). Jessie Louisa Hussey, in D.J. & S.G.M. Carr (eds), "People and Plants in Australia ". (Academic: Sydney).
McEwin, G. (1847). Horticultural and botanical sketch of the colony, in J. Stephens (ed.) "The Royal South Australian Almanack and General Directory for 1848". (Stephens: Adelaide).
MacPhie, G.L. (1973). Three successful salt tolerant plants. *J. Agric. S. Aust.* 76: 5-8.
Maiden, J.H. (1920). "Weeds of New South Wales". (Govt Printer: Sydney).
Matheson, W.E. (1968). When salt takes over. *J. Agric. S. Aust.* 71: 266-272.
Michael, P.W. (1972). The weeds themselves — early history and identification, in "History of Weeds Research in Australia" symposium. *Proc. Weed Soc. N.S.W.* 5: 3-18.
Mueller, F. (1853). Flora of South Australia, displayed in its fundamental features and comparatively. *Hooker's J. Bot. & Kew Gard. Misc.* 5: 65-72.
Mueller, F. (1858-82). "Fragmenta Phytographiae Australiae", 12 vols. (Govt Printer: Melbourne).
Pascoe, J.J. (1901). "History of Adelaide and Vicinity". (Hussey & Gillingham: Adelaide).
Robertson, E.L. (1957). "Flora of South Australia", vol. 4, 2nd edn. (Govt Printer: Adelaide).
Schomburgk, R. (1867). "Annual Report of the Director of the Adelaide Botanic Gardens for 1866". (Govt Printer: Adelaide).
Schomburgk, R. (1879). "On the Naturalised Weeds and other Plants in South Australia". (Govt. Printer: Adelaide).
Schomburgk, R. (1889). The Naturalised Noxious Weeds and other Plants in South Australia. Appendix C to the "Annual Report of the Director of the Botanic Gardens for 1888". (Govt Printer: Adelaide).
Stevenson, G. (1838). Gardener and Farmer's calendar, in "Royal South Australian Almanack for 1839". (Thomas: Adelaide).
Tate, R. (1883a). The botany of Kangaroo Island. *Trans. Proc. Royal Soc. S. Aust.* 6: 116-171.
Tate, R. (1883b). A list of unrecorded plants and of new localities for rare plants in the southeast part of this Colony. *Trans. Proc. Royal Soc. S. Aust.* 6: 95-99.
Tate, R. (1888). Additions to the flora of the Port Lincoln district, including brief descriptions of two new species. *Trans. Proc. Royal Soc. S. Aust.* 11: 82-84.
Tate, R. (1890a). "A Handbook of the Flora of Extra-Tropical South Ausdtralia". (Education Department: Adelaide).
Tate, R. (1890b). On the geological and botanical features of southern Yorke Peninsula. *Trans. Proc. Royal Soc. S. Aust.* 13: 112-120.
Tepper, O. (1880). On the characteristics and distribution of the native and naturalised plants about Ardrossan, Yorke's Peninsula. *Trans. Proc. Royal Soc. S. Aust.* 3: 25-45.
Tutin, T.G. *et al.* (1964-80). "Flora Europaea", 5 vols. (Univ. Press: Cambridge).
Yelland, E.M. (ed.) (1970). "Colonists, Copper and Corn in the Colony of South Australia 1850-51". (Hawthorne Press: Melbourne).

J. Adelaide Bot. Gard. 10(1): 91-98 (1987)

THE NATURALISED FLORA OF SOUTH AUSTRALIA
2. ITS DEVELOPMENT THROUGH TIME

P.M. Kloot

South Australian Department of Agriculture,
GPO Box 1671, Adelaide, South Australia 5001

Abstract

The development of the naturalised flora of South Australia has been quantified by examining the number and the familial and generic composition of species in four years of significance in local botanical history and the present, viz. 1855, 1909, 1929, 1965 and 1984. The numbers of naturalised species were 101, 397, 539, 803 and 977 respectively. The last figure includes seven doubtfully recorded species and a further 64 believed to be extinct, not having been collected since 1950. The overall rate of acquisition of naturalised species has been just over six per year. The consistently best-represented families have been Gramineae, Compositae, Leguminosae and Cruciferae, whilst the best represented genera have been *Trifolium* and *Medicago*. Similar rankings were found in Victoria and New South Wales. The reasons for this are discussed.

Introduction

From the herbarium specimens and literary records previously reviewed (Kloot, 1987), a checklist of the naturalised alien flora was prepared (Kloot, 1987). The checklist includes the date of first record of each species as well as the date of the first herbarium specimen. In many cases these two dates are identical.

There are two methods available to estimate the number of alien plants naturalised at different times. The first is to use the checklist and assume that any plant was naturalised by the time of the first collection. The second is to study and analyse the relevant literature such as Mueller (1853), Black (1909, 1922-29, 1943-52), Robertson (1957) and Eichler (1965). The data derived from both approaches are presented and compared in this paper. The terms "naturalised" and "established" are used as defined previously (Kloot, 1987) except where they are cited from other writers who commonly used the word "naturalised" in my sense of "established".

Data

Mueller's (1853) figure of "about 100" naturalised (*sic*) aliens was supported by my study of extant specimens and relevant literature for that period (Kloot, 1983) and it was concluded that by 1855, 101 specimens were established in South Australia.

It is not possible to dissect the figures to the extent possible for current records, but the following analysis was made of the species included by Kloot (1983).

	Species	Genera	Families
Monocotyledons	19	15	2
Dicotyledons	82	70	30
Totals	101	85	32

The best-represented families were:

Gramineae	14 genera	19 species
Compositae	14	16
Caryophyllaceae	8	10
Cruciferae	7	7
Leguminosae	4	7

At the generic level there were 3 species of *Bromus* and 2 each of *Briza*, *Lolium*, *Calendula*, *Sonchus*, *Spergularia*, *Stellaria*, *Medicago*, *Trifolium*, *Vicia*, *Papaver*, *Erodium*, *Centaurium*, *Heliotropium* and *Rumex*. The remaining 70 genera had one species each.

However, according to the checklist data (Kloot, 1986), only 90 species had first collection dates of 1855 or earlier. The reasons for the discrepancy will be discussed below.

Black (1909, p. 3) stated that his book treated 368 species. According to my count only 364 can be included in a tally of established species, the remaining 4 species being explicitly noted as not being "naturalised" (*sic*). The following analysis is based on the 364 species:

	Species	**Genera**	**Families**
Monocotyledons	96	64	7
Dicotyledons	268	160	49
Totals	364	224	56

The most numerous families were as follows:

Gramineae	39 genera	62 species
Compositae	37	51
Leguminosae	12	44
Cruciferae	14	22
Iridaceae	14	20
Caryophyllaceae	8	11
Labiatae	7	11
Scrophulariaceae	8	10

At the generic level, *Trifolium* was represented by 14 species, *Medicago* by 9 species, *Euphorbia* and *Bromus* by 6 species each, *Vicia* by 5 species, 6 genera by 4 species, 19 genera by 3 species, 49 genera by 2 species and 145 genera by 1 species each.

According to the checklist data, 397 species were collected in 1909 or earlier. It is noted that by this time the difference in number is in favour of the specimens and this will be discussed below.

Wood (1937) analysed the South Australian flora presumably using the first edition of Black's (1922-29) Flora as a data base, and noted that there were 381 species of naturalised (*sic*) alien plants in South Australia belonging to 160 genera. My own count of Black's Flora revealed considerably more than this, viz. 526 species belonging to 307 genera. Even allowing for splitting of genera in later years the discrepancy is very large and I can only suggest that Wood excluded species that were not 'established' in my sense i.e. he omitted those species that I would classify as 'adventive' or 'casual '. He apparently excluded the 69 'Alien but scarcely naturalised plants' i.e. casuals, that Black (1929) appended to his last volume.

My count of the species in Black's first edition yielded the following analyses:

	Species	Genera	Families
Monocotyledons	120	78	12
Dicotyledons	406	223	57
Totals	526	301	69

The best-represented families were as follows:

Gramineae	50 genera	78 species
Compositae	42	61
Leguminosae	14	56
Cruciferae	21	29
Caryophyllaceae	15	26
Iridaceae	14	21
Scrophulariaceae	9	18
Labiatae	9	15

At the generic level, *Trifolium* was represented by 18 species, *Medicago* by 12 species, *Euphorbia* by 8 species, *Bromus, Rumex, Chenopodium* and *Silene* by 6 species each, 9 genera by 5 species, 7 genera by 4 species, 24 genera by 3 species, 62 genera by 2 species and 190 genera by 1 species.

There is again a discrepancy, although only slight, between this figure of 526 and that of 539 being the number of species in the checklist that were first collected in 1929 or earlier.

In his revision of Wood's (1937) handbook, Specht (1972) also briefly referred to alien plants. Using the second edition of Black's Flora (Black, 1943-52; Robertson, 1957) and the Supplement (Eichler, 1965), he arrived at a total of 654 alien species. Again my count is somewhat higher, although not to the same extent as it differs from Wood's count of the first edition. My analyses, which also included a few species noted in the separately issued Corrigenda and Addenda (Eichler, 1966) are as follows:

	Species	Genera	Families
Monocotyledons	180	98	12
Dicotyledons	541	299	67
Totals	721	397	79

The most-heavily represented families were:

Gramineae	63 genera	117 species
Compositae	57	91
Leguminosae	20	73
Cruciferae	27	40
Caryophyllaceae	15	33
Iridaceae	16	24
Rosaceae	10	22
Scrophulariaceae	12	21
Labiatae	11	21
Solanaceae	8	20
Liliaceae	7	17

At the generic level, *Trifolium* was represented by 22 species, *Medicago* by 16, *Oxalis* and *Euphorbia* by 11 each, *Bromus* by 9 and *Allium, Amaranthus, Silene, Fumaria* and *Solanum* by 8 species each, 7 genera by 6 species, 14 genera by 5 species, 28 genera by 4 species, 24 genera by 3 species, 66 genera by 2 species and 258 genera by 1 species each.

There is a considerable difference between the figure of 721 species derived here and that of 803 species whose first collection date was 1965 or earlier. Like the figures for 1909 and 1929, the latter number is greater than that derived from the published literature.

Analysis of the checklist reveals that 977 species were recorded in the naturalised alien flora of South Australia up to December 1984. Of them 73 are either extinct or doubtful records. Such doubt may arise because of suspected misidentification or the uncertainty as to whether the extant specimens were actually collected in South Australia or elsewhere, or from situations outside cultivation. The following table summarises the information derived from analysis of the entries in the checklist.

SPECIES

	Established*	Adventive	Casual	Doubtful	Extinct	Total
Monocotyledons	119	71	44	3	13	250
Dicotyledons	333	212	125	6	51	727
Totals	452	283	169	9	64	977

*As defined (Kloot, 1986a)

GENERA

	Present	Doubtful or Extinct	Total
Monocotyledons	114	6	120
Dicotyledons	346	19	365
Totals	460	25	485

FAMILIES

	Present	Extinct	Total
Monocotyledons	13	1	14
Dicotyledons	77	2	79
Totals	90	3	93

The most-heavily represented families are:

Gramineae	68 genera	142 species
Compositae	70	123
Leguminosae	26	83
Cruciferae	30	53
Iridaceae	20	43
Caryophyllaceae	16	34
Solanaceae	11	29
Liliaceae	12	27
Rosaceae	11	26
Labiatae	14	25

The genera containing the most species are as follows:

Trifolium	26 spp.
Medicago	14
Solanum	13
Oxalis	12
Opuntia	12
Euphorbia	12
Amaranthus	10
Cyperus	9
Bromus	9
Fumaria	8
Polygonum	8

Of those remaining, 8 genera contain 7 species each, 11 contain 6 species, 16 contain 5 species, 22 contain 4 species, 31 contain 3 species, 75 contain 2 species and 312 genera are represented by 1 species each.

Discussion

The number of naturalised alien species present at any time were, with one exception, consistently underestimated by contemporary observers. There are a number of reasons for this. Firstly, taxonomic revisions separate species erroneously considered as but one. For example, *Aira caryophyllea* as understood by Black (1909) is now known to be three species, *A. caryophyllea*, *A. cupaniana* and *A. elegantissima* (see Jessop, 1984), all of which had actually been collected before 1909.

Secondly, at the time of writing, authors may not be aware of recently collected specimens or of material which may be unavailable to them for various reasons. This particularly applies to J.M. Black who appears to have made very little use of collections lodged at the National Herbarium, Melbourne (MEL), which are at least as rich in South Australian material up to the death of Mueller in 1896 as are local collections.

Thirdly, it takes time for a plant to arrive, become established, be noticed and then collected so it is likely that plants collected for the first time in a given year were actually present earlier. For most species, it is impossible to estimate such lag periods where the date of introduction is unrecorded. Therefore to establish a consistent basis in this study for determining the year of naturalisation the date has been taken of the first collection of apparently naturalised populations i.e. excluding obviously cultivated specimens.

Fourthly, in the case of garden escapes, or more generally, any intentionally cultivated species, collectors will differ in their interpretation of a spreading infestation. Some will consider spreading from a garden as naturalisation, others would defer such an interpretation until the original connection with the garden was broken. Even where sheet annotations are superficially clear, i.e. the collector indicated that it was spreading from a garden, a later interpretation of that statement is still problematical for flora writers. For such cases in this study, a subjective decision was made, usually in consultation with other experienced botanists.

For these reasons therefore the numbers of specimens first collected in 1909, and 1965 respectively exceed the numbers derived from the cited literature of those years.

Conversely, there are documented cases where readily-recognised plants, the identities of which are beyond doubt, were present in South Australia for many years prior to the date of the earliest extant collections. Thus the first collection located of *Xanthium spinosum* is from 1904, although that species had been the subject of the Thistle and Burr Act of 1862. *Ricinus communis*, although apparently naturalised during the 1840s (Kloot, 1983), was not collected until 1903.

Furthermore, there are cases (Kloot, 1983) where specimens are wrongly considered to be separate species, e.g. *Centaurea solstitialis* from *C. melitensis*, and plants noted as naturalised when in fact they were not, at least at that time.

Errors arising from the two latter reasons, are not included in the figure of 101 species given for 1855. The discrepancy between the figures of 90 and 101 species for that year arise from the lack of collections of plants known to have been present, (Kloot, 1983).

	Increment	Species/year	Total
1847-1852	90	15.0	90
1853-1868	—	—	90
1869-1878	7	0.7	97
1879-1885	73	10.4	170
1886-1902	37	2.2	207
1903-1909	192	27.4	399
1910-1929	141	7.1	540
1930-1945	98	6.1	638
1946-1965	161	8.1	799
1966-1984	105	5.5	904

For period 1847-1984, the overall rate is 6.6 species/year.

For period 1836-1984, the overall rate is 6.1 species/year.

Table 1: The apparent annual acquisition of naturalised alien species in South Australia based on the earliest extant collections.

Since colonization the rate of acquisition has continued more or less constantly to the present (Table 1). In fact, if it is argued that my figure for 1984 must be an underestimate for the reasons canvassed above, then it is possible that the rate of establishment may actually be increasing.

Whether that be the case or not, the constant rate of acquisition of alien species does not augur well for the conservation of native vegetation as individual species or as plant communities.

Although the absolute numbers of their genera and species have increased markedly between 1855 and the present, it is remarkable that the relationship of the families relative to each other has stayed so constant over that period. They all tend to be families consisting of both intentionally and unintentionally introduced species, although the Caryophyllaceae has a preponderance of the latter. The families Iridaceae, Solanaceae, Liliaceae and Rosaceae which only became prominent in later periods, have a greater proportion of intentionally introduced species.

At the species level, nothing can be drawn from the 1855 list, but by 1909 a trend emerged which has continued to the present. The two pasture legume genera *Trifolium* and *Medicago* have consistently headed the species list. In spite of the fact that documentation was not located in most cases, I believe that species of these genera were widely imported and sown under the general term "clovers". In some cases, a species may have been imported as a contaminant of seed of another, but all would have been welcomed, particularly prior to the development of modern pasture technology.

Of the other well-represented genera, *Solanum*, *Oxalis* and *Opuntia* are documented as having a majority of intentionally introduced species. *Euphorbia* is not as certain, although its characteristic flowers and attractive foliage have caused some species to be grown ornamentally and could well have been sufficient reason for others lacking documentation.

Amaranthus seems to have been the most successful "weedy" genus and this is probably due to seed of that genus contaminating imported garden seeds which, when sown, placed the weeds in a suitable environment.

	South Australia	Victoria (Ross, 1976; Todd 1979, 1981, 1985)	New South Wales (Jacobs & Pickard, 1981)
Dicotyledonous Families			
Compositae	123	101	153
Leguminosae	83	65	110
Cruciferae	53	41	49
Caryophyllaceae	34	30	34
Solanaceae	29	32	38
Rosaceae	26	24	45
Labiatae	25	17	24
Scrophulariaceae	24	25	33
Monocotyledonous Families			
Gramineae	142	136	208
Iridaceae	43	20	26
Liliaceae	27	4	19
Cyperaceae	14	9	21

Table 2: The number of introduced species in the most numerous families in south-eastern Australia.

Recent comparable figures for the south-eastern Australian States (Table 2) show a remarkable similarity between the number and ranking of the major families of the naturalised flora. Because north-eastern New South Wales is an almost sub-tropical environment, the Solanaceae and Cyperaceae, both being families more typically tropical, are more heavily represented in that State. Similarly, sub-tropical grasses not found in South Australia or Victoria markedly enhance the number of Gramineae in New South Wales. Conversely the naturalised species of Iridaceae originating from South Africa appear to have found the mediterranean conditions of South Australia more congenial and are more numerous there.

At the generic level, there is also much similarity between the States' respective floras (Table 3). *Solanum* and *Cyperus* being more sub-tropical in distribution are better represented in New South Wales. The case with *Crotalaria* is even more striking. Introduced species of this genus are not found at all in South Australia and Victoria. The distribution data provided by Jacobs and Pickard (1981) show that it is largely confined to the northern coast of the State where the environment tends to be sub-tropical. The considerably higher numbers of *Bromus* for New South Wales and *Rubus* for that State and Victoria, are probably a reflection of more intensive taxonomic work in those genera in local institutions leading to the recognition of more species. The situation with *Oenothera* is not so certain. Whilst detailed investigations may be responsible for some of the extra species, there may be some biological reason for the large number of species in New South Wales or there may even be an historical explanation, in that Sydney would probably have been the most common port of call for ships travelling from the west coast of North America. It may be relevant that *Oenothera* is very well-represented in South Africa (Wells & Stirton, 1982).

	South Australia	Victoria (Ross, 1976; Todd 1979, 1981, 1985)	New South Wales (Jacobs & Pickard, 1981)
Trifolium	26	20	22
Medicago	14	10	11
Solanum	13	12	16
Oxalis	12	9	12
Opuntia	12	6	5
Euphorbia	12	7	12
Amaranthus	10	9	10
Cyperus	9	8	13
Bromus	9	9	17
Juncus	7	9	12
Rubus	7	11	13
Oenothera	4	4	12
Crotalaria (introduced)	—	—	11

Table 3: Numbers of introduced species in the most numerous genera in south-eastern Australia.

References

Black, J.M. (1909). "The Naturalised Flora of South Australia". (privately printed: Adelaide).
Black J.M. (1922-29). "Flora of South Australia", 4 vols, 1st ed. (Govt Printer: Adelaide).
Black J.M. (1943-52). "Flora of South Australia", 3 vols, 2nd ed. (Govt Printer: Adelaide).
Eichler, H. (1965). "Supplement to J.M. Black's Flora of South Australia". (Govt Printer: Adelaide).
Eichler, H. (1966). "Corrigenda and Addenda to the Supplement to J.M. Black's Flora of South Australia". (Govt Printer: Adelaide).
Jacobs, S.W.L. & Pickard, J. (1981). "Plants of New South Wales". (Govt Printer: Sydney).
Jessop, J.P. (1984). "A List of the Vascular Plants of South Australia", 2nd ed. (Botanic Gardens: Adelaide).
Kloot, P.M. (1983). Early records of alien plants naturalised in South Australia. *J. Adelaide Bot. Gard.* 6: 93-131.
Kloot, P.M. (1986). Checklist of the introduced species naturalised in South Australia. *S.A. Dept. Agric. Tech. Paper* No. 14.
Kloot, P.M. (1987). The naturalised flora of South Australia 1. The documentation of its development. *J. Adelaide Bot. Gard.* 10:81-90.
Mueller, F. (1853). Flora of South Australia, displayed in its fundamental features and comparatively. *Hooker's J. Bot. & Kew Gard. Misc.* 5: 65-72.
Robertson, E.L. (1957). "Flora of South Australia", vol. 4, 2nd edn. (Govt Printer: Adelaide)
Ross, J.H. (1976). An analysis of the flora of Victoria. *Muelleria* 3: 169-176.
Specht, R.L. (1972). "The Vegetation of South Australia", 2nd edn. (Govt Printer: Adelaide).
Todd, M.A. (1979). A conspectus of new records and nomenclature for vascular plants in Victoria during the period 1970-1977. *Muelleria* 4: 173-199.
Todd, M.A. (1981). A conspectus of new records and nomenclature for vascular plants in the Victoria. 2. 1978-early 1980. *Muelleria* 4: 429-438.
Todd, M.A. (1985). A conspectus of new records and nomenclature for vascular plants in the Victoria. 3. Early 1980-early 1984. *Muelleria* 6: 59-78.
Tutin T.G. *et al.* (1964-80). "Flora Europaea", 5 vols. (Univ. Press: Cambridge).
Wells, M.J. & Stirton, C.H. (1982). South Africa, in W. Holzner and M. Numata (eds) "Biology and Ecology of Weeds". (Junk: The Hague).
Wood, J.G. (1937). "The Vegetation of South Australia". (Govt Printer: Adelaide).

J. Adelaide Bot. Gard. 10(1): 99-111 (1987)

THE NATURALISED FLORA OF SOUTH AUSTRALIA 3. ITS ORIGIN, INTRODUCTION, DISTRIBUTION, GROWTH FORMS AND SIGNIFICANCE

P.M. Kloot

South Australian Department of Agriculture,
GPO Box 1671, Adelaide, South Australia 5001

Abstract

Some features of the South Australian naturalised flora were examined. The predominant source of naturalised alien species has changed from Europe or Eurasia in 1855 to the Mediterranean and environmentally similar areas at present. It is suggested that this is due to the history of northern European settlement of South Australia and the attendant importation of plants from that region. The majority of presently naturalised plants were recorded in Great Britain at the time of South Australian settlement and it is suggested that regardless of their ultimate origin, most plants would have arrived via Great Britain or, more generally, northern Europe. The majority of naturalised plants have been documented or are suspected to have been introduced intentionally. Most of them were ornamental, fodder or culinary plants. Of the unintentionally introduced species, most were fleece, seed or ballast contaminants. A number of characteristic distribution patterns of naturalised plants in South Australia are recognized. These result from climatic and edaphic features and from patterns of land use. Annuals are the predominant growth form of the well-established species. The majority of the unintentionally introduced species are annuals.

Introduction

The development of the South Australian alien flora since colonization (Kloot, 1987) was ascertained from the documentation discovered during an intensive search (Kloot, 1987) to locate more material than was thought available hitherto (Michael, 1972). In this paper the changes in its geographical origins since 1855 are examined and compared with those in other environmentally similar regions. Additionally the present naturalised flora (Kloot, 1986) is analysed with respect to its route of introduction, reasons for introduction, its distribution patterns in the State, growth form and importance in the total flora.

The Geographical Origins of the Naturalised Flora

Data

In this section, changes are demonstrated in the proportion of the naturalised flora originating from different regions of the world. The data used are derived from the checklist (Kloot, 1986) except for 1855, for which (Kloot, 1983) is used as the base, being more complete as explained earlier (Kloot, 1987). The origins of the plants listed as naturalised in 1855, 1909, 1929, 1965 and 1984 are shown in Table 1.

Discussion

The figures shown in Table 1 show some consistent trends. Firstly, there has been a steady fall in the proportion of species originating from Europe and Western Asia outside the Mediterranean basin, although the proportion from the Mediterranean itself has stayed remarkably constant since 1909. Secondly, the percentage of plants originating from South Africa has risen consistently. Thirdly, the proportion of plants from the Americas has risen but the number and proportions from South America have always exceeded those from North America.

South Australia was settled by Northern Europeans largely migrating directly from that region. It is understandable therefore that the weeds originating in the same areas would have the best opportunity for early transportation to the new settlement. With time, plants originating from areas more akin environmentally to South Australia found their way here and became established, altering the proportions as shown in Table 1. Apart from South African species that reached South Australia via Europe, the stopover of many ships at South African ports on the way to Australia, particularly prior to the opening of the Suez Canal, facilitated the movement of local plants to Australia. This could have occurred by contamination of fodder loaded there, e.g. *Emex australis*, *Pentzia suffruticosa* and probably *Cyperus tenellus*, or adhering to animals or humans e.g. *Cotula* spp., *Arctotheca calendula*. Intentional movement is also implicated, particularly in the case of ornamentals (e.g. Aizoaceae) or potentially useful plants (e.g. *Ehrharta* spp.)

The same argument applies to South America, for many ships stopped at South American ports, particularly Rio de Janiero and Buenos Aires, before heading for the Cape of Good Hope, or sailing further south and making directly for Australia (Charlwood, 1981). Also sailing ships returning to Europe often went around Cape Horn and then called at South American ports. These ships eventually returned to Australia and some contamination leading to the transport of propagules is at least theoretically possible.

Conversely, the proportion of North American species has always been low. There was no regular direct link between there and South Australia. Almost all of the North American species listed for South Australia are also found in Europe (Tutin *et al.*, 1964-1980) which suggests that these plants reached Australia via Europe. The movement of fodder from North America, which on a large scale at least was rather erratic, could have been responsible for the arrival of some species that became successfully naturalised afterwards. *Solanum elaeagnifolium* appears to be such an example, as it is believed to have been brought, to South Australia at least, in hay imported from North America during the 1914 drought.

Willis (1972) remarked that no North American species of *Trifolium* had been introduced (? become established) in Victoria. It should be noted that none of these species have become established in Europe either (Tutin *et al.*, 1968). As these species have not been commercialised, there appears to be no intentional movement of propagules and they do not seem to have transport mechanisms to facilitate their movement.

Everist (1959) convincingly demonstrated that settlers' origins affected the composition of the alien flora. He showed that the alien flora of Queensland at that time was predominantly temperate in origin, although the local environment is basically sub-tropical. Later, the development of agricultural systems based on sub-tropical pastures and crops necessitated the import of large quantities of seeds from similar environments. Consequently the proportion of sub-tropical species established in Queensland has risen sharply (Kleinschmidt and Johnson, 1977).

The settlement of the mediterranean areas of the world also demonstrates this effect. South Africa (Wells & Stirton, 1982) and southern Australia were settled by northern Europeans, viz. the Dutch, English and Germans. Their naturalised floras showed the same general trends in the change from a high proportion of European species to those of more specifically Mediterranean origins. However, California and Chile were both initially settled by the Spanish. They had similar naturalised floras (Solbrig *et al.*, 1977) which always had a high proportion of Mediterranean species (Gulmon, 1977), which for California at least, were specifically noted as originating chiefly in Spain (Naveh, 1967).

One striking difference between Australian and other mediterranean areas is in the proportion of indigenous weeds. The following figures (after Wells and Stirton, 1982) of the number of families, genera and species of introduced and indigenous weeds in South Africa demonstrate this point.

	Families	Genera	Species
	No. (%)	No. (%)	No.(%)
Exotic weeds	78 (51)	284 (57)	503 (57)
Indigenous weeds	75 (49)	211 (43)	381 (43)

Comparable figures for South Australia after Kloot (1985a) are:-

	Families	Genera	Species
	No. (%)	No. (%)	No. (%)
Exotic species	88 (85)	448 (95)	875 (95)
Indigenous species	16 (15)	26 (5)	c.50 (5)

Routes of Introduction to South Australia

The present South Australian alien flora originated predominantly in other mediterranean regions with which, historically, there was very little direct contact apart from South Africa. It is clear therefore that apart from a limited number of species that were imported directly as potential fodder plants, and generally only in the last fifty years or so, the vast majority of these plants must have reached South Australia via a circuitous route. The species concerned must have been transported intentionally or otherwise, to a third region from which they were then moved again, on purpose or accidentally, to South Australia. The same argument applies for other regions from which members of the alien flora originated, e.g. China, East Africa.

Because South Australia was settled from northern Europe, and in particular Britain, it is reasonable to assume that those localities would be the staging posts from which plants were moved to South Australia. It is remarkable that of the 904 alien species, at least 765 were native to Britain or had been introduced and grown there by the 1830s (Loudon, 1830). This fact is not conclusive proof that all these plants were actually introduced to South Australia from Britain. However it certainly would apply for most of the intentional introductions such as the ornamental bulbs from South Africa and probably even such Australian ornamentals as *Sollya heterophylla*, *Pittosporum undulatum* and *Albizia lophantha* which had all been introduced to the British horticultural trade before the colonization of South Australia (Loudon, 1830). Their early appearance in local horticultural catalogues alongside other material imported from Britain (McEwin, 1843; Bailey, 1845) is strong evidence that their introduction to South Australia was via Britain.

The alien flora may be categorised as to its route of introduction as follows:

(a) Plants intentionally introduced or native to Britain where they were used for one or more purposes and then introduced intentionally to South Australia such as ornamentals, crop and fodder plants.

In some cases, such plants subsequently escaped and became naturalised in Britain and then did so in South Australia, e.g. *Briza maxima* and *Lobularia maritima* from the Mediterranean, *Fuchsia magellanica* and *Bromus unioloides* from South America and *Mimulus moschatus* and *Helianthus annuus* from North America, are all naturalised in Britain (Clapham *et al.*, 1962), and South Australia.

(b) Plants unintentionally introduced, or native to Britain and introduced generally unintentionally to South Australia, e.g. *Amaranthus retroflexus*, *Coronopus didymus*, *Medicago polymorpha.* Species referred to as "cosmopolitan" would be included here.

Also, the possibility must be considered that some plants believed to have been introduced directly to South Australia may have come via Britain. Thus both *Cyperus tenellus* (Kloot, 1979) and *Solanum elaeagnifolium* were believed to have reached South Australia in

ORIGIN	1855 No.	1855 Proportion	1909 No.	1909 Proportion	1929 No.	1929 Proportion	1965 No.	1965 Proportion	1984 No.	1984 Proportion
Mediterranean	25 spp.	25%	128 spp.	32%	177 spp.	33%	264 spp.	33%	284 spp.	31%
Europe[1]	50	49	142	35	174	32	222	28	232	26
Eurasia[1]	9	9	28	7	31	6	39	5	41	5
Asia	—	—	2	+	4	+	5	+	11	1
Eastern Asia	—	—	—	—	1	+	9	1	11	1
Old world tropics	—	—	3	+	5	1	7	+	8	+
California	2	2	2	+	2	+	6	+	8	+
North America[1]	2	2	9	2	21	4	43	5	51	6
Central America	1	1	4	+	6	1	12	1	19	2
South America	4	4	18	5	27	5	51	6	63	7
South Africa	8	8	49	12	72	13	110	14	132	15
East Africa	—	—	1	+	3	+	7	+	9	1
Western Australia	—	—	1	+	1	+	3	+	5	+
South Australia	—	—	3	+	4	+	5	+	5	+
Eastern Australia + N.Z.	—	—	4	+	6	1	11	1	15	2
Garden origin	—	—	3	+	5	1	9	1	10	1
TOTALS	101 spp.	100%	397 spp.	100%	539 spp.	100%	803 spp.	100%	904 spp.	100%

([1] Excluding that area immediately preceding in the list; + Less than 1% of total).

Table 1: The origins of the naturalised flora of South Australia at different periods, derived from Kloot (1986).

contaminated fodder from South Africa and North America respectively, but both species were being grown in Britain by 1830 (Loudon, 1830).

(c) Plants intentionally moved directly to South Australia from their origin, e.g. *Pentzia virgata* introduced from South Africa, *Paspalum dilatatum* from South America, *Ehrharta* spp. from South Africa and *Medicago rugosa* from the Mediterranean as potential fodders.

(d) Plants unintentionally moved directly to South Australia from their native origin as fodder or ballast contaminants or attached to implements, etc., e.g. *Cyperus arenarius* from southern Asia; *Scirpus hamulosus* from central Asia in camel fodder or harnesses; *Eragrostis curvula* from South Africa, apparently as a contaminant of *Ehrharta* seed; *Emex australis* from South Africa as a fodder contaminant; *Galenia* spp. from South Africa and *Suaeda aegyptiaca* from Europe in ballast.

It is a feature of such species that they have never been recorded from Britain or other parts of north-western Europe with which South Australia has historical ties. Consequently very few of such plants are of temperate origin, but rather from Mediterranean or sub-tropical regions.

Even within Australia, a number of plants have been specifically documented as reaching South Australia via other States as illustrated by the following examples:

Brassica tournefortii, *Berkheya rigida* and *Emex spinosa* were apparently transported across the Transcontinental Railway from Western Australia. *Aster subulatus* and *Acroptilon repens* were recorded as moving down the Murray River valley from Victoria, whilst *Amsinckia hispida* was brought across the border in contaminated seed grain from the Wimmera and Mallee of Victoria to contiguous regions of South Australia. *Schismus barbatus* moved down the railway line from Broken Hill, New South Wales, while *Xanthium occidentale* and *Salvia reflexa* were introduced from Queensland through New South Wales.

Manner of Introduction

Of the 904 species recorded as naturalised, 515 are either documented or suspected with good reason to have been introduced on purpose. A total of 214 species have been documented or are suspected of being accidentally introduced. The remaining species are uncertain at this stage. A further breakdown is as follows:

	Intentional introduction		**Accidental introduction**		**No.**
	Documented	**Suspected**	**Documented**	**Suspected**	**info.**
Monocotyledons	142	20	5	35	32
Dicotyledons	309	44	30	144	143
Totals	451	64	35	179	175

Thus 69% of the monocotyledonous species are documented or suspected of having been introduced intentionally as are 53% of the dicotyledonous species. Overall 57% were thus introduced. The group for which information is lacking can only add to these proportions should their means of introduction be determined in the future, but even now it is clear that the majority of naturalised aliens was intentionally introduced. This was not realised in the past and led to comments such as "Most introduced plants have entered the country fortuitously and without conscious human aid" (Trumble, 1949) or that weeds were "fellow travellers" (i.e. unintentional introductions) Parsons, 1981).

The following analysis reveals the overwhelming dominance of ornamentals as the means by which naturalised alien plants were first introduced.

	Documented	Suspected	Totals
Ornamentals	319	40	359
Culinary plants	43	1	44
Medicinals	8	5	13
Hedges	14	—	14
Fodder plants	58	17	75
Others	9	1	10
Total	451	64	515

It should be noted that many plants had multiple uses e.g. as hedges and ornamentals e.g. *Genista* spp., *Crataegus* spp. or as culinary and medicinal herbs, e.g. *Mentha* spp., *Taraxacum officinale*, but the categorisation shown here is derived from careful analysis or available data.

A similar analysis of the numbers of accidentally introduced species shows the following:

	Confirmed	Possible (based on overseas records)	Total
Contaminated seed	16	41	57
Ballast plants	7	36	43
Contaminated footwear	—	11	11
Contaminated fodder	3	3	6
Attached to stock	4	88	92
Others	5	—	5
Total	35	179	214

This leaves a further 175 species for which no information, even suggestive, has been located.

Distribution Patterns of Aliens in South Australia

A number of different distribution patterns of naturalised alien plants in the State may be discerned. Within a particular type there is great variation, reflecting the dynamic nature of plant distribution. In some cases the range is so restricted or at least the data are so limited at present, that the potential distribution is still uncertain. Nevertheless, for many species it is apparent that the distributions may be restricted due to natural factors e.g. soil salinity, or management factors e.g. the extent of cropping.

The following comments relate to those species sufficiently widespread that a distribution pattern may be discerned.

Ubiquitous

Many of the major weeds show an ubiquitous distribution pattern, being found very widely throughout the settled areas and extending to a greater or lesser extent into the interior. Some examples are *Lolium rigidum*, *Arctotheca calendula*, *Hypochoeris glabra*, *Sisymbrium orientale*, *Erodium cicutarium*.

Maritime

Some plants are strictly maritime in distribution, being almost wholly confined to the strand itself or perhaps the first dune. Such species include *Cakile* spp., *Euphorbia paralias, Ammophila arenaria.*

Others are found predominantly near the sea but also in other saline areas inland. Such species include most local representatives of the Aizoaceae, *Puccinellia* spp., *Lolium loliaceum, Limonium* spp., *Dischisma arenarium.*

Urban

Most of the species found about towns and settlements in general are garden escapes which have not or cannot spread into farmland, scrub, or land used for other purposes. Some examples are *Amaryllis belladonna, Aeonium arboreum* and *Cestrum parqui.*

Others are associated, at least so far, with transport such as *Ecballium elaterium* which is associated with railway lines. The compacted earth of roadsides, industrial yards and similar areas seems to favour certain species such as *Conyza bonariensis.*

One of the features of urban areas is the increased runoff from compacted or sealed ground surfaces as well as the enhanced watering of gardens. Consequently many species commonly found in such situations are also found in irrigation areas. *Aster subulatus* and *Chenopodium album* are but two examples.

Cyperus rotundus and *Dischisma capitatum* are two species mostly confined to the Adelaide urban area, although the former is found around other population centres and in irrigation areas. In metropolitan Adelaide they have been spread in garden loam and sand respectively and are restricted to the area serviced by that trade.

Farming areas

Geographically the distributions are diverse in extent. Some approach the ubiquitous distributions already mentioned whilst others are restricted to only a small part of the settled areas, e.g. *Monopsis simplex* is found in a narrow band from Comaum through Penola to Millicent in the Lower South East, and *Glaucium flavum* is restricted to a belt of sandy country extending from Port Gawler to beyond Balaklava in the Lower North.

Some general patterns are obvious. *Avena fatua, Aira cupaniana, Bromus hordeaceus, Echium plantagineum, Hypochoeris radicata* and *Plantago lanceolata*, among others, are very widespread throughout the settled areas. Many species, however, show restricted distributions.

The following species are examples of well-established plants that are still largely confined to the South East: *Alopecurus myosuroides, Monopsis simplex, Anchusa capensis, Hirschfeldia incana, Euphorbia exigua, Blackstonia perfoliata, Lotus angustissimus, Trifolium stellatum* and *Reseda alba.* Conversely, there are plants widespread in the northern parts of the State but not found in the South East except as strays: *Bromus rubens, Schismus barbatus, Neatostema apulum, Calendula arvensis, Centaurea melitensis, Carrichtera annua, Rapistrum rugosum, Sisymbrium erysimoides, S. irio* and *Astragalus* spp. It is interesting to note that Black (1918) recognised that in the South East *Hirschfeldia incana* occupied the same ecological niche that *Rapistrum rugosum* occupied in the northern cereal areas.

Three plants are more or less restricted to the Mallee where they are well-established. *Lycopis arvensis, Silene apetala* and *Salvia lanigera* have shown little propensity to spread to other areas yet.

A few plants are widespread to the east of Spencer Gulf but are absent or almost so from Eyre Peninsula. They include *Amsinckia* spp., *Heliotropium europaeum, Centaurea calcitrapa* and *Reichardia tingitana.*

Petrorhagia nanteulii is the only alien species restricted to Kangaroo Island whilst *Dimorphotheca sinuata*, *Berkheya rigida*, *Iberis crenata* and *Withania somnifera* are only established on Eyre Peninsula, not having been found east of Spencer Gulf.

Pastoral areas

There are a number of naturalised aliens that, at present, are well-established in the pastoral zone, although they may be found occasionally in the adjacent farming areas. Some are restricted to damp areas and are included below with aquatics. The others rely on natural rainfall, although they do better where this is supplemented by springs or roadside runoff. Such species include *Eragrostis barrelieri*, *Lamarckia aurea*, *Lophochloa pumila*, *Schismus arabicus*, *Heliotropium curassavicum*, *Sonchus tenerrimus*, *Alyssum linifolium*, *Argemone subfusiforme*, *Glaucium corniculatum*, *Rumex vesicarius* and *Myosurus minimus*.

High rainfall areas

The high rainfall areas of South Australia, i.e. those receiving more than 400 mm rainfall per annum, are relatively small, being the southern-most part of Eyre Peninsula, the Mt Lofty Ranges and the Lower South East. Many species are restricted to these areas or even to only part of them. Some examples are most members of the Iridaceae, the Amaryllidaceae, *Cynosurus echinatus*, *Asclepias* spp., *Myosotis sylvatica*, *Rumex crispus*, *Rubus* spp. and *Tropaeolum majus*, and a number of woody species.

The soil types of high rainfall areas tend to be neutral to acidic and are never highly alkaline as found in the cereal growing areas. Furthermore, such areas are cooler, so that temperature, rainfall and soil type effects are confounded. Therefore it is uncertain which causal factor is limiting. It probably differs between species.

There is a small number of species which appear to require very high rainfall, by local standards. They are restricted to the immediate vicinity of Mt Lofty where the average annual rainfall exceeds 750 mm. They include *Agrostemma githago*, *Lychnis coronaria*, *Sambucus nigra*, *Cistus psilosepalus*, *Cardamine flexuosa* and *Crataegus sinaica*.

Soil types

There are a number of species that are strongly confined to alkaline soils such as *Adonis microcarpus*, *Buglossoides arvensis* and *Bifora testiculata*. It could be argued that as in the higher rainfall areas, arid soil types are confounded with temperature and average annual rainfall. However Trumble and Donald (1938) and Kloot (1973) show that it is not so for *Medicago truncatula* and *Adonis microcarpus* respectively. The distributions of these plants are dependent on the alkalinity of the soil *per se*.

Experimental data obtained by the author (Kloot, 1985a) demonstrate the importance of soil characteristics in determining the distribution of alien plants in the Lower North of South Australia.

Aquatics

There are three sub-groups within the small group of naturalised free-floating aquatics found in South Australia. *Ludwigia peploides* and *Potamogeton* spp. seem to be found in many water bodies. *Zanichellia palustris*, *Sagittaria graminea* and formerly, *Eichhornia crassipes*, have only been found in the River Murray. *Alisma lanceolatum* and *Aponogeton distachyon* have only been found in the westward-flowing rivers of the Mt Lofty Ranges. *Callitriche hamulata* has been recorded once from the South East. It is recorded from acidic water bodies in Europe (Landolt, 1977) so it is unlikely to invade the Murray system.

The case of *Sagittaria graminea* is particularly interesting. It has been found regularly in the River Murray upstream from Mannum since it was first collected in 1967, and was charted in detail during an extensive survey in 1982 (R. Carter, pers. comm.). However, it has never been found further downstream, suggesting that environmental conditions below Mannum are not suitable for its establishment. A strong possibility would be the salinity of the river which increases throughout its course in South Australia. It is possible that in the vicinity of Mannum the level of salinity generally exceeds the threshold above which the plant will not grow. It would be interesting to see if there is any temporary establishment further downstream during prolonged flows of fresh water.

In the checklist of naturalised species (Kloot, 1986) 14 are listed as aquatics which are defined as free-floating plants and necessarily are restricted to water bodies. A further 10 species such as *Cyperus* spp. and *Agrostis gigantea* are only found in very wet environments but are not aquatics, as defined here. *Scirpus hamulosus* and *Cyperus laevigatus* are two examples of a further sub-group that inhabits the permanently damp patches around springs, etc. in the interior.

Growth Form

Analyses of lists of native and introduced species in various plant associations in South Australia reveal that the native vegetation is predominantly perennial, but the successful aliens are mainly annual (Kloot, 1985b). This is understandable as an annual growth form will accommodate the two most prominent features of the South Australian environment, the short growing-season and the cycle of annual cultivation in the settled areas.

Because the areas of high rainfall (more than 500 mm per annum) are so restricted, occurring as three small, disjunct zones, only a very small proportion of the alien flora consists of shrubs and trees which need more humid conditions for survival than annuals. The scarcity of water bodies has similarly precluded the establishment of many aquatics.

The breakdown of the alien flora by growth form is as follows:

Annuals	454	50.2%
Herb. perennials	298	33.0
Shrubs	76	8.4
Trees	36	4.0
Climbers	24	2.7
Aquatics	14	1.5
Parasites	2	0.2
	904	100.0%

The preponderance of perennials in the South Australian native flora may be shown by examining the ratios of annual to perennial species. In the four land systems considered by Specht (1972) the ratios are as follows:

	Ratio of annual/perennial species		
	Native species	**Introduced species**	**All species**
Sclerophyll	.037	1.06	.088
Mallee	.064	3.44	.141
Arid Lands	.261	*	.289
Savannah	.157	1.74	.460

* There are no perennial species in this category.

Comparable figures given by Barbour *et al.* (1981) for Israel, the Mediterranean generally and California are as follows:-

	Israel coastal	**Israel desert**	**Mediterranean**	**Californian coastal**
A/P ratio	1.60	0.69	1.06	0.43

From these figures it is clear that the ratios for native Australian communities are very low. The invasion of aliens increases the ratios, that of the savannah system exceeding that of the Californian coastal dunes, but still well below those of Israel and the Mediterranean generally to which the ratios of the introduced species are more comparable.

Because of their ability to take advantage of even shorter term opportunities, a high proportion of annuals in a plant community would be advantageous in ensuring that the community itself could recolonise any grossly disturbed areas rather than leave them available to alien invaders.

The Importance of Aliens in the South Australian Flora

Based on the checklist, the following figures demonstrate the degree of naturalisation of the alien flora.

Established*	452 spp.	50.0%
Adventive	283	31.3
Casual	169	18.7
	904 spp.	100.0%

*As defined previously (Kloot, 1987a)

Schomburgk (1878) listed over 8000 species growing in the Adelaide Botanic Gardens, most of which were exotic. Allowing arbitrarily that 2000 extra species not recorded by Schomburgk were introduced by others, either prior to or after that time, then less then 10% of the introduced species have become naturalised to any extent and less than 5% have become established. These figures agree with estimates made on a national basis (R.H. Groves, pers. comm.).

The breakdown of these categories according to growth forms (Table 2) emphasises the success of annual plants, in particular, and herbaceous perennials to a lesser extent, compared to shrubs and trees for the reasons canvassed above. Established annuals is the largest single category in that Table and they alone comprise 31.6% of the alien flora.

A further analysis was made of the degree of naturalisation with respect to accidental and intentional introductions and is presented in Table 3. The proportion of plants accidentally introduced that have become established (65%) is greater than the proportion of those intentionally introduced that have become so (39%). If they are able to grow at all in our environment, then if they are "weedy" enough to arrive here unaided, it is likely that they have the "weedy" characteristics (Baker, 1974) to spread and become completely naturalised.

All species were categorised further as being insignificant, minor or major weeds. The first category includes most persistent or escaped crop plants for the assessment was made solely on perceived negative aspects of naturalised populations. Therefore *Triticum aestivum* was regarded as insignificant because outside cultivation it is of no significance to landholders.

In the following figures the "minor" and "major" categories have been subdivided into those species "intentionally" and "unintentionally" introduced.

	Annuals			Herbaceous Perennials			Shrubs			Trees			Climbers			Aquatics			Parasites		
	E*	A	C	E	A	C	E	A	C	E	A	C	E	A	C	E	A	C	E	A	C
Monocotyledons	58	11	13	55	58	30		1	1							5	2				
Dicotyledons	226	80	66	70	48	37	20	43	10	8	24	4	5	12	7	4	2	1	1	1	—
Totals	284	91	79	125	106	67	20	45	11	8	24	4	5	12	7	9	4	1	1	1	—
Percentages of each growth form	62.6	20.0	17.4	41.9	35.6	22.5	26.3	59.2	14.5	22.2	66.7	11.1	20.8	50.0	29.2	64.3	28.6	7.1	50.0	50.0	—

(* E = Established, A = Adventive, C = Casual as defined earlier (Kloot, 1987a).)

Table 2: The degree of naturalisation of the alien flora of South Australia as influenced by growth form.

	Intentionally Introduced			Unintentionally Introduced			Totals		
	E*	A	C	E	A	C	E	A	C
Monocotyledons	66	57	33	53	15	11	119	72	44
Dicotyledons	133	151	75	200	60	50	333	211	125
Totals	199	208	108	253	75	61	452	283	169
	—	515	—	—	389	—	—	904	—

* E = Established, A = Adventive, C = Casual, as defined earlier (Kloot, 1987a)

Table 3: The degree of naturalisation of the alien flora as influenced by means of introduction.

	Insignificant	Minor weed		Major weed		Total
		Intentionally introduced	Unintentionally introduced	Intentionally introduced	Unintentionally introduced	
Monocotyledons	170	28	11	12	13	234
Dicotyledons	354	131	99	31	55	670
TOTALS	524	159	110	43	68	904
		269		111		

It is clear that the majority of major weeds was accidentally introduced. Those plants having the "weediness" to move successfully without the intentional assistance of Man are those most likely to succeed in a new environment (Baker, 1974).

For various reasons (Kloot, 1985b) native plant communities are unable to stand disturbance and degenerate as a result of European activities. Although Moore (1957) concluded that in south-eastern Australia introduced species do not invade undisturbed climax communities, his finding is of limited applicability, particularly in South Australia. Firstly, truly undisturbed communities are almost non-existent (Bridgewater & Kaeshagen, 1979). Even in places where gross disturbances such as ploughing or timber-getting have not occurred and relatively benign activities such as light grazing or the movement of people and their belongings have left the vegetation more or less intact, alien species have been introduced. They tend to form only a minor part of the flora, although this varies between different land systems.

Secondly, the communities studied by Moore are found in relatively high rainfall areas (>400 mm p.a.) compared to those of South Australia (100-400 mm p.a.) which consequently have slower growth rates. Such communities do not have as much resilience to counter disturbance.

Further analysis of the data derived from Specht (1972) presented by Kloot (1985b, Table 1) reveals the following:

	No. of species		
	Native	Introduced	% Introduced = Invasion index (Bridgewater & Kaeshagen, 1979)
Sclerophyll	336	35	9.4
Mallee	414	40	8.8
Arid Lands	227	5	2.2
Savannah	258	145	36.0

The proportion of introduced species in the vegetation of Californian sand dunes is 14% (Barbour *et al.*, 1981). By comparison, in coastal dunes in Israel the porportion is about 1% (*Ibid.*). This is further support for the view (Kloot, 1985b) that the present flora of the Middle East is better adapted to withstand competition than the Australian flora, or for that matter, the Californian flora, having developed during a much longer history of traumatic disturbance (>100,000 year cf. <10,000 years, (*Ibid.*).

Acknowledgements

I am grateful to Mr. D.E. Symon, formerly of the Waite Agricultural Research Institute for many helpful discussions during the preparation of this manuscript.

References

Bailey, J. (1845). Catalogue of plants cultivated in and for sale at the Hackney Nursery, Adelaide, 1945. *The Adelaide Observer*, 3.v.1845, pp 1-2.

Baker, H.G. (1974). The evolution of weeds. *Ann. Rev. Ecol. & Syst.* 5: 1-24.

Barbour, M.G., Shmida, A., Johnson, A.F. & Holton, B. (1981). Comparison of coastal dune scrub in Israel and California: physiognomy, association patterns, species richness, phytogeography. *Isr. J. Bot.* 30: 181-198.

Black, J.M. (1918). Additions to the flora of South Australia, No. 14. *Trans. Proc. Royal Soc. S. Aust.* 42: 168-184.

Bridgewater, P.B. & Kaeshagen, D. (1979). Changes induced by adventive species in Australian plant communities, in O. Wilmans & R. Tuxen (eds) "Werden und Vergehen van Pflanzengesellschaften". (Cramer: Vaduz).

Charlwood, D. (1981). "The Long Farewell". (Allen Lane: Ringwood).

Clapham, A.R., Tutin, T.G. & Warburg, E.F. (1962). "Flora of the British Isles," 2nd ed. (Univ. Press: Cambridge).

Everist, S.L. (1959). Strangers within the gates. *Qld. Natural.* 16: 49-60.

Gulmon, S.L. (1977). A comparative study of the grassland of California and Chile. *Flora* 166: 261-278.

Kleinschmidt, H.E. & Johnson, R.W. (1977). "Weeds of Queensland". (Govt Printer: Brisbane).

Kloot, P.M. (1973). Studies in the ecology of *Adonis microcarpus.* M. Ag. Sc. Thesis, University of Adelaide.

Kloot, P.M. (1979). The native and naturalised *Cyperus* species in South Australia. *J. Adelaide Bot. Gard.* 1: 333-341.

Kloot, P.M. (1983). Early records of alien plants naturalised in South Australia. *J. Adelaide Bot. Gard.* 6: 93-131.

Kloot, P.M. (1984). The introduced elements of the flora of southern Australia. *J. Biogeogr.* 11: 63-78.

Kloot, P.M. (1985a). Studies in the alien flora of the cereal rotation areas of South Australia. Ph.D. Thesis, University of Adelaide.

Kloot, P.M. (1985b). The spread of native Australian plants as weeds in South Australia and other Mediterranean regions. *J. Adelaide Bot. Gard.* 7: 145-157.

Kloot, P.M. (1986). Checklist of the introduced species naturalised in South Australia. *S.A. Dept. Agric. Tech. Paper* No. 14.

Kloot, P.M. (1987a). The naturalised flora of South Australia. 1. The documentation of its development. *J. Adelaide Bot. Gard.* 10: 81-90.

Kloot, P.M. (1987b). The naturalised flora of South Australia. 2. Its development through time. *J. Adelaide Bot. Gard.* 10: 91-98.

Landolt, E. (1977). "Oekologische Zeigerwert zur Schweizer Flora". (Geobotanisches Inst.: Zürich).

Loudon, J.C. (1830). "Loudon's Hortus Brittanicus". (Longman: London).

McEwin, G. (1843). Catalogue of plants grown at Melbourne Cottage, North Adelaide, in J. Allen (ed.) "The South Australian Almanack and General Directory for 1844". (Allen: Adelaide).

Michael, P.W. (1972). The weeds themselves — early history and identification, in History of Weeds Research in Australia symposium. *Proc. Weed Soc. N.S.W.* 5: 3-18.

Moore, R.M. (1957). Some ecological aspects of the weed problem in Australia. *Proc. 4th Inter. Congr. Crop Prot., Hamburg* 1: 447-449.

Naveh, Z. (1967). Mediterranean ecosystems and vegetation types in California and Israel. *Ecology* 48: 445-459.

Parsons, W.T. (1981). The history of introduced plants, in D.J. & S.G.M. Carr (eds)"Plants and Man in Australia". (Academic Press: Sydney).

Schomburgk, R. (1878). "Catalogue of the Plants under Cultivation in the Government Botanic Gardens, Adelaide, South Australia". (Govt Printer: Adelaide).

Solbrig, O. *et al.* (1977). Cited by M.L. Cody & H.A. Mooney (1978). Convergence versus non-convergence in mediterranean-climate ecosystems. *Ann. Rev. Ecol. Syst.* 9: 265-321.

Specht, R.L. (1972). "The Vegetation of South Australia", 2nd ed. (Govt Printer: Adelaide).

Trumble, H.C. (1949). The ecological relations of pastures in South Australia. *J. Brit. Grassl. Soc.* 4: 135-160.

Trumble, H.C. & Donald, C.M. (1938). Soil factors in relation to the distribution of subterranean clover and some alternative legumes. *J. Aust. Inst. Agric. Sci.* 4: 206-208.

Tutin, T.G. *et al.* (1964-80). "Flora Europaea", 5 vols. (Univ. Press: Cambridge).

Wells, M.J. & Stirton, C.H. (1982). South Africa, in W. Holzner & M. Numata (eds.) "Biology and Ecology of Weeds". (Junk: The Hague).

Willis, J.H. (1972). "A Handbook to Plants in Victoria", vol. 2 (Univ Press: Melbourne).

J. Adelaide Bot. Gard. 10(1): 113-117 (1987)

A NEW SPECIES OF *GYMNANTHERA* (PERIPLOCACEAE) IN AUSTRALIA

K.L. Wilson

National Herbarium of New South Wales, Royal Botanic Gardens, Sydney 2000

Abstract

A new species of the genus *Gymnanthera* (Periplocaceae) is described from Central Australia.

Gymnanthera R. Br. is a small genus in the Periplocaceae, with about five species in the Australian – South-East Asian region. It is characterised by the following combination of features: usually twining or climbing shrubs (*G. pedunculata* is described as being twining or suberect), with rather glossy leaves; corolla salverform, with a long tube, aestivation contorted; corona with five ovate lobes, usually with a minutely bifid apex; no teeth alternating with stamen filaments. The species are generally described as glabrous, but minute hairs can be found on leaf petioles and on young inflorescences in *G. nitida* at least.

Gymnanthera was described by Robert Brown in his Prodromus (1810a). He simultaneously published a description of the genus, but without reference to any included species, in his paper on Asclepiadeae (1810b). *G. nitida* R. Br. is the type species and until now the only known species from Australia (it also occurs in Malesia and South-East Asia). It is also the only described species of Periplocaceae (or Asclepiadaceae subfamily Periplocoideae if the separate family is not recognised) native to Australia. Four other species have been described from the Malesian region: *G. insularum* King & Gamble, *G. hypoleuca* (Miq.) Boerl., *G. paludosa* (Bl.) K. Schum. and *G. pedunculata* (Miq.) Villar. The last three species were originally described in the genus *Dicerolepis*, established by Blume (1850) with just *D. paludosa* Bl. Bentham (Bentham & Hooker, 1876) synonymised *Dicerolepis* with *Gymnanthera*. Costantin (1912) described *G. nitida* var. *cochinchinensis* Pierre ex Costantin. The status of the Malesian species is uncertain and requires further study. They are not dealt with in this paper.

The only species previously known from Australia, *G. nitida*, is a slender liane, found near water courses from the Kimberley region of Western Australia to the tropical east coast of Queensland and associated islands. Recently, collections of a new shrubby species of the family Periplocaceae have been made from the northern part of Central Australia. The species generally has the characters of *Gymnanthera* (the notable exception being habit), and is here described to enable its inclusion in the second edition of the 'Flora of Central Australia'.

Gymnanthera fruticosa K.L. Wilson, sp. nov.

Ex affinitate *G. nitidae* sed habitu erecto-fruticosi, foliis gracilioribus, corollae lobis tubum subaequantibus, differt.

Type: NORTHERN TERRITORY: Blackwater area, 15 km SSW. Papunya, 23° 20′S, 131° 48′E, *P.K. Latz 7623*, 3.iv.1978. *Holotype*: NSW. *Isotypes*: NT (also AD, BRI, CANB, CBG, MEL, PERTH, not seen).

Erect, multistemmed, glabrous shrub, 1-2 m high; stems slender, woody and rigid, softer at apices. *Leaves* opposite, simple; petiole 5-8 mm long, canaliculate near apex to nearly terete near base; lamina narrow-elliptic, entire, 5-7 cm long, 12-19 mm wide, chartaceous (only dried

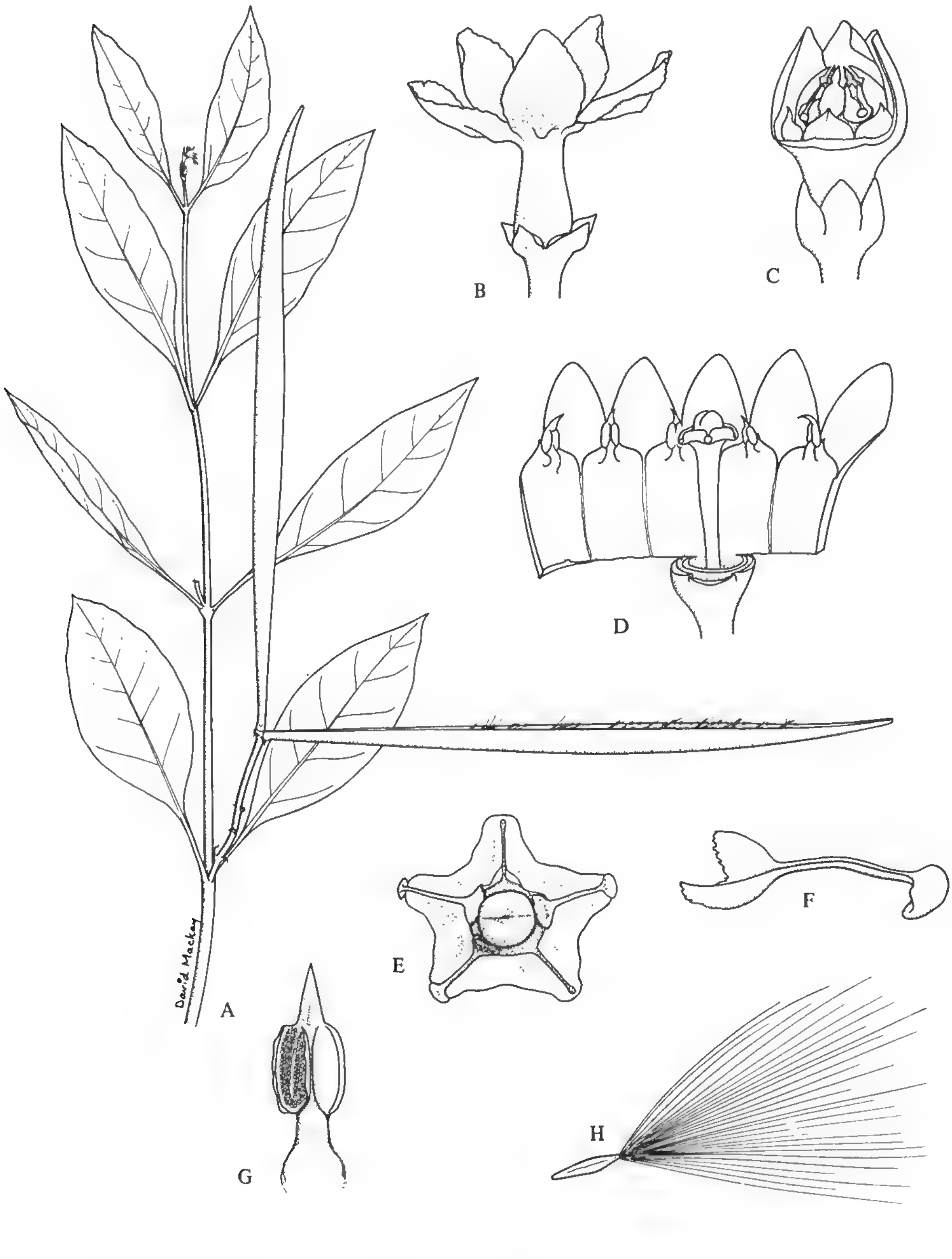


Fig. 1. *Gymnanthera fruticosa* K.L. Wilson. A, habit × 1. B, flower × 5. C, bud with corolla lobes removed to show corona lobes, anthers and style-head × 5. D, flower opened out to show corona lobes, anthers and style-head × 5. E, style-head from above, showing translators lying in three of the five stigmatic grooves × 20. F, translator × 40. G, anther × 20. H, seed with coma × 1.5. (A, H from *Latz 7623*, B-G from *Latz 9414*).

material seen), ± concolorous, glossy on upper surface, with brochidodromous venation; base attenuate; apex acute to short-acuminate. *Inflorescences* small slender cymes in leaf axils; peduncles becoming woody as fruits develop; pedicels of varying lengths (to 10 mm long) depending on age of flowers. *Calyx* lobes 5, broad-triangular, imbricate, 1-1.5 mm long; glands 5, small, inside calyx between lobes, transverse-triangular or deeply divided. *Corolla* more or less salverform (lobes not spreading very widely), greenish-white; tube 4-6 mm long, about as long as lobes; lobes contorted in bud, triangular, somewhat incurved, 4-5 mm long. *Corona* fleshy, arising at throat of corolla behind stamens, of 5 transverse-triangular segments with a minutely bifid apex. *Stamens* 5, inserted at throat of corolla, overarching central gynoecial column and expanded style-head; filaments free, broad, flat, dilated at base; anthers 2-celled with 2 loose, elongate pollen masses per cell; connective produced as a long terminal appendage. *Translators* (pollen carriers) consisting of caudicle and corpuscle (viscidium); caudicle slender, slightly concave, expanded at adaxial end (to which pollen masses become attached), translucent, lying in groove in lobe of expanded style-head; corpuscle cup-shaped, creamy-white, attached to abaxial end of caudicle and extending beyond lobe at right angles to caudicle, protruding between anther filaments. *Style-head* expanded, creamy-white, central region hemispherical with central groove, and with large ruff-like stigmatic outgrowth immediately beneath; outgrowth 5-lobed, much thickened, with a groove extending the length of each lobe with the caudicle of a translator lying in it and the corpuscle extending just beyond the rounded end of the lobe. *Follicles* long, slender, narrow-fusiform, 8-10 cm long, c. 5 mm diam. at broadest point, the pair on each peduncle held erect and parallel to each other at first, spreading to an angle of c. 45° at maturity. *Seeds* numerous, narrow-elliptic, flattened, ridged along middle of one flat face for c. ¾–⅞ length, surfaces finely and irregularly wrinkled or reticulate, pale brown, c. 7 mm long, c. 2 mm wide; coma white, c. 2 cm long, readily deciduous. Figs. 1, 2.

Habitat

In sandy or gravelly creek beds in the north of the Central Australian region, Northern Territory.

Specimens examined

NORTHERN TERRITORY: Central North: 15 km SW. of Barrow Creek Roadhouse, 21° 35'S, 133° 47' E, *P.K. Latz 9567*, 8.vi.1983 (NT, NSW); 12 km S. Barrow Creek on Stuart Highway, 21° 35'S, 133° 47'E, *G. Leach & R. Smith 712*, 19.viii.1985 (NSW ex NT); Lander River, 'Pine Hill' Station, 22° 16'S, 132° 53'E, *B.G. Thomson 436*, 27.v.1983 (NT); 'Pine Hill' Station, 22° 19'S, 132° 53'E, *P.K. Latz 6702*, 3.xii.1976 (NT); 15 km SSW. of 'Utopia' Homestead, 22° 22'S, 134° 29'E, *P.K. Latz 9414*, 2.xii.1982 (NT, NSW).

The species differs from other species of *Gymnanthera* in being an erect shrub rather than a liane or twining shrub (hence its epithet). *G. pedunculata*, from Flores and Mindanao, is described by Miquel (1857) as being 'frutex volubilis vel substrictus'. From Miquel's description and from the only specimen I have seen of that species (*Merrill 11981*), it is more twining than erect in habit, and differs further from *G. fruticosa* in its leaves (shorter, discolorous, relatively broader especially towards the rather obtuse apex) and its smaller flowers. It is described as occurring in thickets behind mangroves, which is a very different habitat from the ephemeral watercourses of Central Australia. *G. fruticosa* differs from the only other Australian species, *G. nitida*, in having more slender leaves (narrow-elliptic with length:width c. 1:3, rather than elliptic with ratio ranging from 1:2 to 2:3), and a corolla tube about as long as the lobes (c. $1^1/_3$-2 times as long in *G. nitida*).

The terminology I have used to describe the specialised floral parts is based on that in Airy Shaw (1973), Newton (1984) and Schill & Jaekel (1978).

Fig. 2. Holotype of *Gymnanthera fruticosa* K.L. Wilson.

Acknowledgements

My thanks are due to the curator of the Northern Territory Herbarium (NT), who kindly sent me photographs and pickled material as well as specimens; Mr David Mackay, who ably drew Figure 1; and Dr Surrey Jacobs and Mr Ken Hill, who commented on a draft of the manuscript.

References

Airy Shaw, H.K.(1973). 'Dictionary of the flowering plants and ferns', edn 8. (Cambridge Univ. Press: Cambridge).

Bentham, G., & J.D. Hooker (1876). 'Genera Plantarum' vol. 2 part 2. (Lovell Reeve/Williams & Norgate: London).

Blume, C.L. (1850). 'Museum Botanicum Lugduno—Batavum' Vol. 1 no. 10.

Brown, R. (1810a). 'Prodromus Florae Novae Hollandiae'. (J. Johnson: London).

Brown, R. (1810b). On the Asclepiadeae. Preprint 1810 of paper published 1811 in *Mem. Werner Soc.* 1: 12-78.

Costantin, J. (1912). Asclépiadacées. Pp. 1-154 in H. Lecomte, 'Flore Générale de l' Indo-Chine' vol. 4, part 1. (Masson et Cie: Paris).

Miquel, F.A.W. (1857). 'Flora van Nederlandsch Indië' vol. 2. (van der Post: Amsterdam).

Newton, L.E. (1984). Terminology of structures associated with pollinia of the Asclepiadaceae. *Taxon* 33: 619-621.

Schill, R., & U. Jaekel (1978). Beitrag zur Kenntnis der Asclepiadaceen-Pollinarien. *Akad. Wiss. Lit. Mainz Trop. Subtrop. Pflanzenwelt* 22: 53-122.

J. Adelaide Bot. Gard. 10(1): 119-126 (1987)

TAXONOMIC NOTES ON SOME AUSTRALIAN SPECIES OF *INDIGOFERA* (FABACEAE - FABOIDEAE)

Peter G. Wilson

National Herbarium of New South Wales, Royal Botanic Gardens, Sydney 2000

Abstract

Five species of *Indigofera*, chiefly from central and northern Australia, are typified and provided with full descriptions and a few notes. Of these, two, *I. bancroftii* (Queensland) and *I. verruculosa* (Northern Territory), are described as new. The new name *I. helmsii* (*I. uncinata* Ewart & Kerr, non G. Don, nec Roxb.) is published, the circumscription and application of *I. adesmiifolia* A. Gray is clarified and the new combination, *I. basedowii* ssp. *longibractea* (*I. longibractea* J.M. Black), is made.

Introduction

The genus *Indigofera* is represented in Australia by at least 35 species, some of which are naturalised introductions. Many of these species are poorly known and there is confusion over the application of some names, particularly *I. brevidens*. This is a preliminary paper to establish names for two taxa to be used in the forthcoming second edition of the 'Flora of Central Australia', to provide names for two species from northern Australia, and to clarify the application of a long-overlooked name.

1. **Indigofera helmsii** Peter G. Wilson, nom. nov.

I. uncinata Ewart & Kerr, Proc. Roy. Soc. Vic., n.s., 39:3 (1926) fig. 2, *non* G. Don, Gen. Hist. 2:208 (1832), *nec* Roxb., Fl. Ind. 3:382 (1832).

Lectotype (here designated): Mt Watson near Birksgate Range (Camp 17, Elder Exploring Expedition), *R. Helms*, 8.vii.1891 (AD 97310107).

Syntypes: Forrest Expedition, "F78 Spring" (Third Expedition, camp 78, vicinity of Elder Spring, 26° 15′ 10″S, 129° 09′E) 23-27.viii.1874 (MEL 586329); Gawler Ranges, *R.F. Sullivan*; Camp 17, S.A., *R. Helms*, 8.vii.1891 (two labels with a single specimen, MEL 586332); Tarella, *W. Baeuerlen*, vii. 1887 (MEL 586333); Cobar, *J.M. Curran*, 1887 (MEL 586324).

Excluded syntypes: towards Alice Springs, *Flint*, 1882 (MEL 586330); Taylor, N.T., *A.J. Ewart*, vi. 1924 (MEL 586331, –36, –37, –38, –41); without locality, *Mueller*, i.1853 (MEL 586513, listed as doubtful by Ewart and Kerr).

Description

Shrub, usually around 0.6 m high but occasionally reaching 1 m or more; young stems distinctly square in section, green; hairs biramous, hyaline to almost black, appressed, scattered. *Leaves* pinnate, (5-) 7-11 -foliolate, up to 5 cm long: rachis furrowed, bearing groups of orange to red glandular hairs between the pairs of leaflets, stipellae 0.5-1.5 mm long; leaflets elliptical to obovate, obtuse and mucronate, 10-20 (-25) x 4-9 mm, glabrous on the upper surface and bearing scattered appressed hairs below. *Stipules* triangular, red-brown, 4-7 (-9) mm long, glabrous inside, usually persistent, recurved and spinescent. *Inflorescence* an axillary raceme (1.5-) 2-4.5 (-5.5) cm long; bracts subulate, 2.5-4 mm long; flowers deep pink. *Calyx* up to 3 mm long, covered with dark, appressed hairs; lobes as long as or shorter than the tube, unequal, up to 1.5 mm long. *Standard* broadly obovate, 5.5 x 4-5 mm, the outside covered with golden to dark brown hairs, the inside glabrous, deep pink with a white spot at the base; *wing* oblong to spathulate, 4.5-5.5 x 1-1.5 mm; *keel* 4.5-5 mm long, with an indumentum of golden hairs at the tip and along the bottom. *Stamens* 9 + 1, the free ends pigmented, anthers apiculate. *Ovary* appressed-hairy, stigma capitate.*Pod* cylindrical, 20-30 x 2.5 mm, red-brown and sparsely hairy; endocarp with pale-brown spots. *Seeds* cuboid to compressed-cylindrical, 4-7 per fruit.

Habitat

This species is found on rocky hills or in rocky creek beds in ranges.

Selected specimens (total seen 58)

WESTERN AUSTRALIA: Pass in the Blackstone Range, *A.S. George 8756*, 17.vii.1967; *A.S. George 12158*, 26.vii.1974 (PERTH).

NORTHERN TERRITORY: Mount Sonder, Heavitree Range, *G.W. Carr 1650 & Beauglehole 45429*, 11.vi.1974 (MEL, NSW); Mount Palmer, *Cleland*, 26.viii.1956 (AD); Haasts Bluff Reserve, *Cleland*, 23.viii. 1956 (AD); Standley Chasm, *Hill & Lothian 962*, 17.vii.1958 (AD, NT); *Nelson 1633*, 8.ii.1968 (AD, BRI, NSW, NT).

SOUTH AUSTRALIA: North-Western Region: Upper slopes of Mount Woodroffe, Musgrave Range, *Symon 2680*, 11.viii.1962 (AD); Mount Lindsay, Birksgate Range, *P.G. Wilson 2482*, 6.viii.1962 (AD).
Flinders Ranges: Southern slopes Yankaninna Range, *Lothian 2096*, 25.viii.1956 (AD); central Chace Range, *Crisp 857*, 1.ix.1974 (AD); "Baratta" station, just SE of The Bluff, *Whibley 4452*, 11.viii.1974 (AD); Mount Remarkable National Park, Mambray Creek, *Donner 4925*, 6.viii.1974 (AD).
Eyre Peninsula: Mount Wallaby, WNW of "Kondoolka" H.S., *Jackson 2032*, 24.ix.1972 (AD); Mount Double, *Weber 3377*, 4.x.1972 (AD); Wudinna Hill, *Ising*, 7.ix.1938 (AD); Cunyarie Hills, N of Kimba, *P.G. Wilson 1864*, 27.ix.1960 (AD); South Corunna Hill, *Chinnock 2006 & Copley*, 8.ix.1974 (AD).

NEW SOUTH WALES: Maccullochs Range, *Sikkes 1298 & Ollerenshaw*, 1.x.1973 (AD, NSW).

The groups of glandular hairs on the rachis recorded here for this species and for *I. adesmiifolia* and *I. bancroftii* are dense clusters of multicellular club-shaped hairs that become orange or red with age, possibly due to the accumulation of tannin. These hairs may also be found in the axils of the stipules and bracts of the inflorescence.

In the protologue to *I. uncinata*, Ewart and Kerr say "this plant appears to be the same as that placed by Bentham as *Indigofera brevidens* var. *uncinata*". It is possible, but by no means certain, that Bentham (who did not cite a specimen) was describing the same taxon as Ewart and Kerr; these authors, however, treated the taxon as a new species rather than a new combination and this is followed here.

The protologue cites nine specimens as belonging to this taxon, including one listed as doubtful. These may readily be sorted into two taxa, *I helmsii* and another species still to be positively identified. The latter group includes Ewart's own collections from Taylor on which the habit description is undoubtedly based (no specimen of *I. helmsii* has the habit described by Ewart and Kerr), but in choosing the lectotype I have selected a specimen from the first, and larger, group because the species was named for its spinescent stipules (which are not well developed in the second taxon) and the illustration shows a specimen with spinescent stipules and other attributes of *I. helmsii*. The specimen chosen as lectotype is the one that matches the illustration most closely.

2. **Indigofera basedowii** E. Pritzel, Fedde Repert. Sp. Nov. 15:356 (1918).

Type: 'Hab. in Australia centrali', *H. Basedow 33*, 1903 (B, destroyed).

Description

Shrub, up to 1.5 m high; stems terete, densely grey-pubescent, hairs biramous, the ends usually spreading. *Leaves* pinnate, 5-25 -foliolate, 2-7 cm long; rachis shallowly furrowed, stipellae up to 3 mm long; leaflets elliptical to obovate or cuneate; densely grey-pubescent. *Stipules* narrowly triangular, 3-7 (-9) mm long, persistent but not spinescent. *Inflorescence* an axillary raceme, 6-16 (-18.5) cm long; bracts very narrowly ovate, subulate, 2.5-5 (-7) mm long, grey-tomentose; flowers deep pink to purple. *Calyx* 4-6 mm long, densely covered with dark brown to black hairs; lobes narrowly triangular, longer than the tube, up to 4 mm long. *Standard* obovate to orbicular, 5.5-8.5 x 4.5-8 mm, the outside densely grey-pubescent, the inside glabrous, deep pink to purple with a yellow spot at the base; *wing* oblong to narrow-obovate, 5.5-6.5 x 1-2.5 mm, more or less glabrous; *keel* 5.5-8.5 mm long, grey-pubescent at the tip and along the bottom. *Stamens* 9 + 1, filaments and tube pigmented, anthers apiculate. *Ovary* densely pubescent, stigma capitate. *Pod* cylindrical, 20-40 x 3-3.5 mm, pubescent; endocarp with orange spots. *Seeds* cuboid, 6-9 per fruit.

Key to the subspecies

Leaves usually 7-11 -foliolate, hairs all spreading, stipellae conspicuous .... a. ssp. *basedowii*

Leaves usually 15-21 -foliolate, hairs appressed on the upper surface, stipellae inconspicuous ...... b. ssp. *longibractea*

a. ssp. **basedowii**

Leaves (5-) 7-11 -foliolate, (2.5-) 4-7 cm long; stipellae usually conspicuous, 1-3 mm long; leaflets elliptical to obovate, (8-) 10-20 (-25) x 4-10 (-14) mm, obtuse with a mucronate tip up to 3 mm long, hairs all with spreading tips, less dense above. *Stipules* (3-) 4-7 (-9) mm long. *Pod* very densely pubescent.

Distribution and habitat

The type subspecies occurs in the Northern Territory, mostly in the southern central region, and in the Everard Ranges in South Australia; it is commonly found in rocky gorges near creeks.

Selected specimens (total seen 20)

NORTHERN TERRITORY: King Creek, George Gill Range, *Chippendale NT 3657*, 15.viii.1957 (AD, BRI, NSW, NT); Mount Sonder, *Chippendale NT 4852*, 10.ix.1958 (AD, NSW, NT); Standley Chasm, *Nelson 1632*, 8.ii.1968 (AD, NSW, NT).

SOUTH AUSTRALIA: North Western Region: Mount Illbillee, Everard Range, *Forde 930*, 7.viii.1957 (AD, BRI, NSW).

From the published account of the Government Exploring Expedition (Basedow 1915), and from the known distribution of the subspecies, it seems likely that Basedow collected the type of this taxon between the 21st and the 25th of April, 1903 as the expedition travelled from the vicinity of Mount Chandler to beyond Moorilyanna Well heading towards the Musgrave Range.

b. ssp. **longibractea** (J.M. Black) Peter G. Wilson, comb. et stat. nov.

I. longibractea J.M. Black, Trans. Roy. Soc. S. Aust. 47:369 (1923).

Lectotype (here designated): Musgrave Ranges, *S.A. White 211*, 18.vii.1914 (AD 98233333, upper left hand element).

Leaves (11-) 15-21 (-25) -foliolate, 2-5 cm long; stipellae inconspicuous; leaflets oblong-elliptical to obovate or cuneate, 4-10 x 2-4.5 mm, obtuse or retuse, with a very short mucronate tip, hairs appressed on the upper surface, spreading and denser below. *Stipules* 3-7 mm long. *Pod* pubescent.

Distribution and habitat

This subspecies occurs in the Musgrave and Flinders Ranges, South Australia, and in the Waukeroo Hills, New South Wales; it occupies a variety of rocky habitats ranging from creeksides to scree slopes or ridges.

Selected specimens (total seen 14)

SOUTH AUSTRALIA: North-Western Region: 10 miles W of "Musgrave Park" HS., *George 5180*, 20.vii.1963 (AD, PERTH); Ernabella, *Turvey*, 2.vii.1966 (AD, NSW).
Flinders Ranges: Mount Caernarvon, *Bates 710*, v.1980 (AD); 6.5 km SE of "Arkapena" HS., *Crisp 840*, 1.ix.1974 (AD); Paralana Hot Springs, *Kuchel 919*, 22.viii.1963 (AD, CANB); Frome River, "Mount Serle" station, *Lothian 2147*, 25.viii.1956 (AD, NSW); Parachilna Gorge, *Lovett 29*, 2.viii.1969 (AD).

NEW SOUTH WALES: Waukeroo Hills, just N of Broken Hill, *Cunningham 1376 & Milthorpe*, 29.viii.1973 (NSW).

Black's concept of *I. longibractea* seems to have been somewhat confused. Specimens from Black's herbarium are now at AD and those with localities that match the ones given in the protologue include three different taxa, viz. *I. georgei* (Bloods Creek, *S.A. White* 13.vii.1921, AD 95848044), *I. basedowii* ssp. *basedowii* (Moorilyanna Native Well, *S.A. White* 13.vii.1914, 29.vii.1914, AD 95848009) and *I. basedowii* ssp. *longibractea* as lectotypified above. I do not believe the name could be dismissed as a *nomen confusum* since it has always been placed in the synonymy of *I. basedowii* sens. lat., and I here attach it by lectotypification to the South Australian (excluding the Everard Range populations) and New South Wales form with the higher number of leaflets. The subspecies do intergrade around the South Australian/Northern Territory border (e.g., Kelly Hills, Mackay Exploring Expedition, *Basedow 71*, vi. 1926 (AD) and "Lilla Creek", *A.L. Rose NT 2990*, 14.viii.1956 (AD)).

3. **Indigofera adesmiifolia** A. Gray, Bot. U.S. Expl. Exped. 1:405 (1854) 'adesmiaefolia'.

Holotype: 'Hunters River, New South Wales', U.S. Exploring Expedition, xii.1839 (G).

I. australis var. *signata* F. Muell. ex Benth., Fl. Aust. 2:200 (1864).

Type: between Ovens River and Mayday Hills, Victoria. *Mueller* (Syntype, K, photograph seen).

I. signata (F. Muell. ex Benth.) Domin, Bibl. Bot. 89 (3): 192 (1926).

I. australis var. *platypoda* Benth., Fl. Aust. 2: 200 (1864).

Type: New England, *C. Stuart* (Syntype, K, photograph seen).

I. signata var. *platypoda* (Benth.) Domin, Bibl. Bot. 89 (3): 192 (1926).

Description

Much branched shrub to around 1.5 m tall; stems terete, hairs biramous, appressed, scattered. *Leaves* pinnate, (9-) 11-19 (-23)-foliolate, up to 6.5 cm long, rachis flattened, 0.5-2.5 mm broad, bearing prominent groups of glandular hairs, stipellae very small; leaflets obovate, obtuse or emarginate, 1.5-5 x 1-2 mm. *Stipules* small, triangular, up to 1 mm long. *Inflorescence* an axillary raceme 2.5-5.5 (-7) cm long; flowers pink. *Calyx* 3 mm long; lobes shorter than the tube, unequal, up to 1 mm long. *Standard* obovate, 5.5-8 x 5-7 mm, the outside greenish and bearing dark brown hairs, the inside rose-pink with a darker zone in the centre and a white to green base; *wing* 6-7 mm long, rose-pink; *keel* 6-8 mm long, pink at the distal end, ciliate along the opening. *Stamens* 9 + 1, anthers apiculate. *Ovary* glabrous, stigma capitate. *Pod* cylindrical, 15-35 mm long, shortly beaked, chestnut-brown; endocarp with red-brown spots. *Seeds* cuboid, 6-8 per fruit.

Distribution and habitat

The species occurs in SE Queensland around Stanthorpe, through New South Wales on the slopes and tablelands, and in Victoria in the Beechworth area; it is found in rocky places, mostly on volcanics (basalt, trachyte, granite) with some records from limestone and quartzite.

Selected specimens (total seen 73)

QUEENSLAND: 1.6 km E of Fletcher, *Armstrong 681*, 27.xi.1973 (BRI, NSW).

NEW SOUTH WALES: Dawsons Spring, Mount Kaputar National Park, *Coveny 8703 & Roy*, 17.xi.1976 (NSW); Munghorn Hill, Mudgee-Wollar road, *Johnson & Constable*, 9.viii.1950 (NSW); Wymah Gap, Wymah, *McBarron 5769*, 29.xi.1951 (NSW); Burrinjuck road, 1.5 miles (c. 2.4 km) from Burrinjuck, *Moore 1630*, 2.iv.1952 (NSW); Abercrombie Caves, *Rodd 500*, 23.vii.1967 (NSW); road to Ashford Caves, c. 8 km NE of Ashford, *T. & J. Whaite 3506*, 21.iv.1973 (NSW).

VICTORIA: c. 2 km E of Mount Pilot, c. 9.6 km N of Beechworth, *Beauglehole 43599*, 23.xi.1973 (MEL, NSW).

This taxon is clearly distinct from *I. australis*. Apart from the obvious differences in leaf morphology, *I. adesmiifolia* differs in the more distinctly toothed and less obviously ribbed calyx, the rose-pink and green flower, and the dark brown indumentum on the back of the standard. The two species occupy different habitats but in at least one locality, on the west side of the Weddin Range, the species intergrade.

The type locality is most likely to be in the vicinity of Puen Buen (32° 02′S, 150° 48′E) which is the only part of the range of this species visited by members of the U.S. Exploring Expedition. Wilkes (1845, 2:255) states "some others of our gentlemen paid a visit to Peuen Beuen (sic), the seat of Mr Stevens, near the headwaters of the Hunter river"; this was in mid-December, 1839.

The type specimen has its leaf rachis up to 1 mm wide, which would have put it in the variety *signata* of *I. australis*. The variety *platypoda* of Bentham represents one extreme of a range of variation, viz., those specimens with the rachis width over 1 mm. Although the leaves of these specimens have commonly become phyllode-like by the shedding of their leaflets, the recognition of two subordinate taxa does not seem to be warranted on the evidence at present available, although detailed research could possibly justify it.

I have not lectotypified Bentham's two varietal names since I have not yet examined all specimens listed in the protologues. From the descriptions and from the photographs of syntypes seen so far, there is no doubt that these taxa are conspecific with *I. adesmiifolia*.

4. **Indigofera verruculosa** Peter G. Wilson, sp. nov.

Species verruculis numerosis in omnes partes instructa ab aliis speciebus australiensibus facile distinguenda.

Holotype: Little Nourlangie Rock, Northern Territory, *Dunlop 4943*, 10.iii.1979 (BRI) Fig. 1. (*Isotypes*: DNA, NSW).

Description

Diffuse shrub to 1.5 m high; stems slender, terete, hairs biramous, appressed, rather sparse; the whole plant covered with numerous small warty protuberances. *Leaves* pinnate, (7-) 9-13 -foliolate, 3-8 cm long; rachis furrowed, stipellae very small, up to 0.5 mm long; leaflets opposite and well spaced on the rachis, discolorous, darker and with more hairs on the upper surface, elliptical to narrowly elliptical, lateral leaflets (3.5-) 5-11.5 x 1.5-2.5 mm, terminal leaflet 9-19 x 2-3.5 mm, acute or obtuse, with a short mucronate tip. *Stipules* small, linear, up to 1.5 mm long. *Inflorescence* an axillary raceme up to 14.5 cm long; flowers pale purple, borne on slender pedicels 2-4.5 mm long; bracts narrowly triangular, under 1 mm long, deciduous. *Calyx* 2 mm long, bearing scattered hairs and warts; lobes deltoid, acute, 1mm long. *Corolla* sparingly pubescent on the back of the standard and the tips of the wings and keel,

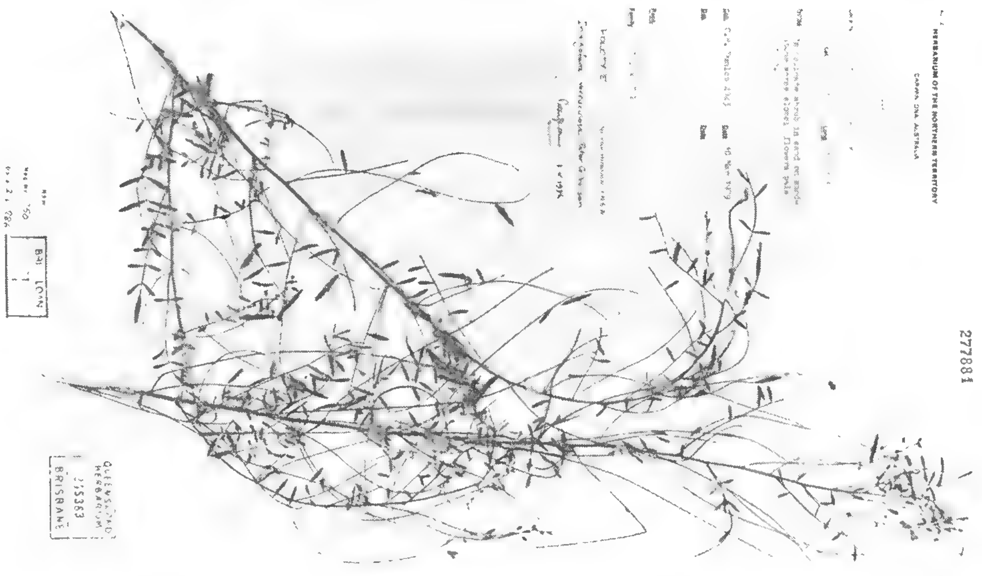


Fig. 1. Holotype of *Indigofera verruculosa* Peter G. Wilson (*Dunlop 4943*, BRI).

Fig. 2. Holotype of *Indigofera bancroftii* Peter G. Wilson (*Clarkson 4235*, BRI).

warts occasionally present; *standard* obovate, 5-5.5 x 3-3.5 mm, with a distinct apiculum 0.5 mm long; *wing* 4.5 x 0.8-1.5 mm; *keel* 5.5-6 x 2.5-3 mm. *Stamens* 9 + 1, anthers, spiculate. *Ovary* glabrous but warty, stigma capitate. *Pod* narrowly cylindrical, 7-20 x 1.5-2.5 mm, dark brown, studded with warts; endocarp with dark brown to black spots. *Seeds* irregularly shaped, 0.8-1.3 mm in diameter, 5-6 per fruit.

Distribution and habitat

Appears to be confined to the Arnhem Land escarpment where it occurs in sandstone heath communities.

Specimens examined

NORTHERN TERRITORY: Little Nourlangie Rock, 12° 52'S, 132° 48'E, *Dunlop 4754*, 19.iii.1978 (DNA); top of Jim Jim Falls, 13° 17'S, 132° 51'E, *Dunlop 5668*, 30.i.1981 (BRI, DNA, NSW); near Three Pools, Ngarradj escarpment, 12° 29'S, 132° 54'E, *Russell-Smith 977*, 15.i.1984 (DNA).

I. verruculosa has no clear affinities with any other Australian species although it may be related to the little-known *I. mckinlayi* F. Muell. The species is very distinctive in having numerous small warty protuberances on almost all parts; it is likely that these are similar in structure to the spots in the endocarp and consist of several swollen cells rich in tannin (Gillett 1958:2).

5. **Indigofera bancroftii** Peter G. Wilson, sp. nov.

I. bancroftii ab *I. pratense* foliolis minoribus infra densissime albo-tomentosis, inflorescentibus brevioribus paucifloribus differt.

Holotype: 17 km from Mutchilba on the road to Irvinebank via Stannary Hills, Queensland, 17° 16'S, 145° 12'E, *Clarkson 4235*, 12.i.1982 (BRI) Fig. 2. *Isotypes*: PERTH, QRS, UNSW).

Description

Erect shrub, to 1.5 m high; stems somewhat angular, brown to chestnut-brown when young, paler when older, covered with more or less appressed biramous hairs. *Leaves* pinnate, (11-) 15-21 (-27) -foliolate, rachis narrow, furrowed, bearing groups of orange-red glandular hairs, stipellae absent; leaflets oblong-elliptical to obovate with slightly recurved margins, obtuse or emarginate, mucronate, (2-) 4-11 x 1-4 mm; green with scattered appressed hairs above, white with dense hairs below. *Stipules* narrowly triangular, 1-3.5 mm long. *Inflorescence* an axillary raceme 2-8 (-10) cm long; flowers blue-mauve to purple. *Calyx* 2.5 mm long, lobes shorter than the tube, unequal. *Standard* 9-12 x 8-9 mm, the outside pale with white hairs, the inside glabrous, purple with pale longitudinal lines; *wing* 8-12 x 3-3.5 mm, purple, with hairs on the tip and upper margin; *keel* 10-13 mm long, pubescent at the distal end. *Stamens* 9 + 1, anthers apiculate; ovary densely pubescent, stigma capitate. *Pod* cylindrical, 25-40 (-50) x 3-4 mm, with an acute apex, pale brown and lightly pubescent; endocarp with orange-brown spots. *Seeds* cuboid, c. 1.5 mm long, 5-8 per fruit.

Distribution and habitat

This species appears to be restricted to drier areas between 17° 10'S and 20° 40'S. It is found on rocky hills in shallow soils in open eucalypt forest or woodland.

Selected specimens (total seen 18)

QUEENSLAND: Cook District: Stannary Hills, *T.L. Bancroft*, 1908 (BRI); W of the road from Ravenshoe to

Koombooloomba Dam, *Clarkson 2670*, 11.x.1979 (BRI, QRS); Tinaroo Forestry Reserve, *Clarkson 5082*, 21.xii.1983 (BRI); 1.5 km W of Herberton on Herberton-Petford road, *Conn 1141 & Clarkson*, 26.v.1983 (BRI); Stannary Hills road, *Dockrill 642*, 9.ii.1973 (BRI, QRS); Baal Gammon mining lease, 17° 23'S, 145° 20'E, *Hyland 10330*, 22.iii.1980 (QRS); headwaters of Archer Creek, 8 km W of Ravenshoe, *Lockyer 189A, B*, 11.iii.1979 (BRI); Herberton-Irvinebank road, c. 1.9 km E of Irvinebank, *Staples 080574/6*, 8.v.1974 (QRS); Herberton-Irvinebank road, c. 1.9 km E of Irvinebank, *Staples 2901*, 6.iv. 1975 (BRI); 2 km E of Watsonville, Herberton-Irvinebank road, *Wilson UNSW 13350*, 16.iv.1982 (NSW, UNSW).
North Kennedy District: Pentland, *Abell 71*, v.1974 (BRI); behind Mt Spec, *White 1324*, xi.1956 (BRI).

I. bancroftii is most closely related to *I. pratensis* sens. lat., which it resembles in having angular stems, and in its flower and fruit morphology, but from which it differs in leaf morphology and indumentum, in flower colour, and in the shorter and fewer-flowered inflorescence. It is named in honour of Dr Thomas L. Bancroft (1860-1933) who had a great interest in the flora of the Stannary Hills area and collected a number of new species there.

Acknowledgements

I am grateful to the directors or curators of AD, BRI, CANB, DNA, G, MEL, PERTH and QRS for loans of or access to collections under their care. Field work to examine two of the species treated here was facilitated by a University of New South Wales Special Project Grant and by a grant from ABRS. Valuable technical assistance was given by Jeannie Highet and Marc Tippett.

References

Basedow, H. (1915). Journal of the Government North-West Expedition. *Proc. Roy. Geog. Soc. Australasia, S.A. Branch* 15: 57-242.

Gillett, J.B. (1958). *Indigofera* (*Microcharis*) in tropical Africa with the related genera *Cyamopsis* and *Rhynchotropis. Kew Bull., Add. Ser.* I: 1-166.

Wilkes, C. (1845). 'Narrative of the United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842'. Five Volumes. (Philadelphia: Lea & Blanchard).

J. Adelaide Bot. Gard. 10(1): 127-129 (1987)

PULTENAEA QUADRICOLOR J. BLACK IS A SYNONYM OF *P. LAXIFLORA* BENTH.

D. A. Cooke

South Australian Department of Agriculture,
GPO Box 1671, Adelaide, South Australia 5001

Abstract

Pultenaea quadricolor J. Black is shown to be a synonym of *P. laxiflora* Benth.

Pultenaea quadricolor J. Black has been regarded as a rare species endemic to the Southern Lofty region of South Australia (Leigh et al., 1981; Weber, 1986). However, it has proved difficult to distinguish from the more widespread and variable *P. laxiflora* Benth. in the field.

Black (1931) in the protologue differentiated *P. quadricolor* from *P. elliptica* Smith, *P. trinervis* J. Black and *P. villifera* Sieber ex DC. var. *glabrescens* J. Black, but appears not to have considered its similarity to *P. laxiflora*. Comparison of the descriptions in Black (1948) yielded 5 characters in which his concepts of these species clearly differed (Table 1).

	P. laxiflora	*P. quadricolor*
Habit	procumbent	erect
Leaves	linear, c. 0.5 mm wide	linear-lanceolate, 1-2 mm wide
Flowers	forming leafy terminal clusters or solitary and axillary	solitary and axillary
Peduncles	spreading or drooping	erect
Bracteoles	subulate, equal to calyx	lanceolate, almost equal to calyx

Table 1. Comparison of *P. quadricolor* with *P. laxiflora* as circumscribed by Black.

Comparison of all specimens at AD previously referred to *P. quadricolor* and South Australian material of *P. laxiflora* revealed continuous variation in each of these characters and no clear correlation between characters.

The range of variation in *P. laxiflora* was recognised by Williamson (1921), who described the erect, relatively hairy plants with very short peduncles at one extreme of the range as var. *pilosa* and procumbent subglabrous specimens close to the type as var. *procumbens.* These varieties intergrade with typical *P. laxiflora* (Corrick, 1977; Weber, 1986). As the holotype of *P. quadricolor* is within this range of variation in all characters observed, this name is here treated as a synonym of *P. laxiflora.*

The supposed difference in inflorescence between *P. laxiflora* and *P. quadricolor* appears to have arisen because their authors examined flowering branchlets at different stages of development. The first flowers are produced from the resting bud in a short raceme with a vegetative apex, each flower being subtended by a caducous brown-scarious bud scale. These scales are the 'short imbricate bracts' mentioned by Bentham (1864). The apex grows out as a leafy shoot which usually bears further flowers in the axils of unmodified foliage leaves (or, at the first 1 or 2 nodes, of leaves reduced to pairs of stipules); this is the condition observed by Black (1931, 1948).

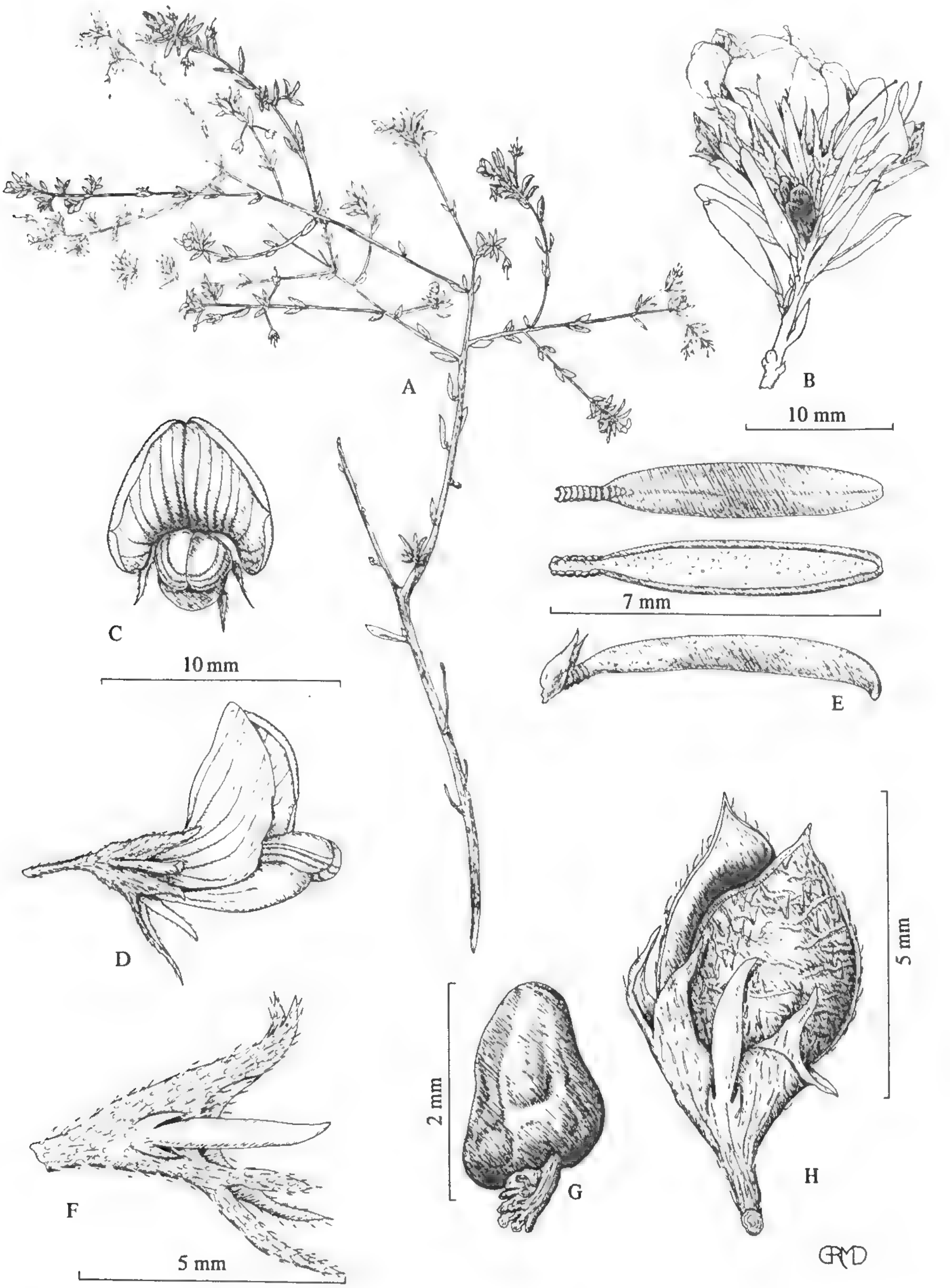


Fig. 1. *Pultenaea laxiflora* Benth. A, habit; B, young inflorescence; C, flower in distal view; D, flower in lateral view; E, leaf in adaxial, abaxial and lateral views; F, flowering calyx with bracteole; G, seed; H, legume with calyx. A, C-H drawn from *R. Davies s.n.* (AD 98421079); B from *Ising s.n.* (AD 96150313).

Pultenaea laxiflora Benth., *Fl. Aust.* 2:133 (1864).

Syntypes: Victoria, near western frontier, *Robertson* (n.v.); Grampians, *F. Mueller* (n.v.); Encounter Bay, *F. Mueller* (n.v.); Onkaparinga River, *F. Mueller* (K, photo!).

Tax. syn.: *Pultenaea quadricolor* J. Black, *Trans. R. Soc. S. Aust.* 55:139 et fig.8 (1931).

Type: Back Valley near Encounter Bay, *J.B. Cleland*, 17.xi.1930 (Holo.: AD 97428180!)

Selected specimens examined (Collections seen: 35)

SOUTH AUSTRALIA: Upper Willow Creek, Waitpinga, *J.B. Cleland s.n.*, 6.i.1940 (AD 966060616); Mylor, *N.N. Donner 433*, 9.xii.1961 (AD 96212111); Upper Sturt Road c. 5 km SW of Mt Lofty, *R. Hill 1230*, 11.xii.1963 (AD 96529160); Glen Shera Swamp, *A.G. Spooner 6847*, 16.xii.1979 (AD 98027177).

Acknowledgements

I thank Mr R. J.-P. Davies for pointing out the problem of *P. quadricolor*, and Mr G.R.M. Dashorst for the illustration.

References

Bentham, G. (1864). "Flora Australiensis". Vol. 2. (Reeve: London).
Black, J.M. (1931). Additions to the Flora of South Australia No. 29. (*Trans. R. Soc. S. Aust.*) 55: 136-142.
Black, J.M. (1948). "Flora of South Australia". edn 2. Part 2. (Govt Printer: Adelaide).
Corrick, M.G. (1977). Bush peas of Victoria — genus *Pultenaea* — 6. *Victorian Nat.* 94: 148-151.
Leigh, J., Briggs, J. & Hartley, W. (1981). "Rare or Threatened Australian Plants". Australian National Parks and Wildlife Service Special Publication No. 7.
Weber, J.Z. (1986). Papilionoideae. In Jessop, J.P. & Toelken, H.R. (eds) "Flora of South Australia". edn 4. Part 2. (Govt Printer: Adelaide).
Williamson, H.B. (1921). A revision of the genus *Pultenaea*, Part II *Proc. R. Soc. Vic.* n.s. 33: 133-148.

J. Adelaide Bot. Gard. 10(1): 131-143 (1987)

NOTES ON *LEPTOSEMA* AND *MIRBELIA* (LEGUMINOSAE - PAPILIONOIDEAE) IN CENTRAL AUSTRALIA

M.D. Crisp and J.M. Taylor

Australian National Botanic Gardens, G.P.O. Box 1777,
Canberra, Australian Capital Territory, 2601

Abstract

A combination in *Leptosema* is made for *Brachysema daviesioides* and *L. aculeatum* is described as new. Taxonomy of the *Mirbelia* species with spinescent branchlets and reduced leaves is reviewed for the 'Flora of Central Australia'. Three species, *M. granitica*, *M. rhagodioides* and *M. stipitata*, are described as new. *M. microphylloides* is reduced to synonymy under *M. microphylla* and a neotype is chosen for *M. depressa*. A key to the group is presented.

Introduction

In the course of preparation of a revised treatment of the Leguminosae subfam. Papilionoideae for the second edition of the 'Flora of Central Australia', it has become evident that a few taxonomic changes are necessary. They are dealt with here so that they can be given a fuller treatment than is possible in the Flora. All types cited have been seen, except where otherwise indicated.

1. **Leptosema** Benth.

Leptosema daviesioides (Turcz.) Crisp, comb. nov.

Kaleniczenkia daviesioides Turcz., Bull. Soc. Imp. Naturalistes Moscou 26:252 (1853).

Brachysema daviesioides (Turcz.) Benth., Fl. Austral. 2:13 (1864).

Type: Swan River Colony, *Drummond coll. IV no. 26* (holotype: KW; isotypes BM, CGE, FI-W, G, K, MEL, P, W; photos CBG).

Crisp (1982) has provided evidence in support of this transfer. It is made here to simplify the discussion under *L. aculeatum* (below).

Leptosema aculeatum Crisp, sp. nov.

L. chambersii F. Muell. et *L. daviesioidi* (Turcz.) Crisp affinis sed *ramulis* valde compressis complanatisve glabrescentibus, *ramulis superis* squamis (foliis redactis) plerumque absentibus, *floribus* subsessilibus vel in pedicellis ad 6 mm longis, differt.

Type: Western Australia, c. 35 km W of Plumridge Lakes and 8.5 km WNW of Salt Creek airstrip, 29° 34'S, 124° 50'E, *M.D. Crisp 5814*, *J.M. Taylor & R. Jackson*, 14.ix.1979 (holotype: CBG; isotypes: AD, BISH, K, MEL, NSW, PERTH).

The epithet is Latin, meaning prickly, and refers to the numerous divergent, spinescent branchlets.

Shrub with woody taproot and a tuft of stems to 0.3 m tall; new stems initiated annually at perimeter of plant; sericeous with laterally attached hairs. *Branchlets* numerous, rigid, divaricate, strongly compressed or flattened, spinescent, glabrescent. Adult *leaves* reduced to appressed, subulate scales 0.5-2 mm long, mostly absent form upper branchlets. *Inflorescences* rosulate, numerous but loosely arranged, spreading along surface of soil, racemose or rarely once-branched, with 2-20 rather distant, secund flowers; rachis to 15 cm long. *Flowers* resupinate, subsessile or on pedicels to 6 mm long, 35-45 mm long; *bracts* ovate, acuminate, c. 3 mm long; *bracteoles* at base of calyx, subulate, c. 3 mm long. *Calyx* 2-lipped, angular, 25-30 mm long; upper lip recurved so that flower gapes, ventricose at base, linear above, conduplicate, divided near apex into two broadly falcate lobes c. 4 mm long; lower lip divided to near base into three linear-triangular lobes as long as upper lip; tube c. 4 mm long. *Corolla* red; *standard* enclosed in calyx, narrow-triangular, long-acute, conduplicate, slightly auriculate, c. 20 x 5 mm including stout c. 3 mm long claw; *wings* linear, ± acute, scarcely auriculate, c. 32 x 2-3 mm including the 2 mm claw; *keel* much exserted, linear, incurved, apiculate, scarcely auriculate, c. 40 mm x 5 mm including the 3 mm claw. *Stamens*: upper three filaments with flared, thickened, sigmoid bases covered with small tubercles; anthers uniform, versatile, narrow-ellipsoid, c. 4 mm long. *Ovary* subsessile, densely sericeous; *style* thickened and hairy at base, glabrous and filiform above, hooked; *stigma* terminal; *ovules* c. 60. Old *pods* sessile, obliquely ellipsoid, beaked, 12 x 15 mm, densely sericeous; seed unknown.

Flowering period: September. *Fruiting period*: unknown.

Distribution

Western Australia; Austin, Coolgardie and Helms districts (for definition of districts, see Beard (1979)). The range of the species is bounded by Sandstone and Mt Jackson in the west and Queen Victoria Spring and Salt Creek in the east. Map 1.

Habitat

L. aculeatum occurs on deep red and yellow sands, in hummock grasslands dominated by *Triodia*, usually with scattered eucalypts (*E. youngiana*, *E. trivalvis* and *E. leptopoda*) and shrubs such as *Grevillea* and *Callitris*.

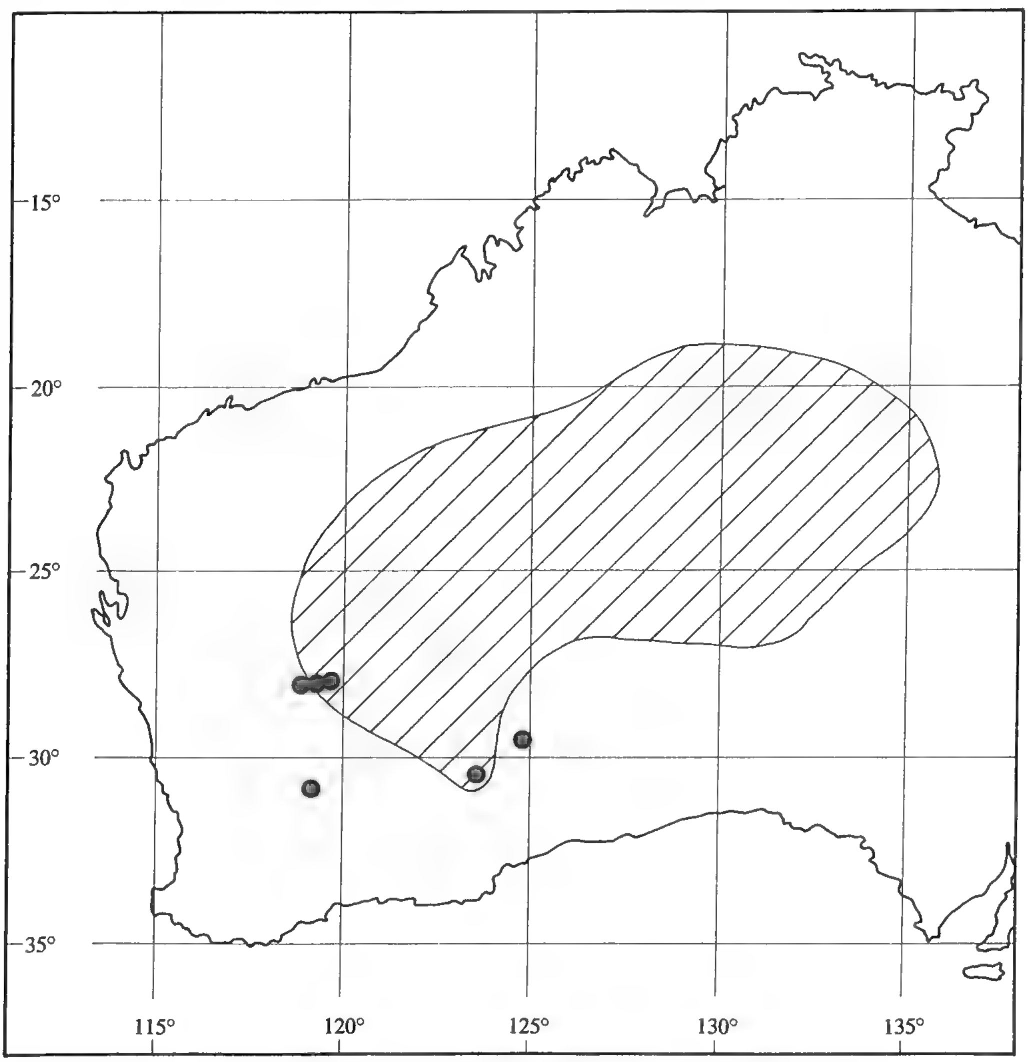
Selected specimens (9 examined)

WESTERN AUSTRALIA: Type locality, *M.D. Crisp 5815*, *J.M. Taylor & R. Jackson*, 14.xi.1979 (CBG, PERTH); Anketall, near Sandstone, *C.A. Gardner 2499*, viii.1939 (BM, K, PERTH), 11 km S of Mt Correll, c. 45 km NNW of Bullfinch, *K.R. Newbey 9597*, 24.ix.1982 (PERTH); Mount Magnet-Sandstone road, 80 miles E of Mount Magnet and 20 miles W of Sandstone, *R.V. Smith 66/455*, 12.ix.1966 (MEL); [Queen] Victoria Spring, *J. Young s.n.*, [ix-x.1875] (MEL 91363).

Affinity

A cladistic analysis of *Leptosema*, made before *L. aculeatum* had come to light (Crisp 1982), showed that *L. chambersii* and *L. daviesioides* belonged to a monophyletic group characterized by spinescent branchlets. In a more recent analysis, to be published elsewhere, *L. aculeatum* was consistently placed in the same group. No other species of *Leptosema* has spinescent branchlets. From *L. chambersii* and *L. daviesioides*, the new species is readily distinguished by the flattening of its branchlets. By contrast, the stems and branchlets of *L. chambersii* are slender and apparently terete, although actually angular in cross-section. Those of *L. daviesioides* are quite terete. Both the latter species differ from *L. aculeatum* in having well-developed pedicels, (2) 5-20 mm long and scale-leaves subtending the ultimate branchlets, although in *L. daviesioides* the scale-leaf base is shortly fused to the subtended branchlet. Somewhat less reliably, *L. chambersii* may be distinguished from *L. aculeatum* by its rarely glabrescent branchlets and usually golden-brown indumentum on the calyx. *L. daviesioides* also differs from *L. aculeatum* in having glabrate branchlets; ± spreading, basally attached hairs (not appressed and peltate); and inflorescences that are shorter (< 8 cm long), more densely packed around the base of the plant and steeply ascending from below ground, not tending to spread along the surface of the soil.

One collection (18 miles E of Sandstone, *A.S. George 8005*, 13.ix.1966 — CBG, K, PERTH) appears to be intermediate between *L. aculeatum* and *L. chambersii*. It is from an area where the ranges of these species overlap (Map 1), and typical specimens of both have been collected from near to *George 8005*. Initially the intermediate specimen seemed to be evidence that these taxa were not specifically distinct. However, the unpublished cladistic analysis referred to above had indicated that *L. chambersii* and *L. daviesioides* are probably more closely related to each other than either is to *L. aculeatum*. Therefore, if *L. aculeatum*



Map 1. Distribution of *Leptosema aculeatum* (dots) in relation to that of *L. chambersii* (cross-hatching).

were to be included within *L. chambersii*, the resultant 'species' apparently would be paraphyletic, as it would exclude an element (*L. daviesioides*) that had descended from the common ancestor of the 'species'.

Specimens of *L. aculeatum* annotated before September 1986 have been determined as '*L. chambersii* subsp. *platyclada*'. These should be corrected. Similarly, specimens determined as '*L. chambersii* subsp. *chambersii*' should be corrected to '*L. chambersii*'.

2. Mirbelia Smith

In Western Australia there occur two groups of *Mirbelia* species with spinescent branchlets and more or less reduced leaves. One, the '*M. spinosa*' group, has leaves that are developed but very small (mostly < 8 mm long) and more or less clustered or whorled. The other, the '*M. viminalis*' group, has all leaves reduced to scales. Both groups extend into central Australia and both require some taxonomic adjustments for the second edition of the Flora.

Key to *Mirbelia* spp. with spinescent branchlets and reduced leaves

1. Leaves small but with petiole and spreading lamina clearly developed 4

   Leaves reduced to broad-based, sessile, appressed scales 2

2. Calyx with appressed short hairs; lobes acute to acuminate, equal to or longer than tube; buds acuminate .... *M. viminalis*

   Calyx glabrous; lobes acute or obtuse, shorter than tube; buds not acuminate 3

3. Stems striate to sulcate; scattered short hairs on young shoots and inflorescence; stipe of pod shorter than calyx-tube; ovules 14-18 .... *M. ramulosa*

   Stems scarcely striate; plant glabrous; stipe of pod longer than calyx-tube; ovules 2 .... *M. stipitata*

4. Calyx 2-4 mm long, free part of upper lobes obtuse or scarcely acute; pod 5-7 mm long, emergent 6

   Calyx (4) 5-6 mm long, free part of upper two lobes acuminate; pod 2-3 mm long, completely enclosed by persistent petals 5

5. Calyx and upper parts of main (non-spinescent) branches sericeous to glabrescent .... *M. spinosa*

   Calyx and upper parts of main branches villous .... *M. trichocalyx*

6. Spinescent branchlets very reduced, neither bearing nor subtended by leaves; plant multi-stemmed from a buried rootstock .... *M. multicaulis*

   Spinescent branchlets either bearing or subtended by leaves; mostly low-branching but single-stemmed shrubs 7

7. Leaves verticillate, flat or slightly complicate; venation inconspicuous; midrib raised on lower surface; ovary and pod appressed-hairy all over .... *M. microphylla*

   Leaves not combining the above characters; ovary and pod glabrous at least along adaxial suture 8

8. Leaves elliptic or ovate or orbicular, flat or slightly complicate; venation conspicuous; ovary and pod sericeous, except glabrous along upper suture .... *M. depressa*

   Leaves narrow-obovate or linear, not complicate and usually with revolute margins; venation obscure; ovary and pod glabrous except for few hairs at base of style 9

9. Indumentum tomentose; calyx 3-4 mm long; pod depressed, broad-ovate (6-8 mm broad), obtuse or truncate, with very conspicuous lateral ribs .... *M. rhagodioides*

   Indumentum sericeous; calyx 2-3 mm long; pod ovoid (2-3 mm broad), acute, turgid, deeply grooved or depressed along upper suture, with inconspicuous lateral ribs .... *M. granitica*

The '*Mirbelia spinosa*' group

The '*M. spinosa*' group was known to be represented in Central Australia but was not included in the first edition of the Flora except as a footnote because suitable material was not available to us at the time. Confusion has prevailed in this group because of the close similarity of its members and the diminutive size of their parts. The existence of several undescribed species has added to the confusion. By using a combination of vegetative and pod characters we have been able to resolve the taxonomic problems, at least within Central Australia. Here we describe two new species. The key provided above includes all described species in the '*M. spinosa*' group, both within and beyond Central Australia. In south-west Western Australia there appear to be one or two taxa still undescribed, and the relationship of *M. trichocalyx* Domin to *M. spinosa* (Benth.) Benth. remains unclear.

Mirbelia depressa E. Pritzel, Bot. Jahrb. Syst. 35: 20 (1904).

Neotype, here designated: Western Australia, 27 miles E. of Kalbarri, *A.S. George 7933*, 8.ix.1966 (PERTH); isoneotype: CBG.

Original type: 'Hab. in distr. Irwin ad pedem collis White Peak in lutosis glareosis subhumidis deflor. m. Sept. (D.6065)' (holotype: ?B, missing presumed destroyed).

As far as is known, the only material seen by Pritzel was *Diels 6065* (cited above). Presumably the holotype was held in Berlin (Stafleu & Cowan 1976: 646), but destroyed during World War II. A recent search of many herbaria that hold Australian types, particularly B, BM, CANB and MEL failed to locate a sheet of *Diels 6065* or any other likely to have been seen by Pritzel.

We have chosen the neotype from among several recent collections from the Geraldton-Kalbarri area, where the original type collection was made. No specimen matched Pritzel's description perfectly, although all agreed with it sufficiently for us to be confident that they belonged to the same taxon. The particular specimen selected agrees with the protologue as well as any other and is good material bearing buds flowers and young fruits.

Mirbelia granitica Crisp et J.M. Taylor, sp. nov.

Frutex 0.3-1 m altus indumento sericeo; *ramulis* dispersis divergentibus spinescentibus, ultimis brevissimis aphyllis; *foliis* dispersis fasciculatisve breviter petiolatis, nunc linearibus obtusis marginibus revolutis nunc angusto-obovatis acutis marginibus recurvis, 2-6 mm longis, 0.5-1 mm latis, venatione obscura; *floribus* solitariis in axillis; *calyce* 2-3 mm longo, lobis tubo brevioribus, duobus supernis in labium emarginatum connatis; *vexillo* latissime ovato; *alis* obovato-oblongis; *carina* triangulari; *ovario* glabro praeter pilos paucos ad basim styli, ovulis 2-6; *legumine* ovoideo acuto, secus suturam adaxialem depresso vel profunde canaliculato, c. 5 mm longo, 2-3 mm lato, reticulato, dissepimentis falsis secus ambo suturas evolutis.

Type: Western Australia, Kumarl to Lake King road, 24 km west of its junction with Peak Charles road, 32°43'S, 121°02'E, *M.G. Corrick 9489*, 21 Sep. 1985 (Holotype: CBG; isotypes: MEL, PERTH, n.v.).

The epithet refers to the habitat of the species, which is usually on or near granitic outcrops.

Erect or spreading shrub, 0.3-1 m tall, with appressed short hairs, glabrescent on stems and upper sides of leaves; *branchlets* mostly scattered, ± rigid, divergent, spinescent; ultimate branchlets very short, leafless. *Leaves* scattered or clustered, shortly petiolate, either linear and obtuse with revolute margins or narrow-obovate and acute with recurved margins,

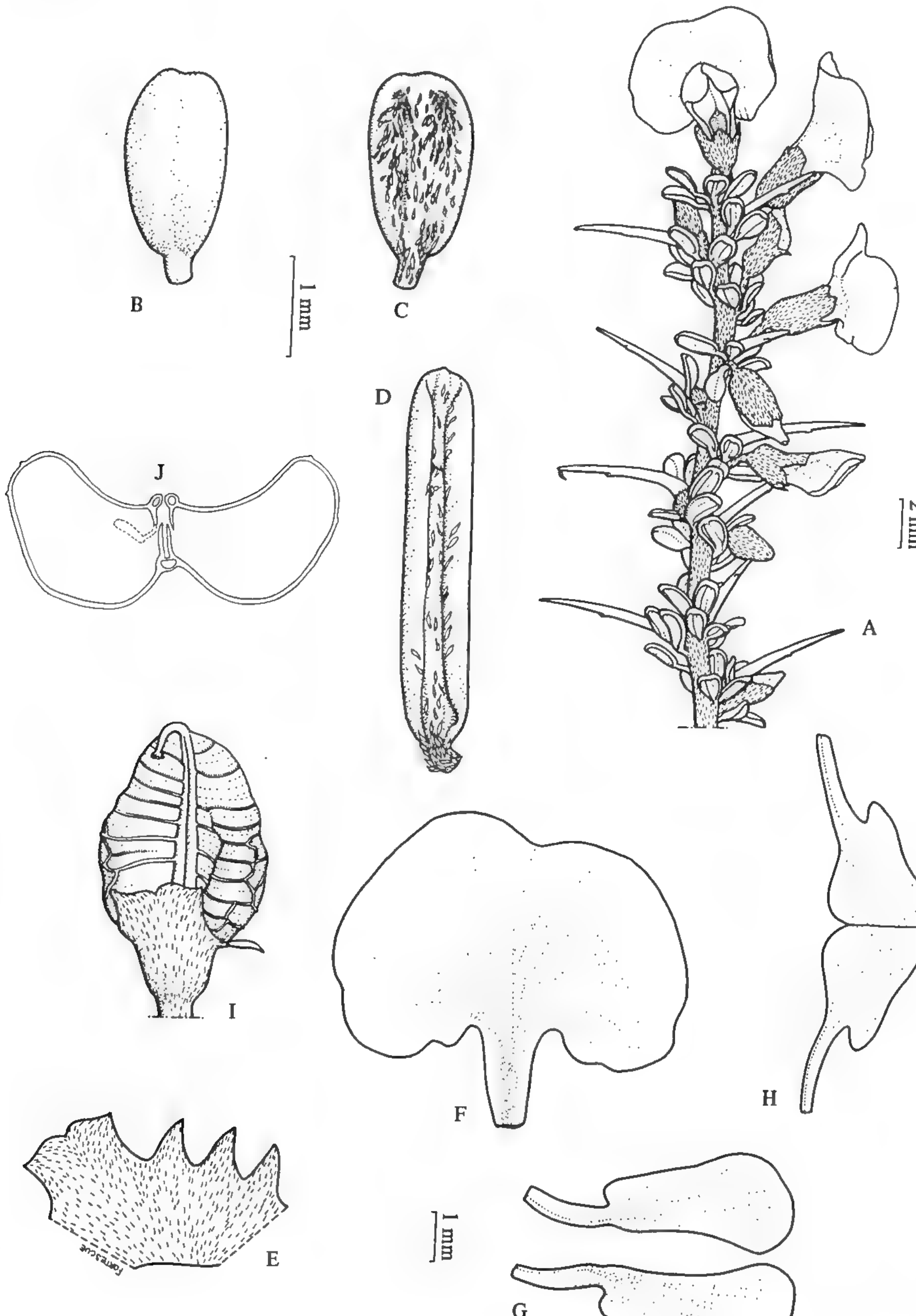


Fig. 1. *Mirbelia granitica*: A, branchlet; B, leaf, adaxial surface; C-D, leaves, abaxial surface; E, calyx, opened out, upper lobes at left; F, standard; G, wings; H, keel; I, pod, adaxial view; J, pod, median transection, adaxial side upwards. A-C, E-H from *Corrick 9489* (BG); D from *Main s.n.* (PERTH); I, J from *Royce 10158* (PERTH).

2-6 x 0.5-1 mm, venation obscure; stipules absent. *Flowers* axillary, apparently solitary. *Pedicels* c. 1 mm long; *bracts* minute, caducous; *bracteoles* minute, attached mid-pedicel. *Calyx* 2-3 mm long; lobes shorter than tube; upper two lobes united into a truncate or slightly rounded, emarginate lip; lower three lobes acute, c. 0.75 mm long. *Corolla*: *standard* very broad-ovate, shallowly emarginate, 5.5-7 x 5-7.5 mm including 1.75-2 mm claw, yellow with dull red markings; *wings* obovate-oblong, scarcely auriculate, 4.5-5.5 x 1.25-3 mm including c. 1.5 mm claw, yellow; *keel* triangular, auriculate, 3-4 x 1.5-2 mm including 1.5-2 mm claw, dull red. *Stamens* with filaments c. 3 mm long, anthers versatile, c. 0.3 mm long. *Gynoecium* 2.5-4 mm long including 0.5-1 mm stipe and 1-1.5 mm incurved style, glabrous except for few hairs at base of style; *stigma* capitate; *ovules* 2-6. *Pod* ovoid, acute, depressed or with a deep groove along adaxial suture, c. 5 x 2-3 mm, reticulate; false dissepiments developed along both sutures, abaxial one more pronounced; seed unknown. Fig. 1.

Flowering period: August to September. *Fruiting period*: November to December.

Distribution

Western Australia; Avon(?), Austin, Coolgardie, Roe and Helms districts. The main area of distribution is between 'Edjudina' (NE of Kalgoorlie), Queen Victoria Spring, Mt Ragged and Peak Charles, with an outlying record from Muntadgin, farther west. Map 2.

Habitat

M. granitica often occurs on or near granitic hills or outcrops. Soils have been variously described as granitic loam, stony loam, loamy sand, aeolian sand and silt. Associated vegetation may be heath with *Leptospermum*, open heath with *Callitris*, or low shrubland with scattered mallee.

Selected specimens (13 examined)

WESTERN AUSTRALIA: Muntadgin, *E.T. Bailey 229*, ix. 1947 (PERTH); 48 km W of Coonana near Cardonia Rocks (Transcontinental Railway), 30°57'S, 122°33'E, *R.J. Chinnock 1120*, 18.ix.1973 (AD, PERTH); Woodline, c. 85 km ENE of Norseman, 312°57'S, 122°22'E, *G.J. Keighery 2956*, 8.viii.1980 (PERTH); Cundeelee-Queen Victoria Spring area, *A.R. Main s.n.*, 25.viii.1960 (PERTH); S of Mt Ragged, Cape Arid National Park, *R.D. Royce 10158*, 5.xii.1971 (PERTH); 45 km E of 'Eujudina' H.S., c. 260 km NE of Kalgoorlie, *P.G. Wilson 7576*, 1.ix.1968 (PERTH).

Affinity

M. granitica bears a superficial resemblance to *M. microphylla* (Turcz.) Benth. and *M. depressa*. *M. microphylla* differs in having flat or slightly complicate leaves, sericeous indumentum of the ovary and pod, and a turgid (never depressed) pod. *M. depressa* differs in having leaves that are elliptic, ovate or almost round, often larger (3-7 x 1-4 mm) and usually flat or slightly complicate, although a few specimens have recurved margins. Also, *M. depressa* has prominent venation, a sericeous ovary except for a glabrous band along the adaxial suture, 8-10 ovules and a depressed-spherical pod which is sericeous abaxially and glabrous in the hollow (adaxially).

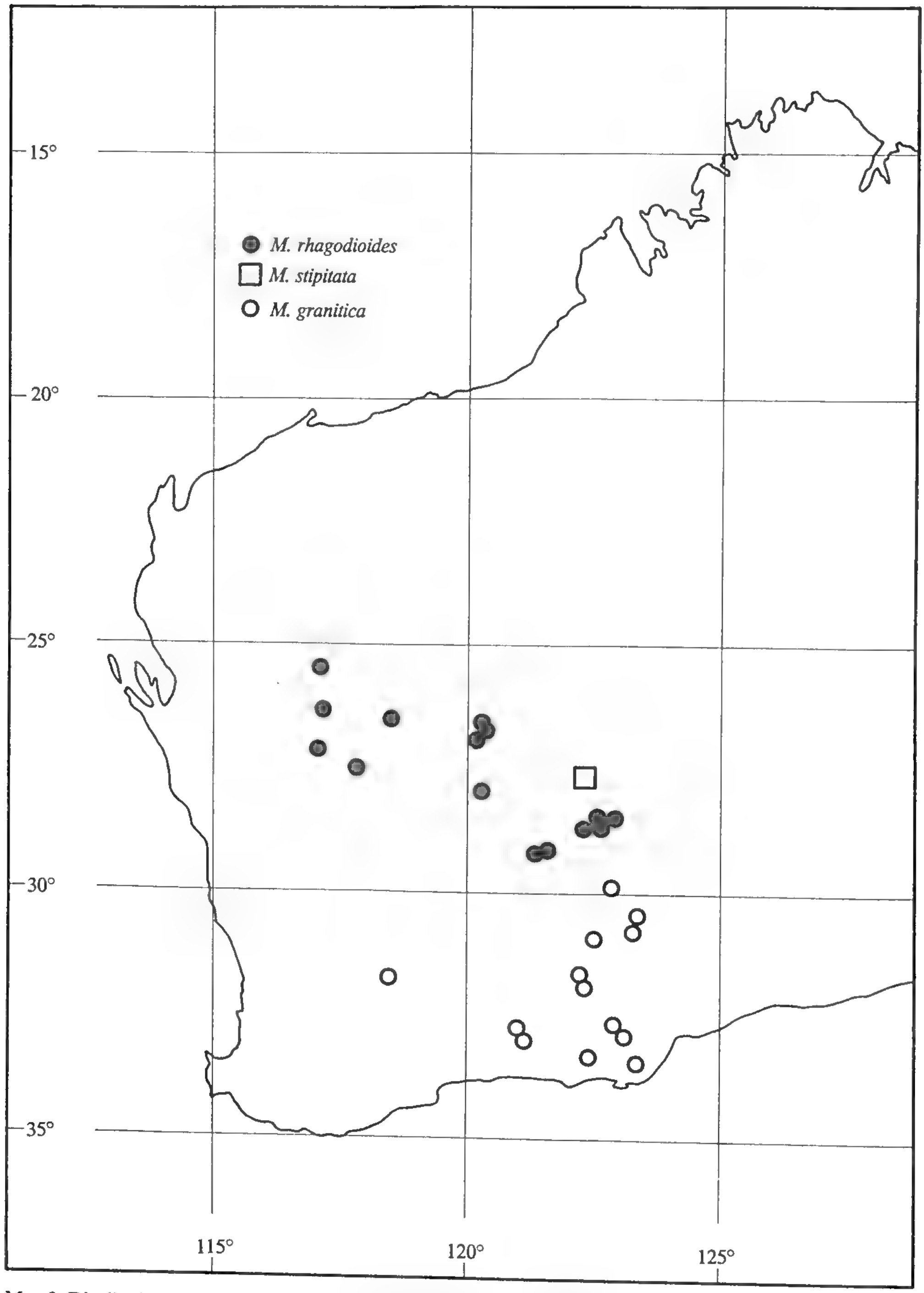
Mirbelia microphylla (Turcz.) Benth., Fl. Austral. 2: 37 (1864).

Dichosema microphyllum Turcz., Bull. Soc. Imp. Naturalistes Moscou 26: 283 (1853).

Type: *J. Drummond Coll. V. no. 34* (holotype: KW; isotypes: BM, K, W; photos CBG).

Mirbelia microphylloides S. Moore, J. Bot., London 35: 164 (1897).

Type: Western Australian goldfields, near Coolgardie, *S. Moore s.n.*, viii.1895 (holotype: BM; isotypes: K, NY; photos CBG).



Map 2. Distribution of *Mirbelia granitica*, *M. rhagodioides* and *M. stipitata*.

M. microphylloides is here reduced to synonymy with *M. microphylla*. Moore attempted to distinguish *M. microphylloides* by characters of leaf shape, degree of fusion of the upper calyx lobes and ovule number. All these show a wider degree of variation than he apparently saw, and his type falls within the range of variation accepted by us for *M. microphylla*.

Mirbelia rhagodioides Crisp et J.M. Taylor, sp. nov.

Frutex 0.5-1 m altus, tomento cinereo vel candido vel stramineo; *ramulis* dispersis divaricatis spinescentibus, interdum brevissimis nodis carentibus; *foliis* plerumque fasciculatis breviter petiolatis linearibus vel angustissimo-ellipticis obtusis marginibus revolutis, 3-9 mm longis, 0.5-0.75 mm latis, venatione obscura; *floribus* solitariis in axillis; *calyce* 3-4 mm longo, lobis tubo brevioribus, duobus supernis in labium truncatum emarginatum connatis; *vexillo* late reniformi retuso; *alis* obovatis; *carina* falcato-obovata; *ovario* glabro praeter pilos paucos ad basim styli, ovulis 4-6; *legumine* depresso latissime ovato truncato, c. 6 mm longo, c. 8 mm lato, costis lateralibus prominentibus, versus margines manifeste reticulato, dissepimentis falsis secus ambo suturas evolutis.

Type: Western Australia, near Laverton, N of Kalgoorlie, *W.E. Blackall 418 & C.A. Gardner*, 10.viii.1931 (holotype: PERTH; isotypes CBG, MEL).

The epithet refers to the strong superficial resemblance that the new species shows to species of the genus *Rhagodia* (Chenopodiaceae).

Dense or open shrub, 0.5-1 m tall; grey-, white- or yellowish-tomentose except the ovary and occasionally the mature leaves, the hairs laterally attached (asymmetrically peltate); *branchlets* scattered, divaricate, rigid, spinescent, occasionally very short and lacking nodes. *Leaves* mostly clustered, shortly petiolate, linear or very narrow-elliptic, obtuse often with a small mucro, margins revolute, 3-9 x 0.5-0.75 mm, venation obscure; stipules absent. *Flowers* solitary in axils. *Pedicels* 1-2 mm long; *bracts* minute or absent; *bracteoles* minute, attached at or below middle of pedicel, caducous. *Calyx* 3-4 mm long; lobes shorter than tube; upper two lobes united into a truncate, emarginate lip; lower three lobes a little shorter, acute, c. 1 mm long. *Corolla*: *standard* broad-reniform, retuse, 5.5-7 x 5-7.5 mm including c. 2.5 mm claw, yellow with dark red towards centre; *wings* obovate, slightly auriculate, 5-6 x 1.5-1.75 mm including c. 2.5 mm claw, mostly yellow; *keel* falcate-obovate, auriculate, 4.5-5.5 x 1.5-2 mm including c. 2.5 mm claw, dark red. *Stamens* with filaments 4-5 mm long, anthers versatile, nearly 0.5 mm long. *Gynoecium* 4.5-5 mm long including c. 1.5 mm stipe and 1.5-2 mm incurved style, glabrous except for a few hairs at base of style; *ovules* 4-6; *stigma* terminal, minute. *Pod* depressed, very broad-ovate, truncate, c. 6 x 8 mm, with prominent lateral ribs, prominently reticulate towards margins, margins upturned; false dissepiments developed along both sutures, abaxial one more pronounced ; mature seed unknown. Fig. 2.

Flowering period: June to August. *Fruiting period*: September to October.

Distribution

Western Australia; Ashburton, Austin, ?Coolgardie and Helms districts. *M. rhagodioides* occurs within an area bounded by 'Errabiddy' (which is S of the Gascoyne River and c. 175 km NW of Meekatharra), Wiluna, White Cliffs, Leonora and Cue. Map 2.

Habitat

Recorded in yellowish sand, red loam and skeletal soil on plains and dunes, on rocky hills, near granite and quartz outcrops, lateritic mesas and breakaways, and in rocky places near creeks. Associated vegetation is commonly *Acacia* shrubland.

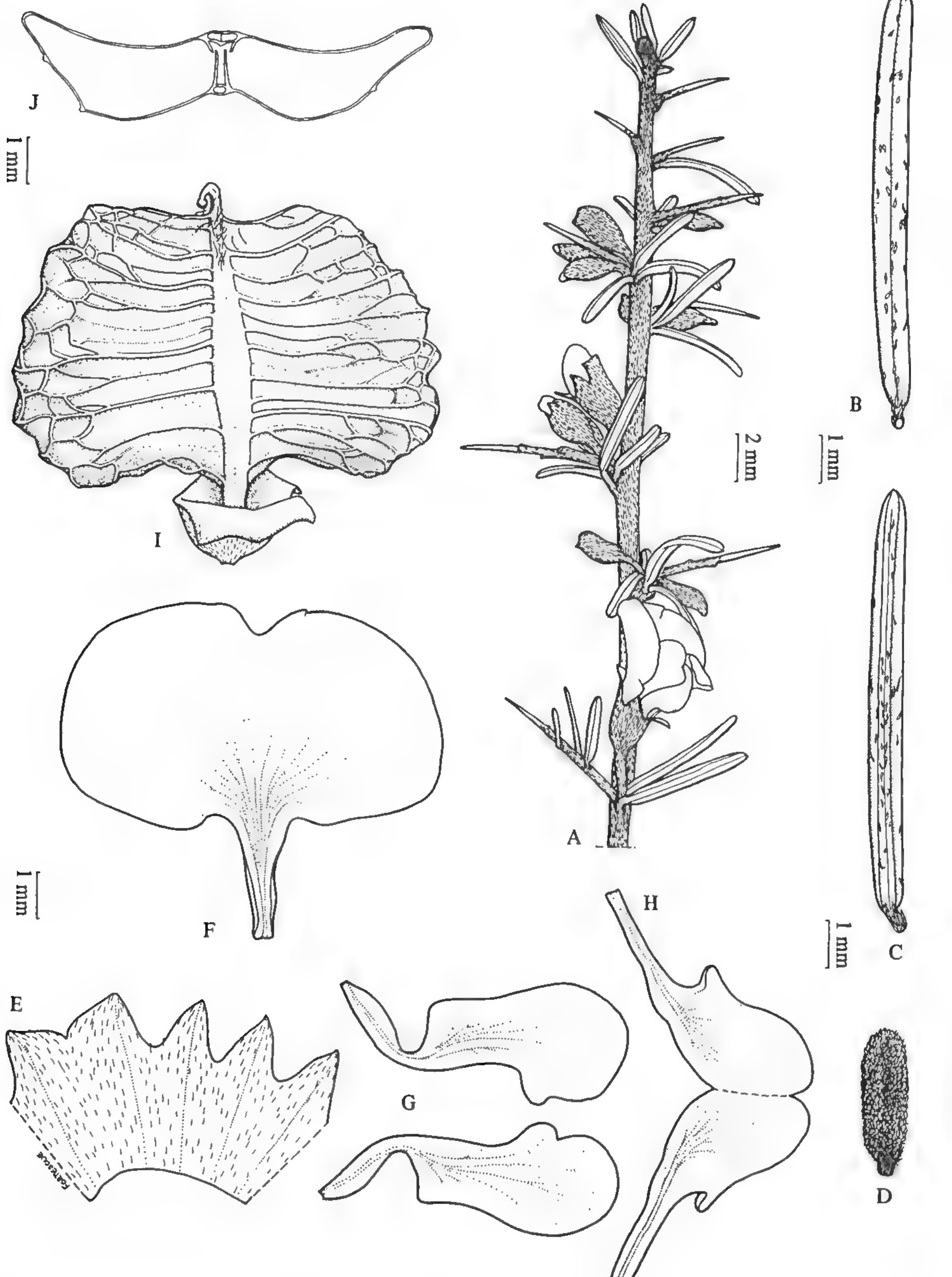


Fig. 2. *Mirbelia rhagodioides*. A, branchlet; B, leaf, adaxial view; C, leaf, abaxial view; D, leaf, adaxial view; E, calyx, opened out, upper lobes at left; F, standard; G, wings; H, keel; I, pod, adaxial view; J, pod, median transection, adaxial surface upwards. A-C, E-H from *George 5568* (PERTH); D, I & J from *Weber 5090* (PERTH).

Selected specimens (16 examined)

WESTERN AUSTRALIA: c. 15 miles E of Laverton, *A.S. George 4500*, 29.vi.1963 (PERTH); 16 miles E of Wiluna, *A.S. George 5623*, 28.vii.1963 (PERTH): 69 miles E of Sandstone, *A.S. George 8012*, 13,ix.1966 (PERTH); Errabiddy Station, *A.A. Mitchell 984*, 6.viii.1982 (PERTH); 11 miles N of 'Mileura' H.S., *N.H. Speck 969*, 15.iv.1959 (CANB, PERTH); 14-18 km E of Wiluna (SW corner of Gibson Desert), *A. Strid 20260*, 6.ix.1982 (PERTH); Cue, *E. Wittwer 1269*, 1.viii.1974 (PERTH).

Affinity

Specimens of *M. rhagodioides* usually have been identified as *M. microphylla*, which they superficially resemble, but there are significant morphological differences between these taxa. In *M. microphylla* the main branchlets are not spinescent as they are in *M. rhagodioides*, the leaves are narrow-obovate and flat or slightly folded up, the ovary is minutely hairy all over and the pod is ovoid and turgid, with a deep adaxial groove. In fact, *M. rhagodioides* is readily distinguished from all other species in the '*M. spinosa*' group by the remarkable morphology of its pods, which are larger (especially broader), strongly depressed and prominently ribbed.

The 'Mirbelia viminalis' group

Hitherto, this group has included two described species: *M. viminalis* (Cunn. ex Benth.) C. Gardner and *M. ramulosa* (Benth.) C. Gardner. Only the former had been recorded from Central Australia until the recent discovery of both *M. ramulosa* and a new species within the region. The new species, *M. stipitata*, is described below. The new record for *M. ramulosa* will be treated in the Flora and is not dealt with further here.

Mirbelia stipitata Crisp et J.M. Taylor, sp. nov.

Frutex c. 0.6 m altus, glabratus; *ramulis* dispersis vel sub-oppositis divaricatis leviter striatis spinescentibus; *foliis* in squamas redactis; *floribus* plerumque versus extrema ramulorum solitariis, alabastris obtusis; *calyce* ad basim obtuso, c. 4 mm longo, lobis tubo brevioribus, duobus supernis in labium connatis apicibus liberis acutis obtusisve; *vexillo* late reniformi emarginato; *alis* obovatis; *carina* oblique late elliptica; *ovario* glabro, ovulis 2; *stylo* leviter compresso; *legumine* immaturo conspicue stipitato ellipsoideo, canale abaxiali profundo, dissepimentis falsis secus ambo suturas praesertim adaxialem evolutis.

Type: Western Australia, c. 100 km N of Laverton, 30 km NE of 'Bandya' H.S., *P.G. Wilson 7349*, 27. viii.1968 (Holotype: PERTH; isotypes CBG, MEL, K).

The epithet refers to the long stipe subtending the ovary and developing pod.

Shrub c. 0.6 m tall, glabrous except for scattered short hairs on bracts and bracteoles, and pubescence inside calyx lobes; *branchlets* alternate or sub-opposite, divaricate, slightly striate, spinescent. *Leaves* reduced to scales $<$ 1 mm long; stipules absent. *Flowers* mostly solitary towards ends of branchlets; buds obtuse. *Pedicels* 2-2.75 mm long; *bracts* ovate, c. 0.75 mm long; *bracteoles* similar, attached near the middle of the pedicel, caducous. *Calyx* obtuse at the base, 4-5 mm long; lobes shorter than tube; upper two lobes united into a lip, acute or obtuse at tips, free parts 0.5 mm long; lower three lobes triangular, acute, 1.25 mm long. *Corolla*: *standard* broad-reniform, emarginate, c. 6 x 8 mm including 2 mm claw; *wings* obovate, auriculate, c. 5.75 x 2.75 mm including 1.5 mm claw; *keel* obliquely broad-elliptic, auriculate, c. 5.25 x 2 mm including 2 mm claw. *Gynoecium* c. 5 mm long including 1.75 mm stipe and 1.75 mm slightly compressed incurved style, glabrous; *ovules* 2; *stigma* capitate. Immature *pod* conspicuously stipitate (the stipe not enclosed by the persistent calyx), ellipsoid with a deep abaxial groove, c. 6 mm long including the c. 3 mm stipe; false dissepiments developed along both sutures, abaxial one much more pronounced; seed unknown. Fig. 3.

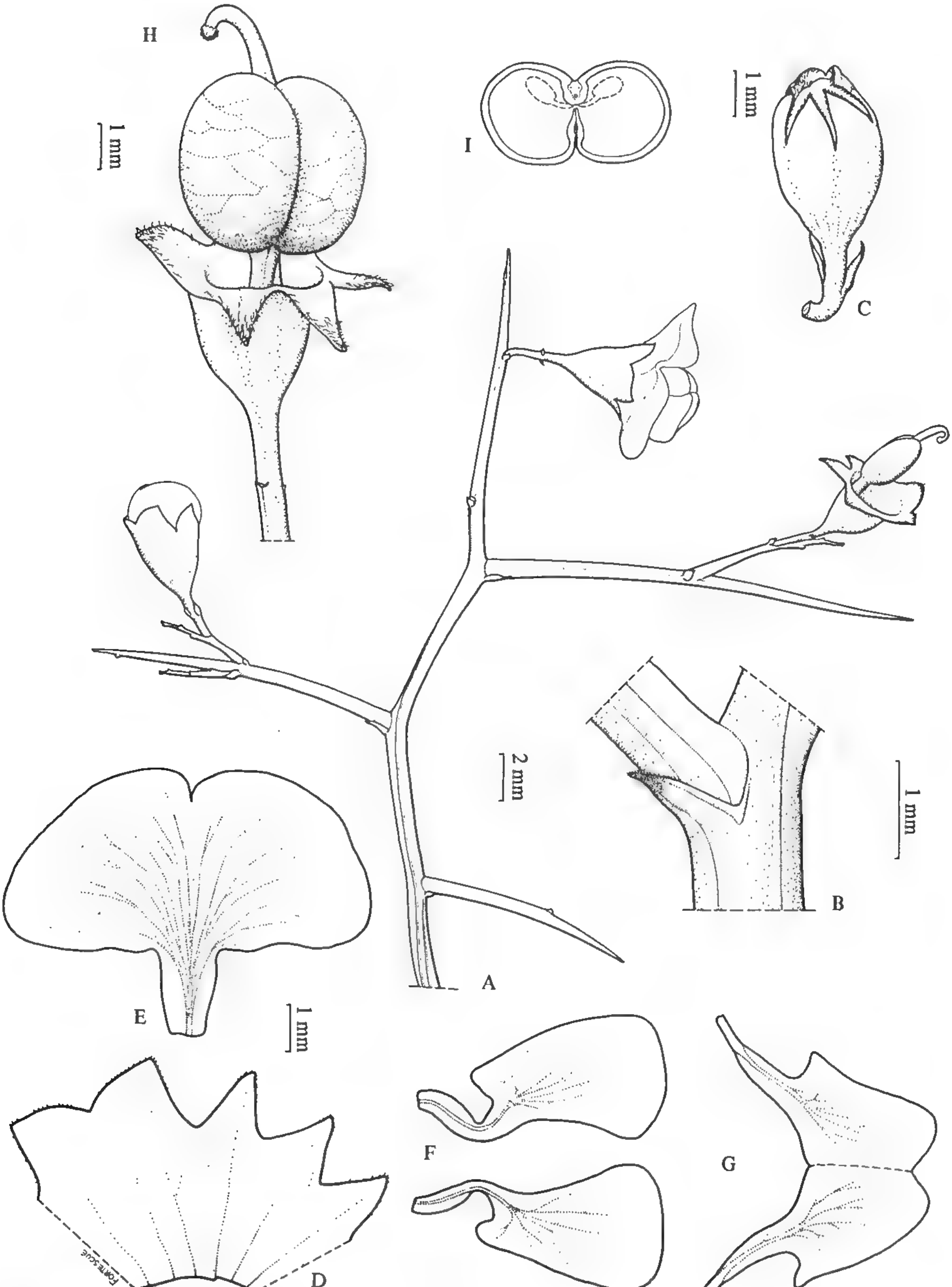


Fig. 3. *Mirbelia stipitata.* A, branchlet; B, detail of branchlets and scale leaf; C, flower bud; D, calyx, opened out, upper lobes at left; E, standard; F, wings; G, keel; H, immature pod with persistent calyx, abaxial view; I, pod, median transection, adaxial surface upwards. Drawn from *Wilson 7349.*

Flowering period: August.

Distribution

Western Australia; Austin/Helms district boundary. Known only from the type locality which is c. 110 km N of Laverton. Map 2.

Conservation status

Rare, coded 1K (criteria from Leigh et al. 1984). Although this species is known from only a single collection, it occurs in a region that is so poorly explored, and is itself such a nondescript plant, that at present there is no basis for suspecting that it is threatened.

Affinity

M. stipitata resembles both *M. ramulosa* and *M. viminalis* insofar as all three species have spinescent branchlets with leaves reduced to scales. It is readily distinguished from both by several characters. *M. viminalis* differs in having conspicuously striate or ribbed branchlets, acuminate flower buds, appressed hairs outside the calyx, calyx lobes usually longer than the tube, 4 ovules and an adaxial groove on the pod. *M. ramulosa* differs in having conspicuously striate or ribbed branchlets which are mostly 3-forked, 14-18 ovules and a pod which is scarcely stipitate (the persistent calyx embraces its base) and only shallowly grooved on the abaxial side.

Acknowledgements

We are grateful to Don Fortescue for preparing fine illustrations. Our thanks go to Mark Clements and Alex George for reading and commenting upon the manuscript. We appreciate the large loan made available by the PERTH herbarium. Production of the manuscript was made possible by a grant from the Nell and Hermon Slade Trust.

References

Beard, J.S. (1979). Phytogeographic regions. In J. Gentilli (Ed.), 'Western Landscapes', pp. 107-121. (Univ. W.A. Press: Nedlands).

Crisp, M.D. (1982). Evolution and biogeography of *Leptosema* (Leguminosae: Papilionoideae). In W.R. Barker & P.J.M. Greenslade (Eds), 'Evolution of the Flora and Fauna of Arid Australia', pp. 317-322. (Peacock Publications: Adelaide).

Leigh, J.H., Boden, R.W. & Briggs, J.H. (1984). 'Extinct and Endangered Plants of Australia' (Macmillan: Melbourne).

Stafleu, F.A. & Cowan, R.S. (1976). 'Taxonomic Literature', edn 2, vol. 1: A-G (Bohn, Scheltema & Holkema: Utrecht).

J. Adelaide Bot. Gard. 10(1): 145-153 (1987)

ANALYTICAL NOTES ON THE FLORA OF SOUTH AUSTRALIA

H.R. Toelken

State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

The taxa in the recently published 'Flora of South Australia' are analysed quantitatively in different ways and compared with those found in Victoria, Australia, as well as the world. A high percentage of naturalised taxa and low number of endemics are characteristic of the S. Australian flora which shares many taxa with surrounding territories. The largest families and genera are tabulated. An attempt is also made to assess the advances in knowledge made during the past 60 years in order to establish the present level of understanding of the S. Australian flora.

Black (1922-29) recognised about 2400 species in the first edition of the 'Flora of South Australia'. He included 2982 species in the second edition (1943-57). These additional 582 species, 19.5% of the flora, represent an average addition of nineteen species per year during approximately 30 years. Eichler (1965) added more species in his 'Supplement', but this publication is better known for its corrections and changes to previously accepted names. Further additions were made in part I of a third edition by Jessop (1978), but this edition was never completed.

Nearly thirty years after the second edition a complete fourth edition has been published. There are now 3639 species described, adding 657 species, 18.1% of the flora, or an average increase of 22 species per year. The rate of increase of knowledge of the flora has been, if measured by the number of species added, more or less constant during the past 60 years. Churchill & de Corona (1972) reported an average annual increase of 15 species in the Victorian flora for the period of 1931-72 and Ross (1976) found that it continued at the same rate.

A comparison of the South Australian flora with that of Victoria is instructive since Ross (1976) published a detailed evaluation of the latter although now slightly outdated. Any comparisons can only be taken as indicative because different approaches were used in the delimitation of families and genera and the number of species would have presumably increased at an average annual rate of 15 species since the beginning of 1976. Adjustments made for surface area, South Australia (380,070 miles^2) is more than four times the size of Victoria (87,884 miles^2), would not give a totally reliable comparison as only small southern areas of South Australia are climatically comparable with Victoria. Large parts of South Australia belong to a relatively poor flora of semi-arid central Australia (Maslin & Hopper 1982), and because of the absence of natural boundaries South Australia shares taxa with all adjoining territories. The more humid climate of Victoria supports approximately double the number of Pteridophyta than S. Australia (Table 1) at genus and species level. The incompletely published 'Flora of south-eastern Queensland' by Stanley & Ross (1983) with its estimated 3600 species for a surface area of about 71,255 miles^2, may become a very closely comparable floristic region with that of Victoria.

The 'Flora of South Australia' (1986) describes 159 families, 1016 genera and 3639 species compared with Willis (1970-72), the basis of Ross (1976), who recognised 178 families, 918 genera and 3322 species for Victoria (see Table 1). Forbes et al. (1984) updated information on the Victorian flora and although there are references to taxa accepted by Willis, they do not distinguish between name changes and the less common addition of new species.

Most comparisons are made here on the basis of percentage. In the South Australian flora there are 2671 indigenous species, or 73.4% compared with 77.6% in Victoria. The

		Families				Genera				Species					
		Total		Naturalised		Total		Naturalised		Total		Indigenous		Naturalised	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%
Pteridophyta	SA	18	11.4	0	0	31	3.1	0	0	59	1.7	55	1.5	4	0.1
	VIC	24	13.5	0	0	47	5.2	0	0	112	3.4	111	3.4	1	0.1
Gymnospermae	SA	2	1.3	1	0.7	2	0.2	1	0.1	10	0.3	5	0.1	5	0.2
	VIC	3	1.7	1	0.6	3	0.4	1	0.1	9	0.3	6	0.2	3	0.1
Dicotyledoneae	SA	109	68.6	25	15.8	723	71.3	291	28.7	2703	74.3	1978	54.4	725	20.0
	VIC	115	64.6	14	7.9	626	68.2	201	21.9	2318	69.8	1256	52.9	562	17.0
Monocotyledoneae	SA	30	18.9	5	3.2	260	25.7	85	8.3	867	23.9	633	17.4	234	6.5
	VIC	36	20.3	5	2.8	242	26.4	66	7.2	883	26.6	702	21.1	181	5.5
Total	SA	159		31	19.7	1016		376	37.0	3639		2671	73.4	968	26.8
	VIC	178		20	11.3	918		268	29.2	3322		2575	77.6	747	22.5

Table 1. Proportional representation of the total number of families, genera and species and their naturalised component in the South Australian compared with the Victorian flora (Ross 1976). (Percentages are calculated of the total of each taxon in its respective flora.)

Dicotyledoneae are at all levels between 3 and 8% (Table 1) better represented in South Australia than in Victoria while the Monocotyledoneae are marginally better represented in Victoria. The percentage naturalised species in the Dicotyledoneae of both States is about three times larger than in the Monocotyledoneae, and in both groups the percentage is larger in South Australia than in Victoria.

Table 2 provides a comparison of the South Australian and Victorian floras, especially their indigenous components, with the flora of the whole of Australia including Tasmania. The genera are predictably represented by a higher percentage being a higher taxonomic grouping and thus more likely to have a wider distribution. The percentage representation of the total of the genera in the Monocotyledoneae and Dicotyledoneae is almost twice that of the species for both States. The percentage representation of all categories of Dicotyledoneae and the genera of Monocotyledoneae are higher for South Australia (cf. Table 1). The percentage of the total species of Monocotyledoneae is about equal for both States and that of the indigenous species is higher for Victoria. It must also be noted that once the Monocotyledoneae of both States are expressed in terms of the flora of Australia they have a marginally higher representation throughout whereas their relative representation is about one-third that of the Dicotyledoneae (cf. Table 1). Similarly the percentage of the total genera and species of the Pteridophyta are raised into the range of those for the Angiospermae, while figures for the Gymnospermae remain very low for both States.

Tables 3 and 4 present some of the largest angiosperm families in South Australia shown in relation to figures for Victoria, Australia and the whole world. The floras of Victoria, Australia and the world would each have a somewhat different descending order of families and additional families would need to be inserted where they are not well represented in South Australia. In Table 3 the families are arranged in order of decreasing number of genera, while in Table 4 they are arranged in order of similar numbers of species. Beadle (1981) published a list of all Australian families with their number of genera, species and their distribution together with similar data for the world. In Figs 2.9, 2.10 he illustrated diagramatically the proportions of the Australian flora in the world's largest families in regard to their genera and species. The characteristics of the flora of South Australia approach the structure of his 'the flora of the arid zone'. The figures for the number of genera and species in the world's larger families vary greatly according to the source as shown in the last two columns of Tables 3 and 4 and should consequently be treated as estimates.

The largely indigenous families often have very large genera so that they rank much higher in Table 4. These include the Myrtaceae, Goodeniaceae and Myoporaceae, while the Epacridaceae is relatively small in South Australia in contrast to Australia as a whole. The large families account for 71.2% of the genera and 77.6% of the species in South Australia and similar high percentages were reported for Victoria (Ross 1976).

In contrast, the largest genera each with 25 or more species, account for only a small part (17.6%) of the South Australian species (cf. Table 5). All of them have a low number of naturalised species except for *Senecio* and *Solanum.* The total of the naturalised species amount to 3.5% as compared with 26.8% (Table 2) of the flora of South Australia. Their percentage endemism is slightly higher (10.2%) than the 6.4% for the whole State. All genera have at least one species endemic to South Australia.

Discussion

Ross (1976) makes special mention of the high incidence of naturalised taxa in Victoria and they are here similarly delimited in that families and genera are restricted to those with all their species being of foreign origin. These species are usually introduced from outside Australia but in about fifteen cases in the South Australian flora, e.g. four in *Acacia*, they are interstate introductions. In South Australia there is a particularly large percentage of naturalised

	Genera									Species								
	South Australia				Victoria				Australia	South Australia				Victoria				Australia
	Total		Indigenous		Total		Indigenous			Total		Indigenous		Total		Indigenous		
	No	%	No	%	No	%	No	%	No	No	%	No	%	No	%	No	%	No
Pteridophyta	31	26.1	31	26.1	47	39.5	47	39.5	119[1]	59	14.6	55	13.6	112	27.7	111	27.4	405[1]
Gymnospermae	2	11.8	1	5.9	3	17.7	2	11.8	17	10	14.3	5	7.2	9	12.9	6	8.6	70
Dicotyledoneae	723	41.7	442	25.5	626	36.1	425	24.5	1735	2703	22.4	1978	16.4	2318	19.2	1756	14.5	12085
Monocotyledoneae	260	42.4	180	29.3	242	39.5	176	28.7	614	867	24.2	633	17.7	883	24.7	702	19.6	3585
Total	1016	41.1	654	26.4	918	37.1	650	26.3	2475	3639	22.6	2671	16.6	3322	20.6	2475	15.3	16140

Table 2. Proportional representation of the total number of genera and species and their indigenous component in the South Australian compared with the Victorian flora (Ross 1976). (Percentages are calculated of the total of each category in the Australian flora (Morley & Toelken 1983; R.J. Chinnock[1] oral comm.).

	South Australia				Victoria		Australia	World[1]	World[2]
	Number of Genera	% of Total[4]	%[3] Indigenous	%[3] Naturalised	Number of Genera	% of Total[4]	Number of Genera	Number of Genera	Number of Genera
Compositae	137	13.5	52.6	47.5	105	11.4	201	900	1100
Gramineae	119	12.7	59.7	40.3	106	11.6	217	620	670
Papilionoideae	61	6.0	73.8	26.2	42	4.6	136	400	500
Cruciferae	43	4.2	37.2	62.8	39	4.3	53	375	375
Chenopodiaceae	27	2.7	88.9	11.1	18	1.9	31	102	100
Liliaceae	27	2.7	55.5	44.5	23	2.5	53	250	219
Umbelliferae	26	2.6	50	50	24	2.6	36	275	300
Orchidaceae	22	2.2	100	—	25	2.7	90	735	600
Iridaceae	22	2.2	9.1	90.9	17	1.9	29	60	70
Labiatae	20	2.0	45	55	19	2.1	38	180	200
Caryophyllaceae	20	2.0	25	75	20	2.2	25	70	80
Cyperaceae	19	1.9	100	—	21	2.3	47	90	90
Scrophulariaceae	19	1.9	52.6	47.4	19	2.1	44	220	250
Malvaceae	18	1.8	61.1	38.9	10	1.1	24	75	85
Aizoaceae	17	1.7	52.9	47.1	10	1.1	19	130	140
Euphorbiaceae	15	1.5	86.7	13.3	13	1.4	53	300	300
Boraginaceae	14	1.4	57.2	42.8	12	1.3	23	100	100
Solanaceae	14	1.4	16.3	83.3	9	1.0	24	90	84
Rosaceae	12	1.2	81.8	18.2	12	1.3	24	100	122
Myrtaceae	11	1.1	80	20	13	1.4	70	100	147
Rubiaceae	10	1.0	100	—	8	0.8	42	500	500
Rutaceae	9	0.9	100	—	10	1.1	41	150	150
Convolvulaceae	9	0.9	100	—	6	0.7	18	55	55
Epacridaceae	9	0.9	100	—	15	1.6	28	30	31
Goodeniaceae	8	0.8	100	—	6	0.7	16	14	17
Proteaceae	8	0.8	100	—	10	1.1	45	62	75
Amaranthaceae	7	0.7	71.4	28.6	3	0.5	14	65	65
Asclepiadaceae	7	0.7	57.1	42.9	5	0.6	19	130	130
Restionaceae	7	0.7	100	—	6	0.7	20	28	28
	723	71.2[4]	43.5[4]	27.7[4]	622	67.8[4]	1480	6206	6583

Table 3. The 29 largest families (including subfam. Papilionoideae) represented by 7 or more genera listed in order of decreasing number of genera and compared with similar figures for Victoria (Ross 1976) and Australia (Morley & Toelken 1983) as well as the world (Airy Shaw 1973[1]; Morley & Toelken 1983[2]). (Percentages are calculated of the number of genera in the family[3], or the total of each category in the respective flora[4]).

	South Australia					Victoria		Australia	World[1]	World[2]
	Number of species	%[4]	%[3] Endemic	%[3] Indigenous	%[3] Naturalised	Number of species	% of Total[4]	Number of species	Number of species	Number of species
Compositae	433	11.9	5.1	70.7	29.3	361	10.9	970	13000	25000
Gramineae	374	10.3	3.2	63.4	36.6	323	9.7	1225	10000	9000
Papilionoideae	206	5.7	6.8	67.0	33.0	202	6.1	1100	9000	12000
Chenopodiaceae	198	5.5	5.1	95.5	4.5	101	30	300	1400	1500
Orchidaceae	128	3.5	7.0	100	—	175	5.3	100	17000	30000
Myrtaceae	126	3.5	15.9	97.6	2.4	138	4.2	1280	3000	3000
Cyperaceae	122	3.4	3.3	91.0	9.0	168	5.1	650	4000	4000
Mimosoideae	110	3.0	15.5	95.5	4.5	94	2.9	700	2000	3000
Cruciferae	107	2.9	2.8	53.3	46.7	80	2.4	153	3200	3200
Liliaceae	76	2.1	7.9	65.8	34.2	49	1.5	188	3700	3500
Goodeniaceae	71	2.0	12.7	100	—	42	1.2	380	300	410
Solanaceae	69	1.9	7.3	60.9	39.1	48	1.4	186	2000	2000
Umbelliferae	56	1.5	1.8	69.7	30.4	57	1.7	167	2850	3000
Scrophulariaceae	53	1.5	9.4	60.4	39.6	51	1.5	165	3000	3-5000
Labiatae	52	1.4	15.4	57.7	42.3	51	1.5	250	3500	3000
Amaranthaceae	51	1.4	3.9	74.5	25.5	21	0.7	131	850	900
Euphorbiaceae	51	1.4	7.9	72.6	27.5	33	1.0	215	5000	5000
Myoporaceae	50	1.4	10.0	100	—	18	0.5	198	90	215
Malvaceae	49	1.4	2.0	73.5	26.5	27	0.8	160	1000	2000
Proteaceae	48	1.3	22.9	93.7	6.3	66	2.0	900	1050	1500
Caryophyllaceae	46	1.3	—	26.1	73.9	48	1.4	75	1750	2000
Iridaceae	44	1.2	—	6.8	93.2	29	0.9	74	800	1800
Aizoaceae	37	1.0	—	62.2	37.8	17	0.5	60	1200	2300
Boraginaceae	36	1.0	11.1	52.8	47.2	29	0.9	89	2000	2400
Polygonaceae	35	1.0	5.7	51.4	48.5	31	0.9	47	800	750
Rosaceae	34	0.9	—	20.6	79.4	32	1.0	65	2000	3370
Rutaceae	34	0.9	20.6	100	—	49	1.5	320	900	1800
Rubiaceae	33	0.9	3.0	78.8	21.2	39	1.2	203	6000	7000
Convolvulaceae	32	0.9	3.1	78.1	21.8	16	0.5	100	1650	1650
Haloragaceae	31	0.9	3.2	100	—	23	0.7	90	120	120
Epacridaceae	30	0.8	13.3	100	—	60	1.8	335	400	426
Total	2822	77.6[4]	4.7[4]	57.6[4]	20.0[4]	2478	74.7[4]	10876	103560	140841

Table 4. The 31 largest families (including subfams Mimosoideae and Papilionoideae) with 30 or more species in South Australia are listed in decreasing order of species and compared with figures for Victoria (Ross 1976) and Australia (Morley & Toelken 1983) as well as the world (Airy Shaw 1973[1]; Morley & Toelken 1983[2]). (Percentages are calculated of the number of species in the families[3], or the total of each category in the respective flora[4]).

Genera	South Australia: Total number of species in South Australia	South Australia: Number of Endemic in South Australia	South Australia: Number of Naturalised species in South Australia	Victoria: Total	Australia: Total
Acacia	107	17	4	93	660
Eucalyptus s.l.	63	9	—	79	470
Eremophila	44	4	—	13	180
Atriplex	42	4	1	24	60[2]
Stipa	40	4	—	23	61
Goodenia	39	6	—	22	170
Maireana	39	2	—	19	57[2]
Sclerolaena	35	2	—	16[1]	62[2]
Solanum	31	1	11	25	125
Brachycome	30	6	—	34	52
Olearia	30	2	—	37	80
Swainsona	29	3	—	14	52
Pterostylis	29	2	—	39	65
Senecio	29	1	7	27	36
Helipterum	27	1	—	15	60
Ptilotus	25	1	—	9[1]	79
Total	639 17.6%[2]	65 10.2%[3]	23 3.5%[3]	489 14.7%[2]	2269 14.1%[2]

Table 5. The 16 largest genera with 25 or more species in South Australia listed in decreasing order and compared with respective figures for Victoria (Ross 1976) and Australia (Morley & Toelken 1983; P.G. Wilson 1984[1]). (Percentages are calculated of the total number of species in the respective flora[2], the sum of species enumerated[3]).

taxa in the Angiospermae (Table 1) and this cannot be explained wholly by differences in the interpretation and definition of naturalised taxa, adventives and casuals. It might reflect the presence of several botanists especially interested in aliens. There are 31 families, or 19.7%, 376 genera, or 37.0%, and 968 species, or 26.8% of the flora, naturalised in South Australia. Green (1985) reported only 838 naturalised species in a flora of 7963 species of Western Australia.

All 31 families confined to naturalised aliens have only 1-5 genera (Table 6) and 371 genera of these 376 naturalised have 1-5 species. Of the 122 (76.7% of the total) families with only 1-5 genera 91 (71.1%) are indigenous families; of 857 (84.4% of the total) genera, 486 (56.7%) comprise 1-5 species. In order to further illustrate the extent of naturalised taxa in the South Australian flora, the number of families with at least half of their genera having half or more of their species naturalised raised the above figure from 31 families to 53 (Table 6) among those with 1-5 genera.

Table 3 and 4 show that families vary greatly in the ratio of naturalised and indigenous taxa and generalisations can rarely be made. For instance, the Caryophyllaceae and Cruciferae are well known for their high content of naturalised weeds, but they are unexpectedly surpassed in S. Australia by the Iridaceae, a family rarely found in this category in many floras. Similarly, the Chenopodiaceae are usually classed with the above two weedy families, yet in S.Australia it has a very low content of naturalised genera and species. Other families with a high number of species indigenous to Australia such as the Rutaceae and Proteaceae have few or no naturalised species in South Australia in spite of many species being widely cultivated.

Some 6 genera (0.6% of the flora) are endemic to South Australia viz. *Achnophora* (1 sp.), *Basedowia* (1 sp.), *Carinavalva* (1 sp.), *Embadium* (3 spp.), *Grammosolen* (2 spp.) and *Pseudanthus* (1 sp.), and 234 species are endemic consisting of 201 Dicotyledoneae and 33

No. of genera in family	No. of families	% of Total	No. of families with only naturalised genera	% of Total	No. of families with ½ or more genera and species naturalised	% of Total
1	66	41.5	25	15.7	30	18.9
2	23	14.5	3	1.9	5	3.1
3	15	9.4	2	1.3	9	5.7
4	10	6.3	—	—	6	3.8
5	8	5.0	1	0.6	3	1.9
Total	122	76.7	31	19.5	53	33.4

Table 6. Proportional representation of families with 1-5 genera as well as the proportional naturalised component expressed in two different ways.

Monocotyledoneae. The endemic species represent 6.4% of the species in the State and 1.5% of the total Australian flora. Unfortunately no such information is available for Victoria. South Australia could be grouped with poorer continental floras having a low percentage of endemism and is comparable to the British Isles (1.2% endemism), but not Europe as defined by 'Flora Europaea' which includes the Mediterranean region (33% endemism) Webb (1978). This low endemism in S. Australia is significant as Australia was estimated to have 85% endemism (Specht et al. 1974) comparing well with New Zealand (81.1%), or Hawaii (92.3%) (Raven & Axelrod 1978). In contrast, the endemism of southern Western Australia is estimated at 68% (Tilman et al. 1983). There are centres of higher endemism in parts of South Australia, especially Kangaroo Island, but details are not at present available.

The figures for number of species in Australia are based on Morley & Toelken (1983), which are considered conservative, yet the 15735 species referred to there, or 16140 vascular plants, exceed the upper limit of the estimates of Specht et al. (1974) and Beadle (1981) of 13-15000. Both Specht and Beadle based their figures on Burbidge (1963). Black (1943, p. 9) reported that "no less than 1400 genera and 8163 species were described" in Bentham's 'Flora Australiensis' when completed in 1878. In little more than a century the numbers of recognised genera and species have almost doubled to 2475 and 16140 respectively. The comment by Ride (1978, p. 79) 'it is currently believed that the Australian flora comprises about 25000 species of vascular plants', an assumption probably based on a few genera, shows that the Australian flora is far from being taxonomically described. Other evidence on how thoroughly the Australian vascular flora is known is shown in the abscence of any decrease in the average number of new species recorded per year in both South Australia and Victoria. These additions consist of species new to science, species previously only known from other States and newly naturalised species. Since a similar constant increase of the number of naturalised species has been found (Kloot, oral comm.), the resultant number of new species and new records of species must also be constant. The new 'Flora of South Australia' is a great improvement on the existing literature, but at the same time new species and a more adequate knowledge of existing species distribution, biology and environmental requirements still need to be acquired.

Acknowledgements

The author is very grateful to Drs R.J. Chinnock and P.M. Kloot for permission to use some of their as yet unpublished material which is individually acknowledged in the text. Thanks are also due to Dr J.P. Jessop for assistance in writing this paper.

References

Airy Shaw, H.K. (1973). 'A Dictionary of the Flowering Plants and Ferns' edn 8. (Cambridge University Press).
Beadle, N.C.W. (1981). 'The Vegetation of Australia'. (Gustav Fischer: Stuttgart).
Bentham, G. (1963-78). 'Flora Australiensis' vol. 1-7. (Reeve: London).
Black, J.M. (1922-29). 'Flora of South Australia' edn 1. (Govt Printer: Adelaide).
Black, J.M. (1943-57). 'Flora of South Australia' edn 2. (Govt Printer: Adelaide).
Burbidge, N.T. (1963). 'Dictionary of Australian Plant Genera'. (Angus & Robertson: Sydney).
Churchill, D.M. & de Corona, A. (1972). 'The Distribution of Victorian Plants'. (Dominion Press: North Blackburn, Victoria).
Eichler, Hj. (1965). Supplement to Black, J.M. 'Flora of South Australia'. (Govt Printer: Adelaide).
Forbes, S.J., Gullan, P.K., Kilgour, R.A. & Powell, M.A. (1984). 'A Census of the Vascular Plants of Victoria'. (National Herbarium of Victoria: Melbourne).
Green, J.W. (1985). 'Census of the Vascular Plants of Western Australia' edn 2. (Western Australian Herbarium: Perth).
Jessop, J.P. (1978). Black, J.M. 'Flora of South Australia' edn 3. (Govt Printer: Adelaide).
Jessop, J.P. & Toelken, H. (1986). 'Flora of South Australia' edn 4. (Govt Printer: Adelaide).
Maslin, B.R. & Hopper, S.D. (1982). Phytogeography of *Acacia* (Leguminosae: Mimosoideae) in Central Australia. In Barker, W.R. & Greenslade, P.J.M. (eds) 'Evolution of the Flora and Fauna of Arid Australia'. (Peacock Publications: Frewville, Adelaide).
Morley, B. & Toelken, H. (1983). 'Flowering Plants in Australia'. (Rigby: Adelaide).
Axelrod, D.I. & Raven, P.H. (1978). Late cretaceous and tertiary vegetation history of Africa. In Werger, M.J.A. (ed.), 'Biogeography and Ecology of Southern Africa'. (W. Junk: The Hague).
Ross, J.H. (1976). An analysis of the flora of Victoria. *Muelleria* 3: 169-176 (1976).
Specht, R.L., Roe, E.M. & Broughton, V.H. (1974). Conservation of major plant communities in Australia and Papua New Guinea. *Austr. J. Bot. Suppl. Ser.* 7: 1-667.
Stanley, T.D. & Ross, E.M. (1983). 'Flora of south-eastern Queensland' vol. 1. (Queensland Dept of Primary Industries: Brisbane).
Ride, W.D.L. (1978). Towards a national biological survey: the Australian biological resources study. *Search* 9: 73-82.
Tilman, D. et al. (1983). Origin and maintenance of plant species diversity. In Day, J. (ed.) 'Mineral Nutrients in Mediterranean Ecosystems' 125-155. (C.S.I.R.: Pretoria).
Webb, D.A. (1978). Flora Europaea — A retrospect. *Taxon* 27: 3-14.
Willis, J.H. (1970-72). 'A Handbook to Plants in Victoria' vol. 1 & 11. (Melbourne University Press).
Wilson, P.G. (1984). Chenopodiaceae. In George, A.S. (exec. ed.) 'Flora of Australia' 4:81-317. (Austr. Govt Publ. Services: Canberra).

J. Adelaide Bot. Gard. 10(1): 155-156 (1987)

BOOK REVIEWS

Flora of New Zealand. Lichens

Galloway, D.J. 'Flora of New Zealand. Lichens', 1985,
Government Printer, Wellington.

Although plans are well advanced towards coverage of Australian lichens in the Flora of Australia series, it will be some time yet before this is available. This volume will be of interest and usefulness to workers in southern Australia and primarily Tasmania, regions with a similar cryptogam flora to that of New Zealand. This similarity is most noticeable at generic level, but also substantial among the species. Most keys should be usable with southern Australian material, but a good treatment of Australian lichen genera is already available. (Rogers, R.W. (1981) The Genera of Australian Lichens. Univ. of Qld. Press).

This work is comprehensive, even with the proviso that the 966 taxa described possibly represent only 60% of the New Zealand lichens. As a whole it is concise and the ten years taken to assemble the daunting mass of information are easily understood. It is refreshing to find detailed information regarding the methods involved in the work's technical production, with a frank appraisal of its scientific limitations and strengths. Pages xi and xii of the Preface could be considered a model for a minimum amount of information required for readers of a flora account to assess its scientific basis.

The keys appear successful on brief inspection and are easily intelligible, making use of basic and readily-discernible characters wherever possible. Subjectively, the overall layout of the key seems poor as regards distinction of the major morphological groups of lichens. It would have saved much time and page-turning to have the major groups segregated in one place at the beginning of the key. The initial heading CRUSTOSE is also misleading, implying that one should seek another page to start identifying other groups. A useful addition is the indication in parenthesis of the previous lead which has brought one to the relevant point. It is occasionally necessary to work backwards through part of a key. The somewhat complex chemical methods which are taking an increasingly important role in professional lichenology have been kept to a minimum wherever possible, but groups like *Cladonia* tend to read like a catalogue of chemicals at times.

My most serious criticisms of this otherwise excellent work are two. Firstly illustrations, which can often save many words, are lacking. Secondly, and arguably more significant, the lack in an otherwise professional treatment of any super-generic classification beyond simple assignation of genus to family, without cross-referencing. Whilst the taxonomy of lichens will continue for some time to be unstable, even a simple conspectus of families as generally accepted would have produced a more complete taxonomic work.

Galloway, D.J. (1985). 'Flora of New Zealand. Lichens', pp. 662, with 8 colour photographs, 4 maps (endpapers). (Published by P.D. Hasselberg, Government Printer, Wellington, New Zealand). Hard-bound. NZ $39.95.

Southern Australian Liverworts

Scott, G.A.M. 'Southern Australian Liverworts', 1985,
Australian Flora and Fauna Series Number 2;
Australian Government Publishing Service, Canberra.

Similar in style to 'Mosses of Southern Australia' (Scott, G.A.M., Stone I.G. and Rosser, C. 1976), but with greater and valuable emphasis on illustrations, is this first treatment of any substantial regional coverage of Australian hepatics. An almost complete absence of literature about these plants in Australia has frightened off many with potential interest, be they students or amateurs. This production, as with 'Mosses of Southern Australia', is an intentionally simple coverage of the hepatic flora as it is currently known and frequent mention is made of present inadequacies in the biological or taxonomic knowledge. It is intended as a starting-point, not a sophisticated or erudite work solely for the professional bryologist.

In broad terms, the region covered by the book includes most of southern Australia, although descriptions are principally based on Victorian material. The northern limits in New South Wales see the addition of subtropical species, whilst Tasmania has a richer temperate flora than Victoria. The western States have poorer hepatic floras which largely consist of species found also in Victoria.

Several general reference works on hepatics are available and methods are similar to those used with mosses, hence the Introduction deals only briefly with general information. A useful conspectus of classification follows and taxa are arranged systematically in the taxonomic sections. For those without access to other reference works, a simplified coverage of morphology and biology is included, as well as a glossary.

The keys in this book have been circulated in various draft forms among many Australian bryologists for several years, so considerable experimentation and refinement has gone into their production. This has produced a result which is as functional as is currently possible, given that much basic research is needed in several areas.

The volume features brief descriptions and an honest open-ended approach which points to problems where more work is required. This gives a much needed basis on which future studies in Australian hepatics will rest.

Scott, G.A.M. (1985). 'Southern Australian Liverworts', pp. 216, with 134 black-and-white photographs. (Published in Australian Flora and Fauna Series Number 2 by Australian Government Publishing Service, Canberra). Soft-bound. A$19.20.

Graham H. Bell
State Herbarium of South Australia.

J. Adelaide Bot. Gard. 10(1): 157-164 (1987)

PLANT PORTRAITS

20. **Pultenaea trifida** J. Black (Leguminosae - Papilionoideae)

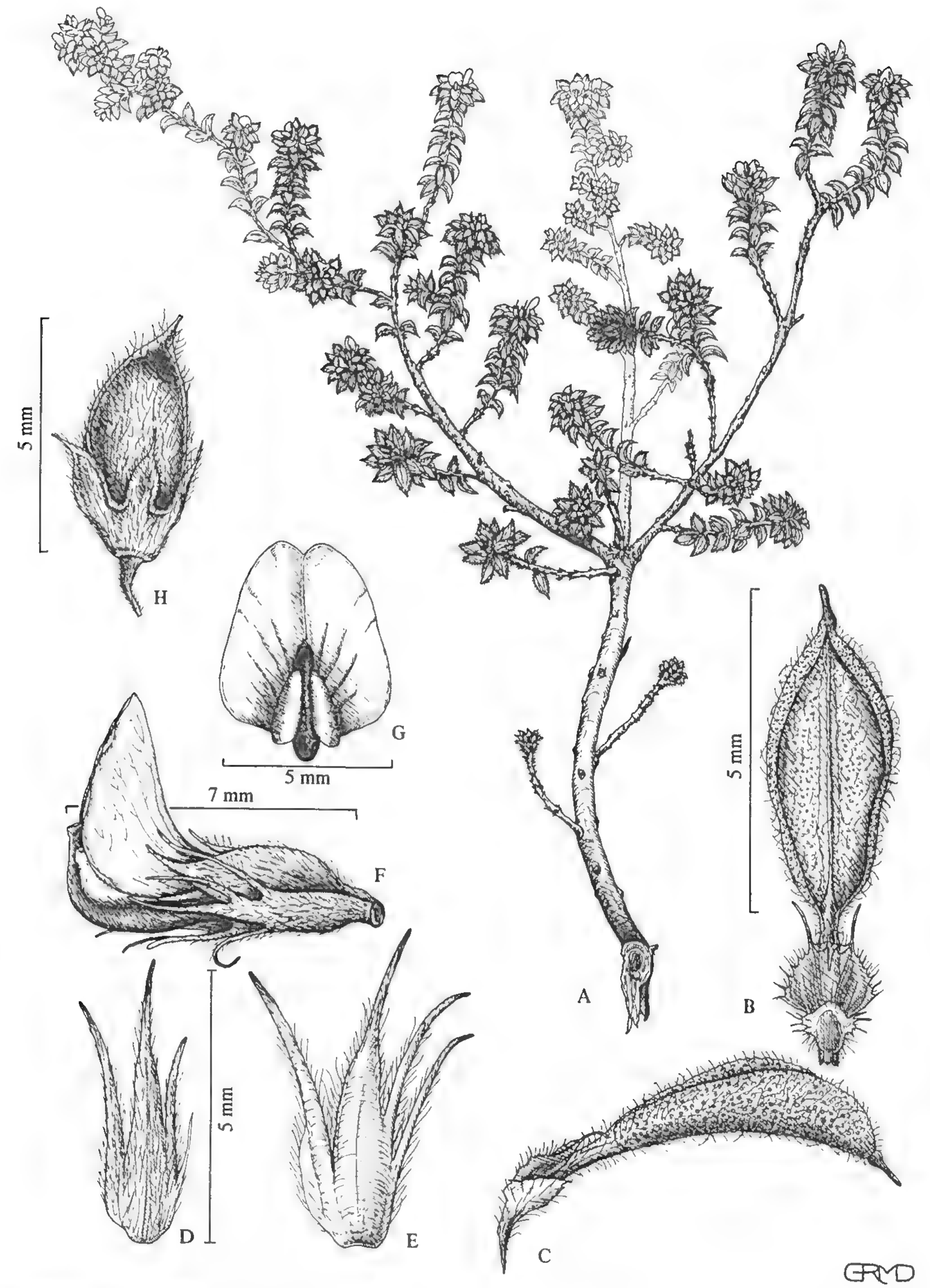
Pultenaea trifida J. Black, Trans. Roy. Soc. S. Aust. 33 (1909) 224, t. 14.

Illustration: Based on fresh material preserved under *W. Bushman & R. Davies 425*, 23.x.1983, Kangaroo Island, Flinders Chase National Park, on Shackle Road, north of Rocky River Homestead, 35° 52'S, 136° 44'E.

Suberect shrub or small bush to 80 cm high, with greyish to brownish-grey thin but hard woody branches, commonly much branched, terminating in whitish-grey to rusty-tomentose wiry branchlets. *Leaves* dense, in a 1/3 phyllotaxis; petiole 1-5 mm long, pale-yellow; lamina greyish-green, obovate or sometimes ovate, recurved in the upper part, 3-5 mm long, 2-3.5 mm wide when flattened, otherwise concave by involute margins, glabrescent to sparsely pubescent above, densely pubescent or villous with curled or crimped, whitish, thin hairs below, midrib always visible on lower and sometimes on upper surface, terminating in a light-brown bristle-like mucro to 0.5 mm long. *Stipules* 1-2 mm long, lanceolate, joined basally, central rib extended into acute or long-acuminate tip, brown-leathery with scarious margins. *Inflorescence* terminal, consisting of few to many crowded flowers, only 4 or 5 in flower at a time, may proliferate later, when flowers appear axillary and singly, or are axillary and single at first. *Bracts* few, suborbicular to ovate, 1.5-2 mm long, distinctly keeled, reddish-brown medially, brown to light-brown distally with scarious, long or short-ciliate margins, sometimes pubescent on back. *Bracteoles* trifid (hence the specific epithet), 3.5-4.5 mm long, shorter or as long as the calyx, exstipulate, the central lobe more greenish and slightly longer but similar to light-brown lateral lobes, linear-lanceolate and white-pubescent basally with light-brown, subulate, glabrous tips. *Flowers* about 7 mm long, subsessile, on pedicel to 1 mm long and about 0.5 mm thick, with 2 opposite bracteoles attached at base of the calyx. *Calyx* campanulate, 4-5 mm long, rosy-reddish-brown, densely white-pubescent outside, glabrous inside, lobes widely lanceolate, the 2 upper broader and united higher up, tips subulate, light-brown, glabrous. *Standard* about 7 mm long including narrow claw, lamina suborbicular, about 5-6 mm diam., abruptly incurved in lower third and nearly at right angles to base, folded inwards and scarcely expanded, yellow and red-tinted centrally, without callosities or hairs. *Wings* 5-6 mm long, as long as keel, with a narrow claw 1.5 mm long, lamina yellow, obovate-spathulate with a distinct auricle basally. *Keel* on distinct yellowish claw 1.5 mm long, lamina crescent-shaped with subacute tip, purple in distal half, yellowish with distinct auricle at the base and a callus-like light-brown pouch. *Stamens* 10, free, filaments long, yellowish, filiform, anthers dorsifixed, green, 2-celled, dehiscing longitudinally. *Ovary* shortly stipitate, subglobose and attenuated into long filiform style terminating in a capitulate stigma, densely villous to base of style but less so distally. *Ovules* 2, on short funicles. *Pod* ovoid, protruding from the calyx, about 5 mm long, 2.5 mm wide, reddish-brown, white pubescent, the base of the style persists as a long-acute apex, dehiscing longitudinally and opening outwards like a split funnel. *Seed* carunculate, not seen.

Pultenaea is an endemic Australian genus of about 100 species and is represented in South Australia by 24 species of which 9 are endemic. Of 28 pultenaeas present in Western Australia only 2 are present here, but with eastern Australia there are 13 species shared. In South Australia the genus is distributed south of 32° latitude with the exception of one species in the Flinders Range, representing the most northern occurrence of the genus in the State.

P. trifida is very restricted in its range to the western part of Kangaroo Island, found generally between 136° 30'E to 137° 15'E longitude. It is widespread throughout the Flinders Chase National Park but was not found in its most southern portion below 36° latitude. The eastern boundary is along a line between Mount Pleasant in the south and head of the Cygnet River in the north. It is assumed that the vague locality on the specimen collected by J.B. Cleland on "16.ix.1924, Between Kingscote and Vivone Bay" does not represent a more easterly distribution of the species as no plants were ever found in the eastern part of the island.



Pultenaea trifida J. Black. A, habit; B, C, leaf in surface and side view respectively; D, E, variation of bracteoles; F, flower with bracteole; G, flower in front view; H, fruit.

The species occurs inside the 700 mm isohyet of average annual rainfall (K. Burrows, Natural History of Kangaroo Island, p. 55). The landform and soil types are at present being described by R. Davies (in prep.) as being light hilly uplands of broad crests, valley slopes and broad gentle-sloping drainage lines. The soils of the sites where the species occurs are light sandy clay-loam, sandy loam or loamy sand.

P. trifida was found, except for the cleared areas under agriculture, in tall shrubland of *Eucalyptus remota* as well as in tall open shrubland where it occurs as a codominant in the understorey. The species was also observed at a lower frequency in low open forest with *E. baxteri* dominant, and less commonly widespread in association with *E. diversifolia* in tall open shrubland. It was also found in open heath dominated by *Caustis pentandra* and *Melaleuca gibbosa.*

The earliest collection was made in 1886 by J.G.O. Tepper, "the indefatigable collector of plants" and the above collections of this species were also made in the vicinity, or at the same locations. From the present collections it seems that enough of the population of the species is adequately conserved and under no threat of extinction in spite of its restricted range.

The main flowering season is spring, but flowers have been recorded from late September to the beginning of January, usually in small numbers at any time. There may be up to 10 buds in the terminal inflorescence, but only a small number (about 4) will be in flower at one time and most of the buds never develop. The fertility also appears to be very low: from about 27 collections examined only one pod was found on a specimen collected in January still bearing a few flowers.

P. trifida is similar to *P. densifolia* F. Muell., which occurs widespread over Eyre and Yorke Peninsula, Murray, Southern Lofty and the South-Eastern Regions as well as western Victoria. *P. densifolia* is spreading in eastern and southern parts of Kangaroo Island, but apparently outside the 700 mm isohyet (K. Burrows, Natural History of Kangaroo Island, p. 55) and comes into contact with but does not overlap with *P. trifida.* The two species have a similar prostrate to suberect habit, small dense leaves and terminal inflorescence, but they can be distinguished by almost glabrous leaves, ovate scarious bracts and a purple sometimes red-streaked standard in *E. densifolia.*

J.Z. Weber
State Herbarium of South Australia

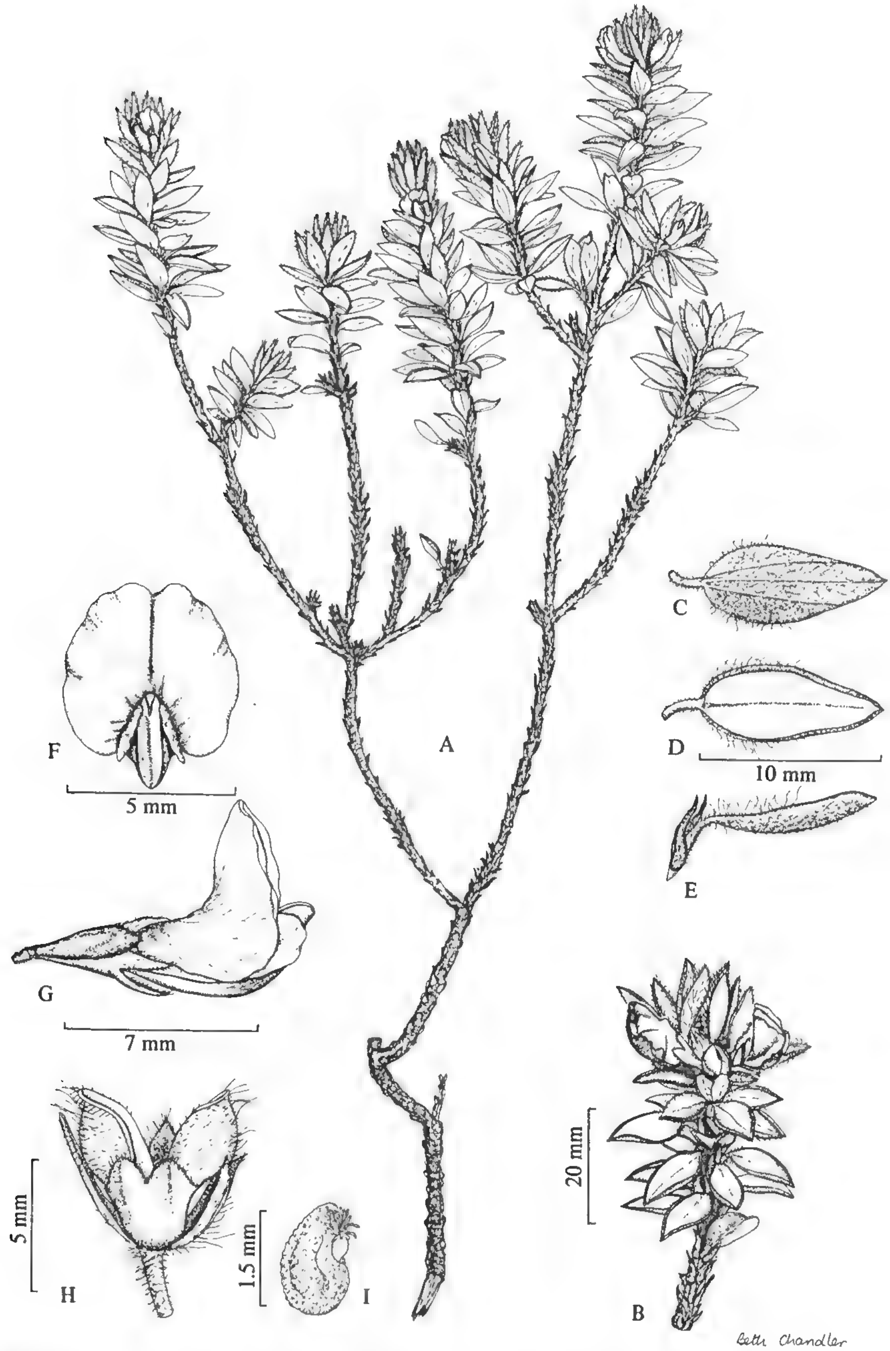
Del. G.R.M. Dashorst
State Herbarium of South Australia

21. **Pultenaea trinervis** J. Black (Leguminosae - Papilionoideae)

Pultenaea trinervis J. Black, Trans. Roy. Soc. S. Aust. 47:370 (1923).

Illustration: Based on fresh material preserved under *R. Davies s.n.*, 22.vi.1983, 4 km NE of Newland Head along eastern boundary of State Planning Authority Land, Southern Lofty Region, South Australia.

Low shrub with rather diffuse or suberect habit, to 0.5 m high, with brown-green to dark-green aspect. *Branches* slender and divided into several often long, wiry terminal branchlets, villous at first, later only covered with leathery stipules, finally reddish-brown to blackish-brown and free of stipules and hairs. *Leaves* dense at the end of branches, with a 1/3 phyllotaxis, absent on older branches; petioles distinct, appressed to stem, 0.5-1 mm long, cylindric, c. 0.2 mm thick, yellowish-grey, villous; lamina spreading, lanceolate to ovate-lanceolate, commonly 8-12 mm long but sometimes only 4 mm, 1.5-4 mm wide when expanded, rigid, subacute to mucronate but not pungent-pointed, above concave, glabrous, grey-green to green, usually lighter in colour with hardly visible venation, below darker green, often with reddish-brown tinge, with 3 distinct nerves running from the base, the midnerve



Pultenaea trinervis J. Black. A, habit; B, terminal inflorescence; C-E, leaf from below, above and in side view respectively; F, flower in front view; G, flower in side view; H, dehisced fruit; I, seed.

terminating at apex, villous all over, more so on margins. *Stipules* ovate-acute, bilobed, 2-keeled, 1-2 mm long, with scarious brown to dark red-brown margins, sometimes faintly ciliate, often pubescent on back, persistent on older branches. *Flowers* 6-8 mm long, 1-2 axillary along the branches or terminal in short proliferating head-like inflorescence, supported at the base of petiole by 2 stipules of the subtending leaves, the calyx partly exposed. *Bracts* absent. *Bracteoles* 2, opposite, adnate at base of calyx, ovate-oblong, about 2.5 mm long and usually exceeding the tube, red-brown, scarious, often keeled, usually glabrous except for some short cilia, or sometimes with few hairs. *Calyx* campanulate, 3-4 mm long, straw-coloured to pinkish-red, glabrescent to pubescent with short white hairs outside, glabrous inside, teeth triangular and shorter than tube, margins fimbriate to long-ciliate. *Standard* on distinct flat claw c. 1.5 mm long, lamina suborbicular, c. 7-8 mm diam. when flattened, scarcely notched, gradually recurved in distal half and expanded outwards, yellow, sometimes red-streaked, callosities usually absent or vaguely developed. *Wings* oblong-obovate, as long as keel, yellow, auriculate above the c. 2 mm long colourless claw. *Keel* 5-6 mm long, on distinct yellowish claw to 2 mm long, lamina narrowly crescent-shaped, more purple coloured in distal half than on proximal, tip obtuse, with a narrow and long auricle basally, without pouches. *Stamens* 10, free, filaments filiform, yellowish; anthers small, to 0.4 mm long, reniform, dorsifixed, green to purple, splitting lengthwise. *Ovary* subsessile, obpyriform, gradually constricted into a long filiform style which terminates in an inconspicuous stigma, white-villous as well as base of style, style distally glabrous. *Pod* obovoid, 4-5 mm long, exceeding the calyx, reddish-brown, white-pubescent, base of the style persists as an apiculate apex on a subobtuse apex, 2-seeded, dehiscing lengthwise. *Seed* reniform, c. 1.5 mm long, reddish-dark-brown, dull. *Caruncle* whitish to light-yellow, long-papillose.

P. trinervis is endemic to South Australia. It is quite common in the Southern Lofty Region south of 35° latitude and not extending beyond 130° longitude into the Murray Mallee. It is also frequent in the southern parts of Eyre Peninsula south of 34° latitude and rare north except for 3 collections one each from Coolanie Valley, Mangalo and Carpie Punta. On Kangaroo Island it is rarely found at Muston, Parndana and Ravine des Casoars. It is found quite frequently in hilly country, sandy flats and extending to the beaches, and is also found along road sides. It appears as a undershrub in open woodlands, heath-like tall open shrublands and grows on laterite, sandy or gravelly soils, on hillsides and in valleys and coastal shrubland.

The flowering season is generally in spring, starting as early as August with odd flowering plants recorded throughout the summer from January to March, and fully developed pods with seeds found by the end of December. Although plants usually have ample flowers the fertility appears to be rather low, as only a few pods have been present on plants investigated. The flowers appear to be insect pollinated. In fully opened flowers the stigma protrudes from the tip of the keel where the 2 joined petals have a notch-like slit, while the anthers are encased in the keel below the stigma.

P. trinervis and *P. involucrata* Benth. both have a similar habit, branches, ramification as well as 3-nerved leaves and occur sympatrically in the Southern Lofty Region. The inflorescence of *P. involucrata* differs in that each flower is later surrounded by numerous imbricate bracts which completely conceals the calyx. *P. trinervis* also resembles *P. villifera* Sieber var. *villifera* from eastern New South Wales, but differences in their leaf are quite striking as the latter "has rigid, pungent leaf tips and slender acicular tips and stipules and bracteoles". *P. trinervis* was first described as *P. villifera* var. *australis* Bentham, Fl. Aust. 2 (1864) 137 based on collections by both R. Brown and F. Mueller from Port Lincoln and from Encounter Bay by C. Wilhelmi [the type specimens have not been seen by the author]. Since then more material has been obtained and J.M. Black expressed the opinion that "it would be better to treat it as a distinct species" and in this respect H.B. Williamson, the monographer of the genus *Pultenaea*, agreed (*Transaction Royal Society of South Australia* 47 (1923) 370).

In South Australia *P. villifera* is represented only in the form of the var. *glabrescens* J. Black on Kangaroo Island and it is remarkably distinct from *P. trinervis* and *P. villifera* var. *villifera* by large flat pungent-pointed leaves. Comments made by J. Thompson (*Contributions from the New South Wales National Herbarium Flora Series 101.1* (1961) 62) that South Australian material is probably not conspecific with var. *villifera* agree with my observation on ample material from South Australia. I now believe that *P. trinervis* is not a geographic variant of *P. villifera*, but a endemic species of South Australia.

J.Z. Weber
State Herbarium of South Australia

Del. Beth Chandler
South Australia (fomerly State Herbarium)

22. **Eremophila pentaptera** J. Black (Myoporaceae)

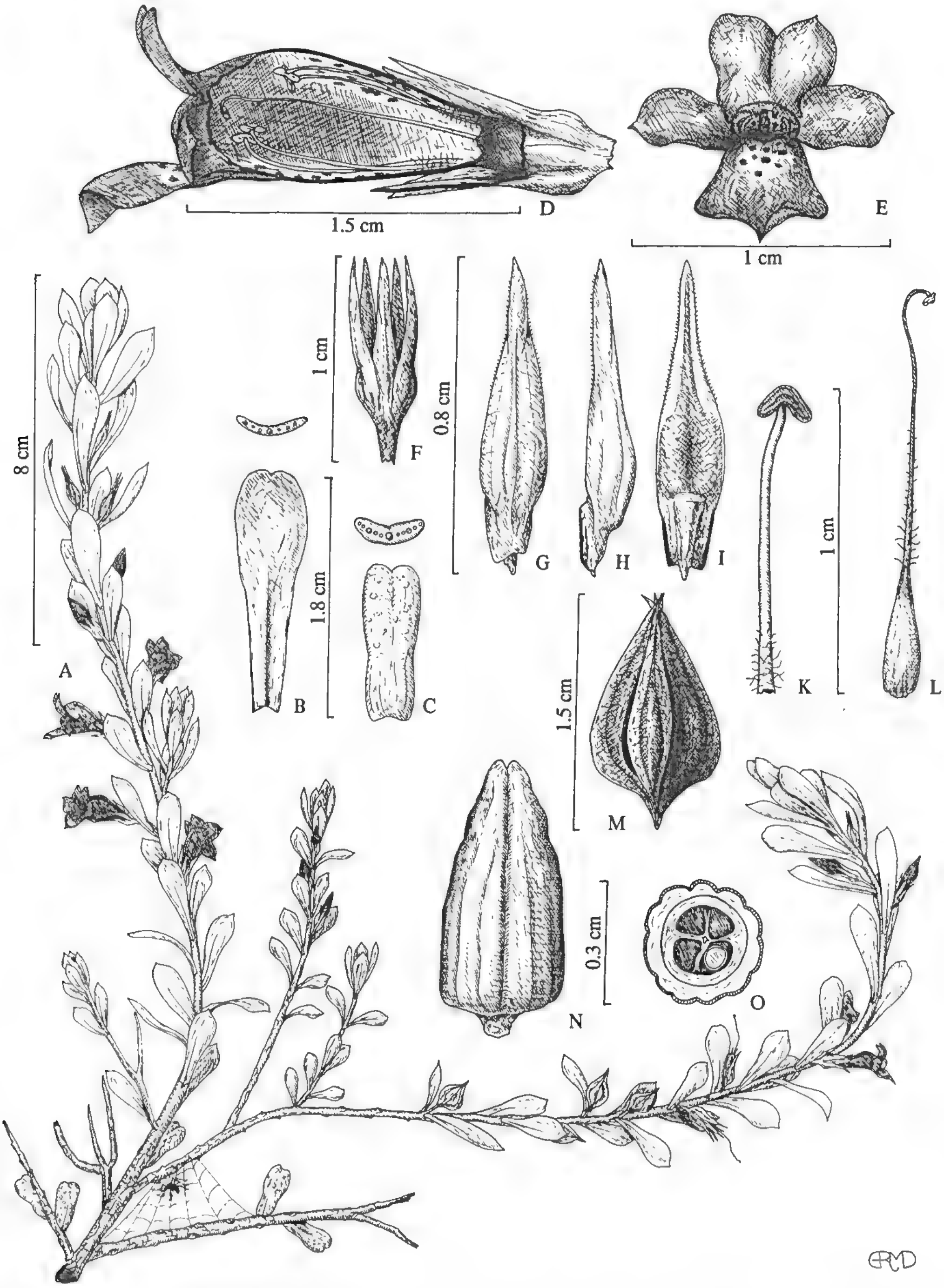
Eremophila pentaptera J. Black, Trans.Proc.Roy.Soc.S.Aust. 46:570 (1922).

Illustration: Based on cultivated and dried material preserved as *Lothian 4751*, 27.vii.1968, between Pedirka and the Stevenson River, c. 26° 39'S, 135° 12'E (AD).

Small shrub to 0.4 m tall. *Branches* erect or spreading, light-green to reddish-brown, greyish-white to buff in woody parts, terete but ribbed when dry, longitudinally fissured on woody parts, non-tuberculate, obscurely glandular-pubescent. *Leaves* sessile, alternate, fleshy to succulent, green or glaucous grey-green, oblanceolate, 12-29.5 (-36) x 3-7 (-10) mm, obtuse or rarely acute, entire, concavo-convex to almost flat, faintly to prominently tuberculate on lower side at least when dry, smooth above; glabrous or obscurely sparsely glandular-pubescent often with hairs restricted to the margins, non-viscid. *Flowers* solitary; pedicel 3.5-6.5 mm long, terete in lower part, dilating upwards and distinctly 5-ribbed, glabrous. *Sepals* 5, imbricate, green often tinged purplish, lanceolate, 9-12.5 x 1.5-3.5 mm, apex obtuse or acute, fleshy, prominently sharply keeled and triquetrous in cross-section towards the base; margins membranous, white often tinged purplish; outside surface glabrous; inside surface and margins glandular-puberulous. *Corolla* 22-32 mm, light-purple to reddish-violet, lower half of medial lobe of lower lip white or cream, faintly lilac spotted; lobes obtuse, lowermost one dilated; outside surface of lobes and tube glabrous; inside surface of tube and base of medial lobe of lower lip villous often with a very dense band below the medial lobe. *Stamens* 4, included but extending to the throat, filaments hirsute at base, anthers glabrous. *Ovary* ovoid-oblong, yellow, quadrilocular with one ovule per loculus, 3.5-5 x 1-2.5 mm, glabrous; style villous. *Fruit* ovoid to bottle-shaped, 6-7.5 x 2.3-3 mm, ribbed, often verrucose when immature, glabrous. *Seed* ovoid-oblong, c. 3.5 x 1 mm, cream.

This rare species was described from material collected on flats at Millers Creek by F. Wood-Jones in 1922. Both E.H. Ising (1932) and T.R.N. Lothian (1968) made collections in the Pedirka area north of Oodnadatta with Lothian collecting the species on Tableland slopes and plains and Ising in "a little creek through Gibbers". More recently B.P. Isaacson and F.A. Mason located the species on the lower rubbly slopes of a small isolated hill north of Copper Hills Homestead. It seems likely from this information that the species favours rocky slopes or flats on soils subject to periodic flooding.

E. pentaptera is unique in the genus by having thick fleshy to succulent leaves. During dry periods (in cultivated specimens) plant growth is slow, the leaves are short, thick, more or less oblong and dull glaucous-green but during wetter periods growth is rapid, the leaves bright green, long, thinner especially in the distal part, oblanceolate in shape. These observations are consistent with the herbarium specimens, Lothian collecting his material in winter during an obviously wet season while the other collections were made in drier periods. The very white woody branches and the distinctly keeled sepals and ribbed pedicel are also distinctive features



Eremophila pentaptera J. Black. A, flowering branch; B, C, fleshy leaves with transverse sections; D, opened flower; E, flower in front view; F, calyx; G, H, I, calyx lobes from outside, side and inside respectively; K, stamen; L, ovary with slender style; M, mature fruit enclosed in calyx; N, fruit; O, transverse section of fruit.

of this species. This species was accidentally omitted from the fourth edition of the 'Flora of South Australia' (1986).

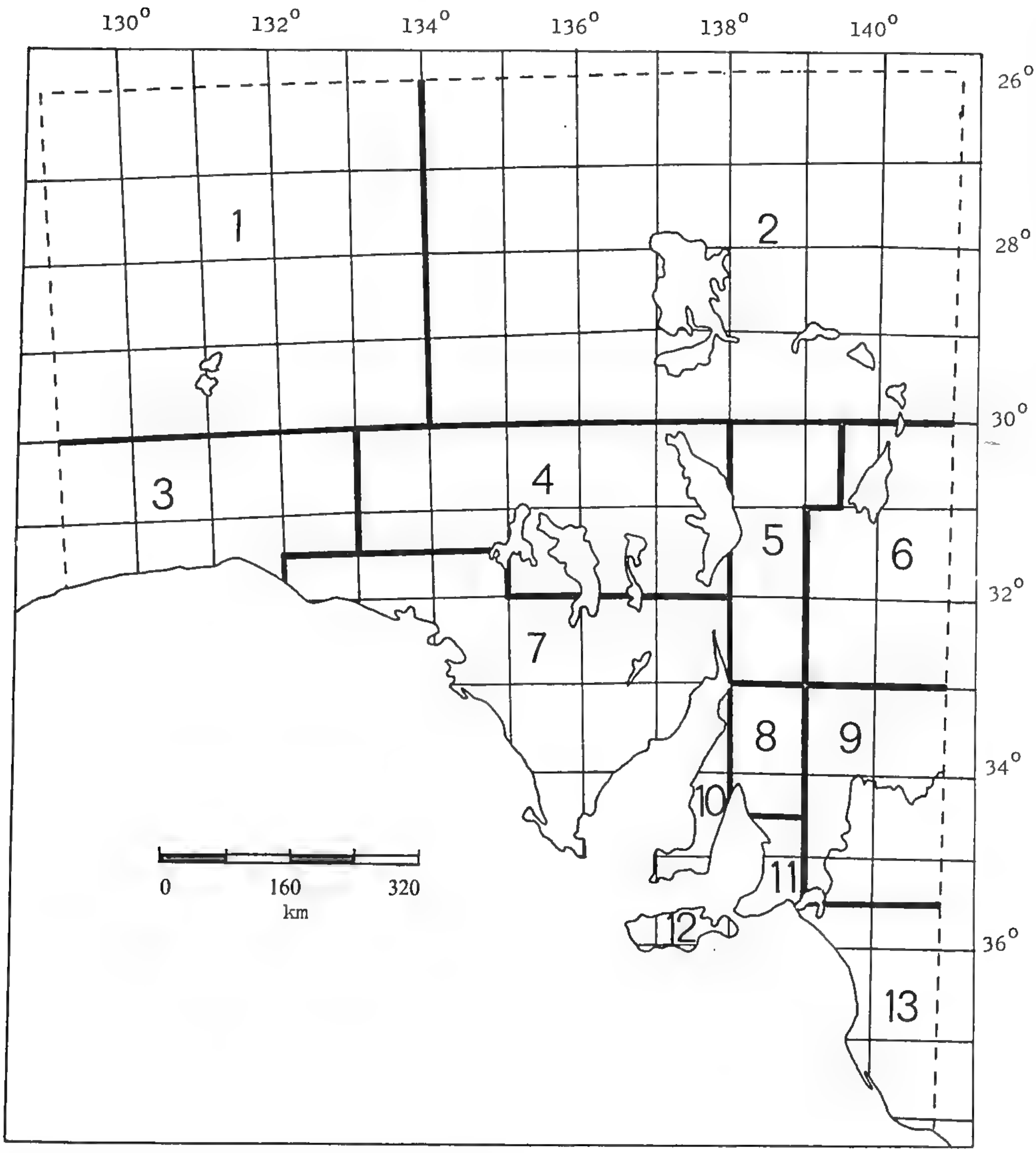
E. pentaptera is in cultivation in South Australia but it is not common. The species roots readily from cuttings but is susceptible to rot. Grafted plants appear to overcome this problem.

R.J. Chinnock
State Herbarium of South Australia

Del. G.R.M. Dashorst
State Herbarium of South Australia

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre Basin
3. Nullarbor
4. Gairdner-Torrens Basin
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. Yorke Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



Typeset by P. & L. REPRODUCTIONS PTY. LTD.
Printed by AUSTRALIAN PRINTING SPECIALISTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

CONTENTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 10 Part 2

7 August, 1987

Instructions to Authors

Topics

Papers will be accepted in the following categories:
(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

Copy

Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of generic or lower rank must be underlined.

The print area for illustrations is 18 x 13 cm (excluding captions). Half-tone material should be submitted this size if possible, but will be reduced by the printers, if necessary.

Reprints

50 copies of reprints will be provided for each paper. Additional reprints may be purchased at cost.

Layout

The pattern of the paper should generally be:
(i) Title; (ii) Author and Address; (iii) Abstract (except for short papers); (iv) Introduction and subject matter; (v) Acknowledgements; (vii) References.

References

Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

Text references to specimens should be italicized, for example *Kock 276.*

Indices

When required, follow the pattern on, for example, p. 106 of vol. 1, pt. 2.

Recommendations on taxonomic papers

Synonymy

Authors are requested to include in the synonymy only references to publications containing information additional to that to be published in the paper being submitted. Within this section journal and book titles must be conistently abbreviated. B-P-H journal abbreviations and book titles abbreviated in a similar way are desirable. Authors of references cited in the synonymy should preferably be abbreviated according to the 'Index of Author Abbreviations' compiled and published by Royal Botanic Gardens, Kew (1980). References may be cited as:

Benth., *Fl. Austral.* 4: 111 (1868) OR
Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

All correspondence concerning the journal should be addressed to:
The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

ISSN 0313-4083

J. Adelaide Bot. Gard. 10(2): 165-177 (1987)

A TAXONOMIC REVISION OF THE GENUS *FARADAYA* F. MUELL. (VERBENACEAE)* IN AUSTRALIA

Ahmad Abid Munir

State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

A taxonomic revision of *Faradaya* in Australia is presented. The following two species are recognised: *F. albertisii* and *F. splendida*. *F. albertisii* is confirmed from Australia. A wide range of material has been examined from Malesia and Oceania.

The affinities and distribution are considered for the genus and each species. A key to the species is provided and a detailed description of each species is supplemented by an illustration.

Taxonomic History of the Genus

The genus *Faradaya* was described by F. Mueller (1865) with one species, *F. splendida*, the type of which came from Queensland. Originally it was placed in the Bignoniaceae, but soon after its publication, Seemann (1865) referred the genus to the "Natural Order Verbenaceae, closely related to *Clerodendrum* and *Oxera*". The family Verbenaceae has been accepted for the genus by all subsequent botanists. Earlier, one *Faradaya* collection from Tonga and another from Fiji were respectively described by Seemann (1862) and Asa Gray (1862) as new species of *Clerodendrum*. In view of their difference from other *Clerodendrum* taxa, Asa Gray (1862) formed for them a new section of the genus namely *Clerodendrum* sect. *Tetrathyranthus* A. Gray. Subsequently, Seemann (1865) recognised both types of the section *Tetrathyranthus* as *Faradaya* species and thus reduced this section to synonymy under *Faradaya*.

Bentham (1870, 1876) divided the family Verbenaceae into different tribes, with *Faradaya* in the tribe Viticeae subtribe Oxereae. The tribe Viticeae was considered the appropriate position for the genus by Durand (1888), Baillon (1891), Bailey (1901, 1913) and Lemée (1943). In 1891, Baillon described one of M. Jacquinto's congeneric collection from Melanesia as a new genus, *Schizopremna*, which was later found congeneric with *Faradaya*. In the same publication, however, he also recorded *Faradaya* as a genus native to Oceania. Both *Schizopremna* and *Faradaya* were later accepted by Briquet (1895) and Junell (1934) as distinct genera. Subsequently, van Steenis (1955) considered *Schizopremna* congeneric with *Faradaya* and reduced the former to synonymy under *Faradaya*.

In 1895, Briquet reclassified the Verbenaceae and upgraded the tribe Viticeae to a subfamily Viticoideae. The latter consisted of four tribes: Callicarpeae, Tectoneae, Viticeae and Clerodendreae, with *Faradaya* in the tribe Clerodendreae. This classification was accepted by Dalla Torre & Harms (1904), H.J. Lam (1919), Junell (1934) and Moldenke (1959, 1971).

Seemann (1865) made detailed comments on the stability of the genus *Faradaya*, and recorded under it 4 species. For many years subsequently, *Faradaya* was considered to be a genus of only one or two species. Bentham (1870) reported it to have 4 species, but in Bentham & Hooker's *Genera Plantarum* (1876) he reduced the number to 2. Baillon (1891) also regarded *Faradaya* as a genus of 2 species, Briquet (1895) recognised 4 or 5, and H.J. Lam (1919) recorded 9. In 1973, Airy Shaw gave the number as 17 species. Recently, Moldenke (1971, 1982, 1983) recorded 23 as the number of specific and infraspecific taxa in *Faradaya*.

*The present treatment of the genus *Faradaya* is the sixth in the series of taxonomic revisions in the family Verbenaceae in Australia (See Munir, 1982, 1984a, 1984b, 1985, 1987).

Australian History of the Genus

Faradaya was for many years thought to be solely represented in Australia by the type species. Moldenke (1959, 1971) recorded *F. papuana* Scheff. from Queensland without citing any collection. This species is endemic to Papua New Guinea. Moldenke's record may have been based on a misidentification of *F. splendida* which closely resembles *F. papuana*. During present investigations, *F. albertisii* F. Muell. has been recorded from Australia for the first time, and consequently 2 species are recognised in Australia. In the past, most *F. albertisii* collections from Australia were misidentified as *F. splendida*.

In the present publication, Briquet's (1895) classification of the Verbenaceae is accepted for the genus.

FARADAYA F. Muell.

Faradaya F. Muell., Fragm. Phyt. Austral. 5(1865) 21; Seemann, J. Bot. Lond. 3 (1865) 256-258; Fl. Viti. (1866) 188; F. Muell., Fragm. Phyt. 6 (1868) 153; Benth., Fl. Austral. 5 (1870) 69; Benth. in Benth. & Hook. f., Gen. Pl. 2 (1876) 1154; F. Muell., Syst. Cens. Austral. Pl. 1 (1882) 103; Sec. Syst. Cens. Austral. Pl. 1 (1889) 173; Baillon, Hist. Pl. 11 (1891) 113; Briq. in Engl. & Prantl, Nat. Pflanzenfam. 4, 3a (1895) 173; Bailey, Qld Fl. 4 (1901) 1181; Dalla Torre & Harms, Gen. Siphonog. (1904) 433; H.J. Lam, Verbenac. Malay. Arch. (1919) 228; H.J. Lam & Bakh., Bull. Jard. Bot. Buitenz. Ser. 3, 3 (1921) 71; Lemée, Dict. Descrip. Syn. Gen. Pl. Phan. 8b (1943) 656; Steenis, Act. Bot. Neerland. 4 (1955) 477-478; Mold., Résumé Verbenac. etc. (1959) 343, 411; N. Burb., Dict. Austral. Pl. Gen. (1963) 125; Balgooy, Blumea Suppl. 6 (1971) 200; Mold., Fifth Summary Verbenac. etc. 2 (1971) 518, 519, 619, 641, 760; Airy Shaw, J.C. Willis Dict. Fl. Pl. & Ferns edn 8 (1973) 454; Baines, Austral. Pl. Gen. (1981) 155; Mold., Phytologia 51 (1982) 384; Phytologia 52 (1982) 20; Mold. in Dassan., Fl. Ceylon 4 (1983) 402; Munir in B. Morley & Toelken, Fl. Pl. Austral. (1983) 288.

Type species: *F. splendida* F. Muell., Fragm. Phyt. Austral. 5 (1865) 21.

Clerodendron sect. *Tetrathyranthus* A. Gray, Proc. Am. Acad. 6 (1862) 50; Benth. in Benth. & Hook. f., Gen. Pl. 2 (1876) 1156.

Type species: *Clerodendron ovalifolium* A. Gray, Proc. Am. Acad. 6 (1862) 50; *C. amicorum* Seemann, Bonplandia 10 (1862) 249.

Schizopremna Baillon, Hist. Pl. 11 (1891) 119; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 166; Junell, Symb. Bot. Upsal. 4 (1934) 84; Barkley, List Ord. Fam. Anthoph. (1965) 76, 166.

Type: *S. timorensis* Baillon, Hist. Pl. 11 (1891) 120.

Climbing shrubs, lianas or (not in Australia) wide-spreading trees. *Leaves* simple, decussate, opposite or (not in Australia) verticillate, mostly petiolate, exstipulate; lamina chartaceous or coriaceous, reticulate-veined, unicostate, the venation rather prominent. *Inflorescence* cymose, the cymes aggregated in terminal corymbose thyrse, sessile in the leaf axils or rarely (not in Australia) cauliflorous. *Flowers* large and conspicuous, zygomorphic, bisexual, hypogynous. *Calyx* of 4 fused sepals, campanulate, mostly coriaceous, apically closed when immature, but during anthesis split into 2-4 lobes. *Corolla* of 4 fused petals, zygomorphic, rather large and showy, deciduous, tubular below; tube cylindrical below, gradually broadening above; lobes 4, wide-spreading, subequal, the posterior one wider and with apex entire or emarginate. *Stamens* 4, almost equal or slightly didynamous, exserted, alternate with the corolla-lobes, epipetalous, inserted about the middle of the corolla-tube; filaments filiform, usually villous towards the base; anthers ovate-oblong, 2-lobed, the lobes parallel. *Ovary* bicarpellary, syncarpous, shortly or deeply 4-lobed, 4-locular, with one ovule in each cell, attached to an axile placenta; style filiform, sunken between the ovary lobes, glabrous, with 2 short stigmatic lobes.

Fruit drupaceous, 4-lobed and 4-locular or by abortion reduced to 1-3 large obovate pyrenes, the exocarp fleshy and succulent, the endocarp hard, 1-4-seeded. Seeds exalbuminous.

Number of species: World ± 18; Australia 2

Derivation of name

The genus is named after Michael Faraday (1791-1867), world famous English Chemist and Physicist, a pioneer in electromagnetic research.

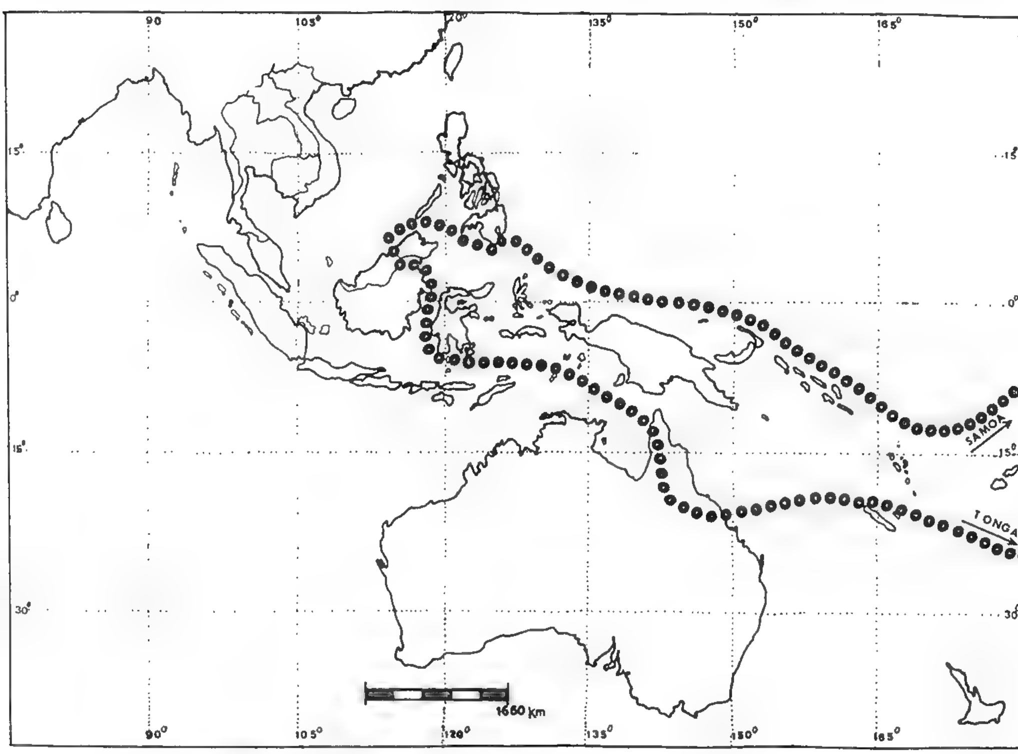
Distribution (Map 1)

The genus *Faradaya* is known to occur in East Malaysia (Sabah), Indonesia, Melanesia, Polynesia, and south to the north-eastern tropics of Australia.

Comments

In the synonymy of this genus, Moldenke (1959, 1971, 1982, 1983) cited "*Tetrathyranthus* A. Gray ex Benth.", giving the impression that Bentham (1876) had raised the status of *Clerodendron* sect. *Tetrathyranthus* A. Gray to that of a genus. In fact, Bentham (1876) only made some comments on the sect. *Tetrathyranthus* while citing it in the synonymy of *Clerodendron*. He did not upgrade it to the genus level.

Under the generic description, H.J. Lam (1919) and Moldenke (1982, 1983) stated that of the four stamens "two are inserted in the upper part and two near the base of the corolla-tube, or sometimes all subequal and all inserted near the apex or near the base of the tube". In the



Map 1. Distribution of the genus *Faradaya* F. Muell.

two Australian species, however, stamens are inserted about the middle of the corolla-tube. Distinctly didynamous stamens have not been found in Australia.

Several *Faradaya* species are cultivated as ornamentals. Of these, *F. splendida* seems the most popular and widely cultivated.

In his comments on this new genus, Seemann (1865) said that "The genus I hold to be a sound one, but Dr Mueller, usually so correct, was, in this instance, certainly wrong, in referring it to Bignoniaceae, with which the plant has nothing to do, it being a genuine member of the Natural Order Verbenaceae, closely related to *Clerodendron* and *Oxera*". After giving short comments on the history of the genus, Seemann (1865) explained the possible reasons which may have led F. Mueller (1865) to refer *Faradaya* to the Bignoniaceae. Seemann states: "The calyx I found to be closed before anthesis and splitting or rather tearing irregularly into 4, 3 or 2 lobes, when the corolla is forcibly pushed through a very narrow aperture at the extreme end, indicated by four very minute points, one would hardly call them teeth, though they are in reality the teeth of the limb of the calyx. The splitting of the calyx is analogous to what we find in the genus *Tecoma* (as now circumscribed) and several genera of *Eubignonieae*; we have nothing like it in the *Clerodendrons*; and, I think, there can be no doubt that this set of plants must constitute a separate genus".

Affinities

Faradaya shows closest similarities to *Clerodendrum* by its inflorescence being cymose and centrifugal; flowers (especially the corollas) more or less zygomorphic; stamens 4; fruit drupaceous; drupes composed of four (or through abortion less numerous) 1-locular pyrenes. Nevertheless, *Faradaya* can easily be distinguished by its calyx, which is closed before anthesis, with a more or less long and subulate apex, and splits into 2 or 3 lobes when mature. According to Seemann (1865), *Faradaya* is closely related to *Clerodendrum* and *Oxera*. Bentham (1870) states that "the nearest affinity of the genus appears to be with the New Caledonian *Oxera*". With the exception of stamen number, all other characters common to *Faradaya* and *Clerodendrum* are also common to *Oxera*. The last, however, may easily be identified by its 4- or 5-toothed or 4- or 5-partite calyx and only 2 fertile stamens.

Ewart & Rees (1912) claim that *Huxleya* is related to *Faradaya* but differs in having a 5- (instead of 2-) lobed calyx, a 5- (instead of 4-) lobed corolla, equal (instead of didynamous) stamens, and a 2- (rather than 4-) lobed ovary, as well as being only a foot high upright herb (rather than woody climbers), having solitary flowers instead of their being in terminal panicles, and in having only small linear leaves. Beer & Lam (1936) point out that *Faradaya* has a similar liana-like habit of *Archboldia*. Hooker (1891) says that "the genus is closely allied to *Vitex*, differing chiefly in the spathaceous 2-lobed calyx and the lobed ovary".

The somewhat gynobasic style seems to indicate a close affinity between *Faradaya* and several genera in the Lamiaceae (Labiatae) and Boraginaceae.

Key to the Species

1a. Inflorescence only axillary, dense, shorter than the subtending leaves .... 1. *F. albertisii*

b. Inflorescence only terminal or both axillary and terminal, lax, longer than the subtending leaves .. 2. *F. splendida*

1. **Faradaya albertisii** F. Muell., Descr. Notes Papuan Pl. VIII (1886) 46; Schumann in Schumann & Hollr., Fl. Kais. Wilh. Land (1889) 122 in obs.; Pulle in Lorentz, Nov. Guin. Ser. 1, 8 (2) (1910) 402 & ibid. 8 (4) (1912) 686; H.J. Lam, Verbenac. Malay. Arch. (1919) 230; H.J. Lam & Bakh., Bull. Jard. Bot. Buitenz., Ser. 3, 3 (1921) 71, pro syn.; Mold., Known Geogr. Distrib. Verbenac. edn 2 (1949) 149; Résumé Verbenac. etc. (1959) 201; Sen & Nasker, Bull. Bot. Surv. India 7 (1965) 45; Mold., Résumé Suppl. 15 (1967) 15; Fifth Summary Verbenac. etc. 1 (1971) 336; Phytologia Mem. 2 (1980) 326; Phytologia 51 (1982) 391.

Lectotype: *D'Albertis s.n.*, on the Fly River, Papua New Guinea, 1876 (MEL 98045!, lectotype designated here; MEL 98046 & MEL 98047 — isolectotypes!).

Typification

F. albertisii is based on D'Albertis' (s.n.) collection from near the Fly River in Papua New Guinea, consisting of at least three duplicates. All duplicates are preserved in Herb. MEL and were annotated by F. Mueller and certainly used by him in preparing the original description of this species. Since he did not select a specimen as a holotype, it is proposed to designate a lectotype for this name. Of all the available syntypes, the one numbered MEL 98045 is the best representative of this species and is chosen here as the lectotype.

Description (Fig. 1)

A tall climbing shrub or shrubby vine, 3-15 m tall. *Stem* cylindrical, 20-50 mm diam., greyish-brown, the young parts at first sparingly puberulous, later glabrescent. *Leaves* petiolate; lamina oblong, narrowly ovate, ovate-oblong or ovate-elliptic, (8-) 11-20 (-30) cm long, (4-) 6-12 (-18.5) cm wide, chartaceous to subcoriaceous, glabrous but not shiny, pale-green below, basally rounded or cordate, apex acuminate, margin entire, often with flat orbicular glands near the base; main pairs of nerves 6-10, very prominent beneath; petioles 10-55 (-100) mm long, glabrous. *Inflorescence* a dense axillary thyrse, 5-15 cm long, 5-11 cm wide; cymes shorter than the subtending leaves; primary lateral peduncles 10-25 (-50) mm long. *Flowers* pedicellate, strongly scented; pedicels (3-) 5-12 mm long. *Calyx* yellowish-green, 15-25 mm long, glabrous, before expanding (i.e. in bud) apically pointed in horn-like fashion, divided to the middle or to the base when full grown; lobes semi-lanceolate, acuminate, sometimes with a few sparsely scattered large external glands. *Corolla* white, glabrous, infundibular; lobes obovate or elliptic-obovate, the large adaxial lobe apically rounded, the remaining three deeply emarginate or bilobed, 15-20 (-23) mm long, 10-16 (-20) mm wide; tube slender, funnel-shaped toward the top, 25-35 mm long. *Stamens* exserted, scarcely didynamous, inserted about the middle of the corolla-tube; filaments white, filiform, villous-papillose towards the base, glabrous above, (35-) 40-50 (-60) mm long; anthers oblong-ellipsoid, 3-4 mm long, with 2 parallel lobes free in the lower half. *Ovary* globular, 4-furrowed, densely grey-tomentose, 2-3.5 mm diam.; style exserted, white, filiform, glabrous, 45-70 mm long, with shortly bifid stigma. *Fruit* not seen but other sources indicate the size as "76 mm x 51 mm x 51 mm".

Representative specimens (collections seen: Australian 13, non-Australian 20)

AUSTRALIA: QUEENSLAND: *Bell 679*, 11.4 km NE of Tinaroo Dam bridge on Danbulla Forest Drive, 12.x.1982 (AD). *Blake 9723*, West of Kennedy, 27.ix.1935 (BRI). *Chapman A 126*, Kuranda Range, between Cairns and Kuranda, 26.viii.1972 (JCT). *Fitzsimon 297*, State Forest Reserve 185 opposite Fire Tower, 31.x.1978 (AD, QRS). *Fraser s.n.*, Atherton Tableland, undated (BRI). *Cooke 209*, Murray Upper, 16.xi.1977 (JCT). *Jones 766*, Dunbulla, 21.ix.1957 (JCT). *Kajewski 1293*, Lake Barrine, Atherton Tableland, 29.x.1929 (BRI). *Stocker 951*, State Forest Reserve 700, Gillies Highway, 18.x.1972 (QRS). *Whiting s.n.*, Atherton, 23.x.1935 (BRI). *Williams 206*, 21 km from Ravenshoe, Ravenshoe - Millaa Millaa Road, 10.x.1968 (BRI). *Williams 215*, 1.6 km from Bramston Beach, 16.x.1968 (BRI). *Wrigley 249*, Iron Range (Kennedy) Road, between Tozer's Gap and turnoff to Iron Range Airfield, 6.ix.1976 (CBG).

PAPUA NEW GUINEA: *Armit s.n.*, Mt Dayman, New Guinea, 1894 (MEL). *Bäuerlen s.n.*, Thickland River, New Guinea, 1885 (MEL). *Brass 7442*, Fly River, 48.28 km above D'Albert Junction, Papua, Aug. 1936 (A, BRI). *Brass 8200*, Lower Fly River, east bank opposite Sturt Island, Papua, Oct. 1936 (A, BRI). *Carr 11594*, Veiya, Papua, 8.iii.1935 (CANB). *Gillison NGF 22481*, Alimbit River, Kandrian sub-district, West New Britain, 8.x.1965 (BRI, L, LAE). *Hartmann s.n.*, loc. incert., New Guinea, 1887 (MEL). *Hoogland & Craven 10125*, along Sepik River near Ambunti, New Guinea, 24.v.1966 (A, CANB, K, L, LAE). *Hoogland & Womersley 3243*, c. 2 km NE of Sangara homestead, North Div. Terr. of Papua, 8.vii.1953 (BRI, CANB). *Millar NGF 14606*, Tuamina River, Lae-Wau Road, Morobe District, New Guinea, 14.viii.1962 (BRI, CANB, LAE). *Millar NGF 23526*, c. 20 km from station, Northern District, Papua, 22.vii.1964 (BRI, CANB, L, LAE). *Millar NGF 35136*, Amboin, Angoram subdistrict, New Guinea, 28.vii.1967 (A, BRI, CANB, L, LAE). *Saunders 560*, Ramu Valley, Madang subdistrict, New Guinea, 3.viii.1955 (BRI, CANB). *Streimann & Lelean NGF 18437*, Oriomo River, Daru subdistrict, Papua, 20.ix.1972 (BRI, CANB, L, LAE). *Turner 76*, Fife Bay, Papua, Aug. 1930 (BRI). *Womersley 3757*, Sepik River near Yesan, New Guinea, 4.ix.1949 (BRI, CANB, LAE).

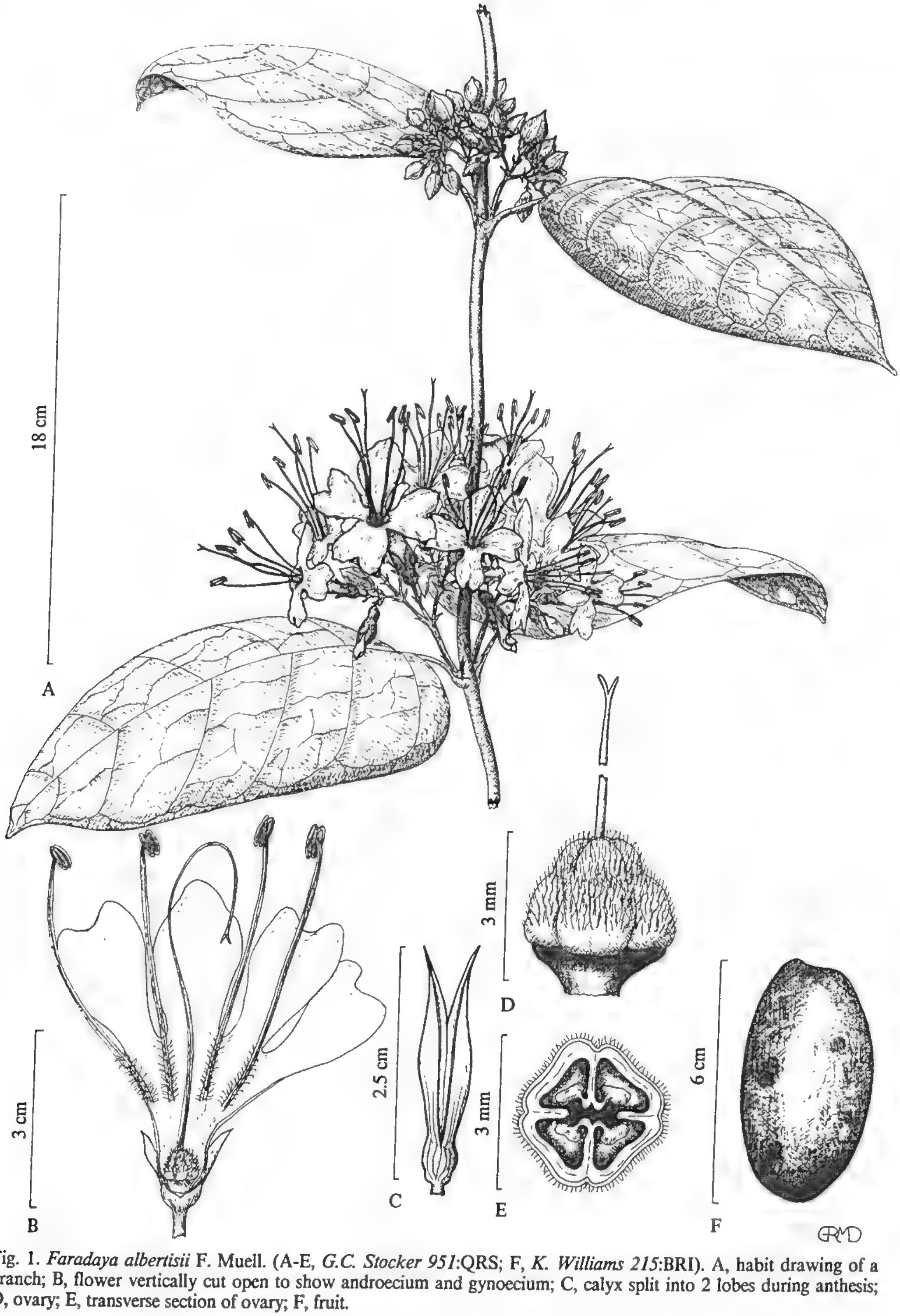


Fig. 1. *Faradaya albertisii* F. Muell. (A-E, *G.C. Stocker 951*:QRS; F, *K. Williams 215*:BRI). A, habit drawing of a branch; B, flower vertically cut open to show androecium and gynoecium; C, calyx split into 2 lobes during anthesis; D, ovary; E, transverse section of ovary; F, fruit.

IRIAN JAYA: *Brass 13918*, Bernhard Camp, Idenburg River, -.iv.1936 (A, BRI). *Djamhari 378*, Sorong Kp. 27.vii.1948 (BRI). *Pleyte 478*, Sorong, 5.viii.1948 (A, BO, K, L).

Distribution (Map 2)

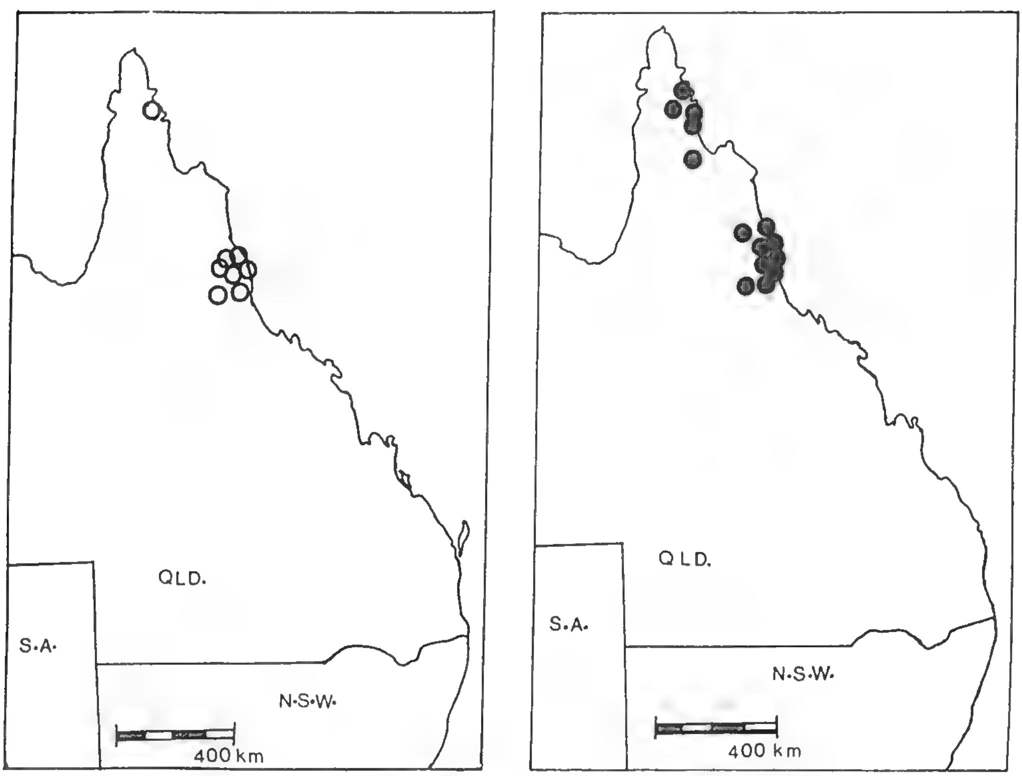
In Australia, *F. albertisii* is found only in the northern tropical areas of Queensland, where the major distribution is to the south and south-west of Cairns, chiefly on the Atherton Tableland. In addition, one locality is to the north of Cairns near Kuranda, and another one further north around Iron Range mining area. Throughout its distribution range in Australia, *F. albertisii* seems to overlap its nearest ally *F. splendida* F. Muell.

Collections from overseas have been examined from Papua New Guinea, New Britain and Irian Jaya.

Comments

The occurrence of *F. albertisii* in Australia is confirmed. Its presence in "tropical Australia" was mentioned by H.J. Lam (1919) but no specimen was cited. All Australian collections of *F. albertisii* had previously been identified as *F. splendida* F. Muell.

H.J. Lam (1919) and Moldenke (1982) described the stamens as "distinctly didynamous", with two being inserted near the base and two at the middle of the corolla-tube. During present studies, however, the stamens of several specimens examined (including the types) were found to be almost equal or very slightly unequal. Their insertion in the corolla-tube is invariably about the middle.



Map 2. Distribution of *F. albertisii* ○ *F. splendida* ●

H.J. Lam (1919) and Moldenke (1982) state that the corolla is "internally papillose-pilose near the stamen insertion". Amongst the many specimens examined by the present author, villous hairs were found only on the basal parts of the filaments and not in the corolla-tube, and were never reduced to papillae.

Flat orbicular glands on the lamina are somewhat similar to those found in *Gmelina dalrympleana* (F. Muell.) H.J. Lam and *Gmelina schlechteri* H.J. Lam. The glands in *F. albertisii*, however, are smaller, less conspicuous and not restricted to the base of the lamina.

The type of this species was collected from Papua New Guinea by Count Luigi Maria d'Albertis (1841-1901) in whose honour it is named.

Affinities

F. albertisii is very similar to *F. splendida* F. Muell. and *F. papuana* Scheff. by its leaves being regularly decussate-opposite, glabrous; inflorescence and flowers of the same general aspect; stamens and style exserted; filaments villous towards the base; fruit ovoid-ellipsoid, creamish-white, about the shape and size of a hen's egg. Nevertheless, *F. albertisii* may easily be distinguished by its inflorescence which is strictly axillary and shorter than the subtending leaves.

According to F. Mueller (1886), "this species is closely akin to *F. splendida*; the petioles are however thicker, the leaves of a firmer texture with stronger nervation and venation and also with a longer and more pointed terminal protraction, and they are not shining; the stalks and stalklets of the flowers are much shorter, by which means the inflorescence becomes very contracted; the bud of the calyx is longer and acutely pointed; perhaps the fresh flowers and ripe fruits may exhibit other marks of discrimination. A comparison should still be instituted with *F. papuana* from Andaj, described by the lamented Dr Scheffer on p. 42 in the *Annales du jardin botanique de Buitenzorg*, volume premier; but in the narrow acumination of the leaves is not alluded to, while according to Dr Scheffer's description the petioles of this plant are longer, the flowers larger, and the stamens inserted lower on the corolla-tube. He records simultaneously the interesting observation, that sometimes all four of the large distinct fruitlets become developed".

H.J. Lam (1919) comments under *F. ternifolia* F. Muell. that *F. splendida* and *F. albertisii* show some affinities to that species.

2. **Faradaya splendida** F. Muell., Fragm. Phyt. Austral. 5 (1865) 21; Seemann, J. Bot. Lond. 3 (1865) 257 & 258; Seemann, Fl. Viti. part 5 (1866) 190; F. Muell., Fragm. Phyt. Austral. 6 (1868) 153; Benth., Fl. Austral. 5 (1870) 69; Seemann, Fl. Viti. (1873) 441; F. Muell., Descr. Notes Papuan Pl. 6 (1875) 47 & 48; Syst. Cens. Austral. Pl. 1 (1882) 103; Sec. Syst. Cens. Austral. Pl. 1 (1889) 173; Schumann in Schumann & Hollr., Fl. Kais. Wilh. Land (1889) 122; Hook. f., Curtis Bot. Mag. 117 (1891) t. 7187; Warb., Bot. Jahrb. 18 (1894) 209; Schumann in Schumann & Lauterb., Fl. Deutsch. Schutzgeb. Südsee (1900) 524; Bailey, Compreh. Cat. Qld Pl. (1913) 385 & 386, fig. 363; H.J. Lam, Verbenac. Malay. Arch. (1919) 234, excl. syn. *F. papuana* Scheff.; H.J. Lam & Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 71, excl. syn. *F. papuana* Scheff. & *F. albertisii* F. Muell.; H.J. Lam, Bot. Jahrb. 59 (1924) 94, excl. syn. *F. papuana* Scheff. & *F. albertisii* F. Muell.; H.J. Lam & Bakh., Nova Guinea 14 Bot. 1 (1924) 169; Bakh., J. Arnold Arb. 10 (1929) 72; Junell, Symb. Bot. Upsal. 4 (1934) 109, fig. 173; Webb, Bull. Sci. Indust. Res. Org. Melbourne 241 (1949) 53; Mold., Résumé Verbenac. etc. (1959) 194, 195, 201, 202, 209; Burkill, Dict. Econ. Prod. Malay Penins. 1 (1966) 1013; Corner & Watanabe, Illustr. Guide Trop. Pl. (1969) 760; Mold., Fifth Summary Verbenac. etc. 1 (1971) 324, 333, 336, 338, 346, 363; Phytologia 28 (1974) 449; Lord, Trees Shrubs Austral. Gard. edn 5 (1982) 322, fig. 594; Mold., Phytol. Mem. 2 (1980) 315, 323, 326, 328, 336, 353, 547; Phytologia 52 (1982) 36.

Lectotype: *J. Dallachy s.n.*, Rockingham Bay, Queensland, Australia, undated (K, lectotype designated here!; MEL 583466-583468, isolectotypes!).

F. matthewsii Merr., J. Roy. Asiat. Soc. Sing. 76 (1917) 115; Bibl. Enum. Born. Pl. (1921) 515; Fedde & Schust., Justs Bot. Jahresber. 47 (1927) 245; Mold., Known Geogr. Distrib. Verbenac. etc. edn 2 (1949) 145, 185; Résumé Suppl. 3 (1962) 24; Fifth Summary Verbenac. etc 1 (1971) 324; Phytologia Mem. 2 (1980) 315; Phytologia 52 (1982) 22.

Type: *A. Villamil 253*, in ravines at an altitude of about 12 m, at Sandakan, Sabah, East Malaysia, Sept.-Oct. 1916 (K!, PNH n.v., probably destroyed in World War II — syntypes).

Typification

F. splendida is based on an unnumbered J. Dallachy collection consisting of at least 4 duplicates, all of which were annotated by F. Mueller and certainly used by him in preparing the original diagnosis of this species. Since he did not choose a specimen as a holotype, it is proposed to select a lectotype for this name. Of all the available syntypes, a duplicate in Herb. K is particularly complete and well preserved and chosen here as the lectotype.

Description (Fig. 2)

A strong-growing woody climber (1.5-) 3-15 (-20) m high. *Stem* pale-brown; branchlets minutely puberulous when young, eventually glabrescent. *Leaves* petiolate; lamina ovate, oblong-elliptic to subrotund, with acuminate, acute or sometimes subobtuse apex, rounded or cordate at the base, entire, (8-) 10-32 (-41) cm long, (3-) 5-12 (-15) cm wide, glabrous, sometimes minutely pubescent on the veins beneath, chartaceous or subcoriaceous, pale to dark-green and glossy above; petiole (1.5-) 3-7 (-8) cm long, minutely puberulous when young, later glabrous. *Inflorescence* lax terminal thyrse, 9-28 cm long, 7-25 cm wide, glabrous; primary lateral peduncles 2.5-7 (-11) cm long. *Flowers* pedicellate, large, showy, fragrant; pedicels 3-15 mm long. *Calyx* pale-green, 15-25 mm long, before expanding obovoid and acuminate, later dividing to about the middle into 2 acute or acuminate lobes, glabrous, sometimes externally minutely puberulous, with a few large external glands. *Corolla* white or greenish-white, glabrous, 4-lobed in the upper half, tubular below; lobes elliptic-oblong or oblong-obovate, flat, often deeply emarginate or somewhat bilobed at the top, 12-25 mm long, 6-15 (-20) mm wide; tube slender, funnel-shaped, 20-40 mm long. *Stamens* exserted, scarcely didynamous, inserted about the middle of the corolla-tube; filaments white, filiform, villous towards the base, 35-65 mm long; anthers oblong-ellipsoid, 3-4 mm long, with 2 parallel lobes free in the lower half. *Ovary* globose, 4-furrowed, densely tomentose, 4-lobed, 3-5 mm diam.; style exserted, filiform, glabrous, occasionally sparsely puberulous in the lower half, 50-78 mm long, with minutely bifid stigma. *Fruit* creamish-white, 2-4-lobed, ovoid-ellipsoid, 50-70 mm long, 30-55 mm diam., glabrous, composed of 4 (sometimes 1-3 by abortion) basally connate pyrenes, each one-seeded.

Representative specimens (collections seen: Australian 50, non-Australian 10)

AUSTRALIA: QUEENSLAND: *Archer 3*, Johnston River, 4.x.1949 (BRI). *Bailey s.n.*, Mulgrave River, undated (BRI). *Bellenden Ker Exped. s.n.*, Bellenden Ker Range, 1904 (BRI 266886, NSW 145031). *Birch 70*, Copper Lode Falls Dam area, Cairns, 7.xii.1972 (BRI). *Brass 19757*, Archer River, Wenlock - Coen Road, 31.vii.1948 (A, CANB). *Cooke 85*, Murray Upper, 21.vi.1977 (JCT). *Cooke 136*, Dingo Pocket, Tully River, 28.i.1977 (JCT). *Cooke 150*, Bilyana, 29.i.1977 (JCT). *Dallachy s.n.*, Rockingham Bay, 3.ix.1867 (MEL 98062). *Donahue 8*, Cardwell Range, near lookout, -.viii.1974 (JCT). *Eaton s.n.*, Herbert River, undated (BRI 266833). *Farrell 106*, Dunbulla, State Forest Reserve 185, 14.x.1971 (QRS). *Fitzsimon 206*, State Forest Reserve 755, Gosschalk L.A. EP/34, 30.xi.1976 (QRS). *Gittins 2143*, Whitfield Range Road, Cairns, 23.viii.1970 (BRI, NSW). *Hunt 2*, Kuranda, -.xi.1939 (BRI). *Irvine 987*, Forest and Timber Bureau, Atherton, 9.x.1974 (BRI, QRS). *Jackes s.n.*, Clump Point, E. of Tully, 14.ix.1985 (AD). *Jones 2833*, Clump Point, El Arish, 14.vii.1964 (CANB). *Jones 3895*, Gadgarra, Atherton, 31.viii.1968 (CANB). *Kelly s.n.*, Lake Barrine, undated (BRI 266888). *Sayer s.n.*, Russell River, 1886 (MEL 98065). *Smith 11882*, Upper Massay Creek, ENE of Coen, 13.x.1962 (BRI). *Smith & Tracy 6570*, Boonjie, west of Mt Bartle Frere, 1962 (BRI, CANB). *Thurston 623*, Tarzali, 21.vii.1944 (QRS). *Unwin 678, 679*, Claudie River, 22.vii.1978 (QRS). *Webb & Tracy 9361*, Rocky River on eastern foot hills of McIlwraith Range, x.1969 (BRI, CANB). *Whaite 3612*, Musgrave River, 25.viii.1979 (NSW). *White s.n.*, The Dirran, -.i.1918 (BRI 266880). *Wrigley 413*, Tozer Range, ridge running

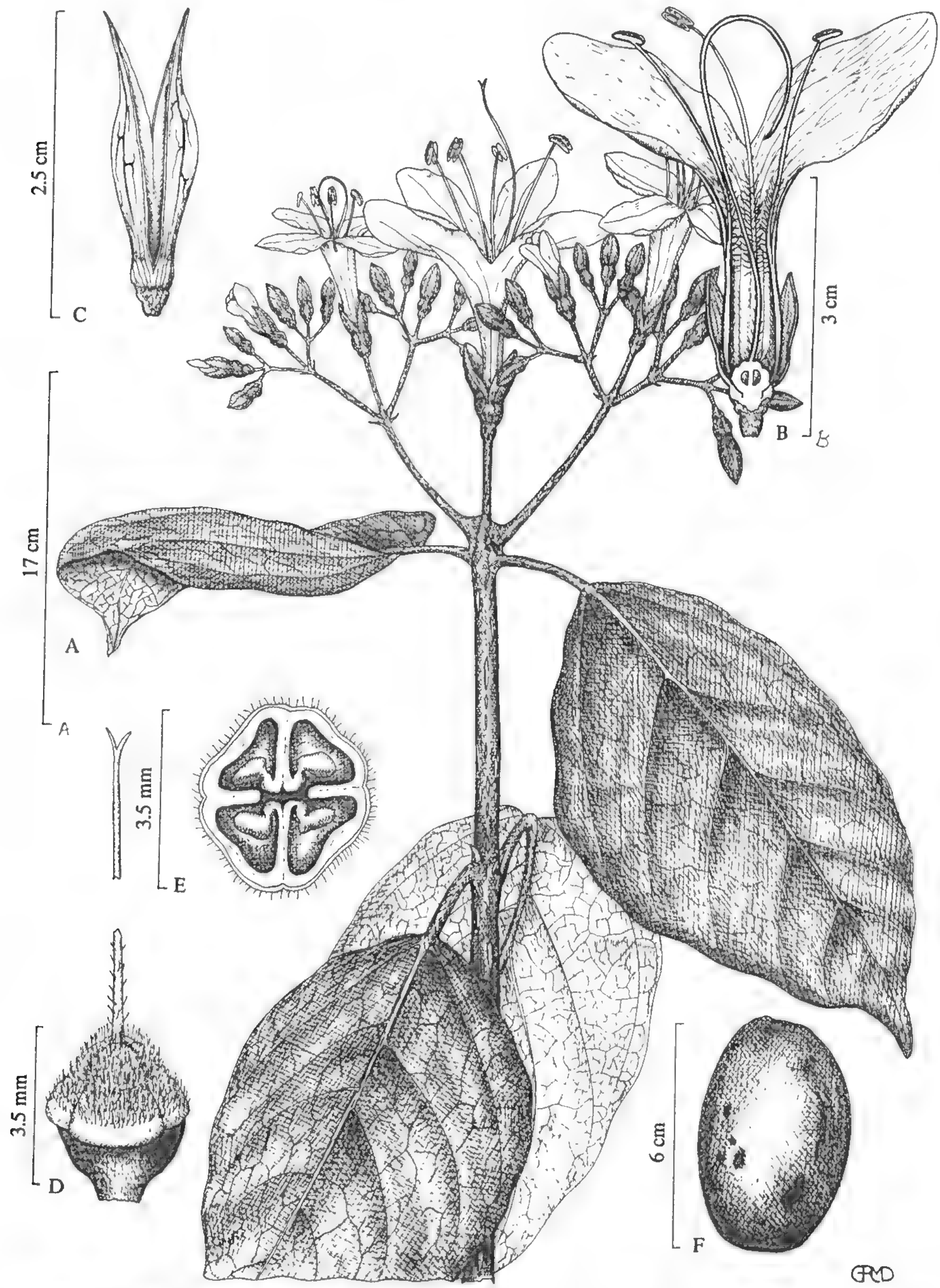


Fig. 2. *Faradaya splendida* F. Muell. (A-F, *B.R. Jackes s.n.*:AD). A, flowering branch; B, flower vertically cut open showing androecium and gynoecium in one half only; C, calyx split open into 2 lobes during anthesis; D, ovary, E, transverse section of ovary; F, fruit.

between upper reaches of Yarraman and Dick Creeks, Cape York Peninsula, 15.ix.1976 (CBG).

PAPUA NEW GUINEA: *Brass 7770*, Lake Daviumbu, Middle Fly River, Papua, -.ix.1936 (A, BRI, LAE). *Henty & Sayers NGF 20530*, Gurumbu, Madang District, New Guinea, 3.viii.1964 (BRI, CANB, L, LAE). *Kanis 1081*, c. 12 km N of Amazon Bay, Central District, 24.vi.1969 (A, BO, BRI, CANB, CHR, K, L, LAE, US). *Millar NGF 35136*, Amboin, Angoram subdistrict, East Sepik District, 28.vii.1967 (A, BRI, CANB, L, LAE). *Millar NGF 48608*, Brown River, Port Moresby subdistrict, Papua, 12.viii.1970 (A, BO, BRI, CANB, K, L, LAE, SING, NSW).

INDONESIA: *H.J. Lam 3342*, Karakelong, Talaud Island, 4.vi.1926 (BO).

EAST MALAYSIA: *A. Villamil 253*, at Sandakan, Sabah, -ix.-x.1916 (K, syntype of *F. matthewsii* Merr.).

Distribution (Map 2)

In Australia, *F. splendida* is restricted to the northern tropics of Queensland. The major distribution is on Atherton Tableland and its surrounding areas, chiefly between Cairns and Ingham. Further north, the distribution on Cape York Peninsula has been recorded between Claudie River and Morehead River.

Collections from overseas have been examined from Papua New Guinea, Sabah and Talaut Islands. In addition to the above distribution range, Moldenke (1959, 1971) recorded this species from Irian Jaya, Japen Island, Aroe Island and the Celebes in Indonesia, and from New South Wales, Australia. The occurrence of this species in New South Wales has not been confirmed.

Comments

F. splendida is widely cultivated outdoors for ornament in tropical parts of both hemispheres and in greenhouses elsewhere. In Australia, it has been cultivated in the Botanic Gardens or nurseries in Brisbane, Cairns and Sydney. From overseas, cultivated material has been examined from Botanic Gardens at Lae and Singapore. In addition, Moldenke (1959, 1971) recorded its cultivation in Malaya, India, England, Dominica and Puerto Rico.

Regarding natural distribution within Australia, Moldenke (1959, 1971) reported this species from New South Wales. In support of this, Moldenke (1982) cited an un-numbered Cambage collection from "Fort of Bellerden" which could be an incorrect spelling of Bellenden Ker in Queensland and agree with the present range of distribution.

H.J. Lam & Bakhuizen (1921) regarded *F. albertisii* F. Muell., *F. matthewsii* Merr. and *F. papuana* Scheff. as synonyms of *F. splendida*. During the present investigation, only *F. matthewsii* has been considered synonymous with *F. splendida*. Of the other two, *F. albertisii* is distinct by its strictly axillary inflorescence, and *F. papuana* by its elliptic obtuse leaf-blades, crowded inflorescence and short pedicelled (up to 4 mm long) flowers.

Material of *F. splendida*, however, has been misidentified and distributed to some herbaria as *F. papuana*. Moldenke's (1959, 1971) records of *F. papuana* from Queensland were possibly based on such misidentifications of *F. splendida*. So far, *F. papuana* is not known to occur in Australia.

F. splendida is popularly called "Buku" or "Fragrant Faradaya".

Affinities

F. splendida is very similar to *F. papuana* in its inflorescence being terminal only or both axillary and terminal; leaves regularly decussate-opposite; stamens indistinctly or not at all didynamous; leaf-blades with several prominent discoid glands near the base beneath. In *F. papuana*, the inflorescence is dense; branches densely puberulent, pedicels only to 4 mm long, calyx only 16-20 mm long during anthesis, corolla-lobes only to 5 mm wide, and leaf-blades usually more narrowly ovate or elliptic, basally rounded, truncate or subcordate and apically obtuse. *F. splendida* has several characters common with *F. albertisii*. For detail see "affinities" under *F. albertisii*.

Acknowledgements

The author is grateful to Dr J.P. Jessop for comments on the draft of this manuscript, to Dr B.R. Jackes for supplying fresh material of the type species; to Mr B.P.M. Hyland for providing fresh mature fruits of the type species; to Mr G.R.M. Dashorst for preparing the illustrations; to Miss T. Eadsforth for typing the manuscript.

Thanks are also due to the Directors/Curators of the following institutions for the loan of herbarium specimens: A, BO, BRI, CANB, CBG, HO, JCT, K, L, LAE, MEL, NSW, QRS, SING, US.

References

Airy Shaw, H.K. (1973). "A Dictionary of the Flowering Plants and Ferns". 8th edn: 454. (The Cambridge University Press: London).

Bailey, F.M. (1901). Verbenaceae. "The Queensland Flora". Part IV: 1164-1185. (H.J. Diddams & Co.: Brisbane).

Bailey, F.M. (1913). Verbenaceae. "Comprehensive Catalogue of Queensland Plants". 381-387. (Govt Printer: Brisbane).

Baillon, H.E. (1891). Verbenaceae. "Histoire des Plantes". Vol. 11: 78-121. (Libraire Hachette & Co.: Paris).

Beer, E. & Lam, H.J. (1936). The Verbenaceae, collected in Papua by L.J. Brass for the Archbold Expedition. *Blumea* 2 (3): 221-228.

Bentham, G. (1870). Verbenaceae. "Flora Australiensis". Vol. 5: 31-70. (L. Reeve & Co.: London).

Bentham, G. (1876). Verbenaceae. In Bentham, G. & Hooker, J.D. "Genera Plantarum". Vol. 2: 1131-1160. (L. Reeve & Co.: London).

Briquet, J. (1895). Verbenaceae. In Engler, A. & Prantl, K. "Die natürlichen Pflanzenfamilien". IV, 3a: 132-182. (Wilhelm Engelmann: Leipzig).

Dalla Torre, C.G. & Harms, H. (1904). Verbenaceae. "Genera Siphonogamarum ad Systema Englerianum Conscripta" : 429-434. (Wilhelm Engelmann: Leipzig).

Durand, Th. (1888). Verbenaceae. "Index Generum Phanerogamarum" : 319-322. (Dulau & Co.: London).

Ewart, A.J. & Rees, B. (1912). Contribution to the flora of Australia. no. 19. *Proc. Roy. Soc. Vic.* n.s. 25 (1): 105-114.

Gray, A. (1862). Characters of some new or obscure species of plants, of Monopetalous Order, in the collection of the United States South Pacific Exploring Expedition under Captain Charles Wilkes, U.S.N. with various notes and remarks. *Proc. Am. Acad. Arts & Sc.* 6: 49-51.

Hooker, J.D. (1891). *Faradaya splendida*. Native of Queensland. *Curtis Bot. Mag.* 117: t. 7187.

Junell, S. (1934). Zur Gynäceummorphologie und Systematik der Verbenaceen und Labiaten. *Symb. Bot. Ups.* 4:1-219.

Lam, H.J. (1919). "The Verbenaceae of the Malayan Archipelago". (M. De Waal: Groningen).

Lam, H.J. & Bakhuizen van den Brink, R.C. (1921). Revision of the Verbenaceae of the Dutch East-Indies and surrounding Countries. *Bull. Jard. Bot. Buitenz.* III. 3: 1-116.

Lemée, A. (1943). Verbenaceae. "Dictionnaire descriptif et synonymique des generes de plantes phanerogames". Vol. 8b: 650-657. (Imprimere Commerciale et Administrative: Brest).

Merrill, E.D. (1917). Contribution to our knowledge of the flora of Borneo. *J. Roy. Asiat. Soc. Straits* 76: 113-116.

Moldenke, H.N. (1959). "A Résumé of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". (H.N. Moldenke: Mountain, New Jersey).

Moldenke, H.N. (1971). "A Fifth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". Vol. 1 & 2. (H.N. Moldenke: Wayne, New Jersey).

Moldenke, H.N. (1982). Notes on the Genus *Faradaya*. *Phytologia* 51 (6): 384-400.

Moldenke, H.N. (1982). Additional notes on the genus *Faradaya* (Verbenaceae). I. *Phytologia* 52 (1): 20-45.

Moldenke, H.N. (1983). Verbenaceae. In Dassanayake, M.D. & Fosberg, F.R., "A Revised Handbook to the Flora of Ceylon". Vol. 4: 196-487. (Amerind Publishing Co. Pvt. Ltd.: New Delhi).

Mueller, F.v. (1865). "Fragmenta Phytographiae Australiae". Vol. 5: 21-22. (Govt Printer: Melbourne).

Mueller, F.v. (1886). Verbenaceae. "Descriptive Notes on Papuan Plants". VIII: 46-48. (Govt Printer: Melbourne).

Munir, A.A. (1982). A taxonomic revision of the genus *Callicarpa* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 6 (1): 5-39.

Munir, A.A. (1984a). A taxonomic revision of the genus *Premna* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7 (1): 1-43.

Munir, A.A. (1984b). A taxonomic revision of the genus *Gmelina* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7 (1): 91-116.

Munir, A.A. (1985). A taxonomic revision of the genus *Viticipremna* H.J. Lam (Verbenaceae). *J. Adelaide Bot. Gard.* 7 (2): 181-200.

Munir, A.A. (1987). A taxonomic revision of the genus *Vitex* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 10 (1): 31-79.
Seemann, B.C. (1862). Über neue und verkannte Clerodendron-Arten. *Bonplandia* 10 (16): 249-250.
Seemann, B.C. (1865). On *Faradaya*, a new Australian Genus. *J. Bot. Brit. & Foreign. London.* 3: 256-259.
Steenis, C.G.G.J. van (1955). Reduction of the genera *Schizopremna* Baill. (Verb.) and *Worcesterianthus* Merr. (Olaca.). *Acta Bot. Neerl.* 4: 477-480.

Index to Scientific Names

Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked refer to figures and maps.

J. Adelaide Bot. Gard. 10(2): 179-199 (1987)

PLACENTATION PATTERNS AND SEED NUMBERS IN *SOLANUM* (SOLANACEAE) FRUITS

D.E. Symon

C/- State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

Placenta patterns of about 100 species of *Solanum* are presented. Considerable diversity occurs with elaboration and eventual division of the placenta. The septum may disintegrate or the development of extra septa and intrusions of the pericarp may occur. Elaboration of the placenta is closely correlated with high seed numbers and disintegration of the septum is found mostly in species with small red fruits. In section *Archaesolanum* the seeds become embedded in an enlarged placenta which appears to occupy the free space in the locule completely and in some species of section *Leiodendra* a reticulum develops which separates the numerous seeds singly or in small groups. In subgenus *Lycianthes* several species have intrusions from the pericarp partially separating the seeds.

Introduction

The ovary of species of the Solanaceae is usually described as bicarpellate with axile placentation. The common exception noted is *Nicandra physalodes* (L.) Gaertner which may have 3, 4 or 5 locules.

After studying examples of 14 genera and 21 species of the Solanaceae, Murray (1946) concluded that the placentae are axile in position while the carpel walls, the septa and ovule bearing portions of the placentae are foliar in origin. It was noted that in some species, e.g. *Capsicum frutescens*, the growth of the placenta did not keep pace with the growth of the pericarp and the septum so that the upper parts of the locules are not isolated, ie. the septum is incomplete. Other works, cited by Murray, note that the ovule bearing tissue of the gynoecium (in *Lycopersicon esculentum*, *Lycium*, *Capsicum* and *Solanum tuberosum*) appears to be a prolongation of the axis, the outer portion of the carpels arch over the central axile prolongation and then fuse, the apex prolonged into the style. The time of carpel fusion differed in different genera.

In a detailed study of many genera and species by Huber (1980), the late fusion of the carpel apex is clearly demonstrated and the ovary is mostly bicarpellate at least in its lower half. In addition to *Nicandra* a multiloculate ovary was also shown for *Jaborosa*. In all cases only a single species per genus was investigated. Both these studies showed that central axile placentation was often well developed and that the upper part of the septum is developed late or weakly.

Few studies of the mature fruits of *Solanum* on a broad scale have been located. An early paper by Perlova (1946) considered the morphology of the berries as a taxonomic character but confined this to tuber-bearing species. She concluded that the berries were taxonomically useful even within the restricted group she investigated. The nature of the placenta was not investigated.

Roth (1977) has assembled much of the published information on fruits of the Solanaceae. The interpretation of the significance of the stone cell concretions was not advanced beyond that of Bitter (1911, 1914) who considered them evolutionary relics of a once stony endocarp or, according to Kaniewski (1966) in Roth, of an ancestral fruit type. This may have had both a stony endocarp and stony outerpart as the stone cell masses are mostly in the outer fleshy pericarp. The biology of the stone cell concretions is still not satisfactorily understood. Stone cells are believed to be wholly absent from subgenus *Leptostemonum* and from other sections except where mentioned.

The placentae and septa may be enlarged and proliferations which form the bulk of the intra-locular flesh develop from these. Houghtaling (1935) in a study of the size and shape of tomato fruits states that the placental tissue grows up around the ovules and that the cells of this outgrowth eventually become very large and rupture as the fruit becomes ripe. However Czaja (1963) in Roth, has demonstrated that in tomato, at least, the jelly-like (slimy) material enveloping the seeds, so conspicuous in fruits of many *Solanum*, is in fact developed from the epidermis of the testa. In other cases the endocarp may proliferate and developmental studies will be needed to distinguish which of these is predominant. In the capsular fruited species, e.g. *S. rostratum*, the inner half of the pericarp develops a collenchymatous hypoderm and the differential shrinking as the berry dries, causes the fruit to open as a capsule. The majority of species produce fleshy berries in which the pericarp wall and the placentae are well developed. Both may proliferate into the locule so that all free space is occupied. At maturity the cell walls of the proliferations become thin and the cells partially collapse to become succulent, juicy and finally deliquescent. The abscission of some fruits, generally with their pedicel, e.g. *S. opacum*, *S. macoorai*, *S. xantii*, is facilitated by layers of specially modified cells in the pedicel which hydrolyse and enable separation to occur. A study of fruit types and their dispersal was published by Symon (1979) and a censer fruit form was described by Symon (1984); for further details of the latter see under section *Melongena*.

At the 1982 Conference on the Solanaceae held at St Louis Dr M. Nee and I found that, quite independently, we had both been making transverse sections of mature fruits and were surprised at the variety of placenta patterns revealed. Nee (1986) has now presented an array of placenta patterns observed in five genera of the Solanaceae and in 13 species of *Solanum*. He showed that the multiloculate condition occurred in several species of *Solanum* in addition to cultivars of the species *S. melongena*, *S. aethiopicum*, (*S. gilo*) and *Lycopersicon esculentum* (*S. lycopersicum*). In addition the septum appears to be absent in the mature fruits of a number of species.

Material and method

Transverse sections of full-sized or ripe fruits of *Solanum* were made at about midpoint of the fruit and scale drawings of the sections were sketched. In a few cases sections of ovaries were also made and fruits were dissected to explore the ramifications of the placenta and septum. About 100 species have been sectioned and to these have been added some redrawn from Nee (1986) and one from Hassler (1917) to enlarge the taxonomic coverage.

Limitations on the numbers of fruits and the range of species available mean that this study must be considered an introductory survey only. Herbarium specimens are frequently unavailable or unsuitable for use. The convention used in the illustrations has been to indicate the pericarp, septum, placenta and seeds in white space and the locule space in black. However in many cases the locule is occupied by cellular tissue developed from the inner wall of the pericarp, or from the placenta, or when jelly-like, apparently from the testa of the seeds. When the fruits are finally dry the locule space may be empty except for the seeds, e.g. *S. cinereum* (Fig. 10a, b) or *S. petrophilum* (Fig. 9d). Botanical authorities for all *Solanum* names used are given in the list of voucher material.

Subgenera, sections & species of *Solanum* examined

Subgenus **Solanum** (syn. subgenus *Pachystemonum*) section **Solanum** (Black Nightshades)

Species examined: S. americanum, S. nigrum, S. physalifolium, S. opacum, S. retroflexum, S. villosum. Fig. 1a-f, Table 1.

This section which contains the type species of the genus has its greatest diversity in South America and is now cosmopolitan. At maturity all fruits are relatively small (6-12 mm diam.), globular and succulent, green, purple-black or yellow to red in colour. Without exception these have been bilocular with the placenta not elaborated. The pulp is invariably succulent and some species may contain stone cell concretions, e.g. *S. americanum*, *S. furcatum*, *S. opacum*, *S. physalifolium*, which are usually peripheral in position (in the pericarp) and may be confined to the apex of the berry in some cases. The green, aromatic fruit of *S. opacum* is shed with its pedicel at maturity.

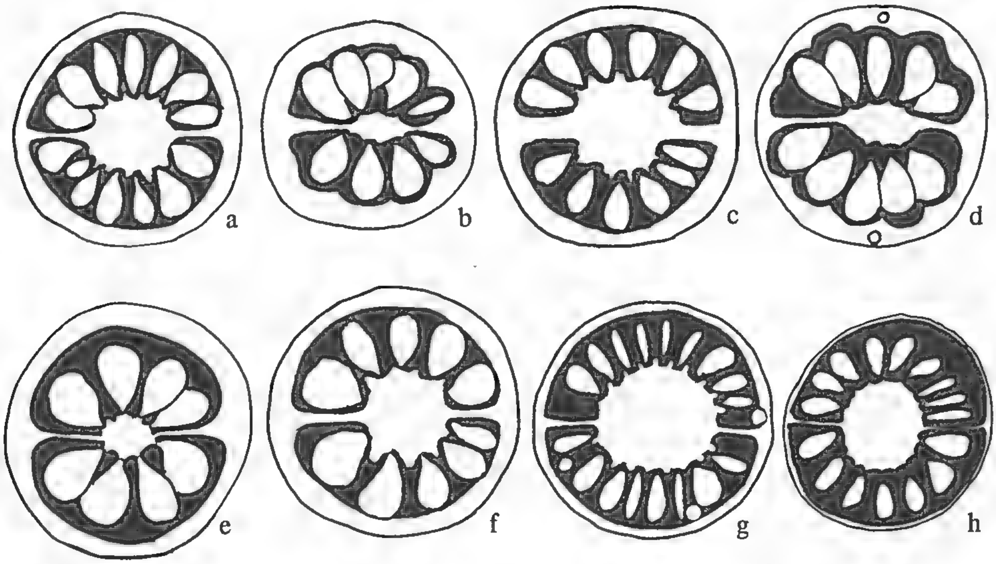


Fig. 1a, *S. americanum*; b, *S. nigrum*; c, *S. opacum*; d, *S. physalifolium*; e, *S. retroflexum*; f, *S. villosum*; g, *S. triflorum*; h, *S. xantii*.

All the species examined in Fig. 1a-f, had a simple septum and central axile placenta and did not display much variation. A summary of seed numbers recorded is given in Table 1.

Table 1

Species	No. of fruits	Range and mean			
		Seeds			Stone cells
S. americanum	76	(30-)	52	(-90)	2-4(-8)
S. chenopodioides	10	(22-)	49	(-64)	0
S. furcatum	8	(16-)	20	(-25)	10
S. nigrum	111	(10-)	37	(-72)	0
S. nigrum (green frtd)	10	—	43	—	0
S. opacum	56	(7-)	42	(-68)	2
S. physalifolium	60	—	19	—	4
S. scabrum	6	(79-)	103	(-126)	0

Subgenus **Solanum** section **Parasolanum** Child

Species examined: *S. triflorum*. Fig. 1g.

A small section of 10-13 species (in need of revision) from temperate North and South America. Considered close to section *Solanum*. One species *S. triflorum* has become weedy in a number of temperate areas. This has a green, succulent berry with abundant stone cells. The placenta is axile and though large, is not elaborated. Twenty fruits provided a mean and range of (78-) 129 (-163) seeds and (20-) 28 (-35) stone cell granules.

Subgenus **Solanum**; **S. xantii** group

Species examined: *S. xantii*. Fig. 1h.

S. xantii together with *S. parishii* and *S. umbelliferum* form a small group of species from southern North America that are not satisfactorily placed at the moment. They may have distant relationships with the tuber-bearing species. *S. xantii* has a green, aromatic, succulent berry that is shed with pedicel at maturity. The large central placènta is not elaborated. Three fruits provided a mean of 48 seeds per berry.

Subgenus **Solanum** section **Leiodendra** Dunal

Species examined: *S. callium*, *S. nudum*. Fig. 2a & b.

This section is concentrated in Central America and northern South America. Three species are widely disjunct or were dispersed very early after the European discovery of the Americas. viz. *S. callium* in Australia, *S. superficiens* in Java and *S. spirale* (=?*S. antillarum* in Central America) in India. The two species examined *S. callium* (Aust.) and *S. nudum* (Central America), Fig. 2a-b, have unusual berries in which the septum and placenta are not at all distinct. The berry is filled with a reticulum which separates the seeds individually or in very small groups. No other berries like these were seen, but in subgenus *Lycianthes* several were seen in which intrusions developed from the pericarp and extended into the locule partially separating the seeds.

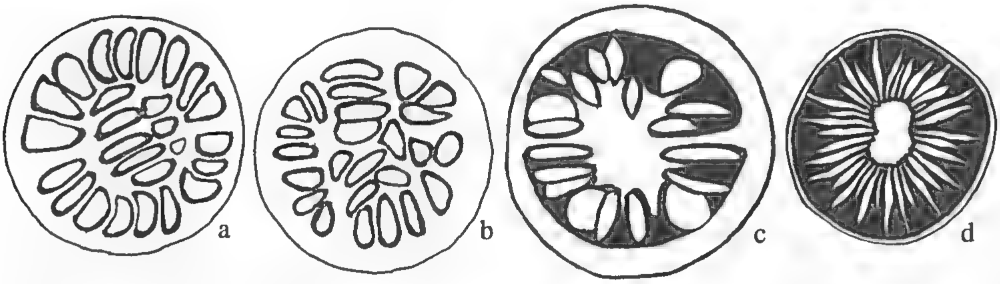


Fig. 2a, *S. callium*; b, *S. nudum*; c, *S. pseudocapsicum*; d, *S. pugiunculiferum*.

Subgenus **Potatoe** (G. Don) D'Arcy section **Petota** Dumort

Species examined: *S. tuberosum* cv. Coliban. Fig. 3a & b.

Species of this large and well known section are concentrated along the Andes of South America and extend to southern North America. All have green fruits some being attractively aromatic as in this species. They are succulent at maturity. The seeds are embedded in the periphery of the large placenta which completely fills the locule. They do not contain stone cells. Seed were counted on fruits from field grown plants in South Australia as no wild material has been available; 16 berries from 3 cultivars yielded a range and mean of (70-) 128 (-200) seeds.

Subgenus **Potatoe** (G.Don) D'Arcy section **Neolycopersicon** Correll

Species examined: *S. pennellii*. Fig. 3c.

This interesting species forms a connecting link between *Lycopersicon* and *Solanum* and occurs in Peru. The berry is distinctly bilobed, green, pubescent and with well developed calyx lobes. The locule is filled with green flesh which must be developed from the placenta as it is separate from the inner wall of the pericarp. Like *S. tuberosum* the placenta is well developed with the seeds on the periphery. Eight berries (52-) 112 (-155) seeds.

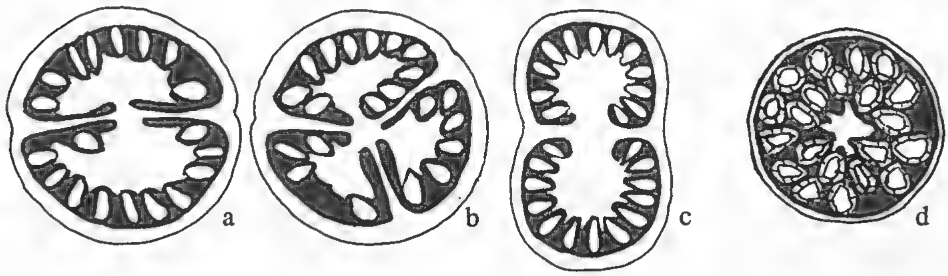


Fig. 3a & b, *S. tuberosum*; c, *S. pennellii*; d, *S. seaforthianum*.

Subgenus **Potatoe** (G. Don) D'Arcy section **Jasminosolanum** Bitter ex Seithe

Species examined: *S. seaforthianum*. Fig. 3d.

The species of this section are mainly found in South America and are climbers or lianes. Several species have been widely grown as ornamentals and *S. seaforthianum* has become established in several tropical areas. At maturity the berries are red and succulent. The septum is not apparent in fully ripe seeds. The seed number is relatively low, 15 berries yielding a range and mean of (22-) 27 (-30) seeds. The seeds have a conspicuous envelope during development which at maturity breaks down to leave a 'fuzz' of vertical cell walls giving the appearance of a pubescent seed.

Subgenus **Lycianthes** (Dunal) Bitter

Species examined: *S. amatitlanense*, *S. biflorum*, *S. bitterianum*, *S. escuintlense*, *S. geminiflorum*, *S. guianense*, *Lyc. hawkesiana*, *Lyc. howardiana*, *S. lycioides*, *S. moskowskii*, *S. oliverianum*, *S. rantonnei*, *S. sanctaeclarae*, *S. shanesii*, *S. synantherum*, *S. vitiense* and *S. umbonatum*. Figs 4a-p.

Species included by me in this subgenus are at times maintained at the rank of genus, viz. *Lycianthes* Hassl. and were monographed by Bitter (1919). The type of the genus is *S. lycioides*. One of the distinguishing features of the genus as defined by Hassler was the reduction in seed number to about 8 per fruit and the enclosure of each seed in a bony endocarp, Fig. 4a. This is quite exceptional among the many species included in the genus in the emended and enlarged concept of Bitter (1919). The genus (or subgenus) was divided by Bitter into several subgenera and sections:

"*Lycianthes* subgenus 1. *Eulycianthes*" from S. America of two species and including the type of the genus *L. lycioides* (L.) Hassl. As stated above this has about 8 seeds per berry each enclosed in a bony endocarp (Fig. 4a), which is distinct from any other species included in the genus by Bitter (or indeed unlike any other *Solanum* I have seen). Bitter's second subgenus *Polymeris* from C. and S. America was further divided into 7 sections: 1. *Eupolymeris* including

S. guianense (Fig. 4b), *Lyc. hawkesiana* (Fig. 4c), *Lyc. howardiana* (Fig. 4d), *S. rantonnei* (Fig. 4e), *S. sanctaeclarae* (Fig. 4f). It may be noted that of these *S. rantonnei* is distinct with abundant stone cell masses and that the remaining three species have distinctive instrusions partially separating the seeds which will be seen in other species of subgenus *Lycianthes*. Sections *Kittoides*, *Perennans* and *Asaropsis*, all American, are not represented. In section *Simplicipila*, *S. amatitlense* (Fig. 4g) has the H-shaped placenta seen in other sections of *Solanum* (no stone cells nor intrusions). Section *Asiomelanesia* from S.E. Asia, e.g. *S. biflorum* and *S. bitterianum* (Fig. 4h & i), has no stone cells nor intrusions and moderately developed placentae; section *Synantheroides* from C. America, e.g. *S. escuintlense* (Fig. 4j), *S. geminiflorum* (Fig. 4k), the first with quadrilocular berry and dispersed placentae, the second with a very narrow placenta at right angles to the septum and weakly developed intrusions. The third subgenus *Cypellocalyx* is confined to Malesia and includes

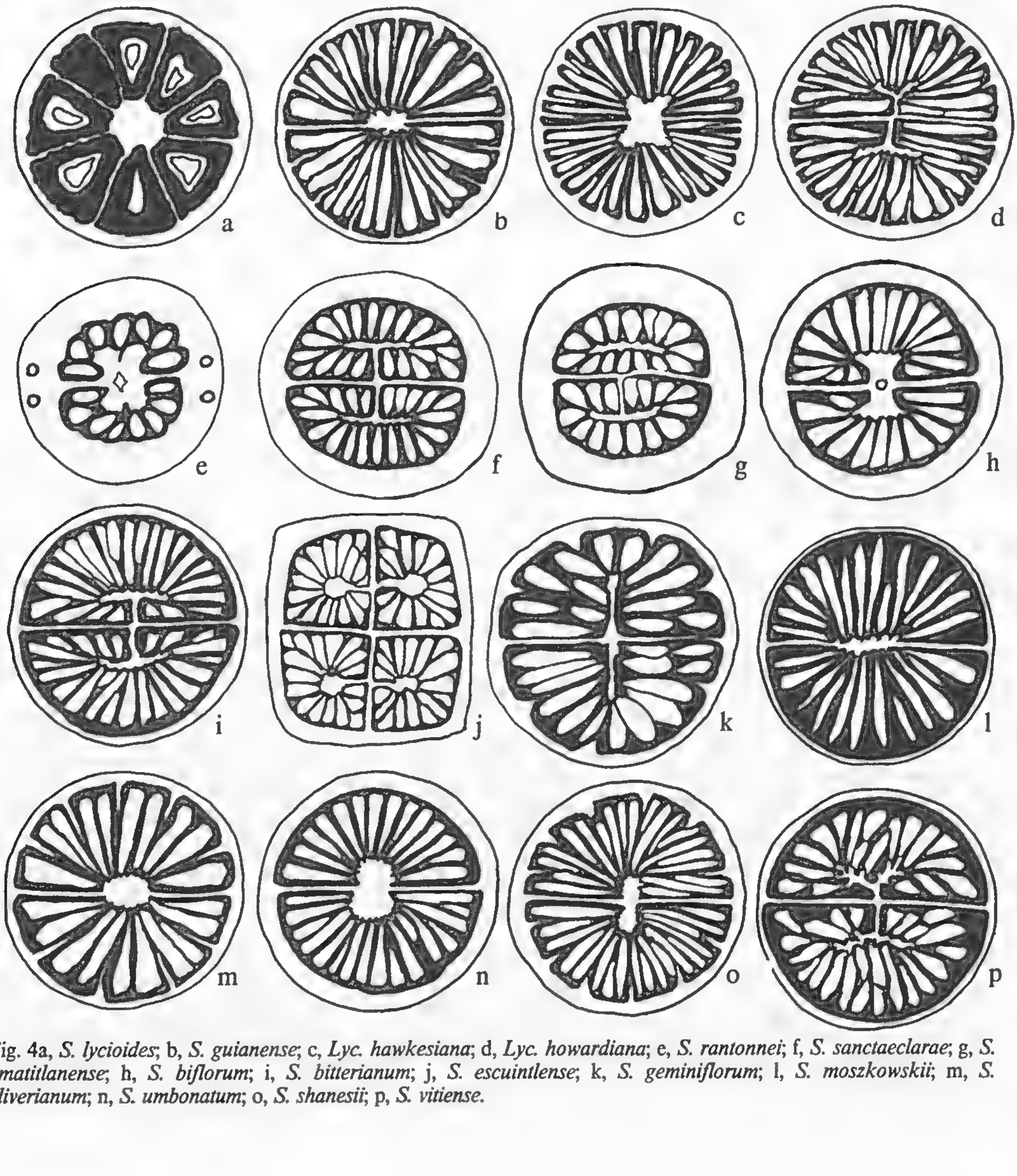


Fig. 4a, *S. lycioides*; b, *S. guianense*; c, *Lyc. hawkesiana*; d, *Lyc. howardiana*; e, *S. rantonnei*; f, *S. sanctaeclarae*; g, *S. amatitlanense*; h, *S. biflorum*; i, *S. bitterianum*; j, *S. escuintlense*; k, *S. geminiflorum*; l, *S. moszkowskii*; m, *S. oliverianum*; n, *S. umbonatum*; o, *S. shanesii*; p, *S. vitiense*.

S. moszkowskii, *S. oliverianum*, *S. umbonatum* and probably *S. shanesii* and *S. vitiense* (Fig. 4l-p). All these have bilocular fruits with moderately developed placentae and it may be significant that two of these, *S. oliverianum* and *S. shanesii*, also have the intrusions developed from the pericarp partially separating the seeds.

Seed numbers are given in Table 2 but unfortunately few fruits have been available in many cases. The seeds vary as much as the fruits and range from thick blocky seeds of *S. rantonnei* to the highly compressed, papery seeds with a membranous wing of *S. moszkowskii* which are similar to the otherwise unrelated *S. capsicoides*.

It will be seen then that the subgenus (or genus) *Lycianthes* contains a wide array of fruit and seed forms all remarkably different from the type species.

Table 2

Species	No. of fruits	Range and mean Seeds	Range and mean Stone cells
S. biflorum	8	(66-) 120 (-178)	0
S. bitterianum	7	(45-) 110 (-198)	0
S. geminiflorum	1	114	0
S. lycioides (ex literature)		8	0
S. moszkowskii	1	51	0
S. rantonnei	3	80	20
S. sanctaeclarae	1	461	0
S. shanesii	22	(5-) 40 (-56)	0
S. synantherum	2	220	0

Subgenus **Archaesolanum** Marz. section **Archaesolanum** (Marz.) Danert (Kangaroo Apples).

Species examined: *S. aviculare*, *S. capsiciforme*, *S. linearifolium*, *S. laciniatum*, *S. simile*, *S. symonii*, *S. vescum*. Fig. 5a-h, Table 3.

An Australasian subgenus of 8 species with green (sometimes flushed purple) orange or vermilion succulent berries which are relatively large, 1.5-5 cm long. They may be conical

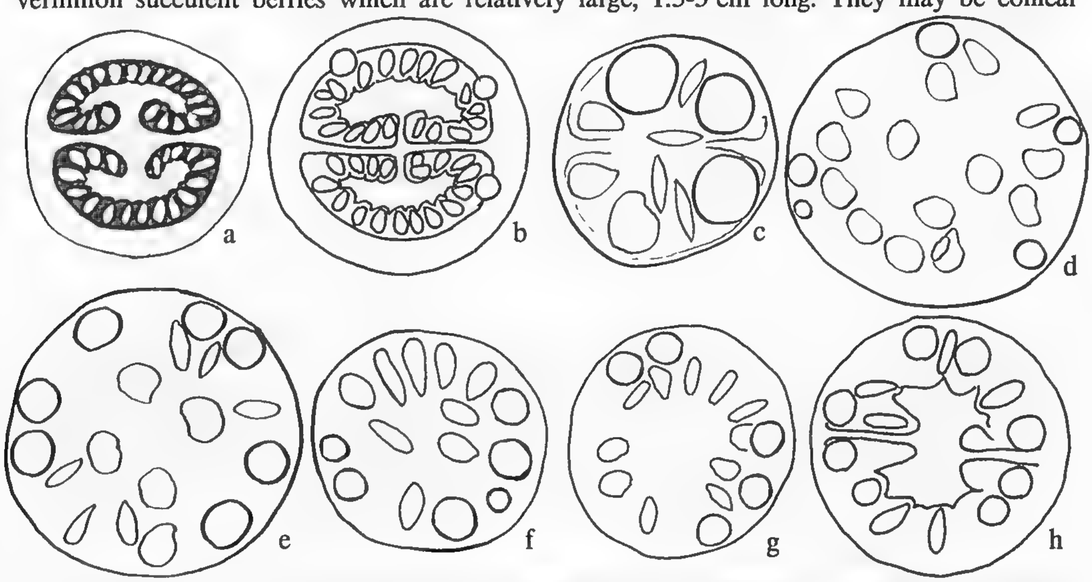


Fig. 5a, *S. aviculare* (ovary); b, *S. aviculare* (berry); c, *S. capsiciforme*; d, *S. laciniatum*; e, *S. linearifolium*; f, *S. simile*; g, *S. symonii*; h, *S. vescum*.

(*S. capsiciforme*), globular, or elliptical in shape. In most species stone cell concretions are abundant and seed numbers high, e.g. *S. multivenosum* may contain up to 1,200 seeds and 180 stone cell concretions per berry. The placenta may be enlarged to an H-shape bearing seeds on the inner face as well as the outer surface. At maturity the septum is often not readily distinguished, the placenta proliferates so that the seeds appear embedded in placental tissues and the locule is not clearly distinguished. The section has provided a coherent group with no other species looking quite like them which reinforces its distinction.

Seed numbers and stone cells are summarised in Table 3.

Table 3

Species	No. of fruits	Range and mean Seeds	Range and mean Stone cells
S. aviculare	18	(388-) 648 (-845)	(27-) 40 (-69)
S. capsiciforme	10	(82-) 99 (-132)	(31-) 40 (-48)
S. laciniatum	20	(116-) 211 (-344)	(33-) 47 (-78)
S. linearifolium	15	(46-) 187 (-232)	(17-) 25 (-38)
S. multivenosum	3	(1003-) 1110 (-1196)	(138-) 162 (-186)
S. simile	84	(29-) 99 (-260)	(15-) 34 (-87)
S. symonii	20	(100-) 174 (-258)	(26-) 54 (-77)

Subgenus **Brevantherum** (Seithe) D'Arcy section **Pseudocapsica** Roem. & Schult.

Species examined: *S. pseudocapsicum*. Fig. 2c.

This small section comes from Mexico and South America. The species has been widely cultivated as an ornamental and is now naturalised in mesic warm-temperate sites. The few or solitary, red, succulent berries are held erect. At maturity the locules are not clearly defined. A count of seeds in 24 fruits provided the range and mean (18-) 48 (-79) per berry.

Subgenus **Brevantherum** (Seithe) D'Arcy section **Brevantherum** Seithe

Species examined: *S. erianthum*, *S. mauritianum*. Fig. 6a & b.

A Central American section of about 30 species two of which are now pan-tropic weeds. The fruits are generally held erect in dense corymbose cymes, are succulent, ochre yellow and of medium size, about 1 cm diam. They are known to be eaten by birds and fruit bats. The placenta is H-shaped with numerous seeds; stone cells are absent. Seed numbers in the two species examined were: *S. erianthum*, 6 fruits, (143-) 215 (-300) and *S. mauritianum*, 6 fruits (158-) 191 (-228).

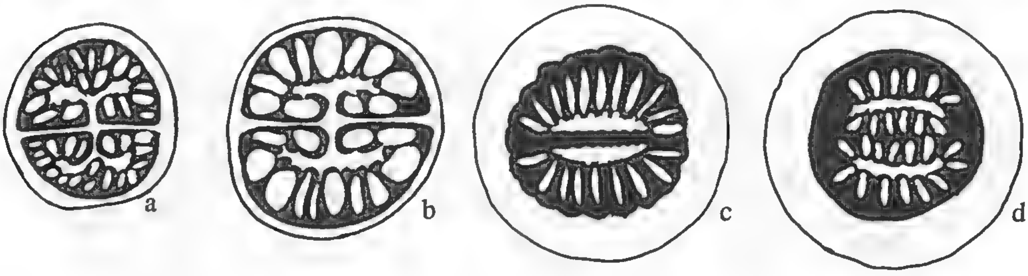


Fig. 6a, *S. erianthum*; b, *S. mauritianum*; c, *S. capsicoides*; d, *S. mammosum*.

Section **Pugiunculiferum** Symon Fig. 2d.

This monotypic section contains the anomalous species, *S. pugiunculiferum*, which has dryish fruits which are purplish green at maturity and contain little flesh. They do not appear to become succulent. No septum is apparent at maturity and the strongly flattened papery seeds (cf. *S. capsicoides*) are packed on edge around the placenta. A count of 27 fruits provided the range and mean (26-) 39 (-57) seeds per berry.

Subgenus **Leptostemonum** (Dunal) Bitter section **Acanthophora** Dunal

Species examined: S. capsicoides, S. mammosum. Fig. 6c & d.

This section of about 20 species is centred in Central and South America. The two species above have frequently been cultivated as ornamentals and have become widely naturalised in tropical zones. In both it will be seen that the septum has degenerated and the two placenta bodies stand erect and separated. In *S. capsicoides* the flesh is crisp and white and the seeds strongly flattened and paper-like. In *S. mammosum* the seeds are thicker and rounded. Fourteen fruits of *S. capsicoides* yielded the wide range and mean (73-) 188 (-346) seeds per fruit and four fruits of *S. mammosum* yielded (215-) 279 (-352) seeds per berry.

Subgenus **Leptostemonum** (Dunal) Bitter section **Dunaliana** (Bitter) Symon

Species examined: S. tetrandrum, S. viride, S. viridifolium, and *S. mankiense.* Fig. 7a, b, c, e.

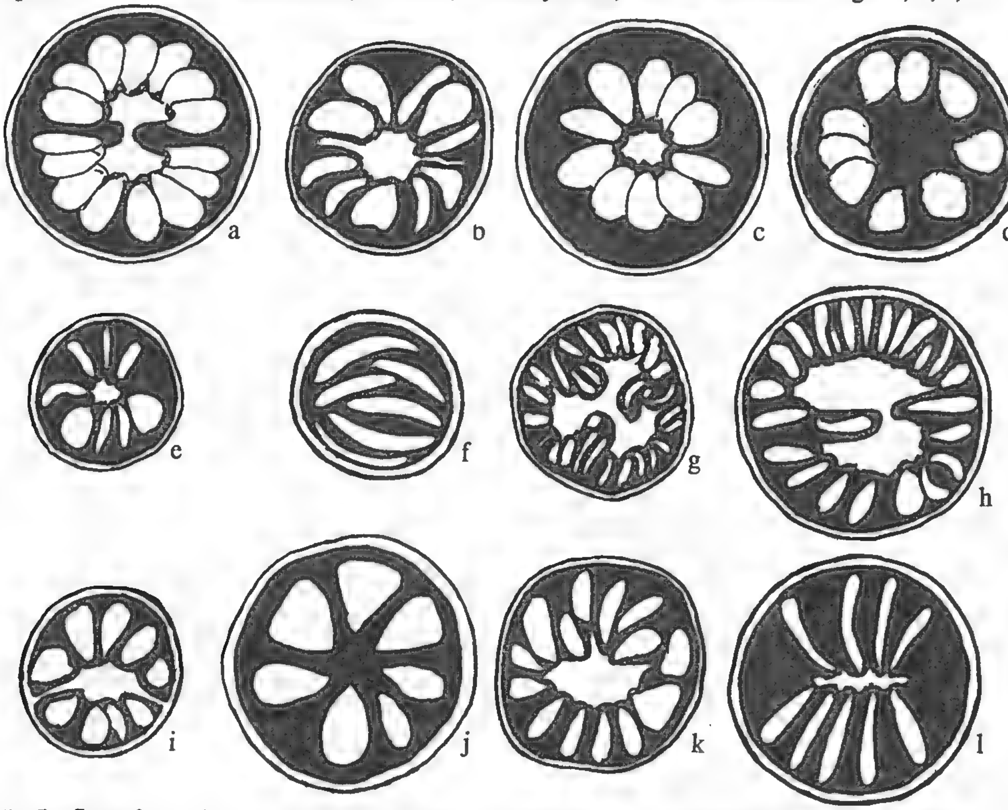


Fig. 7a, *S. mankiense*; b, *S. tetrandrum*; c, *S. viride*; d, *S. missimense*; e, *S. viridifolium*; f, *S. chenopodinum*; g, *S. corifolium*; h, *S. discolor*; i, *S. ferocissimum*; j, *S. parvifolium*; k, *S. semiarmatum*; l, *S. persicaeifolium*.

A section of about 8 species centred on New Guinea with a few species extending to northern Australia and to the Pacific Islands. The species have smallish (less than 1 cm), red, succulent fruits often crowded in corymbose cymes which are held erect. As with the other small red-fruited species the septum appears to disintegrate and the seeds are arranged about the central placenta. Seed numbers are relatively low. Sixteen fruits of *S. tetrandrum* yielded a range and mean (7-) 12 (-18), fifteen fruits of *S. viridifolium* (12-) 19 (-36) and two of *S. mankiense* 61, 63.

Subgenus **Leptostemonum, S. ferocissimum** group Whalen (1984), section **Gracilliflorum** sensu Symon (1981) non (Dunal) Seithe

Species examined: S. chenopodinum, S. corifolium, S. ferocissimum, S. parvifolium, S. persicaeifolium, S. semiarmatum and *S. stelligerum*. Fig. 7f-l, Table 4.

This group is well represented in Australia, New Guinea and New Caledonia. Two closely related groups, *S. crotonoides* and *S. bahamense* of Whalen (1984) are reported from the Greater Antilles and Caribbean Islands respectively. Only one fruit of the latter group has been available to me. They are characterised by having small to medium sized, red (to black), succulent berries. Seed numbers are less than 100 and the placenta is little elaborated. However in most, including the single example from the Caribbean (*S. persicaeifolium*), the septum disintegrates by maturity and the berries appear unilocular. Some are known to be dispersed by birds, Symon (1979) and a succulent pulp with minimum structure is likely to pass through the gut of a bird quickly and with least damage. Unfortunately none of the red fruited African species have been available to see whether this phenomenon occurs there. Seed numbers are given in Table 4.

Table 4

Species	No. of fruits	Seeds Range and mean
S. chenopodium	58	(4-) 7 (-14)
S. corifolium	10	(40-) 57 (-93)
S. densevestitum	24	(6-) 21 (-35)
S. expedunculatum	7	(30-) 43 (-62)
S. ferocissimum	23	(8-) 29 (-52)
S. parvifolium	9	(17-) 30 (-37)
S. persicaeifolium	1	— 13 —
S. semiarmatum	22	(36-) 60 (-75)
S. stelligerum	33	(23-) 54 (-96)

Subgenus **Leptostemonum** (Dunal) Bitter section **Torva** Nees

Species examined: S. hispidum and *S. torvum*. Fig. 8a & b.

Perhaps 50 species (currently under study) from Central America to mainly South America. The fruits are of medium size, yellowish to orange-yellow to brownish, mucilaginous and with numerous seeds. Both examples were quadrilocular and particularly with the weedy *S. torvum*, packed with seeds. Six fruits of *S. hispidum* yielded a mean of 176 seeds and twelve fruits of *S. torvum* yielded a range and mean (235-) 345 (-409) seeds per berry.

Subgenus **Leptostemonum** (Dunal) Bitter section **Leprophora** Dunal, pro parte (*S. ellipticum* group, Whalen [1984])

This section is well represented in Australia with a few species also in the Americas. The following species are illustrated: *S. coactiliferum*, *S. dianthophorum*, *S. dimidiatum*, *S. eardleyae*, *S. echinatum*, *S. ellipticum*, *S. esuriale*, *S. karsensis*, *S. lacunarium*, *S. lucani*, *S. nummularium*, *S. oldfieldii*, *S. orbiculatum*, *S. petrophilum*, *S. quadriloculatum* and *S. sturtianum*. Fig. 8c-o, 9a-d.

Most species have medium sized, firm mucilaginous berries that are yellow at maturity. *S. eardleyae*, *S. petrophilum* and *S. quadriloculatum* are hard and bony at maturity. All have a simple bilocular berry with variously enlarged placenta except that quadrilocular examples have been seen in *S. ellipticum*, *S. lucani* and *S. quadriloculatum.*

Fig. 8a, *S. hispidum*; b, *S. torvum*; c, *S. dimidiatum*; d, *S. orbiculatum*; e, *S. nummularium*; f, *S. oldfieldii*; g, *S. coactiliferum*; h, *S. esuriale*; i, *S. lacunarium*; j, k, *S. dianthophorum*; *S. ellipticum*; m, *S. echinatum*; n, *S. lucani*; o, *S. sturtianum*.

The seed numbers recorded for this Section, Table 5, show a range of means from 4 to 341. With only one exception, *S. petrophilum*, all those with mean seed numbers greater than 100 have expanded placentae.

Table 5

Species	No. of fruits	Seeds Range and mean
S. centrale	7	(17-) 54 (-94)
S. cleistogamum	51	(27-) 55 (-119)
S. coactiliferum	8	(27-) 49 (-106)
S. dianthophorum	11	(116-) 219 (-291)
S. dimidiatum	4	(46-) 72 (-97)
S. eardleyae	17	(82-) 156 (-281)
S. echinatum	14	(41-) 107 (-185)
S. ellipticum	17	(23-) 131 (-323)
S. esuriale	35	(18-) 51 (-204)
S. gabriele	9	(164-) 232 (-278)
S. gilesii	5	(13-) 32 (-55)
S. horridum	5	(130-) 341 (-498)
S. lachnophyllum	8	(10-) 34 (-55)
S. lacunarium	14	(10-) 35 (-76)
S. lasiophyllum	4	(50-) 67 (-78)
S. lucani	35	(33-) 112 (-224)
S. nummularium	8	(5-) 18 (-33)
S. oligacanthum	27	(2-) 4 (-7)
S. orbiculatum	30	(20-) 38 (-95)
S. petrophilum	19	(13-) 66 (-250)
S. quadriloculatum	28	(59-) 156 (-336)
S. seitheae	8	(204-) 253 (-330)
S. sturtianum	23	(22-) 55 (-73)
S. tetrathecum	7	(165-) 236 (-291)

Subgenus **Leptostemonum** (Dunal) Bitter, **S. macoorai** and **S. hystrix** groups of Whalen (1984).

Species examined: S. dallachii, S. dimorphispinum, S. furfuraceum, S. inaequilaterum, S. leopoldensis, S. macoorai, S. oedipus and *S. prinophyllum*. Fig. 9e-k, Table 6.

The species listed here combine two all Australian groups separated by Whalen (1984). They generally have largish fruits (greater than 2 cm) and are mostly succulent, (*S. leopoldensis* dry and bony, *S. oedipus* dry and membranous) and are green or orange-red when ripe.

Most have high seed numbers, Table 6, and enlarged placentas. Exceptions are *S. inaequilaterum* which has an enlarged placenta with a mean of 49 seeds and *S. oedipus* with an axile placenta and a mean of 39 seeds. As these are large chunky seeds the figures may be representative, but the seed numbers for *S. inaequilaterum, S. macoorai* and *S. multiglochidiatum* are based on cultivated plants where full pollination may not have occurred.

Subgenus **Leptostemonum** section **Campanulata** Symon Fig. 9l.

S. campanulatum is an isolated species that has a relatively large (3 cm diam.), yellowish, firm fruit which may finally darken to almost black. It does not appear to be succulent when ripe. The septum persists in the fruit and the placenta is enlarged. The black seeds are numerous and the counts of nineteen berries have yielded the range and mean (147-) 568 (-947) seeds per berry.

Table 6

Species	No. of fruits	Seeds Range and mean
S. cookii	5	(251-) 367 (-563)
S. dallachii	1	168
S. dimorphispinum	3	(68-) 115 (-156)
S. furfuraceum	36	(48-) 173 (-246)
S. hystrix	6	(118-) 153 (-204)
S. inaequilaterum	16	(14-) 49 (-124)
S. leopoldensis	15	(200-) 428 (-620)
S. macoorai	17	(58-) 100 (-178)
S. multiglochidiatum	3	(16-) 23 (-33)
S. oedipus	4	(25-) 39 (-56)
S. prinophyllum	71	(101-) 376 (-647)

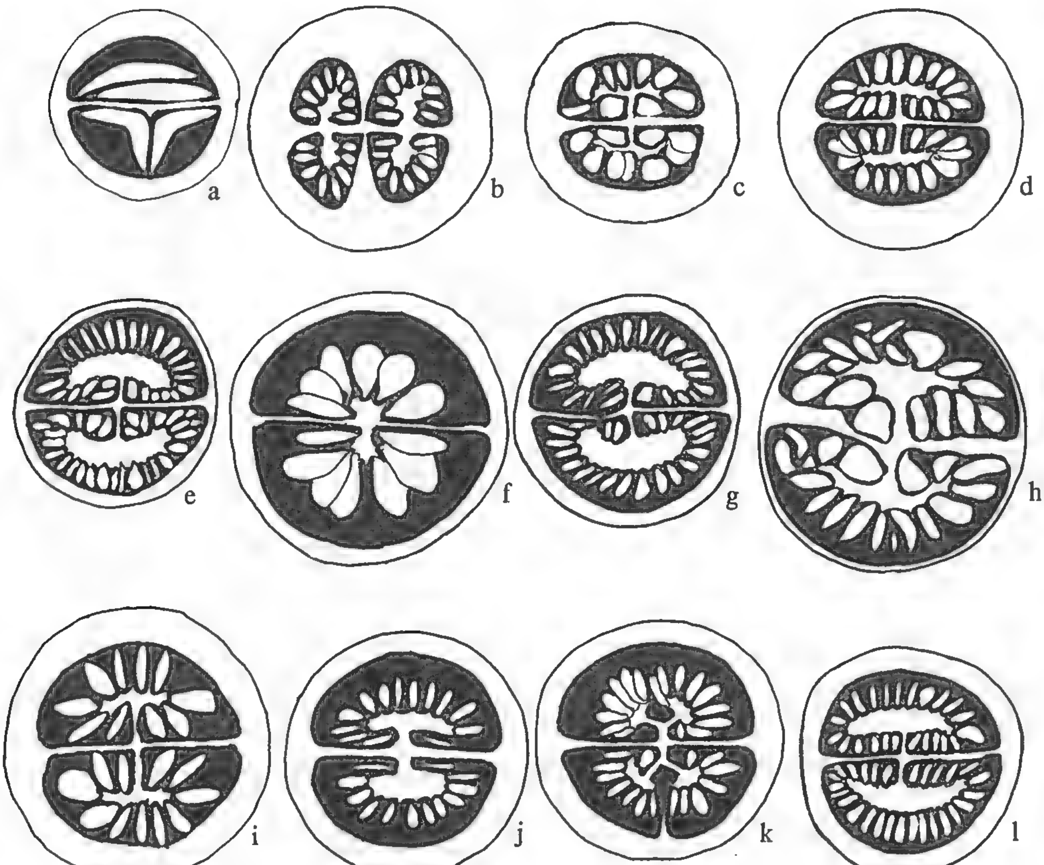


Fig. 9a, *S. karsensis*; b, *S. quadriloculatum*; c, *S. eardleyae*; d, *S. petrophilum*; e, *S. prinophyllum*; f, *S. macoorai*; g, *S. furfuraceum*; h, *S. inaequilaterum*; i, *S. dallachii*; j, *S. furfuraceum*; k, *S. dimorphispinum*; l, *S. campanulatum*.

Subgenus **Leptostemonum** (Dunal) Bitter section **Cryptocarpum** Dunal

Species examined: *S. sisymbriifolium*. Fig. 11o.

A small section from South America. The species listed has been cultivated as an ornamental and is sparingly naturalised in Australia. The immature fruit is largely protected by a prickly calyx until mature after which the bright red succulent berry is exposed. In the local example the berry is quadrilocular with the placenta well separated from the septum. Counts of 29 fruits yielded the range and mean (33-) 116 (-205) seeds per berry.

Fig. 11a, *S. asymmetriphyllum*; b, c, *S. dioicum*, d, e, *S. leopoldensis*; f, g, *S. petraeum*; h, *S. tudununggae*; i, *S. citrinum*; j, *S. grandiflorum*; k, *S. repandum*; l, *S. quitoense*; m, *S. aethiopicum*; n, *Lycopersicon esculentum*; o, *S. sisymbriifolium*.

Subgenus **Leptostemonum** (Dunal) Bitter, **S. crinitum** group Whalen (1984)

Species examined: S. crinitum, S. grandiflorum. Fig. 11i & j.

A small group of about 8 species from the north of South America. The species are often relatively large growing. One, *S. grandiflorum* has been widely grown in the tropics for its showy, rapidly fading changeable flowers. The fruits tend to be large (to 5 cm diam.) drab green with a firm rind. Both examples have been 4-locular with greatly modified placentas, in the case of *S. grandiflorum* being almost parietal in position. A single fruit of *S. grandiflorum* yielded 258 seeds.

Subgenus **Leptostemonum** (Dunal) Bitter section **Lasiocarpum** (Dunal) D'Arcy

Species examined: S. quitoense, S. repandum. Fig. 11k & l.

A section of 12 species centred in the northern Andes of South America but three species extending to the Pacific and south east Asia. The berry is often large, usually densely pubescent, succulent, orange, with numerous seeds. The berries of this section may have highly elaborated septa and placentae in some species, e.g. *S. quitoense* (Fig. 11l), or *S. repandum* (Fig. 11k). Not only are they multilocular but the placentae may be dispersed. Three species are cultivated for their fruits eg. *S. lasiocarpum, S. quitoense* and *S. repandum. S. quitoense* has a long history as a cultigen and it is not known whether wild type fruits with simpler placentas occur. Seed numbers in the two species available have been *S. lasiocarpum*, grown from seed from Thailand, 4 fruits (186-) 215 (-256) and *S. repandum*, four fruits yielded (224-) 232 (-248).

Subgenus **Leptostemonum** (Dunal) Bitter section **Melongena** Dunal

Species examined: (I) Andromonoecious species a. *S. beaugleholei*, b. *S. chippendalei*, c. *S. cinereum*, d. *S. clarkiae*, e. *S. heteropodium*, f. *S. incanum*, g. *S. linnaeanum* (*S. sodomenum*), h. *S. marginatum*, i. *S. melanospermum*. Fig. 10a-j.

(II) Dioecious species a. *S. asymmetriphyllum*, b & c. *S. dioicum*, d & e. *S. leopoldensis*, f & g. *S. petraeum*, h. *S. tudununggae*. Fig. 11a-h.

This section with species in Afro-Asia and Australia has generally large fruits, commonly 2-3 cm diam. They tend to be firm and mucilaginous in texture rather than succulent and pulpy. The colours are generally shades of yellow though some may darken to almost black or may finally become dry and bony. In almost all cases the seeds are high in number, often dark in colour and stone cell concretions are absent. Elaboration of the placenta is quite common and quadrilocular forms occur. Several distinct variations occur. The most common form represented here by *S. marginatum, S. incanum* and *S. linnaeanum* from Afro-Asia and by *S. beaugleholei, S. chippendalei, S. clarkiae* and *S. melanospermum* from Australia have the large yellowish fruits referred to above. In all except *S. melanospermum* the placenta is elaborate, a false septum may develop and the seeds are numerous. *S. cinereum* (Fig. 10a & b), is most distinctive as the fruit, which is at first yellow and finally almost black, is a globe with the seeds densely clustered on the central axile placenta. When ripe all septa have disintegrated, though marginal bumps indicate where the transverse septum originated. The mature dried fruit of *S. cinereum* Fig. 10b is unique in this section.

S. tudununggae Fig. 11a and *S. vansittartensis* both have the unusual censer mechanism described by Symon (1984). The placenta is enlarged to an H-shape. The mature berry is circumcissile above its base and shrinks and separates becoming a cap remaining within the

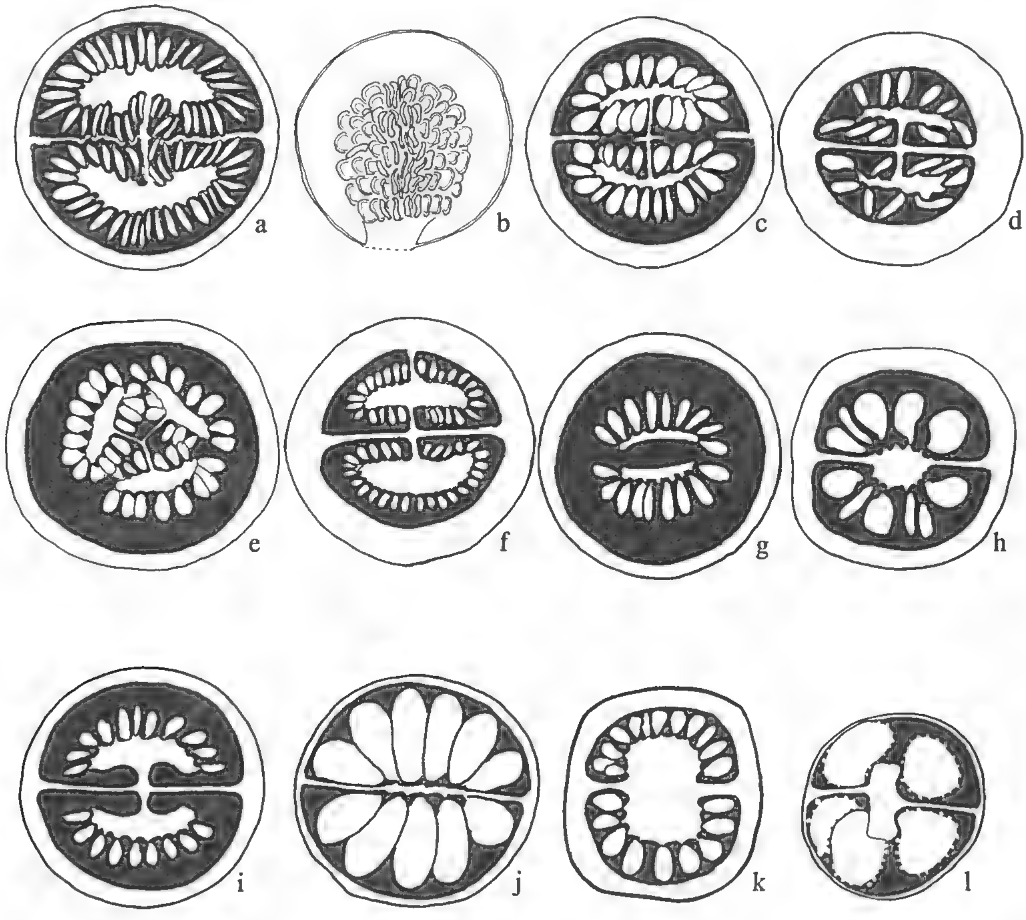


Fig. 10 a & b, *S. cinereum*; c, *S. linnaeanum*; d, *S. incanum*; e, *S. marginatum*; f, *S. beaugleholei*; g, *S. chippendalii*; h, *S. melanospermum*; i, *S. clarkiae*; j, *S. heteropodium*; k, *S. oedipus* (ovary); l, *S. oedipus* (fruit).

enlarged coriaceous now globular calyx tube from which orifice the seeds escape on shaking. Most capsular and dehiscent fruits fracture along major structural junctions. Rethke (1946) in examining the anatomy of circumcissile dehiscence in *Hyoscyamus* (Solanaceae) showed that a zone of mechanical weakness is formed between the lid and base due to the alignment of the cells. Fracture was due to the differential shrinkage of the two parts. A glance at the illustrations will indicate the many placenta variations are found in this section. *S. chippendalei* Fig. 10g, is similar to the two species of section *Acanthophora* Fig. 6c-d.

Table 7 summarises the seed numbers recorded for some of these species.

Table 7

Species	No. of fruits	Seeds Range and mean
S. asymmetriphyllum	8	(302-) 429 (-639)
S. beaugleholei	16	(63-) 628 (-1164)
S. chippendalei	50	(66-) 208 (-785)
S. cinereum	1	384
S. clarkiae	29	(50-) 182 (-272)
S. dioicum	10	(40-) 417 (-907)
S. incanum	1	158
S. linnaeanum	13	(130-) 323 (-456)
S. marginatum	19	(657-) 1397 (-2206)
S. melanospermum	8	(68-) 93 (-109)
S. petraeum	3	463

Subgenus **Leptostemonum** (Dunal) Bitter section **Oliganthes** (Dunal) Bitter (**Anguivi** group Whalen [1984])

Species examined: *S. aethiopicum* (*S. gilo*). Fig. 11m.

A complex section of varied species from Africa. The fruits are red or orange, succulent and generally bilocular. In the example studied which is a subcultivar 6-locules are well developed and the placentae are dispersed. This is probably the result of domestication and the selection for larger, fleshier fruits. Six fruits of *S. aethiopicum* yielded the range and mean (111-) 171 (-218) seeds per berry.

Summary

Trends which are evident in this survey may be summarised as follows.

1. The basic condition appears to be axile placentation with a simple septum. All other forms can be developed from this.

2. Retention of axile placentation with little elaboration, but with degeneration of the septum at least at maturity. This may be seen especially in section *Dunaliana* (Fig. 7a, b, c), section *Jasminosolanum* (Fig. 2d), *S. ferocissimum* (Fig. 7d-k) and *S. bahamense* (Fig. 7l) groups. These all have relatively small, succulent, red fruits and seed numbers are never high.

3. Species with low seed numbers have simple non-elaborated placentas and those with high numbers have without exception some elaboration though this may take many forms. The potential for high seed numbers is thus greatly increased. A further septum may develop to form a 4-locular berry. This has occurred in several widely separated sections e.g. Fig. 4, 8, 11. However, high seed numbers also occur in subgenus *Archaesolanum* (Fig. 5), where the seeds are apparently immersed in an enlarged placenta.

4. Separation of the placenta into two erect lobes with degeneration of the septum and of the link between the two lobes. This development is not so common and may be seen in section *Acanthophora* (Fig. 6c, d), and also in section *Melongena* (Fig. 10g).

5. Elaboration and migration of the placenta arms along the 'false' septum to form a 4-locular berry with, at times, near parietal placentation. Seed numbers are then generally very high. This has been found in several sections e.g. *Lycianthes* (Fig. 4), *Torva* (Fig. 8),

Melongena (Fig. 10-11), *Oliganthes* (Fig. 11), *Lasiocarpum* (Fig. 11) and *S. crinitum* group (Fig. 11).

6. Elaboration of multilocular fruits with dispersed placentae, which occurs under domestication may be seen in domesticates like *S. aethopicum* (Fig. 11m), in *Lycopersicon esculentum* (*S. lycopersicum*) (Fig. 11n), *S. quitoense* and *S. repandum* (Fig. 11k & l).

7. Intrusions of the pericarp occur in some species of subgenus *Lycianthes* (Fig. 4b, c, d, k, m, o) and the two species of section *Leiodendra* (Fig. 3a, b) have distinctive intrusions separating the seeds.

8. Clear cut differences of taxonomic significance between subgenus *Solanum* and subgenus *Leptostemonum* are not apparent. Fruits like those of subgenus *Archaesolanum* were not seen in other groups. No fruits with pericarp intrusions, nor stone cells were found in subgenus *Leptostemonum*. The elaboration of the placenta was, with few exceptions, more developed and more varied in subgenus *Leptostemonum*.

References

Hassler, E. (1917). Solanaceae Austro-Americanae. *Annuaire Conserv. Jard. Bot. Geneve.* 20: 173-189.

Huber, A.K. (1980). Morphologische und entwicklungsgeschichtliche Untersuchungen an Blüten und Blütenständen von Solanaceen und von *Nolana paradoxa* Lindl. (Nolanaceae). *Dissertationes Botanicae*, Vol. 55, J. Cramer, Vaduz.

Bitter, G. (1911). Steinzellkonkretionen im Fruchtfleisch beerentragender Solanaceen und deren systematische Bedeutung. *Bot. Jahrb. Syst.* 45: 483-507.

Bitter, G. (1914). Weitere Untersuchungen über das Vorkommen von Steinzellkonkretionen im Fruchtfleisch beerentragender Solanaceen. *Abh. Naturwiss. Vereine Bremen.* 23: 114-163.

Bitter, G. (1919). Die Gattung *Lycianthes*. *Abh. Naturwiss. Vereine Bremen.* 24: 292-520.

Houghtaling, H.B. (1935). A developmental analysis of size and shape in tomato fruits. *Bull. Torrey Bot. Club* 62: 243-252.

Miller, R.H. (1969). A morphological study of *Solanum mammosum* and its mammiform fruit. *Bot. Gaz.* 130: 230-237.

Murray, M.A. (1945). Carpellary and placentae structure in the Solanaceae. *Bot. Gaz.* 107: 243-260.

Nee, M. (1986). Placentation patterns in the Solanaceae. In W.G. D'Arcy Edit. "Solanaceae: biology & systematics". (Columbia Univ. Press: New York), pp 169-175.

Perlova, R.L. (1946). Morphology of the berries as a taxonomic character of tuber bearing *Solanum*. *Bot. Zurn. S.S.S.R.* 31: 19-32.

Rethke, R.V. (1946). The anatomy of circumcissile dehiscence. *Amer. J. Bot.* 33: 677-683.

Roth, I. (1977). "Fruits of Angiosperms". (Gebrüder Borntraeger: Berlin).

Symon, D.E. (1979). Fruit diversity and dispersal in *Solanum* in Australia. *J. Adelaide Bot. Gard.* 1: 321-331.

Symon, D.E. (1984). A new form of *Solanum* fruit. *J. Adelaide Bot. Gard.* 7: 123-126.

Symon, D.E. (1985). The re-instatement of *Solanum shanesii* F. Muell. Section *Lycianthes* (Solanaceae) with discussion of its significance. *J. Adelaide Bot. Gard.* 7: 201-206.

Whalen, M.D. (1984). Conspectus of species groups in *Solanum* subgenus *Leptostemonum*. *Gentes Herbarum* 12: 179-282.

Voucher material

S. aethiopicum L. (*S. gilo* Raddi) redrawn from Nee (1986), Fig. 11m.

S. amatitlanense Coult. & Donn. Sm., *Berlin 1773*, Quebrada Huampami, Peru, Fig. 4g.

S. americanum Miller, grown from *Constable 5633*, Kogarah N.S.W., Fig. 1a.

S. antillarum O.E. Schultz.

S. asymmetriphyllum Specht, *Symon 12138*, near Alligator Riv. N.T., Fig. 11a.

S. aviculare G. Forster, grown from *Eichler 18243*, Mt Wilhelm, P.N.G., Fig. 5a, b.

S. bahamense L.

S. beaugleholei Symon, *Symon 12107*, Napier Range, W.A., Fig. 10f.

S. biflorum Lour., *Symon 10652*, Bulolo, P.N.G., Fig. 4h.

S. bitterianum Symon, *Symon 10651*, Bulolo, P.N.G., Fig. 4i.

S. callium C.T. White ex R. Henderson, *Webb & Tracy 10741*, Levers Plateau N.S.W., Fig. 2a.

S. campanulatum R. Br., grown from *Whitehead s.n.*, Kulnara, N.S.W., Fig. 9l.

S. capsiciforme (Domin) Baylis, grown Waite Inst., Glen Osmond, S.A. Fig. 5c.

S. capsicoides All., redrawn from Nee (1986), Fig. 6c.

S. centrale J.M. Black, seed from *Latz 178.*

S. chenopodinum F. Muell., *Symon 5972*, Old Moolawatna, S.A., Fig. 7f.

S. chenopodioides Lam., seed grown from *Beauglehole 37803.*

S. chippendalei Symon, *Symon 2272*, Sir Frederick Range, W.A., Fig. 10g.

S. cinereum R. Br., *Symon 9851*, Cootamundra, N.S.W., Fig. 10a, b.

S. citrinum M. Nee, redrawn from Nee (1986), Fig. 11i.

S. clarkiae Symon, *Symon 12133*, Alligator River, N.T., Fig. 10i.

S. cleistogamum Symon, seed from *Symon 5418, 10611.*

S. coactiliferum J. Black, *Symon 4481*, Kyancutta, S.A., Fig. 8g.

S. cookii Symon, seed grown from *Tracey s.n.*

S. corifolium F. Muell., *Tracey s.n.*, Mt Glorious, Qld, Fig. 7g.

S. crinitum Lam.

S. crotonoides Lam.

S. dallachii Benth., grown from *Hyland 7367*, Wyvuri Holding, Qld, Fig. 9i.

S. densevestitum F. Muell., seed from *Symon s.n.*

S. dianthophorum Dunal, grown from *Redgen 044*, Glen Morgan, Qld, Fig. 8j, k.

S. dimidiatum Raf., grown from roots from *Everist s.n.*, Bundaberg, Qld, Fig. 4c.

S. dimorphispinum C. White, *Webb & Tracey 8352*, Mt Lewis, Qld, Fig. 9k.

S. dioicum W.V. Fitz., *Latz 4019*, Sturt Creek, N.T., Fig. 11c.

S. dioicum W.V. Fitz., *Symon 5336*, near Fitzroy Crossing, W.A., Fig. 11b.

S. discolor R. Br., *Moriarty 879*, Yarraman, Qld, Fig. 7h.

S. eardleyae Symon, *Latz 5058*, Mt Fraser, N.T., Fig. 9c.

S. echinatum R. Br., *Symon 7189*, Pine Creek, N.T., Fig. 8m.

S. ellipticum R. Br., grown from *Symon s.n.*, Ayer's Rock, N.T. Fig. 8l.

S. erianthum D. Don, grown from *Tracey s.n.*, Johansons Cave, Qld, Fig. 6a.

S. escuintlense (Coult.) Hunz., *Gilmartin 235*, Santo Domingo, Fig. 4j.

S. esuriale Lindl., *Symon 115777*, near Renmark, S.A., Fig. 8h.

S. expedunculatum Symon, seed from *Symon 10700.*

S. ferocissimum Lindl., grown from *Tracey s.n.*, Narayen, Qld, Fig. 7i.

S. furcatum Dunal, seed grown from *Edmonds s.n.*

S. furfuraceum R. Br., *Webb & Tracey 10740*, Lever's Plateau, Qld, Fig. 9g, j.

S. gabriele Domin, seed from *Symon 5399, 10036.*

S. geminiflorum Mart. & Gal., *Nee 23551*, NW of Teocelo, Veracruz, Fig. 4k.

S. gilesii Symon, seed from *Latz 4035.*

S. grandiflorum Ruiz & Pavon, redrawn from Nee (1986), Fig. 11j.

S. guianense Dun., *Gentry 6229*, Cerro Tute, Panama, Fig. 4b.

S. hawkesiana D'Arcy, *Croat 9901*, near Guasimo, Panama, Fig. 4c.

S. heteropodium Symon, *Kenneally 9604*, W. Kimberleys, W.A., Fig. 10j.

S. hispidum Pers., grown from *Howard s.n.*, near Brisbane, Qld, Fig. 8a.

S. horridum Dunal, seed grown from *Symon 5403.*

Lyc. howardiana D'Arcy, *Dressler & D'Arcy 5505*, Cerro Campana, Panama, Fig. 4d.

S. hystrix R. Br.

S. inaequilaterum Domin, grown from *Henderson 1304*, Levers Plateau, Qld, Fig. 9h.

S. incanum L., grown from seed ex Kyambogo, Africa, Fig. 10d.

S. karsensis Symon, grown from roots *Pearce 63*, Kars Stn., N.S.W., Fig. 9a.

S. lachnophyllum Symon, seed from *Symon 9971.*

S. laciniatum Aiton, *Symon 10562*, Waitpinga, S.A., Fig. 5d.

S. lacunarium F. Muell., *Symon 11579*, Chowilla Creek, S.A., Fig. 8i.

S. lasiocarpum Dunal, seed ex *Aree*, Thailand.

S. lasiophyllum Dunal, seed from *Howard 5806.*

S. leopoldensis Symon, grown from *Symon 7028*, Mt Broome, W.A., Fig. 11d, e.

S. linearifolium Herasim. ex Symon, grown from *Myers C.P.I. 1163*, A.C.T., Fig. 5e.

S. linnaeanum Hepper & Jaeger, *Symon s.n.*, Myponga, S.A., Fig. 10.

S. lucani F. Muell., *Symon 6976*, near Mary River, N.T., Fig. 8n.

S. lycioides L., redrawn from Hassler (1917), Fig. 4a.

S. macoorai Bailey, grown from *Symon 4752*, Atherton, Qld, Fig. 9f.

S. mammosum L., redrawn from Nee (1986), Fig. 6d.

S. mankiense Symon, grown from *Symon 13857*, Manki, P.N.G., Fig. 7a.

S. marginatum L.f., grown from *D. of A. 562*, Nuriootpa, S.A., Fig. 10e.

S. mauritianum Scop., *Browning s.n.*, Waterfall Gully, S.A., Fig. 6b.

S. melanospermum F. Muell., grown from *Symon 5064*, Robinson River Stn, Qld, Fig. 10h.

S. missimense Symon, grown from *Symon 13844*, Mt Missim, P.N.G., Fig. 7d.

S. moszkowski Bitter, *Symon 10631*, Aseki Road, P.N.G., Fig. 4l.

S. multiglochidiatum Domin, seed from *Symon 4873.*

S. multivenosum Symon, seed from *Symon 10697.*

S. nigrum L., Waite Arboretum, Glen Osmond, S.A., Fig. 1b.

S. nudum Humb. & Bonpl., *D'Arcy 10958*, La Popa, Panama, Fig. 2b.

S. nummularium S. Moore, grown from *Symon 5478*, Kalgoorlie, W.A., Fig. 8e.

S. oedipus Symon, (ovary) grown from *Symon 7119*, Kalumburu, W.A., Fig. 10k.

S. oedipus Symon, (mature fruit) grown from *Symon 7119*, Kalumburu, W.A., Fig. 10l.

S. oldfieldii F. Muell., *Symon 5450*, N of Geraldton, W.A., Fig. 8f.

S. oligacanthum F. Muell., seed from *Barlow 1518, 1523, Symon 5891.*

S. oliverianum Lauterb. & Schumann, *Schram BW10620*, Manokwari, P.N.G., Fig. 4m.

S. opacum A. Braun & Bouché, grown from *Beauglehole 33110*, Bonang, Vic., Fig. 1c.

S. orbiculatum Dunal, *Symon 3420*, Commonwealth Hill, S.A., Fig. 4d.

S. parishii Heller

S. parvifolium R. Br., grown from *Moriarty 1557*, near Injune, Qld, Fig. 7j.

S. pennellii Correll, garden grown, *Symon s.n.*, Fig. 3c.

S. persicaeifolium Dun., *D'Arcy 4767*, Tortola Island, Fig. 7l.

S. petraeum Symon, *Symon 7139*, Pt Warrender, W.A., Fig. 11f, g.

S. petrophilum F. Muell., *Symon 8175*, Waltinga Dam, Gawler Ranges, S.A., Fig. 9d.

S. physalifolium Rusby, *Paton s.n.*, Launceston, Tas., Fig. 1d.

S. prinophyllum Dunal, grown from *Pearce s.n.*, near Healesville, Vic., Fig. 9e.

S. pseudocapsicum L., *Symon s.n.*, Willunga, S.A., Fig. 2c.

S. pugiunculiferum C.T. White, grown from *Chippendale 506*, Elsey Stn., N.T., Fig. 2d.

S. quadriloculatum F. Muell., *Symon 6004*, Paralana, S.A., Fig. 9b.

S. quitoense Lam., drawn from slide of fruit, Fig. 11l.

S. rantonnei Carriere, Adelaide Bot. Gard. classground, Fig. 4e.

S. repandum G. Forster, cult. Adelaide Bot. Gard., *Symon 14297*, Fig. 11k.
S. retroflexum Dunal, grown from *Alcock s.n.*, Pilli Waterhole, S.A., Fig. 1e.
S. sanctaeclarae Greenm., *Croat 44230*, Sarapigui, Costa Rica, Fig. 4f.
S. scabrum Mill., seed grown from *Dept. Agric. s.n.*
S. seaforthianum Andrews, *Symon 4754*, Atherton, Qld, Fig. 3d.
S. seithae Symon, seed from *Symon 4959*.
S. semiarmatum F. Muell., grown from *Tracey s.n.*, Narayen, Qld, Fig. 7k.
S. shanesii F. Muell., *Clarkson 4217*, Palmer River, Qld, Fig. 4o.
S. simile F. Muell., grown from *Alcock 7543*, Marble Range, S.A., Fig. 5f.
S. sisymbriifolium Lam., grown from seed ex Kew, U.K., Fig. 11o.
S. spirale Roxb.
S. stelligerum Sm., origin lost.
S. sturtianum F. Muell., *Symon 5423*, Yanrey Stn., W.A. Fig. 8o.
S. superficiens Adelb.
S. symonii H. Eichler, grown from *Symon 4696*, Ceduna, S.A., Fig. 5f.
S. synantherum Sendtn., *Croat 26254*, near Concepcion, Panama.
S. tetrathecum F. Muell., seed from *Redgen 044*, *Symon 6721*.
S. tetrandrum R. Br., grown from *Symon 7774*, Gove, N.T., Fig. 7b.
S. torvum Sw., grown from *Symon 4755*, near Hockley, Qld, Fig. 8b.
S. triflorum Nutt., grown from *Whissen s.n.*, Tintinara, S.A., Fig. 1g.
S. tuberosum L. cv. Virginia, S. Aust. no voucher, Fig. 3a, b.
S. tudununggae Symon, grown from *Symon 10181*, Kalumburu, W.A., Fig. 11h.
S. umbelliferum Eschsch.
S. umbonatum Symon, *Symon 10630*, Aseki Road, P.N.G., Fig. 4n.
S. vansittartensis C.A. Gardner
S. vescum F. Muell., from *Carrodus 1161072*, Grampians, Vic., Fig. 5h.
S. villosum Miller, grown from D. of A. Strathalbyn, S.A., Fig. 1f.
S. viride G. Forster ex Sprengel, grown from *Buelow & Sykes 172*, Late Island, Pacific, Fig. 7c.
S. viridifolium Dunal, *Webb & Tracey 8351*, Bingal Bay, Qld, Fig. 7e.
S. vitiense Seemann, *Kajewski 2451*, Guadalcanal, Fig. 4p.
S. xantii A. Gray, grown from seed from San Francisco, U.S.A., Fig. 1h.
Lycianthes hawkesiana D'Arcy
Lycianthes howardiana D'Arcy, *Dressler & D'Arcy 5505*, Cerro Campana, Panama, Fig. 4d.
Lycianthes escuintlensis (J. Coulter) D'Arcy, *Gilmartin 235*, Touchi, Santo Domingo, Fig. 4j.
Lycianthes guianense (Dunal) Bitter, *Gentry 6229*, Cerro Tute, Panama, Fig. 4b.
Lycopersicon esculentum Miller, domestic garden, Adelaide, S.A. Fig. 11n.

J. Adelaide Bot. Gard. 10(2): 201-221 (1987)

TAXONOMIC STUDIES IN *EUPHRASIA* L. (SCROPHULARIACEAE). V. NEW AND REDISCOVERED TAXA, TYPIFICATIONS, AND OTHER NOTES ON THE GENUS IN AUSTRALIA

W.R. Barker

State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

A new species *E. amphisysepala* W.R. Barker is distinguished within Sect. *Phragmostomae*; it occurs within a few kilometres of its closest ally *E. phragmostoma* W.R. Barker. The circumscription of the extinct *E. arguta* R. Br. is expanded on the basis of additional collections seen from the last century. The discovery of several taxa believed extinct or rare in all or part of their range, two probable hybrids, and unusual collections indicating taxonomic problems requiring investigation are documented. Further types of 16 names have been located since the publication of a revision of the genus in Australia in 1982, leading to the recognition of two holotypes and three lectotypifications. Additional synonymies and misapplications of names are provided.

Introduction

The publication of a revision of *Euphrasia* in Australia (Barker 1982) has prompted interest from a number of ecologists, conservationists and naturalists in resolving some of the problems raised. This paper presents the results of some of their efforts to date.

In addition, a number of typifications dealt with in Barker (1982) have had to be reassessed. A visit to Europe in 1985 provided the opportunity to examine the holdings of Australian *Euphrasia* in many herbaria. All too often important material had been omitted from loans requested for the original revision. Fortunately, no lectotypification has had to be rescinded. In some cases a preferable syntype has been found, e.g. in the case of *E. multicaulis* Benth. in Bentham's herbarium at K. However, in such cases the existing lectotype has been maintained as, in accordance with Article 8 (ICBN), it is not in serious conflict with the protologue. Nevertheless, some new lectotypifications have had to be made where no types or only a single type had been seen before. The additional material seen has also enabled an assessment to be made of the affinities of two old names proposed by Bentham (1846) for which no type material had been previously seen, while it is now possible to reassess the circumscription of *E. arguta* R. Br., an apparently extinct species poorly collected in the past.

This is the fifth in a series of papers on the taxonomy of *Euphrasia*, the others being Barker (1982, 1984, 1985), Barker & Christensen (1984) and Barker, Kiehn & Vitek (in preparation). Important corrigenda for Barker (1982) are given in *J. Adelaide Bot. Gard.* 7 (2) (1985) 216.

The chapters and sections of text within them are cross-referenced to the 1982 revision of the genus and arranged roughly in the order that the taxa they relate to appear there.

A review of Sect. *Phragmostomae* of south-eastern Tasmania
(Barker 1982, p. 102)

A suite of collections by Mr P. Collier from the top of the cliffs lining Fortescue Bay on the Tasman Peninsula, south-eastern Tasmania, has confirmed the existence of a second species of Sect. *Phragmostomae* at Cape Hauy. This location is only a few kilometres from each of the two nearest known populations of its closest ally *E. phragmostoma* W.R. Barker. One of these populations is on the northern perimeter of Fortescue Bay, the other is further south at Cape Pillar. Despite the proximity and similar cliff habitats of the two taxa, the morphological differences are so many as to place no doubt on their distinction as species. In addition to the description of the new species, amendments to the description of *E. phragmostoma* are given which exclude the specimen of the new species encompassed in the protologue (Barker 1982) and which cover material collected since then.

The branching pattern of the additional specimens of the two species confirms the development of branches at spaced groups of nodes in Sect. *Phragmostomae.* Whole first-year plants now available (*E. phragmostoma*: *Collier 1693*, *1694*; *E. amphisysepala*: *Collier 1688*) have an erect stem which develop branches in small groups of nodes as in subsequent seasons (Fig. 1A). Subsequent growth is as described in Barker (1982) with the existing main axes usually becoming procumbent and branching continuing on the main laterals. However *Collier*

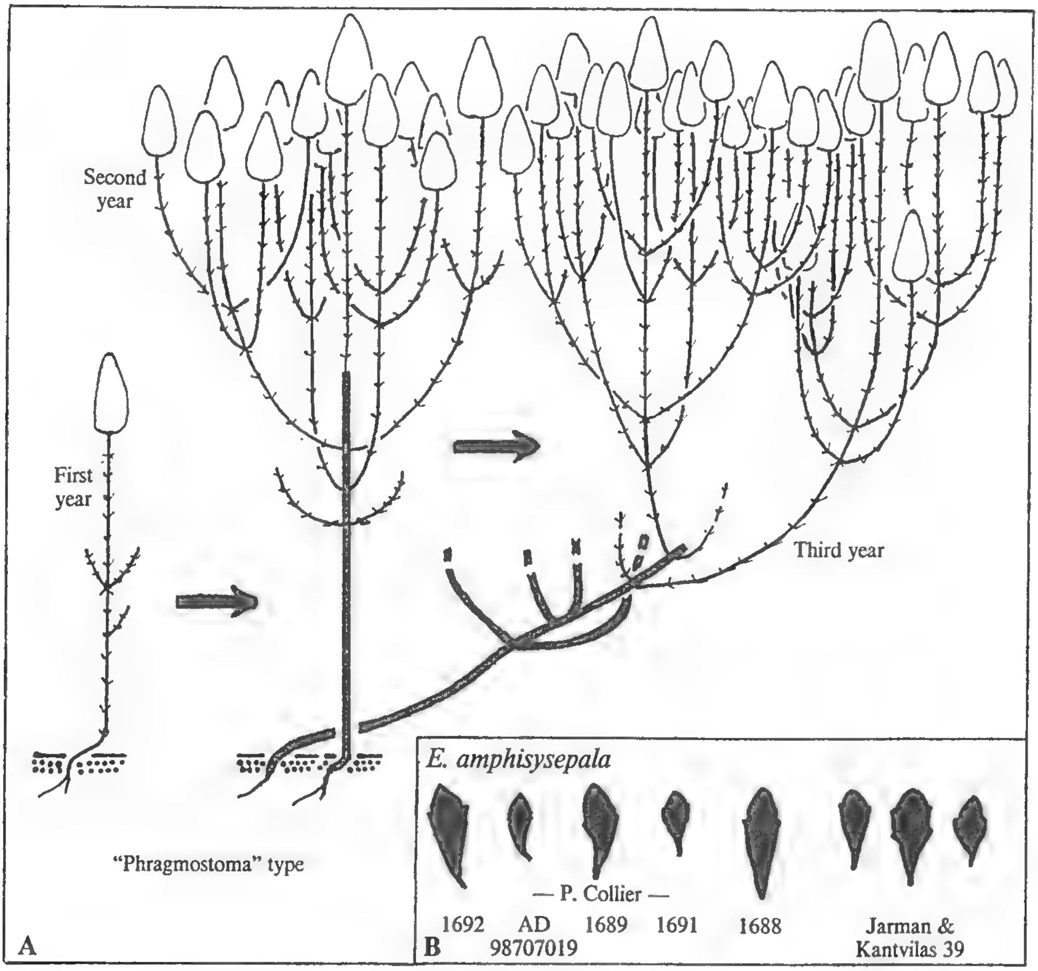


Fig. 1. A. The "Phragmostoma" habit type. (Inflorescences are represented by an oval outline; branches of current year by fine lines, those of prior years by thick lines; nodes are shown as fine transverse lines on current year's branches). It is uncertain if the procumbent axes shown for later years occur in *E. amphisysepala*.
B. Uppermost leaves of main inflorescence-bearing branches, actual size, dried, of *E. amphisysepala*.

1694 shows an excellent example, additional to that noted in Barker (1982), of the stem remaining erect and continuing to develop beyond the fruiting nodes of the first year, finally producing a fully-formed inflorescence. The sequence of branching seems generally not to be strictly basipetal.

Key to the species of Sect. *Phragmostomae*

1a. Lobes on either side of calyx distinct at apex, the cleft between 0.5-2.0 mm deep. Glandular hairs present on calyces, bracts, rachises, leaves and branch axes, 0.1-0.5 mm long. Uppermost leaves 5-8 (10) mm wide. Corolla 14-24 mm long along upper side, with striations lacking or 3 short striations behind lateral lobes of lower lip, lacking elsewhere. Anthers 2.3-3.0 mm long, with rearmost awns (1.5) 2.5-3.2 mm long, erose or flattened and twisted at tip .... 1. *E. phragmostoma*

b. Lobes on either side of calyx completely fused or slightly separated at very apex, the cleft between 0-0.3 (0.6) mm deep. Glandular hairs lacking from calyces, bracts, rachises, leaves and branch axes, except around median clefts of calyx where 0.03-0.1 mm long. Uppermost leaves 3.4-5.5 mm wide. Corolla 11-16 mm long along upper side, with conspicuous striations extending well out onto each lobe of lower lip and to a lesser extent onto upper lobes. Anthers 1.8-2.5 mm long, with rearmost awns 1.0-2.2 mm long, sharp, straight .... 2. *E. amphisysepala*

1. E. phragmostoma W.R. Barker, J. Adelaide Bot. Gard. 5(1982)103, p. maj. part. (excl. *Jarman & Kantvilas 39*)

The following amendments are made to the previous description. Characters not mentioned are unchanged.

Much-branched perennial *herb* or undershrub . . . with many ascending branches arising from erect or procumbent stem or main branches of previous years. *Stem* in first year erect or ascending, often subsequently procumbent; *main inflorescence-bearing* branches . . . simple for 0-35 nodes below inflorescence . . .; *axes* covered by a dense mixture of moderately long to very long glandular hairs and short to moderately long eglandular hairs . . . . *Leaves*: *uppermost* . . . [with] *teeth* (1) 2 along each margin . . . ; *apical tooth* . . . 1-3 x 3-6 mm. *Bracts*: lowermost bracts similar in shape, size and indumentum to uppermost leaves, distal ones progressively smaller, otherwise similar. *Calyx* . . . externally covered by sparse to dense, short eglandular hairs mixed with sparse to dense, short to long glandular hairs . . . ; *lateral clefts* 0.5-2.0 mm deep . . . *Corolla* cream-white, lacking prominent yellow patches or, usually, purple striations (W.M. Curtis pers. comm. 1976; also from colour slides sent by her), rarely (observation of dried material in *Collier 1693*) possibly with short striations behind each of the lateral lower lobes . . . ; *tube* . . . abaxially and somewhat laterally expanded below point of insertion of anterior filaments c. 4.5-8 mm from base of corolla . . . *Stamens* with . . . *anthers* 2.3-3.0 x 1.2-1.9 mm.

Distribution and ecology

E. phragmostoma is now known from two localities on Tasman Peninsula, one at Dolomieu Point, Bivouac Bay just north of Fortescue Bay, the other further south at The Chasm on Cape Pillar. The old Marion Bay locality has yet to be rediscovered.

The new collections have indicated that the species is not confined to the exposed upper edges and faces of the coastal cliffs (Barker 1982), but also near their base. *Collier 1694* is recorded at sea level "emergent from rock crevice at edge of land vegetation and rocky shore", while *Collier 1693*, a plant which, from the remnants of the prior season's fruits, is in its second flowering season, comes from 20 m above sea level in "a locally abundant stand in dense shrub and herb regeneration after recent fire".

Additional specimens examined

TASMANIA. EAST COAST: *Collier 1693, 1694*, 4.x.1986, Dolomieu Point, Fortescue Bay (Storm Bay sheet 793 248) 43°08'S, 147°58'E, HO(2 collections).

2. Euphrasia amphisysepala W.R. Barker, sp. nov.

E. phragmostoma auct. non W.R. Barker: W.R. Barker, J. Adelaide Bot. Gard. 5 (1982) 103, p.p. (as to *Jarman & Kantvilas 39*).

Species nova in Sectione *Phragmostomis* foliis subpetiolaribus, habitu ramis principalibus inflorescentigeris ramulos in gregibus dispersis nodorum productentibus, et aristis postremis antherae longissimis posita; ab *E. phragmostoma* pilis glandulosis carentibus, foliis angustioribus dente apicali angustiore, paribus lateralibus sepalorum connatis vel fere ita, et corollis manifeste striatis differt.

Holotypus: S.J. Jarman & G. Kantvilas 39, 17.xi.1979, Tasmania, East Coast region, Cape Hauy, Tasman Peninsula, Lat. 43°09′ Long. 148°00′, AD 98047536. *Isotypi*: HO (2 sheets).

Much-branched erect to sprawling perennial *herb* or undershrub, to c. 20 or 25 cm tall, with many ascending to erect branches arising from stem and main branches of previous year(s). *Stem* in first year erect, subsequently possibly procumbent; *main inflorescence-bearing branches* 3.5-17 cm long, simple for 0-19 nodes below inflorescence, developing branches in axils of widely spaced groups of 1-4 (5) consecutive nodes, within groups the distal node(s) developing inflorescences; *internodes* shorter than leaves throughout except at base where

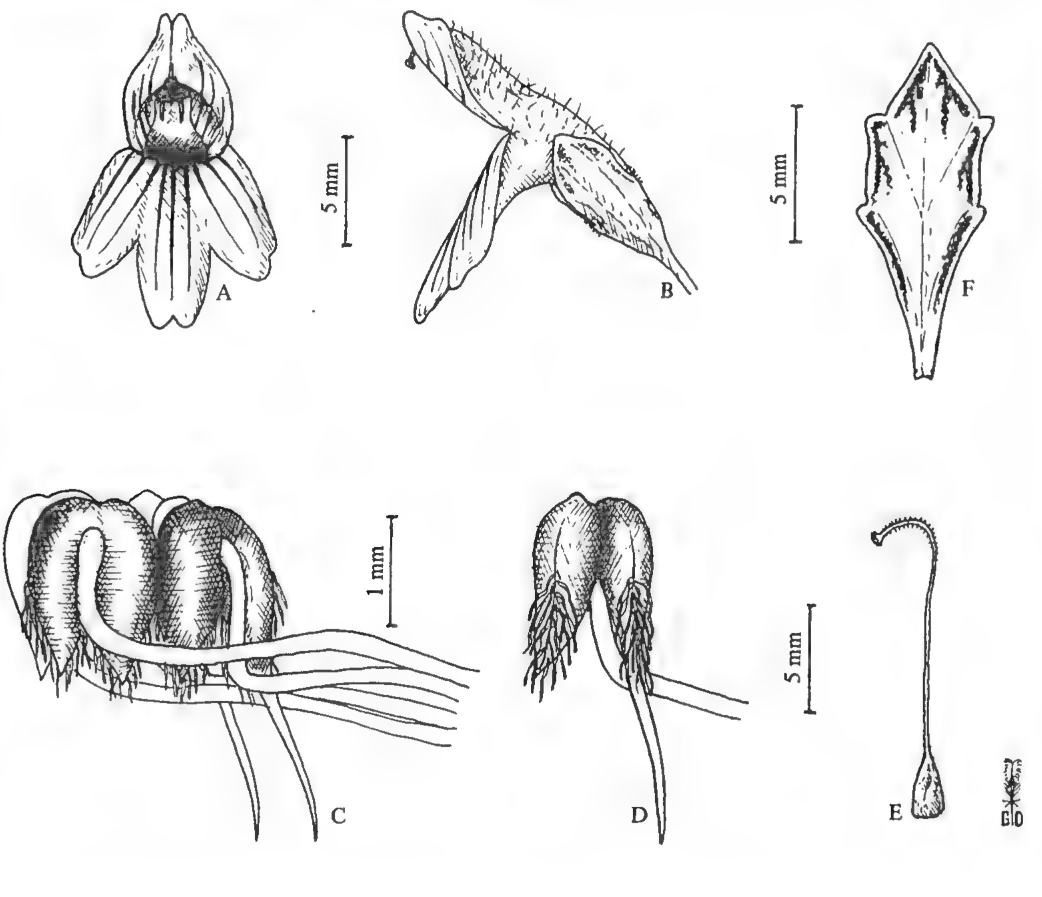


Fig. 2. *Euphrasia amphisysepala* W.R. Barker. A, flower, front view; B, flower, side view; C, external view of anthers from one side of flower, with anterior anther on left; D, internal view of posterior anther; E, lateral view of pistil; F, abaxial view of uppermost leaf of main inflorescence-bearing axis. (A, *Collier 1392*; B-F, *Jarman & Kantvilas 39*).

usually longer; *axes* with 2 rows of dense short eglandular hairs. *Cotyledons* not seen. *Leaves*: *uppermost* leaves of main inflorescence-bearing branches 8.5-15.5 x 3.4-5.5 mm, spathulate, crenulate-serrulate, with sessile gland patches confined to distal c. 0.6-0.75 of undersurface, otherwise glabrous; *base* narrowly long-attenuate, subpetiolate; *teeth* 1-2 along each margin, confined to distal c. 0.24-0.55, bluntly obtuse to acute, the longest tooth 0.2-0.8 mm long; *apical tooth* usually bluntly, sometimes sharply, broad-acute to obtuse or acuminate, 2.2-4.8 x 2.9-4.3 mm; leaves *lower down* more or less similar, towards very base often smaller. *Inflorescences* racemes, moderately dense to dense in flower, the young inflorescences seen with 8-14 flowers, the lowest nodes sometimes with only one flower; *pedicels* at lowest node 1.5-3.3 (4.0) mm long, shorter higher up; *rachis* with indumentum similar to upper part of axis; *apical bud cluster* moderately dense, initially elongated, extended c. 0.3-3 cm above first flower or pair of flowers, becoming hidden by the uppermost flower pair after flowers at first c. 2-4 nodes have reached anthesis. *Bracts*: lowermost bracts similar in size, shape and indumentum to uppermost leaves, distal ones progressively smaller. *Calyx* 6.8-10.2 mm long, externally glabrous but sometimes for a small patch of tiny glandular hairs around the median clefts, internally glabrous, at least sometimes (*Collier AD 9870719*) apart from a few scattered tiny glandular hairs on the lobes; *teeth* bluntly acute if present, the adaxial pair longer than the abaxial, often each lateral pair fused to form a single bluntly acute to bluntly acuminate lateral segment; *lateral clefts* absent to very shallowly broad-emarginate and oblique, 0-0.3 (0.6) mm deep; *median clefts* 3.5-6.3 mm deep. *Corolla* 11-16 mm long along upper side, (from colour of dried material) white, sometimes flushed pink to pale purple around mouth (*Collier 1392*) and possibly sometimes at ends of lower lobes, with 3 conspicuous fine red-purple lines extending well out onto each lower lobe and to a lesser extent onto upper lobes, with yellow patches apparently occurring behind middle lobe (*Collier 1689, 1691, AD 98707019*) and at least sometimes also in tube (*Collier AD 98707019*); *tube* 6-8.6 mm long, narrow cylindrical in basal half, beyond point of insertion of anterior filaments 3.8-6 mm from the base abaxially and somewhat laterally expanded, externally glabrous at very base, distally covered by dense, downturned, short to long eglandular hairs, usually lacking from the upper side, sometimes also lacking from lower side, internally from above ovary to the base of the anterior filaments covered all around by dense, short to long eglandular hairs; *hood* 5-8 mm long, including lobes c. 4-6 mm wide, externally covered by dense, short to long, downturned eglandular hairs, usually absent from sides, sometimes all over, with sparse, very short glandular hairs extending from part of way along sides from base, internally glabrous apart from dense, moderately long to long eglandular hairs mixed with sparse, very short glandular hairs behind sinus; *upper lobes* shallowly emarginate to very shallowly broad-emarginate, glabrous on both surfaces, with the cleft between 0.4-1.2 mm deep; *lower lip* 6.5-9 x 10-15 mm, externally glabrous but for sparse to dense, short to long eglandular hairs behind lateral lobes, usually also with a few, very short glandular hairs on lobes, internally glabrous; *lower lobes* emarginate or shallowly so, the middle lobe sometimes truncate, with clefts between 3-4.8 mm deep. *Stamens* with *filaments* glabrous but for moderately to dense, short to long eglandular hairs at base of anterior pair, the anterior pair 5.9-7.3 mm long, the posterior pair 2.7-5 mm long; *anthers* 1.8-2.5 x 1.0-2.0 mm, with area surrounding *connectives* glabrous, with *slits* lined densely by moderately long to long eglandular hairs, with *awns* smooth and sharp, the anterior three pairs 0.1-0.2 mm long, the rearmost pair 1.0-2.2 mm long. *Ovary* in lateral view elliptic to narrow-ovate, laterally compressed, in median view narrowly elliptic-acuminate to narrowly ovate-caudate, glabrous or with very few short setae towards apex on one or both lines of dehiscence, sometimes also with dense very short setae in upper $^1/_3$ only on lateral surfaces; *apex* in lateral view broadly acute to obtuse; *ovules* c. 46-70. *Capsules* (from decayed ones of prior year on most specimens) c. 7.0-9.5 x 2.2-3.0 mm, in lateral view obovate to narrowly oblong-elliptic, with indumentum not known; *apex* truncate-obtuse to truncate, possibly sometimes shallowly emarginate; *seeds* unknown. *Chromosome number*: unknown. Figs 1, 2, 3.

Fig. 3. Holotype of *Euphrasia amphisysepala* W.R. Barker, sp. nov. (scale 5 cm long).

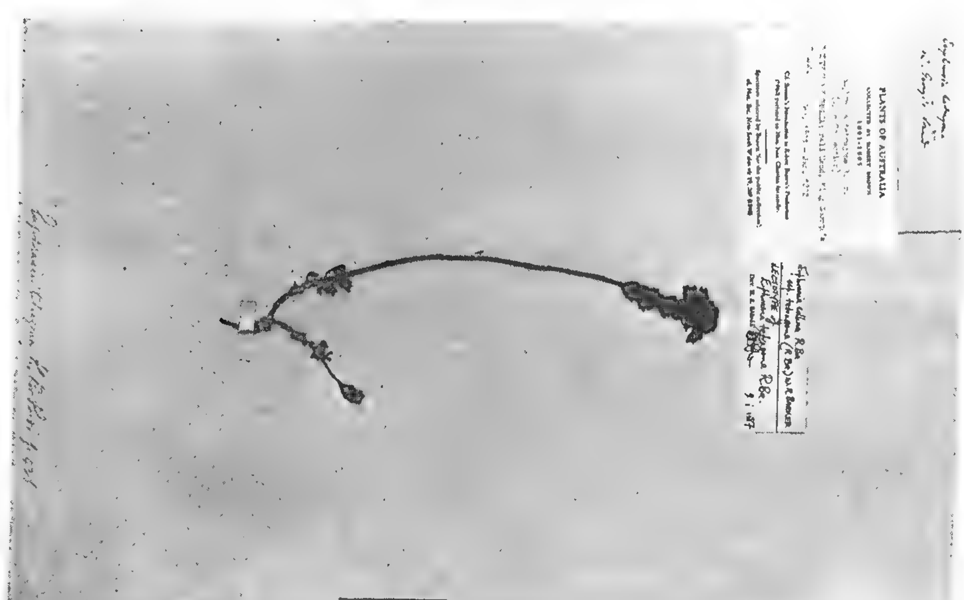


Fig. 4. Lectotype of *Euphrasia tetragona* R. Br. (scale 5 cm long).

Distribution and ecology

E. amphisysepala is known only from a single location at Cape Hauy on the south side of Fortescue Bay on the Tasman Peninsula, southeastern Tasmania.

It is recorded from the edge of the cliffs at 75-100 m altitude overlooking a large "hole" (?chasm) in small soil pockets and on rock faces, sometimes beneath a shrub layer.

From the few specimens seen, flowering occurs at least between late September and December, with another record in May. It is possible that the growing and flowering seasons are not one each year as the inflorescences in each of these months are young, none having developed flowers at more than 3-4 nodes.

Conservation status: 2 ?E. The vicinity of the only known population and similar habitats elsewhere in southeastern Tasmania need to be searched further to determine if further populations of this species (and its ally *E. phragmostoma*) exist.

Specimens examined

TASMANIA. EAST COAST: *Collier 1392*, 25.v.1986, Cape Hauy (Storm Bay sheet 814 226) 43°09'S 148°00'E, HO. — *Collier 1688*, 4.x.1986, Cape Hauy (Storm Bay sheet 814 227), HO. — *Collier 1689*, 4.x.1986, Cape Hauy (Storm Bay sheet 813 225), HO. — *Collier 1691*, 4.x.1986, Cape Hauy (Storm Bay sheet 814 227), HO. — *Collier 1692*, as for *1691*, AD, HO. — *Collier s.n.*, 4.x.1986, Cape Hauy [without grid reference], AD 98707019. — *Jarman & Kantvilas 39*, 17.xi.1979, Cape Hauy, Tasman Peninsula, 43°09'S, 149°00'E, AD (holotype); HO (2 sheets).

The rediscovery of *E. gibbsiae* Du Rietz ssp. *psilantherea* (FvM.) W.R. Barker
(Barker 1982, p. 119)

A single plant of *E. gibbsiae* ssp. *psilantherea* was collected by P. Collier in October 1985 in the Southport region, south of Hobart, Tasmania. The only dated collection made previously was the type, gathered in 1855 (Barker 1982). Although the importance of the find was not realised until identified subsequently, Mr P. Collier (pers. comm., April 1986) comments that he saw no other plant of the taxon. A further search in early November 1986 was unsuccessful (Mr P. Collier pers. comm., April 1987). The plant was found amongst low sedges in open wet heathland. The location has extensive heath and wetter areas with a few copses of *Eucalyptus* on higher ground. It is designated State Forest and "Southport Lagoon Wildlife Sanctuary" and is entered in the National Estate Register. Mr Collier sees the biggest threat to the habitat being from four-wheel drive recreation vehicles which alone have access. Other areas with similar habitats are likely to occur further south, particularly at a location known as Blowhole Valley. It is imperative that the extent of this subspecies be determined to ensure it survives.

Flower colour of the subspecies is described as white with "black/dark purple striations extending out into the lobes".

Several further old collections of this subspecies were seen in the European herbaria, but none bore additional localities.

Specimen examined

TASMANIA. EAST COAST: *P. Collier 729*, 12.x.1985, NE of Blackswan Lagoon, Southport, (D'Entrecasteaux sheet 947 805) 43°32'S, 146°56'E, HO.

The status of a variant allied in the past to *E. collina* R. Br. s. str.
(Barker 1982, p. 176, 181)

Du Rietz (1948b) noted two variants under his discussion of the *E. collina* R. Br. of his conception, equivalent to *E. collina* ssp. *collina*. One of these represented by *Gunn* $\frac{863}{1837}$

belonged to *E. collina* ssp. *tetragona* (R. Br.) W.R. Barker (Barker 1982). The two collections in Du Rietz's second variant, *Gunn 1993* and *Gunn 1995*, have now come to light. Both belong to *E. collina* ssp. *diemenica* (Sprengel) W.R. Barker of Tasmania.

In the informal varietal framework proposed in Barker (1982) for this subspecies, *Gunn 1995* from the Central Plateau region resembles *var. G* with large flowers and lacking glandular hairs on the calyx and vegetative parts, which is known from the same region.

Gunn 1993 from St Patricks River is non-glandular and with white, relatively small corollas. It is possibly allied to *var. I* which is a hypothetical taxon represented only by one specimen from Ben Lomond in the same general region. With its subglabrous capsules it would qualify well as the missing parental taxon in the proposed intraspecific hybrid swarm (Barker 1982) on the edge of Ben Lomond massif.

Du Rietz (1948b) noted that *Gunn 1993* had some resemblance to *E. striata* in habit, leaves and anthers. While one specimen has glabrous anther backs, those in one of the other two specimens are densely hairy while in the remaining they are intermediate, possessing just a few hairs. It is unlikely that this is associated with Sect. *Striatae* which has yet to be recorded from north-eastern Tasmania. All other attributes conform well with *E. collina* ssp. *diemenica*.

Specimens examined

TASMANIA. CENTRAL PLATEAU: *Gunn 1995*, 17.i.1845, Arthurs Lakes From the summit of the Western Mts and may perhaps prove similar to some others Nos. — Flowers purple, K (Herb. Hook.). BEN LOMOND: *Gunn 1993*, 16.xi.1844, St. Patricks Riv[er], alt. 1500 ft. Flowers white. I am keeping the species (or vars.) of *Euphrasia* as separate as possible as I believe there are a greater no. of actual species than I formerly thought. The present plant is common in the cold wet country N.E. of Launceston — very abundant at an elevation of about 1500 feet, K (Herb. Hook.).

A specimen allied to *E. collina* R. Br. ssp. *diemenica* (Sprengel) W.R. Barker from eastern Tasmania
(Barker 1982, p. 181)

A collection allied to *E. collina* ssp. *diemenica* from St Marys, Tasmania represents a significant eastward extension of range of this group. It is to be linked with this subspecies by its relatively broad leaves with the lateral extensions of the marginal rows of sessile glands usually short, emarginate corolla lobes and apparently decumbent main branches produced only from the base of the plant. The flower is described as "blue". The specimens diverge from ssp. *diemenica* by the long apical bud cluster, thus tending towards ssp. *collina*, which is also not known from this vicinity.

Further collections are needed from the region before the taxonomic significance of the collection can be assessed.

Specimen examined

TASMANIA. EAST COAST: *E. Rees s.n.*, xi.1929, St Marys, K (ex HO).

The glandular subspecies of *E. collina* R. Br. in eastern Tasmania
(Barker 1982, pp. 198-204)

Additional collections seen from K and HO indicate that the circumscriptions or diagnostic characters of ssp. *gunnii* (Du Rietz) W.R. Barker, ssp. *deflexifolia* (Gand.) W.R. Barker and a further provisional subspecies based on *E. tasmanica* Gand. among the glandular forms of *E. collina* in eastern lowland to low montane Tasmania may need reassessment.

Collections allied to ssp. *deflexifolia* outside the Freycinet Peninsula, from where the bulk of collections seen for Barker (1982) came, show a tendency to diverge. *Hemsley 6321A* from west of Swanport has the large white corollas and long glandular indumentum of ssp. *deflexifolia*, but has the rather narrow leaves with 1(2) teeth and long anther awns of ssp. *gunnii*.

Further afield to the northwest of Swanport *Moscal 492* tallies well with ssp. *deflexifolia* in the length and density of its glandular indumentum, its apparently white corollas, its short rear anther awns and its densely setose capsules. Its inflorescences are rather fewer flowered than usual for the subspecies, but the branches are clearly depauperate lateral branches. The one major area of divergence is in the narrow 1 (2)-toothed leaves; those occurring on similar lateral branches in similar instances in the Freycinet Peninsula material are broad. With narrow leaves occurring in some plants of *Barker 977* on the coastal flats west of the granitic mountains of the Freycinet Peninsula, it is possible that such leaf forms are associated with the non-granitic soils. *Moscal 492* is noted as growing in the doleritic soils which (Banks 1965) predominate in the region. It had been noted (Barker 1982) that previous collections seen may have been associated with granite which (Banks l.c.) forms a marginal belt along the east Tasmanian coast.

Additional or cited specimens examined

E. collina ssp. *deflexifolia*

TASMANIA. EAST COAST: *W.M. Curtis s.n.*, ix.1948, 42°07'S 148°20'E, Coles Bay, AD (ex HO). — *W.R. Barker 977* (see Barker 1982). — *A. Himson s.n.*, 22.xi.1968, Coles Bay, light *Eucalyptus* forest, K. — *A. Moscal 769*, 10.v.1981, 41°32'S, 148°10'E, North Sister (6 km N of St Marys), rock plates at summit, alt. 700 m, corolla lilac, AD (ex HO).

E. collina aff. ssp. *deflexifolia*

TASMANIA. EAST COAST: *Hemsley 6321A*, 1.xi.1967, 14 miles W of Swansea, open sandy places in open *Eucalyptus* forest, rocky places, flowers white, K. — *A. Moscal 492*, 27.xii.1980, 41°54'S 147°59'E, West Swan River, open forest, open heathy understorey, stony dolerite soils, AD (ex HO).

The rediscovery of *E. collina* R. Br. ssp. *muelleri* (Wettst.) W.R. Barker in Victoria (Barker 1982, p. 209)

The efforts of the group at La Trobe University studying endangered plants have resulted in the rediscovery of *E. collina* ssp. *muelleri*. This subspecies was known previously mainly from collections from the last century when it was widely distributed in south-east mainland Australia (Barker 1982). As circumscribed by Barker (l.c.) it comprises only those plants of *E. collina* with a short to long eglandular-scabrous to -scaberulous indumentum covering the calyx surface; they also have a characteristic pattern of shooting from the base of the plant. The collections *Scarlett 83-156* and *Scarlett 84/697-699* from Wren's Flat belong to this taxon. *Scarlett 86/473-474* and the majority of specimens in *Scarlett 85/122-125* from near Dromana also belong here, but one of the four plants in the latter has a glabrous calyx.

Variants allied to ssp. *muelleri* but divergent in indumentum were noted in Barker (1982). A representative of the groups with sparse to dense glandular hairs amongst the scabrous or scaberulous indumentum of the typical variant has been located south of Arthurs Seat on the east side of Port Philip Bay (*Eichler AD 98709096*). It also shows the branching pattern characteristic of ssp. *muelleri*.

Among other collections made in the course of the La Trobe University work* are a number of small samples of populations of *E. collina* from various parts of montane and lowland Victoria. A high proportion of these show a tendency for break-down of the diagnostic limits recognised in Barker (1982) for ssp. *collina*, ssp. *paludosa* (R. Br.) W.R. Barker, ssp. *trichocalycina* (Gand.) W.R. Barker and ssp. *muelleri*. For the 1982 revision modern collections from Victoria were limited and field work in the State was restricted to the Grampians and the summer-flowering,

*The principal duplicate of all *Euphrasia* collections made under this project presently at La Trobe University will ultimately be transferred to MEL (Mr N.H. Scarlett pers. comm., April 1987).

higher montane populations of the eastern highlands. A number of problems of delimitation of these subspecies were indicated and it is now more apparent that field studies are needed to ascertain whether the existing infraspecific framework is a natural one and whether factors of introgression are involved.

Specimens cited

E. collina ssp. *muelleri*

VICTORIA. EASTERN HIGHLANDS: *Scarlett 82-156*, 16.xi.1982, *84/697-699*, 12.xii.1984, Lower slopes of the spur east of the Mitchell's Flat track, immediately south of the Jamieson River, at Wren's Flat, 37°20′45″S 146°22′20″E, 740 m a.s.l., AD (ex LTB). EASTERN COASTAL PLAINS: *Scarlett 85/122-125*, 29.ix.1985, Junction Rd., approx. 9 km east of Dromana: 0.4 km south by road of the Myer's Road/Junction Road intersection, 145°03′E 38°21′S, approx. 200 m a.s.l., AD (ex LTB). — *Scarlett 86-473, 86-474*, 15.xii.1986, as for Scarlett 85/122-125, AD (all material).

E. collina aff. ssp. *muelleri*

VICTORIA. EASTERN COASTAL PLAINS: *Eichler s.n.*, 7.x.1985, Mornington Peninsula, Seamists Drive, approx. 4 km south of Arthurs Seat: 44 m north of the road at a point 0.3 km west of the Seamists Drive/Purves Road junction, 144°58′E 38°22′S, 260 m a.s.l., AD (ex LTB).

New South Australian records of *E. collina* R. Br. ssp. *osbornii* W.R. Barker (Barker 1982, p. 218)

Three new populations of this rare South Australian subspecies have been located in recent years. One occurs at the foot of Fleurieu Peninsula in Deep Creek Conservation Park (*Meyers AD 98346073*). Another represents its most southerly mainland record (*Carpenter AD 98709001*); the land on which it was found is privately owned, has had a clearance application refused, and is currently subject to negotiation for conservation under Heritage Agreement. Both these collections were made casually, their importance being realised only subsequently. As a result the extent of the populations and their habitat is unknown.

The third new population (*Lang D8902*) was from near Clare, about 1 km from the Clare Cemetery from which the collection *Bates 803* was made in 1980. This new location on a council reserve contained over 200 individuals growing in low *Eucalyptus leucoxylon* woodland with an open understorey of grasses, herbs and low shrubs on the upper slopes of a hill. The area had been burnt in recent times.

Further collections made or seen since the last documentation of the subspecies (Barker 1982) have verified the continued existence of populations, more accurately defined their location or added also to the list of former localities of the subspecies.

Specimens examined

SOUTH AUSTRALIA. NORTHERN LOFTY: *Hinterocker s.n.*, s. dat., Sylv[aticae] Sevenh[ills], W7932. — *Lang D8902*, 23.x.1984, Section 461, Hundred of Clare, ca. 2 km WSW Clare, AD. YORKE PENINSULA: *W.R. Barker 5418, R.M. Barker, J. Short*, 7.ix.1986, Remnant patch of Stansbury Scrub, 10 km direct ESE of Minlaton, c. 0.4 km S of main Minlaton-Stansbury road, 34°49′S 137°41½′E, AD. SOUTHERN LOFTY: *Bates 3605*, 1.x.1977, sphagnum bog near Myponga, AD. — *Brown s.n.*, ix.1948, Cape Jervis, AD. — *Meyers s.n.*, 1.x.1983, Deep Creek Conservation Park, on track ca. 100 m from Black Bullock Road towards Deep Creek, AD 98346073. — *Riedel s.n.*, 6.x.1945, Mt Compass, AD 98023153. SOUTH-EASTERN: *Carpenter per Lang s.n.*, 12.xii.1986, Section 33, Hundred of Strawbridge, 12 km SE of Coonalpyn, private property of K.M. & D.B. Lutze, AD 98709001.

The rediscovery of *E. scabra* R. Br. in montane southeastern Australia
(Barker 1982, p. 270)

As a result of investigations of endangered species being undertaken at La Trobe University, Mr N.H. Scarlett and his colleagues have located in the Victorian Alps populations of *E. scabra* and also of the allied form discussed by Barker (1982) which approaches *E. caudata* (J.H. Willis) W.R. Barker. Both are reported to occur as distinct populations in the region, with no evidence in Mr Scarlett's view or from his collections of intergrading specimens. Field study seems desirable for as many populations as can be located before a taxonomic solution is proposed for the allied form. Mr N.H. Scarlett (pers. comm., April 1987) reports further collections of typical lowland *E. scabra* from the other side of the Dividing Range (*M.J. Bartley 57, 58 & Scarlett*, 11.ii.1987, Victoria, Eastern Highlands, beside the western approach track to King Spur, 3 km W of Mt Koonika, approx. 50 km E of Mirimbah, MEL). There was not time for me to examine these before going to press. These populations are the first records of these taxa from mainland southeastern Australia in many years, and it is imperative that they be conserved while there are so few known.

Specimens examined

E. scabra R. Br.

VICTORIA. EASTERN HIGHLANDS: *Beardsell s.n.*, 6.iv.1985, Little Bog Creek, approx. 20 km east of Bendoc (direct) between 0.5 & 1.5 km south of the track crossing near the N.S.W. border, 149°06′E 37°10′S, 830 m a.s.l., AD (ex LTB). — *Parsons 600*, 18.ii.1986, Mundy Plain, 17 km NW of Gelantipy, AD (ex LTB). —*Scarlett 84-136*, 17.ii.1984, East branch of the Delegate River, above 'the forks', approx. 10.5 km south of Bendoc (direct), 37°14′30″S 148°55′E, 880 m a.s.l., AD (ex LTB). — *Scarlett 84-160*, s. dat., as for 84-136, AD (ex LTB). — *Scarlett 85-48, 85-50, 85-51*, 19.ii.1985, Little Bog Creek, 19 km ESE of Bendoc (direct), 37°10′S 149°06′E, 830 m a.s.l., AD (ex LTB). — *Scarlett 86-79, 86-81*, 11.iii.1986, Bentley's Plain, Nunniong Plateau, 18 km NNE of Ensay, 147°55′E 37°14′S, 1600 m a.s.l., AD (ex LTB).

E. scabra R. Br. ssp. *'large-flowered'*

VICTORIA. EASTERN HIGHLANDS: *Scarlett 84-110, 84-111*, 5.ii.1984, West side of unnamed creek running off Bucketty Plain, 36°58′20″S 147°21′10″E, AD (ex LTB). — *Scarlett 84-118*, 5.ii.1984, West side of Clearwater Creek, below Bucketty Plain, 37°57′S 147°21′15″E, AD (ex LTB). — *Scarlett 84-214*, 19.iii.1984, as for *84-111*, AD (ex LTB).

E. arguta R. Br.: two species or one?
(Barker 1982, p. 282)

In the revision of the genus in Australia (Barker 1982) it was thought possible that two species may have been confused under the name *E. arguta* R. Br. Both Bentham's (1846, 1868) and Wettstein's (1896) descriptions were discordant with the specimens available to me.

In 1985 a number of additional collections of *E. arguta* were located. Amongst these were material seen by Bentham and the Hügel collection in W used principally by Wettstein (1896) in drawing up his description.

After an analysis of the length, distribution and density of glandular and eglandular hairs on the plant, the capsule apex and indumentum, the length of the calyx, bract and leaf teeth, and the length of the rearmost anther awns, it is concluded that all the material belongs to one species, variable in these attributes.

The following is an amended description.

Erect brittle annual *herb*, (17) 20-35 (45) cm high. *Stem* to base of inflorescence (12) 13-28 (33) cm tall, bearing (13) 15-28 (30) pairs of leaves, with axillary branches developing from (1) 2-11 (12) nodes above cotyledons to 1-2 (5) nodes below inflorescence, rarely

(*Crawford 577*, one of four plants; *Brown BM*, lecto) with an extra shoot along underside of branch in axils of upper leaf pair; *branches* flowering later than stem, developing in basipetal sequence, lower branches bearing 3-c. 13 leaf pairs, uppermost pair bearing 0-4 (5) leaf pairs, with usually all, otherwise most, leaf pairs subtending shoots sometimes developing into inflorescence-bearing branches; *axes* in upper parts covered equally all around by moderately to very dense, short to moderately long downturned eglandular hairs, often dense on young shoots, sometimes mixed with moderately long to long glandular hairs, the indumentum somewhat sparse to very sparse lower down stem. *Cotyledons* caducous. *Leaves*: *uppermost* stem leaves in outline ovate to elliptic, often broadly so, pinnatifid-serrate to deeply pinnatifid, (6.8) 7.5-12.5 (14.5) x (3.5) 4.0-12.0 (13.0) mm, very sparsely to densely eglandular-scaberulous, sometimes sparser rarely glabrous on lower side, sometimes with scattered to moderately dense, tiny to long glandular hairs, rarely densely scabrous on upper surface and margins, with blade lanceolate to elliptic or narrowly so, with margins recurved; *base* rounded-cuneate to narrowly cuneate; *teeth* 2-3 (4) along each margin, sharply acuminate to long acuminate with longest (1.2) 1.5-4.8 (5.5) mm long; *apical tooth* (2.7) 3.1-6.0 (7.5) mm long, sharply acute to long acuminate; *lower leaves* similar to upper leaves, sometimes with somewhat longer scabridity or broader blades with shorter teeth; leaves in similar positions on *branches* similar but somewhat smaller. *Inflorescences* dense racemes, with that of stem producing (30) 50-90 or more flowers, those of branches somewhat fewer; *rachis* of same pilosity as upper stem; *internodes* sometimes elongating after anthesis, the capsules extending well past or just reaching node above; *pedicels* (0.2) 0.3-0.5 (1.1) mm long, remaining the same length after anthesis; *apical bud cluster* rounded to broadly bluntly conical, up to 1.5 cm long, emergent above flowers even after many flowers are produced. *Bracts* similar in dimensions to upper leaves, with blade usually broader with shorter teeth, rarely narrower with longer teeth (*Hügel W*), usually moderately to densely scaberulous, often also bearing tiny to moderately long, scattered to moderately dense glandular hairs, rarely densely scabrous. *Calyx* (5.0) 5.5-7.0 (8.2) mm long, externally usually densely scaberulous, usually also bearing scattered to moderately dense glandular hairs 0.03-0.2 mm long, rarely densely scabrous, internally bearing sparse to dense, very short to moderately long, appressed upturned eglandular hairs mixed with sparse to dense, very short glandular hairs, the indumentum on the teeth shorter or sometimes lacking; *teeth* sharp-tipped, usually very narrowly acuminate, sometimes narrowly acute; *lateral clefts* 2.0-3.7 (4.0) mm deep, shorter than the *median clefts* which are (2.6) 3.0-5.2 (6.3) mm deep. *Corolla* 10.0-13.5 (14.0) mm long along upper side, with lower side ± broadly grooved, white or lilac and (Brown unpubl.) with yellow area on lower side of mouth; *tube* 6.7-8.3 (8.5) mm long, laterally and somewhat medianally narrowly broadened from below bases of anterior filaments, which are (3.0) 4.0-5.8 (6.0) mm from base of corolla, externally glabrous at base, distally covered by dense, moderately long to long eglandular hairs, usually with dense patch of short glandular hairs behind lateral cleft extended towards base of anterior filaments, internally glabrous to summit of ovary, distally covered by dense, short to long, downturned eglandular hairs up to bases of posterior filaments; *hood* 3.0-5.0 (5.5) mm long, covered externally by dense, moderately long to long eglandular hairs, sometimes mixed with dense, very short glandular hairs on sides, internally with moderately long to long flexuose eglandular hairs, dense at sinus, sparser above anthers, and usually lacking proximally, often mixed with very few to moderately dense, very short glandular hairs, with *upper lobes* usually obtuse, sometimes acute or shortly apiculate, with front glabrous or covered by moderately dense to dense, very short to short eglandular hairs, with rear usually covered by sparse to dense, short to long eglandular hairs, rarely glabrous, with margins lined by moderately to dense, short to moderately long eglandular hairs, with cleft between (1.0) 1.2-2.3 (2.5) mm deep; *lower lip* (4.5) 5.0-7.0 (9.0) x (8.2) 8.6-12.5 (13.0) mm, ± flat cross-wise, apparently distally bent downwards, always longer than upper lip, externally covered by dense, moderately long to long eglandular hairs, internally covered behind lobes by sparse to dense, short to moderately long eglandular hairs, on lobes usually sparser and shorter, sometimes lacking, with margins lined by moderately dense to dense, short to moderately long eglandular hairs, with *lower lobes* broadly obtuse, sometimes praemorse or slightly apiculate, with clefts between (2.0) 2.2-3.5 (5.0) mm deep. *Stamens* with *filaments* glabrous but for sparse to dense, short to very long eglandular hairs on anterior pair in lower half to at base only, anterior pair (4.0) 4.5-6.3 (6.5) mm long, posterior pair (1.7) 2.0-3.6 mm long; *anthers* (0.9) 1.3-1.6 (1.7) x (0.6) 0.8-1.2 mm, with *connectives* of anterior pair surrounded by sparse to dense, long flexuose eglandular hairs, less or equally as hairy as those of posterior pair which bear dense long eglandular hairs, with rearmost pair of *awns* (0.2) 0.3-0.4 (0.5) mm long, longer than the three anterior pairs. *Ovary* laterally compressed, in lateral view narrowly ovate to elliptic or oblong-elliptic, glabrous but for dense antrorse setae in apical $^1/_8$-$^1/_3$, long at very apex, very short to short below; *apex* in lateral view usually acute or somewhat shortly acuminate, rarely obliquely obtuse; *ovules* c. 35-80. *Capsule* laterally compressed, in lateral view usually obovate-elliptic to oblong-elliptic or obliquely so, sometimes ovate-elliptic, 4-7 (7.5) x (1.5) 1.8-2.5 (3.2) mm, usually with setae, moderately to dense over upper ¼-½ and dense along upper $^1/_3$-$^2/_3$ of lines of dehiscence, short to long at apex, shorter lower down, sometimes glabrous but for a few setae at very apex; *apex* in lateral view usually acute to obtuse, sometimes acuminate or obliquely so; *seeds* (8) 23 (50), usually ± oblong-ellipsoid, sometimes broadly so, (0.4) 0.6-0.8 (1.0) x (0.3) 0.4-0.6 (0.9) mm. *Chromosome number*: unknown. Figs. 5, 7.

Additional specimens examined

NEW SOUTH WALES. NORTH COAST: *R. Brown s.n.*, 1802-1805, Hunter's River, BM (lectotype). — *R. Brown s.n.*, s. dat., Paterson's River, K p.p. (syntype, probable isolectotype). NORTH-WESTERN SLOPES: *Boorman s.n.*, vi.1904, Nundle, E. CENTRAL COAST: *Anon. s.n.*, s. dat., Port Jackson, Blue Mountains, BM. — *Hügel s.n.*, s. dat. [prior 1824], prope Port Jackson, M 2923. CENTRAL TABLELANDS: *Anon. s.n.*, s. lat., Blue M[ountain]s, K (Herb. Hook.) p.p. — *[A.] Cunningham 229*, 1817, Bathurst Plains, BM. — *[A. Cunningham] s.n.*, s. dat., Bath[urs]t, K (Herb. Hook.) p.p. — *A. Cunningham* $\frac{229}{1817}$ p.p., iv.1817, in the open forest country around Bathurst (the western

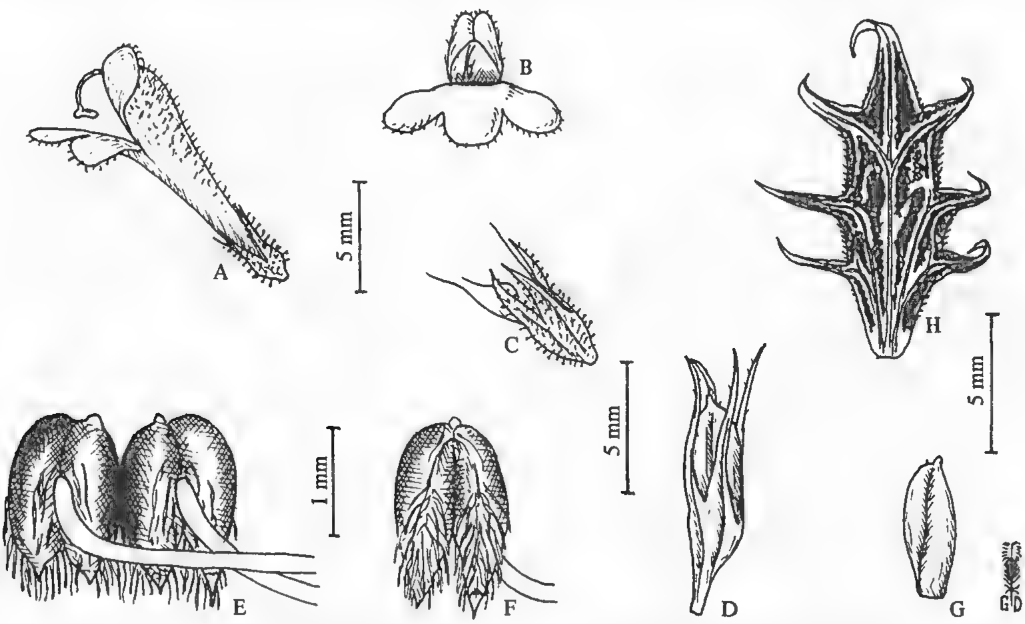


Fig. 5. *Euphrasia arguta* R. Br. A, side view of flower; B, front view of flower; C, oblique side view of base of flower of variant with calyx bearing glandular hairs; D, similar view of fruit with subglabrous calyx; E, external view of anthers; F, internal view of anterior anther; G, capsule in lateral view; H, abaxial view of uppermost leaf of main inflorescence-bearing axis. (A-C, E-H, *Sieber 490W*; D, *Boorman s.n. E*).

settlement) in subhumid places, flores albi, K p.p. — *A. Cunningham s.n. (p.p.)*, s. dat., Bathurst plains, K (Herb. Hook.) p.p. — *Fraser s.n.*, s. dat., [Fo]und on the grassy country near Bathurst & Flowers in March, [Petals] white, BM. — *Urville 7*, s. dat., Bathurst, P. CENTRAL WESTERN SLOPES: *Woolls s.n.*, s. dat. (prior 1868), Mudgee, K p.p.

AUSTRALIA. WITHOUT SPECIFIC LOCALITY: *R. Cunningham s.n.*, s.dat., N. Holld., CGE (Herb. Lindley) p.p. — *Hügel s.n.*, s. dat., Australasia orient., W. — *Sieber 490 p.p., Sieber 490 p.p. Euphrasia n. [5]76*, s. dat., F[lora] Novae Holl[andiae], W s.n., W 300499 p.p., W (reg. Berol.), K p.p., K (Herb. Benth.), E p.p., M 2906.

A further example of hybridism between *E. striata* R. Br. and *E. collina* R. Br. ssp. *diemenica* (Sprengel) W.R. Barker
(Barker 1982, p. 287)

A single specimen in K from Tasmania has the habit and leaves of *E. collina* ssp. *diemenica* and the glabrous anther backs of Sect. *Striatae*. The pollen from two flowers was examined, one showing little but mostly functional pollen (voucher slide PS 407 in AD), the other showing a large proportion of small malformed and often empty grains (PS 408). It is likely that the specimen is of hybrid origin. Because it lacks glandular hairs it is likely that *E. striata* is the other parent.

Specimen examined

TASMANIA. WITHOUT LOCALITY: *Anon. s.n.*, s. dat., V.D.L., K (Herb. Hook.) p.p.

A probable hybrid between *E. orthocheila* W.R. Barker ssp. *orthocheila* and *E. ciliolata* W.R. Barker
(Barker 1982, p. 287)

A collection of a single annual plant dating from prior to 1868 (it was seen by Bentham for his 'Flora Australiensis' treatment) from near Tenterfield, New South Wales has characteristics of both *E. orthocheila* ssp. *orthocheila* and *E. ciliolata*, taxa which are also known from this region. It has the very short glandular hairs, dense and 0.02 mm long on the calyx, small calyces, narrow-linear leaves with 1 pair of teeth and small, densely setose capsules of the former species. From the dark brown colour of the dried corolla and anthers the corolla was not yellow (see Barker 1982) and was probably lilac rather than white, a characteristic of the latter. Both species have the densely scaberulous indumentum and basipetal branching pattern with many axillary shoots seen in the specimen. An examination of the pollen shows it to be almost completely sterile (PS405, 406).

Specimen examined

NEW SOUTH WALES. NORTHERN TABLELANDS: *C. Stuart s.n.*, s. dat., Nr. Tenterfield, K.

Typification, affinities and status of two names

E. alpina R. Br. γ. **angustifolia** Benth. in DC., Prod. 10 (1846) 553 (= *E. collina* ssp. *collina*: Barker 1982, p. 176).

Lectotypus hic designatus: *R. Gunn 1219*, s. dat., Tasmania, Hobarton, K (Herb. Benth.). — *Isolectotypus et syntypus probabilis*: *Gunn $\frac{1219}{1842}$*, s. dat, V.D.L., Hobart. There seem to be many more species of this genus than I at first supposed. The present is from the hills about Hobart Town. K (Herb. Hook). — *Isolectotypi sed non syntypi probabiliter*: *Gunn $\frac{1219}{1842}$*, 23.x.1839, Hobart, CGE (Herb. Lemann). — *Gunn 1219*, s. dat. Hobart Town, CGE (Herb. Lindley) p.p.

In 1985 several syntypes and isosyntypes were located. They apparently all belong to the one collection under Gunn's species number *1219*. The dates 1842 on most specimens and 1844 on labels in the Bentham herbarium refer not to date of collection but to the year of shipment in the former case (Burns & Skemp 1961) and presumably the year of acquisition in the latter. No syntypes occur in the De Candolle herbarium in G.

The syntypes and isosyntypes belong to *E. collina* ssp. *collina*. With *E. collina* s. str. misapplied by Bentham (1846, 1868) and subsequent authors (cf. Du Rietz 1948b, Barker 1982), *E. alpina* γ. *angustifolia* was the name Bentham (1846) applied to typical *E. collina*. Later (Bentham 1868), he reduced it to synonymy under an expanded *E. collina*.

E. paludosa R. Br. β. **pedicularoides** Benth. in DC., Prod. 10 (1846) 554 (= *E. collina* ssp. *paludosa*: Barker 1982, p. 204)

Holotype: *A. Cunningham 1836*, vi.1827, on the hills in the vicinity of Logan Vale, at the western base of the Main, [a] dividing chain of mountains, in Lat. 28°S, Long. 152°E, K (Herb. Benth.) p.p.

The single specimen seen was given the species name "pedicularioides" on Cunningham's field label. It is a particularly robust plant of *E. collina* R. Br. ssp. *paludosa* (R. Br.) W.R. Barker with large, many-toothed leaves.

Further Typifications

Names are placed in the order of their appearance in the revision (Barker 1982).

Except where a lectotypification is proposed here, only additional types seen are cited.

E. brownii FvM. var. **psilantherea** FvM.
(Barker 1982, p. 119)

Possible isolectotype, not syntype: *C. Stu[?a]rt s.n.*, s. dat., Without locality, K (Herb. Hooker) p.p.

The label is annotated "C. Sturt" not Stuart, the collector of the type of this name. Although I am unaware whether the South Australian explorer Charles Sturt visited Tasmania, it would be extremely improbable that he would have collected so rare a taxon. I know of no other *Euphrasia* collected by him.

As there is no evidence that Charles Stuart made more than the one collection of this taxon, it is likely that this specimen is an isolectotype.

E. striata R. Br.
(Barker 1982, p. 134)

Syntype and isolectotype: *R. Brown s.n.*, s. dat. Table Mountain, BM.

This specimen clearly comes from the lectotype collection.

E. alpina R. Br. β. **humilis** Benth.
(Barker 1982, p. 134)

Syntype, possible isolectotype: Gunn $\frac{1221}{1842}$, 31.i.1840, Mt Wellington, K p.p. *Syntypes or isosyntypes, possible isolectotypes*: *R. Gunn* $\frac{1221}{1842}$, 7.i.1841, Mt Wellington, BM. — *Gunn* $\frac{1221}{1842}$, 7.i.1841, Mt Wellington, V. Diemen's Land, CGE (Herb. Lemann). — *Gunn* $\frac{1221}{1842}$, s. dat., Near summit of Mt Wellington, CGE (Herb. Lindley).

Gunn made two collections under his species number *1221*, one on 31.i.1840 cited previously by Barker (1982) and by Du Rietz (1948a), the other on 7.i.1841, a fact only discovered from the above collections in 1985. If all syntypes and isosyntypes were assembled together it may be possible to determine from which collection the lectotype comes.

E. cuspidata Hook. f. (≡ *E. hookeri* Wettst.)
(Barker 1982, p. 142)

Isolectotypes: *J. Milligan 767*, 15.i.1847, Mt Sorrel [...] Peaty ground, BM p.p. — *[J. Milligan] 767*, s. dat., Mt Sorrel, McQr. Hr., Tasmania, BM p.p. *Isolectotypes, not syntypes*: *J. Milligan s.n.*, s. dat., Summit Mt Sorrel. Peaty ground. Macqie Harbour. K (presented by Linn. Soc. in 1915). — *Milligan 767*, 15.i.1847, Summit Mt Sorrel. Peaty ground, K.

E. collina R. Br.
(Barker 1982, p. 159)

Syntype, not isolectotype: *R. Brown s.n.*, s. dat. Derwent, K (Herb. Hook.) p.p. *Syntypes*: *[R. Brown] s.n.*, s. dat. V. Diemen's Island, BM (2 sheets).

The additional K syntype bears the manuscript name "Euphrasia collina" in Brown's hand, came from the locality "Derwent", has upper leaves with two pairs of teeth, and is in bud and flower. All these factors conform with its coming from the collection of plants intermediate between ssp. *collina* and ssp. *diemenica*, not from the lectotype collection (see discussion in Barker 1982). The two BM specimens are syntypes but I am uncertain to which of the two known collections they belong.

E. alpina R. Br. non Lamk. (≡ *E. diemenica* Sprengel)
(Barker 1982, p. 181)

Isolectotype & syntype: *R. Brown s.n.*, s. dat., Table Mountain, K p.p.

Brown supplied a third manuscript name "E. tabularis" to this taxon on the accompanying label to add to "E. speciosa" and "E. grandiflora" on other syntypes (Barker 1982).

E. tetragona R. Br.
(Barker 1982, p. 189)

Lectotypus hic designatus: *R. Brown s.n.*, xii.1801-i.1802, Bald Head, King George's Sound, BM (Fig. 4). *Syntypi et isolectotypi possibiles*: *R. Brown s.n.*, xii.1801-i.1802, Bald Head, King George's Sound, BM. — *R. Brown 2720*, s. dat. [Dec. 1802?]. In collibus [prope] Bald Head, King Georges Sound, BM p.p. (seen for Barker 1982). — *R. Brown s.n.*, s. dat., Bald Head, K p.p.

Of the four collections seen which apparently comprise all the extant syntypes, the one chosen as lectotype is in the best condition and the only one with a substantial inflorescence. It is also apparently the specimen seen by Du Rietz (1948b) and described by him as the holotype. Brown's (unpubl.) manuscript contains probably two descriptions, the one from "in collibus arenosis prope Bald Head" relating to plants in both flower and fruit, while the one from "King George III^{d} Sound" describes only the fruits.

Brown was at King George's Sound in early summer when flowering of the plant would have been near completion (as indicated in the material). It is uncertain, particularly with the loss of specimens with the wreck of the 'Porpoise' (Stearn 1960; Mabberley 1985), whether the new syntypes on which the locality 'Bald Head' has been typed in recent times, actually belong to the same collection as that seen for Barker (1982).

The K collection consists of a mixture of the syntype material with specimens collected later by Brown from Memory Cove, South Australia, as indicated by two labels in his hand. This latter material is a duplicate of the collection discussed in Barker (1982). It is not clear whether the mixing indicates that Brown considered the two collections to be conspecific.

E. multicaulis Benth.
(Barker 1982, p. 189)

Syntype, possible isolectotype: *Gunn 863*, s. dat., Van Diemen's Land, K (Herb. Benth.). *Probable syntypes or isosyntypes, possible isolectotypes*: *R. Gunn* $\frac{863}{1842}$, 30.x.1837, Circular Head, BM. — *Gunn 863*, s. dat., Circular Head, CGE (Herb. Lindley) p.p. — *Gunn* $\frac{863}{1842}$, s. dat., Circular Head, V. Dieman's Land, CGE. *Possible syntype or isosyntype*: *R. Gunn 1220 p.p.*, s. dat., Tasmania, BM p.p. (as to the discordant specimen; this locality and species number presumably apply only to the other specimens).

The only definite syntype found additional to those cited in Barker (1982) was in the Bentham Herbarium at K. The existing previously chosen lectotype (Barker 1982) in the Hooker Herbarium at K is maintained. Both syntypes are annotated "E. multicaulis" by Bentham, both have uncertain locality details, one coming from two possible collections, the other lacking any specific locality, and both are in equivalent condition and of similar quantity of material.

Specimens with Gunn's species numbers *200, 836? or 1220?*, and *1220*, although annotated as *E. multicaulis* by Bentham, are considered to have no type status. It is assumed that they were seen by Bentham after preparation of the protologue (Bentham 1846) as he otherwise would have cited them there.

E. gunnii Du Rietz
(Barker 1982, p. 199)

Lectotypus hic designatus: *Gunn* $\frac{1220}{1842}$, 24.xii.1842, 10 miles N of Launceston, K (Fig. 6). *Isolectotypi non syntypi*: *R. Gunn* $\frac{1220}{1842}$, 24.xii.1842, 10 miles N of Launceston, BM p.p., CGE p.p. — *R. Gunn* $\frac{1220}{1842}$, 24.xii.1842, 10 miles N of Launceston road to Pipers, NSW 10830, CGE. *Isolectotypi possibiles*: *R. Gunn 1220*, s. dat., Tasmania, BM p.p., M (ex Herb. Hook.). *Syntypi alteri, possibiles isolectotypi pro parte*: *Gunn* $\frac{1220}{1842}$, 20.ix.1841 & 1842, Launceston. This is the commonest species about Launceston . . ., K p.p. ("holotype": Barker 1982). — *R. Gunn* $\frac{1220}{1842}$, 18.ix.1841, 1842 & 1843, Launceston, BM p.p. *Isosyntypus, non isolectotypus*: *R. Gunn* $\frac{1220}{1842}$, 20.ix.1841, Launceston, BM p.p.

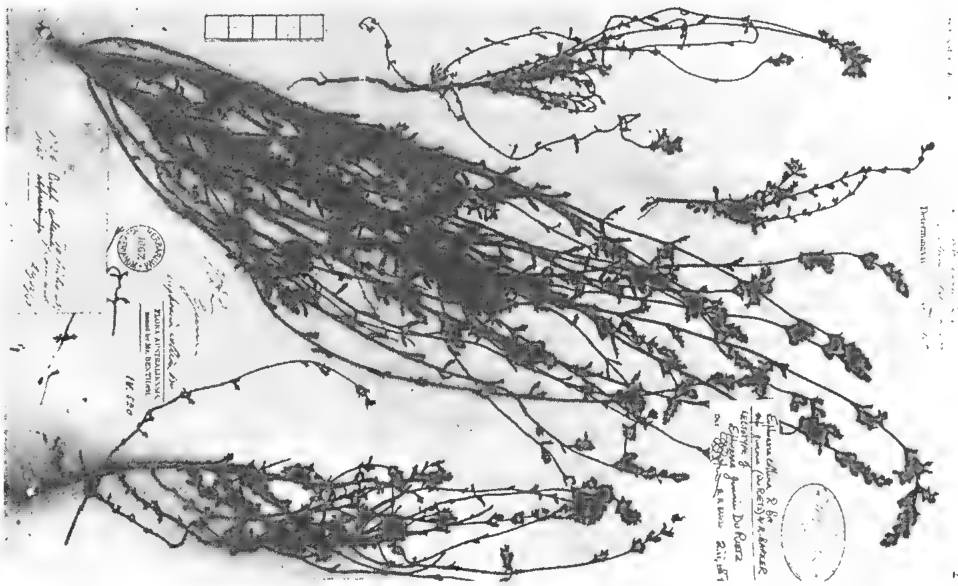


Fig. 6. Lectotype of *Euphrasia gunnii* Du Rietz (scale 5 cm long).

Fig. 7. Lectotype of *Euphrasia arguta* R. Br. (scale 5 cm long).

In 1930 Du Rietz annotated two sheets collected by Gunn and numbered $\frac{1220}{1842}$ in K as *E. gunnii* without noting which he considered was the principal type. The lectotype, not seen by me for my previous study, is chosen because it is of good quality and shows in the four plants a wide variation from depauperate to a large robust habit and, unlike the other candidate assumed previously (Barker 1982) to be the holotype, apparently belongs to the one gathering.

E. paludosa R. Br.
(Barker, 1982, p. 204)

Syntype and possible isolectotype: *R. Brown s.n.*, 1802-1805, Port Jackson, BM.

It is not possible to know whether Brown made more than one collection of this taxon. In his manuscript (Brown unpubl.) there is not the usual lengthy description with locality details cited. Instead reference to this species is appended to one of the descriptions of his *E. speciosa*. The newly seen specimen is of somewhat better quality than the lectotype chosen in Barker (1982). The lectotype, however, has more flowering branches (6 vs. 3) and bears one of Brown's labels, which was probably written on the expedition.

E. glacialis Wettst.
(Barker 1982, p. 233)

Isolectotypes, not syntypes: *Dr Mueller s.n.*, s. dat., Highest mountains of the sources of the Murray, K(2 sheets).

Both specimens conform with other isolectotypes seen in having the same locality wording and bearing Mueller's unpublished annotation "Euphrasia alpina Br. var. nivalis Muell.".

E. alsa FvM.
(Barker 1982, p. 256)

Syntypes, possible isolectotypes: *Dr Mueller s.n.*, s. dat., Munyang Mountains 5-6000 ped, K. — *Ferd. Mueller s.n.*, s. dat., Munyang Mountains 5-6000, K (Herb. Hook.) p.p. — *Dr M[ueller] s.n.*, i.1855, In montibus altioribus lapidosis tractus Munyang Mountains 5-6000′ elevation (crescit gregarie), K. — *Anon. s.n.*, s. dat., Summit of Munyang Mts. So Australia —6000 ped. s.m., BM p.p. — *Dr Ferd. Mueller s.n.*, s. dat., Munyang Mountains, BM p.p.

E. scabra R. Br.
(Barker 1982, p. 270)

Syntype and isolectotype: *R. Brown 2718*, 1802-5, Port Dalrymple, Tasmania, E. *Syntype, not isolectotype*: *[R. Brown] s.n.*, [i.1804], Port Philip, BM.

All the specimens denoted as isolectotypes in Barker (1982) are to be considered syntypes; they were in Brown's possession until his death (Stearn 1960; Mabberley 1985).

E. arguta R. Br.
(Barker 1982, p. 282)

Lectotypus hic designatus: *R. Brown s.n.*, 1802-1805, Hunter's River, BM (Fig. 7). *Syntypi,* *probabiliter isolectotypi*: *R. Brown s.n.*, s. dat., Paterson's River, K p.p. — *R. Brown s.n.*, x-xi.1804, In pascuus prope fluv: Patersons & Williams Rivers, BM (seen for Barker 1982, but not for this study).

Two further syntypes of *E. arguta* were found in the collections of BM and K. The single syntype seen previously by me and considered to be a holotype was in very poor condition, lacking inflorescences (Barker 1982). The lectotype chosen is the best of the three specimens, the K specimen being damaged by injudicious gluing.

Despite the four different localities given on the three syntypes and in Brown's (unpubl.) manuscript ("In pratio prope ripas Paterson's River, inter Mt. Anna and Mt. Elizabeth. Oct. 1804./No. 58"), the stage of flowering and general appearance of the material make it possible that they come from the one gathering. The "Hunters River" designation is not in Brown's usual hand and may represent the later provision of a more widely known regional name as often occurred on duplicate material in the 19th century.

Additional synonymies and misapplications of names

E. gibbsiae Du Rietz ssp. **kingii** (W.M. Curtis) W.R. Barker
(Barker 1982, p. 124)

E. alpina auct. non R. Br.: Benth., *Fl. Austral.* 4 (1868) 521, p.p. (as to *Milligan 766*, 8.x.1846, between Birchs Inlet and the Gordon river, Macquarie Harbour, K p.p.; *Milligan s.n.*, 1.viii.1846, Kelly's Basin McQuarie Hbr, K p.p.)

E. collina R. Br. ssp. **collina**
(Barker 1982, p. 176)

E. alpina R. Br. γ. *angustifolia* Benth. in DC., *Prod.* 10 (1846) 553 (see p. 214).

E. paludosa R. Br.: Wettst., Monogr. Gatt. Euphrasia (1896) 255, p.p. (as to *Gunn s.n.*, s. dat., without locality, W p.p.)

E. collina R. Br. ssp. **diemenica** (Sprengel) W.R. Barker
(Barker 1982, p. 181)

E. collina R. Br.: Du Rietz, Sv. Bot. Tidskr. 42(4) (1948) 357, p.p. (as to *Anon s.n.*, s. dat., without locality, W p.p., W (ex Herb. Hook.), W (ex Herb. Hook.).

E. collina R. Br. ssp. **tetragona** (R. Br.) W.R. Barker
(Barker 1982, p. 189)

E. alpina R. Br. β. *[humilis]* auct. non Benth.: Hook.f., Fl. Tasm. 1 (1857) 296, p.p. (as to *Anon s.n.*, s. dat., without locality, W (ex Herb. Hook.).

E. collina R. Br. ssp. **paludosa** (R. Br.) W.R. Barker
(Barker 1982, p. 204)

E. paludosa R. Br. β. *pedicularoides* Benth. in DC., Prod. 10 (1846) 554 (see p. 215).

E. collina R. Br. ssp. **osbornii** W.R. Barker
(Barker 1982, p. 218)

E. scabra auct. non R. Br.: Wettst., Monogr. Gatt. Euphrasia (1896) 260 p.p. (as to *Anon s.n.*, s. dat. Lofty-ranges, W; *Mueller s.n.*, s. dat., Nov. Holland. meridional, Fiedlers Section, W; *Wilhelmi s.n.*, s. dat., Lofty Ranges, W).

Acknowledgements

Mr Phil Collier and Dr A.E. Orchard of Hobart and Mr N. Scarlett, Dr R.F. Parsons and Mr J. Eichler of La Trobe University, together with the other users of my revision who have sent collections of possible interest, are thanked for their continuing assistance. Miss Tina Eadsforth is thanked for typing the paper and Mr Gilbert Dashorst for preparing Figures 2 and 5.

The herbaria BM, CGE, E, FI, G, HO, K, L, LTB, M, P and W are gratefully acknowledged for the loan and/or donation of specimens.

References

Banks, M.R. (1965). Geology and mineral deposits. *In* Davies, J.L. (Ed.). "Atlas of Tasmania". (Lands and Surveys Dept: Hobart), pp. 12-17.

Barker, W.R. (1982). Taxonomic studies in *Euphrasia* L. (Scrophulariaceae). A revised infrageneric classification, and a revision of the genus in Australia. *J. Adelaide Bot. Gard.* 5:1-304.

Barker, W.R. (1984). *Euphrasia.* The Australian eyebrights. *Austral. Pl.* 12: 333, 335-348.

Barker, W.R. (1986). Biogeography and evolution in *Euphrasia* (Scrophulariaceae), particularly relating to Australasia. *In* Barlow, B.A. (Ed.) "Flora and Fauna of Alpine Australasia. Ages and Origins". (E.J. Brill: Leiden; CSIRO: Australia), pp. 489-510.

Barker, W.R. & Christensen, T.J. (1984). Propagation of Australian eyebrights. *Austral. Pl.* 12, 347.

Barker, W.R., Kiehn, M. & Vitek, E. (in preparation). Chromosome numbers in Australian *Euphrasia* (Scrophulariaceae).

Bentham, G. (1846). Scrophulariaceae. *In* Candolle, A. de (Ed.). "Prodromus systematis naturalis regni vegetabilis". (Paris), vol. 10: 186-586.

Bentham, G. (1868). Scrophulariaceae. *In* "Flora Australiensis". (Reeve: London), vol. 4, 470-523.

Brown, R. (unpubl.). "Botanical Descriptions (Manuscript) of Australian Plants held by the British Museum (Natural History)". (Positive microfilm: 22 reels in AD).

Burns, T.E. & Skemp, J.R. (1961). Van Diemen's Land correspondents. *Rec. Queen. Vic. Mus.* n.s. 14.

Du Rietz, G.E. (1948a). Taxonomical notes on some Tasmanian species of *Euphrasia.* I. *Euphrasia striata* R. Br. and *E. gibbsiae* Du Rietz n. sp. *Svensk. Bot. Tidskr.* 42: 99-115.

Du Rietz, G.E. (1948b). Taxonomical notes on some Tasmanian species of *Euphrasia.* II. *Euphrasia collina* R. Br. and *E. gunnii* Du Rietz, nov. nom. *Svensk. Bot. Tidskr.* 42: 348-363.

Mabberley, D.J. (1985). "Jupiter Botanicus. Robert Brown of the British Museum". (Cramer: Braunschweig; British Museum (Natural History): London).

Stearn, W.T. (1960). An introduction to Robert Brown's 'Prodromus Florae Novae Hollandiae'. *In* Brown, R. "Prodromus Florae Novae Hollandiae et Insulae Van Diemen (1810) and Supplementum Primum (1830)". Facsimile Edition. (Engelmann: Weinheim), pp. v-lii.

Wettstein, R. von (1896). "Monographiae der Gattung Euphrasia". (Engelmann: Leipzig).

J. Adelaide Bot. Gard. 10(2): 223-240 (1987)

THE NATURALISED FLORA OF SOUTH AUSTRALIA 4. ITS MANNER OF INTRODUCTION

P.M. Kloot

South Australian Department of Agriculture,
G.P.O. Box 1671, Adelaide, South Australia 5001

Abstract

Many species of the present naturalised alien flora of South Australia were introduced intentionally for ornamental, culinary, medicinal, fodder, hedge and other purposes. The paper discusses these uses. Unintentional introductions occurred through contaminated seed, ballast, fleece, footwear, fodder and packing material. The scant documentation of those processes in South Australia that has been located, is presented. The roles and consequences of intentional and accidental introductions are discussed and compared.

Introduction

The species comprising the naturalised alien flora of South Australia (Kloot, 1986a) have been introduced both intentionally and accidentally since the first European contact in 1802 (Kloot, 1985b). The summarised results of the analyses of the available data (Kloot, 1986b) revealed that the majority of the naturalised flora had been introduced intentionally mainly as ornamentals. Other uses were as fodder and culinary plants and to a lesser extent as hedges and medicinals.

Local evidence for unintentional introductions is scarce. The main manner of introduction was in contaminated seed but other means included contaminated ballast and fodder and attached to stock. Overseas literature suggest that this last reason is more important than our records demonstrate.

In this paper, these methods of introduction are examined further, compared and discussed.

Intentional introductions

That a plant was recorded elsewhere as an ornamental, hedge plant, medicinal etc. (e.g. Loudon, 1830), is not proof that it was introduced for that purpose to South Australia. Furthermore, even when a plant was recommended to be grown in South Australia, e.g. Heyne (1871), this also is not proof that it actually was grown here for that purpose. Similarly, that certain plants were recorded as seed-contaminants or wool-adventives (e.g. Hayward and Druce, 1919; Probst, 1949) is evidence that such plants are capable of spreading by these means, but cannot be taken, by itself, as proof that this was the means by which they were introduced to South Australia. Nevertheless, plants listed by Loudon (1830) as ornamentals may be sought successfully in local nurserymen's catalogues. Many of Schomburgk's (1885) recommendations for medicinal herbs were actually listed as growing in the Adelaide Botanic Garden a few years later (*J. Bur. Agric.* 1: 18-19). Other local documentation (e.g. Stevenson, 1839; McEwin, 1841 *et seq.*, 1843a; Bailey, 1845; Francis, 1859; Schomburgk 1871, 1878) refers to local experience of the respective authors and may be cited confidently as evidence.

The following sections deal with a number of specific uses for which plants were imported. Particular emphasis has been given to plants being introduced for purposes considered no longer fashionable, useful or effective.

Ornamentals

Of the thousands of plants that were introduced to South Australia as ornamentals, 359 are now part of the naturalised flora (Kloot, 1986b). They are too numerous to be considered individually, but two groups in particular that have waned in popularity since the last century are "ornamental grasses" and "curiosities".

Ornamental grasses

Last century the cultivation of ornamental grasses was very fashionable both overseas (e.g. Delamer, 1865) and locally (e.g. Heyne, 1871; Hackett, 1876). The term "grass" was used somewhat loosely to include other monocotyledonous plants, particularly Cyperaceae. Of the presently naturalised grasses, 18 species and 7 generic groups (e.g. "*Agrostis*", "*Chloris*") are known to have been promoted and sold in South Australia last century. They include *Aira caryophyllea* (Anon., 1879), *Avena fatua* (Anon., 1879), *Avena sterilis* (Heyne, 1871), *Briza maxima* (McEwin, 1843; Heyne, 1871), *Briza minor* (Heyne, 1871), *Cenchrus echinatus* = *C. longispinus* (Pascoe, 1886), *Cyperus* — "many kinds" (Heyne, 1871), *Digitaria ciliaris* (Pascoe, 1886), *Eragrostis megastachya* = *E. cilianensis* (Anon., 1879) and *Vulpia bromoides* (Pascoe, 1886).

Curiosities

The Victorian era was one of great scientific curiosity (Barber, 1980), and gardeners cultivated interesting or "curious" plants from all over the world. Loudon (1830) listed many plants cultivated in Britain as "curiosities" as distinct from "ornamentals". This interest was also found amongst early Australian gardeners. Thus Hackett (1876) advertised gourds as being "curious and beautiful". Of presently established plants, 39 species were noted by Loudon (1830) as being grown in Britain as "curiosities" at that time, although little local evidence is available. They include *Avena sterilis*, *Cyperus tenellus*, *Echinochloa crus-galli*, *Euphorbia terracina*, *Medicago spp.*, *Onopordum acaulon*, *Peganum harmala*, *Silene apetala*, and *Sporobolus indicus* = *S. africanus*.

Culinary plants

A number of presently naturalised plants were introduced to South Australia for culinary purposes. As a result of changed eating habits, the following are no longer, or at least rarely, used as such.

Calendula officinalis — Pot marigold, a pot herb (McEwin, 1843), but introduced even earlier (Bailey, 1841).

Cichorium intybus — Chicory although sown as a fodder plant (Capper, 1838), was also used by the earliest settlers as a coffee substitute (Stevenson, 1839).

Cynara cardunculus — Cardoon or chardon, a salad vegetable (Stevenson, 1839). The use of the flowers as a substitute for "Scotch thistles" (Parsons, 1973) arose fortuitously, advantage being taken of their wide availability in the absence of the true Scotch thistle (*Onopordum acanthium*).

Cyperus rotundus — in error for *C. esculentus*, groundnut or chuffa (Kloot, 1979).

Mesembryanthemum crystallinum — Iceplant, although originally introduced as an ornamental (Kloot 1983) it was recommended locally to be grown as a substitute for spinach (Heyne, 1871).

Nasturtium officinale — Watercress.

Opuntia spp. — Prickly pear. Specifically included with fruit trees (McEwin, 1843).

Physalis peruviana — Cape gooseberry.

Physalis viscosa — Sticky cape gooseberry.

Rumex acetosella — Garden sorrel (*R. acetosa*) was an early introduction as a garden vegetable (Stevenson, 1839) and noted as being grown very commonly soon after (Bailey, 1847). I suggest that the present species was introduced in error and/or as a contaminant of the garden sorrel.

Tragopogon porrifolius — Salsify or oyster plant.

Tropaeolum majus — Greater Indian cress, a pot herb (McEwin, 1843) now known as garden nasturtium. Recorded as flowering in the old Botanic Garden in 1841 (Bailey, 1841).

Medicinal herbs

The cultivation of many herbs in home gardens for medicinal use was considered desirable, if not essential. Many culinary herbs were also used medicinally so they have been included here also. Extant references to the cultivation of herbs show that they were very early introductions (Stevenson, 1839; McEwin, 1843; Bailey, 1847). Schomburgk (1885) recommended 38 species of medicinal plants which, from their success in the Botanic Gardens, he believed should be grown more widely. Of those that he listed, the following species are now naturalised in South Australia:

Achillea millefolium — Yarrow.

Cichorium intybus — Chicory.

Cytisus scoparium =
Sarothamnus scoparius — Common English broom.

Foeniculum vulgare — Fennel.

Lavandula spica = *L. dentata* — Lavender.

Leontodon taraxacum = *Taraxacum officinale* — Dandelion.

Marrubium vulgare — Horehound.

Melissa officinalis — Lemon balm.

Mentha pulegium — Pennyroyal.

Mentha piperita — Peppermint.

Mentha viridis = *M. spicata* — Spearmint.

Rosmarinus officinalis — Rosemary.

Thymus vulgaris — Thyme.

Verbascum thapsus — Broad-leafed mullein.

A slightly later listing of herb plants growing in the Adelaide Botanic Garden in January-February, 1889 (*J. Bur. Agric.* 1: 18-19) adds:

Anthemis nobilis = *Chamaemelum nobile* — Chamomile (common).

Poterium sanguisorba = *Sanguisorba minor* — Sheep's burnet.

Withania coagulans = *S. somnifera* — Winter cherry.

Hedge Plants

Away from the stringybark forests of the higher rainfall areas, timber suitable for fencing was generally scarce in South Australia. Consequently hedges were planted as paddock and property boundaries, apart from a general attempt to recreate the hedgerowed scenery of the English countryside.

Hedge-growing was largely abandoned and while most of the hedges were removed or died out, remnants survived and, through neglect, spread into surrounding pastures and bushland, particularly in the high rainfall areas where most of the former hedge species are more aggressive. *Lycium ferocissimum* was a notable exception, being the most invasive of the abandoned hedge plants. Its berries were spread by birds and now it is found from the wettest pockets of the Adelaide Hills to the flood plains of the rivers in the interior. It was of such concern that this species was subject to its own Act of Parliament, the Boxthorn Removal Act, 1925. In contrast, hedges of *Agave americana* have hardly spread during a century.

Each of the following species, presently naturalised in South Australia, is known to have been promoted and used for hedges in this State last century:

Acacia armata = *A. paradoxa* (McEwin, 1843a)

Agave americana (1858 — *Farm & Garden*, 1: 59)

Aloe arborescens

Arundo donax

Crataegus azarolus

Crataegus monogyna (1858 — *Farm & Garden*, 1: 3, as white thorn)

Genista canariensis = *G. maderensis* (Heyne, 1871)

Cytisus scoparius = *Sarothamnus scoparius* (1859 — *Farm & Garden*, 1: 199)

Hakea eucalyptoides = *H. laurina* (Heyne, 1871)

Lycium afrum } = *L. ferocissimum* (Heyne, 1871)
Lycium horridum }

Lycium barbarum

Olea europaea (1862 — *Farm & Garden*, 5: 51)

Opuntia spp. (McEwin, 1843a)

Pittosporum undulatum (Heyne, 1871)

Polygala myrtifolia (Heyne, 1871)

Rhamnus alaternus (Heyne, 1871)

Rosa canina (1858 — *Farm & Garden*, 1: 10)

Rosa rubiginosa ("The Observer", 30 March 1844, p. 4)

Rosmarinus officinalis (1858 — *Farm & Garden*, 1: 189)

Spartium junceum (1858 — *Farm & Garden*, 1: 109)

Ulex europaeus (1860 — *Farm & Garden*, 2: 129)

Fodder plants

Many species of alien plants have been documented as being distributed, intentionally sown or encouraged for fodder at various times and places in South Australia. A species may not have been introduced for that purpose necessarily but many plants were tried, perhaps in desperation, as the native flora disappeared under the close grazing of introduced ruminants and the perennial pasture species of northern Europe and Britain known from the settlers' homelands viz. *Lolium perenne* and *Trifolium repens*, failed to persist in the short growing seasons of South Australia. The adoption of annual ryegrass (*Lolium* spp.), subterranean clover (*T. subterraneum*) and medics (*Medicago* spp.) largely obviated the necessity for the wide range of species tried in the past. All such species are listed in Appendix 1 with selected references, including the earliest located, to illustrate their use as fodder.

Sundry agricultural uses

The major remaining use is that of "sandbinding" or erosion control. A number of plants were recommended and used for that purpose, including many that were used for fodder, particularly on sandhills. A few species were grown in the belief that they kept away crop predators. Representative references, including the earliest located for the specified use are cited in Appendix 2.

Unintentional introductions

The means of accidental introduction, whilst clear in principle, are very rarely documented in practice. Locally, I am unaware of any studies of ballast heaps, contaminated footwear or carriage on animals. Some anecdotal references of varying reliability are available. The most extensive documentation exists for seed contamination, as seed testing records indicate the contaminants found. As with intentional introductions, it is rarely possible to be certain that any particular means of entry was the source of present infestations. For example, *Bromus unioloides* is documented as being first introduced by Taylor in 1857, who bulked up the seed and sold it commercially in 1858 (*Farm & Garden* 1: 7). However, Mueller had collected weedy forms of the same species in 1848 (Kloot, 1983).

The following records are available, suggesting possible means of entry.

Contaminated seed

This is a particularly effective means of introduction for should a weed be successful enough to reproduce and contaminate the crop with which it is competing, then it is likely to be able to succeed again, when the contaminated seed is moved and sown elsewhere.

Although it may be assumed that agricultural and horticultural seeds would have been contaminated and agricultural implements brought by farmers from England would also have carried propagules (Letter from H. Duncan "S.A. Register" - 4.iv.1840), there are no records as to what they might have been. It is reasonable to assume that seeds brought from Britain would contain weeds recorded there. Loudon (1835) lists the following weeds as infesting the English cereal sample at that time — *Lolium temulentum*, *Agrostemma githago*, *Ervum tetraspermum* (= *Vivia tetrasperma*), *Melilotus officinalis*, *Avena fatua*, *Galium aparine*, *Scandix pectens* (= *S. pecten-veneris*), *Polygonum convolvulus*, *Polygonum lapathifolium*, *Sinapis*, *Brassica* and *Raphanus*. Some of these weeds became established very early in South Australia (Kloot, 1983). *Avena fatua* was noted as a contaminant of the original seed wheat introduced to South Australia (*Farm & Garden* 1: 38). *Silene gallica* and *Agrostemma githago* were further grain contaminants from the very early days (Kloot, 1983). The former was still recorded as a contaminant of wheat seed in 1893 (*J. Bur. Agr.* 6: 110).

Dittrichia graveolens was probably introduced to Australia in contaminated wheat imported from Germany sown in the Adelaide Hills about 1863 (W.C. Grassby, quoted by Maiden, 1920). *Ambrosia psilostachya* was introduced from North America in contaminated *Sorghum* seed (A. Jericho, *in litt.* attached to AD 97417250). The parasites, *Cuscuta* spp. are notorious as seed contaminants, and would have entered Australia by that means.

After the introduction of quarantine regulations in 1908, the testing of imported seed for disease and contamination was instituted. Andrew (1916, 1917) presented results from the first years of seed testing in South Australia. He concluded that "the chief medium through which new weed pests have been introduced into various countries is by way of agricultural and other seed". He was particularly concerned with seed intended for sowing but he was also alarmed at the contamination of other seed, particularly bird feed.

Praeger (1911) highlighted the potency of contaminated seed as a means of weed introduction to Clare Island, Co. Mayo, Eire. Prior to 1907, farmers had only locally purchased agricultural seeds, but then began to use higher quality seed brought from the Irish and English mainlands. Commercial seed available on the Island was sampled in 1910 and many weeds not previously recorded there were found as contaminants.

Broad (1953) and Wellington (1960) provide extensive listings of weed species found in pasture seed examined in Great Britain. Whilst these lists are not directly relevant to South Australia, they are still useful indicators of the extent of contamination of seed in the agricultural trade prior to the advent of present seed-cleaning equipment and the adoption of modern weed control methods. Many of our present naturalised species are listed there.

Ballast weeds

There was a long local history of ships arriving in South Australian ports under ballast. This practice continued until after World War II, when the grain ketches ceased operating from the various outports, being superseded by centralised terminals serviced by land transport (Heinrich, 1976). There are many instances of ballast being dumped but I do not believe that any botanical records of such sites exist. Certain plants are believed to be ballast plants — *Diplotaxis tenuifolia*, *Galenia pubescens*, *Reseda lutea* and *Sida leprosa*, on the basis of annotations to locally collected specimens and comments by earlier authors. The distribution of some species suggests a ballast origin, e.g. *Suaeda aegyptiaca* in the saline flats at Port Pirie, *Euphorbia paralias* on the foreshore of Yorke Peninsula and adjacent coasts, and *Chenopodium multifidum* which since its first discovery in 1911 has only been found at three ports, Tumby Bay, Wallaroo and Port Adelaide. Although contaminated ballast was likely to have been a powerful influence on the alien flora, Ridley's (1930) statement that the species described by Black (1909) were "all probably introduced in ships' ballast" is an exaggeration.

Tovey (1911) noted a number of plants found around a ballast dump on Coode Island in the Port of Melbourne. Some of his species could have also been introduced in a similar manner to South Australia.

A number of lists of plants found on ballast heaps overseas last century are available:- Martindale (1876, 1877) for Philadelpha and Perkins (1883) for Boston in the U.S.A., and Kirk (1896) for Wellington, New Zealand. More recently Ouren (1979) has investigated some of the former ballast dumps of Norway. Although it is many years since they were in use, many plants are clearly recognised as having been associated with the dumps. Soil and sand used for ballast were known to be a source of weeds and in some places such material was required to be dumped at sea to minimise weed invasion (Ridley, 1930). All the cited lists contain many species now naturalised in South Australia. It is reasonable to assume that ballast dumped in those places would have been similar in origin and contained similar weed propagules to that dumped locally. In particular, strand plants or ruderals found in the vicinity of ports would be most likely to be found in ballast.

Some species that were recorded overseas as ballast plants were not recorded until much later in South Australia, so that it is unlikely that their entry was through that means. For example, *Potentilla reptans* was recorded by Martindale (1876, 1877) but it was not known locally until 1967, well after the ballast period. Its congener *P. anserina*, also listed by Martindale, was first recorded in South Australia in 1882, within the period of ballast dumping.

Contaminated footwear

There is little doubt that plant propagules are carried in mud attached to footwear (Praeger, 1911; Clifford, 1956) but apart from the cited papers, no other studies were located. These authors were concerned with such movement within the British Isles, but it is reasonable to assume that the same species, probably in lesser numbers and less frequently, could have arrived in South Australia in the same manner. It is quite likely that other species recorded as introduced intentionally were also introduced on footwear, e.g. *Anthoxanthum odoratum* and *Bromus hordeaceus* in South Australia may be derived from accidentally introduced propagules on footwear (Praeger, *op. cit.*) rather than from intentional introductions for fodder (Appendix 1).

Attached to stock

Plant propagules encased in fruits or attached to stalks which adhere by spines or bristles e.g. *Echium plantagineum*, are likely to be moved attached to fleeces and coats of animals (e.g. van der Pijl, 1982). There are very few empirical data to support this classification. Shmida and Ellner (1983) report the only experimental study of seed dispersal on grazing animals in a Mediterranean environment and their observations include some of our naturalised species. Milthorpe (1943) investigated the vegetable matter in the New South Wales wool clip at that time and Church (1947) surveyed the wool clip from a wider area of south-eastern Australia, including South Australia. Most of the species found were Australian natives, but many aliens were also present.

Although such species were clearly being carried in fleeces at that period, that is not conclusive proof that they were introduced to South Australia or Australia generally, in that manner. Hayward and Druce (1917) and Probst (1949) have indicated an even wider range of species that might be carried by such means by listing the "wool-aliens" i.e. the plants introduced to northern England and Central Europe respectively in wool for processing, although it must be allowed that more propagules are likely to be successfully transported in baled fleeces rather than on live animals which would tend to shed plant fragments during the voyage.

Locally, *Xanthium spinosum* was introduced in the fleeces of animals brought from New South Wales (S.A. Parl. Paper (205/1862) as were *X. occidentale* and *X. orientale* in recent years (Pest Plant Commission records). *Chloris truncata* was spread to the southern parts of South Australia by movement in contaminated fleeces (Kloot, 1985a). It was also recorded as a wool alien by all four cited authors.

Contaminated fodder

As with seed intended for sowing, fodder such as hay, feed grains, and chaff may contain weed propagules. During drought, even low-quality, contaminated produce finds a ready market. It is noticeable that imports of hay and chaff peaked during drought years and a number of weeds were first recorded in the aftermath of drought e.g. *Solanum elaeagnifolium* in 1914, *Pentzia suffruticosa* in 1922. Apart from introduction *per se*, weeds greatly extend their distribution during droughts being moved around in fodder (Thomas *et al.*, 1984). They are then well-placed to take advantage of subsequent favourable seasons.

Emex australis was introduced in fodder from South Africa about 1840 (The Advertiser, 19.xii.1934) as was *Cyperus tenellus* (Kloot, 1979). *Carthamus lanatus* could also have been introduced in contaminated fodder having first been observed in an area where travelling bullock teams camped (S.A. Parl. Paper No. 102/1887).

Contaminated packing material

Straw was a common packing material around bottles and other fragile articles and was also used as stuffing for saddles, mattreses and so on. *Scirpus hamulosus* and *Cenchrus ciliaris* were both specifically noted (as annotations to herbarium sheets of early specimens) as originating from stuffing in camel saddles. *Carrichtera annua* (Quinn and Andrew, 1915) and *Cirsium arvense* (*J. Bur. Agr.* 1: 5) both originated in dumped straw packing that had protected goods imported from Europe and Victoria respectively. It was noted that dried grasses and other growths from the vicinity of nurseries were used for packing around plants sent from the eastern colonies around the turn of the century. Portions of weeds including seed heads were often found (*J. Agric. S.A.* 2: 968).

These uses are now very uncommon and consequently their importance as a means of introduction of alien plants is now negligible.

Motor vehicles

In more recent years, larger-spined propagules were, and still are carried about on car tyres. Although the introduction of *Tribulus terrestris* preceded the invention of motor cars, it was carried on vehicle tyres throughout the Adelaide metropolitan area (Walker and Parker, 1941). More recently, *Alternanthera pungens* was introduced by vehicles from New South Wales and its progress from one caravan park to the next westward from the border areas has been quite obvious (C.R. Alcock, pers. comm.).

Motor vehicles are efficient carriers of plant propagules (Wace, 1977 *et seq.*) and the long distances traversed by individual vehicles in this country will result in a greater distribution of naturalised species.

Intentional and accidental introductions

Whether a plant was introduced accidentally or on purpose can only be expressed in a context defined both in time and space. It is not possible in many cases to state categorically that a given species was introduced one way or another. Futhermore, there are many examples where more than one type of introduction was involved. For example, *Digitaria sanguinalis* was introduced accidentally at various times but it was also introduced intentionally to the Adelaide Botanic Garden as a potential fodder grass in 1880 (Schomburgk, 1881). *Agrostemma githago* was first introduced as a contaminant of seed grains but failed to persist and was introduced again later as an ornamental (Kloot, 1983). *Trifolium repens* was introduced and sown by the earliest settlers as a fodder plant (Capper, 1838) but it was reported as having been introduced accidently as a contaminant of seed wheat brought from Tasmania some years later (*Farm & Garden* 1: 207).

As regards space it is necessary to define the area being considered. There are many examples of plants being introduced intentionally to South Australia as a whole or to a specific locality within it, but once established there spreading unaided to a greater or lesser extent. Some examples are *Echium plantagineum*, *Oxalis pes-caprae* and *Adonis microcarpus*. Each of these species was introduced as an ornamental and moved around the State as such (primary spread). After introduction to suitable habitats each species spread unaided or with unintentional human aid to cover varying areas of the settled areas of the State (secondary spread).

Another situation is where a plant has different histories in different places. Certain pasture plants are good examples. *Trifolium subterraneum* seems to have been introduced accidentally to South Australia and subsequently became established in the Adelaide Hills. However, following its promotion as a pasture legume, it was sown deliberately over vast areas of south-eastern Australia. *Lolium rigidum* was similarly introduced accidentally although there is a record that a higher yielding form was introduced intentionally from Europe (Mullet, 1919). Within southern Australia both desirable and weedy forms were sown widely from the mid-1920s and like *T. subterraneum* it still is being sown as an annual pasture plant.

A related situation occurred where certain plants native to restricted areas of Australia were moved, intentionally or otherwise, to other regions and became established there. For example, *Cyperus rotundus* was moved both intentionally and accidentally from sub-tropical Australia to southern Australia where it became well-established (Kloot, 1979). *Chloris truncata*, rare or even absent from the southern regions of South Australia until the first decade of this century, is now found throughout the State and is particularly common in the Adelaide area. The case of *Eucalyptus cladocalyx* is even more extreme, originally being restricted to three areas in South Australia. Now it is sparingly naturalised over much of south-eastern Australia having spread from its extensive planting as an ornamental and for shelter belts (Kloot, 1985a).

Where plants have been introduced both intentionally and accidentally it is difficult to determine which introduction led to the present infestations. Because of reports of *Echium plantagineum* in seed imports, e.g. Andrew, (1916), Piggin (1977) concluded that accidental introductions were the origin of present populations. However, I rejected this explanation (Kloot, 1982) because more intensive investigations of the literature and herbarium specimens revealed a history consistent with that of a garden escape. In such a case there must be, firstly, a documented history as an ornamental, medicinal, hedge plant, etc. Secondly the records of its spread must suggest that it moved outward from settlements or even from isolated homesteads. Conversely, a seed contaminant tends to be noticed in paddocks quite widely. Thus *Amsinckia calycina* was introduced to the Mallee and Upper South-East in contaminated seed wheat brought from Victoria in the mid-1950s. It was noted in cereal paddocks over a large area in a short period. Similarly, *Solanum elaeagnifolium* although recorded earlier from Victoria (Tovey, 1909), seems to have been introduced to South Australia in hay imported from the U.S.A. during the 1914 drought and was reported from a number of well-scattered sites within a few years.

As a result of property consolidation or the building of new houses, older homestead gardens and orchards were abandoned and the land amalgamated with adjoining paddocks. Cultivation moved bulbs, fruits or other propagules of persistent garden plants about the enlarged paddocks. Subsequently, attached to animals or implements, propagules were carried further afield. This has been documented for *Adonis microcarpus* (Kloot, 1973), and extensive evidence for *Oxalis pes-caprae* was obtained from a survey carried out by the Central Agricultural Bureau in 1898 (*J. Agric. S.A.* 2: 126).

It is incorrect to assess the status of the plant introduced in the past and in particular in the earliest years of settlement on the basis of its benefit or disadvantages as perceived at present. Many plants currently regarded as possessing no redeeming factors were considered desirable or even essential in earlier times.

The failure to establish hedgerows led to a further suite of species being abandoned. More productive fodder species superseded the species that were relied upon formerly. Attempts to create fibre and oilseed industries and a belief that certain plants were vermifuges led to the widespread planting or yet other species that ultimately were unsuccessful for their intended purposes in this country.

There is a further relevant point bearing on plant introduction that has been under-estimated. The Victorian age was one of utilitarianism. It was believed that the dawning scientific age would ensure that any latent benefit would be identified, utilised and hopefully turned to economic benefit. Woolls (1867) expressed this feeling most succinctly as follows: "... posterity may find out that amongst the weeds of the land which many so unscrupulously condemn, there are some of the marvellous beauties of nature. I believe that God has made nothing in vain and that every species, whether in the animal or vegetable kingdom, has been created for some especial purpose in the economy of nature. If we cannot at present discover these purposes, it is rather owing to our ignorance than to any other cause." As regards native plants, this attitude reached its acme in the publications of Mueller (1876) and Maiden (1889) who summarised all the available economic information to aid the exploitation of such plants (Mueller's work was wider in scope, also including plants from other temperate areas of the world).

With regard to introduced plants there are many examples of well-meant attempts to turn the apparently wasted resources of an infestation of unwanted plants into an economic crop. Thus Hayter (1861) reported that the woolly pappuses of *Arctotheca calendula* were suitable for making felt hats. Distillation experiments were carried out on *Lavandula stoechas* collected at Finniss to demonstrate to complaining landholders that rather than being a potential weed, it was a new economic opportunity (*J. Bur. Agr.* 5: 137,172). (Ultimately the landholders were right; the distillations were unsuccessful because under South Australian conditions the proportion of volatile oil developed in the plant is too low to extract profitably). Similarly, landholders who drew attention to the weedy potential of *Marrubium vulgare* were rebuked with the information that dried leaves were worth one shilling per pound on the London market (*Ibid.*, 6: 60). The harvesting of *Ricinus communis* was regarded as being suitable for women and children and therefore the cultivation of a few trees on every farm was still being encouraged (Schomburgk, 1881), in spite of the failure and abandonment of the large plantation at Monarto and the general recognition of the weediness of the plant.

Whilst the examples given are well documented, it is highly likely that there were many unrecorded cases of the introduction and/or intentional spread of alien plants which were considered at the time to have some economic potential. I would suggest that *Trifolium* spp. and many grasses would fall into this category. The reasoning is that "clover" *per se* was regarded as beneficial to pastures and that "grasses" were seen similarly as being desirable and therefore to be encouraged. It is noteworthy that most of the pasture species regarded favourably by the British authorities of that time such as Sinclair (1815) and Loudon (1835) have become established in, or at least were introduced to, South Australia.

Acknowledgements

I am most grateful to the staff of the following libraries for their assistance with the research reported in this paper: the Department of Agriculture, the Waite Agricultural Research Institute, the Botanic Gardens and the State Library, all of Adelaide, and the National Herbarium and La Trobe Library, both of Melbourne. Mr D.E. Symon, formerly of the Waite Agricultural Research Institute made many suggestions for improving the manuscript for which I thank him sincerely.

References

Andrew, H.W. (1916). Seed imported from abroad into South Australia. *J. Agric. S. Aust.* 20: 103-115.

Andrew, H.W. (1917). Introduction of weeds. *J. Agric. S. Aust.* 21: 298-307.

Anon. (1879). *Garden & Field* 5: 41.

Bailey, J. (1841). Plants flowering in the Botanic Gardens, June 1841. *S.A. Magazine* 1: 11.

Bailey, J. (1845). Catalogue of Plants cultivated in and for sale at the Hackney Nursery, Adelaide, 1845. "The Adelaide Observer", 3 May, 1845, pp 1-2.

Bailey, J. (1847). Horticulture in South Australia, in "Royal South Australian Almanack and General Directory for 1847" (Adelaide: Stephens).

Barber L. (1980). "The Heyday of Natural History". (London: Cape/Doubleday).

Black J.M. (1909). "The Naturalised Flora of South Australia". (Adelaide: Privately published).

Black, J.M. (1918). Additions to the flora of South Australia No. 14. *Trans. & Proc. Royal Soc. S. Austral.* 42: 168-184.

Broad, P.D. (1952). The occurrence of weed seeds in samples submitted for testing by the O.S.T.S. *J. Nat. Inst. Agric. Bot.* 6: 275-286.

Capper, H. (1838). "South Australia". (London: Tyas).

Church, S.J. (1947). A survey of vegetable matter in the wool clip of S.E. Australia. *Proc. Royal Soc. Vic.* 59: 53-62.

Clifford, H.T. (1956). Seed dispersal on footwear. *Proc. Bot. Soc. Brit. Isles* 2: 129-131.

Delamer, E.S. (1865). "The Flower Garden". (London: Routledge).

Francis, G.W. (1859). "Catalogue of the Plants under Cultivation in the Government Botanic Garden, Adelaide, South Australia". (Adelaide: Govt Printer).
Francis, G.W. (1859a). Pasture grasses. *Farm & Garden* 1: 27.
Hackett, E.&. W. (1876). Flower Seeds (Catalogue). *Garden and Field* 1: 209-218.
Hackett, E.&.W. (1907). Illustrated and Descriptive Catalogue, 1907. (Adelaide).
Hackett, E.&.W. (1912). Illustrated and Descriptive Catalogue, 1912. (Adelaide).
Hallack, E.H. (1892). "Our Townships, Farms and Homesteads". (Adelaide: Thomas & Co.).
Hayter, H.H. (1861). Remarks on a filamentous material grown upon the plant *Cryptostemma calendulaceum*, believed to be suitable for manufacturing purposes. *Trans. Royal Soc. Vic.* 6: 26.
Hayward, I.M. & Druce, G.C. (1919). "The Adventive Flora of Tweedside". (Arbroath: Buncle).
Heinrich, R. (1976). "Wide Sails and Wheat Stacks". (Adelaide: Gillingham).
Heyne, E.B. (1871). "The Fruit, Flower and Vegetable Garden". (Adelaide: Andrews).
Heyne, E.B. (1882). List of Garden, Agricultural and Other Seeds. Supplement to *Garden and Field*, May 1882.
Kirk, T. (1896). On the products of a ballast heap. *Trans. N.Z. Inst.* 28: 501-507.
Kloot, P.M. (1973). Studies in the ecology of *Adonis microcarpus*. M. Ag. Sc. Thesis, University of Adelaide.
Kloot, P.M. (1979). The native and naturalised *Cyperus* species in South Australia. *J. Adelaide Bot. Gard.* 1: 333-341.
Kloot, P.M. (1982). The naturalisation of *Echium plantagineum* in Australia *Aust. Weeds* 1(4): 29-31.
Kloot, P.M. (1983). Early records of alien plants naturalised in South Australia. *J. Adelaide Bot. Gard.* 6: 93-131.
Kloot, P.M. (1985a). The spread of native Australian plants as weeds in South Australia and other mediterranean regions. *J. Adelaide Bot. Gard.* 7: 145-157.
Kloot, P.M. (1985b). Plant introductions to South Australia prior to 1840. *J. Adelaide Bot. Gard.* 7: 217-231.
Kloot, P.M. (1986a). Checklist of the introduced species naturalised in South Australia. S.A. Dept. Agric. Technical Paper No. 14.
Kloot, P.M. (1986b). The naturalised flora of South Australia. 3. Its origin, introduction, distribution, growth forms and significance. *J. Adelaide Bot. Gard.* 10: 99-111.
Loudon, J.C. (1830). "Loudon's Hortus Brittanicus". (London: Longman).
Loudon, J.C. (1835). "An Encyclopaedia of Agriculture". (London: Longman).
McEwin, G. (1841). List of Fruit and Forest Trees, Shrubs, Plants &c at present growing in the garden of Geo. Stevenson, Esq. North Adelaide. "S.A. Register", 16 January, 1841, p. 4.
McEwin, G. (1842). Catalogue of plants introduced by and cultivated in the garden of Mr. Stevenson, North Adelaide. "S.A. Register", 23 April 1842, p. 3.
McEwin, G. (1843). Catalogue of plants grown at Melbourne Cottage, North Adelaide, in J. Allen (ed.) "The South Australian Almanack and General Directory for 1844" (Adelaide: Allen).
McEwin, G. (1843a). "The South Australian Vigneron and Gardeners' Manual". (Adelaide: Allen).
Maiden, J.H. (1889). "The Useful Native Plants of Australia". (Sydney: Turner and Henderson).
Maiden, J.H. (1920). "The Weeds of New South Wales" (Sydney: Govt Printer).
Martindale, I.C. (1876). The introduction of foreign plants. *Bot. Gaz.* 2: 55-59.
Martindale, I.C. (1877). More about ballast plants. *Bot. Gaz.* 2: 127-129.
Milthorpe, E.J. (1943). "Vegetable Matter in the New South Wales Wool Clip". (Sydney: Central Wool Committee Testing House).
Mueller, F. (1876). "Select Plants readily eligible for Industrial Culture or Naturalization in Victoria". (Melbourne: McCarron, Bird & Co.).
Mullet, H.A. (1919). Minyip crop and fallow competition. *J. Agric. Vic.* 17: 65-75.
Ouren, T. (1979) [Ballast places and ballast plants in the county of Ostfold in Norway]. *Blyttia* 37: 167-179.
Parsons, W.T. (1973). "Noxious Weeds of Victoria". (Melbourne: Inkata).
Pascoe, J.F. (1886). Seed catalogue. *Garden & Field*, April 1886. Suppl. pp 1-2.
Perkins, C.E. (1883). Ballast plants in Boston and vicinity. *Bot. Gaz.* 6: 188-190.
Piggin, C.M. (1977). The herbaceous species of *Echium* (Boraginaceae) naturalized in Australia. *Muelleria* 3: 215-244.
Praeger, R.L. (1911). Clare Island Survey, Part 10. *Proc. Roy. Irish Acad.* 31: 54.
Probst, R. (1949). "Wolladventivflora Mitteleuropas". (Solothurn: Vogtschild).
Quinn, G. and Andrew, H.W. (1915). A new weed. *J. Agric. S. Aust.* 19: 380-384.
Ridley, H.N. (1930). "The Dispersal of Plants throughout the World". (Ashford: Reeve).
Schomburgk, R. (1871). "Catalogue of the Plants under Cultivation in the Government Botanic Gardens, Adelaide, South Australia". (Adelaide: Govt Printer).
Schomburgk, R. (1871a). "Annual Report of the Director of the Adelaide Botanic Gardens for 1870". (Adelaide: Govt Printer).
Schomburgk, R. (1874). "Annual Report of the Director of the Adelaide Botanic Gardens for 1873". (Adelaide: Govt Printer).
Schomburgk, R. (1876). "Annual Report of the Director of the Adelaide Botanic Gardens for 1875". (Adelaide: Govt Printer).
Schomburgk, R. (1877). "Annual Report of the Director of the Adelaide Botanic Gardens for 1876". (Adelaide: Govt Printer).
Schomburgk, R. (1878). "Catalogue of the Plants under Cultivation in the Government Botanic Gardens, Adelaide, South Australia". (Adelaide: Govt Printer).

Schomburgk, R. (1881). "Annual Report of the Director of the Adelaide Botanic Gardens for 1880". (Adelaide: Govt Printer).

Schomburgk, R. (1885). "Annual Report of the Director of the Adelaide Botanic Gardens for 1884". (Adelaide: Govt Printer).

Shmida, A.& Ellner, S. (1983). Seed dispersal on pastoral grazers in open Mediterranean chaparral, Israel. *Isr. J. Bot.* 32: 147-159.

Sinclair, G. (1815). "Hortus Gramineus Woburnensis". (London).

Stevenson, G. (1839). Gardening in South Australia, in "Royal South Australian Almanack and General Directory for 1840", pp. 9-20. (Adelaide: Thomas).

Thomas, A.G., Gill, A.M., Moore, P.H.R. & Forcella, F. (1984). Drought feeding and the dispersal of weeds. *J. Aust. Inst. Agric. Sci.* 50: 103-107.

Tovey, J.R. (1909). Unrecorded introduced plants not sufficiently established to be considered naturalised. *Proc. Roy. Soc. Vic.* 22: 24-25.

Tovey, J.R. (1911). Some notes on Coode Island and its flora. *Vic. Natural.* 28: 57-61.

Trumble, H.C. & Donald, C.M. (1938). Soil factors in relation to the distribution of subterranean clover and some alternative legumes. *J. Aust. Inst. Agric. Sci.* 4: 206-208.

van der Pijl, L. (1972). "Principles of Dispersal in Higher Plants", 2nd ed. (Berlin: Springer).

Wace, N.M. (1977). Assessment of dispersal of plant species — the car-borne flora in Canberra. *Proc. Ecol. Soc. Aust.* 10: 167-186.

Walker, A.J.K. & Parker, D.L. (1941). Caltrop (*Tribulus terrestris* L.) and its recent spread in South Australia. *J. Agric. S. Aust.* 45: 109-112.

Wellington, P.S. (1960). Assessment and control of the dissemination of weeds by crop seeds. *Brit. Ecol. Soc. Symp.* 1: 94-107.

Woolls, W. (1867). Plants introduced accidentally (1866), in "A Contribution to the Flora of Australia". (Sydney: White).

Appendix 1

List of alien species with selected references documenting their use as fodder in South Australia

GRAMINEAE

Alopecurus pratensis — meadow foxtail
1913 — recommended for sandy country at Monteith. J.Agric., 16: 1193.
1947 — still recommended in pasture mixes. J. Agric., 50: 455.

Anthoxanthum odoratum — sweet vernal grass
1925 — recommended *inter alia* for higher rainfall areas. J. Agric., 28: 215.

Arrhenatherum elatius — false oat (grass)
1909 — in pasture plots at Saddleworth. J. Agric., 13: 408.

Arundo donax — giant reed
1897 — useful for fodder and windbreak J. Agric., 1: 472.
1941 — recommended, *inter alia,* for feed. J. Agric., 45: 75.

Avena fatua — wild oats
1891 — so well adapted as a fodder plant that no other species is necessary in Maitland area. J. Bur. Agr., 4: 9, 11.
1892 — seed distributed in the Mundoora area from supply sent from Stansbury. J. Bur. Agr., 4: 223.
— fertilized at Nairne with guano. Hallack (1892) p. 75.

Bromus madritensis — Madrid brome
1912 — seen to be thriving in (Adelaide) suburban garden, seeds collected and scattered over newly cleared Mallee country at Nunkeri. J. Agric., 36: 206.

Bromus unioloides — prairie grass
1857 — seed introduced by Taylor and bulked up. Seed freely available by summer 1858. Farm & Garden, 1:7.

Chloris gayana — Rhodes grass
1907 — recommended for fodder. J. Agric., 10: 841.
1911 — sown as fodder at Millicent. J. Agric., 14: 1017.

Cynodon dactylon — couch
1928 — *inter alia*, sown in pastures at Yurgo. J. Agric., 32: 147.

Cynosurus echinatus — crested dogstail
1927 — *Inter alia*, trial for pasture at Jamestown. J. Agric., 30: 997.

Dactylis glomerata — cockfoot
1859 — highly recommended as a fodder grass. Francis (1859a).

Echinochloa crus-galli — barnyard grass
1893 — being sown at Naracoorte. J. Bur. Agr., 5:244.
1909 — best fodder on saline areas of reclaimed swamps. J. Agric., 12: 817.

Ehrharta calycina — perennial veldt grass
1908 — "cuttings" (sic,? rhizomes) obtained from South Africa and planted at Kalangadoo. J. Agric., 13: 1119.
1928 — well established at Reeves Plains and Minda Home. J. Agric., 32: 512.

Ehrharta longiflora — annual veldt grass
1930 — included in pasture mixes at Keith. J. Agric., 13: 681.

Elymus repens — quackgrass
1897 — sown as a potential fodder at Crystal Brook. J. Agric., 1: 454.

Festuca arundinacea — Williams Grass, tall fescue
1900 — growing well on Messrs. Williams' property at Millicent and promises to be the best grass to grow on reclaimed swamp land. J. Agric., 3: 1031.

Festuca pratensis — Meadow fescue
1907 — recommended for fodder. J. Agric., 10: 604.

Festuca rubra — red fescue
1894 — sown at Warrow. J. Bur. Agr., 7: 91.

Holcus lanatus — fog grass
1875 — seed distributed and sown throughout State from German supply labelled *Dactylis caespitosa* in error. Schomburgk (1876) p. 4.
1931 — still being sown as fodder at Longwood. J. Agric, 34: 986.

Hordeum? leporinum or? *glaucum* — barley grass
1901 — being deliberately sown for fodder at Craddock. J. Agric., 5: 480.
1912 — seen to be thriving in (Adelaide) suburban garden, seed collected and scattered over newly cleared Mallee country at Nunkeri. J. Agric., 36: 206.
1919 — recommended to be sown at Coonalpyn. J. Agric., 23: 262.

Lolium multiflorum — Italian ryegrass
1906 — recommended for fodder. J. Agric., 10: 480.

Lolium perenne — perennial ryegrass
1906 — recommended for fodder. J. Agric., 10: 480.

Lolium rigidum — Wimmera ryegrass
1919 — recommended to be sown at Coonalpyn. J. Agric., 23: 262.
1922 — combined with sub. clover is good pasture for S.E. J. Agric., 25: 605.
1927 — recommended that wheat should be undersown with it. J. Agric., 31: 174.

Paspalum dilatatum — paspalum
1876 — introduced to Adelaide Botanic Gardens as a potential fodder grass. Schomburgk (1877), p. 4.
1897 — being grown at Lucindale from seeds provided by Botanic Gardens. J. Bur. Agr., 9: 249.

Paspalum vaginatum — salt-water couch
1951 — introduced as a salt-tolerant fodder grass, doing well by 1973. J. Agric., 76: 5.

Pennisetum clandestinum — Kikuyu (grass)
1926 — introduced from Natal and sown as a fodder crop at Mt Remarkable J. Agric., 30: 56.
1929 — sown on Kybybolite. J. Agric., 36: 409.

Pennisetum villosum — long-styled feather grass
1892 — potentially valuable fodder grass at Tatiara. J. Bur. Agr., 5: 81.

Phalaris aquatica — phalaris
1889 — potential fodder plant growing in Adelaide Botanic Gardens. J. Bur. Agr., 1: 19.
1905 — first sown commercially in S.A. J. Agric., 37: 400.

Phleum pratense — Timothy grass.
1904 — growing at Longwood. J. Agric., 8: 465.
1907 — recommended for fodder. J. Agric., 10: 604.

Piptatherum miliaceum — rice millet.
1908 — sown at Kanmantoo. J. Agric., 12: 71.
1913 — recommended for sandy country at Monteith. J. Agric., 16: 1193.
1914 — for pasture at Geranium. J. Agric., 17: 1219.

Poa annua — winter grass, annual meadow grass.
1912 — "A very hardy grass, affording an early sweet herbage greatly relished by stock. It is a good thing to mix a few pounds of it with other grasses for pasture." Hackett (1912), p. 48.

Poa pratensis — Kentucky blue grass.
1907 — recommended for fodder. J. Agric., 10: 604.

Secale cereale — rye
1899 — being sown at Strathalbyn. J. Agric., 3: 336.

Sorghum halepense — Johnson grass
1875 — doing well at Yankalilla. Highly recommended. Garden & Field, 1: 196.
1899 — sown as fodder at Riverton. J. Agric., 3: 234.
1924 — being sown at Nantawarra. J. Agric., 27: 1002.

Sorghum vulgare — forage sorghum
1858 — highly recommended since that year in S.A. Garden & Field, 1: 40.
1870 — fresh seed obtained from Sydney for Botanic Gardens. Schomburgk (1871a), p. 5.

Stenotaphrum secundatum — buffalo grass
1928 — *inter alia* sown in pastures at Yurgo. J. Agric., 32: 147.

BORAGINACEAE

Echium plantagineum — salvation Jane
1918 — desirable plant in North. J. Agric., 21: 884.

CARYOPHYLLACEAE

Silene dichotoma — twobranch catchfly
1897 — potential fodder available from Germany. J. Agric., 1: 47.

Spergula arvenis — (corn) spurry
1897 — well-grown plants from seed sent by the Central Bureau to Naracoorte. J. Bur. Agr., 2: 27.
1898 — distributed to Bureau Branches as potential fodder plant. J. Agric., 1: 362.

COMPOSITAE

Achillea millefolium — yarrow
1896 — weed in garden but good fodder in pasture at Millicent. J. Bur. Agri., 8: 159.
1927 — showing promise (for fodder) at Kybybolite. J. Agric., 29: 1078.
1928 — *inter alia*, sown in pastures at Yurgo. J. Agric., 32: 147.

Arctotheca calendula — capeweed, (cape) dandelion
1893 — considered desirable at Mt Pleasant. J. Bur. Agr., 6: 79.
1899 — sown for fodder at Mt Gambier. J. Agric., 3: 471.
1907 — good feed, farmers glad to see it. J. Agric., 10: 911.

Cichorium intybus — chicory
1837 — sown at Adelaide for fodder (Capper, 1838).
1934 — recommended as pasture species. J. Agric., 37: 1416.

Cynara cardunculus — artichoke thistle
1897 — grown for sheep fodder at Stockport. J. Agric., 1: 163.
1899 — seed supplied to Craddock Bureau as a good fodder. J. Agric., 3: 52.
1920 — being sold as a drought resistant fodder. J. Agric., 24: 4.

Dittrichia graveolens — stinkwort
1899 — considered useful sheep fodder at Redhill. J. Agric., 2: 1015.

Helianthus annuus — sunflower
1946 — still being sown as a fodder crop J. Agric., 49: 449.

Lactuca saligna — wild lettuce
1890 — valuable fodder at Melrose. J. Agric., 2: 88.
1900 — useful fodder (at Pt Elliot). J. Agric., 3: 1015.

Pentzia virgata — sheep bush
1897 — growing at Lyrup. J. Agric., 1: 296.
1900 — growing at Pt Lincoln. J. Agric., 3: 778.

Taraxacum officinale — dandelion
1923 — recommended for fodder in combination with sub. clover at Lake Wangary. J. Agric., 26: 580.

Tragopogon porrifolius — salsify, oyster plant
1894 — reasonable fodder at Naracoorte. J. Bur. Agr., 6: 195.
1900 — seed earlier introduced from Central Bureau (for fodder). J. Agric., 4: 392.

CRUCIFERAE

Camelina sativa — false flax, gold of pleasure
1891 — seed sent as a pasture species by Central Bureau. J. Bur. Agr., 3: 173.

Diplotaxis tenuifolia — Lincoln weed
1907 — seed obtained from Pt Lincoln to be tested elsewhere. J. Agric., 5: 687.
1918 — introduced to Yunta area as a fodder (Black, 1918).

Sinapis alba — white mustard
1923 — fodder at Yallunda Flat. J. Agric., 27: 302.

Sisymbrium orientale — wild mustard
1901 — being deliberately sown for fodder at Craddock. J. Agric., 5: 480.

LEGUMINOSAE

Cytisus proliferus — tree lucerne
1897 — recommended fodder — J. Agric., 1: 106, 509.
1899 — Plants distributed at Angaston. J. Agric., 2: 1027.

Lotus tetragonolobus — squarepod trefoil
1894 — seed presented by Mueller for distribution to Ag. Bureau Branches. J. Bur. Agr., 7: 125.

Medicago lupulina — black medic
1893 — seed distributed by Central Bureau to all branches. J. Bur. Agr., 6: 47.
1912 — seed for sale. Hackett (1912).

Medicago polymorpha — burr medic
1909 — generally common in pastures. J. Agric., 11: 375.
1912 — seed for sale. Hackett (1912).
1916 — in plots at Naracoorte. J. Agric., 20: 521.

Medicago rugosa — gama medic
1956 — tested at Roseworthy. J. Agric., 60: 268.

Medicago sativa — lucerne
1901 — "Hunter River lucerne" sown at Pt Pirie by Mr Mallyon. J. Agric., 5: 185.

Medicago scutellata — snail medic
1955 — recommended for southern Yorke Peninsula. J. Agric., 59: 121.

Medicago truncatula — barrel medic
1938 — shown to be a useful fodder on alkaline soils. Trumble and Donald (1938).
1940 — sown at Gawler. J. Agric., 44: 683.
1946 — recommended for Yorke Peninsula. J. Agric. 49: 492.

Melilotus alba — Bokhara clover
1896 — well established at Millicent as a pasture. J. Bur. Agr., 9: 59.
1914 — *inter alia*, sown at Geranium. J. Agric., 17: 1219.

Melilotus indica — melilot
1906 — fodder plant at Naracoorte. J. Agric., 10: 243.
1908 — sown at Corny Point as, erroneously, "Bokhara clover". J. Agric., 11: 526.
1946 — recommended for fodder on Yorke Peninsula. J. Agric., 49: 492.

Trifolium alexandrinum — berseem clover
1911 — doing well at Roseworthy College. J. Agric., 15: 54.
1912 — being grown at Lyndoch. J. Agric., 16: 88.

Trifolium angustifolium — narrow-leaf clover
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium arvense — haresfoot clover
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium campestre — hop clover
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium clusii — annual strawberry clover
1899 — seed available for sowing from Millicent grower. J. Agric., 2: 938
1944 — valuable at Comaum. J. Agric., 48: 257.

Trifolium dubium — suckling clover
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium fragiferum — strawberry clover
1894 — valuable fodder at Millicent. J. Bur. Agr., 7: 57.
1904 — doing well at Millicent. J. Agric., 8: 57.
1906 — useful clover spreading in (Adelaide) Hills. J. Agric., 10: 339.

Trifolium glomeratum — cluster clover
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.
1927 — *inter alia*, tried for pasture at Jamestown. J. Agric., 30: 997.
1932 — *inter alia*, tried for pasture at Copeville. J. Agric., 36: 293.

Trifolium incarnatum — crimson clover
1895 — plants grown from seeds introduced by Agric. Bureau to Millicent doing well. J. Agric., 7: 282.
1899 — spreading at Mt. Gambier. J. Agric., 2: 945.
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium micranthum — slender suckling clover
1912 — seed for sale. Hackett (1912).
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium pratense — red clover, cowgrass
1909 — had grown luxuriantly around Mt Gambier and Penola in past but now dying out. J. Agric., 12: 1062, 1064.
1916 — in plots at Naracoorte. J. Agric., 20: 521.

Trifolium repens — white clover
1837 — patches at Glenelg sown by earliest settlers. Farm & Garden, 1: 207.
1909 — had grown luxuriantly around Mt Gambier and Penola in past but now dying out. J. Agric., 12: 1062, 1064.

Trifolium striatum — knotted clover
1925 — in pasture plots at Kybybolite. J. Agric., 29: 25.

Trifolium subterraneum — subterranean clover
1906 — spreading over (Adelaide) hills, good for early feed. J. Agric., 10: 339.
1907 — seed for sale (Hackett, 1907).
1908 — probably the most valuable of our naturalised fodders. J. Agric., 11: 577.

Trifolium tomentosum — woolly clover
1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Ulex europaeus — furze
1858 — recommended as a fodder plant. Farm & Garden, 1: 85.
1897 — encouraged as drought fodder. J. Agric., 1: 106.
1900 — recommended as fodder. J. Agric., 3: 651.

Vicia atropurpurea — purple vetch
1950 — being sown on Coonalpyn Downs Development. J. Agric., 54: 140.

Vicia sativa — tares, vetch
1858 — recommended as valuable fodder. Farm & Garden, 1: 10.
1898 — recommended as source of nitrogen for soils. J. Agric., 1: 789.
1950 — being sown on Coonalpyn Downs development. J. Agric., 54: 140.

ONAGRACEAE

Oenothera stricta — evening primrose
1889 — sown successfully in Mannum area. J. Bur. Agric., 2: 89.
1897 — noted as valuable fodder on sandy soils. J. Agric., 1: 43.
1913 — recommended for pasture on sandy country at Monteith. J. Agric., 16: 1193.

OXALIDACEAE

Oxalis pes-caprae — soursob
1914 — regarded by some as good feed at Stockport. J. Agric., 18: 83.

PLANTAGINACEAE

Plantago lanceolata — ribgrass
1837 — planted by the earliest settlers. Capper (1838).
1900 — extensively sown at Auburn. J. Agric., 4: 49.
1931 — still being sown as fodder at Longwood. J. Agric., 34: 986.

Plantago major — greater plantain
1873 — recommended for fodder. (Schomburgk, 1874).

POLYGONACEAE

Polygonum aviculare — wireweed
1859 — valuable summer fodder. Farm & Garden, 1: 153.
1934 — useful for fattening sheep in early summer. J. Agric., 38: 597.

ROSACEAE

Sanguisorba minor — sheep's burnet
1873 — recommended for fodder. Schomburgk (1874).
1907 — growing at Millicent. J. Agric., 10: 912.
1925 — *inter alia*, good pasture at Melrose. J. Agric., 29: 560.

SALICACEAE

Salix spp. — willows
1941 — recommended as being highly nutritious for stock. J. Agric., 44: 635.

Appendix 2

List of alien species with selected references documenting their use for erosion control and other purposes in South Australia.

GRAMINEAE

Ammophila arenaria — marram grass
1893 — successfully established for sandbinding at Corny Pt. J. Bur. Agric., 6: 1.
— one ton to be obtained for coastal plantings at various places. J. Bur. Agric., 6: 60.

Arundo donax — giant reed
1897 — suitable for windbreak. J. Agric., 1: 472.

Ehrharta calycina — perennial veldt grass
1936 — recommended for planting on sane dunes. J. Agric., 40: 32.
1940 — sown at Bute for erosion control. J. Agric., 44: 354.

Paspalum distichum — water couch
1901 — to be introduced as a sandbinder. J. Agric., 4: 632.

Pennisetum clandestinum — Kikuyu grass
1936 — recommended for planting on sane dunes. J. Agric., 40: 32.

Pennisetum villosum — long-styled feather grass
1940 — sown at Bute for erosion control. J. Agric., 44: 354.

Piptatherum miliaceum — rice millet
1940 — sown at Bute for erosion control. J. Agric., 44: 354.

Secale cereale — rye
1936 — recommended for sowing on sand dunes. J. Agric., 40: 32.

Stenotaphrum secundatum — buffalo grass
1936 — recommended for sowing on sane dunes. J. Agric., 40: 32.

EUPHORBIACEAE

Ricinus communis — castor oil plant
1844 — leaves recommended to be placed around grape vines to keep insects away. "S.A. Register", 11.xii.1844.

LABIATAE

Lavandula stoechas — topped lavender
1893 — seed sent to Corny Pt for sand binding. J. Bur. Agr., 5: 279.
— potential perfume plant. J. Bur. Agri., 5: 189.

LEGUMINOSAE

Lupinus cosentinii — blue lupin
1936 — recommended for sowing on sand dunes. J. Agric., 40: 32.

ONAGRACEAE

Oenothera stricta — evening primrose
1936 — recommended for sowing on sand dunes. J. Agric., 40: 32.

RANUNCULACEAE

Consolida ajacis — larkspur
1882 — "for keeping locusts away". Heyne (1882).

J. Adelaide Bot. Gard. 10(2): 241-244 (1987)

A NEW *PHEBALIUM* (RUTACEAE) ENDEMIC TO KANGAROO ISLAND

D.A. Cooke

South Australian Department of Agriculture,
G.P.O. Box 1671, Adelaide, South Australia 5001

Abstract

Phebalium equestre is described and illustrated; it is endemic to eastern Kangaroo Island and is regarded as endangered.

Populations of the only *Phebalium* on Kangaroo Island were referred tentatively to *P. hillebrandii* J.H. Willis by Wilson (1970) and by Armstrong & Telford (1986); their status as a distinct endemic species close to *P. brachyphyllum* Benth. was first suggested by Davies (1986). The rarity of this species is demonstrated by the absence of any herbarium collections prior to 1952. No *Phebalium* other than *P. pungens (=Eriostemon pungens*) was listed for Kangaroo Island by Cleland and Black (1927; 1941; 1952), and Wilson (1970) had seen only one collection.

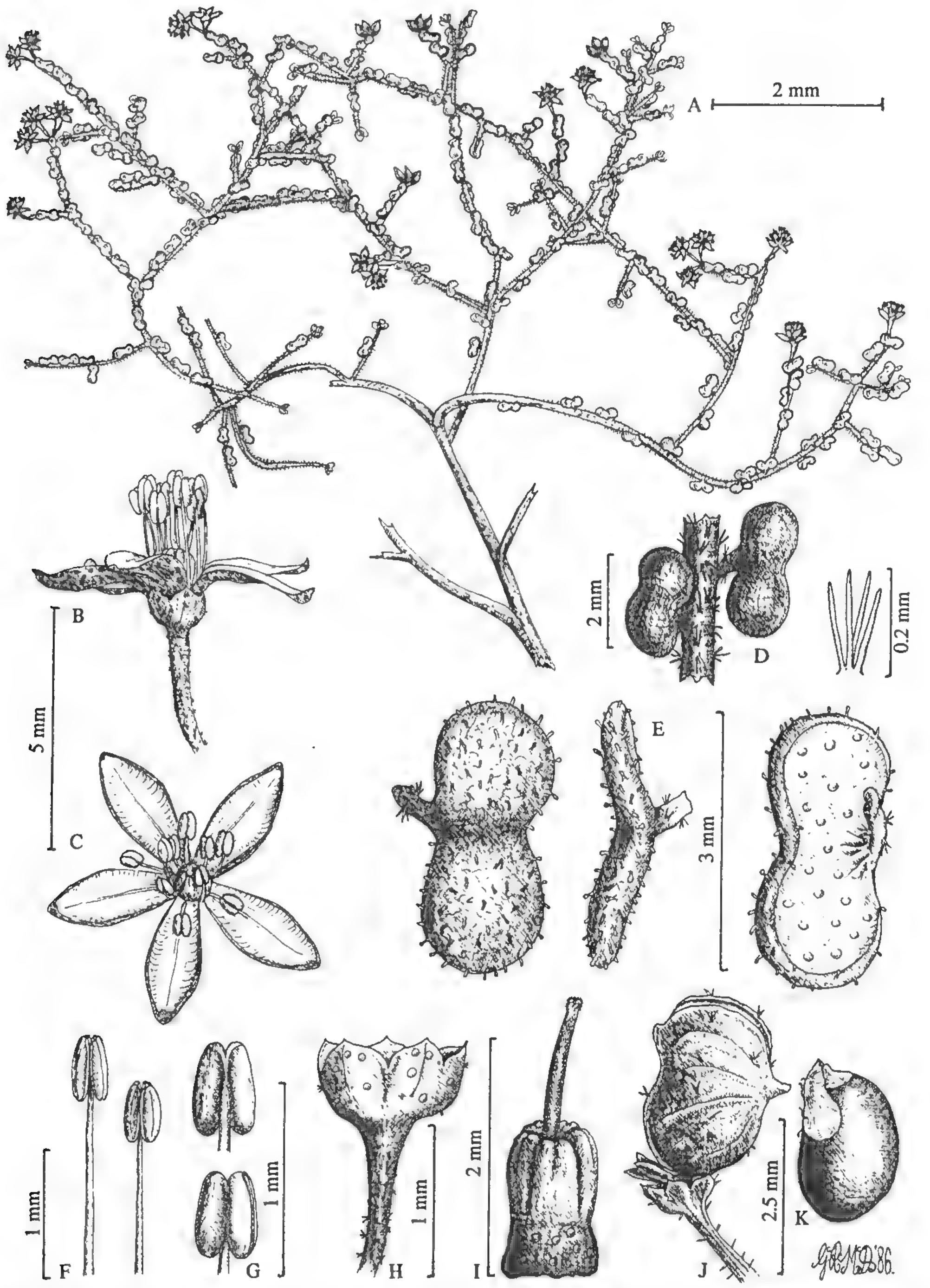
Phebalium equestre D.A. Cooke, sp. nov.

Frutex nanus diffusus virgatus ad 30 cm altus. *Caules* repetite divaricati; ramuli graciles laeves, virides vel rubescentes, pilis stellatis c. 0.2 mm longis pubescentes. *Folia* brevissime petiolata, patentia, ephippioidea, transverse oblonga cordata 1-3.5 mm longa 1.8-4 mm lata, subcoriacea glandulis depressis punctata, supra scabra, subtus glabra, marginibus integris recurvis, apicibus obtusis decurvis ut videtur retusis. *Flores* terminales solitarii vel 2-3 cymam umbelliformem sessilem formantes, in pedicellis 2-4 mm longis rubentibus infime bibracteolatis; alabastra obovoidea obtusa 2.3-3 mm longa rosea. *Calyx* turbinatus sparsim glandulosus lobis transverse triangularibus c. 0.3 mm longis. *Petala* anguste elliptica 2.5-3.5 mm longa glabra, extra rosea valdiore apicem versus, intra alba, apicibus acutis inflexis, in aestivatione valvata. *Stamina* 10 erecta biseriata, ea petalis alternantia eis subaequantia, ea petalis opposita eis breviora; filamenta teretia glabra; antherae versatiles oblongae cordatae retusae c. 0.5 mm longae, sine glandula apicale, luteolae raro roseotinctae. *Gynobasis* cylindrica c. 0.5 mm alta glandulosa vinacea. *Ovarium* 0.8-1 mm altum vinaceum carpellis 4-5 obtusis; stylus 1-1.3 mm longus. *Coccus* patens c. 3 mm longus minute apiculatus sparsim stellato-pilosus. *Semen* ovoideo-reniforme c. 2.5 mm longum laeve fuscum exarillatum, placenta persistenti postremo membranacea. (Fig. 1).

Type: Three Chain Road, Kangaroo Island, 3.x.1986, *B.M. Overton 435* (Holotype: AD).

Etymology: Latin *equester*, belonging to cavalry or to horsemen; in reference to the saddle-shaped leaves.

Virgate dwarf spreading shrub to 30 cm high. *Stems* repeatedly divaricate-branched; branchlets slender, smooth, green or becoming reddish, pubescent with stellate hairs c. 0.2 mm long. *Leaves* very shortly petiolate, patent, saddle-shaped, tranversely oblong, cordate, 1-3.5 mm long, 1.8-4 mm wide, subcoriaceous, dotted with depressed glands, scabrous above, glabrous below; margins entire, recurved; apices obtuse, decurved, appearing retuse. *Flowers* terminal, solitary or 2-3 forming an umbel-like sessile cyme; pedicels 2-4 mm long, reddish,



Phebalium equestre A, flowering branch; B, flower in lateral view; C, flower from above; D, branchlet and detail of stellate hairs of branchlet; E, leaf in adaxial, apical and abaxial views; F, stamens of outer and inner series; G, anther in dorsal and ventral views; H, calyx; I, ovary with gynobase and style; J, ripe coccus; K, seed. Drawn from holotype and from cultivated material.

with 2 bracteoles at the base; upopened flowers obovoid, obtuse, 2.3-3 mm long, pink. *Calyx* turbinate, sparsely glandular, with transversely triangular lobes c. 0.3 mm long. *Petals* valvate, narrowly elliptic, 2.5-3.5 mm long, glabrous, externally pink deeper towards the apex, internally white; apices acute, inflexed. *Stamens* 10, erect, biseriate, those alternating with the petals subequal to them, those opposite the petals shorter; filaments terete, glabrous; anthers versatile, oblong, cordate, retuse, c. 0.5. mm long, lacking an apical gland, pale yellow rarely tinted pink. *Gynobase* cylindrical, c. 0.5 mm high, glandular, wine-red. *Ovary* 0.8-1 mm high, with 4-5 obtuse carpels, wine-red; style 1-1.3 mm long. *Coccus* patent, c. 3 mm long, minutely apiculate, sparsely stellate-pubescent. *Seed* ovoid-reniform, c. 2.5 mm long, smooth, fuscous; aril absent; placenta persistent, ultimately membranous.

P. equestre is restricted to the Hundred of Haines, Kangaroo Island. It occurs mainly on sandy soils in *Eucalyptus diversifolia* mallee, often associated with *E. cosmophylla* and *Melaleuca uncinata*. It also extends to lateritic soil and *E. cneorifolia* mallee (Davies, pers. comm.). These habitats have largely been cleared and the remaining *Phebalium* populations are restricted to road verges and small patches of native vegetation subject to stock grazing. Flowering occurs in August to October.

Specimens examined

SOUTH AUSTRALIA: c. 200 m down road to Salt Lakes from intersection of Penneshaw-Kingscote road and American River road, 4.vi.1984, *R. Davies 562* (AD); American River, 22.x.1974, *N. Gemmell 328* (AD 97617349); Three Chain Road, 3.ix.1984, *K.C. Holliday s.n.* (AD 98433148); road joining Kingscote-Penneshaw road to South Coast road, *G.Jackson 328* (AD 96347015); Salt Lakes road, 7.ix.1965, *G. Jackson 444* (AD 96548007; MEL); Kangaroo Island, 14.vii.1952, *T.R.N. Lothian s.n.* (AD 96429021); Seal Bay road turnoff, 6.vii.1977, *M.D. Moore s.n.* (AD 97838007); Three Chain Road, 21.ix.1985. *B.M. Overton 382* (AD 98624078).

Phebalium equestre is placed in the section *Leionema* (F. Muell.) Benth. on the basis of its stellate vestiture, valvate petals, anthers without apical glands and the persistence of the placental endocarp on the seed. It differs from the closely related *P. brachyphyllum* in being smaller in all measurements with a diffuse divaricate habit, a characteristic leaf shape and fewer flowers in the inflorescence; these characters are maintained in cultivated specimens. It differs further from *P. bilobum* Lindley and *P. hillebrandii* in having leaves which are broader than they are long with entire apices and upper surfaces scabrous with rigid simple papillae.

Anther colour, used in the key of Armstrong & Telford (1986), does not appear to be a useful character in this species, varying from yellow to pale pink on the same plant. The carpel number may be 5 as in *P. brachyphyllum* or reduced to 4 as in *P. bilobum* and *P. hillebrandii.* At anthesis the carpels are obtuse as in *P. brachyphyllum*; the apiculum which develops on the fruiting carpel may be homologous to that observed in flowers of *P. hillebrandii* (Wilson, 1971) but appearing later in development.

Acknowledements

Thanks are due to the staff of the State Herbarium, Adelaide where this paper was prepared and especially to Mr G.R.M. Dashorst for the illustration.

References

Armstrong, J.A. & Telford, I.R. (1986). Rutaceae. In Jessop. J.P. & Toelken, H.R. (eds) "Flora of South Australia" 4th edn. Part 2. (Govt Printer: Adelaide).

Cleland, J.B. & Black, J.M. (1927). An enumeration of the vascular plants of Kangaroo Island. *Trans. R. Soc. S. Aust.* 51: 24-61.

Cleland, J.B. & Black, J.M. (1941). An enumeration of the vascular plants of Kangaroo Island: Additions and corrections. *Trans. R. Soc. S. Aust.* 65: 244-248.

Cleland, J.B. & Black, J.M. (1952). An enumeration of the vascular plants of Kangaroo Island: Second list of additions and corrections. *Trans R. Soc. S. Aust.* 75: 22-24.

Davies, R.J-P. (1986). "Threatened Plant Species of the Mount Lofty Ranges and Kangaroo Island Regions of South Australia". (Conservation Council of South Australia Inc.: Adelaide).

Wilson, P.G. (1970). A taxonomic revision of the genera *Crowea*, *Eriostemon* and *Phebalium* (Rutaceae). *Nuytsia* 1: 3-155.

J. Adelaide Bot. Gard. 10(2): 245-246 (1987)

CRYPTANDRA UNCINATA (F. MUELL. EX BAILLON) GRÜN. IS A SYNONYM OF *EREMOPHILA STURTII* R. BR.

Richard J.-P. Davies

C/- State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

Cryptandra uncinata (F. Muell. ex Baillon) Grün. is shown to be a synonym of *Eremophila sturtii* R. Br. and the history of the former epithet is described.

Taxonomic History

The taxonomy of the species *Cryptandra uncinata* (F. Muell. ex Baillon) Grün. has been controversial. The species is represented by two specimens of a collection by F. Mueller, one at K and the other at MEL. The author has examined the latter specimen, which was labelled by F. Mueller as "*Beyeria viscosa* var. *unicata*". The first formal description was by Baillon (1865-1866) who published it as "*Beyeria? uncinata*". However, he also noted that "this specimen may not belong to this genus; because of the thick cylindric leaves without reflexed margins and above all because of the thin calyx which is in no way joined to the ovary and the completely caducous style, it is very distinct. Because of the lack of male flowers, its placement in the genus should be very uncertain".

Bentham (1873) also referred to *Beyeria uncinata* but was critical of some of the distinguishing characters used by Baillon: "the thinner calyx-segments, more free from the ovary, and the very caducous stigma". Bentham commented that these distinctions were "scarcely warranted by the specimens".

In his revision of the genus *Beyeria*, Grüning (1912) transferred this species to *Cryptandra* noting that the structures which previous taxonomists had interpreted as elongated capsules were "almost spherical hermaphrodite flowers, the construction of which indicates Rhamnaceae" rather than Euphorbiaceae. However, he did not list flower characters which had influenced his decision.

Distribution

Although Baillon (1865-1866) referred to the type locality as "Murray Desert", as appears on the type specimen in MEL, Tate (1883) instead referred to "Murray Scrub near the Great Bend" as the collection locality. However, Canning (1986) notes that "search [in this area] has proved unsuccessful". Leigh, Briggs & Hartley (1981) listed the species as presumed extinct, being known only from the type collection and of uncertain taxonomic status.

Discussion

The type specimen of *Cryptandra uncinata* in MEL consists of a vegetative stem, leaf fragments and an envelope containing three galled flower buds, one partially dissected. A diagram by Grüning of a dissected flower bud is mounted with the specimen. However, this diagram is not consistent with the flower buds enclosed with the specimen, the diagram showing some floral parts which apparently had not developed in the buds due to galling. The specimen is exstipulate and stems have a covering of dried resin.

No resin vesicles or protruberances are evident on the specimen, but the coating of dried resin on the stem is consistent with that often seen in Myoporaceae and certain genera of Euphorbiaceae (e.g. *Beyeria*). This would be less likely in *Cryptandra* or Rhamnaceae in general.

The scant, mostly vegetative, material of the specimen agrees with the description of *Eremophila sturtii* given by Chinnock (1986) and with herbarium material in AD. Significant points are the resinous coating of the stem, leaf size and form (especially the apical hook) and the pedicels. Sepals are smaller than those usually seen in *E. sturtii*, but are consistent with those seen on galled buds, which are present on a considerable number of specimens of the species. Chinnock has examined the material and supports this identification. Thus, *Cryptandra uncinata* is considered to be a synonym of *Eremophila sturtii.*

Acknowledgements

I thank Dr H.R. Toelken, Dr R.J. Chinnock, Mr D.A. Cooke and Dr W.R. Barker for assistance during the preparation of this publication.

References

Baillon, H.E. (1865-1866). Euphorbiacées Australiennes. *Adansonia* 6: 306.
Bentham, G. (1873). "Flora Australiensis". Vol. 6. (Reeve: London).
Canning, E.M. (1986). "Family — Rhamnaceae". "Flora of South Australia", edn 4, part 2. (South Australian Govt Printer: Adelaide).
Chinnock, R.J. (1986). "Family — Myoporaceae". "Flora of South Australia", edn 4, part 3. (South Australian Govt Printer: Adelaide).
Leigh, J., Briggs, J. & Hartley, W. (1981). "Rare or Threatened Australian Plants". (Australian National Parks & Wildlife Service Special Publication No. 7).

Index to Volume 10

Names

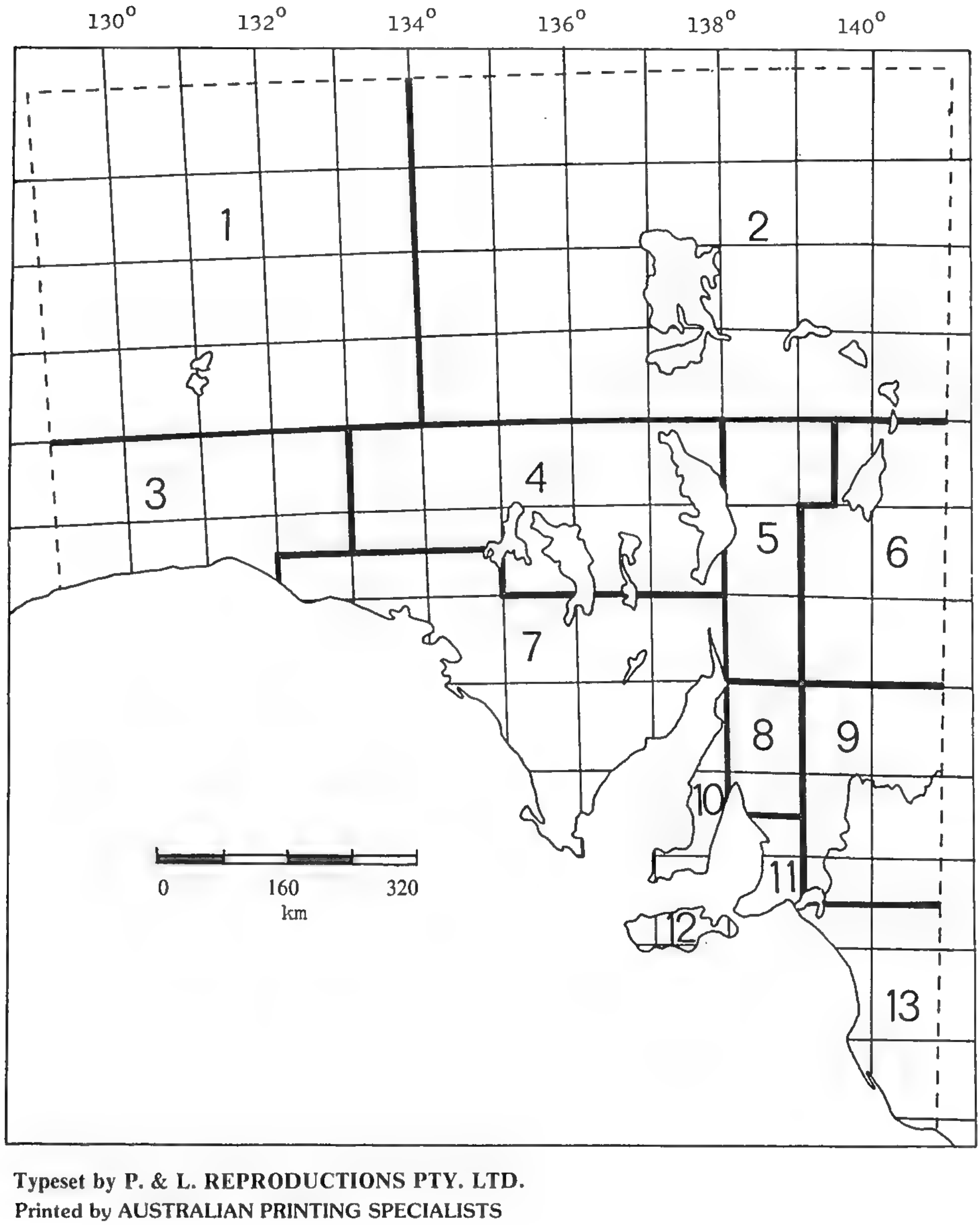
New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*. Names of taxa above genus are in CAPITALS.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked (*) refer to figures and maps.

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre Basin
3. Nullarbor
4. Gairdner-Torrens Basin
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. Yorke Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



Typeset by P. & L. REPRODUCTIONS PTY. LTD.
Printed by AUSTRALIAN PRINTING SPECIALISTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

CONTENTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 11 1988-89

Journal of the
Adelaide Botanic Gardens
Vol. 11

Dates of publication

Part 1	1 August, 1988
Part 2	20 July, 1989

Volume 11

Contents

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 11 Part 1 1 August, 1988

Instructions to Authors

Topics

Papers will be accepted in the following categories:
(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

Copy

Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of generic or lower rank must be underlined.

The print area for illustrations is 18 x 13 cm (excluding captions). Half-tone material should be submitted this size if possible, but will be reduced by the printers, if necessary.

Reprints

50 copies of reprints will be provided for each paper. Additional reprints may be purchased at cost.

Layout

The pattern of the paper should generally be:
(i) Title; (ii) Author and Address; (iii) Abstract (except for short papers); (iv) Introduction and subject matter; (v) Acknowledgements; (vii) References.

References

Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

Text references to specimens should be italicized, for example *Kock 276.*

Indices

When required, follow the pattern on, for example, p. 106 of vol. 1, pt. 2.

Recommendations on taxonomic papers

Synonymy

Authors are requested to include in the synonymy only references to publications containing information additional to that to be published in the paper being submitted. Within this section journal and book titles must be conistently abbreviated. B-P-H journal abbreviations and book titles abbreviated in a similar way are desirable. Authors of references cited in the synonymy should preferably be abbreviated according to the 'Index of Author Abbreviations' compiled and published by Royal Botanic Gardens, Kew (1980). References may be cited as:

Benth., *Fl. Austral.* 4: 111 (1868) OR
Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

All correspondence concerning the journal should be addressed to:

The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

ISSN 0313-4083

J. Adelaide Bot. Gard. 11(1): 1-17 (1988)

THE MOSSES OF THE NORTHERN TERRITORY, AUSTRALIA

D.G. Catcheside
Waite Agricultural Research Institute,
Glen Osmond, South Australia 5064

&

I.G. Stone
Botany School, University of Melbourne,
Parkville, Victoria, Australia 3052

Summary

The total number of species of mosses now definitely known to occur in the Northern Territory of Australia is 95. Of these 54 have not been reported previously, 7 are confirmed and 15 are new records for the Australian flora, including two new species (*Fissidens darwinianus* and *F. gillianus*); 7 previously reported were based on errors of identification; 6 others remain doubtful, no collections having been seen. Collections representative of distribution and presence in different herbaria are cited.

Introduction

It was long supposed that the moss flora of the Northern Territory was very meagre. Thus F. von Mueller (Mitten 1883, p.93) noted *Fissidens victorialis* Mitt. as "One of the only three mosses seen by me in North-west Australia in 1855 and 1856" while spending eleven months in the Northern Territory with 'A.C. Gregory's expedition'. Later (Mueller 1864) he wrote "The whole of tropical Australia with the exception of its eastern wet forest mountains, is almost totally devoid of mosses". Likewise Specht, with the National Geographic Society cum Smithsonian Institution Expedition to Arnhem Land in 1948, collected only one moss, a sterile *Archidium*. However, recent expeditions have uncovered a fair number of species, especially in the tropical north and the mountains of the southern area. We are particularly indebted to the following for the privilege of studying their collections: Mr L.A. Craven (CANB), Mr P.K. Latz (Conservation Commission of the Northern Territory), Dr G. Leach, Mr G. Wightman (DNA), Mr R. Filson (MEL), Mr H. Streimann (CBG), Mr A.C. Beauglehole, whose extensive collections are in MEL and to Mr J. Russell-Smith, whose collections are in CANB and DNA.

Some remarkable absences may be noted. No Polytrichaceae have been found in N.T., a lack also in W.A., and the weedy *Ceratodon purpureus* also appears to be absent. Even more surprising is the great rarity of *Gigaspermum repens*, which is found in Kimberley in W.A. and as far north as Millstream Falls in Queensland. The following is a record of present knowledge, including reports which are dubious. In the case of species for which numerous collections have been made, only a few are cited, sufficient to indicate the range of distribution and disposition in different herbaria. Herbarium D.G.C. will eventually be deposited in AD; I.G. Stone specimens in MEL or MELU. Previous published records were by F. von Mueller in Mitten (1883), J.H. Willis (1955, 1957 and 1958), G.A.M. Scott & I.G. Stone (1976), I.G. Stone (1979, 1982 and 1985) and D.G. Catcheside (1980). Species not included for N.T. in these publications, are indicated by an asterisk (*); those previously doubtful and now confirmed are indicated by a dagger (†); deletions are shown by #. Occurrence in other States is noted.

Archidiaceae

Archidium rothii Watts ex Roth: Mount Olga Gorge, *D.G. Catcheside 76.310*, 8.ix.1976; same locality, *I.G. Stone 5150* (Stone 1982); Harts Range, *P.G. Martin 1052*, vii.1953 (Herb. D.G.C.); Kings Canyon, *I.G. Stone 5158*, 15.vi.1977; Katherine Gorge, *I.G. Stone 23309 p.p.*, 12.vi.1985 (MELU). Also in Qld and W.A.

Other species of *Archidium*, apparently always sterile (without capsules), are evidently widely distributed and common in the Northern Territory (Stone 1982). They are perennial, often binding soil to form solid mats, expecially on shady banks and in the beds of streams between rocks and the roots of trees where they are watered intermittently. The consistent absence of sporophytes is surprising in view of the fact that all species are said to be monoicous. It may be that some species have lost the capacity to reproduce sexually and depend on vegetative reproduction by means of detached branches, tips of leaves or other fragments which are readily spread by water or wind. It is difficult to be sure of their correct names, but there appear to be two or three species, one or two related to *A. indicum* and *A. birmannicum* and the other to *A. ohioense*. These names are used tentatively. They are similar superficially and all in the section *Protobium* C. Müll. of the subgenus *Archidium*. The following key, adapted from the monograph by Snider (1975), may serve to distinguish the species.

1. Median cells of upper stems and perichaetial leaves usually irregular in shape, from quadrate to shortly rectangular, trapezoid or rhomboidal in one leaf; alar cells quadrate to shortly rectangular, only slightly smaller than the median cells, not conspicuously differentiated. .... Section *Phascoidea* (*A. stellatum*, *A. clavatum*)

   Median cells of upper stem and perichaetial leaves usually uniform, rhombic hexagonal to elongately or linearly rhomboidal or rectangular; if areolation irregular, the alar cells quadrate, smaller than the inner cells, in 2-8 rows extending 4-15 cells up the margin. Section *Protobium* 2

2. Costa of upper stem leaves strongly excurrent, usually forming a hair point, sometimes broken off 3

   Costa of upper stem leaves subpercurrent to shortly excurrent, rarely forming a hair point 4

3. Leaves ovate to rounded ovate lanceolate, the apex abruptly shortly acuminate to form a hair point; median cells of upper leaves uniformly shortly rectangular to elongately hexagonal, mostly less than 40 μm long; perichaetial leaves less than 1 mm long, ovate to oblong, costa faint, percurrent to shortly excurrent .... *A. rothii*

   Leaves narrower, ovate lanceolate to narrowly lanceolate or elongately triangular, the apex gradually acuminate to a hair point; median cells elongately rhomboidal, variable in length, mostly more than 40 μm long; perichaetial leaves 1-1.8 mm long, ovate to ovate lanceolate, costa strong, normally excurrent, usually with a hair point .... *A. ohioense*

4. Median cells of upper stem leaves mostly rectangular, only a few rhomboidal to rhombic hexagonal, 12-18 μm wide; perichaetial leaves long-lanceolate to linear lanceolate, about 8 times as long as wide .... *A. indicum*

   Median cells of upper stem leaves mostly rhombic hexagonal to rhomboidal or prosenchymatous, rarely rectangular, 9-14 μm wide; perichaetial leaves ovate to lanceolate, mostly 4 times as long as wide .... *A. birmannicum*

***A. birmannicum** Mitt. ex Dixon: Kakadu N.P., *L.A. Craven & G. Whitbread 6791*, 20.iii.1981, CANB 303359.

A. indicum Hamp. & C. Müll.: Reported by Stone (1982). Arnhem Land Expedition, *R.L. Specht M2* and *M3* (AD), originally recorded (Catcheside 1958) as perhaps *Pseudephemerum nitidum*; Kakadu N.P., *L.A. Craven & G. Whitbread 6792*, 20.iii.1981, CANB 303347; McArthur River area, on sandstone near the Clyde River, *L.A. Craven 3522*, 29.i.1976, CANB 270616; Darwin, *H. Streimann 8768*, 29.xii.1984 (CBG). Occurs also in W.A. and S.A.

A. ohioense Schimp. ex C. Müll.: Kakadu N.P., *L.A. Craven & G. Whitbread 6571*, 23.iii.1981, CANB 303388; Katherine Gorge N.P., *L.A. Craven 6690*, 6.iv.1981, CANB 303374; Bessey Spring, McArthur River Homestead, *J. Eurell 22*, 22.viii.1977, CBG 7707737; 6 km from DUPHKA College on road to Cape Arnhem, *J.* and *J. Eurell 78/45*, 13.viii.1978, CBG 7810567. Also in Qld (Stone 1982) and S.A.

Fissidentaceae

Fissidens asplenioides Hedw.: Doubtful. Recorded by Willis (1955) from Tallaputta (Talli-Patta) Springs, about 35 km W of Haasts Bluff, NW extremity of MacDonnell Ranges, *Paul Fisch*, 29.v.1954, MEL 1022417. The specimen seen (D.G.C., 17.xii.1979) contained one stem of *F. hebetatus*, the rest being probably *Philonotis tenuis*. Occurs in W.A., S.A., Vic., Tas., N.S.W., A.C.T. and Qld.

***F. borgenii** Hampe: near Moline, *J. Russell-Smith 114*, 10.x.1981, CANB 334648. New to Australia. Also in W.A. Related to *F. humilis* Dixon & Watts, but different in the dorsal lamina ending abruptly at the base of the costa.

***F. cairnensis** Broth. & Watts: Oenpelli Road from Darwin, *G.J. Anderson 1369 & D.E. Symon*, 22.iv.1980. Beatrice Hill, 55 km ESE of Darwin, *H. Streimann 8830 p.p.*, 3.i.1985 (CBG). Also in Qld.

F. ceylonensis Doz. & Molk. (syn. *F. subhumilis* Catcheside): George Creek, 16 km S of Adelaide River, *L. Adams 256*, 17.iii.1965, CANB 162816 (type of *F. subhumilis*), MEL 1024243 (isotype of *F. subhumilis*); Kakadu N.P. about 65 km S of Jabiru, *L.A. Craven & G. Whitbread 6809*, 24.iii.1981, CANB 303342; Wangi Road, Walker Creek, *H. Streimann 8807*, 1.i.1985; near Moline on Oenpelli-Pine Creek Road, *J.R. Smith 114*, CANB 334648; Kakadu N.P., Baroalba Spring, *I.G. Stone 23396*, 26.vi.1985; also Nourlangie, on termite mound in *Callitris* forest, *I.G. Stone 23386*. Also in Qld and W.A.

***Fissidens darwinianus**, sp. nov.:

F. bogoriensi Fleisch. affinis, sed cellulis laminae parvioribus, ca 16-20 x 12-15 μm. Dioicus.

Holotype: Darwin, Rapid Creek, *Victor Pedersen*, i.1965, MEL 1024242 p.p.

Paratype: Queensland, Helenvale, south of Cooktown on earth bank in shaded very wet rainforest, *I.G. Stone 19232 p.p.*, 19.vi.1982 (MEL).

A member of the section Areofissidens C. Müll.; plants green, protonema persistent, shoots short, 1-2.5 x 1.0 mm, with up to 5 pairs of leaves. Leaves small, cultriform below, lanceolate above, reaching 1-1.4 x 0.3 mm, widest in apical lamina; margin weakly crenulate, bordered with 1-3 rows of longer, more thickly walled cells, the outer ones about 20 x 10 μm, an inner row, often bistratose, longer and narrower, 30-60 μm, appearing as a weak intramarginal limbidium, ceasing well below the apex; vaginant laminae barely reaching to mid-leaf, closed, the blades meeting at the margin; costa reaching apex and just excurrent; apex acute; cells lax, thinly walled, more or less hexagonal, 16-20 μm long x 12-15 μm wide in apical lamina, longer and oblong, to 50 x 18 μm, at base of vaginant lamina. Dioicous. Perigonial leaves mostly unbordered, antheridia 130 μm long, clustered at apex. Perichaetia terminal, leaves similar to vegetative. Seta 4-5 mm long, geniculate at base. Capsule inclined, asymmetrical, 0.5-0.6 mm long; exothecial cells quadrate to rectangular 25-30 μm long x 10-20 μm wide, longer on convex upper side, with thin bulging walls greatly thickened at the corners; peristome teeth 35-40 μm wide at base, the rest not seen. Figs 1 and 2.

Similar to *F. bogoriensis* Fleisch. in which the plants are autoicous and the cells of the apical lamina are larger, 30-45 x 20-25 μm, and those at base of vaginant lamina reach 80 μm long.

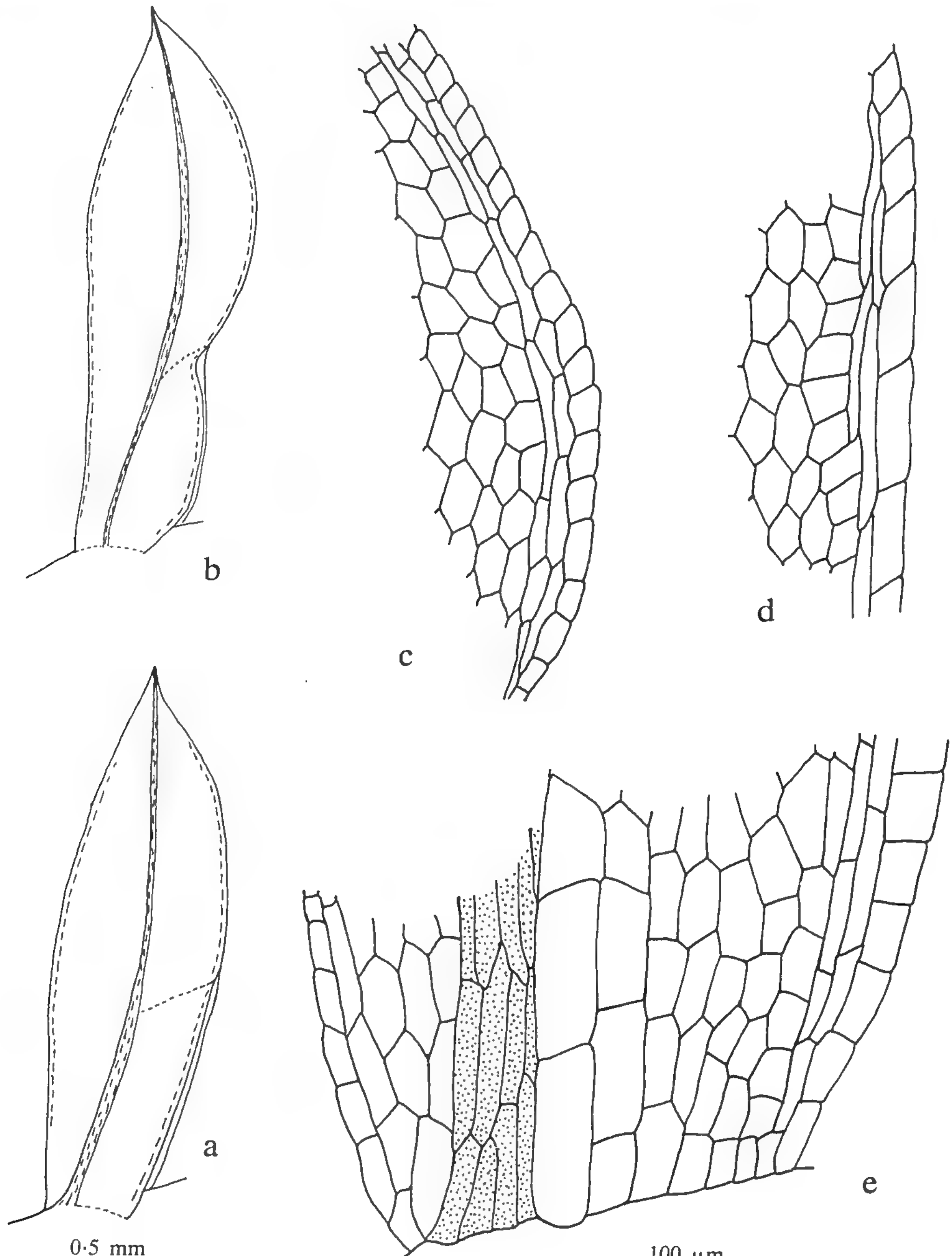


Fig. 1. *Fissidens darwinianus*: MEL 1024242 p.p.: a, b, leaves; c, adaxial margin of apical lamina; d, adaxial margin of vaginant lamina; e, base of leaf.

***F. aff. dietrichiae** C. Müll.: George Gill Range, Reedy Creek Rock Hole, *J.H. Willis*, 28.vii.1966, MEL 1022407 and 1022408; also *A.C. Beauglehole 20937*, 10.x.1966. MEL 1037897. The aquatic species related to *F. crassipes* are in need of revision. Also in N.S.W.

***F. gillianus**, sp. nov.:

F. taylorii C. Müll. affinis, sed lamina vaginans longissima, ad apicum folii fere attingens, elimbata; lamina dorsali lata superne; lamina apicali acuta; folia perichaetialia intralimbata brevi indistincta; capsula suberecta; peristomii dentes divisi.

Type: Kings Canyon, George Gill Range, on shaded earth among fallen boulders below north wall of gorge, *J.H. Willis*, 29.vii.1966, MEL 1022414.

Plants small, vegetative shoots to 3.5 mm tall, 0.65 mm wide. Leaves on vegetative shoots in 18-20 pairs, increasing in size upwards to 0.5 mm x 0.2 mm wide, the lower ones with a

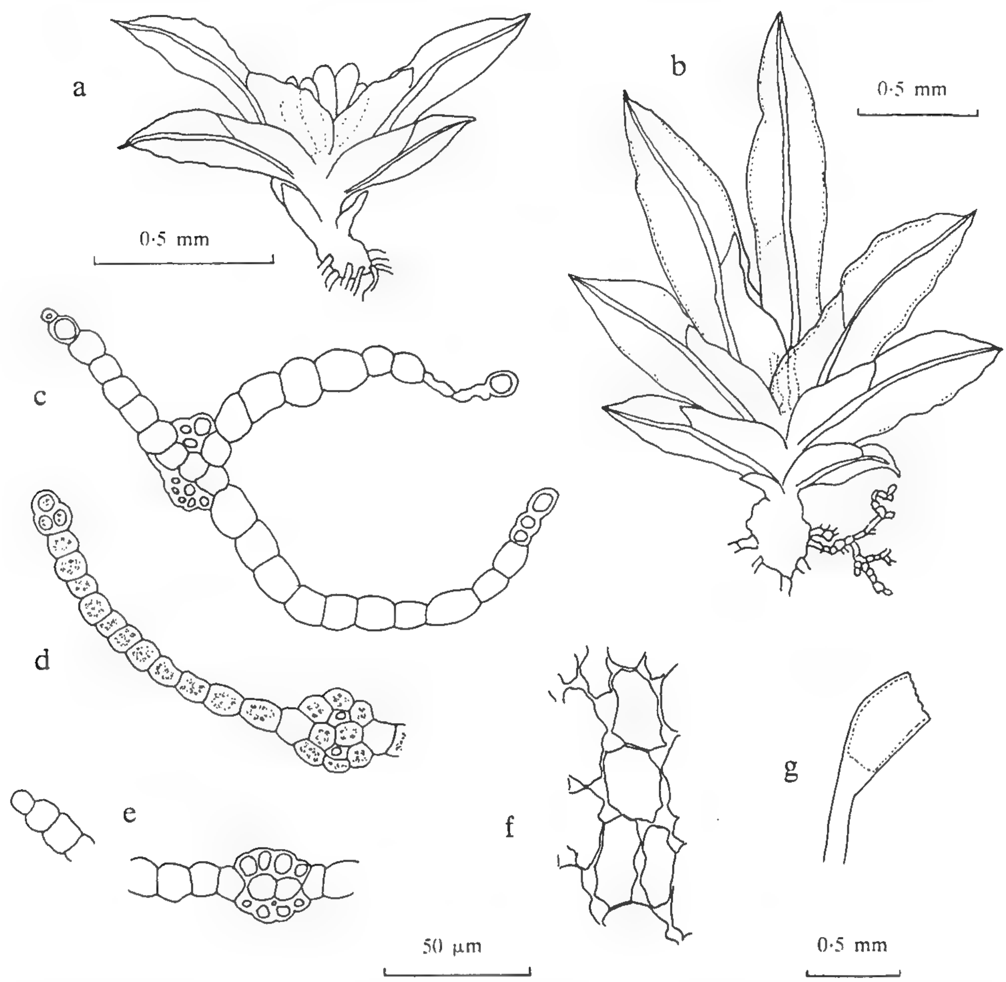


Fig. 2. *Fissidens darwinianus*: (a-e) MEL 1024242 p.p.; (f-g) *I.G. Stone 19232 p.p.*: a, male plant; b, female plant; c-e, transverse sections of leaf from base upwards; c, dorsal and vaginant laminae; d, mid-leaf with bistratose intramarginal border; e, nearer apex; f, exothecial cells; g, old capsule.

small apical lamina and narrow dorsal lamina in the upper third to half of the leaf. Upper leaves oblong, broadening above, the vaginant laminae nearly equal, occupying 0.8-0.9 of the length of the leaf, uniting near the margin, totally without a limbidium; costa sinuous, fading below the acute apex; apical lamina very short; dorsal lamina bowed outwards above, tapering below to one row of cells and ceasing above insertion. Cells smooth, mostly roughly hexagonal, the upper ones 10-15 μm long x 8-10 μm wide, the lower ones larger, the marginal cells of the vaginant lamina rather wider than long and slightly protuberant to form an obscurely crenulate margin. Rhizoid gemmae small, 2-4-celled, rare. Figs 3 and 4.

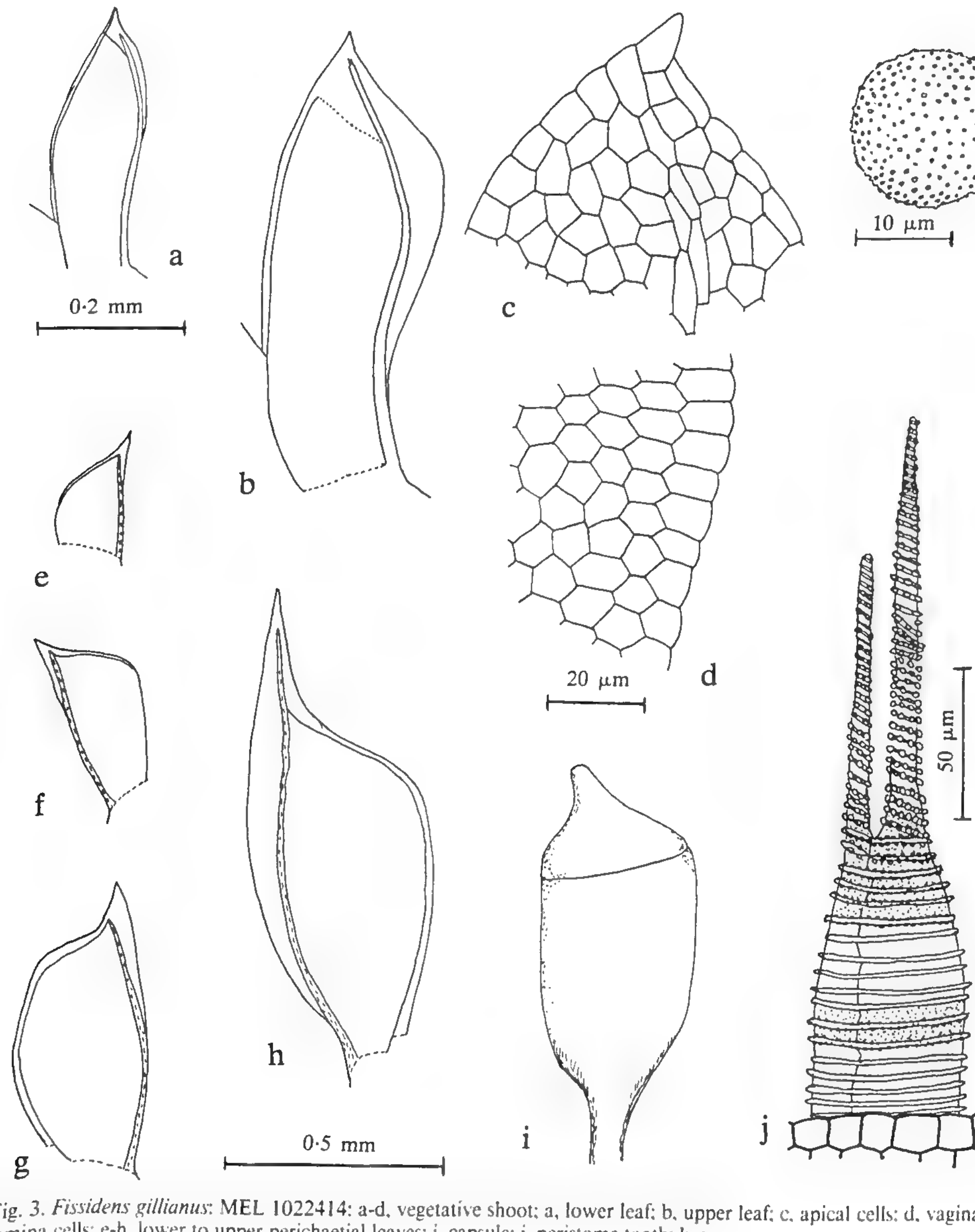


Fig. 3. *Fissidens gillianus*: MEL 1022414: a-d, vegetative shoot; a, lower leaf; b, upper leaf; c, apical cells; d, vaginant lamina cells; e-h, lower to upper perichaetial leaves; i, capsule; j, peristome tooth; k, spore.

Inflorescence variable, rhizautoicous, autoicous, possibly sometimes dioicous. Perigonia small, bud-like, sometimes axillary on vegetative shoots, sometimes at base of female plant. Perichaetia terminal on very short fertile shoot or axillary or basal on vegetative shoot; perichaetial leaves about five, the lower three small and consisting of inflated vaginant laminae, the upper two with narrow extended apical laminae. Cells similar to those of vegetative leaves, but with a short ill defined row of elongated cells intramarginally in the lower part of the vaginant lamina. Capsule short, cylindrical, nearly erect, on a seta 2.5-2.8 mm long, bent at the base; operculum rostellate. Peristome teeth 50-60 μm wide at base, divided to about halfway or rather more, the basal part with 16-18 (-20) trabeculae, the plates finely papillose between the trabeculae; the forks spirally thickened and with prominent conical papillae. Spores brown, 18-20 μm diameter, finely papillose.

This plant was labelled *F. taylorii* C. Müll., in the Melbourne herbarium, but it is distinct in leaf shape and in the absence of a limbidium in the vaginant laminae, except obscurely in the perichaetial leaves. *F. taylorii* has been used to cover a group of species, but none of the

Fig. 4. *Fissidens gillianus*: MEL 1022414: a, rhizoid gemmae; b, vegetative shoot with lateral perichaetium and capsule, calyptra loose; c, female plant with young capsule, perigonium at base; d, axillary perigonium on vegetative shoot; e, ditto, with one antheridium and one perigonial leaf (enlarged) in axil of stem leaf.

existing names fits the species described above. Other specimens of *F. gillianus* seen include: Northern Territory: Mount Conner, *J.H. Willis*, 17.vi.1974, MEL 1514426; Mount Olga, *Marie Allender*, 23.viii.1960, MEL 1022409; summit of Ayers Rock, *J.H. Willis*, 11.ix.1965, MEL 1022412; A.C.T.: Acton, *D.G. Catcheside 68.117*, 20.vii.1968: N.S.W.: Caloola Creek, 62 km NNE of Broken Hill, *H. Streimann 6334*, 28.ix.1978, CBG 7903946; W.A.: Three Mile Rocks, 37 km NNE of Bullfinch, *R. Wyatt 4199 & A. Stoneburner*, 7.viii.1984.

***F. gymnocarpus** Stone: Wangi Road, Finniss Range, *H. Streimann 8792*, 1.i.1985; Katherine Gorge, base of scarp, *I.G. Stone 23301*, 12.vi.1985; Kakadu N.P., road to Obiri, on mound of earth near swamp, *I.G. Stone 23362*, 23.vi.1985; Petherick's rainforest, near Woolaning, SSW of Darwin, *I.G. Stone 23471*, 3.vii.1985. Also in W.A. and Qld.

F. hebetatus Catcheside: Nourlangie Camp, S. Alligator River, *L. Adams 303*, 23.ii.1965, CANB 162836 (holotype), MEL 1024241 (isotype); Upper Katherine River, Wangi Road, Walker Creek, *H. Streimann 8809*, 1.i.1985; Sleisbeck Uranium Field, *V. Pedersen*, 10.i.1955; Kakadu N.P., about 50 km W of Jabiru, *L.A. Craven & G. Whitbread 6777*, 19.iii.1981; Simpsons Gap, *P.G. Martin 1036*, vi.1953 (herb. D.G.C.); Kings Canyon, *J.H. Willis*, 30.vii.1966, MEL 1024250 and *D.G. Catcheside 76.315*, 10.ix.1976; Reedy Creek Rock Hole, George Gill Range, *J.H. Willis*, 28.vii.1966, MEL 1024252; SSW of Darwin, on magnetic termite mound, *I.G. Stone 23491*, 3.vii.1985. Also in W.A., N.S.W. and Qld.

F. humilis Dix. & Watts: MacDonnell Ranges, Standley Chasm, *P.G. Martin 1087*, vii.1953 (herb. D.G.C.), also *Neville Forde 733 p.p.*, 10.iii.1957, MEL 1024245, and *I.G. Stone 5154*, 17.vi.1977; Chewings Range, *P.K. Latz 6633c*, 22.ix.1976 (herb. D.G.C.); George Gill Range, Kings Canyon, *H.A. Morrison*, 19.vii.1964, MEL 1024247; Kakadu N.P., about 45 km WNW of Jabiru, *L.A. Craven and G. Whitbread 6781*, 18.iii.1981, CANB 303352. Also Vic., N.S.W., A.C.T. and Qld.

F. leptocladus C. Müll.: Central Australia, Harts Range, Mount Riddock, *J.H. Willis*, 26.v.1974, MEL 1024239. This has relatively wider leaves than usual, approaching *F. patulifolius* Dixon, but without the cuspidate apex and somewhat larger cells of that species. In all States.

***F. perobtusus** Dixon (syn. *F. traversii* Stone).: The close resemblance of *F. traversii* to *F. perobtusus* was pointed out by Dr Z. Iwatsuki (pers. comm.) who kindly sent drawings he had made of the type specimen of the latter. The two species are undoubtedly conspecific and *F. traversii* must be reduced to the synonymy of *F. perobtusus*. A specimen is in herb. BM labelled '*F. tatei*' Mitt. ined, Port Darwin, iii.1882, the collector not specified, but probably R. Tate; Jasper Gorge, near Buchanan Hwy, *J.H. Willis*, 3.vii.1974, MEL 1024237; Darwin, *H. Streimann 8774*, 29.xii.1984 (CBG); Beatrice Hill, Arnhem Hwy, 55 km SE of Darwin, *H. Streimann 8830*, 3.i.1985 (CBG); Kings Canyon, George Gill Range, *P.K. Latz*; Katherine Gorge, base of southern scarp, *I.G. Stone 23311*, 12.vi.1985, also on seepage wall, *I.G. Stone 23325*, 13.vi.1985; Kakadu N.P., Nourlangie, *I.G. Stone 23378*, 24.vi.1985. Also in Qld and W.A.

F. pungens C. Müll. & Hampe: Banks of Daly River, 90 m S of Darwin, *V. Pedersen*, 13.viii.1952, MEL 1034031. Listed by Willis (1955). The plants are rather large for *F. pungens*, but within the range of variation. In all States.

F. victorialis Mitt.: Cataract of the Victoria River, *F. von Mueller*, 1855/6, MEL 1022405 (isotype), BM (holotype); Arnhem Land, about 10 km SSE of Mt Brockman, *L.G. Adam & L.A. Craven 3127*, 27.ii.1973, CANB 251264; Butterfly Gorge, off Katherine Gorge, *J. Eurell*

16, 14.vii.1977, CBG 7707731; Katherine Gorge, base of southern scarp, *I.G. Stone 23302*, 12.vi.1985, also on seepage wall, *I.G. Stone*, 13.vi.1985; Kakadu N.P., Baroalba Spring, *I.G. Stone*, 26.vi.1985; also Obiri, under rock ledge, *I.G. Stone 23339*, 22.vi.1985; Oenpelli, Arnhem Land, rainforest, *I.G. Stone 16243*, 26.vii.1980. Also in W.A. and Qld.

***F. zollingeri** Mont.: Kakadu N.P. about 40 km NNE of Jabiru, *L.A. Craven & G. Whitbread 6771*, 22.iii.1981, CANB 3033394; about 35 km W of Jabiru, *L.A. Craven 6784*, 19.iii.1981, CANB 303404; Darwin, Doctors Gully, *H. Streimann 8760*, 29.xii.1984 (CBG). Also in Qld and N.S.W.

Grimmiaceae

***Grimmia laevigata** (Brid.) Brid.: Mulga Park, on rock. *A.C. Beauglehole*, 26.vi.1965, MEL 1038489; Henbury Meteor Crater, *A.C. Beauglehole*, 4.vii.1965, MEL 1037944. In all States.

Ditrichaceae

Ceratodon purpureus (Hedw.) Brid.: Scott & Stone (1976) wrote 'apparently through all parts of Australia'. Its occurrence in the N.T. is doubtful.

Eccremidium arcuatum (Hook. f. & Wils.) C. Müll.: Listed as probable by Scott & Stone (1976). Occurs in W.A., S.A., Vic., N.S.W. and Qld.

***E. minutum** (Mitt.) Stone & Scott: Ayers Rock, near base, *A.C. Beauglehole 25885 p.p.*, 5.vii.1968; Manton River between Katherine & Darwin, *A.C. Beauglehole*, 20.vii.1965, MEL 1037998; George Gill Range, 2 km NE of Reedy Rock Hole, *A.C. Beauglehole*, 11.vii.1968, MEL 1038784, all as *Ephemerum whiteleggi*; Kakadu N.P., road to Obiri, on mound of earth near swamp, *I.G. Stone 23361*, 23.vi.1985. Occurs in all other States.

†**E. pulchellum** (Hook. f. & Wils.) C. Müll.: Listed as probable by Scott & Stone (1976). Summit of Ayers Rock, *P.G. Martin*, 14.vi.1953 (Herb. D.G.C.); Valley of Eagles, 52 km ENE of Alice Springs, *A.C. Beauglehole 44965*, 2.vi.1974 and Mt Olga, *Marie Allender*, 23.vii.1960, MEL 1023850, both as *Pleuridium nervosum*. Occurs in all other States.

***Garckea comosa** (Doz. & Molk.) Wijk & Marg.: Latran River, about 4 km S of Gove Airport, *J. & J. Eurell 78/40*, 16.vii.1978, CBG 7810561. Also in W.A. and Qld.

Pleuridium nervosum (Hook.) Mitt.: Listed by Scott & Stone (1976); George Gill Range, Penny Springs area, *A.C. Beauglehole*, 14.vii.1968, MEL 1037910. Also in W.A., S.A., Vic., Tas., N.S.W. and A.C.T.

Dicranaceae

***Campylopus cf. atroluteus** (C. Müll.) Par.: Kakadu N.P., about 65 km S of Jabiru, *L.A. Craven & G. Whitbread 6811*, 24.iii.1981, CANB 303348. New to Australia. This collection has been identified also as *C. comosus* (Hornsch. & Reinw.) Bosch & Lac., which occurs in Qld. However, it differs from that species in several respects, especially the absence of adaxial (ventral) stereids in the costa and the elongated rhomboidal cells in the upper lamina. It agrees well with Magill's (1981) description and with African specimens of *C. atroluteus*.

#**C. clavatus** (R.Br.) Wils.: The previous record (Catcheside 1980) was based on a mis-identification of what is *C. perauriculatus*.

***C. inchangae** (C. Müll.) Par. (syn. *C. wattsii* Broth.): Kakadu N.P., 16 km SE of Koongarra, *L.A. Craven 6251*, 2.vi.1980, CANB 303363. Also in Qld.

C. introflexus (Hedw.) Brid.: Listed as probable by Scott & Stone (1976), but no actual specimen has been seen.

***C. perauriculatus** Broth.: Mount Giles, 23.39S. x 132.55E, *P.K. Latz 6604c p.p.*, 19.ix.1976; Mount Giles, 23.39S x 132.50E, *P.K. Latz 6623 c*, 21.ix.1976, (both in herb. D.G.C.). Also in S.A., Vic., N.S.W. and Qld.

#Pseudephemerum nitidum (Hedw.) Reim. To be deleted, as the specimen is *Archidium indicum* (q.v.).

Leucobryaceae

***Leucobryum aduncum** Dozy & Molk.: Kakadu N.P., *Craven 2487*, 4.iii.1973; Oenpelli, Arnhem Land, *I.G. Stone 16241*, reported by Stone (1982) as possibly *L. candidum* var. *pentastichum*. New to Australia. Also in Qld. Similar to *L. scalare*, but without small quadrate cells abaxially near the base.

***L. brachyphyllum** (Hornsch.) Hampe: Oenpelli, Arnhem Land, *I.G. Stone 16245*, 26.vii.1980.

***L. scalare** C. Müll. ex Fleisch.: Arnhem Land, about 9 km NE of Jabiru, *L.G. Adams & P. Richardson 3035*, 19.ii.1973, CANB 251265; Katherine Gorge N.P., Edith Falls, *L.A. Craven 6764*, 8.iv.1981, CANB 303372; Kakadu N.P., Jim Jim Falls, *I.G. Stone 23436*, 26.vi.1985; Kakadu N.P., Baroalba Spring, *I.G. Stone 23404*, 26.vi.1985; Katherine Gorge, seepage wall, *I.G. Stone 23317*, 13.vi.1985; Melville Island, Taracumbie Falls, *G. Wightman 1019*, 31.i.1984 (DNA): Melville Island, Taracumbie Creek, *J. Russell-Smith 1308*, 9.xi.1983 (DNA). Also Qld, N.S.W. and W.A. New to Australia.

***L. stenophyllum** Besch.: Kakadu N.P., about 10 km SE of Jabiru, *L.A. Craven & G. Whitbread 6803*, CANB 303350. New to Australia. Also in Qld, e.g. *H. Flecker 949* identified in error as *L. bowringii* var. *sericeum* (Broth.) Dixon.

#L. teysmannianum Dozy & Molk.: Recorded by Stone (1982). To be deleted as the specimen is *L. scalare.*

Leucrobryums in the *L. candidum* complex have generally been lumped under *L. candidum* (P. Beauv.) Wils., though Thériot (1922) recognised that confusion has arisen through the presence of two species mixed in type material. The following three may be separated:

(1) *L. candidum* (P. Beauv.) Wils.: Robust, leaves commonly in five twisting rows on the stem, secund, broadly ovate lanceolate, 5-6 x 1.2-1.5 mm, narrowly involute in the upper third, with a broad hyaline border (the lamina) in the basal part of 4-6 (average 5) rows of outer linear cells and 1-3 (average 1.9) rows of inner wide cells. Occurs in Tas., Vic., N.S.W. and Qld, in tropical and temperate rain forests.

(2) *L. brachyphyllum* (Hornsch.) Hampe: Small, leaves short, relatively broad more or less straight, 1.7-2.4 x 0.4-0.5 mm, involute from just above base and widely so from midleaf, with a narrow hyaline border of 2-3 (average 2.5) rows of outer linear cells and 1-2 (average 1.1) rows of inner wide cells. Occurs in N.S.W. and Qld, in drier forest.

This may include *L. ballinense* Broth.

(3) *L. aduncum* Dozy & Molk.: Intermediate in size, leaves long and narrow, 2-4 x 0.5-0.65 mm, falcate, often with an apical tuft of rhizoids, narrowly involute from just above the base, border narrow as in *L. brachyphyllum*. Occurs in Qld and N.T., in monsoon rainforest.

***Leucophanes australe** Broth.: Kakadu N.P., about 10 km S of Jabiru, c.fr., *L.A. Craven & G. Whitbread 6806*, 25.iii.1981, CANB 33453; 'Black Jungle' 10 km E of Humpty Doo, near Darwin, *J.R. Smith 140*, 20.viii.1981, CANB 33452; Petherick's rainforest, SSW of Darwin, *I.G. Stone 23480*, 3.vii.1985. Also Qld.

Octoblepharum albidum Hedw. First record F. von Mueller (Mitten 1883); Cox Peninsula, coll. R. Tate, 20.iii.1882, det. W. Mitten. Common in northern N.T. Kakadu N.P., about 65 km S of Jabiru, *L.A. Craven & G. Whitbread 6808*, 24.iii.1981, CANB 303349; Koolpin Gorge near El Sherana, SW Arnhem Land, *J.R. Smith 132*, 11.x.1981, CANB 33641; Wangi Road, Walker Creek, 68 km SSW of Darwin, *H. Streimann 8810 p.p.*, 1.i.1985 (CBG); about 11 km E of Mudginberrie Station on road to Oenpelli, *D.E. Symon*, 23.iv.1980 (Herb. D.G.C.); Robin Falls, *A.C. Beauglehole*, 23.vii.1965, MEL 13871; Petherick's rainforest, *I.G. Stone 23470*, 3.vi.1985; Katherine Gorge, on fig root at base of south facing scarp, *I.G. Stone 23308*, 12.vi.1985; Melville Island, 1 km W Snake Bay, Sandspears Jungle, *J. Russell-Smith*, 8.xi.1983 (DNA). Also in W.A. and Qld.

Calymperacae

Calymperes tenerum C. Müll.: Kakadu N.P., near Kapalga Billabong, *L.A. Craven & G. Whitbread 6817*, 18.iii.1981, CANB 303346; Darwin & Gulf District, "Kapalga" CSIRO Research Property, North Point, *H.S. Thompson 494*, 6.vi.1983, CBG 8309279; Manton Dam, *H. Streimann 8739*, 26.xii.1984 (CBG). Also in W.A. and Qld.

C. tenerum var. edamense Fleisch: Reported by Stone (1982). The var. *edamense* Fleisch. differs from the typical species in having broader leaves, but in view of the variation in this respect, the variety is scarcely worth maintaining.

***C. erosum** C. Müll.: Berry Springs, near Darwin, *I.G. Stone 815*, 28.viii.1967, originally recorded incorrectly (I.G. Stone 1982) as *C. moluccense*; near Woolaning H.S., *L.A. Craven & C.R. Dunlop 6664*, 4.iv.1981, CANB 303386; source of Barramundie Creek, *J.R. Smith 130*, 9.x.1981, CANB 334634; Kakadu, Radon Gorge, Mt Brockman, *J.R. Smith 137*, CANB 334636; Petherick's rainforest, SSW of Darwin, *I.G. Stone 23476*, 3.vii.1985. Also in Qld, recorded by Reese & Mohamed (1985).

***C. motleyi** Mitt. in Dozy & Molk.: Manton Dam, *H. Streimann 8740 p.p.*, 26.xii.1984 (CBG); Kakadu N.P., Nourlangie, *Callitris* forest, *I.G. Stone 23388*, 25.vi.1985; Kakadu N.P., Baroalba Spring, *I.G. Stone 23399*, 26.vi.1985 Petherick's rainforest, SSW of Darwin, *I.G. Stone 23472*. Also in Qld.

***C. palisotii** Schwaegr.: Wangi Road, Walker Creek, 68 Km SSW of Darwin, *H. Streimann 8810* (CBG). Previous record (Stone 1982) as *C. moluccense* Schwaegr. (a synonym) was due to misidentification; it is *C. erosum* (q.v.). Also in Qld.

***Mitthyridium flavum** (C. Müll.) Robins: Melville Island, Jump-Up Jungle, monsoon forest, on tree, *J. Russell-Smith 1300*, 11.xi.1983, DNA 25919. Also in Qld. Reported for Australia by Reese *et al.* (1986).

***Syrrhopodon spiculosus** Hook. & Grev.: Kakadu N.P. near Anbangbang Billabong, Nourlangie Rock, *J.R. Smith 134*, 11.vi.1981, CANB 334637; source of the Barramundie Creek, S of Kakadu, *J.R. Smith 128*, 9.x.1981, CANB 334643. Although of different habit, *Smith 134* being tall and lax, these are the same species. Katherine Gorge, on seepage wall, *I.G. Stone 23323*, 13.vi.1984; Kakadu N.P., cave at base of Barramundie Falls, *I.G. Stone 23466*, 30.vi.1985. Also in Qld. Reported for Australia by Mohamed & Reese (1985).

Pottiaceae

Acaulon crassinervium C. Müll.: Recorded by Stone (1985). Also in W.A., S.A., Vic., N.S.W. and Qld.

A. eremicola Stone. Type from Mt Olga, Stone (1979). Also in W.A. and S.A.

#**A. robustum** Broth. ex Roth.: Reported by Stone (1979) as like a papillose *A. robustum*, to be deleted as the specimen is *A. crassinervium.*

A. triquetrum (Spruce) C. Muell.: Recorded by Stone (1979). Also in all other States except Tas.

Barbula calycina Schwaegr.: Recorded by Willis (1957) from Finke River, Palm Valley, as *Tortella calycina* (Schwaegr.) Dixon. Occurs in W.A., S.A., Vic., Tas., N.S.W. and A.C.T.

***B. crinita** Schultz: The Amphitheatre, near Palm Valley, *Marie Allender*, 27.viii.1960, MEL 102240; as *B. pseudopilifera* C. Müll. & Hampe (a synonym). Occurs in W.A., S.A., Vic., Tas., N.S.W. and A.C.T.

***B. indica** (Hook.) Spreng. in Steud.: Kakadu N.P., E. Alligator River, monsoon forest, *I.G. Stone 23344*, 23.vi.1985; Berry Springs, W. of Stuart Hwy, *A.C. Beauglehole 13849*, 23.vii.1965, MEL 1038707, as *Tortella calycina* (Schwaegr.) Dix. Also in W.A. and Qld.

***B. subcalycina** C. Müll.: Trephina Gorge, *A.C. Beauglehole 24391*, 30.vii.1967, MEL 1038392. In all States.

***Bryoerythrophyllum binnsii** (R. Br. ter.) Wijk & Marg.: Kakadu N.P., E. Alligator River, *L.A. Craven 6145B*, 30.v.1980, CANB 303391. Also in W.A., S.A. and Vic.

***Crossidium davidai** Catcheside: 5 km north of Alice Springs, *A.C. Beauglehole*, 3.viii.1967, MEL 24473, as *C. geheebii*; The Olgas, *A.C. Beauglehole 25794*, 4.vii.1968, MEL 1038534, as *Tortella*; N'Dahla Gorge, E. of Alice Springs, *A.C. Beauglehole 24429*, 30.vii.1967, MEL 1038522, as *Tortula princeps.* Also S.A. and W.A.

†**Crossidium geheebii** (Broth.) Broth. Listed as probable by Scott & Stone (1976). Ochre Pits, west of Alice Springs, *A.C. Beauglehole*, 26.vii.1967, MEL 1038628. Occurs in W.A., S.A. and Vic.

Desmatodon convolutus (Brid.) Grout: Recorded by Willis (1957). Mount Conner, *P.G. Martin*, 15.vi.1953 (Herb. D.G.C.); Palm Valley, near Hermannsburg, *D.G. Catcheside 76.321*, 13.xi.1976; Kings Canyon, George Gill Range, *D.G. Catcheside 76.313*, 10.ix.1976. All States.

Didymodon torquatus (Tayl.) Catcheside. Recorded by Willis (1958) as *Barbula torquata* Tayl. Also in W.A., S.A., Vic., Tas., N.S.W. and A.C.T.

***Gymnostomum calcareum** Nees: Ormiston Gorge, *A.C. Beauglehole*, 10.vii.1975, MEL 1037965. In all States.

Gymnostomum calcareum Nees var. **longifolium** Dixon: Recorded by Willis (1955). Also in N.S.W.

Hyophila involuta (Hook.) Jaeg.: Recorded by Stone (1982). Darwin, *H. Streimann 8734*, 24.xii.1984 (CBG); Manton Dam, *H. Streimann 8737*, 26.xii.1984; Kakadu N.P., Obiri Rock, *I.G. Stone 16236 p.p.*, 26.vii.1980. Also in W.A. and Qld.

***H. rosea** Williams: Kakadu N.P., Kuna, *H.S. Thompson 390*, v.1983. Also in W.A.

***Pottia brevicaulis** (Tayl.) C. Müll.: Standley Chasm, *A.C. Beauglehole 27614*, 27.vii.1968, MEL 1037565; The Olgas, *A.C. Beauglehole 22951*, 30.vi.1967, MEL 1037702, both as *Weissia willisiana* Sainsbury. Also in W.A., S.A., Vic. and N.S.W.

P. latzii Catcheside: Mount Giles, *P.K. Latz 6604d*, 19.ix.1976 (Herb. D.G.C., type).

Pottia scabrifolia Bartram: *P.K. Latz 5639c*, (Herb. D.G.C.). Also in W.A. and S.A.

Tetrapterum cylindricum (Tayl.) Jaeg.: Queried by Scott & Stone (1976) as doubtful. Occurs in W.A., S.A., Vic., Tas., N.S.W. and Qld.

***Tortula pagorum** (Milde) De Not: Standley Chasm: *A.C. Beauglehole 23663*, 13.vii.1967, MEL 1038679, King's Canyon, George Gill Range, *A.C. Beauglehole 23193*, 5.vii.1967, MEL 1038687; Ayers Rock, *A.C. Beauglehole 25874*, 5.vii.1968, MEL 1038580, all as *Tortula princeps*; Ooraminna Rock Hole, 40 km S of Alice Springs, *A.C. Beauglehole 27720*, MEL 1038341. Also in W.A., S.A., Vic. and N.S.W.

***Trichostomum brachydontium** Bruch: Standley Chasm, *D.G. Catcheside 76.319*, 12.ix.1976; Palm Valley, near Hermannsburg, *D.G. Catcheside 76.320*, 13.ix.1976; Palm Valley, *J.H. Willis s.n.*, 16.ix.1965 (MEL 1023855); George Gill Range, Kings Canyon, *A.C. Beauglehole 26472*, 10.vii.1968 (MEL 1038478). New to Australia. Also in S.A. (as *T.* species A, see Catcheside 1980), N.S.W. and Qld.

***T. crispulum** Bruch: Amphitheatre near Palm Valley, near Hermannsburg, *Winifred M. Curtis*, .viii.1954 (MEL 1023874), also *Marie Allender*, 27.viii.1960, (MEL 1022439) as *B. pseudopilifera* C. Müll & Hampe; Hanns Range, S. of Aileron, *A.C. Beauglehole 24499*, 3.viii.1967 (MEL 1038561). New to Australia.

All Australian specimens of these two species of *Trichostomum* are sterile, but are vegetatively like exotic specimens, certainly within the range of variation.

Weissia willisiana (Sainsbury) Catcheside: Type (as *Pottia willisiana*) from Standley Chasm, MacDonnell Ranges.

Funariaceae

#Funaria apophysata (Tayl.) Broth.: Recorded by Willis (1957), but deleted by Willis (1958) as being a mixture of "*F. glabra*" and *F. gracilis*.

#F. gracilis (Hook. f. & Wils.) Broth.: Recorded by Willis (1958), but both collections are *F. helmsii* Broth. & Geh. according to Willis (1964, in litt.).

F. helmsii Broth. & Geh.: Ross River area, on bank of Bitter Springs River, *D.G. Catcheside 76.329 p.p.*, 16.ix.1976; Chewing Range, *P.K. Latz 6604b*, 19.ix.1976 (Herb. D.G.C.); Mount Olga, *P.G. Martin 1099*, vi.1953 (Herb. D.G.C.), also *I.G. Stone 5131*, 13.vi.1977. Also in W.A., S.A. Vic. and N.S.W.

F. hygrometrica Hedw.: Willis (1957). Finke River, coll. *H. Kempe*, 1882, det. F. von Mueller, MEL 1023867. Alice Springs, *P.K. Latz & D.G. Catcheside 76.324*, ix.1976; Mount Giles, *P.K. Latz 6614b p.p.*, 20.ix.1976 (Herb. D.G.C.). In all States.

F. muhlenbergii Turn. (syn. *F. glabra* Tayl.): bank of Bitter Springs River, E. of Alice Springs, *D.G. Catcheside 76.329*, 16.ix.1976; Valley of Eagles, *A.C. Beauglehole 20944*, ix.1966, MEL 1037518 as *F. glabra*. Formerly recorded as *F. glabra*. Occurs in W.A., S.A., Vic., N.S.W. and A.C.T.

***F. radians** Hedw. (syn. *F. acaulis* Hampe.): Ormiston Gorge, *A.C. Beauglehole 13724*, 10.vii.1965, MEL 1037968; George Gill Range, Reedy Creek Rock Hole, *A.C. Beauglehole 20938*, 10.x.1967, MEL 1037890; Serpentine Gorge, *A.C. Beauglehole 24320*, 27.vii.1967, MEL 1038775, all as *F. glabra*. New to Australia. Occurs in W.A., S.A., Vic., N.S.W. and A.C.T.

***F. subnuda** Tayl.: Chewings Range, 23.42S x 133.19E, *P.K. Latz s.n.*, 26.v.1977, in herb. *I.G. Stone 5098*. Also in W.A. and S.A.

Goniomitrium acuminatum Hook. f. & Wils.: Alice Springs, *H.A. Morrison*, 17.vi.1974, MEL 1024235; Serpentine Gorge, on rock above waterline, *I.G. Stone 814*, 20.viii.1968; Olga Gorge, on earth near spring, *I.G. Stone 5133*, 13.vi.1977; Standley Chasm, *D.G. Catcheside 76.316*, 12.ix.1976; Palm Valley, *A.C. Beauglehole*, 27.vii.1968. Also in W.A., S.A., Vic., N.S.W., A.C.T. and Qld.

***G. enerve** Hook. f. & Wils.: near Kunoth Well, *D. Nelson 2307*, 15.viii.1973 (NT). Also W.A., S.A., Vic. and A.C.T.

Gigaspermaceae

***Gigaspermum repens** (Hook.) Lindb.: Ayers Rock, at base, *A.C. Beauglehole*, 5.vii.1968, MEL 1038365 p.p.; Palm Valley, *A.C. Beauglehole*, 24.vii.1968, MEL 1038501; George Gill Range, Wallaby Gorge area, *A.C. Beauglehole*, 11.vii.1968, MEL 103851. In all States.

Ephemeraceae

Ephemerum cristatum Hook. f. & Hook. f. & Wils.: Stone (1982); Ayers Rock, *A.C. Beauglehole*, 29.vi.1967, MEL 1037691. Also in W.A., S.A., Vic., Tas., N.S.W. and Qld.

Splachnobryaceae

***Gymnostomiella vernicosa** (Hook.) Fleisch.: Cape Beach on Cape Arnhem, S of Gove, *J. & J. Eurell 78/39*, 15.vii.1978, CBG 7810560. Also in Qld (Stone 1985).

Splachnobryum baileyi Broth.: Stone (1982). Also in Qld.

***S. indicum** Hampe & C. Müll.: Darwin, Fannie Bay; *H. Streimann 8829*, 3.i.1985 (CBG). New to Australia.

***S. geheebii** Fleisch.: Kakadu N.P., E. Alligator River, monsoon forest, *I.G. Stone 23343*, 23.vi.1985. The cells are smaller than in *S. oorschotti* (Lac.) C. Müll. but the toothing of the margin matches that species. New to Australia.

The following key may serve to distinguish the species in northern Australia:

1. Leaves concave, margin narrowly recurved from base to mid-leaf usually on one side; costa to ca 40 μm wide and 4 cells deep, begleiter cells present 2

   Leaves concave to flat, sometimes sinuous to undulate; margin not recurved; costa weaker to 20 μm wide and shallower, with no begleiter cells 3

2. Cells mostly 15-18 μm wide, margin mostly entire .... *S. baileyi*

   Cells smaller, 8-10 μm wide, margin crenulate at apex .... *S. indicum*

3. Apex rounded or obtuse, not recurved 4

   Apex of leaf often recurved, sometimes with a throat-like constriction, cells 10-12 μm wide ...... *S. wiemansii*

4. Margin toothed above, cells about 15 μm wide .... *S. oorschotti*

   Margin deeply crenulate above, cells smaller, 9-12 μm wide .... *S. geheebii*

Bryaceae

Brachymenium exile (Dozy & Molk.) Bosch & Lac.: Streimann & Touw (1981).

B. preissianum (Hampe) Jaeg.: F. von Mueller (Mitten 1883); with *Funaria hygrometrica*, Finke River, *H. Kempe*, 1882, MEL 1023867. In all States.

Bryum argenteum Hedw.: Willis (1957). Top of Ayers Rock, *P.G. Martin 1127c*, 14.vi.1953; Mount Conner, *P.G. Martin*, 15.vi.1953 (Herb. D.G.C.); Mount Olga Gorge, *D.G. Catcheside 76.311*, 8.ix.1976; also *I.G. Stone 5140*, 13.vi.1977, George Gill Range, Kings Canyon, *A.C. Beauglehole*, 2.vii.1965, MEL 1037546. In all States.

B. caespiticium Hedw.: Kakadu N.P., *L.A. Craven 6145A*, 30.v.1980, CANB 303390. Also S.A., Vic., Tas. and A.C.T.

B. capillare Hedw.: Mount Giles, *P.K. Latz 6614b p.p.*, 20.ix.1976 (Herb. D.G.C.). In W.A., S.A., Tas., N.S.W. and A.C.T.

B. dichotomum Hedw.: Alice Springs, *P.K. Latz & D.G. Catcheside 76.326*, 15.ix.1976; Mount Giles, *P.K. Latz 6623b p.p.*, 21.ix.1976; top of Ayers Rock, *P.G. Martin 1102*, 12.vi.1953; Standley Chasm, *D.G. Catcheside 76.318*, 12.ix.1976; Mt Conner, *J.H. Willis*, 17.vi.1974, MEL 1039543. In all States.

B. pachytheca C. Müll.: J.H. Willis (1957). There is some uncertainty about the identity of this material. In all States.

B. radiculosum Brid.: Mount Giles, *P.K. Latz 6614b p.p.*, 20.ix.1976 (Herb. D.G.C.).

***Leptobryum pyriforme** (Hedw.) Wils.: Arid Zone Research Institute, Alice Springs, *P.K. Latz 5639d*, 19.vii.1974. Also S.A., Vic., Tas. and N.S.W.

***Pohlia wahlenbergii** (Web. & Mohr.) Andrews: Darwin, *H. Streimann 8773*, 29.xii.1984. In Tas, Vic., N.S.W. and A.C.T.

Bartramiaceae

Philonotis tenuis (Tayl.) Reichdt.: Willis (1955); George Gill Range, Reedy Rock Hole, above fall, *A.C. Beauglehole*, 10.x.1966, MEL 1037898. In all States.

***P. hastata** (Dub.) Wijk & Marg.: Katherine Gorge N.P., Edith Falls, *J. Eurell 4*, 19.vi.1977, CBG 7707719. Also Qld.

Erpodiaceae

***Erpodium australiense** Stone: Abandoned silver mine near Moline, *J.R. Smith 115*, 10.x.1981, CANB 334650; E side of S Alligator River, near Jabiru Bridge, *J.R. Smith 117*, 23.ix.1981, CANB 334667 (with *Calymperes tenerum*). Also W.A. and Qld.

E. biseriatum (Aust.) Aust.: Recorded by Stone (1985). Although superficially like the Australian endemic *Wildia solmsiellacea* C. Müll. & Broth., it differs vegetatively in the papillae on the leaf cells being simple or only slightly compound. *Wildia* has larger, C-shaped papillae. Nourlangie Rock, Kakadu, *J. Russell-Smith 106*, CANB 334663, has no sporophytes. Distribution highly disjunct.

Entodontaceae

***Trachyphyllum inflexum** (Harv.) Gepp: Widely spread in Kakadu N.P. in rainforest; near Kapalga Billabong, *L.A. Craven & G. Whitbread 6824*, 18.iii.1981, CANB 334672; Koolpin Gorge, *J.R. Smith 133*, CANB 3346531; Kakadu N.P., near Nourlangie Safari Camp, *M. Lazarides & L. Adams 302*, 23.iii.1965, CANB and MEL 1519433; Petherick's rainforest, SSW of Darwin, *I.G. Stone 23481*, 3.vi.1985. Also in W.A. and Qld.

Sematophyllaceae

***Sematophyllum caespitosum** (Hedw.) Mitt.: Kakadu N.P., 6.5 km SE of Jim Jim Falls, *L.A. Craven 5809*, CANB 303379; Katherine Gorge N.P., Edith Falls, *L.A. Craven 6763*, 8.iv.1981, CANB 303373; Nourlangie Creek, *J. Heaton*, x.1959, ex herb. J.H. Willis as *Isopterygium*. Also Qld.

Taxithelium nepalense Fleisch.: Stone (1982). Petherick's rainforest, SSW of Darwin, *I.G. Stone 23485 p.p.*, 3.vii.1985. Also in Qld.

***T. instratum** (Brid.) Broth.: "Black Jungle", 10 km E of Humpty Doo, *J.R. Smith 139*, 20.viii.1981, CANB 334649. Also Qld.

***T. kerianum** (Broth.) Fleisch.: Berry Springs, 30 km SE of Darwin, *H. Streimann 8833*, 3.i.1985 (CBG). Also Qld.

***Wijkia** sp.: Kakadu N.P., Nourlangie Rock, *J.R. Smith 110*, 30.ix.1981, CANB 334668. This may be *W. hornschuchii* (Dozy & Molk.) Crum, but the points of the leaves are rather short. If it is this species, it is new to Australia.

Hypnaceae

***Isopterygium minutirameum** (C. Müll.) Jaeg.: Kakadu N.P., about 10 km SE of Jabiru, *L.A. Craven & G. Whitbread 6801*, 25.iii.1981, CANB 303354; Kakadu N.P., Nourlangie Rock, *J.R. Smith 108*, 28.ix.1981, CANB 334670; Radon Gorge, Mt Brockman, *J. Russell-Smith 138 p.p.*, 10.vii.1981, CANB 334635. Also N.S.W. and Qld.

Isopterygium sp.: Wangi Road, Walker Creek, 68 km SSW of Darwin, *H. Streimann 8814*, (CBG); Emerald River, Groote Eylandt, *D.H. Ashton s.n.*, 19.v.1979 (MELU).

Acknowledgements

One of us (I.G.S.) thanks the Australian Biological Resources Study for a grant in support of the work, the Director (Professor J.D. Ovington) of the Australian National Parks and Wild Life Service for a permit to visit Kakadu National Park and especially the Officers there for much assistance and Mr Alex Wood, Ranger at Katherine Gorge National Park.

References

Brotherus, V.F. (1924). Die Natürlichen Pflanzenfamilien. Teil 1, Bd 10. (Engelmann: Leipzig).

Catcheside, D.G. (1958). In R.L. Specht and C.P. Mountford (eds). Records of the American-Australian Scientific Expedition to Arnhem Land, Vol. 3, p. 169.

Catcheside, D.G. (1980). Mosses of South Australia. (Govt Printer: Adelaide).

Fleischer, M. (1904). Die Musci der Flora von Buitenzorg 1. (E.J. Brill: Leiden).

Magill, R.E. (1981). Flora of Southern Africa: Bryophyta, Part 1, Mosses, Fascicle 1. (Republic of South Africa).

Mitten, W. (1883). Australian Mosses. *Trans. Proc. Roy. Soc. Victoria* 19: 49-96.

Mohamed, H. & Reese, W.D. (1985). *Syrrhopodon* (Musci: Calymperaceae) in Malaysia and adjacent regions. *The Bryologist* 88: 223-254.

Mueller, F. von (1864). Analytical Drawings of Australian Mosses. (Govt Printer: Melbourne).

Mueller, F. von (1880). Fragmenta Phytographiae Australiae. Vol. 11, Supplement 3. (Govt Printer: Melbourne).

Reese, W.D. & Mohamed, H. (1985). A synopsis of *Calymperes* (Musci: Calymperaceae) in Malaysia and adjacent regions. *The Bryologist* 88: 98-109.

Reese, W.D. & Mohamed, H. & Mohamed, A.D. (1986). A synopsis of *Mitthyridium* (Musci: Calymperaceae) in Malaysia and adjacent regions. *The Bryologist* 89: 49-58.

Scott, G.A.M. & Stone, I.G. (1976). The Mosses of Southern Australia. (Academic Press: London, New York, San Francisco).

Snider, J.A. (1975). A revision of the genus *Archidium* (Musci). *Jl Hattori bot. Lab.* 39: 105-201.

Stone, I.G. (1979). *Acaulon eremicola*, a new moss from the Australian arid zone. *Jl Bryol.* 10: 467-474.

Stone, I.G. (1982). Some new and noteworthy records of mosses mostly from Queensland, Australia. *Austrobaileya* 1: 511-520.

Stone, I.G. (1985). New records of mosses in Australia. *Jl Bryol.* 13: 475-478.

Streimann, H. & Touw, A. (1981). New records for some Australian mosses. *Jl Hattori bot. Lab.* 39: 105-201.

Thériot, I. (1922). Le problème du *Leucobryum candidum*. *Bull. Soc. Bot. Genève Ser* 2, 13: 217-225.

Willis, J.H. (1955). New and interesting moss records for Australia. *Victorian Naturalist* 72: 73-78.

Willis, J.H. (1957). New records of mosses for Australian States. *Victorian Naturalist* 74: 101-105.

Willis, J.H. (1958). Additional notes on Northern Territory Mosses. *Victorian Naturalist* 75: 189.

J. Adelaide Bot. Gard. 11(1): 19-49 (1988)

REVISION OF THE CASSIINAE IN AUSTRALIA. 1. *SENNA* MILLER SECT. *CHAMAEFISTULA* (COLLADON) IRWIN AND BARNEBY

B.R. Randell

Department of Botany, the University of Adelaide,
G.P.O. Box 498, Adelaide, S.A. 5001

Abstract

Information is presented supporting the division of *Cassia* L. into three genera, and as a result sect. *Chamaefistula* is treated within *Senna* Miller. Nine species are shown to have been introduced to Australia. The endemic taxa have been revised and are now recognised as three species, one of which has been raised from varietal rank. New combinations are provided for *Senna barclayana* (Sweet) Randell, *Senna clavigera* (Domin) Randell and *Senna planitiicola* (Domin) Randell.

I. Introduction

This is the first in a series of papers in which it is hoped to revise all the members of the Cassiinae (i.e. *Cassia* L. sens. lat.) which are known to occur in Australia.

Irwin and Barneby (1982) raised the genus *Cassia* L. sens. lat. to the level of subtribe, and elevated the previous subgenera to generic rank. They thus reinstated *Senna* Miller and *Chamaecrista* Moench. Included here is a list of the characters on which that decision was based, together with a statement of the reasons for its acceptance here.

This paper deals with *Senna* sect. *Chamaefistula* comprising 12 species recorded in Australia, but only 3 of these are native. Of the remainder 5 are cultivated garden plants, some of which have become naturalised, and 4 are known only as weeds.

There are few taxonomic problems among these species. Names have been misapplied among the cultivated plants and this situation is clarified. In eastern Australia, there has been some confusion involving the two varieties of *S. barclayana*, and this has been resolved by preparing a new circumscription of the type variety and recognising a second species.

In this paper no attempt has been made to give full synonymy for the American species, as these details are available in Irwin and Barneby (1982). However, all names known to have been used in Australia are included.

II. THE GENUS *CASSIA*

1. Introduction

The genus *Cassia* L. is the largest genus in the subfamily Caesalpinioideae of the Leguminosae, and is probably one of the twentyfive largest genera of dicotyledons (Irwin and Turner 1960). The first comprehensive review of the genus was made by Colladon (1816), followed by Vogel (1837). A major revision was published by Bentham (1871), with the Malesian species treated by De Wit (1955) and African species by Brenan (1967). Australian species were revised by Symon (1966). Over many years, American species have been closely studied by Irwin and co-workers Turner and Barneby (e.g. Irwin and Turner 1960; Irwin and Barneby 1976a, 1976b, 1982).

In discussions of the taxonomy of the Caesalpinioideae, Cowan (1981), and Polhill and Vidal (1981) have shown that *Cassia* L. sens. lat. is in fact recognised by the absence of a number of characters. In the Caesalpinioideae, numerous small natural groups (tribes and subtribes) have each been defined by a few conspicuous morphological characters (Table 1). The residuum of species is recognised as *Cassia* L. sens. lat., even though the only characters common to all species are those which are important at the family or subfamily level, i.e. 5-merous, more or less zygomorphic flowers; single carpel; paripinnate leaves. A very great range of variation is accepted in all other characters in, e.g. plant habit; number of leaflet pairs; size of leaflets; number and arrangement of foliar and other extrafloral glands; root nodulation; form and venation of sepals; colour of petals; number and dehiscence of fertile anthers; length and arrangement of anther filaments; characteristics and dehiscence of legumes; seed funicle structure etc.

In these circumstances, it is highly unlikely that *Cassia* sens. lat. represents a single evolutionary line.

Table 1. Characters used in the delimitation of tribes and subtribes of the subfamily Caesalpinioideae (data from Cowan 1981 and Polhill and Vidal 1981).

Character	Taxon so defined	Conditions in subtribe Cassiinae
	Tribe	
Sepals fused to hypanthium	**Cercideae**	Sepals never fused
Hypanthium tubular or long and infilled	**Caesalpinieae** **Detarieae** **Amherstieae**	Hypanthium not tubular, nor long and infilled
Anthers opening by long slits	**Caesalpinieae**	Anthers opening by pores or short slits
Leaves bipinnate, or imparipinnate, or simple by reduction	**Caesalpinieae**	Paripinnate, very rarely phyllodinous by reduction
Leaves palmately lobed	**Cercideae**	Leaves never palmate
Stipules intrapetiolar	**Detarieae** **Amherstieae** Other subtribes of tribe Cassieae	Stipules never intrapetiolar
Pod drupaceous or indehiscent and winged	**Dialiinae**	Pod never drupaceous nor both indehiscent and winged
Flowers apetalous, usually dioecious	**Ceratoniinae**	Flowers with petals, hermaphrodite
Stamens fused into a synangium	**Duparquetiinae**	Stamens free
Androecium of 2-3 anthers	**Labicheinae**	Androecium of 5, 6, 7 or 10 anthers.

2. The lectotype of *Cassia* L.

The current lectotype, *C. fistula* L., chosen by Britten and Brown (1913) and accepted by the International Botanical Congress (1930), agrees with the protologue descriptions of calyx, corolla, pistil, fruit and seed. However, it does not agree with the detailed description of the anthers, as the three large abaxial anthers of *C. fistula* are not beaked, are not larger than the laterals, are on filaments which are sigmoidally curved not arcuate, and are dehiscent by both basal and apical pores (see e.g. Irwin and Barneby 35: 64, (1982). There is thus a conflict between the protologue, which describes the androecium of *Senna* Miller, and the current lectotype, *C. fistula*.

However, it is clear that Linnaeus (1737) intended to apply the name *Cassia* in the sense of *C. fistula*. Almost all later workers (e.g. Colladon, 1816; Vogel 1837; Bentham 1871; De Wit 1955; Brenan 1967; Symon 1966) have also used the name in the sense of *C. fistula*. In the interests of stability, it has been proposed that the genus *Cassia* be conserved with the currently accepted lectotype, *C. fistula*. A manuscript embodying this proposal has been accepted for publication (Randell, *Taxon*, in press).

3. Earlier taxonomic treatments

The protologue of *Cassia* L. (1737, 1754) makes it clear that Linnaeus included within the one genus plants that had previously been placed in at least three separate genera, i.e. *Cassia*, *Senna* and *Chamaecrista*. In this decision Linnaeus disagreed with a long herbal tradition.

Matthiolus (1554) and Dodonaeus (1553) (both cited in De Wit 1955), and Miller (1754) all recognised two entities, 'cassia' with long woody indehiscent pods whose pith was used as a purgative, and 'senna' with short flat dehiscent pods and associated leaves, also used as a purgative.

Breyne (1678) described several species in 'cassia', 'chamaecassia' (equivalent to 'senna') and 'chamaecrista'. He was obviously convinced that the entities were different.

Tournefort (1700) maintained herbal practice by using both names 'cassia' and 'senna', but Linnaeus, while acknowledging his debt to Tournefort, used *Cassia* for the whole group and reduced both 'senna' and 'chamaecrista' to synonymy (1753, 1754).

Linnaeus' decision was not universally adopted, e.g. Miller (1754) chose to continue to use the name *Senna* for the plant which had always carried that name in herbals. He was followed in many details by Garsault (1769), Gaertner (1791) and Roxburgh (1832). On the other hand, Lamarck (1785), Colladon (1816), Vogel (1837), Bentham (1871) and most modern workers followed Linnaeus.

One of the strongest arguments in favour of Linnaeus' approach was the absence of known characters which would always separate the three subgroups whose presence within *Cassia* sens. lat. was acknowledged by virtually all workers. For example Bentham (1871) based his classification on pod structure. However, structure of the pods does not always correlate well with other important characters, e.g. of the androecium, and his classification was not entirely satisfactory.

Success in the delimitation of the subgroups was achieved when Irwin and Barneby (1982) recognised the suite of characters listed in Table 2. These primarily concern the androecium and are illustrated in Plate 1. Correlations between the characters are very strong and persist in the Americas (Irwin and Barneby 1982), in India (Roxburgh 1832), in Africa (Brenan 1967) and Australia (Randell, unpublished).

Table 2. Characters defining the three genera recognized by Irwin and Barneby (1982).

	Cassia	Senna	Chamaecrista
Androecium	Bilaterally symmetrical	Bilaterally symmetrical	Never bilaterally symmetrical
	Lower whorl sigmoidally elongate	Upper whorl elongate, not sigmoidally	Never elongate
	All versatile	None versatile	None versatile
	Some basal pores	All apical pores	All apical pores
	Never beaked	Sometimes some beaked	Never beaked
Pods	Woody indehiscent	Flattened dehiscent (Or terete, pithy) (Or woody indehiscent but then leaf glands present)	Elastically dehiscent
Leaf glands	Absent	Present or absent	Present or absent
Inflorescence	Terminal	Axillary	Axillary
Floral bracteoles	Present	Absent	Present
Root nodules	Absent	Absent	Sometimes present

As it is considered unlikely that *Cassia* sens. lat. represents a single evolutionary line (see above), and the subgroups within it are separated by a suite of significant characters which are strongly correlated over wide geographic areas, the three subgroups are considered as separate genera in the revision which follows.

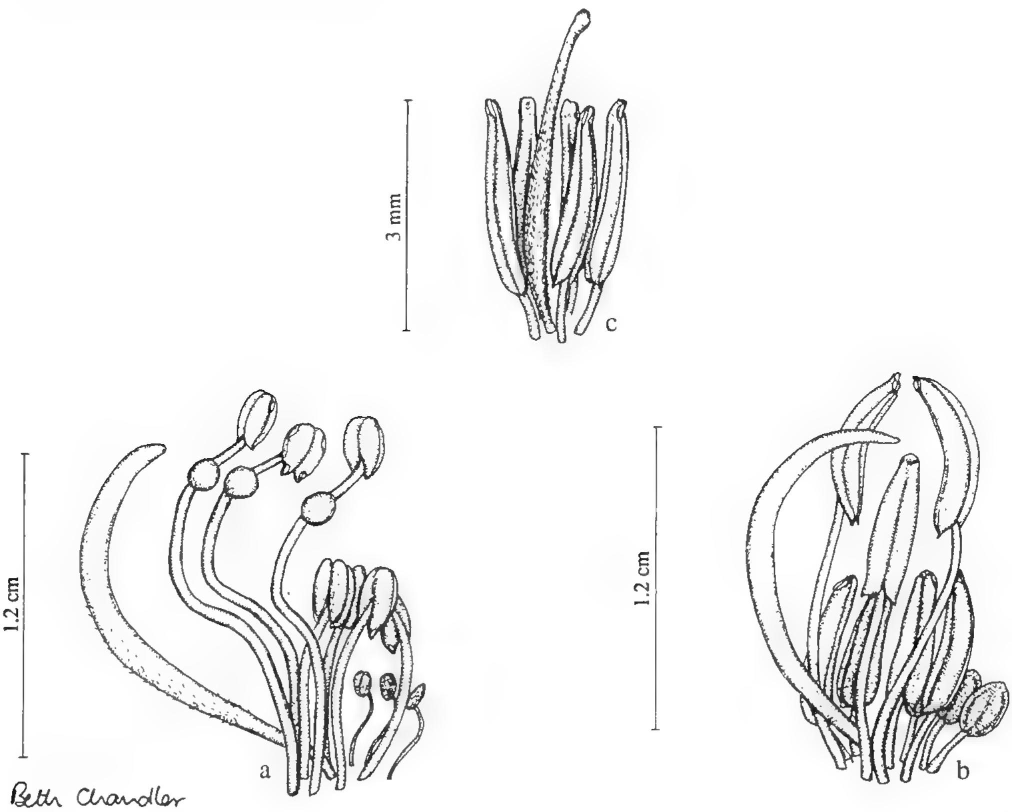


Plate 1. a, androecium of *Cassia brewsteri* (from *Messner s.n.*, ix.1962 AD); b, androecium of *Senna* × *floribunda* (from *Ashby 2829*, AD); c, andreocium of *Chamaecrista* sp. (from *Latz 60*, AD).

4. Key to the genera of subtribe *Cassiinae*

1. Androecium not zygomorphic; sepals acute; floral bracteoles 2; pod elastically dehiscent, the valves coiling spirally .... *Chamaecrista*

1. Androecium weakly to very strongly zygomorphic; sepals obtuse; floral bracteoles 0 or 1; pod never elastically dehiscent:

    2. Inflorescences terminal; floral bracteole 1; longest anther filaments sigmoidally curved; anthers versatile, some dehiscent by both basal and apical pores, never beaked; pods cylindrical woody and indehiscent; leaves eglandular .... *Cassia*

    2. Inflorescences axillary; floral bracteole 0; longest anther filaments arcuate; anthers basifixed, dehiscent only by apical pores, sometimes beaked; pods variable, flat or cylindrical, with coriaceous valves and dehiscent, or cylindrical woody and indehiscent (but then leaves glandular); leaves glandular or not .... *Senna*

III. SENNA

Senna Miller, *Gard. Dict. Abr. edn 4*, vol. 3. (1754). Gaertner, *Fruct. sem. pl.* 2, 312 (1791); Link, *Handbuch* 2:139 (1831); Roxb., *Fl. Ind. ed. Carey*, 2:339 (1832); Irwin and Barneby, *Mem. New York Bot. Gard.* 35:64 et seq. (1982).

Lectotype: "Senna Alexandrina sive foliis acutis C(aspar) B(auhin) P(inax 397)", equivalent to *Senna alexandrina* Miller 1768. Fide Irwin and Barneby, *Mem. New York Bot. Gard.* 35:64, (1982).

Synonyms and selected bibliography

1. *Cassia* sensu Persoon, *Syn. pl.* 1:459 (1805); Willdénow, *Enum. pl. horti Berol.* :439 (1809), non L.

2. *Cassia* L. sect. *Senna* (Miller) DC. ex Colladon, *Hist. nat. méd. Casses* 92 (1816); Benth. in Bentham and Hooker, *Gen. pl.* 1:139 (1865).

3. *Cassia* L. subgen. *Senna* (Miller) Benth. in Martius, *Fl. Bras.* 15:96 (1870); Benth., *Trans. Linn. Soc. London* 27:513 (1871); Symon, *Trans. Roy. Soc. S. Australia* 90: 76 (1966).

Characteristics of the genus

Anthers basifixed, several of the upper whorl on longer arcuate (never sigmoidal) filaments, all truncate or sometimes some produced into beaks, all ten fertile or more often seven abaxial fertile and three adaxial reduced to staminodes, opening only by apical pores or short slits; floral bracteoles absent; pods flat or cylindrical with coriaceous valves and opening by slow degeneration (never elastically dehiscent) or rarely cylindrical and indehiscent (but then leaves always with rachis glands); seed funicles filiform; root nodules absent (Table 2).

Key to the sections and series of *Senna* Miller in Australia

1. Pods cylindrical with pith; leaves always glandular .... 1. sect. *Chamaefistula*
    2. Glands at base of petiole .... 1b. ser. *Basiglandulosae*
    2. Glands between leaflet pairs:
        3. Shrubs; leaflets (3-) 4-6 pairs; seeds without areoles .... 1a. ser. *Coluteoideae*
        3. Herbs; leaflets 1-3 pairs; seeds with areoles .... 1c. ser. *Trigonelloideae*
1. Pods cylindrical and leaf rachis eglandular, or pods flat:
    4. Fertile anthers 7 often beaked; 2 or 3 abaxial anthers markedly larger and borne on filaments often elongate and widely divergent; leaf rachis usually without glands .... 2. sect. *Senna*
    4. Fertile anthers 10 (rarely 7), truncate, subequal; filaments short, straight, 3 abaxial barely elongate; leaf rachis with glands between leaflet pairs......................... 3. sect. *Psilorhegma*

Notes

1. The sections *Senna* and *Chamaefistula* are separated by Irwin and Barneby (1982) primarily on the disposition of the long abaxial anther filaments — whether parallel with (sect. *Chamaefistula*) or perpendicular to (sect. *Senna*) the plane of floral symmetry. While this character is clear in fresh flowers it is almost impossible to determine in dried materials, making identification of herbarium specimens difficult. The above key therefore makes use of correlated characters, to allow the identification of species likely to be encountered in Australia.

2. Ser. *Florideae* was placed in sect. *Chamaefistula* by Irwin and Barneby (1982), solely on the disposition of its anther filaments, (i.e., without obvious correlated characters). It is considered that this places unacceptable weighting on a single character. In this revision, ser. *Florideae* will be treated as part of sect. *Senna*, thus following Bentham (1871). Identification of characters correlated with anther filament disposition would reverse this decision.

1. *Senna* sect. *Chamaefistula*

Senna Miller sect. **Chamaefistula** (Colladon) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:82 (1982).

Lectotype: *Cassia coluteoides* Colladon, *Hist. nat. méd. Casses* 102, t. 12 (1816) fide Irwin and Barneby op. cit p. 382, a synonym of *Senna pendula* (Willd.) Irwin and Barneby var. *glabrata* (J. Vogel) Irwin and Barneby, op. cit. p. 382.

Note: Irwin and Barneby (loc. cit. p. 82) designated ser. *Coluteoideae* as the type of the section. Hence the lectotype of that series must also be the lectotype of the whole section. The species in question is *Cassia coluteoides* Colladon not, as suggested by Irwin and Barneby (loc. cit. p. 82) *Cassia corymbosa* Lam.

Selected synonyms and bibliography

1. *Cassia* L. sect. *Chamaefistula* DC. ex Colladon, *Hist. nat. méd. Casses* 21 (1816).

Description

Defined by Irwin and Barneby (1982) as having the characteristics of the genus and in addition, the two long abaxial filaments parallel to or at a small angle from each other, and in the plane of symmetry of the zygomorphic androecium. In addition, Australian species have acicular caducous stipules, glandular leaf rachises, and cylindrical pithy pods with coriaceous valves.

1a. Ser. *Coluteoideae*

Senna Miller [sect. *Chamaefistula* (Colladon) Irwin and Barneby] ser. **Coluteoideae** (Colladon) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:345 (1982).

Lectotype: *Cassia coluteoides* Colladon, *Hist. nat. méd. Casses* 102, t. 12 (1816), a synonym of *Senna pendula* (Willd.) Irwin and Barneby var. *glabrata* (J. Vogel) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:382 (1982).

Selected synonyms and bibliography

1. *Cassia* L. sect. *Chamaesenna* Colladon ser. *Coluteoideae* Colladon, *Hist. nat. méd. Casses* 98 (1816).

2. *Cassia* L. sect. *Senna* (Miller) Colladon subsect. *Chamaefistula* (Colladon) Benth. in Benth. & Hooker, *Gen. pl.* 1, 572 (1865).

3. *Cassia* L. subgen. *Senna* (Miller) Benth. sect. *Chamaefistula* Colladon ser. *Corymbosae* Benth. in Martius, *Fl. Bras.* 15, 2:106 (1870); *Trans. Linn. Soc. London* 27:525 (1871).

Lectotype: *Cassia corymbosa* Lam. a synonym of *Senna corymbosa* (Lam.) Irwin and Barneby, *Mem. New York Bot. Gard.* (op. cit. p. 397).

Description

Defined by Irwin and Barneby (1982) as having a zygomorphic corolla, numerous ovules (25-150), and exareolate seeds turned broadside to the septae of the pod. Most Australian species have coriaceous leaflets, however those of *S.* × *floribunda* are thinner and become flaccid on wilting.

Key to Australian species of ser. *Coluteoideae*
(all species below are introduced, some naturalised)

1. Plants with all parts tomentose; leaflets revolute; glands 3-5 between leaflet pairs. Sparsely naturalised in southern Australia .... 2. *S. multiglandulosa*

1. Plants glabrous or very sparsely pubescent; leaflets flat; glands 1-2 between leaflet pairs:
    2. Leaflet apex acuminate; leaflets not coriaceous, becoming flaccid on wilting. Naturalised in eastern subtropical Australia . . . . 1. *S.* × *floribunda*
    2. Leaflet apex not acuminate; leaflets coriaceous, but often folding inwards when wilting:
        3. Leaflets 2-4 pairs lanceolate; fertile anthers 7, central abaxial anther plump; anthers biporose. Hardly naturalised . . . . 5. *S. corymbosa*
        3. Leaflets 3-6 pairs elliptic to obovate; fertile anthers 6, central abaxial anther shrunken or much reduced; anthers with a single U-shaped pore:
            4 Leaflets broadest at or below the middle, folding forward in sleep; pedicels not more than 1.0 cm long. Not naturalised . . . . 4. *S. bicapsularis*
            4. Leaflets broadest at or above the middle, not folding or drooping; pedicels usually more than 1.0 cm long. Weedy in eastern subtropical Australia . . . . 3. *S. pendula* var. *glabrata*

1. **S.** × **floribunda** (Cav.) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:360 (1982); De Wit, *Webbia* 11, 245 (1955); Symon, *Trans. Roy. Soc. S. Australia* 90:86 (1966); Stanley and Ross, *Fl. S-e Queensland* 1:391 (1983); Beadle, Evans and Carolin, *Fl. Sydney Region* 276 (1976).

Lectotype: "Crece en la Neuve-Espanã junto a la Puebla de los Angeles (Puebla, Mexico) . . . se cultiva en el Jardín botánico" i.e. cultivated in Madrid, "sent as *C. floribunda* ex. hort. matrit. by Lagasca in 1807 to De Candolle", now in G-DC, fide Irwin & Barneby loc. cit.

Selected synonyms and bibliography

1. *Cassia corymbosa* Gomez Ortega, *Nov. pl. descr. dec.* 10:124 (1800) (nomen illeg.: non Lam. 1785).

Lectotype: as *S. floribunda* above, fide Irwin and Barneby loc. cit.

2. *Cassia floribunda* Cav., *Descr. pl.* 132 (1801).

Lectotype: as above.

3. *Cassia laevigata* sensu Benth., *Fl. Austral.* 2:282 (1864); Benth., *Trans. Linn. Soc. London* 27:527 (1871); sensu Bailey, *Fl. Queensland* 2, 457 (1900), non Willd.

Description

Shrub 1-3 m tall; leaves 6-8 cm long, apparently glabrous; *leaflets* 4-5 pairs, ovate, 1.5-3 cm apart on the rachis, the largest 4.5-7 x 1.5-2.8 cm, increasing in size from the base of the rachis, apex acuminate, base symmetrical, glabrous, midrib prominent below, concolorous; *glands* 3-4 between lowest pairs of leaflets, erect and club-shaped; *petiole* 1.5-3 cm long, terete; *inflorescence* racemose with 5-8 flowers; *peduncle* 3-4 cm; *pedicel* of open flower 1-1.3 cm long; *bracts* caducous; *flowers* 1.5-1.8 cm diam. when open; *sepals* lanceolate to obovate; unequal to 8 mm long; *petals* obovate, yellow, to 8 mm long; *androecium* of 3 adaxial staminodes and 7 rarely 6 fertile anthers, 3 abaxial anthers largest to 6 mm long with central anther (sometimes shrunken) on filament 2 mm long, the 2 plump lateral anthers on filaments 8 mm long; *ovary* glabrous; *fruiting peduncle* 4-5 cm long; *fruiting pedicel* 1.5-2.5 cm, robust; *pod* 7-8 x 1.5 cm diam. with blunt tip; not all ovules developing to form mature seeds so pod often partly empty and irregular in shape; *seeds* olive green and glossy, obovate. Plate 2a-e.

Distribution and Ecology

Probably introduced as a garden specimen, now naturalised and weedy in pasture or rainforest over extensive areas of subtropical coastal New South Wales and Queensland, first collected near Brisbane in 1856 (Symon 1966 not seen). Map 1.

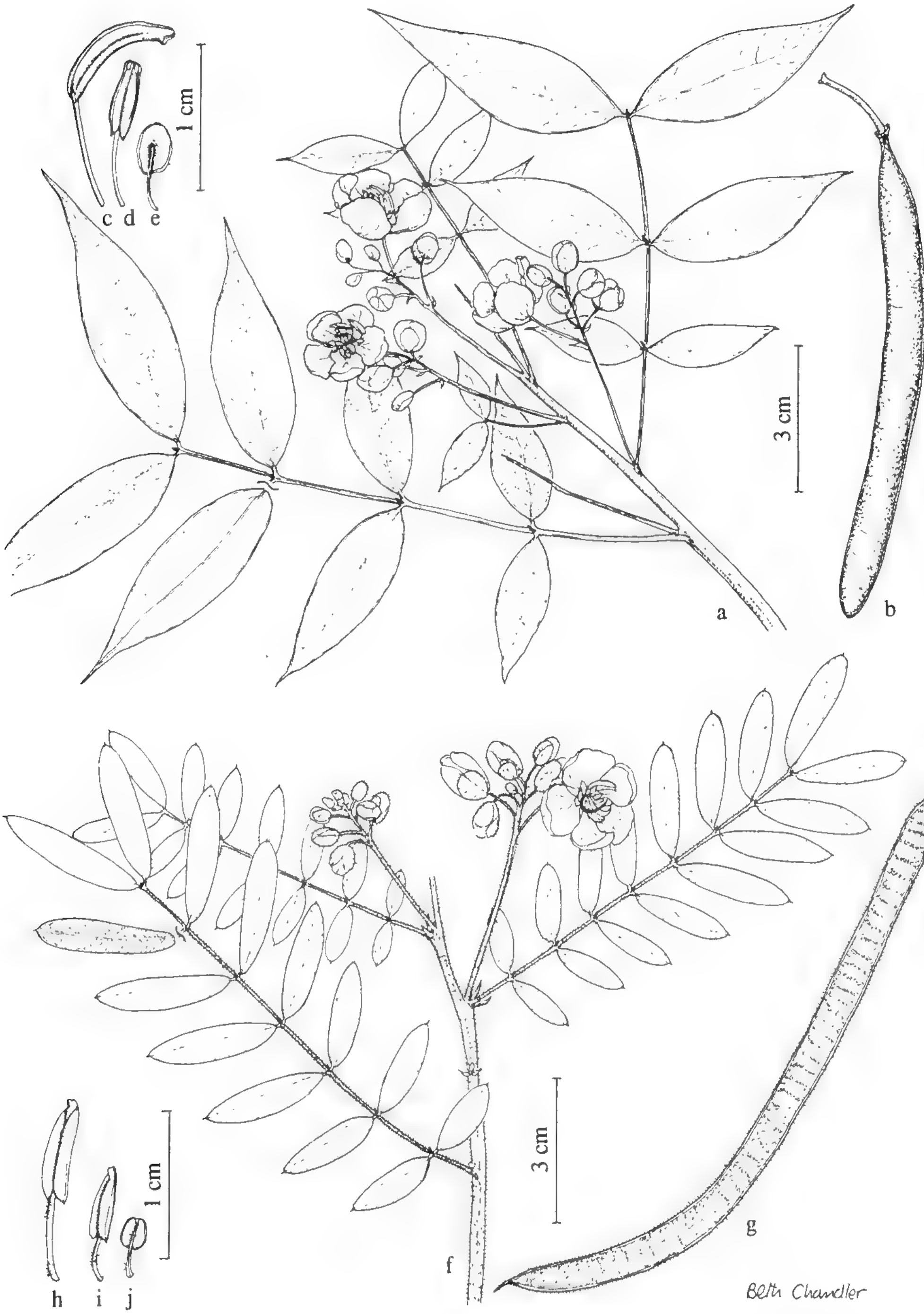


Plate 2. a-e, *S.* × *floribunda*. a, habit; b, pod; c, largest anther (lateral abaxial); d, median anther; e, adaxial staminode (all from *Ashby 2829*, AD). f-j, *S. multiglandulosa*; f, habit (from *Fisher 68*, AD); g, pod (from *Brink 542*, AD); h, largest anther (lateral abaxial); i, median anther; j, adaxial staminode (all anthers from *Symon s.n.*, 22.x.1959, AD).

Notes

1. Identified by Irwin and Barneby (1982), as of hybrid derivation from *S. septemptrionalis* (Viv.) Irwin and Barneby and *S. multiglandulosa* (Jacq.) Irwin and Barneby, where these are sympatric in areas of Mexico (Irwin and Barneby op. cit. p. 362). This hybrid origin may explain the irregular seed set described above. However in Australia it acts as a good taxon, showing little morphological variation and setting viable seeds.

2. In this and all future descriptions the character *peduncle* refers to the length of the axis below the lowest flower.

Specimens seen (24 sheets):

QUEENSLAND: Banks of Logan R., near Waterford, *Willis s.n.*, 23.v.1981 (MEL); Maleny, *Randell 283*, 8.ix.1985, (ADU, 6 sheets).

NEW SOUTH WALES: Ca 10 km NW of Upper Colo, *Donner 7761*, 3.i.1981 (AD); between Batemans Bay and Braidwood Rd., *Orchard 4511*, 8.ii.1975 (AD); 18 km W Mullumbimby, *Randell 274*, 3.ix.1985 (ADU, 2 sheets); roadside, central Bucca, *Randell 270*, 2.ix.1985 (ADU); Dorn Dorn, Tweed Valley, *Kooyman s.n.*, 1986 (ADU); roadside 2 km E Copeland, *Randell 286*, 16.xii.1985 (ADU); Bulli, *Morris s.n.*, 25.ix.1927 (AD); Epping, *Rainbow s.n.*, 29.xii.1928 (AD); Georges R. Reserve Ingleburn, *McBarron 14180*, 29.iv.1967 (AD); 'Brit Brit' near Balmoral/Coleraine, *Beauglehole 49776*, 24.iii.1975 (AD); "Woollongong", *Macpherson 125*, 1889 (MEL); Nowra, *Rupp s.n.*, .xii.1915 (MEL); Bulladelah, *Rupp s.n.*, .v.1923 (MEL).

SOUTH AUSTRALIA: Adelaide, Marion, cult. in home garden, *Randell 296*, 3.iv.1986 (ADU, 2 sheets); Blackwood, cult., *A.M. Ashby 2829*, 25.iii.1969 (AD).

2. **S. multiglandulosa** (Jacq.) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:357 (1982).

Holotype: "cult. in hort schoenbrun., semina a Massone accepi, qui in hortis Tenerifae crescentem invenit" W (hb Jacq.) fide Irwin and Barneby loc. cit.

Selected synonyms and bibliography

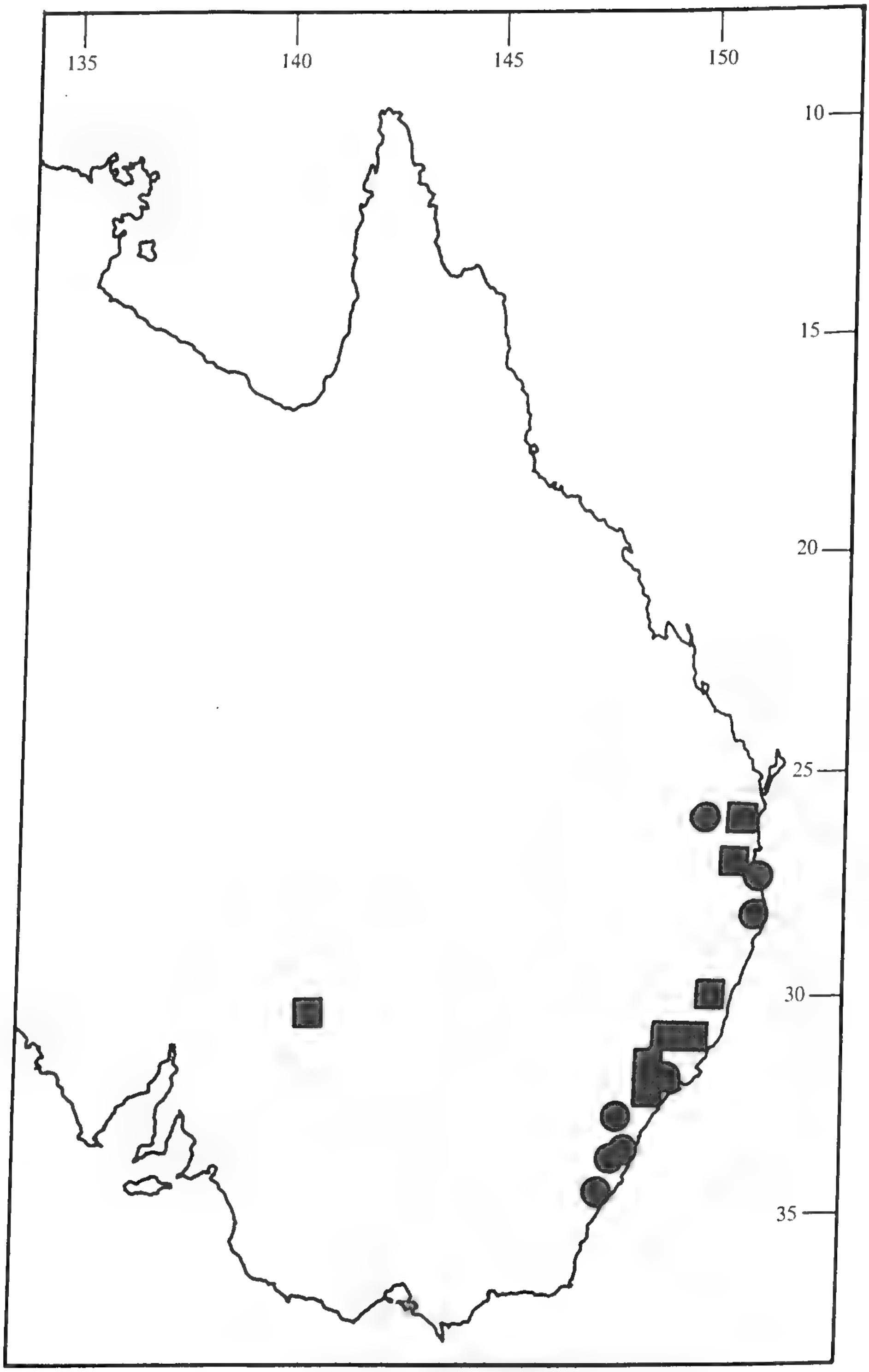
1. *Cassia tomentosa* L.f., *Suppl. pl.* 231 (1781); Benth., *Trans. Linn. Soc. London* 27:528 (1871); De Wit, *Webbia* 11:275 (1955); Symon, *Trans. Roy. Soc. S. Australia* 90:87 (1966), non *Senna tomentosa* Batka, *Bot. Zeitung* 11:193 (1849).

Holotype: LINN 528/23 fide Irwin and Barneby, op. cit. p. 357.

2. *Cassia multiglandulosa* Jacq., *Icon. pl. rar.* 1:8, t. 72 (1783).

Description

In cultivation, tall shrub or small tree to 4 m, the stem usually glabrescent and sometimes angular; *leaves* 6-8 cm including the petiole; *leaflets* 6-8 pairs, linear to lanceolate, 0.8-1.2 cm apart on the rachis, the largest 2-3 x 0.8-1.2 cm, increasing in size from the base of the rachis, apex acute and mucronate, base asymmetric, with dense short erect hairs adaxially, and yellow villous abaxially, veins yellowish abaxially, green adaxially, paler abaxially; *glands* 2-4, dark, erect and pointed, between the lowest leaflet pairs; *petiole* 0.8-1.2 cm long, terete; *inflorescence* racemose, bearing 10-20 flowers; *peduncle* 2-3 cm long; *pedicel* of open flower 1.0-1.2 cm long; *bracts* caduous; *flowers* 2.5 cm in diam.; *sepals* lanceolate to obovate, unequal in length to 1.0 cm long, villous; *petals* broad obovate, yellow, the largest 1.0-2.0 cm long; *androecium* of 3 adaxial staminodes, and 7 fertile anthers, 3 abaxial anthers largest to 7 mm long, with central anther on filament 6 mm long, the 2 lateral anthers on filaments 8 mm long; *ovary* with long dense semierect shining white hairs; *fruiting peduncle* 2-3.5 cm long; *fruiting pedicel* 1.8-2.5 cm long; *pod* 6-8 x 0.8 cm, with a persistent style, pilose; *seeds* olive-green, obovate. Plate 2f-j.



Map 1. Distribution of *S.* × *floribunda* ● and *S. pendula* var. *glabrata* ■

Distribution and ecology

Probably introduced as a garden specimen. Now sparingly naturalised in SE South Australia, SW Victoria, and border areas between Victoria and New South Wales.

Note

Identified by Irwin and Barneby (1982) as naturally distributed in upland areas of Mexico and much of South America.

Specimens seen (14 sheets):

NEW SOUTH WALES: 27 km from Victorian border towards Eden, *Canning 1239*, 30.vi.1968 (AD); East Boyd, *Gray 5675*, 28.i.1965 (AD).

VICTORIA: Battery Pt area, Portland, *Beauglehole 5214*, 20.ii.1962 (MEL,AD); Lakes Entrance, *Robbins s.n.*, c. 1937 (MEL); Snowy R. at Bete Bolong, east Gippsland, *Geary s.n.*, 15.vii.1985 (MEL); Snowy R., 1.0 km N of Bete Bolong turnoff, *van Rees 028*, 17.viii.1979 (MEL).

SOUTH AUSTRALIA: Foot of Mt Shank, S of Mt Gambier, *Randell 330*, -.v.1986 (ADU, 3 sheets); Mil Lel, near Mt Gambier, *Symon s.n.*, 2.xii.1971 (AD, 2 sheets); Riverton, home garden, *Symon s.n.*, 22.x.1959 (AD); Furner, cult garden shrub, *Fisher 68*, -.x.1974 (AD).

3. **S. pendula** (Willd.) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:378 (1982) var. **glabrata** (J. Vogel) Irwin and Barneby, op. cit., p.382).

Neotype and presumed isotype: "In Brasilia: Sellow legit pr. Ypanema (São Paulo) K." fide Irwin and Barneby, loc. cit.

Selected synonyms and bibliography

1. *Cassia coluteoides* Colladon, *Hist. nat. méd. Casses* 102, t. 12 (1816); De Wit, *Webbia* 11:239 (1955); Symon, *Trans. Roy. Soc. S. Australia* 90:85 (1966).

Lectotype: "an old cultivated specimen dating back to De Candolles years at Montpellier, the stock acquired from Lisbon", MPU, fide Irwin and Barneby, loc. cit.

2. *Cassia crassisepala* Benth., *Linnaea* 22:527 (1849).

Holotype: *Regnell 76* of collection II K (hb Benth.), not seen.

3. *Cassia bicapsularis* sensu Benth. in Martius, *Fl. Bras.* 15:107 (1870); Benth., *Trans. Linn. Soc. London* 27:525 (1871) p.p. as for *C. coluteoides*.

Description

Spreading shrub to 3 m tall; *leaves* 4-8 cm long including petiole, very sparsely hairy; *leaflets* 3-6 pairs, oblanceolate to obovate, 1-2 cm apart on the rachis, the largest 2-5 x 1-1.5 cm, increasing in size from the base of the rachis, apex usually obtuse, rarely emarginate, base unequal, veins not obvious, concolorous; *gland*, 1 clavate, between lowest pair of leaflets, green; *petiole* 2-4 cm long, terete; *inflorescence* racemose, of 15-20 flowers; *peduncle* 3-4 cm long; *pedicel* of open flower 2-2.5 cm long; *bracts* usually caducous; *flower* 2.5-3 cm in diam.; *sepals* lanceolate to obovate, unequal in length, to 1.0 cm long; *petals* obovate, emarginate, yellow, the longest to 1.5 cm; *androecium* of 3 adaxial staminodes and 6 or 7 fertile anthers, the 3 abaxial anthers the longest to 8 mm, with central anther (sometimes shrunken) on filament 4 mm long and the 2 lateral anthers on filaments 15 mm long, dehiscent by one U-shaped pore; *ovary* almost glabrous; *fruiting peduncle* 3-6 cm long; *fruiting pedicel* to 3 cm long; *pod* 10-14 x 1.0 cm; *seeds* olive-green, oval, asymmetrical. Plate 3d-f.

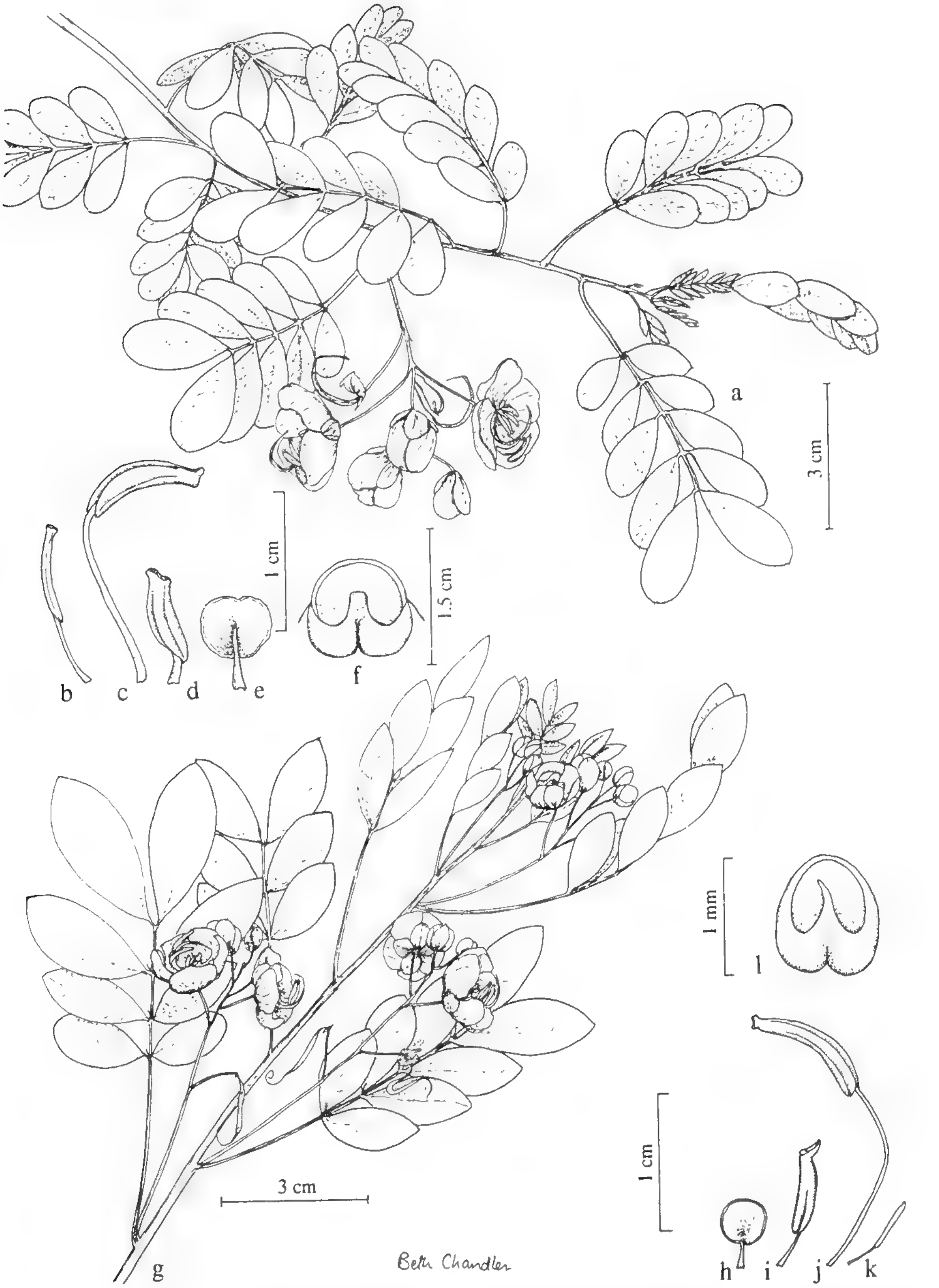


Plate 3. a-f, *S. pendula* var. *glabrata*. a, habit (from living material, cult. Adelaide. *Randell 297*, (ADU) and *JWR (sic) s.n.*, AD); b, central abaxial staminode; c, largest anther (lateral abaxial); d, median anther; e, adaxial staminode; f, single pore of largest anther (all anthers from *JWC (sic) s.n.*, AD). g-k, *S. bicapsularis*. g, habit, h, adaxial staminode; i, median anther; j, largest anther (lateral abaxial); k, central abaxial staminode; l, single pore of largest anther (all from *Kiesing 3397* (AD) ex South America).

Distribution and Ecology

Probably introduced as a garden specimen, now extensively naturalised in coastal areas of northern New South Wales. Map 1.

Note

Identified by Irwin and Barneby (1982) as native of forest margins of large areas of Brazil.

Specimens seen (24 sheets):

QUEENSLAND: Mt Buderim, *Pederson s.n.*, -.iv.1931, (AD); Ipswich, naturalised, *Pedley 4567*, 10.iv.1979 (MEL).

NEW SOUTH WALES: Broken Hill, cult., *Cooper s.n.*, -.v.1928, (AD); E of Bowmans, N of Gloucester, *Randell 289*, 17.xii.1985, (ADU, 2 sheets); beside road from Barrington Guest House to Dungog, *Randell 266*, 31.viii.1985, (ADU, 4 sheets); roadside Wauchope Township, *Randell 268*, 1.ix.1985, (ADU, 6 sheets); Buxner Flora Reserve, Coffs Harbour, *Randell 269*, 2.ix.1985, (ADU); between Bucca and Nova Glen, *Randell 271*, 2.ix.1985, (ADU); Myocum, *Kooyman s.n.*, 1986, (ADU, 2 sheets).

SOUTH AUSTRALIA: Morphettville, cult. home garden, *Randell 297*, 4.iv.1986, (ADU); cult. suburban garden, *J.R. s.n.*, 1.iv.1965, (AD); Medindie, cult. garden, *Waller 145*, 17.v.1976, (AD); cult. W.A.R.I., *Symon s.n.*, 1.v.1964, (AD); Tusmore, cult., *Symon s.n.*, 10.v.1966, (AD).

4. **S. bicapsularis** (L.). Roxb., *Fl. Ind. edn* 2:342 (1832).

Lectotype: LINN 528/10 (designated De Wit, *Webbia* 11:236 (1955), accepted by Brenan, *Flora of Tropical East Africa*, 71 (1967), Isley, *Mem. New York Bot. Gard.* 25:198 (1975) and Irwin and Barneby op cit., p. 401 (1982), not seen).

Synonyms and bibliography: see Irwin and Barneby (1982), p. 401.

Note

This name has been extensively used in Australia, almost entirely in error, for plants referable to both *S. pendula* var. *glabrata* and *S. corymbosa*. Only one plant truly referable to this species has been recorded in Australia [Pt Hedland, W.A., cult., *Stone s.n.*, -.vi.1973 (PERTH)], and may be quickly recognised by the short pedicels (never more than 1.0 cm even in fruit) and folding habit of leaflets. Plate 3g-l.

However, there are in cultivation in Adelaide, S. Australia, a number of plants which may be of hybrid origin, as they appear intermediate in morphology between *S. pendula* var. *glabrata* and *S. bicapsularis* and have poor seed set and abnormal pollen. The origin of the form is not known, but the earliest record is of its cultivation in the arboretum of the Waite Institute in 1938 (Symon, pers. comm.). As it is a handsome floriferous shrub, it may have been transported into cultivation in other parts of Australia. A full description is provided to allow identification of such specimens.

S. pendula × bicapsularis (?)

Description

Spreading shrub to 3 m; *leaves* including petiole 3-9 cm, glabrous; *leaflets* 3-4 pairs, broad lanceolate to broad elliptic, 1.0-1.5 cm apart on the rachis, the largest 2.5-5 x 0.8-2.0 cm, noticeably increasing in size from the base of the rachis, apex obtuse to acute, base unequal, veins impressed below, dark green above, paler below, margin yellow; *gland* 1 between lowest pair of leaflets, dark or green, erect; *petiole* 2-3 cm long, terete; *inflorescence* racemose, with 6-15 flowers; *peduncle* 2-4 cm; *pedicel* of open flower 1.0-1.5 cm long; *bracts* usually caducous; *flowers* to 3.5 cm diam.; *sepals* lanceolate to oval or obovate, unequal in length to

8 mm long; *petals* obovate, yellow, the longest to 15 mm; *androecium* of 3 adaxial staminodes and 6 or 7 fertile anthers, the 3 abaxial anthers the largest, to 7 mm long, the central anther (sometimes shrunken) on filament 4 mm long, the 2 plump lateral anthers on filaments 12 mm long, dehiscing by one U-shaped pore; *ovary* glabrous; *fruiting peduncle* to 4 cm long; *fruiting pedicel* 1.5-2.0 cm long; *pod* to 8 x 1.0 cm, not all ovules developing mature seeds so that this is sometimes misshapen; *seeds* dark green.

Notes

Differs from *S. pendula* because the leaflets fold forwards and downwards in sleep or on wilting, and from *S. bicapsularis* in the length of the pedicels. The poor seed set is in accord with hybrid origin as are the high frequencies of misshapen pollen grains (30-60%, Randell unpubl.)

Specimens seen (8 sheets):

SOUTH AUSTRALIA: Cult. Waite arboretum, *Wright s.n.*, 19.iv.1940 (AD); cult. Adelaide Botanic Garden, *Jaegermann 60*, 16.vi.1972 (AD); cult. University of Adelaide garden, *Randell 294*, -.iv.1986 (ADU, 2 sheets); cult. University of Adelaide garden, *Randell 295*, -.iv.1986 (ADU, 3 sheets); Dover Gardens, cult. home garden, *Randell 331*, -.iii.1987 (ADU).

5. **S. corymbosa** (Lam.) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:397 (1982).

Holotype: "cult. at Paris from seeds collected by Commerson on Bougainville's voyage, P-LA isotype P (hb. Poiret)" fide Irwin and Barneby, loc. cit.

Selected synonyms and bibliography

1. *Cassia corymbosa* Lam., *Encycl. 1:644 (1785).*

Description

Spreading shrub to 3 m; leaves 4-6 cm long including petiole, apparently glabrous; *leaflets* 2-3 pairs, narrow to broad lanceolate, 1.2-2 cm apart on the rachis, the largest 2.5-5 x 0.8-1.2 cm, increasing in size from the base of the rachis, apex acute, base unequal, slightly darker adaxially than abaxially; *gland* 1 dark and erect between the lowest pair of leaflets; *petiole* 2-3.5 cm long; *inflorescence* racemose, bearing 15-20 flowers; *peduncle* 2-3 cm long; *pedicel* of open flower 1.2-1.8 cm long; *bracts* caducous; *flowers* 2.0 cm in diam; *sepals* lanceolate to obovate, unequal in length, to 8 mm long; *petals* obovate, yellow, the largest to 1.5 cm long; *androecium* of 3 adaxial staminodes, and 6 or 7 fertile anthers, the 3 abaxial anthers the largest to 7 mm long, the central anther (sometimes shrunken) on filament 5 mm long, the 2 plump lateral anthers on filaments 10 mm long, dehiscent by 2 circular pores; *ovary* glabrous; *fruiting peduncle* 2.5-3.5 cm long; *fruiting pedicel* 2.0-2.5 cm long; *pod* to 15 x 1.0 cm curved; *seeds* 20-30 per pod. Plate 4a-g.

Distribution and ecology

In Australia, mostly cultivated. There is a single collection of a garden escape from New South Wales.

Notes

This is the only Australian species of ser. *Coluteoideae* to have the largest anthers biporose. The name has frequently occurred in nursery catalogues in Australia, usually for plants of *S. pendula*. It was identified by Irwin and Barneby as originating in South America, but was cultivated in Europe before 1800.

Plate 4. a-g, *S. corymbosa*. a, habit; b, pod (both from living material, cult. Adelaide Bot. Gard., *Haegi 3906*, AD); c, adaxial staminode; d, median anther; e, largest anther (laterial abaxial); f, central abaxial stamen; g, twin pores of largest anther (all anthers from *Johnson & Briggs 3252*, AD). h-n, *S. barclayana*. h, habit, i, pod; j, adaxial staminode; k, median anther, l, largest anther (lateral abaxial); m, central abaxial staminode; n, twin pores of largest anther (all from living material, cult. Adelaide Bot. Gard., *Randell 333*, ADU).

Specimens seen (10 sheets):

NEW SOUTH WALES: Tumbi Umbi, roadside near Tuggerah Lake, *Briggs 3252*, 14.iii.1970, (AD); cult. Royal Bot. Gard. Sydney, *Rodd s.n.*, 6.x.1968, (seed ex. Genoa, Italy), (AD).

SOUTH AUSTRALIA: cult. Waite Institute, *Symon s.n.*, winter 1986, (ADU, 4 sheets); cult. Adelaide Bot. Gard., *Randell 332*, -.v.1986, (ADU, 2 sheets); cult. Adelaide Bot. Gard., *Haegi 3906*, 18.iii.1986, (AD, ADU).

S. candolleana

The name *Cassia candolleana* has also appeared in horticultural catalogues in Australia. *Senna candolleana* (J. Vogel) Irwin and Barneby (p. 376, 1982) can be recognised by the following character suite: 4-8 pairs oblong-obovate, emarginate leaflets 2-4.5 cm long; petals 12-17 mm long; and only 6 fertile anthers, the central abaxial staminode on a filament 4 mm long, the 2 lateral abaxial anthers fertile biporose on filaments 7-10 mm long. The presence of *S. candolleana* in Australia has not yet been verified.

1b. Ser. *Basiglandulosae*

Senna Miller [sect. *Chamaefistula* (Colladon) Irwin and Barneby] ser. **Basiglandulosae** (Colladon) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:405 (1982).

Lectotype: *Cassia occidentalis* L., syn. *Senna occidentalis* (L.) Link fide Irwin and Barneby loc. cit.

Synonyms and selected bibliography

1. *Cassia* L. sect. *Chamaesenna* Colladon ser. *Basiglandulosae* Colladon, *Hist. nat. méd. Casses* 107 (1816); DC. *Prod.* 2:497 (1825).

2. *Cassia* L. sect. *Chamaefistula* Colladon subsect. *Oncolobium* J. Vogel, *Gen. Cass. syn.* 10 (1837).
Lectotype: *C. occidentalis* L. fide Bentham p. 530 (1871); Irwin and Barneby loc. cit.

3. *Cassia* L. subgen. *Senna* (Miller) Benth. sect. *Oncolobium* (J. Vogel) Benth. in Martius, *Fl. Bras.* 15:110 (1870); Benth., *Trans. Linn. Soc. London* 27:530 (1871); Symon, *Trans. Roy. Soc. S. Australia* 90:79 (1966).

Description

Defined by Irwin and Barneby (1982) as having the petiolar gland either truly basal and juxtaposed to the pulvinus, or displaced towards the first pair of leaflets, obliquely-appendaged long anthers, and style dilated towards the apex. Stipules are usually acicular, or lanceolate, and caducous.

Key to the Australian species of ser. Basiglandulosae

1. Petioles 3-5 cm long; pods 10-20 cm long; ovules 40-100; exotics:
    2. Peduncles less than 0.5 cm long; leaves with sparse fine hairs .... 9. *S. occidentalis*
    2. Peduncles 0.5-3.0 cm long; leaves with dense setaceous hairs .... 10. *S. hirsuta*
1. Petioles 1.5-4 cm long; pods 4-9 cm long; ovules 20-30, natives:
    3. Glands of petiole squat, broader than tall:
        4. Leaflets 0.4-0.9 cm broad; pod 3-5 cm long .... 6. *S. barclayana*
        4. Leaflets 1.5-2.5 cm broad; pods 7.5-9 cm long .... 7. *S. planitiicola*
    3. Glands of petiole erect, taller than broad .... 8. *S. clavigera*

6. **S. barclayana** (Sweet) Randell, comb. nov.

Basionym: *Cassia barclayana* Sweet, *Fl. Australas.* t. 32, (1828).

Lectotype: the cited plate "from the collection of Robert Barclay Esq., of Bury Hill and . . . raised from seed from New Holland in 1824" fide Symon p. 89, 1966 (!in microfiche).

Synonyms

1. *Cassia lancifolia* Colla, *Herb. Pedem.* 281 (1831).

Holotype: "Grown from seed collected by Schultes collected in New Holland with that of *C. barrenfieldii* and *C. schultesii.*" TO (!in photograph).

2. *Cassia schinifolia* DC. *7th Not. Plantes rares jard. Genève* 35 (1825-1827).

Type: "of uncertain locality, the seed came to Geneva from Montpellier", not located. Equated with *C. barclayana* by Benth. p. 533 (1871) and Symon p.89 (1966).

3. *Cassia sophera* var. *schinifolia* (DC.) Benth., *Fl. Austral.* 2:283 (1864).

4. *Cassia sophera* L. var. *sophera* Benth., *Trans. Linn. Soc. London* 27:533 (1871) p.p. as for *C. sophera* var. *schinifolia* and *C. barclayana*.

5. *Cassia sophera* var. *barclayana* (Sweet) Domin, *Biblioth. Bot.* 89:792 (1926).

6. *Cassia occidentalis* var. *schinifolia* (DC.) De Wit, *Webbia* 11:258 (1955).

7. *Cassia barclayana* var. *barclayana Sweet. Symon, Trans. Roy. Soc. S. Australia* 90:89 (1966), p.p. except for *C. sophera* var. *clavigera*.

Description

Herb or shrub to 1.5 m tall; *stems* glabrous; *leaves* 8-12 cm long including petiole; *leaflets* 6-10 pairs, narrow elliptic to lanceolate, 1.0-1.5 cm apart on the rachis, the largest 2-5 x 0.4-0.9 cm, increasing in size from the base of the rachis but the terminals often shorter than the subterminals, apex acute to acuminate, base equal, glabrous, veins conspicuous below, olive green above, dull below; *gland* one, dark, broader than tall, concave, close to stem; *petiole* 1-2 cm long; *inflorescence* racemose bearing 6-10 flowers; *peduncle* 2-3.5 cm long; *pedicel* of open flower 1.2-2.0 cm long; *bracts* usually caducous; *flowers* 1.8-2 cm in diam. when open; *sepals* oval, subequal; *petals* obovate, yellow, to 1.2 cm long; *androecium* of 3 adaxial staminodes, 1 abaxial staminode, 4 median fertile beaked anthers and 2 larger (to 3 mm long) abaxial fertile anthers with pale recurved beaks on filaments 2 mm long; *ovary* sparsely hairy; *fruiting peduncle* 3-4 cm long; *fruiting-pedicel* 1.5-2.5 cm long; *pod* 3-5 x 0.6-0.9 cm, dark brown with conspicuous pale sutures; *seeds* dark, elliptic to oval. Plate 4h-n.

Distribution and ecology

Widespread and weedy in open forests of eastern northern New South Wales and southern Queensland. Now spreading to southern and western States. Map 2.

Notes

1. Differs from *S. clavigera* in the squat glands, absence of hairs, smaller leaves and recurved anther beaks.

2. Western Australian specimens are slightly atypical in having 9 pairs of very narrow leaflets. They represent a new record for Western Australia, but it is not clear if they are endemic or recently introduced weeds.

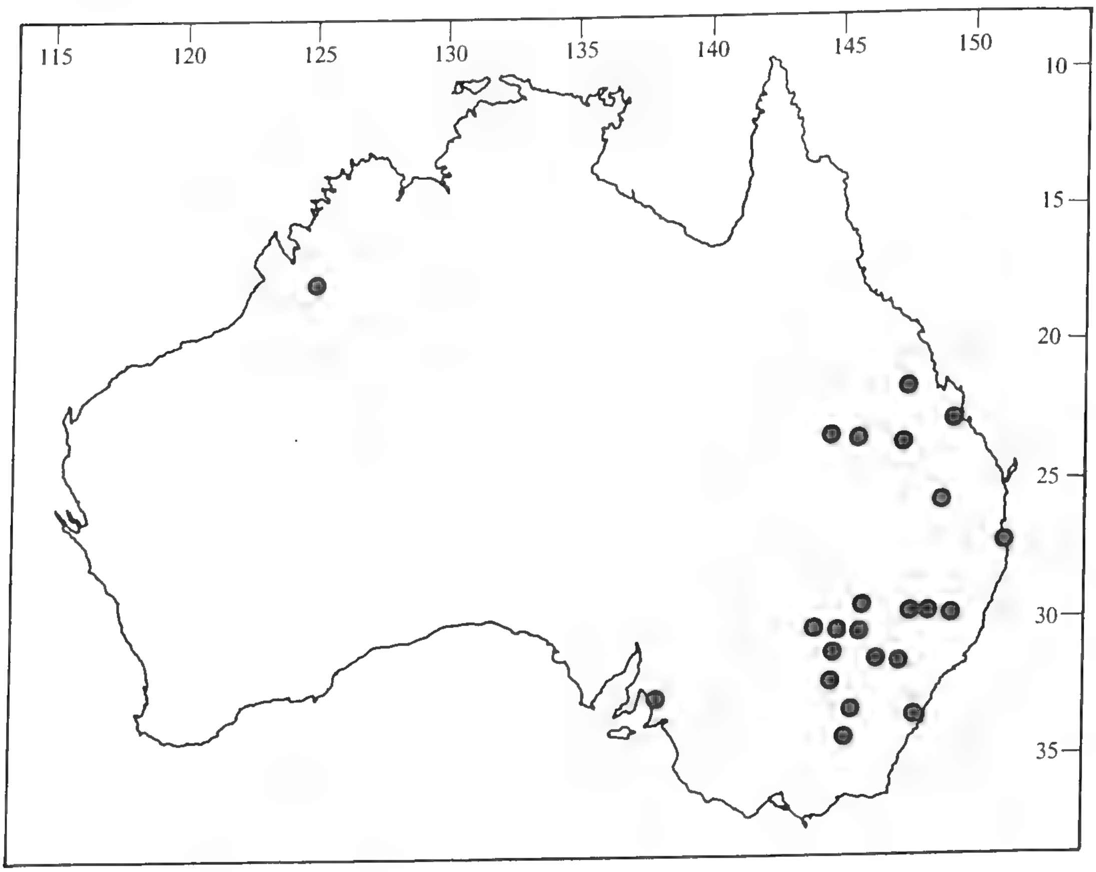
Selection of specimens examined (45 sheets seen):

WESTERN AUSTRALIA: Comballin, *Power 726*, -.v.1970 (PERTH); Noonkanbah Crossing, *Royce 6986*, 12.v.1962 (PERTH).

QUEENSLAND: Upper Barcoo, *Miss Walker s.n.*, 1890 (MEL); between the Barcoo and the Roma, *Birch s.n.*, 1871 (MEL); Rockhampton, *O'Shanesy 139*, 20.viii.1867 (MEL, 2 sheets); Tambo Barcoo, *Schneider s.n.*, 1871 (MEL); Peak Downs, *Burkitt s.n., s.d.*, (MEL); Mudflats, Moreton Bay, *Anon. 157*, 7.i.1867 (MEL); Greenswamps Rd, Chinchilla, *Hando s.n.*, 25.ii.1985 (ADU, 3 sheets).

NEW SOUTH WALES: Ingleburn, Railway Enclosure, *McBarron 12034*, 29.i.1966 (AD, 2 sheets); Glenlee near Menangle Pk, *McBarron 16561*, 17.v.1969 (AD); 2 miles SE Narrabri towards Boggabri, *Morrow 46*, 20.iii.1968 (AD); 32 km E Cobar on Barrier Highway, *Blaxell 685*, 16.xi.1971 (AD); Hermidale, between Nyngham and Cobar, *Howard s.n.*, 25.xii.1962 (AD); Condumbul, *Filson 668*, 10.i.1959 (AD); Culcairn, *McBannon 3024*, 25.i.1949 (MEL); Moona Plains Walcha, *Crawford s.n.*, 1884 (MEL); Namoi, *Musson s.n.*, 1890 (MEL); Dubbo, *Boorman s.n.*, -.xii.1897 (MEL).

SOUTH AUSTRALIA: Riverton, *Dept. of Agriculture 354*, 24.iii.1971 (AD); Salisbury, *Symon s.n.*, 25.xii.1954 (AD); Salisbury, *Kloot s.n.*, 2.ii.1978 (AD).



Map 2. Distribution of *S. barclayana*.

7. **S. planitiicola** (Domin) Randell, comb. nov.

Basionym: *Cassia planitiicola* Domin, *Biblioth. Bot.* 89:791 (1926); Symon, *Trans. Roy. Soc. S. Australia* 90:91 (1966).

Holotype: "Locis graminosis in collibus. Rolling Downs inter opp. Hughenden et Cloncurry, Queensland." *K. Domin 5027*. PR 527594 (!in photograph).

Description

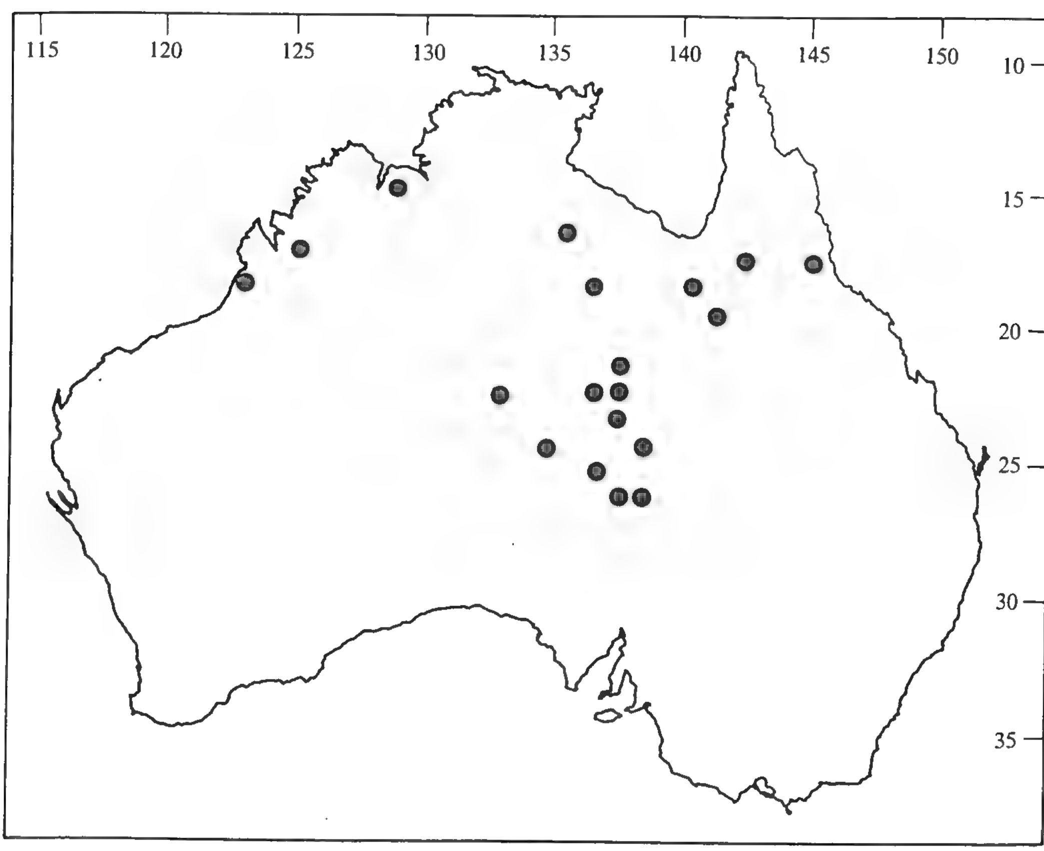
Shrub to 2.5 m; *leaves* 10-12 cm including the petiole, glabrous; *leaflets* 5-7 pairs, broad elliptic, 1.5-2.0 cm apart on the rachis, the largest 2-5.5 x 1.5-2.5 cm, almost equal in size, apex acute to acuminate, base unequal, glabrous, veins conspicuous below, olive green, concolorous; *gland* one, flat, broader than tall, 5-8 mm from the stem; *petiole* 2.5-5 cm long; *inflorescence*, racemose bearing 3-8 flowers; *peduncle* 2-4 cm long; *pedicel* of open flower 1.0-2.0 cm; *bracts* caducous; *sepals* lanceolate to elliptic, unequal in length, to 8 mm; *petals* elliptic to obovate, yellow, the largest to 1.2 cm long; *androecium* of 3 adaxial staminodes, 1 abaxial staminode, 4 median fertile beaked anthers, and 2 larger (to 4 mm long) abaxial fertile anthers with pale incurved beaks; *ovary* golden pilose; *fruiting peduncle* 1.5-4 cm long; *fruiting pedicel* 1.0-2.0 cm long; *pod* 7.5-9.5 x 0.8-1.1 cm, rich brown with broad paler sutures; *seeds* 20-40, dark, oval, wrinkled. Plate 5a-e.

Distribution

Widespread over subtropical Australia. Map 3.

Notes

Differs from both *S. barclayana* and *S. clavigera* in the longer pods.



Map 3. Distribution of *S. planitiicola*.

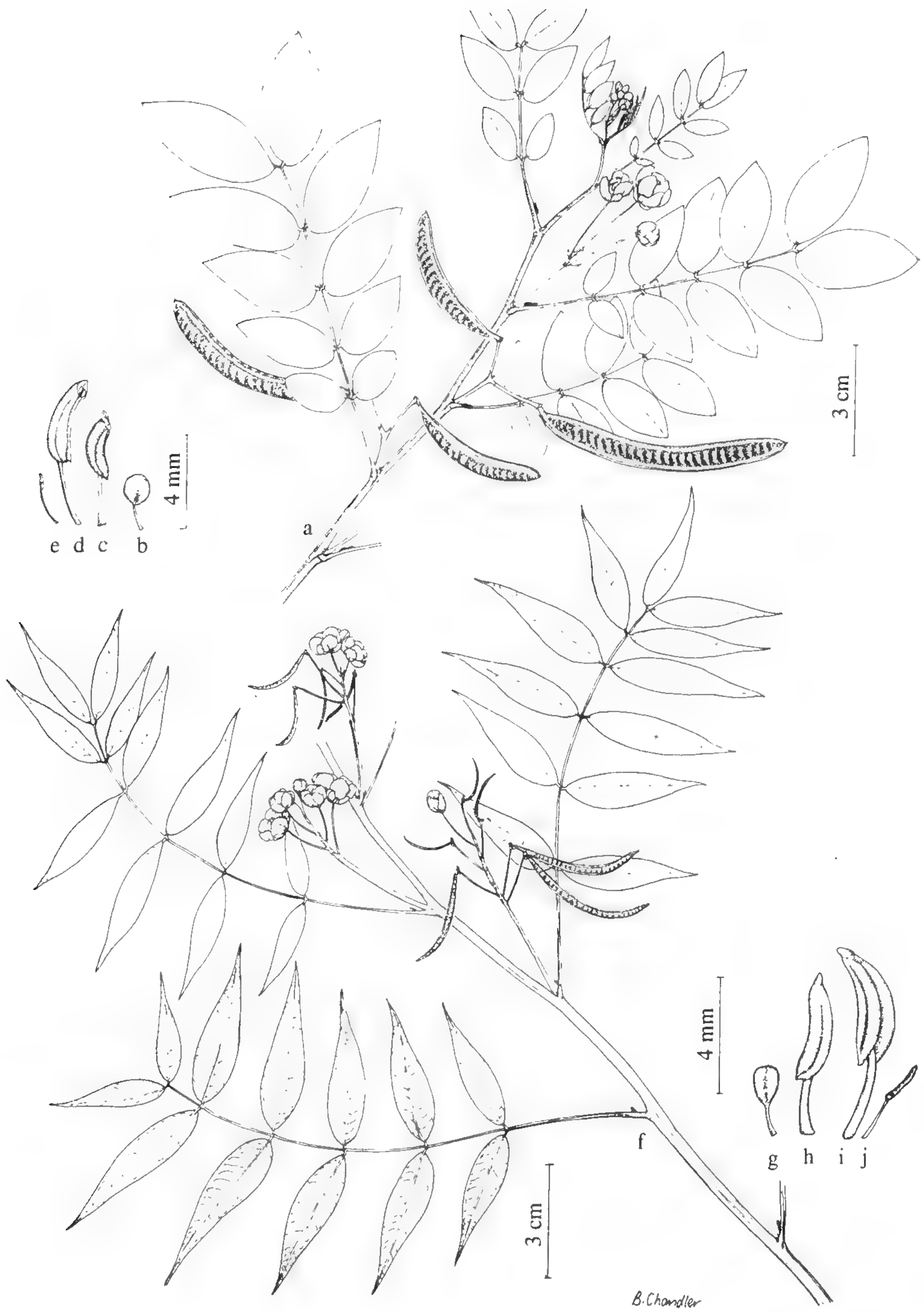


Plate 5. a-e, *S. planitiicola*. a, habit (from *Chippendale 7165*, AD); b, adaxial staminode; c, median anther; d, largest anther (lateral abaxial); e, abaxial staminode (all from *Chippendale 3979*, AD). f-j, *S. clavigera*. f, habit (from *Coveny 14419*, AD); g, adaxial staminode; h, median anther; i, largest anther (lateral abaxial); j, abaxial staminode (all from *Blaxell & Pickard 228*, AD).

Selection of specimens examined (42 sheets seen):

WESTERN AUSTRALIA: Windjana Gorge, Napier Range, *Beauglehole 47812*, 22.viii.1947 (AD); Ivanhoe Station, Buttons Gap, *Jackson 1022*, 1.vi.1967 (AD); entrance to Buttons Gap, *Burbidge 5194*, 17.iv.1956 (AD, CANB); Phangoo Station, 20 km S Broome, *McCormick s.n.*, 25.iii.1987 (PERTH).

NORTHERN TERRITORY: Finke River Mission, *Kempe s.n.*, 1879 (MEL); Mt Sonder *Tietkins s.n.*, 1889 (MEL); 10.2 miles SE Alexandria, *Chippendale 7165*, 19.vi.1960 (AD, MEL); 5 miles N Derwent Homestead, *Chippendale 274*, 7.ii.1955 (AD); Kulgera, *Chippendale 3979*, 14.x.1957 (AD); nr Wavehill Police Station, *Perry 2253*, 25.vi.1949 (AD, MEL); Hermannsburg, c. 110 km WSW Alice Springs, *Pink 78*, 23.xii.1930 (AD); Glen Helen, *Chippendale 785*, 4.ii.1955 (AD); Haast's Bluff, McDonnell Range, *Hill 177*, 16.iv.1911 (MEL).

QUEENSLAND: Gregory R., *MacGillivray s.n.*, 27.vii.1928 (AD); Toorak Field Stn, S of Julia Ck, *Burbidge 5331*, 4.v.1956 (AD); Gilbert R., *Flecker 4962*, 21.iv.1938 (AD); Herbert R. to Carpentaria, *Lieut. Dittrich s.n.*, 1886 (MEL).

SOUTH AUSTRALIA: Mt Carmeena, Everard Range, *Krahenbuehl 3944*, 5.ix.1968 (AD); Musgrave Range toward Everard Range, *E.C. Black s.n.*, 10.iv.1950 (AD); Robb Well, Everard Range, *Kalotas 989*, 3.xii.1981 (AD); Illibilli Well, Everard Range, *Beauglehole 10172*, 24.vi.1965 (AD); Wantapella Swamp, *Symon 16*, 27.v.1953 (AD); Pt Augusta, *Kain 673*, 13.vi.1962 (AD).

8. **S. clavigera** (Domin) Randell, comb. et stat. nov.

Basionym: *Cassia sophera* var. *clavigera* Domin, *Biblioth. Bot.* 89:792 (1926).

Holotype: "Queensland, *A. Dietrich*, PR. 527798" (! in photograph).

Synonyms

1. *Cassia sophera* var. *pubescens* Benth., *Fl. Austral.* 2:283 (1864).

Lectotype: "Broad Sound, *R. Brown 101*, 1802", BM lower specimen (! in photograph) lectotype here designated, isolectotypes BM, K (! in photograph), MEL ! (2 sheets).

Syntypes: "Broad Sound Bowman" MEL, not seen; "Parramatta, Wools" MEL!; "Ottleys Station, Leichardt", not seen.

2. *Cassia barclayana* var. *barclayana* sensu Symon, *Trans. Roy. Soc. S. Australia* 90:89 (1966) as for *C. sophera* var. *clavigera*.

Description

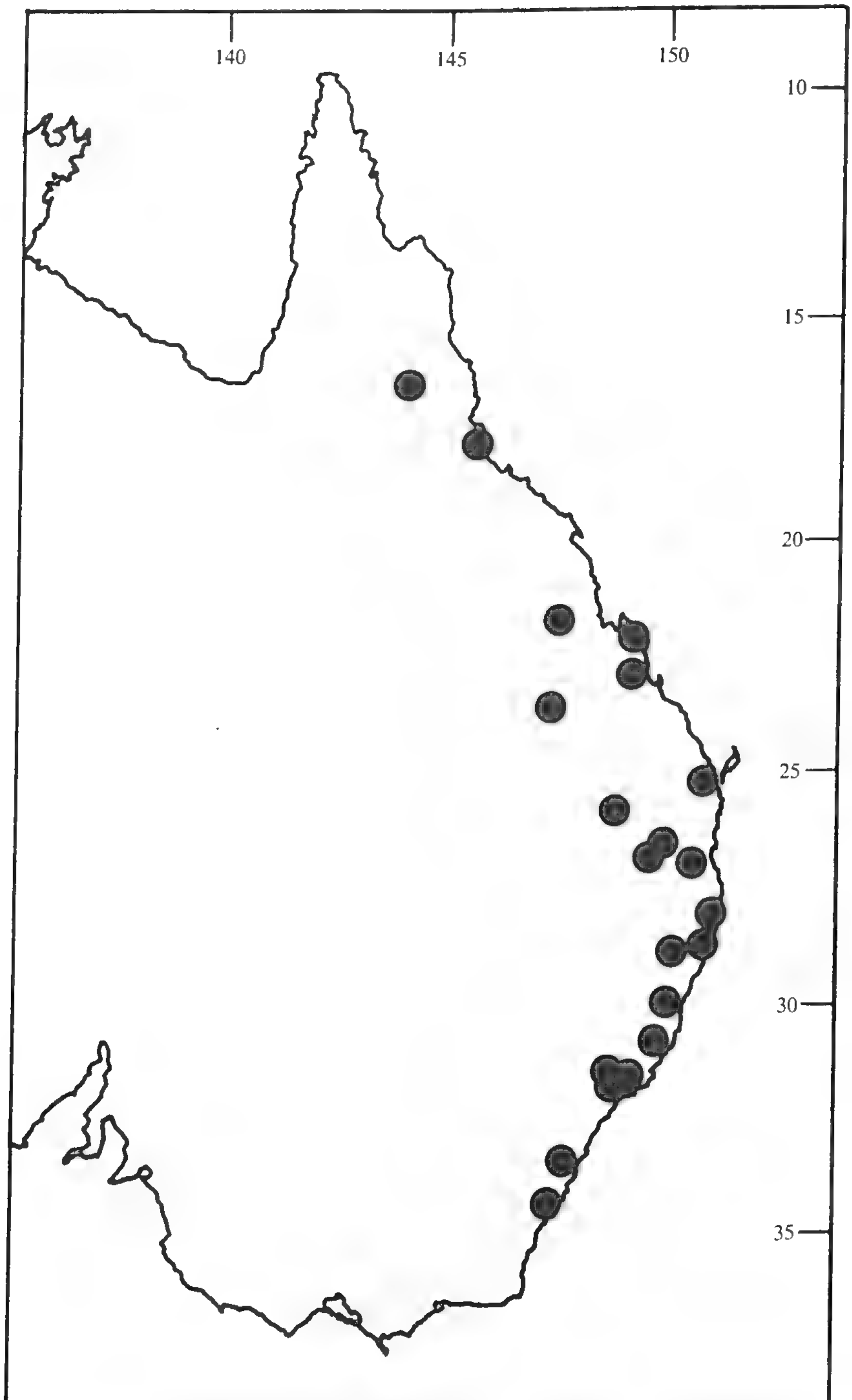
Herbs to 1.5 m tall; *stems* pubescent or not; *leaves* 10-12 cm long, including petiole; *leaflets* 4-7 pairs, narrow elliptic to elliptic, 1-2 cm apart on the rachis, the largest 4-7 x 1-2 cm, increasing in size from the base of the rachis but the terminals often shorter than the subterminals, apex acute to acuminate, base cuneate, slightly unequal, glabrous, or with scattered hairs on the lower surface, veins conspicuous below, dark green above and paler below; *gland* one, club-shaped, (taller than broad), dark, 5-8 mm from the stem; *petiole* 1,5-3.5 cm long; *inflorescence* racemose or paniculate 4-20 flowered; *peduncle* 2-4 cm long; *pedicel* of open flower 1.2-1.5 cm long; *bracts* caducous; *flowers* to 1.8 cm diam.; *sepals* subequal, oval to 0.8 cm long; *petals* obovate, yellow, to 1.0 cm long; *androecium* of 3 adaxial staminodes, 1 abaxial staminode, 4 median fertile beaked anthers and 2 larger (to 4 mm long) abaxial fertile anthers with pale incurved beaks on filaments 2 mm long; *ovary* sparsely hairy; *flowering peduncle* 3 cm long; *flowering pedicel* 1.5-2 cm long; *pod* 4-5 cm x 0.5 cm, dark brown with paler sutures, *seeds* oval, olive-green. Plate 5f-j.

Distribution and ecology

Apparently restricted to wet sclerophyll forests of eastern Australia. Perhaps weedy in nearby areas. Map 4.

Notes

Differs from *S. barclayana* in the erect glands, pubescent stems, larger leaves and incurved anther beaks.



Map 4. Distribution of *S. clavigera*.

Selection of specimens examined (42 sheets seen):

QUEENSLAND: Tanderra, 45 miles SW Springsure, *Johnson 1301A*, 15.ii.1960, (AD); between Lotus and Marlborough, *Beauglehole 3577*, 27.vi.1955 (MEL, 2 sheets); Peak Downs, *George Burkitt s.n.*, (MEL); Fraser Is., *Eaves s.n.*, 1874 (MEL, 2 sheets); Moggill, Moreton Bay, *Paddich(?) 317*, (MEL); Ipswich, *Nearnst s.n.*, (MEL); 43 miles SSW of Mt Garnet, *Lazarides 4211*, 27.ii.1954, (MEL); Baking Board near Chinchilla, *V. Hando no. 12*, 25.i.1976 (ADU).

NEW SOUTH WALES: near Cobbitty Trig, 5.5 km N Cobbitty, *Coveny 7432*, 12.iii.1976 (AD); Moonpar State Forest, *Pickard & Blaxell 228*, 18.iv.1969 (AD); Wherral Flat near Wingham, *Coveny 144119*, 11.i.1967 (AD); Richmond R., *Fawcett s.n.*, (MEL); Clarence R., *Wilcox s.n.*, 1875 (MEL); Shoalhaven Gullies, *Fetry 1865* (MEL); Williams R., Newcastle, *R. Brown s.n.*, 1802-1805, (MEL); roadside, 20 km N Gloucester towards Nowendoc, *Randell 290*, 17.xii.1985 (ADU).

SOUTH AUSTRALIA: Berri Nursery, *Gray s.n.*, 13.i.1972 (AD).

9. **S. occidentalis** (L.) Link, *Handbuch* 2:140 (1831).

Lectotype: "a cultivated plant, BM (hb. Cliffort.)" not seen . . . designated Brenan, *Flora of Tropical East Africa* p. 78 (1967), accepted by Irwin and Barneby, *Mem. New York Bot. Gard.* 35:436 (1982).

Synonym: *Cassia occidentalis* L., *Sp.Pl.* 377 (1753); De Wit, *Webbia* 11:256 (1955); Symon, *Trans. Roy. Soc. S. Australia* 90:87 (1966).

Description

Foetid shrub 1-2 m; *stems* olive green with pale ribs; *leaves* including petiole 15-17 cm long, glabrescent; *leaflets* 3-7 pairs, broad elliptic to ovate, 1.5-3 cm apart on rachis, the largest 5-7 x 3-4 cm, increasing in size from the base of the rachis, apex acute to acuminate, base slightly unequal, very sparsely pubescent, midrib prominent below, immersed above, concolorous, olive green; *gland* 1, dark sessile, broader than tall, very close to stem; *petiole* 2-4 cm long; *inflorescence* racemose, 2-4 flowered; *peduncle* 0.2-0.5 cm; *pedicel* of open flower 1.0-1.5 cm; *bracts* caducous; *sepals* lanceolate, to 8 mm long; *petals* yellow, to 10 mm long; *androecium* of 3 adaxial staminodes, 1 abaxial staminode, 4 fertile median beaked anthers, and 2 large fertile beaked abaxial anthers 4 mm long on filaments 4 mm long; *ovary* densely pilose; *fruiting peduncle* 0.5 cm long; *fruiting pedicel* 0.8-1.0 cm long; *pod* 10-12 x 0.8-1.1 cm, golden brown with paler margins; *seeds* olive green, oval. Plate 6a-e.

Distribution and ecology

Now weedy in Queensland, Northern Territory and South Australia. Also recorded for New South Wales (Jacobs and Pickard, 1981) not seen. Map 5.

Notes

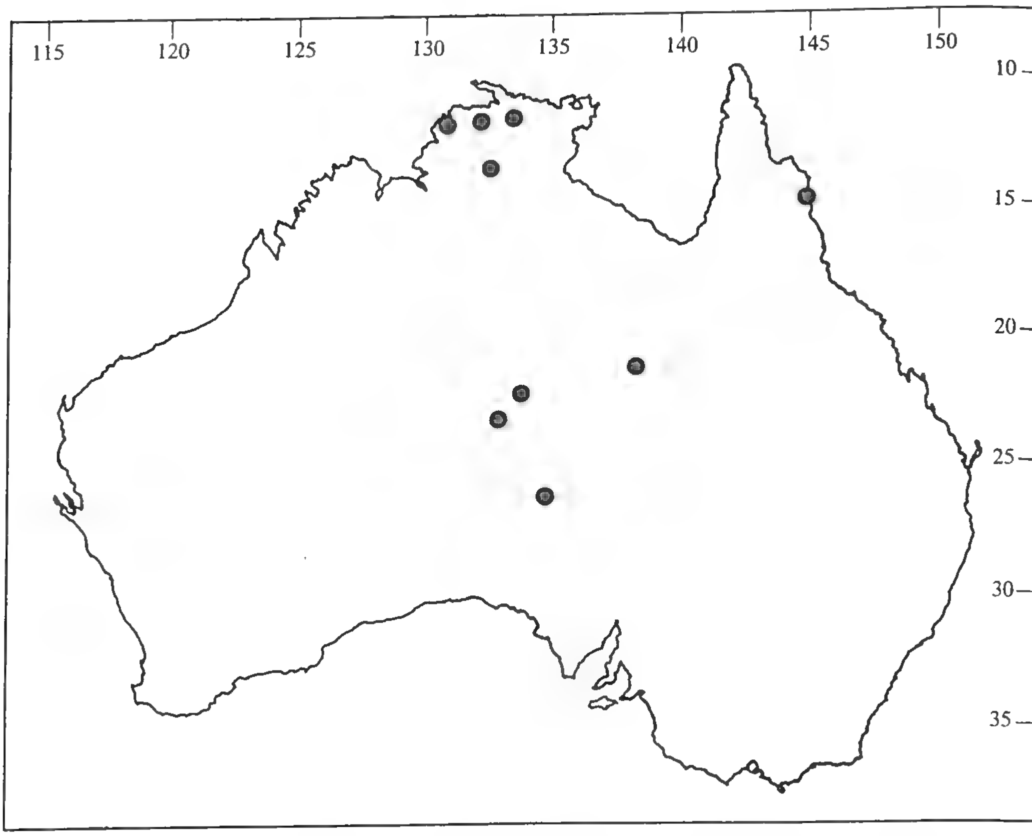
Described by Irwin and Barneby (op. cit) as 'now everywhere weedy in the New World, not demonstrably native but distributed throughout the American Tropics'. Also widespread in similar habitats almost throughout tropical Africa, India, Sri Lanka, Indochina, South China, Malesia, North Australia and east through Micronesia to Hawaiian Is. The plant has been given many names since it was first described (for full synonymy, see Irwin and Barneby (op. cit.) but in Australia has always been known as *Cassia occidentalis*.

Specimens seen (15 sheets):

NORTHERN TERRITORY: Tempe Downs Stn., ca. 170 km WSW Alice Springs, *Schneider s.n.*, 8.iv.1970, (AD); Santa Teresa Road, 13 miles SE Alice Springs, *Nelson 1609*, 19.xii.1967 (AD); near Oenpelli Mission, *Specht 1200*, 17.x.1948, (AD, MEL); 1 mile S Katherine on Stuart Highway, *Burbidge 5045*, 6.iv.1956, (AD); Fogg Dam area, 40 miles SE Darwin, *Chippendale 6185*, 18.v.1959 (AD); Kapalaga, Bullocky Point, *Dunlop 6126*, 13.iii.1982 (MEL).

QUEENSLAND: Georgina R., *Wilkinson s.n.*, 1893 (MEL); Endeavour R., *Persieh 1151*, 1883, (MEL); Endeavour R., *Persieh s.n.*, 1884 (MEL).

SOUTH AUSTRALIA: Todmorden Homestead, *Wigg s.n.*, 23.ii.1958, (AD); cult. Waite Institute, *Symon s.n.*, (AD, 3 sheets).



Map 5. Distribution of *S. occidentalis*.

10. **S. hirsuta** (L.) Irwin & Barneby, *Phytologia* 44:499 (1979); *Mem. New York Bot. Gard.* 35:425 (1982).

Holotype: "a plant cultivated at Hartekamp and described by Linnaeus BM (hb. Cliffort.)" fide Brenan, *Flora of Tropical East Africa*, p. 80, 1967; Irwin and Barneby (1979 & 1982).

Synonym: *Cassia hirsuta* L., *Sp. Pl.* 378 (1753); De Witt, *Webbia* 11:250 (1955); Symon, *Trans. Roy. Soc. S. Australia* 90:88 (1966).

Description

Herb or woody shrub 0.2-2.5 m, foetid, pubescent; *stem* grooved; *leaves* 10-16 cm long, including petiole; leaflets 2-6 pairs, ovate to obovate, the largest 4-9 x 2-3.5 cm, increasing in size from the base of the rachis, apex acute to acuminate, base unequal, villous on both faces,

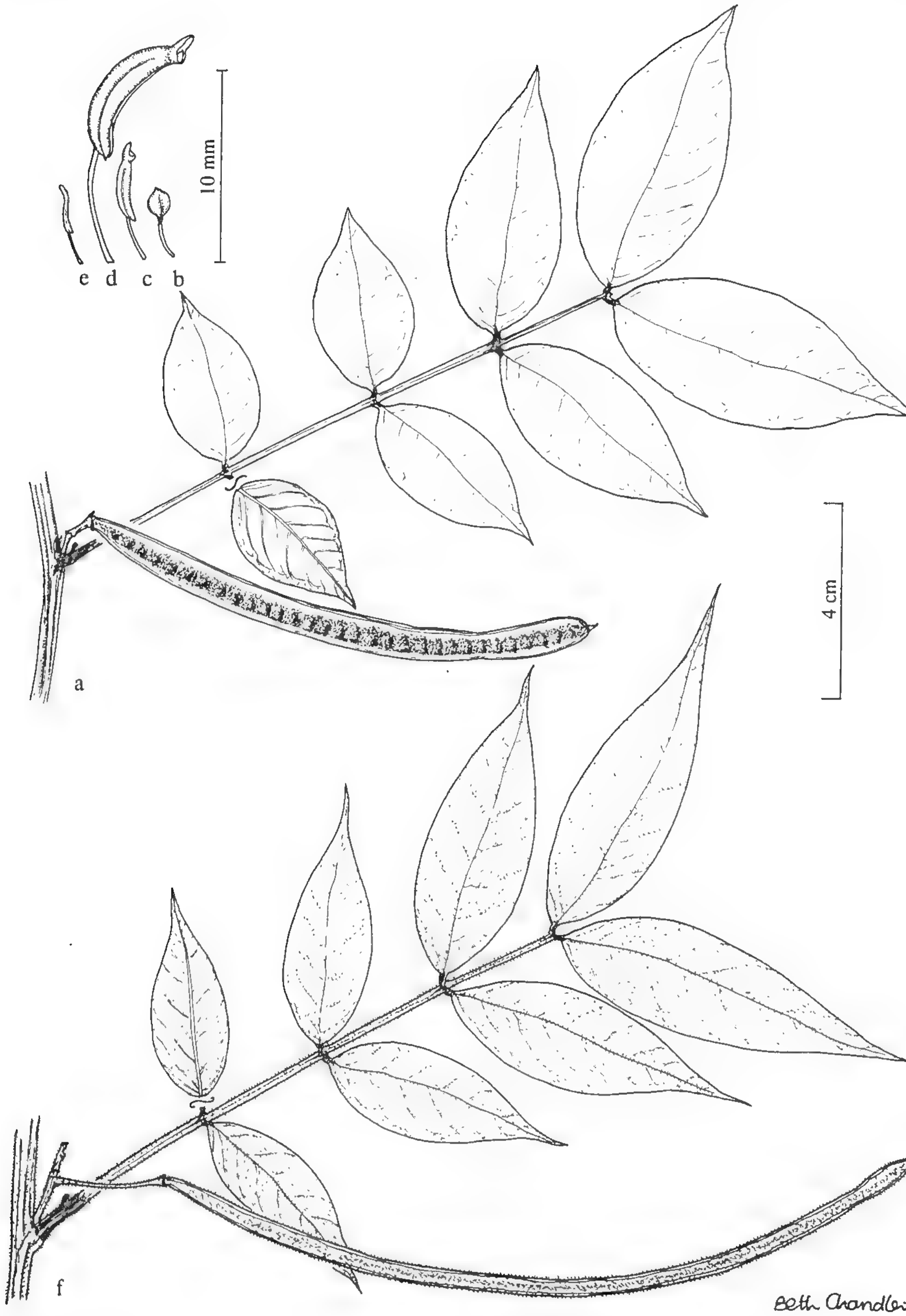


Plate 6. a-e, *S. occidentalis.* a, habit (from *Symon s.n.*, 8.iii.1966, AD; pod from *Maconochie s.n.*, 18.xii.1967, AD); b, adaxial staminode; c, median anther; d, largest anther (lateral abaxial); e, abaxial staminode (all from *Symon s.n.*, 8.iii.1966, AD); f, *S. hirsuta*, habit (from *Cabrera et al. 30258*, AD, ex South America). Both habit drawings show abaxial surface of one disconnected leaflet.

nerves raised below, concolorous; *gland* 1, sessile, conical at the base of the petiole; *petiole* 4-6.5 cm long; *inflorescence* racemose, 2-5 flowered; *peduncle* 1.0 cm long; *pedicel* of open flower 1.2-2.0 cm long; *sepals* obovate, unequal in length, to 9 mm long; *petals* obovate, yellow, the largest 12-16 mm long; *androecium* of 3 adaxial staminodes, 1 abaxial staminode, 4 median fertile beaked anthers on short filaments, and 2 large abaxial fertile beaked anthers 7-8 mm long on filaments 5-6 mm; *ovary* villous; *fruiting pedicel* 1.5-2.0 cm long; *pod* 10-14 x 0.4-0.6 cm, pilose; *seeds* 50-90, dark. Plate 6f.

Distribution and ecology

Recorded as a weed in Queensland (Symon 1966).

Notes

Irwin and Barneby have described 7 varieties within this extremely variable species which was probably native somewhere in southern America, but is now 'prevailing weedy even where native' with 'extensions of range due to human interference.' It is a weed in Africa and South-east Asia. The Australian collections are variable and apparently include several of the varieties recognised by Irwin and Barneby. A full treatment of synonymy, typification and bibliography is given by Irwin and Barneby (p. 425, 1982).

Specimens seen (11 sheets: BRI):

QUEENSLAND: Roma, *Gould s.n.*, 26.v.1959; Danbulla, *Volck 2744*, vii.1960; Murray Upper, *Lavers s.n.*. 5.v.1961; 5 miles from Seaforth, *Onley s.n.*, 23.i.1963; Innisfail, *Dore s.n.*, 22.vii.1970; Atherton, *Hyland 5243*, 6.vii.1971; King Ranch near South Johnstone, *Teitzel s.n.*, 22.v.1978 (2 sheets); O'Reilly's Creek Rd., Lowood, *Dillewaard 546*, 14.iv.1981; East Funnel Ck, Sarina, *Thomas s.n.*, v.1984; Andromache, nr Proserpine, *Lade s.n.*, 15.vi.1987.

1c. Ser. *Trigonelloideae*

Senna Miller [sect. *Chamaefistula* (Colladon) Irwin and Barneby] ser. **Trigonelloideae** (Colladon) Irwin and Barneby, *Mem. New York Bot. Gard.* 35:237 (1982).

Lectotype: *Cassia tora* L., syn. *Senna tora* (L.) Roxb., fide Irwin and Barneby loc. cit.

Synonyms

1. *Cassia* L. sect. *Chamaesenna* Colladon ser. *Trigonelloideae* Colladon, *Hist. nat. méd. Casses* 95 (1816); DC., *Prod.* 2:493 (1825).

2. *Cassia* L. sect. *Prososperma* J. Vogel, *Gen. Cass. Syn.* p. 7, 9 & 23 (1837).

3. *Cassia* L. subgen. *Senna* (Miller) Benth. sect. *Prososperma* (J. Vogel) Benth. in Martius, *Fl. Bras.* 15:114 (1870); Symon, *Trans. Roy. Soc. S. Australia* 90:76 (1966) where *C. tora* L. was designated as lectotype.

4. *Cassia* L. subgen. *Senna* (Miller) Benth. sect. *Prososperma* (J. Vogel) Benth. ser. *Torae* Benth., *Trans. Linn. Soc. London* 27:535 (1871).

Description

Defined by Irwin and Barneby (1982) as having an herbaceous life-form, few ample leaflets, shortly pedunculate, 1-3 flowered racemes devoid of glands, and the peduncle usually shorter than the pedicels. In Australian species stipules are acicular to lanceolate and more or less persistent.

Key to Australian species of ser. *Trigonelloideae*

Petioles 1.5-2 cm long; fruiting pedicels 1-2 cm long; anthers with short beaks; seed areole narrow, not longitudinal . . . . 11. *S. obtusifolia*

Petioles 2-4.5 cm long; fruiting pedicels to 1.5 cm long; anthers truncate, beakless; seed areole broad, longitudinal . . . . 12. *S. tora*

11. **S. obtusifolia** (L.) Irwin and Barneby, *Mem. New York Bot. Gard. 35:252 (1982).*

Lectotype: 'the plate in Dillenius, *Hort. Eltham. Pl. Rar.* 71, t. 62 (1732) and typotype specimen OXF (hb. Dillen)' fide Brenan, *Kew Bull.* p. 250 (1958), not seen, accepted by Irwin and Barneby (loc. cit.).

Selected synonyms

1. *Cassia obtusifolia* L., *Sp. Pl.* 377 (1753); De Wit, *Webbia*, 11:254 (1955); Symon, *Trans. Roy. Soc. S. Australia* 90:93 (1966).

2. *Cassia tora* sensu Benth., *Trans. Linn. Soc. London* 27:535 (1871) p.p. as for *Cassia obtusifolia.*

3. *Cassia tora* var. *obtusifolia* (L.) Haines, *Bot. Bihar & Orissa* 304 (1922).

Description

Herb or subshrub 1-2 m tall; *leaves* 4-6 cm long including petiole; *leaflets* 2-3 pairs, obovate, 1.2-1.5 cm apart on rachis, the largest 4-5 x 2-3 cm, markedly increasing in size from the base of the rachis, apex obtuse, mucronate, base acute, unequal, with sparse short hairs below, veins impressed above, conspicuous below, dark green above and paler below; *glands* 1-2, erect, between lowest leaflet pairs; *petiole* 1.5-2 cm long; *inflorescence* racemose 1-2 flowered; *peduncle* very short, 2-4 mm long; *pedicel* of open flower 1.5-2 cm long; *bracts* lanceolate, ciliate, caducous; *sepals* elliptic, subequal, to 8 mm long; *petals* obovate, yellow, 8-10 mm long; *androecium* of 3 adaxial staminodes, 4 median fertile shortly-beaked anthers on short filaments, 3 larger (to 5 mm) abaxial fertile shortly-beaked anthers on longer (to 4 mm) filaments; *ovary* slightly pubescent; *fruiting peduncle* 2-4 mm long; *fruiting pedicel* 2-3 cm long; *pod* 12-18 x 0.3 cm, dark brown with paler line above the seeds; *seeds* rhomboidal, areole narrow (to 1 mm broad) diagonally across the face of the seed. Plate 7f-i.

Distribution and ecology

Irwin and Barneby (1982) give the distribution as 'probably native of the Americas but now (of) almost circumtropical dispersal' through North and South America and warm temperate Australia. It was first recorded as a weed in the Northern Territory in 1961, and in Queensland in 1963. Since then it has spread rapidly in Queensland and is now a serious problem in pastures, having been declared a noxious plant in 1981.

Specimens seen (9 sheets):

NORTHERN TERRITORY: 7.6 miles ENE Batchelor, *Chippendale 7752*, 18.iii.1961, (AD); Lee Point, 13 miles N Darwin, *Nelson 1157*, 13.vi.1964 (AD); Kapalga, *Collins B.C. 383*, 27.iv.1977 (AD); South Alligator Crossing, 97 km NE of Pine Ck, *R.M. Barker 514*, 9.v.1983, (AD); East Point, Darwin, *Robinson and Nelson 1060*, 8.vi.1964 (AD).

QUEENSLAND: Roadside, Claudie R. Crossing, Iron Range National Park, *E.L. Robertson s.n.*, 18.viii.1986 (ADU, 3 sheets); Utchee Ck, *Bailey 14*, 18.vi.1963 (BRI).

12. **S. tora** (L.) Roxb., *Fl. Ind. ed. Carey* 2:340 (1832).

Lectotype: "the type of Flora Zeylanica No. 152, which is a specimen in the Hermann Herbarium at the British Museum (Natural History)" fide Brenan, *Kew Bull.* p. 250 (1958) not seen.

Synonyms (based on the list of De Wit, 1955)

1. *Cassia tora* L., *Sp. Pl.* 376 (1753); De Wit, *Webbia* 11:276 (1955); Brenan, *Kew Bull.* 248 (1958); Symon *Trans. Roy. Soc. S. Australia* 90:92 (1966).

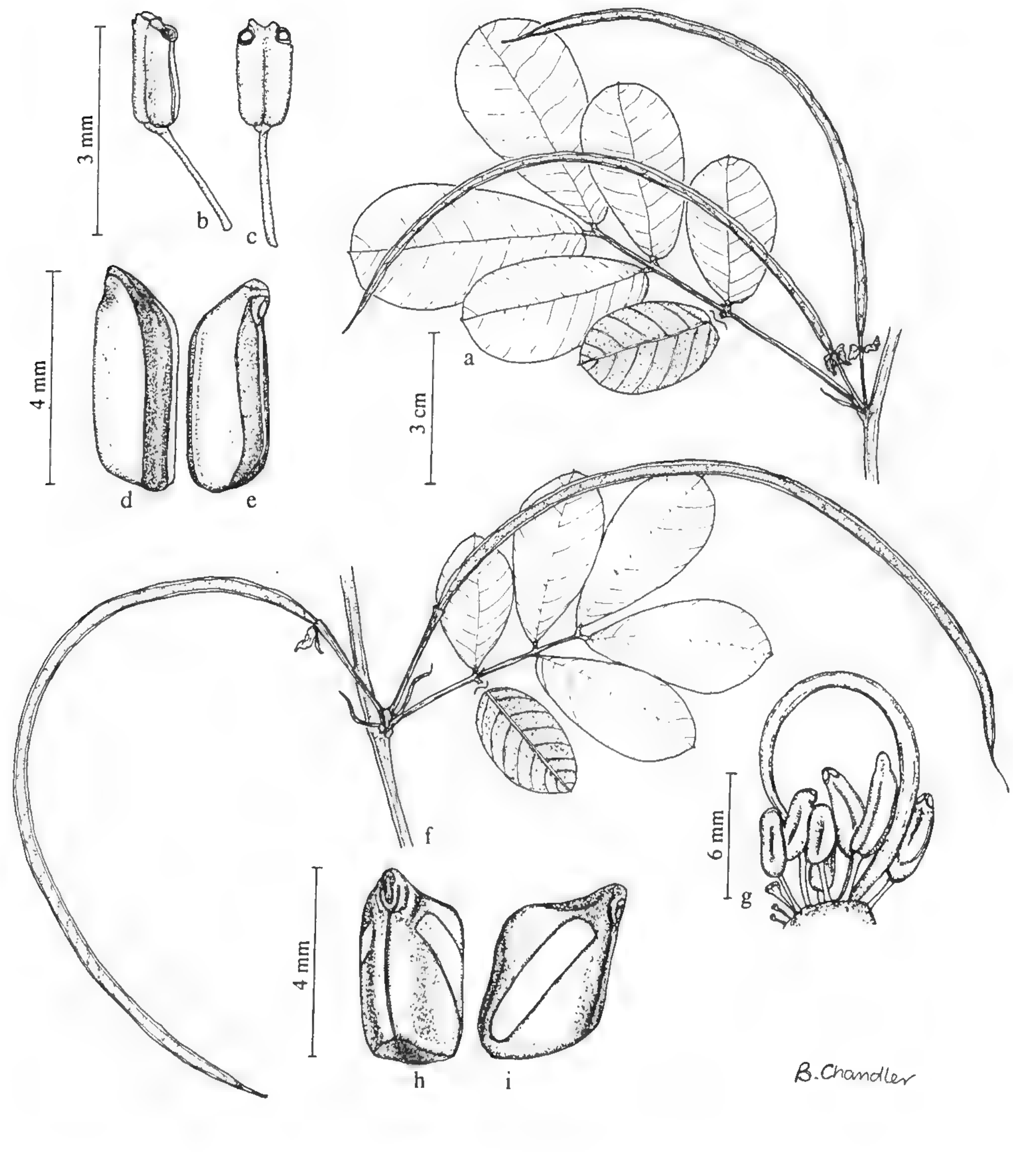


Plate 7. a-e, *S. tora*. a, habit (from *Hyland 8786*, AD); b & c, isolated anthers showing truncate tips; d & e, seed, two views showing broad longitudinal areole (anthers and seed from *Everist 5159*, AD). f-i, *S. obtusifolia*. f, habit; g, androecium showing 3 abaxial beaked anthers (both from *R.M. Barker 514*, AD); h & i, seed, two views showing narrow transverse areole (from *Dutton & Taylor 6175*, AD). Both habit drawings show adaxial surface in one disconnected leaflet.

2. *Cassia tala* Desvaux., *Journ. Bot. (Morot)* 3:73, t. 73 (1814).

Type: not determined.

3. *Cassia gallinaria* Colladon, *Hist. nat. méd. Casses* 96 (1816).

Type: not determined.

4. *Cassia borneensis* Miquel, *Anal. Bot. Ind.* 1:9 (1850); Merrill, *Bibl. Enum. Born. Pl.* 300 (1921).

Type: not determined.

5. *Cassia tora* var. *borneensis* Miquel, *Fl. Ind. Bat.* 1:95 (1855).

Type: not determined.

6. *Emelista tora* Britton & Rose, *Bot. Porto Rico* 5:371 (1925); Britton & Rose, *N. Amer. Fl.* 23:242 (1930).

Description

Herb or subshrub to 0.5 m tall, sometimes sparsely hairy on leaves and stems; *leaves* 5-6 cm long including petiole; *leaflets* 2-3 pairs, obovate, 1.0-1.5 cm apart on rachis, the largest 2.5-5.5 x 1.0-3.5 cm, increasing in size from the base of the rachis, apex obtuse or rounded, sometimes with a very short mucro, base very unequal, sparsely pubescent, veins conspicuous below, green above, paler below; *glands* 1-2, erect, sometimes pointed, between the leaflet pairs; *petiole* 2-4.5 cm long; *inflorescence* racemose, 1-2 flowered; *peduncle* 0.2-0.4 cm long; *pedicel* of open flower 1.0 cm long; *bracts* caducous; *sepals* broad elliptic to obovate, 0.5 cm long; *petals* obovate, yellow, 0.8-1.0 cm long; *androecium* of 3 adaxial staminodes (rarely these fertile and resembling the medians and then the androecium of 10 fertile anthers), 4 median fertile truncate anthers and 3 abaxial slightly larger fertile truncate anthers; *ovary* slightly pilose; *fruiting peduncle* 0.2-0.4 cm long; *fruiting pedicel* 0.8-1.0 cm long; *pod* 12-18 x 0.2-0.5 cm, curved, dark brown with paler sutures; *seed* twice as long as broad, areole longitudinal, almost as wide as the seed. Plate 7a-e.

Distribution and ecology

Sparingly naturalised in tropical Northern Territory and Queensland, sometimes in rainforest.

Notes

In gross morphology very similar to *S. obtusifolia*. Field identification must rely on petiole length (long in *S. tora*) and pedicel length (short in *S. tora*). Closer examination can utilise characters of the anther beaks (absent in *S. tora*) and seed areole (broad, longitudinal in *S. tora*; narrow and displaced from the longitudinal in *S. obtusifolia*), characters first emphasised by De Wit (1955), and Brenan (1958).

Because of the morphological similarities between these last taxa, they have been the subject of much discussion among taxonomists. It now seems reliably established that *S. obtusifolia* is native to South America, and has been transported as a weed to tropical areas of Africa, Asia and the Pacific (Irwin and Barneby p. 252, 1982). Similarly it seems highly probable that *S. tora* was native somewhere in the Asian-Pacific region and has been transported as a weed to Africa and Australia (Brenan 1967, Vatsavaya and Rama Rao 1986, Symon 1966). The suite of diagnostic characters first suggested by De Wit (1955) and amplified by Brenan (1958), have proven reliable in both Australian and Indian materials (Randell, unpubl. and Vatsavaya and Rama Rao 1986). In addition Indian studies have reported differences in parameters such as height, dry weight of root, pod length, number of seeds per pod, germination percentage (Singh 1968), certain secondary metabolites (Nageshwar et al. 1984), and leaf epidermal features (Mathur 1985 cited by Vatsavaya and Rama Rao 1986). In the light of such extensive differences, it is desirable to treat the two taxa as separate species.

Specimens seen (5 sheets):

NORTHERN TERRITORY: Pt Darwin, *Holtze s.n.*, 1888 (AD, MEL).

QUEENSLAND: East Palmerston, about 20 miles SE Millaa Millaa, *Everist 5159*, 29.v.1952 (AD, BRI); Whyanbeel, *Hyland 8786*, 13.v.1976 (AD).

Acknowledgements

Many people have given great assistance in the preparation of this publication. The editor, Dr H. Toelken, was very patient in explaining matters of presentation, and Ms B. Burns, Miss T. Eadforth and Mrs C. Robinson typed several versions of the manuscript. Mrs B. Chandler prepared the illustrations. In addition many botanists in several places in Australia have shared rewarding discussions on the nature of both genera and species. To all these people I express my thanks. The work on the *Cassiinae* has been supported for several years by grants from ABRS and the University of Adelaide.

References

Bailey, F.M. (1900). "The Queensland Flora". Vol. 2. (Govt Printer: Brisbane).
Batka, J.B. (1849). Über *Senna*, *Bot. Zeitung* 7 (11); 185-194, t. 11.
Beadle, N.C.W., Evans, O.D. & Carolin, R.C. (1972). "Flora of the Sydney Region" edn 2 (Reed: Sydney).
Bentham, G. (1849). Plantae Regnellianae: Leguminosae. *Linnaea* 22: 527.
Bentham, G. (1864). *Cassia* in "Flora Australiensis". Vol. 2 (Reeve: London).
Bentham, G. (1865). *Cassia* in G. Bentham and J.D. Hooker "Genera Plantarum". Vol. 1. (Black: London).
Bentham, G. (1870). *Cassia* in Martius (ed.) "Flora Braziliensis". Vol. 15 (2). (Reeve: London).
Bentham, G. (1871). Revision of the genus *Cassia*. *Trans. Linn. Soc. London* 27: 503-593.
Brenan, J.P.M. (1958). New and Noteworthy Cassias from tropical Africa. *Kew Bull.* p. 231-252.
Brenan, J.P.M. (1967). *Cassia* in E. Milne-Redhead & R.M. Polhill (eds) "Flora of Tropical East Africa. Leguminosae Pt 2". (Minister for Overseas Development: London).
Breyne, J. (1678). "Exoticarum aliarumque minus cognitarum plantarum centuria prima" (Danzig).
Britton, N.L. & Brown, H.C. (1913). *Cassia* in "Illustrated Flora of the Northern United States and British Possessions" edn 2 (2). (Charles Scribner's sons: New York).
Britton, N.L. & Rose, J.N. (1925). Spermatophyta *Bot. Porto Rico* 5: 371.
Britton, N.L. & Rose, J.N. (1930). *Cassia* in "North American Flora" 23 (4, 5).
Cavanilles, A.J. (1801). "Description de las plantas". (Madrid).
Colla, L. (1831). "Herbarium pedemontanum". (Turin).
Colladon, L.T.F. (1816). "Histoire naturelle et Médicale des Casses". (Montpellier).
Cowan, R.S. (1981). Caesalpinioideae in Polhill, R.M. & Raven, P.H. (eds). "Recent Advances in Legume Systematics" (Roy. Bot. Gard.: Kew).
De Candolle, A. (1825). Prodromus systematic naturalis regne vegetabilis Vol. 2. (Paris).
De Candolle, A. (1827). *7th Not., Plantes Rares Jard. Genève.* 35.
Desvaux, N.A. (1814). *J. de Bot. Appl.* 3 (2): 73.
De Wit, H.C.D. (1955). A revision of the genus *Cassia* as occurring in Malaysia. *Webbia* 11: 197-292.
Dillenius, J.J. (1732). "Hortus elthamensis" (London).
Dodoens, R. (1553). "Cruijdeboeck". (Antwerp).
Domin, C. (1926). Beitrage zur Flora und Pflanzengeographie Australiens. *Biblioth. Bot.* 89: 790-797.
Gaertner, J. (1791). "De fructibus et seminibus plantarum". Vol. 2 (G.H. Schramm).
Garsault, F.A.P. (1764). "Les Figures de Plantes et Animaux d'usage en Médicine" (Garsault: Paris).
Haines, H.H. (1922). "The Botany of Bihar & Orissa" 304. (Allard & Son: London).
Irwin H.S. & Barneby, R.C. (1976a). Notes on the generic status of *Chamaecrista* Moench. *Brittonia* 28: 28-36.
Irwin, H.S. & Barneby, R.C. (1976b). Nomenclatural notes on *Cassia* L. *Brittonia* 28: 435-442.
Irwin, H.S. & Barneby, R.C. (1979). New names in *Senna* Miller and *Chamaecrista* Moench. *Phytologia* 44: 499.
Irwin, H.S. & Barneby, R.C. (1982). The American *Cassiinae*. *Mem. New York Bot. Gard.* 35 (1.2): 1-918.
Irwin, H.S. & Turner, B.L. (1960). Chromosome relationships and taxonomic considerations in the genus *Cassia*. *Amer. J. Bot.* 47: 309-318.
Isley, D. (1974). Leguminosae of the United States II *Caesalpinioideae*. *Mem. New York Bot. Gard.* 25 (2): 52-133.
Jacobs, S.W.L. & Pickard, J. (1981). "Plants of New South Wales" (Govt Printer: Sydney).
Jacquin, N.J. (1783). "Icones Plantarum rariorum" 1: 8 t. 72. (B. White & Son: London).
Lamarck, M. (1785). "Encyclopédie méthodique Bot". Vol. 1. (Chez Panckouche: Paris).
Lindley, J. (1831). *Edward's Bot. Reg.* Vol. 17, t. 1422.

Link, J.H.F. (1829). "Handbuch zur Erkennung der nutzbarsten" . . . Vol. 2. (Berlin).
Linnaeus, C. (1737). "Genera plantarum" edn 1 (Leiden).
Linnaeus, C. (1753). "Species plantarum" edn 1 (Stockholm).
Linnaeus, C. (1754). "Genera plantarum" edn 5 (Stockholm).
Linnaeus, C. (1781). "Supplementum plantarum" 231. (Braunschweig).
Matthiolus, P.A.G. (1554). "Pedasii Dioscoridis de materia medica" (Venice).
Merrill, E.D. (1921). "A bibliographic enumeration of Bornean plants" 300 (Fraser & Neave: Singapore).
Miller, P. (1754). "The gardeners dictionary" edn 4 (author: London).
Miller, P. (1768). "The gardeners dictionary" edn 8 (author: London).
Miquel, F.A.W. (1850). "Analecta botanica indica" 1: 9 (Sulpke: Amsterdam).
Nageshwar, G., Radhakrishnaiah, M. & Narayana, L.L. (1984). Numerical chemotaxonomy of *Cassia* L. *J. Econ. Tax. Bot.* 5: 1189-1197.
Ortega, C.G. (1800). "Novarum aut rariorum plantarum descriptionum decades" 10: 124. (Madrid).
Persoon, C.H. (1805). "Synopsis plantarum". Vol. 1: 459.
Polhill, R.M. & Vidal, J.E. (1981). *Caesalpinieae* in Polhill, R.M. & Raven, P.H. (eds). "Recent Advances in Legume Systematics". (Roy. Bot. Gard.: Kew).
Randell, B.R. (in press). Proposal to conserve the genus *Cassia* L. with the currently accepted lectotype *C. fistula* L., *Taxon.*
Roxburgh, W. (1832). *Cassia* in Carey (ed). "Flora Indica". Vol. 2. (Parbury Allen: London).
Singh, J.S. (1968). In support of the separation of *Cassia tora* L. and *Cassia obtusifolia* L. as two distinct taxa. *Curr. Sci.* 37: 381-382.
Standley, T.D. & Ross, E.M. (1983). "Flora of south-eastern Queensland". Vol. 1. (Department of Primary Industries: Brisbane).
Steudel, E.G. (1840). "Nomenclater botanicus" edn 2, 2 (10): 304.
Sweet, R. (1828). Flora Australasica. (Ridgeway: London).
Symon, D.E. (1966). A Revision of the genus *Cassia* in Australia. *Trans. Roy. Soc. S. Australia* 90: 73-146.
Tournefort, J.P. (1700). "Institutiones Rei Herbariae" edn altera (Typographia Regia: Paris)
Vatsavaya, S.R. & Rama Rao, N. (1986). On the identity and distribution of *Cassia obtusifolia* in southern India. *J. Econ. Tax. Bot.* 8: 485-487.
Vogel, J. (1837). "Generis *Cassiae* synopsis". (Berlin).
Vogel, J. (1841). Synopsis generis *Cassiae*, *Linnaea* 15: 66-73.
Willdenow, K.L. (1809). "Enumeratio plantarum horti regii botanici Berolinensis". (Berlin).

J. Adelaide Bot. Gard. 11(1): 51-54 (1987)

A NEW SPECIES OF *BRACHYCOME* (ASTERACEAE) FROM THE LAKE EYRE REGION, SOUTH AUSTRALIA

Ahmad Abid Munir

State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

A new *Brachycome*, *B. coongiensis*, is described from the Lake Eyre Region, South Australia. A detailed description of the species is supplemented by a sketch; affinities and distribution are considered.

Introduction

Since the recently published account of the genus *Brachycome* in South Australia (Cooke, 1986), a new species of the genus from the Lake Eyre Region has come to hand. Attempts have been made to identify it with the help of a "revision of the genus *Brachycome*" by G.L. Davis (1948) and D.A. Cooke (1986). In both publications the key to the species identified these collections as close to *B. basaltica* F. Muell. The key to the species by Cooke (1986) also leads close to *B. trachycarpa* F. Muell. The new material, however, did not agree with these or any other species of the genus. After examination of the types of *B. basaltica* and *B. trachycarpa*, and comparing the new material with authentic collections of other *Brachycome* species, the new material is found to be an undescribed new taxon. It is, therefore, being described here as a new species, *Brachycome coongiensis*. In order to show briefly the similarities and differences between *B. coongiensis* and its nearest allies, a short key to the species, modified from D.A. Cooke (1986), is presented here:

(1) a. Plants with widely spreading stolons .... *B. graminea* & allied species

b. Plants without stolons .... 2.

(2) a. Leaves mostly basal and near-basal; peduncles occupying more than half the length of the stems .... *B. diversifolia* & allied species

b. Leaves mostly cauline; peduncles occupying less than half the total length of the stems .... 3.

(3) a. Achenes with smooth surfaces .... *B. parvula* & allied species

b. Achenes with tuberculate surfaces .... 4.

(4) a. Undershrubs with stems woody near ground level .... *B. trachycarpa* & allied species

b. Annual or perennial herbs .... 5.

(5) a. Leaves ovate, obovate or oblanceolate to cuneate, distinctly toothed at least near the tip .... *B. goniocarpa* & allied species

b. Leaves linear-lanceolate to narrowly oblanceolate, entire or the lower sometimes with a few small linear lobes or teeth .... 6.

(6) a. Stems woody near ground level; peduncles with scattered glandular hairs; leaves entire or the lower with a few small linear lobes or teeth; pappus a minute ring or connate teeth .... *B. trachycarpa*

b. Stems herbaceous, with or without underground rhizome; peduncles glabrous, sometimes with sessile glands; leaves entire; pappus papillose, reduced to a microscopic rim.

(7) a. Perennial herb with an underground rhizome; achenes with minute tubercles all over on each surface; tubercles in 3-5 longitudinal rows .... *B. basaltica*

b. Annual herb, without underground rhizome; achenes with distinct tubercles in a single longitudinal central row on each surface .... *B. coongiensis*

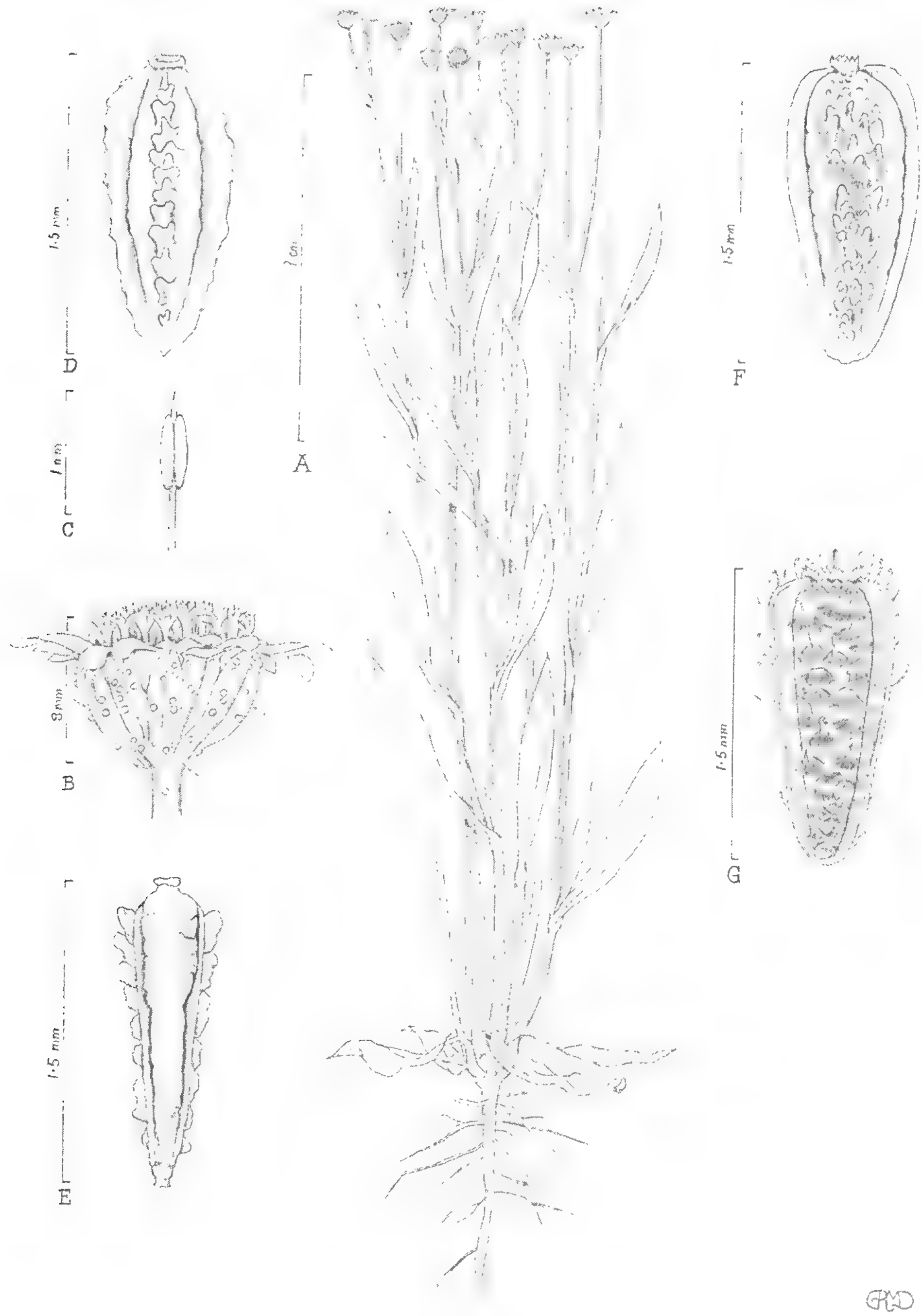


Fig. 1. *Brachycome coongiensis.* A, habit sketch of the type specimen; B, capitulum; C, anther showing connective produced beyond the pollen-sacs; D, achene showing tubercles in a single longitudinal line along the middle; E, lateral view of achene showing single longitudinal row of tubercles on each surface; F, *B. basaltica* achene showing tubercles all over the surface; G, *B. trachycarpa* achene showing tubercles and glandular ("Hooked") hairs. (A-E, *J. Reid 1183*: AD, holotype; F, *Hj. Eichler 15677*: AD; G, *J.Z. Weber 6594B*: AD).

Brachycome coongiensis Munir, sp. nov.

Herba annua ad 35 cm alta. *Caulis* solitarius vel aliquot a base exorientes erecti ramosi glabri striati. *Folia* caulina ramicolaque sessilia lineari-lanceolata usque oblanceolata integra glabra 2-7 cm longa 0.5-1 cm lata; folia basalia versus basem longiattenuata mox marcescentia; folia caulina ramicolaque lata et adbasim fere amplexicaulia ad basim apparenter semidecurrentia. *Capitulum* 5-8 mm diam.; pedunculi in corymbis laxis dispositi aphylli vel 1 vel 2 foliis diminutis glabri striati 2.5-10 cm longi; receptaculum convexum leviter foveatum 1.5-2.5 mm diam. *Bracteae involucrales* 18-20 oblongae usque obovatae acutae 3-5 mm longae 1-2 mm latae intra glabrae extra minute glanduloso-puberulae virides apicibus marginibusque scariosis. *Flosculi radii* 25-32; ligulae oblongae 3-4 mm longae c. 1 mm latae pallide violaceae usque albae. *Antherae* appendiculis terminalibus. *Achenia* cuneata plus minusve complanata atrobrunnea 1-1.5 mm longa c. 1 mm lata glabra distincte tuberculata secus medium superficiei quaeque; tubercula plus minusve U-forma cristam singularem longitudinalem formantia; pappus papillosus ad cristam microscopicam reducta.

Type: *J. Reid 1183*, Coongie, Lake Eyre Region, 27°10′S 140°09′E, South Australia, 1.ix.1987 (AD, holotype; AD, BRI, MEL, NSW — isotypes).

Description (Fig. 1)

Annual herb to 35 cm high. *Stem* solitary or a few arising from the base, erect, branched, glabrous, striate. *Leaves* cauline and ramal, sessile, linear-lanceolate to oblanceolate, entire, glabrous, 2-7 cm long, 0.5-1 cm wide; basal leaves long-attenuate towards the base, soon withering; cauline and ramal leaves broad and almost amplexicaul at the base, apparently semi-decurrent. *Capitulum* 5-8 mm diam.; peduncles in loose corymbs, leafless or with 1 or 2 reduced leaves, glabrous, striate, 2.5-10 cm long; receptacle convex, slightly pitted, 1.5-2.5 mm diam. *Involucral bracts* 18-20, oblong to obovate, acute, 3-5 mm long, 1-2 mm wide, glabrous inside, minutely glandular-puberulus outside, green with scarious apices and margins. *Ray florets* 25-32; ligules oblong, 3-4 mm long, c. 1 mm wide, pale-violet to white. *Anthers* with terminal appendages. *Achenes* cuneate, more or less flattened, dark-brown, 1-1.5 mm long, c. 1 mm wide, glabrous, distinctly tuberculate along the middle of each surface; tubercles ± U-shaped, forming a single longitudinal ridge along the middle; pappus papillose, reduced to a microscopic rim.

Specimens examined

SOUTH AUSTRALIA: Lake Eyre Region: *Conrick 2255*, Innamincka Station, 4.xi.1987 (AD, K); *C. O'Malley 229*, Coongie Lake, 25.i.1987 (AD); *J. Reid 1142*, 2 km south of Coongie, 15.ix.1987 (AD, NT, PERTH); *J. Reid 1147*, Embarka Swamp, 11.ix.1987 (AD); *J. Reid 1183*, Coongie, 1.ix.1987 (AD, holotype; AD, BRI, MEL, NSW).

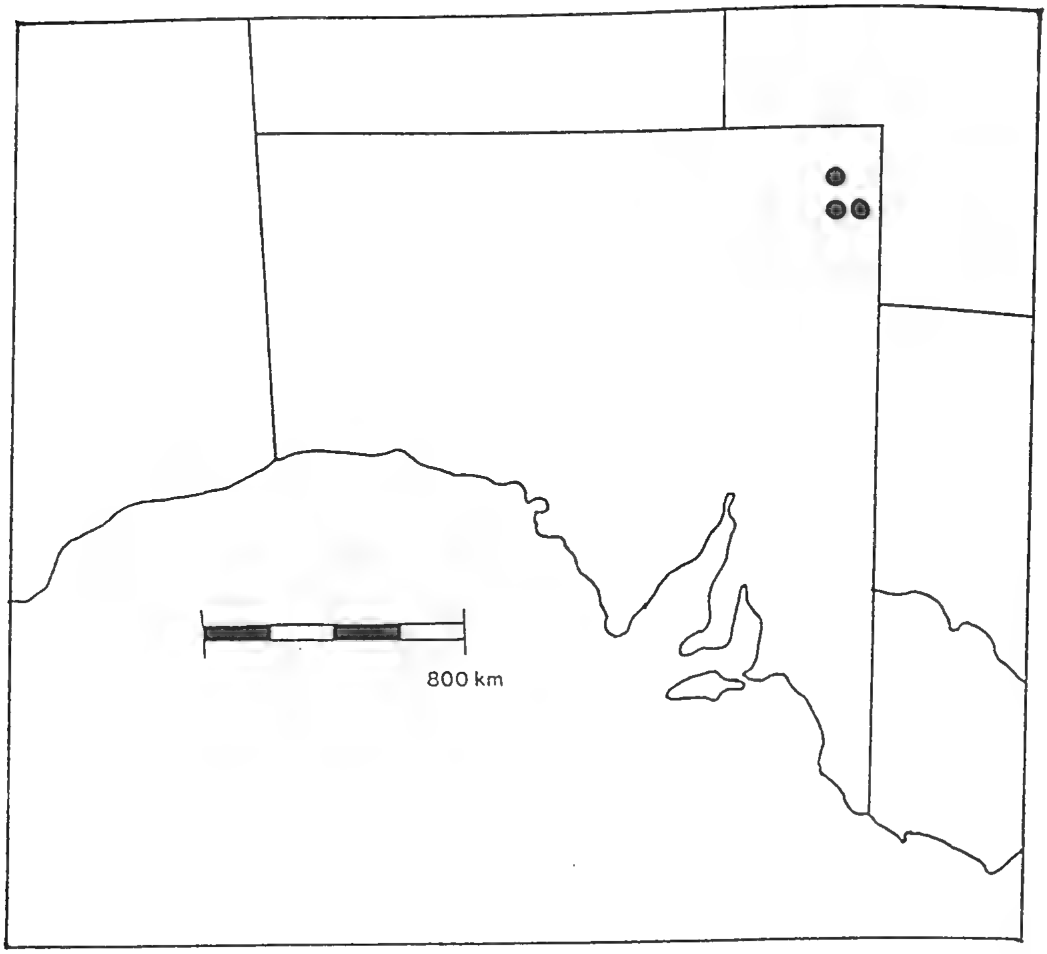
Distribution (Map 1)

B. coongiensis seems confined to the far north-eastern corner of South Australia. So far it has been recorded only from the area around Coongie Homestead in the Lake Eyre Basin.

Affinities

In view of the anther connective being produced beyond the pollen-sac, *B. coongiensis* is referred here to the subgenus *Eubrachycome*. Within the subgenus, *B. coongiensis* is nearest to *B. basaltica* from which it can easily be distinguished by its herbaceous habit and the much more distinct tubercles arranged in a single longitudinal row on each surface of the achene. In *B. basaltica*, the achenes have small tubercles not much raised above the surface and occupying almost the entire surface except the marginal ridges. Moreover, *B. basaltica* is known to occur only in the south-eastern and Murray region in South Australia.

There are several characters common to *B. coongiensis* and *B. trachycarpa*. The latter, however, is a woody perennial with glandular hairy stems and peduncles, and achene surface tuberculate with glandular ("hooked") hairs. So far, *B. trachycarpa* has not been found north of the Gairdner-Torrens and Flinders Ranges regions in South Australia.



Map 1. Distribution of *Brachycome coongiensis.*

Acknowledgements

The author is grateful to Dr J.P. Jessop for translating into Latin the description of this species; Mr D.A. Cooke for confirming this taxon as new; Mr G.R.M. Dashorst for preparing the drawing; Miss M. Eadsforth for typing the manuscript.

References

Davis, G.L. (1948). Revision of the genus *Brachycome* Cass. Part I. Australian species. *Proc. Linn. Soc. N.S.W.* 73: 142-241.

Cooke, D.A. (1986). *Brachycome.* In J.P. Jessop & H.R. Toelken, "Flora of South Australia" 3: 1445-1458. (Govt Printer: Adelaide).

J. Adelaide Bot. Gard. 10(1): 55-58 (1987)

ACACIA UNDOOLYANA: A NEW SPECIES FROM CENTRAL AUSTRALIA

G.J. Leach, P.K. Latz & A. Soos

Conservation Commission of the Northern Territory,
P.O. Box 1046, Alice Springs, Northern Territory, 5750

Abstract

A. undoolyana G. Leach is described as a new species. It is closely related to *A. macdonnelliensis* Maconochie and also shows some affinities to *A. ammobia* Maconochie. The species is restricted to the East Macdonnell Ranges of Central Australia. It is considered vulnerable with frequent wildfires identified as the major threat.

Acacia undoolyana G. Leach, sp. nov.

Frutex elatus vel arbor 2-15m alta. *Cortex* scaber griseus ad brunneus. *Ramuli* pubescentes glabrescentes costis inconspicuis flavidis. *Phyllodia* sparsim pubescentia argentei-furfuracea valde falcata cuneata ad apices acuta 15-22 cm longa 6-12 mm lata, nervis 1 vel 3 longitudinalibus ceteris prominentioribus et nervis secundariis tenuibus congestis non anastomantibus praedita, venis marginalibus conspicuae luteae; glans basalis obscura 1-1.5 mm longa; pulvinus 2-3 mm longus, phyllodia juvenalia argentea dense appresse pubescentia obovata, glande apicali prominenti. *Inflorescentia* brevis axillaris racemosa, spicis 1-4, axe pubescenti 1-15 mm longo saepe axe in surculum foliaceum elongato. *Spicae* densae vivide aureae 15-25 mm longae in pedunculis dense pubescentibus 4-6 mm longis; rhachis glaber; bracteolae spathulatae c. 1 mm longae. *Flores* 5-meri; calyx 0.75-1 mm longus pubescens, lobis c. 0.25 mm longis obtusis; corolla 1.5-2 mm longa, calyce c. duplo longior, glabra, lobis tubum aequantibus, apicibus incrassatis; stamina 3-4 mm longa; ovarium dense pubescens. *Legumen* planum 60-110 mm longum 2-3 mm latum inter semina contractum sparsim pubescens. *Semina* longitudinalia nitida brunnea oblonga c. 4 mm longa 1.5-2 mm lata; funiculus sub semino 2-3plo plicatus.

Type: *G.J. Leach 1367*, 17.viii.1987, N'Dhala Gorge Nature Park, 23° 38′ S, 134° 28′ E (DNA, holo.; AD, BRI, CANB, CBG, K, MEL, NSW, NT, PERTH, iso.).

Tall shrub to tree 2-15 m high. *Bark* rough, grey-brown. *Branchlets* pubescent, glabrescent, with indistinct yellowish ribs. *Phyllodes* sparsely pubescent with dense white scurfy bloom, strongly falcate, narrowed to each end, acute, 15-22 cm long, 6-12 mm wide; 1 or 3 longitudinal nerves more prominent than the rest with many fine crowded secondary nerves, not visibly anastomosing, with conspicuous yellow margins; gland basal, inconspicuous, 1-1.5 mm long; pulvinus 2-3 mm long, immature phyllodes silvery, densely appressed-pubescent, obovate, apical gland prominent. *Inflorescence* a short axillary raceme with 1-4 spikes, axis pubescent, 1-15 mm long, often growing into leafy shoot. *Spikes* dense, bright yellow, 15-25 mm long on densely pubescent peduncles 4-6 mm long; rachis glabrous; bracteoles spathulate, c. 1 mm long, pubescent. *Flowers* 5-merous; calyx 0.75-1 mm long, pubescent, lobes c. 0.25 mm long, obtuse; corolla 1.5-2 mm long, c. twice as long as calyx, glabrous, lobed to about middle, apices thickened; stamens 3-4 mm long; ovary densely pubescent. *Pod* flat, 60-110 mm long, 2-3 mm wide, constricted between seeds, sparsely pubescent. *Seeds* longitudinal, shiny, brown, oblong, c. 4 mm long, 1.5-2 mm wide; funicle folded 2-3 times below the seed. (Fig. 1).

Specimens examined

NORTHERN TERRITORY: N'Dhala Gorge, c. 65 km E of Alice Springs, *A.C. Beauglehole 20792*, 15.x.1966 (NT); *P.K. Latz 10259*, 13.ix.1985 (NT, PERTH); *A. Soos 7, 8, 9*, 7.ix.1987 (DNA, NT); Kadaicha Ranges, *A. Soos 23, 24, 25, 26, 27*, 10.ix.1987 (DNA, NT); 25 km SW of Trephina Gorge, *P.K. Latz 10427, 10428*, 9.iv.1987 (DNA, NT).

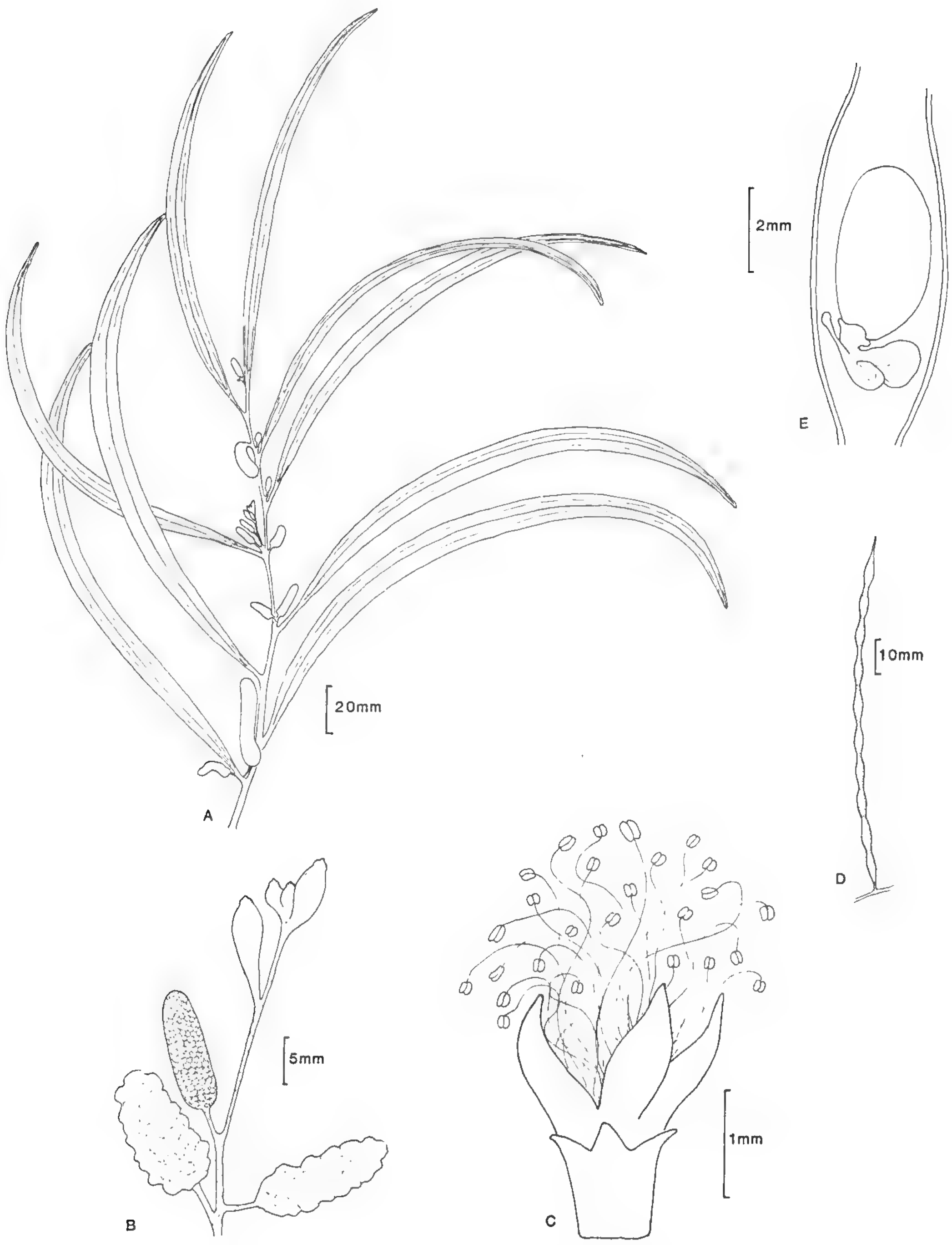


Fig. 1. *A. undoolyana.* A, flowering branch; B, inflorescence; C, flower; D, pod; E, seed in pod. (A-C, *Leach 1367*; D, E, *Beauglehole 20892*). Illustrated by P. Fox.

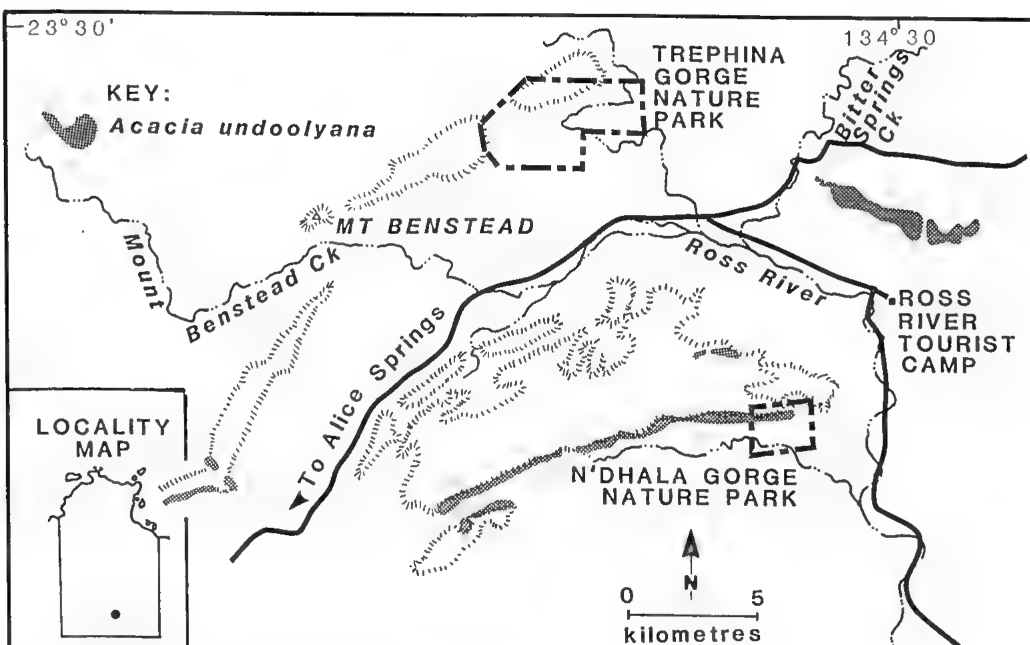
Affinities

Early collections of this species have previously been identified as *A. cowleana* or *A. ammobia*, however, *A. undoolyana* is most similar to *A. macdonnelliensis*. The latter two species are separated by *A. undoolyana* having longer, broader and strongly falcate phyllodes which in the field have a distinctive silvery sheen. These four species can be distinguished as follows:

1. Phyllodes with obvious anastomosing veins .... *A. cowleana*
1. Phyllodes with numerous close parallel veins; anastomoses not visible 2
2. Phyllodes 6-15 cm long, 1-3 mm broad; peduncle 2-4 mm long .... *A. macdonnelliensis*
2. Phyllodes 12-22 cm long, 4-12 mm broad; peduncle 4-7 mm long 3
3. Phyllodes mostly straight, rarely curved at tip; peduncle glabrous; mostly on sand dunes .... *A. ammobia*
3. Phyllodes strongly falcate; peduncle densely pubescent; rocky hills .... *A. undoolyana*

Distribution and ecology (Map 1)

A. undoolyana is only known from 3 populations in the East Macdonnell Ranges covering c. 35, 200 and 600 ha respectively (Soos et al., 1987). It is considered a threatened species and is here designated as 2VCi based on the coding scheme of Leigh, Briggs and Hartley (1981). Frequent wildfires are identified as the major threat. Although the species is marginally represented in the N'Dhala Gorge Nature Reserve the small size of this reserve makes an adequate fire management plan almost impossible and so the species must be considered inadequately conserved. All remaining populations are on a pastoral lease but as the species inhabits rocky ranges the threat from grazing by stock is minimal. The species is restricted to steep rocky slopes with skeletal soils. On ridgetops, it is replaced by *A. macdonnelliensis* and on slopes with increasing amounts of soil it is replaced by *A. aneura*.



Map 1. Distribution map of *A. undoolyana*.

Flowering and fruiting

Flowering specimens have been collected in August and September; fruiting material in September and October. The extensive flowering observed during August/September of 1987 did not result in any successful fruit set.

Etymology

The main population is on the Undoolya pastoral lease, managed over the last 80 years by the Hayes family.

Acknowledgement

Les Pedley (BRI) is gratefully acknowledged for comparing material of *A. undoolyana* with several Queensland taxa.

References

Leigh, J., Briggs, J. & Hartley, W. (1981). Rare or threatened Australia plants. *ANPWS Special Publication 7.*

Soos, A., Latz, P.K. & Kube, P. (1987). Occurrence of two rare plant populations in the Eastern Macdonnell Ranges. *Conservation Commission of the Northern Territory, Technical Memorandum 87/11.*

J. Adelaide Bot. Gard. 10(1): 59-61 (1987)

A NEW *EUCALYPTUS* SPECIES FROM THE WYOLA REGION, IN THE FAR WEST OF SOUTH AUSTRALIA

Cliff D. Boomsma

144 Cashel Street, St Marys, South Australia 5042

Abstract

A new *Eucalyptus* species *E. wyolensis* (series *Oleosae*, superspecies *socialis*), is described from the North-West Region of South Australia. It is a mallee or small tree, which is allied to *E. socialis* by similarities in fruits and buds, and to *E. gillii* by the persistent, opposite, glaucous, rounded leaves of the mature crown.

Eucalyptus wyolensis C.D. Boomsma, sp. nov.

Arbor parva multicaulis vel unicaulis ad c. 6 m alta, cortice superne laevi pallentique, versus basim asperantur et persistenti. Rami usque ad annos duos aetate valde glauci tetragonique sed glaucedone erodenti et caulibus post annos aliquot pluribus teretibus crescentibus. Folia plantularum sessilia decussata glauca; foliis superis ovato-lanceolatis, ovatis ovato-cordatis vel suborbicularibus apiculatis, nervatura obscura ubi glauca praeter costam prominentem. Ramuli valde glauci tetragoni initio alati post annos paucos teretes crescentes. Partium maturarum folia similaria foliis superis plantularum sed majora ad 6 x 7 cm crassa coriacea, costa robusta in superficiebus ambalus folii elevata, glaucedone erosa paribus c. 20 nervorum secundariorum sub angulo 45-60° ad costam distinguibilibus sed reticulo et glandulis olei obscuris remanentibus. Inflorescentiae axillares decussatae glaucae, floribus ad 11 in fasciculo quoque. Pedunculi glauci plani sursum dilati 10-15 mm longi. Pedicelli glauci angulosi robusti ad 6 x 1.8 mm. Alabastra glauca rostrata ad 15 x 6 mm, operculo hypanthium aequantibus vel superantibus. Staminia aurea inflexa omnino fertilia, antheris parvis "platyantherae" sensu Blakely. Stylus in alabastro super antheras elongatus. Fructus pedicellatus plus minusve cupulatus interdum orificio constricto interdum pariete valde incrassato ad 9 x 10 mm disco verticali, valvis subulatis exsertis ubi siccis fragilibus 4 (5). Semina elliptica ovato-acuminata vel oblongo-obtusa brunnea usque brunneo-cinerea vade foveata.

Type: 50 km W of Lake Maurice [south of Lake Wyola] (29°25'S, 130°E), 27.xii.1987, *G. White 13*, (holotype: AD; isotype: CANB, K, NSW). Fig. 1.

A mallee or small tree to 6 m tall, persistent rough bark at the base of the trunk replaced by smooth pale bark above. Branches up to two years old markedly glaucous and square in section but glaucescence eroding and stems becoming round after a few more years. *Seedling* leaves sessile, decussate, glaucous, upper leaves ovate-lanceolate, ovate, ovate-cordate to almost orbicular, apiculate, venation obscure while glaucous except for the strong midrib. *Branchlets* markedly glaucous, square in section, winged at first becoming rounded after a few years. *Leaves of the mature canopy* similar to upper seedling leaves, but larger to 6 x 7 cm, thick, coriaceous, midrib robust, raised on both leaf surfaces. After glaucescence erodes, about 20 pairs of secondary veins arising at angles 45°-60° to the midrib discernable but reticulation and oil glands remaining obscure. *Inflorescences* axillary decussate glaucous, and up to 11 buds per cluster. *Peduncles* glaucous, flat, dilated upwards, 10-15 mm long. *Pedicel* glaucous, angular, robust to 6 x 1.8 mm. *Buds* glaucous, rostrate, to 15 x 6 mm, operculum as long as or longer than hypanthium. *Flowers*: stamens golden, inflexed, all fertile, anther small, *platyantherae* (sensu Blakely, 1965) style elongated above stamens in bud. *Fruit* pedicellate, more or less cupular, sometimes constricted at the orifice, sometimes markedly thick-walled, to 9 x 10 mm. *Disc* a vertical inner lining to the fruit. *Valves* subulate, exsert, fragile when dry, 4 (5). *Seed* elliptical, ovate-acuminate, to oblong-obtuse, brown to brown-grey, shallowly-pitted. Fig. 2.

Distribution and habitat

Appears to be restricted to patches of red-brown sands over limestone sandwiched between the north edge of the Nullarbor Plain and sandhills of the Victoria Desert. Its occurrence could therefore extend westwards in a similar habitat in Western Australia.

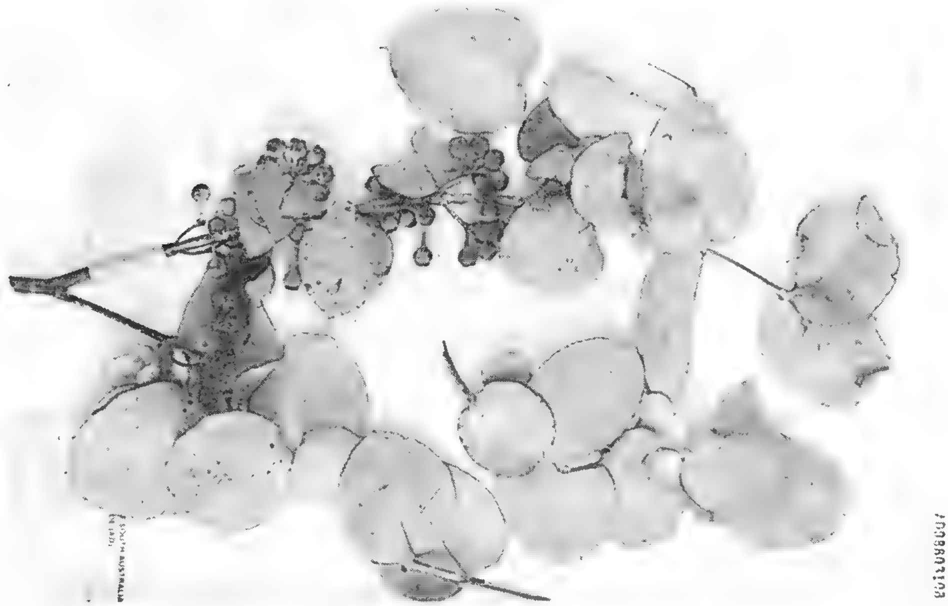


Fig. 1. Holotype of *Eucalyptus wyolensis*, *White 13* (AD).

Fig. 2. *Eucalyptus wyolensis* is a codominant mallee associated with *E. socialis*, *E. oleosa*, *E. concinna* and *E. striaticalyx* in open scrub over a discontinuous understory of mainly *Triodia basedowii* and scattered shrubs and herbs (*Dennis 304*). Photo by T.E. Dennis.

It occurs in open scrub apparently in association with sandy soils overlying limestone (often shallow). Associated mallees include *E. concinna* Maiden & Blakely, *E. ewartiana* Maiden, *E. oleosa* F. Muell. ex Miq. and *E. striaticalyx* W.V. Fitzg. Small trees of *Acacia aneura* F. Muell. and a ground cover of *Triodia* sp. also occur.

Flowering

Flowering period in cultivation extends from late summer to early autumn.

Affinities

The elegant rostrate bud and subulate valves place it in the superspecies *socialis* in the series *Oleosae* of Pryor & Johnson (1971). It differs from *E. socialis* F. Muell. in the opposite rounded leaves of the mature canopy, from *E. gillii* Maiden by the large size of its leaves, buds and fruits as well as the bright yellow colour of the flowers and from *E. yumbarrana* C.D. Boomsma by the persistent opposite leaves in the mature canopy.

Specimens examined

SOUTH AUSTRALIA: *T. Dennis 304*, vii.1982, north-west Maralinga and south-west of Lake Wyola (AD); *G. White 18*, 29.viii.1986, south of Lake Wyola (AD); *P. Canty 2373*, 16.x.1987, 2 km east of Vokes Hill-Muckera Junction on Oak Valley Road (AD).

EX CULT.: *C.D. Boomsma 878*, 10.i.1987, Clovelly Park (AD); *C.D. Boomsma 903*, 24.iii.1988, Clovelly Park (AD).

References

Blakely, W.F. (1965). A key to the eucalypts, edn 3. (Forestry and Timber Bureau: Canberra).

Pryor, L.D. & Johnson, L.A.S. (1971). A classification of the eucalypts. (Australian National University: Canberra).

J. Adelaide Bot. Gard. 11(1): 63-65 (1988)

BOOK REVIEWS

The Moraeas of Southern Africa

Goldblatt, P. "The Moraeas of Southern Africa", 1986,
National Botanic Gardens, Kirstenbosch, Cape Town.

"The Moraeas of Southern Africa" is an interesting, if occasionally slightly disconcerting, mixture of a systematic monograph in a more popular "coffee-table" format. Although the first of a new series to be known as *Annals of Kirstenbosch Botanic Gardens*, this is designated number 14 of the superseded Supplementary Volumes to *Journal of South African Botany*.

The volume draws together many of the results of three or four scattered publications which collectively form a monographic revision of the genus *Moraea*, in which 119 species are recognised, all native to southern parts of Africa. This treatment covers only the 103 species in "Southern Africa", the bounds of which appear not to be mentioned except on the title page.

It is apparent throughout the book that the author has a strong interest in botanical history. The largest of the introductory sections is devoted to a history of the genus, as well as each species having a small "history" section: these tend to be rather "mixed bags" of information of limited interest. The history of the genus (pp. 2-7) is cumbersome due to the rigid chronological treatment. The high aesthetic quality of the book is, I believe, spoiled by poor reproductions from historic works.

Interesting and useful sections follow on morphology, general biology, cultivation and taxonomic relationships. These are generally well-written and of interest to both scientific and amateur readers. The lay-out seems at times to be poor. It is unfortunate, for instance, that the synopsis (Table 1) is placed so as to disrupt the continuity of the Floral Biology section. This could easily have been overcome by omission of some meaningless illustrations (pp. 7, 11).

The main section of the book consists of a "Systematic Treatment" of the genus in Southern Africa. The key is divided "for convenience" into two sections — species of the winter rainfall area and those of the summer rainfall area. I believe this to be a disadvantage if one considers its use with certain types of herbarium specimen or with horticultural material from sources outside Africa. I am also informed that these regions are difficult to interpret in southern Africa. Little mention is made of modern cultivation of *Moraea* outside Africa, or of known naturalisation of the genus in other areas, e.g. three species naturalised in parts of southern Australia. This type of information, rather than long taxonomic histories, would have given the book wider appeal.

In general, the taxonomic section is well set out and the illustrations, especially the water-colours, are well executed, aesthetically pleasing and botanically adequate as aids to identification. The pencilled captions to the paintings are unfortunate, as the clarity of reproduction is inconsistent and where there are two species on one plate, it is sometimes not clear which caption applies.

The book is well presented and produced. I believe it would appeal more to those with horticultural or artistic interest, especially due to the large format. It is a pity that small editorial inaccuracies and textual problems detract from its excellent first impression.

Goldblatt, P. (1986). 'The Moraeas of Southern Africa', *Annals of Kirstenbosch Botanic Gardens*, vol. 14, pp. 224, with approximately 60 watercolour illustrations by Fay Anderson and 150 line drawings by Margo Branch and Janet Klein. Maps. (Published by National Botanic Gardens, Kirstenbosch: Claremont). Hard-bound. R44.00 (Overseas price US $33.00 incl. postage).

Graham Bell
State Herbarium of South Australia

The Botany of the Southern Natal Drakensberg

Hilliard, O.M. & Burtt, B.L. "The Botany of the Southern Natal Drakensberg", 1987, National Botanic Gardens, Kirstenbosch, Cape Town.

This is another product of the authors' years of combined botanical exploration and research in Natal (South Africa). It is much more than a checklist of some 1500 plants from an area of 1115 km² (430 square miles) as measured on the map but much larger because of its mountainous terrain. The botany in its widest sense includes more than the usual subjects of topography, climate, fire, historical exploration, vegetation patterns and the actual checklist of all flowering plants, ferns and mosses. The vignettes such as the discussions on 'pollination' syndromes, 'hybrids', 'growth forms', 'assimilating stems' etc. reflect the work of observant collectors to whom the smallest detail matters. It might seem extravagant to include several pages on natural hybrids outside the checklist, but in a world with few areas so unaffected by exploration and land use such hybrids in undisturbed vegetation are important to note.

The 'Enumeration of the flora' provides ecological details and in plants other than mosses phytogeographical information at genus and species level and general comments usually of a taxonomic nature. The book is a source of bibliographical information as references to recent relevant literature are common. Of the many approaches to the presentation of local floras, this is one which can certainly be recommended. Instruments for identification of plants from this region are to be found in the by now somewhat dated Ross (1972) 'Flora of Natal', but a key to the species of *Erica* and *Philippia* is included here. The photographs of plants usually shown in their habitat are informative, but the printing has reduced clarity in some of them. It is a pity, although probably unavoidable that the illustrations are towards the end very much out of synchrony with the text.

The particular area was, it seems, not selected entirely because it is a little known area, but rather as a vehicle for a discussion of the phytogeography of the area within the Drakensberg and in turn the flora of the Drakensberg within Africa. Analyses of the composition of the flora of various areas and their affinities lead the authors to recognise on top of the Drakensberg an Eastern Mountain Region separate from the Afro-alpine or Afro-montane Regions.

This reference book presents a high standard for a local flora in conciseness and clarity of presentation from finest detail to overview by two authors who are uniquely familiar with the area and its plants.

Hilliard, O.M. & Burtt, B.L. "The Botany of the Southern Natal Drakensberg", *Annals of Kirstenbosch Botanic Gardens*, vol. 15, pp. 253, plates 37 (colour photographs), 6 maps. (Published by National Botanic Gardens, Kirstenbosch; Claremont). Hard-bound. R52.40 (Overseas price US$ 25.00 incl. postage).

H.R. Toelken
State Herbarium of South Australia

Conserving Genetic Diversity in Crop Plants

"Botanic Gardens and Germplasm Conservation", 1986, Harold L. Lyon Arboretum Lecture Number Fourteen, University of Hawaii Press: Honolulu

The Harold L. Lyon Arboretum of the University of Hawaii has since 1970 held an annual lecture which is published by the Arboretum Fund and University of Hawaii Foundation. The fourteenth lecture was published in 1986 entitled 'Botanic Gardens and Germplasm Conservation', by Professor Nigel J.H. Smith of the Department of Geography, University of Florida. This is a topical and important subject which is likely to receive much more attention with recent regional developments within the International Association of Botanic Gardens, (Larsen & Morley, in press), and the creation of the I.U.C.N. Botanic Gardens Conservation Secretariat at Kew, (Heywood & Wyse Jackson, 1988). The role of botanic gardens as centres for *ex situ* conservation of rare and endangered species, as well as cultivar germplasm, is rapidly expanding, as is the corresponding need for botanic gardens to avoid duplicating each others activities and to co-operate more in securing additional resources. The dramatic loss of habitat, particularly in tropical and arid land ecosystems, especially in developing nations, leaves very little time in which to undertake responsible and considered conservation measures.

Unfortunately, some three quarters of the article deals with an historical description of the role of largely tropical botanic gardens as plant acclimatization centres, in many cases rather briefly through lack of space. The list of references includes a number of useful up-to-date titles. The last seven pages contain interesting observations on how different tropical botanic gardens have developed collaborative germplasm conservation programmes with agricultural research organisations, city recreation departments and private citizens. The author visited centres in Singapore, Indonesia, the Philippines, Hong Kong, Macau, and the Hawaiian Islands in 1985.

On p. 12, showing a world map of the distribution and founding dates of botanic gardens involved in the spread of tropical crops, there is no reference to the Jardin Botanique de Victoria, Cameroon, founded in 1892 (p. 9), or either of the botanic gardens in Brisbane or Sydney. Powell's (1972 & 1973) critical articles on crop plant introduction to Jamaica by Captain Bligh could have usefully supplemented the information obtained from the semi-popular work by Eyre (1966). The correct spelling is Castleton Botanic Garden in Jamaica, not "Carleton" on p. 20, and on p. 28 it would have been appropriate to mention that Sir Joseph Banks also visited Australia on the Cook voyage (Tahiti, New Zealand, the East Indies and South Africa are all cited). On p. 34 the possible impression is given that Augustine Henry was employed in the Irish consular service in China; he worked for the British Government in the Imperial Maritime Customs Service. Although he lived for most of his European life in Ireland, he was born in Dundee in Scotland! The collections of herbarium specimens and such seed he obtained were largely sent to Kew, or the Arnold Arboretum to a lesser extent, certainly not Ireland.

Despite these minor points the lecture is interesting, attractively produced and continues the worthwhile tradition of the Harold L. Lyon Arboretum Lecture Series.

Smith, N.J.H. (1986). 'Botanic Gardens and Germplasm Conservation' Harold L. Lyon Arboretum Lecture Number Fourteen, pp. 55, 14 monochrome illustrations, 1 map. (University of Hawaii Press; Honolulu). Soft bound US$8.00 available from University of Hawaii Press, Order Department, 2840 Kolowalu Street, Honolulu, Hawaii 96822.

References

Eyre, A. (1966). 'The Botanic Gardens of Jamaica' (Andre Deutsch: London).
Heywood, V.H. & Wyse Jackson, P.S. eds. (1988). *Botanic Garden Conservation News* 1 (1): 3-6.
Larsen, K. & Morley, B.D., eds. (in press). 'Botanic Gardens and Nature Reserves in the Tropics. Proceedings of the Tenth General Meeting, I.A.B.G., Frankfurt, W. Germany, 1987'. (Botanical Institute: Aarhus).
Powell, D. (1972). 'The Botanic Garden, Liguanea'. *Bull. Institute of Jamaica* (Science) 15 (1): 1-94.
Powell, D. (1973). 'The voyage of the plant nursery, H.M.S. Providence 1791-1793'. *Bull. Institute of Jamaica* (Science) 15(2): 1-70.

Brian Morley
Botanic Gardens of Adelaide

J. Adelaide Bot. Gard. 10(1): 67-74 (1987)

PLANT PORTRAITS

23. **Spyridium tridentatum** (Steudel) Benth. (Rhamnaceae)

Spyridium tridentatum (Steudel) Benth., *Fl. Austral.* 1 (1863) 427.

Cryptandra tridentata Steudel in Lehm., *Pl. Preiss.* 1 (1845) 186. — *Stenanthemum tridentatum* (Steudel) Reisseck, *Linnaea* 29 (1858) 295.

Ic.: Apparently not previously illustrated.

Illustration: Based partly on fresh material collected at the same time as the population sample *P. Lang DEP 8674-8681*, partly on dried specimens as indicated.

Small rather intricate shrub with fine, erect to procumbent, often leafless, woody branches c. 8-25 cm long and with short lateral branchlets with clustered leaves at the apex, all but the oldest branches persistently stellate-tomentose with the hair arms ascending from the branch surface. *Leaves* 2-6 mm long, subpetiolate, with the blade broadly obovate, conduplicate by folding upwards on either side of the midrib, the margins c. 1-1.6 mm from the midrib at their widest point towards the apex, persistently densely stellate-pubescent to shortly stellate-tomentose, in younger leaves overtopped by sparse antrorse apparently simple rust-brown hairs, the apex broadly emarginate when the blade is flattened, with the midrib projected forward by the coherent mass of long antrorse hair arms surrounding a fine woody mucro if present, giving the flattened apex a 3-toothed appearance; paired *stipules* broadly ovate, c. 1.5-2 mm long, each irregularly sparsely finely dentate, long-caudate with the fragile long slender apical portion sometimes as long as the blade, mid brown ageing to dark brown, sparsely shortly pubescent inside, the midrib and margins predominantly antrorse-sericeous outside. *Flowers* sessile or subsessile usually few and clustered at the apex of short shoots, in clusters subtended by leaf-like bracts, rarely solitary in a leaf axil further back, subtended by small stipule-like brown bracts, stellate-pubescent with ascending hair arms outside; *hypanthium* very short; *sepals* ovate to broadly ovate, 0.8-1.2 mm long, acute to shortly acuminate, valvate in bud, erect at anthesis and on fruit. *Fruit* a capsule surrounded by the persistent ovary-wall and topped by the hardly enlarged hypanthium and sepals, broadly ellipsoid, 1.8-2.2 mm long, persistently stellate-pubescent, dehiscing into 3 valves; *seed* smooth, compressed broadly ellipsoid to broadly ovoid-ellipsoid, 1.2-1.5 mm long, the body smooth, cream or somewhat brown tinged, with scattered short dark brown longitudinal streaks, the apex dark brown and covered by a hyaline caruncular cap with an irregularly toothed margin.

Spyridium tridentatum is known from widely disjunct regions across southern Australia, outside South Australia being in the South-western Botanical Province of Western Australia (Wheeler 1987) and the north-western mallee regions of Victoria (Willis 1973). The species was only recently recognized in South Australia (Barker in Jessop 1983), but, although uncommon and at present known only from the northern half of Eyre Peninsula, it is relatively widespread there. There it occurs on deep sandy soils, although exceptions are two in the Gawler Ranges on the rocky outcrops of Scrubby Peak (*Bates 3353*, AD) and on a rocky hill face 9 km NNE of Yarna Homestead (*Culic & Williams 9137*, AD). It is particularly abundant in the bleached alkaline sands of tall dunes south of Kimba in the Hundred of Jamieson and further south near the western side of Hincks Conservation Park. It is also known to the north from the brown sands of the desert dune system extending along the northern fringe of Eyre Peninsula, where it is represented by collections from north of Ceduna, near Corrobinnie Hill and in Pinkawillinie Conservation Park. Typically, *Spyridium tridentatum* occurs on the slopes of dunes in *Eucalyptus incrassata* tall shrubland with a species-rich heath understorey ½-1½ m high.

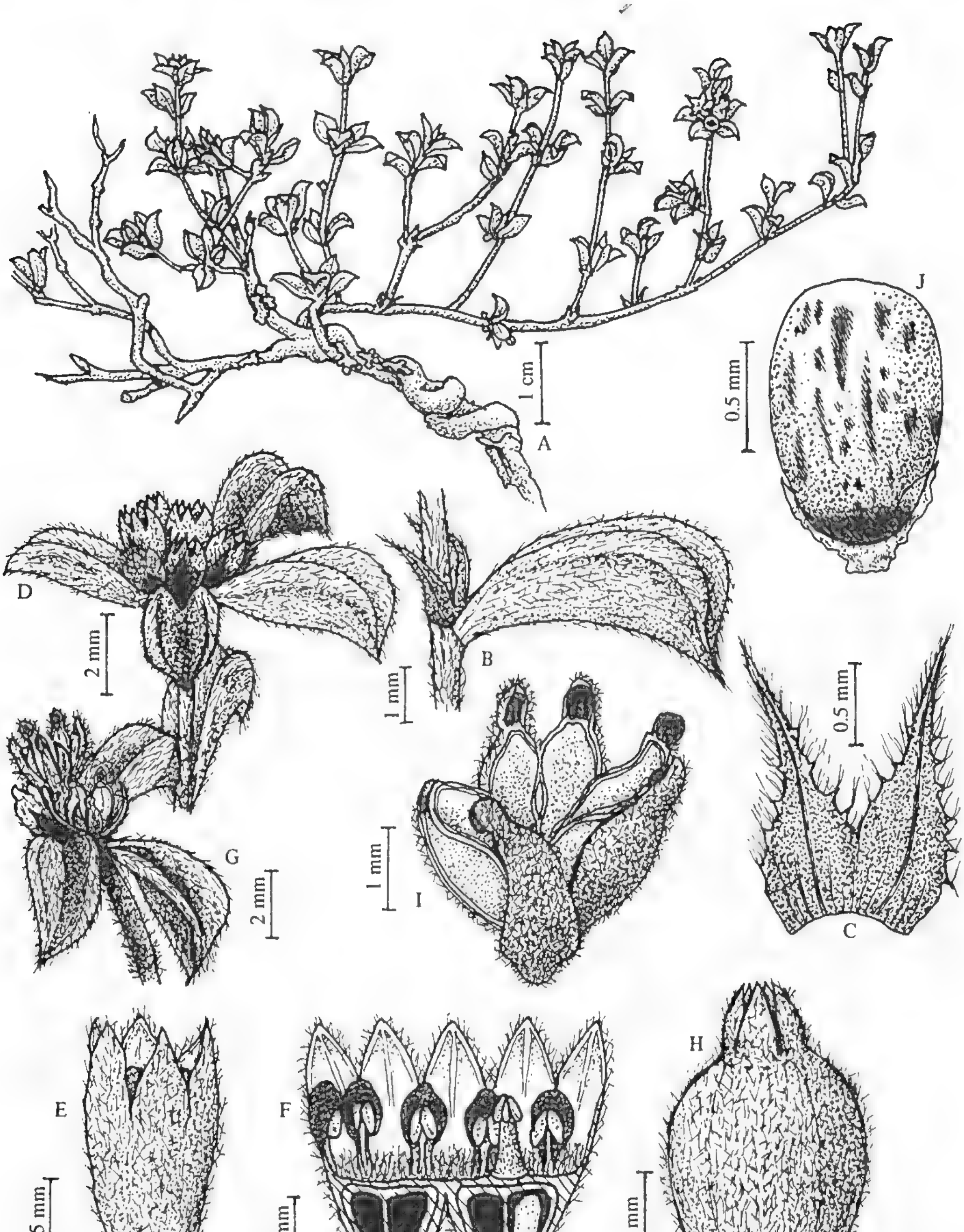


Fig. 1. *Spyridium tridentatum*. A, habit; B, leaf; C, paired stipules; D, short lateral branchlet in flower; E, flower; F, flower longitudinally sectioned and opened out, showing petals hooding anthers and short style; G, short lateral branchlet in fruit; H, fruit prior to dehiscence; I, fruit after dehiscence; J, seed. (A-C, G-I, fresh material, *Lang DEP 8674-8681*, AD; D-F, *Lang DEP 8760*, AD; J, *Lang DEP 8807*, AD).

On Eyre Peninsula *Cryptandra leucophracta*, a shrub of superficially similar appearance to *S. tridentatum*, is commonly associated with the *Spyridium*, for example at Mt Bosanquet (*Lang DEP 8670-8681*, AD), 12 km WSW of Waddikee (*Lang DEP 8834, 8835*, AD) and 20 km E of Peachna (*Lang DEP 8807*, AD). At Mt Bosanquet the two species were sampled along a transect up a major sandy rise where they were freely intermixed with no apparent differences in micro-habitat. Wider observations, however, show *C. leucophracta* to occupy a broader ecological range, including swales and flats with heavier soils and impeded drainage.

The confusion of *Spyridium tridentatum* with the more common *Cryptandra leucophracta* has often occurred in the herbarium since its first South Australian collection made in 1967. The morphological similarities encompass all organs. Both species are small semi-prostrate woody perennials covered by a stellate indumentum. Their leaves are almost identical in shape with upwardly folded (conduplicate) spathulate blades and persistent tomentum extended at the apex as if into a mucro. Their flowers and fruits form in terminal clusters of leaves or bracts morphologically similar to adjacent leaves. At a more microscopic level both species have a stellate indumentum; flowers composed of 5 sepals, 5 tiny petals hooding the anthers and an inferior ovary; and similarly ellipsoid capsular 3-valved fruits. Their seeds are also almost identical; they are smooth and streaked and capped by a removable caruncle. Like other Australian members of these genera (Berg 1975) they are obviously dispersed by ants. A comparative study of pollination and dispersal of these sympatric species would be of interest.

The current published means of separation of the two species (Canning 1986; Willis 1973) is based solely upon the character of hypanthium length which separates the two genera.

In the field the two species can be difficult to distinguish, particularly in summer when bushes are often desiccated. *Spyridium tridentatum* has relatively uniform, pale bluish-green, fine foliage in contrast to the darker green, more coarse leaves of *Cryptandra leucophracta*. The leaves of the *Spyridium* are consistently dull and concolorous from being tomentose on both surfaces, while in *C. leucophracta* they may become somewhat shiny above through an absence of hairs, and are generally paler and often rust-coloured through their persistent tomentum below.

Reliable field identification is, however, easiest when flowers and fruits are present. The inflorescence provides the most conspicuous diagnostic feature. In *Cryptandra leucophracta* the flowers are clustered in strict terminal heads surrounded by spreading flat leaf-like inflorescence-subtending bracts which are distinctively white velvet pubescent above. Such conspicuous bracts surrounding the inflorescence (often called 'floral leaves', a poor term as they are not associated with each flower) are generally associated with *Spyridium* (Black 1952; Canning 1986; Suessenguth 1953; Willis 1973). In *S. tridentatum* inflorescence-subtending bracts are not conspicuous and white above, but are identical to adjacent leaves, a feature uncharacteristic of a member of the genus (Suessenguth 1953).

Apart from the presence of inflorescence-subtending bracts, the next most obvious diagnostic feature lies in the generic character of the length of the hypanthium, the floral tube above the ovary which supports the sepals, petals and stamens. In *Cryptandra leucophracta* it is much longer than the sepals and, partly through persistence of the associated long style, frequently persists with the attached sepals as a slender elongated cylinder on the summit of the mature fruits. In *Spyridium tridentatum* the hypanthium is almost absent in the flower, which is consequently much shorter; the sepals form a much shorter apical projection on the mature fruit.

Longer petioles, a prominence of the lateral veins on the underside of the leaves, a longer antrorse-sericeous to woolly tomentum external on the flowers, and the glabrescent ribbed capsules are other differences distinguishing *C. leucophracta* from *S. tridentatum*.

The comparison of these two species, each atypical of its genus, indicates a need to review the delimitation of *Cryptandra* and *Spyridium*. Such a review should encompass close generic relatives such as *Pomaderris* and *Trymalium*. Generic delimitation should reflect phylogeny.

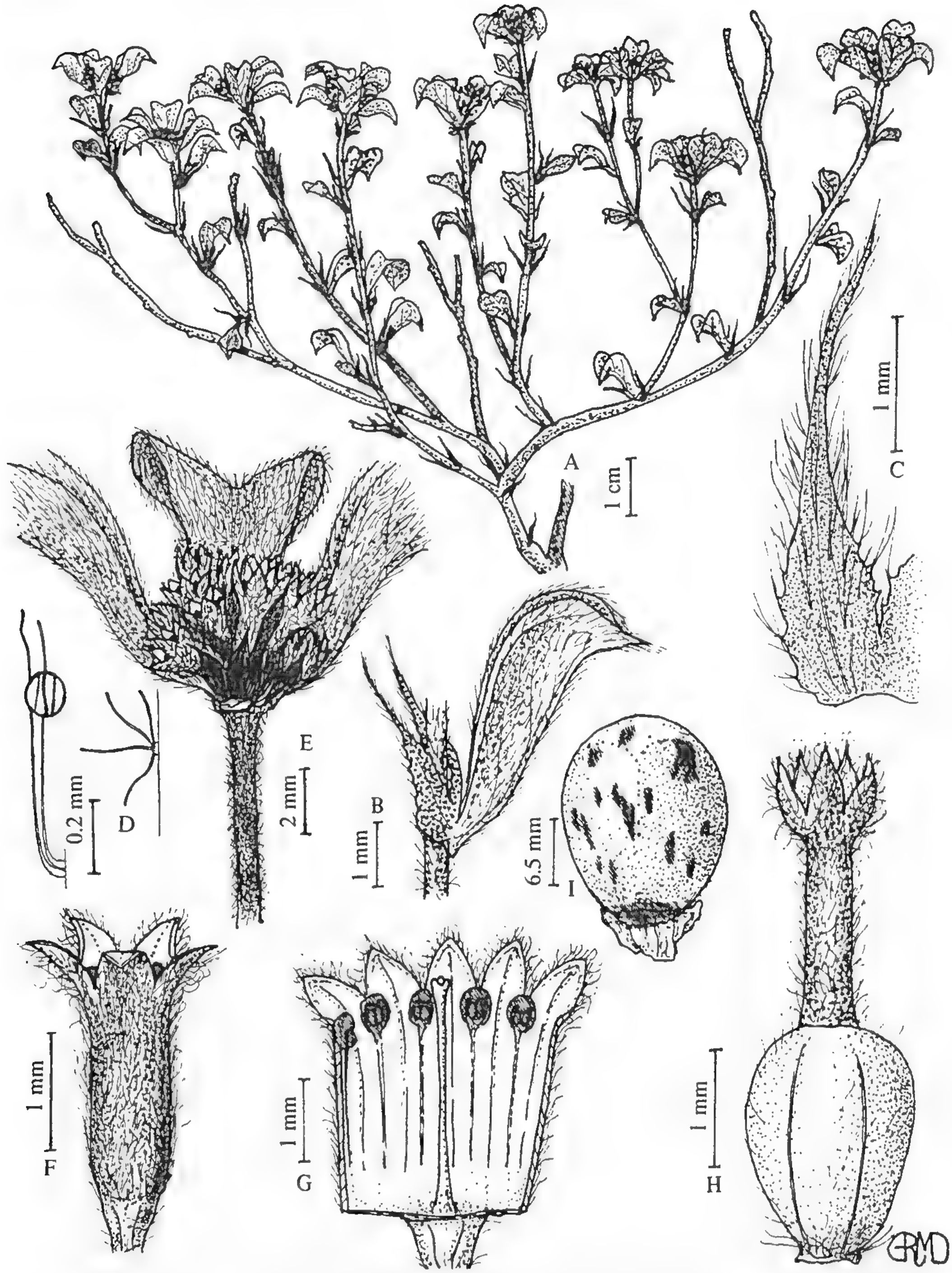


Fig. 2. *Cryptandra leucophracta*. A, habit; B, leaf; C, stipule of fused pair; D, stellate hair and pair of overlying antrorse simple hairs from abaxial side of leaf; E, terminal inflorescence showing 3 subtending bracts, a fourth removed from the front; F, flower; G, flower opened out above the ovary to show the long hypanthium, the anthers hooded by the petals, and the long style; H, fruit; I, seed. (A, fresh material, *Lang DEP 8670-8673*, AD; B, D-F, *Kraehenbuehl 4084*, AD; C, *Lang DEP 8835*, AD; F, *Alcock 3475*, AD; G-H, *Reynolds 51*, AD).

Each of the two genera as presently constituted contains other species or groups of species anomalous in the above characters. It is possible, as a consequence, that the single character state of hypanthium length currently used to distinguish each genus could have arisen more than once. In these genera further characters, such as style length, the presence or absence of the tiny petals and whether or not they hood the anthers, the crowding of flowers into heads, and the presence or absence of conspicuous leaf-like inflorescence-subtending bracts, could well have evolved more than once in particular combinations of states as adaptations, for example, to different types of pollinators.

The current circumscription of *Cryptandra* and *Spyridium* apparently dates from the survey of Weberbauer (1895-6) in Engler & Prantl's monumental survey of the vegetable kingdom. Before that time other genera had been variously recognised. The additional genus *Stenanthemum* was segregated by Reisseck (1858) and subsequently, for example J.D. Hooker (1862) and Bentham (1863), to cover several species including *Cryptandra leucophracta*. Of this genus Bentham said, "The floral characters are those of *Cryptandra*, with the inflorescence of *Spyridium*". Weberbauer (1895-6, p. 421) himself stated (in translation), "The limits between the genera *Pomaderris*, *Trymalium*, *Spyridium* and *Cryptandra* are rather weak; they seem based less on habit characters than on the form structure of the flowers and fruit." In the second edition of Engler & Prantl's work Suessenguth (1953) retained the two genera but provided infrageneric frameworks in each genus, formal in *Cryptandra* and informal in *Spyridium*. Such a history of uncertainty indicates that a generic review is long overdue.

References

Bentham, G. (1863). Rhamneae. *Fl. Austral.* 1, 409-445.

Berg, R.Y. (1975). Myrmechorous plants in Australia and their dispersal by ants. *Austral. J. Bot.* 23, 475-508.

Black, J.M. (1952). Rhamnaceae. "Flora of South Australia", 2nd edn, pp. 544-553. (Govt Printer: Adelaide).

Canning, E.M. (1986). Rhamnaceae (in part). In, J.P. Jessop & H.R. Toelken "Flora of South Australia", 4th edn, pp. 807-821. (South Australian Govt Printing Division: Adelaide).

Hooker, J.D. (1862). Rhamneae. In, G. Bentham & J.D. Hooker, "Genera Plantarum" 1 (1), 371-386. (London).

Jessop, J.P., Ed. (1983). "A list of the Vascular Plants of South Australia". (Adelaide Botanic Gardens & State Herbarium, and Environmental Survey Branch, Department of Environment & Planning).

Reisseck, S. (1858). Plantae Muellerianae. *Linnaea* 29, 265-296.

Suessenguth, K. (1953). Rhamnaceae. In, H. Melchoir & E. Werdermann, "Die natürlichen Pflanzenfamilien" 20d, 7-173. (Duncker & Humblot: Berlin).

Weberbauer, A. (1895-6). Rhamnaceae. In, A. Engler & K. Prantl, "Die natürlichen Plfanzenfamilien", III, 5, 393-427. (W. Engelmann: Leipzig).

Wheeler, J.R. (1987). Rhamnaceae. In, N.G. Marchant et al. "Flora of the Perth Region. Part I." pp. 456-462. (Western Australian Herbarium, Department of Agriculture: Western Australia).

Willis, J.H. (1973, as 1972). "A Handbook to Plants in Victoria. Volume II, Dicotyledons". (Melbourne University Press).

W.R. Barker
State Herbarium of South Australia

Del. G.R.M. Dashorst
State Herbarium of South Australia

P.J. Lang
South Australian Department for Environment and Planning

24. **Teucrium grandiusculum** F. Muell. & Tate ssp. **pilosa** Toelken (Labiatae)

Teucrium grandiusculum F. Muell. & Tate ssp. *pilosa* Toelken, J. Adelaide Bot. Gard. 7:299 (1985).

Illustration: Based mainly on fresh material preserved under *H.R. Toelken 7796*, 30.ix.1987, 0.6 km S of railway crossing at Ooldea siding, 30°29'S, 131°50'E; fruit: *D.J.E. Whibley 729*, 20.ix.1960, same locality.

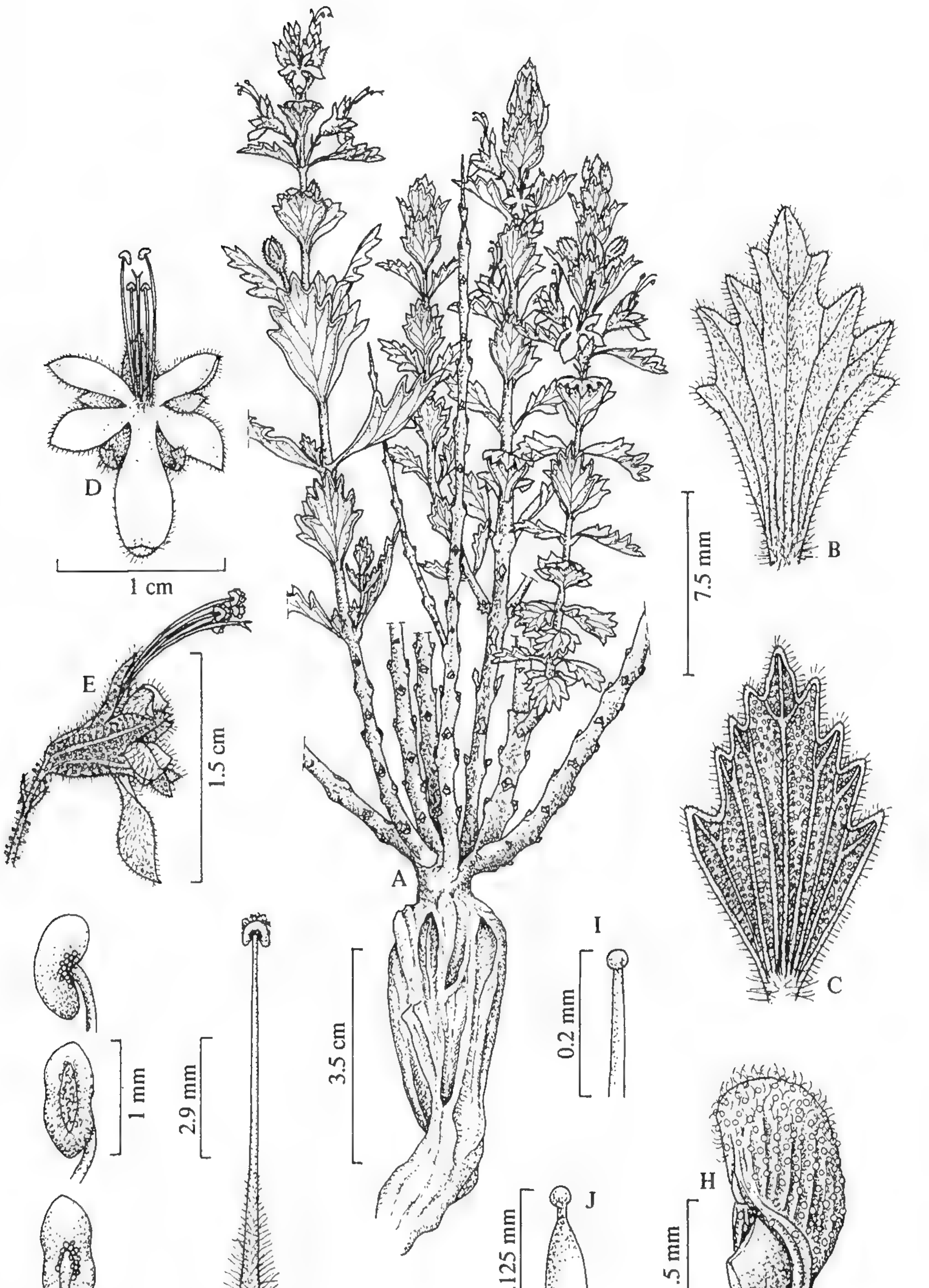
Perennial shrub 15-35 (-45) cm tall, usually much branched especially from the woody rootstock with its pale fluted bark; young branches at first quadrangular in section but soon becoming terete, pilose with long and short eglandular hairs up to 1.5 mm long. *Leaves* sessile or subpetiolate, obovate to angular-oblanceolate, (0.6-) 0.8-1.8 (-2.2) x 0.6-1.2 (-1.4) cm, coarsely toothed or shallowly lobed with (7-) 9-12 lobes almost right around the leaf and fanned venation at the base, or with (3-) 5-7-toothed towards the apex and with sinuate veins below the inflorescence, puberulous above, below pubescent especially along the distinctly raised veins and recurved margins as well as with sessile glands. *Inflorescence* a raceme-like thyrse with leaf-like bracts subtending each stalked single-flowered cymule; bracteoles linear, placed between the lower third and half the length of the pedicel. *Sepals* regularly connate to about half their length, with spreading usually eglandular hairs and sessile glands mainly on the outside; lobes often toothed, 3-4 mm or up to 5 mm long when fruiting. *Corolla* white, 1-lipped, with deep posterior split, 2 posterior lobes longer or subequal to 2 lateral ones and usually about half the length of the anterior lobe, with spreading eglandular hairs and sessile glands outside, and inside with spreading eglandular hairs around the insertion of the stamens, on the lower filaments and particularly long ones in front of an anterior pouch; stamens 4, inserted near the base of the corolla, arched well above the anterior lobe; anthers 2-celled, dehiscing by incomplete longitudinal slit. *Ovary* slightly 4-lobed, with slender style inserted near the apex and then curved like the stamens, with bifid stigma situated between the anthers. *Mericarps* narrowly cylindrico-obovoid, c. 3 mm long, attachment scar a large concavity in the lower half of the inner surface but partly concealed by a prominent tooth in its centre, vaguely rugose, with few hairs towards the apex and many sessile glands over the exposed surfaces.

On a recent expedition to Ooldea a special effort was made to collect more material of this subspecies which is poorly represented in herbaria. This is where it was realised how rare the plant seems to be, as it was found only in one small area where the sandy soil of the dune formation comes in contact with those encrusted by surface limestone. This population of not more than 30 plants was the only one found in an extensive area investigated. It is hoped that this publication will urge exploration of the area to hunt for more populations. The plants were growing near or on top of a rise quite unlike the typical subspecies which is usually recorded from sandy soil along creeks or at the base of ravines.

A few old plants with their woody rootstock continued in a pronounced tap root had resprouted and just started flowering. A number of small plants occurring around the above mature plants were at first thought to be suckers as they are commonly found in *T. racemosum*, but proved to be seedlings when taken out. They grew well at first in sandy soil in Adelaide and then died one-by-one without any apparent reason.

The plants within the population showed little variation as one would expect in such a small population. The variation of the shape of leaves is, however, considerable as lower ones are often more frequently and deeply toothed, or rather lobed with lobes occurring almost right around it. This type of leaf was thought to be characteristic of the typical subspecies when the original description was drawn up, but might only be more common in that taxon. It is obviously a juvenile character that is retained for a longer or shorter period in individuals from different populations.

The typical pilose hairs of subsp. *pilosa* were obvious in these plants but it is important to note that at the flowering stage glandular hairs are often present on the pedicels and



Teucrium grandiusculum F. Muell. & Tate subsp. *pilosum* Toelken. A, flowering plant; B, C, lower leaf with fanned venation from above and below; D, front view of flower; E, side view of flower; F, stamen; G, anther in side, front and rear view; H, mericarp in side view; I, glandular hair from pedicel; *T. grandiusculum* subsp. *grandiusculum*; J, typical glandular hair. (A-G, I, *H.R. Toelken 7796*; H, *D.J.E. Whibley 729*; J, *W.S. Reid 108*).

occasionally on the lower part of the calyx. The actual glands at the tip of the hairs have, however, usually been worn off by the time the fruits are mature.

The indumentum of subsp. *pilosa* is capillaceous whereas in the typical subspecies hairs are usually ampule-like. The latter trichomes have a broad base followed by cylindrico-conical body which is abruptly constricted into a longer or shorter narrow stalk below the terminal spherical gland. The only exceptions are specimens collected from the Palm Valley (Northern Territory), which have a hair-like indumentum but the hairs are gland-tipped unlike those of subsp. *pilosa.*

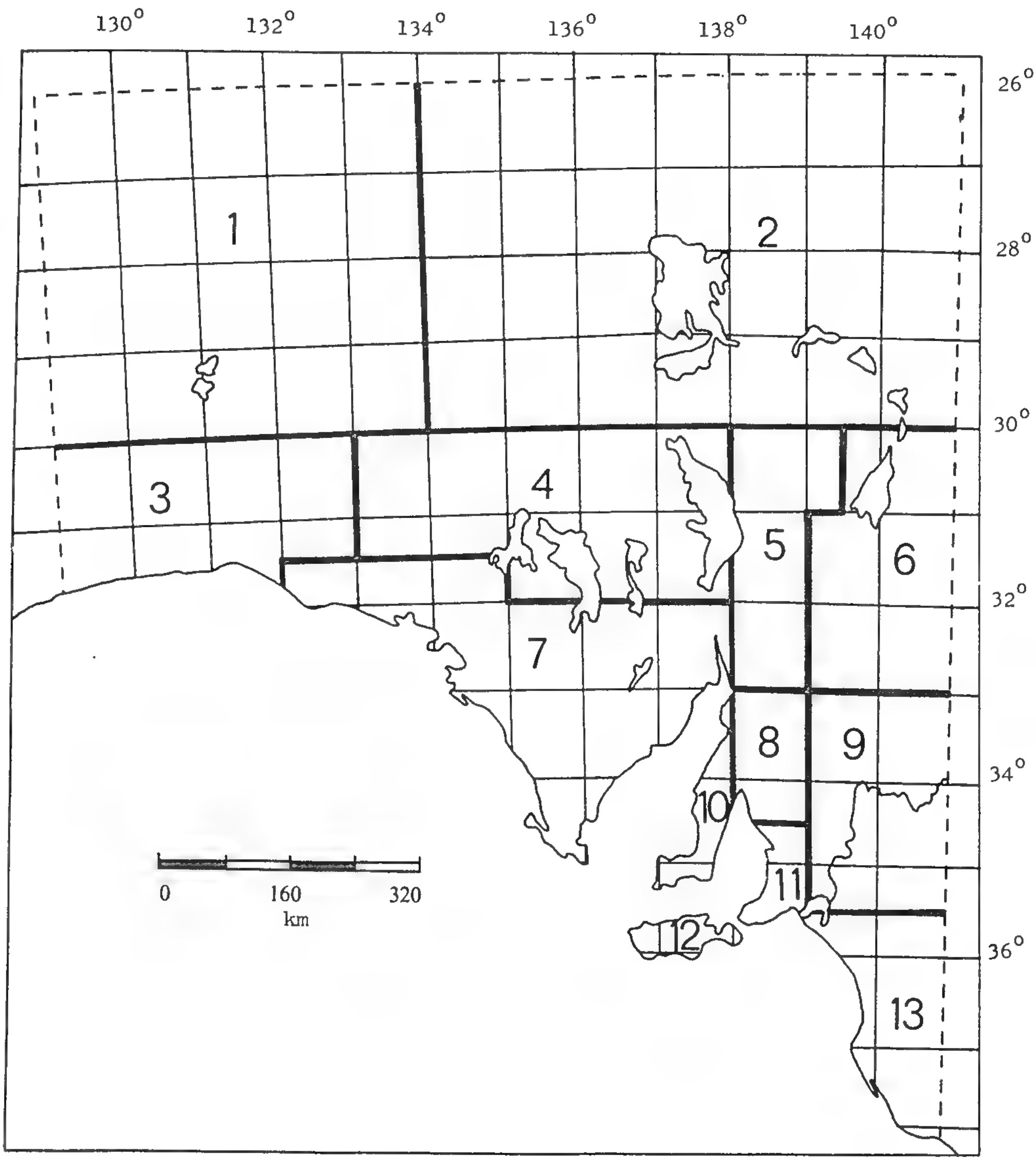
Teucrium grandiusculum which has been recorded from often widely separated localities shows a number of local variations and might best be understood in terms of several subspecific taxa.

H.R. Toelken
State Herbarium of South Australia

Del. G.R.M. Dashorst
State Herbarium of South Australia

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre Basin
3. Nullarbor
4. Gairdner-Torrens Basin
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. Yorke Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



Typeset by P. & L. REPRODUCTIONS PTY. LTD.
Printed by APPLE PRESS

JOURNAL of the ADELAIDE BOTANIC GARDENS

CONTENTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 11 Part 2 20 July, 1989

Instructions to Authors

Topics

Papers will be accepted in the following categories:

(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

Copy

Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of generic or lower rank must be underlined.

The print area for illustrations is 18 x 13 cm (excluding captions). Half-tone material should be submitted this size if possible, but will be reduced by the printers, if necessary.

Reprints

50 copies of reprints will be provided for each paper. Additional reprints may be purchased at cost.

Layout

The pattern of the paper should generally be:

(i) Title; (ii) Author and Address; (iii) Abstract (except for short papers); (iv) Introduction and subject matter; (v) Acknowledgements; (vii) References.

References

Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

Text references to specimens should be italicized, for example *Kock 276.*

Indices

When required, follow the pattern on, for example, p. 106 of vol. 1, pt. 2.

Recommendations on taxonomic papers

Synonymy

Authors are requested to include in the synonymy only references to publications containing information additional to that to be published in the paper being submitted. Within this section journal and book titles must be conistently abbreviated. B-P-H journal abbreviations and book titles abbreviated in a similar way are desirable. Authors of references cited in the synonymy should preferably be abbreviated according to the 'Index of Author Abbreviations' compiled and published by Royal Botanic Gardens, Kew (1980). References may be cited as:

Benth., *Fl. Austral.* 4: 111 (1868) OR

Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

All correspondence concerning the journal should be addressed to:

The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

ISSN 0313-4083

J. Adelaide Bot. Gard. 11(2): 75-100 (1989)

TAXONOMIC REVISION OF *BERGIA* (ELATINACEAE) IN AUSTRALIA

G. J. Leach

Northern Territory Herbarium, Conservation Commission
of the Northern Territory,
P.O. Box 496, Palmerston, Northern Territory 0831

Abstract

A taxonomic revision of *Bergia* in Australia is presented. The following ten species are recognised: *B. pedicellaris*, *B. henshallii*, *B. perennis*, *B. barklyana*, *B. auriculata*, *B. ammannioides*, *B. trimera*, *B. occultipetala*, *B. diacheiron* and *B. pusilla*. *B. barklyana*, *B. auriculata*, *B. henshallii*, *B. occultipetala* and *B. diacheiron* are described as new. *B. perennis* comprises three subspecies. The existing infrageneric classification is considered inadequate and four informal groups based on Australian taxa are suggested. *B. ammannioides* and *B. trimera* have an extra-Australian distribution; all other taxa are endemic. A key to the species and distribution maps are provided.

Introduction

The Elatinaceae are a small family of aquatic or wetland plants with an almost global distribution but absent from colder regions. Recent workers e.g. Cronquist (1981) have concurred with placement of the Elatinaceae in the Theales and that its closest affinity is to the Clusiaceae. Tucker (1986) provides a recent summary and detailed references to the family. *Bergia* is one of two genera recognised in the Elatinaceae, the other being *Elatine*. Both genera are recorded for Australia, *Bergia* now with 12 taxa recognised, and *Elatine* generally accepted as represented by a single species.

The genus *Bergia* was described by Linnaeus in 1771 and commemorates Petrus Jonas Bergius (1766-1790), a Swedish pupil of Linnaeus and later professor of natural history and pharmacy at the Collegium Medicum in Stockholm.

Statements as recent as those by Tucker (1986) that only two species are known for Australia and that Africa was the centre of greatest diversity indicate the paucity of knowledge of the genus in Australia. Verdon (1981) recognised a number of undescribed taxa occurring in central Australia but suggested material was generally inadequate to delimit these. The author feels that *Bergia* is under-collected and poorly represented in most Australian herbaria. In recognition of this problem *Bergia* species have been actively collected by staff at NT, notably S. Parker, T.S. Henshall and P.K. Latz. Examination of this material by the author in preparation for a generic treatment in the revised 'Flora of Central Australia' showed that a considerable number of sheets had accumulated and that it was now possible to morphologically delimit a number of new taxa. Subsequent examination of all material at other Australian state herbaria supported the groupings initially delimited and also led to the recognition of an additional two species outside central Australia. This revision is therefore based on a morphological study of most available Australian herbarium material. A limited number of extra-Australian sheets were also examined from MEL and NSW. Measurements reported are from dried herbarium specimens. The distribution maps show all specimens examined.

Generic and infrageneric relationships

Elatine is distinguished by its membranous sepals and capsules from *Bergia* which has herbaceous sepals and crustaceous capsules. As pointed out by Bentham (1863), the slight morphological generic differences are associated with significant differences in habit; *Elatine* is principally aquatic, while *Bergia* is predominantly terrestrial although favouring habitats that are periodically inundated. Although von Mueller (1861, 1862) clearly did not recognise *Bergia* and described some species as *Elatine* there has otherwise been broad acceptance of the generic distinction by most taxonomists.

Niedenzu (1925) divided *Bergia* into two sections and each of these further into two subsections. The sectional subdivision was based primarily on whether flowers are solitary or in dichasia. Characters used for subsectional groupings include shape and apex of perianth parts, ovary shape and length relative to the stamens, seed surface, general indumentum and leaf margin. This infrageneric classification was clearly developed with minimal reference to Australian material. For example, Australian taxa within an obviously closely related natural group are contrasted by ovoid or globular ovaries, generally glabrous or pubescent, serrate or ± entire leaf margins and acuminate or obtuse sepals and petals. Further, it is not possible to logically place a number of Australian taxa with particular combinations of characters within Niedenzu's scheme. Any further formal proposals for a infrageneric classification must await a detailed monographic treatment. However, from this study it is suggested that inflorescence type, number of staminal whorls, style length and seed texture best delimit apparent natural groupings of Australian taxa. On this basis four informal groups are recognised. Listed under each are the species belonging to these groups.

Group 1. Flowers in dense many-flowered axillary clusters; stamens in a single whorl; style short; seeds smooth or sculptured. *B. ammannioides*, *B. trimera*.

The highly reduced *B. pusilla*, even though with solitary flowers, is probably best placed in this group.

Group 2. Flowers typically 2 per leaf axil; stamens in 2 whorls; style short; seeds smooth. *B. pedicellaris*.

Group 3. Flowers solitary but usually on condensed short shoots; stamens in a single whorl; style short; seeds sculptured. *B. diacheiron*, *B. occultipetala*.

Group 4. Flowers solitary; stamens in 2 whorls; style long; seeds sculptured. *B. auriculata*, *B. barklyana*, *B. henshallii*, *B. perennis*.

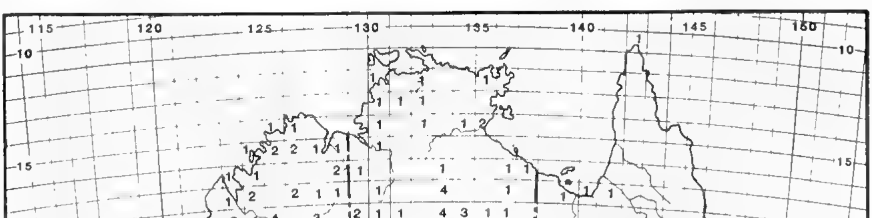
Biology and geography

There are about 24 species of *Bergia* worldwide with centres of diversity in southern Africa and Australia. The genus has an essentially Gondwanan distribution, being represented in Africa, India, Australia and South America. Ten species are recorded for southern Africa, eight of which are restricted to this region (Obermeyer 1976). Two species, *B. ammannioides* Roxb. and *B. capensis* L., are widespread from southern Africa through to India and parts of South East Asia (Backer 1951). *B. capensis* has also been recorded as an adventive in South America and Europe (Tucker 1986). *B. ammannioides* is further distributed to southern China, Taiwan, the Philippines and south through Java, Timor to Australia (Backer 1951). Five species are recorded from the Indian subcontinent; of these *B. ammannioides* and *B. capensis* are widespread, *B. suffruticosa* (Delile) Fenzl extends through the Middle East to tropical Africa, *B. aestivosa* Wight & Arnott appears restricted to the region, while the remaining species, *B. trimera* Fischer & C. Meyer, is disjunct, being also recorded from Australia (Thiselton Dyer 1874). A further species, *B. serrata* Blanco, is endemic to the Philippines although some workers (e.g. Backer 1951) have doubted the validity of its distinction from *B. ammannioides*. Based on the limited material seen, *B. serrata* appears quite distinct from Australian material of *B. ammannioides*. In particular, *B. serrata* has ten stamens which clearly distinguishes it from Australian *B. ammannioides*. Currently only two native species are known from the New World: *B. arenarioides* Camb. from Brazil and *B. texana* (Hook.) Seub. from southern U.S.A. and northern Mexico.

Australia as the other centre of diversity has 12 taxa (ten species, one with three subspecies). Two species, *B. ammannioides* and *B. trimera* extend outside Australia; the remainder are endemic. Despite its Gondwanan distribution *Bergia* is not recorded for Tasmania, New Zealand or New Guinea.

In Australia the genus is centred within the arid zone and notably absent from the south western area, most of the east coast and Tasmania (Map 1). *Bergia* occurs in habitats subject to periodic inundation and within the arid zone is restricted to habitats such as floodouts, claypans, swales and creek lines. The absence of *Bergia* from the more mesic areas of Australia is of interest particularly for a genus with apparent high dispersal ability and adaptations to seasonally inundated habitats. A possible explanation may be that *Bergia* is not a strong competitor with other wetland species in favourable conditions. The ability of *Bergia* species to survive higher salinities, higher temperatures and extended dry periods, however, means that they establish well under the low competition in the marginal wetland habitats of the arid zone.

B. trimera is the most widespread species in Australia (Map 8) and is also recorded from India (Thiselton Dyer 1874). Its occurrence in Malesia would seem likely, but has not been confirmed. As it is easily confused with *B. ammannioides* there is a need to examine Malesian specimens. *B. ammannioides*, although widespread globally, is not as common nor as widespread in Australia as *B. trimera*. This may suggest that *B. trimera* is of Australian origin and that *B. ammannioides* is a recent arrival in Australia from Malesia. Further critical studies into the patterns of variation shown by *B. ammannioides* are needed.



Map 1. Distribution of *Bergia* in Australia as recorded from herbarium specimens. Figures show the number of taxa recorded from each 1° square.

Bergia species can clearly disperse long distances and successfully establish in new areas as exemplified by the introductions recorded for Europe and South America (Tucker 1986). A number of authors (e.g. Verdcourt 1968) have suggested that the small seeds could be easily dispersed by birds. *Elatine* seed, which is of similar size and texture to *Bergia*, has been recorded in the mud attached to feet and feathers of birds (Salisbury 1967). Floodwaters would also be an important dispersal agent. Salisbury (1967) suggested that in *Elatine* the pitted seed surface would greatly enhance their buoyancy; this would apply equally to *Bergia*. The most widespread species, *B. ammannioides* and *B. capensis*, are also the two species known to have become established as adventives.

There appear to be no studies of pollination biology in *Bergia*. Cleistogamy is a frequent reproductive strategy in aquatic plants (Sculthorpe 1967) and is reported for some taxa of *Elatine* (Keighery 1984; Salisbury 1967). No open flowers have been observed on herbarium specimens of either *B. occultipetala* or *B. diacheiron*. The flowers are also sessile and highly cryptic due to the surrounding stipules and bracteoles. In some dissected flowers the anther has been found adhering to the stigma. As the capsule matures and expands the adherence of the anther to the stigma appears to be strong enough to cause detachment of the anther from the filament. These species (Group 3) are likely to be cleistogamous.

Other species having small inconspicuous flowers which appear to be chasmogamous are considered likely to be self-pollinated. Similar observations of the anther adhering to the stigma have been made by the author in *B. trimera*, *B. ammannioides* and *B. pedicellaris*. At anthesis the stamens and stigma are at the same level within the flower. *B. pusilla* would also belong in this group. Several Australian species (Group 4) have colourful flowers often with the pale pink petals contrasting with the blue to purple gynoecium. The petals are prominently reflexed during anthesis with the anthers separated from the stigma. This group of species may have some degree of outcrossing and in cultivation the flowers of *B. henshallii* are visited by ants.

Morphological characters

The following characters proved to be of taxonomic value within Australian *Bergia* species.

Pubescence

Both glandular and eglandular hairs are found on Australian species of *Bergia* and the indumentum is of some taxonomic value. The eglandular hairs (type c) are uniseriate, c. 0.5 mm long, shiny, transparent and colourless (Fig. 1B). The septa are usually readily observed. As described by Ramayya and Prabhakar (1975), the glandular hairs are multiseriate and capitate. These authors also recorded sessile forms of the glandular hairs. Two forms were also noted in Australian species. The shorter, type b glandular hairs (c. 0.1 mm long) have a persistent, enlarged, globular terminal head with copious secretion which results in a shiny, transparent, resinous appearance (Fig. 1B). The longer, type a glandular hairs (c. 0.25 mm long) mostly lack a distinct terminal head and the hair appears dull and opaque (Fig. 1B).

Inflorescence

Variation of inflorescence type is shown within the genus by species having the following attributes: flowers solitary, 1-2 per axil, 2-8 per axil, numerous flowers in dense axillary clusters, compound cymes. The inflorescence in Australian species is predominantly a solitary flower which in most taxa is conspicuously pedicellate although two taxa (*B. diacheiron*, *B. occultipetala*) have sessile flowers. *B. pedicellaris* typically has two flowers per axil; *B. trimera* and *B. ammannioides* have numerous flowers in dense axillary clusters. The inflorescence type has been used as an important primary character for the infrageneric classification of *Bergia* (Niedenzu 1925).

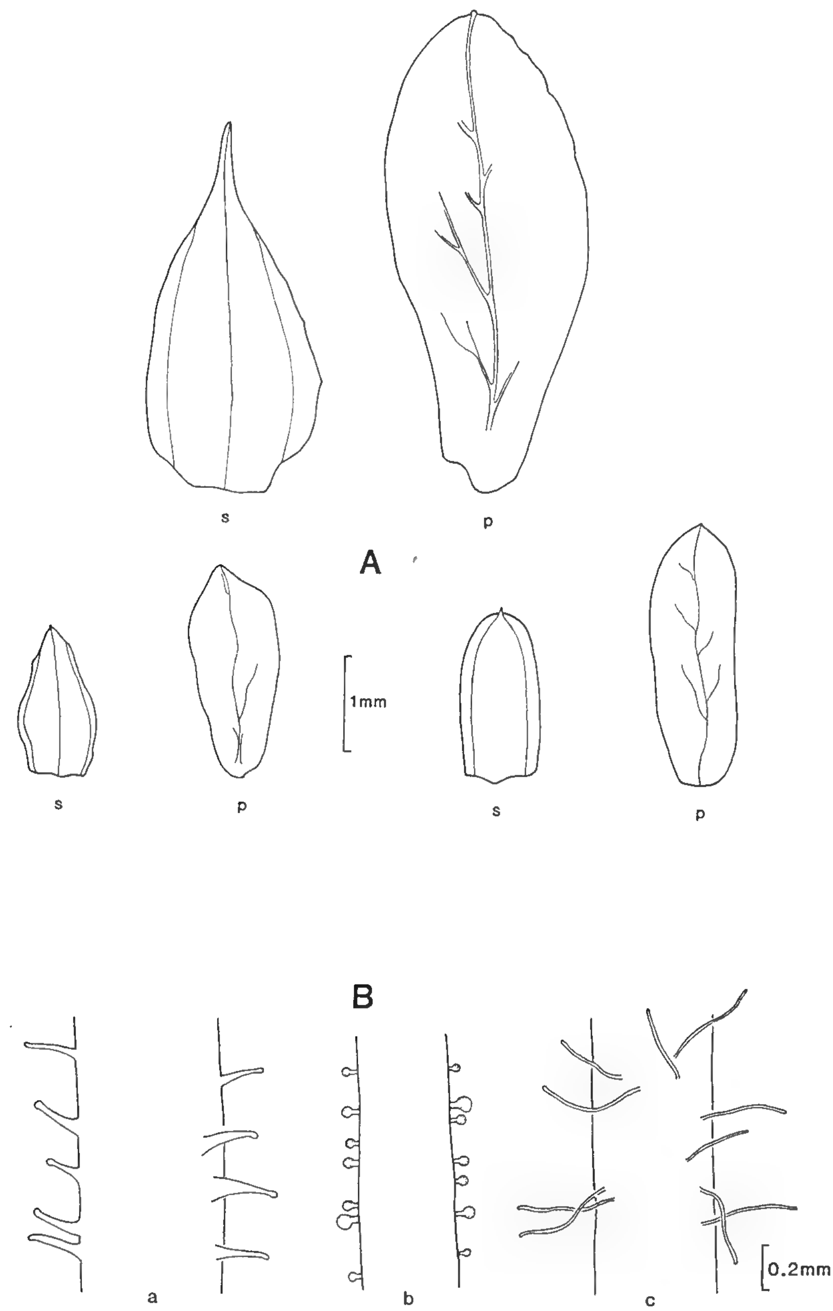


Fig. 1. A. Representative sepals (s) and petals (p) of the three subspecies of *Bergia perennis*. Upper: subsp. *perennis* (*Maconochie 2470*); lower left: subsp. *exigua* (*Badman 1070*); lower right: subsp. *obtusifolia* (*Thomson 886*). B. Indumentum types found in Australian *Bergia* species. a, long glandular hairs lacking globular terminal head; b, short glandular hairs with enlarged globular head; c, uniseriate eglandular hairs. (a, *Royce 10331*; b, *Leach 796*; c, *Parker 285*).

Flower and fruit

The flowers in Australian species of *Bergia* vary from the small inconspicuous flowers of *B. occultipetala* to the large flowers with conspicuous pink petals of *B. henshallii*. Apart from floral part number, features of the sepals and ovary shape have proved useful taxonomic characters.

The sepals have a scarious margin which may only be obvious in the basal part. Where the margin is lacking apically, the sepals typically have an acute to acuminate apex (Fig. 1A). In some taxa such as *B. perennis* subsp. *obtusifolia* (Fig. 1A) the scarious margin continues for the length of the sepal to produce an obtuse apex, often with a protruding short mucro. The margin has been interpreted by Obermeyer (1976) as stipular in origin, supported by observations in *B. glomerata* (a South African Cape endemic), where in the outer sepals the margin is separated to form a basal pair of stipule-like auricles. A similar occurrence is reported in *B. auriculata* (*q.v.*) where the outer three sepals also have a basal pair of auricles while the inner two sepals have the margin continuously attached to the sepal. Dimorphism of the sepals also occurs in *B. occultipetala* where the three outer sepals are larger than the inner two (*q.v.*).

The stamens, present in one or two whorls, are either equal to or twice the number of sepals or petals. The outer whorl, alternating with the petals, has filaments with broadly dilated bases. The inner whorl is generally slightly shorter. In those taxa with only one whorl the members alternate with the petals. The number of staminal whorls is a reliable character within the Australian species and is also considered a useful character in defining some species groups. However Verdcourt (1968) reported *B. ammannioides* in Africa as varying with 3-12 stamens in either one or two whorls.

The ovary and subsequent mature capsule is ovoid to pyriform in some taxa, globular to depressed-globular in others. The styles can be comparatively long with a terminal capitate stigma or the stigmas ± sessile on the ovary summit and often recurved.

Seed

Most Australian *Bergia* species have an alveolate, deeply pitted seed surface but three taxa have distinctive smooth to faintly striate seeds.

BERGIA L.

Bergia L., Mant. Pl. Alt. :152, 241 (1771); DC., Prodr. 1:390 (1824); Benth. & Hook., Gen. Pl. 1:162 (1862); Thiselton Dyer, Fl. Brit. India 1:251 (1874); Niedenzu, Pflanzenfam. ed. 1, 3, 6:281 (1895); ed. 2, 21:273 (1925); Backer, Fl. Malesiana 4:204 (1951); Obermeyer in Fl. Southn Afr. 22:24 (1976).

Type species: *B. capensis* L.

Erect to prostrate herbs, annual or perennial, usually in seasonally wet areas. *Indumentum* of multiseriate glandular or uniseriate eglandular hairs. *Leaves* opposite, usually serrulate, with teeth often conspicuously red gland-tipped, base attenuated into a short petiole. *Stipules* narrow-triangular, herbaceous with scarious, laciniate margins, usually with conspicuous midrib, apex acuminate, bases often connate and/or adnate to petioles, persistent. *Flowers* solitary, paired or in dense fascicles, bracteoles present. *Sepals* 3-5, conspicuous, usually herbaceous with scarious margins, ± fimbriate, concave, sometimes keeled, persistent. *Petals* as many as sepals, white to pink, persistent. Stamens 3-10, persistent, pink to purple. *Capsule* often obscured by persistent floral parts, walls subcrustaceous. *Seeds* cylindrical, straight or curved, smooth, faintly marked or alveolate.

About 24 species in the drier parts of tropical and warm-temperate regions of the world and with 10 species in Australia.

Key to species in Australia

1. Stamens 10 2
   Stamens 3-5 6
2. Indumentum of short glandular hairs with globular terminal cell 3
   Plant glabrous or indumentum eglandular or of long glandular hairs lacking an enlarged terminal cell 5
3. Leaves longer than 6 mm 4
   Leaves shorter than 6 mm .... 5. *B. auriculata*
4. Annual, ± erect; pedicels 15-25 mm long; capsule globular; stigmas ± sessile; seeds smooth, to 0.3 mm long .... 1. *B. pedicellaris*
   Perennial, prostrate; pedicels to 7.5 mm long; capsule pyriform; styles 1-1.5 mm long; seeds alveolate, 0.5-0.75 mm long .... 2. *B. henshallii*
5. Stems glabrous; leaves mostly greater than 10 mm long, ± entire; stipules greater than 1 mm broad; sepals 5-6 mm long .... 4. *B. barklyana*
   Stems mostly pubescent, rarely glabrous; leaves less than 10 mm long, serrate; stipules to 0.5 mm broad; sepals to 3.5 mm long .... 3. *B. perennis*
6. Calyx and corolla 5-merous 7
   Calyx and corolla 3-4-merous 9
7. Flowers in dense fascicles; bracteoles inconspicuous at base of pedicel; seed faintly striate ... 6. *B. ammannioides*
   Flowers solitary; bracteoles prominent, at apex of pedicel; seed distinctly alveolate 8
8. Sepals longer than petals, externally with blunt, transparent, strap-like, long (c. 0.7 mm) hairs; capsule c. 2 mm diam., 5-(rarely 4-) locular .... 8. *B. occultipetala*
   Sepals shorter than petals, externally glabrous or sparsely pubescent with short (less than 0.5 mm) hairs; capsule 1-1.2 mm diam., 3-locular .... 9. *B. diacheiron*
9. Annual, erect, glabrous; capsule 4-locular .... 10. *B. pusilla*
   Perennial or annual, prostrate or decumbent, rarely erect in young stages, mostly pubescent; capsule 3-(rarely 4-) locular .... 7. *B. trimera*

1. **Bergia pedicellaris** (F. Muell.) Benth., Flora Australiensis 1:180 (1863); Ewart & Davies, Fl. N. Terr. 194 (1917); Niedenzu in Engl. & Prantl, Nat. Pflanzenfam. ed. 2. 21:274 (1925); Chippendale, Proc. Linn. Soc. N.S.Wales 96:249 (1971); Verdon in Jessop, Fl. Central Austral. 229 (1981); Green, Census Vasc. Pl. W.Austral. 188 (1985).

Elatine pedicellaris F. Muell., Fragm. Phytogr. Austral. 2:145 (1861).

Lectotype (here designated): Fitzmaurice River, *F. Mueller s.n.* (Lecto.: MEL 534788, isolecto.: K).

Spreading or erect annual to 30 cm high. *Indumentum* of long type a glandular hairs or rarely lacking. *Leaves* elliptic to narrow-elliptic, 10-35 x 3-11 mm, acute, glandular hairy on midvein and at base, margin serrate, mid-vein prominent. *Stipules* 2.5-3 mm long, c. 0.3 mm wide at base. *Flowers* single or paired; pedicel slender, 15-40 mm long. *Bracteoles* at base of pedicels, narrow-triangular, c. 1 x 0.1 mm. *Sepals* 5, ovate, 2-3.5 x 1-1.5 mm, acuminate, glandular-pubescent, green or pink, margin fimbriate, keel absent or rarely slightly developed. *Petals* 5, elliptic, c. 3 x 1-2 mm, acute, shorter or equalling sepals, erect at anthesis. *Stamens* 10, ± equal, 1.5-2 mm long; filament base slightly expanded to c. 0.2 mm. *Capsule* globular, 2.5-3.5 mm diam., 5-locular; stigmas ± sessile. *Seeds* ellipsoid or slightly curved, 0.25-0.3 x 0.1-0.15 mm, smooth, shiny, light brown.

Habitat

Frequently on cracking clay soils, rarely on alluvial sandy soils.

Selected specimens from 63 collections examined

WESTERN AUSTRALIA: Durack River, ± 80 km SSW Wyndham, *A.C. Beauglehole 51474*, 28.v.1976 (PERTH); Yule River, Woodstock Station, *N.T. Burbidge 5947*, 30.iv.1958 (CANB); Halls Creek, *C.A. Gardner 7160*, 14.v.1944 (PERTH); Euro Gorge, Drysdale River National Park, *K. Kenneally 4411*, 17.viii.1975 (PERTH); 4 km SW Shay Gap, *Newbey 10256*, 2.vii.1984 (PERTH); Googhenama Creek, *R.D. Royce 1801*, 18.v.1947 (PERTH).

NORTHERN TERRITORY: Calvert River, *L.J. Brass 93*, xi.1921 (BRI, CANB); Skull Creek, *N. Byrnes 742*, 10.v.1968 (BRI, NT); Newcastle Waters, *G.M. Chippendale 5832*, 18.iv.1959 (NT); Andado Station, *P.K. Latz 6763*, 14.iv.1977 (AD, CANB, NSW, NT, PERTH); 42 miles W Wavehill Police Station, *R.A. Perry 2274*, 27.vi.1949 (CANB, NT).

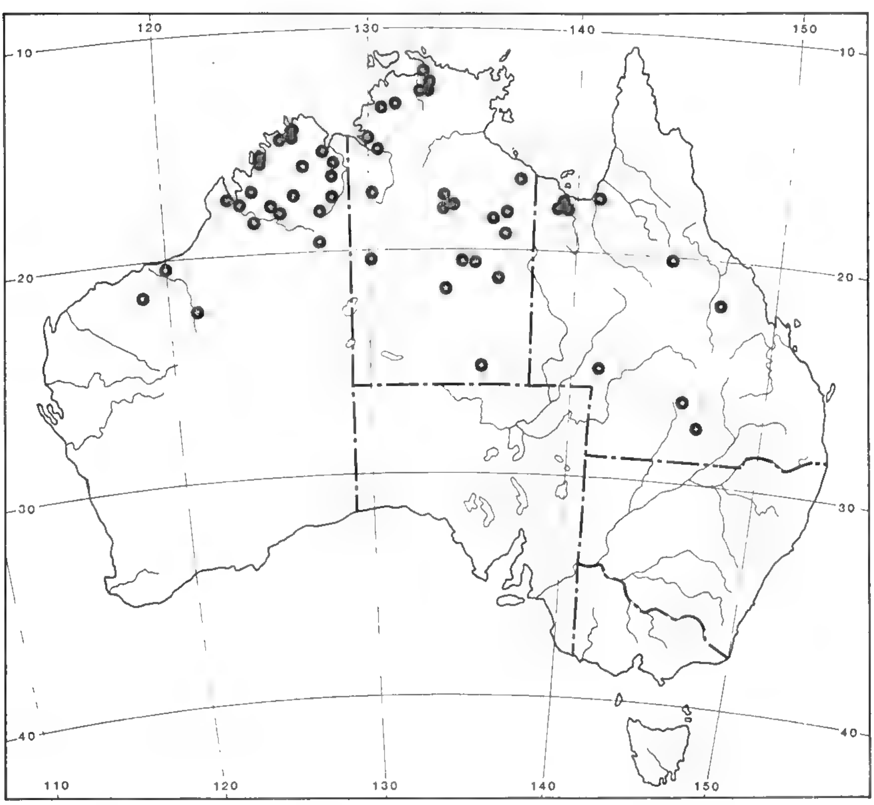
QUEENSLAND: Lowholm, NW Pentland, *S.T. Blake 19366*, 4.vii.1954 (BRI); Elmina Station, *S.L. Everist 2947*, 26.iii.1947 (BRI); Currawilla, *S.L. Everist 4090A*, 29.viii.1949 (BRI); c. 10 km SW Normanton, *R. Pullen 8853*, 23.iv.1974 (BRI, CANB); Leichhardt River, SE Burketown (CANB), *R. Pullen 9052*, 3.v.1974 (CANB).

Distribution

Found in all districts of the Northern Botanical Province and in the Fortescue and Mueller Districts of the Eremaean Botanical Province of Western Australia; in all botanical provinces of the Northern Territory; and in the Burke, Gregory North, Maranoa, North Kennedy, South Kennedy and Warrego Pastoral Districts of Queensland (Map 2).

Etymology

The specific epithet refers to the prominent long pedicels of this species.



Map 2. Distribution of *B. pedicellaris*.

Notes

Mueller records this species from the Victoria and Fitzmaurice Rivers and their tributaries. The MEL sheet from the Fitzmaurice River with Mueller's handwriting is here designated as the lectotype. In the protologue of *Elatine pedicellaris*, Mueller clearly had no intention of publishing the name under *Bergia*. Hence the combination *Bergia pedicellaris* made by Bentham should be attributed to Bentham alone. This species appears closely related to the African *B. anagalloides* E. Mey. ex Fenzl and *B. polyantha* Sond.; particularly the latter. It differs by the glandular indumentum, longer pedicels and smooth seeds.

2. **Bergia henshallii** G. Leach, sp. nov.

Bergia perennis (F. Muell.) Benth. form B, Verdon in Jessop, Fl.Central Austral. 229 (1981).

B. perenni (F. Muell.) Benth. affinis, sed pilis glandulosis, plerumque foliis longioribus et latioribus, sepalis longioribus et manifeste carinatis, utrinque carina conspicua laciniata differt.

Type: B.G. Thomson 887, 15 km S Tennant Creek, 23.x.1985 (Holo.: NT, iso.: CANB, BRI, MEL).

Prostrate perennial. *Indumentum* of sparse to dense short type b glandular hairs. *Leaves* narrow-elliptic to elliptic, 6-25 x 2.5-7.5 mm, acute, glandular hairs often restricted to leaf base, margin serrate, veins prominent. *Stipules* 2-4 mm long, c. 0.5 mm wide at base. *Flowers* solitary; pedicel 0.6-7.5 mm long. *Bracteoles* inconspicuous, at base of pedicel, narrow-triangular, c. 3 x 0.5 mm, pubescent, margin fimbriate. *Sepals* 5, narrow-ovate, 3-7 x 1.2-2.4 mm, acute to shortly acuminate, glandular-pubescent, green or pink, margin broad, often fimbriate, keel prominent, laciniate. *Petals* 5, narrow-obovate, 3.5-6.5 x 1.8-2.5 mm, acute to obtuse, mostly longer than sepals, reflexed at anthesis. *Stamens* 10; antipetalous ones 1.3 mm long, filament flattened, narrowly dilated to c. 0.4 mm wide at base; antisepalous 1.6-4 mm long, filament broadly dilated to c. 0.8 mm wide at base, margin recurved. *Capsule* pyriform, 1.75-2.8 mm long, 1.5-3 mm diam., 5-locular; styles 1-1.5 mm long; stigmas clavate, pink. *Seeds* reniform, 0.5-0.75 x 0.25-0.3 mm, alveolate, dark brown. (Fig. 2C).

Habitat

Commonly in inundated areas such as river beds and floodouts on sandy soil.

Selected specimens from 51 collections examined

WESTERN AUSTRALIA: 80 km from Halls Creek to Wolf Creek Crater, *N.B. Carriage 63*, 26.vii.1979 (PERTH); Dampier Downs Station, *M. Delong s.n.*, 25.iii.1983 (PERTH); Dusty Bore, Gogo, *C.A. Gardner 10152*, 6.v.1957 (PERTH); E of Gregory Range, *R.D. Royce 1898*, 22.v.1947 (PERTH).

NORTHERN TERRITORY: 10 miles NE Argadargada Homestead, *G.M. Chippendale 388*, 22.ix.1954 (NT); Simpson Desert, *T.S. Henshall 1414*, 14.iv.1977 (NT); Georgina Downs Station, *T.S. Henshall 4117*, 24.viii.1986 (NT); 20 miles WNW Papunya, *P.K. Latz 1337*, 23.iii.1971 (NT); Merrina Waterhole, *G.J. Leach 796*, 5.ix.1986 (NT); Alroy Downs, Bore 28, *B.G. Thomson 223*, 14.ix.1982 (NT).

Distribution

Found in the Fortescue and Canning Districts of the Eremaean Botanical Province, and in the Dampier and Hull Districts of the Northern Botanical Province of Western Australia; and in the Central South, Central North, Barkly Tablelands and Victoria River Botanical Provinces of the Northern Territory (Map 3).

Etymology

The specific epithet acknowledges the botanical efforts of Tom Henshall over many years;

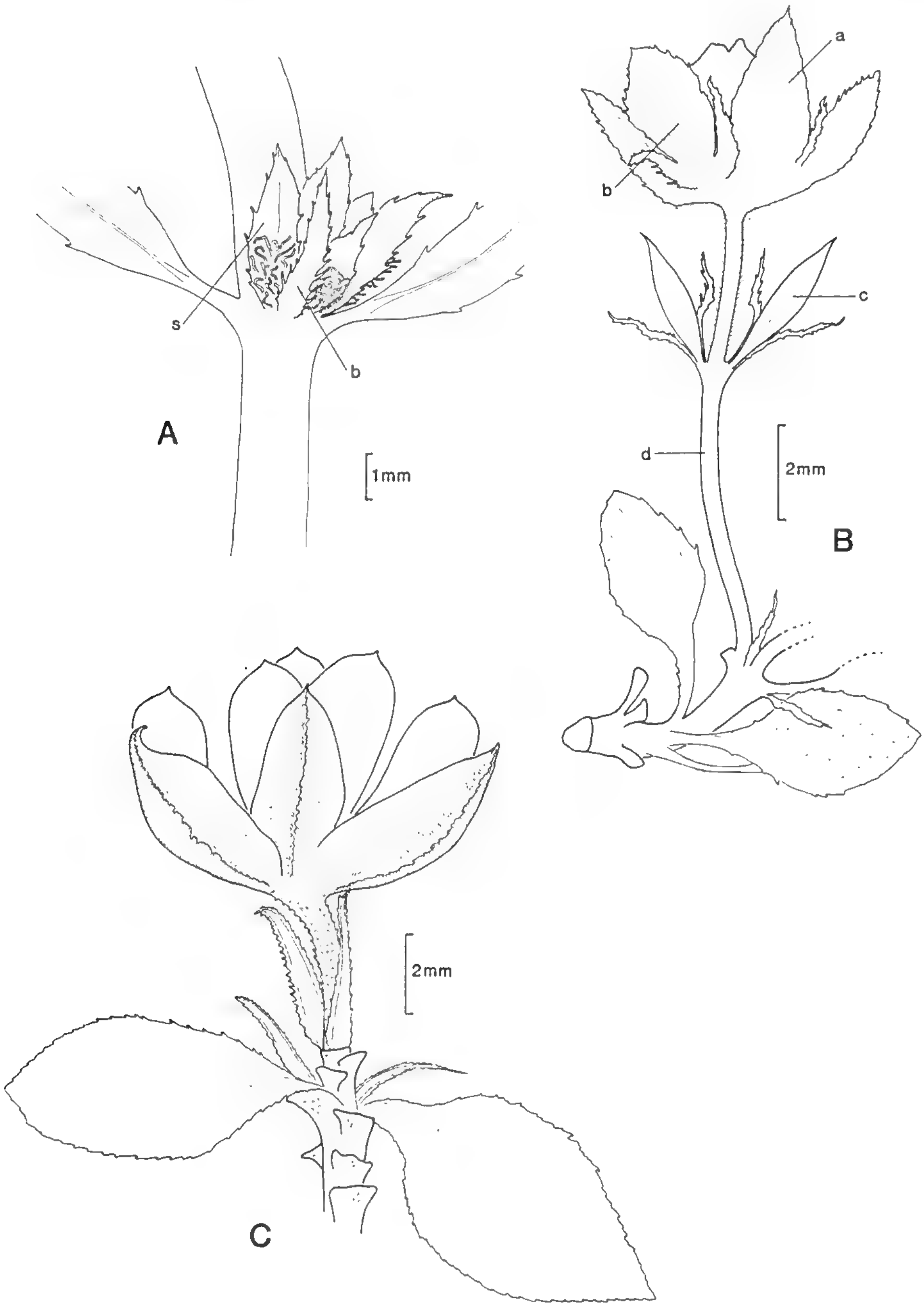


Fig. 2. A. Flower of *Bergia occultipetala* with stipules removed. s, sepal; b. bracteole. (*Symon 6924A*). B. *Bergia auriculata*. a, inner sepal with entire margin; b, outer sepal with auricles; c, bracteole; d, pedicel (*Gardner 7828*). C. Flower of *Bergia henshallii* (*Thomson 887*).

well known for his collections of, and enthusiasm for, the Australian arid zone flora and in particular his attention to collecting Northern Territory bergias.

Notes

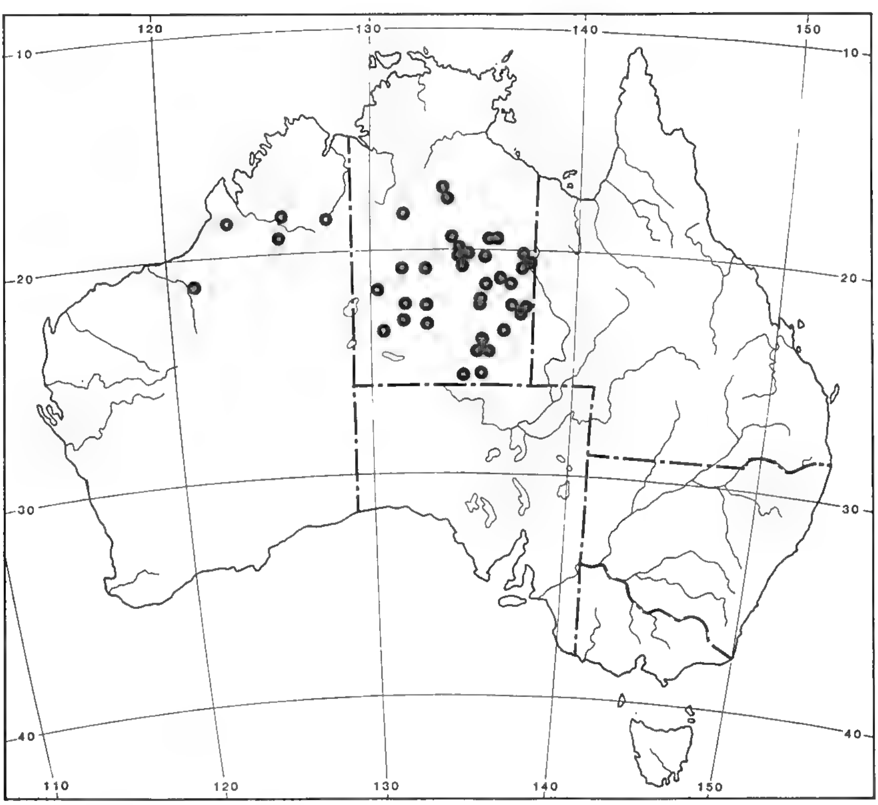
Collections from the Tennant Creek area and eastwards are generally of larger dimensions in leaves and flowers and many specimens have particularly showy flowers. These have some potential as an ornamental ground cover.

3. **Bergia perennis** (F. Muell.) Benth., Flora Australiensis 1:181 (1863); F.M. Bailey, Qld Fl. 1:100 (1899); Ewart & Davies, Fl. N. Terr. 194 (1917); Niedenzu in Engl. & Prantl, Nat. Pflanzenfam. ed. 2. 21:274 (1925); Chippendale, Proc. Linn. Soc. N.S. Wales 96:249 (1971); Green, Census Vasc. Pl. W. Austral. 188 (1985); Jessop in Jessop & Toelken, Fl. S. Austral. 883 (1986).

Elatine perennis F. Muell., Fragm. Phytogr. Austral. 2:146.

Lectotype (here designated): Sturts Creek, *F. Mueller s.n.* (Lecto.: MEL 534789, isolecto.: K, ?AD 97620385).

Prostrate perennial. *Indumentum* of eglandular or type a glandular hairs or lacking. *Leaves* narrow-elliptic to almost circular, 1.5-10 x 0.75-3.5 mm, acute to obtuse, glabrous



Map. 3. Distribution of *B. henshallii.*

to sparsely pubescent, margin entire to serrate, secondary venation obscure. *Stipules* 0.7-2.5 mm long, c. 0.5 mm wide at base. *Flowers* solitary; pedicel to 6 mm long. *Bracteoles* usually inconspicuous, 0-1.5 mm from base of pedicel, 0.75-2.5 x 0.2-0.4 mm, like stipules. *Sepals* 5, elliptic to ovate, 0.75-3.5 x 0.5-2 mm, obtuse to acuminate, glabrous to sparsely pubescent, green to pink, margin broad, entire to serrulate, keel absent or rarely midrib prominent but never winged. *Petals* 5, narrow-obovate to spathulate, 1.25-5 x 0.5-2 mm, obtuse often mucronate, reflexed at anthesis. *Stamens* 10; antipetalous ones c. 1-2 mm long, filament slightly dilated at base, to 0.25 mm wide; antisepalous 1.5-3 mm long, filament dilated to 0.5 mm wide at base. *Capsule* globular to pyriform, 1-2.2 x 1-2.2 mm, 5-locular; styles 0.5-1.5 mm long. *Seeds* ovoid to reniform, 0.5-0.75 x 0.25-0.45 mm, alveolate, brown.

Etymology

The specific epithet refers to the perennial nature of this species.

Notes

There is considerable variation within *B. perennis* with some variants morphologically and geographically distinct as to warrant recognition at the subspecific level. These have been long informally recognised (Verdon, 1981).

As discussed previously in the introduction and under *B. pedicellaris*, Mueller clearly had no intention of accepting *Bergia* at the generic level. Thus the transfer of *Elatine perennis* to *Bergia* should be attributed to Bentham alone.

As Mueller records the species only from Sturts Creek the MEL sheet with Mueller's handwriting is here designated as the lectotype.

Key to subspecies

1. Leaves narrow-elliptic to elliptic; capsule pyriform .... a. subsp. *perennis*
   Leaves elliptic to ± circular; capsule globular 2
2. Leaf apex obtuse; bracteoles obscure, at base of pedicel; sepals mostly greater than 1.5 mm long, c. ½ length of petal, apex obtuse; indumentum if present of eglandular uniseriate hairs .... b. subsp. *obtusifolia*
   Leaf apex acute, rarely obtuse; bracteoles conspicuous, mostly well above base of pedicel, sepals mostly less than 1.5 mm long, c. ¾ length of petal, apex acute; indumentum if present of multiseriate glandular hairs .... c. subsp. *exigua*

3a. subsp. **perennis**.

Indumentum of dense eglandular hairs, glabrescent on older parts. *Leaves* narrow-elliptic to elliptic, 3-10 x 2-3.5 mm, acute, margin serrate. *Stipules* 2-2.5 mm long. *Bracteoles* inconspicuous, at base of pedicel, c. 2.5 x 0.4 mm. *Sepals* ovate, 2-3.5 x 1.3-2 mm, acute to acuminate. *Petals* 3.5-5 x 1.25-2 mm, longer than sepals. *Stamens* 2-3 mm long. *Capsule* pyriform, to 2.2 x 2.2 mm; styles 1-1.5 mm long. (Fig. 1A).

Habitat

In clay or sand soils, occasionally in saline situations.

Specimens examined

WESTERN AUSTRALIA: Two Mile Creek, Warralong Stn, *N.T. Burbidge 767*, 19.v.1941 (PERTH).

NORTHERN TERRITORY: 40 km W Suplejack Stn, *T.S. Henshall 2352*, 30.ix.1978 (NT); 12 km E No. 37 bore, Wallamunga Stn, *W.A. Low 381*, 19.x.1987 (NT); Sanctuary Swamp, *J.R. Maconochie 2470*, 3.vii.1980 (B, CBG, NT); 45 miles SW Mongrel Downs Homestead, *S. Parker 284*, 285, 2.viii.1970 (NT); 6 km SW MacFarlanes Bore, *S. Parker 311*, 5.viii.1970 (AD, NT).

Distribution

Found in the Fortescue and Mueller Districts of the Eremaean Botanical Province of Western Australia; and in the extreme western area of the Central Northern Botanical Province and the southwestern Victoria River Botanical Provinces of the Northern Territory. (Map 4).

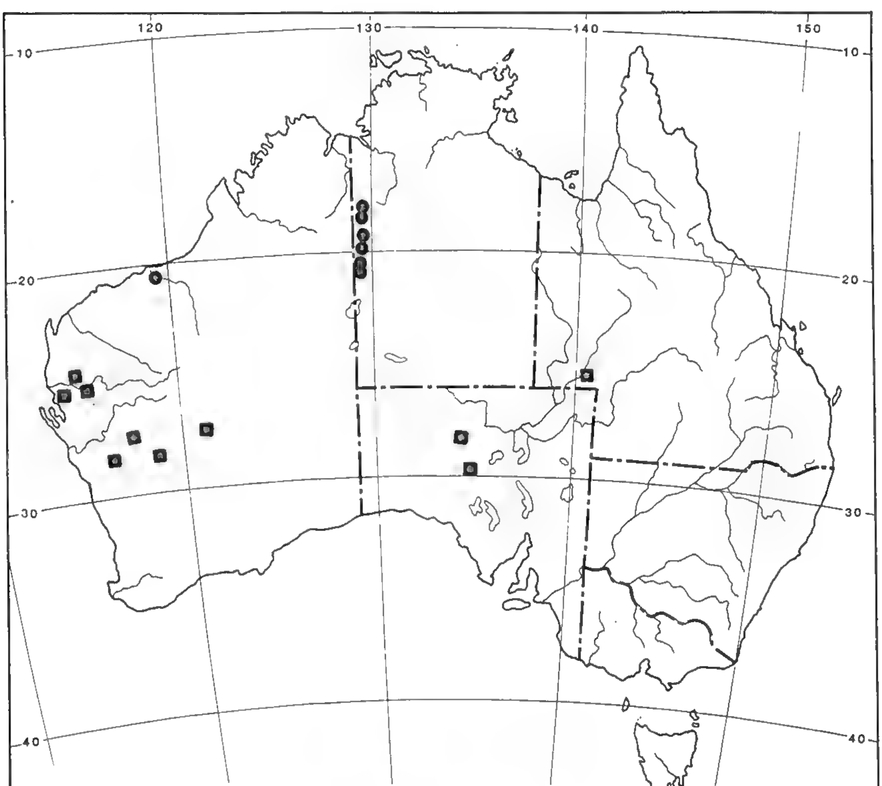
3b. subsp. **obtusifolia** G. Leach, subsp. nov.

Bergia perennis (F. Muell.) Benth. form A, Verdon in Jessop, Fl.Central Austral. 229 (1981).

Ab aliis subspeciebus foliis ellipticis ad rotundis, apicibus obtusis, marginibus integris vel vix serrulatis, floribus minoribus, apicibus sepalorum obtusis, capsulis globosis differt.

Type: *B.G. Thomson 886*, Stirling Swamp on Stuart Highway, c. 32 km S.W. of Barrow Creek, Northern Territory, 23.x.1985: (Holo.: NT, iso.: AD, BRI, CANB, CBG, DNA, K, L, MEL, NSW, PERTH).

Indumentum of eglandular hairs or lacking. *Leaves* elliptic to almost circular, 1.5-10 x 1-2.25 mm, obtuse, margin smooth to inconspicuously serrulate. *Stipules* 0.7-1.5 mm long. *Bracteoles* inconspicuous, at base of pedicel, c. 1 x 0.25 mm. *Sepals* elliptic to ovate, 1.25-2.5 x 1-2 mm, obtuse. *Petals* 2-3.8 x 0.9-1.25 mm, to twice length of sepals. *Stamens* to 1.75 mm long. *Capsule* globular, 1-1.5 x 1-1.5 mm; styles 0.75-1 mm long. (Fig. 1A).



Map 4. Distribution of *B. perennis* subsp. *perennis* ● and subsp. *exigua* ◼.

Habitat

In sandy or loam soils; often in saline areas.

Selected specimens from 24 collections examined

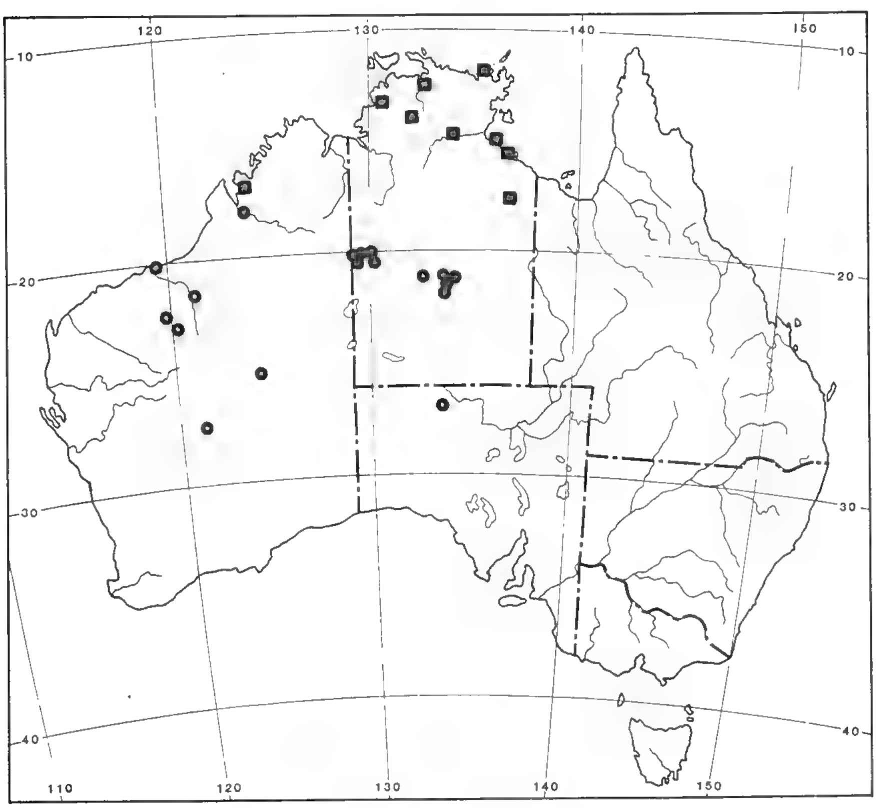
WESTERN AUSTRALIA: Fortescue River, just S Roy Hill, *A.C. Beauglehole 11411*, 12.viii.1965 (NSW); Yandal, NNW Leonora, *W.E. Blackall s.n.*, ix.1939 (PERTH); Mungilli claypan, *A.S. George 5441*, 26.vii.1963 (PERTH); near Liveringa Station, *M. Lazarides 6471*, 1.viii.1959 (CANB, MEL, PERTH); Rabbit proof fence, E of Gregory Range, *R.D. Royce 1897*, 22.v.1947 (PERTH).

NORTHERN TERRITORY: Stirling Creek, *N. Byrnes 1124*, 22.xi.1968 (DNA, NT); 9 km SE Rabbit Flat, *T.S. Henshall 3996*, 22.v.1986 (CANB, DNA, NT, PERTH); 8 mile bore, 14 miles N Willowra homestead, *P.K. Latz 1230*, 15.i.1971 (AD, NT, PERTH); Lake Ruth, *J.R. Maconochie 1045*, 26.v.1970 (AD, BRI, NT, PERTH); Lake Alex, *D. Nelson 1923*, 30.viii.1969, (AD, NT, PERTH).

SOUTH AUSTRALIA: 10 miles SW Granite Downs, *N. Forde 1008*, 26.ix.1960 (CANB).

Distribution

Found in the Dampier District of the Northern Botanical Province and in the Austin, Carnegie and Fortescue Districts of the Eremaean Botanical Province of Western Australia; in the Central North Botanical Province of the Northern Territory; and in the North Western region of South Australia. (Map 5).



Map 5. Distribution of *B. perennis* subsp. *obtusifolia* ● and *B. pusilla* ■.

Etymology

The subspecific epithet refers to the obtuse leaf apices; a distinguishing feature from the other subspecific taxa of *Bergia perennis.*

3c. subsp. **exigua** G. Leach, subsp. nov.

Bergia perennis (F. Muell.) Benth. form C, Verdon in Jessop, Fl. Central Austral. 229 (1981).

Bergia aff. *pedicellaris* (F. Muell.) Benth. of Jessop in Jessop & Toelken, Fl. S. Austral. 883 (1986).

B. perennem subsp. *obtusifoliam* G. Leach aemulans, ab aliis subspeciebus bracteolis manifestis supra basim pedicelli, floribus parvissimis, sepalorum apicibus acutis, petalis sepala aequantibus vel paulo superantibus, capsulis globosis differt.

Type: *F.J. Badman 1070*, 30 km S Mt Willoughby Homestead and 1 km W of Stuart Highway, South Australia, 1984, (Holo.: AD, iso.: NT).

Indumentum of long type a glandular hairs or lacking. *Leaves* elliptic to broad-elliptic, 1.5-5 x 0.75-2 mm, acute, rarely obtuse, margin entire to serrate. *Stipules* 0.75-1.5 mm long. *Bracteoles* usually conspicuous, (0.25-) 0.5-1.5 mm from base of pedicel, 0.75-1.5 x c. 0.2 mm. *Sepals* ovate, 0.75-2 x 0.5-1 mm, acute. *Petals* 1.25-2.25 x 0.5-1 mm, barely exceeding sepals. *Stamens* 1-1.5 mm long. *Capsule* globular, 1-1.75 x 1-1.75 mm; styles to 0.75 mm long. (Fig. 1A).

Habitat

Predominantly on clay pans.

Specimens examined

WESTERN AUSTRALIA: Lake Yandel, *W.E. Blackall s.n.*, ix.1939 (PERTH); 3 km E Pell Creek, *R.J. Cranfield 2005*, 24.iv.1982 (PERTH); Marron Station, *R.J. Cranfield 2256*, 6.v.1982 (PERTH); 4 miles W Yalgoo, *C.A. Gardner 7759*, 10.x.1945 (PERTH); Nallan, *C.A. Gardner 7825*, 13.x.1945 (PERTH); 13 km W Yalgoo, *G.J. Keighery 5132*, 25.viii.1982 (PERTH); 18 miles N Youanmi, *R.D. Royce 10331*, 13.x.1972 (PERTH); 115 km E Carnarvon, *P.G. Wilson 8417*, 29.vii.1969 (CANB, PERTH).

SOUTH AUSTRALIA: McDoull Peak Station, *Cleland s.n.* (2 sheets), 31.x.1929 (AD).

QUEENSLAND: Mooraberree, about 40 miles ENE Betoota, *S.E. Everist 4107*, 3.ix.1949 (BRI).

Distribution

Found in the Austin and Carnarvon Districts of the Eremaean Botanical Province of Western Australia; in the Lake Eyre Basin region of South Australia; and in the Gregory South Pastoral District of Queensland. (Map 4).

Etymology

The subspecific epithet refers to the diminutive nature of this taxon relative to the other subspecies of *B. perennis.*

4. **Bergia barklyana** G. Leach, sp. nov.

Bergia perenni (F. Muell.) Benth. subsp. *perenni* et *B. henshallii* G. Leach affinis, ab utroque indumentio destituto, stipulis latioribus et plerumque foliis integris, a *B. perenni* subsp. *perenni* omnibus partibus majoribus, a *B. henshallii* sepalis glabris et carina laciniata carenti differt.

Type: *P.K. Latz 461*, 12 miles SE Elliott, Northern Territory, 20.ii.1969 (Holo.: NT, iso.: AD, MEL).

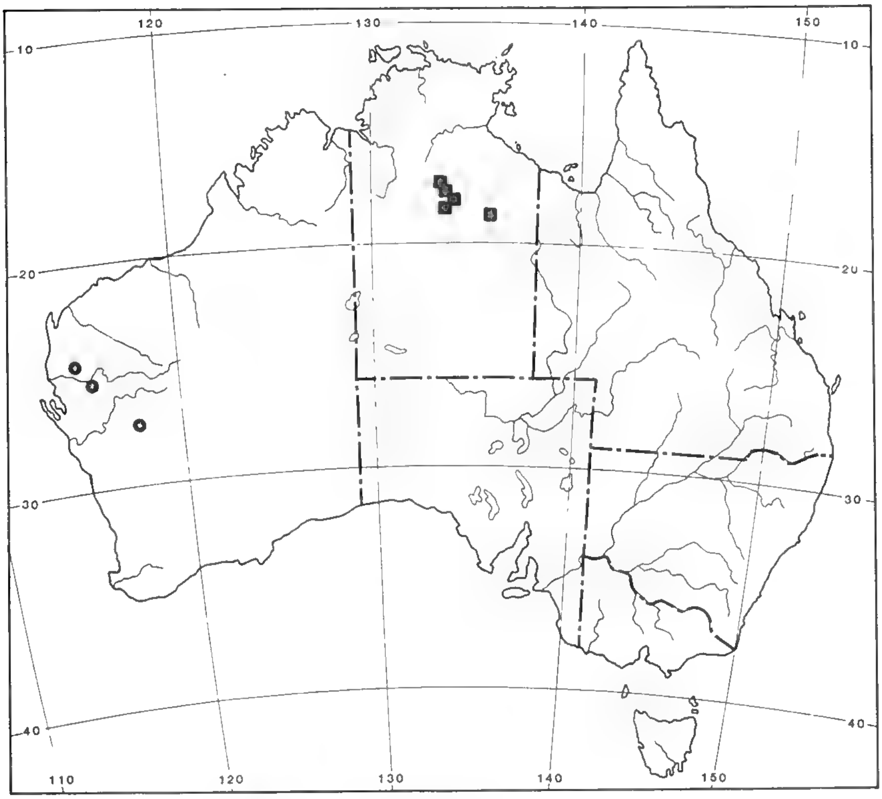
Prostrate perennial. *Indumentum* lacking, glaucous. *Leaves* elliptic (8) 12-24 x 4-9 mm, acute, margin entire, rarely with a few inconspicuous teeth, mid-vein prominent. *Stipules* 2.5-5.2 x 1-1.5 mm. *Flowers* solitary; pedicel 3-8 mm long. *Bracteoles* like stipules, at base of pedicel. *Sepals* 5, narrow-ovate, 5-6 x 2-2.5 mm, acuminate, glabrous, green, margin broad, entire, rarely with a few inconspicuous teeth, midnerve prominent but lacking keel. *Petals* 5, narrow-obovate, 4.5-6 x 1.6-2.2 mm, obtuse, ± equalling sepals, reflexed at anthesis. *Stamens* 10; antipetalous ones c. 3 mm long, filament flattened, narrowly dilated to c. 0.2 mm wide at base; antisepalous c. 3 mm long, filament margin recurved, broadly dilated, 0.5-1 mm wide at base. *Capsule* pyriform, 2.5-3 mm long, c. 2-3 mm diam., 5-locular; styles c. 1 mm long; stigmas clavate, purple. *Seeds* reniform, 0.5-0.6 x c. 0.25 mm, alveolate, dark brown.

Habitat

"Gravelly clay soil on edge of black soil plain".

Specimens examined

NORTHERN TERRITORY: Corella Lagoon, Upper Georgina River, *Lt Dittrich s.n.*, viii.1886 (MEL); Upper Georgina River, *Lt Dittrich s.n.*, 1886 (MEL); Powells Creek, near Lake Woods, *W. Holtze 223*, 1895 (MEL); 25-30 km SE Elliott, *S. Ingleby s.n.*, 24.vi.1986 (NT); E of Rifle Range, Elliott, *S. Ingleby s.n.*, 28.vi.1986 (NT); 32 km SE Elliott, No. 7 bore, *S. Ingleby s.n.*, 5.vi.1987 (NT).



Map 6. Distribution of *B. barklyana* ◘ and *B. auriculata* ●.

Distribution

Known from the Barkly Tableland Botanical Province of the Northern Territory. (Map 6).

Etymology

The specific epithet refers to the distribution of this species in being restricted to the Barkly Tableland.

5. **Bergia auriculata** G. Leach, sp. nov.

B. perenni (F. Muell.) Benth. et *B. henshallii* G. Leach pilis glandulosis ad 1 mm longis, calyx pilis densis affinis; sepalis dimorphis, 3 exterioribus auriculatis, 2 interioribus margine membranaceo integro, auriculis destitutis differt.

Type: C.A. Gardner 7828, Nallan, Western Australia, 13.x.1945 (Holo.: PERTH).

Prostrate perennial. *Indumentum* of dense type a glandular hairs, 0.5-1 mm long. *Leaves* elliptic, 3-4 x 2-3 mm, acute, pubescent, margin ciliate to serrulate, veins obscure. *Stipules* 1.5-3 mm long, 0.2-0.5 mm wide at base. *Flowers* solitary; pedicel 3-7 mm long. *Bracteoles* conspicuous, inserted at middle of pedicel, narrow-elliptic, to 4.5 x 1 mm, pubescent, margin serrulate, auriculate at base. *Sepals* 5, ovate, 3-4.5 x 1.25-2 mm, acute, densely pubescent, outer 3 sepals lacking membranous margin and with laciniate auricles 1.5-2.2 mm long, inner 2 sepals with membranous margin and lacking auricles, keel absent. *Petals* 5, obovate, 2.5-4 x 2-2.5 mm, obtuse, equalling or shorter than sepals, reflexed at anthesis. *Stamens* 10; antipetalous ones c. 2 mm long, filament flattened narrowly dilated to c. 0.25 mm wide at base; antisepalous 2.8-3.8 mm long; filament broadly dilated to c. 0.5 mm wide at base, margin slightly recurved or flat. *Capsule* globular 2-3 mm long, 1.5-2 mm diam., 5-locular; styles 5, 1-1.5 mm long, stigma capitate. *Seeds* reniform, 0.7-1 x 0.4-0.5 mm, alveolate, dark brown. (Fig. 2B).

Habitat

On mud flats and clay soils.

Specimens examined

WESTERN AUSTRALIA: Nallan, *C.A. Gardner 7828*, 13.x.1945 (Holo.: PERTH); 82 km E Carnarvon, *P.G. Wilson 8404*, 29.vii.1969 (PERTH); 72 km W Gascoyne Junction, *Wittwer 1751*, 7.viii.1976 (PERTH).

Distribution

Known from the Austin and Carnarvon Districts of the Eremaean Botanical Province of Western Australia. (Map 6).

Etymology

The specific epithet refers to the distinctive character of the auricles found at the base of the outer three sepals.

6. **Bergia ammannioides** Roxb., Hort. Beng. 34 (1814); Ser. in DC., Prodr. 1:390 (1824); Benth., Fl. Austral. 1:180 (1863); F.M. Bailey, Qld Fl. 1:100 (1899); Niedenzu in Engl. & Prantl, Nat. Pflanzenfam. ed. 2. 21:274 (1925); Backer, Fl. Malesiana 4:205 (1951); Chippendale, Proc. Linn. Soc. N.S. Wales 96:249 (1971); Willis, Handb. Plants Vic. 2:394 (1972); Verdon in Jessop, Fl. Central Austral. 228 (1981); Cunningham et al., Pl. W. N.S.Wales 499 (1982); Green, Census Vasc. Pl. W. Austral. 188 (1985); Jessop in Jessop & Toelken, Fl. S. Austral. 883 (1986).

Type: *Heyne s.n.*, India (location not known).

Prostrate or erect herb to 40 cm, annual. *Indumentum* of eglandular hairs with occasional long type a glandular hairs. *Leaves* narrow-elliptic to elliptic, 8-25 x 3-8 mm, acute, glabrous or sparse hairs usually restricted to base or nerves, margin serrate, veins prominent. *Stipules* 1.5-2 mm long, 0.5 mm wide at base. *Flowers* in dense fascicles; pedicel to 4 mm long. *Bracteoles* inconspicuous, at base of pedicel, linear, c. 1 mm long. *Sepals* 5, narrow-ovate, 1.2-2 x c. 0.5 mm, acute to acuminate, pubescent, green, margin narrow, fimbriate, keel absent. *Petals* 5, narrow-ovate, 1.5-2 x c. 0.5 mm, acute, ± equal to sepals, erect at anthesis. *Stamens* 5, c. 1 mm long, filament base slightly expanded. *Capsule* globular, 1.5-2 mm diam., 5-locular; styles c. 0.25 mm long, stigmas capitate. *Seeds* ellipsoid, 0.25-0.3 x 0.15 mm, faintly striate, light brown.

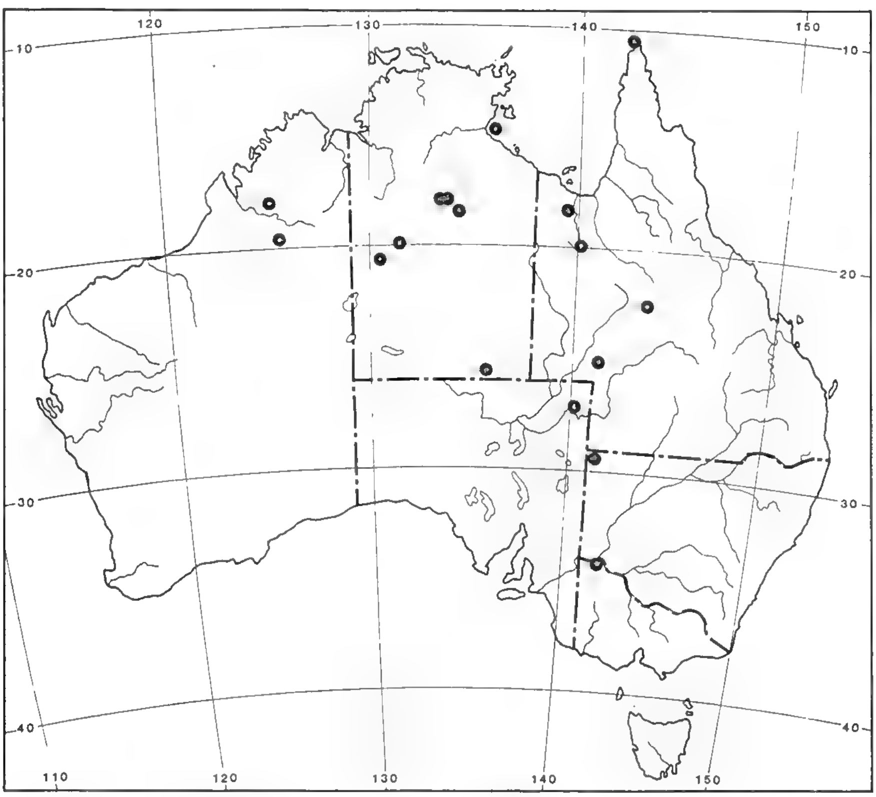
Habitat

By clay-pans, swamps, creeks and saline areas, in clay or sand.

Specimens examined

WESTERN AUSTRALIA: 19°52′, 125°15′, *T.J. Fatchen 968*, 27.v.1984 (AD); West Kimberley, *F.M. House s.n.*, 1901 (PERTH).

NORTHERN TERRITORY: Maria Island, *C.R. Dunlop 2969*, 13.vii.1972 (DNA, NT); Lander Creek, *G.F. Hill 315*, 10.vi.1911 (MEL); Powell Creek, *W. Holtze s.n.*, 1895 (MEL); Indinda Swamp, Andado Station, *P.K. Latz 6829*, 17.iv.1977 (AD, CANB, MEL, NT); c. 35 km SSE The Granites, *P.K. Latz 8709*, 24.vi.1981 (NT); Junction Reserve,



Map 7. Distribution of *B. ammannioides*.

P.K. Latz 9307, 16.vii.1982 (NT); 10 km S Sangsters Bore, *P.K. Latz 9392*, 8.viii.1982 (CANB, NT); Victoria River, *F. Mueller s.n.*, s.d. (K); 42.9 miles E Helen Springs, *R.A. Perry 211*, 5.vii.1947 (CANB).

QUEENSLAND: Kajabbi, Leichhardt River, *S.T. Blake 9309*, 6.vi.1935 (BRI); 40 miles NW Longreach, *Davidson 281*, viii.1952 (BRI); Currawilla, *S.L. Everist 3974*, 11.vi.1949 (BRI); Thursday Island, *Palmer s.n.*, s.d. (BRI); Leichhardt River, SE Burketown, *R. Pullen 9053*, 3.v.1974 (CANB).

NEW SOUTH WALES: Fort Grey Basin, *S. Jacobs 3089*, 8.v.1977 (AD, NSW).

VICTORIA: 3.5 km N Mildura, *J.H. Browne 108*, 3.v.1982 (AD, MEL); 2.5 km SE Psyche Bend, *J.H. Browne s.n.*, 13.iii.1982 (AD, MEL).

Distribution

Found in the Dampier District of the Northern Botanical Province and in the Canning District of the Eremaean Botanical Province of Western Australia; in all Botanical Provinces of the Northern Territory; in the Burke, Cook, Gregory North, Maranoa and Mitchell Pastoral Districts of Queensland; in the North Far Western Plains Botanical Division of New South Wales and the Mallee Study Area of Victoria. Widespread from tropical Africa through tropical Asia, southern China, Java, Philippines, Timor. (Map 7).

Etymology

The specific epithet refers to the superficial similarity of this species to *Ammannia* (Lythraceae).

Notes

B. ammannioides in Australia is morphologically quite uniform. However, Verdcourt (1968) comments that although a highly variable species, the Australian material appears racially distinct from African and presumably Asian material. Following examination of a limited selection of material from Africa and Asia I can see no morphological basis to support any distinction from Australian specimens. Despite frequent citation in the literature that the type is at K, the specimen has not been located there (Verdcourt 1968). Location of the type and detailed examination of Indian material is required to confirm the application of the name to Australian material.

7. **Bergia trimera** Fischer & C. Meyer, Linnaea 10:74 (1836); Niedenzu in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 21:274 (1925); Chippendale, Proc. Linn. Soc. N.S. Wales 96:249 (1971); Jacobs & Pickard, Pl. N.S.Wales 111 (1981); Verdon in Jessop, Fl. Central Austral. 229 (1981); Cunningham et al., Pl. W. N.S. Wales 499 (1982); Green, Census Vasc. Pl. W. Austral. 188 (1985); Jessop in Jessop & Toelken, Fl. S. Austral. 883 (1986).

Bergia ammannioides var. *trimera* (Fischer & C. Meyer) Benth., Flora Australiensis 1:180 (1863).

Type: India orientali, (location not known, not at K or LE).

Bergia tripetala F. Muell., Trans. Philos. Inst. Victoria 2:66 (1858).

Elatine tripetala (F. Muell.) F. Muell., Pl. Vict. 1:196, t. 9. (1862).

Type: *F. Mueller s.n.*, at the confluence of the rivers Murray and Darling (Holo.: MEL534790).

Prostrate or erect herb to 15 cm, annual, ? perennial. *Indumentum* of eglandular hairs. *Leaves* narrow-obovate to narrow-elliptic, 3.5-30 x 1.5-8 mm, acute, glabrous, margin serrate, veins obscure. *Stipules* 1.2-2 mm long, c. 0.5 mm wide at base. *Flowers* 4-20 in dense fascicles; pedicel 0-2.5 mm long. *Sepals* 3-4, narrow-elliptic, 0.7-1.5 x c. 0.3 mm, acute, glabrous, rarely pubescent, green or pink, margin broad, entire or fimbriate, keel absent. *Petals* 3-4, elliptic, 0.7-1.5 x 0.4-0.6 mm, obtuse, equalling sepals, erect at anthesis. *Stamens* 3-4, 0.5-1 mm long; filament base slightly expanded to c. 0.1 mm. *Capsule* globular, 1-1.2 x 0.8-1 mm, 3-4-locular; stigmas ± sessile. *Seeds* ovoid or reniform, 0.3-0.4 x 0.2 mm, alveolate, brown.

Habitat

In sand, loam or clay soils, often saline.

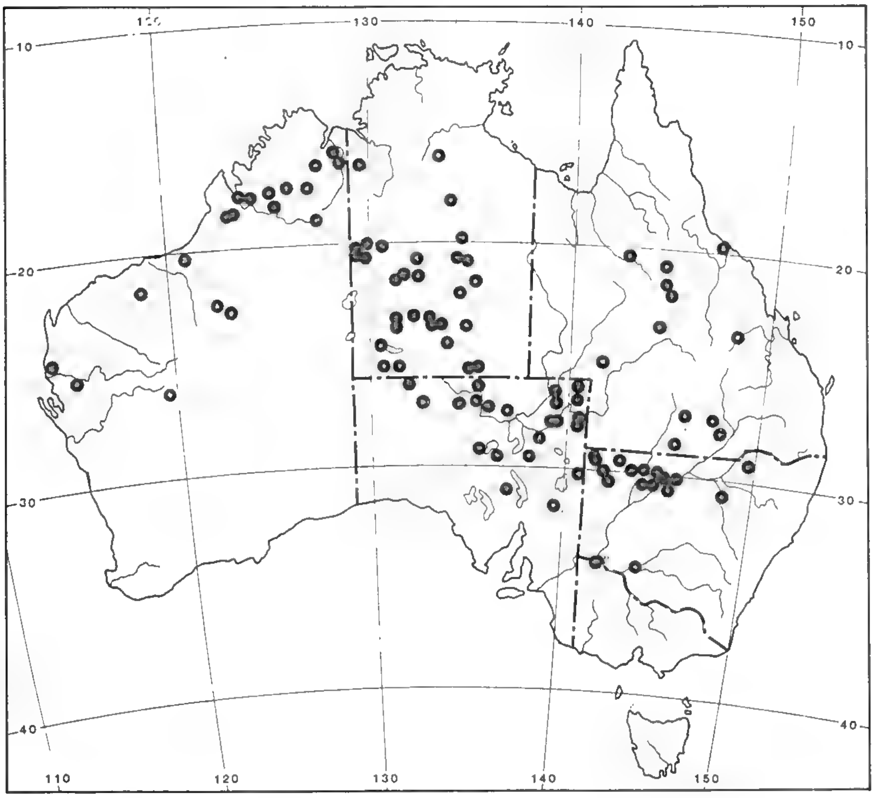
Selected specimens from 113 collections examined

WESTERN AUSTRALIA: Sturt Creek near Billilune, *A.C. Beauglehole 47490*, 14.vii.1974 (PERTH); Turner River, Abydos Station, *N.T. Burbidge 5855*, 24.iv.1958 (CANB); 2 miles SW Fitzroy Crossing, *A.J. Ewart s.n.*, 1927 (PERTH).

NORTHERN TERRITORY: Lake Amadeus area, *T.S. Henshall 740*, 18.ix.1974 (NT); Lander Creek, *G.F. Hill 305*, 10.vi.1911 (MEL); 9 miles S Mongrel Downs homestead, *P.K. Latz 748*, 4.viii.1970 (AD, NT).

SOUTH AUSTRALIA: Macumba Station, *Ising 35*, xi.1950 (AD); Innamincka, Coopers Creek, *Tate s.n.*, 1884 (AD); Goyders Lagoon, *J.Z. Weber 4508*, 14.viii.1975 (AD); c. 10 km W Quinyambie homestead, *D.J.E. Whibley 3560*, 30.vii.1971 (AD).

QUEENSLAND: 30 miles SW Bollon, *G.H. Allen 662*, 20.ii.1944 (CANB); Emerald, *S.T. Blake 8210*, 18.iii.1935 (BRI); Dingwall, *S. Everist 3412*, 19.iv.1948 (BRI, CANB).



Map 8. Distribution of *B. trimera*.

NEW SOUTH WALES: Yantara Lake, *W. Bäuerlen* NSW 141289 (NSW); 21 km E Brindiwilpa, *R. Chinnock 3631*, 12.v.1977 (AD); Lake Fort Grey, *S. Jacobs 3438*, 15.xi.1978 (NSW); Horsefalls Billabong, Bourke, *E.J. McBarron 18593*, 14.xi.1969 (AD).

VICTORIA: Kings Billabong State Game Refuge, *J. Browne 79*, 13.i.1982 (MEL); Boonie Doon Bend, 7 km E Red Cliffs, *J. Browne 118*, 18.vii.1982 (MEL).

Distribution

Found in all districts of the Northern Botanical Province and in the Austin, Canning, Carnarvon, Fortescue, Keartland and Mueller Districts of the Eremaean Botanical Province of Western Australia; in all Botanical Provinces of the Northern Territory; in the Eastern, Gairdner-Torrens, Lake Eyre Basin and North-western regions of South Australia; in the Burke, Gregory North, Leichhardt, Maranoa, Mitchell, North Kennedy and Warrego Pastoral Districts of Queensland; in the North Western Plains and North Far Western Plains Botanical Subdivisions of New South Wales; and in the Mallee Study Area of Victoria. Also from India and Sri Lanka. (Map 8).

Etymology

The specific epithet refers to the predominantly 3-merous flowers; a distinguishing feature from the closely related *B. ammannioides.*

Notes

Some authors (Thiselton Dyer 1872; Bentham 1863) have reduced *B. trimera* to a variety or a synonym (Sohmer 1980) of *B. ammannioides.* The Australian material is sufficiently distinct to warrant recognition at the specific level. Further work is needed to clarify the global distribution of *B. trimera.* Failure to recognise the distinction from the closely related *B. ammannioides* may account for apparent disjunctions between Australia and India. As for *B. ammannioides* there is a need to examine Indian material to clarify application of the name to Australian material.

8. **Bergia occultipetala** G. Leach, sp. nov.

Species nova affinitatibus obscuris, floribus sessilibus solitariis, bracteolis persistibus et adpressis calyci, sepalis ecarinatis, sepalorum pilis dorsis ligulatis obtusatis hyalinis longis (ad 0.7 mm), petalis a sepalis plerumque obtectis, staminibus 5, ovario 5-loculari raro 4-loculari, stylis brevissimis, seminibus alveolatis.

Type: *D.E. Symon 6924A*, 22 km NE Wilson Creek Bore, 17.v.1971 (Holo.: NT).

Prostrate perennial. *Indumentum* of eglandular hairs. *Leaves* elliptic, 8-25 x 3-7.5, acute, glabrous, margin serrate, mid-vein prominent, leaves on condensed axillary shoots smaller, 3-3.5 x 1-1.5 mm. *Stipules* 2.5-3.5 mm long, 1-1.5 mm wide at base. *Flowers* solitary, sessile. *Bracteoles* appressed to calyx, 1-4.5 x 0.7-1.5 mm, acuminate, green, margin white, laciniate, sometimes separated as distinct auricles. *Sepals* 5, elliptic, 2-4.5 x 1-2 mm, acuminate, dimorphic with inner 2 sepals smaller, green, margin fimbriate, keel absent, pubescent externally on basal half with blunt, transparent, strap-like hairs to 0.7 mm long. *Petals* 5, narrow-obovate to spathulate, 1.6-2.5 x 0.5-0.9 mm, obtuse, shorter than sepals, enclosed within sepals at anthesis. *Stamens* 5, c. 1.5 mm long; filament flattened, linear or narrowly dilated at base. *Capsule* globular, 1.5-2.5 mm diam., 5-, rarely 4-locular; styles absent or to 0.5 mm long. *Seeds* ellipsoid or reniform, 0.5 x 0.1-0.2 mm, alveolate, dark brown. (Fig. 2A).

Habitat

Grows on sandy or clay soils. Recorded from lower dune slopes and swamp margins.

Specimens examined

NORTHERN TERRITORY: Old Andado, *R. Buckley 1692*, 24.viii.1976 (CANB); Indindo Swamp, Andado Station, *T.S. Henshall 1479*, 17.iv.1977 (NT, PAUH, SP).

SOUTH AUSTRALIA: Camerons Corner, *S. Jacobs 3851*, 6.vii.1980 (NSW); 10 km SE Callamurra W.H., *L.D. Williams 8219*, 27.v.1976 (AD); 5 km SW Innamincka Bore No. 3, *L.D. Williams 8257*, 28.v.1976 (AD).

Distribution

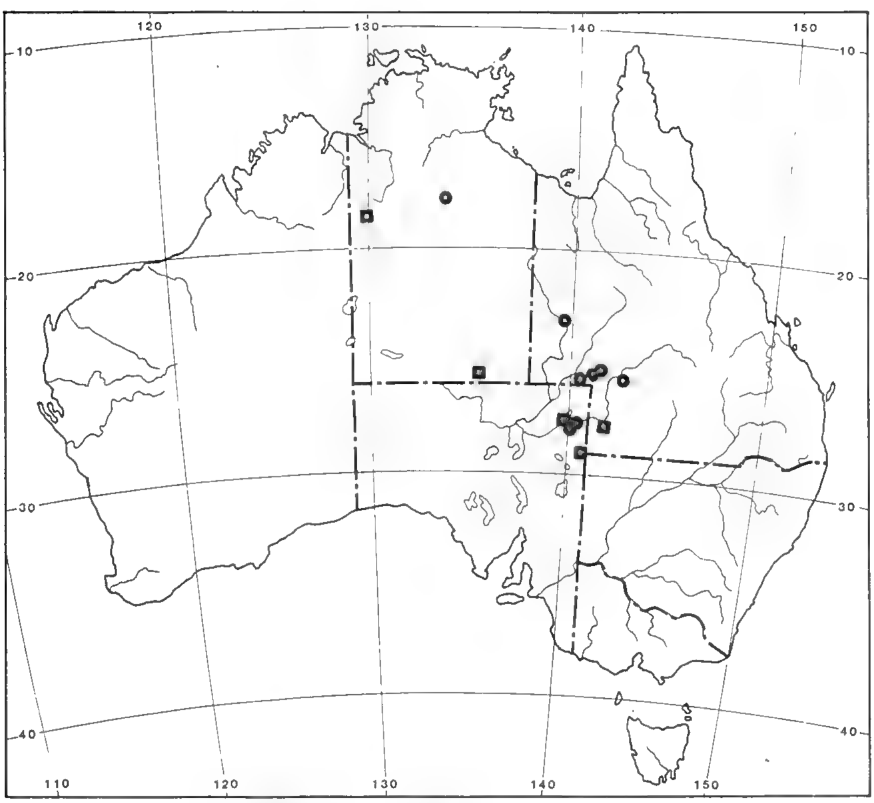
Found in the Victoria River and Central South Botanical Provinces of the Northern Territory and the Lake Eyre Basin region of South Australia. (Map 9).

Etymology

The name refers to the petals which remain enclosed within the calyx.

Notes

The flowers are almost certainly cleistogamous. While the species must be presently considered rare, it is likely that the inconspicuous nature of the flowers has meant the species being often overlooked by collectors.



Map 9. Distribution of *B. occultipetala* ■ and *B. diacheiron* ●.

9. **Bergia diacheiron** Verdon ex G. Leach, sp. nov.

B. occultipetalae G. Leach affinis, a qua sepalorum pilis longis propriis destitutis, petalis calycem superantibus, ovario 3-loculari differt.

Type: *P.K. Latz 460*, 13 miles SE Elliott, 20.ii.1969 (Holo.: NT, iso.: BRI, AD).

Prostrate perennial. *Indumentum* of eglandular hairs or lacking. *Leaves* elliptic, 1.5-5.5 x 1.4-2.5 mm, acute or rarely mucronate, glabrous, margin serrate, venation obscure. *Stipules* 1.2-2 x 0.5-1 mm. *Flowers* solitary, ± sessile. *Bracteoles* appressed to and shorter than calyx, elliptic, 1-2 x 0.4-0.6 mm, margin broad, white, fimbriate. *Sepals* 5, ovate, 1.2-2.2 x 0.8-1.2 mm, acuminate, glabrous or sparsely pubescent, green, margin broad, white, laciniate, keel obscure or absent. *Petals* 5, narrow-obovate, 2-2.5 x 0.45-0.7 mm, obtuse, rarely mucronate, longer than sepals, erect at anthesis. *Stamens* 3-5, 1.2-1.6 mm long; filament flattened, dilated at base. *Capsule* globular, 1-1.2 mm diam., 3-locular; styles 0-0.25 mm long; stigmas capitate. *Seeds* ovoid, slightly curved, 0.3-0.5 x 0.15-0.25 mm, alveolate, light to dark brown.

Habitat

On sandy, gravelly or clay soils.

Specimens examined

SOUTH AUSTRALIA: Innamincka homestead, *N. Lothian 683*, 29.viii.1960 (AD); 4 km S Innamincka bore No. 3, *L.D. Williams 8255*, 28.v.1976 (AD).

QUEENSLAND: Currawilla, *S. Everist 3980*, 11.vi.1949 (BRI, CANB); Birdsville, *E.R. Gowan s.n.*, 18.ix.1957 (BRI); Windorah, *L.S. Penrose 2525*, 9.v.1975 (BRI); 3 km SSW Mudgeacca, *Purdie 1452*, 11.ix.1978 (BRI); 14 km S Mooraberrie, *Purdie 1494*, 19.x.1978 (BRI).

Distribution

Found in the Barkly Tableland Botanical Province of the Northern Territory; the Lake Eyre Basin region of South Australia; and in the Gregory South and Gregory North Pastoral Districts of Queensland. (Map 9).

Etymology

The specific epithet refers to the character of the prominent bracteoles clasping and partially enclosing the flower.

Notes

One specimen from Currawilla, Qld, (*Everist 3980*) differs from the typical by leaves up to 12 x 4 mm and much longer internodes. It is probably a growth form responding to more favourable conditions.

10. **Bergia pusilla** Benth., Flora Australiensis 1:180 (1863); Ewart & Davies, Fl. N. Terr. 194 (1917); Chippendale, Proc. Linn. Soc. N.S. Wales 96:249 (1971).

Lectotype (here designated): *F. Mueller s.n.*, Arnhem Land, Roper River, 10.vii.1856 (Lecto.: MEL 534787, isolecto.: K).

Erect annual herb to 6 cm high. *Indumentum* lacking. Leaves narrow-elliptic to elliptic, 3-9 x 1.5-2.5 mm, acute, margin entire or occasionally glands prominent, veins obscure, prominent brown apical gland. *Stipules* 1.25-2.5 x 0.25-0.5 mm. *Flowers* single per axil, appearing clustered terminally; pedicel 1-2.5 mm long. *Bracteoles* absent. *Sepals* 4, narrow-elliptic, 2.5-5 x 0.5-1 mm, acuminate, often with mucro to 0.4 mm long, glabrous, margin narrow, entire, naviculate, keel mostly prominent, sinuate. *Petals* 4, narrow-ovate, 1.5-2.5 x 0.5-1 mm, acute, mucronate, c. ½ to subequal with sepals, erect at anthesis. *Stamens* 4; antisepalous, 1-1.5 mm long, filament flattened, scarcely dilated at base. *Capsule* pyriform, 1.75-2.5 x 1-1.5 mm, 4-locular; styles ± sessile - 0.25 mm long; stigmas clavate. *Seeds* ellipsoid, c. 0.3 x 0.1 mm, smooth to faintly alveolate, shiny, pale yellow-brown.

Habitat

Seasonally inundated areas; typically on sandy soil associated with watercourses.

Specimens examined

WESTERN AUSTRALIA: Meda-oobagooma road, *A.C. Beauglehole 52752*, 13.vi.1976 (PERTH).

NORTHERN TERRITORY: Katherine, *S.T. Blake 17436*, 24.iv.1947 (BRI); vicinity of Woolaning Homestead, *Craven & Dunlop 6667*, 4.iv.1981 (CANB); Maria Island, *C.R. Dunlop 2822*, 13.vii.1972 (DNA, NT); 10 miles W Borroloola, *N. Henry 71*, 5.vi.1971 (NT); Galiwinku, Elcho Island, *J.R. Maconochie 2165*, 9.vii.1975 (CANB, DNA, K, L, MEL, NT); c. 80 km SW Calvert Hills, *R. Pullen 9268*, 15.v.1974 (CANB, DNA); Koongarra, *B.L. Rice 2928*, 3.vi.1978 (CANB); Koongarra, *B.L. Rice 3356*, 19.v.1981 (CANB).

Distribution

Found in the Dampier District of the Northern Botanical Province of Western Australia; and in the Darwin and Gulf and Barkly Tablelands Botanical Provinces of the Northern Territory. (Map 5).

Etymology

The specific epithet refers to the small individual size typical of the species.

Notes

Bentham (1863) in his description of *B. pusilla* cites *Elatine verticillaris* F. Muell. apparently as a validly published synonym. Mueller, however, includes *E. verticillaris* under his discussion of *E. ammannioides* and mentions it as a herbarium name used for specimens collected during the Gregory Expedition. It would appear he had no intention of recognising or publishing *E. verticillaris.*

Type material of Mueller's collection from the Roper River is at K and MEL. The MEL sheet has Bentham's initial and his statement concerning *Bergia verticillata* Willd. as it appears in the protologue. The MEL sheet is therefore here designated the lectotype.

Acknowledgements

The author is grateful to Mr C.R. Dunlop for comments on a draft of this paper, and to Phillipa Fox, Cathy Keegan, Toni-Maree Semple and Jarka Skrivan for preparation of illustrations and distribution maps. Thanks are also due to the Directors/Curators of the following institutions for the loan of herbarium specimens: AD, BRI, CANB, K, MEL, NSW, PERTH.

References

Backer, C.A. (1951). Elatinaceae. In van Steenis, C.G.G.J. (ed.). 'Flora Malesiana', Vol. 4:203-206. (Noordhoff: Djakarta).

Bentham, G. (1863). 'Flora Australiensis', Vol. 1. (Lovell Reeve & Co.: London).

Keighery, G. (1984). Cleistogamy in *Elatine gratioloides* A. Cunn. (Elatinaceae). *W.A. Naturalist* 16:22.

Mueller, F. (1861). Elatinaceae. 'Fragmenta Phytographie Australiae', Vol. 2: 145-147. (Govt Printer: Melbourne).

Mueller, F. (1862). 'The Plants indigenous to the Colony of Victoria'. Thalamiflorae. (Govt Printer: Melbourne).

Niedenzu, F. (1925). Elatinaceae. In Engler, A. & Prantl, K. (eds.). 'Nat. Pflanzenfam.", ed. 2, 21: 270-276.

Obermeyer, A.A. (1976). Elatinaceae. In Ross, J.H. (ed.). 'Flora of Southern Africa', Vol. 22. (Department of Agricultural Services: Pretoria).

Ramayya, N. & Prabhakar, M. (1975). Morphology of the shaggy appendages II. Elatinaceae. *J. Indian Bot. Soc.* 54: 110-115.

Salisbury, E.J. (1967). On the reproduction and biology of *Elatine hexandra* (Lapierre) DC. (Elatinaceae); a typical species of exposed mud. *Kew Bull.* 21: 139-149.

Sculthorpe, C.D. (1967). "The Biology of Aquatic Vascular Plants". (Edward Arnold: London).

Sohmer, S.H. (1980). Elatinaceae. In Dassanayake, M.D. & Fosberg, F.R. (eds.). 'A Revised Handbook to the Flora of Ceylon'. (Amerind: New Delhi).

Thiselton Dyer, W.T. (1874). Elatinaceae. In Hooker, J.D. 'The Flora of British India'. (Lovell Reeve & Co.: London).

Tucker, G.C. (1986). The genera of Elatinaceae in the southeastern United States. *J. Arn. Arb.* 67: 471-483.

Verdcourt, B. (1968). Elatinaceae. In Milne-Redhead, E. & Polhill, R.M. (eds.). 'Flora of Tropical East Africa'. (Crown Agents: London).

Verdon, D. (1981). Elatinaceae. In Jessop, J.P. (ed.). 'Flora of Central Australia'. (Reed: Sydney).

Index to Collectors of *Bergia* from Australia

1. *B. pedicellaris*
2. *B. henshallii*
3a. *B. perennis* subsp. *perennis*
3b. *B. perennis* subsp. *obtusifolia*
3c. *B. perennis* subsp. *exigua*
4. *B. barklyana*
5. *B. auriculata*
6. *B. ammannioides*
7. *B. trimera*
8. *B. occultipetala*
9. *B. diacheiron*
10. *B. pusilla*

Allen, G.H. 662, 7; *Andrew s.n.*, 1.viii.1920, 7; *Andrewartha, H.G. 2784*, 7; *Anon.* AD 97417246, 7; NT 71363, 1; *Badman, F.J. 653*, 7; *802*, 7; *1070*, 3c; *1104*, 7; *Barron s.n.*, 14.xi.1969, 7; *Bates, R. s.n.*, 19.v.1983, 7; *Bäuerlen, W.* NSW 141289, 7; *Beauglehole, A.C. 10639*, 2; *10644*, 7; *10674*, 2; *11101*, 1; *11411*, 3b; *22786*, 7; *47329*, 7; *47490*, 7; *47651*, 7; *51474*, 1; *52752*, 10; *53174*, 7; *53184*, 1; *53566*, 7; *53800*, 7; *53945*, 1; *53950*, 1; *54333*, 7; *Betche, E. s.n.*, xii.1885, 7; *Blackall, W.E. s.n.*, ix.1939, 3c; ix.1939, 3b; *Blackwell, M.I. 492*, 1; *493*, 1; *Blake, S.T. 8120*, 7; *9309*, 6; *17436*, 10; *19366*, 1; *Brass, L.J. 93*, 1; *Browne, J.H. 108*, 6; *114*, 7; 13.iii.1982, 6; *Buckley, R. 1692*, 8; *Burbidge, N.T. 767*, 3a; *1526*, 3b; *5855*, 7; *5859*, 7; *5945*, 7; *5947*, 1; *Byrnes, N. 742*, 1; *1124*, 3b; *Carr, G.W. 3676*, 1; *Carriage, N.B. 63*, 2; *Chinnock, R. 3631*, 7; *Chippendale, G.M. 241*, 2; *388*, 2; *3800*, 2; *4747*, 7; *5832*, 1; *7182*, 1; 22.v.1951, 7; *Chisholm s.n.*, xii.1889, 7; *Cleland, J.B. 61*, 7; 11.iv.1958, 7; v.1924, 7; 1931, 7; 31.x.1929, 3c; 9.iv.1958, 7; 3.ix.1938, 7; 21.viii.1931, 7; v.1924, 7; 1931, 7; 31.x.1929, 3c; *Copley, P. 566*, 2; *Cranfield, R.J. 2005*, 3c; *2223*, 7; *2256*, 3c; *Craven, L.A. 2253*, 1; *4338*, 1; *4597*, 1; *4648*, 1; *6149*, 1; *Craven, L.A. & Dunlop, C.R. 6667*, 10; *Cunningham, A. 234*, 1; *Dale 150*, 1; *Davidson 281*, 6; *361*, 7; *Delong, M. s.n.*, 25.iii.1983, 2; *Dittrich s.n.*, viii.1886, 4; *Dittrich* MEL 1539077, 4; *Dittrich s.n.*, 1886, 2; *Dunlop, C.R. 2500*, 1; *2822*, 10; *2969*, 6; *Eddy, N.G. 186*, 2; *Everist, S.L. 2947*, 1; *3412*, 7; *3974*, 6; *3978*, 7; *3980*, 9; *4090A*, 1; *4107*, 3c; *5342*, 7; *Ewart, A.J. s.n.*, 1927, 7; v.1927, 7; *Fatchen, T.J. 968*, 6; *999*, 2; *Fitzgerald, W.V. 449*, 1; *1628*, 7; x.1906, 1; viii.1906, 1; x.1906, 7; *Forde, N. 758*, 2; *1008*, 3b; *Froggat 1888*, 1; *Fryxell, P.A. et al. 4489*, 2; *Gardner, C.A. 7160*, 1; *7302A*, 1; *7759*, 3c; *7825*, 3c; *7828*, 5; *9683*, 1; *10152*, 2; *11822*, 1; *22245*, 1; *George, A.S. 5441*, 3b; *9108*, 7; *13601*, 1; *14059*, 1; *Gittens 2365*, 3b; *2430*, 3b; *Gowan, E.R. s.n.*, 18.ix.1957, 9; *Graham s.n.*, ix.1960, 7; *Halford, D. 83937*, 1; *Hartley, T.G. 14534*, 1; *14681*, 7; *Henry, N. 71*, 10; *185*, 3b; *Henshall, T.S. 740*, 7; *1414*, 2; *1475*, 2; *1477*, 7; *1479*, 8; *1701*, 2; *2071*, 2; *2352*, 3a; *3996*, 3b; *4104*, 2; *4117*, 2; *Hill, G.F. 305*, 7; *315*, 6; *Holtze, W. 208*, 6; *209*, 1; *223*, 4; *House, F.M. 1901*, 1; 1901, 6; *Hubbard & Winders 6219*, 7; *Ingleby, S. s.n.*, 28.vi.1986, 4; 5.vi.1987, 4; 30.vi.1986, 7; 21.ix.1987, 2; *Ising, E.H. M35*, 7; xi.1950, 7; 29.viii.1933, 2; viii.1933, 2; *Jacobs, S.L. 2075*, 3b; *3089*, 6; *3438*, 7; *3851*, 8; *Keighery, G.J. 5132*, 3c; *Kempe* MEL 1539126, 7; *471*, 2; *Kenneally, K.F. 4411*, 1; *5588*, 7; *5705*, 7; *5708*, 7; *8601*, 1; *Langford, D. s.n.*, 26.ix.1983, 7; *Latz, P.K. 460*, 9; *461*, 4; *494*, 3b; *577*, 1; *598*, 7; *731*, 7; *748*, 7; *1230*, 3b; *1231*, 2; *1337*, 2; *2526*, 2; *2648*, 7; *4073*, 7; *4427*, 2; *4442*, 7; *5019*, 7; *5633*, 3b; *5952*, 7; *6560*, 3b; *6763*, 1; *6829*, 6; *7038*, 1; *8380*, 1; *8480*, 7; *8709*, 6; *9107*, 1; *9307*, 6; *9308*, 7; *9309*, 1; *9392*, 6; *9732*, 2; *Lazarides, M. 6471*, 3b; *Leach, G.J. 709*, 3b; *796*, 2; *883*, 2; *1294*, 2; *Lothian & Francis 683*, 9; *Lothian, T.R.N. 480/54*, 7; *Low, W.A. 381*, 3a; *Maconochie, J.R. 1045*, 3b; *1282a*, 1; *2165*, 10; *2470*, 3a; *McBarron, E.J. 18593*, 7; *McDonald 2518*, 7; *McKey, D 319*, 2; *McLeod, J.* 18.vi.1884, 7; *Michael, Rev. 1623*, 7; *Mitchell s.n.*, v.1974, 7; *Mitchell, A.S. 54*, 1; *755*, 7; *Moloney 13*, 2; *Moore 6894*, 7; *6947*, 7; *7084*, 7; *8101*, 7; *Morton, A.G. 126*, 2; *Mueller, F. s.n.*, 10.vii.1856, 10; MEL 534788, 1; MEL 534789, 3a; MEL 534790, 7; *Mulham 887*, 7; *912*, 7; *Murray s.n.*, s.d., 7; *Must, J. 258*, 2; *Nelson, D.J. 332*, 7; *1923*, 3b; *2380*, 7; *Newbey, K. 10152*, 3b; *10256*, 1; *O'Malley 188*, 6; *Ollrenshaw 1368*, 1; *Paijmans, K. 2560*, 7; *Palmer* BRI 53464, 6; *Parker, S. 284*, 3a; *285*, 3a; *287*, 7; *304*, 3b; *311*, 3a; *Penrose, L.S. s.n.*, 9.v.1975, 9; *Perry, R.A. 211*, 6; *867*, 2; *2274*, 1; *4117*, 2; *5350*, 3b;

Power 881, 7; *Power, Y. 285*, 1; v.1967, 1; *Pullen, R. 395*, 1; *1452*, 9; *1494*, 9; *8853*, 1; *8884*, 1; *9052*, 1; *9053*, 6; *9268*, 10; *Reid 542*, 6; *Rice, B.L. 2928*, 10; *3356*, 10; *Richley 1284*, 7; *1579*, 7; *Royce, R.D. 1801*, 1; *1892*, 2; *1897*, 3b; *1898*, 2; *1926*, 7; *6893*, 7; *10331*, 3c; *Smith, F. 53*, 2; *Strong, B.W. 606*, 2; *698*, 2; *805*, 2; *806*, 2; *949*, 2; *Swinbourne 803*, 7; *824*, 7; *Symon, D. 6924a*, 8; *Tate, R. s.n.*, 1894, 7; 7.v.1894, 7; AD 97620386, 7; 8.v.1894, 7; 1884, 7; NSW 141287, 7; *Thompson 1707*, 7; *Thomson, B.G. 223*, 2; *886*, 3b; *887*, 2; *Tietkins s.n.*, 1889, 2; *Weber, J.Z. 4508*, 7; *4548*, 7; *4650*, 7; *Whibley, D.J.E. 3560*, 7; *Whitehouse s.n.*, vi.1943, 1; *Williams, L.D. 8078*, 7; *8219*, 8; *8255*, 9; *8257*, 8; *8258*, 7; *Wilson 1416*, 7; *1659*, 7; *Wilson, P.G. 8404*, 5; *8417*, 7; *8417*, 3c; *Winnecke 1883*, 2; *Wittwer 1751*, 5.

J. Adelaide Bot. Gard. 11(2): 101-173 (1989)

A TAXONOMIC REVISION OF THE GENUS *CLERODENDRUM* L. (VERBENACEAE)* IN AUSTRALIA

Ahmad Abid Munir

State Herbarium, Botanic Gardens, North Terrace,
Adelaide, South Australia 5000

Abstract

A taxonomic revision of *Clerodendrum* in Australia is presented. The following ten species are recognised: *C. costatum, C. floribundum, C. grayi, C. heterophyllum, C. inerme, C. longiflorum, C. parvulum, C. tatei, C. tomentosum* and *C. tracyanum*. Described as new are *C. grayi* and *C. longiflorum* var. *glabrum* (from Queensland). *C. longiflorum* and *C. heterophyllum* var. *baueri* f. *angustifolium* are recorded from Australia for the first time. *C. costatum* is reinstated as the oldest valid name for the species currently named *C. cunninghamii. C. populneum* is placed in the synonymy of *C. floribundum* var. *ovatum*. A new combination of *C. tatei* (based on *Strobilanthus tatei* F. Muell.) is made and *C. holtzei* is placed in its synonymy. *C. lanceolatum* is relegated to the rank of a variety under *C. tomentosum*. The following nine taxa are typified: *C. costatum, C. cunninghamii, C. floribundum* var. *floribundum, C. floribundum* var. *coriaceum, C. floribundum* var. *ovatum, C. tatei, C. tomentosum* var. *lanceolatum, C. tomentosum* var. *mollissima* and *C. tracyanum*. In the case of the non-endemic species a range of material including specimens from Malesia was examined.

Affinities and distribution are considered for the genus and each species. A key to the species and infraspecific taxa is provided and a detailed description of each species is supplemented by a habit sketch of a flowering branch and analytical drawings of the flowers.

Taxonomic History of the Genus

The genus *Clerodendrum* was described by Linnaeus (1753) with one species, *C. infortunatum*, the type of which came from India. It was placed in "Didynamia Angiospermia" where it was retained by P. Browne (1756), Burman (1768), Murray (1774), Reichard (1778), Thunberg (1784), Loureiro (1790), Gmelin (1791), Schreber (1791), Persoon (1797, 1807), Willdenow (1800, 1809), Lamarck (1823), Sprengel (1825), Roxburgh (1832), Blanco (1837), Dietrich (1842) and a few others. In 1763, Adanson changed the latinised form of the genus, as originally published, to an all Greek form "*Klerodendron*" p. 12 or "*Clerodendron*" p. 199 as also used by most subsequent authors of the eighteenth-, nineteenth- and early twentieth centuries (see citations under the genus). A return to the original spelling was initiated by the various publications of Moldenke from 1942 onwards, and was generally accepted by subsequent authors. Adanson (1763) placed the genus in "Verbenae", Gleditch (1764) in "Petalostemonum", Rueling (1774) in "Ringentes Halleriae", Scopoli (1777) in "Personatae", Jessieu (1789) in "Vitices", Necker (1790) in "Plasyrgophytum", Giseke (1792) and Batsch (1802) in "Personatar", Ventenat (1799) in "Pyrenaceae", and Reichenbach (1828) under the tribe "Verbeneae" in the Labiatae. In 1805, Jaume Saint-Hilaire proposed the family Verbenaceae for *Clerodendrum* and other related genera, a concept accepted by subsequent botanists.

Jaume Saint-Hilaire (1805) distinguished three sections in the family Verbenaceae: first section with flowers opposite on a branched corymb, second section with flowers arranged in alternate spikes and third section with genera which have some affinity with the Verbenaceae. In this arrangement, *Clerodendrum* was placed in the first section.

In 1829, Dumortier divided the Verbenaceae into two tribes based on their bracteoles being alternate or opposite in Verbeneae and Viticeae respectively with *Clerodendrum* in the

*The present treatment of the genus *Clerodendrum* is the seventh in the series of taxonomic revisions in the family Verbenaceae in Australia (see Munir, 1982, 1984a, 1984b, 1985, 1987a, 1987b).

tribe Viticeae. This tribe was accepted for the genus by Bartling (1830), Bentham (1870, 1876), Spach (1840), Schauer (1847), Walpers (1852), Miquel (1858), Bailey (1883, 1901, 1913), C.B. Clarke (1885), Durand (1888), Post & Kuntze (1904), King & Gamble (1909), Ewart & Davies (1917), Ridley (1923), Fletcher (1938), Lemée (1943) and others. The above-named tribes were called "sections" by Bartling (1830) and Spach (1840).

In 1838, Endlicher divided the family Verbenaceae into three tribes: Lippieae with fruit drupaceous but splitting at maturity, Lantaneae with fruit drupaceous but indehiscent, and Aegiphileae with fruit a berry. In this system, *Clerodendrum* was placed in the tribe Lantaneae. This tribe was accepted for the genus by Meisner (1840), Endlicher (1841), Brongniart (1843), Dietrich (1842) and Walpers (1845). Schauer (1847) re-classified the Verbenaceae into three tribes: Verbeneae, Viteae and Avicennieae. He based the tribe Verbeneae on its inflorescence being indeterminate, ovules erect, anatropous, attached at the base of the locule; Viteae on inflorescence definite, ovules pendulous, amphitropous or subanatropous, attached to the central axis above the base, and Avicennieae on inflorescence capitate, ovules paired, pendulous, amphitropous, attached to the apex of the axis.

He subdivided the tribe Viteae into three subtribes: Symphoremeae with cymes involucred and contracted to few flowers, capsule coriaceous and indehiscent, twining shrubs from eastern India; Caryopterideae with cymes without involucre, mature capsule dividing into 4-valves, shrubs from Asia; Viticeae with cymes without involucre, drupe juicy, succulent, spongy-tuberous, very rarely hard nut-like, trees or shrubs. In this classification, *Clerodendrum* was placed in the subtribe Viticeae. Later the subtribe Viticeae, as "Euviticeae", was accepted by Miquel (1858) and Bentham (1870). Miquel (1858) based the subtribe "Euviticeae" on its inflorescence being without involucre; corolla regular or two-lipped; drupe rarely nut-like, seated on or enclosed by the enlarged calyx. On the other hand, Bentham (1870) characterized the subtribe "Euviticeae" on its ovary being not at all or scarcely lobed; fruit a drupe; shrubs or trees; seeds without albumen. In 1895, Briquet re-classified the Verbenaceae and upgraded the tribe Viticeae to a subfamily Viticoideae. The latter was subdivided into four tribes largely based on the type of drupe and the corolla being zygomorphic in the tribes Viticeae and Clerodendreae. This classification was adopted by Dalla Torre & Harms (1904), H.J. Lam (1919), Junell (1934), Moldenke (1959, 1971), Lopez-Placios (1977) and several other botanists. Post & Kuntze (1904), however, did not accept Briquet's (1895) above classification and relegated the subfamily Viticoideae to the synonymy of the tribe Viticeae.

Schauer (1847) also divided the genus into two sections: *Euclerodendron* and *Siphonanthus*, based chiefly on the shape of corolla, length of corolla-tube and the arrangement of corolla-lobes. The section *Euclerodendron* was further subdivided into six subsections: *Axilliflora*, *Penduliflora*, *Racemiflora*, *Densiflora*, *Paniculata* and *Squamata*. Schauer's (1847) sections and subsections of the genus were accepted by Miquel (1858). C.B. Clarke (1885) called both the above sections as two subgenera of the genus. In the above mentioned Briquet's (1895) treatment of the Verbenaceae, he too subdivided the genus *Clerodendrum* into five sections: *Volkameria*, *Euclerodendron*, *Cyclonema*, *Cornacchinia* and *Siphonanthus*, each characterised chiefly by the shape and length of corolla-tube, disposition of corolla-lobes and the arrangement of stones in the fruit. These sections are based on genera previously recognised but now included in the large variable genus *Clerodendrum*. Briquet also accepted Schauer's (1847) subdivision of the section *Euclerodendron* into above named six subsections. These sections and subsections were adopted by Dalla Torre & Harms (1904). The majority of botanists, however, have not divided the genus into sections and subsections, but have retained it in the Verbenaceae without reference to any subfamily or a tribe. Since most recent taxonomist worked on a regional flora, comments on the higher classification of a pantropical genus cannot be ventured. The study of the few Australian species does not allow speculation on the supra- and infra- generic structure of the genus. It is, however, unfortunate that Moldenke in his various summaries of the Verbenaceae has not given a lead in this matter.

Australian History of the Genus

The first Australian records of *Clerodendrum* were collected by Banks and Solander during 1770 from northern Queensland. Then more specimens were collected by Robert Brown during 1802-1805 from New South Wales, Queensland and Northern Territory. All these collections were identified by Robert Brown (1810) as eight species namely *C. tomentosum* (Vent.) R. Br., *C. medium* R. Br., *C. attenuatum* R. Br., *C. floribundum* R. Br., *C. ovatum* R. Br., *C. coriaceum* R. Br., *C. costatum* R. Br. and *C. inerme* (L.) Gaertner. He thus described six new species. Later, *C. medium* was found to be synonymous with *C. tomentosum* (Vent.) R. Br. and *C. attenuatum*, *C. ovatum* and *C. coriaceum* were relegated to varieties of *C. floribundum.*

In 1847, Schauer placed all of Robert Brown's new *Clerodendrum* species from Australia under "Species denuo recognoscendae". He did not elaborate on their short original descriptions, nor cite any plant collection from Australia. In addition he recorded *C. tomentosum* from Australia. In 1863, F. Mueller described the two new species, *C. cardiophyllum* from Northern Territory and *C. lanceolatum* from Western Australia. Domin (1928) seems to have included the former species in the synonymy of *C. floribundum*; the latter is being regarded here as a narrow-leaved variety of *C. tomentosum.* In 1865, F. Mueller described *Premna tracyana* F. Muell. from Queensland which Bentham (1870) transferred to *Clerodendrum.* Subsequently, F. Mueller (1868, 1875) listed from Australia respectively three and two *Clerodendrum* species of which *C. linnaei* F. Muell. and *C. hemiderma* F. Muell. were later found to belong to the genus *Glossocarya* Wall. ex Griffith which is distinguished by the capsular fruit and non-accrescent calyx. Thus they were transferred by Bentham (1876) to the genus *Glossocarya* as *G. hemiderma* (F. Muell.) Benth.

In 1870, Bentham published a complete account of the Australian Verbenaceae, and listed eight *Clerodendrum* species, viz. *C. hemiderma* F. Muell., *C. inerme* (L.) Gaertner, *C. tracyanum* (F. Muell.) Benth., *C. tomentosum* (Vent.) R. Br., *C. lanceolatum* F. Muell., *C. floribundum* R. Br., *C. cunninghamii* Benth. and *C. costatum* R. Br. Of these *C. cunninghamii* Benth. was described as new and *C. tracyanum* (F. Muell.) Benth. was a new combination. For the first time, Bentham (1870) provided keys to the Australian Verbenaceae genera and their species. He also listed under *C. floribundum* R. Br. five doubtful species, namely *C. attenuatum* R. Br., *C. medium* R. Br., *C. ovatum* R. Br., *C. cardiophyllum* F. Muell. and *C. coriaceum* R. Br. These were considered by him as variants of *C. floribundum* R. Br. Nevertheless, the occurrence of these species in Australia was recorded by F. Mueller (1882a, 1889) and Bailey (1883, 1901, 1913). In 1882, F. Mueller (1882b) mistook a new *Clerodendrum* collection from Northern Territory as acanthaceous, and described it as *Strobilanthus tatei* F. Muell. F. Mueller (1891) described *C. holtzei* based on a collection of the same species and from the same area.

In their posthumous publication, Banks & Solander (1901), described one of their 1770 collection from Queensland as *Siphonanthus floribundus* which has now been placed into the synonymy of *C. longiflorum* Decne. var. *glabrum* Munir. Ewart & Davies (1917) listed five species from Northern Territory, Gardner (1931) three species from Western Australia and Anderson (1947) three species from New South Wales. Moldenke (1952) recorded for the first time *C. heterophyllum* (Poir.) R. Br. from Queensland, and L.S. Smith (1969) described *C. parvulum* from the same State. Subsequently, Beadle (1984) reported two species from north-eastern New South Wales and Stanley (1986) four species from south-eastern Queensland. All the above named taxa described by Robert Brown, F. Mueller, Bentham and others were enumerated for Australia by Moldenke (1959, 1971, 1980). Presently, the known *Clerodendrum* species in Australia are only ten (10) with nine infraspecific taxa.

Chromosome number

No cytological investigations of any of the Australian species of *Clerodendrum* have been done. All available chromosome counts are reported from species found outside Australia except *C. inerme* (L.) Gaertner of which the known chromosome count (2n = 46) was based on material from outside Australia. In a review of the cytotaxonomy of the family Verbenaceae, Sharma and Mukhopadhyay (1963) reported that the haploid numbers so far recorded in the genus *Clerodendrum* are 12 and 23, but the counts show a wide range of chromosome numbers from 24 to 184. The lowest number (2n = 24) has been recorded for *C. aculeatum* (L.) Schlecht., *C. trichotomum* Thunb. var. *fargesii* (Dode) Rehd. (=*C. fargesii* Dode) and *C. scandens* P. Beav. (=*C. umbellatum* Poir.), and the highest (2n = 184) for *C. ugandense* Prain. (Darlington & Wylie 1955, Sharma & Mukhopadhyay 1963, Fedorov 1974). In addition, Choudhry & Roy (1983) reported a range of aneuploid numbers which can, however, be derived from the above base numbers. The lack of any counts from Australian collections and the wide range of numbers recorded indicate the need for work on the Australian taxa.

CLERODENDRUM L.

Clerodendrum L., Sp. Pl. 2 (1753) 637; Gen. Pl. edn 5 (1754) 285;
Adans., Fam. Pl. 2 (1763)12 — "Klerodendron"; ib. (1763) 199 — "Clerodendron"; Burm. f., Fl. Indica (1768) 137; L., Mant. Pl. 2 (1771) 90; Murray, Syst. Veg. edn 13 (1773) 483; Scop., Intr. Hist. Nat. (1777) 170; Reichard, Gen. Pl. (1778) 327 — "Clerodendron"; Thunb., Fl. Jap. (1784) 256; Gaertner, Fruct. Sem. Pl. (1788) 271, t. 57 f. 1; A.L. Juss., Gen. Pl. (1789) 106; Lour., Fl. Cochinch. 2 (1790) 387; Schreber, Gen. Pl. 2 (1791) 426 — "Clerodendron"; Pers., Syst. Veg. (1797) 615; Vent., Tabl. Régn. Vég. 2 (1799) 316; Willd., Sp. Pl. 3 (1800) 386; A.L. Juss., Ann. Mus. Nat. Hist. Paris 7 (1806) 74; Pers., Syn. Pl. 2 (1807) 145; Willd., Enum. Pl. Hort. Reg. Bot. Berl. (1809) 658; R. Br., Prodr. Fl. Nov. Holl. (1810) 510; Kunth, Syn. Pl. 2 (1823) 39; Lam., Tabl. Encycl. 3 (1823) 56; Sprengel, Syst. Veg. 2 (1825) 758 — "Clerodendron"; Blume, Bijdr Fl. Neth. Ind. (1826) 807; Dumort., Anal. Fam. Pl. (1829) 22 — "Clerodendron"; Bartling, Ord. Nat. Pl. (1830) 180 — "Clerodendron"; Sprengel, Gen. Pl. 2 (1831) 479 — "Clerodendron"; Roxb., Fl. Ind. 3 (1832) 57; Endl., Gen. Pl. 1 (1838) 637 — "Clerodendron"; Benth., Ann. Nat. Hist. 2 (1839) 450 — "Clerodendron"; Meissner, Pl. Vasc. Gen. Vol. 1, "Tab. Diag." (1840) 291; Vol. 2 "Commentarius" (1840) 200 — "Clerodendron"; Steudel, Nomencl. Bot. (1840) 382; Brongn., Enum. Pl. Mus. Paris (1843) 65 — "Clerodendron"; Walp., Repert. Bot. Syst. 4 (1845) 102 — "Clerodendron"; Schauer in A. DC., Prodr. 11 (1847) 658 — "Clerodendron"; Walp., Annal. Bot. Syst. 3 (1852) 238 — "Clerodendron"; Miq., Fl. Ind. Bat. 2 (1858) 867 —"Clerodendron"; Benth., Fl. Aust. 5 (1870) 60 — "Clerodendron", excl. *C. hemiderma* F. Muell.; Pfeiffer, Nom. Bot. 1 (1873) 784 — "Clerodendron"; Benth. in Benth. & Hook.f., Gen. Pl. 2 (1876) 1155 — "Clerodendron"; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; C.B. Clarke, Fl. Brit. Ind. 4 (1885) 589 — "Clerodendron"; Maxim., Bull. Acad. Sc. St. Petersb. 31 (1887) 83; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173, excl. syn. *Glossocarya*; Kuntze, Revis. Gen. Pl. part 2 (1891) 505 — "Clerodendron"; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 174 — "Clerodendron"; Bailey, Qld Fl. 4 (1901) 1181 — "Clerodendron"; T. Post & Kuntze, Lexic. Gen. Phan. (1904) 688; King & Gamble, Mat. Fl. Malay Penins. 4 (1909) 825 — "Clerodendron"; Bailey, Comp. Cat. Qld Pl. (1913) 386 —"Clerodendron"; Ewart & Davies, Fl. N. Terr. (1917) 238 — "Clerodendron"; H.J. Lam, Verbenac. Malay. Archip. (1919) 239 — "Clerodendron"; Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 73 — "Clerodendron"; Ridley, Fl. Malay. Penins. 2 (1923) 623 — "Clerodendron"; Péi, Verbenac. China (1932) 122 — "Clerodendron"; Junell, Symb. Bot. Upsal. 4 (1934) 100 — "Clerodendron"; Lemée, Dict. Descr. Syn. Gen. Pl. Phan. 8b (1943) 657 — "Clerodendron"; Mold., Résumé Verbenac. etc. (1959) 411; N. Burb., Dict. Aust. Pl. Gen. (1963) 74; Baker & Bakh. f., Fl. Java 2 (1965) 607; Mold., Fifth Summary Verbenac. etc. 2 (1971) 760; Farr et al., Index Nomin. Gen. 1 (1979) 384; Baines, Aust. Pl. Gen. (1981) 97, excl. syn. *C. hemiderma*; Mold. in Dassan. & Fosb., Fl. Ceylon 4 (1983) 407; Mod., Phytologia 58 (1985) 178; Stanley in Stanley & Ross, Fl. S.E. Qld 2 (1986) 369.

Type species: *C. infortunatum* L.

Ovieda L., Sp. Pl. 2 (1753) 637; Gen. Pl. edn 5 (1754) 284; Gaertner, Fruct. Sem. Pl. (1788) 272; Murray, Syst. Veg. edn 13 (1774) 483; Reichb., Consp. Reg. Veg. (1828) 117; Vent., Tabl. Régn. Vég. 2 (1799) 317, non K.P.J. Sprengel 1817.

Type species: *O. spinosa* L.

Volkameria L., Sp. Pl. 2 (1753) 637; Gen. Pl. edn 5 (1754) 284; Mant. Pl. (1771) 90; Jacq., Select. Stirp. Amer. Hist. (1763) 185; Burm. f., Fl. Ind. (1768) 136; Gaertner, Fruct. Sem. Pl. (1788) 267; Schreber, Gen. Pl. 2 (1791) 425; Lam., Tabl. Encycl. 3 (1823) 56; Dumort., Anal. Fam. Pl. (1829) 22; Meissner, Pl. Vas. Gen. Vol. 1 "Tab. Diag." (1840) 291; Vol. 2 "Commentarius" (1840) 200; Murray, Syst. Veg. edn 13 (1774) 483; Necker, Elem. Bot. 1 (1790) 384; Pers., Syn. Pl. 2 (1807) 144; Reichb., Consp. Reg. Veg. (1828) 117; Scop., Intr. Hist. Nat. (1777) 169; Spach, Hist. Nat. Veg. 9 (1840) 226; Vent., Tabl. Régn. Veg. 2 (1799) 317; Willd., Enum. Pl. (1809) 658; Walp., Repert. Bot. Syst. 4 (1845) 99; Schauer in DC., Prod. 11 (1847) 656, non P. Browne 1756.

Type species: *V. aculeata* L., **lectotype.**

Siphonanthus L., Sp. Pl. 1 (1753) 109; Gen. Pl. edn 5 (1754) 47.

Type species: *S. indicus* L.

Douglassia Miller, Gard. Dict. edn 4 (1754); Adans., Fam. Pl. 2 (1763) 200, non Schreber 1791, nec Reichb. 1828, nec. Lindl. 1829, nec. Heist 1973.

Type species: *D. frutescens* Miller.

Cryptanthus Osbeck, Dagb. Ostind. Resa (1757) 215, non Nutt. 1849, nor Otto & Dietr. 1836.

Type species: *C. chinensis* Osbeck.

Valdia Plum. ex Adans., Fam. Pl. 2 (1763) 157, nom. superfl., with *Ovieda* L. quoted in its synonymy.

Bellevalia Scop., Introd. Hist. Nat. (1777) 198, non Delile 1836, nec Lepyr 1808, nec Roem. & Schult. 1819.

Type species: non designatus.

Montalbania Necker, Elem. Bot. 1 (1790) 273, nom. illeg.

Volkmannia Jacq., Pl. Rar. Hort. Schoenbr. 3 (1798) 48, t. 338, non Sternb. 1825.

Type species: *V. japonica* Jacq.

Agricolaea Schrank, Denkschr. Kőnigl. Akad. Wiss. München (1809) 98.

Type species: *A. fragrans* Schrank.

Torreya Sprengel, Neue Endeck. 2 (1821) 121, non Raf. 1818 & 1819, nec Eaton 1829, nec Arn. 1838, nec Croom 1843.

Type species: *T. paniculata* Sprengel.

Cornacchinia Savi, Mem. Mat. Fis. Soc. Ital. Sci. Modena 21 (1837) 184, t. 7, non Endl. 1841.

Type species: *C. fragiformis* Savi.

Egena Raf., Fl. Tellur. 2 (1837) 85.

Type species: *E. emirnensis* (Bojer ex Hook.) Raf., loc. cit. 2 (1837) 85, based on *Clerodendron emirnense* Bojer ex Hook., Bot. Mag. New Ser. 3 (1829) t. 2925.

Rotheca Raf., Fl. Tellur. 4 (1838) 69.

Type species: non designatus; *R. bicolor* Raf., loc. cit. 4 (1838) 69, lectotype, here designated.

Cyclonema Hochst., Flora 25 (1842) 225.

Type species: non designatus, *C. myricoides* Hochst., Flora 25 (1842) 226, lectotype, here designated.

Spironema Hochst., Flora 25 (1842) 226, nom. nud.

Cyrtostemma Kunze, Bot. Zeit. 1 (1843) 272, non Spach 1841.

Type species: *C. myricoides* Kunze.

Cleianthus Lour. ex Gomes, Mem. Acad. Ci. Lisboa, Cl. Sci. Mor. Pol. Bel.-Let., Ser. 2, 4 (1868) 28.

Type species: non cognitus.

Shrubs, small trees or woody climber, rarely herbs. *Stem* and branches almost terete or obscurely tetragonal. *Leaves* simple, decussate-opposite, entire or variously dentate, exstipulate, reticulate-veined, unicostate, petiolate or sessile. *Inflorescence* cymose; cymes mostly loose-flowered or capitate, pedunculate, usually forming terminal, or rarely axillary, corymbose or thyrsoid panicles. *Flowers* usually large and showy, complete, zygomorphic, bisexual, hypogynous; bracts small, narrow. *Calyx* of 5 fused sepals, persistent, tubular or somewhat campanulate, variously 5-toothed, 5-lobed or sometimes almost truncate, accrescent and spreading under the fruit. *Corolla* of 5 fused petals, deciduous, tubular below, with nearly equally spreading 5 lobes at the top; tube slender, often much longer than calyx, narrowly cylindrical, straight or incurved. *Stamens* 4, didynamous, usually much exserted, alternate with the corolla-lobes, epipetalous, inserted about the middle of the corolla-tube; filaments filiform; anthers dorsifixed, oblong or elliptic, 2-lobed, lobes parallel or divergent. *Ovary* bicarpellary, syncarpous, 4-locular, with one ovule in each cell, attached to an exile placentation at or above the middle; style terminal, exserted, filiform, glabrous, with 2 short stigmatic lobes. *Fruit* drupaceous, globose or obovoid, the endocarp separating into 4 one-seeded or rarely into 2 two-seeded pyrenes. *Seeds* exalbuminous.

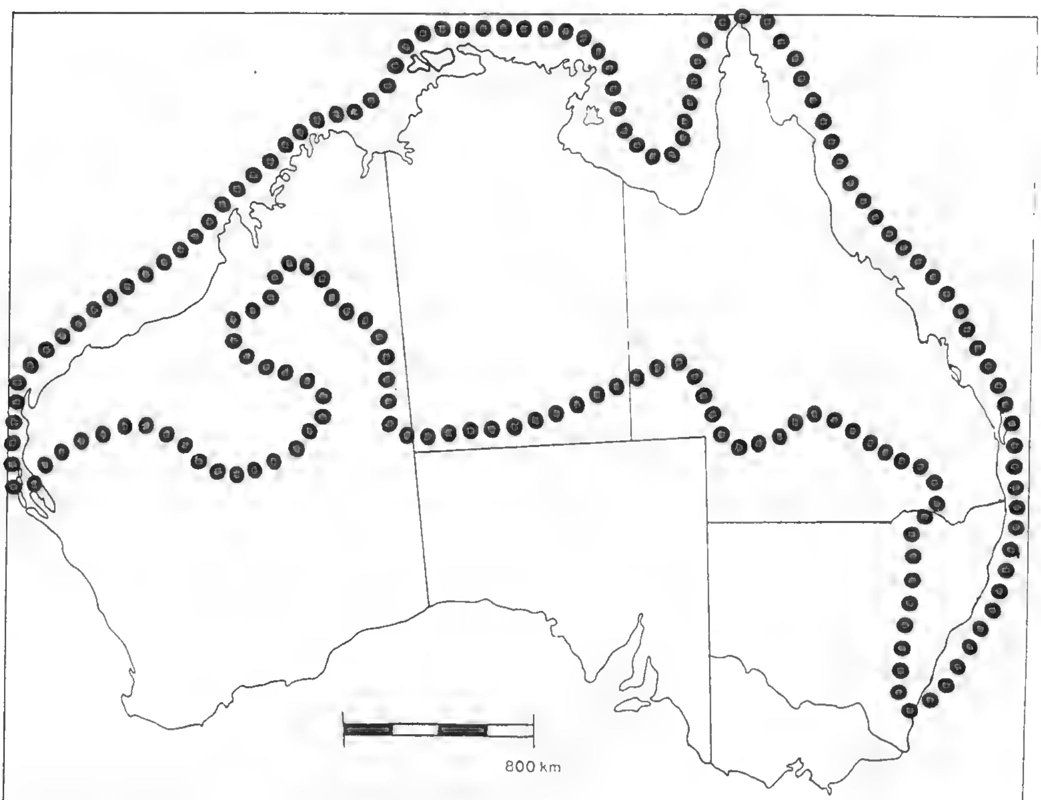
Number of species: World: ± 584 specific and infraspecific taxa; Australia: 10 species, 7 varieties and 2 forms.

Derivation of name

The generic name is derived from the Greek *kleros*, chance; *dendron*, tree; referring to its uncertain medicinal properties.

Distribution (Map 1)

The genus *Clerodendrum* is widely distributed in the tropical and subtropical regions of



Map 1. Distribution of the genus *Clerodendrum* L. in Australia.

Australia, Asia, Africa, Central and South America and the West Indies. It is poorly represented in North America and Europe except in cultivation and by naturalization.

Of the ten Australian species, three are endemic in Australia and six are also known from Papua New Guinea, Solomon Islands and neighbouring Indonesian Islands. One species, *C. inerme* (L.) Gaertner, is the most widespread of all and has been recorded along the sea coasts from India to Taiwan through Malesia, tropical Australia and Polynesia.

Comments

Clerodendrum is a very complex and the largest genus in the family Verbenaceae. Due to their polymorphic nature different forms of the same species were described in the past as distinct species. During the present investigation, several such taxa have been relegated to infraspecific level. One such example is *C. floribundum* R. Br. with five varieties. All varieties, except var. *angustifolium* were originally described as distinct species.

Moldenke (1971, 1980) recorded three *Clerodendrum* taxa from Queensland namely *C. album* Ridley, *C. umbellatum* Poir. var. *speciosum* (Dombrain) Mold. and *C. viscosum* Vent. So far, no one else has ever recorded these taxa from Australia. Of these three taxa, *C. album* Ridley seems to be a nomen nudum as it is not known to have ever been validly published. Moldenke repeatedly recorded *C. album* Ridley in his publications, but then admitted that: "As yet I have not been able to ascertain where, if at all, Ridley published a description of this taxon, known to me only from herbarium specimens so annotated; apparently previously, at least in one case, distributed as *C. coriaceum* R. Br." [*Phytologia* 57 (1985) 474-475]. In the present publication, therefore, *C. album* Ridley is considered another name attributed to the complex of *C. floribundum* R. Br. The other two taxa recorded from Australia by Moldenke, *C. umbellatum* var. *speciosum* and *C. viscosum*, do not occur here naturally, or in a naturalised form. Moldenke may have recorded these taxa from cultivation, or from herbarium specimens annotated erroneously.

Affinities

Clerodendrum is closely related to *Faradaya* F. Muell. in its inflorescence being cymose and centrifugal; flowers more or less zygomorphic; stamens 4; fruit drupaceous; drupes composed of four (or through abortion less numerous) 1-locular pyrenes. Nevertheless, *Clerodendrum* is easily distinguished by its calyx being open before anthesis, 5-lobed, 5-dentate, without subulate apex, sometimes almost truncate, split into lobes from the beginning; corolla of 5 fused petals; style terminal, not sunken between the ovary lobes.

Clerodendrum is also closely allied to *Gmelina* L. and *Premna* L. in having a cymose and centrifugal inflorescence, zygomorphic flowers, 4 stamens in each flower and drupaceous fruit. However, *Gmelina* and *Premna* can readily be identified by their calyx and corolla being 4- or 5-lobed, corolla-tube mostly much dilated above the calyx, stamens and style scarcely or shortly exserted above the corolla-lobes and drupe composed of one 4-locular pyrenes. The calyx and corolla in *Clerodendrum* are always 5-lobed and stamens and style much exserted.

There are a few characters common between *Clerodendrum* and *Vitex* L. Both have cymose inflorescence, zygomorphic flowers, 5-lobed calyx as well as corolla, 4 stamens in each flower and drupaceous fruit. Nevertheless, *Vitex* may easily be identified by its leaves being digitate, often with 3-7 leaflets, rarely 2 or 1; corolla-tube more or less bilabiate; drupe composed of one 4-locular pyrenes.

Key to species and infraspecific taxa
(Taxa asterisked are new)

1a. Leaf-blades pubescent, hirsute or tomentose at least on the lower (abaxial) surface; calyx distinctly pubescent outside 11

b. Leaf-blades glabrous, sometimes sparsely puberulous on abaxial veins; calyx glabrous, sometimes sparsely puberulous outside 2

2a. Calyx 5-toothed or deeply 5-lobed 4

b. Calyx truncate or shallowly toothed 3

3a. Leaf-blades elliptic-ovate, not punctate; corolla-tube 15-40 mm long; ovary glandular; scandent shrub .... 1. *C. inerme*

b. Leaf-blades narrow elliptic-lanceolate, punctate; corolla-tube 10-15 mm long; ovary non-glandular; non-scandent shrub (not in Australia) .... 2a. *C. heterophyllum* var. *heterophyllum*

4a. Calyx deeply 5-lobed, non-glandular outside; corolla white, non-glandular, glabrous all over; corolla-tube (15-) 20-100 mm long 6

b. Calyx 5-toothed, glandular outside; corolla purple, glandular outside, villous inside the tube; corolla-tube 10-15 mm long 5

5a. Leaf-blades narrowly elliptic-lanceolate, 10-35 mm wide at the mid-point .... 2b. *C. heterophyllum* var. *baueri* f. *baueri*

b. Leaf-blades linear, less than 10 mm wide at the mid-point .... 2c. *C. heterophyllum* var. *baueri* f. *angustifolium*

6a. Corolla-tube 50-100 mm long; filaments 35-50 mm long; style 65-105 mm long; calyx-lobes 5-8 mm long .... 3. **C. longiflorum* var. *glabrum*

b. Corolla-tube (15-) 20-45 mm long; filaments 9-35 mm long; style 30-60 mm long; calyx-lobes 2-5 mm long .... 4. *C. floribundum* 7

7a. Petiole, peduncle, pedicel and calyx glabrous 9

b. Petiole, peduncle, pedicel and calyx puberulous-pubescent or pubescent-tomentose 8

8a. Leaf-blades elliptic or elliptic-lanceolate, up to 130 x 55 mm; petiole, peduncle, pedicel and calyx puberulous; inflorescence more or less lax .... 4a. *C. floribundum* var. *floribundum*

b. Leaf-blades elliptic-obovate, up to 175 x 100 mm; petiole, peduncle, pedicel and calyx pubescent-tomentose; inflorescence more or less congested .... 4b. *C. floribundum* var. *attenuatum*

9a. Leaf-blades cordate-subcordate, ovate or almost truncate at the base, coriaceous; inflorescence very lax .... 4c. *C. floribundum* var. *coriaceum*

b. Leaf-blades ovate, lanceolate or narrow elliptic-lanceolate, rounded or cuneate towards the base, chartaceous or subcoriaceous; inflorescence semi-lax 10

10a. Leaf-blades ovate, rounded or very broadly narrowing towards the base, generally 35-90 mm wide .... 4d. *C. floribundum* var. *ovatum*

b. Leaf-blades lanceolate or narrowly elliptic-lanceolate, long cuneate towards the base, generally 15-30 mm wide .... 4e. *C. floribundum* var. *angustifolium*

11a. Leaves distinctly petiolate, petioles 10-200 mm long; corolla-tube glabrous inside or with a few sparse gland-tipped hairs on the inner upper-half 13

b. Leaves sessile or with minute petioles of 1-3 mm long; corolla-tube villous inside without gland-tipped hairs 12

12a. Prostrate, decumbent or sub-erect herb or subshrub; leaves variable, cordate, rhomboid-orbicular, ovate-elliptic, oblong or linear-lanceolate, (5-) 10-30 (-40) mm wide; corolla-tube (8-) 12-18 (-25) mm long; stamens and style white; endemic to NNW Northern Territory .... 5. *C. tatei*

b. Erect shrub or subshrub; leaves obovate-oblong, elliptic-oblong, oblanceolate to lanceolate, (1.5-) 2-5 (-7) mm wide; corolla-tube 7-10 mm long; stamens and style purple; endemic to Cape York Peninsula, Qld .... 6. *C. parvulum*

13a. Inflorescence not exceeding the upper leaves; flowers small, up to 10 mm long; calyx-and corolla-ubes with sparse gland-tipped hairs inside; filaments 8-12 mm long; style 10-18 mm long .... 7. *C. tracyanum*

b. Inflorescence exceeding the upper leaves; flowers larger, 18-70 mm long; calyx-and corolla-tubes glabrous and without gland-tipped hairs inside; filaments (15-) 20-40 mm long; style 30-100 mm long 14

14a. Flowers in lax pubescent-puberulous thyrse; corolla glabrous or puberulous only outside the lobes, tube 25-70 mm long; style 60-100 mm long 17

b. Flowers in dense tomentose thyrse; corolla pubescent outside, tube 18-25 (-27) mm long; style 30-43 mm long .... 8. *C. tomentosum* 15

15a. Leaf-blade broadly ovate, with almost rounded base, densely velvety-tomentose all over; corolla-tube always villous-tomentose outside .... 8c. *C. tomentosum* var. *mollissima*

b. Leaf-blades elliptic, elliptic-oblong or lanceolate, with a cuneate-attenuate base, tomentose or pubescent-glabrescent above; corolla-tube villous-tomentose or almost glabrous outside 16

16a. Leaf-blades elliptic, elliptic-oblong or broadly lanceolate, pubescent-glabrescent above; corolla-tube sparsely villous-pubescent or almost glabrous outside; calyx glandular and puberulous inside .... 8a. *C. tomentosum* var. *tomentosum*

b. Leaf-blades narrow-lanceolate, pubescent-tomentose all over; corolla-tube usually densely villous-tomentose outside; calyx glandular and pubescent-tomentose inside .... 8b. *C. tomentosum* var. *lanceolatum*

17a. Leaf-blades glabrous above, ovate or broadly elliptic-ovate; corolla glabrous, tube non-glandular, 45-70 mm long .... 9. *C. costatum*

b. Leaf-blades puberulous above, oblong or narrowly elliptic-oblong; corolla puberulous outside the lobes, tube sparsely glandular outside, 25-40 mm long .... 10. **C. grayi*

1. **Clerodendrum inerme** (L.) Gaertner, Fruct. Sem. Pl. 1 (1788) 271, t. 57 fig. 1;
R. Br., Prodr. Fl. Nov. Holl. (1810) 511; Sprengel, Syst. Veg. 2 (1825) 758, "Clerodendron"; Blume, Bijdr. Fl. Ned. Ind. (1826) 808; Schauer in A.DC., Prodr. 11 (1847) 660, "Clerodendron"; Walp., Repert. Bot. Syst. 4 (1845) 112, "Clerodendron"; Miq., Fl. Ind. Bat. 2 (1858) 868, "Clerodendron"; F. Muell., Essay Pl. Fitzal. Smith's Exped. Burdek. (1860) 17, "Clerodendron"; F. Muell., Landsb. Explor. Aust. (1866) 119, "Clerodendron"; F. Muell., Fragm. 6 (1868) 152, "Clerodendron"; Benth., Fl. Aust. 5 (1870) 61, "Clerodendron"; F. Muell., Descr. Notes Papuan Pl. 1 (1875) 11, "Clerodendron"; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; Bailey, Synop. Qld Fl. (1883) 380, "Clerodendron"; C. Moore, Cens. Pl. N.S.W. (1884) 52, "Clerodendron"; C.B. Clarke in Hook.f., Fl. Brit. Ind. 4 (1885) 589; Maxim., Bull. Acad. Sc. St. Petersb. 31 (1887) 83; Schumann, Fl. Deutsch-Ostas. Schutzgeb. (1887) 200, "Clerodendron"; Bailey, Qld Woods (1888) 92, "Clerodendron"; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Watt., Dic. Econ. Prod. India 2 (1889) 372, "Clerodendron"; Bailey, Cat. Qld Pl. (1890) 36, "Clerodendron"; C. Moore, Hanb. Fl. N.S.W. (1893) 357, "Clerodendron"; Bailey, Qld Fl. 4 (1901) 1182, "Clerodendron"; Schumann & Lauterb., Fl. D. Südsee (1901) 525, "Clerodendron"; Dixon, Pl. N.S.W. (1906) 236, "Clerodendron"; Pulle in Lorentz, Nova-Guinea Bot. 8(2) (1910)402, "Clerodendron"; 8 (4) (1911) 687, "Clerodendron"; Bailey, Compr. Cat. Qld Pl. (1913) 386, "Clerodendron"; Maiden, Cens. N.S.W. Pl. (1916) 178, "Clerodendron"; Ewart & Davies, Fl. N. Territory (1917) 238, "Clerodendron"; H.J. Lam, Verbenac. Malay. Archip. (1919) 251, "Clerodendron"; Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 77, "Clerodendron"; H.J. Lam, Bot. Jahrb. Syst. 59 (1924) 95, "Clerodendron"; Bakh. in Bakh. & H.J. Lam in Nova Guinea 14 (Bot) (1924) 170, "Clerodendron"; Bakh., J. Arn. Arb. 16 (1935) 71, "Clerodendron"; A.D.J. Meeuse, Blumea 5 (1942) 74; Webb, C.S.I.R. Bull. 232 (1948)168, "Clerodendron"; Specht in Specht & Mountford, Recd. Amer. Aust. Sc. Exped. Arnhem Land 3 (1958) 289, 404, 470; Mold., Résumé Verbenac. etc. (1959) 200, 204, 206-208, 216, 250, 261, 262, 264-267, 301, 391, 392; T. Cooke, Fl. Bombay Pres. 2, 2nd reprint edn (1967) 511; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 273, 282, 299, 304, 315, 322, 330, 332, 335, 340, 343, 345, 359, 441, 442, 447-449, 452, 461, 464, 531, 732-734; Chippendale, Proc. Linn. Soc. N.S.W. 96 (1972) 256; Court, Cat. Pl. Nat. Bot. Gard. Canberra (1980) 81; Mold., Sixth Summary Verbenac. etc. (1980) 259, 267, 284, 295, 306, 313, 320, 325, 334, 384, 386, 391-393, 412, 461; Baines, Aust. Pl. Gen. (1981) 97; Jacobs & Pickard, Pl. N.S.W. (1981) 209; Graf, Exotica, Ser. 4, 2 (1982) 2115; Bhoj-Raj, Rev. Palaeobot. & Palynol. 39 (1983) 358; Mold. in Dassan & Fosb., Fl. Ceylon 4 (1983) 447; Beadle, Stud. Fl. N.E. N.S.W. part 5 (1984) 858, fig. 378A; Elliot & Jones, Encyc. Aust. Pl. 3 (1984) 49 & t. ; Williams, Native Pl. Qld 2 (1984) 84, coloured photo p. 85; Stanley in Stanley & Ross, Fl. S.E. Qld 2 (1986) 369; Dunlop, Checklist Vasc. Pl. N.T. (1987) 79.

Type: Habitat in India, Herb. Linnaeus 809/3 (LINN, n.v.). Microfiche in AD seen.

Volkameria inermis L., Sp. Pl. 2 (1753) 637, **basionym**; Burm.f., Fl. Ind. (1768) 136; R. Br. in Ait. Hort. Kew. edn 1, 2 (1789) 364; Lour., Fl. Cochin. (1790) 388; Willd, Sp. Pl. 3 (1800) 383; Pers., Synop. Pl. 2 (1807) 144; Blanco, Fl. Filip. edn 1 (1837)511.

Type: As for *C. inerme* (L.) Gaertner.

V. commersonii Poir. in Lam., Encyc. 8 (1808) 688.

Type: From Philippines (FI herb Desfontaines, n.v.).

V. nereifolia Roxb., Fl. Ind. edn 2, 3 (1832) 64.

Type: "Island of Mascal, on the coast of Chittagong", India, now Bengladesh (K, n.v.).

Jasminum litoreum Rumph., Herb. Amb. 5 (1747) 86, t. 46, nom. inval.

Type: Herb. Amb. 5 (1747) 86, t. 46. Most of Rumphius' books, manuscripts and collections were destroyed by fire on 11 Jan. 1687. See Stafleu & Cowan, Taxonomic Literature 1983.

Clerodendron ovatum Poir., Encyc. Suppl. 4 (1816) 352, non R. Br. 1810.

Type: From Pondicherry, India (FI herb Desfontaines, n.v.).

C. buxifolium Sprengel, Syst. Veg. 2 (1825) 758.

Type: From "Patria" (HBG, n.v.).

C. coromandelianum Sprengel, Syst. Veg. 2 (1825) 758; Walp., Repert. Bot. Syst. 4 (1845) 112.

Type: From Pondicherry, Coromandel coast, India (HBG, n.v.).

C. commersonii (Poir.) Sprengel, Syst. Veg. 2 (1825) 758; Schauer in A. DC., Prodr. 11 (1847) 673; Miq., Fl. Ind. Bat. 2 (1858) 882; Merr., Philip. J. Sc. (Bot.) 7 (1912) 245; Fl. Manila (1912) 403; Philip. J. Sc. Bot. 9 (1914) 135; Interp. Rumph. Herb. Amb. (1917) 455; Sp. Blancoanae (1918) 334; Chung, Mem. Sc. Soc. China 1 (1924) 227; Domin, Biblioth. Bot. 89 (1928) 557.

Type: As for *Volkameria commersonii* Poir.

C. javanicum Sprengel, Syst. Veg. 2 (1825) 759; Walp., Repert. Bot. Syst. 4 (1845) 103; Miq., Fl. Ind. Bat. 2 (1858) 882.

Type: From Java, Indonesia (HBG, n.v.).

C. capsulare Blanco, Fl. Filip. edn 1 (1837) 509; edn 2 (1845) 355; edn 3, 2 (1878) 292; Schauer in A.DC., Prodr. 11 (1847) 674.

Type: From Philippines, n.v. whereabout not known.

C. neriifolium Wall. [cat. no. 1789 (1829)] ex Walp., Repert. Bot. Syst. 4 (1845) 110; Schauer in A. DC., Prodr. 11 (1847) 660; Miq., Fl. Ind. Bat. 2 (1858) 869; C.B. Clarke in Hook.f., Fl. Brit. Ind. 4 (1885) 589; King & Gamble, Mat. Fl. Malay. Penins. 4 (1909) 827; Fletcher, Kew Bull. (1938) 425; Prain, Bengal Pl. 2, reprint edn (1963) 623.

Type: From Tavoy, Tenasserim, Burma (K-W, n.v.).

C. inerme (L.) Gaertner var. *oceanicum* Gray, Proc. Amer. Acad. Arts & Sc. 6 (1862) 50.

Type: C. Wilkes s.n., South Pacific Explor. Exped. (GH, n.v.).

C. inerme (L.) Gaertner var. *neriifolium* (Wall. ex Walp.) Kurz, Forest Fl. Burma 2 (1877) 266, based on *C. neriifolium* Wall. ex Walp. 1845.

Type: As for *C. neriifolium* Wall. ex Walp.

C. inerme (L.) Gaertner var. *ovalifolium* Kuntze, Rev. Gen. Pl. 2 (1891) 506.

Type: From Pondicherry, India (NY?, n.v.).

Description (Fig. 1)

A scandent shrub to 4 m high, sometimes prostrate or a large liana climbing to 13 m in trees. *Stem* 30-78 mm diam., hollow; bark pale-brown or whitish-grey, shallowly fissured; branches and branchlets slender, obtusely tetragonal, very minutely puberulous or glabrous. *Leaves* ovate or elliptic, entire, obtuse or shortly and obtusely acuminate, cuneate towards base, (3-) 4-10 (-12) cm long, (1-) 2-5 (-6) cm wide, thickly chartaceous or coriaceous, glabrous when fully grown, punctate beneath; petioles slender, puberulous, (3-) 5-15 (-23) mm long. *Inflorescence* more or less umbelliform thyrse, pubescent; cymes subterminal or in uppermost leaf-axils, usually 3-flowered, but sometimes 7- or more-flowered; peduncles slender, puberulous, (10-) 15-40 (-50) mm long. *Flowers* pedicellate, lax; pedicels puberulous, (2-) 3-6 (-9) mm long. *Calyx* campanulate, slightly dilated on margin, truncate and minutely toothed, glandular, glabrous or puberulous and with a few large nectariferous glands outside, glabrous inside, accrescent, 3-6 mm long, (2-) 3-5 mm diam. at top; teeth minute. *Corolla* white or sometimes touched with purple, hypocrateriform, 5-lobed, glabrous and glandular outside, villous inside tube; tube slender, cylindrical, (15-) 20-35 (-40) mm long, 2-3 mm diam. at throat; lobes elliptic-obovate to elliptic-oblong, (3.5-) 5-8 (-11) mm long, (1.5-) 2.5-4 (-5) mm wide. *Stamens* exserted; filaments inserted above middle of corolla-tube, pink or purple, filiform, mostly glabrous, villous near base, (15-) 20-35 (-38) mm long; anthers "yellow",

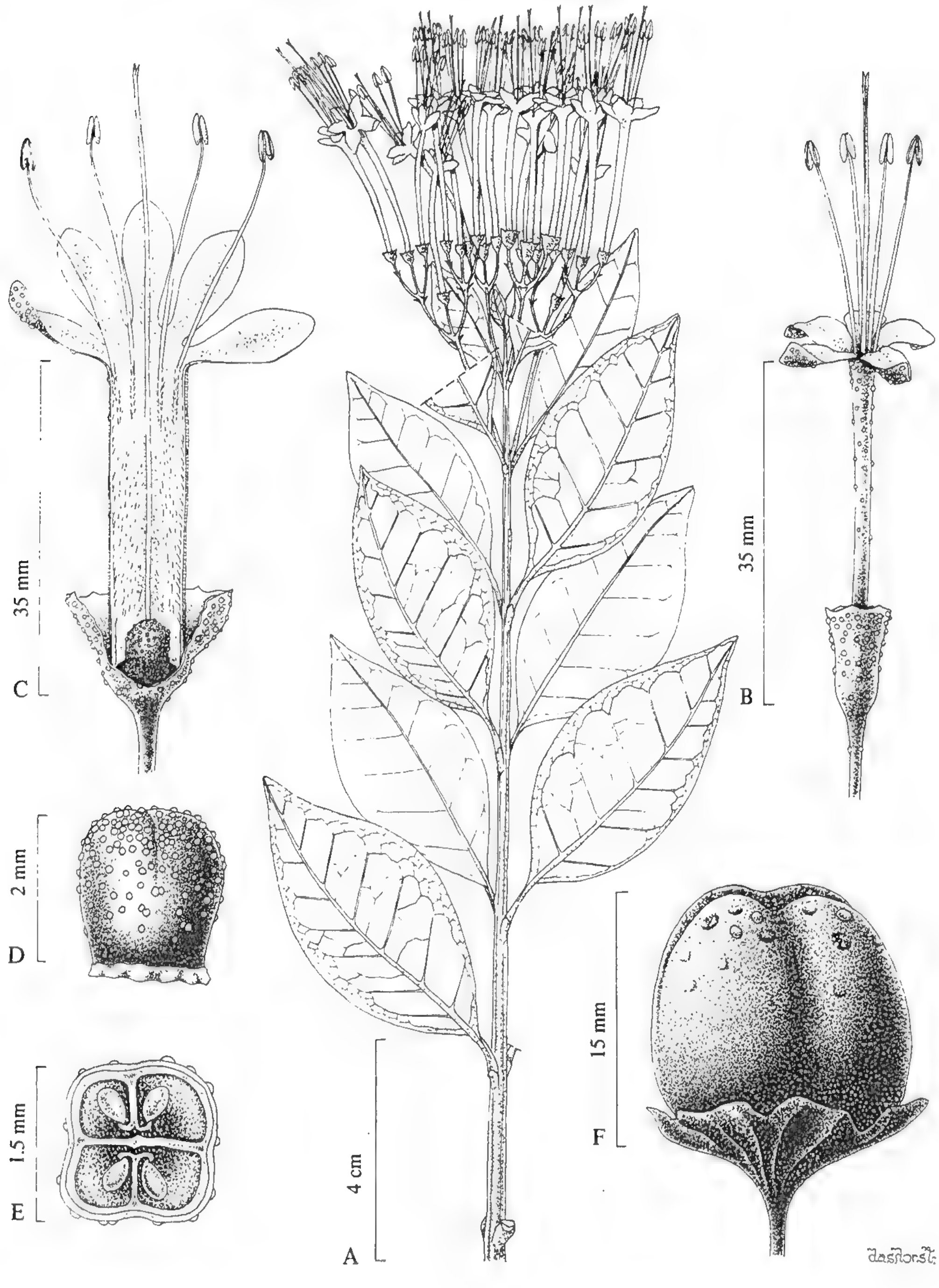


Fig. 1. *Clerodendrum inerme* (L.) Gaertner (A-F, *B. Gray 175*: BRI). A, habit sketch of a flowering branch; B, flower showing glands outside calyx and corolla; C, flower with calyx and corolla longitudinally cut open showing androecium and gynoecium, and hairs inside the corolla-tube; D, glandular ovary; E, transverse section of ovary; F, fruit with persistent calyx.

oblong, 2.5-3 mm long, ± 1 mm wide. *Ovary* obovoid-subglobose, glabrous, glandular, somewhat 4-lobed, 1.5-2 mm long, 1-1.5 mm diam; style purple, exserted, filiform, glabrous, 25-48 mm long; stigma bifid. *Fruit* green, later turning brownish-black, obovoid to subglobose, distinctly 4-lobed, 10-15 (-20) mm long, 7-13 (-15) mm diam.; fruiting calyx 7-12 mm diam.

Representative specimens (collections seen: Australian 160, non-Australian 80)

AUSTRALIA: NORTHERN TERRITORY: *Burrell W/L1485*, Kapalga, South Alligator River, 30.x.1974 (DNA, NE); *Byrnes 880*, Thrings Creek, near mouth, 18.vii.1968 (AD, DNA, NT); *Craven 3661*, Samphire-saline grassland near mouth of the McArthur River, 6.ii.1976 (BRI, CANB, L, NT); *Craven 4395*, Black soil plain, Daly River, 24.vi.1977 (CANB, L, NT); *Cunningham 290*, Banks of S. Alligator River, 1819 (BM, MEL); *Dunlop 2683*, Rose River, Gulf of Carpentaria, 7.vii.1972 (AD, CANB, NSW, NT); *Dunlop 2944*, Maria Island, Gulf of Carpentaria, 26.vii.1972 (AD, CANB, NSW, NT); *Holtze 91*, Port Darwin, 1891 (G, Z); *Latz 3255*, Wessell Islands, 29.ix.1972 (BRI, CANB, NT); *Latz 6242*, Elcho Island, 16.vii.1975 (CANB, DNA, L, NT); *McKean B175*, East Arm, Darwin, 12.xii.1971 (CANB, DNA, K, NT); *Must 1343*, Berry Springs, 13.xii.1974 (BRI, DNA, NE, NT); *Perry 1787*, On bank McArthur River, c. 21 km NNE Borroloola, 27.vii.1948 (BRI, CANB, NT); *Rankin 1226*, East Point, 25.iv.1978 (DNA, NT); *Rankin 1946*, Woolner Stn, Adelaide River, 18.vi.1980 (CANB, DNA); *Robinson R827*, Adelaide River subcoastal plains Marrabai, 26.viii.1964 (DNA); *Specht 945*, Gove Peninsula, 22.viii.1948 (AD, BRI, CANB, L, MEL, PERTH); *Specht 1193*, Oenpelli, Arnhem Land, along the bank of tidal East Alligator River, 14.x.1948 (AD, BRI, CANB, L, MEL).

QUEENSLAND: *Bailey s.n.*, Port Curtis, Rockhampton, undated (BRI); *Bancroft 29*, Palm Island, undated (BRI); *Banfield 2805*, Brammo Bay, Dunk Island, 16.v.1917 (NSW 145076); *Banks & Solander s.n.*, Bay of Inlet, 1770 (BM 2 spec.); *Barker 5580*, Port Douglas, 21.vii.1988 (AD); *Betche s.n.*, Cairns, -.viii.1901 (NSW); Birch 66/45, Townsville, -.xi.1965 (JCT 2 spec.); *Blake 15116*, Normanton, 13.viii.1945 (BRI, MEL); *Brass 189*, Massacre Inlet, 2.viii.1922 (BRI, CANB); *Brass 2347*, Daintree River, 19.iii.1932 (B, BRI, K); *R. Brown 2309*, Gulf of Carpentaria, Sweers Island, Bentinck Island, Allen Island, Pisonia Island, one of Bountiful Islands, 1802-3 (BM, LE); *Cameron 2175*, Horn Island, Torres Strait, 27.vii.1975 (QRS); *Cameron 2260*, Gabba Island, Torres Strait, 30.vii.1975 (QRS): *Cameron 2363*, Dauan Island, Torres Strait, 31.vii.1975 (QRS); *Cameron 2468*, Kubin Village, Banks (Moa) Island, 4.viii.1975 (QRS); *Cameron 2572*, Badu Island, Torres Strait, 17.xii.1976 (QRS); *Chalmers s.n.*, Murray Island, 1878 (MEL 98278); *Chalmers s.n.*, Thursday & Jervis Islands, 1878 (MEL 98373); *Clarkson 2027*, Escape River, 3.vi.1979 (BRI); *Clarkson 2307*, Howick Island, 12.vi.1978 (BRI); *Clarkson 3882*, Saibai Island, 21.x.1981 (AD, BRI); *Clarkson 5219*, 2.5 km N of the mouth of the McIvor River, 3.ii.1984 (AD, BRI, DNA, K, NSW, PERTH, QRS); *Dallachy s.n.*, Rockingham Bay, 11.iii.1863 (MEL 98485); *Domin 8138, 8139*, Russel River, -.i.1910 (PR); *Done s.n.*, Low Island, Great Barrier Reef, 22.vi.1969 (BRI); *Done s.n.*, Cairncross Islet East, Great Barrier Reef, 12.vii.1969 (BRI); *Elso 557 & Stanley s.n.*, Howick Island, 5.v.1979 (BRI); *Everist 9663*, Hinchinbrook Island S of Kirkville Hills, 14.viii.1970 (BRI); *Fagg 731*, Forrest Beach, c. 20 km E of Ingham, 25.v.1970 (AD, BRI, CBG); *Fitzalan s.n.*, Port Denison, 1874 (MEL 98258, MEL 98281); *Fosberg 54994*, Lizard Island, 26.vi.1973 (BRI, K, L); *Griffith s.n.*, Pioneer River, undated (MEL 98254); *Heatwole s.n.*, Bay Rock, about 19 km N Townsville near Magnetic Island, 4.iii.1971 (BRI 2 spec.); *Henne s.n.*, Sir Charles Hardy Island, undated (MEL 98271, MEL 98272, MEL 98283); *Hyland 6205*, Claudie River, 2.vii.1972 (BRI, L, QRS); *Johnson s.n.*, Russell River, 1892 (AD, MEL 98479, MEL 98443, MEL 583092, MEL 583093, MEL 583094); *Johnson s.n.*, Johnstone River, 1889 (MEL 98402, MEL 98403); *Johnson s.n.*, Endeavour River, -.vi.1891 (MEL 98502); *Johnson s.n.*, Stuart River, 1891 (MEL 583117, MEL 583118); *McDonald & Batianoff 1454*, 1 km N Cardwell, 10.iv.1975 (BRI); *McGillivray 396*, Yarraman, 1.ix.1957 (NSW); *Michael 1017*, Cannon Valley Beach, undated (BRI); *Moriarty 1460*, Bramston Beach E Babinda, 29.viii.1973 (BRI, CANB); *F. Mueller 44*, Port Denison, 14.xii.1862 (MEL 98259); *F. Mueller s.n.*, Gregory Exped., Moreton Bay, 1855 (MEL 98264); *F. Mueller s.n.*, Burdekin River, undated (MEL 98260, MEL 98261); *Ollerenshaw 1379, Kratzing & Telford*, Burketown, c. 8 km NE Triginnii landing, 13.vii.1974 (BRI, CBG, NT); *Paijmans 2883*, Bank of tidal Marrett River, 40 km N of Kalpower Homestead, 13.viii.1978 (CANB); *Paijmans 3506*, Barratta Creek, lower Burdekin valley, 6.vi.1980 (CANB); *Persieh 283*, Endeavour River, 1882 (MEL); *Persietz 23*, Cooktown, 1877 (MEL 98474); *Sayer 158*, Mosman River, 1886 (MEL 98408); *Scarth-Johnson 319A*, Quarantine Bay, Cooktown, -.viii.1976 (BRI); *Simmonds 380*, Brisbane, 9.xi.1889 (BRI); *Smith 4920*, Clump Point, 4.xi.1951 (BRI, L); *Smith 12514*, Cape York, c. 8 km S of Cape York tip, 27.x.1965 (BRI, L); *Specht & Salt W133*, 12.5 km N of Wiepa Mission, 9.xii.1974 (BRI); *Stocker 1197*, Thursday Island, 12.vii.1975 (BRI, L, QRS); *Stoddart 4237*, Green Island, 18.viii.1973 (BRI, K, L); *Stoddart 4441*, East Hope Island, 4.ix.1973 (BRI, L, MO); *Stoddart 5077*, Saunders Island, 6.xi.1973 (BRI, L); *Telford 1688*, Malambin Beach, Yeppoon-Emu Park, 16.v.1970 (CBG); *Tindale & Aitken s.n.*, Bentinck Island, Gulf of Carpentaria, 1963 (AD); *Trapnell 181*, Walker Creek, 28 km N Normanton, 11.vii.1960 (BRI); *Tryon s.n.*, South Percy Island, 5.iii.1906 (BRI 265854, BRI 265856, BRI 265857); *Whaite 3642*, Smalley's Beach near Cape Hillsborough, 31.viii.1979 (BRI, NSW); *Webb & Tracy 5993*, Jacky Jacky Creek Bamaga, Cape York Peninsula, -.v.1962 (BRI, CANB); *White 10168*, Hayman Island, 9.vi.1934 (BRI); *White 12164*, Long Island, 20.vii.1935 (BRI, LE); *Woods 5 & 35*, 6th & 5th Isl., Northumberland Group. -.xi.1873 (MEL 98475, MEL 98477); *Wrigley & Telford 1428*, Quarantine Bay. S Cooktown, 19.vi.1972 (CBG).

NEW SOUTH WALES: *Bailey 310*, Ballina, -.vi.1891 (NSW 145073); *Floyd 934*, Deadmans Creek, Ballina, 16.v.1978 (NSW); *Guilfoyle s.n.*, Tweed Heads, undated (MEL 98277); *Henderson s.n.*, Richmond River, undated (MEL 98297); *Williams 75011*, Tweed River, opposite Stott's Island, 19.ii.1975 (BRI); *Williams s.n.*, North Thumblegum, Tweed River, -.v.1964 (NSW 145071).

PAPUA NEW GUINEA: *Brass 8017*, Lower Fly River, east bank, opposite Sturt Island, -.x.1936 (A, BRI, CANB, LAE); *Hartley 9741A*, Along the coast at Malahang, c. 5 km NE of Lae, 16.i.1962 (BRI, C, CANB, LAE); *Pullen 8161*, Cape Rodney, Central District, East Papua, 29.viii.1969 (A, CANB, K, L, LAE).

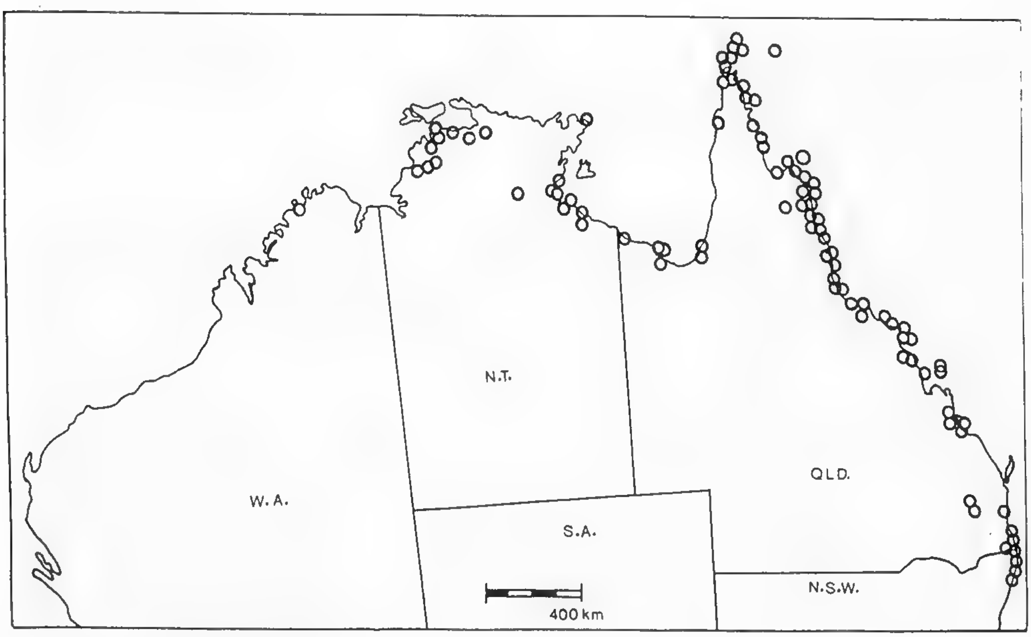
Distribution and ecology (Map 2)

In Australia, *C. inerme* is chiefly distributed in the coastal areas of Northern Territory, Queensland and far north-eastern tip of New South Wales. In Northern Territory, most localities are from Daly River northwards to western part of Arnhem Land. Along the coast of the Gulf of Carpentaria, it has been collected from Gove Peninsula and along the coastal parts of Limmen Bight. A few collections are also known from Maria Island and Sir Edward Pellow Group of Islands.

Distribution in Queensland is mainly along the east coast. It has been most commonly recorded from the areas along the Gold Coast, Brisbane and from Rockhampton northwards to the tip of Cape York Peninsula. On the Gulf-side it has been recorded from coastal areas near Wiepa, Normanton, Burktown and Massacre Inlet. A few collections are also known from South Wellesley Islands in the Gulf of Carpentaria. Besides, this species has been recorded from several off-shore islands in the Torres Strait and along the Great Barrier Reef.

In New South Wales, this species is known to occur in the area called MacPherson Macleay Overlap. Here, it has been collected from Richman River and Ballina northwards to Coolangatta and Tweed Heads near the Queensland border.

Collections from outside Australia have been examined from most parts of Malesia, Melanesia and Polynesia. In addition to this, Moldenke (1983) recorded it from India, Sri Lanka, Bangladesh, Burma, Thailand, Indo-China, southern China, Taiwan and almost throughout Oceania.



Map 2. Distribution of *C. inerme* O.

Found usually along "tidal river banks" and on "coastal sand dunes".

Comments

The authorship of *C. inerme* has been erroneously attributed by Bentham (1870) and a few others to Robert Brown (1810). As shown here in the literature cited, this species is based on *Volkameria inermis* L. which was first combined with *Clerodendrum* by J. Gaertner, resulting in a new combination *C. inerme* (L.) Gaertner.

This species is characterized by its truncate calyx and usually 3-flowered cymes. According to H.J. Lam (1919); this "species is a rather polymorphous one, being variable in form of leaves, form and tomentum of calyx, and in the cymes".

The corolla and stamens have been recorded by several botanists and collectors as "white". According to present investigation, however, the corolla is found to be white but touched with purple, and stamens and style almost always purple-pink when fresh.

Presence of glands on the outside of the corolla and on the ovary, and hairs inside the corolla-tube have not been mentioned in any previously published description of this species. In a fully mature flower, the glands on the outside of the corolla often tend to become thin and sparse.

Elliot & Jones (1984) recorded *C. inerme* from Western Australia, but the occurrence of this species in that state has not been confirmed by any collection. It is reportedly very common near the sea and along coasts from India to the coasts of Australia and almost throughout Oceania. Therefore, this species could be expected along Western Australia's coastal areas of Kimberley region.

According to some botanists, *C. inerme* can be carefully trained and sheared by the art of topiary.

Affinities

C. inerme is apparently close to *C. heterophyllum* in its leaves being glabrous; calyx glabrous, glandular outside, truncate or shallowly toothed; corolla-tube glabrous and glandular on the outside, villous inside; stamens and style purple. Nevertheless, *C. inerme* may easily be identified by its large leaf-blades being elliptic-ovate, non-punctate, 30-120 by 10-60 mm; corolla-tube much larger, 15-40 mm long; ovary glandular and plant habit scandent. The leaf-blades in *C. heterophyllum* are narrowly elliptic or lanceolate-elliptic, 5-35 mm wide; corolla tube short, 10-15 mm long.

C. inerme is also nearer to *C. parvulum* in their corolla-tubes being villous inside and stamens and style purple. The latter, however, differs in its leaves being much smaller, 5-30 by 1.5-7 mm, narrower and sessile; calyx distinctly 5-lobed, pubescent on the outside and ovary non-glandular. Moreover, *C. parvulum* is a small erect shrub 24-100 cm high only, while *C. inerme* is a scandent shrub to 4 m high or a large liana climbing to 13 m in trees.

2. **Clerodendrum heterophyllum** (Poir.) R. Br. in Ait., Hort. Kew. 2nd edn, 4 (1812) 64; Sprengel, Syst. Veg. 2 (1825) 758; Schauer in A. DC., Prodr. 11 (1847) 660; Baker, Fl. Mauritius & Seychells (1877) 254; Mold., Résumé Verbenac. etc. (1959) 155, 157, 158, 161, 208, 216, 273, 391, 392; in Humbert, Fl. Madag. 174 (1966) 237; Fifth Summary Verbenac. etc. 1 & 2 (1971) 260, 264, 265, 272, 345, 358, 463, 732, 733, 971; Phytologia 31 (1975) 391; Phytologia 36 (1977) 38; Sixth Summary Verbenac. etc. (1980) 249, 252, 254, 259, 334, 349, 461; Mani. & Siv., Fl. Calicut (1982) 233; J. Econ. Tax. Bot. 3 (1982) 814; Mold. in Dassan & Fosb., Fl. Ceylon 4 (1983) 430; Phytologia 60 (1986) 182-188, 362, 465.

Type: Herb. *Desfontaines s.n.*, from Mauritius (FI or P, n.v.).

Volkameria heterophylla Poir. in Lam., Encycl. 8 (1808) 687, **basionym.**

Type: As for *C. heterophyllum* (Poir.) R. Br.

Description (Fig. 2)

A low much-branched shrub, 1-3 m high. *Branches* twiggy, subterete or obscurely tetragonal, cinereous-puberulous, glabrescent when old; nodes often distinctly marked with leaf-bases; principal internodes greatly abbreviated. *Leaves* decussate-opposite or more often ternate, approximate and crowded; leaf-blades narrowly elliptic or lanceolate-elliptic, entire, short-acuminate, (15-) 25-75 (-90) mm long, (5-) 10-25 (-35) mm wide, membranous, bright green on both surfaces or slightly lighter beneath, glabrous or somewhat puberulous on main nerves beneath, densely punctate on both surfaces; petioles slender, minutely puberulous, 3-10 (-15) mm long. *Inflorescence* axillary, lax, usually corymbiform, densely greyish-puberulous; cymes once or twice dichotomously branched, 30-50 mm long, 40-60 mm wide; primary lateral peduncles 10-35 mm long. *Flowers* pedicellate; pedicels slender, densely cinereous-puberulous, 3-12 (-15) mm long, the central flowers often with longer pedicels. *Calyx* campanulate, its rim truncate, entire to subentire or distinctly 5-toothed, glandular and sparsely puberulous on the outside, glabrous inside; teeth minute, ovate, acuminate, triangular, 1-1.5 mm long; tube cylindrical, 3-4 mm long, 1.5-2 mm wide. *Corolla* white, glandular and very minutely pulveraceous-puberulous or almost glabrous outside, villous inside tube; lobes subequal, oblong or obovate-oblong, obtuse, glabrous and non-glandular on inner surface, 3.5-6 (-7) mm long, 2-3 (-3.5) mm wide; tube slender, cylindrical, 10-13 (-15) mm long, 1-1.5 mm diameter. *Stamens* purple, exserted; filaments inserted above middle of corolla-tube, glabrous, filiform, 15-22 mm long; anthers oblong, 1-2 mm long. *Ovary* glabrous, obovoid-globose, faintly 4-lobed, 1-1.5 mm diameter; style purple, much exserted, surpassing the stamens, filiform, glabrous, (15-) 20-35 mm long, with stigma minutely 2-lobed. *Fruit* subglobose, glabrous, somewhat sulcate between seeds, about 7 mm diam., turning black in drying.

Distribution (Map 3)

This species is native to the Mascarene Islands, but is cultivated in many places namely Russia, Europe, India, Sri Lanka, Maryland U.S.A., Australia and South Africa. In India, Madagascar and Australia, it has been found growing wild as a naturalised garden escape.

Comments

C. heterophyllum seems to be a variable and somewhat polymorphic species. Baker (1877) recorded the leaves as being "2-4 inches", but leaves that long have not been observed in the Australian collections.

No mature fruit was available for examination. The fruit-size recorded here has been taken from the species description by Moldenke (1983).

The presence of villous tomentum on the inside of corolla-tube has not been recorded by any previous botanist.

In Mauritius and Reunion, *C. heterophyllum* is reportedly "employed medicinally as an antisyphilitic. It contains some ethereal oil, but no alkaloides nor glycosides".

According to Moldenke (1986), "material of *C. heterophyllum* has been misidentified and distributed in some herbaria as *C. aculeatum* (L.) Schlecht., *C. inerme* (L.) Gaertner, *C. inerme* R. Br. (sen. lat.), *C. laciniatum* Balf.f., *C. ligustrinum* (Jacq.) R. Br., *C. splendens* G. Don, *C. tomentosum* (Vent.) R. Br., *Manabea* sp., *Volkameria ligustrina* Jacq., *V. angustifolia* Lam., *V. angustifolia* Poir. and *Volkameria* sp."

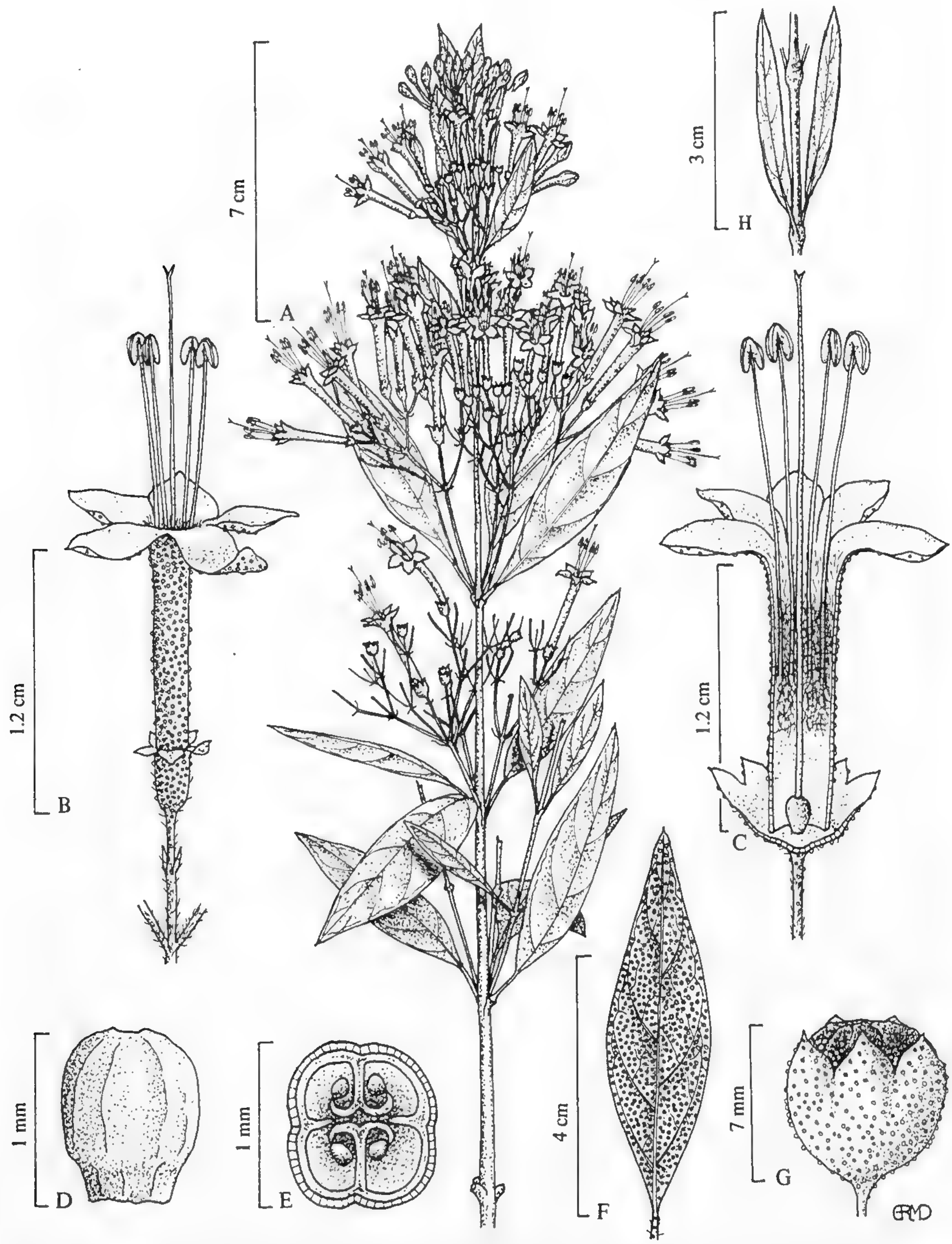


Fig. 2. *Clerodendrum heterophyllum* (Poir.) R.Br. var. *baueri* Mold. f. *baueri* (A-G, *C.T. White 12647*: BRI). A, habit sketch of a flowering branch; B, flower showing glands outside calyx and corolla; C, flower with calyx and corolla vertically cut open showing androecium, gynoecium and villosity inside the corolla-tube; D, ovary; E, transverse section of ovary; F, leaf-blade showing glands on adaxial surface; G, fruit with persistent calyx. *Clerodendrum heterophyllum* (Poir.) R. Br. f. *angustifolium* Mold. (H, *C.T. White 12401*: BRI). H, showing narrow linear leaf-blades.

In northern Queensland, it is grown in "Greenleaves Nursery" at Mt Gravatt and at Julia Creek near Cairns. "Widely planted as a hedge" in some areas.

Affinities

According to Moldenke (1986), *C. heterophyllum* "is very closely related to *C. angustifolium* (Poir.) Spreng., *C. ligustrinum* (Jacq.) R. Br. and *C. aculeatum* (L.) Schlecht. and probably also to *C. emirnense* Bojer ex Hook.". Among the Australian species of the genus *Clerodendrum*, *C. heterophyllum* seems nearest to *C. inerme*. In both species, the leaf-blades and calyces are glabrous, and calyx-tube truncate or shallowly toothed. For distinguishing characters see "affinities" under *C. inerme*.

2a. **C. heterophyllum** (Poir.) R. Br. var. **heterophyllum**. Mold., Phytologia 4 (1952) 127.

C. heterophyllum (Poir.) R. Br. in Ait., Hort. Kew. 2nd edn, 4 (1812) 64.

Type: As for *Volkameria heterophylla* Poir.

The typical variety of this species has leaf-blades "10-35 mm" wide at the mid-point and the rim of calyces truncate and entire or subentire (Moldenke, 1983), and does not seem to exist in Australia because all available collections of this species are found to have their calyx-rim distinctly but shortly toothed.

2b. **C. heterophyllum** (Poir.) R. Br. var. **baueri** Mold., Phytologia 4 (1952) 127; Biol. Abstr. 27 (1953) 984; Résumé Verbenac. etc. (1959) 208; Fifth Summary Verbenac. etc. 1 (1971) 345; Sixth Summary Verbenac. etc. (1980) 334; in Dassan. & Fosb., Fl. Ceylon 4 (1983) 432; Phytologia 60 (1986) 188 f. **baueri** (Mold.) Munir, comb. nov.

Type for variety and forma: "The taxon is based on a series of drawings made from living material at Keppel Bay, Queensland, Australia, by Ferdinand Lucas Bauer between 1801 and 1803 and deposited in the herbarium of the Naturhistorisches Museum at Vienna, drawing 968a being regarded as the type" (W, holotype, n.v.; LL, NY — photos of isotype drawings, n.v.).

Volkameria angustifolia Ander., Bot. Repos. 9 (1809) t. 554.

Type: Based on a specimen communicated by Mr. Donn, Curator of the Cambridge Botanic Garden. Plant is a native of the Isle of France (=Mauritius) grown in the Cambridge Botanic Garden. No herbarium specimens are known to exist.

Diagnosis (Fig. 2)

This taxon differs from the typical variety of the species in having its calyx-rim distinctly toothed, the teeth short and triangular. The forma *baueri* differs from forma *angustifolium* by its broader leaves.

Specimens examined

AUSTRALIA: QUEENSLAND: *Boorman s.n.*, Brisbane, -.iv.1899 (NSW); *Brazil s.n.*, Julia Creek, -.xii.1935 (BRI 266618); *Flecker 591*, Cairns, 29.vi.1935 (QRS); *Jarvis 29*, Meringa near Cairns, undated (BRI 265799); *Maiden s.n.*, Maryborough, -.iii.1909 (NSW 145084); *McKenzie 371*, Woorim, Bribie Island, 4.ii.1977 (BRI); *Rowan s.n.*, northern Queensland, loc. incert., 1891 (MEL 560539); *Scarth-Johnson 383A*, Cooktown, near Grassy Hill, 18.iii.1977 (BRI); *Schuurman 192*, Brisbane, 18.vii.1969 (L.); *Kleinschmidt 276*, Mt Gravatt, 14.iv.1970 (BRI); *Webb 390*, Gladstone Road, 22.xii.1944 (CANB); *White 1588*, Cairns, 16.iii.1922 (BRI 265798).

Distribution and ecology (Map 3)

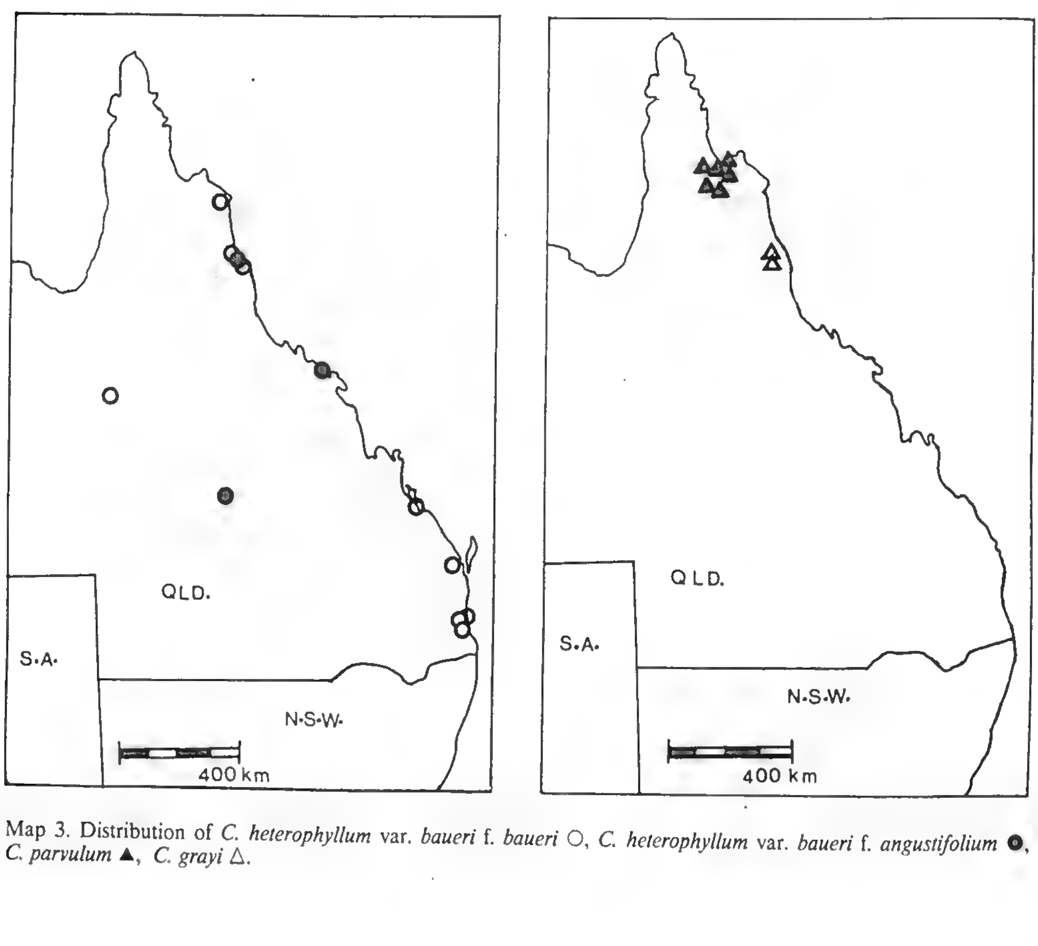
Forma *baueri* seems endemic to Queensland in Australia. In Queensland, the main distribution is along the east coast between Cooktown and Brisbane. The only known inland locality is near Julia Creek township. Being a naturalised garden escape, almost all known localities are close to cities and towns. According to some collectors' field notes, this taxon occurs mostly on beach-fronts or along sandy sea-shores.

Comments

In Australia, f. *baueri* is often widely planted as a hedge in northern Queensland. It is also planted as an ornamental shrub in gardens, particularly in seaside localities.

According to collectors' field notes the flowers of this taxon are unscented or only very slightly.

Moldenke (1986) placed *Volkameria angustifolia* Andr. in the synonymy of *C. heterophyllum* f. *angustifolium* Mold. During present investigations, the leaf-blades in the type (coloured plate only) of *V. angustifolia* Andr. are found to be more than 10 mm wide at the mid-point and the calyx-rim distinctly toothed. In view of the wider leaf-blades and toothed calyx-rim *V. angustifolia* Andr. seems nearest to var. *baueri* f. *baueri*. Similarly, the Indian records of this species reported by Sivarajan & Manilal (1982) may also belong to this variety.



Map 3. Distribution of *C. heterophyllum* var. *baueri* f. *baueri* ○, *C. heterophyllum* var. *baueri* f. *angustifolium* ●, *C. parvulum* ▲, *C. grayi* △.

According to the protologue of var. *baueri*, "one of the types (drawing) was submitted to the Royal Botanic Gardens, Kew, where late Dr. R. Melville studied it. His report was that it did not match any material in the Kew herbarium nor any known Australian species. He thought that the plant may have been a hybrid between "*C. hemiderma*" [=*Glossocarya hemiderma*] and *C. floribundum*". Moldenke (1952), however, did not agree with Dr. Melville's view and observed that this taxon represents a variety of the very variable *C. heterophyllum* with which its broad-leaved typical form agrees almost perfectly in all characters except the plainly short-toothed calyx-rim.

Affinity

Forma *baueri* is nearest to the typical form in all major characters, particularly in the shape, size and width of its leaf-blades. However, it may easily be distinguished by its calyx-rim being distinctly toothed.

2c. **C. heterophyllum** (Poir.) R. Br. var. **baueri** Mold. f. **angustifolium** Mold., Phytologia 3 (1950) 315.

C. heterophyllum (Poir.) R. Br. f. *angustifolium* Mold., Phytologia 3 (1950) 315, in Humbert, Fl. Madag. 174 (1956) 155, 237, 267; Résumé Verbenac. etc. (1959) 157, 158; Fifth Summary Verbenac. etc. 1 (1971) 264, 265; Phytologia 36 (1977) 39; Sixth Summary Verbenac. etc. (1980) 252, 254, 259, 340, 349; in Dassan. & Fosb., Fl. Ceylon 4 (1983) 431; Phytologia 58 (1985)189; Phytologia 60 (1986)186, 187, 465.

Type: *George Gardner s.n.*, Port Louis, Mauritius, (K, holotype; LL, NY — photos of type; NY, isotype).

Diagnosis (Fig. 2H)

This form differs from the typical variety and f. *baueri* in having its leaf-blade linear, less than 10 mm wide at the mid-point.

Specimens examined

AUSTRALIA: QUEENSLAND: *Flecker s.n.*, Cairns, 3.xii.1933 (QRS); *Rogers s.n.*, Queen's Beach, Bowen, 1.vii.1957 (BRI 004956); *White 12401*, Barcaldine, 21.xi.1943 (BRI).

Distribution and ecology (Map 3)

In Australia, f. *angustifolium* has been recorded only from three different localities, of which two are along the east coast near Cairns and Bowen townships, and the third at least 50 km inland to the west of Rockhampton near Barcaldine.

Distribution outside Australia has been recorded by Moldenke (1971, 1980, 1986) from Mauritius and Réunion on the Mascarene Islands, and as naturalised in Kerala in southern India.

Growing usually in sandy soil in beach front.

Comments

The form *angustifolium* is apparently native to Mauritius and Runion, but has been introduced and become naturalised in parts of southern India and north-eastern Australia. According to collector's notes, this taxon is a common hedge plant in Queensland. It is not recorded in collections from Queensland, whether they are from naturalised plants or from abandoned cultivated areas.

The precise flowering period remains uncertain. One collector "found the plant in anthesis in April", while the other collector has noted: "in flower in October".

According to Moldenke (1986), material of f. *angustifolium* "has been misidentified and distributed in some herbaria as typical *C. heterophyllum* (Poir.) Spreng., *C. commersonii* Spreng., *C. neriifolium* Wall. and *Manabea* sp."

Affinities

According to Moldenke (1986), "this form as well as *C. heterophyllum* itself, is certainly closely related to *C. angustifolium* (Poir.) Spreng." The toothed calyx-rim places it nearer to var. *baueri* but the narrow linear leaves at once distinguish it.

3. **Clerodendrum longiflorum** Decne., Nouv. Ann. Mus. Hist. Nat. 3 (1834) 400 var. **glabrum** Munir, var. nov.

Siphonanthus floribundus Banks & Sol., Ill. Austral. pl. Cook's voy. (1901) 75, t. 239 **syn. nov.**; Mold., Résumé Verbenac. etc. (1959) 344, pro syn. *C. floribundum* R. Br.; Mold., Fifth Summary Verbenac. etc. 2 (1971) 622, pro syn. *C. floribundum* R. Br.; Mold., Sixth Summary Verbenac. etc. (1980) 437, pro syn. *C. floribundum* R. Br.

Type: *J. Banks & D. Solander s.n.*, Bay of Inlets, Palm Island, Endeavour River, Queensland, 1770 (BM, syntypes!).

Clerodendrum cunninghamii Benth., Fl. Aust. 5 (1870) 64, p.p. quoad syntypes *E. Daemel s.n. & J. Jardine s.n.*, Cape York, Qld; Bailey, Qld Fl. 4 (1901) 1184, p.p. quoad spec. *E. Daemel s.n. & J. Jardine s.n.*, Cape York, Qld.

C. floribundum auct. non R. Br.: Mold. in Dassan. & Fosb., Fl. Ceylon 4 (1983) 456, p.p. quoad syn. *Siphonanthus floribundus* Banks & Sol.

Var. *glabrum* a varietate typica ramulis, foliorum venis abaxialibus, pedunculis, pedicellis calycibusque semper glabris differt.

Type: *I.R.H. Telford 1997*, Paluma Range Road, S of Ingham, Queensland, 24.v.1970 (CBG, holotype; BRI, isotype).

Diagnosis

Var. *glabrum* differs from the typical variety by its branchlets, abaxial leaf-veins, peduncles, pedicels and calyces always being glabrous.

Description (Fig. 3)

A tall shrub or small tree, (1-) 2-9 (-20) m high. *Stem* light-brown with greenish-grey bark, 10-30 cm diam. at breast height. *Leaves* ovate, elliptic-ovate or oblong-elliptic, attenuate towards both ends, entire, (6-) 8-20 (-26) cm long, (3-) 5-10 (-15) cm wide, glabrous, chartaceous; petiole glabrous, (1-) 3-6 (-8) cm long. *Inflorescence* a corymb-like thyrse, 10-15 (-20) cm long, 10-15 (-25) cm wide, somewhat exceeding upper leaves; peduncle glabrous, primary lateral branches 1.5-5 (-7) cm long. *Flowers* pedicellate; pedicels glabrous, (3-) 5-15 (-30) mm long. *Calyx* campanulate, deeply lobed, 7-15 (-18) mm long, glabrous, glandular inside; lobes ovate-lanceolate or almost triangular, acuminate, 5-8 mm long, 2.5-5 (-6) mm wide at base; tube narrowed at base, 3-5 (-6) mm long. *Corolla* white, hypocrateriform, glabrous; tube slender, rather long, (5-) 6-8 (-10) cm long, 1.5-3 mm diam.; lobes elliptic, elliptic-oblong or oblong-spathulate, 5-10 (-13) mm long, 3-5 (-7) mm wide. *Stamens* much exserted; filaments inserted above middle of corolla-tube, white, glabrous, filiform, 35-50 mm long; anthers oblong, 2.5-3 mm long. *Ovary* glabrous, globose, 1.5-2.5 mm diam.; style much exserted, white, filiform, glabrous, 65-105 mm long. *Fruit* globose-obovoid, dark-purple or blue-black, glabrous, 6-10 mm long, 6-9 (-10) mm diam. at top end; fruiting calyx dark-purple or dark-red, enlarged, somewhat funnel-shaped, shortly contracted at base, lobes spreading or recurved, deltoid, 20-25 (-30) mm diam.

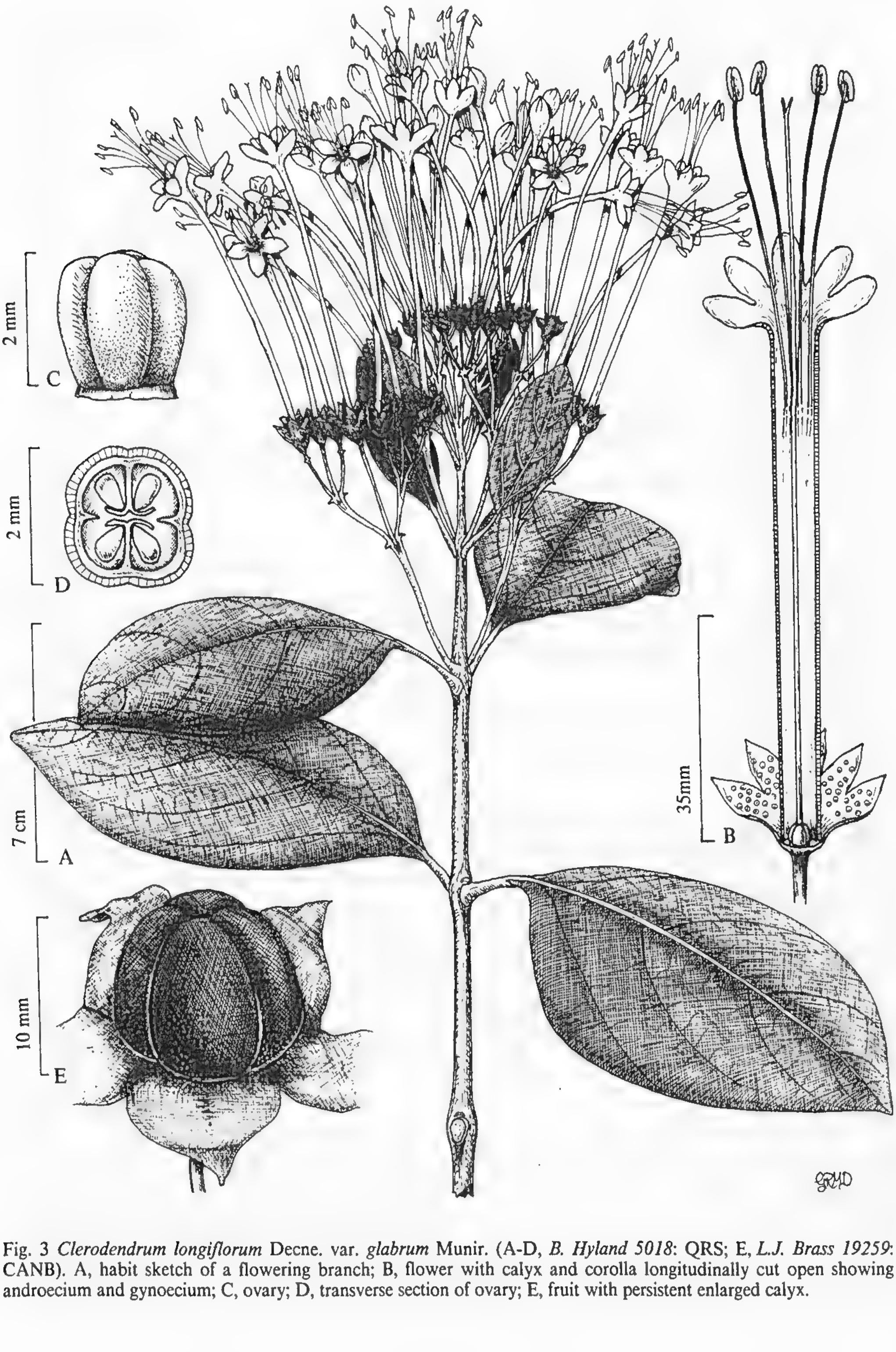


Fig. 3 *Clerodendrum longiflorum* Decne. var. *glabrum* Munir. (A-D, *B. Hyland 5018*: QRS; E, *L.J. Brass 19259*: CANB). A, habit sketch of a flowering branch; B, flower with calyx and corolla longitudinally cut open showing androecium and gynoecium; C, ovary; D, transverse section of ovary; E, fruit with persistent enlarged calyx.

Representative specimens (collections seen: Australian 83; non-Australian 8)

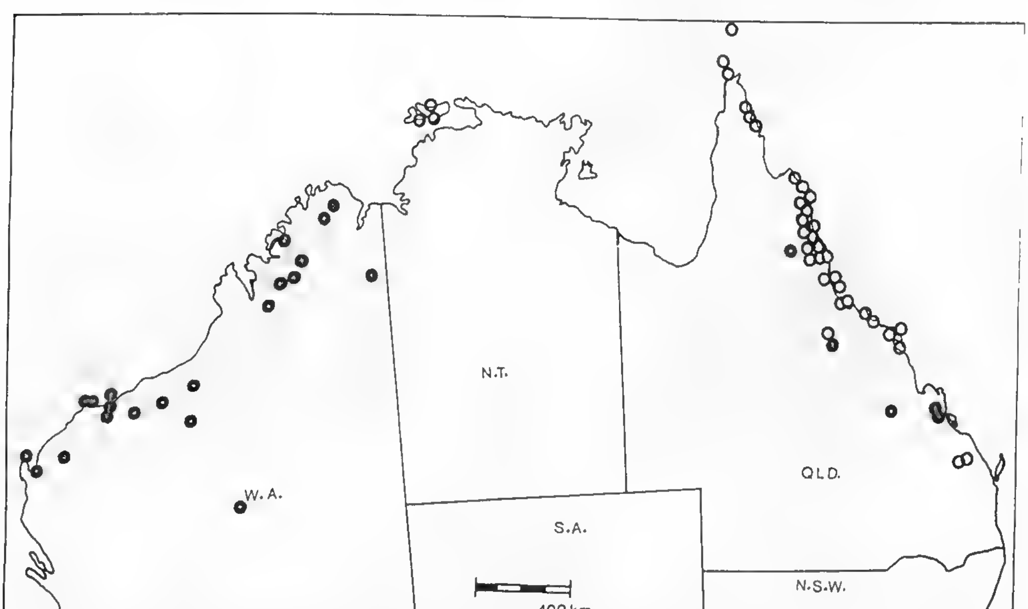
AUSTRALIA: QUEENSLAND: *Andrews 165*, beside Old Dalrymple Track near Cardwell, 10.v.1975 (BRI); *Banks & Solander s.n.*, Bay of Inlets, Palm Islands, Endeavour River, 1870 (BM, syntypes of *Siphonanthus floribundus* Banks & Sol.); *Barnard 7741*, Lake Barrine, Atherton, 15.vi.1941 (BRI); *Betche s.n.*, Cairns, -.viii.1901 (G); *Boyland (& Gillieatt) 501*, c. 30 km NNW Daintree, 20.xi.1967 (BRI, QRS); *Brass 19259*, Iran Range, Cape York Peninsula, 19.vi.1948 (A, CANB, K, L, LE); *Brass 33624*, Saddle Mountain near Kuranda, 3.viii.1967 (BRI, QRS); *Cameron 2463*, Moa Island, Torres Strait, 4.viii.1975 (QRS); *Cameron 20209*, Prince of Wales Island, Torres Strait, 13.ii.1975 (QRS); *Craven 3169*, c. 20 km from Bowen on Townsville Road, 7.iv.1975 (CANB); *Daemel s.n.*, Cape York, undated (MEL 98069, syntype of *C. cunninghamii* Benth.); *Dallachy s.n.*, Rockingham Bay, 3.vi.1863 (K, MEL 98078, MEL 98079, MEL 98080); *Gilmour s.n.*, Wyvuri Holding, 22.iii.1974 (BRI, L, QRS); Gittins 2168, Shipton's Flat, S Helenvale, 30.viii.1970 (BRI, NSW); *Goy 336*, Magnetic Island, 24.vii.1938 (BRI); *Guymer 1135*, 23.6 km NNW Proserpine, 4.ix.1977 (BRI); *Hockings 18*, 8th Creek, Missionary Bay, Hinchinbrook Island, 24.viii.1979 (BRI); *Hyland 4079*, S.F.R. 299 Conway, 1.viii.1974 (BRI, L, QRS); *Hyland 7502*, Olive River, 14.ix.1974 (BRI, QRS); *Irvine 88*, Mt. Lewis Area, 25.xi.1971 (BRI, L, QRS); *Jacks s.n.*, Windsor Tablelands, 14.vi.1980 (AD); *Jardine s.n.*, Cape York, loc. incert., undated (MEL 98077, syntype of *C. cunninghamii* Benth.); *Ladbrook s.n.*, Johnstone River, -.viii.1917 (BRI); *Moriarty 1410*, Gap Creek, S of Cooktown, 18.viii.1973 (BRI); *Persieh 77*, Endeavour River, 1883 (MEL 98497, MEL 98509); *Sayer s.n.*, near Trinity Bay, 1886 (MEL 98459); *Schulz 194*, Cape Hillsborough, 26.viii.1976 (QRS); *Telford 1997*, Paluma Range Road, S Ingham, 24.v.1970 (CBG holotype, BRI isotype); *Webb & Tracy 11495*, Tinaroo Range Road, between Mareeba and Tinaroo Dam, 11.v.1972 (BRI, CANB); *Wrigley & Telford 583*, Millstream Falls, W Ravenshoe, Qld (CBG); *Wyatt 6*, Tolga, -.xii.1961 (BRI).

NORTHERN TERRITORY: *Cunningham 289*, Bathurst Island, 1818 (BM, K); *Dunlop 3454*, Melville Island, 18.iv.1973 (CANB, DNA, NT); *Webb & Tracy 12896*, Snake Bay, Melville Island, -.v.1978 (QRS).

PAPUA NEW GUINEA: *Brass 13474*, 2 km SW Bernhard Camp, Idenburg River, -.iii.1939 (A, BRI, LAE); *Henty & Katik NGF 38743*, Wassi Kussa River, Western District, Papua, 11.vii.1968 (A, BRI, CANB, K, L, LAE).

Distribution and ecology (Map 4)

In Australia, *C. longiflorum* var. *glabrum* is found in the tropics of Northern Territory and Queensland. In Northern Territory, this taxon has been recorded only from Bathurst Island and Melville Island. Distribution in Queensland is chiefly along the east coast from Bundaberg northwards to the tip of Cape York Peninsula. The major area of its occurrence, however, is



Map 4. Distribution of *C. longiflorum* var. *glabrum* ○, *C. tomentosum* var. *lanceolatum* ●.

between Mackay and Cooktown, and is most common in the coastal area east of the Atherton Tableland. In the northern part of the Cape York Peninsula, it has most frequently been recorded from the vicinity of the Iron Range and Scrubby Creek. It has also been recorded from several off-shore Islands along the east coast and in the Torres Strait. So far, it has not been reported from within or along the Gulf of Carpentaria, nor from inland area of the state.

Collections examined from Papua New Guinea were the only ones seen from outside Australia.

Growing usually on "sandy" or gravelly soil or among "granite boulders", and often recorded on margin of rainforest or vineforest. Also found in "open grassy forest" on "banks of creeks" and "in woodland on rocky hills".

Comments

C. longiflorum is recorded for Australia for the first time. Previously, all Australian collections of this species were identified as *C. cunninghamii* Benth. or *C. floribundum* R. Br.

The pedicels of terminal flowers are often much longer than those of lateral ones. For instance, in *A. Irvine 88* (QRS) the terminal pedicels are up to 30 mm long while the lateral ones are mostly 3-10 mm long.

In some overseas collections, the pedicels and calyces are somewhat puberulous when young, but become glabrous at fruiting stage.

Affinities

C. longiflorum var. *longiflorum* is easily distinguished from var. *glabrum* by its branchlets, peduncles, pedicels, calyces and petioles being pubescent, calyx and corolla glandular on the outside and leaf-veins puberulous on abaxial surface. *C. longiflorum* var. *glabrum* is similar to *C. costatum* R. Br. (=*C. cunninghamii* Benth.) in its inflorescence being a corymb-like thyrse, calyx glandular inside, corolla-tube always more than 45 mm long and leaves more or less of similar shape and size. Nevertheless, *C. longiflorum* var. *glabrum* can readily be identified by its leaves and inflorescence always being glabrous and corolla-tube up to 100 mm long. The corolla-tube in *C. costatum* is up to 70 mm long and the abaxial leaf-surface, petiole, pedicel, peduncle and outer surface of calyx are always pubescent.

4. **Clerodendrum floribundum** R. Br., Prodr. Fl. Nov. Holl. (1810) 511; Schauer in A. DC., Prodr. 11 (1847) 671; Benth., Fl. Aust. 5 (1870) 63; Bailey, Qld Fl. 4 (1901) 1183; H.J. Lam, Verbenac. Malay. Archip. (1919) 258; Domin, Biblioth. Bot. 89 (1928) 558; Mold., Résumé Verbenac. etc. (1959) 260, 266, 271, 273; Fifth Summary Verbenac. etc. 1 (1971) 345, 349, 439, 441, 442, 450, 452, 460, 461, 464, 576; Sixth Summary Verbenac. etc. (1980) 325, 334, 339; in Dassan & Fosb., Fl. Ceylon 4 (1983) 456, p.p. excl. syn. *Siphonanthus floribundus* Banks & Sol.; Stanley in Stanley & Ross, Fl. S.E. Qld 2 (1986) 370.

Lectotype: *R. Brown s.n. (J.J. Bennett no. 2314)*, "Littora Novae Hollandiae intro tropica", "one of Harvey's Islands", 25.ix.1802 (BM, lectotype designated here!; BM, 2 spec., K, 2 spec. — isolectotypes!).

Typification

C. floribundum is based on Robert Brown's three different collections from "East Coast" of Queensland consisting of at least 7 duplicates. All duplicates were annotated by Robert Brown and certainly used by him in preparing the original diagnosis of this species. As no holotype was designated by the author a lectotype is selected here. Of all the syntypes, a duplicate of his [possibly "one of Harvey's Islands"] one collection in Herb. BM is particularly complete and well preserved and is chosen here as the lectotype of this species.

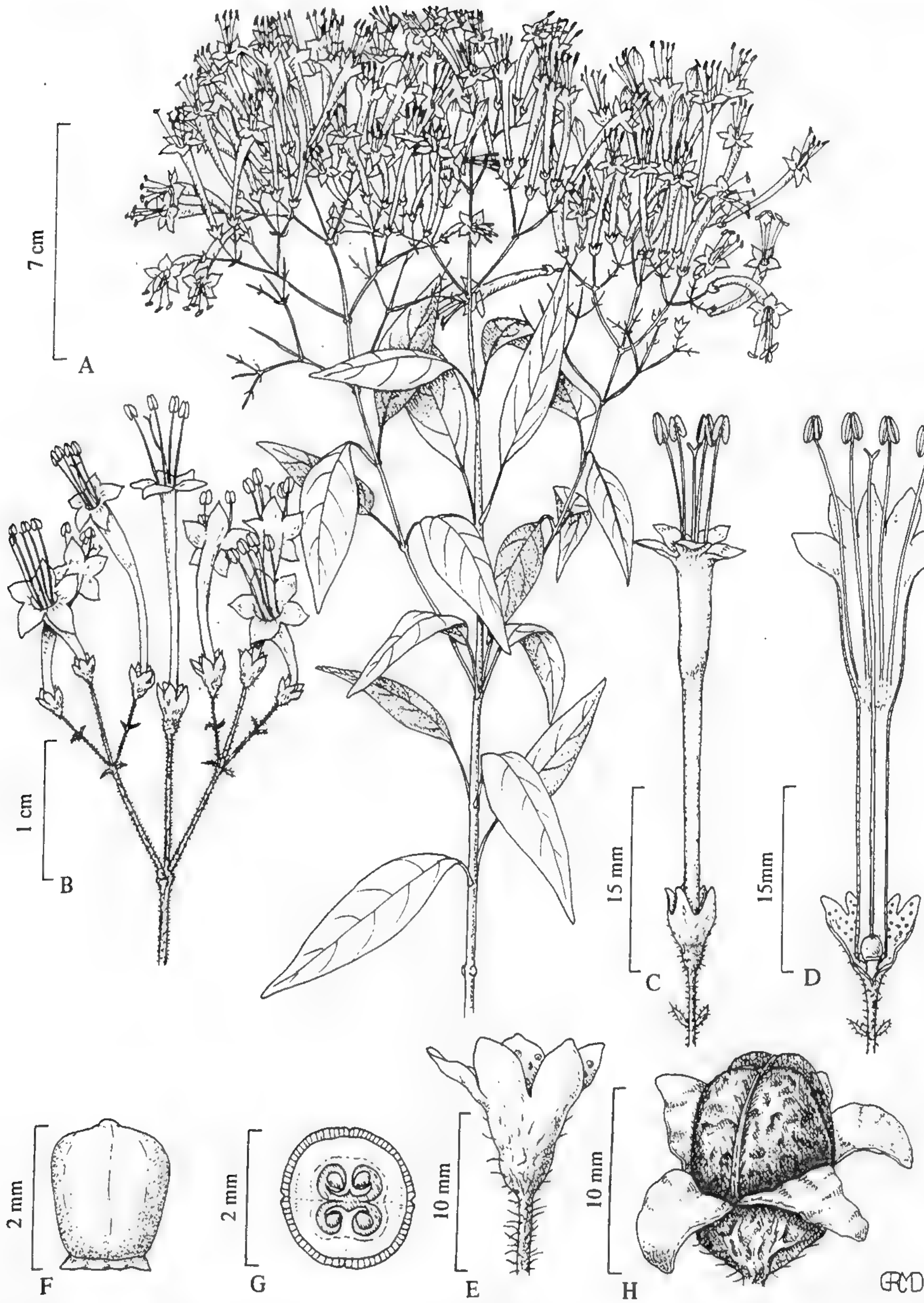


Fig. 4. *Clerodendrum floribundum* R. Br. var. *floribundum* (A-G, *R. Brown s.n. J.J. Bennett no. 2314*: BM, lectotype; H, *R. Brown s.n. J.J. Bennett no. 2313*: E). A, flowering branch; B, cyme; C, flower; D, flower with calyx and corolla vertically cut open to show androecium and gynoecium; E, enlarged calyx; F, ovary; G, transverse section of ovary; H, fruit with persistent calyx.

Description

A tall shrub or small tree, usually quite glabrous, or in some varieties young parts sparsely or densely pubescent. *Stem* smooth, cylindrical, speckled, greenish-yellow or greyish-brown, sometimes young parts dull purplish; bark light grey, often furrowed. *Leaves* petiolate; lamina variable, ovate, elliptic, lanceolate or varying from broadly ovate, cordate, narrowly elliptic-lanceolate to elliptic-obovate, membranous, subchartaceous or coriaceous, sometimes densely punctate beneath, usually glabrous or very minutely pilose on venations beneath, acute, obtuse or acuminate, with margins entire or subundulate, attenuate, rounded, cordate or subcordate; petioles glabrous, pubescent or puberulous, but often eventually glabrescent. *Inflorescence* cymose; cymes loose and few flowered in axils of upper leaves or aggregated in a broad terminal corymbose thyrse, branches glabrous, pubescent or minutely puberulous, ultimate ones 3-flowered; peduncles slender, glabrous or puberulous; bracts foliaceous, petiolate, lanceolate or elliptic, glabrous or somewhat pubescent on both surfaces; bracteoles lanceolate, sessile. *Flowers* pedicellate, often galled; pedicels slender glabrous or minutely puberulous. *Calyx* campanulate, glabrous or varying to puberulous outside, glabrous and glandular inside; lobes lanceolate, acute, about as long as tube or rather longer; tube wider at top. *Corolla* white or creamy white, hypocrateriform or infundibular, glabrous; tube slender; lobes elliptic-oblong or ovate. *Stamens* exserted; filaments inserted about ⅔ above base of corolla-tube, white, filiform, glabrous; anthers oblong-ellipsoid, with 2 parallel lobes free in lower half. *Ovary* globose, glabrous, 1-2 mm diameter; style exserted, white, filiform, glabrous, with shortly bifid stigma. *Fruit* globose-obovoid, 5-15 mm diam., purple or purple-black when mature in fresh state, blackish when dry, fruiting calyx bright- or dark-red, expanding to 25 mm diam.

Distribution

A native of Australia, Papua New Guinea and Irian Jaya. Cultivated in Australia, South Africa, Sri Lanka and India as an ornamental and specimen plant.

Comments

C. floribundum is an extremely variable polymorphic species. In Australia, the popular names for this species are "Lolly Bush" and "Smooth *Clerodendron*".

Affinities

C. floribundum closely resembles *C. longiflorum* Decne. var. *glabrum* Munir as its leaves and inflorescence are glabrous; calyx deeply 5-lobed, glandular inside; corolla white, glabrous and non-glandular, not hairy inside the tube. Nevertheless, *C. floribundum* may easily be indentified by its leaf-blades only 30-130 by 15-55 mm and flowers being much smaller; calyx 5-10 mm long; corolla-tube 15-35 mm long and style 30-60 mm long only. In *C. longiflorum*, the leaf-blades are 60-260 by 30-150 mm; calyx 7-18 mm long; corolla-tube 50-100 mm long and style 65-105 mm long.

There are a few characters in common between *C. floribundum* and *C. inerme*. Both species have somewhat similar shaped glabrous leaf-blades, glabrous calyx and corolla. The latter species, however, may easily be distinguished by its scandent habit, the calyx being truncate and glandular outside; corolla-tube villous inside; stamens and style are pink-purple and the ovary glandular.

4a. var. **floribundum.**

C. floribundum R. Br., Prodr. Fl. Nov. Holl. (1810) 511; Sprengel, Syst. Veg. 2 (1825) 759; Walp., Rep. Bot. Syst. 4 (1845) 105; Schauer in A. DC., Prodr. 11 (1847) 671, p.p.; Benth., Fl. Aust. 5 (1870) 63, p.p.; F. Muell., Fragm. 9 (1875) 5; Syst. Cens. Aust. Pl. 1 (1882) 103; Bailey, Synop. Qld Fl. (1883) 381; Proc. Roy. Soc. Qld 1 (1884) 71; C. Moore, Cens. Pl. N.S.W. (1884) 52; Palmer, Proc. Roy. Soc. N.S.W. 17 (1884) 108; Bailey, Qld Woods (1888) 93;

F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Schumann in Schumann & Hollr., Fl. Kais.-Wilh. Land (1889) 122; Bailey, Cat. Pl. Qld (1890) 36; Tate, Handb. Fl. Extratrop. S. Aust. (1890) 156, 254; C. Moore, Handb. Fl. N.S.W. (1893) 357; Tepper, Bot. Centralbl. 54 (1893) 260; Tate in Horn. Sc. Exped. Cent. Aust. III (1896) 175; Bailey, Qld Fl. 4 (1901) 1183, p.p.; Schumann in Schumann & Lauterb., Nachtr. Fl. D. Südsee (1905) 371; Dixson, Pl. N.S.W. (1906) 236; Bailey, Qld Agric. Journ. 27 (1911) 67; Bailey, Comp. Cat. Qld Pl. (1913) 386; Maiden & Betche, Cens. N.S.W. Pl. (1916) 178; Ewart & Davies, Fl. N. Territory (1917) 238; H.J. Lam, Verbenac. Malay. Archip. (1919) 258; C. White & Francis, Proc. Roy. Soc. Qld 38 (1927) 257; Domin, Biblioth. Bot. 29 (1928) 558, p.p.; R. Anderson, Trees N.S.W. (1947) 272; Webb, C.S.I.R. Bull. No. 232 (1948) 167; Francis, Aust. Rain Forest Trees (1951) 367, 454; Mold., Résumé Verbenac. etc. (1959) 200, 207, 208; Beard, W. Aust. Pl. edn 2 (1970) 113; Mold., Fifth Summary Verbenac. etc. 1 (1971) 335, 345, 349; Court, Cat. Liv. Pl. Nat. Bot. Gard. Canb. (1980) 81; Mold., Phytologia Mem. Sixth Summary Verbenac. etc. (1980) 325, 334, 339; Baines, Aust. Pl. Gen. (1981) 97; J. Green, Cens. Vasc. Pl. W.A. (1981) 89; S. Jacobs & Pickard, Pl. N.S.W. (1981) 209; Munir in Jessop, Fl. Cent. Aust. (1981) 297; Mold. in Dassan. & Fosb., Fl. Ceylon 4 (1983) 456, p.p. excl. syn.; Lassak & McCarthy, Aust. Medic. Pl. (1983) 30; Elliot & Jones, Encyc. Aust. Pl. 3 (1984) 49; Stanley in Stanley & E. Ross, Fl. S.E. Qld 2 (1986) 370, p.p.; D. Jones, Ornament. Rainforest Pl. Aust. (1986) 207, t. p. 215.

Description (Fig. 4)

A tall shrub or small tree, 1.5-6.5 m high. *Stem* glabrous or pubescent on young parts. *Leaves* narrowly elliptic or lanceolate, (3-) 4.5-10 (-13) cm long, (1.5-) 2-4 (-5.5) cm wide, subchartaceous, glabrous or minutely pilose on venation beneath, acute-acuminate towards apex, tapered towards base; petioles pubescent-puberulous, (5-) 7-20 (-30) mm long. *Inflorescence* a terminal corymbose thyrse; peduncles puberulous, slender, 2-5 cm long; bracts lanceolate, foliaceous, petiolate, pubescent, 15-25 mm long, 5-10 mm wide, on a petiole of 2-3 mm long; bracteoles lanceolate, sessile, 2-5 mm long. *Flowers* pleasantly scented; pedicels slender, puberulous, (4-) 5-10 (-14) mm long. *Calyx* campanulate, 5-10 mm long, puberulous outside, glabrous and glandular inside; lobes lanceolate, acute, (2-) 3-4 (-5) mm long, (1-) 2-2.5 mm wide at base; tube (2-) 3-4 (-5) mm long. *Corolla* white, hypocrateriform, glabrous; tube slender, (15-) 20-30 (-35) mm long, 1-2 mm diam.; lobes elliptic-oblong, 3-5 (-6) mm long, 2-3 (-4) mm wide. *Stamens* much exserted; filaments white, glabrous, filiform, (9-) 15-25 (-35) mm long; anthers 2-3 mm long. *Ovary* glabrous, 1-1.5 mm diam.; style much exserted, white, filiform, glabrous, 30-45 (-60) mm long. *Fruit* globose-obovoid, 5-10 mm diam., purple-black, glabrous; fruiting calyx dark-red, 12-20 mm diam.

Representative specimens (collections seen: Australian 70, non-Australian 4)

AUSTRALIA: QUEENSLAND: *Alkin s.n.*, Gympie, 1913 (Z); *Bevege s.n.*, Blackall Range, Cooloolabin via Yadina, undated (BRI 063778); *Blake 2814*, Petrie, 29 km N Brisbane, -.x.1931 (BRI); *Blake 15350*, Gogango Range, near Edungalba, 27.ix.1945 (BRI, MEL); *Bowman s.n.*, Herbert Creek, undated (MEL 582981, MEL 582982); *R. Brown s.n.*, *J.J. Bennett no. 2314*, Littora Novae Hollandiae intro tropica, Harvey's Islands, 15.ix.1802 (BM, lectotype; BM, K, isolectotypes); *R. Brown s.n.*, *J.J. Bennett no. 2313*, Thirsty Sound, 1802-5 (E); *Byrnes & Clarkson 3782*, Tributary of Hazelwood Creek, 9.iv.1978 (BRI); *Clemens s.n.*, Mt Glorious, Moreton District, -.i.1945 (L 95930582); *Dallachy s.n.*, Rockingham Bay, 14.vii.1844 (MEL 98090); *Dietrich 2169*, Rockhampton, 1864-66 (AD); *Gulliver 44*, Cape Kimberley, 1874 (MEL); *Helms 1449*, Howard, 1.xii.1921 (C); *Hyland 5829*, SE Chillagoe, 26.i.1972 (L, QRS); *Leichhardt s.n.*, Archer Mt, 16.viii.1843 (NSW 145174); *F. Mueller s.n.*, Port Denison, undated (MEL 98098); *F. Mueller s.n.*, Burdekin River, undated (MEL 98178); *Rawson s.n.*, Wooroolin, -.ii.1965 (BRI 060232); *Rodway s.n.*, Bundaberg, undated (HO); *Stoddart 5002*, Lowrie Island, 29.x.1973 (BRI); *Thozet s.n.*, Expedition Range, 1878 (MEL 582833); *White s.n.*, Nerang River, -.x.1917 (BRI 265676, NSW 145178); *White 9526*, Roma, Maranoa District, 25.x.1933 (BRI); *Wilkinson s.n.*, sources of the Thomson River, 1893 (MEL 98139).

NEW SOUTH WALES: *Campbell s.n.*, Tweed River, -.ix.1900 (G); *Fawcett A32*, Richmond River, 1878 (MEL); *Hadley 7918/5*, Woodford Island, Clarence River, -.x.1915 (NSW 145187); *Hambly s.n.*, Comboyne, 12.iii.1946 (NSW 145186); *Lawrence s.n.*, Urunga, -.xi.1918 (NSW 145182); *Lyne s.n.*, Taree, 31.i.1919 (NSW 145184); *Martin P.S. 1353*, Cooper Creek Road, north of Mullumbimby, 8.xi.1967 (SYD); *Morris s.n.*, Nana Glen, -.xi.1957 (NSW 145190); *Sieber 267*, Port Jackson, undated (W); *Tanner s.n.*, Lismore, -.xi.1911 (NSW 145196).

WESTERN AUSTRALIA: *Cunningham 255*, Cape Pond & York Sound, 1820 (BM); *George 12665*, Mt Trafalgar, Prince Regent River, 25.viii.1974 (PERTH); *Lullfitz L6086*, Balmoral Station between Onslow & Roebourne, 27.iv.1968 (AD, PERTH); *Wilson 10986*, Bat Island, Bonaparte Archipelago, 26.vi.1973 (PERTH); *Wilson 11415*, Boongaree Isl. Prince Fredrick Harbour, 7.vii.1973 (PERTH).

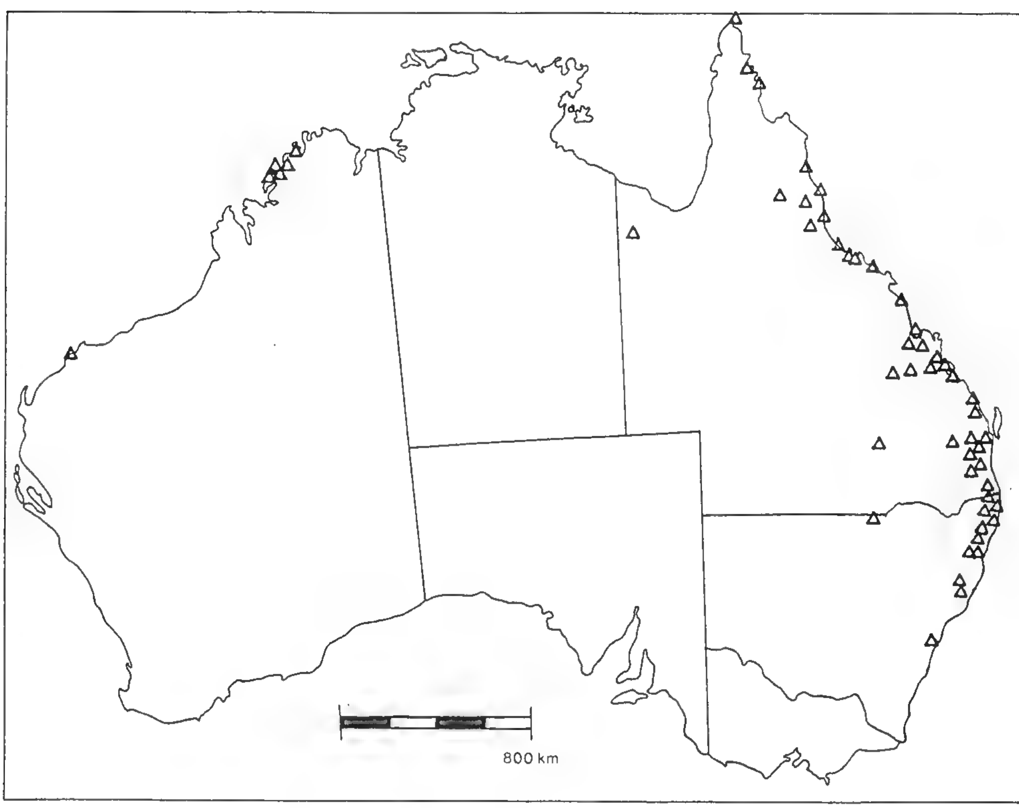
PAPUA NEW GUINEA: *Eddowes & Kumul NGF 13126*, Brown River, Central District, 29.iii.1966 (A, BO, BRI, CANB, K, L, SING); *Havel & Kairo NGF 17288*, Lower Crooked Creek, Bulolo, 2.x.1963 (A, BO, BRI, BISH, CANB, K, L, NSW, PNH, SING, US); *Millar & Holttum NGF 15785*, near Watut, subdistrict Wau, Morobe district, 16.viii.1963 (A, BO, BRI, CANB, K, L, PNH, NSW, SING, UH).

Distribution and ecology (Map 5)

In Australia, *C. floribundum* var. *floribundum* is found chiefly in Queensland, New South Wales and Western Australia. The localities in Queensland are mainly in the eastern coastal region, particularly in the area between Cape York Peninsula and New South Wales border. Further from coastal areas, a few inland localities are near Mitton Creek (a tributary of Gregory River), Longreach and Roma. One off-shore locality is at Lawrie Island on the east coast of Cape York Peninsula and another at Harvey's Island in the Torres Strait. So far, it has not been recorded from west-coast of Cape York Peninsula, Gulf of Carpentaria region or any part of Northern Territory where its presence seems most likely. In New South Wales, the distribution is in the coastal area between the Queensland border and Sydney. Distribution in Western Australia is mainly along the west-coast of Kimberley region where it is known to occur between 14° and 16°S and between 124° and 126°E. The only known locality outside this area is near Balmoral Station between Onslow and Roebourne.

Collections from Papua New Guinea are the only ones examined from outside Australia.

Growing on sandy or stony soils often associated with "banks of rivers" in rainforest. Also on "sandstone boulders" and in "semi-deciduous thicket".



Map 5. Distribution of *C. floribundum* var. *floribundum* △.

Comments

C. floribundum was based on Robert Brown's three different collections from northern and eastern parts of Queensland, and northern part of Northern Territory. Of these, three duplicates of his collection (J.J. Bennett no. 2314) from Northumberland Islands are preserved in Herb. BM, E and K. All three duplicates have large elliptic glabrous leaves and glabrous inflorescence. Since the shape and size of leaves and glabrous inflorescence are the characters of *C. floribundum* var. *ovatum*, the above (syntype) specimens from Northumberland Islands have been referred to var. *ovatum*. The typical form of *C. floribundum* has narrow-lanceolate leaves with petioles and inflorescence being pubescent. These characters were found in the syntypes from Harvey's Island, of which a lectotype has been chosen for the typical variety.

C.T. White's collection (no. 9526) in Herb. BRI has not only comparatively much smaller leaves, smaller inflorescence and flowers, but also abnormal flower-parts. In some flowers the number of calyx- and corolla-lobes are at least seven each, and the number of stamens up to eight.

Moldenke (1959, 1971) erroneously regarded *C. medium* R. Br. as a synonym of *C. floribundum*. Subsequently (1978, 1980, 1983) he recorded *C. medium* as a variety of *C. floribundum*, apparently without examining their types in Herb. BM and K. During present investigation, *C. medium* is found to have densely pubescent-tomentose leaves and a congested tomentose inflorescence. Since these characters are typical of *C. tomentosum* (Vent.) R. Br., *C. medium* has been placed in the synonymy of the former species. In general, *C. floribundum* is an exceedingly variable species distinguished from *C. tomentosum* by the absence of pubescence, lax inflorescence, acute calyx-lobes and slightly longer corolla-tube.

Bentham (1870) and Moldenke (1959, 1971, 1980) reported this species from South Australia, but its occurrence there has not been confirmed.

According to Edward Plamer (1884), "two sticks of this plant are used for drills to make fire with" by the aborigines. Its wood is reportedly close-grained and light coloured.

In Australia, the common name for this species is "Lolly Bush", and within Queensland it is named by some as "Thurkoo of Cloncurry Aborigines".

R.B. Jone's un-numbered collection (NSW 145183) from "Burrengbar", New South Wales, may have come from Burrenbah near the Queensland border. The locality "Burrengbar" has not been found in any available atlas, while Burrenbah is within the distribution range of this species.

4b. var. **attenuatum** (R. Br.) Mold., Phytologia 39 (1978) 236; Sixth Summary Verbenac. etc. (1980) 334, 390; in Dassan. & Fosb., Fl. Ceylon 4 (1983) 457.

Type: *R. Brown s.n. (J.J. Bennett no. 2311)*, Hunter River, Newcastle, New South Wales, Australia, 1802-1805 (BM, holotype!).

C. attenuatum R. Br., Prodr. Fl. Nov. Holl. (1810) 511; Sprengel, Syst. Veg. 2 (1825) 759; Walp., Rep. Bot. Syst. 4 (1845) 105; Schauer in A. DC., Prodr. 11 (1847) 671; Benth., Fl. Aust. 5 (1870) 64; Kuntze, Rev. Gen. Pl. 2 (1891) 506.

Type: As for *C. floribundum* R. Br. var. *attenuatum* (R. Br.) Mold.

C. floribundum auct non R. Br.: Domin, Biblioth. Bot. 89 (1928) 1112, p.p., quoad syn. *C. attenuatum* R. Br.; Mold., Résumé Verbenac. etc. (1959) 260, p.p., quoad syn. *C. attenuatum* R. Br.; Fifth Summary Verbenac. etc. 1 (1971) 460, p.p., quoad syn. *C. attenuatum* R. Br.

C. ovalifolium auct non (A. Juss.) Bakh.: Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Ser. 3, 3 (1921) 95, p.p., quoad syn. *C. attenuatum* R. Br.

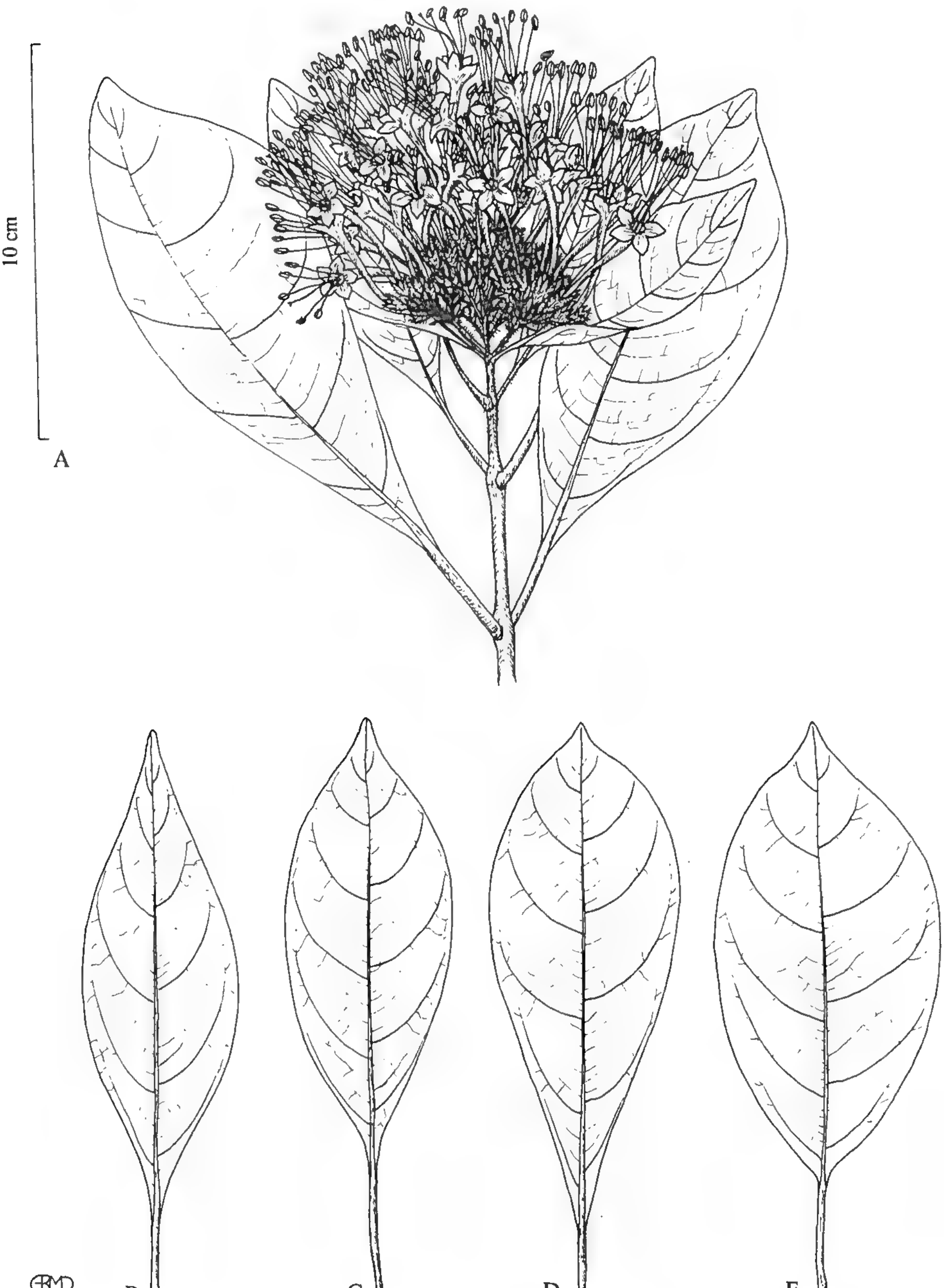


Fig. 5. Habit sketch and range of variation in leaf form of *Clerodendrum floribundum* R. Br. var. *attenuatum* (R. Br.) Mold. (A & C, *R. Brown s.n. J.J. Bennett no. 2311*: BM, holotype; B, *M. Gray 4421*: CANB; D, *J.A. Henderson 147*: MEL; E, *R.D. Hoogland 8606*: BRI). A, habit sketch of a flowering branch; B-E, range of variation in leaf form.

Diagnosis

Var. *attenuatum* is distinct from other varieties of *C. floribundum* in its leaf-blades being elliptic to obovate-elliptic, acute at tip, cuneate towards base, glabrous all over; petiole pubescent; inforescence pubescent-tomentose, with more or less congested flowers; peduncle and pedicel pubescent; calyx pubescent outside, glabrous and glandular on the inner surface.

Description (Fig. 5)

A tall shrub or small tree, 3-8 m high. *Stem* with soft, flaky, grey-brown bark. *Leaves* with blades elliptic or obovate-elliptic, acute apex, cuneate towards base, chartaceous or subcoriaceous, glabrous, (35-) 45-140 (-175) mm long, (25-) 30-80 (-100) mm wide; petiole pubescent, (10-) 15-40 (-55) mm long. *Inflorescence* dense, pubescent-tomentose; primary lateral peduncles pubescent, 10-45 mm long. *Flowers* pedicellate, more or less congested; pedicels pubescent, 5-12 mm long. *Calyx* deeply lobed, pubescent outside, glabrous and glandular on inner surface, 7-10 mm long; lobes acute, 3-5 mm long; tube 4-5 mm long. *Corolla* white or cream-white, glabrous, 30-40 mm long; tube cylindrical, 25-35 mm long, 1.5-3 mm diam. *Stamens* exserted, white, glabrous. *Ovary* globose, glabrous; style exserted, glabrous, white, 40-50 mm long. *Fruit* obovoid or somewhat globose, glabrous, glossy, purple-black or blue-black, 5-12 mm long, 5-8 mm diam. at top; fruiting calyx purple-red, 10-25 mm diam.

Representative specimens (Collections seen: Australian 62, non-Australian 5)

AUSTRALIA: NORTHERN TERRITORY: *Allen 483*, Daly River, 16.vi.1920 (NSW); *Bleeser 262*, Darwin, -.iv.1927 (NSW); *Cunningham 289*, Port Hurd, Bathurst Island, 1818 (MEL); *Dunlop 3454*, Melville Island, 18.iv.1973 (CANB, DNA, NT).

QUEENSLAND: *Borman s.n.*, Capricorn Group Isl., undated (MEL 98156); *Dallachy s.n.*, Rockingham Bay, undated (MEL 98171); *Dietrich s.n.*, near Brisbane River, 1863-1865 (BRI, MO, W); *Gray 4421*, Mt. Glorious, 38 km W Brisbane, 2.xii.1957 (CANB, MEL); *Heatwole 571*, Murray Island, Torres Strait, 18.vii.1974 (QRS); *Henderson, Moriarty & Swan H2215*, c. 15 km N Proserpine, 21.vii.1974 (BRI); *Michael s.n.*, Johnston River, -.ix.1917 (BRI); *Mitchell s.n.*, Kamerunga Nursery, Cairn, -.viii.1911 (NSW 145173); *Moriarty 1815*, Eastern fall of Mt Dryander, 21.vii.1974 (QRS); *F. Mueller s.n.*, Port Denison, undated (MEL 98145); *O'Shanesy 145*, Rockhampton, 1.vi.1867 (MEL); *Simmonds s.n.*, Tamborine Mt, -.x.1919 (BRI); *Smith 4146*, Fairmead, 27.x.1948 (BRI); Verreaux 690, Moreton Bay, 1844-1846 (LE); *Webb & Tracey 6392*, Fraser Island, -.v.1964 (BRI); *Webb & Tracey 6955*, Bamaga at tip of Cape York Peninsula, 1962 (BRI); *White s.n.*, Macpherson Range, -.i.1919 (BRI 266129); *White 12163*, Long Island, 18.vii.1935 (BRI); *Young 11*, Maryborough, undated (BRI); *Young s.n.*, Grenville Cape, -.vii.1943 (BRI).

NEW SOUTH WALES: *R. Brown s.n. J.J. Bennett no. 2311*, Hunter River, Newcastle, 1802-1805 (BM, holotype!); *Henderson 80*, Richmond River, -.xi.1867 (MEL 98086, MEL 98138, MEL 98172); *Hoogland 8606*, near Vallery, c. 21 km SW Coffs Harbour, 28.x.1962 (A, BRI, CANB, K, L, NSW); *Jozer s.n.*, Hastings River, 1864 (MEL 98361); *Lean s.n.*, Kyogle, -.xii.1917 (NSW 145198); *C. Moore s.n.*, Tweed River, -.v.1867 (K); *C. Moore 205*, Clarence River, 1867 (MEL, NSW 145193); *Telford 2287*, 3.2 km from Elands towards Wingham, 25.xi.1970 (CBG); *Webb & Tracey s.n.*, Whian Whian, 1933 (BRI 037582).

PAPUA NEW GUINEA: *Eddowes & Kumul NGF 13126*, Brown River, c. 1.6 km from Forest Station, New Guinea, 29.iii.1966 (A, BO, BRI, CANB, K, L, LAE, SING); *Pullen 6619*, Rubulogo Creek, c. 29 km N Port Moresby, 7.iv.1967 (A, B, BO, BRI, BISH, CANB, E, G, K, L, LAE, P, PNH, SING, TNS, US); *Streimann & Kairo NGF 39398*, Palenkwa, Golden Pines, district Morobe, 24.iv.1969 (A, BISH, BO, BRI, CANB, K, L, NSW, PNH, SING, US).

Distribution and ecology (Map 6)

In Australia, *C. floribundum* var. *attenuatum* is known to occur in Northern Territory, Queensland and New South Wales. Distribution in all these states is chiefly in the high rainfall areas. In Northern Territory, this variety occurs in the far north-western parts around Darwin, and on Bathurst Island and Melville Island. Distribution in Queensland is scattered along the east coast from the tip of Cape York Peninsula to north-eastern tip of New South Wales. The major concentration, however, appears to be in the areas between Townsville and Proserpine, and from Maryborough up to the New South Wales border. A few off-shore collections have come from Capricorn Island Group and Frazer Island. The northern-most locality within Queensland is on Murray Island in the Torres Strait. In New South Wales, the distribution is in the north-eastern coastal area between the Queensland border and Hunter River near Newcastle. The best known localities, however, are in the north-eastern tip of the state, in the area called Macpherson-Macleay Overlap.

Collections from Papua New Guinea are the only ones examined from outside Australia.

Growing "on stony slopes" in usually poorly developed rainforest.

Comments

In view of the pubescent-tomentose inflorescence, several collections of this taxon have been identified by others as *C. tomentosum* (Vent.) R. Br. To some extent, the inflorescence of var. *attenuatum* has the aspect of *C. tomentosum*, but var. *attenuatum* differs in its leaf-blades, corolla and inner surface of calyx being glabrous. The inflorescence and leaf-blades in *C. tomentosa* are always much more densely tomentose, with hairs often perceptible to touch.

Generally more than one type specimen or their duplicates have been examined by Robert Brown for each *Clerodendrum* species described in his "Prodromus Florae Novae Hollandiae". In the case of var. *attenuatum*, however, which was also described by Robert Brown as *C. attenuatum*, only one type specimen (in Herb. BM) is available for examination. The type specimen was not in the type-folder but mixed with the general BM collections of *C. floribundum*. It has the annotation in Robert Brown's handwriting, and was possibly used

Map 6. Distribution of *C. floribundum* var. *attenuatum* ▲.

by him in preparing the protologue of *C. attenuatum.* The specimen is particularly complete and well preserved, and has been accepted here as the holotype of this taxon. If in the future any type duplicate is discovered, a lectotypification of this taxon would be needed.

A few collections from New South Wales were annotated by F. Mueller as "*C. tomentosum* var. *glabra*", but his varietal name was apparently never published.

In Dietrich's collection no. 2173, the young apical leaves and outer surface of corolla-lobes are somewhat puberulous like *C. tomentosum.* Nevertheless, the mature leaf-blades, the inner surface of calyx and the corolla-tube are throughout glabrous.

This taxon seems to be an intermediate form between *C. tomentosum* and *C. floribundum.* The majority of its characters, however, are similar to those of *C. floribundum.* For more detail see "affinities" under var. *attenuatum.*

Affinities

Of all varieties of *C. floribundum*, var. *attenuatum* is nearest to the typical variety as its leaf-blades are elliptic, cuneate towards base, acute at apex, glabrous; petiole pubescent; peduncles, pedicels and outside of calyces also pubescent. However, var. *attenuatum* may easily be distinguished by its mostly larger leaf-blades measuring up to 175 by 100 mm; inflorescence being more densely pubescent-tomentose, and the flowers are much more congested than in var. *floribundum.* There are several characters in common between var. *attenuatum* and *C. tomentosum.* Both taxa have a densely pubescent-tomentose inflorescence, congested flowers, pubescent petioles and pedicels and also a densely pubescent outer surface of the calyx. *C. tomentosum* can, however, be easily identified by its always densely tomentose leaf-blades, the densely pubescent-tomentose outer surface of the corolla and densely tomentose inner surface of the calyx-lobes.

4c. var. **coriaceum** (R. Br.) Mold., Phytologia 39 (1978) 236; Sixth Summary Verbenac. etc. (1980) 334, 391; in Dassan. & Fosb., Fl. Ceylon 4 (1983) 457.

Lectotype: *R. Brown s.n., J.J. Bennett no. 2316*, North Coast Islands, Australia, 1802-1805 (BM, lectotype designated here; BM, K — isolectotypes!); *J. Banks & D. Solander s.n.*, Endeavour River, Queensland, 1770 (BM, 2 syntypes!).

C. coriaceum R. Br., Prodr. Fl. Nov. Holl. (1810) 511; Sprengel, Syst. Veg. 2 (1825) 759; Walp., Rep. Bot. Syst. 4 (1845) 105; Schauer in A. DC., Prodr. 11 (1847) 671; Benth., Fl. Aust. 5 (1870) 64, p.p. excl. descr. "pubescent leaves"; Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Buitenzorg, Ser. III, 3 (1921) 95, as syn. of *C. ovalifolium* (Juss.) Bakh.; Mold., Résumé Verbenac. etc. (1959) 272, pro syn.; Fifth Summary Verbenac. etc. 1 (1971) 442, pro syn.

Type: As for above.

C. cardiophyllum F. Muell., Fragm. 3 (1863) 144; Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Ser. 3, 3 (1921) 95, p.p., pro syn. *C. ovalifolium* (A. Juss.) Bakh.

Type: *J. Macd. Stuart s.n.*, in virgultis Acaciae aneurae (Mulga scrub) Australiae Centralis, 1860 (MEL 98182, syntype!); *F. Waterhouse s.n.*, ad paludes Daly Waters, N.T., undated (MEL 98183, syntype!).

C. floribundum auct non R. Br.: Ewart & Davies, Fl. N. Territory (1917) 238, p.p., quoad spec. *G.F. Hill 88 & 91* from Finke River, Northern Territory.

C. album Ridley ex Mold., known Geogr. Distrib. Verbenac. edn 1 (1942) 69 & 89, nom. nud.

Typification

C. floribundum var. *coriaceum* is based on two different collections from the northern parts of Australia. Of these, one by Robert Brown (s.n., J.J. Bennett no. 2316) from "North Coast Islands" comprises at least 3 duplicates, and another by Joseph Banks & Daniel Solander (s.n.) from Endeavour River, Queensland, has at least 2 duplicates. Apparently, the duplicates of these collections were seen by Robert Brown and possibly used by him in preparing the original diagnosis of this taxon. Since he did not select one specimen as a type, it is, therefore, necessary to choose a lectotype for this name. Of all the syntypes, a duplicate of Robert Brown's above collection (s.n., J.J. Bennett no. 2316) in Herb. BM is particularly complete and well preserved and is chosen here as the lectotype of this taxon.

Diagnosis

Var. *coriaceum* is distinguished from other taxa of this species in its leaf-blades being cordate, ovate-cordate or almost truncate at the base, coriaceous, glabrous, generally larger than any other variety measuring (40-) 50-150 (-180) by (25-) 40-90 (-140) mm, and the inflorescence somewhat lax and glabrous.

Description (Fig. 6)

A shrub or small tree, 1-6 m high. *Stem* glabrous, bark yellowish-grey, corky and deeply fissured. *Leaves* cordate, ovate-cordate or almost truncate at base, sometimes almost orbicular, coriaceous, glabrous, (40-) 50-150 (-180) mm long, (25-) 40-90 (-140) mm wide, entire, subacute or obtuse; petioles glabrous, (25-) 35-70 (-90) mm long. *Inflorescence* lax, glabrous; peduncles glabrous, 30-75 (-90) mm long. *Flowers* lax; pedicels glabrous, (4-) 5-15 (-20) mm long. *Calyx* deeply lobed, glabrous, glandular on inner surface, 4-10 mm long; lobes lanceolate, acute, often slightly longer than tube. *Corolla* cream-white, 25-45 mm long, glabrous. *Stamens* exserted, white, glabrous. *Ovary* glabrous; style exserted, white, glabrous. *Fruit* globose-obovoid, 5-10 mm long, narrowing towards base, glabrous, purple-black when ripe; fruiting calyx purple-red, 10-20 mm diam.

Representative specimens (Collections seen: Australian 157, non-Australian 21)

AUSTRALIA: WESTERN AUSTRALIA: *Donnell s.n.*, near the Ord River, 1886 (MEL 98121); *George 15422*, Djaluwon Creek, near S end of Lake Gregory, 26.iv.1979 (CANB, K, NT, PERTH); *N. Johnson 33*, near Kununurra, 13.ii.1977 (PERTH); *Lullfitz L6087*, Broome, north-west, 20.v.1968 (PERTH); *Wilson s.n.*, Careening Bay, S Coronation Island, 25.v.1972 (PERTH).

NORTHERN TERRITORY: *Adams 868*, c. 8 km NW Katherine, 6.ii.1964 (BRI, CANB, K, L, NSW, NT); *Angeles s.n.*, Banjo Jungle, Melville Island, 17.iii.1977 (DNA); *Bake s.n.*, Darwin, 22.vi.1943 (BRI 265752-3); *Byrnes 2455*, South Alligator Uranium Mine, 5.i.1972 (CANB, DNA, K, L, NT); *Chippendale 4572*, Docker Creek, 13.vi.1958 (AD, BRI, L, NT, PERTH); *Chippendale 5687*, 93 km NE Tanami, 12.iv.1959 (AD, BRI, CANB, L, MEL, NT); *Cleland s.n.*, Pine Hill, 11.viii.1936 (AD); *Dunlop 2961*, Gulf of Carpentaria, Maria Island, 12.vii.1972 (NT); *Forde 84*, Benstead Creek, c. 51 km ENE Alice Springs, 11.ii.1956 (AD, BRI, CANB, MEL, NT, PERTH); *Fox 2569*, Little Nourlangie Rock, 25.ii.1977 (BRI, CANB, DNA, NT); *Gardner 11603*, Narwietooma, 11.iii.1953 (MEL, NT, PERTH); Henry 18, c. 35 km NNE New Tanumbirini Homestead, 3.vi.1971 (NT); *Ising s.n.*, Macdonald Station, 25.vii.1936 (AD); *Johnson 74*, 9.6 km NE of Coles Hill, 21.x.1956 (AD, NT); *Lazarides 7972*, c. 21 km E El Sharana Mine, 3.iii.1973 (B, BRI, CANB, L, NT, PERTH); *Lothian 277*, Bank of Derwent Creek, 155 km WNW Alice Springs, 1954 (AD); *Maconochie 115*, Entire Creek, 13.iv.1967 (AD, BRI, MEL, NT); Maconochie 1124, c. 21 km NE Top Springs, 19.v.1971 (AD, CANB, CBG, NT, PERTH); *Martensz AE685*, c. 2.5 km SW Cannon Hill, 2.ii.1973 (BRI, CANB, DNA, NT); *Nicholls 506*, Todd River, Mosquito-Barstard bore crossing, 31.iii.1967 (NT); *Parker 666*, 2 km W South Alligator River, 18.vii.1975 (MO, NT); *Perry 652*, c. 27 km NE Tennant Creek, 28.iv.1948 (BRI, CANB); *Perry 3436*, c. 27 km NW Ooratippra Station, 14.iii.1953 (BRI, CANB, NT, PERTH); *Rankin 1911*, Native Gap, 12.iv.1979 (CANB, DNA, NSW); *Tate 16*, Adelaide River, 1882 (MEL 98140); *Webb & Tracey 12252A*, NE Coast of Van Diemen, Melville Island, -.v.1978 (BRI); *S.A. White s.n.*, Hermannsburg, undated (AD); *Winkworth 322*, 38.5 km WNW Haasts Bluff, 9.vi.1954 (BRI, CANB, NT, PERTH).

QUEENSLAND: *Altena c.28*, Bruce Highway S Cardwell near Waterfall Creek, 21.iii.1976 (QRS); *Armit 317*, South Barnard Island, undated (MEL); *Bancroft s.n.*, Palm Island, undated (BRI); *Blake 17944*, Barkly Downs Station, 27.v.1947 (BRI, CANB); *Carolin 8731*, 1.6 km S Karumba, 19.iv.1974 (SYD); *Domin 8145*, Harveys Creek, -.xii.1909 (PR); *Everist 7365*, 80 km W Yaraka, 1.viii.1963 (BRI, LE); *Fitzalan s.n.*, Port Denison, undated (MEL 98180, MEL 98181, MEL 98184); *MacGillivray s.n.*, Lizard Island, -.viii.1848 (K); *MacGillivray s.n.*, Gregory River near Gregory Downs, -.viii.1928 (BRI); *McKee 9449*, S Tinaroo Creek road, 22.5 km from Mareeba, 1.v.1962 (BRI, CANB); *F. Mueller s.n.*, Rockhampton, undated (MEL 98484); *Ollerenshaw 1069 & Kratzing s.n.*, 3 km N Reid River, 30.vii.1974 (BRI, CBG, NT); *Persieh s.n.*, Endeavour River, 1883 (MEL 98495); *Persietz s.n.*, Cooktown, 1877 (MEL 98434); *Scarth-Johnson 85A*, Walker's Creek near Normanton, -.v.1976 (BRI); *Smith 4291*, Mt Woodhouse,

c. 40 km SW Ayer, 19.vi.1949 (BRI, L); *Tindale & Aitken s.n.*, Bentinck Island, Gulf of Carpentaria, 29.v.-18.vi.1963 (AD); *Webb & Tracey 8340*, Claudie River, -.x.1968 (BRI); *Wrigley & Telford 98*, White Cliff Point, N Cairns, 28.v.1972 (CBG).

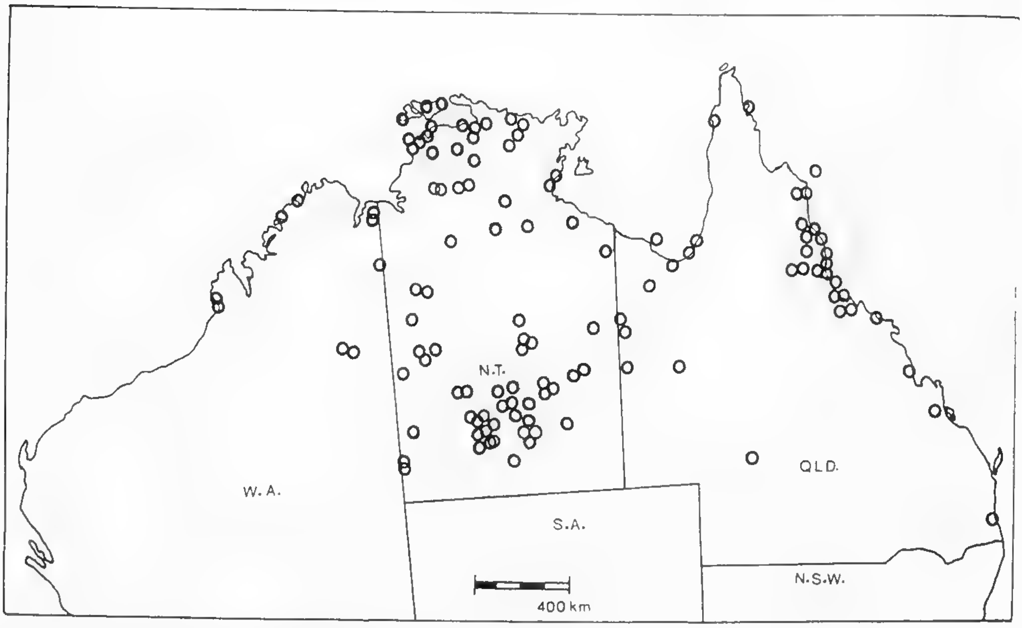
PAPUA NEW GUINEA: *Armit s.n.*, British New Guinea, 1895 (MEL 98546); *Chalmers s.n.*, near Port Moresby, 1878 (MEL 98593); *Darbyshire 646*, c. 13 km W Kanosia Plantation, Papua, 12.vii.1962 (A, BO, BRI, K, L, LAE, US); *Gray NGF 12906A*, Boroko, Central District, Papua, 13.ii.1962 (BRI, CANB, L, LAE); *Pullen 3529*, S of Rogers Airstrip, 17.viii.1962 (CANB, LAE); *Schodde 2648*, near SW base of Mt Lawes, Central District, Papua, 26.vii.1962 (A, CANB, L, LAE).

Distribution and ecology (Map 7)

In Australia, *C. floribundum* var. *coriaceum* is known to occur in Western Australia, Northern Territory and Queensland. The distribution in Western Australia is chiefly in the Kimberley region except for one record each from near Roebuck Bay and near Lake Gregory. In the Northern Territory, this variety is widely distributed throughout the State, ranging from the northern wet tropics of Arnhem Land to the southern dry parts bordering South Australia. It is known to occur in all major areas of the Northern Territory excepting the interior of the Tanami Desert and the Simpson Desert. From off-shore parts of the State, it has been recorded from Melville Island and Bathurst Island.

In Queensland, var. *coriaceum* is known to occur chiefly in the areas along the east coast, southern coastal area of the Gulf of Carpentaria and in the western part of the State bordering Northern Territory. Along the east coast, the northern-most locality is near Iron Range in the Cape York Peninsula and the southern-most near Brisbane. The major distribution, however, is in the area between Cooktown and Rockhampton. From off-shore islands, this variety has been reported from Bentinck Island in the Gulf of Carpentaria, and from Lizard Island, Palm Island and the Fisherman Islands along the east coast. So far, it has not been recorded from the southern part of the State, and the distribution in the mid-interior areas is scarce.

Collections from Papua New Guinea are the only ones examined from outside Australia.



Map 7. Distribution of *C. floribundum* var. *coriaceum* O.

Growing on a wide range of substrates but often recorded from "sandy soils" sometimes with "limestone outcrops". Often recorded from "banks of watercourses" but usually in "savannah" or "woodland". Several collections are known from "rocky hillside in pockets of soils" and from "sandstone boulders close to escarpment".

Comments

After examining the types of *C. coriaceum* R. Br. and *C. ovatum* R. Br., it appears that the characters erroneously mentioned by Bentham (1870, p. 64) under *C. ovatum* are, in fact, those of *C. coriaceum*, and those noted under *C. coriaceum* are of *C. ovatum*. Bentham (1870) admitted that he "did not see flowers, and without the corolla there appears to be no positive character to distinguish". In his opinion, "*C. ovatum* and *C. coriaceum* are both much like the garden specimens figured by Ventenat as *Volkameria tomentosa*". In fact *C. ovatum* and *C. coriaceum* are so close to each other that sometimes it was rather difficult to distinguish the intermediate forms from one or the other. In the present studies, therefore, *C. ovatum* and *C. coriaceum* are treated as two varieties of *C. floribundum* R. Br. According to the present circumscription of this species, both var. *coriaceum* and var. *ovatum* are very distinct from *Clerodendrum tomentosum*. The pubescent-tomentose syntypes of *C. ovatum*, however, are being treated here as belonging to *C. tomentosum* (Vent.) R. Br. (=*Volkameria tomentosa* Vent.).

In the protologue of *C. coriaceum* the leaves are described as having tomentose petioles. This character has not been found in the type specimens nor in any other collection referred to this taxon.

Moldenke (1980) regarded this taxon endemic to Queensland. During present investigation, however, it has been recorded from Western Australia, Northern Territory and Queensland. Moreover, several new collections have been examined from Papua New Guinea as well.

Galled flowers are commonly found in var. *coriaceum*.

Affinities

Amongst the infraspecific taxa of *C. floribundum*, var. *coriaceum* is nearest to var. *ovatum* in its petioles, peduncles, pedicels and calyces being glabrous, and inflorescence fairly lax. Nevertheless, var. *coriaceum* may readily be indentified by its leaf-blades being cordate, ovate-cordate or almost truncate at the base, and distinctly coriaceous in texture. The leaf-blades in var. *ovatum* are ovate with generally rounded base and chartaceous to sub-coriaceous in texture.

4d. var. **ovatum** (R. Br.) Domin, Biblioth. Bot. 89 (1928) 1112.

Lectotype: *R. Brown s.n. (J.J. Bennett no. 2317)*, North Coast, Gulf of Carpentaria, South Wellesley Islands, Queensland, 18.xi.-4.xii.1802 (BM, lectotype designated here!; BM, LE 2 sheets, MEL 98119 — isolectotypes!).

C. ovatum R. Br., Prodr. Fl. Nov. Holl. (1810) 511, excl. descr. "B. Folia calycesque pubescentes" & syntype *R. Brown s.n., J.J. Bennett no. 2315*, Allen Island, Gulf of Carpentaria, Qld; Sprengel, Syst. Veg. 2 (1825) 758, p.p. excl. syn. *Ovieda ovalifolia* A. Juss. & loc. Coromandel; Walp., Rep. Bot. Syst. 4 (1845) 105, p.p. excl. descr. "B. Folia Calycesque pubescentes"; Schauer in A. DC., Prodr. 11 (1847) 671, p.p., excl. descr. "B. Folia Calycesque pubescentes"; Benth., Fl. Aust. 5 (1870) 64, p.p., excl. syn. *C. cardiophyllum* F. Muell.; Bailey, Qld Fl. 4 (1901) 1184, p.p., excl. syn. *C. cardiophyllum* F. Muell.

Type: As for above.

C. floribundum auct. non R. Br.: F. Muell., Fragm. 6 (1868) 152, p.p., quoad syn. *C. ovatum* R. Br.; Benth., Fl. Aust. 5 (1870) 63, p.p., quoad descr. & spec. *Banks & Solander s.n.*, *Dallachy s.n.*, *Fitzalon s.n.* and *F. Mueller s.n.*; Ewart &

O.B. Davies, Fl. N. Territory (1917) 238, p.p., quoad spec. *Henne s.n.*; Domin, Biblioth. Bot. 89 (1928) 1112, p.p., quoad syn. *C. ovatum* R. Br.; Mold., Résumé Verbenac. (1959) 273, p.p., quoad syn. *C. ovatum* R. Br.; Fifth Summary Verbenac. etc. 1 (1971) 452, 464, p.p., quoad syn. *C. ovatum* R. Br.; R.J. Hend. in Carr (ed.), Sydney Parkinson Artist in Cook's Endeav. Voy. (1983)167, t. 160; Elliot & Jones, Encycl. Austr. Pl. 3 (1984) 49 & t.; Stanley in Stanley & Ross Fl. SE Qld 2 (1986) 370, p.p., quoad descr.

C. floribundum R. Br. var. *latifolium* F. Muell., Fragm. 9 (1875) 5, nom. nud.; Domin, Biblioth. Bot. 89 (1928) 1112; Mold., Phytologia Mem. II, Sixth Summary Verbenac. etc. (1980) 334, 385, 388, 424.

C. ovalifolium auct. non (A.L. Juss.) Bakh.: Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Buitenzorg, Ser. III, 3 (1921) 95, p.p., quoad syn. *C. ovatum* R. Br.; C. Gardner, Enum. Pl. Aust. Occ. III (1931) 112; Beard, Descrip. Cat. W. Aust. Pl. (1965) 91; ibid 2 nd edn (1970) 113; J. Green, Cens. Vasc. Pl. W.Aust. (1981) 89; Lassak & McCarthy, Aust. Medic. Pl. (1983) 31.

Oviedea ovalifolia auct. non. A.L. Juss.: Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Ser. 3, 3 (1921) 95. (See comments).

C. populneum E. Beer & H.J. Lam, Blumea 2 (1936) 224, fig. 2, **syn. nov.**; Mold., Résumé Verbenac. etc. (1959) 200; Phytologia 31 (1975) 391; Fifth Summary Verbenac. etc. 1 (1971)335, 453; Phytologia Mem. II, Sixth Summary Verbenac. etc. (1980) 325, 335.

Type: *L.J. Brass 3781*, Baroka, Central Division, Papua New Guinea, April, 1933 (L, holotype!; NY, isotype).

Typification

C. floribundum var. *ovatum* is based on Robert Brown's three different collections from the Islands of the Gulf of Carpentaria. Since the author did not select any one specimen of these collections as a type, it is necessary to choose a lectotype for this name. Out of three collections, the one (with J.J. Bennett no. 2315) bearing pubescent-tomentose leaves and inflorescence, is found to belong to *C. tomentosum* (Vent.) R. Br., and is, therefore, excluded from *C. floribundum* and *C. ovatum*. Of the remaining two collections, one with J.J. Bennett no. 2317 has at least 5 duplicates and the other with no. 2316 only one. A duplicate of J.J. Bennett no. 2317 in Herb. BM is particularly complete and well preserved and therefore selected here as the lectotype for this taxon.

Diagnosis

Var. *ovatum* is distinct from other taxa of *C. floribundum* in its leaf-blades being ovate, rounded or broadly cuneate at the base, chartaceous or subcoriaceous. Similar to var. *coriaceum*, this variety is also glabrous with lax inflorescence, but the shape and texture of leaves easily distinguish it from that taxon.

Description (Fig 6)

A shrub or small tree, 1-5 m tall. *Stem* with a longitudinally fissured yellowish-grey corky bark, glabrous. *Leaves* ovate, rounded or somewhat broadly cuneate at base, chartaceous or subcoriaceous, glabrous, (30-) 50-130 (-175) mm long, (20-) 35-90 (-110) mm broad, entire, obtuse or subacute; petiole glabrous, (20-) 30-50 (-72) mm long. *Inflorescence* lax, glabrous; peduncles glabrous, (15-) 25-50 (-90) mm long. *Flowers* lax; pedicels glabrous, 3-10 mm long. *Calyx* reddish, deeply lobed, glabrous, glandular on inner surface, 5-9 mm long, red and accrescent in fruit; lobes narrow lanceolate, acute, longer than tube. *Corolla* white or cream-white, glabrous, 25-45 mm long. *Stamens* exserted, white, glabrous. *Ovary* glabrous; style exserted, glabrous, white. *Fruit* obovoid or somewhat globose, 5-10 mm long, 5-8 mm diam. at top, glabrous, glossy, blue-black or purple-black; fruiting calyx red, 10-25 mm diam.

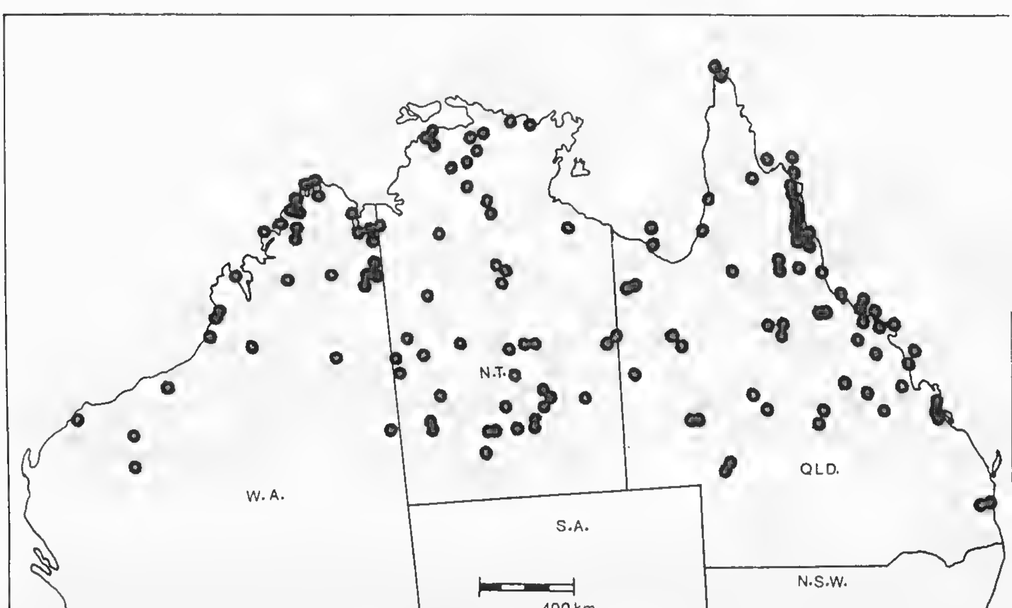
Representative specimens (Collections seen: Australian 221, non-Australian 4)

AUSTRALIA: WESTERN AUSTRALIA: *Beard 4898*, between Carey Junction and Sandy Blight Junction, 26.vii.1967 (King's Park Perth, PERTH); *Beard 8261*, Bougainville, on plateau of NW Kimberley, 10.ix.1978 (PERTH); *Bradshaw & Allen s.n.*, Prince Regent River, 1891 (MEL 98130); *Crawford 87*, Kalumburu, 11.i.1974

(PERTH); *Gardner 7381*, Thompson Spring, Argyle Downs, Ord River, 9.vi.1944 (PERTH); *George 14673*, McLarty Hills, Great Sandy Desert, 6.viii.1977 (CANB, K, PERTH); *Hartley 14436*, base of Northern Carr Boyd Ranges bordering the Ord River, 10.iii.1978 (CANB, L, NT, PERTH); *Kenneally 5152*, Camp Creek South, Mitchell Plateau, 19.vi.1976 (CANB, PERTH); *Lazarides 5114*, 16 km SE Tableland Station, 18.iv.1955 (BRI, CANB, NT); *Pullen 10689*, Kununurra-Lake Argyle road, near Spillway Creek, 11.iv.1977 (CANB, LE, PERTH); *Forbes 2638*, Bungle Bungle massif, Piccaninny Creek V bend, 14.7 km more or less SSE (147°) Bungle Bungle Outcamp, 12.vii.1984 (AD, MEL); *Symon 10119*, 30 km SW Thangoo turnoff, 21.v.1975 (AD, PERTH); *Wilson 11376*, Boongaree Island, Prince Fredrick Harbour, 5.vii.1973 (PERTH).

NORTHERN TERRITORY: *Adams 868*, 8 km NW Katherine, 6.ii.1964 (BRI, CANB, K, L, NSW, NT); *Butler 34*, Ehrenberg Range, 96.5 km of Sandy Blight Junction, -.v.1967 (PERTH); *Byrnes 199*, 145 km S Katherine, 29.ii.1967 (L, NT, PERTH); *Chippendale 1133*, 24 km E Tarlton Downs Homestead, 9.v.1955 (AD, CANB, NT); *Dunlop 3394*, Nourlangie Creek, 28.ii.1973 (CANB, DNA, NSW, NT); *Fox 2509*, Deaf Adder Gorge, 21.ii.1977 (CBG, MO, NE); *Henry 316*, Gardens Station, 7.i.1972 (CANB,.CBG, NT); *Latz 6004*, Newcastle Waters Stn., 30.v.1975 (AD, BM, CBG, NT); *Lazarides & Adam 180*, near Plum Tree Creek, c. 75 km ENE Pine Creek Township, 11.iii.1965 (B, CANB, E, K, L, NT, US); *Maconochie 572*, 32 km S Larrimah, 18.ii.1968 (K, NT, NY, TEX); *F. Mueller s.n.*, Upper Victoria River, -.xii.1855 (MEL 98099, MEL 98150); *Parker 150*, The Devils Marbles, 21.iv.1970 (AD, MEL, NT); *Schwarz s.n.*, Macdonell Ranges, 1889 (MEL 98401); *Strong s.n.*, Bullock Head Waterhole, Georgina River, 31.viii.1984 (AD, NT); *Winkworth 428*, Vaughan Springs, 4.vii.1954 (CANB, NT).

QUEENSLAND: *Bailey s.n.*, Bentinck Island, -.vi.1901 (BRI); *Banks & Solander s.n.*, Endeavour River, 1770 (NSW 145168); *Blake 23309*, Cooktown, mouth of Endeavour River, 16.v.1970 (BRI, MEL); *Brass 422*, Gilbert River, -.iv.1925 (BRI, CANB); *Robert Brown s.n. (J.J. Bennett no. 2317)*, North coast, Gulf of Carpentaria, South Wellesley Island, 18.xi.-4.xii.1802 (BM, lectotype, BM, LE, MEL, isolectotypes); *Dallachy s.n.*, Rockinghams Bay, 3.v.1867 (MEL 98146, MEL 98160, MEL 98162, MEL 98163, MEL 98170); *Everist 7386*, c. 25 km W Windorah, 1.viii.1963 (BRI, K); *Fitzalan s.n.*, Port Denison, undated (MEL 98097, MEL 98141, MEL 98142, MEL 98149, MEL 98151, MEL 98161, MEL 98167); *Heatwole 93*, Lizard Isl., Great Barrier Reef, 1.x.1967 (BRI); *Henne s.n.*, Whitsunday Island, undated (MEL 98169); *Macgillivray 90*, Sandy Cape & Bowen Port, undated (BM, CANB); *Macpherson 759*, Proserpine, -.iv.1935 (AD, BRI); *Perry 1100*, 35.5 km N Lawn Hill Station, 31.v.1948 (AD, BRI, CANB, NT, PERTH); *Scarth-Johnson 507*, Cloncurry, 27.viii.1970 (K); *Simmons s.n.*, Rockhampton, 1903 (NSW 145179); *Sutherland 81*, Flinders Island, 8.x.1883 (MEL); *Telford 1942*, Bowen, Horseshoe Bay, 23.v.1970 (CBG); *Webb & Tracey 5543*, c. 2 km S Chewko turnoff on Mareeba-Atherton Rd, 17.i.1962 (BRI); *Webb & Tracey 7129*, Galloway Creek, Bamaga, at tip of Cape York Peninsula, 1962 (BRI); *Williams 80061*, Road between Valley of Lagoons and Ingham via Douglas Creek and Mt. Fox, 10 km W Douglas Creek, 15.iv.1980 (BRI).



Map 8. Distribution of *C. floribundum* var. *ovatum* ●.

PAPUA NEW GUINEA: *Armit s.n.*, Arora River, 1884 (MEL 98105); *Bell 65*, Bootless Inlet, Central District, Papua, 15.iv.1965 (MEL); *Poole 437*, Port Moresby, -.iv.1922 (BRI); *Pullen 6936*, Tavai Creek area, c. 69 km SE Port Moresby, 7.v.1967 (CANB, L, LAE).

Distribution and ecology (Map 8)

In Australia, *C. floribundum* var. *ovatum* is known to occur in Western Australia, Northern Territory and Queensland. Distribution in Western Australia is chiefly in the Kimberley region, with a few disjunct localities near Broome and Dampier along the Northern and North West Coastal Highways. Further inland, it has been reported from near the sources of the Fortescue River and in the area adjacent to Northern Territory. In the Northern Territory, this variety is widespread all over the state. The major known occurrences, however, are in Arnhem Land, MacDonnell Ranges and along the Stuart Highway. A few scattered localities are also in the areas along the borders of Western Australia, Northern Territory and Queensland. In Queensland, var. *ovatum* is widely distributed deep inland and along the east coast. The overall occurrence is chiefly to the north of 24°S, though a few collections from further south have been reported from Windorah and north of Brisbane. It has been recorded from several off-shore Islands along the east coast and near the Great Barrier Reef. The most northern localities of this variety are at the tip of Cape York Peninsula, and on Horn Island in the Torres Strait. It has also been recorded from near Mitchell River and Gilbert River along the west coast of Cape York Peninsula. In the Gulf of Carpentaria, this variety has been recorded from Wellesley Islands.

Collections from Papua New Guinea are the only ones examined from outside Australia.

Recorded from a wide range of habitats ranging from "course red sandy soil" to "heavy soil" from near-desert conditions with spinifex to "vineforest or "rainforest"

Comments

Bakhuizen (1921) recorded *C. floribundum* R. Br., *C. ovatum* R. Br., *C. medium* R. Br. and *C. attenuatum* R. Br. as doubtful synonyms under *C. ovalifolium* (A. Juss.) Bakh. which was based on *Ovieda ovalifolia* A. Juss. According to the protologue, the type of *Ovieda ovalifolia* came from Pondicherry along the Coromandel Coast of southern India where *C. floribundum does not occur. Since the type of Ovieda ovalifolia* has not been seen, the precise identity of this species is not known. However, it is certain from the distribution pattern that *C. floribundum* does not occur in India. It is most likely, therefore, that *Ovieda ovalifolia* and *C. floribundum* are not conspecific. According to Moldenke (1959, 1971, 1980) and the present investigations, *C. floribundum* is found only in Australia and Papua New Guinea.

Sydney Parkinson's illustration (Plate 160) of *C. floribundum*, prepared during Cook's Endeavour Voyage in 1770, should be identified as *C. floribundum* var. *ovatum* (R. Br.) Domin. According to Henderson (1983), "Parkinson's sketch was prepared from one of the 14 or 15 new plants Banks and Solander hastily collected on Palm Island just on dusk on 7 June 1770. Judging from their specimens at the British Museum (Natural History) they had also collected the species at Thirsty Sound and were to collect it again at Cape Grafton and Endeavour River. In writing it up in his manuscript Solander associated the plant with *Volkameria*, a genus now considered to belong to *Clerodendrum*. The large numbers of insects often associated with the showy flower-heads must have been what prompted him to propose *V. insectorum* for the species. Brown, however, chose to highlight the floriferous nature of the species".

Moldenke (1975) for the first time reported *C. populneum* E. Beer & H.J. Lam from Northern Territory, Australia. The examination of its type has revealed that this species is conspecific with *C. floribundum* and has, therefore, been placed in the synonymy of the latter. In 1980, Moldenke recorded *C. floribundum* var. *ovatum* as a synonym of *C. floribundum* var. *latifolium* F. Muell. which being nomen nudum is an invalid (varietal) name.

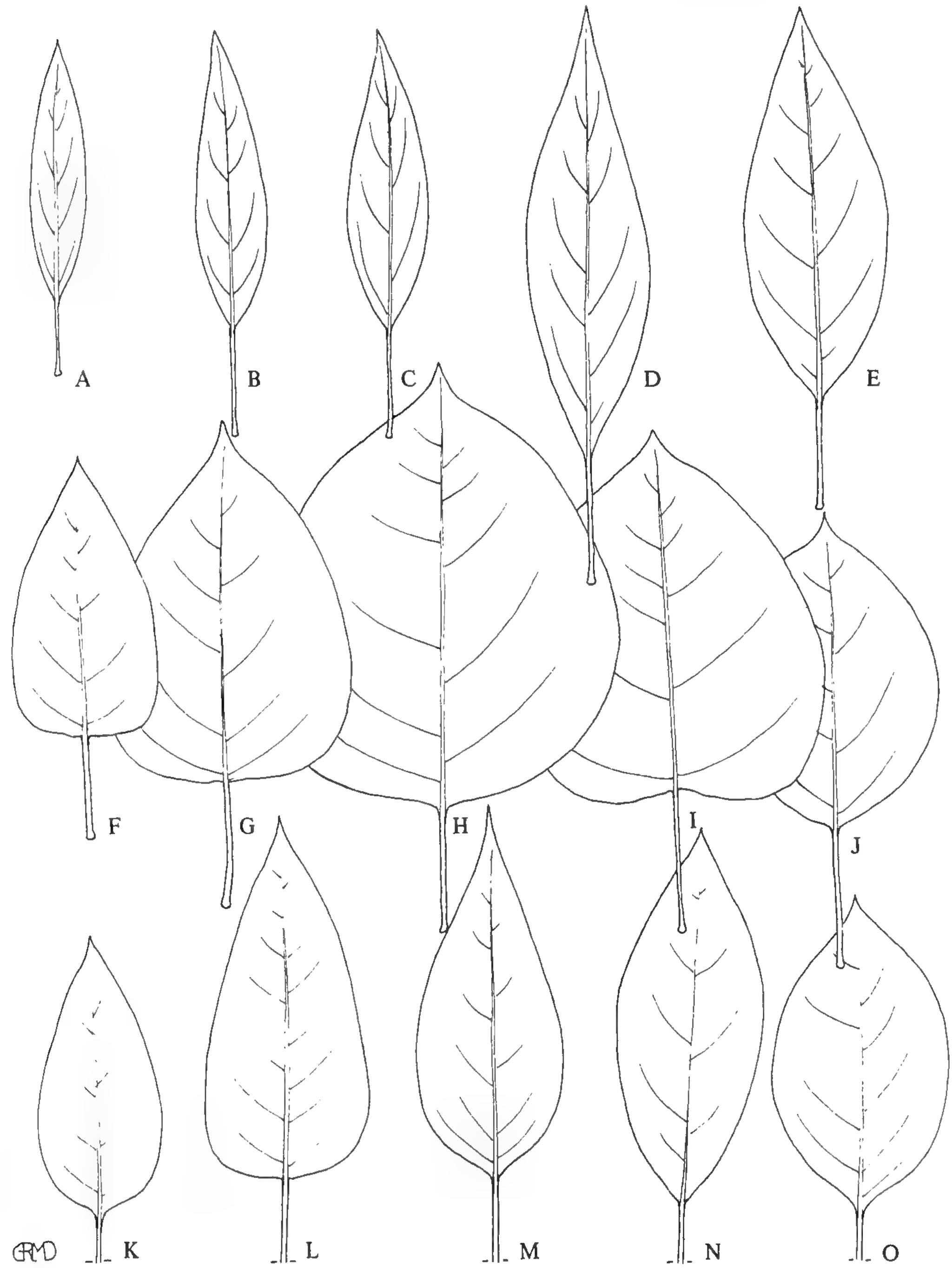


Fig. 6. Range of variation in leaf form of *Clerodendrum floribundum* R. Br. (A-E, var. *angustifolium* Mold.; F-J, var. *coriaceum* (R. Br.) Mold.; K-O, var. *ovatum* (R. Br.) Domin). A, *S.T. Blake 23495*: BRI; B, *R. Pullen 10928*: PERTH; C, *A. Dietrich 1986*: AD; D, *L.A. Craven 3165*: CANB; E, *E.M. Jackes s.n.*: JCT/S-7074; F, *M. Lazarides 7972*: CANB; G, *L.G. Adams 868*: CANB; H, *P. Martensz AE540*: BRI; I, *R. Pullen 3594*: CANB; J, *T.B. Croat 52469*: MO; K, *R. Brown s.n., J.J. Bennett no. 2317*: BM, type of var. *ovatum*; L, *M. Lazarides 868*: L; M, *L.A. Craven 3892*: CANB; N, *E. Fitzalan s.n.*: MEL 98097; O, *K. Macpherson 759*: BRI.

Due to lax disposition of leaves, a few herbarium specimens have been identified by F. Mueller as "*C. sparcifolium*". This name, however, was never published by F. Mueller.

One of D.E. Symon's collection (no. 10119) from Western Australia has puberulous petioles and pedicels, but the shape and texture of leaf-blades and semi-lax appearance of inflorescence is similar to that of var. *ovatum.*

In Telford's collection (no. 1942) from Queensland, the leaf-blades are somewhat cuneate towards the base and calyx and corolla are mostly 6-lobed. This abnormality has not been found in any other collection of this species.

Of all the infraspecific taxa of *C. floribundum*, the var. *ovatum* seems to be the most widespread variety of this species.

Affinities

Var. *ovatum* is nearest to var. *coriaceum.* For similarities and differences see "affinities" under the latter taxon. There are a few characters common between var. *ovatum* and var. *angustifolium.* The latter, however, can easily be distinguished by its leaf-blades being lanceolate or narrowly elliptic-lanceolate, long cuneate towards the base and generally 15-30 mm wide at mid-point.

4e. var. **angustifolium** Mold., Phytologia 37 (1977) 22; Sixth Summary Verbenac. etc. (1980) 334; in Dassan. & Fosb., Fl. Ceylon 4 (1983) 456, 457.

Type: *C.T. White 8675*, Torrens Creek, North Queensland, Australia, 19.iii.1933 (NY, holotype!; BRI, G, NY — isotypes).

Diagnosis

Var. *angustifolium* differs from the typical variety by its petiole, peduncle and calyx being glabrous; leaf-blades narrow-lanceolate or very narrowly elliptic-lanceolate and long-cuneate towards the base.

Description (Fig. 6)

A shrub or small tree, (1-) 2-6 (-7) m high. *Stem* with rough to flaky bark often slightly fissured. *Leaves* glabrous; leaf-blades narrow-lanceolate or very narrowly elliptic-lanceolate, acute, long cuneate towards base, punctate on lower surface, (30-) 50-100 (-150) mm long, (10-) 15-30 (-45) mm wide; petioles (10-) 15-30 (-40) mm long, glabrous. *Inflorescence* more or less lax, glabrous; primary lateral peduncles (10-) 15-40 (-50) mm long, glabrous. *Flowers* white, lax; pedicels glabrous, 2-6 (-10) mm long. *Calyx* deeply lobed, glabrous all over, glandular on inner surface, 5-6.5 mm long; lobes acute, 3-4 mm long; tube 2-3 mm deep. *Corolla* creamy-white, glabrous, 25-45 mm long; tube cylindrical, 20-35 mm long, 1-2 mm diam. *Stamens* white, much exserted, glabrous. *Ovary* glabrous; style exserted, white, 35-65 mm long. *Fruit* obovoid or obovoid-globose, glabrous, glossy, purple-black or blue-black, 7-10 mm long, 5-8 mm diam. at top; fruiting calyx red or purplish-red, 10-18 mm diam.

Representative specimens (Collections seen: Australian 115, non-Australian 0)

AUSTRALIA: QUEENSLAND: *Armit 525 & 588*, Gilbert River, undated (MEL); *Auldist 12*, Roundstone Creek, c. 21 km W Moura on levee near creek, 9.vi.1969 (BRI); *Bancroft 118*, Stannary Hills, -.xii.1908 (BRI); *Batianoff & McDonald 352*, Farnborough Beech, 17.vii.1977 (BRI); *Birch s.n.*, sources of Thomson River, 1871 (MEL 98425); *Blake 23495*, Cooktown, Point Saunders, 23.v.1970 (CANB, L, MEL, PERTH); *Boorman s.n.*, Rockhampton, -.viii.1982 (NSW 145176); *Bowman s.n.*, Cape River, undated (MEL 98092, MEL 98147); *Briggs 1156*, 14.48 km SE Blackall, 14.viii.1967 (NSW); *Clemens s.n.*, Spring Vale, -.iv.1946 (BRI 004783, BRI 265764); *Craven 3165*, c. 15 km from Collinsville on Bowen Road, 6.iv.1975 (BRI, CANB); *Dallachy 424*, Rockhampton, 10.iii.1863 (MEL 532417);

Fitzalan s.n., Port Denison, undated (MEL 98087, MEL 98093, MEL 98153); *Fitzalan s.n.*, Mt Elliot, undated (MEL 98476); *Gittins 480*, Mt. Douglas, -.v.1962 (AD, BRI); *Godwin C1365*, Featherbed Range, 2.v.1980 (BRI); *Gray 1693*, Walsh River, 11 km toward Wrotham Park from Mungana, 9.v.1980 (AD, QRS); *R.W. Johnson 3091*, Budgerygar, 11.xi.1975 (BRI); *S. Johnson s.n.*, Ravenswood, Burdekin River, 1887 (MEL 98398); *Moriarty 1358*, Rockhampton-Duaringa Road, 4.viii.1973 (BRI); *Paijmans 3512*, mouth of Barratta Creek, lower Burdekin Valley, 6.vi.1980 (CANB); *Perry 3586*, 26 km ENE Torrens Creek, 21.vi.1953 (AD, BRI, CANB, MEL, NT, PERTH); *Puttock & Wilson UNSW 13570*, Budgerygar, Cheviot Range, 14.ix.1982 (AD, UNSW); *Randall 2*, Coalstoun Lake, 15.x.1979 (BRI); *Speck 2007*, c. 3.2 km NE Westwood, Port Curtis (BRI, CANB, L); *Story & Yapp 184*, 48 km ENE Capella, 17.vii.1962 (CANB); *Webb & Tracey 10155*, Black Rock, 26 km S Lynd Junction on Hann Highway between Hughenden and Mt. Garnet, 19.v.1970 (AD, BRI); *White 8675*, Torrens Creek, 19.iii.1933 (BRI, G, NY — isotypes of var. *angustifolium* Mold.).

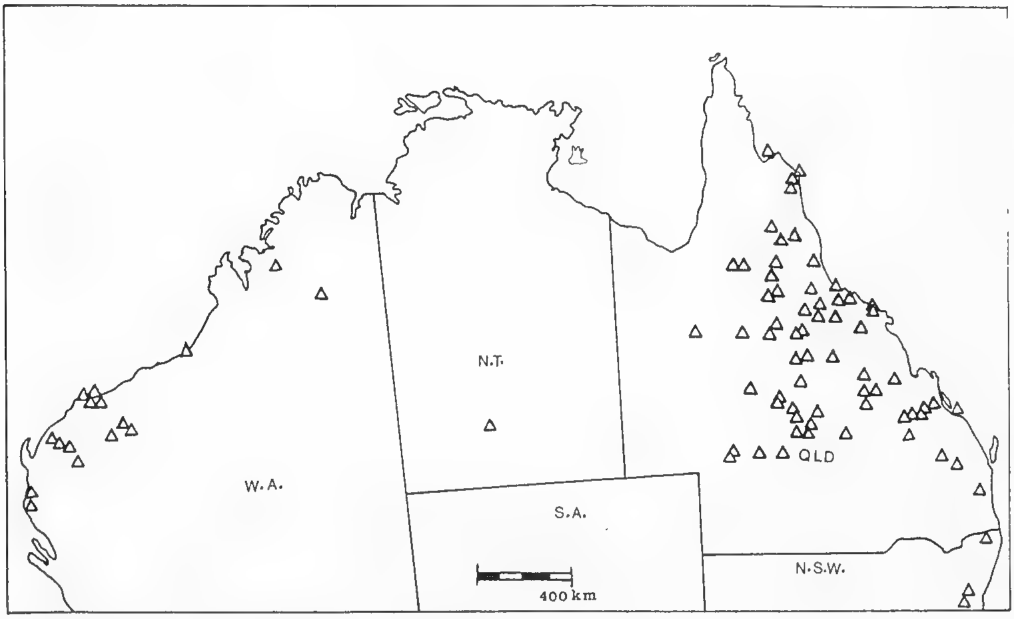
NEW SOUTH WALES: *Boorman s.n.*, Dorrigo, -.xii.1909 (NSW 145189); *Birch & Zelling s.n.*, Taits Creek, 1892 (MEL 98390); *Forsyth s.n.*, Murwillunbah, 18.x.1898 (NSW 145197).

NORTHERN TERRITORY: *Williams 6757*, Ellery Gorge, Macdonnell Range, 15.v.1975 (AD).

WESTERN AUSTRALIA: *Birch s.n.*, between Bowen Downs and Mueller's Range, undated (MEL 98387); *Blockley 169*, Dales Gorge, Wittenoom area, 26.iv.1966 (Kings Park Perth, PERTH); *Burbidge 5999*, Stony Creek, Hamersley Range, 6.v.1958 (AD, CANB, PERTH); *Cusack 156*, Harding River, 1895 (MEL); *Forrest & Carey s.n.*, between De Grey River & Lagrange Bay, 1879 (MEL 98374); *J. Forrest s.n.*, Jones Creek & George River, S Roebourne, 1878 (AD, MEL 98424); *J. Forrest s.n.*, Gascoyne River, 1882 (MEL 98305); *Giles s.n.*, between the rivers Ashburton & Gascoyne, undated (MEL 98482); *F. Mueller s.n.*, Nickol Bay, undated (MEL 98312); *Pullen 10928*, Yampire Gorge, Hammersley Range National Park, E of Wittenoom, 30.iv.1977 (BRI, CANB, PERTH); *Robinson s.n.*, Karragoogaranna, Barlee Range, 10.ix.1959 (PERTH); *Royce 6546*, Barlee Range, Henry River, 17.viii.1961 (PERTH); *Wittwer 2305*, 15 km S Nanutarra, 21.vi.1980 (Kings Park Perth).

Distribution and ecology (Map 9)

C. floribundum var. *angustifolium* seems endemic to mainland Australia. It has been recorded chiefly from the tropical areas of Western Australia, Queensland and New South Wales, with only one disjunct locality in the Macdonnell Ranges in the Northern Territory. In Western Australia, the distribution is mainly in the north-western areas and in the southern part of Kimberleys. The major occurrence within this range is between Broome and



Map 9. Distribution of *C. floribundum* var. *angustifolium* △.

Carnarvon, chiefly along North West Coastal Highway. It has not been recorded from the interior of Western Australia or the north-western half of Kimberleys where it is likely to occur.

The occurrence of this variety in the Northern Territory is based only on a solitary collection from Ellery Gorge, west of Alice Springs. It has not been reported from the tropical north (i.e. Arnhem Land area) where it is likely to be found. The distribution in Queensland is mainly in the mid-east of the State, with most localities between 15° and 26°S, and between 141° and 153°E. With the exception of one collection from Flinders Island in the Bathurst Bay, this taxon has not been recorded from any other part of Cape York Peninsula or the Gulf of Carpentaria. This variety is fairly well scattered inland, with the farthest locality near Windorah towards the South Australian border.

In New South Wales, this taxon has been recorded from the north-eastern tip of the State with two localities to the west of Coffs Harbour and one at Murwillumbah near the Queensland border.

Growing usually on "stony" or "boulder strewn" hillsides but also on dunes and usually associated with "woodland", "banks of creeks" or "dune scrub".

Comments

Var. *angustifolium* has been identified by many as *C. lanceolatum* F. Muell. which has more or less similar shaped narrow-lanceolate leaves and similar looking inflorescence. The major difference is that the leaves in *C. lanceolatum* are densely tomentose all over, and calyx-lobes are obtuse and tomentose outside as well as on the inner side.

One of W.A. Cusack's collection no. 156 (in Herb. MEL) from Harding River, Western Australia has some characters of var. *angustifolium* and some of *C. lanceolatum*. The glabrous branches, peduncles and leaves are like that of var. *angustifolium*, and the pubescent pedicels, calyces and corolla-lobes are similar to that of *C. lanceolatum*. The calyces in Cusack's collection, however, are 6-8-lobed and corollas 5-6-lobed. The number of calyx- and corolla-lobes is certainly abnormal, otherwise this collection seems to be an intermediate form between var. *angustifolium* and the species *C. lanceolatum*.

According to Moldenke (1980) this variety is endemic in Queensland. During present investigation, however, this taxon has been found in Western Australia, Northern Territory, Queensland and New South Wales. Notes with the type collection say that it is a fairly common shrub in rocky places and has faintly scented white flowers. In the protologue, Moldenke (1977) stated that "this variety differs from the typical variety of the species in its leaf-blades being narrowly elliptic, mostly 4-7 cm long and 1-3 cm wide, acuminate at the apex and acute or subacuminate at the base". During the present study, however, many leaves have exceeded the above quoted range of dimensions.

Galled flowers have been noticed in several collections of this variety.

Affinities

Among the infraspecific taxa of *C. floribundum*, var. *angustifolium* is nearest to var. *coriaceum* and var. *ovatum*. From both these varieties, however, var. *angustifolium* may easily be distinguished by its leaf-blades being lanceolate or narrowly elliptic-lanceolate, long cuneate towards the base and generally 15-30 mm wide at mid-point. The narrow lanceolate leaf-blades and the presence of glands on the inner surface of calyx in var. *angustifolia* are similar to those of *C. tomentosum* var. *lanceolatum* (F. Muell.) Munir. The latter, however, differs in its leaf-blades being pubescent-tomentose, calyx and corolla-tube pubescent-tomentose outside, and calyx-lobes pubescent on the inside.

5. **Clerodendrum tatei** (F. Muell.) Munir, comb. nov.

Lectotype: *R. Tate s.n.*, At the Twelve Mile, McKinlay River, Arnhem Land, Northern Territory, 1882 (MEL 602001, lectotype; AD, isolectotype).

Strobilanthes tatei F. Muell., Trans. & Proc. Roy. Soc. South Australia 5 (1882) 81, **basionym**; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 99; Sec. Syst. Cens. Aust. Pl. 1 (1889) 167; Ewart & Davies, Fl. N. Territory (1917) 252; L.S. Smith, Contrib. Qld Herb. No. 6 (1969) 20; R.M. Barker, J. Adelaide Bot. Gard. 9 (1986) 281.

Type: As for above.

Clerodendrum holtzei F. Muell., J. & Proc. Roy. Soc. N.S.W. 24 (1891) 75; Mold., Résumé Verbenac. etc. (1959) 148, 208, 264; Fifth Summary Verbenac. etc. 1 (1971) 247, 345, 446, 462; Sixth Summary Verbenac. etc. (1980) 237, 334; Dunlop, Checklist Vasc. Pl. N. Territory (1987) 79; R.M. Barker, J. Adelaide Bot. Gard. 9 (1986) 281, **syn. nov.**

Type: *Maurice Holtze s.n., [995 & 109]*, near Port Darwin, Northern Territory, 1890 (G 2 spec., K, LE, MEL 98245 — MEL 98250 six spec., NSW 2 spec., Z — syntypes!).

Description (Fig. 7)

Perennial herb or subshrub. *Stem* prostrate, decumbent or suberect, 15-40 cm long, cylindrical, pubescent. *Leaves* extremely variable in shape and size, sessile or with petiole 1-3 mm long, cordate, rhomboid-orbicular, ovate-elliptic, oblong or linear-lanceolate, entire, denticulate or deeply dentate, obtuse or shortly pointed, (10-) 15-45 (-55) mm long, (5-) 10-30 (-40) mm wide, pubescent-hirsute. *Inflorescence* thyrse, terminal and from axils of upper leaves; cymes three to several flowered; peduncles slender, not longer than subtending leaves, pubescent-hirsute, (10-) 15-30 (-40) mm long; bracteoles short, narrow, 1-3 mm long, 0.5-1 mm wide, pubescent. *Flowers* pedicellate; pedicels pubescent-hirsute, 2-7 mm long. *Calyx* campanulate, divided to more than halfway down into 5, occasionally 4 or 6, ovate or linear-lanceolate lobes, (3.5-) 4-8 (-10) mm long, glandular and pubescent-hirsute all over, often glands not distinct in mature flowers; lobes acute, (2-) 3-5 (-6) mm long, 1-2.5 mm wide near base; tube (1-) 2-3 (-4) mm long. *Corolla* white, pubescent-tomentose outside, villous inside tube, hairs protruding above opening of corolla-tube; tube cylindrical, (8-) 12-18 (-25) mm long; lobes glabrous inside, spreading, elliptic-oblong to obovate-orbicular, (5-) 7-12 (-14) mm long, (2-) 3-5 (-7) mm wide. *Stamens* exserted beyond corolla-tube; filaments inserted in corolla-throat, white, glabrous, filiform, 4-7 mm long; anthers ellipsoid-sagittate, oblong, with cells free up to middle, 1.5-2.5 mm long. *Ovary* glabrous, globose, 1-1.5 mm diam.; style exserted above corolla-tube, filiform, glabrous, (10-) 13-20 (-27) mm long. *Fruit* globose-obovoid, 4-lobed on top, glabrous, 5-10 mm diam., often shorter than accrescent calyx; fruiting calyx spreading, 10-15 mm diam.

Representative specimens (Collections seen: Australian 41, non-Australian 0)

AUSTRALIA: NORTHERN TERRITORY: *R.M. Barker 386*, 32.4 km from Winellie P.O. and 1 km N Elizabeth River on Stuart Highway, 1.v.1983 (AD); *Bowman 406 & Wilson s.n.*, Munmalary, 3.v.1986 (DNA); *Briggs 781*, Berrimah, C.S.I.R.O. Wildlife Research Laboratory, 30.iv.1983 (CBG); *Byrnes 1245*, Daly River Road, Foster Block, 19.xii.1968 (NT); *Byrnes 1269*, 14.4 km E Pine Creek, 9.i.1969 (BRI, NT); *Byrnes 2799*, c. 5 km NE Finniss River, 16.i.1973 (BRI, CANB, DNA, FRI-DWN, K, NT); *Byrnes & McKean B207*, 8 km NW Humpty Doo, 11.i.1972 (NT); *Calaby AE394*, vicinity of El Sharana, 17.i.1973 (CANB, NT); *Chippendale 7774*, c. 63 km S Darwin, 18.iii.1961 (BRI, MEL, NT); *Collins BC211*, Kapalga Ref 0920, 9.ii.1977 (CANB, DNA); *Cousins 78*, Flying Fox Creek area, 29.iii.1979 (DNA); *Eddy 5222*, c. 33 km S Darwin, 23.iii.1958 (CANB, NT); *Foelsche 14*, Jam Creek —near Brook's Creek, -.i.1883 (AD, MEL); *Foelsche 29*, loc. cit., 29.i.1883 (AD, MEL); *Foelsche 122*, Finniss River, -.i.1883 (MEL); *Gittins 2561*, 41 km from Pine Creek, on UDP Falls Road, -.vii.1973 (BRI, NSW); *Holtze s.n.*, near Port Darwin, 1890 (G 2 spec., K, LE, MEL 98245 — MEL 98250, six spec., NSW, Z — syntypes of *C. holtzei* F. Muell.); *Lazarides 7883*, Mt Basedow, c. 26 km SSE Nourlangie Safari Camp, 27.ii.1973 (CANB); *Lazarides 7982*, c. 23 km SE Mt Basedow, 3.iii.1973 (CANB); *Lazarides & Adams 59*, c. 98 km NE Maranboy Police Station, 4.iii.1965 (CANB); *O.H. & J.R. Marshall s.n.*, Koongarra area, -.xi.-xii.1978 (CANB); *McKean B174*, c. 30.5 km S Darwin, 12.xii.1971 (DNA); McKean B224, c. 21 km S Adelaide River, 15.i.1972 (NT); *McKee 8364*, Winellie near Darwin, 11.ii.1961 (BRI, CANB, L, NSW, NT); *Morgan 42*, Coomalie Creek, 7.ii.1971 (DNA); *Muspratt SSO251*, Noonamah area, 7.ii.1963 (DNA); *Muspratt SSO360*, Lake Deane, 5.i.1963 (DNA); *Parker 154*, Finniss River area, 12.viii.1973

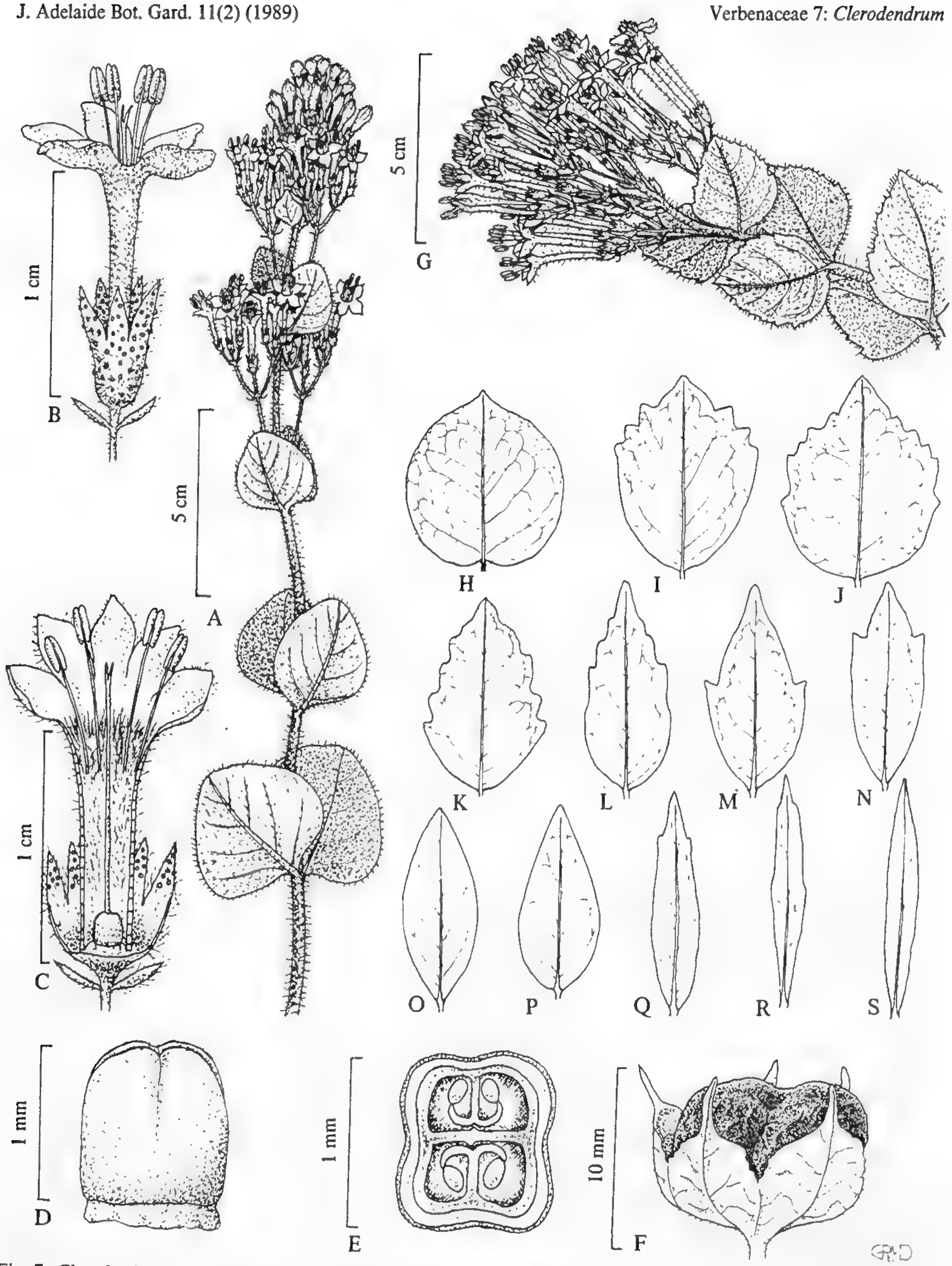


Fig. 7. *Clerodendrum tatei* (F. Muell.) Munir. Habit sketch and range of variation in leaf form. (A-E, *M. Holtze s.n.*: MEL98247; F, *C.R. Dunlop 6084 & J.A. Taylor s.n.*: DNA; G & J, *M. Lazarides 7883*: CANB; H, *G.M. Chippendale 7774*: NT; I, *R. Collins BC211*: DNA; K, *C.S. Robinson R124*: NT; L, *N.B. Byrnes 1269*: BRI; M, *D.J. Morgan 42*: DNA; N, *M. Parker 154*: MO; O, *N.B. Byrnes 2799*: CANB; P, *M. Parker 328*: CANB; Q, *N.B. Byrnes 2799*: DNA; R, *N. Byrnes 2799*: BRI; S, *N.B. Byrnes 2799*: NT). A, flowering branch with entire leaves and lax inflorescence; B, flower showing bracteoles and hairs outside calyx and corolla; C, flower with calyx and corolla longitudinally cut open showing androecium and gynoecium; D, ovary; E, transverse section of ovary; F, fruit with persistent calyx; G, flowering branch with dentate margined leaves and congested inflorescence; H-S, range of variation in leaf form.

(DNA, MO); *Parker 328*, Tortilla Flats, 17.i.1974 (BRI, CANB, NSW, NT); *Robinson 124*, 164 km Stuart Highway, 3.ii.1964 (DNA, NT); *R. Tate s.n.*, at the Twelve Mile, McKinlay River, Arnhem Land, 1882 (MEL 602001, lectotype; AD isolectotype); *Telford 7778 & Wrigley s.n.*, Kakadu National Park, 2 km Arnhem Hwy, along Jim Jim road, 20.iv.1980 (CBG); *Weston (?) s.n.*, Darwin Aerodrum, 25.xi.1950 (BRI).

Distribution and ecology (Map 10)

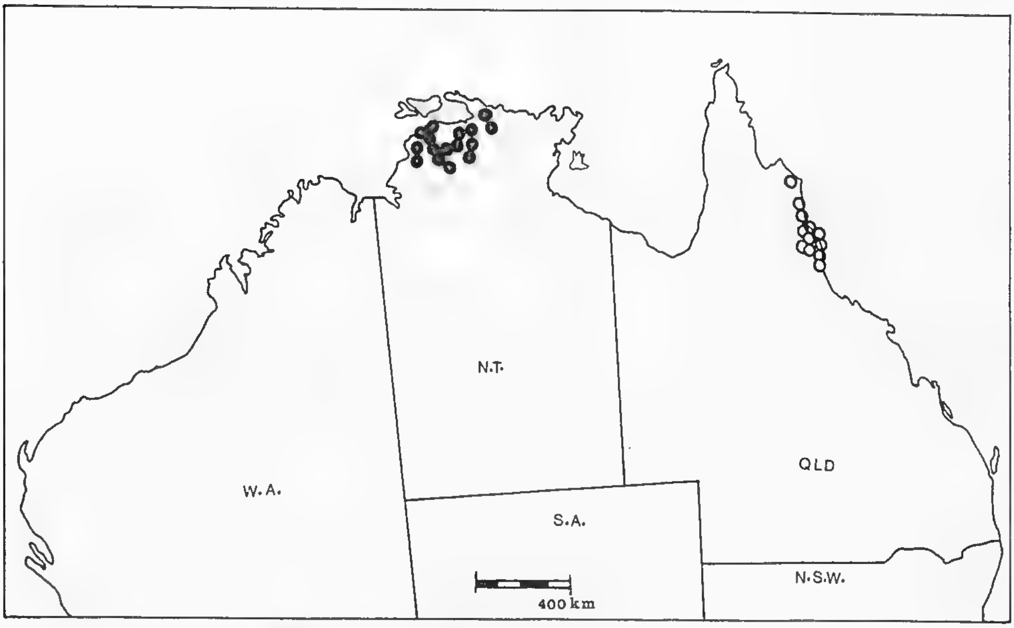
C. tatei is endemic to the north-north-west of Northern Territory. The main distribution is to the south and east of Darwin between latitude 12° and 14°S, and between longitude 130° and 134°E. The majority of localities are inside Kakadu National Park in the western part of Arnhem Land. Moldenke (1959, 1971, 1980) recorded this species from Zimbabwe in Africa, but so far its occurrence anywhere outside Australia has not been confirmed.

Found on "sandy" or "lateritic soil", rarely on "gravelly loam" and usually associated with "woodlands" or seldom in "savannah".

Comments

The leaves in *C. tatei* are highly variable in shape, ranging from orbicular-cordate to linear-lanceolate with margins entire, denticulate or deeply toothed. Similarly, fairly lax and long peduncled inflorescence or congested and short peduncled ones have been observed in different collections of the species. Such variations in the leaf-form and inflorescence may have influenced Mueller who in 1882 first described this taxon as *Strobilanthes tatei* in the Acanthaceae and later in 1891 as *Clerodendrum holtzei* in the Verbenaceae. After examining the types of both taxa, they are found to belong to the same *Clerodendrum* species and combination *C. tatei* was made.

In the protologue of *S. tatei* F. Muell., the corolla is described as "purple" and anther-cell "scantily hairy". Similarly, in the protologue of *C. holtzei* the style is noted as "almost totally enclosed" inside the corolla-tube. During present investigations, however, the corolla was found to be always white, anther-cells glabrous and style much exserted above the corolla-tube.



Map 10. Distribution of *C. tatei* ●, *C. tracyanum* ○.

In the typification of *Strobilanthes tatei*, R. Barker (1986) regarded the isolectotype in AD as "p.p." because the type material collected by *R. Tate s.n.*, was "mixed with another species of similar habit vegetatively" collected by *Foelsche 14*. She also noted that *Foelsche 14*, "although resembling it vegetatively, has five stamens (or four stamens plus a staminode) not four". During present studies, *Foelsche 14* has now been separated from the type material collected by *R. Tate s.n.* and the isolectotype in AD is no more "p.p.". Secondly, *Foelsche 14* does not belong to a different species, and the fifth stamen or staminode observed in this collection by R. Barker (1986) is in fact the part of style and the ȧctual stamen number is four.

Affinities

Amongst Australian *Clerodendrum*, *C. tatei* seems nearest to *C. parvulum* in its leaves being sessile or with minute petioles of 1-3 mm long, calyx pubescent outside and corolla-tube villous inside. Nevertheless, *C. tatei* may readily be identified by its habit being a prostrate, decumbent or suberect herb or subshrub; leaves variable in shape, ranging from cordate, rhomboid-orbicular to oblong-lanceolate with entire or toothed margins; stamens and style white. On the contrary, *C. parvulum* is an erect shrub with leaves obovate-oblong, elliptic-oblong to linear-lanceolate with entire margins, and stamens and style purple. Moreover, *C. parvulum* is endemic to Cape York Peninsula in Queensland, while *C. tatei* is endemic to north-north-west of Northern Territory.

There are several characters in common between *C. tatei*, *C. tomentosum* (Vent.) R. Br. and *C. tracyanum* (F. Muell.) Benth. In all these species, the leaves are pubescent-tomentose or hirsute and calyx pubescent outside. However, *C. tatei* differs by its prostrate-decumbent habit, sessile or almost sessile and of various shaped entire or dentate leaves and non-glandular villous hairs inside the corolla-tube.

6. **Clerodendrum parvulum** L.S. Smith, Contrib. Qld Herb. No. 6 (1969) 19; Mold., Fifth Summary Verbenac. etc. 1 (1971) 345; Sixth Summary Verbenac. etc. (1980) 335.

Type: *L. Pedley 2647*, 35 miles E of Musgrave Telegraph Office, Queensland, Australia, 17.vi.1968 (BRI, holotype).

Description (Fig. 8)

A shrub or subshrub, 24-75 (-100) cm tall. *Stem* erect, branched or single-stemmed, cylindrical, pubescent-hirsute, cineraceous, up to 5 mm diam. *Leaves* sessile, opposite, subopposite, scattered or ternate, approximate, single or apparently in clusters of 2-4 due to much reduced axillary branches; lamina narrowly obovate-oblong, elliptic-oblong, oblanceolate or linear-lanceolate, obtuse or subacute, cuneate, entire with slightly recurved margins, (5-) 10-25 (-30) mm long, (1.5-) 2-5 (-7) mm wide, pubescent-hirsute, more or less punctate all over. *Inflorescence* thyrse; cymes in axils of upper leaves, 1- or 3-flowered, lax; peduncle slender, pubescent, 10-25 mm long; bracteoles opposite, linear-lanceolate, pubescent, 1-3 mm long. *Flowers* pedicellate; pedicels pubescent, (2-) 3-8 (-10) mm long. *Calyx* campanulate, distinctly 5-lobed, 5-5.5 mm long, pubescent outside and on inner surface of lobes, glabrous inside tube; lobes deltoid, acute, 1.5-2 mm long, 1-1.5 mm wide at base; tube cylindrical, 3-3.5 mm long. *Corolla* white, sparsely pubescent outside, villous inside tube on level with insertion of stamens; lobes elliptic-oblong, rounded or obtuse at apex, ciliate along margins, 6-10 mm long, 4-6 mm wide; tube cylindrical, 7-10 mm long, c. 2 mm diam. *Stamens* purple, exserted; filaments inserted above middle of corolla-tube, mostly glabrous, villous near base only, filiform, 8-11 mm long; anthers elliptic-oblong, c. 2 mm long. *Ovary* glabrous, subglobose, faintly 4-lobed, c. 1.5 mm long; style purple, exserted, filiform, glabrous, 10-12 mm long, stigma shortly 2-lobed, lobes c. 1 mm long. *Fruit* obovoid-globose, glabrous, 5-7 mm long, ± 5 mm diam.; fruiting calyx spreading to 10 mm diam.

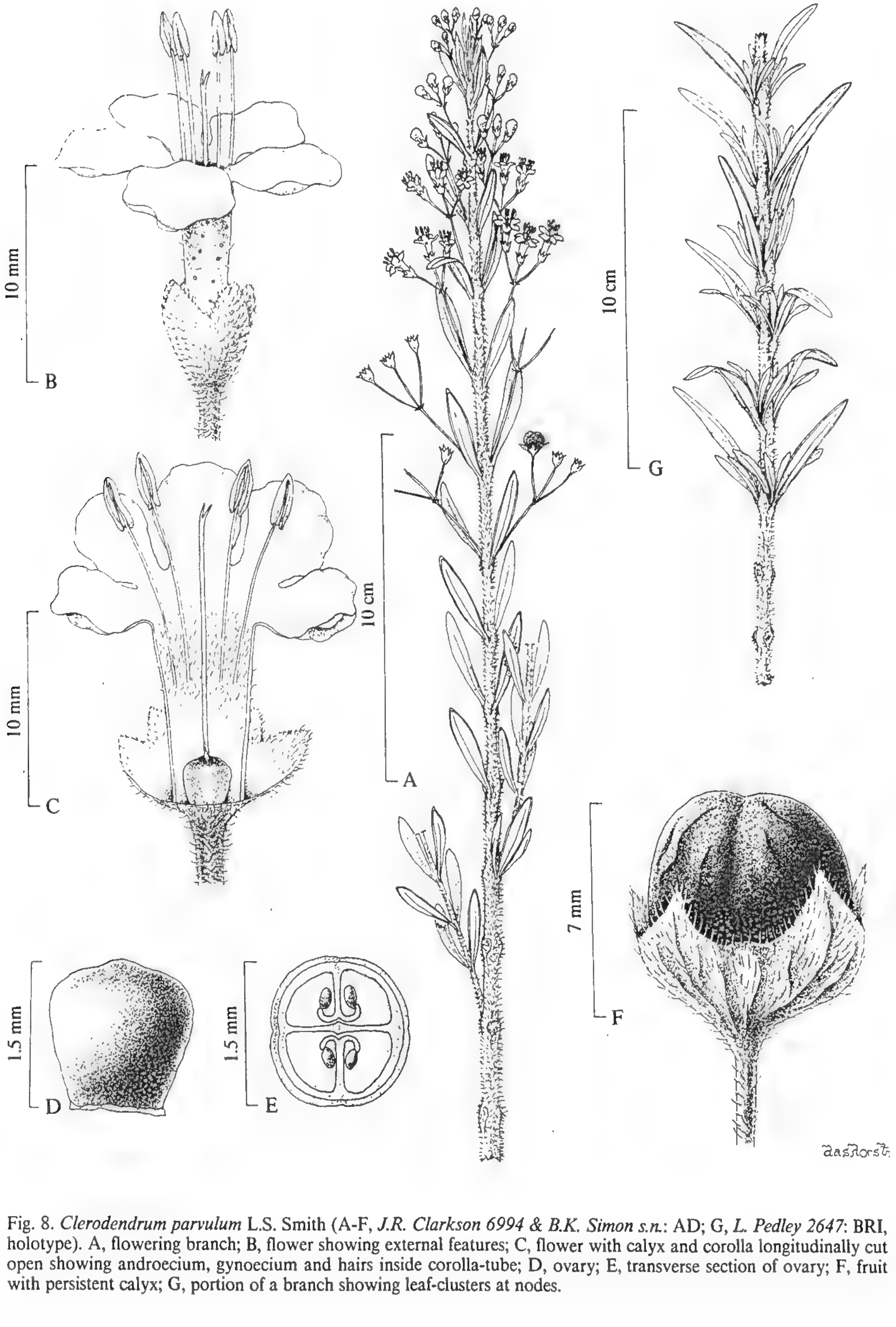


Fig. 8. *Clerodendrum parvulum* L.S. Smith (A-F, *J.R. Clarkson 6994 & B.K. Simon s.n.*: AD; G, *L. Pedley 2647*: BRI, holotype). A, flowering branch; B, flower showing external features; C, flower with calyx and corolla longitudinally cut open showing androecium, gynoecium and hairs inside corolla-tube; D, ovary; E, transverse section of ovary; F, fruit with persistent calyx; G, portion of a branch showing leaf-clusters at nodes.

Specimens examined

AUSTRALIA: QUEENSLAND: *Breeden s.n.*, near Musgrave Telegraph Office, c. 59.5 km SW of the southern most part of Princess Charlotte Bay, -.v.1968 (BRI 266004, paratype); *Clarkson 4812*, 28.3 km N Kennedy River on Peninsula Development Road, 28.iv.1983 (AD, BRI, K, QRS); *Clarkson 6994*, Lakefield National park, Hann Crossing of the Kennedy River, 7.v.1987 (AD, BRI, L, MBA, QRS); *Gasteen 682*, Lakefield, -.viii.1980 (BRI); *Hind 515*, 29.5 km S Musgrave, Peninsula Development Road, -.ix.1974 (NSW); *Pedley 2647*, 56.3 km E Musgrave Telegraph Office, 17.vi.1968 (BRI, holotype).

Distribution and ecology (Map 3)

C. parvulum is endemic to Cape York Peninsula in northern Queensland where it has been recorded from between latitudes 14° and 16°S, and between longitudes 143° and 145°E. Almost all known localities are to the south and south-west of Princess Charlotte Bay where the major distribution seems to be in the area around Musgrave and inside the Lakefield National park.

Growing in "poorly drained sand" in *Melaleuca viridiflora* woodland or in grassy area on levee of rivers.

Comments

In the protologue, the length of the pedicel and peduncle of the single flowered cyme appear to have been combined. In the present study, therefore, the pedicel is considered to be the stalk of flower between calyx and the pair of small bracteoles below.

The type collections have no duplicate and comprise a single sheet each of holotype and paratype. According to collector's field notes "the plant was rare, and in both localities it was found growing on poorly drained sandy soil in open tea-tree (*Melaleuca* sp.) woodland".

In the protologue, the author of this species considered it to be closely allied to *C. tracyanum* and *C. holtzei* (now *C. tatei*) because, in his opinion, these two "are the only other Australian species with corolla-tube less than 1.5 cm long". According to the present investigation, however, the flowers of *C. heterophyllum* (Poir.) R. Br. are also smaller with a corolla-tube up to 1.5 cm long. Also, the opposite and ternate narrow leaves of this species are similar to that of *C. parvulum*. Among Australian *Clerodendrum*, therefore, the arrangement and shape of leaves of *C. parvulum* seems closer to that of *C. heterophyllum* than to *C. tracyanum* or *C. holtzei*. As for the length of corolla-tube, the corolla-tube in *C. holtzei* is 8-25 mm long and the shape and size of the leaf-lamina in *C. tracyanum* and *C. holtzei* are also different. Nevertheless, there are several other characters why *C. parvulum* is considered nearest to *C. tatei* and *C. tracyanum*. For detail see "Affinities".

Of the known Australian *Clerodendrum*, *C. parvulum* is the only species with sessile leaves. The proposed specific epithet parvulum for this species was presumably alluding to its comparatively smaller size.

S.L. Smith (1969) erroneously attributed the authorship of *C. holtzei* to Bleeser. As recorded here in the synonymy of *C. tatei*, *C. holtzei* was described by F. v. Mueller in 1891.

Affinities

C. parvulum is nearest to *C. tatei* in its leaves being pubescent-hirsute, sessile; calyx distinctly pubescent outside and corolla-tube villous inside. Nevertheless, *C. parvulum* can easily be identified by its leaves being obovate-oblong, elliptic-oblong to oblanceolate and entire; the inflorescence lax with cymes 1- or 3-flowered; the corolla-tube shorter, 7-10 mm long; stamens and style are purple.

There are several characters common between *C. parvulum* and *C. tracyanum* (F. Muell.) Benth. Both species have pubescence on the leaves, calyces and corollas, and with hairs inside the corolla-tubes. Nevertheless, *C. tracyanum* may easily be distinguished by being a tall shrub or a small tree of 2-12 m high; the stem 4-18 cm diameter at breast height; leaves with long petiole; leaf-blades cordate, very large measuring 6-34 x 4-25 cm; inflorescence never exceeding the upper leaves; flower small; corolla-tube 6-8 mm long; calyx- and corolla-tubes with gland-tipped hairs inside.

7. **Clerodendrum tracyanum** (F. Muell.) Benth., Fl. Aust. 5 (1870) 62; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; Bailey, Synop. Qld Fl. (1883) 380; F. Muell., Descr. Note Pap. Pl. 5 (1885) 91; Bailey, Rep. Gov. Sc. Exped. Bell.-Ker (1889) 52; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Bailey, Cat. Indig. & Natur. Pl. Qld (1890) 36; Qld Woods (1888) 106; Qld Fl. 4 (1901) 1182; Compr. Cat. Qld Pl. (1913) 386; H.J. Lam, Verbenac. Malay. Archip. (1919) 274; Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Ser. III, 3 (1921) 96; C. White & Francis, Proc. Roy. Soc. Qld 38 (1927) 259; Domin, Biblioth. Bot. 89 (1928) 557; Mold., Résumé Verbenac. etc. (1959) 201, 208, 339, 389; L.S. Smith, Contrib. Qld Herb. No. 6 (1969) 20; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 335, 338, 340, 345, 611, 729; Sixth Summary Verbenac. etc. (1980) 326, 328, 330, 335; Baines, Aust. Pl. Gen. (1981) 97; Elliot & Jones, Encyc. Austral. Pl. 3 (1984) 50.

Lectotype: *J. Dallachy s.n. [101]*, Rockingham Bay, Queensland, Australia, 1 or 13.vi.1864 (K, lectotype designated here!; MEL 98353 — MEL 98360, MEL 98465, MEL 982953, MEL 982954 — isolectotypes!).

Premna tracyana F. Muell., Fragm. 5 (1865) 61, **basionym.**

Type: As for *Clerodendrum tracyanum* (F. Muell.) Benth.

Vitex tracyana F. Muell., Fragm. 5 (1865) 61, nom. invalid., pro syn. *Premna tracyana.*

Typification

C. tracyanum was originally described as *Premna tracyana* F. Muell., the type of which is based on J. Dallachy's (s.n.) collection from Rockingham Bay, Queensland. It consists of at least 12 duplicates of which one is preserved in Herb. K and the rest in Herb. MEL. Since the author of the basionym (F. Mueller) did not choose any one of them as a type, it is necessary to select a lectotype for this name. Out of all the syntypes, the one preserved in Herb. K is found annotated in F. Mueller's handwriting as "*Premna tracyana*". The specimen has both flowers and fruits, and seems to be the best representative of this species. It has been, therefore, selected here as the lectotype of this species.

Description (Fig. 9)

A tall shrub or small tree, 2-7 (-12) m high. *Stem* 4-18 cm diam. at breast height, with flaky-papery bark, young branches more or less velvety-pubescent or hirsute. *Leaves* broadly ovate, shortly acuminate, rounded or broadly cordate at base, entire, (6-) 10-30 (-34) cm long, (4-) 8-20 (-25) cm wide, chartaceous, more or less velvety-pubescent or hirsute; petiole velvety-pubescent, (2.5-) 5-15 (-20) cm long. *Inflorescence* a terminal trichotomous thyrse, dense at time of flowering (i.e. anthesis), velvety-pubescent or hirsute, 6-12 cm diam. when in fruit; bracts very small and deciduous; peduncle pubescent-hirsute, primary lateral branches (1-) 2-4 cm long. *Flowers* pedicellate; pedicels pubescent-hirsute, 3-6 (-11) mm long. *Calyx* turbinate-campanulate, divided to near middle into acute lobes, glandular and pubescent-hirsute outside, pubescent on inner surface of lobes, glandular with minute gland-tipped hairs inside tube, 5-7 mm long, enlarged and coloured in infructescence; lobes ovate-lanceolate or more or less deltoid, 1.5-3 mm long, 1.5-2.5 mm wide at base; tube 2.5-3 mm long. *Corolla* white, villous outside, glabrous inside excepting a few gland-tipped minute hairs in upper part of tube; lobes spreading, almost equal, ovate-elliptic, 4-6 mm long, (2.5-) 3-4 mm wide, glandular and villous on back (i.e. outside); tube cylindrical, 6-8 mm long, 1-2 mm in diam. *Stamens* exserted; filaments inserted above middle of corolla-tube, white, glabrous, filiform, 8-12 mm long; anthers oblong, 1.5-2 mm long, ± 1 mm wide. *Ovary* globose, glabrous, 1-1.5 mm diam.; style exserted, white, glabrous, filiform, 10-18 mm long. *Fruit* globose-ovoid, glabrous, dark green to bluish-green, turning black when mature and dry, 4-6 mm long, 6-7 (-8.5) mm diam., enclosing 4 distinct 1-seeded pyrenes; fruiting calyx pink-red or deep red, enlarged, funnel-shaped, lobes recurved or spreading to 10 mm diam.

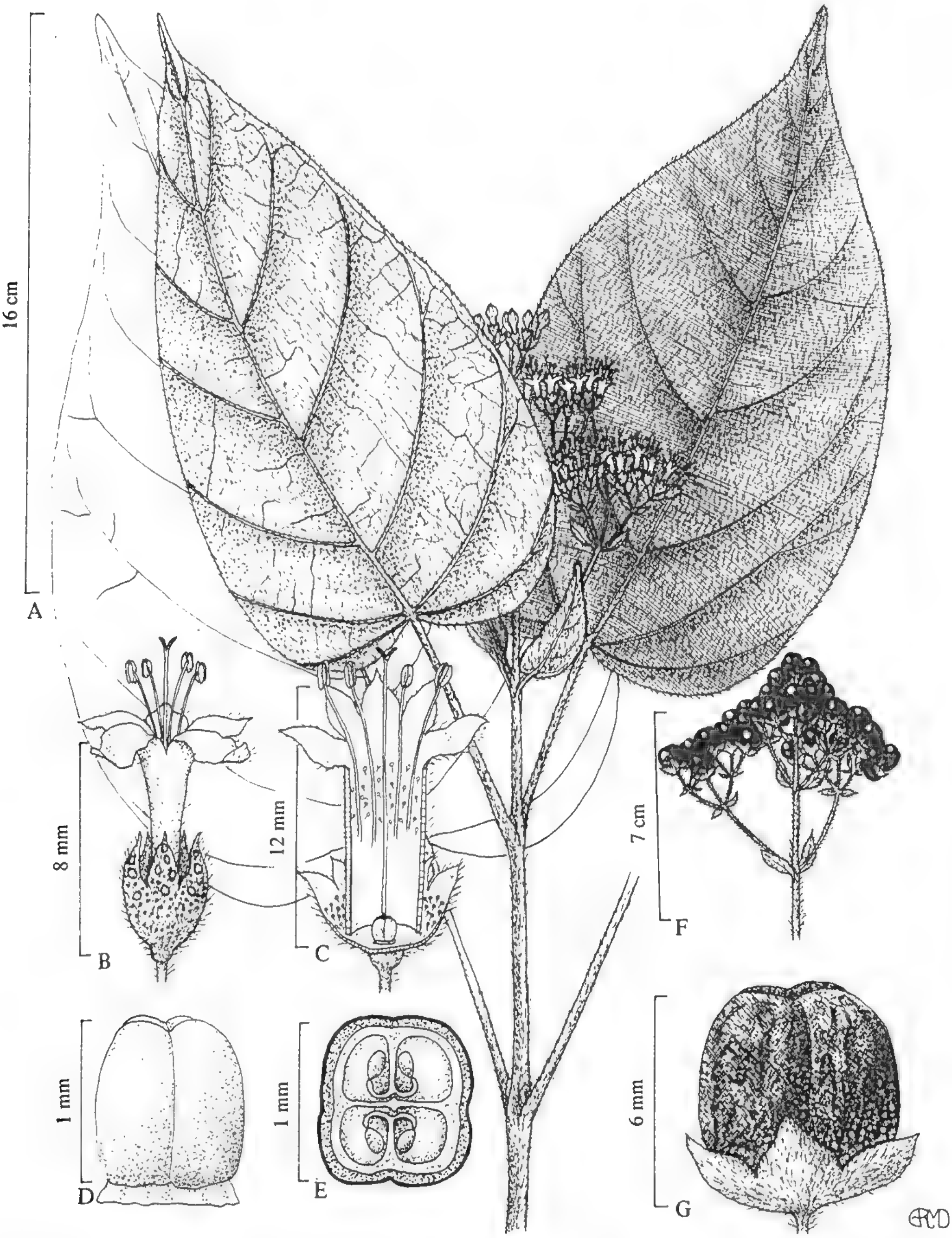


Fig. 9. *Clerodendrum tracyanum* (F. Muell.) Benth. (A-E, *D.I. Nicholson 4759*: QRS; F-G, *B.P.M. Hyland 3606*: L). A, flowering branch; B, flower showing hairs outside calyx and corolla; C, flower with calyx and corolla longitudinally cut open showing androecium and gynoecium; D, ovary; E, transverse section of ovary; F, infructescence; G, fruit with persistent calyx.

Representative specimens (Collections seen: Australian 55, non-Australian 17)

AUSTRALIA: QUEENSLAND: *Bailey s.n.*, Harveys Creek, 1889 (BRI 265903 & -04); *Bailey s.n.*, Kamerunga, -.vi.1892 (NSW 145089); *Berthoud s.n.*, Johnstone River, -.xii.1882 (MEL 582841); *Brass 2045*, Mossman River, 4.ii.1932 (A, B, BRI); *Brass 2249*, Daintree River, 7.iii.1932 (A, B, BRI, K); *Brass 33519*, Whitfield Range, 23.ii.1967 (BRI, K, L, QRS); *Cambage 3835*, foot of Bellenden-Ker, 14.viii.1913 (NSW, SYD); *Crome 466*, Lacey's Creek, Mission Beach, 6 km W Clump Point, 1.vi.1972 (CANB, L); *Dallachy s.n.*, Rockingham Bay, 1 or 13.vi.1864 (K, lectotype; MEL 98353 — MEL 98360, MEL 98465, MEL 582953, MEL 582954 — isolectotypes); *Dixon s.n.*, near Herberton, 1899 (NSW 145088); *Gray 2640*, State Forest Reserve 755, Barong L.A., 27.vi.1982 (AD, QRS); *Helms 1184*, Barron Falls near Cairns, 20.vi.1922 (C); *Hyland 3606*, S.F.R. 1073, c. 56 km NNE Atherton, -.v.1966 (L, QRS, Z); *Hyland 1471*, S.F.R. 933, 9.iv.1968 (QRS); *Hyland 5256*, Cooroo Land, 15.vii.1971 (BRI, QRS); *Hyland 7330*, TR55, 2.vii.1974 (BRI, CANB, L, QRS); *Hyland 11723*, S.F.R. 933, 10.iii.1982 (AD, QRS); *Moriarty 2053*, S.F.R. 675, Little Mulgrave, c. 8 km WSW Gordonvale, 8.iv.1976 (BRI, L, QRS); *Nicholson 4759*, S.F.R. 675, Little Mulgrave Valley, 2.vi.1971 (AD, BRI, QRS); *Scarth-Johnson 168A*, Bloomfield, Gap Creek, undated (BRI); *Sparvell 5857*, Upper Mowbray, 22.iv.1939 (QRS); *Webb & Tracey 6660*, Miriwinni near Mt Bartle Frere, 1962 (BRI); *Webb & Tracey 8994*, end of Granite Creek Logging Road, Bloomfield River, W Ayton, 13.v.1969 (AD, BRI); *White 1540*, Kuranda, 28.ii.1922 (BRI, NSW); *Wrigley & Telford 1028*, Stewart Creek gorge, N Mossman, 11.vi.1972 (CBG).

PAPUA NEW GUINEA: *Carr 16464*, Kokodu, Papua, 23.iv.1936 (BM, CANB); *Gafui et al. BSIP 10280*, Torasina Ridge, Wairokai, SW Malaita, Solomon Islands, 15.vii.1968 (L); *Hoogland & Craven 10256*, near Ambunti, Sepik District, Territory of New Guinea, 9.vi.1966 (A, BRI, CANB, K, L, LAE, US); *Pullen 8219*, c. 15 km NE Cape Rodney, Central District, East Papua, 5.ix.1969 (CANB, L, LAE); *Stevens & Lelean LAE-58312*, lower slopes of Mt. Lululua, East New Britain, 6.v.1973 (A, BISH, BRI, CANB, E, K, L, M, NSW, US).

INDONESIA: IRIAN JAYA: *Kalkman BW6306*, Beriat, c. 12 km S Teminaboean, 27.iv.1958 (CANB, L, MAN); *Shram BW5996*, Tafelberg near Manokwari, 13.iii.1958 (BRI, L); *Versteegh BW4682*, between Sorong and Klamono, 5.xi.1956 (CANB, L, MAN).

Distribution and ecology (Map 10)

In Australia, *C. tracyanum* is known to occur in north-eastern Queensland where it has been reported from the coastal areas between Cooktown and Rockingham Bay. Within this range, it has been most commonly recorded on Atherton Tableland, chiefly in the south and south-west of Cairns. Moldenke (1959, 1971, 1980) recorded this species from Northern Territory, but so far its occurrence there has not been confirmed.

Collections from outside Australia have been examined from Papua New Guinea, Solomon Islands and Irian Jaya (Netherland New Guinea).

Growing often on rocky substrate in rainforest or "complex mesophyll vineforest". Occasional on alluvial soil or edge of rainforest.

Comments

Bentham (1870) described the calyx as being "glabrous inside" and a similar view was expressed by Bailey (1883, 1901) and H.J. Lam (1919). After critical examination, however, the calyx is found pubescent inside with simple hairs on the lobes and gland-tipped short hairs inside the tube.

According to H.J. Lam (1919), *C. tracyanum* and *C. buruanum* Miq. are so close to each other that he could not find any difference between the two. In his key to the species, twice the same combination of characters are shown to lead simultaneously to the identification of both the species. During present investigation, the types as well as a range of material of both the species have been examined. As a result, *C. buruanum* Miq. is found to be fairly close to *C. tracyanum*, but differs in its leaves and inflorescence being much more densely hirsutus-tomentose, calyx glabrous inside, corolla more densely pubescent-tomentose outside, inflorescence larger, drupe and fruiting calyx almost double the size of *C. tracyanum.*

H.J. Lam (1919) recorded the drupe as "0.7-1 cm in diam." for *C. tracyanum*, but this is larger than that generally found in the Australian specimens of the species. It is likely, that Lam confused the fruit of the two species which are very similar in shape.

The pedicels of the terminal flowers are often at least twice the length of the laterals.

The species is cultivated in Botanic Garden at Edge Hill, Cairns, northern Queensland.

Affinities

C. tracyanum approaches closely to *C. buruanum* Miq. in overall appearance of its leaves, inflorescence, flowers, fruit and the presence of indumentum. However, *C. tracyanum* may easily be identified by its leaves and inflorescence being less densely hairy; inflorescence somewhat smaller; calyx pubescent on the inner surface of the lobes and with short gland-tipped hairs inside the tube; corolla pubescent outside and with short gland-tipped hairs inside the tube; drupe and fruiting calyx almost half the size of *C. buruanum.*

Amongst the Australian *Clerodendrum*, *C. tracyanum* seems similar to *C. costatum* R. Br. in its leaves being pubescent-tomentose; petioles, pedicels, peduncles and outside calyx pubescent; stamens and style exserted; ovary and fruit (drupe) globose and glabrous. Nevertheless, *C. tracyanum* may readily be distinguished by its leaves being cordate; inflorescence congested, much shorter than the terminal leaves; primary lateral peduncles up to 40 mm long; calyx 4-7 mm long; corolla villous outside, the tube 6-8 mm long with gland-tipped short hairs inside; filaments 8-12 mm long; style 10-18 mm long and fruiting calyx spreading to 10 mm diameter. In *C. costatum*, the inflorescence is lax, much longer than the terminal leaves, the primary lateral peduncles are up to 80 mm long, calyx 8-12 mm long, corolla glabrous all over with tube 45-70 mm long, filaments 33-40 mm long, style 60-100 mm long and fruiting calyx spreading to 25 mm diam.

There are a few characters common between *C. tracyanum* and *C. parvulum.* For similarities and differences see "affinities" under *C. parvulum.*

8. **Clerodendrum tomentosum** (Vent.) R. Br., Prodr. Fl. Nov. Holl. (1810)510.

Type: G, no specimens seen; here based on Ventenat's (1804) plate 84 from cultivated material without definite locality.

Volkameria tomentosa Vent., Jard. Malm. (1804) t. 84, **basionym**; Pers., Synop. Pl. 2 (1807) 145.

Type: As for above.

Description

A tall shrub or a small tree, (1-) 2-7 (-10) m high. *Stem* "with a finely and regularly longitudinally fissured bark", branchlets pubescent-tomentose. Leaves petiolate; lamina variable, ovate, elliptic, oblong-elliptic or lanceolate, rounded, cuneate-attenuate, entire, shortly acuminate or acute, (4-) 6-13 (-16) cm long, (1.5-) 2.5-6 (-7.5) cm wide, thinly pubescent-tomentose to velvety-tomentose all over, sometimes almost glabrescent above; petiole pubescent-tomentose (10-) 15-30 (-40) mm long. *Inflorescence* a terminal corymbose thyrse; cymes compact, sometimes in the axils of upper leaves; peduncles pubescent-tomentose, primary lateral branches (5-) 10-20 (-25) mm long. *Flowers* pedicellate, congested; pedicels tomentose, 5-12 mm long. *Calyx* campanulate, pubescent-tomentose outside, glandular and pubescent-tomentose on inner surface, divided to about middle into acute or often obtuse lobes, 6-9 mm long; lobes 3-4 mm long, (1.5-) 2-3 mm wide at base; tube (2-) 3-4 mm long. *Corolla* white- or cream-coloured, pubescent or villous-tomentose outside, rarely glabrescent, always glabrous inside tube; tube cylindrical, 18-25 (-27) mm long, 2-3 mm diam.; lobes elliptic-oblong, rounded or obtuse at apex, (4-) 6-8 mm long, 2.5-4 mm wide. *Stamens* much exserted, protruding ± 12-25 mm above corolla-tube; filaments inserted about ⅔ above base of corolla-tube, white, glabrous, filiform, (15-) 20-30 (-37) mm long; anthers oblong, 2-2.5 mm long. *Ovary* glabrous, obovoid-globose, faintly or distinctly 4-lobed, 1.5-2.5 mm diam.; style exserted, white, filiform, glabrous, 30-43 mm long. *Fruit* globose-obovoid, blue-black, purple or dark-purple, shiny, 5-15 mm long, 4-12 mm diam.; fruiting calyx funnel-shaped, 15-20 (-25) mm diam., bright- or dark-red.

Distribution

A native to Australia and Papua New Guinea. Distribution in Australia is restricted chiefly to the tropical parts of Western Australia, Northern Territory, Queensland and New South Wales. In New South Wales, this species provides the most southerly records of the genus in Australia.

Affinities

Amongst Australian *Clerodendrum* species, *C. tomentosum* is similar to *C. grayi* Munir in that its stem, leaves and inflorescence are pubescent-tomentose; leaf-blades oblong to elliptic-oblong; inflorescence exceeding the upper leaves; calyx- and corolla-tubes glabrous inside. Nevertheless, *C. tomentosum* may readily be identified by its foliage and inflorescence usually being velvety-pubescent; leaf-blades often cuneate-attenuate towards the base; inflorescence of somewhat compact cymes; calyx-lobes shorter, 3-4 mm long, pubescent on the inner surface as well; corolla-tube pubescent on the outside, shorter, 18-25 (-27) mm long; style shorter, 30-43 mm long. In *C. grayi*, the foliage and inflorescence are pubescent; leaf-blades rounded at the base; inflorescence of somewhat lax cymes; calyx-lobes 5-9 mm long, glabrous on the inner surface; corolla-tube glabrous and sparsely glandular on the outside, 25-40 mm long and style 60-75 mm long.

There are a few characters in common between *C. tomentosum* and *C. costatum* R. Br. In both species, the leaves are pubescent-tomentose at least on the abaxial surface; calyx pubescent outside, glandular on the inner surface of the lobes; stamens, style, ovary and inside of corolla-tube glabrous. However, *C. tomentosum* may easily be distinguished by its leaf-blades being pubescent-tomentose on both surfaces; inflorescence dense, composed of somewhat compact cymes; calyx-lobes pubescent inside; corolla-tube pubescent outside, less than half the length of *C. costatum* i.e. 18-25 (-27) mm long. In *C. costatum*, the leaf-blades are glabrous adaxially; corolla-tube glabrous all over, 45-70 mm long and style 60-100 mm long.

C. tomentosum has some characters in common with *C. floribundum* var. *attenuatum*. In both taxa, the petioles, peduncles and pedicels are pubescent; leaf-blades cuneate and inflorescence dense and pubescent-tomentose. For distinguishing characters see "affinities" under *C. floribundum* var. *attenuatum*.

8a. var. **tomentosum**.

C. tomentosum (Vent.) R. Br., Prodr. Fl. Nov. Holl. (1810) 510; Andr., Bot. Repos. 9 (1812) t. 607; Sims, Curtis's Bot. Mag. 37 (1813) t. 1518; Sprengel, Syst. Veg. 2 (1825) 759; Walp., Rep. Bot. Syst. 4 (1845) 106; Schauer in A. DC., Prodr. 11 (1847) 662; F. Muell., Fragm. 6 (1868) 152; Benth., Fl. Aust. 5 (1870) 62; F. Muell., Syst. Cens. Aust. Pl. 1 (1882)103; Bailey, Synop. Qld Fl. (1883) 381; Proc. Roy. Soc. Qld 1 (1884) 71; Nilson, Timber Trees N.S.W. (1884) 44; Bailey, Qld Wood (1888) 92; Maiden, Usef. Nat. Pl. Aust. (1889) 406; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Bailey, Cat. Pl. Qld (1890) 36; Moore, Handb. Fl. N.S.W. (1893) 357; Tepper, Bot. Centralbl. 54 (1893) 260; A.G. Ham., Proc. Linn. Soc. N.S.W. 9 (1894) 15, t. 2, fig. 1-2; Bailey, Qld Fl. 4 (1901) 1183; Dixon, Pl. N.S.W. (1906) 236; Bailey, Compr. Cat. Qld Pl. (1913) 386; Maiden & Betche, Cens. N.S.W. Pl. (1916) 178; W. Fitzg., J. & Proc. Roy. Soc. Western Australia 3 (1918) 201; Bakh. in Lam & Bakh., Bull. Jard. Bot. Buitenzorg Ser. III, 3 (1921) 96; Domin, Biblioth. Bot. 89 (1928) 558; Bakh., J. Arn. Arb. 10 (1929) 72, 264; C. Gardner, Enum. Pl. Aust. Occ. 3 (1931) 112; Anderson, Trees N.S.W. (1947) 272; Webb, C.S.I.R. Bull. No. 232, (1948) 168; Francis, Aust. Rainforest Trees (1951) 367; Mold., Résumé Verbenac. etc. (1959) 201, 208, 217, 264, 270, 393; Beard, W. Aust. Pl. 2nd edn (1970) 113; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 335, 345, 360, 447, 466, 734; Beadle et al., Fl. Syd. Region (1972) 508; Rotherham et al., Flow. Pl. N.S.W. & S. Qld (1975) 100, t. 308; Mold., Sixth Summary Verbenac. etc. (1980) 326, 335, 351, 461; Baines, Aust. Pl. Gen. (1981) 97; J. Green, Cens. Vasc. Pl. W. Aust. (1981) 89; Jacobs & Pickard, Pl. N.S.W. (1981) 209; Munir in Jessop (ed.), Fl. Cent. Aust. (1981) 296; Beadle, Student's Fl. NE N.S.W. 4 (1984) 858; Elliot & Jones, Encyc. Aust. Pl. 3 (1984) 50; Stanley in Stanley & Ross, Fl. SE Qld 2 (1986) 370; D. Jones, Ornament. Rainforest Pl. Aust. (1986) 207; Dunlop, Vasc. Pl. North.-Terr. (1987) 79.

Type: As for *Clerodendrum tomentosum* (Vent.) R. Br.

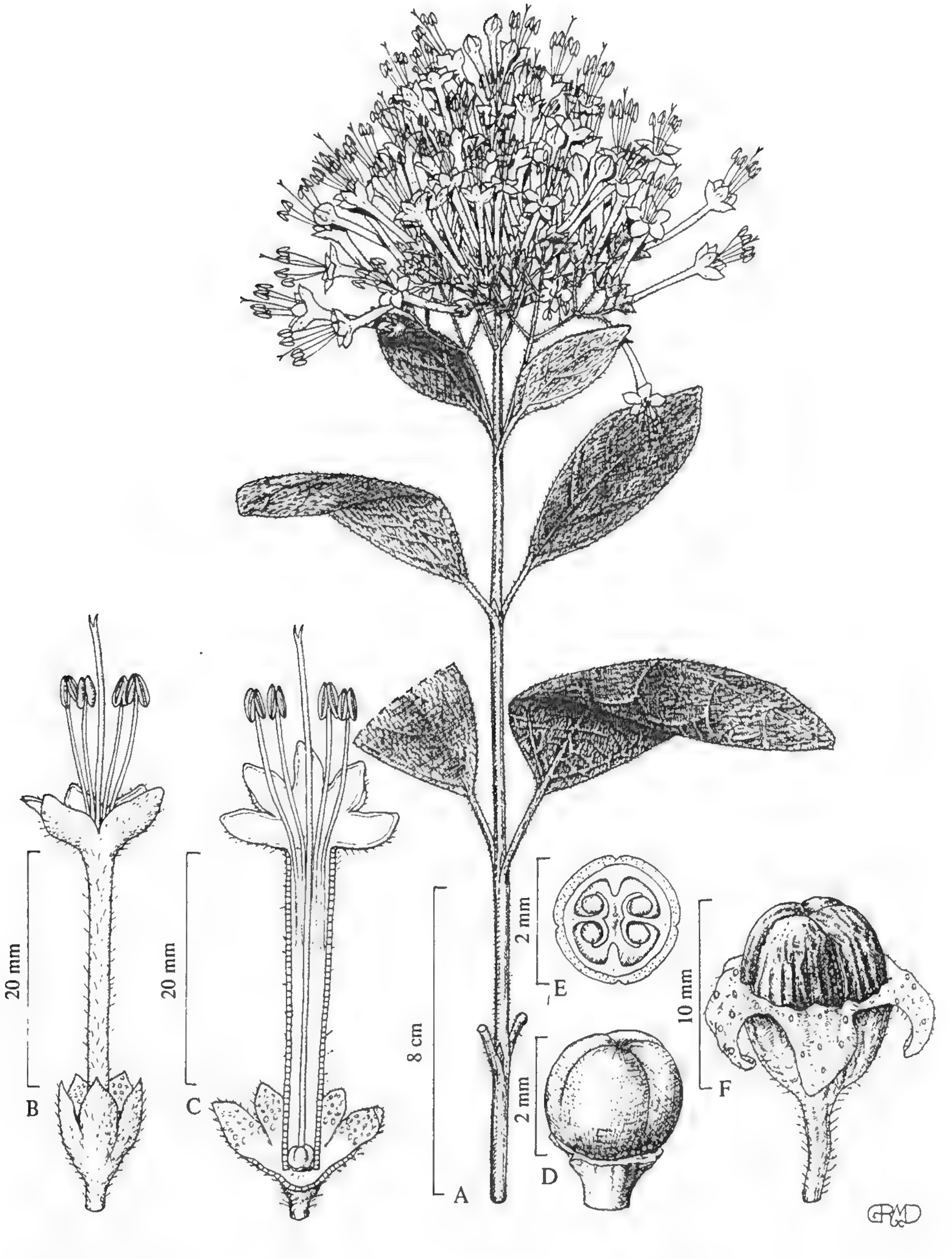


Fig. 10. *Clerodendrum tomentosum* (Vent.) R. Br. var. *tomentosum* (A-E, A. *Morrison 5104*: K; F, *C. Burgess s.n.*: CBG009494). A, flowering branch; B, undissected flower; C, flower with calyx and corolla longitudinally cut open showing androecium and gynoecium; D, ovary; E, transverse section of ovary; F, fruit with persistent enlarged calyx.

C. medium R. Br., Prodr. Fl. Nov. Holl. (1810) 510; Sprengel, Syst. Veg. 2 (1825) 759; Walp., Rep. Bot. Syst. 4 (1845) 105.

Type: *R. Brown s.n., J.J. Bennett no. 2312*, Keppel Bay, Qld, 1802-1805 (BM!, syntype); *R. Brown s.n., J.J. Bennett no. 2313*, Thirsty Sound, Qld, 1802-1805 (BM!, K! — syntypes).

C. hügelii Regel, Gartenflora 10 (1861) 51.

Type: *Baron von Hügel s.n.*, introduced by Baron von Hügel from New Holland (i.e. Australia) and cultivated at the Royal Botanic Gardens St. Petersburg, undated (LE!).

C. floribundum R. Br. var. *medium* (R. Br.) Mold., Phytologia 39 (1978) 236.

Type: As for *C. medium* R. Br., Prodr. Fl. Nov. Holl. (1810) 511.

C. ovatum R. Br., Prodr. Fl. Nov. Holl. (1810) 511, p.p. quoad descr. "B. folia calycesque pubescentes" and syntype *R. Br. s.n., J.J. Bennett no. 2315*, Carpentaria Island, Northern Territory, 1902-1905 (BM!, E!, K!).

Diagnosis (Fig. 10)

Of all infraspecific taxa of the species, var. *tomentosum* is distinguished by its leaf-blades being elliptic, elliptic-oblong or broadly lanceolate, attenuate towards the base, thinly pubescent-tomentose or almost glabrescent above, tomentose underneath; the inflorescence congested, tomentose; the calyx softly pubescent on the outside, glandular and puberulous inside; the corolla-tube pubescent or sometimes glabrescent outside; the fruit slightly larger than the other varieties, mostly 8-15 x 5-12 mm.

Representative specimens (Collections seen: Australian 274, non-Australian 3)

AUSTRALIA: WESTERN AUSTRALIA: *Barnett s.n.*, Kimberley, 1938 (PERTH); *Beard 4027*, 16-80 km NE Callawa Stn, 7.v.1965 (King's Park Perth, L, NSW, PERTH); *Beard 4061*, between Radi Hills and Wallal Downs, 9.v.1965 (Kings's Park Perth, PERTH); *Copley 1201*, Mt Davis, E Carnarvon Ranges, 19.vii.1985 (AD); *George 5482*, 43.5 km W Mt Nossiter, 20.vii.1963 (B, PERTH); *Harrington 1*, Anna Plains, 5.v.1967 (King's Park Perth); *Perry 2392*, c. 42 km N Nicholson Stn., 7.vii.1949 (BRI, CANB, NT); *Royce 7439*, Rosemary Island, Dampier Archipelago, 16.vi.1962 (PERTH); *Taylor 36*, Cable Beach, Broome, 24.v.1971 (CANB, K, NT).

NORTHERN TERRITORY: *Forrest s.n.*, Port Darwin, 1879 (MEL 98438 & MEL 98439); *Craven 3702*, Sir Edward Pellow Group of Islands, Gulf of Carpentaria, 8.ii.1976 (CANB, NT).

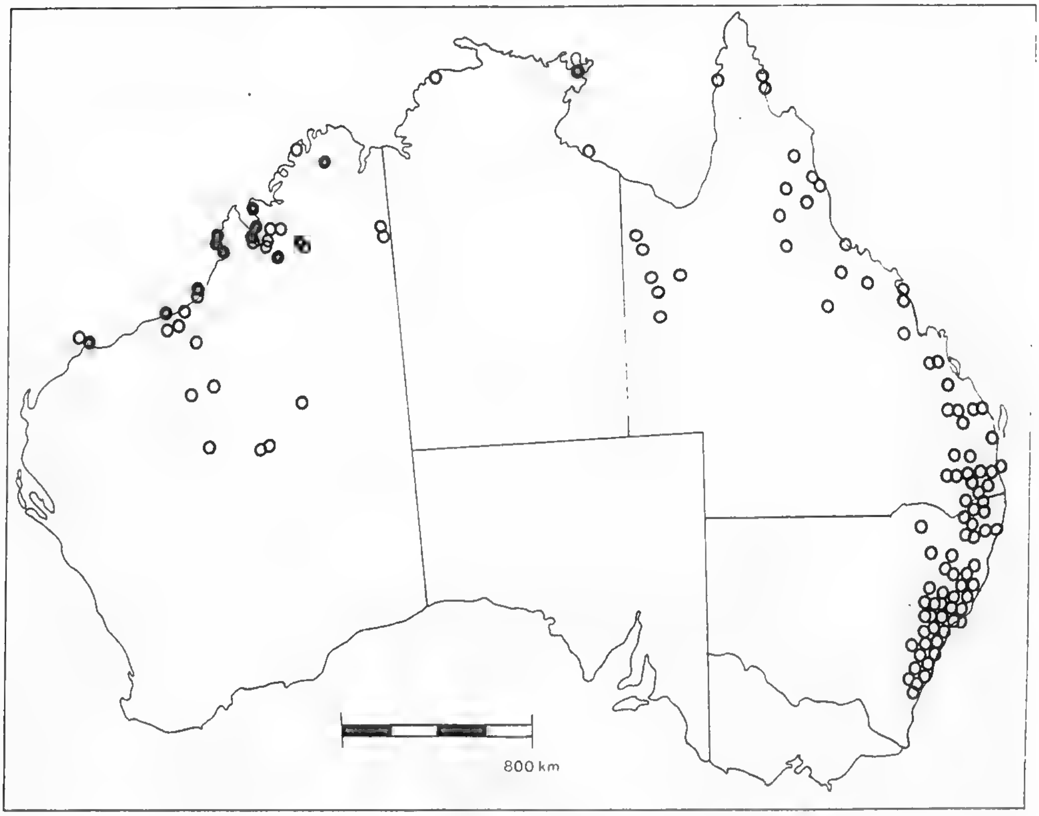
QUEENSLAND: *Bailey s.n.*, Brisbane River, undated (BRI 266135); *Bancroft s.n.*, Samford, undated (BRI 266128); *Batianoff & McDonald 135*, Livingstone Shire, Coconut Pt., 4 km S Emu Park, 12.vii.1977 (BRI); *Batianoff & McDonald 359*, 7.5 km N Yepoon, 18.vii.1977 (BRI); *Blake 8802*, Mount Isa, 28.iv.1935 (BRI); *Dietrich 973*, Rockhampton, -.vi.1865 (MEL, PR); *Dunn s.n.*, Acacia Creek via Killarney, -.xi.1905 (NSW 145115); *Everist 3268*, Armore, c. 40 km W Dajarra, 24.xi.1947 (BRI); *Farrell 696*, 2 km N Smelter Stack, 20.xii.1976 (BRI); *Gittins 1131*, Dundowran, -.ix.1965 (BRI, NSW); *Hyland 6058*, Barrabas Scrub, 16.v.1972 (BRI, L, QRS); *Johnson 1801*, c. 21 km S Collinsville, 24.v.1960 (BRI); *Kenny & White 1026*, Crows Nest, -.x.1921 (BRI); *Longman s.n.*, Toowoomba, -.ix.1931 (K); *Moriarty 1450 & 1453*, Almaden-Chillagoe Rd, c. 5 km from Chillagoe, 24.viii.1973 (BRI, CANB, E); *F. Mueller s.n.*, Burnett River, undated (MEL 98179); *F. Mueller s.n.*, Port Denison, undated (MEL 98326); *Perry 1434*, 48.28 km SE Riversleigh Station, 11.vi.1949 (BRI); *Sellwood s.n.*, Biddaddaba, 1.vii.1965 (BRI 061280); *Shirley s.n.*, Mt Mistake, undated (BRI 266138); *Simmonds s.n.*, Milton, 17.xi.1888 (BRI); *Stanley s.n.*, Cania Gorge, c. 30 km NW Monto, 3.xi.1976 (BRI 219548); *Stocker 1064*, Rocky River area, 11.ix.1973 (BRI, CANB, L, QRS); *Weatherhead s.n.*, Benarkin, undated (BRI 266131); *Webb 657*, Mungana Caves area, 17.vi.1945 (CANB, JCT); *Webb & Tracey 7274*, W Mt Garnet, 1962 (BRI); *Webb & Tracey 7399*, Davies Creek, Lamb Range between Mareeba and Kuranda, 1962 (BRI); Webb & Tracey 10162, Black Rock, c. 26 km S Lynd Junction on Hann Highway between Hughenden and Mt Garnet, 19.v.1970 (BRI).

NEW SOUTH WALES: *Alkin s.n.*, Bulli Mount, 9.i.1880 (Z); *Bäuerlen 336*, Lower Shoalhaven, -.i.1884 (MEL); *Bauer s.n.*, Port Jackson, undated (W 2 spec.); *Betche 78*, Manning River, -.ii.1882 (MEL); *Blakely s.n.*, Hornsby, -.vi.1917 (NSW 145106); *Blaxell 258, Pickard & Hayes*, Pikapene State Forest, SW Casino, 20.iv.1969 (NSW); *Boorman s.n.*, Paterson River, -.viii.1906 (NSW 145126); *R. Brown s.n., J.J. Bennett no. 2310*, Port Jackson, 1802-1805 (BM, E, K); *Burbidge 2873*, S Camden, 11.x.1948 (CANB); *Burgess s.n.*, Silverdale, 7.vii.1962 (CBG 012579); *Chadwick 1376*, Wollongong district, 19.iii.1946 (NSW); *Chapman s.n.*, Mosman, 25.xi.1906 (SYD); *Constable 24027*, Kempsey-Bellbrook Road, 20.i.1953 (NSW); *Constable 5898*, Kanangra, 16 km SE Jenolan Caves, 23.v.1965 (NSW); *Crawford 361*, Moona Plains, Walcha, -.xii.1884 (MEL); *Dunlop 152*, Little Forest, 8 km from Milton, 1.x.1968 (CBG, DNA); *Evans s.n.*, Eastwood, 10.i.1966 (NSW 145107); *Fraser & Vickery s.n.*, Clarencetown, 7.xi.1936 (L, NSW 145137); *Fraser & Vickery s.n.*, Coneac district, 3.ii.1937 (NSW 145138); *Gregson s.n.*, Barrington River, 2.ii.1898 (NSW 145146); *Hitchcock 97*, Sandy Creek, 7 km E Aberdeen, 19.xi.1978 (NSW); *Johnson & Constable s.n.*, Caird's Gap, Liverpool Range, 31.x.1954 (NSW 145152); *Michael s.n.*, Cremorne Point, 1929 (NSW); *Morrison 5104*, Pymble, 14.5 km NW Sydney, 3.xi.1896 (K, MEL) NSW); *F. Mueller s.n.*, Clarence River, undated (MEL 98340); *Oxenford s.n.*, Nymboida, 18.xi.1957 (NSW); *Rodway s.n.*, Nowra to Berry, -.x.1917 (HO 23619, NSW 145102); *Rodway s.n.*, Brundee, Crookhaven River, -.ii.1921 (NSW 145201); *Salasoo s.n.*, Smith's Lake, S Forster, 5.i.1967 (NSW); *Schodde 5168*, Yellow Rock Creek, c. 6.4 km SW Albion Park, Central Coast, 13.xii.1966 (A, CANB, CHR, K, L, NSW); *Schwarz 61*, Ash Island, undated (W); Sieber 267, Port Jackson, 1823 (B, BR, G, L, LE, MEL, MO, W 4 spec.); *Streimann 8029*, Macquarie Pass, 28 km SW Wollongong, 12.viii.1972 (A, BISH, CBG, L); *Telford 2242*, Upper Allyn River, 24.xi.1970 (CBG); *Telford 2335*, Upper Macleay River, 26.xi.1970 (CBG); *Telford 2852*, O'Sullivan's Gap, 14.5 km N Bulahdelah, 15.ii.1971 (CBG); *Whaite 2129*, Maitland Bay, 30.i.1959 (NSW); *Willis s.n.*, Cambewarra Mt near Nowra, 22.iii.1954 (MEL 98352).

PAPUA NEW GUINEA: *Australian Forest Survey Co. NGF268*, Yalu Camp area, Morobe District, 7.vii.1944 (BRI, LAE); *Brass 1586*, Domera River, 31.v.1926 (BRI, LAE); *Garrett-Jones ANU 21125*, Lae subdistrict, Morobe Province, 30.iv.1976 (CANB).

Distribution and ecology (Map 11)

In Australia, *C. tomentosum* var. *tomentosum* is known to occur chiefly in the coastal regions of Western Australia, Northern Territory, Queensland and New South Wales. A few inland collections, however, have been made from Western Australia and Queensland. In Western Australia, the distribution is mainly in the north-western coastal areas between Dampier and Derby. It has also been recorded from southern Kimberley though its occurrence in northern Kimberley is highly likely. From the interior of that State, it has been collected along the north-western fringes of the Gibson Desert. Within Western Australia this taxon is known to occur below 26°S. Distribution in the Northern Territory has been reported from near Darwin, and from Sir Edward Pellow Group of Islands in the Gulf of Carpentaria.



Map 11. Distribution of *C. tomentosum* var. *tomentosum* ○, *C. tomentosum* var. *mollissima* ●.

In Queensland, the distribution is sparse in the northern half with frequency of records gradually increasing towards south. The northern-most distribution limit along the east coast is near Iron Range in the Cape York Peninsula, and the southern limits extend over the border into north-eastern New South Wales. On the Gulf side, it has been recorded from near Aurukun Mission. From the interior of the State, it is known to occur in the areas around Mt Isa and Cloncurry. The occurrence in New South Wales is fairly dense but restricted to the coastal areas between 28° and 36°S and between 150° and 154°E. Within this area, the taxon is known to occur throughout from the north-eastern tip of the State southwards to Ulladulla Township. It has not been recorded from the dryer interior parts of the State.

Collections from Papua New Guinea are the only ones examined from outside Australia. The occurrence of this taxon in Papua New Guinea was first recorded by R.C. Bakhuizen (1929) who also for the first time relegated *C. medium* to a synonym of *C. tomentosum*. Since then, this taxon has not been frequently recorded from that region. According to Moldenke (1959, 1971, 1980), this species has been cultivated in Australia, Belgium, Brazil, California in the U.S.A., France and Russia. Specimens from cultivation have been examined from the Waite Agricultural Research Institute Adelaide, Botanic Gardens Melbourne and Botanic Gardens Geneva in Switzerland.

Growing usually on coarse soils, often with limestone outcrops associated with forest, stunted rainforest or deciduous vine thicket. Also occurs among "boulders", beachside scrub and along river banks.

Comments

Of all the species of *Clerodendrum*, *C. tomentosum* has the southern-most distribution in Australia. It has been recorded as far south as the sources of Shoalhaven River in south-eastern New South Wales. In this State, this species is called by the common name "Lolly Bush", but in Curtis's Botanical Magazine 37 (1813) t. 1518, the popular name recorded for *C. tomentosum* is "Downy *Clerodendrum*, or Cumberland Tree". Due to velvety-pubescent foliage and inflorescence, this species has been called by some "Hairy *Clerodendrum*".

In Sims' (1813) view, "Ventenat's figure in the Jardin de Malmaison seems to have been taken from a weakly flowering plant. Mr. Brown has even expressed a doubt whether it be the same species, on account of there being others so nearly related, as not to be very easily distinguished".

According to Webb (1948), this species was "suspected on several occasions of poisoning stock in New South Wales". In Anderson's (1947) view, the timber of *C. tomentosum* var. *tomentosum* is soft, light in weight, and has no particular use.

Abnormal flower parts have been noticed in collections by *E. Gauba s.n.*, (CBG 002949) and *R. Schodde 5168* (CANB). In both collections, some flowers were found to be with calyx 4-6 (-7)-lobed, corolla 4-6-lobed and stamens 5.

8b. var. **lanceolatum** (F. Muell.) Munir, comb. & stat. nov.

Lectotype: *P. Walcott s.n.*, Nickol Bay, Western Australia, undated (MEL 98304, lectotype designated here!; K, MEL 98302, MEL 98303 — isolectotypes!).

C. lanceolatum F. Muell., Fragm. 3 (1863) 145, **basionym**; Benth., Fl. Aust. 5 (1870) 63; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Bailey, Qld Fl. 4 (1901) 1183; Bailey, Compr. Cat. Qld Pl. (1913) 386, fig. 364; Domin, Biblioth. Bot. 89 (1928) 558; C. Gardner, Enum. Pl. Aust. Occ. 3 (1931) 112; Mold., Résumé Verbenac. etc. (1959) 427; Beard, W. Aust. Pl. edn 2 (1970) 113; Mold., Fifth Summary Verbenac. etc. 1 (1971) 345; Sixth Summary Verbenac. etc. (1980) 335; Baines, Aust. Pl. Gen. (1981) 97; Green, Cens. Vasc. Pl. W. Aust. (1981) 89; Elliot & Jones, Encyc. Aust. Pl. 3 (1984) 49.

Type: As for above.

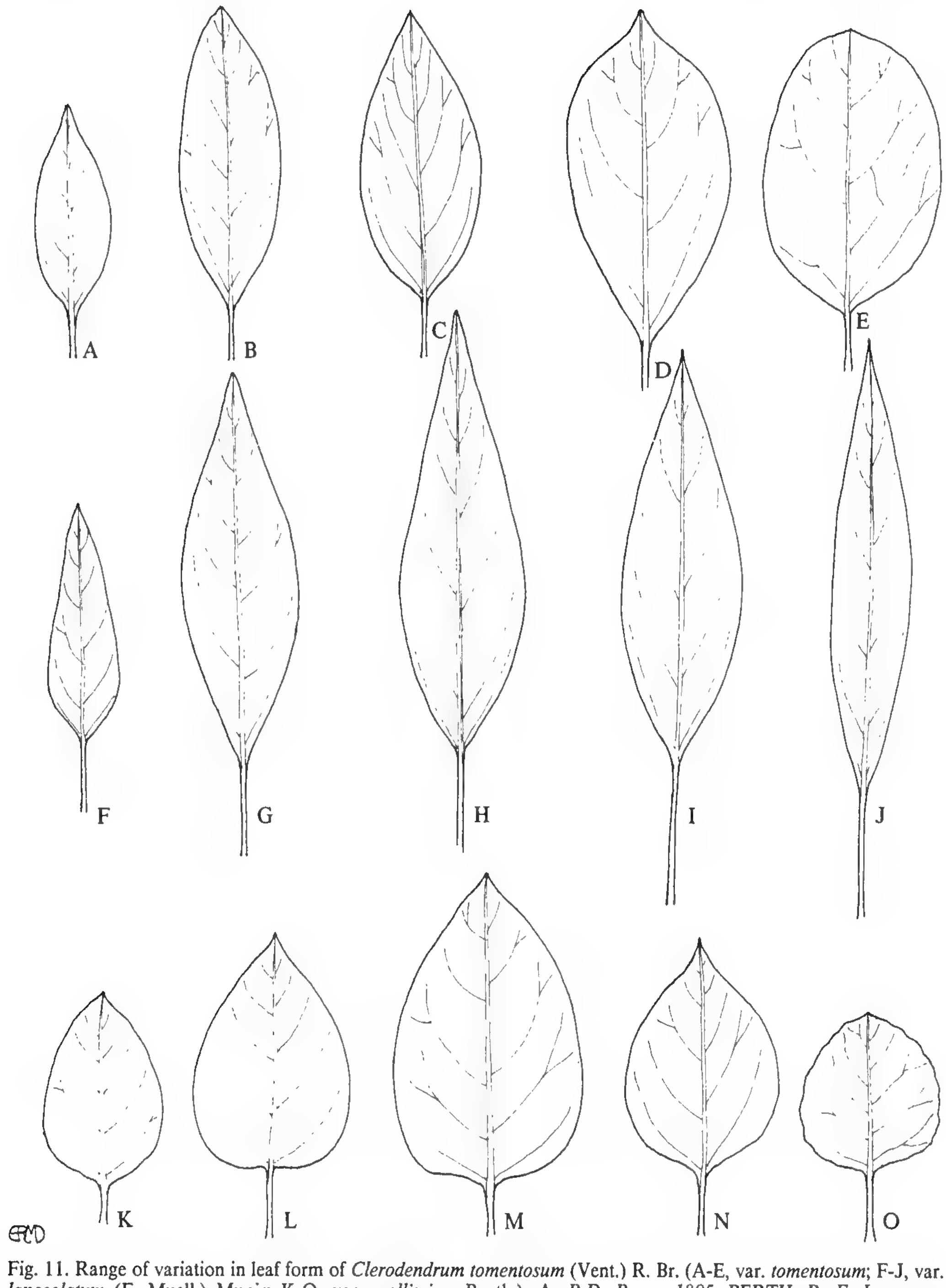


Fig. 11. Range of variation in leaf form of *Clerodendrum tomentosum* (Vent.) R. Br. (A-E, var. *tomentosum*; F-J, var. *lanceolatum* (F. Muell.) Munir; K-O, var. *mollissima* Benth.). A, *R.D. Royce 1895*: PERTH; B, *E. Long s.n.*: QRS039812; C, *D.M. Harington 1*: King's Park, Perth; D, *W.T. Jones 3829*: CANB; E, *F. v. Mueller s.n.*: MEL98420; F, *A.R. Fairall 2088*: King's Park, Perth; G, *G.N. Batianoff 193 & T.J. McDonald s.n.*: BRI; H, *C.H. Gittins 1438*: NSW; I, *W.V. Fitzgerald 1223*: PERTH; J, *S.J. Forbes 2564*: AD; K, *U. Johnson 31*: NSW; L, *N.T. Burbidge 1371*: PERTH; M, *I.R. Telford 6407 & G. Butler s.n.*: CBG; N, *C.A. Gardner 7005*: PERTH; O, *C.A. Gardner 7013*: PERTH.

Typification

C. tomentosum var. *lanceolatum* is based on Pemberton Walcott's (s.n.) collection from Western Australia consisting of at least 4 duplicates. Since the author of the basionym did not select any of them as a holotype, it is necessary to choose a type for this name. All syntypes were annotated by F. Mueller who apparently used them in preparing the original description of *C. lanceolatum*. Of these syntypes, MEL 98304 seems a better representative of this taxon and is, therefore, designated here as the lectotype.

Diagnosis (Fig. 11)

Amongst the infraspecific taxa of *C. tomentosum*, var. *lanceolatum* is distinguished by its leaf-blades being narrow-lanceolate, cuneate-attenuate towards both ends and pubescent-tomentose all over; the inflorescence less congested than in the typical form; the calyx pubescent-tomentose outside, glandular and pubescent-tomentose inside; the corolla-tube usually densely villous-tomentose outside, sometimes glabrescent in specimens having very narrow and small glabrescent leaves; fruit a little smaller than the typical form, mostly 5-7 by 4-6 mm.

Representative specimens (Collections seen: Australian 35, non-Australian 0)

WESTERN AUSTRALIA: *Beard 2842*, 15 km N Marble Bar, 16.viii.1963 (King's Park Perth); *Beard 3583*, Cape Range, W Learmouth, 22.vii.1964 (King's Park Perth, PERTH); *Blockley 867*, Winjina Gorge, Napier Range, 6.viii.1968 (King's Park Perth); *Broadbent 1957*, Pyramid, SE Roebourne, 28.v.1954 (BM, CANB); *Fairall 2088*, 45 km from Carnegie to Mt Everard, 28.vii.1966 (King's Park Perth, PERTH); *Fitzgerald 1478*, Packhorse Range, -.ix.1905 (NSW, PERTH); *Forbes 2564*, 9 km SSW Bungle Bungle, SE Kimberley, -.vii.1984 (AD, MEL); *Forbes 2594*, between Njitparriya and Dilmariyu, SE Kimberley, 9.vii.1984 (AD, MEL); *Forrest s.n.*, Jones Creek & George River, S Roebourne, 1878 (AD, MEL 98415); *Forrest s.n.*, Sherlock River, 1878 (MEL 98306); *Gardner 3049*, banks of Ashburton River, 17.viii.1932 (PERTH); *George 13426*, Drysdale River National Park, 5.viii.1975 (PERTH); *Gittins 1438*, southern foot of Bold Bluff, Kimberley, -.vii.1967 (NSW, PERTH 2 spec.); *Kenneally 4400*, Euro Gorge, 15°03'S, 126°44'E, 17.viii.1975 (CANB, PERTH); *King s.n.*, between the Gascoyne & Fortescue Rivers, 1885 (MEL 98310); *Power 852*, Camballin, -.v.1970 (PERTH); *Royce 1939*, N Cecilia Mount, 25.v.1947 (PERTH); *Stanley s.n.*, Yandeyarra, -.viii.1929 (PERTH); *Walcott s.n.*, Nickol Bay, undated (MEL 98304, lectotype; K, MEL 98302, MEL 98303 — isolectotypes).

QUEENSLAND: *Batianoff & McDonald 193*, Coorooman Creek, 6 km S Emu Park, 13.vii.1977 (BRI); *Batianoff & McDonald 670*, Rosslyn Head National park, 7 km SE Yeppoon, 9.ix.1977 (BRI); *Moriarty 1473*, Almaden-Chillagoe Road, c. 9 km from Chillagoe, 24.viii.1973 (BRI, CANB); *Story & Yapp 206*, 14.48 km W Wilpeena Park Homestead, 23.vii.1962 (BRI, CANB, MEL); *Whitehead s.n.*, Fletcher River, c. 64.37 km S Charters Towers, 6.xi.1920 (BRI).

Distribution and ecology (Map 4)

Var. *lanceolatum* is endemic to mainland Australia. It has been recorded from north-north-west of Western Australia and north-east of Queensland. In Western Australia, it has been found mainly in the Kimberley and in the coastal region between Eighty Mile Beach and Exmouth Gulf. The only inland locality is between Carnegie and Mt Everard to the south-west of Gibson Desert. Distribution in Queensland is limited to a few localities. Here it is known to occur in the north-east of Rockhampton, south of Charters Waters and near Chillagoe on Atherton Tableland. Further inland, one locality to the west of Rockhampton is near Wilpeena Park Homestead.

Growing mostly on sandy or rocky substrate, sometimes with limestone in "scrub" to "low woodland" vegetation and often associated with banks of creeks. In open heath scrub vegetation include mainly *Banksia*, *Casuarina* and *Eucalyptus* species.

Comments

According to Bentham (1870), *C. lanceolatum* "is not very definitely separated from *C. tomentosum*". The present investigations agree and, therefore, *C. lanceolatum* is relegated to the rank of a variety under *C. tomentosum*. The former differs from *C. tomentosum* only by its narrow lanceolate leaves, somewhat lax inflorescence, more dense pubescent tomentum on the inner surface of calyx, dense villous-tomentum outside corolla-tube and somewhat smaller sized fruit. Sometimes, however, it is difficult to place intermediate forms of *C. lanceolatum* and *C. tomentosum*. Generally, the very narrow and small leaved collections tend to have glabrescent leaf-blade, calyx and corolla-tube.

Moldenke (1959) recorded this taxon as endemic in Northern Territory. Subsequently, in 1971, he expanded its distribution to Western Australia and Queensland. According to present studies, however, the occurrence of this taxon in the Northern Territory has not been confirmed.

Affinities

Amongst the infraspecific taxa of *C. tomentosum*, var. *lanceolatum* is nearest to the typical variety by its leaf-blades being much longer than wide, cuneate-attenuate towards the base, tomentose all over or pubescent-glabrescent above and corolla-tube villous-tomentose or sometimes glabrescent outside. For distinguishing characters, see "Key to the species and infraspecific taxa".

There are a few characters in common between var. *lanceolatum* and *C. floribundum* var. *angustifolium* (see "Affinities" under the latter taxon).

8c. var. **mollissima** Benth., Fl. Aust. 5 (1870) 63; Bailey, Qld Fl. 4 (1901) 1183; Bailey, Compr. Cat. Qld Pl. (1913) 386; Ewart & Davies, Fl. N. Territory (1917) 238; Mold., Fifth Summary Verbenac. etc. 1 (1971) 345, 457; Sixth Summary Verbenac. etc. (1980) 335.

Lectotype: *Dr. Martin 44*, Roebuck Bay, Western Australia, undated (MEL 98342, lectotype designated here!); *B. Gull s.n.*, Caledon Bay, N.T., 2.x.1867 (MEL 98346, syntype!).

C. ovatum R. Br., Prodr. Fl. Nov. Holl. (1810) 511, p.p. quoad descr. "B. folia calycesque pubescentes"; Sprengel, Syst. Veg. 2 (1825) 758, p.p.; Walp., Rep. Bot. Syst. 4 (1845) 105, p.p. quoad descr. "B. folia calycesque pubescentes"; Schauer in A. DC., Prodr. 11 (1847) 671, p.p. quoad descr. "B. folia calycesque pubescentes".

Type: *R. Brown s.n. J.J. Bennett no. 2315*, Allen Island, Gulf of Carpentaria, Queensland, 1802 (BM, E, K, W — syntypes!).

Typification

C. tomentosum var. *mollissima* is based on two collections, one by Dr. Martin from Roebuck Bay, Western Australia, and another by B. Gull from Caledon Bay, Northern Territory. Since the author did not designate a holotype for this taxon, a lectotype was chosen. Of the two syntypes, Dr. Martin's collection from Roebuck Bay seems to be a better representative of this variety. It has been selected here as the lectotype for this taxon.

Diagnosis (Fig. 11)

Var. *mollissima* differs from the typical variety by its leaf-blades being broadly ovate, rounded at the base, densely velvety-tomentose all over; the inflorescence more congested, densely villous-tomentose, usually more so than the typical form; the corolla-tube always villous-tomentose outside, and never glabrous.

Representative specimens (Collections seen: Australian 22, non-Australian 0)

WESTERN AUSTRALIA: *Briggs 3673*, Geikie Gorge, 16 km NE of Fitzroy Crossing, 17.vi.1970 (NSW); *Broadbent 792*, between Wallal and De Grey, 31.v.1953 (BM); *Broadbent 821*, Noonkanbah, 9.vi.1953 (BM); *Burbidge 1297*, Kalgi Station, 80-mile Beach, 1.vii.1941 (PERTH); *Burbidge 1371 & 1482*, Anna Plains Stn., 80-mile Beach, 9.vii.1941 (PERTH 2 spec.); *Davis s.n.*, between Lanji Bridge and Neilibublica Well, 29.vi.1943 (NSW 145122); *Forrest s.n.*, Fitzroy River, 1883 (MEL 98379, MEL 98380); *Froggat s.n.*, King Sound, 1888 (MEL 98364);

Gardner 7005, Broome, 28.iv.1944 (PERTH); *George 13853*, Drysdale River National Park, 15.viii.1975 (CANB, PERTH); *Johnstone s.n.*, between Nickol Bay and Kimberley River, 1887 (MEL 98416); *Kenneally 6861*, Poinciana Well, Dampierland, 16 km N Broome, 15.ix.1978 (PERTH); *Martin 44*, Roebuck Bay, undated (MEL 98342, lectotype); *Telford 6407 & Butler s.n.*, Kimbolton Homestead, c. 70 km NNE Derby, 2.viii.1977 (CBG); *Tepper 16*, Roebuck Bay, -.viii.1889 (MEL 98128); *Wittwer 2300*, Kimbolton Homestead, 2.vii.1980 (King's Park Perth).

NORTHERN TERRITORY: *B. Gull s.n.*, near Caledon Bay, Arnhem Land, 2.x.1867 (MEL 98346, syntype).

Distribution and ecology (Map 11)

Var. *mollissima* is known to occur chiefly in the north-north-west of Western Australia with only one record from near Caledon Bay in Northern Territory. The distribution in Western Australia is along the North West Coastal Highway, Northern Highway and in the northern and western Kimberley region. Distribution along the Highways has been recorded from between Broome and Dampier, chiefly near Eighty Mile Beach and Roebuck Bay. Collections from the Kimberleys have come from Drysdale River National Park, King Sound area and along Fitzroy River.

Growing usually on sandy soils and often found in "fragmented deciduous vine thickets" on coastal dunes ("hind dunes").

Affinity

Var. *mollissima* resembles the typical form by its inflorescence being compact and densely tomentose, and corolla-tube villous-tomentose outside. However, var. *mollissima* may be distinguished by its leaf-blades being very broadly ovate with an almost rounded base, densely velvety-tomentose all over, and corolla-tube always villous-tomentose outside, never glabrescent.

9. **Clerodendrum costatum** R. Br., Prodr. Fl. Nov. Holl. (1810) 511; Sprengel, Syst. Veg. 2 (1825) 759; Walp., Rep. Bot. Syst. 4 (1845) 105; Schauer in A. DC., Prodr. 11 (1847) 671; Benth., Fl. Aust. 5 (1870) 64; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; Bailey, Synop. Qld Fl. (1883) 381; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Bailey, Cat. Indig. & Natur. Pl. Qld (1890) 36; Qld Fl. 4 (1901) 1184; Mold., Résumé Verbenac. etc. (1959) 208; Fifth Summary Verbenac. etc. 1 (1971) 345; Sixth Summary Verbenac. etc. (1980) 334, 348, 384; Baines, Aust. Pl. Gen. (1981) 97.

Lectotype: *J. Banks & D. Solander s.n.*, Endeavour River, Queensland, Australia, 1770 (BM, lectotype designated here!; BM, isolectotype!).

C. cunninghamii Benth., Fl. Aust. 5 (1870) 64, p.p. excl. glabrous syntypes *Daemel s.n. & Jardine s.n.* from Cape York, Qld; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; Bailey, Synop. Qld Fl. (1883) 381; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Bailey, Cat. Indig. & Natur. Pl. Qld (1890) 36; Qld Fl. 4 (1901) 1184, p.p. excl. glabrous spec. of *Daemel s.n. & Jardine s.n.* from Cape York, Qld; Compr. Cat. Qld Pl. (1913) 386, t. XI; Ewart & Davies, Fl. N. Territory (1917)238; Bakh. in H.J. Lam & Bakh., Bull. Jard. Bot. Buitenzorg, Ser. III, 3 (1921) 89; Mold., Résumé Verbenac. etc. (1959) 200, 207, 208, 215; Backer & Bakh.f., Fl. Java 2 (1965) 607; Mold., Fifth Summary Verbenac. etc. 1 (1971) 335, 345, 358; Court, Cat. Live Pl. Nat. Bot. Gard. Canberra (1980) 81; Mold., Sixth Summary Verbenac. etc (1980) 325, 334, 339, 348; Baines, Aust. Pl. Gen. (1981) 97; Munir in Morley & Toelken, Fl. Pl. Aust. (1983) 286, 287; Elliot & Jones, Encyc. Aust. Pl. 3 (1984) 48 & t.; Williams, Nat. Pl. Qld 2 (1984) 84, 85 coloured plate; Stanley in Stanley & Ross, Fl. SE Qld 2 (1986) 369, p.p. excl. leaf descrip.: "glabrous"; Dunlop, Vasc. Pl. N. Territory (1987) 79, **syn. nov.**

Lectotype: *A. Cunningham 183*, Goulburn Island South, Northern Territory, Australia, March 1818 (K, lectotype designated here!; BM, K — isolectotypes!); *C. Hulls s.n.*, Escape Cliffs, Northern Territory, Australia, undated (K, MEL 98068, MEL 98070 — syntypes!); *A. Cunningham 80*, Endeavour River, Queensland, Australia, July 1820 (K, MEL — syntypes!).

Typifications

C. costatum is based on a Joseph Banks and Daniel Solander (s.n.) collection from Endeavour River, Queensland. It consists of at least two duplicates, both preserved in Herb. BM. As no holotype was designated by the author a lectotype is selected here. Of the two syntypes, the one with the label "Type Specimen" and the name "*Clerodendrum costatum* R. Br." written on the herbarium sheet seems to be a better representative of this species, and is therefore selected here as the lectotype.

C. cunninghamii Benth. was based on five different collections namely *Cunningham 183* and *C. Hulls s.n.* from Northern Territory, *Cunningham 80, Daemel s.n.* and *Jardine s.n.* from Queensland. As no holotype was designated by the author, a lectotype is selected here. All the syntypes were seen and apparently used by the author in preparing the protologue of this species. The author, however, did not realise that out of the five specimens, three tomentose and two glabrous syntypes respectively belong to two different taxa. In the protologue of *C. cunninghamii*, Bentham (1870) described "either quite glabrous or the underside of the leaves and inflorescence more or less tomentose". In reality, the "glabrous" and "tomentose" characters were not present on the same plant, but on different syntypes of *C. cunninghamii* Benth. The glabrous syntypes (*Daemel s.n.* & *Jardine s.n.*, from Cape York Peninsula) are here found to belong to *C. longiflorum* Decne. var. *glabrum* Munir and the tomentose ones to *C. costatum* R. Br. The inflorescence and leaves in the tomentose syntypes are mostly intact and well preserved, while in the glabrous syntypes most flowers have fallen off and the leaves are also no longer connected with the main branch. Since both elements were used in preparing the protologue, the lectotype of *C. cunninghamii* is chosen from the tomentose syntypes. The specimen collected by *Allan Cunningham 183* from Goulburn Island South in the Northern Territory, and now preserved in Kew herbarium, seems to be the best representative of this taxon and is designated here as the lectotype.

Description (Fig. 12)

A shrub or small tree, (1-) 2-5 (-7) m high. *Stem* with a brownish furrowed bark. *Leaves* broadly ovate or elliptic-ovate, acute or obtuse, narrowed at base, (4-) 6-18 (-22) cm long, (2.5-) 4-10 (-15) cm wide, glabrous above, pubescent-tomentose underneath, membranous; petiole pubescent, (10-) 20-50 (-75) mm long. *Inflorescence* a corymb-like thyrse, more or less pubescent-tomentose; peduncle pubescent, primary lateral branches (25-) 50-60 (-80) mm long. *Flowers* pedicellate, numerous in a broad terminal corymb-like dichasium; pedicels pubescent, (3-) 5-10 (-15) mm long. *Calyx* campanulate, 8-12 mm long, puberulus-pubescent outside, glabrous and glandular inside; lobes ovate-lanceolate, or sometimes almost triangular, 3-7 mm long, 3-4 mm wide at base; tube narrowed at base, 3-5 mm long. *Corolla* white, hypocrateriform, glabrous; tube slender, (45-) 50-60 (-70) mm long, 2-3 mm diam.; lobes elliptic-oblong or oblong-obovate, 5-10 (-12) mm long, 2-5 (-7) mm wide. *Stamens* much exserted; filaments inserted above middle of corolla-tube, white, glabrous, filiform, 33-40 mm long; anthers oblong, 2-3 mm long. *Ovary* glabrous, globose, 1-2 mm diam.; style white, much exserted, filiform, glabrous, 60-100 mm long. *Fruit* globose-obovoid, glabrous, purple-black or blue-black, 7-10 mm long, 6-12 mm diam. at top; fruiting calyx dark-red, enlarged, funnel-shaped, shortly contracted at base, margins very spreading or recurved, 20-25 mm diam.

Representative specimens (Collections seen: Australian 70, non-Australian 3)

AUSTRALIA: NORTHERN TERRITORY: *Byrnes 1496*, East Point, Darwin, 16.iv.1969 (BRI, CBG, DNA, NT); *Carolin 6917*, Humpty Doo, 16.v.1968 (SYD); *Chippendale 4496*, Black Jungle, 51.5 km SE Darwin, 27.v.1958 (MEL, NT); *Cunningham 183*, South Goulburn Island, -.iii.1818 (K, lectotype; BM, K — isolectotypes of *C. cunninghamii* Benth.); *Dunlop 3914*, Refuge Bay, Elcho Island, 15.vii.1975 (DNA, NT); *Gulliver s.n.*, Melville Bay, 4.x.1867 (MEL 98076); *Henshall 878*, Peron Island, 28.x.1974 (NT); *Hulls s.n.*, Escape Cliffs, undated (K, MEL 98068, MEL 98070, syntypes of *C. cunninghamii* Benth.); *Lazarides & Adams 298*, near Nourlangie Safari Camp, c. 145 km NNE Pine Creek Township, 22.iii.1965 (CANB, L, NT); *McKean 1360*, Buffalo Creek, 22.iii.1974 (CANB,

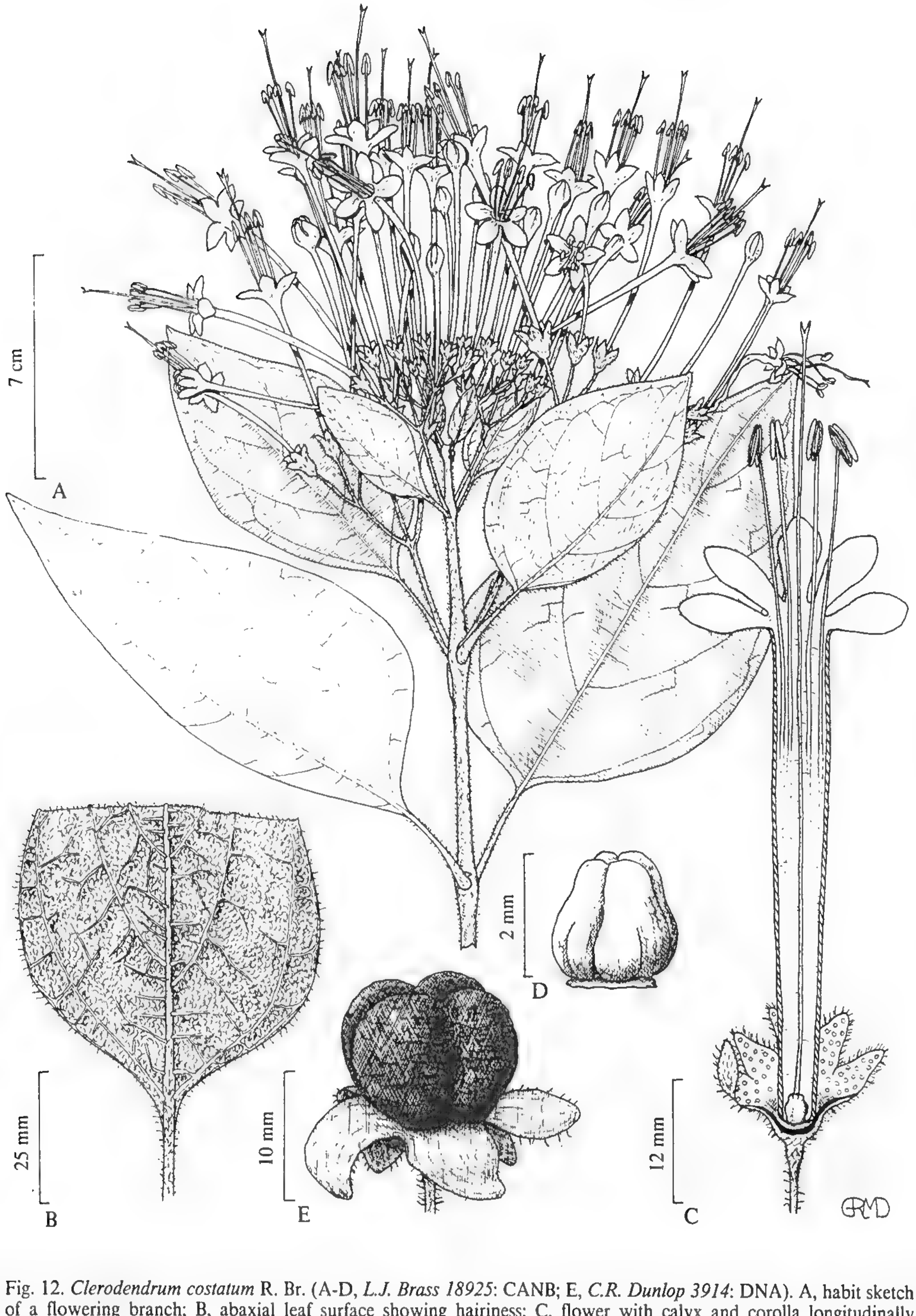


Fig. 12. *Clerodendrum costatum* R. Br. (A-D, *L.J. Brass 18925*: CANB; E, *C.R. Dunlop 3914*: DNA). A, habit sketch of a flowering branch; B, abaxial leaf surface showing hairiness; C, flower with calyx and corolla longitudinally cut open showing androecium and gynoecium; D, ovary; E, fruit with persistent calyx.

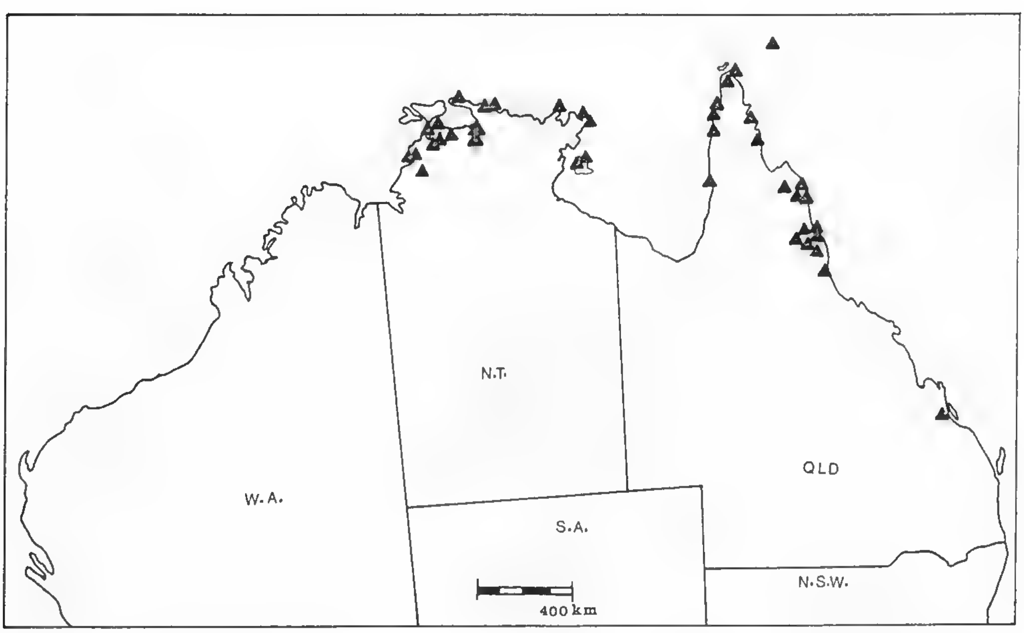
DNA, MO, NT); *Must 1032*, 51.5 km SW Giddy River Crossing, 18.vi.1972 (CANB, DNA, K, NT); *Parker 691*, Berry Springs, 21.ii.1977 (CANB, DNA, NT); *Rankin 2322 & 2323*, Bamboo Pass, Marrakai Track, 30.iv.1980 (DNA, MO); *Robinson 419*, Daly River levee and banks, 12.v.1964 (BRI, CANB, MEL, NT); *Specht 269*, Little Lagoon, Groote Eylandt, Gulf of Carpentaria, 2.iv.1948 (AD, BRI, CANB, L, MEL, PERTH); *Story 8332*, 250 km ENE Darwin, 13.vi.1978 (BRI, CANB, DNA); *Waddy 566*, near Angurugu, Groote Eylandt, 7.x.1976 (DNA, NT); *Wightman 1923*, Murgenella, Brogden Point, 8.vii.1985 (AD, CANB, DNA).

QUEENSLAND: *Bailey s.n.*, Somerset, -.vi.1897 (BRI); *Bailey s.n.*, Mapoon, 20.v.1901 (BRI); *Banks & Solander s.n.*, Endeavour River, 1770 (BM, lectotype; BM, isolectotype); *Blake 23310*, Cooktown, mouth of Endeavour River, 16.v.1970 (BRI 2 spec., L, MEL, PERTH); *Blake 23427*, NW Cooktown, near Isabella Falls, 20.v.1970 (BRI); *Brass 18895*, Jardine River, Cape York Peninsula, 20.v.1948 (A, CANB, L); *Brass 18925*, Red Island Point, Endeavour Strait, 23.v.1948 (A, CANB, L, LE); *Dallachy s.n.*, Rockingham Bay, undated (MEL 98452); *Dunlop 1656*, 3.2 km from Iron Range Airport, Cape York Peninsula, 11.vi.1970 (CBG); *Fitzsimon 64*, S.F.R. 755, Barong L.A., 9.ix.1976 (QRS); *Garnett s.n.*, dunes adjacent Edward River Settlement, 20.iv.1980 (JCT); *Heatwole & Cameron 544*, Murray Island, Torres Strait, 17.vii.1974 (QRS); *Stocker 1504*, EP14, Python L.A., S.F.R. 185, Dunbulla, 16.viii.1976 (QRS); *Smith 10660*, Grassy Hill, Cooktown, 28.viii.1959 (BRI, L); *Webb & Tracey 7144*, Galloway Creek, Bamaga, tip of Cape York Peninsula, 1962 (BRI); *Williams 78091*, Andoom, Weipa Area, 12.vi.1978 (BRI).

PAPUA NEW GUINEA: *Brass 7793*, Lake Daviumbu, Middle Fly river, -.ix.1936 (A, BRI, CANB); *Brass 8346*, Gaima, Lower Fly River's east bank, -.xi.1936 (A, CANB); *Gruttwall 1503*, Raba Raba, Milne Bay district, 20.ix.1965 (BRI, L, LAE).

Distribution and ecology (Map 12)

In Australia, *C. costatum* is known to occur in the tropics of Northern Territory and Queensland. Almost all known localities are in the coastal areas and on nearby off-shore Islands. In Northern Territory, the distribution is restricted between 11° and 14°S and 130° and 137°E. The main occurrence is in the Darwin region, particularly in the areas to the south and south-east of Darwin. It has been collected from several places along the northern coast and also from a few off-shore Islands. In the Gulf of Carpentaria, it has been recorded only from Groote Eylandt. It has not been reported from Arnhem Land where it is most likely to occur.



Map 12. Distribution of *C. costatum* ▲.

Distribution in Queensland is mainly in the coastal areas of Cape York Peninsula where it occurs from Atherton Tableland northwards to the tip of the Peninsula. On the Gulf side, it occurs as far south as Edward River. The only two records outside Cape York Peninsula are one from Murray Island in the Torres Strait and another from near Rockhampton along the eastern coast. This species has not been reported from the interior of Queensland.

Collections from Papua New Guinea are the only ones examined from outside Australia.

According to Moldenke (1959, 1971, 1980) this species has been cultivated in British Guyana, England, Java and Mozambique.

Growing usually on coarse sandy or rocky soils, but also recorded from loam. Often on banks of creeks or rivers, or coastal sand dunes and associated with "savannah mixed open forest" and "rainforest".

Comments

Due to lack of flowers in the type of *C. costatum*, very little effort was made in the past in comparing its leaves and infructescence with *C. cunninghamii* which is now regarded as synonymous. Bakhuizen (1921) for the first time recognised *C. cunninghamii* and *C. costatum* as conspecific. However, he erroneously placed the earlier validly published *C. costatum* in the synonymy of *C. cunninghamii.*

The leaf length of *C. costatum* was recorded by Bentham (1870) as "4 to 5 lines long", i.e. 8.4 to 10.5 mm long. This is far too short for the big leaves of this species. Perhaps the word "lines" was a misprint for "inches" which agrees more closely with the known leaf-length of *C. costatum.*

Of all the Australian taxa of *Clerodendrum*, *C. costatum* R. Br. (=*C. cunninghamii* Benth.) and *C. longiflorum* Decne. have the longest corolla-tube, measuring 45 to 80 mm in length.

Two collections from Endeavour River, *Blake 23310* and *Persieh s.n. (MEL 98106)* have somewhat more dense indumentum on the abaxial surface of their leaf-blades, thinly pubescent on the adaxial leaf surface and outside the corolla-lobes. In all other characters, these collections fall well into the range of variation of this species. Sticks of this species are used by the natives for making fire according to Ewart & Davies (1917).

Affinities

Amongst Australian *Clerodendrum* species, *C. costatum* and *C. longiflorum* Decne. var. *glabrum* Munir are so similar that most Australian collections of *C. longiflorum* var. *glabrum* were identified as "*C. cunninghamii* Benth." The latter is synonymous with *C. costatum.* Both *C. costatum* and *C. longiflorum* var. *glabrum* have similar-shaped large leaves, the longest flowers of all Australian *Clerodendrum* species, a white corolla with a slender glabrous tube, glabrous and glandular on the inner surface of the calyx. *C. costatum* is easily identified by its leaf-blades being pubescent-tomentose underneath; petioles, peduncles, pedicels and outside of calyces are also pubescent. In *C. longiflorum* var. *glabrum*, the leaves, peduncles and flowers are completely glabrous.

C. costatum has several characters common with *C. tracyanum* such as the leaf-blades are pubescent-tomentose at least on the abaxial surface; petioles, peduncles, pedicels and the outside of calyces are pubescent. *C. tracyanum*, however, can be distinguished by its leaf-blades being velvety-pubescent on both surfaces and have a cordate base; the inflorescence is not exceeding the upper leaves; flowers much shorter, up to 10 mm long; calyx- and corolla-tubes have sparse gland-tipped hairs inside; the filaments and the style are hardly ¼ of the length of those of *C. costatum.*

In several characters, *C. costatum* is nearer to *C. tomentosum* (Vent.) R. Br. and *C. grayi* Munir (see "Affinities" under each of these species).

10. **Clerodendrum grayi** Munir, sp. nov.

Frutex elatus vel arbor parva, 3-5 m alta. *Caulis* erectus, ramosus, cylindricus, alto pectoris ± 6 m diametro; ramuli brunneoli, pubescenti-tomentosi. *Folia* oblonga vel anguste elliptico-oblonga, obtusa vel obtuse acuta, basi subrotundata, integra, (6-) 10-18 (-20) cm longa, (2-) 4-8 (-19) cm lata, superne puberula, infra pubescenti-tomentulosa, chartacea; petioli ferrugineo-pubescentes vel tomentosi, (1.5-) 2.5-5.5 (-7) cm longi. *Inflorescentia* thyrsus terminalis corymbosus, plus minusve pubescenti-tomentosus; pedunculus pubescenti-tomentosus, ramulis primariis lateralibus, 3-6 cm longis. *Flores* laxi, pedicellati; pedicelli pubescentes, 4-10 (-13) mm longi. *Calyx* campanulatus, 8-13 mm longus, extra pubescens, intra glaber et sparsim glandulosus; lobi triangulari-lanceolati, acuti, 5-9 mm longi, 3-4 mm lati. *Corolla* alba, hypocrateriformis, glabra sed tubo extra glanduloso, intra glabra, lobis extra puberulis; lobi oblongi vel elliptico-oblongi, 8-11 mm longi, (3-) 4-6 mm lati; tubus tenuis, subcylindricus, (25-) 30-35 (-40) mm longus, 1-1.5 mm diametro. *Stamina* multo exserta, super medium tubi corollae inserta; filamenta alba, filiformia, glabra, 30-35 mm longa; antherae oblongae, ± 2 mm longae. *Ovarium* glabrum, globosum, ad apicem leviter 4-lobatum, 1-1.5 mm longum; stylus albus, multo exsertus, filiformis, glaber, 60-75 mm longus. *Fructus* globulo-obovoideus, glaber, 7-10 mm longus, ad apicem 6-8 (-10) mm diametro; calyx fructu purpureo-ruber vel atro-ruber, accrescens, infundibuliformis, patens, 20-25 mm diametro.

Type: *B. Gray 1327, Upper Barron River, Kennedy Highway, lat. 17°* 25'S, long. 145° 31'E, Queensland, Australia, 12.iii.1979 (AD, holotype; QRS, isotype).

Description (Fig. 13)

A tall shrub or small tree, "3-5 m high". *Stem* erect, branched, cylindrical, ± 6 cm diam. at breast height; branchlets brownish, pubescent-tomentose. *Leaves* oblong or narrowly elliptic-oblong, obtuse or bluntly acute, somewhat rounded at base, entire, (6-) 10-18 (-20) cm long, (2-) 4-8 (-9) cm wide, puberulus above, pubescent-tomentulose below, chartaceous; petioles rusty-pubescent or tomentose, (1.5-) 2.5-5.5 (-7) cm long. *Inflorescence* a terminal corymbose thyrse, more or less pubescent-tomentose; peduncle pubescent-tomentose, primary lateral branches 3-6 cm long. *Flowers* lax, pedicellate; pedicels pubescent, 4-10 (-13) mm long. *Calyx* campanulate, 8-13 mm long, pubescent outside, glabrous and sparsely glandular inside; lobes triangular-lanceolate, acute, 5-9 mm long, 2.5-3.5 mm wide at base; tube narrowed at base, 3-4 mm long. *Corolla* white, hypocrateriform, glabrous but glandular outside tube, glabrous inside, puberulous outside lobes; lobes oblong or elliptic-oblong, 8-11 mm long, (3-) 4-6 mm wide; tube slender, almost cylindrical, (25-) 30-35 (-40) mm long, 1-1.5 mm diameter. *Stamens* much exserted; filaments inserted above middle of corolla-tube, white, filiform, glabrous, 30-35 mm long; anthers oblong, ± 2 mm long. *Ovary* glabrous, globose, faintly 4-lobed at top, 1-1.5 mm diam.; style white, much exserted, filiform, glabrous, 60-75 mm long. *Fruit* globular-obovoid, glabrous, 7-10 mm long, 6-8 (-10) mm diam. at top end; fruiting calyx purplish-red or dark-red, accrescent, funnel-shaped, spreading, 20-25 mm diam.

Specimens examined

AUSTRALIA: QUEENSLAND: *B. Gray 1327*, Upper Barron River, Kennedy Highway, 17°25'S, 145°31'E, 12.iii.1979 (AD holotype, QRS); *K. Sanderson 143*, S.F.R. 185, Robson L.A., E.P.9 sub-plot A, 17°10'S, 145°35'E, 31.v.1972 (QRS); *J. Tracy 14739*, Davies Creek, Forestry Road, S.F. 607, 17°04'S, 145°34'E, -.viii-ix.1971 (QRS).

Distribution and ecology (Map 3)

C. grayi seems to be endemic to the northern part of Queensland in Australia. The present known distribution is on Atherton Tableland with all localities to the south-south-east of Mareeba. So far, it seems restricted between latitudes 17° and 18°S, and longitudes 145° and 146°E.

Recorded as understorey in rainforest, growing "on soil derived from granite".

Comments

This species is named after Mr B. Gray, a collector at Herb. QRS. Previously, this species had been misidentified as *C. cunninghamii* Benth. which has a more or less similar

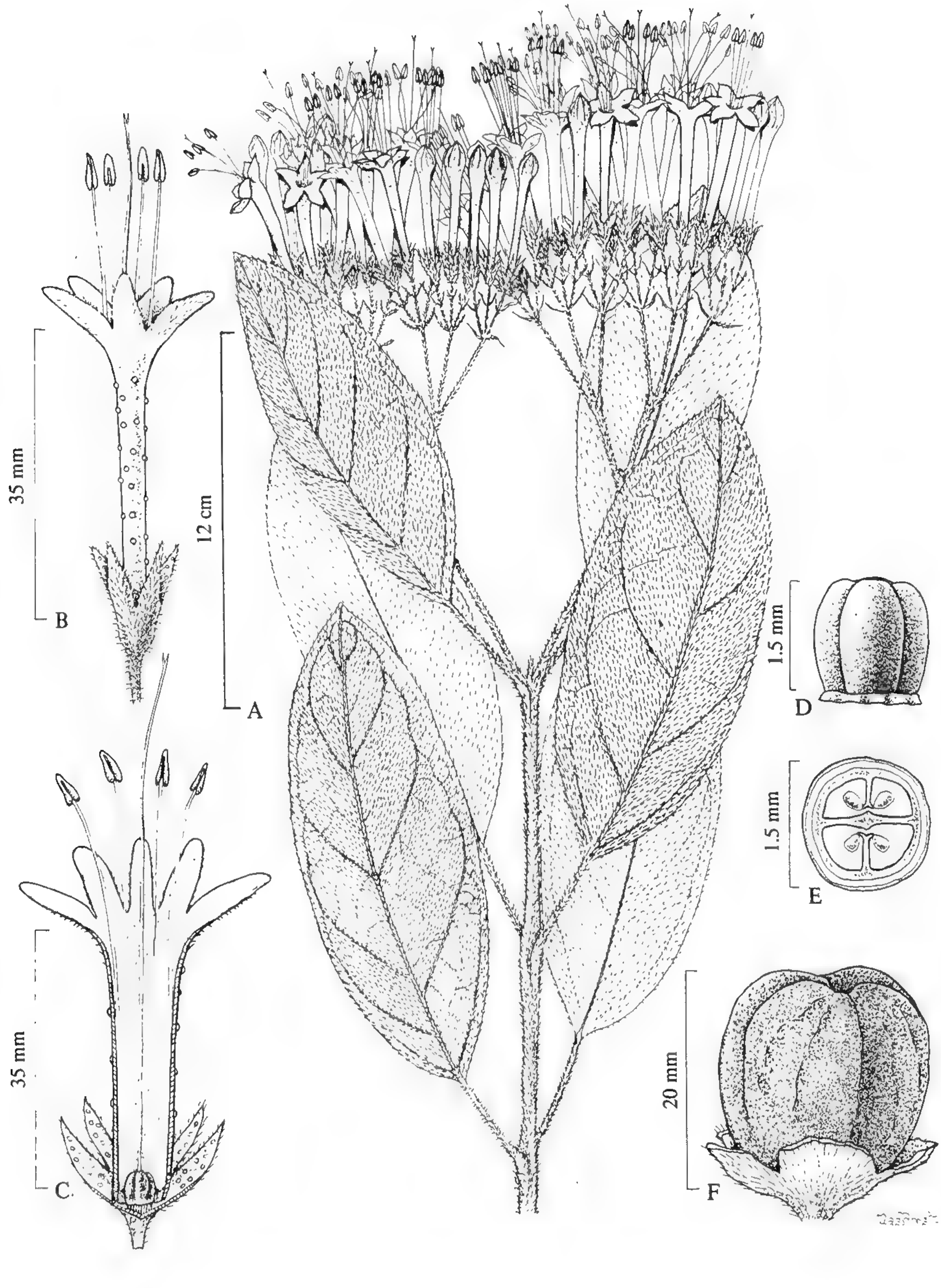


Fig. 13. *Clerodendrum grayi* Munir (A-F, *B. Gray 1327*: AD, holotype). A, habit sketch of a flowering branch; B, flower showing external features; C, flower with calyx and corolla vertically cut open showing androecium, gynoecium and glabrous inside; D, ovary; E, transverse section of ovary; F, fruit with persistent calyx.

inflorescence and overlaps the range of distribution of that species on Atherton Tableland. *C. cunninghamii*, may easily be distinguished by the ovate leaves and much longer corolla-tube.

Affinities

C. grayi closely resembles *C. costatum* in its leaves being pubescent below; inflorescence of similar corymbose appearance; sepals pubescent outside, glabrous and glandular inside; petals, androecium and gynoecium glabrous. The latter, is, however, easily distinguished by its leaf-blade being ovate, narrowing towards the base, glabrous adaxially; corolla-tube much longer (45-70 mm), not glandular outside; corolla-lobes not puberulous outside. Moreover, *C. grayi* is restricted to only a small area on Atherton Tableland, while *C. costatum* is widely distributed along the northern coast of Queensland and Northern Territory, and is also found on several off-shore islands in the Gulf of Carpentaria and Torres Strait.

C. grayi has a few characters common with *C. tomentosum* (Vent.) R. Br. Both species have leaves and inflorescence pubescent-tomentose; calyx pubescent outside, glabrous and glandular inside; corolla-tube glabrous inside; androecium and gynoecium glabrous. *C. tomentosum*, however, may readily be distinguished by its leaves and inflorescence being much more densely pubescent-tomentose; inflorescence much more compact; corolla pubescent outside.

Acknowledgements

The author is grateful to Dr H.R. Toelken for comments on the draft of this manuscript; to Dr J.P. Jessop for translating into Latin the diagnosis of the new taxa; to Ms G. Denny, Librarian, Adelaide Botanic Garden, for help in procuring the relevant literature; to Dr H.N. Moldenke for supplying references relevant to this work; to Mr G.R.M. Dashorst for preparing the illustrations; to Miss M. Eadsforth for typing the manuscript.

Thanks are also due to the Directors/Curators of the following herbaria for the loan of herbarium specimens: B, BM, BO, BR, BRI, C, CANB, CBG, DNA, E, FI, G, GH, HO, JCT, K, Kings Park Perth, L, LAE, LE, MA, MEL, MO, NE, NSW, NT, NY, P, PERTH, PNH, PR, QRS, SING, SYD, W, WRSL, Z.

References

Adanson, M. (1763). "Familles des Plantes". Vol. 2:195-201. (Vincent: Paris).

Anderson, R.H. (1947). *Clerodendron*. "The Trees of New South Wales". (Govt Printer: Sydney).

Bailey, F.M. (1883). Verbenaceae. "A Synopsis of the Queensland Flora". 375-381 (J.C. Beal, Govt Printer: Brisbane).

Bailey, F.M. (1901). Verbenaceae. "The Queensland Flora". Part 4:1164-1185. (H.J. Diddams & Co.: Brisbane).

Bailey, F.M. (1913). Verbenaceae. "Comprehensive Catalogue of Queensland Plants". 381-387 (Govt Printer: Brisbane).

Baker, J.G. (1877). Verbenaceae. "Flora of Mauritius and Seychelles" 250-257. (L. Reeve & Co.: London).

Bakhuizen van den Brink, R.C. (1921). Revision of the Verbenaceae of the Dutch East-Indies and surrounding countries. *Bull. Jard. Bot. Ser. III*. 3:1-116.

Bakhuizen van den Brink, R.C. (1929). The Verbenaceae of British Papua collected for the Arnold Arboretum by L.J. Brass. *J. Arn. Arb.* 10:69-75.

Banks, J. & Solander, D. (1901). "Illustrations of Australian Plants collected in 1770 during Captain Cook's Voyage round the World in H.M.S. Endeavour". Part 2:75, t. 239 (British Museum: London).

Barker, R.M. (1986). A taxonomic revision of Australian Acanthaceae. *J. Adelaide Bot. Gard.* 9:235, 281-282.

Bartling, F.G. (1830). "Ordines naturalis Plantarum". (Dietrich: Goettingen).

Batsch, A.J.G.K. (1802). "Tabula affinitatum Regni vegetabilis". (Landes-Industrie Comptoir: Weimar).

Beadle, N.C.W. (1984). Verbenaceae. "Students Flora of North Eastern New South Wales". Part 5:849-859. (University of New England: Armidale).

Bentham, G. (1870). Verbenaceae. "Flora Australiensis". Vol. 5:31-70. (L. Reeve & Co.: London).

Bentham, G. in Bentham, G. & Hooker, J.D. (1876). Verbenaceae. "Genera Plantarum". Vol. 2:1131-1160. (L. Reeve & Co.: London).

Blanco, F.M. (1837). Didynamia Angiospermia. "Flora des Filipinas Segun el Sistema sexual de Linneo". 484-519. (D. Candido Lopez: Manila).

Blume, C.L. (1826). Verbenaceae. "Bijdragen tot de flora van Nederlandsch Indie". 807-822. (Lands Drukkerij: Batavia).

Briquet, J. (1895). Verbenaceae. In Engler, A. & Prantl, K. "Die natürlichen Pflanzenfamilien". Part 4, 3a:132-182. (Wilhelm Engelmann: Leipzig).

Brongniart, A.T. (1843). "Enumeration des Generes de Plantes cultives au Museum d'histoire naturelle de Paris". (Fortin, Masson & Co.: Paris).

Brown, R. (1810). Verbenaceae. "Prodromus Florae Novae Hollandiae et Insulae Van-Diemen". 510-514. (Richard Taylor & Co.: London).

Browne, P. (1756). "The Civil and Natural History of Jamaica". (P. Browne: London).

Burman, N.L. (1768). Didynamia Angiospermia. "Flora Indica" :126-139 (Johannes Schreuder: Amsterdam).

Choudhry, S.S. & Roy, R.P. (1983). Karyological studies and trend of speciation in some members of Verbenaceae. *Cytologia* 48:735-740.

Clarke, C.B. (1885). Verbenaceae. In Hooker, J.D. "The Flora of British India". Vol. 4:560-604. (L. Reeve & Co.: Ashford).

Dalla Torre, C.G. & Harms, H. (1904). Verbenaceae. "Genera Siphonogamarum ad Systema Englerianum Conscripta". :429-434. (Wilhelm Engelman: Leipzig).

Darlington, C.D. & Wylie, A.P. (1955). "Chromsome atlas of flowering plants". (George Allen & Unwin Ltd.: London).

Dietrich, D.N.F. (1842). Didinamia Angiospermia. "Synopsis Plantarum". Vol. 3:600-620. (B.F. Voight: Weimar).

Domin, K. (1928). Beiträge zur Flora und Pflanzengeographie Australiens. *Biblioth. Bot.* 89:1111-1112.

Don, D. (1825). Verbenaceae. "Prodromus Florae Nepalensis" :102-105. (Linn.Soc.: London).

Dumortier, B.C.J. (1829). Verbenaceae. "Analyse des Familles des Plants" :22. (J. Casterman: Tournay).

Durand, Th. (1888). Verbenaceae. "Index Generum Phanerogamorum". 319-322. (Dulau & Co.: London).

Elliot, W.R. & Jones, D.L. (1984). *Clerodendrum*. "Encyclopaedia of Australian Plants". Vol. 3:48-50. (Lothian Publishing Co.: Melbourne).

Endlicher, S.L. (1838). Verbenaceae. "Genera Plantarum Secundum Ordines Naturales Disposita". Vol. 1:632-639. (Fr.Beck: Vienna).

Endlicher, S.L. (1841). Verbenaceae. "Enchiridion Botanicum" :311-314. (Wilhelm Engelmann: Leipzig).

Ewart, J. & Davies, O.B. (1917). Verbenaceae. "Flora of the Northern Territory" :235-239. (McCarron, Bird & Co.: Melbourne).

Fedorov, A. (1974). "Chromosome Numbers of Flowering Plants". Reprint edn (Otto Koeltz: Koenigstein).

Fletcher, H.R. (1938). The Siamese Verbenaceae. *Kew Bull.* :401-445.

Gaertner, J. (1788). Centuria Quarta. "De Fructibus et Seminibus Plantarum". Vol. 1:266-275. (G.H. Schramm: Tübingen).

Gardner, C.A. (1931). Verbenaceae. "Enumeratio Plantarum Australiae occidentalis". Part 3:111-113. (Govt Printer: Perth).

Giseke, P.D. (1792). "Caroli a Linne . . . Praelectiones in Ordines Naturales Plantarum". (B.G. Hoffmann: Hamburg).

Gleditsch, J.G. (1764). "Systema Plantarum a Staminum situ, etc. (Haude & Spencer: Berlin).

Gmelin, J.F. (1792). "Caroli a Linne . . . Systema Naturae etc. (B.E. Beer: Leipzig).

Henderson, R.J. in Carr, D.J. (1983). Verbenaceae. "Sydney Parkinson Artist of Cook's Endeavour Voyage": 167, t. 160. (British Museum (Natural History) in association with Australian National University Press Canberra: Canberra).

Jaume Saint-Hilaire, J.H. (1805). Verbenaceae. "Exposition des Familles naturelles et de la Germination des Plantes". Vol. 1:245-253. (Treuttel et Würtz: Paris).

Junell, S. (1934). Zur Gynäceummorphologie und Systematik der Verbenaceen und Labiaten. *Symb. Bot. Ups.* 4:1-219.

Jussieu, A.L. de (1789). *Vitices*. "Genera Plantarum secundum Ordines naturalis disposita": 106-110. (Viduam Herissant & T. Barrois: Paris).

Jussieu, A.L. de (1806). Sur la Famille des Plantes Verbenacees. *Ann. Mus. Hist. Nat. Paris.* 7:63-77.

King, G. & Gamble, J.S. (1909). Verbenaceae. "Material for a Flora of the Malayan Peninsula". Vol. 4:1004-1079. (W. Newman & Co.: London).

Kunth, C.S. in Humboldt, F.W.H.A., Bonpland, A.J.A. & Kunth, C.S. (1817). Verbenaceae. "Nova Genera et Species Plantarum". Vol. 2:244-285. (a la Librairie grecque-latine-allemande: Paris).

Kuntze, O. (1891). *Clerodendron*. "Reviso Generum Plantarum". Pars 2:505-506. (Arthur Felix: Leipzig).

Lam, H.J. (1919). "The Verbenaceae of the Malayan Archipelago". (M. De Waal: Groningen).

Lamarck, J.B.A.P. de (1823). "Tableau Encyclopedique et Methodique". Vol. 3:56. (Chez Pancoucke: Paris).

Lemée, A. (1943). Verbenaceae. "Dictionnaire descriptif et Synonymique des Generes de Plantes Phanerogames". Vol. 8b:650-657. (Imprimerie Commerciale et Administrative: Brest).

Lindley, J. (1846). Verbenaceae. "The Vegetable Kingdom" :663-664. (Bradbury & Evans: London).

Linnaeus, C. (1753). Didynamia Angiospermia. "Species Plantarum". edn 1, Vol. 2:602-639. (Laurentius Salvius: Stockholm).

Lopez-Palacios, S. (1977). Verbenaceae. "Flora de Venezuela": 18-643. (Universidad de Los Andes: Merida, Venezuela).
Loureiro, J. de (1790). Didynamia Angiospermia. "Flora Cochinchinensis". Vol. 2:358-393. (Typis et expensis academicis: Lisbon).
Meisner, C.F. (1840). Verbenaceae. "Plantarum Vascularium Genera secundum Ordines Natural Digesta . . . Vol. 1. "Tabulis Diagnosticis" :290-292. Vol. 2. "Commentarius" :197-200. (Libraria Weidmannia: Leipzig).
Merrill, E.D. (1923). Verbenaceae. "An Enumeration of Philippine Flowering Plants". Vol. 3:380-408. (Bureau of Printing: Manila).
Miquel, F.A.W. (1858). Verbenaceae. "Flora Indiae Batavae". 2:856-913. (C.G. van der Post: Amsterdam).
Moldenke, H.N. (1950). Notes on New and Noteworthy Plants. *Phytologia.* 3:315.
Moldenke, H.N. (1952). Notes on New and Noteworthy Plants. *Phytologia.* 4:127.
Moldenke, H.N. (1959). "A Résumé of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". (H.N. Moldenke: Mountain, New Jersey).
Moldenke, H.N. (1971). "A Fifth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World . . . " etc. Vol. 1 & 2. (H.N. Moldenke: Wayne, New Jersey).
Moldenke, H.N. (1975). A Fifth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World as to Valid Taxa, Geographic Distribution and Synonymy . . ., Supplement 5. *Phytologia.* 31:374-412.
Moldenke, H.N. (1977). Notes on New and Noteworthy Plants CIII. *Phytologia.* 37:22.
Moldenke, H.N. (1978). Notes on New and Noteworthy Plants CXI. *Phytologia.* 39:236.
Moldenke, H.N. (1980). "Phytologia Memoirs. II. A Sixth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Chloanthaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World etc" . . . (H.N. & A.L. Moldenke: Plainfield, New Jersey).
Moldenke, H.N. (1983). Verbenaceae. In Dassanayake, M.D. & Fosberg, F.A. "A Revised Handbook to the Flora of Ceylon". Vol. 4: 196-487. (Amerind Publishing Co. Pvt.Ltd.: New Delhi).
Moldenke, H.N. (1986). Notes on the genus *Clerodendrum* (Verbenaceae) XVIII. *Phytologia.* 60:186-188, 464-465.
Mueller, F. v. (1862). "Fragmenta Phytographiae Australiae". Vol. 3. (Govt Printer: Melbourne).
Mueller, F. v. (1863). "Fragmenta Phytographiae Australiae". Vol. 4. (Govt Printer: Melbourne).
Mueller, F. v. (1865). "Fragmenta Phytographiae Australiae". Vol. 5. (Govt Printer: Melbourne).
Mueller, F. v. (1868). "Fragmenta Phytographiae Australiae". Vol. 6. (Govt Printer: Melbourne).
Mueller, F. v. (1875). "Fragmenta Phytographiae Australiae". Vol. 9. (Govt Printer: Melbourne).
Mueller, F. v. (1882a). Verbenaceae. "Systematic Census of Australian Plants". Part 1. Vasculares: 102-103. (McCarron, Bird & Co.: Melbourne).
Mueller, F. v. (1882b). On a new Acanthaceae plant from Arnheim Land, N.A. *Trans. & Proc. Roy. Soc. South Australia.* Vol. 5:81.
Mueller, F. v. (1889). Verbenaceae. "Second Systematic Census of Australian Plants". Part 1. Vasculares: 171-173. (McCarron, Bird & Co.: Melbourne).
Mueller, F. v. (1891). Record of Hitherto Undescribed Plants from Arnheim's *Land. J. & Proc. Roy. Soc. New South Wales.* 24:73-75.
Munir, A.A. (1982). A Taxonomic Revision of the Genus *Callicarpa* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 6(1):5-39.
Munir, A.A. (1984a). A Taxonomic Revision of the Genus *Premna* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7(1):1-43.
Munir, A.A. (1984b). A Taxonomic Revision of the Genus *Gmelina* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7(1):91-116.
Munir, A.A. (1985). A Taxonomic Revision of the Genus *Viticipremna* H.J. Lam (Verbenaceae). *J. Adelaide Bot. Gard.* 7(2):181-200.
Munir, A.A. (1987a). A Taxonomic Revision of the Genus *Vitex* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 10(1):31-79.
Munir, A.A. (1987b). A Taxonomic Revision of the Genus *Faradaya* F. Muell. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 10(2):165-177.
Murray, J.A. (1774). "Caroli a Linne . . . Systema Vegetabilium etc." (J.C. Dietrich: Göttingen).
Necker, N.J. de (1790). "Elementa Botanica Genera Genuina, Species Naturales Omnium Vegetabilium . . .". (Societas Typographica: Neowedae ad Rhenum).
Palmer, E. (1884). On plants used by the Natives of North Queensland, Flinders and Mitchell Rivers, for food, medicine, & c., & c. *J. & Proc. Roy. Soc. New South Wales.* 17:93-113.
Persoon, C.H. (1797). "Caroli a Linne Systema Vegetabilium etc." (J.C. Dietrich: Göttingen).
Persoon, C.H. (1807). Didynamia Angiospermia. "Synopsis Plantarum". Vol. 2:138-182. (J.G. Cotta: Tübingen).
Pfeiffer, L. (1873). *Clerodendron.* "Nomenclator botanicus". Vol. 1(1):784-785. (Sumptibus Theodori Fischeri: Cassellis).
Post, T.V. & Kuntze, O. (1904). "Lexicon Generum Phanerogamorum". (Duetsche Verlags-Anstalt: Stuttgart).
Reichard, J.J. (1778). Didynamia Angiospermia. "Linne's Genera Plantarum". Edn 7. (Varrentrapp: Frankfurt).

Reichenbach, H.G.L. (1828). Labiatae. "Conspectus Regni Vegetabilis Per Gradus naturales evoluti". Part 1:115-117. (Carolus Cnobloch: Leipzig).
Ridley, H.N. (1923). Verbenaceae. "The Flora of the Malay Peninsula". Vol. 2:611-642. (L. Reeve & Co. Ltd.: London).
Roxburgh, W. (1832). Didynamia Angiospermia. "Flora Indica". Edn 2, Vol. 3:1-116. (W. Thacker & Co.: Serampore, Calcutta).
Rueling, J.P. (1774). Ringentes. "Ordines Naturales Plantarum Commentatio Botanica": 54-56. (Sumtilbus Vid Abrah. Vandenhoeck: Gőttingen).
Schauer, J.C. (1847). Verbenaceae. In De Candolle, A. "Prodromus Systematis Naturalis Regni Vegetabilis". Vol. 11:522-700. (Victoris Masson: Paris).
Schreber, J.C.D. (1791). "Caroli a Linne Genera Plantarum . . .". Edito Octava. Post Reichhardianam Secunda, prioribus longe auctior atque emendatior". (Warrentrapp et Wenner: Frankfurt a/M).
Scopoli, G.A. (1777). Personatae. "Introductio ad Historiam Naturalem sistens genera Lapidum et Animalium". (W. Gerle: Prague).
Sharma, A.K. & Mukhopadhyay, S. (1963). Cytotaxonomic investigation with the aid of an improved method on the family Verbenaceae with special reference to the lines of evolution. *J. Genet. (Belghoria)* 58:358-386.
Sims, J. (1813). *Clerodendrum tomentosum.* "Curtis's Botanical Magazine". Vol. 37, t. 1518. (Sherwood, Neely & Jones: London).
Sivarajan, V.V. & Manilal, K.S. (1982). Notes on some interesting species of Verbenaceae from South India. *J. Econ. Tax. Bot.* 3:813-817.
Smith, L.S. (1969). New Species of and Notes on Queensland Plants, V. *Contrib. Qld Herb.* No. 6:19-20.
Spach, E. (1840). "Histoire Naturelle des Vegetaux Phanerogams". Vol. 9:225-243. (Librarie Encyclopedique de Roret: Paris).
Sprengel, K. (1825). Didynamia Angiospermia. "Caroli a Linnei . . . Systema Vegetabilium". Edn 16, Vol. 2:747-765. (Dietrich: Göttingen).
Sprengel, K. (1831). Didynamia Angiospermia. "Genera Plantarum". (Edito nona of Linnaeus Genera Plantarum) Curante Curtio Sprengel. Vol. 2:476-483. (Dietrich: Göttingen).
Stanley, T.D. in Stanley, T.D. & Ross, E.M. (1986). Verbenaceae. "Flora of south-eastern Queensland". Vol. 2:364-374. (Queensland Department of Primary Industries: Brisbane).
Thunberg, C.P. (1784). Didynamia Angiospermia. "Flora Japonica". :251-258. (Müller: Leipzig).
Ventenat, E.P. (1799). Pyrenaceae. "Tableau du Régne Végétal." Vol. 2:315-324. (Imprimerie de J. Drisonnier: Paris).
Walpers, W.G. (1845). Verbenaceae. "Repertorium Botanices Systematicae". Vol. 4:3-134. (Fr. Hofmeister: Leipzig).
Walpers, W.G. (1852). Verbenaceae. "Annales Botanices Systematicae". Vol. 3:231-240. (Abrosii Abel: Leipzig).
Webb, L.J. (1948). Guide to the Medicinal and Poisonous Plants of Queensland. *Bull. Council Sci. Industr. Res.* No. 232:7-202.
Willdenow, C.L. (1800). Didynamia Angiospermia. "Caroli a Linne Species Plantarum Exhibentes Plantas Rite cognitas ad Genera Relatas . . .". Vol. 3:1-403. (G.C. Nauk: Berlin).
Willdenow, C.L. (1809). Didynamia Angiospermia. "Enumeratio Plantarum Horti Regii Botanici Berolinensis" :595-661. (In Taberna Libraria Scholae Realis: Berlin).

Index to Scientific Names

Names

New names and combinations are in **bold.** Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics.*

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked refer to figures and maps.

J. Adelaide Bot. Gard. 11(2): 175-177 (1989)

HAKEA PULVINIFERA L. JOHNSON (PROTEACEAE): A REDISCOVERED SPECIES UNDER THREAT

W. R. Barker

State Herbarium, Botanic Gardens, North Terrace,
Adelaide, South Australia 5000

and

S. P. Morrison
N.S.W. National Parks & Wildlife Service, P.O. Box 402,
Armidale, New South Wales 2350

Abstract

Hakea pulvinifera, discovered only in 1949 from a single population and subsequently believed extinct, has been rediscovered. Its reproductive biology and limited distribution indicate that it will require careful husbandry to survive.

Hakea pulvinifera is one of the more recently discovered and described species of a large Australia-wide genus, presently being revised by R.M. Barker, L. Haegi and one of the authors (W.R.B.). The species was first collected in 1949 and named in 1962 (Johnson 1962). It belongs to the 'corkwood' component of Sect. *Grevilleoides*. L.A.S. Johnson revisited the area in April 1966, collected material and made notes on the plant population, exact location, aspect and ecology. McGillivray (1975) reported that a search in April 1971 with R.C. Coveny failed to locate the species in a site which had been partially cleared and flattened for a car parking area. McGillivray proposed that it was likely that the species was extinct.

In June 1988, one of us (S.P.M.) discovered the species in a localised population on a steep slope of a hillside of similar features and aspect to the type locality as quoted in Johnson's notes in McGillivray (1975). The identity of the population was confirmed by the other (W.R.B.) on a visit to the site on 13th September 1988.

Is this a new or the original population?

The newly found population is almost certainly the original one, despite it not being associated with any car park. Firstly, the new locality is 1.75 km SSE of the Keepit Dam spillway. The original site is recorded almost identically as "1 mile SSE of Keepit Dam" (*L.A.S. Johnson NSW 90975*); on the specimen Johnson has disputed Pacholke's locality of "½ mile below Keepit Dam site". Secondly, new and old localities have been recorded as occurring on the east side of Charcoal Bend on the Namoi River. Thirdly, none of the car parks searched by McGillivray and Coveny (McGillivray 1975) are located on the westerly aspect upon which the original population was noted by Johnson.

Reproductive biology

The species cannot reproduce from seed. J.B. Heywood found no fruits in two years' observation (Johnson 1962). In 1966 Johnson noted the lack of fruits, notably old ones, in his population (McGillivray 1975). This was again noted in the present population. Fruits of a number of corkwood species open readily, apparently seasonally, and the valves usually weather and eventually break away. However, one would expect to find some remnants of the woody rachis and fruit stalks (formed from the pedicel and gynophore) in the population. None were evident.

Investigation of fresh, fixed and dried flowers has shown them to be sterile, with no evidence of pollen.

A brief examination indicated that plants are likely to regenerate by suckering from roots running just below the soil surface. Other corkwood species exhibit a similar means of vegetative reproduction (W.R. Barker, unpublished observations).

Conclusion

A detailed study of the reproductive biology of this species is needed to determine the most appropriate way to conserve the only known population. Its limited known distribution and sterility indicate that it will require careful husbandry to survive.

Following a visit to the site in November 1988 National Parks and Wildlife Service Botanist J. Benson (1988) produced an internal report setting up monitoring of the population and making recommendations on conserving the species.

A search of the general region, not just the immediate neighbourhood, is needed to ascertain if more populations exist. *H. aenigma*, a similarly sterile Kangaroo Island endemic reproducing solely by suckering, has extended over an area of approximately 30 x 15 km (Haegi & Barker 1985). Other corkwood species often occur as very localised populations (W.R. Barker, unpublished observations).

Cuttings have been collected for propagation by the Department of Botany, University of New England (Armidale), the National Botanic Gardens (Canberra) and the Mount Annan Annexe of the Royal Botanic Gardens (Sydney) (Boden 1988).

Grafting onto stock of other readily grown *Hakea* species may be another worthwhile avenue of research. This has proved successful with grass-leaf Hakeas (*H. francisiana* and its allies) using *H. salicifolia* stock (P. Ollerenshaw, pers. comm. 1988).

Specimens examined (in chronological order)

NEW SOUTH WALES. NORTHWEST SLOPES REGION: *G.J. Pacholke s.n.*, 7.xi.1949, ½ mile below Keepit Dam Site, Namoi River; moderate size clump; indications of further clump in the vicinity, NSW 54042. — *J.B. Heywood s.n.*, 9.x.1950, near Keepit Dam; up to 12′ high, inclined to be straggly, on hard rocky hillside, steep slope, on area of several acres; no fruits seen in 2 years; no similar trees except in the one patch, NSW 54043 (holotype). — *L.A.S. Johnson s.n.*, 12.iv.1966, 1 mile SSE of Keepit Dam, N.E. of Gunnedah (E side of Charcoal Bend); shrubs or stunted treelets to 4 m, often less, bark ± corky, thick, ± tessellated; no old parts found; very localised to crest and W. side of very dry, barren conglomerate hillside, with scattered *Callitris columellaris* ssp. *glauca* and *Alstonia constricta*; no eucalyptus; [does not occur "½ mile from Keepit Dam"], NSW 90975. — *W.R. Barker 5649, S. Morrison, I.R. Telford & J.B. Williams*, 13.ix.1988, Keepit State Recreation Area; Little Klori Hill, c. 0.5 km W of park Visitors Centre and Office, c. 1.75 km SSE of Keepit Dam spillway, overlooking and on E side of Charcoal Bend on the Namoi River; locally abundant population of c. 50-100 plants (small trees and ?suckers) over an area c. 100 m along x 50 m down steep W-facing slope with brown loam on conglomerate outcropping with *Callitris glaucophylla*, *Acacia decora*, *Alstonia constricta*, *Dodonaea viscosa*. Small trees to c. 3½ m high with twisted limbs . . . The trees occur in groups which may have formed by suckers . . . No evidence of lignotubers but one 3-branched plant c. 30 cm high produced from ?horizontal root (?sucker) . . . Fruits not evident on any plant (no evidence of . . . remnant stalks), AD (dupl. to be distributed).

Acknowledgements

The National Parks and Wildlife Service of New South Wales is thanked for giving permission to study *Hakea* in areas under its jurisdiction. Mr Ian Telford, Dr John Williams, Mrs M.E. Ballingall, Mr Doug Moffat and Miss Dorothy Catling assisted in the field work.

References

Benson, J. (1988). Survey report on *Hakea pulvinifera* (Proteaceae) L. Johnson, Keepit State Recreation Area. (New South Wales National Parks and Wildlife Service internal report).

Boden, R. (1988). Back from the brink. National Botanic Gardens Newsletter.

Haegi, L. & Barker, W.R. (1985). Taxonomy of the South Australian species allied to *Hakea ulicina* R. Br. (Proteaceae). *J. Adelaide Bot. Gard.* 7:249-271.

Johnson, L.A.S. (1962). Taxonomic notes on Australian plants. *Contrib. N.S. Wales Nat. Herb.* 3:93-102.

McGillivray, D.J. (1975). Australian Proteaceae: new taxa and notes. *Telopera* 1:19-32, pl. I-V.

J. Adelaide Bot. Gard. 11(2): 179-187 (1989)

PRASOPHYLLUM CALCICOLA, *P. MACROSTACHYUM* AND *P. RINGENS* (ORCHIDACEAE): THREE SIMILAR SPECIES FROM WESTERN AND SOUTHERN AUSTRALIA

R. Bates
38 Portmarnock Street, Fairview Park, South Australia 5126

Abstract

Prasophyllum calcicola R. Bates from South and Western Australia is described as new; *Prasophyllum macrostachyum* R. Br. var. *ringens* (Reichb. f.) A.S. George is raised to species rank as *Prasophyllum ringens* (Reichb. f.) R. Bates; *Prasophyllum macrostachyum* R. Br. is given an expanded description and the relationship of the three species discussed.

Introduction

Prasophyllum macrostachyum R. Br. was described in 1810 from material collected by Robert Brown at King George's Sound, Western Australia in December 1801. In 1840 J. Lindley named *Prasophyllum gracile* based on material inscribed "Swan River" by Drummond. *P. gracile* was recognised by A.S. George (1971) as a synonym of *P. macrostachyum* and is so treated here. H.G. Reichenbach (1871) described *P. gracile* var. *ringens* from plants collected by Preiss near York, Western Australia, and George (1971) made the combination *P. macrostachyum* var. *ringens* for this taxon, which is here raised to species status as *Prasophyllum ringens*. *P. macrostachyum* is basically a swamp plant while *P. ringens* favours dry ground. Both are endemic to Western Australia. Weber & Bates (1986) included South Australian material as *Prasophyllum macrostachyum*, but noted that these plants differed considerably from *P. macrostachyum* sensu stricto. This South Australian form is here described as the new species *Prasophyllum calcicola*, from limestone country on Yorke and Eyre Peninsulas in South Australia and in coastal Western Australia. Thus, there are three species of this natural group occurring in Western Australia with one extending to South Australia.

Each is habitat specific and relatively constant over a wide geographical range. Near Peaceful Bay, Western Australia all three occur within 10 km of each other without intermediate forms.

Key of related *Prasophyllum* species

1. Flowers less than 5 mm in diameter; column appendages absent or vestigial (flowers apomictic) .... 1. *P. calcicola*
   Flowers greater than 5 mm in diameter; column appendages well formed (flowers not apomictic) 2
2. Flowers and scape wholly green [or rarely uniformly red]; lateral sepals with 3-8 mm long prong-like tips; petals lanceolate .... 2. *P. ringens*
   Flowers and scape bicoloured, green and red; lateral sepals connate almost to the tips, petals triangular .... 3. *P. macrostachyum*

1. **Prasophyllum calcicola** R. Bates, sp. nov.

P. macrostachyo affine sed inflorescentia breviori (usque ad 3 cm), folii apice minus rigido, floribus quam 6 mm diametro minoribus, labello viridi et rubro, appendiceque columnae absenti vel vestigiali differt.

Holotype: *R. Bates 2252* (AD), Warrenben Conservation Park (S.Aust.), 23.ix.1982.

Plant 5-15 cm high, slender, rigid, green or red and green; tuberoid sub-globose, 4-9 mm diameter with white, parchment-like outer sheath when dry, formed adjacent to old tuber.

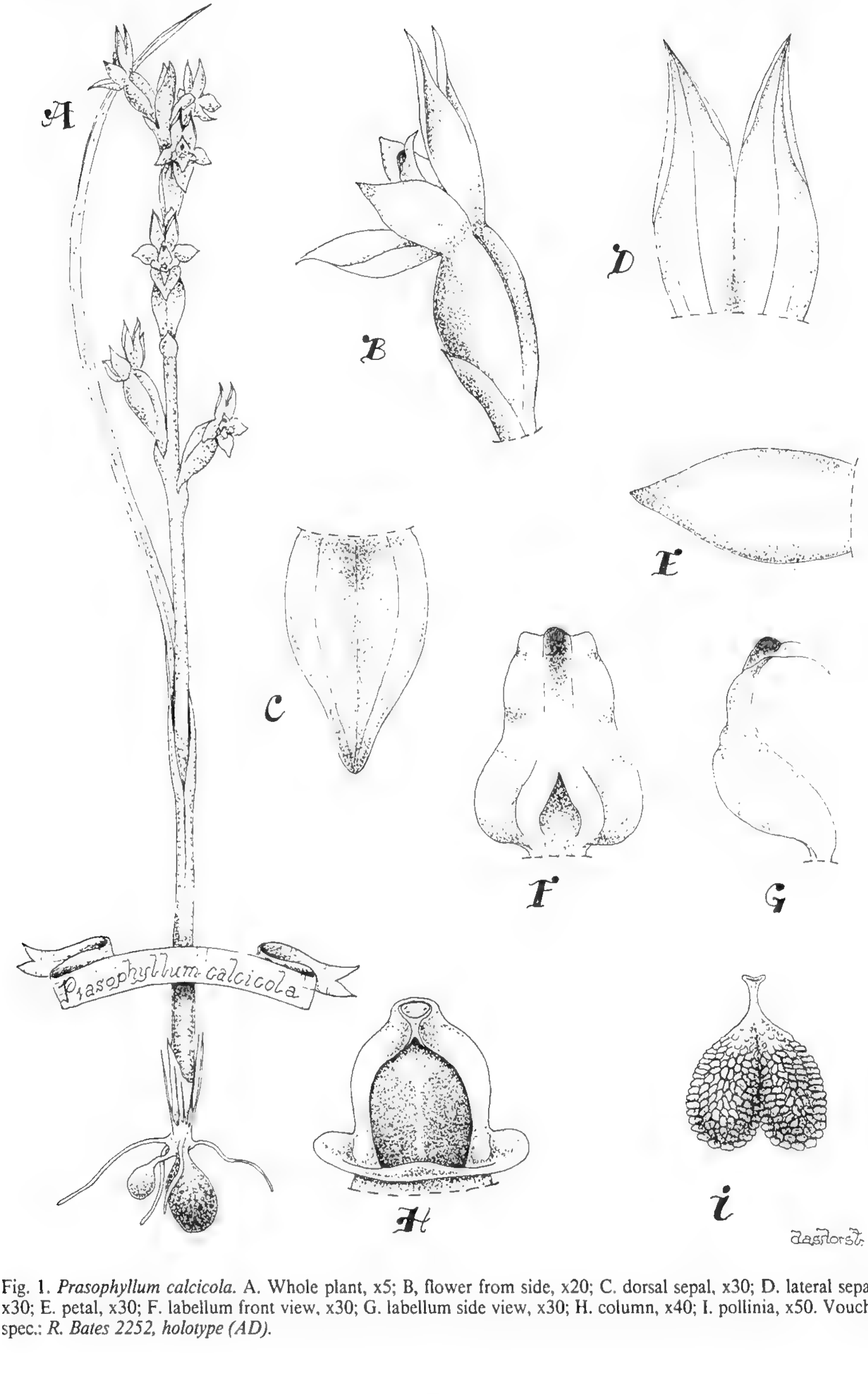


Fig. 1. *Prasophyllum calcicola.* A. Whole plant, x5; B, flower from side, x20; C. dorsal sepal, x30; D. lateral sepals, x30; E. petal, x30; F. labellum front view, x30; G. labellum side view, x30; H. column, x40; I. pollinia, x50. Voucher spec.: *R. Bates 2252, holotype (AD).*

Leaf base red, c. 2 mm diameter, free part becoming almost filiform, erect, 5-15 cm long. *Scape* wiry, green with red tints; base of scape below soil level invested in fibrous tunicate sheaths. *Flowers* 3-12, in loose to moderately crowded spike, to 3 cm long, semi-erect, green with some red tints, not or only slightly fragrant, each subtended by an ovate bract 1.5 x 2 mm; pedicel 0.5-1.5 mm long. *Ovary* ovoid, tumescent, 2-3 x 3-5 mm, large in comparison with flowers. *Dorsal sepal* ovate-lanceolate, 2-2.5 x 2-3 mm, green edged with red, apex straight or incurved; lateral sepals lanceolate, 2.5-3.5 mm long, conjoined for half their length, outer margins inrolled, free part sub-terete, not bidentate; petals triangular 2-2.5 mm long, c. 1.2 mm broad at base, green, edged with red, apex straight or incurved. *Labellum* fleshy, 2.5-3.0 mm long, sub-sessile, oblong-lanceolate, recurved at 90° near middle, green with red tints; basal part oblong, c. 1.2 x 1.5 mm, horizontal, entire, not gibbous, recurved part triangular with entire margins, callus plate triangular, red and green, deeply concave near base, raised and irregularly channelled beyond, extending almost to labellum apex and covering about half its surface. *Column* appendages absent or represented by minute swellings; anther c. 1 x 1 mm, brown, shallow, acute; stigmatic plate c. 1.5 mm high, stigma indistinct; rostellum fleshy, higher than anther; pollinia attached to viscid disk by 0.2 mm long caudicle.

Flowers

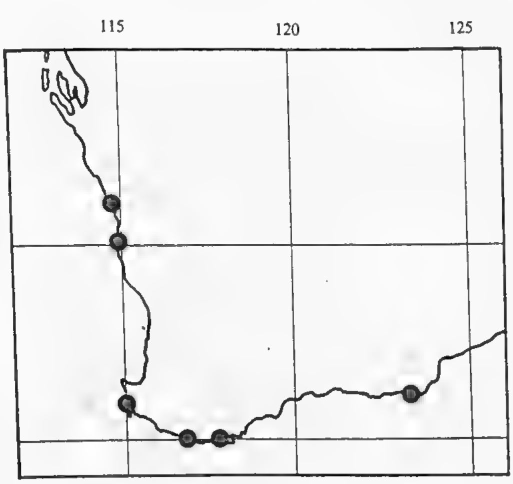
September to early October. Flowering is not dependent on fire or disturbance.

Variation

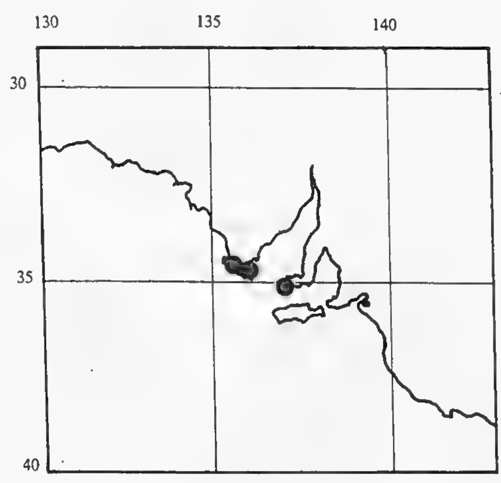
Plants in exposed situations tend to have shorter more crowded inflorescences and are generally more fleshy throughout. Most of the Western Australian plants seen were almost wholly green whereas South Australian plants were more reddish, some specimens having the scape completely deep-red.

Distribution

Not well collected, but certainly widespread along the coast of Western Australia from Kalbarri to Israelite Bay. In South Australia around Port Lincoln and the foot of Yorke Peninsula but possibly also on Kangaroo Island where similar habitats occur. Maps 1 & 2.



Map 1. Distribution of *Prasophyllum calcicola* in Western Australia. Note the very few collections from a wide distribution area.



Map 2. Distribution of *Prasophyllum calcicola* in South Australia with several collections from a limited distribution area.

Habitat

As the name 'calcicola' (growing in calcium rich soils) suggests, plants occur only in calcareous soils, either in leaf litter on travertine limestone, in calcareous sand or in red-brown loam over limestone, usually within a few kilometres of the sea, either in scrubby heath or under mallee, but uncommonly, usually as single plants or small groups widely spread.

Conservation status: 3RC.

Notes

P. calcicola differs from *P. macrostachyum* and *P. ringens* in its smaller apomictic flowers. From *P. macrostachyum* it differs also in its shorter inflorescence, narrow leaf fistula, less rigid leaf apex and green labellum. From *P. ringens* it differs also in having bicoloured flowers with lateral sepals not extended into filiform points. The habitat of *P. calcicola* is also quite different.

In South Australia the species occurs with *Prasophyllum goldsackii* Weber & Bates and at least one other undescribed species. All of these have in common an apparent apomictic habit. This has not been checked in detail, but flowers are short lived, ovaries swell rapidly after anthesis, yet pollinia are rarely removed in nature and do not contact the stigma. Pollinia were removed at anthesis from flowers in cultivation, yet large amounts of apparently viable seed were formed.

It was noted that in some populations of *P. calcicola* flowers did not open, but development of seed capsules progressed as usual. As some flowers have a noticeable fragrance and it is easily demonstrated that pollinia can be removed and transferred to stigmas of other flowers it is likely that some degree of outcrossing may be achieved.

Specimens examined.

SOUTH AUSTRALIA: *C.R. Alcock 2765*, 80 km NW Port Lincoln, 17.ix.1969 (AD); *R. Bates 1877*, Warrenben Conservation Park, 23.ix.1980 (AD); *R. Bates 6237*, Lincoln Conservation Park, 10.ix.1985 (AD); *B.J. Blaylock 223a*, Pondalowie Bay, 9.x.1966 (AD); *R.C. Nash s.n.*, 3 miles N Brown's Beach, Yorke Peninsula, 20.ix.1971 (PERTH).

WESTERN AUSTRALIA: *R. Bates 4142*, 20 km N Jurien Bay, 27.viii.1984 (AD, wet coll.); *R. Bates s.n.*, Peaceful Bay, 26.ix.1984 (AD, wet coll.); *R. Bates 4323*, Cape Leeuwin to Gracetown, 30.ix.1984 (AD); *W.E. Cooke AD97715389*, Cape Leeuwin, no date; *N. Sammy 34A*, Abrolhos Is., Island 20, 28.ix.1972 (PERTH).

2. **Prasophyllum ringens** (Reichb. f.) R. Bates, stat. nov.

Basionym: *Prasophyllum gracile* Lindley var. *ringens* Reichb. f., Beitr. Syst. Pfl. 60 (1871).

Type: *Preiss 2198*, York, W. Aust. (lecto.: W; photo.!). Lectotypification by George (1971).

P. macrostachyum R. Br. var. *ringens* (Reichb. f.) A.S. George, Nuytsia 1(2):188 (1971); Pate & Dixon, "Tuberous, cormous and bulbous plants" pl. 183 (1982) as "*Prasophyllum hians*"; Hoffmann & Brown, Orch. S. West. Aust. 265, colour photo. (1984).

P. macrostachyum auct. non R. Br.: R. Erickson, Orch. West. edn 2:59 (1965) partly; W.R. Nicholls, Orch. Aust. 36, pl. 141 (1969); Pocock, Aust. Ground Orch. photo 99 (1972).

Plant (5-) 10-20 (-25) cm tall, slender, wholly greenish or reddish; tuberoid ovoid, 8-14 mm long, together with base of scape partly enclosed in fibrous sheaths. *Leaf* exceeding scape, usually partly senesced at flowering time, apex lax or erect. *Scape* slender, 1-2 mm diam., straight or slightly flexuose; flowers 5-40, uniformly coloured, in moderately dense spike, thin textured, erect. *Ovary* on pedicel 1.5 mm long, obpyriform, shorter than flower, standing out from axis of scape at c. 30°, not tumescent. *Dorsal sepal* ovate-lanceolate, 4-5 mm long, angled downward or with decurved apex; lateral sepals distinctive, 5-9 mm long, falcate-lanceolate, conjoined in their lower two-thirds, with inrolled or incurved margins, apical one-third terete, free, rigidly erect or falcate, like horns or prongs; petals ovate-lanceolate to linear,

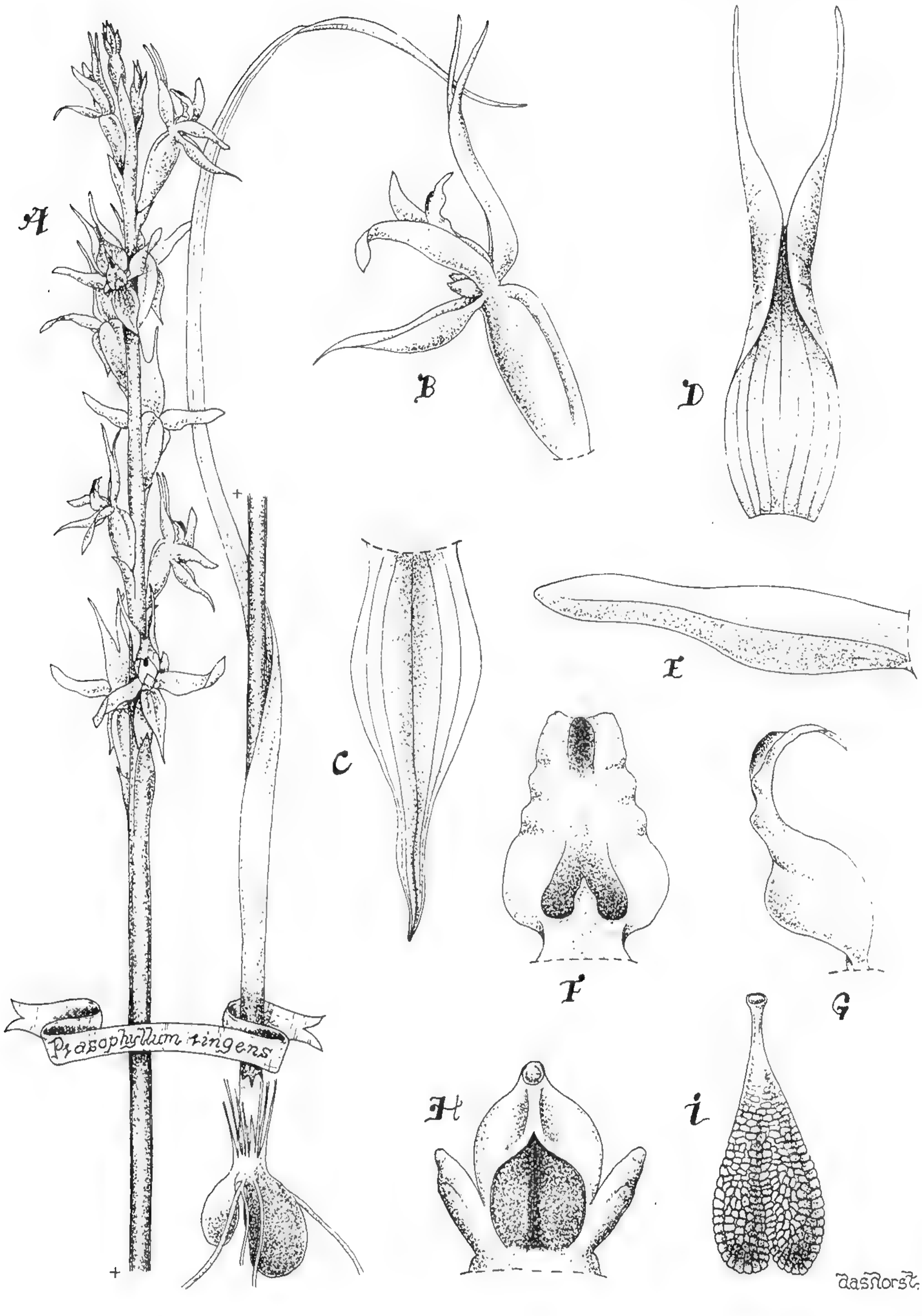


Fig. 2. *Prasophyllum ringens*. A. Whole plant, x4; B. flower from side, x15; C. dorsal sepal, x25; D. lateral sepals, x25; E. petal, x25; F. labellum front view, x25; G. labellum side view, x25; H. column, x30; I. pollinia, x50. Voucher spec.: *R. Bates 2151* (AD).

4-5 mm long, acute. *Labellum* sessile, 4-5 mm long, recurved at 90° near middle, lamina slightly crisped, margins entire, apex acute; callus plate broad at base tapering to an acute apex, not much raised, glabrous and glistening, shallowly channelled before bend. *Column* appendages short (0.5-1 mm high) ovate, obtuse, basal lobe an indistinct bump; anther less than 1 mm high and broad, obtuse; rostellum higher than column appendages, blunt, stigma high up; viscidium orbicular, caudicle c. 0.2 mm long; flowers slightly perfumed.

Flowers

July to October. Flowering freely without fire or disturbance.

Variation

Throughout most of its range *P. ringens* is wholly green or green with light suffusions of brown but on rock outcrops in the central wheat belt north of Hyden a startling wholly red form occurs: scape, rhachis, ovaries and flowers being a deep shining blood-red. On these rock outcrops it occurs sympatrically with the green form or may completely replace it. Specimens seen include — Anderson Rocks, 28.ix.1984, *R. Bates 4525* (AD) and Gorge Rock, 6.ix.1978, *R. Heberle s.n.* (PERTH). One might be tempted to treat them as distinct taxa were it not for the fact that both red and green forms occur in many species of the genus.

On scrub-covered sandhills along the south coast from Albany to Augusta occurs a pallid, few-flowered, very slender race which may prove worthy of subspecific rank but further work is needed. Collections seen include Peaceful Bay, 10.x.1984, *R. Bates 4314* (AD) and William Bay Sandhills, no date, *A. Turner 342* (PERTH).

Distribution

Widespread throughout south-eastern Australia from Shark Bay in the north around the coast to the Great Australian Bight, extending well inland to semi-arid areas.

Habitat

Inland the species is common about granite outcrops; in the wheat-belt it occurs also on fertile flats, especially along drainage lines and on the coast (where it is less frequent) in grassy or rocky places or in coastal sand-hills but not found in poor acid soils.

Conservation status: Common and well conserved.

Notes

Prasophyllum ringens and *P. macrostachyum* both occur together near Busselton and Manjimup without introgression, *P. macrostachyum* in boggy places and flowering more freely after bushfires, *P. ringens* in open grassy dry sites and on rock ledges. Morphological differences include the more rigid leaves of *P. macrostachyum* which are broadest at the fistula and its well-spaced flowers which are distinctly bicoloured with green sepals and purple-red labellum. *P. macrostachyum* also has much longer seed capsules, less acute floral segments, a much shorter and less filiform tip to the lateral sepals, and more distinctly channelled labellum, the whole plant usually drying darker.

This is a strongly outcrossing species. The sweet floral-honey odour of the flowers with their copious nectar seem to assure that a range of small insects visit. The most efficient and frequent pollinators observed have been ichneumon wasps. No evidence of self-pollination or apomixis has been seen.

Specimens examined

WESTERN AUSTRALIA: *R. Bates 2151*, NW Balladonia on rock outcrop, 29.viii.1981 (AD); *R. Bates 4193*, rocks NE Mt Magnet, 2.ix.1984 (AD); *M.G. Corrick 8654*, Cullimbin Reserve E Manmanning, 7.x.1983 (MEL); *D. Cramer sub A. Ashby 2307*, 70 km N Geraldton, 9.ix.1967 (AD); *A.S. George 4193*, Victoria Rocks, 22.ix.1962 (PERTH); *A.S. George 6415*, W Gillingarra, 26.ix.1964 (PERTH), bears label by A.S. George "Agrees well with Lectotype at W. of *Prasophyllum gracile* var. *ringens . . .*".

3. **Prasophyllum macrostachyum** R. Br., Prod. 318 (1810); Spreng., Syst. Veg. 3:712 (1826); Reichb.f., Beitr. Syst. Pfl. 59 (1871), as "*P. macrostachyo*"; Bentham, Fl. Aust. 6:341 (1873); Pelloe, W. Aust. Orchids 26 (1930), partly; Erickson, Orch. West. edn 2:59 (1965), partly; A.S. George, Nuytsia 1(2):187 (1971); Hoffmann & Brown, Orch. S.West Aust. 263, photo (1984); C. & D. Woolcock, Aust. Terrestrial Orchids 88, pl. 43B (1984).

Types: *R. Brown s.n.*, King George Sound, Dec. 1801: (Lecto.: BM!; Syn.: BM, K!). The lectotype designated here is the slenderest plant on a sheet of four specimens and best agrees with the original description. This sheet has in Brown's hand "Oph. parviflorum in paludibus ad portum Regis Georgei . . .". The types are up to 45 cm high and the lower flowers have developed seed capsules to 15 mm long.

P. gracile Lindley, Sketch Veg. Swan Riv. Col. 54 (1840); Lindley, Orch. Pl. 513 (1840).

Types: *Drummond s.n.*, Swan River, 1839 (Lecto.: K-L, photo!). Typification by Clements 1983. George (1971) noted when comparing the types of *P. gracile* with *P. macrostachyum* "The Drummond specimens are much shorter than Brown's but similar morphologically. The type sheet has only two specimens. It bears the annotations "Prasophyllum gracile Lindley, Holotype A.S. George 15.12.1967" and "Prasophyllum gracile Lindley, Lectotype (spec "a") D. Blaxell 1.1.1975). This lectotype (spec "a") is the better of the two specimens.

P. attenuatum auct. non. Fitzg.: Nicholls Orchids Aust. 37, pl. 145 (1969); Pocock, Aust. Ground Orchids 45 (1972).

P. nigricans auct. non. R. Br.: Endl. in Lehm., Pl. Preiss. 2:12 (1846).

Excluded references:

P. macrostachyum sensu Lindley, Orch. pl. 514 (1840) referring to a plant, not determined, collected by R. Brown near Port Jackson.

Plant 10-30 (-45) cm high, slender, green and red; tuberoid ovoid, 5-12 mm long, usually without fibrous sheaths. *Leaf* red at base, shorter than scape, expanded at fistula, apex rigid. *Scape* usually purplish, 1-2 mm diam., often flexuose especially at junction with leaf; flowers 5-30, usually distinctly bicoloured, green and purple-red in attenuated spike to 18 cm long. *Ovary* cylindrical, tumescent, reaching 15 mm long at time of dehiscence; subtending bract reddish, 1-2 mm long, sub-acute. *Dorsal sepal* ovate, 3-4 mm long, green, often with red margins, apex obtuse, not decurved; lateral sepals ovate-lanceolate, 3-4 mm long, green or edged purple-red, ± connate in lower two-thirds, margins much incurved, free apices conical or produced into short prongs. *Petals* very short, 2 x 1 mm, ± triangular, greenish, edged purple, parallel on either side of labellum. *Labellum* on short claw, ovate lanceolate, purplish, 3-4 mm long, recurved at 90° near middle, margins entire, slightly recurved; callus plate broad at base, ill-defined, glabrous, glistening, somewhat triangular in recurved section. *Column* appendages much reduced, 0.4 x 0.4 mm, triangular, obtuse, no basal lobe; anther c. 0.5 mm high, brown, sub-acute; rostellum higher than appendages, c. 1 mm x 0.8 mm; viscidium minute, caudicle only 0.2 mm long.

Flowers

August to December. Flowers with variable sweet fragrance. This species does not need fire to stimulate flowering but fires may increase the proportion of flowering plants.

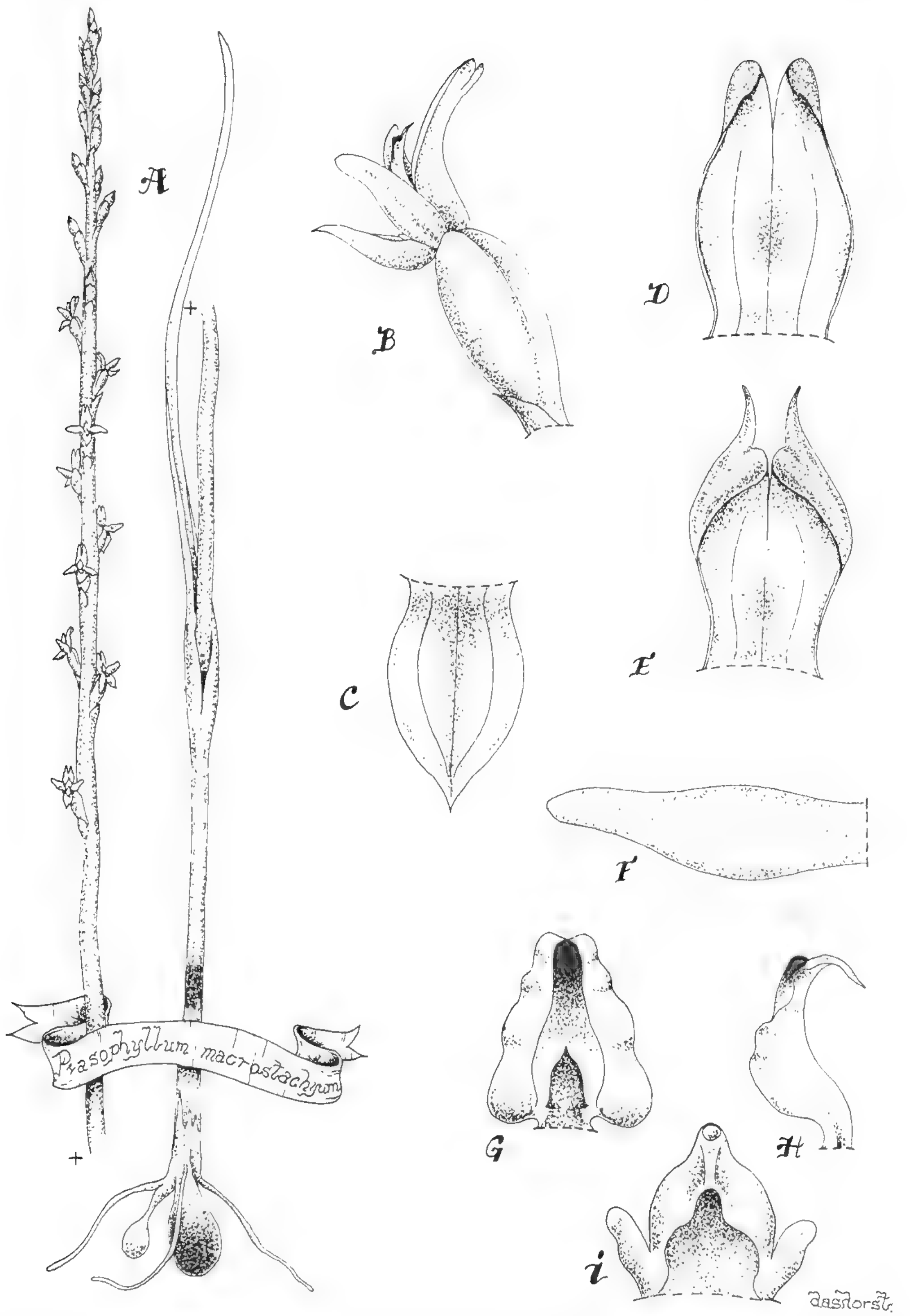


Fig. 3. *Prasophyllum macrostachyum.* A. Whole plant, x2; B. flower from side, x15; C. dorsal sepal, x25; D. & E. lateral sepals, x25; F. petal, x25; G. labellum front view, x25; H. labellum side view, x25; I. column, x30. Voucher spec.: *R. Bates 4560* (AD).

Variation

Two forms have been noted; one (the type form) with short-lived flowers having the ovaries tumescent from bud exhibits some degree of self-pollination; a second form, (*P. gracile* sens. stricto,) has flowers longer lived, the ovaries only swelling after pollination is achieved. The status of these forms requires further investigation. It has also been noted that successively flowering forms may occur in the same area, one group of plants flowering in September, another nearby as late as December. This may be due to environmental differences: flowering may be stimulated by drying out of the soil. Under very wet conditions flowering may be retarded. The author found plants in a waterhole near Northcliffe which were still in bud in December 1987.

Distribution

South-west Western Australia from Dongara to Cape le Grande, usually within 100 km of the coast.

Habitat

Grows in swampy ground, amid low open heathy vegetation, often flowering while standing in water, (however the soil may bake hard in summer).

Conservation status: Common and well conserved.

Selected specimens from 56 examined

WESTERN AUSTRALIA: *R. Bates 4560*, Mount Manypeaks town area, 22.x.1984 (AD); *L. Byrne 3*, Gull Rock E Albany, 10.xi.1968 (PERTH); *A.S. George s.n.*, Foot of Bickley Hill, on clay flat, 4.viii.1961 (PERTH); *A.S. George 15078*, Peaceful Bay, note late flowering, 14.i.1978 (PERTH); *R. Hnatiuk 771395*, 8 km S Enneabba in clay, 27.ix.1977 (PERTH); *T. Wilson s.n.*, Walpole, 1.xi.1975 (PERTH).

References

Bates, R. (1983). Apomixy in two South Australian orchids. *J. Nat. Orch. Soc. South Aust.* 7:35-36.

Clements, M.A. (1983). John Lindley's Orchid Herbarium. *The Orchadian* 7(10):244

George, A.S. (1971). A checklist of the Orchidaceae of Western Australia. *Nuytsia* 1(2):166-196.

Hoffman, N. & Brown, A. (1984). "Orchids of South-west Australia". (Univ. of W. Aust. Press: Nedlands).

Weber, J.Z. & Bates, R. (1986). in Jessop, J.P. & Toelken, H.R. (eds), "Flora of South Australia" edn 4(4):2107 (Govt Printer: Adelaide).

J. Adelaide Bot. Gard. 11(2): 189-194 (1989)

PRASOPHYLLUM FECUNDUM AND *P. OCCULTANS* (ORCHIDACEAE): TWO NEW SPECIES ENDEMIC TO SOUTH AUSTRALIA

R. Bates
38 Portmarnock Street, Fairview Park, South Australia 5126

Abstract

Prasophyllum fecundum R. Bates and *P. occultans* R. Bates are described from southern South Australia, together with illustrations and key.

Introduction

During preparation of a revision for the genus *Prasophyllum* R. Br. it became evident that two undescribed species occurred in South Australia. Although neither is common both are widespread and known from large and stable populations. Indications are that both were probably common before land clearance destroyed most of their habitat. Collections of *P. fecundum* were previously included under *P. fitzgeraldii* R. Rogers & Maiden ex R. Rogers while *P. occultans* has been misidentified variously as *P. occidentale* R. Rogers and *P. pallidum* Nicholls. A key is provided below for identification of these species.

Key to selected *Prasophyllum* species

1. Labellum and callus lanceolate; quite glabrous .... *P. occidentale*
1. Labellum and callus triangular, with some pubescence or papillae on lamina 2
2. Flowers with some purple or pink tints 3
2. Flowers wholly greenish 4
3. Flowers 3-8 rarely to 12, hardly as large as the ovary; dorsal sepal less than 5 mm long; centre of labellum callus glabrous, much raised and polished .... 1. *P. fecundum*
3. Flowers 10-30, much larger than ovary; dorsal sepal more than 5 mm long; centre of labellum callus pubescent and not much raised .... *P. fitzgeraldii*
4. Flowers 10-20 rarely more, lateral sepals parallel, labellum, lamina and callus wholly pubescent..... *P. pallidum*
4. Flowers 3-10 rarely to 12, lateral sepals spreading, labellum, lamina with some papillae about margins of callus plate .... 2. *P. occultans*

1. **Prasophyllum fecundum** R. Bates, sp. nov.

P. fitzgeraldio affine sed plantae parvae, floribus paucioribus parvis in ovariis magnis, labello breviore callo nitido elevato pubescente tomentum in marginibus differt.

Holotype: *R. Bates 6395* Sandy Creek Conservation Park, 4.x.1985 (AD).

Slender herb (6-) 10-20 cm tall; *tuberoid* sub-globose, 4-7 mm diam., outer skin parchment-like when dry, base of stem below ground with 2 cylindrical hyaline sheaths, the lower one less than 1 cm long, upper one to 3 cm long, sheaths persistent, their fibrous remains encasing lower scape. *Leaf* hollow-terete, 2-4 mm diam., to 20 cm long, basal 1 cm tinted red or purplish, apex green, erect. *Scape* green, 1.5-3 mm diam., emerging from leaf at a fistula 3-8 cm above ground level; *flowers* few (3-12), green and purplish, in loose spike 3-6 cm long. *Ovary* sessile, pyriform, about 4 x 3 mm, tumescent; subtending bract, quadrate, 1.5-2 x 1.5-2 mm, more or less truncate. *Dorsal sepal* green, ovate, c. 4 x 2 mm; lateral sepals greenish, lanceolate, 4-5 x 1.5 mm, free and divergent, margins only slightly incurved, apex

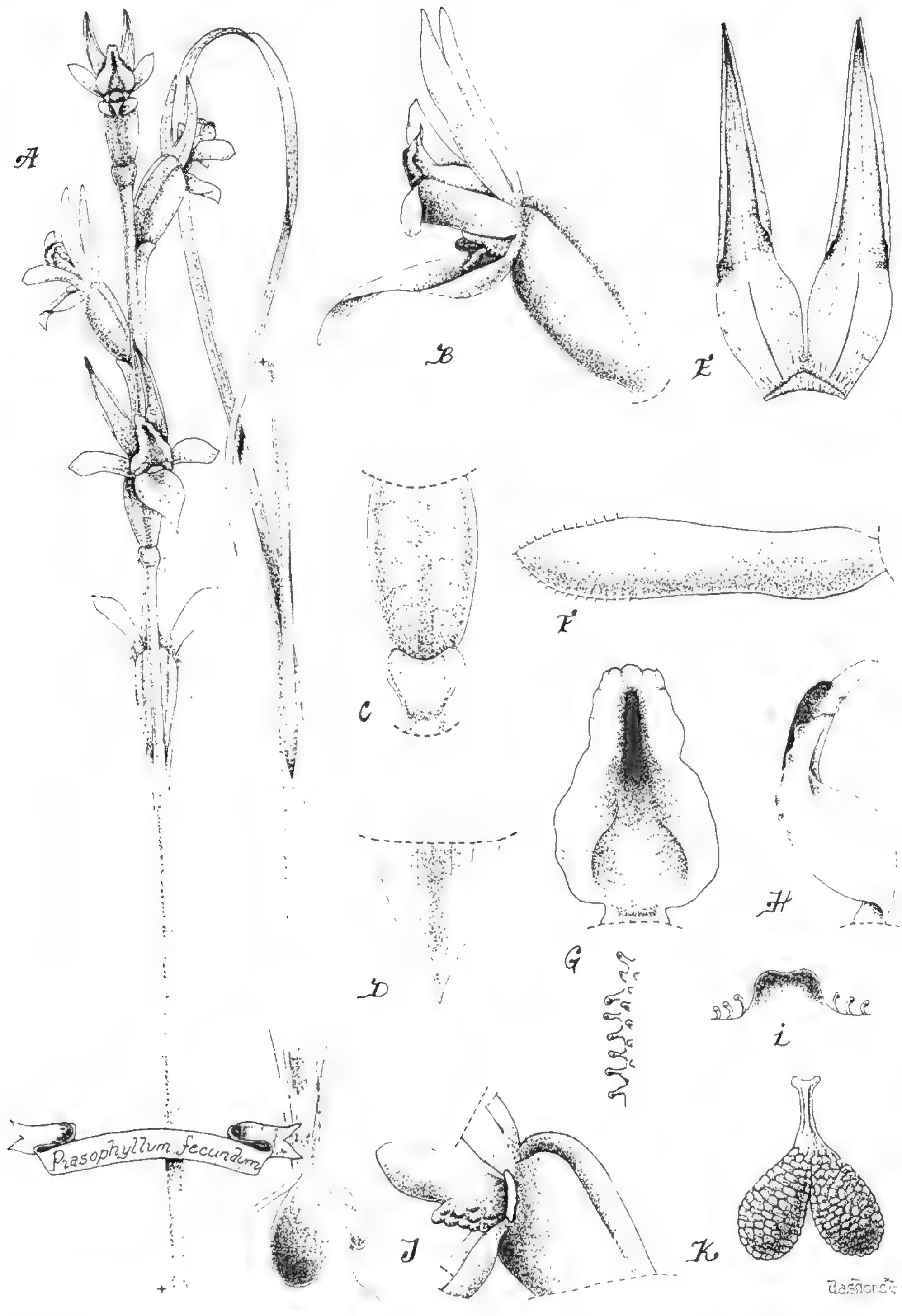


Fig. 1. *Prasophyllum fecundum*. A, plant; B, flower & ovary in side view, x10; C, ovary & bract in front view, x10; D, dorsal sepal, x10; E, lateral sepals, x10; F, petal, x15; G, labellum front view, x10, with magnified view of margin; H, labellum in side view, x10; I, labellum callus, cross section, X15; J, column appendage, x15; K, pollinia, x20. Voucher spec. *R. Bates 6395*, holotype (AD).

subacute, not bidentate. *Petals* linear-oblong, greenish with purple tips, 4 x 1 mm, widely spreading, subacute, apical margins minutely ciliate. *Labellum* almost sessile, ovate, c. 4 x 2.5 mm, pale purple, recurved near middle, basal portion gibbous with entire margins; recurved part triangular, lamina minutely papillose, margins crenulate and minutely ciliate, apex subacute, callus plate slightly more than 1 mm long, greatly raised, rounded, purple-red, ending well before the bend, smooth and shining near centre but with minutely papillose margins. *Column* appendages pale, quadrate, c. 1 x 1 mm, obtuse, basal lobe a mere thickening; anther suborbicular, c. 1 mm long; stigmatic plate 1.2 mm long, stigma semicircular, rostellum very short; pollinia connected directly to viscid disk. Fig. 1.

Flowers

September to early October. The flowers are short lived, apparently apomictic, although fragrant and attractive to insects. Blooming occurs freely and is not facilitated by fires.

Distinguishing features

P. fecundum is a small plant with tiny flowers set on comparatively large ovaries. The very short labellum with its much raised callus, shiny in the middle, papillose near the edges, is unlike that of any other species.

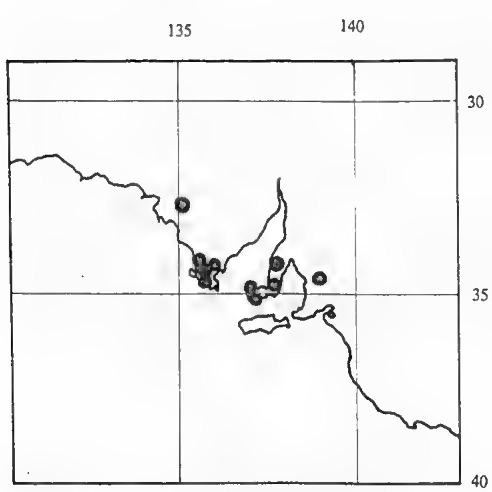
Distribution

Endemic to South Australia where it is found on southern Eyre Peninsula, Yorke Peninsula and the Barossa Valley. Map 1.

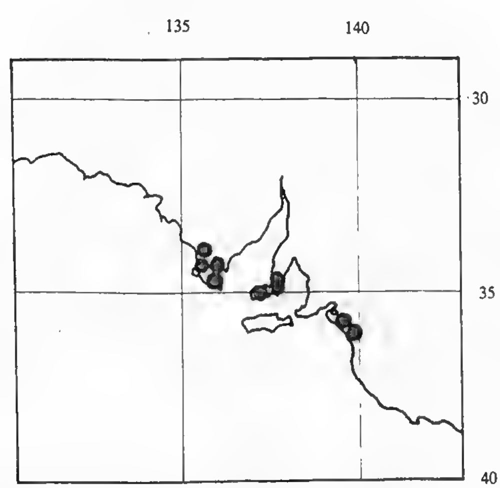
Habitat

Mallee-broombush or *Callitris* scrub in the more fertile terra-rossa soils, or in deep yellow sands, which have largely been cleared for farming so that only small isolated populations of *P. fecundum* remain.

Conservation status: 3RC.



Map 1. Distribution of *Prasophyllum fecundum.*



Map 2. Distribution of *Prasophyllum occultans.*

Notes

The new species is closest to *P. fitzgeraldii* with which it is occasionally sympatric. *P. fitzgeraldii* flowers later, has more crowded, larger flowers with comparatively smaller ovaries, a more voluminous labellum, the callus not greatly raised and in most forms pubescent over its whole surface.

Specimens examined

SOUTH AUSTRALIA: Eyre Peninsula: *R. Bates 372*, Mount Wedge, 26.ix.1974 (AD); *M.G. Clark 32*, Hundred of Koppio, 11.x.1965 (AD); *Mrs Fagg per R.C. Nash s.n.*, Hincks Conservation Park, 7.x.1969 (AD); *J.Z. Weber 6009*, Marble Range, 30.ix.1979 (AD); *J.R. Wheeler 1020*, Hincks "National Park", 11.x.1968 (AD). Yorke Peninsula: *R. Bates 3450*, Maitland to Moonta, 15.ix.1983 (AD); *R. Bates s.n.*, Stansbury-Minlaton Road, 18.ix.1976 (AD wet coll.).

Etymology

From fecund, referring to the tumid ovary which is usually larger than the flower.

2. **Prasophyllum occultans** Bates, sp. nov.

P. occidentali affine sed floribus paucioribus in ovariis marginis, perianthii segmentis brevioribus, sepalis lateralis discretio divergentibusque, labello breviore pubescentia minuta circum calli suggesta indistincto differt.

Holotype: *R. Bates 2334* Lincoln Conservation Park, Eyre Peninsula, scrub adjacent boat ramp on eastern side, 20.ix.1982 (AD).

Slender herb (5-) 10-30 (-35) cm tall; tuberoid ovoid, c. 1 cm diam., outer surface often separating and becoming parchment-like when dry; new tuber produced adjacent to old; base of plant below soil level with 2 cylindrical truncate hyaline sheaths, the lower less than 1 cm long, the upper to 3 cm long. *Leaf* 10-30 mm long, hollow-terete, 3-5 mm diam., purple-red near base, apex filiform, suberect, about as high or higher than flower spike. *Scape* green, emerging from the mid-point or higher up the leaf, 2-4 mm diam.; *flowers* few, mostly less than 10, greenish, well spaced on spike, 3-8 cm long; subtending bract oblong, shorter than broad, c. 3 x 2 mm with a short apiculus. *Ovary* subsessile, ovoid, 4-6 x 1.5-2.3 mm, swelling to 10 x 5 mm after flowering, minutely tuberculate, strongly ribbed. *Dorsal sepal* ovate-lanceolate, 6-8 x 2-3 mm, green with brownish apex; lateral sepals free almost to base, slightly divergent, lanceolate, 2-3 x 7-8 mm, almost straight, thick textured, margins slightly incurved, apex acute, subconical, not bidentate, green with dull brown tints; petals linear-oblong, 5-6 x 1 mm, slightly spreading, green with dull brown apical stripe, thick textured; labellum almost sessile, ovate-lanceolate, 5-6 x c. 2 mm, thick textured, greenish-white, recurved at middle, basal portion slightly gibbous with largely entire margins, apical portion triangular, crisped with crenulate margins, callus green-brown, occupying about half the labellum surface, hardly raised, extending almost to short acute labellum apex, smooth and channelled in centre, with some sparsely papillose areas toward the margins and onto labellum lamina. *Column*: appendages oblong, 2 x 1.5 mm, pale green, thick, basal lobe connate, reaching to mid-point of main lobe; anther almost 2 mm long, red-brown, yellow edged, often with a filiform mucro; stigmatic plate c. 1.5 x 1 mm, stigma reniform near the top; rostellum very short; viscid disk green attached to pollinia by a less than 1 mm long caudicle.

Flowers

The short mid-September to early October flowering season is typical of several other apomictic *Prasophyllum* species in South Australia. Flowers emit a pleasant fragrance in warm conditions.

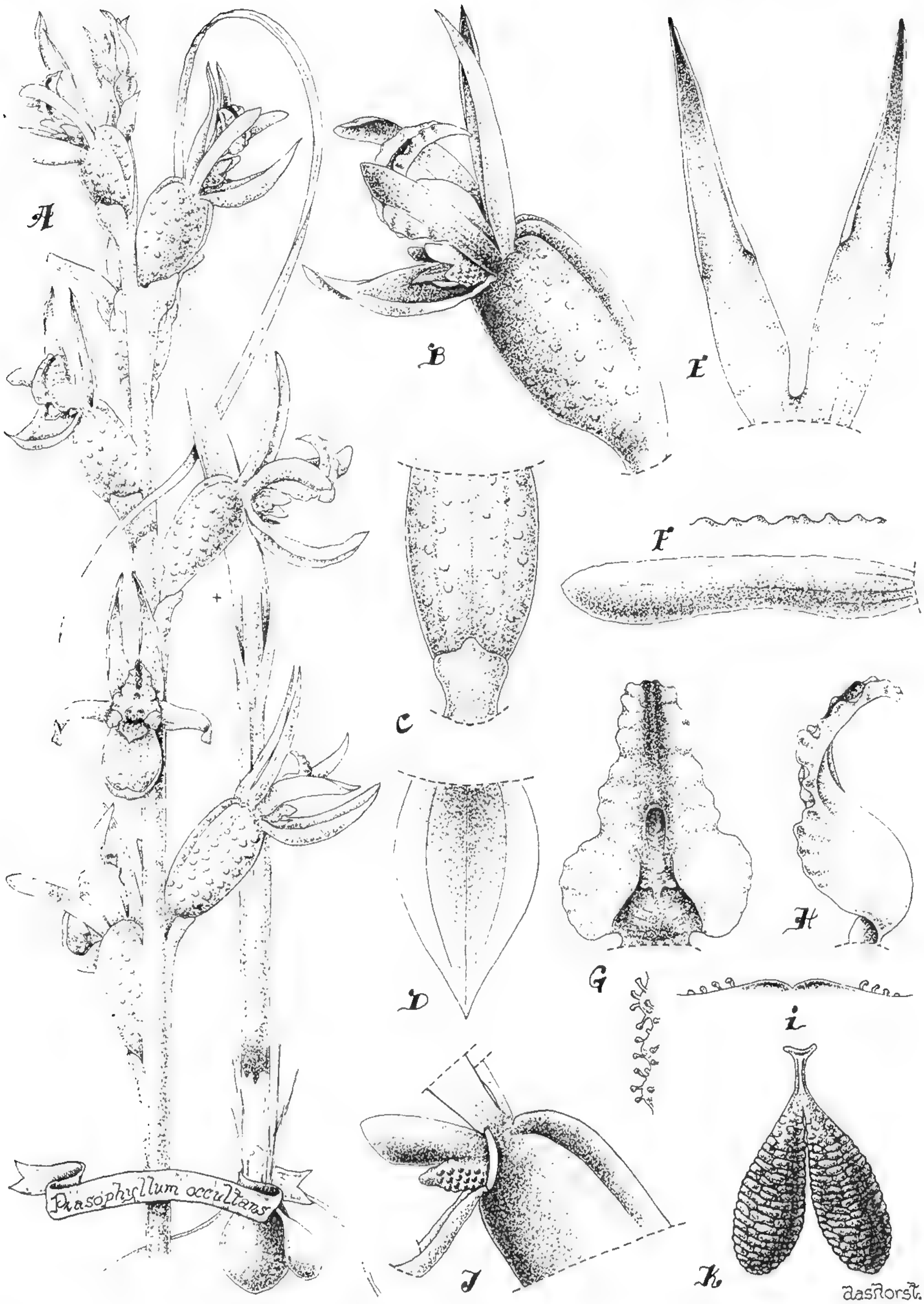


Fig. 2. *Prasophyllum occultans.* A, plant, x5; B, flower & ovary side view, x10; C, ovary & bract, x10; D, dorsal sepal, x10; E, lateral sepals, x10; F, petal x10 with magnification of margin, x20; G, labellum front, x10, with magnification of margin, x20; H, labellum side view, x10; I, cross section of labellum callus, x20; J, column appendage, x15; K, pollinia, x20. Voucher spec. *R. Bates 3450* (AD).

Distinguishing features

The sparse, few-flowered inflorescence, the very dull coloured, thick textured apparently apomictic flowers, the spreading, flat lateral sepals and the hardly-raised, but broad callus plate with its sparse marginal papillae is a distinctive set of characters for *P. occultans.*

Distribution

Endemic to South Australia on southern Eyre Peninsula, Yorke Peninsula and the upper South-East but probably also on Kangaroo Island. Map 2.

Habitat

Commonly in mallee-broombush associations in brown earths or terra rossa soils over limestone, flowering freely without fire.

Variation

Little variation has been noted in colour or morphology but many plants seen had flowers which were teratological.

Conservation status: 3RC.

Specimens examined

SOUTH AUSTRALIA: South-East: *R. Bates 3403*, Mt Boothby Conservation Park, on limestone, 21.ix.1983 (AD, BA, MEL). Yorke Peninsula: *R. Bates 2292*, Warrenben Conservation Park, 25.ix.1982 (AD); *R. Bates 6811*, Warrenben Conservation Park on limestone, ix.1985 (AD); *R. Bates 515*, Stansbury-Minlaton Road, ix.1979 (AD); *P. Hornsby s.n.*, Stansbury scrub, 5 km NNW of 'Yakka' Trig Point, 23.ix.1979 (AD 98011247).

Etymology

Occultans = hidden, a reference to the dull coloured flowers which are not easily seen and also to the sparse papillae on the labellum which are difficult to see without magnification.

Affinities

P. occultans approaches both *P. fitzgeraldii* as well as *P. occidentale* with which it has previously been confused. It is closest to *P. fitzgeraldii* from which it differs in flower colour and particularly in characteristics of the labellum. *P. fitzgeraldii* has a purple labellum with a largely pubescent surface and papillose margins.

From *P. occidentale* it differs in the characters of lateral sepals and labellum; the lateral sepals of *P. occidentale* are largely conjoined not spreading, longer and often bidentate, and the labellum is totally glabrous and has a narrower more raised callus plate.

J. Adelaide Bot. Gard. 11(2): 195-199 (1989)

PTILOTUS BARKERI, A NEW SPECIES OF AMARANTHACEAE FROM LAKE EYRE REGION, SOUTH AUSTRALIA

G. Benl
Botanische Staatssammlung München, W. Germany

Abstract

A new *Ptilotus*, *P. barkeri* Benl sp. nov. from Lake Eyre Region, South Australia, is described and discussed. The taxon is illustrated by a photograph of the holotype sheet and by analytical drawings.

Ptilotus barkeri Benl, sp. nov. (Fig. 1 & 2).

Fruticulus rigidus foliosus plurispicatus usque ad 15 cm altus, ad 20 cm diam. Rami valde ramulosi, ramuli plus minusve intricati, juniores pilis brevibus crassiusculis crispis nodulosis dense, vetustiores sparsius induti, tandem corticati. Folia permulta minuta atroviridia coriacea haud mucronata, juvenilia utrimque modice puberula dein glabrescentia. Spicae solitariae multiflorae ramos ramulosque terminantes, albidi-pilosae, primo subhemisphaericae c. 1.5 cm diam., dein ad c. 3.5 cm elongatae. Rhachis densissime villosa; flores pedicellati ad 30 et ultra conferti. Bractea et bracteolae maiores scariosae partim pilosae, persistentes; bractea subcordati-ovata, bracteolae ovati-lanceolatae concavae aristatae. Perianthium basi indurata tepalorum tubum brevem formans. Tepala elongati-linearia trinervia extus plumosa, pilis strictis obscure articulatis apicem truncatum nudum roseum haud attingentibus, intus glabra, inaequalia: 2 exteriora c. 0.8 cm longa, apice vix contracto eroso-denticulato insignia, 3 interiora angustiora superne plus minusve involuta visu acuta, inferne pilis marginalibus longioribus modice obsessa. Stamina 4 fertilia c. 3-4.5 mm longa, staminodium ad 6 mm et ultra elongatum; filamenta glabra basi valde dilatata in cupulam humilem (c. 1 mm) integram tubo perianthii arcte adnatam coalita; pseudostaminodiis nullis. Gynoecium 6-6.5 mm longum; ovarium subclavatum breviter stipitatum primo densissime pilosum; stylus centralis glaber, ad 3 mm longus.

Differt a *P. parvifolio* (F. Muell.) F. Muell. (var. *laeto* Benl incluso) praecipue indumento permanente ramulorum.

Type: *E.M. James s.n.*, 7.2 km E of Copper Hills by road, South Australia, Region 2: Lake Eyre 27° 56′ 46″S, 134° 23′ 18″E, 13.v.1988 (Holotype: AD, isotype: M). Fig. 1A, 2.

A much-branched rigid shrublet 10-15 cm tall, spreading 10-20 cm across (in type specimen) when fully grown. *Branches* and more or less intricate short branchlets (c. 2-4 cm) with a homogeneous long-persistent whitish cover of thickish crispy nodulose minute (0.2-0.35 mm long) accumbent hairs; leafy throughout on upper, darkly-barked on lower stems. *Leaves* (0.3-) 0.5-1.0 (-1.2) cm apart, alternate, rarely 2 or 3 together, near-sessile, slightly decurrent, to 0.9 x 0.3 cm at most, narrow-elliptic to almost linear-lanceolate, subobtuse or bluntly acute, never mucronate, dark green, thickly coriaceous, entire, loosely pilose on both surfaces with hairs as for branchlets, then turning glabrescent, brownish and rugose when withering; uppermost leaves often subtending inflorescences. *Spikes* numerous, solitary, terminating branches and branclets, usually sessile, compact, subhemispheric to broadly ovoid by 1.2-1.7 cm diam., later elongating to 3.2-3.6 cm long, appearing whitish from pubescence. *Rachis* with a very dense indumentum of faintly articulate silky hairs 1.2-1.5 mm long, surrounding the very short (c. 0.3 mm) flower pedicels; these distinctly jointed above the bracteoles. *Flowers* tightly arranged all along, up to c. 30-35 (-40) a spike. *Bract* and *bracteoles* membranous-scarious, often varying in size and dorsal pubescence consisting of suberect hairs similar to those of the rachis, persistent. Bract (2.6-3.2 x 1.4-1.8 mm) subcordately ovate, subacute, initially white-villous except for the apex, with 3 (4) veins dark reddish-brown inside in about the basal half. Larger bracteoles (3.8-4.2 x 1.8-2 mm) ovate-lanceolate, concavely appressed to perianth; hairs arising in a median area, leaving the wings transparent shining; the prominent inside brownish keel-like midrib produced into an arista-like point ca. 0.5 mm long, not reached by hairs. *Perianth* elongate-erect in anthesis, later subcampanulately diverging in about distal half, the thickened bases of its segments constricted and connected to a callose cup-shaped tube (concave below due to the sunken pedicel attachment) hardly exceeding

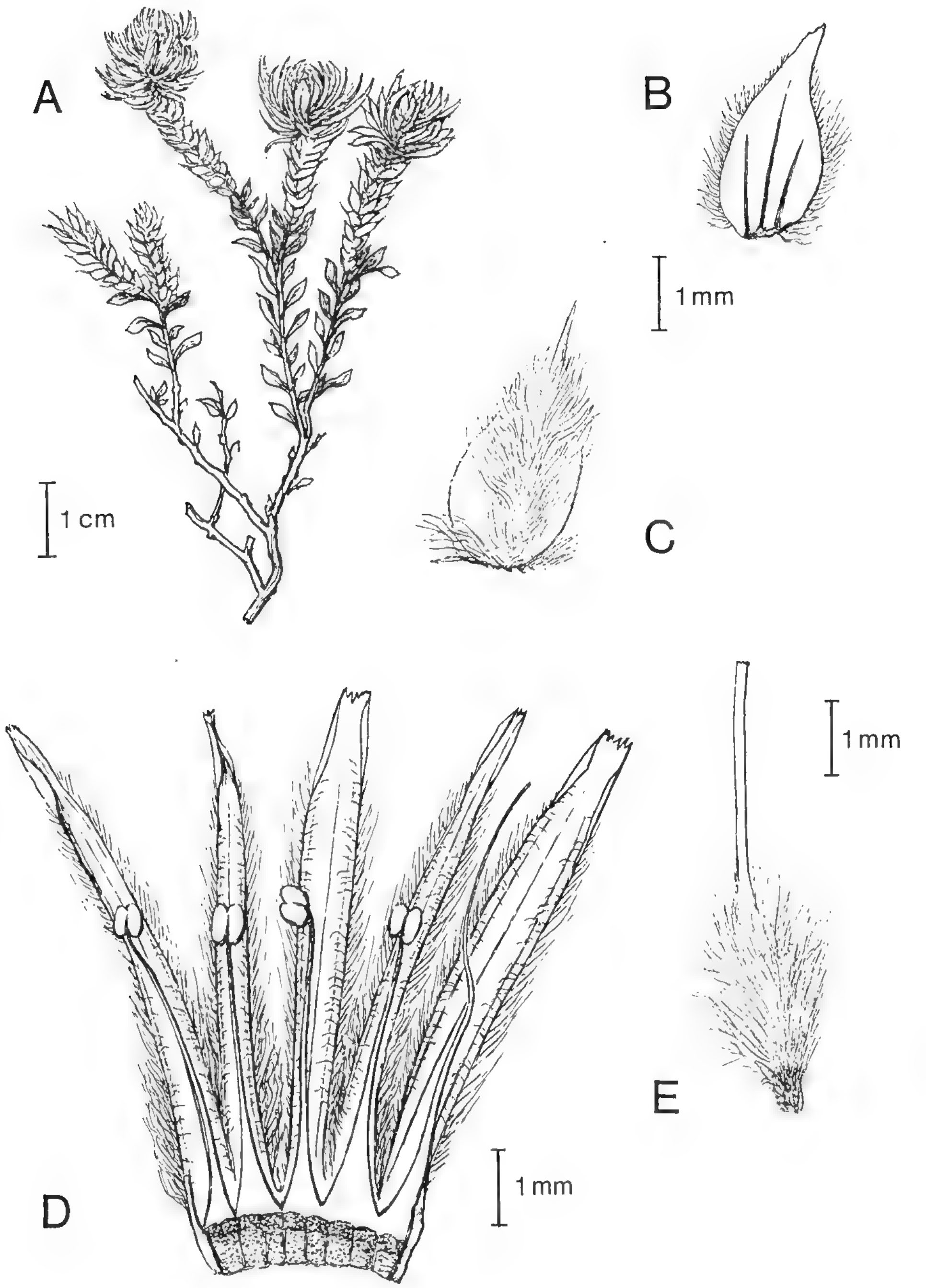


Fig. 1. *Ptilotus barkeri.* A, part of shrublet; B, bract, inner face; C, bracteole, outer face; D, perianth with androecium spread open, inner view; E, gynoecium. (Drawn by A. Bőhm from isotype sheet, M).

1.0 mm high, hirsute outside with narrow glabrous marks continued up to lower parts of tepal midribs. *Perianth segments* almost linear, without a scarious margin, glabrous within, copiously invested outside in fine straight obscurely septate hairs spreading c. 0.6-1.5 mm long, arising all along but never reaching the exposed glabrous tepal ends (pinkish-tinged in fresh material); some shorter marginal hairs turned in against inner surface. Inner view showing three bold ribs in lower third; median vein broadened and prominent externally to form a glabrous ridge in its lower part of c. 1.2 mm, especially obvious in outer segements; fainter lateral veins running near margins. *Outer tepals* from under 7.5 mm to over 8 mm long and 0.8-1.0 (-1.1) mm broad near middle, the truncate-obtuse to truncate, minutely erose-serrate to dentate apex 1.3-1.5 mm long by 0.8-0.9 mm wide. *Inner tepals* slightly shorter but distinctly narrower (c. 6.1-7.8 x 0.5-0.6 mm), the more or less serrulate apex mostly inrolled; an inconspicuous cluster of marginal somewhat wavy (not crisp nor woolly!) hairs to c. 1.8 mm long arising on one or both edges above the tube. *Stamens* five, constantly four perfect, the antherless staminode longer, filiform, somewhat curved; free part of the upright filaments of fertile stamens from c. 3 to 4 (4.5) mm in length, slightly ligulate and c. 0.15 mm wide in the middle, markedly (and sometimes abruptly) broadening near base to 0.6-0.7 mm; the capillary flexuose staminode averaging 5-6 mm long occasionally even overtopping the perianth. *Stamens* and staminode fused below with acute angles to form a cupule 0.8-1 mm high, strongly adnate to the perianth tube, without a free staminal ring and without staminodial teeth or lobes. *Anthers* pale yellow becoming brownish, broad-ellipsoid c. 0.6 x 0.4 mm. *Pistil* short-stipitate when young, not reaching length of perianth. *Ovary* initially club-shaped, up to 3 mm long including the c. 0.6 mm long stipe, then obovoid to complanate-globose of c. 1.8 mm in lateral diam.; a dense pubescence of stiffly erect to c. 1.2 mm long hairs completely occupying the whole juvenile ovary, later limited towards top. *Style* central, stout, glabrous, to 3 mm long and 0.15 mm across near middle, hardly thickened towards ovary, never curved nor bent. *Stigma* papillose, inconspicuous when dry. (Fig. 2).

Specimens examined

SOUTH AUSTRALIA: *E.M. James s.n.*, 7.2 km E Copper Hills by road, Lake Eyre Region, 27° 56′46″S, 134° 23′18″E, 13.v.1988 (AD98824022, M); *E.H. Ising s.n.*, Evelyn Downs, c. 120 km SW Oodnadatta, 25.viii.1954 (AD96929716).

Discussion

In four *Ptilotus* taxa of a shrubby growth, the stems and the usually non-orbicular leaves are more or less persistently pubescent with curved or crisp hairs, i.e. *P. arthrolasius* F. Muell., *P. eriotrichus* W. Fitzg., *P. helichrysoides* F. Muell., *P. maconochiei* Benl. All of them have longer branches and larger leaves than has our plant in question. Furthermore *P. arthrolasius* is characterised by yellowish thin scabrid stem hairs and by tufts of perianth hairs widely projecting beyond the tepals; in *P. eriotrichus* from WA the leaves are discolorous; *P. helichrysoides* from WA is remarkable for its thick prickly tipped leaves; in the greyish tomentose *P. maconochiei* from Qld, the outer tepals exhibit an apical appendage. None of the four species is closely allied to the new taxon.

No doubt, the latter bears some outward resemblance to the twiggy *P. parvifolius* F. Muell. in its two varieties, var. *parvifolius* and var. *laetus* Benl; but in addition to stem pubescence vanishing very soon and to acuminate leaves (with yellowish-cartilaginous margins when fresh) well-pronounced differences concerning floral details came to light upon closer examination. In *P. parvifolius* the tepals are bordered, (very) acute and almost free down to base; only 2 rarely 3 stamens are consistently fertile, the anthers finally drooping, a staminal cup with a free ring is densely hairy or fimbriate, the ovary hairless, the style eccentric and curved; bract and bracteoles are yellowish and shining. Thus the difference between *P. parvifolius* and our taxon is enough to warrant specific recognition.

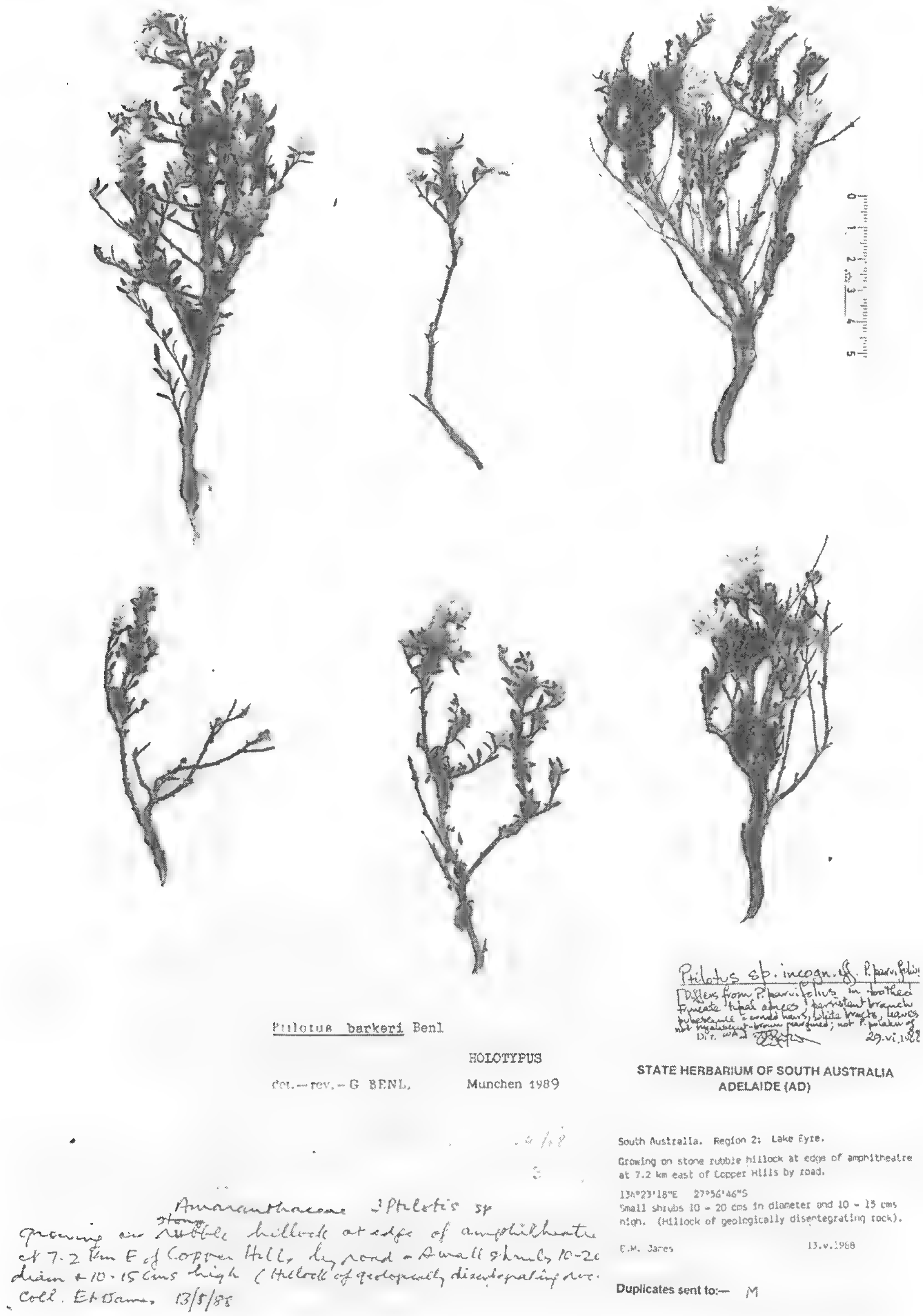


Fig. 2. *Ptilotus barkeri*. Holotype sheet (AD 98824022). (Photograph by K. Liedl).

Etymology

The newly established species is named in honour of Dr W.R. Barker, Senior Botanist in the State Herbarium of South Australia. Dr Barker had recognised the plant as different from *P. parvifolius* and from any other previously described species.

Habitat

Ptilotus barkeri is recorded from "hillock of geologically disintegrating rock" in the label of the holotype collection.

Key to similar species of *Ptilotus*

The new species may easily be inserted into the Key to *Ptilotus* in the "Flora of South Australia", Part 1 (1986), on p. 321, as follows:

1. Shrubs and undershrubs.
    2. Stems and small leaves glabrous except when young .... *P. parvifolius*
    2. Stems and leaves hirsute or pubescent.
        3. Indumentum of curved or crispy hairs.
            3a. Hairs yellowish, curved, rough-walled .... *P. arthrolasius*
            3a. Hairs whitish, crispy, short-nodose .... *P. barkeri*
        3. Indumentum of straight whitish hairs.

Acknowledgements

Dr W.R. Barker is gratefully acknowledged for sending me the material. Thanks are due to Mr A. Böhm for preparing the drawings and to Mr K. Liedl for producing the photograph.

Reference

Benl, G. (1986). *Ptilotus*. In Jessop, J.P. & Toelken, H.R. (eds.) "Flora of South Australia" 4th edn. 1:321-332. (Govt Printer: Adelaide).

Index to Volume 11

Names

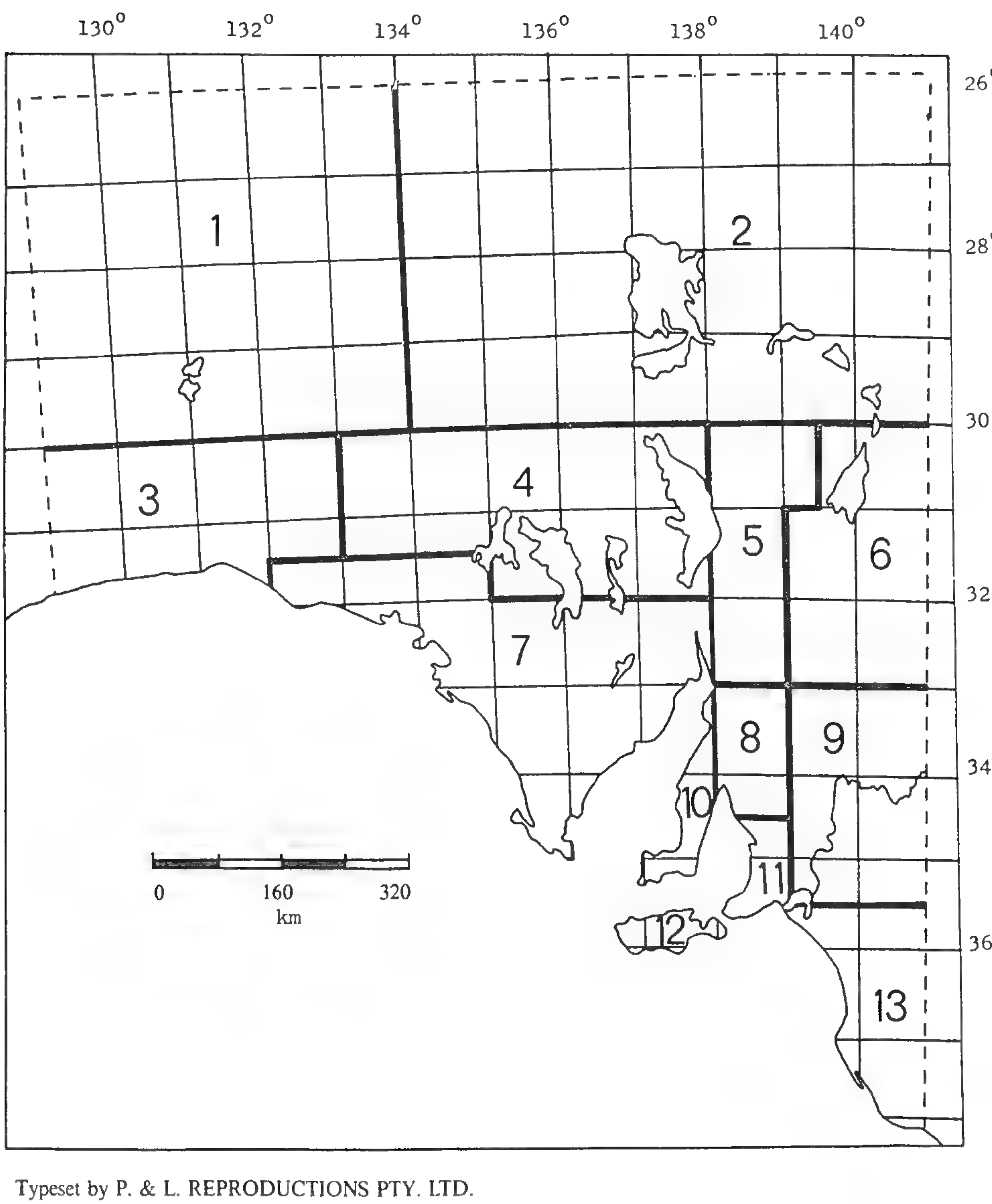
New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked (*) refer to figures and maps.

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre
3. Nullarbor
4. Gairdner-Torrens
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. Yorke Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



Typeset by P. & L. REPRODUCTIONS PTY. LTD.
Printed by APPLE PRESS

JOURNAL of the ADELAIDE BOTANIC GARDENS

CONTENTS