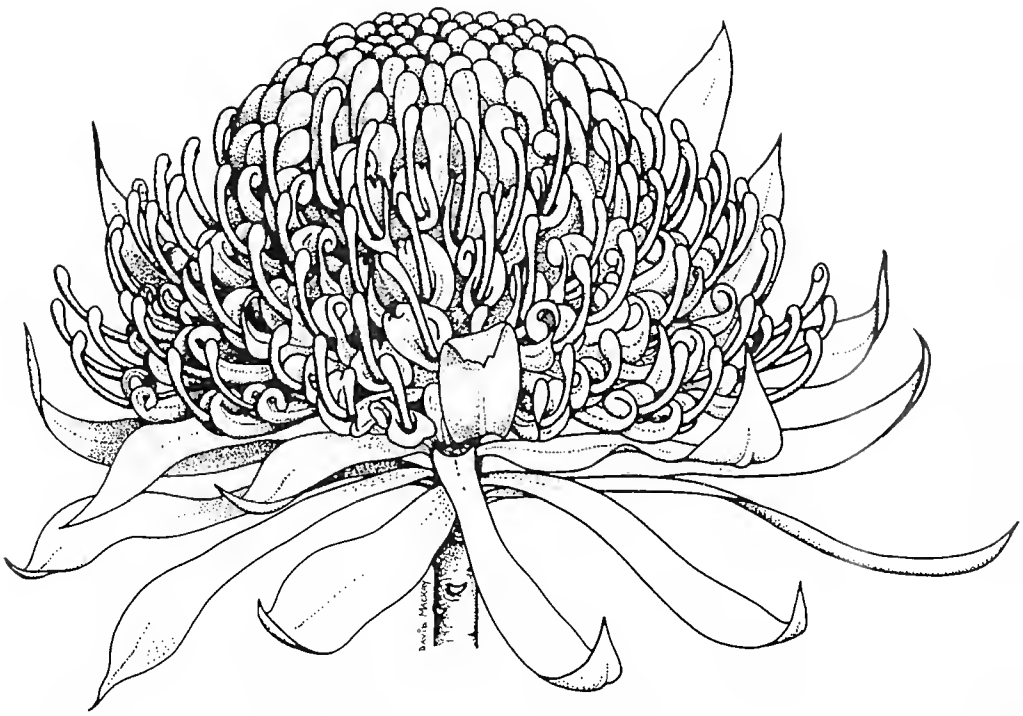
TELOPEA

Volume 7(2) • July 1997



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

TELOPEA

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SHORT COMMUNICATION

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New species in *Angophora* and *Eucalyptus* (Myrtaceae) from New South Wales

K.D. Hill

Abstract

Hill, K.D. (National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquaries Road, Sydney, NSW 2000, Australia) 1996. New species in Angophora *and* Eucalyptus *(Myrtaceae) from New South Wales.* Telopea *7(2): 97–109.* Two new species of *Angophora* (**A. inopina** and **A. exul**) and three new species of *Eucalyptus* (**E. aenea, E. dissita** and **E. fracta**) from New South Wales are described and illustrated. Distribution maps are provided, and conservation status is discussed. All species are regarded as rare or threatened.

Introduction

Two new species of *Angophora* and three new species of *Eucalyptus* from New South Wales are described. All of the new species are classed as rare or threatened, and formal names are required in order to facilitate appropriate listing and action for conservation purposes.

1. Angophora inopina *K.D. Hill*, **sp. nov.**

A. bakeri affinis sed foliis coriaceus, majoribus et latioribus, fructibus majoribus differt. *A. crassifolia* affinis sed foliis latioribus, pedicelli et petioli brevioribus differt.

Type: New South Wales: Central Coast: corner of Old Pacific Hwy and Arizona Rd, Charmhaven, *K.D. Hill 4779 & L.C. Stanberg*, 20 Dec 1995 (holo NSW; iso AD, BRI, CANB, MEL, K, MO).

Tree to 8 m tall, often multi-stemmed. Bark persistent throughout, shortly fibrous. Juvenile leaves not seen. Adult leaves moderately glossy, coriaceous, mid-green, opposite, discolorous and paler beneath, lanceolate to broad-lanceolate, acute, 4–11 cm long, 0.8–2.6 cm wide; petioles robust, flattened, 0.5–0.8 cm long. Inflorescences compound, terminal; unit umbellasters 3–7-flowered. Peduncles setose, terete, 3–17 mm long. Pedicels setose, terete, 7–12 mm long. Mature buds setose, ribbed, globular to pyriform, 5–7 mm long, 5–7 mm diam. Fruits setose, vaguely ribbed, cup-shaped to pyriform, more or less truncate, usually 3-locular, 11–15 mm long, 9–12 mm diam. Valves broadly triangular, obtuse, enclosed, steeply raised. Fig. 1.

Notes: *A. inopina* is a member of the *A. bakeri* C. Hall complex, which also includes *A. crassifolia* (G. Leach) L.A.S. Johnson & K.D. Hill, *A. paludosa* (G. Leach) K. Thiele & Ladiges and *A. exul* (below). It can be distinguished within that group by the broad, coriaceous leaves with short, broad petioles (table 1). It is most similar to *A. crassifolia*, from which it is distinguished by the broader leaves (lower length:breadth ratio) with shorter petioles (lower blade:petiole ratio).

Distribution: a restricted species occurring between Charmhaven and Wyee in the Central Coast region of New South Wales (Fig. 2).

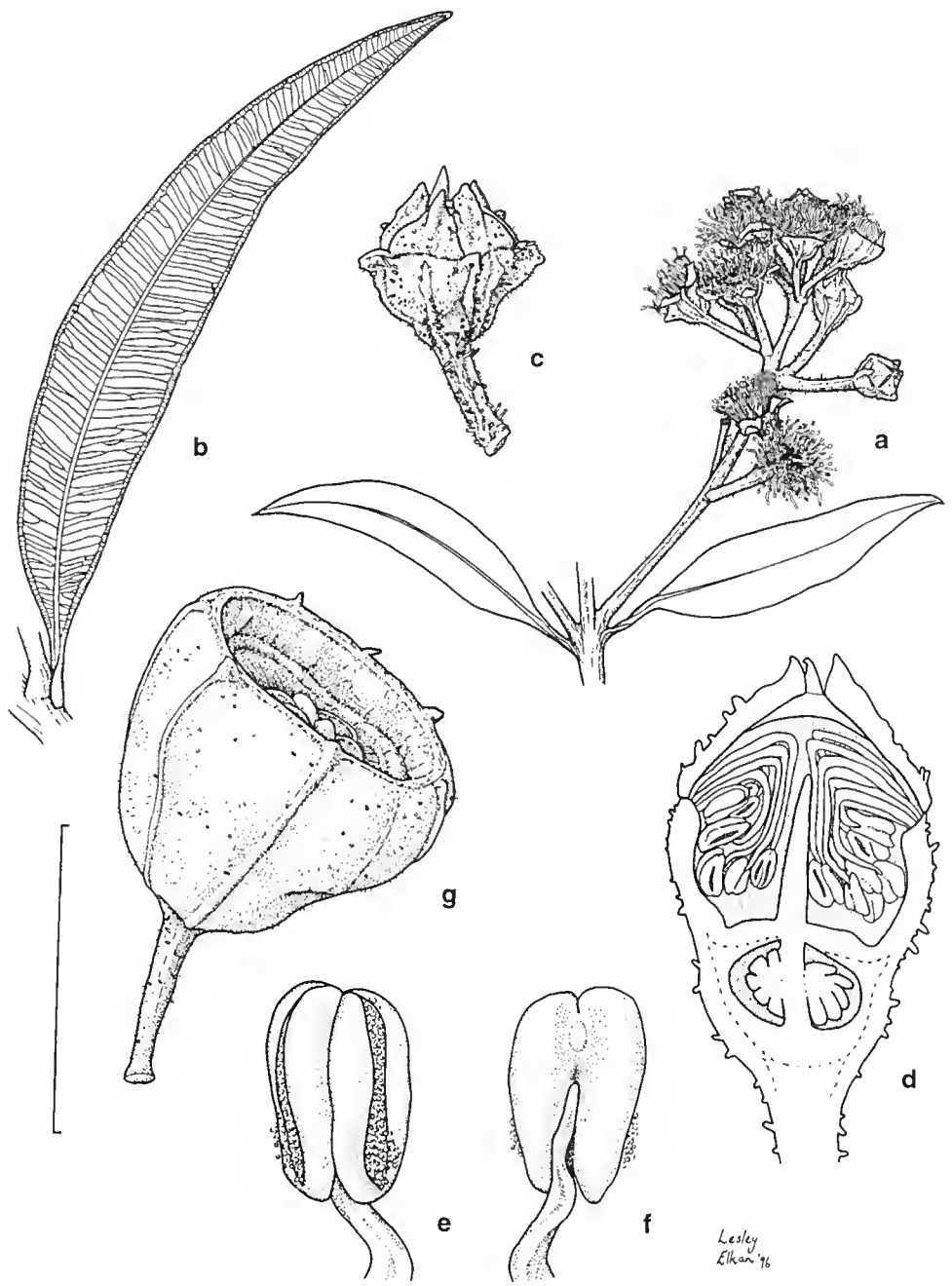

Fig. 1. *A. inopina.* **a,** adult leaves and inflorescence. **b,** adult leaf. **c,** bud. **d,** transverse section of bud. **e, f,** anther. **g,** fruit. (from *Strong s.n., NSW 383911*). Scale bar: a, b = 4 cm; c, g = 1.2 cm; d = 6 mm; e, f = 1.5 mm.

Ecology: locally frequent in open dry sclerophyll woodland of *Eucalyptus haemastoma* Sm. and *Corymbia gummifera* (Sol. ex Gaertn.) K.D. Hill & L.A.S. Johnson with some *E. capitellata* Sm. and a dense shrub understorey on deep white sandy soils over sandstone, often with some gravelly laterite.

Conservation status: 2R–.

The epithet is from the Latin *inopinus*, unexpected, in reference to the occurrence of this undescribed and previously uncollected species on a main road less than 100 km from Sydney.

Selected specimens (from 3 examined): New South Wales: Central Coast: Doyalson–Wyee road, 2.5 km E of Wyee, *Hill 4781 & Stanberg*, 20 Dec 1995 (NSW, BRI, CANB, MEL); along Arizona Rd, Charmhaven, *Strong s.n.*, 1 Jan 1995 (NSW 383911).

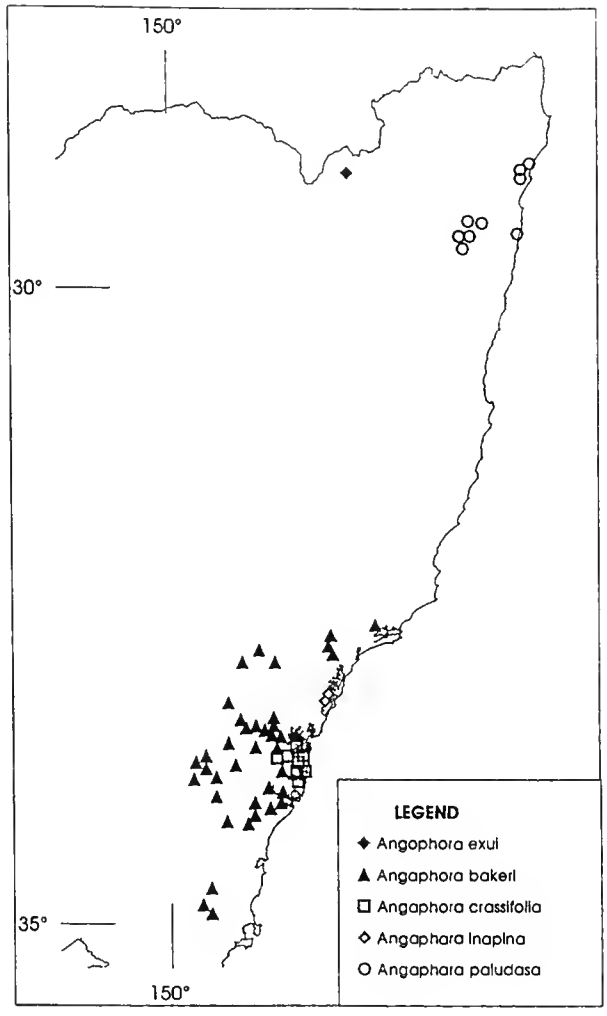

Fig. 2. Distribution of *A. bakeri*, *A. crassifolia*, *A. paludosa*, *A. inopina* and *A. exul*.

2. Angophora exul *K.D. Hill*, **sp. nov.**

A. bakeri affinis sed foliis angustioribus, petiolis longioribus differt.

Type: New South Wales: North Western Slopes: Gibraltar Rock, W of Tenterfield, *K.D. Hill 4788, L.C. Stanberg & K.L. Wilson*, 22 Feb 1996 (holo NSW; iso AD, BRI, CANB, K, MEL, MO, NY, P).

Tree to 8 m tall. Bark persistent throughout, shortly fibrous, shedding in plates. Juvenile leaves not seen. Adult leaves moderately glossy, chartaceous, mid-green, opposite, discolorous and paler beneath, linear to narrow-lanceolate, acuminate, 5–12 cm long, 0.4–0.7 cm wide; petioles slender, 0.7–1.2 cm long. Inflorescences compound, terminal; unit umbellasters 3–7-flowered. Peduncles terete, 6–11 mm long. Pedicels terete, 6–10 mm long. Mature buds ribbed, globular, 6–9 mm long, 6–9 mm diam. Fruits cup-shaped to obconical, usually 3-locular, 5–8 mm long, 5–7 mm diam. Stemonophore flat, < 0.2 mm wide. Disc vertically depressed, 1–1.5 mm wide. Valves broadly triangular, acute, enclosed, steeply raised. Fig. 3.

Notes: another member of the *A. bakeri* group, *A. exul* is distinguished by the very narrow leaves with long, slender petioles (table 1). Forms of *A. floribunda* in nearby woodlands show unusually narrow leaves for the species, and are thought to represent products of introgressive hybridisation with *A. exul*. The latter may in fact be in danger of losing its genetic integrity through such hybridisation.

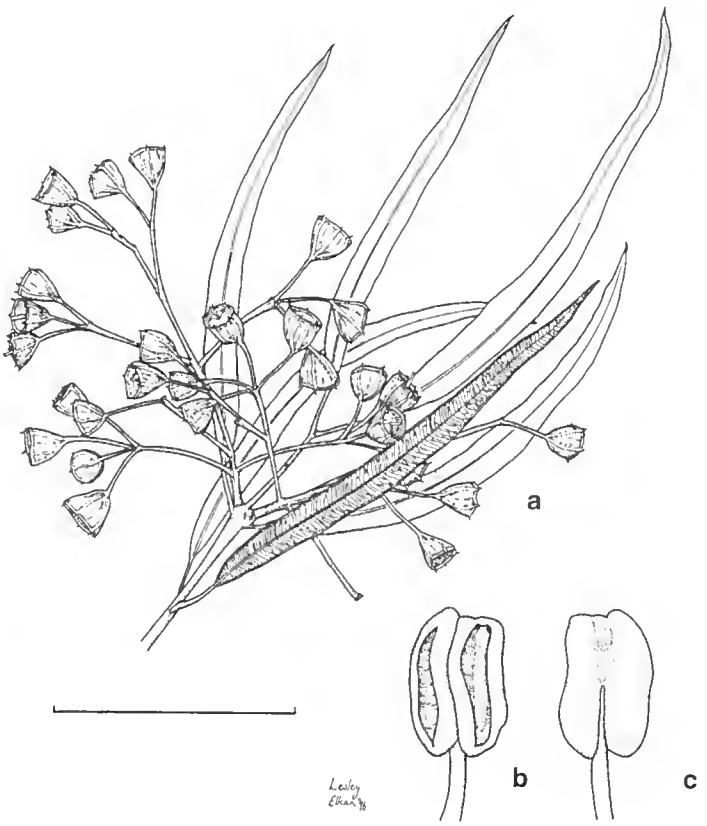

Fig. 3. *A. exul*. **a**, adult leaves, inflorescence and spent flowers. **b**, **c**, anther. (from *Hill 4788 et al.*). Scale bar: a = 4 cm, b, c, = 1.5 mm.

Distribution: known only from a single small stand on Gibraltar Rock, west of Tenterfield (Fig. 2).

Ecology: a rare species occurring only on open scree on a ridge of acid volcanic outcrops.

Conservation status: 2R–.

The epithet is from the Latin *exul*, an exile, from the remote occurrence of this species from other species of the *A. bakeri* group.

Selected specimens (from 3 examined): New South Wales: North Western Slopes: Rock of Gibraltar, 31 km W of Tenterfield, *Roberts s.n.*, 29 Jul 1992 (NSW 370740).

A. floribunda – *A. exul* intergrades:

New South Wales: North Western Slopes: Gibraltar Rock, *Hill 4785*, *Stanberg & Wilson*, 22 Feb 1996 (NSW).

Table 1. Comparison of species in the *Angophora bakeri* complex.

	A. bakeri	*A. crassifolia*	*A. paludosa*	*A. inopina*	*A. exul*
Adult leaf	lanceolate	lanceolate	lanceolate	broad-lanceolate	narrow-lanceolate
cm long	6–10 ×	7–11 ×	7–11 ×	4–11 ×	5–12 ×
cm wide	0.5–1.0	0.7–1.5	0.8–1.5	0.8–2.6	0.4–0.7
l:b	8–12:1	7–10:1	7–9:1	4–7:1	12–17:1
Lamina:petiole	12–18:1	10–12:1	13–18:1	8–14:1	7–10:1
Texture	chartaceous	coriaceous	chartaceous	coriaceous	chartaceous
Petiole mm	3–8	6–10	4–8	5–8	7–12
Pedicel mm	4–11	10–15	4–9	7–12	6–10
Fruit mm	8–10 × 8–10	10–14 × 9–14	7–10 × 7–11	11–15 × 9–12	5–8 × 5–7

3. Eucalyptus aenea *K.D. Hill*, sp. nov.

E. viridi affinis sed foliis adultis et juvenilibus latioribus, cortice trunci laevi differt.

Type: New South Wales: Central Western Slopes: Death Adder rock, near Gungal, *K.D. Hill 4806*, *L.C. Stanberg & M. Sharp*, 12 Mar 1996 (holo NSW; iso AD, BRI, CANB, K, MEL, MO, NY).

Slender mallee to 5 m tall. Bark smooth to base, shedding in ribbons, grey-brown, bronze and dark grey. Juvenile leaves blue-green, dull, disjunct–opposite, lanceolate, 5–8 cm long, 0.7–1.8 cm wide; petioles 0.5–1.0 cm long. Adult leaves glossy yellow-green, disjunct–opposite, similifacial, lanceolate, acute or apiculate, 5–11 cm long, 0.9–1.8 cm wide; petioles 0.6–1.0 cm long. Inflorescences axillary, single or occasionally compound; umbellasters 7-flowered. Peduncles terete, 4–7 mm long. Pedicels terete, 1–3 mm long. Mature buds ovoid, 4–6 mm long, 2–3 mm diam. Calyptra conical or hemispherical, acute, obtuse or rounded, 1/2 as long to about as long as hypanthium. Outer calyptra persistent to anthesis. Stamens irregularly flexed, all fertile. Anthers adnate, basifixed, cuboid to globoid, opening by lateral pores. Fruits cup-shaped, 3–4-locular, 3–5 mm long, 3–5 mm diam. Calyptra scar and stemonophore flat, < 0.2 mm wide. Disc steeply depressed, 1–1.5 mm wide. Valves broadly triangular, obtuse, enclosed, strongly raised. Fig. 4.

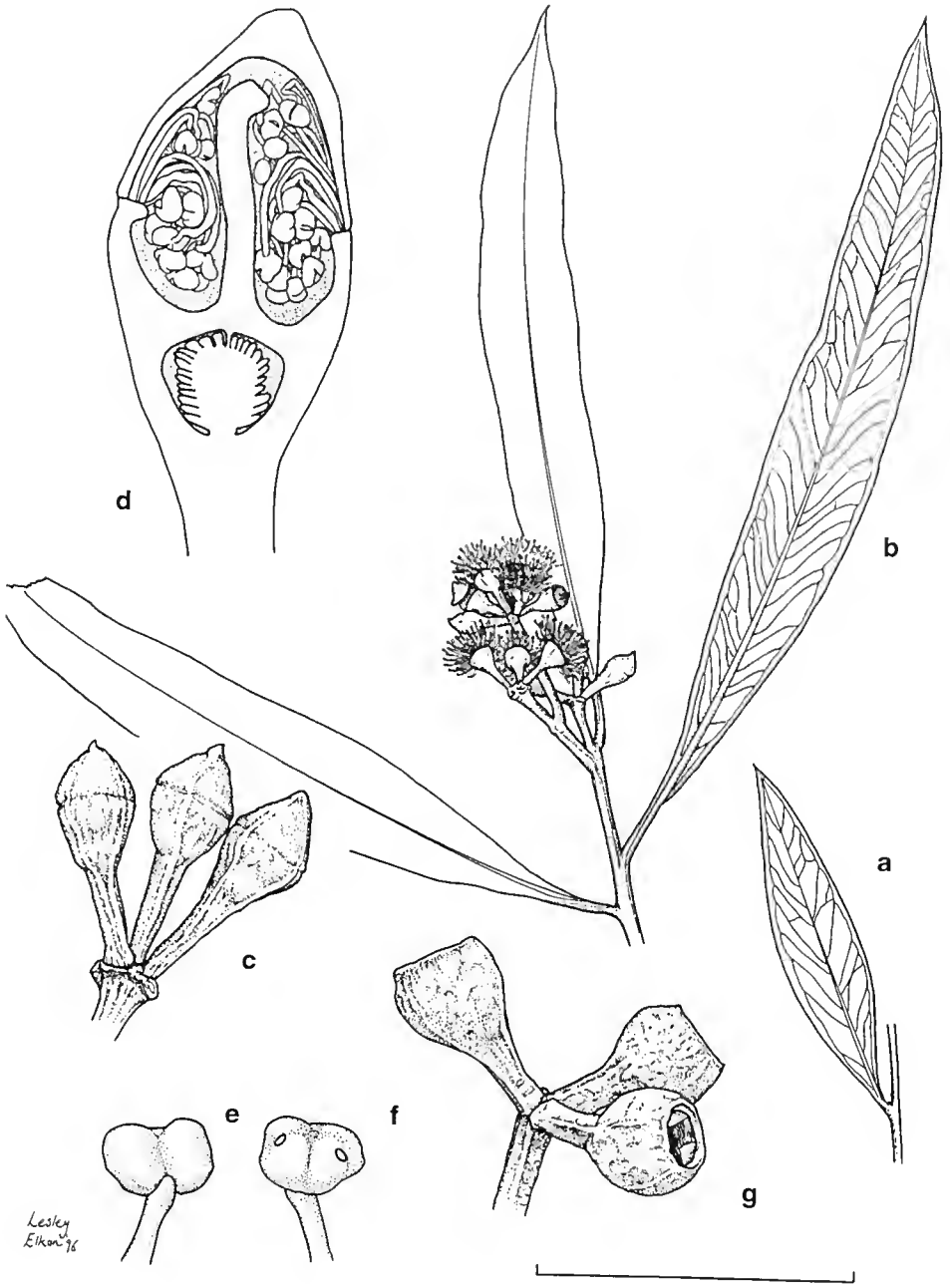

Fig. 4. *E. aenea*. **a**, juvenile leaf. b, adult leaves and inflorescence. **c**, inflorescence and buds. **d**, transverse section of bud. **e**, **f**, anther. **g**, fruit. (a from *Hill 4808 et al.*, b-g from *Hill 4806 et al.*). Scale bar: a = 6 cm, b = 4 cm, c, g = 1.2 cm, d = 6 mm, e, f = 1.5 mm.

Notes: the mallee habit, the predominantly axillary inflorescences and the persistent outer calyptra place *E. aenea* nearest to *E. viridis* R. Baker. It is distinguished by the relatively broader adult and juvenile leaves, the blue-green juvenile leaves (juvenile leaves of *E. viridis* are green and up to 9 × 0.5 cm; adult leaves are up to 10 × 0.8 cm), and the wholly smooth bark. *E. viridis* is generally a plant of drier environments west of the dividing range.

Distribution: known only from a few small stands in the Goulburn River National Park (Fig. 5).

Ecology: locally dominant but very restricted, occurring in small stands on shallow soils on the higher flanks of low sandstone ridges. *E. sideroxylon* A. Cunn. ex Woolls occurs in slightly lower sites adjacent and sometimes within the mallee community, and *E. sparsifolia* Blakely and *E. fibrosa* F. Muell. occur on the tops of the sandstone ridges. The understorey is composed of a variety of scleromorphic shrub species.

Conservation status: 2RC.

The epithet is from the Latin *aenaeus*, bronze, from the frequently bronze-coloured bark.

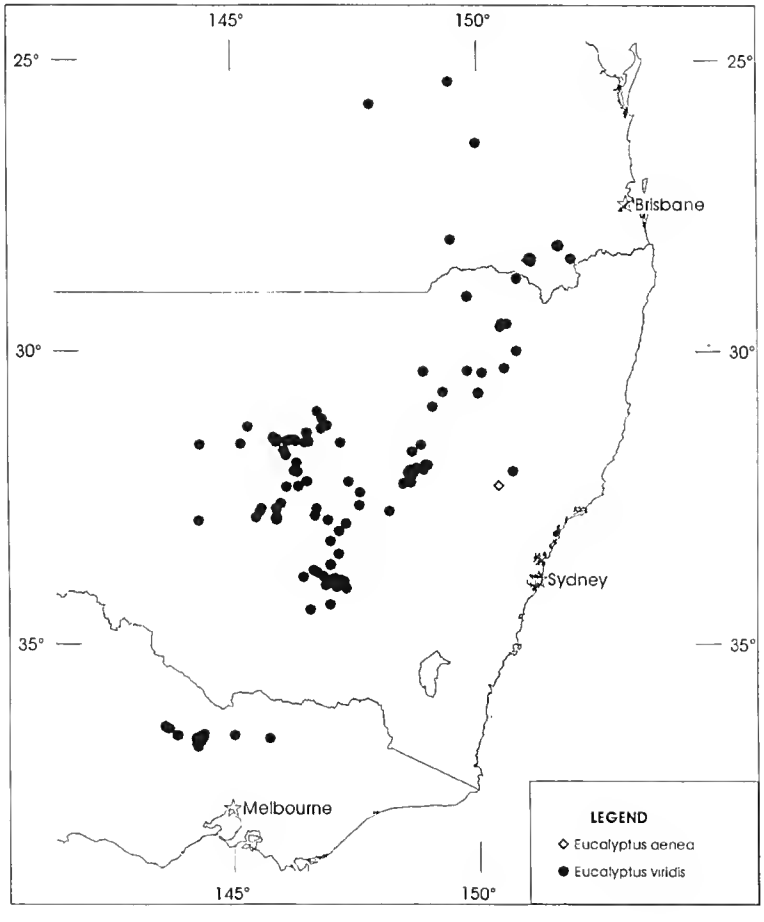

Fig. 5. Distribution of *E. aenea* and *E. viridis*.

Selected specimens (from 16 examined): New South Wales: Central Western Slopes: Flaggs Rd area, eastern edge of Goulburn River Natl Park, *Bell s.n.*, Mar 1995 (NSW 398812); Death Adder Rock, eastern part of Goulburn River Natl Park, *Bell S1, S2, S3, S4, S5*, 20 Jun 1995 (NSW); Death Adder Rock, near Gungal, *Hill 4807, 4808, Stanberg & Sharp*, 12 Mar 1996 (NSW); 800 m E of Death Adder Rock, near Gungal, *Hill 4811, 4812, Stanberg & Sharp*, 12 Mar 1996 (NSW)

4. Eucalyptus dissita *K.D. Hill*, **sp. nov.**

E. moorei affinis sed foliis adultis et juvenilibus latioribus differt.

Type: New South Wales: Northern Tablelands: Surveyors Creek track, *K.D. Hill 4792, L.C. Stanberg & K.L. Wilson*, 22 Feb 1996 (holo NSW; iso AD, BRI, CANB, K, MEL, MO).

Slender mallee to 4 m tall. Bark smooth to base, shedding in ribbons, pale green, yellow-brown and grey. Juvenile leaves blue-green, dull, opposite on early nodes, becoming disjunct-opposite, lanceolate, 2.5–7 cm long, 0.6–1.4 cm wide, sessile on early nodes, becoming petiolate, petioles to 0.7 cm long. Adult leaves glossy mid-green, disjunct-opposite, similifacial, lanceolate, acute or apiculate, 4–8 cm long, 0.7–1.8 cm wide; petioles 0.4–1.0 cm long. Inflorescences axillary; umbellasters many-flowered (more than 11). Peduncles terete, 4–8 mm long. Pedicels terete, 0.5–1.5 mm long. Mature buds fusiform, 4–7 mm long, 1.5–2.5 mm diam. Calyptra conical, acute, about as long as hypanthium. Stamens irregularly flexed, all fertile. Anthers versatile, reniform, opening by confluent diagonal slits. Fruits globular to truncate-globular, 3-, rarely 4-locular, 3–5 mm long, 3–5 mm diam. Calyptra scar and stemonophore flat, < 0.2 mm wide. Disc level, < 1 mm wide. Valves broadly triangular, obtuse, level with stemonophore, slightly raised. Fig. 6.

Notes: *E. dissita* has been included in *E. moorei* Maiden & Cambage (e.g. Hill 1991), from which it is readily distinguished by its broader adult and juvenile leaves (lower length:breadth ratios; Table 2) and longer petioles. *E. serpentinicola* in the same species complex also has narrower juvenile and adult leaves and shorter petioles than *E. dissita*. The foliage of living plants of *E. dissita* is also held in a stiff, erect manner, in contrast to the more lax foliage of *E. moorei* and *E. serpentinicola*. *E. latiuscula*, also in the same complex, has broader juvenile and adult leaves and shorter petioles than *E. dissita* (Table 2).

Table 2. Comparison of species in the *Eucalyptus moorei* complex.

	E. moorei	*E. serpentinicola*	*E. latiuscula*	*E. dissita*
Juvenile leaf	narrow-lanceolate	narrow-lanceolate	ovate to elliptic	lanceolate
Adult leaf	narrow-lanceolate to lanceolate	linear to narrow-lanceolate	lanceolate to broad-lanceolate	lanceolate to broad-lanceolate
cm long	4–10 ×	4–12 ×	5–9 ×	4–8 ×
cm wide	0.5–1.0	0.4–1.0	0.7–1.7	0.7–1.8
l:b	8–10:1	10–12:1	5–8:1	4–7:1
Petiole mm	2–5	2–7	2–6	4–10
Lamina:petiole	18–22:1	16–25:1	15–25:1	8–12:1

Distribution: known only from a few small stands in the Gibraltar Range National Park in the New England region of north-eastern New South Wales (Fig. 7).

Ecology: locally dominant in small patches around the edges of swamps, on gritty sandy soils over granite just above the level of permanent water. *E. ligustrina* DC., *E. radiata* Sieber ex DC. subsp. *sejuncta* L.A.S. Johnson & K.D. Hill and *E. acaciiformis* Deane & Maiden occur in adjacent woodland, with some *E. radiata* subsp. *sejuncta* also

Fig. 6. *E. dissita*. **a**, juvenile leaves. **b**, adult leaves and inflorescence. **c**, inflorescence and buds. **d**, transverse section of bud. **e, f**, anther. **g**, fruit. (a from *Hill 4793 et al.*, b, c, d, g from *Williams s.n., NSW 340500*, e, f from *Hill 4795 et al.*). Scale bar: a = 6 cm, b = 4 cm, c, g = 1.2 cm, d = 6 mm, e, f = 1.5 mm.

among the *E. dissita* population. The near-swamp habitat is similar to that of *E. moorei*, whereas the geographically nearer and also closely related *E. serpentinicola* L.A.S. Johnson & Blaxell occurs on dry elevated sites.

Conservation status: 2RC.

The epithet is from the Latin *dissitus*, lying apart, in reference to the wide separation from the sister species *E. moorei*.

Selected specimens (from 6 examined): New South Wales: Northern Tablelands: Surveyors Creek track, *Hill 4793, 4794, 4795 Stanberg & Wilson*, 2 Feb 1996 (NSW); 65 km NE of Glen Innes, *Roberts s.n.*, 17 Jun 1989 (NE, NSW 397167, BRI); Surveyors Creek Trail, off the Mulligans Hut road, c. 41 miles (66 km) NE of Glen Innes, *Williams s.n.*, 29 May 1974 (NE, NSW 340500).

5. Eucalyptus fracta *K.D. Hill*, **sp. nov.**

E. siderophloiae affinis sed foliis juvenilibus minoribus et latioribus, statura minore differt.

Type: New South Wales: North Coast: Broken Back Range, *K.D. Hill 4776, L.C. Stanberg & T. Tame*, 6 July 1995 (holo NSW; iso AD, BRI, CANB, K, MEL, MO).

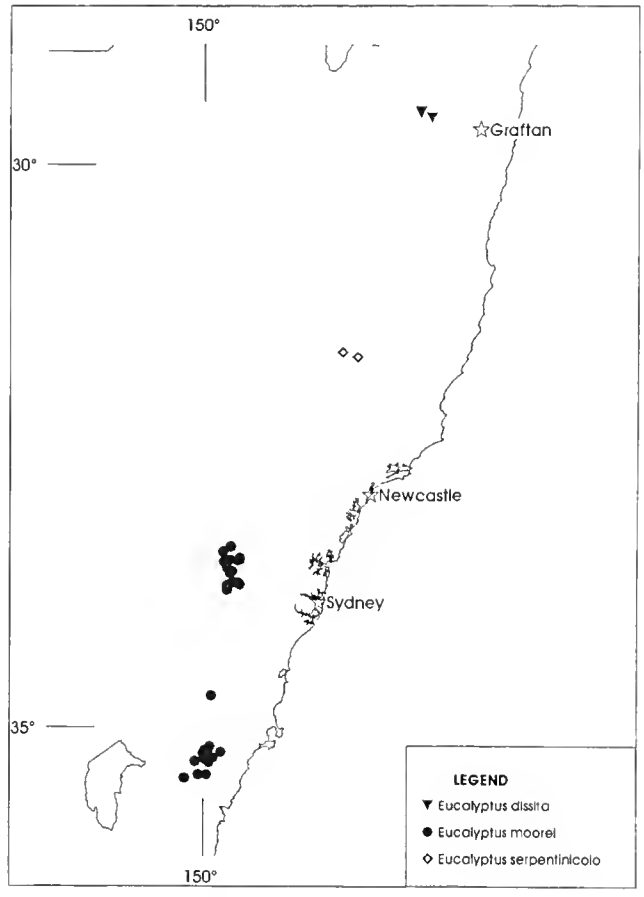

Fig. 7. Distribution of *E. dissita*, *E. serpentinicola* and *E. moorei*.

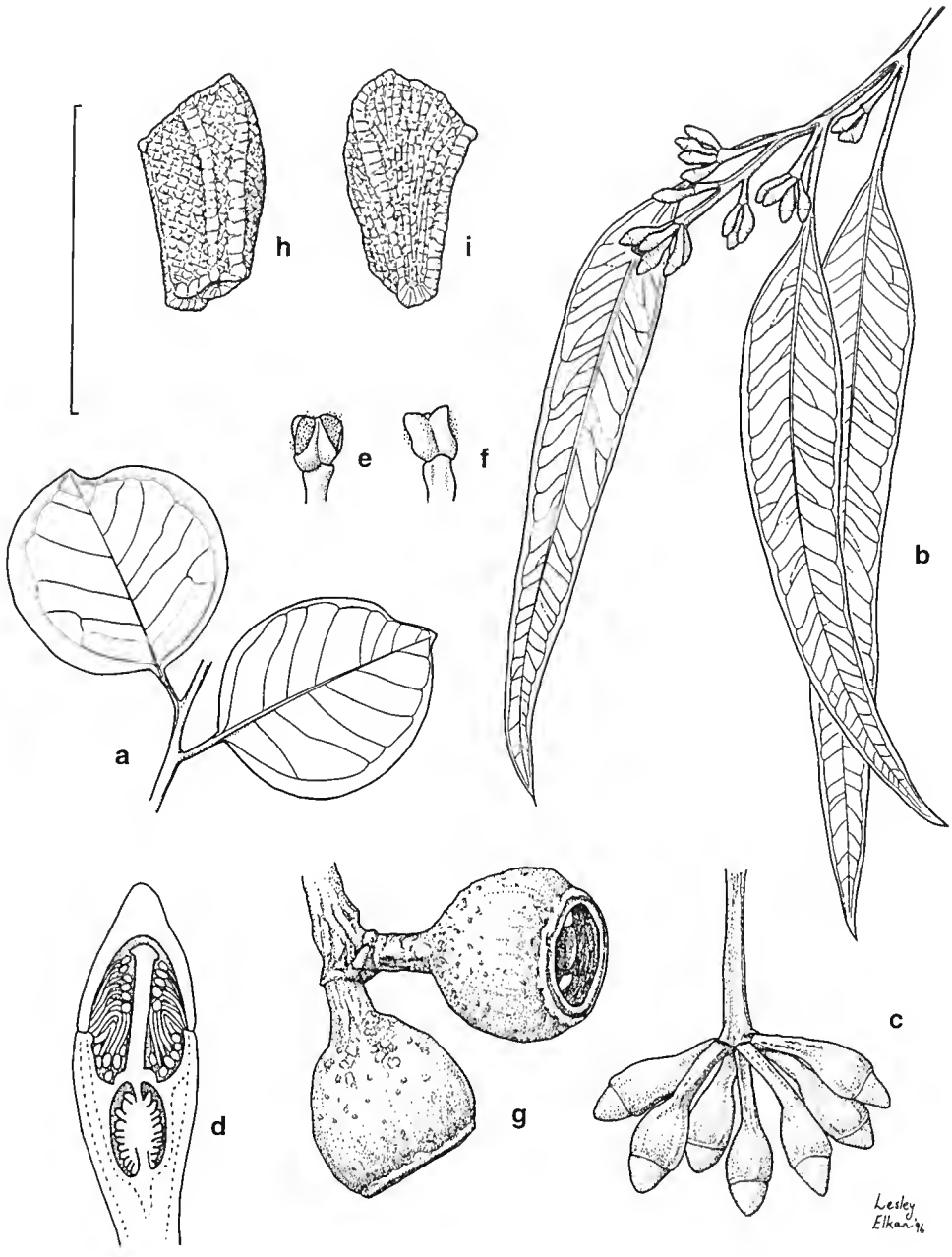

Fig. 8. *E. fracta*. **a,** juvenile leaves. **b,** adult leaves and inflorescences. **c,** inflorescence and buds. **d,** transverse section of bud. **e, f,** anther. **g,** fruit. **h, i,** seed. (a,b from *Hill 4776 et al.*, c, d from *Tame 3505*, g, h, i from *Wiecek 494 et al.*, e, f from *Tame s.n., NSW 392958*). Scale bar: a = 6 cm, b = 4 cm, c, g = 1.2 cm, d = 6 mm, e, f = 1.5 mm.

Tree or mallee to 8 m tall. Bark hard ironbark to branches c. 7 cm diam., then smooth, whitish. Small branchlets slightly glaucous. Juvenile leaves blue-green, dull, disjunct-opposite, orbiculate, later ovate, 3–6 cm long, 2.5–3.5 cm wide; petioles 0.5-0.8 cm long. Adult leaves dull to slightly glossy grey-green, disjunct-opposite, similifacial, lanceolate, acuminate, 7–11 cm long, 1–2.5 cm wide; petioles 0.8–1.8 cm long. Inflorescences compound, often axillary; umbellasters 7-flowered. Peduncles terete, 6–10 mm long. Pedicels terete, 1–5 mm long. Mature buds fusiform, 6–8 mm long, 2–3 mm diam. Calyptra conical, acute or apically rounded, slightly shorter than to about as long as hypanthium. Outer calyptra shed long before anthesis. Stamens irregularly flexed, all fertile. Anthers adnate, basifixed, cuboid to globoid, opening by lateral pores. Fruits cup-shaped, 3–4-locular, 5–8 mm long, 5–7 mm diam. Calyptra scar and stemonophore flat, < 0.2 mm wide. Disc vertically depressed, 1-1.5 mm wide. Valves broadly triangular, acute, steeply raised, level with stemonophore or slightly exserted. Fig. 8.

Notes: *E. fracta* is nearest to *E. siderophloia* Benth., from which it can be distinguished by the smaller habit (*E. siderophloia* is a forest tree to 45 m tall) and the smaller and more rounded juvenile leaves (juvenile leaves are ovate, later broad-lanceolate to lanceolate, to 12 × 4 cm in *E. siderophloia*). Fruits tend to be broader (fruits are obconical

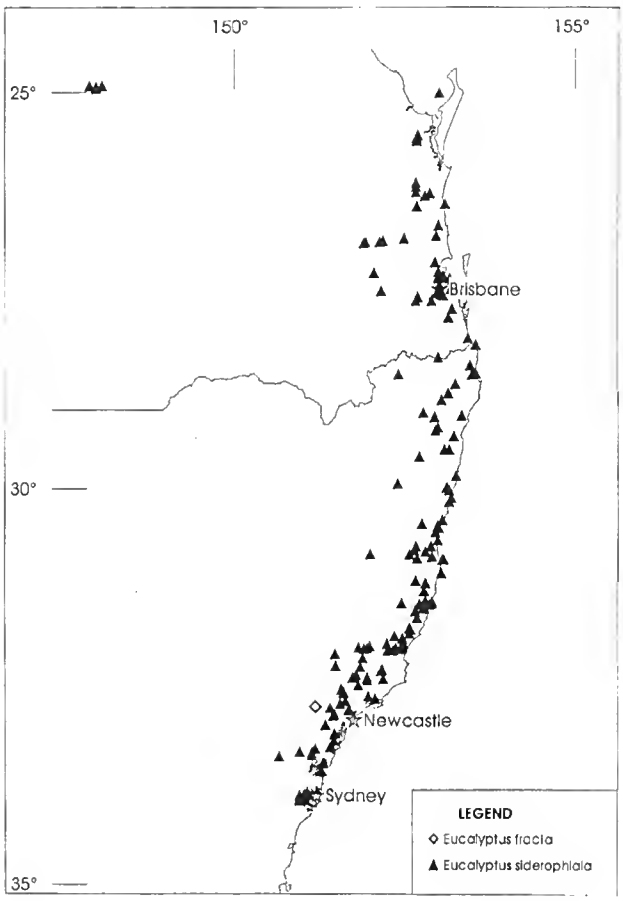

Fig. 9. Distribution of *E. fracta* and *E. siderophloia*.

in *E. siderophloia*). Buds are also usually smaller (buds 6–8 × 3–4 mm in *E. siderophloia*), with the calyptra rounded or obtuse and shorter relative to the hypanthium (the calyptra is acute and frequently longer than the hypanthium in *E. siderophloia*). *E. siderophloia* is also a plant of deeper and generally more fertile soils.

Distribution: known only from parts of the northern escarpment of the Broken Back Range, near Cessnock (Fig. 9).

Ecology: locally frequent but restricted to shallow soils along the upper escarpment of a steep sandstone range. This species is the dominant tree in a narrow band along the upper edge of the escarpment. Associated species in slightly deeper soils include *E. sparsifolia* Blakely, *E. punctata* DC., *Corymbia maculata* (Hook.) K.D. Hill & L.A.S. Johnson and *Angophora euryphylla* (L.A.S. Johnson ex G. Leach) L.A.S. Johnson & K.D. Hill.

Conservation status: 2R-.

The epithet is from the Latin *fractus*, broken, in reference to the species' occurrence in the Broken Back Range.

Selected specimens (from 12 examined): New South Wales: North Coast: Broken Back Range, *Hill 4772, 4773, Stanberg & Tame*, 06 Jul 1995 (NSW, BRI, CAMB, MEL); Broken Back Range, track W of Broken Back Trig out to Mans Head Point, *Wiecek 494, 495, 497, Richards & Tame*, 05 Apr 1993 (NSW); N end of Broken Back Range, *Tame 2046, 2407*, Oct 1987 (NSW); Broken Back Range, *Tame 3504*, 27 Sep 1992 (NSW); far northern end of Broken Back Range, *Tame 3505*, 27 Sep 1992 (NSW).

Cult.: Hunter Region Botanic Garden (grown from seeds collected from Broken Back Range), *Tame s.n.*, Jun 1995 (NSW 392958).

Acknowledgments

Thanks are due to Leonie Stanberg for continued valuable assistance in the field and the herbarium, Lesley Elkan for the illustrations and Lawrie Johnson for helpful comments on the manuscript. Stephen Bell, Greg Roberts, Michael Sharp, Philip Strong and Terry Tame are gratefully acknowledged for drawing attention to the novelties, and for valuable assistance in the field. Peter Wilson is thanked for assistance with Latin diagnoses.

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Notes on *Vallisneria* (Hydrocharitaceae) in Australia, with descriptions of two new species

S.W.L. Jacobs and K.A. Frank

Abstract

Jacobs, S.W.L., and Frank, K.A. (Royal Botanic Gardens, Sydney, NSW 2000, Australia) 1997. Notes on Vallisneria *(Hydrocharitaceae) in Australia, with descriptions of two new species.* Telopea *7(2): 111–118.* Five species of *Vallisneria* are recognised from Australia, namely the cauline-leafed species *V. caulescens* and *V. triptera* and the non-cauline or tufted species *V. americana* (var. *americana*), *V. nana* and *V. annua*. Two of these, **Vallisneria triptera** and **Vallisneria annua**, are described here as new species from northern Australia, and an earlier name, *Vallisneria nana* R. Br., reinstated for a common Australian species. *V. gracilis* Bailey is recognised as a taxonomic synonym of *V. nana*, although many of the specimens previously identified as *V. gracilis* are now included in *V. annua*. Notes on all species and a key are given. The problems of comparing taxa growing in different countries and of applying correct names are discussed.

Introduction

The status of *Vallisneria* in Australia has been in some confusion since Bentham (1873) treated as one (*V. spiralis* L.) the two species, *V. spiralis* and *V. nana*, that Brown (1810) recognised. Den Hartog (1957) treated all Australian non-cauline plants as *V. gigantea* Graebner, basically a recognition that they were not *V. spiralis* s. str., whereas Aston (1973) considered that too little was known so opted to return to using the oldest name, *V. spiralis*.

Lowden (1982) published the first attempt to examine the genus from living populations from around the world. Unfortunately he did not visit Australia, which appears to be a centre of diversity for the genus, but he was able to recognise from the very minimal material that he saw that we have two different common non cauline-leaved species. These he referred to *V. americana* Michaux var. *americana* and *V. spiralis* var. *denseserrulata* Makino. Unfortunately, one of the characters that Lowden found most useful, the degree of filament adherence in the mature free-floating male flowers, is not readily discernible from most herbarium collections. It was also unfortunate that Lowden listed three 'unidentified taxa', *V. nana* R. Br., *V. caulescens* Bailey & F. Muell., and *V. gracilis* Bailey, all Australian.

One of us (SWLJ) has been collecting *Vallisneria* specimens for some years. Following Lowden's (1982) revision, we started making a special effort to collect mature fruit and the free-floating male flowers. The results of these field and specimen studies are presented here to provide new names and explain some of our decisions before a treatment is produced for *Flora of Australia*.

Discussion

As Lowden (1982) correctly points out, the only way to study species that are dioecious, soft, and difficult to preserve adequately, is to study populations in the field, preferably populations of both sexes, and to use a range of preservation

techniques. It is nearly impossible for one person to do this satisfactorily on a world-wide basis, especially for the apparently few taxa involved and the very large distribution of those taxa. It is a credit to Lowden that he was able to accomplish so much. He did not visit Australia and also didnot see duplicates of *Vallisneria caulescens*, which was rediscovered and recognised in the field by Roger Carolin and Surrey Jacobs (*Jacobs 1360, 1400, 1485, 1520*) in 1974. He therefore missed what we now show to be a centre of diversity for the genus and the recognition of the distinct cauline-leaved species that grow in Australia.

The matching of taxa from different countries is difficult enough with field work and good specimens. With the poor quality of many of the specimens of *Vallisneria*, especially older type specimens, identification becomes almost impossible using standard herbarium techniques. While we are confident about the taxa we have recognised, we echo Lowden (1982) in a lack of confidence in applying the earliest possible name, or even producing an accurate synonomy. The nomenclature is, at best, a compromise.

We have been able to examine many more specimens from Australia than Lowden was able to see, particularly the mature seeds and the free-floating male flowers. The seeds are embedded in mucilage which was removed by soaking in acetic acid (1:2 glacial acetic acid : water); they were then dried, coated and examined with an SEM. The free-floating male flowers were collected in 70% ethanol, dried, coated, and examined with an SEM. There is a problem in relating the free-floating flowers to the specimens collected from the rooted plants. In general the herbarium vouchers of rooted plants were collected as close as possible to, and upstream of, the floating flowers. Although more than one species may grow in any one river system, so far we have not found mixed populations (except for the two new species described here where distinction is not a problem), nor have we found such species growing in close proximity, but this is very difficult to check reliably.

For the one southern perennial species, identified both by Lowden (1982) and ourselves as *V. americana* var. *americana*, our observations agree with those of Lowden (1982). This species has the filaments in the male flower fused for about 75% of their length.

Our observations differ from Lowden's for the tropical and subtropical perennial species (identified by Lowden as *V. spiralis* var. *denseserrulata* and by us as *V. nana*) in which we found considerably more variation in the degree of fusion of the filaments than the basically free condition described by Lowden. In our material the filaments varied from almost free to having almost 75% of their length fused, and were most commonly somewhere between these extremes. The variation within a single sample ('specimen') was frequently as great as the total variation recorded.

Of the three facultative annual species, *V. triptera* has the filaments partly fused, whereas *V. caulescens* and *V. annua* have them free to, or almost to, the base.

There are two cauline-leaved species, *V. caulescens* and *V. triptera*. All the cauline-leaved specimens had been included in *V. caulescens*, presumably because of the obvious leaf character, despite the fact that Queensland specimens (plus one from the Northern Territory) of female plants have two perianth segments and the fruits flattened whereas most of the Northern Territory and all of the Western Australian female specimens had three perianth segments and three-winged fruits. These two cauline-leaved species are more different from each other than any of the rosette species are from each other.

V. annua is mostly an annual and has been collected from ephemeral habitats. In common with many annuals it produces numerous flowers and these can start appearing when the plant is very small. It has long-acuminate leaf tips and the female

flowers are usually smaller than those of the other tufted species, *V. nana*, that may grow in the same general area in more perennial water bodies.

The characters

Leaf tip: useful for distinguishing the tufted species if examined on a population basis. *V. annua* has long-acute leaf tips, *V. nana* has acute (rarely obtuse) leaf tips and *V. americana* has obtuse leaf tips. The cauline-leaved species both have acute to obtuse tips.

Leaf margin: each species has a characteristic margin though the differences are slight and difficult to convey in words. The margins of all species are serrulate to some degree. It is best to use several determined specimens for comparison if sterile specimens need to be identified. In *V. americana* the serrulations usually have an obvious basal cell or multi-celled base whereas *V. nana* mostly has serrulations with no obvious base. *V. annua* has smaller and sparser serrulations than the other rosette species. In *V. caulescens* the margin is usually almost straight, the serrulations jutting out from an otherwise almost straight margin; in *V. triptera* the serrulations are usually more forward-pointing with the margins slightly sinuous and coming in slightly after each serrulation.

Leaf nervation: not really useful, directly related to leaf size. The largest-growing species, *V. americana* normally has 5–7 major vascular strands but depauperate specimens may have 3. The normal condition in *V. nana* is 3, and in *V. annua* it is 1–3. In the cauline-leaved species, *V. triptera* generally has more nerves (5–7) than *V. caulescens* (3).

Seeds: while at first seeming a useful character the variation in seed surfaces is sufficiently great to make it difficult to detect any pattern in this variation. The only comments we can make are that:

(i) the two cauline-leaved species have a reticulate seed surface of almost circular to hexagonal cells and are free of projections; and (ii) the three tufted species have the epidermal cells longer than wide and tubercles or spines of various lengths and thicknesses; on any seed or in any one fruit the tubercles are similar but there seems to be substantial variation between populations. We have been unable to detect any taxonomically-correlated pattern in this variation.

Mature fruit: a useful character although mature fruit can be difficult to find in the perennial species, apparently owing to a combination of habitat conditions and predation. Fruit is easily found in the annual species. Mature fruit has dark grey to black seeds. Fruits of the three rosette species are cylindrical; *V. americana* fruit is almost the size of a slender pencil up to 5 mm wide and to 16 cm long (3–5 × 40–160 mm); the fruit of *V. nana* is generally smaller, to 3 mm wide by <10 cm long (2–3 × 20–90 mm); *V. annua* to 2 mm wide, 3.5 cm long (1.5–2 × 18–35 mm); *V. caulescens* has flattened 2-winged fruits to 5 mm wide and 10 cm long (3–5 × 40–100 mm); *V. triptera* has 3-winged fruits to 7 mm wide and 3 cm long (5–7 × 15–30 mm).

Male flowers: male flowers are produced on an axis enclosed in a spathe. They are released as a spherical 'bud' and float to the surface where they open. They have three perianth segments that are normally deflexed and act as floats, and two bisporangiate anthers that are either free or variously fused. The male flowers are of some value when assessing taxa, as they do vary between taxa (see under Discussion). However, they are generally not present on herbarium specimens, are difficult to collect, difficult to relate to living plants, and sometimes variable within the same taxon (see under Discussion).

Female flowers: these are produced in the leaf axils. Each has a long peduncle that allows the flower to reach the surface. The sepals and stigmas are the most obvious features, situated at the apex of the inferior ovary. The flower is white on the first day of opening, turning progressively darker pink as it ages. The free-floating male flowers collect around the meniscus formed by the female flower and pollination occurs when small waves tip the male flowers into contact with the stigmas (Cook 1982). The mature flower is pulled beneath the surface by the tightening spirals of the peduncle whether pollinated or not. There are several useful characters such as the number of perianth segments, the number and degree of fusion of the staminodes, and number, relative size and degree of division of the stigmas (Lowden 1982, McConchie and Kadereit 1987).

Key to species

1 Leaves all cauline; facultative annuals 2

1* Leaves basal, tufted; annuals or perennials 3

2 Fruit 3-winged, trigonous, usually <35 mm long; female flowers with 3 perianth segments ..... **V. triptera**

2* Fruit 2-winged, flattened, usually >40 mm long; female flowers with 2 perianth segments ..... **V. caulescens**

3 Plants facultatively annual (commonly in annual habitats); leaf-tips long-acute; female tufts commonly producing numerous (>12) flowers at maturity in first year while still quite small ..... **V. annua**

3* Plants normally perennial; leaf tips acute or obtuse; female tufts not flowering till plant is several years old and then only producing few flowers (<12) at one time 4

4 Leaf tips acute; filaments in male flower free to fused for about 75% of their length; leaves often <1 cm wide; mostly coastal north of Sydney to the Kimberley ..... **V. nana**

4* Leaf tips obtuse; filaments in male flower fused for about 75% of their length; leaves often >1 cm wide; coastal south of Sydney and inland, sometimes introduced further north ..... **V. americana**

1. Vallisneria triptera *S.W.L. Jacobs & K.A. Frank*, **sp. nov.**

V. caulescenti affinis, sed perianthio 3-partito, fructibus brevioribus latioribus 3-alatisque, differt.

Holotype: Northern Territory: c. 5 km W. of Jabiru, Arnhem Highway, 12°39.19'S 132°48.97'E, *S.W.L. Jacobs 7970*, 5 May 1996 (NSW); female. Duplicates to DNA, MEL, BRI, Z, B, K.

A male specimen was collected from the same locality: *S.W.L. Jacobs 7971* (NSW), duplicates to DNA, BRI, Z, B.

Submerged, dioecious, stoloniferous annual. Roots fibrous. Leaves cauline, alternate to sub-opposite near stem apex where internodes become shorter, 2–9 cm long, 5–12 mm wide, green to red-green, sometimes with a purple tinge; margins finely toothed at least in the upper half; apex acute; 5–7 major longitudinal veins. Male plant with 1 to several inflorescences in each (usually upper) leaf axil; numerous flowers enclosed in a spathe; spathe ovate, 2.5–4 mm long, 2–3 mm diam. Male flowers minute, <0.5 mm

long; perianth segments 3; anthers 2, bisporangiate; filaments appearing fused (like a 'Y'), hairs present on the base of the androecium. Female plant with 1 to several inflorescences in each (usually upper) leaf axil; spathe thin, translucent, 4.6–5 mm long, enclosing 1 sessile flower; apex obtuse. Female flowers 1.2–1.7 mm long; sepals 3, apex acute to obtuse; petals 3, inconspicuous, minute; staminodes 3, inconspicuous; stigmas 3, bifid, deeply divided or cleft, shorter than sepals, 15–25% as wide as sepals, covered with minute filiform papillae. Fruit ovate in outline, trigonous in transsection, 3-winged at margins, 15–30 mm long, 5–7 mm diam, smooth, green to red-brown. Seeds numerous, narrow-ovoid to ellipsoid, 0.6–0.7 mm long, 0.2–0.3 mm diam., with the surface reticulate with oblong to hexagonal cells with ribbed side walls.

Distribution: the Gardner region of north Western Australia and the Darwin & Gulf region of the Northern Territory.

Selected species examined: Northern Territory, Darwin & Gulf: Arnhem Highway, 31 km E of South Alligator River, *Barker 442* /, 13 Mar 1983 (NSW ex AD); between Mt Brockman and Jabiru, *Craven 2353* /, 21 Feb 1973 (BRI, MEL ex CANB); Mt Brockman, *Dunlop 3325*, 21 Feb 1973 (MEL ex DNA); Baralil Creek, Kakadu National Park, *Jacobs 4994* ?, *4995* /, *4996* ?, *5003* ?, *5004* /, *Sainty & K. Wilson*, 15 May 1987 (NSW).

Western Australia: Gardner: Carson River Station, 14 km S of Carson River Homestead, *Fryxell 4139 & Craven* /, 15 May 1983 (MEL ex Dept. of Agric. USA);Mitchell River above Falls, *Jacobs 8041* / 19 May 1996; Airfield Swamp, c. 5 km N of Mining Camspite, Mitchell Plateau, *Kenneally 8043*, 21 Apr 1952 (MEL ex PERTH).

Grows in freshwater ephemeral creeks, waterholes, swamps or billabongs. Flowers Feb-May; fruits Apr-July. Although this species behaves as an annual, it grows in ephemeral habitats, and there is some preliminary suggestion that it may be able to survive for longer periods under cultivation (L. Smith, pers. comm.)

This species is named from the distinctive 3-winged fruit; from the Greek *tri-*, 3 and *-pterus*, winged.

V. triptera is related to *V. caulescens* but differs in the female flowers and fruit being tripartite instead of bipartite.

McConchie and Kadereit (1987) drew attention to the bipartite nature of the female flower of *V. caulescens*, although a third of the specimens they mapped are *V. triptera* with tripartite female flowers. The authors concluded that, although the bipartite female flowers and the cauline leaf arrangement required the expansion of the generic concept in *Vallisneria*, the tripartite male flowers, and other structures in the female flower, best fitted in *Vallisneria* and they wisely decided that more information was needed before changing the generic placement. *V. triptera* reinforces that view with a female flower more like the rest of the genus than that of *V. caulescens* but having other departures such as the winged fruit and the absence of any observed basal rosette. It seems clear that *V. caulescens* and *V. triptera* are closely related, and both are more closely related to other *Vallisneria* species than to species in any other genus. The only exclusive (primitive or derived?) character they share within *Vallisneria* is the cauline leaf arrangement, a character also shared by the florally distinct *Maidenia* (stamen 1, 3-locular) and *Nechamandra* (female flowers sessile with a long delicate hypanthium). On the present evidence it is best to retain both of the cauline-leaved species in *Vallisneria*.

2. Vallisneria annua *S.W.L. Jacobs & K.A. Frank*, **sp. nov.**

V. nanae affinis, sed annua, apicibus longeacutis foliorum, floribus minoribus pluribusque, differt.

Holotype: Western Australia: c. 3 km W of 'Ellenbrae' turn-off, Gibb River road, 15°59.47'S, 127°01.30'E, *S.W.L. Jacobs 8017* 17 May 1996 (NSW); female. Duplicates to PERTH, DNA, B.

A male specimen was collected at the same locality: *S.W.L. Jacobs 8015* (NSW), duplicates to PERTH, DNA, B.

Submerged dioecious stoloniferous annual. Roots fibrous. Leaves basal, to c. 50 cm long, (1.5–)2–7(–10) mm wide, red or reddish green when fresh, marked with red-brown discontinuous longitudinal stripes; margins usually finely toothed; apex long-acute and finely tapering; sometimes with 1 main central nerve or 3–8 longitudinal nerves, although not always obvious. Male plant with usually 1 to several inflorescences in leaf axils; flowers enclosed in a spathe; spathe ovate, (2.7–)7–10 mm long, 2.2–6 mm diam. Male flowers minute, < 0.5 mm long; 3 sepals; 2 bisporangiate anthers; filaments divided obviously very close to the base (like a 'V'), hairs present at the base of the androecium. Female plant with 1-several inflorescences in leaf axils; spathe thin, translucent, 5.5–12(–20) mm long, enclosing one sessile flower. Female flowers 1.4–2.6 mm long; sepals 3; apex obtuse; petals 3, minute and inconspicuous; staminodes inconspicuous or absent; 3 bifid stigmas, shortly divided (or cleft), as long as sepals, almost as wide as sepals, fringed with minute papillae. Fruit narrow-cylindrical, terete in trans-section, 18–35 mm long, 1–2(–3.5) mm diam., smooth, distinctly marked with red-brown narrow stripes. Seeds ovoid to narrow-ovoid, 0.8–1.0 mm long, c. 0.2–0.3 mm diam., with surface sparsely covered in blunt (or rounded) short hairs.

Distribution: grows north from Central Australia (Northern Territory) northwest into north Western Australia, and northeast into Queensland.

Grows in shallow running water or ephemeral pools or billabongs; this is the common species of ephemeral habitats in the warmer parts of the arid and semi-arid. It does also grow in more perennial habitats but it is not clear whether it behaves as an annual or perennial under these conditions. In keeping with many annuals it produces numerous flowers and these usually start appearing while the plant is still small. The truly perennial species usually do not flower for at least the first year. Flowers Dec–Apr, fruits Jan–June.

This species is named for the annual life cycle.

Similar to *Vallisneria nana* but differs by the long-acute finely tapering leaf tips, shorter and narrower fruits, and smaller seeds.

Selected specimens examined: Queensland: Cook: c. 2 km N of the Gulf Development Road on Routh Creek, a right bank tributary of Etheridge River (18°16'S 143°43'E), *Clarkson 2536 & Byrnes*, 10 Aug 1979 ♀ (BRI, MEL); Edward River, *Clarkson 3541A*, 12 Oct 1980, ♀ (MEL ex BRI). Burke: Twelve Mile Creek, 21 km by road N of the Norman River crossing at Normanton (17°32'S 141°07'E), *Aston 2282*, 21 May 1982, ♂ & *2283* ♀ (MEL, BRI); Normanton to Karumba road between Normanton and Maggieville (17°3-'S 141°0-'E), *Clarkson 2698*, 6 Nov 1979, ♀ (MEL, BRI); Kajabbi, Leichardt River, *Jacobs 5920*, 14 Aug 1990, ♀ & *5921* ♂ (NSW); North Kennedy: 0.1 km W of the Burdekin River crossing and 7 km SW of 'Valley of Lagoons' homestead, (18°42'S 145°03'E), *Aston 2300*, 25 May 1982 ♂ (BRI ex MEL); Allingham Swamp, Fletchervale Station, NW of Charters Towers, *Williams 81107*, 14 July 1981 ♀ (BRI). South Kennedy: Kinchant Dam, near Mackay, *Jacobs 4040*, 12 May 1981, ♀ (NSW). Mitchell: Lake Galilee, c. 7 km E of 'Swan Lea' homestead on 'Eastmere' road, *K. Wilson 3542*, *Sharpe & Blaxell*, 1 May 1981, ♀ (NSW).

Northern Territory, Darwin & Gulf: Flying Fox Creek 'Beswick – Mainoru' Road, *Jacobs 1715*, 21 May 1974, ♂ & 1716 ♀ (NSW); Birdie Creek, Kakadu National Park, *Leach 2732 & Cowie*, 18 Apr 1990, ♀ (NSW, MEL ex DNA). Victoria River: Jalabra (Jellebra) Spring Rockhole, eastern Gardiner Range, *Aston 2850*, 12 July 1992, ♂, *2851* ♀ (MEL); Duck Pond Outstation at Merrina Waterhole, *Leach 804*, 5 Sep 1986 ♀ (NSW, MEL ex DNA). Barkly Tableland: Phillip Creek Station, (19°13'S 134°15'E), *Henshall 1035*, 31 May 1975 ♂ (MEL ex DNA); Gold Creek, Wollogorang Station (16°58'S 137°56'E), *Latz 10493*, 9 June 1987 ♀ (MEL ex DNA). Central North: Elkedra Station, Erlpunda waterhole, *Henshall 1756*, 8 May 1977 ♀ (NSW, Mel. ex DNA). Central South: Kings Canyon, (24°15'S 131°35'E), *Latz 9000*, 10 July 1982 ♀ (BRI ex DNA); 3 km N of Kings Canyon (24°12'S 131°35'E), *Latz 8730*, 17 July 1981, ♂ (BRI, MEL ex DNA).

Western Australia: Dampier: c. 21 km downstream of Police Camp Bore, Lennard River, *Jacobs 5600* ♂, *5601* ♀ & *P.G. Wilson*, 11 May 1988, (NSW); 3 km E of Beagle Bay Aboriginal Community, Dampierland Peninsula, (16°58'S 122°42'E), *Kenneally 9484*, 24 Aug 1985 ♂ (MEL ex Perth). Fitzgerald: c. 13 km SE of 'Kimbolton' Homestead, 'Oobagooma' road, *Jacobs 5743* ♂ & *5744* ♀ & *P.G. Wilson* 26 May 1988 (NSW); Traine River, 'Tableland', *Jacobs 4354*, 31 May 1982, ♀ & *4361* ♂ (NSW). Gardner: Drysdale River, at the crossing of the Gibb River – Kalumburu Track, *Fryxell 4860, Craven & J.McD. Stewart*, 19 June 1985, ♀ (MEL ex US Dept. of Agriculture – Cotton Branch Herb.); Lake Argyle, Ord River, *Jacobs 5561* ♀ & *5562* ♂ & *P.G. Wilson*, 8 May 1988 (NSW).

This taxon has been recognised as probably distinct for some years with many of its specimens identified as *V. gracilis* Bailey. There are certain similarities, and the description of *V. gracilis* enhances those similarities. The type of *V. gracilis* though, is a depauperate specimen of the species we are recognising as *V. nana* R. Br. There are still populations in the Little Mulgrave and Mulgrave Rivers (the latter the type locality for *V. gracilis*) that are very similar in all respects to that type. These plants from or near to the type locality are all strongly perennial, produce very few flowers, no fruits have been found and, after cultivation for a few years, grow into plants indistinguishable from *V. nana*.

Vallisneria nana R. Br. (1810: 345)

This name was listed by Lowden (1982) as an unidentified taxon. The few specimens of this taxon that he examined from Australia he placed in *V. spiralis* var. *denseserrulata*. Lowden placed these Australian specimens in *V. spiralis* because the material he examined had the filaments in the male flowers free to the base. We have now examined considerably more material and it is apparent that this species is quite variable in this character (the only species we have found to be so variable), often even within one collection of free-floating flowers, though there is no way of knowing how many individual clones may be represented in such a collection. *Vallisneria spiralis* is a temperate/warm temperate species in its narrowest interpretation. *V. nana* in Australia is tropical/subtropical, being replaced in temperate areas by *V. americana*. From the characters judged important by Lowden (1982), the northern perennial species in Australia seems as closely related to *V. americana* as to *V. spiralis*. We therefore propose to recognise the northern perennial taxon as a distinct species. A problem arises in finding the correct name. Lowden suggests that *Physkium natans* Lour. from 'Indochina' may well be the same taxon as his *V. spiralis* var. *denseserrulata*, but the type is sterile and apparently no male plants of any species of *Vallisneria* have been collected from Indochina (Lowden 1982). It is doubtful whether the true identity of that specimen will ever be known with confidence. The specimen is held at the BM and has 'female' written on the sheet but there are no flowers remaining. There is only one intact leaf tip. The next oldest name that is applicable to our species is *V. nana* R. Br., with the type collected from the Gulf of Carpentaria. Brown's name is earlier than any of the other synonyms suggested for *V. spiralis* var. *denseserrulata* and is the most appropriate name to use for our species, given the uncertainty of the application of the name *Physkium natans*.

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A new species of *Tetragonia* (Aizoaceae) from arid Australia

M. Gray

Abstract

Gray, M. (Australian National Herbarium, Centre for Plant Biodiversity Research, CSIRO, GPO Box 1600, Canberra, ACT 2601 Australia) 1997. A new species of Tetragonia *(Aizoaceae) from arid Australia.* Telopea *7(2):119–127.* **Tetragonia moorei**, previously included in the widespread *T. tetragonioides* (Pallas) Kuntze is described, and the history of both species as potential stock poisons, medicinal plants and human food is briefly discussed.

Introduction

The most recent general treatment of *Tetragonia* in Australia is that of Prescott (1984). Since then the rare and extremely localised *T. coronata* has been described from Western Australia (Rye & Trudgen 1996) and the introduced *T. microptera* Fenzl from southern Africa has been recorded for New South Wales (Jacobs & Highet 1990). The description of the following species brings the number of species in Australia to 11, four of which have been introduced from southern Africa.

Tetragonia moorei *M. Gray*, **sp. nov.**

T. tetragonioidi (Pallas) Kuntze affinis, a qua praecipue differt projecturis fructus unguiculatis et incurvatis vel interdum erectis, segmentis perianthii in fructu non accrescentibus et apicem super fructus nunquam conspicue projectis, staminibus 4–8, et floribus in axillis semper solitariis.

Type: South Australia: Lake Eyre Region: sand dunes and swales just SE of Less Hill, c. 25 km S of Stuart Creek H.S., 30°55'S, 137°04'E, dominant species *Acacia* sp. and *Atriplex spongiosa*, *K.Chorney (Czornij) 1161*, 7 Oct 1978; holo AD (AD 97342259); iso CANB, NSW.

[*T. tetragonioides* p.p. auct. austral. non (Pallas) Kuntze: Bentham, *Fl. Austral.* 3: 325 (1867) (as *T. expansa*); Toelken, H.R. in Jessop, J.P. (ed.), *Fl. Central Australia:* 39, fig. 60B (1981); Jacobs, S.W.L. in Morley, B.D. and Toelken, H.R. (eds), *Flowering Plants in Australia*: fig. 38 e,f (1983); Prescott, A. in George, A.S. (ed.), *Fl. of Australia* 4: 42–3, fig. 11f (1984); Jessop, J.P. in Jessop, J.P. and Toelken, H.R. (eds), *Fl. South Australia* edn 4, 1: 205 (1986).]

Succulent papillate annual from a slender taproot, basicauline fruits often present; stems erect, prostrate or decumbent and trailing to 50 cm or more long, the young shoots pubescent; leaves usually narrowly to broadly ovate, elliptic or rhombic, ± gradually narrowed to the petiole (occasionally triangular-ovate and ± abruptly contracted to a cuneate base which narrows to the petiole in luxuriant specimens); flowers greenish yellow, solitary in the axils; perianth segments 4, distinct, c. 1–2 mm long, pubescent on the outside; stamens 4–8, the filaments 0.5–0.8(–1) mm long, the anthers c. 0.4–0.5 mm long; styles (5–)8–13, c. 0.5–1 mm long; ovules as many as styles; fruit c. 6–14 x 6–10(–14) mm, broadly to transversely ovate or elliptic (rarely obovate or transversely oblong) in outline, and usually elliptic or oblong in T.S., rounded at the

base or truncate with the sides ± expanded and projecting below with the pedicel inserted in a basal groove or depression, variably ribbed on the sides, usually with two large lateral and 2–6(–10) smaller ± incurved claw-like projections, or the projections subequal or occasionally erect, the persistent perianth segments not or only shortly fused at the base, incurved and ± inconspicuous at the base of the projections. (Fig. 1).

Distribution: arid and semi-arid areas of Queensland, New South Wales, Victoria, South Australia and Western Australia (Fig. 2). The species will very likely be found in the Northern Territory portion of the Simpson Desert.

Habitat: found in a variety of habitats eg. sand dunes and swales, and on both light- and heavy-textured soils from red sands to grey cracking clays, particularly in areas subject to periodic inundation e.g. floodplains, creek and stream banks, gilgais, claypans etc.

Selected specimens examined: Queensland: Blackall, fairly common on sand ridges near town, *Everist 1347*, 29 Aug 1935 (BRI); c. 55 miles [88 km] WNW of Birdsville, 25°35'S, 138°35'E, *Boyland 301*, 26 Sep 1966 (BRI); South Galway, *Everist 7428*, 2 Aug 1963 (BRI); Warrego R at Cunnamulla, *Briggs 1855*, 27 July 1968 (NSW).

New South Wales: 1.5km E Gumhole Tank, 35 km NW Tibooburra, 29°17'S, 141°43'E, *Pickard s.n.*, 24 July 1973 (NSW 148771); near Goonery Bore, 65 miles E of Wanaaring, *Moore 5782*, 18 Apr 1971

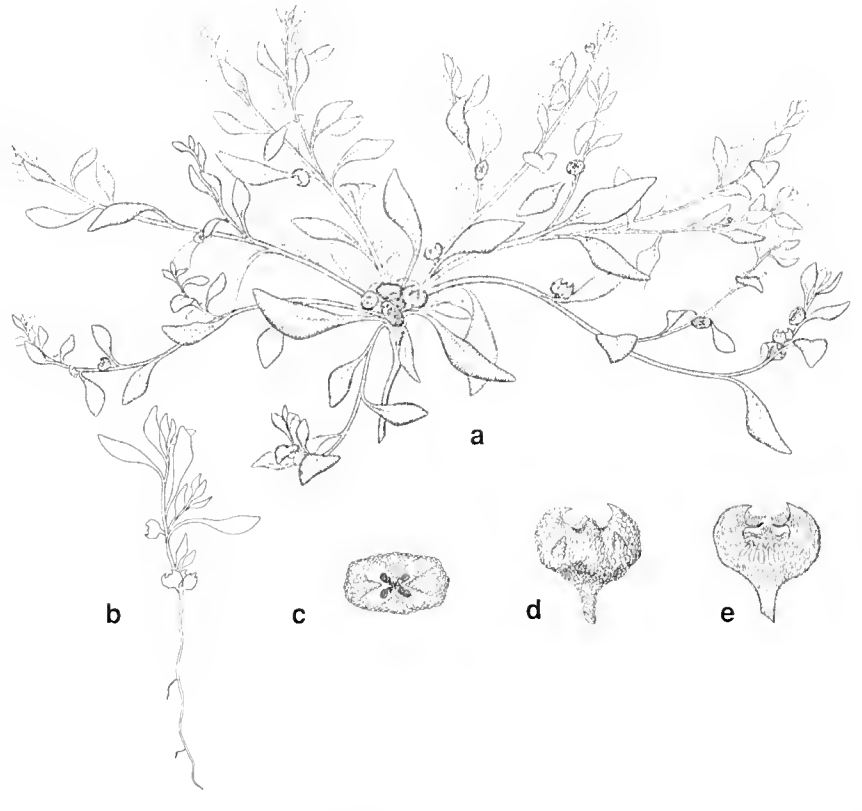

Fig. 1. *Tetragonia moorei* M. Gray. **a**, habit (×0.3); **b**, small plant (×0.5); **c**, fruit from above (×2); **d**, fruit side view (×2); **e**, L.S. fruit (×2); from *Donner 3571* (AD 97211063) except **b**, from *Moore 8532* (CANB 372494).

(CANB); 'Mulya' about 40km SE of Louth, 30°46'S, 145°17'E, *Moore 8008*, 24 Sep 1978 (CANB); 35miles NW of Cobar, *Moore 4260*, 26 Sep 1966 (CANB); Koonenberry Gap, 30°30'S, 142°18'E, *De Nardi 862*, 29 Sep 1971 (NSW); 90km N on Tilpa road from Cobar–Wilcannia road, *Cunningham & Milthorpe 898*, 12 Aug 1973 (NSW); Fowlers Gap near Broken Hill, 31°05'S, 141°40'E, *Jacobs 2107*, 5 Oct 1975 (NSW); near Darling R. 16 km NNE of Wentworth and 2km S of Tapio Station, 33°58'S, 141°57'E, *Muir 5849*, 30 Aug 1978 (MEL).

Victoria: 9 km SSE of Robinvale PO., Mallee Study Area, *Beauglehole 56191*, 5 May 1977 (MEL); Hattah Lakes National Park, E side of Lake Hattah, *Beauglehole 19877*, 11 Sep 1960 (MEL); Wimmera, *Eckert s.n.*, 1892 (MEL 99845); Lost Lake, Wyperfeld National Park, apparently rare, *Beauglehole & Finck, ACB 29427*, 10 Nov 1968 (MEL).

South Australia: c. 35 km SW of Cowarie Homestead on Warburton R., *Chalmers & de S. Disney s.n.*, 16 June 1967 (AD 96951050); Simpson Desert, Christmas Water, c. 32 km N of North Lake Eyre, *Ashton s.n.*, Aug–Sept 1961 (AD 96218094); c. 5 km S of Patchawara Ck., 27°22'S, 140°40'E, *Weber 4681*, 29 Aug 1975 (AD); c. 11km N of Mungeranie Homestead, c. 190 km NNE of Marree, *Lothian & Francis 335*, 24 Aug 1960 (AD); near Glenmanyie Bore, c. 90 km NE of Frome Downs Homestead, *Donner 3571*, 28 July 1971 (AD); Strzelecki Track, c. 165 km NW of Murnpeowie Station, at Tinga-Tingana Station crossing. c. 100 km NE of Leigh Ck., *Kuchel 2511*, 17 Aug 1968 (AD).

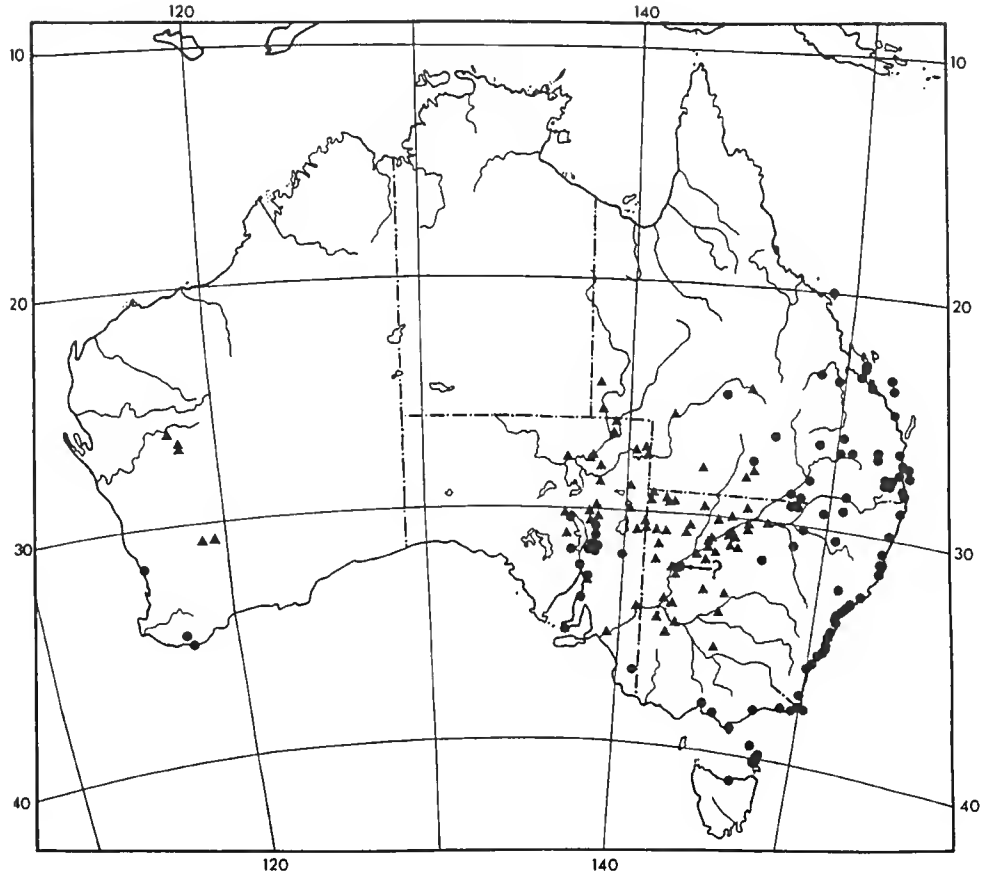

Fig. 2. Distribution of *T. moorei* ▲, and of *T. tetragonioides* ● in mainland Australia and Tasmania.

Western Australia: Murdabool Hill, Belele Station, *Cranfield 5921*, 26 Aug 1986 (PERTH); Donkey Well, Yoothapina Station, 26°35'S, 118°19'E, *Cranfield 5558*, 9 Aug 1986 (PERTH); Meekatharra, *Stuchey s.n.*, Aug–Sep 1926 (AD 97203049); Nannine, between Mt Magnet and Meekatharra, *W.V. Fitzgerald s.n.*, Sep 1903 (PERTH); boundary Ennuin(sic) (=Eeuin?) Station along Mt. Jackson road, *Cranfield & Spencer 7736*, 5 Sep 1989 (P ERTH); Glenn Rhynn Rocks, c. 24km NNE of Koolyanobbing, *Newbey 9072*, 24 Sep 1981 (PERTH).

Etymology: named after my colleague C.W.E. Moore who recognised the distinctiveness of this species (Moore 1986) and whose ecological studies and abundant collections have enriched the Australian National Herbarium.

Notes: one of the specimens quoted by Bentham ('in the interior at the camp at Meninville (*sic*), *Victorian Expedition*') is probably MEL 99856, labelled 'Camp at Menindee, Octob. 19, 1860, V.E.Exped.' The specimen is initialled 'B' on the inturned top left-hand corner, indicating that it had been seen by Bentham, and was probably collected by Dr H. Beckler who was the physician and botanist on the Victoria Exploring Expedition, more commonly known as the 'Burke and Wills Expedition'. The botanical results of this journey have been recorded in detail by Willis (1962). This specimen consists of two fragments, the left hand one of which is *T. tetragonioides* and the right hand one *T. moorei*. This locality is rather a 'wide' for *T. tetragonioides* (Fig. 2) and the two fragments do have a different aspect. It is possible that the specimens could have been mixed in the folder before mounting; however, if the species was indeed collected at this locality, the seed could have been brought down the Darling River in flood.

T. moorei may be distinguished from *T. tetragonioides* by the following key:

1. Projections of the fruit claw-like and incurved or sometimes erect (if the projections reduced then the fruit ± elliptic or oblong in T.S.); persistent perianth segments in fruit not or only shortly fused at the base and always incurved and inconspicuous; leaves usually narrowly to broadly ovate, elliptic or rhombic and gradually narrowed to the petiole (occasionally as in *T. tetragonioides* in well-grown specimens); flowers solitary in the axils; stamens 4–8. ..... **T. moorei**

1* Projections of the fruit horn-like and ± divergent at least at the base (if the projections reduced or absent then the fruit ± rhombic to broadly rhombic to circular in T.S.); persistent perianth segments in fruit often accrescent, yellow on the inside, ± fused at the base and ± conspicuously projecting above the fruit apex, or as in *T. moorei*; leaves usually triangular-ovate, ± abruptly narrowed to a cuneate base which narrows to the petiole (occasionally as in *T. moorei* in depauperate specimens); flowers 1–2 in the axils; stamens (4–)8–22. ..... **T. tetragonioides**

There has been some confusion with regard to the spelling of the specific epithet of *T. tetragonioides*. Some authors, e.g. Jacobs (1983), Prescott (1984), Jacobs & Highet (1990), Taylor (1994) adopt the original spelling of Pallas (1781), i.e. *Demidovia tetragonoides*.

It seems reasonable to assume, as does Green (1994) and many others, that Pallas meant the epithet to indicate 'like *Tetragonia*' since he mentions in the protologue that he received the original seeds under the name of *Tetragonia cornuta*.

Since Pallas cited the genus *Tetragonia* and spelled it correctly, the incorrect epithet formation '*tetragonoides*' should be treated as an orthographic error that is to be corrected under Article 60 of the International Code of Botanical Nomenclature (Tokyo Code 1994).

Tetragonia is derived from the Greek 'tetra' (four) and 'gonia' (angle), referring to the shape of the fruits. Stearn (1992 : 260b) points out that in Greek adjectival compound construction the 'i', as in 'gonia', is not to be elided even before another vowel, e.g. in the suffix '-oides'.

Kuntze (1891), when making the original combination in *Tetragonia*, partially made the required correction; however, he incorrectly used the suffix '-odes', i.e. *T. tetragoniodes*.

Since the original spelling is 'tetragonoides', restitution of the 'i' logically results in the corrected spelling *'tetragonioides'* which has been adopted by many authors and is used throughout this paper.

T. tetragonioides sometimes has accessory flowers or leaves arising from the surface or projections of the fruit (Prakash 1967); however, this feature has not been observed in any of the specimens of *T. moorei* so far examined. The anther filaments of *T. tetragonioides* tend to be longer than those of *T. moorei*, i.e. (0.5–)1–2 mm, and are often swollen and micropapillate towards the base. Basicauline fruit, found near the base of the stem (Fig. 1) and the result of flowering in the rosette stage, are a common feature of *T. moorei* but are uncommon in *T. tetragonioides*.

The fruits of *T. tetragonioides*, which are rather variable throughout its total range, show particular variation in Australia. For example the common littoral and subcoastal form usually has the persistent perianth segments of the fruit accrescent, erect, fused at the base and more or less conspicuously projecting above the apex of the fruit. This corresponds to the common form found elsewhere throughout its range in the Pacific region, and is illustrated in Green (1994, fig. 39B). However, some specimens, particularly from the more arid parts of its range in Australia, have the segments incurved, relatively inconspicuous and only shortly fused at the base, approaching the state found in *T. moorei*. This tendency is particularly evident for example, in the area between Port Augusta, Lake Torrens and the Flinders Ranges in South Australia, where some specimens appear to show morphological convergence in other characters as well. This suggests that, although the two species are well separated both morphologically and geographically throughout most of their range, some introgression may have occurred where their ranges overlap, and this area in South Australia would be particularly favourable in this regard since the two species have probably co-existed here for a considerable period of time. Specimens from this area can be separated when the fruit projections are developed; however, occasional populations have the projections rudimentary or absent (e.g. in specimens of *T. inermis* F. Muell., a synonym of *T. tetragonioides*), and a combination of other characters may be required to distinguish them.

T. tetragonioides is a widespread littoral and estuarine species of the Pacific region from South America to Japan and south-east China, Australia (including Norfolk and Lord Howe Islands), New Zealand, the Kermadec Islands, New Caledonia, Hawaii and other Pacific islands. In South America it is found naturally on both the south-eastern and south-western coasts from central Chile and Uruguay southward to about 45°S (Taylor 1994), and is also widely naturalised in temperate and subtropical parts of the world as an escape from cultivation, e.g. along the west coast of the USA from California to as far north as Oregon. The fruits are dispersed by water and can remain viable for more than a month in salt water (Taylor 1994). Its distribution in mainland Australia and Tasmania, plotted from herbarium specimens, is shown in Fig. 2.

Although typically littoral and estuarine throughout most of its natural range, it is also found in salty soils in some subcoastal and inland areas in Australia; for example, it is commonly found after rains in burned, cleared or drought-affected parts of the Brigalow belt of northern NSW and southern and central Queensland (Everist 1981). Examination of herbarium specimens also confirms that *T. tetragonioides* s.str. is the plant reported by Kleinschmidt and Johnson (1977) as being a serious weed in wheat

on the Darling Downs in Queensland in some years, and a specimen from the Leichhardt District (Wandoan district, *Philp s.n.*, 16 Sep 1964 (BRI 084952, MEL, CANB)) has the following information: 'weed in cultivation ... causing serious trouble in wheat crop almost ready for harvest. Wheat is stunted due to dry conditions early in season and *Tetragonia* is vigorous and succulent following rain in September.'

The high levels of soluble oxalates reported (under *T. expansa*) by Mathams and Sutherland (1952) were from plants collected at Goondiwindi in Queensland and therefore probably belong to *T. tetragonioides* since *T. moorei* has not been found as far east as this (Fig. 2). These levels are sufficiently high to cause poisoning in stock, especially if young green plants are eaten (Everist 1981, McBarron 1977); however, Everist points out that 'livestock rarely eat this plant when it is green and succulent, preferring to leave it until the stems and leaves are dry and presumably low in oxalate'. Ross in Stanley & Ross (1983) also states that this species 'contains oxalates in the green state at potentially poisonous levels'. *T. tetragonioides* is also reported to contain alkaloids and significant amounts of saponin (Hurst 1942) and nitrates (McBarron 1972), the latter especially high in the young seedling stages (McBarron 1977).

The deaths of sheep at White Cliffs and Broken Hill associated with the ingestion of *Tetragonia* containing high levels of oxalate (expressed as 16.1% and 14.8% calcium oxalate respectively) was reported by McBarron (1978, 1983). The suspect plants were probably *T. moorei* (Fig. 2) not *T. tetragonioides*, which he chose to illustrate but which occurs only in the north-easterly part of the area designated in his 1978 publication.

Oxalate in both *T. tetragonioides* and *T. moorei* is mostly soluble, mainly as potassium and/or sodium oxalate (P.W. Michael pers. comm.) and as such, certainly has the propensity to be toxic to animals and humans (Sanz & Reig 1992).

Similarly, the following remarks under *T. tetragonioides* in Cunningham et al. (1981), except for the north-eastern part of the area covered in their book, no doubt refer mainly to *T. moorei* (Fig. 2). These authors, after discussing the forage and toxicological status of these plants, state that 'in the normal grazing situation however, sheep grazing pastures containing a high proportion of the plant will suffer no more than varying degrees of scouring; the risk of incurring more serious consequences increases when hungry animals are allowed access to lush stands'.

A specimen of *T. moorei*, obviously collected in the dry state (Urisino-Thurloo Downs N.S.W., *Boorman s.n.*, Nov 1912 (NSW 148779)), has the note: 'very common in the interior and much relished by stock'; however, a rather luxuriant specimen (Grassmere Station, Broken Hill, *Andrews s.n.*, 25 July 1968 (NSW 178855)) notes: 'suspected of producing hypocalcaemia.'

As reported by Maiden (1889), Gilbert (1966), Cribb & Cribb (1976) and Low (1989), *T. tetragonioides* (sometimes under *T. expansa*) was among the first Australian plants used as food by Europeans from Captain Cook and Sir Joseph Banks onwards, being boiled and eaten like spinach, and it is possible that at least some of the inland localities of this species (Fig. 2) may be due originally to introductions from the coast for use as a vegetable. Cook also made use of the plant as an antiscorbutic both in New Zealand and Australia.

Low (1989) further indicates that *T. tetragonioides* became the first Australian food plant to be cultivated overseas, the seeds having been taken to Kew Gardens by Banks in 1771. Seeds were later distributed from Kew to Europe and North America, and plants grown at Malmaison in France were etched by Redouté in 1803 (Cooper & Cambie 1991). These latter authors also report that *T. tetragonioides* contains 'betain, alkaloids, saponins, and tetragonin, a yeast growth regulator. The plant also exhibits carbonic anhydrase activity, and this apparently has the opposite effects of the

sulphonamide drugs. More recently the plant has been shown to contain cerebrosides, compounds which have anti-ulcerogenic properties.' It has been used in traditional medicine in far eastern Asia for the treatment of oesophageal and stomach cancer (P.W. Michael pers. comm.).

Notes on several specimens of *T. moorei* (e.g. Broken Hill, *Morris 2369*, 28 Aug 1928 (BRI)), indicate that it has been used as a 'spinach' by Europeans in the same way as *T. tetragonioides*. However, some authors state that at least some tribes of Aborigines did not use either species as food. Mann (1811), referring to 'Botany Bay Greens' (*T. tetragonioides*), wrote 'esteemed a very good dish by the Europeans, but despised by the natives'. Cleland & Johnston (1939) (under *T. expansa*) reported from the northern Flinders Ranges, where both species are likely to be found (Fig. 2): 'Used as a source of moisture in steaming cresses (see under Cruciferae). Not utilised as a food formerly by the natives, but now used after boiling (or after cooking in a hole).' The same authors, Johnston & Cleland (1943), most likely referring to *T. moorei* from the general area indicated (Fig. 2), state: 'Native name not known by informant. It is now eaten, its use being made known by the white man, according to our informant.' This makes sense in view of the fact that the Aborigines had no utensils in which food could be boiled (Eyre 1845), and this would have been the most efficient way of reducing potentially dangerous levels of oxalates, etc.

A specimen of *T. moorei*, (Mt Lyndhurst S.A., *Koch s.n.* (MEL 99863)), has the information: "'native spinach', valuable fodder, also an article of food both for European settlers and the aboriginal natives, who call it 'Paldroo' or 'Muna narranarra' in the Dieyeric dialect of Central Australia." ('Dieyeri' or 'Dieri' is now spelled 'Diyari' – see Austin 1981). This specimen, which consists of fruit only, may well have been collected from dried-off plants and is probably the voucher for the reference in Koch (1898), under *T. expansa*. In this paper Koch gives the additional information that the plant was 'also used as a pot-herb by Europeans as well as blacks.' 'Pot-herb' is an old term referring to plants which were boiled before eating.

In view of the above, recent trends to use these plants as a raw salad vegetable, e.g. in restaurants under the names 'New Zealand Spinach' or 'Warrigal Greens' (Low 1989), might need to be treated with some degree of caution, especially since young succulent plants would probably be selected for this purpose. This would apply particularly to the increasing numbers of people adopting 'alternative lifestyles', often involving varying degrees of vegetarianism and an increasing interest in 'wild foods'. Although Sanz & Reig (l.c.) indicate that 'the incidence of poisoning by plants containing oxalic acid is very low, and deaths due to ingestion of this type of plant are rare', they do quote cases of young children having been poisoned, sometimes fatally, from eating plants high in soluble oxalates.

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New segregate species and subspecies from the *Grevillea victoriae* (Proteaceae: Grevilleoideae) aggregate from south-east New South Wales

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Abstract

Makinson, R.O. (Australian National Herbarium, GPO Box 1600, Canberra ACT 2601, Australia; email: rom@anbg.gov.au) 1997. New segregate species and subspecies from the Grevillea victoriae *(Proteaceae: Grevilleoideae) aggregate from south-east New South Wales.* Telopea *7(2): 129–138.* Two segregate species are separated from the aggregate of taxa around *Grevillea victoriae* F. Muell. **G. oxyantha** subsp. **oxyantha**, **G. oxyantha** subsp. **ecarinata**, **G. rhyolitica** subsp. **rhyolitica**, and **G. rhyolitica** subsp. **semivestita** are described and named, with notes on distribution and conservation status.

Introduction

The aggregate of taxa around *Grevillea victoriae* F. Muell. has proved to be one of the taxonomically more intractable complexes in the genus. Mueller (1855a: 107) named *G. victoriae* from Victorian collections made on the 'Buffalo Range, on the summits of Mt Buller and Mt Tambo, on the sources of the Mitta Mitta, at Mt Hotham and Mt Latrobe'. In the same month, he (1855b: 132) named *G. miqueliana* from Victorian collections near Mt McMillan and on the upper Avon River; this was characterised as having a 'grey-downy' perianth, a scabrous leaf upper surface, and tomentose branchlets, floral rachis, and leaf undersurface, in contrast to *G. victoriae*, which has a smooth leaf upper surface, and a 'silky' (sericeous or subsericeous) indumentum on the other organs mentioned.

Bentham (1870: 423, 467) recognised material from Mt Tambo as *G. brevifolia* F. Muell. ex Benth., later reduced to varietal rank within *G. victoriae* by Maiden and Betche (1916: 60). Bentham (op. cit.: 468) also tentatively recognised *G. victoriae* var. *leptoneura* Benth. from the upper Genoa River, near the Victorian border with New South Wales.

In the period since, the species names *G. victoriae* and *G. miqueliana* have been applied with varying degrees of consistency to a range of specimens and populations, from the ranges of eastern Victoria and south-eastern N.S.W., all clearly related, but varying considerably in foliar and floral features.

McGillivray (1993: 320–324) delimited eleven 'races' within a broadly circumscribed *G. victoriae*, including a taxon from eastern Queensland since named as *G. hockingsii* Molyneux & Olde (1994: 784). Since McGillivray's treatment was finalised, the specimen base available has broadened considerably, but the aggregate as a whole remains only partially resolved, and with only sketchy indications of phylogeny. The aggregate is currently under study by Stajsic, Whiffin, and Molyneux, working from La Trobe University in Melbourne, using phytochemical and morphological characters. The present study, oriented to the production of a *Flora of Australia* treatment to be published in 1997, has proceeded in parallel with the Victorian work.

Two of McGillivray's races (races 'j'and 'k'), both endemic to Victoria, had previously been more or less consistently identified by various workers as *G. miqueliana* F. Muell.,

the Type of that name belonging to 'race j'. This assigment has been continued by more recent workers (Olde & Marriott 1995: 31–32, Makinson 1996: 852).

A further taxon, endemic to the far SE of N.S.W. (Nullica State Forest area N to Yowrie), is *G.* sp. aff. *miqueliana* 'Nullica' (*D. Albrecht 2068*; MEL, CBG, NSW), which equates to '*G. victoriae* race l' of McGillivray (1993) and to '*G.* sp. aff. *miqueliana* (Yowaka and Yowrie)' of Olde & Marriott (1995). This has a scabrid upper leaf surface, villous lower leaf surface, and tomentose to villous outer perianth surface in common with *G. miqueliana*, but has narrowly oblong-obovate (rather than elliptical) leaves. Its relationship to *G. miqueliana* sens. str., and to other members of the aggregate, is currently under investigation by Stajsic et al.

Two of McGillivray's remaining taxa (races 'a' and 'b') have together long been known as the 'Canberra form' or 'Australian Capital Territory (ACT) form' of *G. victoriae*, and were treated by Olde & Marriott (op. cit.: 225) as '*G.* sp. aff. *victoriae* 'A''. These are characterised by an acute subpyramidal limb of the flower bud, resulting from an acute apiculation of each tepal.

A further taxon endemic to N.S.W. (Araluen Valley and Deua National Park areas) was distinguished by McGillivray (loc. cit.) as 'race g', and by Olde & Marriott (loc. cit.) as '*G.* sp. aff. *victoriae* 'B''. This taxon was characterised as having a sparse indumentum on the leaf undersurface, and the indumentum of the outside of the perianth comprising both biramous and simple erect hairs.

The present paper gives names at species rank for the last two of the above entities (i.e. the 'Canberra form' and the Deua/Araluen taxon), each with two subspecies, in order to make at least these names available for the forthcoming *Flora of Australia* treatment of the genus (Makinson, in prep., publ. expected late 1997). It is not expected that the work of Stajsic et al. will necessitate further ranks or names for these taxa. The *Flora* treatment will remain somewhat tentative as regards circumscription of other taxa within the aggregate, pending results of their work.

Taxonomy

1. Grevillea oxyantha *Makinson*, **sp. nov.**

G. victoriae F. Muell. sensu stricto similis sed alabastris ad apicem acutis pyramidalibusque, foliis subtus tomentosis pilis crispis vel sinuatis, venis lateralibus subtus plus prominentibus, differt.

Type: New South Wales: Southern Tablelands (A.C.T. boundary): Brindabella Range c. 3 miles [4.8 km] N of Mt Franklin, *R.D. Hoogland 8433*, 6 Dec 1961; holo CANB; iso AD, BM, BRI, E, G, K, MEL, NE, NSW, P, PERTH; also (not seen): A, B, BISH, C, FI, L, M, NY, S, UC, US, W, Z.

Erect to spreading shrub (0.5–)1–3 m tall. Branchlets sub-angular becoming terete. Leaves entire, ovate to obovate or broadly so, occasionally suborbicular, 2–6 cm long, 15–35 mm wide, leathery-textured; apex usually obtuse with a short blunt mucro, or occasionally subacute with a similar mucro; upper surface smooth, minutely foveolate, lateral veins conspicuous; margin very shortly recurved; lower surface densely tomentose to subtomentose with short curled to wavy hairs, or (subsp. ecarinata) subsericeous with more or less straight mutually aligned hairs; venation of lower surface with the lateral veins conspicuous, at c. 45° to the midvein. Conflorescences terminal (often on short axillary branchlets), decurved to pendulous, pedunculate, usually a short loose cluster or sometimes loosely cylindrical, few- to many-flowered; peduncles 2–20 mm long, subsericeous to subtomentose with pale

brown or rarely rusty brown hairs; floral rachises 8–45 mm long, subsericeous to subtomentose with pale brown or rarely rusty brown hairs. Flowers acroscopic; pedicels 3–4.5 mm long; torus oblique to the pedicel at c. 30°; limb of flower bud acutely to bluntly subpyramidal, sometimes shortly apiculate, remaining erect until buds c. 1 cm long and then sharply deflexed; perianth after anthesis narrow and nearly straight below the limb, outer surface densely subsericeous to shortly subtomentose with brown or reddish brown ± appressed hairs, inner surface bearded (dorsal tepals glabrous in basal 2 mm to base of ovary then with a ± dense beard almost to the level of tepal separation, ventral tepals glabrous or nearly so from the base for 5–6 mm then with a short beard 1.5–2 mm long immediately below the level of tepal separation); nectary arcuate, projecting c. 0.5 mm above the toral rim, margin undulate or faintly 3-toothed; pistil 18–24 mm long; stipe of ovary 2–3.5 mm long, glabrous; ovary glabrous; style exserted from dorsal suture of perianth before release of style-end, afterwards nearly straight, minutely and sparsely pubescent or papillose in the apical 3–10 mm; pollen-presenter lateral, sub-oblong to slightly obovate in plan view, 2.5–3 mm long, 1.7–2 mm wide, stigma distally off-centre with a decurrent ridge to the base. Follicle narrowly and obliquely ovoid to obliquely ellipsoid, 15–20 mm long, glabrous, smooth except for one or two longitudinal ridges on each side, faintly glaucous; style persistent.

The epithet is from Greek, 'oxy-', sharp, and 'anthos', a flower, referring to the acute pyramidal limb of the bud.

Flower colour: outer surface of perianth scarlet to crimson (the indumentum red to brownish), inner surface (partly displayed) pinkish red with pale hairs; style deep to pale red.

Distribution: *G. oxyantha* occurs in southern montane areas of N.S.W. (including NW areas of the A.C.T.), in the general area bounded by Wee Jasper, Tumut, Batlow, Mt Franklin, Brown Mtn, and Mongarlowe (i.e. mainly in the Brindabella, Tinderry, Jounama and Kybean Ranges). It does not occur in the Bimberi Range/Scabby Range system (the range of *G. diminuta* L.A.S. Johnson), nor in the main Snowy Mountains ranges (where it is replaced in similar habitats by *G. victoriae* F. Muell.).

Distinguishing features: *G. oxyantha* is distinguished by the pyramidal-acute limb of the flower bud from *G. victoriae*, *G. uniqueliana*, *G.* sp. nov. aff. *uniqueliana* 'Nullica', *G. diminuta*, *G. rhyolitica*, and *G. hockingsii* (all of which have a spheroidal to broadly ovoid, obtuse bud limb). The subsericeous to subtomentose indumentum of the outer surface of the perianth, and the smooth upper surface of the leaf are in contrast to those of *G. uniqueliana* and *G.* sp. nov. aff. *uniqueliana* 'Nullica', which have a subvillous to villous perianth and a scabrid upper leaf surface (the latter also has narrowly oblong-obovate leaves, and a shorter pistil 12–14 mm long). The pistil length of 18–24 mm in *G. oxyantha* is in clear contrast to a length of 10–11 mm in *G. diminuta*, which also has smaller leaves (0.5–2 cm long) and is a generally lower, denser shrub to 1 m tall. *G. rhyolitica* has an open-subvillous or sparse, appressed indumentum on the leaf undersurface, elliptical leaves with a subacute apex, and a strongly tomentose to villous outer perianth surface with mixed biramous and simple erect (possibly glandular) hairs.

Affinities: in the absence of a comprehensive analysis of the *G. victoriae* aggregate of species, affinities are uncertain. On morphological grounds, it is here postulated that *G. oxyantha* is most closely related to *G. victoriae* sens. str. and to *G. diminuta*. Two subspecies of *G. oxyantha* are recognised.

Key to the subspecies

Limb-segment of each tepal with a pronounced longitudinal keel along the midline of the outer surface; leaf undersurface densely tomentose to subtomentose (rarely almost subsericeous) with short tightly curled to wavy or curved hairs; floral rachises 8–13 mm long ..... subsp. **oxyantha**

Limb-segment of each tepal not or scarcely keeled along the midline; leaf undersurface densely subsericeous to subtomentose with appressed to weakly ascending, more or less straight, mutually-aligned hairs; floral rachises (12–)20–45 mm long .....

..... subsp. **ecarinata**

1a. Grevillea oxyantha *Makinson* subsp. **oxyantha**

Spreading to erect shrub 0.5–3 m tall. Leaves broad-ovate or broad-elliptical or sometimes almost orbicular; apex obtuse with a small mucro, or rarely subacute; undersurface densely tomentose with short curled to wavy hairs or sometimes subtomentose with wavy to curved ascending hairs, rarely almost subsericeous. Floral rachises 8–13 mm long. Flower with the limb-segments of the tepals each strongly keeled along the external midline.

Illustrations: P. Olde & N. Marriott, *The Grevillea Book* vol. 3: 224 (184C), 225 (184E) (1995).

G. oxyantha subsp. *oxyantha* corresponds to '*G. victoriae* race a' of D.J. McGillivray, Grevillea: 320–4 (1993), and to '*G.* sp. aff. *victoriae* A' (pro parte) of Olde & Marriott, op. cit.: 225 (1995). It has also been widely known in the botanical and horticultural literature as the 'A.C.T. form' or 'Canberra form' of *G. victoriae*.

Variation: *G. oxyantha* subsp. *oxyantha* shows some variation, mostly on a NW to SE geographical gradient. The indumentum of the leaf undersurface varies, in populations in the Brindabella Range (closely tomentose with tightly curled hairs) to those more to the SE in the Tinderry Ra. and along the eastern scarp of the Tabelands (hairs increasingly wavy or curved rather than tightly curled). The latter populations are still distinguishable on this character from nearly all N.S.W. populations of *G. victoriae*, which have a fully appressed indumentum of straight mutually aligned hairs on the leaf undersurface.

Over most of the range, leaves are broad-ovate or broad-elliptical with an obtuse-mucronate apex. Elliptical, sometimes subacute, leaves are more common (though still occasional) in the Tinderries and to the SE; these are almost entirely absent from the Brindabella Range populations.

Shape and length of the pyramidal floral bud limb in subsp. *oxyantha* varies on the same NW/SE gradient, being most acute and longest (often apiculate) in the Brindabella Range and tending to be progressively shorter and somewhat blunter to the E and SE of the range, except in the Big Badja – Little Badja and Brown Mtn areas where it is again strongly pyramidal.

In the vicinity of Mt Franklin, the range of subsp. *oxyantha* abuts the northern limit of *G. diminuta*; no intergradation has been seen or recorded. In the far north of the range, subsp. *oxyantha* approaches to within a few kilometres the range (Baldy Range in the northern Brindabellas) of a small isolated population assignable to *G. victoriae* (obtuse bud limb, elliptical subacute leaves, appressed, more or less straight hairs on leaf undersurface). In the SE of the range (upper Wadbilliga River and Brown Mtn areas), there is again a geographical approach to *G. victoriae*, with the tendencies in leaf indumentum and bud-limb shape noted above suggesting possible gene flow. An apparent intermediate with *G. rhyolitica* is known from the Bendethera Mtn area in the

west of Deua National Park (*N. Taws 329*; CANB, NSW); the specimen has midline keeling on the tepals, an obtuse bud limb, elliptical leaves, a sericeous leaf undersurface, and scattered simple erect hairs among the biramous hairs on the outer surface of the perianth.

Distribution: subsp. *oxyantha* occurs in southern montane areas of N.S.W. (including NW areas of the A.C.T.), with the main occurrences in the Brindabella Range (north from Mt Franklin, Tidbinbilla, and Booroomba Rocks), the Tinderry Ranges, at scattered localities between Captains Flat, Mongarlowe, and Snowball, and in the Kybean Range along the tablelands escarpment from a little north of Big Badja Mtn south to the Brown Mtn area inland from Bega.

Habitat and ecology: subsp. *oxyantha* grows in various situations, usually in or on the margins of open eucalypt forest in rocky sites, often near peaks or cliffs, sometimes near creeks, usually in skeletal soils over granite or quartzite. There are no records of vegetative reproduction, and it is almost certainly killed outright by fire, with regeneration from seed only. The flowers are heavily visited by nectarivorous birds and are assumed to be primarily bird-pollinated, although introduced honey bees (*Apis melifera*) may now play a role. Flowering is mainly from August to December, occasional in other months.

Conservation status: subsp. *oxyantha* occurs in several conservation reserves, including Namadgi National Park, Tinderry Range Conservation Reserve, and Wadbilliga National Park, and is moderately common, although tending to occur in small, somewhat sporadic populations. It is not considered to be under any current threat, although long-term fire regimes may be significant for local populations.

Selected specimens: New South Wales: Southern Tablelands (including A.C.T.): c. 2 km N of Mt Aggie, Brindabella Ra., *L.A.S. Johnson 7262 & B.G. Briggs* (NSW); Bulls Head to Mt Gingera Rd, c. 4 miles [6 km] from Bulls Head, *C. Totterdell*, 19 June 1968 (CANB); Tidbinbilla Ra., E of Fishing Gap, *L.G. Adams 607* (CANB, E, K, L, MEL, NSW, US); Tinderry Mts, 13.2 km by road ESE of Michelago on the Jerangle Rd, *R. Coveny 6579 et al.* (NSW); Tinderry Ra. on Michelago to Anembo rd, *L.A. Craven 1971* (A, CANB, G, L, NSW, P, PERTH, RSA, SI, UC); between Snowball and Boggy Plain, c. 3 miles [5 km] W of Big Badja Mtn, *L.A.S. Johnson NSW 98417*, 5 Jan 1968 (NSW); Bumberry Ck on the Wadbilliga Fire Trail, *R. Coveny 6598 et al.*, 3 Aug 1975 (CANB, NSW).

1b. Grevillea oxyantha *subsp.* **ecarinata** *Makinson*, **subsp. nov.**

G. oxyanthae Makinson subsp. *oxyanthae* affinis similisque sed parte apicali tepalorum carinam longitudinalem deficienti, foliis subtus subsericeis pilis strictis, rhachidibus floralibus longioribus (12–45 mm longis), differt.

Type: New South Wales: Southern Tablelands: Bulls Flat Creek, 10 miles [16 km] N of Snowy Mts Highway on Yarrangobilly to Goobarragandra rd, 10 miles [16 km] ENE of Talbingo, *A.N. Rodd 1021*, 31 Mar 1970; holo NSW; iso PERTH

Erect to spreading shrub to 2 m tall. Leaves ovate or elliptical to broadly so; apex subacute; undersurface densely subsericeous to subtomentose with loosely appressed to ascending hairs. Floral rachis (12–) 20–45 mm long. Flower with the limb-segments of the tepals not or scarcely keeled along the external midline.

The epithet is from the Latin 'ecarinatus', lacking a keel, in reference to the limb-segments of the tepals as compared to those of the type subspecies.

Subsp. *ecarinata* corresponds to '*G. victoriae* race b' of D.J. McGillivray, Grevillea: 320–4 (1993), and to '*G.* sp. aff. *victoriae* A' (pro parte) of Olde & Marriott (op. cit.: 225).

In addition to the lack of a pronounced midline keel on the limb segments of the tepals, and the straighter ascending to appressed hairs of the leaf undersurface, subsp. *ecarinata* has a generally blunter (though still subpyramidal) bud-limb, more elliptical

leaves with a generally subacute apex, and a generally much longer floral rachis than subsp. *oxyantha*. In these characters it is somewhat intermediate between *G. oxyantha* subsp. *oxyantha* and Snowy Mountains populations of *G. victoriae*, the range of which it approaches E of Yarrangobilly and Tumut. It does, however, possess to some degree the (assumed derived) character-states that are here taken as central to defining *G. oxyantha* (subpyramidal bud-limb, tendency for leaf undersurface hairs to be ascending rather than strictly appressed or felted-matted, and prominent lateral veins especially on the leaf undersurface).

Variation: on specimens and populations seen, there is little variation.

Distribution: occurs from Micalong Creek area near Wee Jasper (NW of Canberra), south to near Tumut and Bago State Forest near Batlow.

Habitat and ecology: poorly recorded, but subsp. *ecarinata* appears to grow in small localised populations in similar sites to the typical subspecies. Regeneration mode is uncertain, but probably from seed only. It is assumed to be bird-pollinated. Flowering occurs mainly August to December.

Conservation status: this subspecies remains relatively poorly known and is rarely collected. Considerable areas of the total range have been converted to conifer plantations or have undergone lesser forms of disturbance. The extent of occurrence of the subspecies in conservation reserves is unknown, although a small population is recorded from Kosciusko National Park on the Peak River. A conservation rating of 2Ei- is recommended pending further survey, following the scheme of Briggs & Leigh (1996), in which '2' indicates a range of less than 100km, 'E' indicates a risk of disappearance from the wild within c. 20 years, and 'i-' indicates a reserved population of unknown size.

Selected specimens: New South Wales: Southern Tablelands: Micalong Ck (near Wee Jasper via Tumut), *W. Wingate Hall NSW 93294*, 18 Oct 1944 (NSW); 15 miles [24 km] SE of Batlow, Bago State Forest, *R.J. Allen NSW 58417*, 25 Oct 1962 (NSW); Bago State Forest, S of Batlow, *'Z.M.' [Z. Mazanec] s.n.*, 10 Aug 1961 (CANB); Kosciusko NP, c. 25 km directly SE of Tumut, Peak R., 1 km upstream of junction with Waterfall Creek, *N. Taws 236*, 31 Oct 1993 (CANB, MEL, NSW); Jounama Ra., *E. Gauba s.n.*, 11 Nov 1952 (CANB).

2. Grevillea rhyolitica *Makinson*, **sp. nov.**

G. victoriae F. Muell. et *G. miquelianae* F. Muell. similis sed foliis subtus indumento diffuso vel sparso, inflorescentiis pilis erectis simplicibus inter pilos dibrachiatos mixtis, differt.

Type: New South Wales: South Coast: Donald Creek near crossing of the Coondella Trig Road (new alignment), c. 4.5 km E of Coondella Trig, *D. Albrecht 3993*, 24 Mar 1990; holo MEL; iso CBG.

More or less erect, often gregarious shrub 0.5–2 m tall. Branchlets angular to subterete in cross-section, loosely to openly tomentose, with ascending to spreading biramous hairs and usually also with few to many simple erect, possibly glandular, hairs (the latter sometimes absent). Leaves narrowly to broadly elliptical, 4–11 cm long, 10–25 mm wide, thin-textured; apex subacute with a short blunt hairy mucro; upper surface of juvenile leaves with an open appressed or ascending indumentum of biramous hairs, of adult leaves smooth (lacking asperities), glabrous or with a few hairs especially near the midvein; lower surface with an open to sparse indumentum (ground tissue clearly visible between hairs), either of ascending biramous hairs and then often also with scattered minute simple erect glandular hairs, or of short-armed closely appressed biramous hairs only; venation with the midvein, lateral veins and sometimes some reticulum evident on both surfaces. Conflorescences terminal or subterminal axillary, simple or basally two-branched; unit conflorescence decurved to pendulous, acropetal

to subsynchronous, (2–)5–18-flowered, a loose ± regular ovoid to subglobose cluster; peduncle 15–20 mm long, thin, wiry; peduncle and floral rachis loosely to sparsely pubescent to tomentose with mixed biramous and erect simple (possibly glandular) hairs. Flowers acroscopic; pedicels 2–4 mm long, tomentose with brownish biramous hairs and usually also erect simple hairs; torus oblique at c. 30°; perianth in bud stage with the limb subglobose, obtuse; perianth outer surface after anthesis subsericeous to loosely tomentose (to densely so on limb segments) with mixed brownish biramous hairs and few to many erect, simple (possibly glandular) hairs; perianth inner surface glabrous near base, with a dense beard commencing just above ovary level and extending for 3.5–6 mm; nectary arcuate to sublinguiform, projecting c. 0.7 mm beyond the toral rim; pistil 16–20 mm long; stipe of ovary glabrous, 1.7–2.5 mm long; ovary glabrous; style with scattered minute erect simple hairs on the back of the style-end and in the apical few mm, or occasionally (subsp. *semivestita* only?) over most of its length; pollen-presenter lateral on the style or nearly so, obovate to broadly so, often slightly emarginate on the distal rim, 2.3–3.0 mm long, 2.2–2.3 mm wide, shallowly concave, the stigma a slight, distally off-centre, papilloid boss. Follicle (subsp. *rhyolitica* only seen) slightly sigmoid when young, at maturity narrowly and obliquely ellipsoid, 18–22 mm long, with several longitudinal ridges especially near the apex; pericarp crustaceous, exocarp possibly exfoliating after seed fall; style persistent. Seeds not seen.

The epithet 'rhyolitica' refers to the occurrence (possibly obligate) of this species on outcrops of rhyolite rock.

Distribution: *G. rhyolitica* occurs in subcoastal montane areas of the New South Wales South Coast botanical district, from NW to SW of Moruya in Dampier State Forest and Deua National Park.

Distinguishing features and affinities: *Grevillea rhyolitica* is distinguished from closely related species by several floral and foliar features. Its most obvious characteristics are the combination of elliptical subacute leaves, smooth upper surface of the leaf, open indumentum (open-tomentose with ascending hairs, or open to sparse and appressed) of the lower leaf surface, and presence of erect simple hairs among the biramous hairs of the outer surface of the perianth (often also on the peduncles and floral rachises). *G. victoriae* has the indumentum of the leaf undersurface more or less densely subsericeous-appressed or irregularly felty, with biramous hairs only (simple erect hairs always lacking); the indumentum of the branchlets, peduncles, rachis, and outer surface of the perianth with biramous hairs only, the arms usually appressed or at most only weakly ascending; and the pistil often longer (to 26 mm long) and with a proportionately smaller pollen-presenter. *G. miqueliana* and *G.* sp. nov. aff. *miqueliana* 'Nullica' have the leaf apex obtuse, the leaf upper surface with granular asperities, and the leaf undersurface with a much denser, villous indumentum of biramous hairs only; the latter also has shorter pistils (12–14 mm long). *G. linsuithii* McGillivray and *G. mollis* Olde & Molyneux are both similar but are geographically remote. *G. linsuithii* has obtuse, narrowly oblong to obovate leaves up to 10 mm wide, with a denser indumentum on the leaf undersurface, the perianth two-toned green and red in colour, and pistils 10–16 mm long. *G. mollis* has generally narrower leaves 4–14 mm wide, persistent spreading hairs on the leaf upper surface, fewer-flowered inflorescences, and the outer surface of the perianth with mainly erect simple hairs (biramous hairs few or absent).

G. rhyolitica has a close geographical, and possibly taxonomic, relationship with *G.* sp. aff. *miqueliana* 'Nullica' (*D. Albrecht 2068*, MEL, CBG, NSW), which has narrowly sub-oblong leaves 5–17 mm wide, with obtuse apices; the leaf upper surface granulate; and biramous hairs only on the branchlets, peduncles, floral rachises and outer surface of the perianth. This taxon, which equates to '*G. victoriae* race I' of McGillivray (1993) and

to '*G.* sp. aff. *uniqueliana* (Yowaka and Yowrie)' of Olde & Marriott (1995) is likely to warrant recognition at species rank; the relationship with *G. uniqueliana* is under investigation by Stasijc et al. It grows in similar habitats to *G. rhyolitica*, and somewhat to the south (from Nullica State Forest near Eden, north to the Tuross River valley near Belowra). At the latter locality it is within 30 km of the known range of *G. rhyolitica*. In the north of its range, some specimens have a more open indumentum on the leaf undersurface, perhaps indicative of an approach to *G. rhyolitica*, although this is not expressed in other characters. A more convincingly intermediate specimen, perhaps representing a genuine intergrade between the 'Nullica' taxon and *G. rhyolitica*, is represented by a single collection from the area inland from Narooma (Wadbilliga River above Wadbilliga Firetrail crossing, *R. Outlred s.n.*, 19 Dec 1982, CBG); this specimen has elliptical sub-acute leaves like those of *G. rhyolitica*, but with the upper surface of the leaf granulate, the undersurface more or less densely subsericeous, and with leaves and flowers lacking erect simple hairs. *G. rhyolitica* has not been recorded so far to the south as yet, and the 'intermediate' population has not been relocated. An apparent intergrade of *G. rhyolitica* with *G. oxyantha* subsp. *oxyantha* (*N. Taws 329*, Bendethera Mtn area; CANB, NSW) is discussed under that taxon, above.

Two subspecies of *G. rhyolitica* are here recognised:

Key to the subspecies

Leaf undersurface with an open indumentum of ascending biramous hairs (often also with simple erect ?glandular hairs); outer surface of perianth with simple erect hairs (mixed among ascending biramous hairs) usually confined to the basal third, occasionally more extensive. ..... subsp. **rhyolitica**

Leaf undersurface with scattered minute closely appressed biramous hairs (surface sometimes appearing glabrous); outer surface of perianth with simple erect hairs (mixed among ascending biramous hairs) distributed over the whole surface, including limb segments. ..... subsp. **semivestita**

2a. Grevillea rhyolitica *subsp.* rhyolitica

Shrub to 2 m tall. Branchlets initially angular to subterete in cross-section, rapidly becoming obscurely angular to subterete, open-tomentose, usually with a mixture of non-glandular brownish biramous hairs, and simple erect, pale, possibly glandular, hairs (sometimes only the latter). Leaves elliptical to narrowly (rarely broadly) so, (4.5–)5.5–11 cm long, 10–25 mm wide; undersurface with an open indumentum of ascending biramous hairs usually denser along the midvein, often also with few to many scattered minute erect simple hairs. Peduncles and floral rachises loosely tomentose with biramous hairs and usually also numerous simple erect hairs (sometimes the latter predominating). Outer surface of perianth loosely tomentose (to densely so on limb), with mainly biramous ascending hairs and usually also relatively few simple erect hairs, the latter usually confined to the basal third and inconspicous, or rarely (e.g. *Walsh 1875*; MEL, NSW) extending over the whole outer surface.

Subsp. *rhyolitica* corresponds to *G. victoriae* 'Unassigned 7' of McGillivray (1993:322), and to *G.* sp. aff. *victoriae* 'B' (in part) of Olde & Marriott (1995:225).

Flower colour: perianth and style red.

Distribution: occurs in montane areas west and south-west of Moruya, in Dampier State Forest and Deua National Park, on the catchments of Donalds Creek and the Coondella Creek–Burra Creek system (all tributaries of the Deua River from the south).

Habitat and ecology: recorded from open eucalypt forest (associations noted are *Encalyptus sieberi* 'Silvertop Ash' with *E. stenostoma* 'Jilliga Ash'), from riparian forest with *Tristaniopsis laurina* and *Lomatia myricoides*, and from mixed sclerophyll shrubland. The species occurs at 100–600 m alt., in both moist gully and steep rocky ridge situations, with southern and north-western aspects, in skeletal soils on rhyolite (Comerong Volcanics group). It is almost certainly killed by fire and regenerant from seed only. It is assumed to be primarily bird-pollinated. Flowering is recorded for Sept.–Dec.

Selected specimens: New South Wales: South Coast: 'Mountains of the Moon', Deua National Park, *G. Moran 110 & L. Thomson* (CBG); Deua National Park, c. 2 km N of Coondella Trig, *P. Gilmour 4320* (CBG); Dampier State Forest, c. 22 km W of Moruya, *R. Pullen 4758* (CANB – 2 sheets); Deua National Park, prominence 1.9 km N of Coondella Trig, *N. Walsh 1875* (CANB, MEL).

2b. Grevillea rhyolitica *subsp.* **semivestita** *Makinson*, **subsp. nov.**

Type: New South Wales: South Coast: Araluen Valley, *E. Gauba CBG 005044*, 3 Aug 1953; holo CANB.

Grevillea rhyoliticae subsp. *rhyoliticae* similis sed foliis plerumque paulo latioribus subtus indumento appresso, diffuso vel sparso ex pilis dibrachiatis solum constantibus, differt.

Shrub to 1 m tall. Branchlets angular, loosely subsericeous with appressed short-armed biramous hairs only. Leaves elliptical, (4–)6–11 cm long, 12–23 mm wide; lower surface often appearing glabrous but with an open inconspicuous indumentum of very short-armed appressed biramous hairs (erect simple hairs lacking), most hairs ferruginous, some pale, lateral veins evident. Peduncles and floral rachises loosely to sparsely pubescent with mainly simple erect hairs and often also a few ascending biramous hairs. Outer surface of perianth loosely tomentose with brownish ascending biramous hairs mixed with numerous weakly erect simple, ?glandular pale hairs, the latter distributed more or less evenly from base to limb.

The epithet is from the Latin 'semi-', half, and 'vestitus', clad or clothed, in reference to the open to sparse indumentum of the leaf undersurface.

Subsp. *semivestita* corresponds to *G. victoriae* 'race g' of McGillivray (1993:320–4), and to G. sp. aff. *victoriae* 'B' (in part) of Olde & Marriott (1995:225)

Flower colour: perianth and style red.

Distribution: occurs in the northern part of the species' range, in coastal mountain ranges NW of Moruya, recorded from the NE slopes of Mt Donovan (Oulla Ck catchment) and from 'Araluen Valley'.

Habitat & ecology: grows in broken escarpment country, recorded from steep upper slopes below rock outcrops in skeletal soils on rhyolite, in open *Encayptus sieberi* forest. This subspecies is apparently fire-sensitive, regenerating from seed only, and bird-pollinated. Flowering is recorded for Oct.–Dec.

Selected specimens: New South Wales: South Coast: Deua National Park, ridge running off Mt Donovan, 1.8 km NE of summit, c. 20 km WNW of Moruya, *P. Beesley 391 & D. Binns* (CBG, NSW); Araluen Valley, *Mrs Shoobridge CBG 006729*, Sep 1964 (CBG, NSW).

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Astonia (Alismataceae), a new genus for Australia

S.W.L. Jacobs

Abstract

Jacobs, S.W.L. (Royal Botanic Gardens, Sydney, Australia, 2000) 1997. Astonia (Alismataceae), a new genus for Australia. Telopea *7(2): 139–141.* A new genus, **Astonia**, is described for the species formerly known as *Limnophyton australiense* H.I. Aston, and the new combination **Astonia australiensis** (Aston) S.W.L. Jacobs provided. The differences between related genera are discussed and a key provided to these and other genera in the family growing in Australia.

Introduction

When Aston (1987) described *Limnophyton australiense* she noted that it differed from other members of that genus in two important fruit characters, namely the presence of large spines and the absence of air canals (*Limnophyton* fruit are spineless and have lateral air canals). After examining the plants in the field there are several more characters that are not clearly obvious on preserved specimens. Firstly the bracts in the inflorescence are a deep maroon, as are the stamens, and the petals a creamy-yellow, some with a greenish tinge (*Limnophyton* has green bracts, white/yellow stamens and white petals). Secondly, the fruits of the Australian species are very much larger than those of any of the other species (11–12 × 8–9 mm vs 4–8 × 3–4 mm). Thirdly, the Australian species appears to have a unique flowering developmental sequence. As the lower whorl of bisexual or female flowers develops, the pedicels thicken and elongate geotropically, and the peduncle bends towards the water surface. When the fruit (nutlets) make contact with the water the remainder of the developing inflorescence containing the male flowers grows upwards or antigeotropically, leaving the developing nutlets in the water where they gradually separate and float away, the peduncle maintaining its curve. This developmental sequence has not been reported from any other species in the family and, coupled with the other characters above, warrants this species being placed in a genus of its own.

Haggard and Tiffney (1997) have reviewed the fruit types of the Alismataceae and their Table 1 provides a means of comparing the fruits of the extant genera. There is one deficiency in the table with a lack of any reference to spines on the fruit, a problem that seems to have led them to mistakenly list *Caldesia acanthocarpa* (F. Muell.) Buch. as a synonym of *C. oligococca* (F. Muell.) Buch. From the description of their *C. acanthocarpa* specimens they were looking at another species. *Astonia*, using the criteria in their Table 1, has fruiting carpels that:

(i) are elliptic in cross-section

(ii) are obovate laterally

(iii) are dorsally 3-ridged

(iv) have a chartaceous exocarp and a thick endocarp

(v) have no glands

(vi) have a ventral style

(vii) have no lateral air chambers

(viii) are indehiscent

(ix) are wingless, and

(x) have one ovule.

In addition they have 4–6 robust spines to 6 mm long.

From those fruit characters on the list, *Astonia* only really differs from *Limnophyton* in the lack of lateral air chambers. There are other characters not on the list, as discussed, that also need to be considered when assessing relationships.

Astonia is most closely related to *Limnophyton* and *Sagittaria*. All three are monoecious with polymorphic pedicellate flowers. *Sagittaria* has numerous non-spinescent carpels arranged spirally on an elongated receptacle and an indefinite (>7) number of stamens. Although the fruiting pedicels of some species of *Sagittaria* thicken and recurve, no species are recorded as having a flowering system similar to *Astonia australiensis*.

The related genera and other Australian genera in the family Alismataceae can be distinguished with the following key:

1 Carpels in several whorls, apparently spirally arranged; flowers bisexual or unisexual 2

1* Carpels in 1 whorl; flowers bisexual 5

2 All flowers bisexual ..... **Echinodorus**

2* Lower flowers female or bisexual, upper flowers male 3

3 Nutlets numerous, flattened, spines usually absent, if present then <2 mm long ..... **Sagittaria**

3* Nutlets few, swollen, spines to 5 mm long or absent 4

4 Nutlets without spines, with lateral air canals; bracts green ..... **Limnophyton**

4* Nutlets with spines to 5 mm long, without lateral air canals; bracts maroon ..... **Astonia**

5 Carpels more or less triangular with a long beak, united along a central axis ..... **Damasonium**

5* Carpels rounded on the back, not triangular, not united along central axis, often closely packed 6

6 Nutlets flattened, when mature forming a circular or rounded-triangular whorl ..... **Alisma**

6* Nutlets subglobose, when mature forming a loose aggregation ..... **Caldesia**

Astonia *S.W.L. Jacobs*, **gen. nov.**

Affinis Limnophyti sed nuculis spinosis, sine canalibus pneumaticis; bracteis staminibusque marroninis; petalis cremicoloribus; pedicellis fructificantibus spinsescentibus elongatis geotropis differt.

Aquatics with emergent leaves and inflorescences. Juvenile leaves linear, submerged; mature leaves with sagittate blades; apex obtuse. Inflorescence with up to 8 whorls of

flowers, the lower 1(-2) whorl(s) bisexual with either bisexual or a mixture of female and bisexual flowers, sometimes with male flowers as well; upper whorls of male flowers; branches and pedicels bracteate, the bracts deeply coloured (maroon); lower bisexual whorl(s) opening and maturing first, the peduncle then bending towards the water until the nutlets contact the water surface, the tip of the inflorescence (with the opening male flowers) then turning upwards. Fruiting pedicels at first reflexing then thickening and elongating geotropically. Sepals 3, green. Petals 3, cream or greenish, constricted at the base. Stamens 6, coloured (maroon). Carpels 5-15; nutlets crowded, spinescent when mature, lateral air chambers absent. One species endemic to NE Queensland.

Astonia australiensis (*Aston*) *S.W.L. Jacobs*, **comb. nov.**

Basionym: Limnophyton australiense H.I. Aston Muelleria 6: 311-313 (1987).

Type: Queensland: Cook: 38 km from Wakooka on the track to Bathurst Bay and Cape Melville National Park, 14°1-'S 144°2-'E, *J.R. Clarkson 5434*, 19 June 1984 (holo BRI; iso BRI, K, MEL, QRS; also spirit collections BRI, MEL).

Cape York Peninsula, north Queensland. Grows in shallow freshwater lagoons and waterholes in lowland areas.

The generic name is to honour Helen Aston who first described the species, in recognition of her distinguished record in studies of Australian aquatic plants.

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Grevillea obtusiflora subsp. *fecunda* (Proteaceae: Grevilleoideae), a new subspecies from New South Wales

R.O. Makinson

Abstract

Makinson, R.O. (Australian National Herbarium, Centre for Plant Biodiversity Research, GPO Box 1600, Canberra, ACT 2601, Australia; email: rom@anbg.gov.au) 1997. Grevillea obtusiflora *subsp.* fecunda *(Proteaceae: Grevilleoideae), a new subspecies from New South Wales.* Telopea *7(2): 143–148. Grevillea obtusiflora* R. Br. sens. strict. is reviewed in the light of newly discovered populations, and a new subspecies is described as **Grevillea obtusiflora** subsp. **fecunda** Makinson, with notes on diagnosis, ecology, and conservation status.

Introduction

Grevillea obtusiflora was originally described by Robert Brown (1830: 19) from collections made by Allan Cunningham in 'brushy hills north of Bathurst' in 1822; the exact collection locality remains uncertain. The species appears not to have been collected again until 1977 when Robert Coveny of the Royal Botanic Gardens, Sydney, discovered a root-suckering and apparently quite sterile population in Clandulla State Forest, approximately 13 km (direct) SSW of Rylstone in the Central Tablelands botanical district of New South Wales. These and subsequent Clandulla collections correspond well with the Type material, although examination of Cunningham's journal entries and maps suggest that this is probably not the type locality.

McGillivray (1986: 11; see also McGillivray 1993: 264–266) recognised two new taxa as subspecies of *G. obtusiflora*; these were subsp. *kedumbensis* McGillivray and subsp. *granulifera* McGillivray. Both were re-ranked as separate species, with an additional segregate species, *G. guthrieana*, by Olde & Marriott (1994a: 726–731, see also Olde & Marriott, 1995a: 183–4, 222–3; 1995b: 59–60), rankings with which this author agrees.

In early 1995, Richard Johnstone of Mt Annan Botanic Gardens and Jane Miller of the Cumberland Bird Observers' Group, assisting with a bird survey in the Capertee Valley about 50 km N of Lithgow, discovered a population of an apparently new taxon. Mr Johnstone brought the material to the author's attention, and field examination was conducted in March 1995, resulting in the location of two populations of the new taxon, here described and named as *Grevillea obtusiflora* subsp. *fecunda* R. Makinson. Both of these populations, and the Clandulla subspecies, have been examined in the field by the author. Herbarium collections of *G. obtusiflora* have been examined at herbaria BM, CANB, K, and NSW, including types at BM and K.

Readers are referred to McGillivray (1993, loc.cit.) and Olde & Marriott (1994a: loc. cit.; 1995a, 1995b: loc. cit.) for typification details, full descriptions, and colour illustrations of the type subspecies and of other closely related taxa. Lectotypification of the name *Grevillea obtusiflora* R. Br. is pending (Makinson in *Flora of Australia* vol.17, in prep., publ. expected late 1997). A brief comparative description and a diagnostic key to the subspecies are given below. Terminology and character-state definitions follow

McGillivray (1993). Specimens registered and cited elsewhere as herbarium CBG are now housed at CANB.

Grevillea obtusiflora subsp. **fecunda** *R. Makinson*, **subsp. nov.**

Subsp. *obtusiflorae* similis sed planta fecunda foliis angustioribus (1.0–1.8 mm latis) valde revolutis, subtus indumento modice denso, differt.

Type: New South Wales: Central Tablelands: c. 18 km (direct) NNE of Capertee; c. 4.7 km along road running NE from 'Port Macquarie' property, towards NE end of ridge, c. 33°00' 34"S, c. 150°04'E, *R.O. Makinson 1574 & R. Johnstone*, 10 Mar 1995 (holo CANB (CBG 9502739); iso NSW).

Low spreading shrub 50–80 cm tall and up to 100 cm wide, sometimes root-suckering, procumbent when young. Branches spreading; branchlets round in cross-section with a subsericeous indumentum, often secund especially on younger plants with the leaves pointing skywards and the leaf undersurfaces facing the distal end of the branchlet. Leaves ascending to spreading, light green when young, darkening with age, subsessile or sessile, simple, very narrowly obovate to linear, (15–) 20–30 (–40) mm long, 1.0–1.2 (–1.8) mm wide; base attenuate; apex mucronate with a short blunt point 0.3–0.5 mm long; margin smoothly revolute, usually concealing all of the undersurface including the midvein, often a few leaves with a narrow strip of the undersurface exposed; upper surface subsericeous to subvillous on young leaves, on older leaves densely granulose (old hair bases) and often also with an open appressed indumentum persisting; lower surface (when visible) with an open appressed indumentum, the ground-tissue clearly visible between the hairs at 10× magnification; venation of the upper surface obscure; venation of the lower surface with a scarcely prominent midvein evident over the full length of the leaf. Conflorescences terminal, erect, simple, sessile or subsessile; peduncles up to 1.5 mm long, subsericeous to tomentose; rachises 1.5–3 mm long, tomentose; conflorescences a loose 1- or 2- (–4) -flowered cluster, often with a few other buds resting at an early stage (only autumn flowering seen); bracts ovate to triangular, 0.7–0.8 mm long, 0.4 mm wide, outer surface tomentose, inner surface glabrous or with a few hairs near the apex, bracts deciduous when the buds are c. 1.5 mm long; floral orientation and order of opening not determined; pedicels spreading, 3–7 mm long, open-tomentose; torus oblique at c. 40°, 1.2–1.4 mm across; perianth dilated at the base, c. 1.5–2 mm across, outer surface below the curve with an open indumentum of appressed to ascending wavy-armed hairs, apical (limb) cups tomentose, inner surface glabrous in the basal 2 mm then with a dense beard of retrorse ascending hairs on the ventral tepals (only) extending for 2.5 mm, then scattered appressed hairs on both dorsal and ventral tepals to the base of the limb cups; limb depressed-globose, 1.7 mm long, 2.1 mm broad; nectary subreniform, extending 0.3–0.4 mm beyond the toral rim, upper surface convex, margin entire; pistil 14–18 mm long; stipe sometimes barely evident, 0–0.3 mm long; ovary sessile or subsessile, obliquely ellipsoid, 1.2–1.5 mm long, villous; ovule attachment not determined; style scarcely exserted from the dorsal suture of the perianth prior to release of style-end, loosely villous especially on the flanks and the dorsal side with biramous hairs, the indumentum persisting on the dorsal side right to the apex, and also with erect simple multicellular (possibly glandular) hairs c. 0.05–0.1 mm long in the apical 3–4 mm especially on the ventral side; pollen-presenter oblique at c. 75°, obovate to almost round, convex, 1.5–1.7 mm long, 1.4–2.0 mm wide, 0.3–0.3 mm high, stigma central to distally off-centre. Follicle erect on the pedicel, narrowly and obliquely ellipsoid or slightly ovoid, 11–13.5 mm long, 4-5 mm wide, style persistent, erect; surface faintly longitudinally ridged along the dorsal side, loosely subsericeous to loosely subvillous; pericarp 0.4 mm across at the suture, 0.3 mm thick at centre-face, 0.5 mm thick at the dorsal side, texture crustaceous. Seeds (*Johnstone 485* – immature) obliquely ellipsoid, 9 mm long, c. 2.4 mm

wide, margin recurved, anterior edge with a narrow waxy wing c. 0.2 mm wide (possibly not persistent); outer face convex with a fine downy covering of minute hair-like processes; inner face sunken, flat, appearing colliculose with the elevations shiny; apical elaiosome triangular, 1.6–1.9 mm long.

Flower colour: perianth usually deep pink to crimson, paling to pink or cream along the dorsal side and with a cream limb, or occasionally pale pink or cream deepening to a weak red along the dorsal side; style deep pink to red with white hairs except for a sometimes yellowish style-end.

The epithet is from the Latin: fecundus – fruitful, fertile; alluding to the copious fruiting of this subspecies in contrast to the apparently quite sterile, vegetatively reproducing type subspecies.

Diagnostic features: subsp. *fecunda* differs from subsp. *obtusiflora* in relatively minor foliar and floral characters. Subsp. *obtusiflora* has leaves 1.5–5 mm wide, with the margins only shortly recurved or shortly revolute, usually with most leaves on a plant having most of the undersurface visible; the leaf undersurface usually more or less densely subsericeous (hairs usually completely obscuring the ground tissue) or occasionally open-villous; the upper surface with the granules less prominent than in subsp. fecunda, and more rapidly glabrescent; the perianth significantly broader (2.5–3 mm across); the pistils longer (18–23 mm long); the stylar indumentum sometimes lacking minute erect multicellular hairs (e.g. *Coveny 9563*, *Makinson 1576*, both from Clandulla) but sometimes with them (*Cunningham 197/1822*, Brushy Hills north from Bathurst, isotype at K); the dominant stylar indumentum of biramous hairs sometimes becomes sparse or absent within 2–3 mm of the apex (e.g. *Coveny 9563*) or remains dense to the apex on the dorsal side (*Makinson 1576*). The Coveny collection is unusual in the open-villous leaf undersurface; all other plants seen of this population are subsericeous.

Distribution: restricted to an area in the New South Wales Central Tablelands in the Capertee Valley SSE of Kandos. Positions of known populations are given under 'Specimens examined' below. The new taxon is on the catchment of the east-flowing Capertee River. Subsp. *obtusiflora* occurs some 15 km away at Clandulla, and both this population, and the general type locality north of Bathurst, are on the other side of the Great Dividing Range watershed, on the catchment of the west-flowing Cudgegong and Macquarie Rivers.

Habitat & ecology: the two populations seen are both growing in a distinctive orange loamy soil with sandstone boulders, at an elevation of about 570 m. At the 'Port Macquarie' (ridge) site, vegetation is a relatively undisturbed low open dry sclerophyll forest with *Eucalyptus tenella*, *E. fibrosa*, *E. macrorrhyncha*, *E. punctata*, *Callitris endlicheri*, *Leptospermum ?continentale*, *Monotoca elliptica*, *Acacia buxifolia*, *Indigofera* sp., *Persoonia linearis*, and *Pomax umbellata*. The grevillea is confined to the upper slopes of the ridge, and shows a definite association with mechanically disturbed ground along the road. At the 'Kooringle Woolshed' site, soil type is similar and is probably part of the same formation, now dissected by the Capertee River. Native vegetation at this site is remnant dry sclerophyll forest with *Eucalyptus tenella* and a mixed shrubby understorey. Brief searches elsewhere in the valley failed to locate other roadside populations. It is likely that the taxon is substrate-specific, and this soil formation should outcrop elsewhere in the valley; the soil type and *Eucalyptus tenella* may prove to be good indicators for the grevillea.

Reproduction: subsp. *fecunda* does root-sucker (*Makinson 1571*, CANB duplicate) but also sets copious numbers of fruits. Mature seeds had all been shed at time of collection, and sifting of leaf litter did not yield any. In common with other *Grevillea* species with elaiosomes or waxy wings on the seeds, it is likely that mature seeds are

rapidly gathered and dispersed by ants (cf. *G. wilkinsonii*, Makinson 1993: 357; *G. ramosissima*, W. Molyneux, pers. comm., 1993; Olde & Marriott 1994b: 93). No seedlings were observed but it is likely that the seeds are fertile.

By contrast, subsp. *obtusiflora* (Clandulla population) is apparently wholly dependent on root-suckering for reproduction; suckers may arise at least five feet from a parent ramet. It is likely that the Clandulla population comprises a very few clonal lines.

Ranking: neither subspecies has been fully surveyed for variation as yet, and the character state variation noted here is based on limited samples from both taxa. From the material seen there are relatively few strongly diagnostic differences, but enough to warrant taxonomic recognition.

Naming of this taxon poses the issue of whether the rank of subspecies is taxonomically meaningful and descriptively useful. Whilst the morphological distinctions between subsp. *obtusiflora* and subsp. *fecunda* are slight, with several characters varying only in degree of expression or (perianth width, pistil length) in adjunct ranges of measurement, there is an apparent strong difference in mode of reproduction as discussed above, with subsp. *obtusiflora* not known to set fruit or seed. This feature, coupled with an apparent geographic disjunction of about 15 km (not confirmed), might reasonably be taken as grounds for assuming geographic isolation. Recent workers in *Grevillea* have differed on the significance of such differences, with McGillivray (1993) having a very inclusive morphologically-based implicit species concept, and others adopting a variant of the Biological Species Concept and arguing that 'isolated, self-reproducing [i.e. reproductively isolated – ROM] populations exhibiting morphological consistency ... should be regarded as species, irrespective of the kind and degree of morphological distinction' (Olde & Marriott, 1993: 239). The latter authors, however (loc. cit.), then admit that in relation to the ranking of 'allopatric populations exhibiting only slight morphological discontinuity ... we would acknowledge the value of the rank of subspecies or variety or a mixture of the two'.

There are numerous examples in *Grevillea* of species with (usually geographically peripheral) local populations exhibiting a partial or total 'abandonment' of sexual reproduction correlated with minor morphological differences (e.g. populations of *G. arenaria* subsp. *canescens* (R. Br.) Olde & Marriott in the area of Gilgandra, N.S.W.; *G. masonii* Olde & Marriott, a very narrow segregate from *G. banyabba* Olde & Marriott; various localised populations in *G. lavandulacea* Schlechtd. and *G. lanigera* A. Cunn. ex R. Br., to name a few). In most of these cases there is some variably expressed capacity for vegetative reproduction in the more widespread, presumed 'parental' populations. Breeding systems for these, and most other, *Grevillea* species have not yet been examined, but it is quite possible that an inability to set fruit in local (possibly clonal) populations may result from self-incompatibility or compounded inbreeding depression within such populations of what may be preferentially out-breeding species. To what extent such features may become genetically fixed and irreversible has not been studied for any cases in *Grevillea* of which I am aware. Given the absence of data, assumptions of reproductive isolation and/or reproductive incompatibility between taxa should be made with care. This is not to imply that the two subspecies of *G. obtusiflora* are not reproductively isolated, but rather that the capacity to lose or suppress a capability for sexual reproduction may be a reasonably common and plastic feature within lineages classified at species rank, and should not therefore be taken as an absolute determinant of rank, at least where other characters indicate a very close relationship.

It seems likely that *G. obtusiflora* subsp. *obtusiflora* is such a geographical (and possibly recent) isolate from an ancestral population that resembled subsp. *fecunda* at least in its

capacity for sexual reproduction. It is not out of the question that the type population of subsp. *obtusiflora* (almost certainly not the Clandulla population) may, if rediscovered, prove to be fertile, but there is no indication of this from the type specimens or in the protologue. In this event, the consistent foliar and floral differences noted here would still warrant the maintenance of two subspecies.

In the circumstances, a rank of subspecies seems justified in respect of both likely degree of lineage divergence and in the inetrests of maximising the information content of the formal nomenclature.

Key to the subspecies

1 Leaves 1.5–5 mm wide, margins shortly recurved or revolute leaving most of the undersurface exposed; leaf undersurface densely subsericeous (ground-tissue not visible between hairs), or occasionally open-villous; perianth 2.5–3mm across .... subsp. **obtusiflora**

1* Leaves 1.0–1.2 (–1.8) mm wide, margins strongly revolute, completely enclosing the undersurface on most leaves; leaf undersurface, when visible, with an open appressed indumentum (ground-tissue clearly visible between the hairs at 10 × maginification); perianth 1.5–2 mm across ..... subsp. **fecunda**

Affinities: *Grevillea obtusiflora* belongs to the Section Ptychocarpa sensu Bentham (1870: 420). Closely related taxa include *G. kedumbensis* (McGillivray) Olde & Marriott, *G. granulifera* (McGillivray) Olde & Marriott, *G. guthricana* Olde & Marriott, and *G. mucronulata* R. Br. These species generally have leaves more than 2 mm wide (and usually more than 5 mm wide), and the perianth predominantly green or cream in colour. The forthcoming treatment in *Flora of Australia* vol. 17 (Makinson, in prep., expected publ. late 1997), will provide fuller comparative notes and diagnostic keys.

Conservation status: one of the known populations of subsp. *fecunda* (represented by *Johnstone 485*) is on a rocky ridge, unsuitable for cropping or grazing; the tenure of the site is not known, but the population is probably relatively secure. The other population (e.g. *Makinson 1575*) is in remnant vegetation on a roadside easement and is not secure. A conservation coding of 2Vi (following the criteria and coding of Briggs & Leigh, 1996) is recommended pending full survey, where (2) indicates a range of less than 100 km, (V) indicates taxon vulnerable, not presently endangered but at risk over 20–50 years, and (i) indicates taxon inadequately reserved.

Specimens examined: New South Wales: Central Tablelands: 6.7 km along road towards 'Port Macquarie' property from Glen Alice–Rylstone Road, 33°0' 40"S, 150°03' 30"E, *R. Johnstone 485, J. Miller & T. Wilson*, 19 Feb 1995 (NSW); c. 17 km (direct) NNE of Capertee, 4 km along road running NE from 'Port Macquarie' property, 33°00' 36" S, 150°03' 46" E, *R. Makinson 1571 & R. Johnstone*, 10 Mar 1995 (CBG 9502738 at CANB, MEL, NSW); c. 14 km SSE of Kandos, 2.2 km from Rylstone to Glen Alice road S along road from 'Kooringle' Woolshed, 32°58' S, 150°03' 30" E, *R. Makinson 1575 & R. Johnstone*, 10 Mar 1995 (CBG 9502742 at CANB).

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Two new species of *Phyllanthus* and notes on *Phyllanthus* and *Sauropus* (Euphorbiaceae: Phyllantheae) in New South Wales

John T. Hunter and Jeremy J. Bruhl

Abstract

Hunter, J.T. and Bruhl, J.J. (Department of Botany, University of New England, Armidale, NSW 2351, Australia) 1997. Two new species of Phyllanthus *and notes on* Phyllanthus *and* Sauropus *(Euphorbiaceae: Phyllantheae) in New South Wales.* Telopea *7(2): 149–165.* Descriptions of two new species of *Phyllanthus* (**P. involutus** J.T. Hunter & J.J. Bruhl and **P. occidentalis** J.T. Hunter & J.J. Bruhl) from New South Wales are presented, together with descriptions and notes on other New South Wales species of *Phyllanthus* and of *Sauropus*.

Introduction

The Phyllantheae, in particular *Phyllanthus* and *Sauropus*, have presented considerable taxonomic problems within Australia. Webster (1956) compared the Phyllantheae to '... political boundaries which are superposed over the natural physiographic features of a region.' He added that *Phyllanthus* was essentially the place where species were put when they did not fit into any of the other genera in the Phyllantheae.

This paper aims to clarify the status of the New South Wales species of *Phyllanthus* and *Sauropus*. Two new species recognised in the current *Flora of Australia* investigation have their distributions predominantly within New South Wales, and full descriptions of these species are presented here. Additionally, an update is presented of the descriptions, distributions and nomenclature for the New South Wales species of these genera (cf. James & Harden 1990).

Methods

Sampling and organisation of data: significant proportions of the *Phyllanthus* specimens held by the herbaria AD, BRI, CANB, DNA, HO, MEL, NSW, PERTH and QRS, and historically important *Phyllanthus* specimens from A and GH were provisionally sorted into taxa. Close inspection of these taxa and subsequent re-sorting of specimens formed the basis for our decisions on the status of these taxa. Ten representative specimens (where available) of these taxa were chosen for detailed analysis of quantitative micromorphological characters. Macromorphological characters (qualitative and quantitative; e.g., leaf length) were scored in all available material. Selection of the ten specimens for study was based on specimen quality in terms of the amount and number of developmental stages displayed.

A DELTA (Dallwitz 1980; Dallwitz *et al.* 1993) list of 395 characters and their states has been created by the authors for the Phyllantheae (Bruhl & Hunter unpublished). This was used to score attributes measured in selected specimens, together with those measured in all available material.

Fresh material was used where possible, but in most instances floral measurements were based on re-hydrated material. Mature leaves only were used for scoring leaf characters.

Terminology: for purposes of consistency across the members of the Phyllantheae, the perianth segments of *Phyllanthus* and *Sauropus* are referred to as sepals. Further developmental investigations need to be carried out to confirm this interpretation (Webster pers. comm. 1993).

Terminology for seed surface characters follows that of Stearn (1992). A bordered hilum is one rimmed by a discoloured and often raised region. This character is most obvious in *Phyllanthus fuernrohrii* F. Muell. (see Hunter & Bruhl 1996, Fig. 1A, C).

There are sometimes differences between the leaves of branches, referred to as 'branch leaves', and those on ultimate branchlets referred to as 'branchlet leaves'. Phyllanthoid branching is indicated by a reduction of the leaf that subtends a branch/branchlet to a scale-like structure, as illustrated by Webster (1970). Branch leaves exhibiting intermediate reduction in size, but still clearly laminate, are referred to as 'reduced'. Care should be taken, where leaves may have fallen, to check for a leaf scar which will always be present.

Citation: type specimens of all relevant names have been seen by one or both of the authors, unless otherwise indicated by *'n.v.'*. Photographs of most of the type specimens examined at BM and K are held at NE, together with photographs taken of type specimens on loan to NE.

Locality statements are direct quotations from labels and are unmodified.

A list of all specimens studied will be deposited at NE. An INTKEY dataset for interactive identification will be made available on completion of our study of the Australian Phyllantheae.

Taxonomy

1. Phyllanthus

1a. Phyllanthus amarus Schum., *Beskrivn. Guin. Pl.*: 421 (1827).

P. niruri var. *amarus* (Schum.) Leandri, *Flore Madagascar* 111: 73 (1958).

Type: 'Guinea', *Schumacher & Thonning s.n.* (holo C, *n.v.*, fide Webster 1970: 69).

Illustration: Webster, *Brittonia* 22: 46, 47 (1970); Wheeler in J.R. Wheeler (ed.), *Flora of the Kimberley Region*: 621, fig. 190A & 623, 191A (1992).

Distribution: *Phyllanthus amarus* is naturalised in Australia, where it has a very sporadic distribution. It occurs more commonly in tropical regions from the Ord River in Western Australia across the north to the Torres Strait Islands, but extends as far south as Sydney (Fig. 1). The species is native to the Americas, but is now a pantropical weed (Webster 1970; Airy Shaw 1980).

Notes: *P. amarus* appears to be restricted to highly disturbed areas within Australia and are often found in lawns and gardens. This species is known to occur in sugar cane crops, but poses no threat to this crop. The earliest known collections of this plant in Australia is from Darwin in 1883 (MEL: *Holtze 291, 374* 'Port Darwin 1883').

1b. Phyllanthus carpentariae Muell. Arg., *Linnaea* 34: 72 (1865).

Type: Northern Territory: 'Tableland ad Sinum Carpentariae', 'Jul 1856 1863', *F. Mueller s.n.* (holo G-DC; ?iso MEL *n.v.*); 'Roper River ex Nat. Herb.' *F. Mueller s.n.* (probable iso BRI (fragment: AQ342649)); 'Tableland, Arnhems Land, Roper River', *F. Mueller s.n.* (probable iso K).

Phyllanthus grandisepalus Muell. Arg., *Linnaea* 34: 72 (1865).

Type: Northern Territory: Fitzmaurice River, Arhemland [as 'Fitzmourice-River'], 1863 *Ferd. Mueller s.n.* (holo G-DC; iso K, ?MEL *n.v.*).

Phyllanthus hebecarpus Benth., *Flora Australiensis* 6: 108 (1873).

Type: Northern Australia: 'Gulf of Carpentaria', *F. Mueller s.n.* (syn K, MEL *n.v.*); 'Burdekin River' *F. Mueller s.n.* (probable syn K, MEL *n.v.*)

Phyllanthus fuernrohrii var. *suffruticosus* Domin, *Beiträge zur Flora Pflanzengeographie Australiens*: 875 (1927) in *Bibliotheca Botanica* 89, 22: 321 (1927).

Type: 'Queensland: Castle Hill bei Townsville', Feb 1910, *Douin s.n.* (probably PR, *n.v.*).

Illustration: James & Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 396 (1990) as *P. hebecarpus*; Dunlop et al.; *Flora of the Darwin Region* 2: 232, fig. 75 (1995) as *P. grandisepalus*.

Distribution: known from Darwin to Groote Eylandt in the Northern Territory, round the Gulf of Carpentaria and south through central and coastal Queensland to Gunnedah in New South Wales. Occurring in a variety of habitats. The palatability of

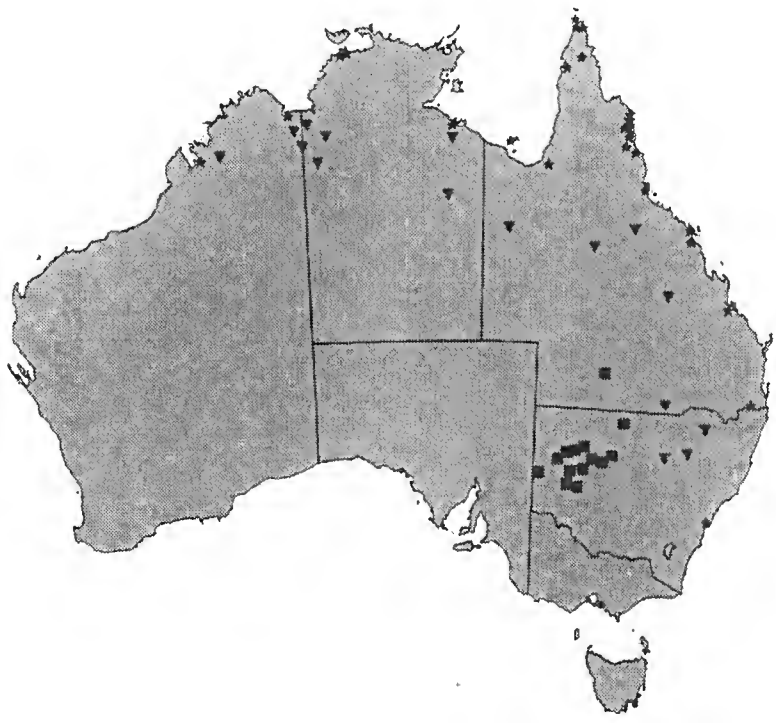

Fig. 1. Distribution of *Phyllanthus amarus* within Australia ⋆, *P. lacerosus* ▼, and *P. involutus* ■.

P. carpentariae is unknown, but L. Bancroft (12 November 1964, AQ 057283 (BRI)) noted that plants were 'Not grazed by cattle.'

Notes: no constantly distinct characters could be found to separate *Phyllanthus grandisepalus*, *P. hebecarpus* or *P. carpentariae*. Therefore, these species have been included within *P. carpentariae*. The main differences within and between populations appears to be the density of indumentum and the length of the trichomes on the leaves and stems.

1c. Phyllanthus gunnii Hook. f., *Hook. Lond. Journ. Bot.* 6: 284 (1847).

Type: [Tasmania], 'Circular Head and George Town': Circular Head, 13 Nov 1837 and 13 Dec 1837, *Gunn s.n.* (syn K, BM); George Town, 29 Jan 1843, *Gunn s.n.* (syn K, BM).

Phyllanthus gasstroemii Muell. Arg., *Linnaea* 32: 17 (1863).

Type: New South Wales: [New South Wales] 'In Nova Hollandia ad Botany-Bay', *Casstroem s.n.* as '*Gasstroem* [sic] in hb. holm' (type unknown, ?UPS).

Illustrations: Cochrane et al., *Flowers and Plants of Victoria*: 102, fig. 298 (1968); Rotherham et al., *Flowers and Plants of New South Wales and Southern Queensland*: 84, fig. 249 (1975) as *P. gasstroemii*; Cunningham et al., *Plants of Western New South Wales*: 460 (1981); Beadle, *Students Flora of North Eastern New South Wales* 3: 308, fig. 143E (1982) as *P. gasstroemii*; Stanley in T.D. Stanley & E.M. Ross, *Flora of South-eastern Queensland* 1: 430, fig. 67H (1983) as *P. gasstroemii*; Fairley & Moore, *Native Plants of the Sydney District*: 100, fig. 276 (1989) as *P. gasstroemii*; James & Harden in G.J. Harden (ed.) *Flora of New South Wales* 1: 397 (1990) as *P. gunnii* and *P. gasstroemii*; Costermans, *Native Trees and Shrubs of South-Eastern Australia*: 209 (1991); Robinson, *Field Guide to the Native Plants of Sydney*: 168 (1991); Howell et al., *Riverside Plants of the Hawkesbury–Nepean*: 51 (1995).

Notes: *Phyllanthus gasstroemii* is treated here as within the variability of *P. gunnii*. *Phyllanthus gasstroemii* has been distinguished from *P. gunnii* on the basis of minor differences in leaf shape, the number of flowers per axillary inflorescence, and the extent of fusion of the staminal filaments in the male flowers (see Bentham 1873; James & Harden 1990). Leaf shape is variable in both entities, and their states largely overlap. The number of flowers per inflorescence is also highly variable and does not help to distinguish these two species. The character most commonly used to separate the species in keys, the extent of staminal filament fusion, is not constant for the species. The type specimen of *P. gunnii* exhibits all states from free to completely fused filaments. Further, both occur in similar habitats.

In general, the northern populations of this taxon have been most commonly called *P. gasstroemii* and the southern populations *P. gunnii*. No attributes were found during this study that supported the recognition of *P. gasstroemii* as distinct from *P. gunnii*. A detailed population study of this complex is warranted, meanwhile we include *P. gasstroemii* within *P. gunnii*.

Phyllanthus saxosus F. Muell., while predominantly a South Australian species, merits discussion here. This species, described in 1853, was ten years later reduced to varietal status as *P. gunnii* var. *saxosus* (F. Muell.) Muell.Arg. Although there are only a few attributes that separate *P. saxosus* from *P. gunnii*, these provide stable and distinct differences supporting the former's recognition at the rank of species. Plants of *P. saxosus* are dioecious, have papillate leaves (Weber 1986), and are restricted to South Australia. Plants of *P. gunnii* are monoecious, have epapillate leaves (see also Weber 1986; James & Harden 1990), and occur in eastern Australia (Figure 4).

1d. Phyllanthus hirtellus F. Muell. ex Muell. Arg., *Linnaea* 32: 22 (1863).

P. hirtellus var. *hirtellus* Muell. Arg., *Linnaea* 32: 22 (1863). *P. thymoides* var. *hirtellus* (Muell. Arg.) Muell. Arg. in DC., *Prodomus* 15(2): 372 (1866).

Type: [Australia], 'In Nova-Hollandia' *F. Mueller s.n.* (syn G-DC), *Mitchell s.n.* (syn 'hb. berol.' *n.v.*) .

Phyllanthus hirtellus var. *ledifolius* Muell. Arg., *Linnaea* 32: 22 (1863).

Phyllanthus thymoides var. *ledifolius* (Muell. Arg.) Muell. Arg. in DC., *Prodromus* 15(2): 372 (1866).

Type: 'N.S. Wales', 1836, *A. Cunningham 115*,. (holo G-DC).

Phyllanthus hirtellus var. *thymoides* Muell. Arg., *Linnaea* 32: 22 (1863).

Phyllanthus thymoides (Muell. Arg.) Muell. Arg. in DC., *Prodromus* 15(2): 372 (1866).

Type: [New South Wales], 'Ad Port-Jackson', 1825, *Sieber 264* (syn G-DC, K, MEL); 'Gaudich.' (syn probably G-DC *n.v.*); 'Cunningh.' (syn probably G-DC *n.v.*).

Phyllanthus thymoides var. *glabratus* Muell. Arg. in DC., *Prodromus* 15(2): (1866: 372); Benth., *Flora Australiensis* 6: 109 (1873) as 'glabrata'.

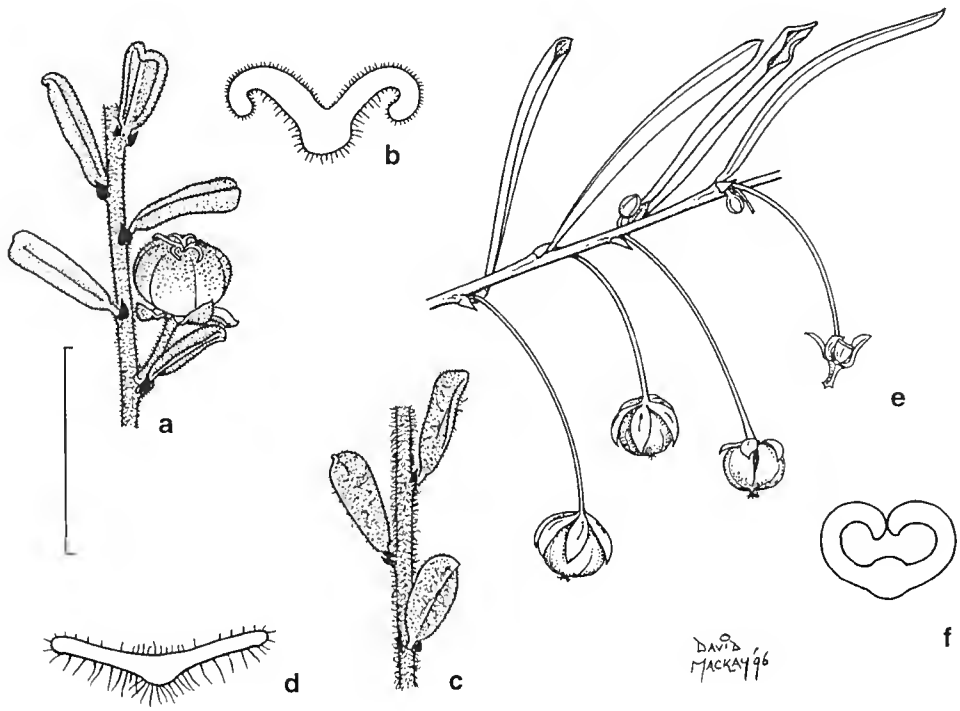

Fig. 2. a & b: *Phyllanthus occidentalis*. **a**, habit; **b**, mid-leaf trans-section; c & d: *P. hirtellus*. c, habit; **d**, mid-leaf trans-section; e & f: *P. involutus*. **e**, habit; **f**, mid-leaf trans-section. a & b from *Norris 852 & Thomas* (NSW); c & d from *Phillips 369* (CBG); e & f from *Wasson s.n.* (NSW 248780). Scale bar: a, c & e = 1 cm; b, d & f = 2 mm.

Type: [New South Wales], Twofold Bay [as 'Tevofold-Bay' in the *Prodromus*], 1863, *F. Mueller s.n.*, (holo G-DC; probable iso K, MEL, two sheets, one with 'Sep').

Phyllanthus thymoides var. *parviflorus* J. M. Black, *Flora of South Australia* 2: 352 (1924); *Phyllanthus hirtellus* var. *parviflorus* (J. M. Black) H. Eichler, *Supplement to J.M. Black's Flora of South Australia*, edn 2, 209 (1965).

Type citation: 'Near Wolseley. – Victoria; New South Wales'.

Type: Tatiara, *J.T. Woods s.n.* (fragment AD, 'Nat. Herb. Vict.' (AD 98438075))

Illustrations: Rotherham et al., *Flowers and Plants of New South Wales and Southern Queensland*: 73, fig. 209 (1975) red flowered form, as *P. thymoides*; Fairley & Moore, *Native Plants of the Sydney District*: 100, fig. 277 (1989) as *P. thymoides*; James & Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 396 (1990) as *P. hirtellus* forma A; Robinson, *Field Guide to the Native Plants of Sydney*: 168, Fig. 4c-d (1991).

Distribution: *Phyllanthus hirtellus* occurs in mainland south eastern Australia generally on and east of the Great Divide, from Lismore on the north coast of New South Wales to the Grampians in Victoria (Fig. 3). Minor extensions of distribution into the Central Western Slopes district of New South Wales also occur.

Notes: Mueller Argoviensis cited three specimens in the *Prodromus* for *P. thymoides* var. *hirtellus* one, 'interiore Novae-Hollandiae (Mitchell! in hb. berol.)', is a syntype for the earlier name *Phyllanthus hirtellus* Muell. Arg. The other two specimens are considered to have no type status. These are G-DC specimens labelled as follows: 'Nov. Holland. meridonal. Mount Hunter. Plantae Muellerianae' and 'Macallister River. F. Muell. 1863'. We have seen a further three MEL sheets that are probably duplicates of the latter specimens, viz. MEL 1594841: 'Mount Hunter Wilsons promontory' and 'Wilsons

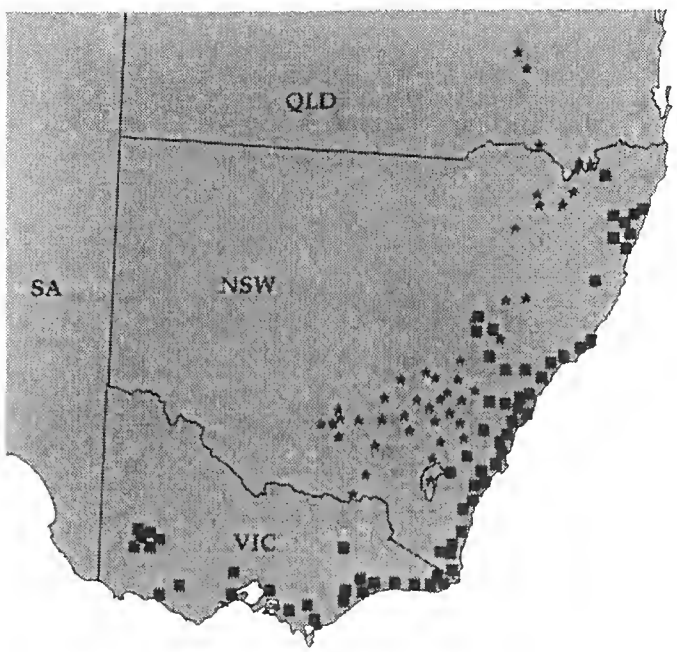

Fig. 3. Distribution of *Phyltanthus hirtellus* ■ and *P. occidentalis* ⋆.

promontory'; MEL 1594850: ' ... Mountain Hunter. 11 May '53'; MEL 1594838: 'Mountains on the M'Allister River'.

We interpret Bentham's (1873) name *Phyllanthus thymoides* var. 'glabrata' as an orthographic variant of *P. thymoides* var. *glabratus* Muell. Arg. (see above). Bentham (1873) cited two specimens, one is a syntype of this variety (viz.: Twofold Bay, *F. Mueller s.n.*), and the other specimen is a topotype (Twofold Bay, *Mossman s.n., n.v.*), but not a syntype.

Some flora treatments (Moore & Betche 1893; Beadle 1976; Stanley 1983) have used the incorrect name *P. thymoides* instead of *P. hirtellus* var. *thymoides*.

We have not detected morphological variants within *P. hirtellus* that are worthy of recognition.

Phyllanthus hirtellus is known from wet sclerophyll forest, swamp sclerophyll forest, dry sclerophyll forest, grassy woodland, dry sclerophyll woodland and coastal and montane heath at altitudes up to 1,100 m. The most northern near-coastal populations at Lismore approach morphologically, but are distinct from, an undescribed Queensland species (Hunter and Bruhl in prep.) that has longer leaves and antrorse indumentum. *P. hirtellus* is morphologically most similar to *P. occidentalis* J.T. Hunter & J.J. Bruhl (Table 1).

A form of *P. hirtellus* with red male flowers occurs in a band across northern Sydney from Wollemi and the lower Blue Mountains in the north and west to the Hawkesbury area in the north-east.

1e. Phyllanthus involutus *J.T. Hunter & J.J. Bruhl*, **sp. nov.**

A congeneribus foliis involutis et *P. exili* S. Moore affini foliis majoribus et fructibus laevibus non tuberculatis differt.

Type: New South Wales: Belaraboon Range, c. 100 km SW of Cobar, *Wasson NSW 248780*, 1971 (holo NSW).

Phyllanthus sp., Cunningham et al., *Plants of Western New South Wales*: 463 (1981). *Phyllanthus* sp. B, Jacobs & Pickard, *Plants of New South Wales*: 117 (1981); James & Harden in G.J. Harden, *Flora of New South Wales* 1: 398 (1990).

[*Phyllanthus subcreenulatus* auct. non F. Muell., A. Morris, *Plantlife of the West Darling*: 70 (1966)]

Illustration: Cunningham et al., *Plants of Western New South Wales*: 464 (1981) as 'hill spurge'; James & Harden in G.J. Harden, *Flora of New South Wales* 1: 398 (1990) as *Phyllanthus* sp. B.

Monoecious perennial shrub, 0.4–1 m tall. *Branchlets* persistent, rounded, 7–20 cm long, 0.4–0.7 mm wide, glabrous. *Stipules* persistent, free, triangular, 1.2–2.6 mm long, cream to red-brown; bases truncate to cordate; apices acuminate to acute, chartaceous, entire or dentate, glabrous. *Leaves* alternate, distichous, brown when dry or remaining green; *petioles* 0.5–1.3 mm long, 0.2–0.6 mm wide, glabrous; *laminae* concave, linear to lanceolate or almost terete, 11.4–26.8 mm long, 0.6–3.8 mm wide, light-green in colour, sub-coriaceous, obscurely pinnately veined, glabrous; bases symmetrical, rounded, obtuse to cuneate; apices erect, acuminate to obtuse, mucronate; margins involute. *Inflorescences* at least sometimes with the sexes mixed, axillary, sessile. *Bracts and bracteoles* present, deciduous. *Male flowers* solitary; pedicels 0.4–2 mm long, glabrous; sepals free, 6, ovate, 0.8–2.1 mm long, 0.1–1.6 mm wide, white to yellow-brown in colour, obtuse to acute, sometimes mucronate, entire, membranous to chartaceous, glabrous; disk of 6 discrete discs, 0.6–1.1 mm wide; stamens 3, 1-whorled,

symmetrical, erect; filaments connate from much more than half their length to fully connate, erect, terete, 0.2–0.5 mm long; anthers extrorse, erect, oblong, 0.3–0.5 mm long; locules parallel. *Female flowers* one in each axil, with one male flower when mature; pedicels at anthesis 3–7 mm long, 0.1–0.3 mm wide, in fruit 3.5–11.1 mm long, glabrous; sepals free, 6, ovate, 1.3–3 mm long, 0.7–1.5 mm wide, white to yellow-brown in colour, with a distinct white margin, obtuse to acute, coriaceous, glabrous, midrib raised; disk lobes crenate, 0.7–1.4 mm wide; styles 3, free, divided for half their length or less, erect to divergent, pink to red in colour, narrow-terete, 0.4–0.8 mm long, 0.1–0.3 mm wide, glabrous, with branches entire or rarely bifid, linear; ovary 0.5–1.2 mm long, 0.7–1.8 mm wide, transversely ellipsoid, apically depressed, smooth, glabrous. *Fruit* a capsule, septicidal, transversely ellipsoid, apically depressed, 2–3 mm long, 3.2–4.6 mm wide, yellow-brown to green in colour, cartilaginous, smooth and glabrous; column persistent, 0.9–1.5 mm long. *Seeds* yellow or black with age, lenticular to prismatic, laterally compressed, 1.8–2.2 mm long, 1.3–1.5 mm wide, smooth; hilum markedly depressed, sometimes slightly discoloured around the margin, ovate, with cavity basal and sometimes displaced. Flowering: March to December. Fruiting: March to December. Fig. 2e, f.

Selected specimens: Queensland: Warrego District: On rock near Globe Mine, *Morris s.n.*, Sep 1919 (AD).

New South Wales: Far North Western Plains: Broken Hill, *Morris s.n.*, Aug 1921 (AD); 'Tongo', Paroo River, West Darling, *Hitchcock s.n.*, 1970 (NSW); 23 km N of Barrier Highway on Tilpa Rd, *Cunningham and Milthorpe 961*, Aug 1973 (NSW); North Western Plains: 3 km N. Ledknapper Crossing [to] Nulty Springs, *Cunningham and Milthorpe 4158*, 20 Nov 1975 (NSW); Mt. Grenfell, c. 40 km NW of Cobar, *Cunningham and Milthorpe 930*, 13 Aug 1973 (NSW). South Far Western Plains: Mt Manara, SH21–38 miles N of Ivanhoe, *Whaite & Whaite 2098*, 10 Nov 1956 (NSW); Mt Manara, *Henshall s.n.*, 19 Nov 1972 (NSW).

Distribution: this species has an infrequent and scattered occurrence in the Western and Far Western Plains of New South Wales from Cobar to Broken Hill, with two collections from south-western Queensland (Fig. 1).

Notes: *Phyllanthus involutus* is known to occur in mallee, grassy woodland and temperate and tussock grasslands on sandstone and quartzite ridges and hills amongst rocks and along intermittently flowing creeks. Many collections by Albert Morris (e.g., Aug 1921, *Morris s.n.* (AD96824222); Sep 1919, *Morris s.n.* (AD98663187)) have been mis-labelled as *P. subcremulatus* F. Muell. Very few collections of *P. involutus* are available in herbaria, although apparently it is common where it is found growing. This species should be considered rare, especially in Queensland where only two collections are known. We suggest an initial conservation coding of 3RC-QN (Briggs & Leigh 1996).

1f. Phyllanthus lacerosus Airy Shaw, *Kew Bull.* 35: 386 (1980).

Type: Northern Territory: Negri-Stirling area, 17°10' S, 129°15' E, black clay plain, *Dunlop 3567*, 3 May 1974 (holo K; iso DNA *n.v.*, NSW).

[*Phyllanthus maderaspatanus* [sic] var. *angustifolius* auct. non Benth.; Forster & Henderson (1994: 115) *p.p.*.]

[*Phyllanthus maderaspatensis* auct. non L.; Dunlop et al., *Flora of the Darwin Region* 2: 231 (1995), *p.p.*]

Phyllanthus sp. A, James & Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 397 (1990).

Phyllanthus sp. A, Wheeler in J.R. Wheeler, *Flora of the Kimberley Region*: 623 (1992).

Illustrations: James and Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 397 (1990); Wheeler in J.R. Wheeler, *Flora of the Kimberley Region*: 621, fig. 190H, 623 fig. 191H (1992), both as *P.* sp. A.

Distribution: The distribution of *P. lacerosus* is extensive but sporadic. It is known from the Kimberley in Western Australia through the Northern Territory and central Queensland to as far south as Narrabri on the North Western Slopes of New South Wales (Figure 1). *Phyllanthus lacerosus* occurs in tropical or temperate grasslands, apparently exclusively on black cracking-clay soils.

Notes: Airy Shaw (1980) published a valid name for this species; however, it apparently has not been used in Australia except for a few specimens annotated by him as such. Both James and Harden (1990) and Wheeler (1992) referred to this species as *Phyllanthus* sp. A.

Phyllanthus lacerosus is endemic to Australia though Wheeler (1992) suggested that it may be an introduced weed as it was found in irrigation fields of Kununurra. This species may be mistaken for *P. maderaspatensis*, but can be distinguished from that by the free not fused staminal filaments, deeply divided not barely notched styles and striate not colliculose seeds. In most herbaria, collections of *P. lacerosus* have been identified as *P. maderaspatensis*, usually as *P. maderaspatanus* var. *augustifolius*. Authors in some Floras (e.g. Dunlop et al. 1995) have widened the circumscription of *P. maderaspatensis* to include the morphological variation that we recognise as *P. lacerosus*.

A specimen from Leichhardt District (Capella, *B. Smith s.n.* (BRI, AD 440662)) is labelled: 'Weed resistant to 2,4-D.'

1g. Phyllanthus maderaspatensis L., *Sp. Pl.* 982 (1753).

Notes: Bentham (1873), Ewart & Davies (1917) and James and Harden (1990) have all used the incorrect spelling *P. maderaspatanus* for the name of this species.

1h. Phyllanthus oblanceolatus J.T. Hunter & J.J. Bruhl, *J. Adel. Bot. Gard.* 17: 127–136 (1996).

Notes: This recently described species has its main distribution within South Australia and the Northern Territory. Collections from within New South Wales have come from near Cobar and the Barrier Range. A full description of this species is given elsewhere by Hunter and Bruhl (1996).

1i. Phyllanthus occidentalis *J.T. Hunter & J.J. Bruhl*, **sp. nov.**

Similis *P. hirtello* F. Muell. ex Muell. Arg., a qua foliis hirtioribus marginibus recurvatis vel revolutis non complanatis plerumque angustioribus (0.5–3.4 non 1.8–6.6 mm latis) differt.

Types: New South Wales: South Western Plains: Mt Bunganbil, NE of Griffith, *Norris & Thomas 852*, Mar 1987 (male specimen) (holo NSW).

Phyllanthus hirtellus Muell. Arg. forma B; James & Harden in G.J. Harden (ed.) *Flora of New South Wales* 1: 396 (1990).

[*Phyllanthus thymoides* auct. non (Muell. Arg.) Muell. Arg.; Stanley in T.D. Stanley & E.M. Ross, *Flora of South-eastern Queensland* 1: 428 (1983); Forster & Henderson, *Queensland Vascular Plants: Names & Distribution* 116 (1993); McDonald et al., *The Flora of Girraween and Bald Rock National Parks*: 78 (1995), *p.p.*]

Illustrations: Cunningham et al., *Plants of Western New South Wales*: 463 (1981) as Thyme Spurge; James & Harden in G.J. Harden (ed.) *Flora of New South Wales* 1: 396 (1990) as *P. hirtellus* forma B.

Dioecious perennial compact shrub 0.2–1 m tall. *Branchlets* rounded, 6–21.5 cm long, 0.5–1.1 mm wide, scabrous, puberulous to pilose. *Stipules* persistent, free, ovate to depressed-ovate, 0.5–1.6 mm long, red to black, scabrous to puberulous; bases rounded to obtuse or cordate; apices acuminate to acute; margins entire. *Leaves* alternate, distichous; *petioles* 0.3–1 mm long, 0.2–0.6 mm wide, indumented; *laminae* convex, elliptical, oblong, obovate to oblanceolate, 4–8.5 mm long, 0.5–3.4 mm wide, mid-green, paler below or with both sides of equal intensity, obscurely veined, puberulous to pubescent and sometimes with scattered pilose hairs or rarely densely scabrous, indumentum seemingly longer and denser on abaxial surface; bases rounded to obtuse; apices erect, acuminate to acute or obtuse to obcordate, often with the tip down-turned, mucronate; margins recurved to strongly revolute and thickened. *Bracts and bracteoles* deciduous, indumented. *Inflorescences* axillary, sessile. *Male flowers* 1–4 per cluster; pedicels 0.7–2.8 mm long, indumented; sepals 6, elliptical, ovate, trullate or obtrullate, obtuse to acute, 0.9–2.4 mm long, 0.7–2.2 mm wide, white to yellow in colour, chartaceous, abaxially (rarely adaxially) puberulous, pubescent or pilose; disk comprising 6 discrete lobes, 0.9–2.1 mm wide; stamens 3, erect to declinate; filaments variously connate, erect, terete, 0.5–1.5 mm long in total; anthers extrorse, ascending to divaricate, oblong, elliptical or circular in outline, 0.3–0.6 mm long, locules parallel to divergent. *Female flowers* 1 or 2 per cluster; pedicels at anthesis 0.7–2.2 mm long, 0.2–0.5 mm wide, in fruit 1.8–3.5 mm long, 0.2–0.5 mm, indumented; sepals free, 6, circular, ovate, trullate or hastate, 0.7–2.3 mm long, 0.6–2 mm wide, white to yellow or green in colour, obtuse to acute, coriaceous, abaxially and more rarely adaxially puberulous, pubescent or pilose; disk lobes crenate, 1.1–2.5 mm wide; styles 3, free, variously divided, ascending to divergent, narrow-terete but often with the base swollen, sometimes pilose on the swollen base, 0.3–1.6 mm long, 0.1–0.4 mm wide, branches entire, linear; ovary transversely ellipsoid and apically depressed, 0.5–1.2 mm long, 0.7–1.7 mm wide, smooth, pubescent. *Fruit* a capsule, septicidal, explosive, transversely ellipsoid, apically depressed, 1.5–2.4 mm long, 2.5–4.2 mm wide, yellow-brown to grey in colour, cartilaginous, smooth, puberulous to pubescent, grooved septicidally; column persistent, narrow oblong, 0.9–1.7 mm long. *Seeds* prismatic, laterally compressed, 1.4–2.2 mm long, 0.9–1.8 mm wide, smooth or scalariform, red-brown, purple to black; hilum circular and elliptic, slightly depressed and sometimes with the border lighter in colour, with cavity basal. Flowering: All year. Fruiting: September to March. Fig. 2a, b.

Selected specimens: Queensland: Darling Downs District: Barakula State Forest, *Williams 84169*, 3 Oct 1984 (BRI).

New South Wales: Central Tablelands: Orange District, *Madsen s.n.* , Nov 1949 (NSW). Southern Tablelands: Queanbeyan, *Burgess s.n.*, 13 Oct 1962 (CBG); Black Mtn near dam on south east slope, *Hain 72*, 26 Sep 1975 (CBG). North Western Slopes: 2 km W of Goolgowi–Rankin Springs Rd, *Mulham 1185*, 1 Sep 1977 (NSW). Central Western Slopes: Harvey Ranges, Peak Hill, *Boorman s.n.*, Nov 1905 (NSW); Weddin Range, 16 km north of Bimbi, Grenfell, *Sikkes AS513*, 1 Nov 1973 (CBG). South Western Plains: Mt Bunganbil, north-east of Griffith, *Norris & Thomas 852*, 1 Oct 1978 (NSW: female branch in type folder); near Griffith, Cocoparra National Park, north face of Mt Caley, *Butler 749*, 17 May 1989 (CBG); Cocoparra Range, north of Yenda, *Bates 18303* (AD).

Distribution: *Phyllanthus occidentalis* is widespread and abundant on the western side of the Great Divide. It is known from the Western Slopes and the western edge of the Tablelands in New South Wales, and the Darling Downs District of Queensland (Fig. 3).

Notes: the holotype is the male specimen tagged 'Holotype of *Phyllanthus occidentalis* J.T. Hunter & J.J. Bruhl'. There are two further branches loose on the sheet (one male and one female) and considerable fragmentary material.

This species is known from a variety of habitats such as dry sclerophyll forest and woodland, arid shrubland and heath, at altitudes of 290–1150 m. This species has almost exclusively been labelled as *P. thymoides*, an incorrect name for *P. hirtellus sensu stricto*, (see above). *Phyllanthus occidentalis* is similar to *P. hirtellus*, in which it has been included by, for example, James and Harden (1990). The diagnostic features of *P. occidentalis* are very stable; however, around Black Mountain in the A.C.T. and the Coonabarabran area of New South Wales, some plants have a form that approaches that of *P. hirtellus*, i.e. possessing wider, less revolute leaves and less dense indumentum.

1j. Phyllanthus microcladus Muell. Arg., *Linnaea* 34: 71 (1865).

Phyllanthus microcladus var. *pubernlus* Muell. Arg., *Linnaea* 34: 71 (1865).

Type: In Nova Hollandia orientali ad Clarence River, *Beckler s.n.* (holo G-DC; probable iso MEL *n.v.*).

Sauropus albiflorus subsp. *microcladus* (Muell. Arg.) Airy Shaw, *Kew Bulletin* 35: 672 (1980).

Phyllanthus microcladus var. *microphyllus* Muell. Arg., *Linnaea* 34: 72 (1865).

Type: In Nova Hollandia orientali ad Moreton-Bay, 1863, *F. Mueller s.n.* (holo G-DC; probable iso MEL *n.v.*).

Phyllanthus pusillifolius S. Moore, *J. Linn. Soc. Bot.* 45: 216 (1920)

Type: Queensland, Broad Sound, *R. Brown [distribution no.] 3601* (BM, fragment of BM specimen: BRI, K).

Table 1: Comparison of selected characters of *Phyllanthus hirtellus* and *P. occidentalis* (measurements in mm).

	Phyllanthus hirtellus	*Phyllanthus occidentalis*
Lamina margins	usually flat, or recurved	usually revolute, or strongly recurved
Lamina width	1.8–6.6	0.5–3.4
Lamina indumentum	scabrous to hirsute	puberulous to pubescent
Male pedicel length	0.6–1.8	0.7–2.8
Female sepal length	1.1–3.5	0.7–2.3
Female sepals	glabrous to hirsute	puberulous, pubescent or pilose
Filaments	connate basally	variously connate
Seed colour	yellow- to pallid brown or black	red-brown to purple
Habit	weakly erect	dense and compact

Phyllanthus sp. 1, Stanley in T.D. Stanley & E.M. Ross, *Flora of South-eastern Queensland* 1: 429 (1983).

[*Sauropus albiflorus* auct. non (Muell. Arg.) Airy Shaw; Henderson & Forster, *Queensland Vascular Plants: Names and Distribution* 116 (1993), *p.p.*]

Illustrations: Stanley in T.D. Stanley & E.M. Ross, *Flora of South-eastern Queensland* 1: 430, fig. 67O (1983); Williams et al., *Trees and Shrubs in Rainforests of New South Wales and Southern Queensland*: 99 (1984) as *Sauropus albiflorus* subsp. *microcladus*; James & Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 399 (1990) as *S. albiflorus* subsp. *microcladus*; Hauser, *Fragments of Green*: 158 (1992).

Distribution: *Phyllanthus microcladus* is known from two widely disjunct populations. The main population occurs on the coast and hinterland of south eastern Queensland and the north eastern coast of New South Wales. The second location is near Cairns in north Queensland. This species occurs mainly in rocky places along creek and river banks in rainforest.

Notes: when describing *Phyllanthus microcladus* and its two varieties, Mueller Argoviensis (see above) did not cite any specimens under the base name. Both varieties conform to the description of this morphologically variable species. Variety *puberulus* describes the common form of this species and we here select it over var. *microphyllus* in order to allocate a type to the species.

1k. Phyllanthus tenellus Roxb., *Fl. Indica* 3: 668 (1832).

Type citation: [India:] 'Introduced from Mauritius in 1802'.

Type: India: Botanic Gardens, Calcutta, *Wallich 7892A p.p.* (holo K *n.v.*, NSW microfiche).

Phyllanthus brisbanicus F.M. Bailey, *Queensland Flora* 5: 1418 (1902).

Type: Brisbane, *Bailey* (holo BRI; iso K).

Illustrations: Bailey, *The Weeds and Suspected Poisonous Plants of Queensland*: 178, fig. 316 (1906) as *P. brisbanicus*; Bailey, *Comprehensive Catalogue of Queensland Plants*: 475, fig. 463 (1909) as *P. brisbanicus*; Webster, *Brittonia* 22: 45, fig. 1 & 2, 46, fig. 5 & 6 and 47, fig. 18 (1970); Stanley in T.D. Stanley & E.M. Ross, *Flora of South-eastern Queensland* 1: 430, fig. 67J (1983); James & Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 398 (1990); Kleinschmidt, *Suburban Weeds*, edn 2, 32 (1991).

Notes: the description of *P. tenellus* given by James and Harden (1990) requires minor amendment. The stamen number given by them is five; however, the species commonly varies between four and six. Western Australia and the Northern Tablelands of New South Wales should be added to the recorded distribution of this species. For illustrations and further synonomy, see Webster (1970).

Key to New South Wales species of *Phyllanthus*

1 Branch leaves mostly scale-like (i.e. with phyllanthoid branching, though plants of *P. lacunarius* may have about half their branch leaves with well developed laminas).

2 Sepals 5, or if 6 then stamens 4–6

3 Branchlets flattened; stamens 3, filaments connate; female flowers solitary; styles notched; seeds striate ..... **P. amarus**

3* Branchlets rounded; stamens 4–6, filaments free; female flowers 1–5; styles divided for half or more of their length; seeds granulate ..... **P. tenellus**

2* Sepals 6 and stamens 3

4 Herbs to 0.3 m tall; stipules cream to yellow-brown; male sepals red; female pedicels at anthesis 0.2–1 mm long, in fruit 1–3 mm long; seeds striate ..... **P. lacunarius**

4* Shrubs to 3 m tall; stipules red-brown; male sepals white, yellow or green; female pedicels at anthesis 1.4–15 mm long, in fruit 2.2–18 mm long; seeds smooth, not striate

5 Branchlets rounded, not ribbed, papillate; lamina concave, with thickened margins; male sepals papillate; female pedicels 5–18 mm long; fruit 2.3–2.5 mm long ..... **P. microcladus**

5* Branchlets angular to flattened, ribbed, smooth; lamina convex to flat, with margins not thickened; male sepals smooth; female pedicels 2.2–5 mm long; fruit 1.8–2.2 mm long ..... **P. similis**

1* Branch leaves laminate or reduced in size (i.e., with sub-phyllanthoid branching)

6 Plants monoecious; stipules 0.3–1.6 mm long, red to black; leaves 3–11 mm long

7 Leaves usually flat or with recurved margins, 1.8–6.6 mm wide, with long scattered hairs mainly on the margins and midvein; weak shrubs. Mainly coastal and eastern parts of the Tablelands ..... **P. hirtellus**

7* Leaves usually revolute or strongly recurved, 0.5–3.5 mm wide, with a dense covering of short hairs; dense compact shrub. Mainly western side of the Tablelands and on the Western Slope ..... **P. occidentalis**

6* Plants dioecious; stipules 0.5–4.1 mm long, cream, red-brown, yellow brown or red; leaves 4.2–57.8 mm long

8 Seeds distinctly granulate to tuberculate

9 Leaves 13.5–32.7 mm long, margins not thickened, veins prominulous; female sepals in fruit 0.9–2 mm wide; filaments connate; styles notched ..... **P. maderaspatensis**

9* Leaves 4.2–19.5 mm long, margins thickened, veins not prominulous; female sepals in fruit 0.3–0.7 mm wide; filaments free; styles divided for half or more of their length ..... **P. virgatus**

8* Seeds rugose, striate or smooth

10 Plants densely hairy or at least glabrescent

11 Branchlets rounded in cross-section; stipules 0.5–1.7 mm long; male flowers 1–3 per axil; male sepals pubescent; male pedicels 0.2–2 mm long; female sepals in fruit 1.6–5.5 mm long, 1–5.3 mm wide, enlarging and enclosing fruit; hilum not distinctly bordered ..... **P. carpentariae**

11* Branchlets elliptic to rounded in cross-section; stipules 0.8–3.2 mm long; male flowers 1–7 per axil; male sepals glabrous to papillose; male pedicels 1.5–5.5 mm long; female sepals 1.1–3.6 mm long, in fruit 1–2.6 mm wide; not enlarging and enclosing fruit; hilum distinctly bordered ..... **P. fuernrohrii**

10* Plants glabrous, rarely scabrous to papillose

12 Branchlets ribbed

13 Branchlets rounded in cross-section; stipules 0.6–1.4 mm long; leaves 5.5–18 mm long, with apex obcordate to emarginate; male pedicels 0.3–1 mm long; female pedicels in fruit 0.8–1.7 mm long; seeds with extra-hilar depression ..... **P. lacunellus**

13* Branchlets angular to flattened in cross-section; stipules 1.1–5.2 mm long; leaves 6.6–57.8 mm long, apex acuminate to acute; male pedicels 1.2–6.3 mm long; female pedicels in fruit 1–7.8 mm long; seeds without extra-hilar depression

14 Stipules cream to yellow-brown, with bases truncate to obtuse; lamina veins prominulous, lamina margins smooth; female pedicels at anthesis 0.3–1.3 mm long; fruit 1.1–2.1 mm long; column 0.3–0.8 mm long; seeds 0.8–1.7 mm long ..... **P. lacerosus**

14* Stipules red-brown, with bases cordate; lamina veins not prominulous, lamina margins distinctly papillate; female pedicels at anthesis 1.5–4.5 mm long; fruit 2.8–3.4 mm long; column 1.9–4.2 mm long; seeds 2–2.7 mm long ..... **P. subcrenulatus**

12* Branchlets not ribbed.

15 Branchlets rounded in cross-section; leaves linear to lanceolate and distinctly involute, 0.6–3.8 mm wide; male pedicels 0.4–2 mm long ..... **P. involutus**

15* Branchlets flattened, ellipsoid or rounded in cross-section; leaves elliptic, circular, obovate or oblanceolate, flat, 2.6–20 mm wide; male pedicels 0.8–6 mm long

16 Shrub to 2.5 m tall; stipule apices obtuse to rounded; styles undivided; hilum not markedly depressed or bordered ..... **P. gunnii**

16* Low shrub or herb to 0.4 m tall; stipule apices acute to acuminate; styles variously divided; hilum markedly depressed and bordered ..... **P. oblanceolatus**

2. Sauropus

2a. Sauropus rigens (F. Muell.) Airy Shaw, *Kew Bull.* 35: 683 (1980).

Synostemon rigens F. Muell., *Fragm.* 2: 153 (1858). *Phyllanthus rigens* (F. Muell.) Muell. Arg., *Flora* 47: 513 (1864). *Glochidion rigens* (F. Muell.) H. Eichler, *Suppl. Black's Flora S. Austral.*, edn 2, 210 (1965).

Type: N.S.W., Ad flumen Bogan, *Bowman s.n.* (MEL *n.v.*); In tractu Mutanic [as 'Mutanie' in F. Muell., *Fragm.*] Range, 3 Jan 1861, *Beckler;* (syn G-DC, MEL: MEL 226732, MEL 226198).

Heterocalymmantha minutifolia Domin, *Biblioth. Bot.* 22: 313 (1927).

Type: Sandsteinhuegel der Dividing Range bei Jericho, Mar 1910, *Domin s.n.* (PR *n.v.*)

Illustrations: Airy Shaw in J.P. Jessop (ed.), *Flora of Central Australia*: 193, fig. 219 (1980); Cunningham et al., *Plants of Western New South Wales*: 462 (1981) as 'Stiff

Spurge'; Weber in J.P. Jessop & H.R. Toelken, *Flora of South Australia* 2: 767, fig. 411B (1986); James & Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 399 (1990).

Distribution: this species has a sporadic distribution across inland Australia. It is most commonly found on the foot hills and peaks of the Northern Flinders Ranges of South Australia. It is also known from Tempe Downs in the Northern Territory, Longreach and the Grey Range in Queensland, and Mootwingee and Nyngan, New South Wales. *Sauropus rigens* does not occur in Western Australia as recorded by James and Harden (1990).

Notes: *Sauropus rigens* is known from arid shrubland and *Triodia* grasslands on rocky slopes of hills and gorges. Some distinct geographical variation is noted and is probably due to populations being so disjunct. The Nyngan population is entirely glabrous. All other populations are hairy. Specimens from populations near Longreach possess longer than usual pedicels in both male and female flowers.

2b. Sauropus hirtellus (F. Muell.) Airy Shaw, *Kew Bull.* 35: 677 (1980).

Synostemon hirtellus F. Muell., *Fragm.* 3: 89 (1862); *Phyllanthus hirtellus* (F. Muell.) Muell. Arg. in DC., *Prodr.* 15: 326 (1866), nom. illeg. non Muell. Arg. (1863); *Glochidion hirtellum* (F. Muell.) H. Eichler, *Suppl. Black's Flora S. Austral.*, edn 2, 210 (1965).

Type: In Nova Hollandia orientali tropica prope, [Queensland], Walloon, *Bowman* (syn MEL, K).

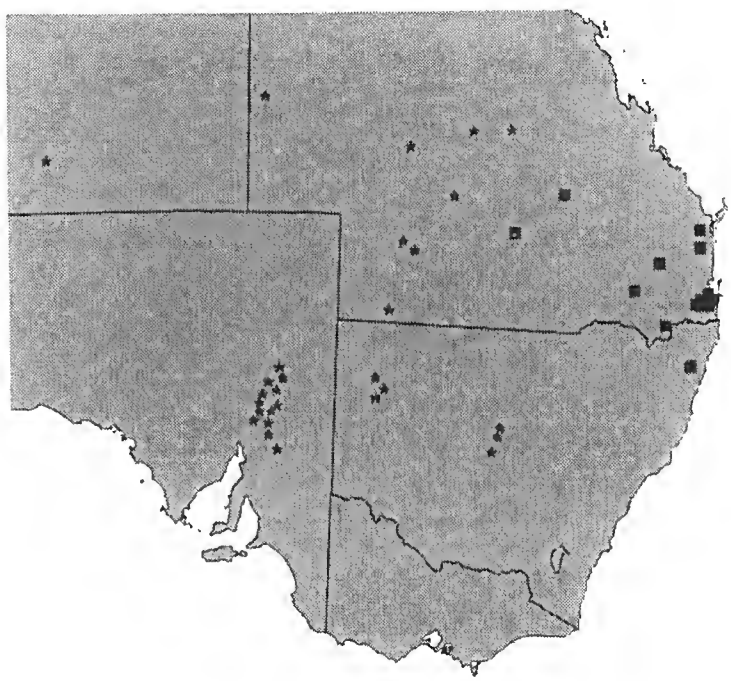

Fig. 4. Distribution of *Sauropus hirtellus* ■ and *S. rigens* ⋆.

Phyllanthus thesioides Benth., *Fl. Austr.* 6: 98 (1873), nom. illeg. non Muell. Arg.; *Glochidion thesioides* H. Eichler, *Suppl. Black's Flora S. Austral.*, edn 2, 210 (1965); *Sauropus thesioides* (H. Eichler) Airy Shaw, *Kew Bull.* 35: 684 (1980).

Type: Queensland: near Brisbane, *C. Prentice* (syn BRI, K).

Illustrations: Stanley in T.D. Stanley & E.M. Ross, *Flora of South-eastern Queensland* 1: 430, fig. 67A & N (1983); James & Harden in G.J. Harden (ed.), *Flora of New South Wales* 1: 400 (1990).

Distribution: this species has a very restricted distribution, primarily in south-eastern Queensland, from Emerald to Maryborough and south to Mitchell, Warwick and Coolangatta. One record is also known from near Lismore on the North Coast of New South Wales (Fig. 4).

Notes: habitat information for *S. hirtellus* on herbarium labels is sparse, but indicates that the species has been found in grassy woodland and temperate grassland. Few herbarium specimens of *S. hirtellus* have been made, with most of those collected last century or early this century. The majority of these are from what is now suburban Brisbane. The record from New South Wales is based on a single collection in 1965. It is possible that *S. hirtellus* is extinct in New South Wales and probably under threat of extinction in Queensland. For these reasons, we suggest an initial ROTAP coding of 3EC-QN (Briggs & Leigh 1996) for this species. James and Harden (1990) used the single New South Wales specimen to describe the species as *Sauropus* sp. *A*.

The nomenclature of this species is somewhat confused. *Sauropus hirtellus*, which was originally described by Mueller as *Synostemon hirtellus*, was later transferred to *Phyllanthus* Muell. Arg. as *P. hirtellus* (F. Muell.) Muell. Arg., the latter is an illegitimate name being a later homonym of *P. hirtellus* Muell. Arg., applicable to a different species (see above). *Synostemon hirtellus* was then transferred to *Glochidion* as *G. hirtellum* by Eichler and later to *Sauropus* as *S. hirtellus* by Airy Shaw.

Further complications occur with *Phyllanthus thesioides* Benth. whose name is illegitimate as it is a later homonym of *P. thesioides* Muell. Arg. Bentham's species was 'transferred' to *Glochidion* as *G. thesioides* by Eichler (1965), with the epithet being treated as published from this date (I.C.B.N. Art 58.1), and later to *Sauropus* as *S. thesioides* by Airy Shaw (1980). The difference between *Sauropus thesioides* and *S. hirtellus* appears to be minor; the former has glabrous leaves and stems, while the later is scabrous.

A second syntype of *Phyllanthus thesioides* Benth. (see above), namely 'New South Wales: Lachlan River, *L. Moreton*' (MEL 1595449), is inconsistent with its protologue description and is here excluded; this specimen is placed in *Sauropus ramosissimus*.

The key to the *Sauropus* by James and Harden (1990, p. 399) should be amended as follows:

4 Leaves oblong or ovate to lanceolate, thin-textured, with margins flat; seeds deeply sculptured ..... **S. trachyspermus**

4* Leaves linear or obovate to oblanceolate, relatively thick, with margins recurved to revolute and thickened; seeds rugose with a longitudinal rib on one side. .... **S. hirtellus**

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A classification for edible *Citrus* (Rutaceae)

D.J. Mabberley

Abstract

Mabberley, D.J. (Rijksherbarium, University of Leiden, Netherlands and Royal Botanic Gardens, Sydney NSW 2000, Australia) 1997. A classification for edible Citrus *(Rutaceae).* Telopea *7(2): 167–172.* A workable Linnaean classification, taking into account recent chemotaxonomic advances, is proposed for edible citrus fruits currently referred to the genus *Citrus*. They are accommodated in three species and four hybrid groups. Four names are lectotypified.

The species problem in *Citrus* subg. *Citrus*

The taxonomy of the citrus fruits is complicated by hybridity and apomixis, with many stable hybrid lines being accorded species status, so that the number of edible species recognised in the genus *Citrus* L. (type: *C. medica* L., the citron) varies from 1 to 162, though Swingle (1944) is widely followed. He recognises 12 species with edible fruits (subg. *Citrus*) and six without (subg. *Papeda* (Hassk.) Swingle). The latter subgenus is characterised by its free as opposed to the basally connate stamens seen in subg. *Citrus* and juice vesicles with acrid oil droplets: in Australia it is familiar in cooking, particularly Thai cuisine, in the 'lime-leaves', kaffir or makrut lime, *Citrus hystrix* DC., a species with widely flanged petioles and probably native in tropical Asia.

Intensive chemotaxonomic studies (see Scora & Kumamoto 1983, Scora 1989) indicate that subg. *Citrus* comprises merely four known allopatric wild species – the tropical (see Jones 1995) *C. halimii* B.C. Stone (Malay Peninsula and Borneo) and *C. maxima* (Burm.) Merr. (pomelo, pummelo, SE Asia) and the subtropical *C. medica* L. (citron) and *C. reticulata* Blanco (mandarin, tangerine). From enzymatic work it has been shown that from the last three of these and two unknown plants, all commercial edible citrus fruits presently referred to the genus *Citrus* have been derived through selection and hybridisation (usually unintentional), followed by further selection of 'agamic complexes'.

The major importance of these plants in commercial horticulture (cf. Walters 1961) inflated the taxonomic rank of the complexes, resulting in an increasingly complicated technical nomenclature as new hybrid lines were introduced. This prevailed up until the beginning of the eighteenth century with Tournefort according oranges, citrons and lemons distinct generic rank as *Aurantium*, *Citreum* and *Limon* respectively in 1700. But the morphological distinctions are slight and much of the commercially significant striking degustatory distinction rests on a subtlety, the presence and relative proportions of the two stereoisomers of limonene, one of which is bitter (as in lemon), the other sweet (as in mandarin), resulting in the differing tastes of the flesh and juice.

The origins of the principal commercial citrus

The wild species are indigenous to the Subhimalayan tract, China and western Malesia but most of our knowledge of them and their hybrids comes from cultivated plants introduced to much of the rest of the world via Europe, where they were first given modern Latin names, which it is therefore necessary to typify. The citron

reached Europe with Alexander the Great after his Asian campaigns, the Romans later introducing the lemon and the Seville orange (a pomelo-mandarin cross), the Arabs adding lime and pomelo after that. The Portuguese brought the sweet orange (another pomelo-mandarin cross), the mandarin (a wild Chinese species) itself not reaching Europe until 1805. The grapefruit arose in the Caribbean as a hybrid (sweet orange pollen on pomelo). The lemon is also of hybrid origin with citron probably a parent and an unknown plant the other. Crossing strains of lemons gives offspring with characteristics of trees known as *C. jambhiri* Lush. (rough lemon, often used as a tristeza-resistant rootstock for other citrus; rind rough and bumpy), *C. aurantiifolia* (Christm.) Swingle (lime, apparently a hybrid with pomelo as one parent and probably a second unrecognised plant as the other) and citron, as well as lemons. Such a range of plants is found around abandoned homesteads in Australia.

The earliest Linnaean names

In his *Species plantarum* (1753), Linnaeus united all of the citrus known to him in one genus of two species: *Citrus medica* L., the citron, with var. *limon* L., the lemon and *C. aurantium* L., the orange with var. *grandis* L., the pomelo, and var. *sinensis* L., the sweet orange. Miller, a year later, revived the Tournefortian genera, but meantime Pehr Osbeck, a devoted disciple of Linnaeus, had been preparing for publication the diary of his journey to the Far East, where he saw citrus in cultivation in Canton. As Hansen and Fox Maule (1973) have shown, Osbeck and Linnaeus corresponded at length about Osbeck's plants, some of which Linnaeus dealt with in his *Species plantarum* where he used Osbeck's manuscript names for some of them. In turn, Osbeck, thereby one of the earliest to use Linnaean nomenclature, incorporated Linnaeus's identifications in his book, which appeared as *Dagbok Öfwer en Ostindsk Resa* (1755); he later made changes to it and these were incorporated in the German edition of 1765.

Linnaeus was most interested in Osbeck's novelties, but not all of even these were included in his own work, such that several of the new plants were to be first described by Osbeck himself in his book (Merrill 1916), where he dealt with some 500 of the 600 species he had collected. According to the published English translation (p. xiv) of the German edition of his book, Osbeck wrote, 'I kept for my own amusement a journal of every thing worthy of observation during my voyage; for this I gave him [Linnaeus] some descriptions of new plants found in Spain, China, and other places, which were immediately incorporated into that capital botanical work then printing under the title of *Species Plantarum*, **and with which my names of plants agree** [my emphasis]'. Indeed the vast majority were given Linnaeus's names and at least one of his own new plants not in Linnaeus's work was 'rechristened' to comply with Linnaeus's authority. This plant was what Osbeck had intended to be *Clerodendrum chinense* (Labiatae s.l.), its presently accepted name (though not published until 1989), as can be seen from his manuscripts preserved in the Linnean Society of London (Mabberley 1995). However, the plant he had was the 'double' form, its flowers with no reproductive structures to speak of, so that he felt compelled to give it the new generic name *Cryptanthus* Osbeck to fit Linnaeus's Sexual System based on the numbers of reproductive parts in the flower!

None of the citrus Osbeck saw in China, however, was new and so it is not surprising that no specimens were sent to Linnaeus, whom Osbeck dutifully followed in uniting them in a single genus, but he had each and all of Linnaeus's varieties at species rank, though without precisely pinpointing 'basionyms' in his work (compare the similar treatment of Philip Miller's *Gardeners Dictionary* binomials (1768) in the *International Code of Botanical Nomenclature* Art. 32.5, Ex. 7). That, otherwise following Linnaean

authority so slavishly, he should have used the same and all of the epithets as an unconnected independent notion, stretches credulity too far. His species names, then, as advocated by Swingle (see Swingle 1944), should indeed stand as based on Linnaeus's variety names: *C. grandis* (L.) Osbeck (= *C. maxima*), *C. sinensis* (L.) Osbeck (see below) and *C. limon* (L.) Osbeck (as *'limonia'*; Merrill (1916) points out that Osbeck made a number of other typographical slips elsewhere in his book).

Classification

From a pragmatic point of view, one which was taken many years ago with bananas, where the major crops are triploid clones, some involving hybridity, it may be preferable to abandon a Linnaean classification and refer to the cultivars merely as, for example, *Citrus* 'Valencia' (an orange) or 'Dancy' (a tangerine): these can then be arranged in Groups as advocated by the *International Code of Nomenclature for Cultivated Plants* – 1995 (Art. 4.1), e.g. *Citrus* 'Valencia' (Sweet Orange Group). Where the history of a particular cultivar is unknown or unclear, as in the case of the 'Meyer' lemon, considered by Swingle (1944) to be an orange-lemon cross but not yet confirmed as such, it is most sensible to refer to it in this way: *Citrus* 'Meyer'. However, where there is certainty, it is more informative to use a Linnaean system, where species and hybrid names for citrus crops indicate their presumed relationship to wild plants. The oldest name for the hybrid group involving oranges (pomelo-mandarin crosses) is *C.* × *aurantium* L. and that for the wild tangerine (i.e. mandarin) is *C. reticulata* Blanco, so that the examples above become *C.* × *aurantium* L. 'Valencia' and *C. reticulata* Blanco 'Dancy', to which the parenthetical Group can be added.

The bulk of commercial edible citrus presently referred to the genus *Citrus* can now be accommodated in a Linnaean scheme as set out below.

1. Citrus medica L., Sp. Pl. 2: 782 (1753)

Type: [icon] 'Citreum' Tournefort, Inst. Rei Herb. t. 396 (1700); lectotype, Porter in Reg. Veg. 127: 34 (1993). [Linnaeus refers to his Hort. Cliff., where Tournefort is cited, though this type may need conserving to maintain the use of the name for the citron.]

N India. The citron; cultivars include 'Etrog' used in the Jewish Feast of the Tabernacles.

Involved in two hybrid taxa:

a. Citrus × **limon** (L.) Osbeck, Reise Ostind. China: 250 (1765) as 'limonia', pro sp.; Burm.f., Fl. Indica: 173 (1768), pro sp.

[1. *Citrus medica* × ?]

C. medica L. var. *limon* L., Sp. Pl. 2: 782 (1753).

Type: [icon] 'Limon vulgaris' Ferrarius, Hesperides: 193 (1646); lectotype selected here.

The lemons (held by some earlier authors to be backcrosses between lime and citron, in which case this binomial would cover the limes too); cultivars include 'Eureka'. The limelo is a lime-lemon cross (one of Swingle's 'lemonimes') of no commercial significance.

Note: Linnaeus also cites Bauhin's Pinax, of which Burser material is often considered 'voucher' specimens but his direct reference to Ferrarius's plate, which is undoubtedly the lemon, fixes the identity of this binomial.

b. Citrus × jambhiri Lush., Ind. Forester 36: 342 (1910), pro sp.

[1. *Citrus medica* × 3. *Citrus reticulata* or (1. × ?, i.e. *Citrus* x *limon*) × 3.]

Type: not indicated but probably a cultivated plant at Dehra Dun, India (?not preserved).

The rough lemons ('bush lemons' in Australia, 'lemandarins' of Swingle); cultivars apparently include the Otaheite Orange (*C.* × *aurantium* L. [var.] *otaitensis* Risso & Poit.), one of the dwarf potted oranges of florists, in which case it would be written *Citrus* × *jambhiri* 'Otaheite', as the cultivar name 'Otaheite' is already in use for it (Swingle 1944: 629).

2. Citrus maxima (Burm.) Merr., Interp. Herb. Amb.: 46, 296 (1917)

Aurantium maximum Burm., Herb. Amb. Actuar. Ind. Univ.: [16](1755)

Type: [icon] 'Limo decumanus' Rumphius, Herbarium Amboinense 2: t. 24 f. 2 & B (1741); holotype, see Scora & Nicolson in Taxon 35: 592 (1986).

C. × *aurantium* L. (pro sp.) var. *grandis* L., Sp. Pl. 2: 783 (1753); *C. grandis* (L.) Osbeck, Dagb. Ostind. Resa: 98 (1757); *C.* × *aurantium* L. (pro sp.) var. *decumana* L., Sp. Pl. ed. 2, 2: 1101 (1763) nom. superfl. pro var. *grandis*

Type: [icon] Sloane, Jamaica 1: 41 t. 12 figs 2 & 3 (1707), lectotype selected here (see also A.C. Smith, Fl. Vitiensis 3: 522 (1985)); 'typotype': Herb. Sloane 7 f. 115 (BM)

SE Asia. The pomelo (pummelo); cultivars include 'Chandler'.

Involved in two hybrid taxa:

a. Citrus × aurantiifolia (Christm.) Swingle, J. Washington Acad. Sci. 3: 465 (1913) pro sp., as 'aurantifolia'.

[2. *Citrus maxima* × ?*]

Limonia × *aurantiifolia* Christm., Vollst. Pflanzensyst. 1: 618 (1777) pro sp., as 'aurantifolia'.

Type: [icon] 'Limonellus sive Limon Nipis' Rumphius, Herbarium Amboinense 2: t. 29 (1741); lectotype selected by Stone in Dassanayake & Fosberg, Rev. Handbk. Fl. Ceylon 5: 424 (1985).

The lime. *The putative parent differs from the unknown parent of the lemon; Scora & Kumamoto (1983) consider there may be three wild species in the lime's ancestry, two of them perhaps from outside subg. *Citrus* (but see also under *C.* × *limon* above). Cultivars include 'Mexican'.

b. Citrus × aurantium L., Sp. Pl. 2: 782 (1753), pro sp.

[2. *Citrus maxima* × 3. *Citrus reticulata*]

Type: Probably cultivated in Europe, Herb. Linn. 937.2, upper row of leaves; lectotype selected here (LINN).

C. × *aurantium* L., pro sp., var. *sinensis* L., Sp. Pl. 2: 783 (1753); *C.* × *sinensis* (L.) Osbeck, Reise Ostind. China: 250 (1765), pro sp.

Type: Probably cultivated in Europe, Herb. Linn. 937.2, lower row of leaves; lectotype selected here (LINN). The choice of *Bauhin s.n.* (BAS) by Porter & Elias, Ann. Missouri Bot. Gard. 66: 132 (1979), apparently unseen, is here considered an unnecessary neotypification.

C. × *paradisi* Macfad. in Hook., Bot. Misc. 1: 304 (1830), pro sp.

Type: not preserved.

Oranges and grapefruits, those of the original hybrids with more features of *C. maxima* being the bitter or Seville oranges (Sour Orange Group), those with more of *C. reticulata* being the sweet oranges (Sweet Orange Group; *C.* × *sinensis*). The grapefruit (Grapefruit Group; *C.* × *paradisi)* is a backcross between an orange and *C. maxima* made in Barbados in the eighteenth century; further backcrosses between it and *C. maxima* are in commerce. Tangors, ortaniques, etc. (Tangor Group; *C.* × *nobilis* Lour., pro sp.) are backcrosses with *C. reticulata*, many of which (?repeated backcrosses) are called mandarins in commerce, though the true mandarin is referable to *C. reticulata* itself. Tangelos (Tangelo Group; *C.* × *tangelo* J.W. Ingram & H.E. Moore) are yet further crosses, between grapefruit and *C. reticulata*; these in turn have been backcrossed with *C. reticulata* to give cultivars such as 'Page'.

The most important group commercially. Cultivars include 'Chinotto' (Sour Orange Group), 'Baia' (the earlier name for 'Washington Navel') introduced to the Sydney Botanic Garden in 1828 (Passos et al. 1978), 'Lane's Late Navel', 'Leng Navel', 'Red Navel', 'Seedless Valencia', 'Shamouti' ('Jaffa') and 'Valencia' (Sweet Orange Group), 'Marsh Seedless' and 'Star Ruby' (Grapefruit Group), 'Honey Murcott' ('Murcott') , 'Wilking' (Tangor Group), 'Minneola' (Tangelo Group).

Note: Coode, Flore des Mascareignes 65: 29 (1979), selected Herb. Linn. 937.2 as lectotype but, as Fawcett & Rendle, Fl. Jamaica 2: 187 (1920), point out, this sheet bears leaves of both bitter (i.e. var. *aurantium* L.) and sweet (i.e. var. *sinensis* L.) oranges. The upper row has the widely winged petioles typical of the type variety, the lower one the narrowly winged petioles of the sweet orange.

3. **Citrus reticulata** Blanco, Fl. Filip.: 610 (1837)

Type: Philippines: Luzon, Species Blancoanae 402; neotype, selected by Swingle 1944: 413 (UC, n.v.; BM, K).

Subtropical China. Tangerine, mandarin, satsuma, clementine; cultivars include 'Clementine', 'Dancy', 'Emperor', 'Fina', 'Imperial', 'Nova', 'Owari'.

Also in commerce, but for flavouring (oil of bergamot extracted from the peel and used in eau-de-cologne and Earl Grey tea) rather than fresh fruit or juice, is the bergamot sour orange, which Scora (1989) considers to be a citron-orange cross, i.e. *C. medica* × (*C. maxima* × *C. reticulata*), and according to the above scheme is '1. x (2. × 3.)', *Citrus* × *bergamia* Risso & Poit.

Conclusion

This scheme provides a workable system for botanists and fruit-growers alike. The nature of the variation in the group, however, makes a conventional identification key to any but the wild species impossible to construct. Here are covered all the commercial citrus presently referred to the genus *Citrus*; those such as calamondins, kumquats and limequats presently referred to allied genera or 'hybrid genera' will be dealt with in a subsequent paper devoted to the relationships of such genera to *Citrus* itself.

Acknowledgments

I am greatly indebted to Charlie Jarvis for help over the typification of the Linnaean names. Alistair Hay and Surrey Jacobs kindly commented on an early draft of the paper.

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SHORT COMMUNICATION

A new combination in *Eryngium* (Apiaceae)

Peter W. Michael

In my studies towards the revision of *Eryngium* in Australia and an account of the genus for the *Flora of Victoria*, involving examination of specimens in MEL, BRI and NSW, it has become clear that the name *E. plantagineum* F.Muell. (type in MEL) has often been misapplied. *E. plantagineum* itself appears to be confined to central Queensland, around the Tropic of Capricorn. Willis in *Handb. Plants Vict.* 2: 487 (1972) pointed out that the Victorian populations he had seen were most probably identical with *E. rostratum* Cav. var. *paludosum* Moore & Betche. The Victorian specimens examined show similar variation to that shown by plants from New South Wales especially in the vesicular scales of the fruit which are more or less cylindrical, sometimes flattened, with apices obtuse, acute or sometimes acuminate with minute teeth towards the apex, not globular as in *E. plantagineum.*

Other features of *E. plantagineum* F. Muell. clearly different from plants so called from New South Wales and Victoria and among those from Queensland include the commonly much longer peduncles to 8 cm or more (cf. 1 to 3 cm) and the more or less flat basal leaves, pinnatifid or with somewhat distant spines or spiny lobes (cf. basal leaves, cylindrical with spines, if they occur, only in upper portion.)

Accordingly, I make the new combination:

Eryngium paludosum *(Moore & Betche) P.W. Michael*, **comb. et stat. nov.**

Basionym: *Eryngium rostratum* Cav. var. *paludosum* Moore & Betche, Handb. Flora N.S.W., 220 (1893)

Holotype: New South Wales: Nevertire, in a waterhole on the railway line. *E. Betche NSW 456361*, Sept. 1886 (NSW)

The type shows many basal leaves with young developing inflorescences just mature enough to show the more or less cylindrical vesicular scales with obtuse apices. Specimens with mature cylindrical flowering heads with similar vesicular scales include:

Victoria: Kerang, on heavy inundated soil, *Baldwin s.n.*, Nov 1937 (MEL) [annotated by J. H. Willis and identified by him as *E. plantagineum* F. Muell. forma in Jan 1965].

New South Wales: North Western Plains: Gwabegar, scattered over 1 ac (0.4 ha) of gilgai country as a result of flooding, *C. Tassell s.n.*, Nov 1971 (NSW 407357); 'Allaru', Mungindi, *J. J. Smith s.n.*, Jan 1922 (NSW 456362).

Specimens of another form with vesicular scales that are acuminate with minute teeth especially towards the apex include:

Victoria: Lake Lalbert, 4 km W of Lalbert, 35°40'S 143°20'E, on heavy clay flat adjacent to lake; several thick patches 5 m in diameter. *R. Jochinke s.n.*, Sep 1983 (MEL).

New South Wales: South Far Western Plains: 2.5 miles (4 km) E of Robinvale, Victoria and 4 miles (6.4 km) S of Lake Benanee, NSW amongst a pumpkin crop in irrigated land, per *R. K. Wall*, Apr 1972 (MEL). North Western Plains: 3.2 km N of Bourke, *E. J. McBarron 18644*, Nov 1969 (BRI, MEL, NSW).

E. ovinum A. Cunn. (syn. *E. rostratum* auctt. non Cav.) was reinstated by me in *Austral. Syst. Bot. Soc. Newsletter* 53: 3–5, 1987. It is distinguished from *E. paludosum* by its

strongly erect more regular dichasial flowering habit, long bracteoles spread throughout the more or less ovoid flowering heads, not confined to the basal involucre and the apex, as in *E. paludosum*, and the long, thin, acuminate vesicular scales on the fruit.

E. supinum J. M. Black, with its cylindrical flowering heads resembling those of *E. paludosum*, is a less robust plant that has long-petiolate, ovate juvenile leaves and much more slender vesicular scales bearing conspicuous teeth from near the base to the apex.

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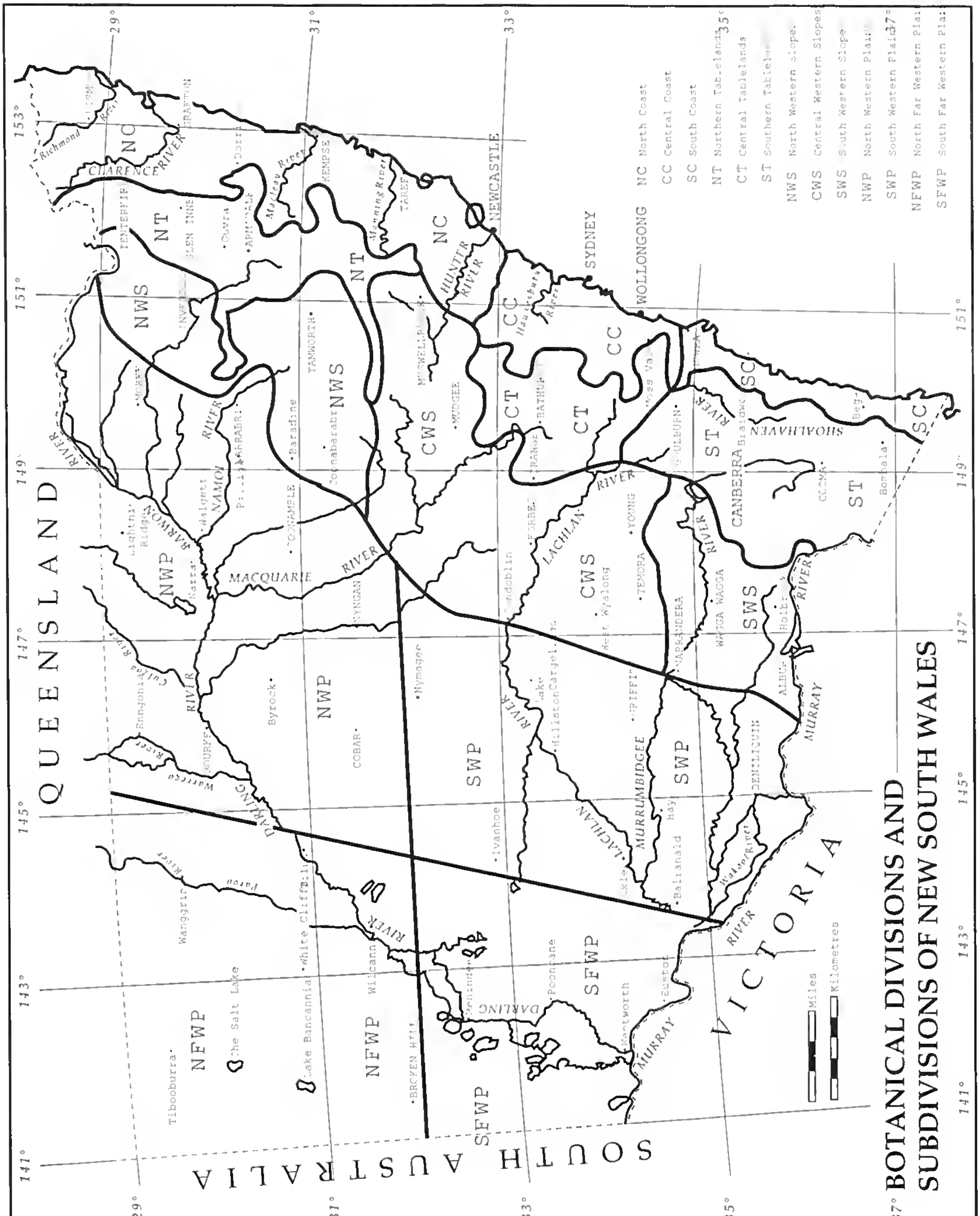
Corrigenda — Telopea 7(1)

J.T. Hunter, F.C. Quinn and J.J. Bruhl. *Micromyrtus grandis* (Myrtaceae), a new species from New South Wales

Page 78: replace 'Monoecious shrub' with 'Shrub'. Flowers of *Micromyrtus grandis* are bisexual.

Page 81, Acknowledgments: add 'Thanks also to David Mackay (NE) for the illustrations.'



BOTANICAL DIVISIONS AND SUBDIVISIONS OF NEW SOUTH WALES

For explanation and description of the Botanical Divisions and Subdivisions of New South Wales see Anderson, R.H. (1961). Introduction. *Contr. New South Wales. Natl. Herb. Fl. New South Wales* Nos 1–18, pp. 1–15.

CONSERVATION CODES APPLIED TO RARE AND THREATENED SPECIES

The codes used in this journal follow J. Briggs & J. Leigh (1988) *Rare or threatened Australian plants* 1988 Revised Edition. Australian National Parks & Wildlife Service, Special Publication no. 14.

Distribution categories

1 species known from type collection only

2 species with a very restricted distribution in Australia and with a maximum geographic range of less than 100 km

3 species with a geographic range of at least 100 km but occurring only in small populations (often restricted to highly specific and localised habitats)

\+ species also occurs naturally outside Australia

Conservation categories

X presumed extinct (not found in recent years)

x presumed extinct within a particular region

E endangered: species in serious risk of disappearing from the wild within 10–20 years

V vulnerable: species not presently endangered but at risk over 20–50 years

R rare: species that are rare in Australia but not endangered or vulnerable

K poorly known: species that are suspected of being at risk but data are inadequate;

k poorly known in Western Australia by the criteria of the Western Australian Dept of Conservation and Land Management

Reservation categories

C species known to be present within a national park or other proclaimed reserve;

a adequately reserved, with at least 1000 plants known to occur in reserves;

i inadequately reserved, with fewer than 1000 plants known from reserves;

\- adequacy of reservation unknown

t total known populations are in reserves

Taxonomic category

? taxonomic status is uncertain

NOTICE TO AUTHORS

Telopea is published twice-yearly, in March and September. Preference will be given to papers relating to the flora of New South Wales. Brief papers may be published as Short Communications.

Deadlines for the submission of papers are **1 June** (for the March issue the following year) and **1 November** (for the following September issue). Authors are expected to have had their papers peer-reviewed before submission. All papers will be refereed. Two copies of the manuscript should be submitted along with originals of photographs and clear photocopies of all other figures. The full postal address (plus telephone and fax numbers) of the author who will check the proofs and receive correspondence should be included. Once a paper has been accepted for publication the author should provide the paper on a computer disk along with final artwork. The disk should be in IBM compatible (MS-DOS) or Macintosh format and clearly labelled with the word processing program used and the file name(s).

General formatting requirements • Text should be justified. This applies also for abstracts, headings, keys and reference lists. Headings should be in upper and lower case, and not underlined. • Use only a single space after *all* punctuation marks including fullstops. • Insert a space between a numeral and unit of measurement, e.g. 3 mm, but no space between initials, e.g. L.A.R. Haegi, or between en dashes and associated numerals, e.g. 5.2–6 mm or between extreme measurements and ranges e.g. (10–)25–35(–90). Use double hyphens (--) to indicate en dashes (–). • Do not use the spacebar to indent or tabulate. Use italics where necessary, and use single quote marks before double.

Organisation of the paper The title should be explicit and descriptive of the content. Include the family name and broad geographic region where appropriate. Abstracts (except for Short Communications) should be included. Check most recent issue for format. Bracketed keys are preferable especially for long keys, but indented keys are acceptable. Long indented keys should be divided into groups. When giving authors of botanical names follow the forms in the Kew Draft Index of Author Abbreviations. But note unabbreviated use in references below.

Types Cite details in full, giving details from protologue and from specimen label separately if there are important differences. Type citations should be in a consistent format, e.g: Type: New South Wales: North Western Plains: 10 km W of Moree (29°08′ S 129°48′ E), *B. Wiecek 1250*, 2 Jan 1989; lecto NSW (Weston 1990: 21); isolecto K, MO.

Selected specimens Cite no more than 20 (except for very widely distributed species) and arrange by Botanical Divisions. Use accepted format: locality, collector & number, date (herbarium code plus institutional number if there is no collector's number) and omit the initials of collectors, unless confusion is likely. Only latitudes and longitudes on the original labels should be included. Give dates in the following format: 12 Jan 1987, 2 June, 30 July, 10 Dec etc.

References In formal taxonomic citations use the fully abbreviated (Harvard) form: author (year: page) e.g. Bentham (1878: 234). The traditional ± abbreviated form, e.g. Bentham, Fl. Austral. 7: 234 (1878), may be used in shorter papers. Authors' names in these citations should be given unabbreviated. References to books published before 1900 need not include the publisher and place of publication, but be consistent.

Index to taxa This is useful if the paper is large and deals with many species and synonyms. The author should prepare the basic alphabetic listing including all names in recent use.

Illustrations/maps/photos • Supply bromides, photographs, transparencies or good quality artwork with the final manuscript. Check that maps show their context clearly (by lat/longs or an inset map) and that relevant place names in the text (but not for cited specimens) are shown. • Photos should be unmounted, good-quality prints. Do not label photos. • Labelling that is part of an illustration, e.g. place names on a map, should be added in Helvetica font by the person preparing the illustration. • Bar scales on the figure are preferable to numerical scales in the caption. Any magnification levels in the caption should refer to the size of the submitted original figure (not anticipated final size). • The maximum final size of the illustration is 205 mm high × 125 mm wide.

Captions Use lower case letters for the parts of a figure e.g. Fig. 1. *Jacksonia michaeliana*. a, stem tissue (× 10); b, calyx lobes (× 0.5). (a from holotype; b from *Barson 234*.)

Tables should preferably be portrait rather than landscape shape.

More detailed instructions are available on request from the editors.

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Contents

Short communication