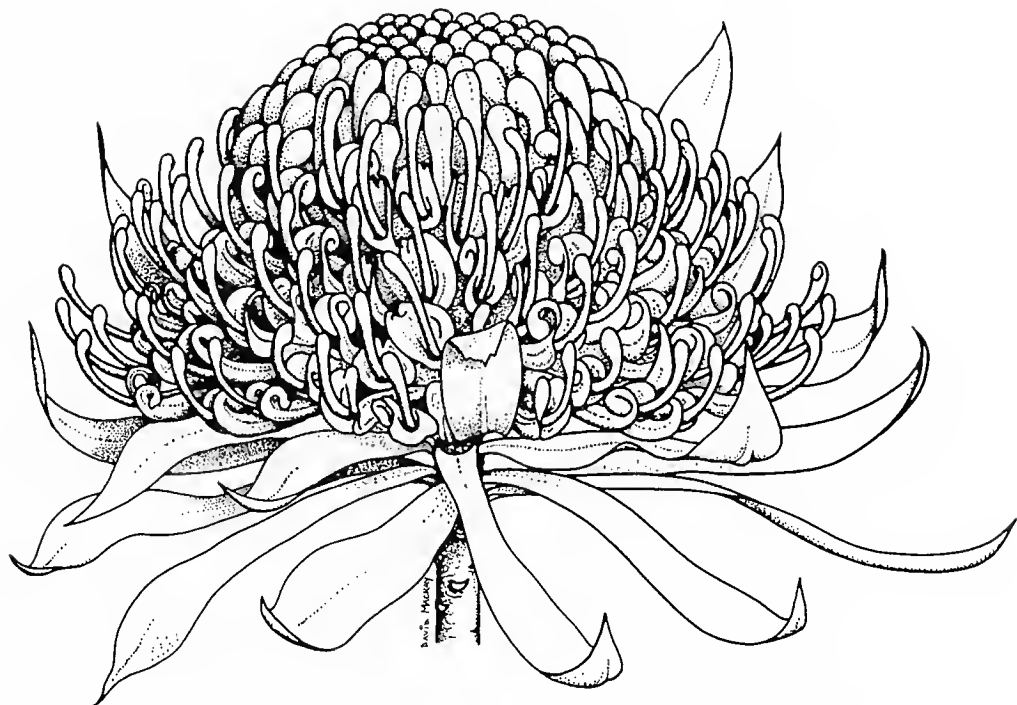


TELOPEA

Volume 9(2) • June 2001



ROYAL BOTANIC GARDENS SYDNEY

National Herbarium of New South Wales

Telopea is published by the National Herbarium of New South Wales, Royal Botanic Gardens Sydney. It covers the field of systematic botany in Australia and the Asia-Pacific region, specialising in the flora of New South Wales.

Telopea is published twice yearly.

Annual subscription for 2001

*Within Australia**

Individuals \$55

Institutions \$90

Overseas

Individuals and institutions, surface mail A\$95

* *This subscription includes an amount for GST (\$5.00/\$8.18).*

Subscriptions start with the first issue of the year.

Subscription details, with a cheque or money order made out to the Royal Botanic Gardens Sydney, should be sent to:

The Finance Officer
Royal Botanic Gardens
Mrs Macquaries Road
Sydney, NSW 2000, Australia

Website: www.rbgsyd.nsw.gov.au

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

A journal of plant systematics

This issue of *Telopea* commemorates the centenary on 8 March 2001 of the first home of the National Herbarium of New South Wales, and also Joseph Henry Maiden (Director of the Botanic Gardens 1896–1924) who founded the Herbarium and first established its scientific reputation.

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ISSN 0312-9764

Telopea 9(1) was distributed on 15 December 2000.

National Herbarium of New South Wales
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The National Herbarium of New South Wales — One Hundred Years



The first home of the National Herbarium of New South Wales, now known as the R.H. Anderson Building. The portico on the right leads to the original Museum and Lecture Hall, a single room constructed in 1878 and incorporated into the two-storey building that was opened in 1901. The entrance on the left bears the title 'National Herbarium' and '1899', the date of construction of that part of the building, and leads to the J.H. Maiden Lecture Theatre.

This issue of *Telopea* commemorates the centenary on 8 March 2001 of the first home of the National Herbarium of New South Wales, and also Joseph Henry Maiden (Director of the Botanic Gardens 1896–1924) who founded the Herbarium and first established its scientific reputation.

Sydney's Royal Botanic Gardens has a proud status as Australia's oldest continuing scientific institution, persisting at its Farm Cove site and with a scientist (or 'botanical soldier' in the case of its first Superintendent, Charles Fraser) at its helm from its earliest days. In 1916 the centenary of its foundation was celebrated, taking the completion of the encircling road in 1816 as marking its identity and foundation (Gilbert 1986). Initially the site was envisaged as an entrepot, from where samples of the 'vegetable resources' of the new colony would be shipped to Britain, the Mother Country, and where plants needed by the colonists could be established and distributed. In keeping with such close links to Britain, the young settlement was not seen as a place for permanent scientific collections — these were sent to Europe for safe keeping and expert study. So the Herbarium's foundation, forty years later than its counterpart in Melbourne, is dated from when Joseph Henry Maiden took up duty as Director in 1896.

Maiden had come from England as a young man but had no doubt that Australia was a place for enduring scientific organisations and specimen collections. His early years in Sydney had been as the first Curator of the Technological Museum, forerunner of today's Powerhouse Museum. As at the Museum, his priority on appointment to the

Gardens was to seek support and funding from the New South Wales Government for construction of a substantial building for rapidly increasing collections and scientific and office staff. His outstanding vision, energy, persistence and powers of persuasion led to success in both cases, and the herbarium building was opened on 8 March 1901, within five years of his appointment at the Gardens. The early years of the Herbarium are the story of that dominant figure, Maiden, whose achievements encompassed also important developments in the Gardens and elsewhere, as well as many and varied scientific publications, contributions to scientific societies, community projects and adult education (Gilbert 2001).

The new two-storey building incorporated an existing Museum room and Lecture Hall built in 1878, during Charles Moore's long directorship (1848–96). Most of the space on both levels held wooden racks for cardboard specimen boxes, interspersed with working areas for the few staff. The Lecture Hall and Museum displaying the economic uses of plants remained in regular use, continuing to give evidence of the importance Maiden also placed on education and outreach to the community.

On arrival at the Gardens, Maiden had found a pitifully deficient library and specimens of only 'a thousand or two named species', but soon the library was growing and the spacious specimen rooms were filling, as Maiden and his staff collected enthusiastically, mostly wherever they could reach by train and foot, rarely by horseback. Botanical assistant Ernst Betche, collector John Boorman, and horticultural managers William Forsyth and Julius Camfield all contributed their specimen collections. Along with vascular plants, there were fungi, lichens, algae, bryophytes, plant products and wood specimens, with small sections devoted to teratological examples and plant galls. Specimen exchanges were established with leading herbaria worldwide and many of the specimens received for identification from all parts of New South Wales were retained for the collection. Part of the herbarium that Maiden had assembled during his 15 years at the Technological Museum was transferred; the remainder was received much later, in the 1980s. During a visit in 1900 by Maiden to the British Museum (Natural History) in London, the case was strongly and successfully made for sending to Sydney duplicates of the Banks and Solander collections from Cook's voyage in 1770; more than 800 duplicates were received. The efforts of knowledgeable amateur collectors were encouraged and some significant collections purchased. The emphasis was on developing comprehensive local and world representation of taxa; since resources were limited the specimens remained largely unmounted.

The botanical output of the Herbarium was overwhelmingly that of Maiden, who worked individually on *Eucalyptus*, *Acacia*, the *Forest Flora of New South Wales* and on plants of economic importance, but also published with his colleagues Betche, Blakely and Cabbage on a wide range of groups. Alone or with colleagues he was responsible for a vast and varied range of scientific publications and other articles, including the description of more than 300 new species. Excellent illustrations by Margaret Flockton contributed to many of the publications.

Almost single-handedly, Maiden had built a scientific and international reputation for the Herbarium but this was not maintained in the decades following his retirement in 1924. With the backdrop of economic depression, resources were grossly inadequate and leaders lacked vision for the scientific or community roles of the organisation. Added to this was a worldwide reduction in the scientific standing of taxonomy. The administrative control of Gardens and Herbarium was divided, with a Gardens Curator and a Herbarium Curator (or later Chief Botanist), instead of a unitary position of Director. All had been within the New South Wales Department of Agriculture since 1880, but for years the Herbarium was administratively separated as a Branch of the Science Services Division of that Department. Moreover, these decades

predated the wider community awareness and concern for environmental and biodiversity conservation that has helped botanic gardens worldwide to redefine their aims, and also the resurgent interest in phylogeny, driven by cladistics and molecular genetics, that has revived biological systematics.

The upturn was slow but, once started, made steady progress. From the late 1930's R.H. (Bob) Anderson (Herbarium Curator and subsequently Chief Botanist, 1936–64) was able to appoint graduates with research experience who were becoming available to fill new botanical positions. Published scientific output increased greatly after 1939 when the series *Contributions from the New South Wales National Herbarium* was initiated, forerunner of today's *Telopea*. The Gardens and Herbarium were administratively re-united and ecological work introduced under Director Knowles Mair (1964–70), while educational programs were initiated by Director John Beard (1970–72). A new herbarium building and the many new opportunities it brought, as well as expansion of the scientific programs were notable during L.A.S. (Lawrie) Johnson's leadership (1972–1985, Briggs 2001) while improvement of the horticultural lands and their landscape features characterised Carrick Chambers' directorship (1986–1996), along with further expansion of herbarium and office space in the new building. The development of the satellite gardens at Mount Tomah and Mount Annan, publication of a four-volume *Flora of New South Wales* (Harden 1990–93, 2000, & in press), establishment of electronic data recording and DNA research were developments that energised the whole organisation and were spread –to varying extents– over several directorships during the last three decades of the century. Recent emphasis with Director Frank Howarth (1996–present), across both the Herbarium and Gardens, is on biodiversity conservation, communicating information by electronic media and forging closer links with other government agencies and universities.

From the 1940s into the 1960s, the Herbarium had been headed by an experienced Botanist informally although effectively guiding less knowledgeable botanists, with management a relatively infrequent and unwelcome interruption into botanical work, as in Joyce Vickery's time (1936–68). Acknowledgment that the Herbarium and scientific programs needed to be managed as an entity within the organisation came with Lawrie Johnson's appointment as Deputy Chief Botanist (1968–72); the position was subsequently retitled Senior Assistant Director (Scientific) while held by myself (1972–97). Now there is a Director Plant Sciences Branch, Tim Entwisle, assisted by a management team, with the Herbarium and systematics forming the Plant Diversity Section. The scope of research has widened geographically and also into new fields, especially in algae and bryophytes, and now the systematists have ecologists, plant pathologists and horticultural researchers among their colleagues, but economic botany (apart from the occurrence of weeds) and the development of general fungal collections are not current priorities. International links have been greatly strengthened and cooperation among botanists and botanical institutions within Australia fostered by the Council of Heads of Australian Herbaria, the Australian Systematic Botany Society and other scientific associations.

The Director's office has continued to be where Maiden established it, except for a short period when Director John Beard had his office in the Cunningham Building. The Herbarium and its staff moved in 1982 from Maiden's building to a long sought and newly constructed adjacent building, providing the desperately overcrowded collections and library with space for some years of growth, as well as vastly improved working conditions and space for laboratories. Research in molecular systematics, a database of specimen data and a volunteers' program to mount the specimens could then be initiated. The space vacated was quickly put to use as a classroom and offices for education programs, lecture theatre, accommodation for Corporate Services staff, Visitor Centre and Gardens' Shop. The Visitor Centre functioned there until 2000 when

it was transferred to a building in a more central location in the Gardens. Buildings were commemoratively named after the great botanist Robert Brown (the new Herbarium building) and two former directors: Robert Anderson (the old Herbarium) and Allan Cunningham (the director's residence, built in 1874, in Moore's time, now providing offices for staff). Maiden's name graces the lecture theatre in the Anderson Building, so essential to community activities, including those of the Friends of the Gardens, and to education.

In many respects the National Herbarium of New South Wales and also the Royal Botanic Gardens Sydney have come full circle, confident of their status in science, internationally recognised and outgoing in serving their community, as they were in the time of J.H. Maiden.

Acknowledgment

This brief account has depended greatly on the research and publications of Dr Lionel Gilbert OAM, Honorary Research Associate of the Royal Botanic Gardens Sydney, and especially on his works cited below.

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The genus *Desmocladus* (Restionaceae) and new species from the south of Western Australia and South Australia

Barbara G. Briggs and L.A.S. Johnson †

Abstract

Briggs, Barbara G. and Johnson, L.A.S. (Royal Botanic Gardens, Mrs Macquaries Road, Sydney, NSW 2000, Australia) 2001. The genus *Desmocladus* (Restionaceae) and new species from the south of Western Australia and South Australia. *Telopea* 9(2): 227–245. The name *Desmocladus* Nees was recently adopted for a genus that has been widely confused with *Loxocarya* R. Br. The two genera are not closely allied and the characters distinguishing them are summarised. In addition to the six previously named species of *Desmocladus*, there are eight new species from Western Australia here described (*D. austrinus*, *D. biformis*, *D. castaneus*, *D. elongatus*, *D. lateriticus*, *D. parthenicus*, *D. quiricanus* and *D. semiplanus*) and one that occurs in the south of both Western Australia and South Australia (*D. diacolpicus*).

This paper is dedicated to Emeritus Professor John S. Pate, of the University of Western Australia, who has made notable contributions to an understanding of an extraordinarily wide range of plant groups and of their biology, physiology and structures. He and his students and associates have made great advances in knowledge of Australian Restionaceae.

Introduction

The first description of species now referred to *Desmocladus* was in 1810 when Robert Brown named *Restio fasciculatus* and *R. flexuosus* (Brown 1810). These species were transferred by Bentham (1878) to Brown's genus *Loxocarya* and further species related to them were named within *Loxocarya*. The confusion was widened since Bentham also transferred to *Loxocarya* a species of *Hypolaena*, *H. pubescens* (R. Br.) Nees, which had also originally been named under *Restio*, although it had since been transferred to an appropriate generic placement in *Hypolaena*. The genus *Loxocarya* is, however, typified by *L. cinerea* R. Br. which is generically distinct from all these species.

We therefore adopted (Briggs & Johnson 1998b) the name *Desmocladus* Nees (1846) for a genus typified by *D. fasciculatus* (R. Br.) B. G. Briggs & L.A.S. Johnson. This new combination for the type species was necessary since it had originally been given the illegitimate name *D. brunonianus* Nees. The name *Desmocladus* was used, in the knowledge of our proposed classification and with our encouragement, in the description of *D. glomeratus* K.W. Dixon & K.A. Meney (Meney, Pate & Dixon 1996). Combinations under *Desmocladus* were provided (Briggs & Johnson 1998b) for the further four species of that affinity which had been named under *Loxocarya*. Accounts of the genera of Restionaceae (Linder, Briggs & Johnson 1998; Briggs & Johnson 1999) should assist in resolving the long-standing confusion in the generic classification of these taxa.

Information on the six previously-named species: *D. asper* (Nees) B.G. Briggs & L.A.S. Johnson, *D. fasciculatus* (R. Br.) B.G. Briggs & L.A.S. Johnson, *D. flexuosus* (R. Br.) B.G. Briggs & L.A.S. Johnson, *D. glomeratus* K.W. Dixon & K.A. Meney, *D. myriocladus* (Gilg)

† Deceased 1 August 1997.

B.G. Briggs & L.A.S. Johnson and *D. virgatus* (Benth.) B.G. Briggs & L.A.S. Johnson, is given by Meney, Pate & Hickman (1999). In addition to these species, there are nine that were not collected until recently or that were confused with related species; they are described here. Their names were included in the conspectus of our classification of Australian Restionaceae (Briggs & Johnson 1999). Information on their features and biology, in advance of the formal naming of the new species, is also given by Meney, Pate & Hickman (*loc. cit.*), who provide excellent illustrations. Further information on the anatomy, biology and conservation of the new species is presented by Pate & Meney (1999), Meney, Dixon & Pate (1999) and Meney, Pate, Dixon, Briggs & Johnson (1999). An account of all species of *Desmocladus* will be given in the *Flora of Australia* (Briggs, Johnson, Porter & Krauss, in preparation).

Desmocladus and *Loxocarya*

Since all the previously described species recently transferred to *Desmocladus* were formerly included in *Loxocarya*, it is appropriate to note that these are not closely allied genera. They are differentiated by a wide range of features (Table 1), despite superficial similarities in some species. DNA sequence data from the chloroplast gene *rbcL*, the *trnL* intron and the *trnL-trnF* intergenic spacer are now also available (Briggs et al. 2000) and confirm the lack of close relationship between them. On the basis of morphology and culm anatomy the *Desmocladus* and *Loxocarya* groups of genera were recognised (Briggs & Johnson 1998a, 1999; Linder, Briggs & Johnson 2000). The *Desmocladus* group is largely concentrated in southern Western Australia where it includes also *Harperia*, *Onychosepalum*, *Catacolea*, *Kulinia* and *Lepidobolus*, in addition to the eastern Australian *Coleocarya*. The *Loxocarya* group is much less clearly characterised and has included 15 genera in both eastern and western Australia. DNA data support the *Desmocladus* group as a robust clade, but show the *Loxocarya* group as paraphyletic in respect of the *Desmocladus*, *Leptocarpus* and *Winiifredia* groups.

Table 1. Morphological, chemical and anatomical characters distinguishing *Desmocladus* and *Loxocarya*.

Character	<i>Desmocladus</i>	<i>Loxocarya</i>
Tepals of female flowers	often absent, if present shed with fruit	4 regularly developed, persistent
Ovary	1-locular	(1-)2 locular
Style	single	mostly 2-branched
Fruit	indehiscent (nut)	dehiscent (capsule)
Seed	not furrowed, surface cells subangular	with a longitudinal furrow, surface cells lobed in outline
Flavonoids (Williams et al. 1998)	luteolin and triclin often present	luteolin and triclin not recorded
Culm anatomy		
Inward projections of stomate guard cells	present	absent
Radial walls of culm epidermal cells	sinuous, outer part thickened	not sinuous, not thickened
Chlorenchyma cell layers	1-2	2-3
Pillar cells in chlorenchyma	absent	present
Sclerenchyma ridges projecting into chlorenchyma over outer vascular bundles	absent	present

Descriptions of new species

1. *Desmocladus lateriticus* B.G. Briggs & L.A.S. Johnson, sp. nov.

A *D. myriocladus* combinatione characterum sequentium distinguitur: apex vaginae culmorum pilis longis (1–3 mm longis) patentibus albisque ciliatus; spiculae masculinae anguste ellipsoideae, 3.0–6.5 mm longae; flores femineae tepalis nullis; vaginae glumaeque herbaceae vel bruneolae.

Type: Western Australia: 30 km NNW of Gin Gin on Brand Hwy (31°08'S 115°46'30"E), 28 Sep 1984, B.G. Briggs 7439 & L.A.S. Johnson ♂ (holo NSW; iso CANB, K, MO, PERTH).

Caespitose, forming small, dense, many-culmed tussocks. Culms repeatedly branched, erect, terete to semi-terete, glabrous or pilose with long hairs, often longitudinally furrowed, smooth or finely striate or minutely tuberculate, to 50 cm tall, 0.5–1.2 mm diam., internodes numerous; culm branches of male plants commonly sinuous-erect, females more flexuose and tangled. Basal sheaths short, 3–8 mm long. Culm sheaths appressed, green to dark red-brown, glabrous or villous, 4–7.5 mm long, truncate, apex fringed by long (1–3 mm) spreading white hairs; lamina 2–3(–5.5) mm long. Male spikelets borne singly or less often in pairs, sessile, axillary at 5–10 successive upper nodes, narrow-elliptic, 3.0–6.5 mm long; 3–7-flowered, glumes 3–8, ovate to lanceolate, acute, 1.6–3.7 mm long, yellow to light brown, glabrous or apically villous, mucro 0.3–1.0 mm long. Female spikelets borne singly at upper nodes, ellipsoid, 4.5–6.0 mm long; 1–(2–3)-flowered, glumes 3–5, ovate, acuminate, 2.3–6.0 mm long, green to pale yellow, usually villous towards apex, mucro 0.4–2.0 mm long. Male flowers: tepals 5, scarious, narrow-lanceolate to linear, acute, ± equal in length or inner tepals occasionally shorter, 1.5–3.3 mm long; anthers 1.0–1.3 mm long. Female flowers lacking tepals. Nut narrow ellipsoid, 2 mm long, dark brown with pale lateral lines, stipitate, the style base persistent as a short apical beak. (Fig. 1g–1j).

The epithet is from the Latin *later*, *lateris*, a brick, referring to the frequent occurrence of the species on soils that include lateritic gravel.

Distribution: occurs in Western Australia from north of Geraldton south to the Regans Ford–Mogumber area and east to Cunderdin. (An isolated population is reported near Williams [Meney, Pate & Hickman 1999] but this should be rechecked cf. *D. quircanus*). Locally occasional to abundant on laterite in heath or open shrubland, frequently on lateritic ridges. Killed by fire.

Conservation status: not at risk.

Distinguished from *D. myriocladus* (Fig. 1a–1c) by the long (1–3 mm), spreading white hairs fringing the apical margin of culm sheaths, the narrow ellipsoid male spikelets 3.0–6.5 mm long, absence of tepals in the female flowers, sheaths and glumes green or light brown. *D. myriocladus* has the apical margin of culm sheaths glabrous or fringed with very short felted hairs, the male spikelets broader (ovoid-ellipsoid) and mostly shorter (3–4 mm long), tepals present in the female flowers, shorter broader nuts and sheaths, glumes and dry culms mostly golden brown.

Selected specimens examined: Western Australia: Irwin: Murchison R., *Oldfield* ♂ (MEL14902); Moresby Range, 3.9 km E of Hwy 1 at 21.7 km N of Geraldton (5 km N of White Peak Rd), 14 Aug 1991, *Briggs 8884a* & *Johnson* ♂ (NSW, PERTH), *8884c* ♀ (NSW, PERTH); 31 km W of Three Springs, W end of Nebru Rd at junction with Moorlaby Rd, 30 Sep 1984, *Briggs 7515* & *Johnson* ♂ (NSW, PERTH), *7517* ♀ (NSW, PERTH); Green Head–Coorow Rd, 0.8 km E from Brand Hwy, 17 Jun 1997, *Davis 3319* ♀ (PERTH); 11 km S of Cataby on Brand Hwy, 13 Apr 1989, *Krauss 132* & *Howitt* ♀ (NSW, CANB, PERTH); Darling: 7 km SW of Mt Lesueur, 26 Sep 1976, *Briggs 6365* ♂ (NSW, PERTH); 16.5 miles [25 km] WNW of Mogumber, 23 Sep 1966, *Briggs 855* ♀ (NSW, K, L, PERTH,

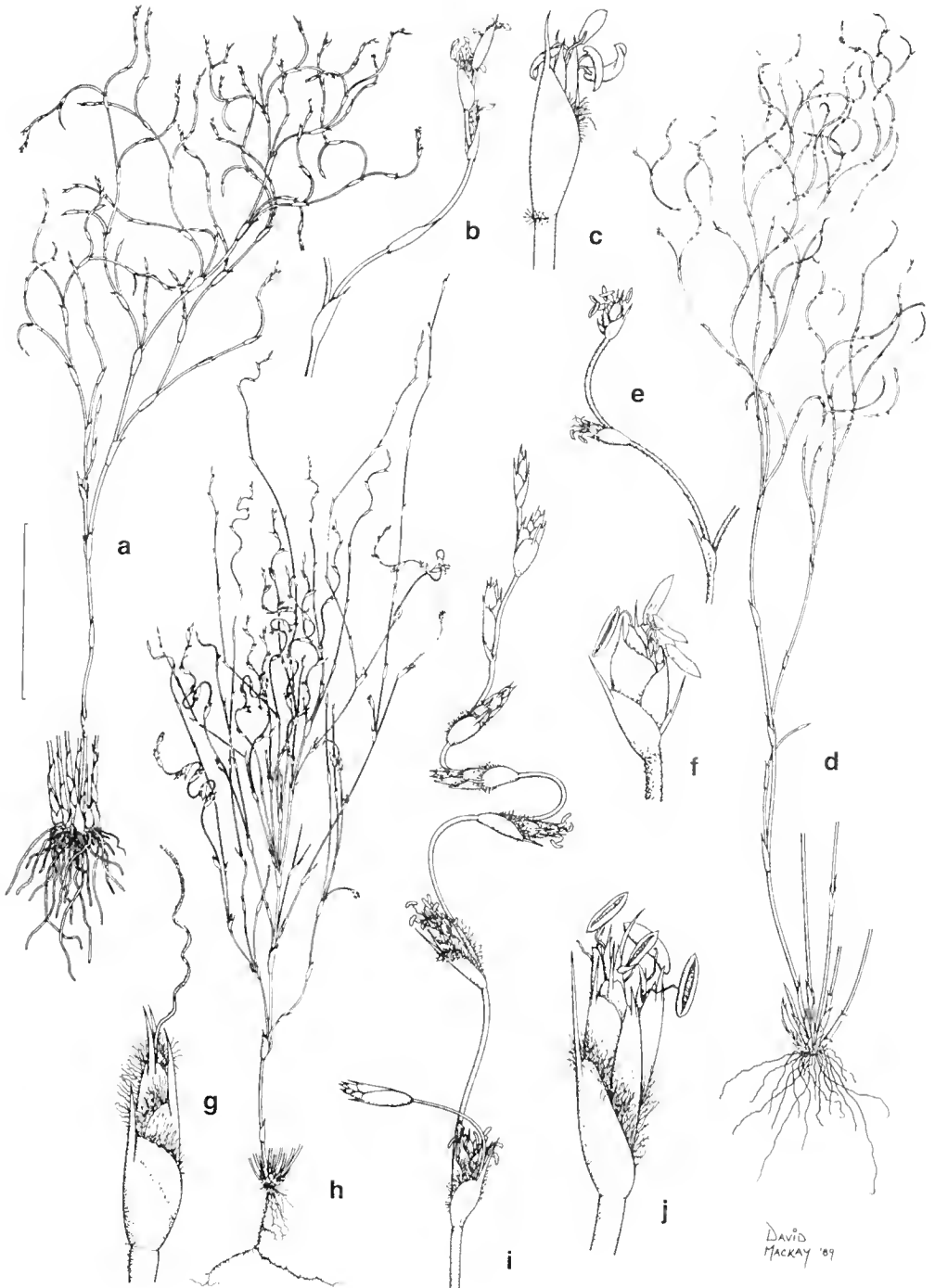


Fig. 1. a–c, *D. myriocladus*, male plant: a, habit; b, inflorescence; c, spikelet (Gibson to Grass Patch, 531 mile peg, Briggs 311, NSW 94960). d–f, *D. quiricanus*, male: d, habit; e, inflorescence; f, spikelet (Briggs 7941 & Johnson). g–j, *D. lateriticus*, g, female spikelet (Briggs 7517); h–j, male: h, habit; i, inflorescence; j, spikelet (Briggs 7439). Scale bar: a, d, h = 4 cm; b, e, i = 1 cm; c, f, g, j = 3.5 mm.

MO); 10 km W of Mogumber on Regans Ford Rd, 2 Oct 1984, *Briggs 7991 & Johnson* ♂ (NSW, CANB, L, NBG, PERTH), 7793 ♀ (NSW, PERTH, PRE); NNW of Gin Gin (details as for type), *Briggs 7443 & Johnson* ♂ (NSW, K, MEL, PERTH, PRE, RSA), 7437 ♀ (NSW, CANB, MO, K, NBG, PERTH), 7444 ♀ (AD, CANB, K, MEL, PERTH, PRE, RSA). Avon: 2 miles [c. 3 km] SW of Cunderdin, 27 Sep 1970, *Salasoo 4370* ♂ (NSW); Youndegin, 1890, *Eaton* ♂ (MEL).

2. *Desmocladus quiricanus* B.G. Briggs & L.A.S. Johnson, sp. nov.

A. D. myriocladus et *D. lateriticus* combinatione characterum sequentium distinguitur: spiculae masculinae breves (2–4 mm longae), obovoideae, glumis numerosis (10–17); vaginae culmorum brunneae vel ferrugineae, sine pilis longis albis; flores femineae tepalis 1–3.

Type: Western Australia: 19 km N of Ongerup on road to Lake Grace (33°47'S 118°29'E), 11 Oct 1984, *B.G. Briggs 7921b & L.A.S. Johnson* ♀ (holo NSW; iso A, CANB, K, L, MO, PE, PERTH, PRE, RSA)

Caespitose. Culms repeatedly branched, sinuous, sparsely to usually densely shortly villous and ± grey, to 30 cm tall, 0.5–1.5 mm diam., internodes numerous. Basal sheaths short, 5–20 mm long. Culm sheaths appressed, 4–9 mm long, glabrous or villous, dark red-brown, apex truncate to obtuse; lamina erect or reflexed, 2.5–4 mm long. Male spikelets solitary or rarely in pairs, ovoid to clavate, 2.0–4.0 mm long; 10–15-flowered; glumes 10–17, ovate, acute, 1.5–2.3 mm long, brown, margins usually villous, abaxial surface often sparsely villous, mucro to 0.8 mm long. Female spikelets borne singly, ellipsoid, 5.0–8.0 mm long, 1-flowered; glumes 4 or 5, ovate, acute, 1.5–4.8 mm long, light to dark brown, villous toward the apex. Male flowers: tepals 5, hyaline, acute, ± equal in length, 1.5–2.2 mm long; outer tepals lanceolate, acuminate, light brown; 2 inner tepals filiform and 1 lanceolate; anthers 0.9–1.2 mm long. Female flowers with 1–3 linear tepals, 3.7–5.0 mm long. Nut ellipsoid, c. 1.5 mm long, smooth, brown with pale lateral lines, stipitate, the style base persistent as a short apical beak. (Fig. 1d–1f).

The epithet commemorates Anna-Louise Quirico (Mrs Garvan), who gave expert technical assistance in studies of Restionaceae and who first recognised the distinctiveness of this species.

Distribution: occurs in southern inland Western Australia from south of Williams eastwards to south of Kulin, Lake Grace, Ongerup and to north of Esperance. Locally rare to abundant on clay or sandy-clay, often subsaline; in poorly drained and seasonally moist depressions in mallee woodland with shrubs or heath. Killed by fire (Meney, Pate & Hickman 1999).

Conservation status: reasonably widespread and sometimes locally common, but in a region where native vegetation has been much depleted.

Distinguished from *D. myriocladus* (Fig. 1a–1c) and *D. lateriticus* (Fig. 1g–1j) by the short broad obovoid male spikelets, 2–4 mm long, with more numerous (10–17) glumes. Also distinguished from *D. myriocladus* by the mostly dark brown or red-brown sheaths and glumes, and from *D. lateriticus* by the lack of long, spreading white hairs fringing the apical margin of culm sheaths, presence of tepals in the female flowers and shorter broader nuts.

Selected specimens examined: Western Australia: Darling: 34 miles [54 km] S of Williams, 28 Jul 1953, *Royce 4209* ♀ (PERTH), 4210 ♂ (PERTH); Beaufort R. Reserve, Apr 1992, *Meney & Pate* ♂ (NSW 254913). Roe: c. 12 km SE of Kulin on road to Tarin Rock, 12 Oct 1984, *Briggs 7941 & Johnson* ♂ (NSW, CANB, MEL, PERTH), 7942 ♀ (NSW, CANB, NBG, PERTH, RSA); Lake Grace, c. 19 km E along road to Lake King, just W of Pungurup Rd, 28 Sep 1992, *Spjut & Smith 12495* ♂ (PERTH); 19 km N of Ongerup (details as for type) ♂ (MEL, NBG, PERTH); Ongerup, at turn-off to town from Gnowangerup to Jerramungup road, 11 Oct 1984, *Briggs 7918 & Johnson* ♂ (NSW, AD,

CANB, K, MEL, MO, PERTH, PRE, RSA); 2.4 km S of Borden on road to Chester Pass, 11 Oct 1984, Briggs 7914 & Johnson ♀ (NSW, CANB, NBG, PERTH); 29.1 km N of Needilup, 11 Nov 1986, Hill, Johnson, Blaxell & Brooker ♀ (NSW 201320); Fitzgerald, N of Grass Patch [as Graspach], 2 Nov 1901, Diels 5296 ♀ (B, NSW) residual syntype of *D. myriocladus* (*Loxocarya myrioclada* E.F. Gilg), not conspecific with lectotype (see Briggs & Johnson 1998b).

3. *Desmocladus biformis* B.G. Briggs & L.A.S. Johnson, sp. nov.

Plantae masculinae culmis erectis, ramulis nullis ad nodos superiores; spiculae masculinae sessiles; plantae femineae ramulis recurvatis ad nodos superiores; spiculae femineae ramulos laterales terminantes.

Type: Western Australia: 3 km N of New Badgingarra on Brand Hwy, just S of Hill R. crossing, 25 Sep 1976, Briggs 6322 ♂ (holo NSW; iso CANB, K, MEL).

Caespitose, forming small, dense, many-culmed tussocks. Culms numerous, erect, terete, glabrous or pubescent, minutely tuberculate, 7–40 cm tall, 0.5–1.0 mm diam., internodes numerous; male plants with culms mostly branched only at lower nodes, straight and erect above; females more sinuous, with a short and strongly recurved branchlet at most upper nodes. Basal sheaths red-brown, to 14 mm long. Culm sheaths 2.5–6.5 mm long, appressed or \pm lax, acute, brown. Male spikelets borne singly at 5–10 upper nodes, sessile on culms or occasionally terminal on lateral branches, ovoid, 5.0–7.0 mm long, 6–18-flowered; glumes 6–18, oblanceolate, aristate, 1.7–2.9 mm long, light brown, glabrous, mucro 0.5–1.2 mm long. Female spikelets mostly terminal on lateral branchlets at 1–10 upper nodes, rarely sessile at culm nodes, ellipsoid, 4.5–8.8 mm long, 1–4-flowered; glumes 4–9, ovate, acute, 2.5–5.0 mm long, light brown, shortly ciliate toward the apex, mucro 0.6–1.6 mm long; the uppermost 1–4 glumes fertile. Male flowers: tepals 5, acute, \pm equal in length or inner tepals shorter, 1.5–2.4 mm long; anthers 1.0–1.3 mm long. Female flowers lacking tepals. Nut ellipsoid, 1.5–2.5 mm long, smooth, brown with pale lateral lines, stipitate, the style base persistent as a short blunt apical beak. (Fig. 2, 3a–3c).

The epithet is from the Latin *bi-*, two and *forma*, form or figure, referring to the dissimilarity in appearance of male and female plants.

Distribution: occurs in Western Australia in a disjunct distribution, from near Eneabba and Badgingarra south to Gin Gin and from the Stirling Ranges to ENE of Jerramungup. Grows in sand or clayey sand, often with some laterite gravel, in heath or shrubland, often with mallee eucalypts. Regenerates from seed after fire (Meney, Pate & Hickman 1999). Sometimes infected by smut fungus (Sieler et al. 1999).

Conservation status: locally common in the south but apparently uncommon in the north where the conservation status of the populations is uncertain and may be vulnerable (Meney, Pate, Dixon, Briggs & Johnson 1999).

Distinguished among the species of *Desmocladus* by the substantial vegetative sexual dimorphism: male plants have straight erect culms, mostly unbranched at the upper nodes, bearing a sessile spikelet at each upper node; culms of female plants are more sinuous, most upper nodes bearing a short, strongly recurved branchlet terminated by a spikelet.

The southern populations were initially considered to be specifically distinct from the northern ones and the unpublished name '*D. tenuis* B.G. Briggs & L.A.S. Johnson unpubl.' was used for them by Williams et al. (1998) and in our determinations in some herbaria. Following further study, plants in the two areas are considered conspecific, although those in the north are mostly taller (to 40 cm), and have somewhat larger spikelets, than those in the south (which are 7–30 cm tall).

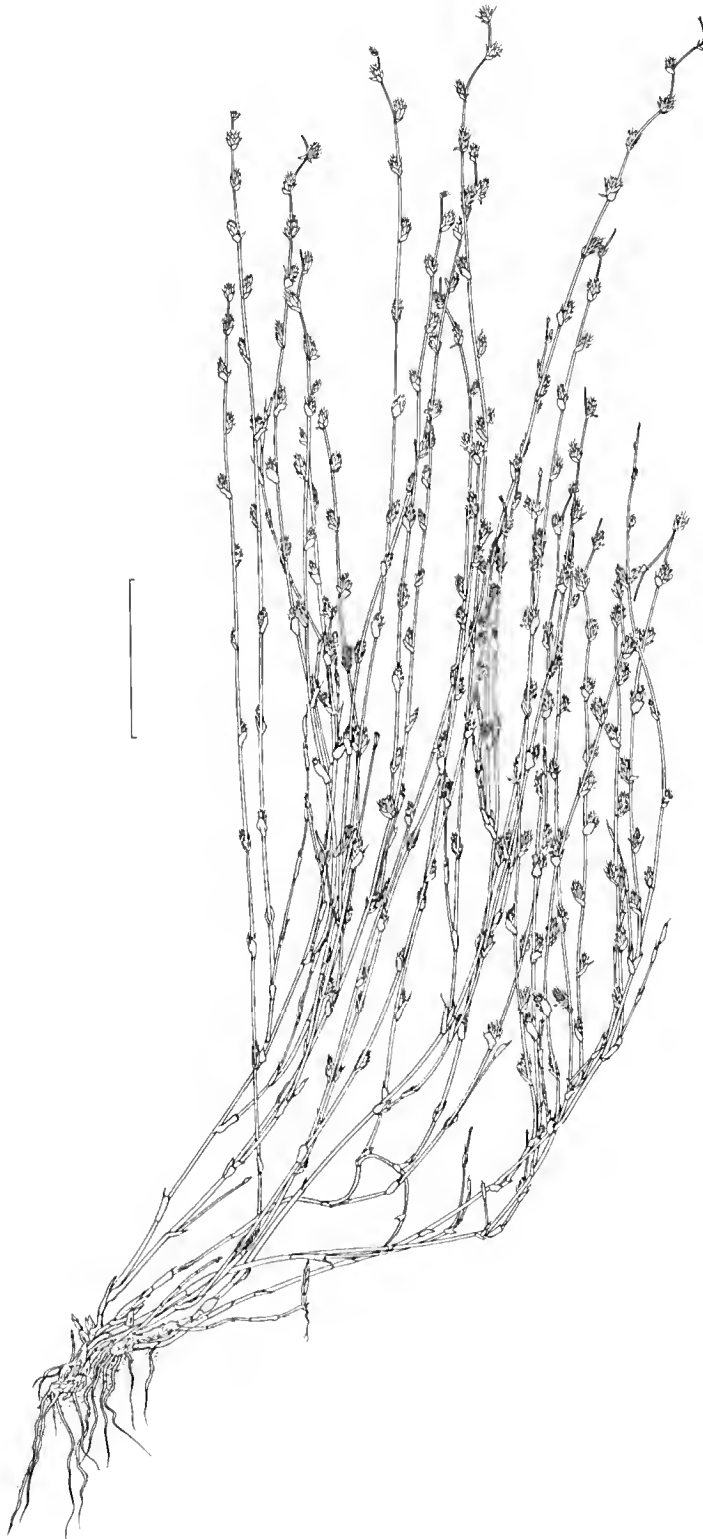


Fig. 2. *D. biformis*, male plant, showing some only of the very numerous culms (Briggs 8615).
Scale bar: 4 cm.

Selected specimens examined: Western Australia: Irwin: Lake Inoon Rd 1 km W of Brand Hwy, Sep 1990, *Meney* ♂ (KPBG); Eneabba-Carnamah Rd, E of Rose Rd, E of Eneabba, 3 Dec 1992, *Griffin* 8150 ♀ (PERTH); W of Eneabba on Leeman Road, c. 5 km from Brand Hwy, near Road 8, Inoon, 7 Sep 1990, *Briggs* 8615, *Johuson*, *Meney*, *Pate* & *Linder* ♂ (NSW, BOL, CANB, K), 8616 ♀ (BOL, NSW); 3 km N of New Badgingarra (details as for type), *Briggs* 6321 ♀ (NSW, PERTH); 5 km S of New Badgingarra, 9 Sep 1979, *Keighery* 2521 ♂ (PERTH). Eyre: 2.9 km NE of Young R. on Red Gum Pass Rd, Stirling Range Natl Park, 30 Oct 1988, *Briggs* 8476a & *Johuson* ♂ (NSW), 8476b ♀ (NSW); S of Stirlings, *Chessell* & *McComb* 128, Aug 1964 ♂ (PERTH). Roe: c. 20 miles (32 km) SE of Ongerup, 13 Sep 1966, *Briggs* 491 ♂ (NSW, PERTH), 490 ♀ (NSW, K, MEL, NBG); Chillinup road, 14.4 km SW of Rams Head, 11 Oct 1984, *Briggs* 7895 & *Johuson* ♂ (NSW, PERTH), 7896 ♀ (NSW, PERTH, MEL); 8 km NNW of Mt Drummond, 13 Nov 1986, *Newby* 11395 ♀ (PERTH, NSW).

4. *Desmocladus semiplanus* B.G. Briggs & L.A.S. Johnson, sp. nov.

Culmi concavo-convexi, internodiis 4–6, ramulis 1–3(–4) per nodum instructis; vaginae culmorum brunneae; ramuli plantarum feminearum valde recurvati.

Type: Western Australia: 22.8 km E of Brand Hwy on Green Head–Coorow Road, Alexander Morrison National Park (30°01'S 115°20'E), 30 Sep 1984, *B.G. Briggs* 7735 & *L.A.S. Johnson* ♂ (holo NSW; iso AD, CANB, MEL, PERTH, RSA).

Caespitose, forming small tussocks. Culms erect, concavo-convex, tuberculate, glabrous to densely pubescent with short hairs, to 22 cm tall, 0.8–1.5 mm diam., internodes 4–6; branchlets 1–3(–4) at most nodes, straight to flexuose, culm-like, floriferous, 4–6 cm long. Basal sheaths short, 4–12 mm long. Culm sheaths appressed, mostly red-brown or dark brown, 3.5–7.5 mm long, truncate, glabrous apart from an apical fringe of white cilia; lamina erect, c. 0.5–2.8 mm long. Male spikelets borne singly, terminal on branchlets, ovoid, 5.0–8.0 mm long, 10–14-flowered; glumes 10–14, ovate-lanceolate, 4.0–6.0 mm long, pale brown, hard, acute, apical margin villous, mucro 0.9–1.5 mm long. Female spikelets borne singly, terminal on branchlets, ellipsoid, c. 4–5 mm long, 1-flowered; glumes 4–6, ovate, acute, 2.3–4.0 mm long, reddish brown to pale brown, apical margin ciliate, mucro to 1.2 mm long. Male flowers: tepals 2–5, oblanceolate, ± equal in length or inner tepals slightly shorter, 3.2–5.3 mm long; lower flowers frequently with more tepals than upper flowers; anthers 1.2–1.7 mm long. Female flowers lacking tepals. Nut not seen. (Fig. 3d–3g).

The epithet is from the Latin *semi-*, half, and *planus*, flat, referring to the branchlets that are flattened only on the adaxial surface.

Distribution: occurs in Western Australia from south of Mingenew to Badgingarra. Locally occasional to frequent on deep sand, sometimes over laterite, in heath and woodland; in moderately low rainfall regions; sites seasonally moist. Regenerates by seed after fire (*Meney*, *Pate* & *Hickman* 1999).

Distinguished among the species of *Desmocladus* by the mostly concavo-convex culms that have 4–6 internodes and 1–3(–4) branches at most nodes, and by the dark brown culm sheaths; resembling *D. biformis* in that the branchlets are more strongly recurved on female plants.

Conservation status: not considered to be at risk.

Selected specimens examined: Western Australia: Irwin: 30 km SSW of Mingenew, Moorlaby Rd 20 km S of Midlands Rd, 30 Sep 1984, *Briggs* 7500 & *Johnson* ♀ (NSW, AD, CANB, MEL, PERTH, RSA), 7504 ♂ (NSW, A, AD, CANB, K, L, MEL, MO, PE, PERTH, RSA); Tathra National Park, *Krauss* 150 & *Howitt*, 22 Apr 1989 ♀ (NSW, CANB, K, PERTH); Alexander Morrison National Park (details as for type), *Briggs* 7736a & *Johnson* ♀ (NSW); Arrowsmith R., Oct 1985, *Pignatti* 550 ♂ (RO, NSW); 8 km N of Eneabba, 14 Aug 1976, *Wittwer* 1822 ♂ (PERTH, NSW); 7 km W of Eneabba, 9 Sep 1979, *Keighery* 2564 ♂ (PERTH); Eneabba, 1 Sep 1979, *Haegi* 1921 & *Powell* ♂ (NSW, AD, CANB, PERTH, PRE, RSA); Badgingarra, 9 Aug 1981, *Greuter* 17916 ♂ (B, NSW).



Fig. 3. a-c, *D. biformis*, a & b, female: a, habit; b, spikelet (Briggs 490); c, male: part of inflorescence (Briggs 491). d-g, *D. semiplanus*, d & e, female: d, habit; e, spikelet (Briggs 7736a); f & g male: f, habit; g, spikelet (Briggs 7735). Scale bar: a, d, f = 4 cm; b, e, g = 5 mm; c = 1 cm.

5. *Desmocladus austrinus* B.G. Briggs & L.A.S. Johnson, sp. nov.

A. D. flexuosus habitu caespitoso distinguitur. *A. D. virgatus* combinatione characterum sequentium distinguitur: ramuli longiores et strictiores; spiculae masculinae plerumque solitariae; spiculae femineae breviores (5.5–7.7 mm longae), mucronibus glumarum brevioribus (ad 1.3 mm longis).

Type: Western Australia: Junction of Chillinup Rd and Kojoneerup Rd, c. 12 km (direct) WNW of Wellstead, 13 Sep 1990, Briggs 8705, L. Johnson, J. Pate, K. Meney & P. Linder ♂ (holo NSW; iso BOL, KPBG, PERTH).

Caespitose, forming few- or many-culmed tussocks. Culms erect, terete, smooth to finely striate, glabrous or pubescent with long hairs, to 70 cm tall, 0.5–1.5 mm diam., internodes numerous; branchlets numerous, 3–16 per node, flexuose and often recurved, slender, to 16 cm long, longer than the internodes so that the upper culm is largely obscured by branchlets, lower branchlets longer than upper. Basal sheaths short, to 10 mm long. Culm sheaths often reflexed, ovate to spatulate, 12–22 mm long, apex truncate; lamina 1.5–10 mm long. Male spikelets mostly borne singly, terminal or sessile and axillary on branchlets, ovoid, 4.0–6.0 mm long, 14–20-flowered; glumes 14–24, narrow-elliptic, acuminate, glabrous, 1.3–2.3 mm long, mucro 0.3–1.3 mm long. Female spikelets borne singly, terminal or sessile and axillary on branchlets, narrow-ovoid, 5.5–7.7 mm long, 1-flowered; glumes 3–8, broadly ovate, acute, 2.3–5.5 mm long, brown, abaxial surface glabrous or sparsely pilose, mucro to 1.3 mm long. Male flowers: tepals 5, scarious, narrow lanceolate, acuminate, ± equal in length, 1.7–2.6 mm long; anthers 0.8–1.4 mm long. Female flowers: 1–5 tepals occasionally present. Nut ellipsoid, 2.5 mm long, smooth, brown with pale lateral lines, stipitate, the style base persistent as a short apical beak. (Fig. 4d).

The epithet is from the Latin, *austrinus*, southern, referring to the species' occurrence in the south of Western Australia.

Distribution: occurs in the south of Western Australia from near Albany and the Stirling Range east to Mt Ragged. Locally abundant in sand or peaty sand or over granite, quartzite or laterite; in heath, shrubland or with mallee eucalypts, near the coast and on ranges some distance inland. Regenerates by seed after fire.

Conservation status: not at risk.

Resembling *D. flexuosus* (Fig. 4e) and especially *D. virgatus* (Fig. 4a–4c), but differing from *D. flexuosus* in its tufted habit and from *D. virgatus* in the lateral branchlets longer and less tightly curled, male spikelets mostly borne singly, and female spikelets 5.5–7.7 mm long with glume mucros to 1.3 mm long. *D. flexuosus* occurs mainly on coastal dunes and headlands, on sand or limestone, from Jurien to Cape Leeuwin and east to Israelite Bay; it is distinctive among these species in its long horizontal or ascending rhizomes, often developing small clusters of erect or ascending culms at widely spaced intervals. *D. virgatus* ranges from Eneabba to Badgingarra and Toodyay, on sand, or sand with laterite, in inland rather than coastal sites; male spikelets are often 2(–3) together; female spikelets 7.2–8.0 mm long, glume mucros to 2.2 mm long.

Selected specimens examined: Western Australia: Darling: Two Peoples Bay, 8 Oct 1984, Briggs 7644 & Johnson ♀ (NSW, AD, CANB, MEL, PERTH, RSA). Eyre: 0.1 km E of Balicup Rd on Salt R. Rd, c. 20 km E of Cranbrook, 30 Oct 1988, Briggs 8488a & Johnson ♂ (NSW, K, PERTH), 8488b ♀ (NSW, K, PERTH); 0.4 miles [0.6 km] from Red Gum Springs towards Cranbrook, Stirling Range Natl Park, 10 Oct 1968, Canning ♂ (CANB, BRI, NSW); 12.3 km NNE of Young R. on Red Gum Pass Rd., 30 Oct 1988, Briggs 8481 & Johnson ♂ (NSW, AD, CANB, K, L, MEL, MO, NY, PERTH); lower N slopes of Mt Hassell, 8 May 1979, Keighery 2301a ♂ (KPBG, NSW), 2301b ♀ (KPBG, NSW); junction of Chillinup Rd and Kojoneerup Rd, (details as for type) Briggs 8706 et al. ♀ (NSW, BOL, KPBG, PERTH); 37 km W of Bremer Bay, 10 Oct 1984, Briggs 7840 & Johnson ♂ (NSW, CANB, PERTH, RSA); SW face of Middle Mt Barren, 17 Jul 1970, Royce 9033 ♂ (PERTH); summit of East

Mt Barren, eastern side, Fitzgerald R. Natl Park, 3 Sep 1986, *Chapman 519* ♀ (NSW, PERTH); Ginganup [as Gininup Wells], Feb 1911, *Staer* ♂ (NSW 48055), ♀ (NSW 91581); Lucky Bay E of Esperance, 10 Sep 1966, *Briggs 370* ♂, (NSW), 369 ♀ (NSW). Roe: SW slopes of Mt Ragged, $\frac{2}{3}$ rds of the way up, 6 Jan 1979, *Barnsley 307* (CANB, NSW, PERTH).

6. *Desmocladus castaneus* B.G. Briggs & L.A.S. Johnson, sp. nov.

A *D. fasciculatus* combinatione characterum sequentium distinguitur: habitus caespitosus, rhizomate haud producto; vaginae basales castaneae; internodia superiora internodia inferiora aequantia.

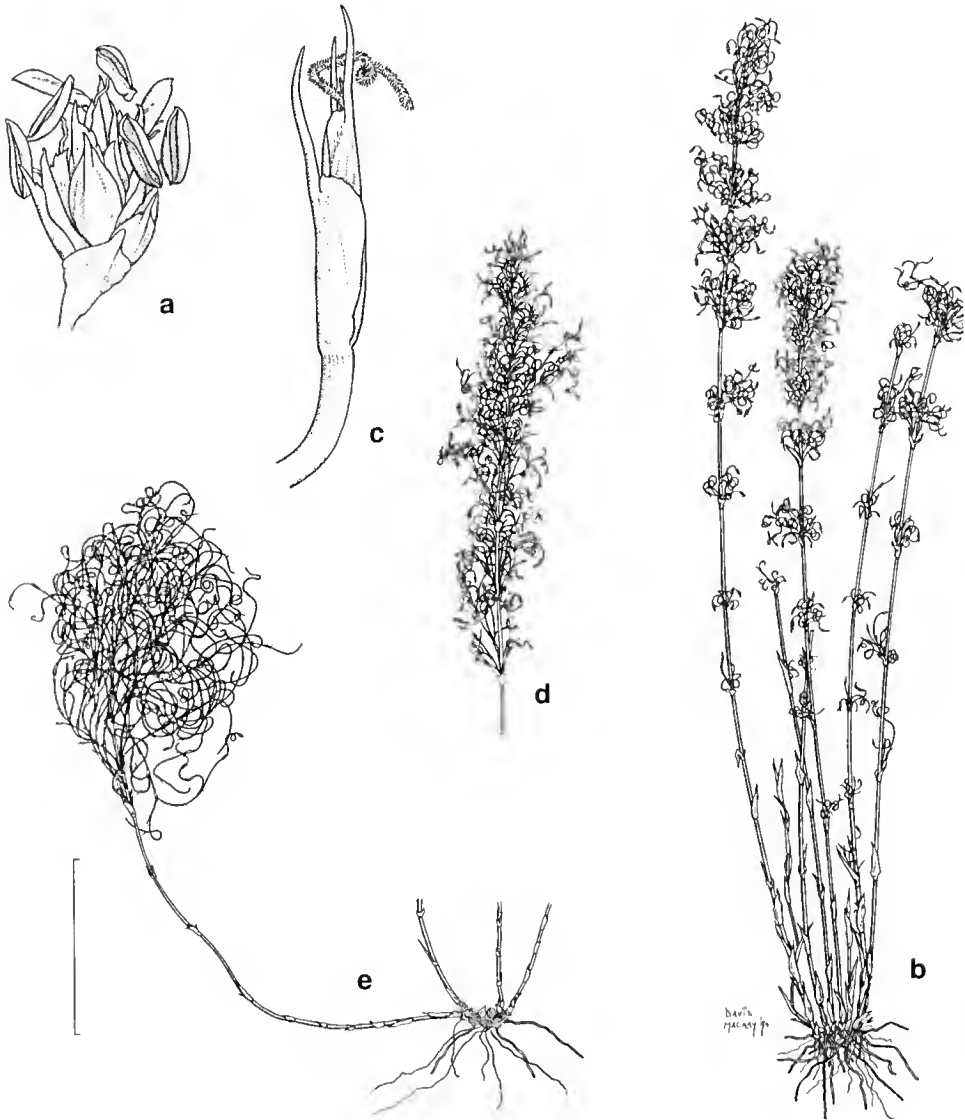


Fig. 4. a-c, *D. virgatus*, a, male spikelet (18.8 km E of Brand Hwy on Coorow Rd, *Briggs 8620 et al.* NSW 233366); b & c, female: b, habit; c, spikelet (*Briggs 8621*); d, *D. austrinus*, female: floriferous culm (*Briggs 8706 et al.*). e, *D. flexuosus*, female: habit (Parrys Inlet, c. 15 km W of Denmark, *Mezey & Pate* NSW 254910). Scale bar: a, c = 4.2 mm; b, d, e = 10 cm.

Type: Western Australia: Governor Broome Road, c. 3 km E of Scott R. Road, Scott R. Plains (34°15'S 115°18'E), 2 Oct 1976, B.G. Briggs 6052 ♂ (holo NSW; iso K, PERTH).

Caespitose. Culms unbranched but with clusters of 12–22 branchlets at most nodes, erect, terete or furrowed, glabrous to sparsely villous, minutely tuberculate, 5–30 cm long, 0.4–1.2 mm diam., internodes 3–8; branchlets straight or recurved, 1–3.5 cm long, laterally flattened and rectangular in cross section. Basal sheaths often conspicuous, appressed, chestnut-brown, to 16 mm long. Culm sheaths erect, lax, oblanceolate to obovate, 3–9 mm long, obtuse or truncate; lamina erect, 2–3.5(–40) mm long. Male spikelets terminal on branchlets, borne singly or occasionally paired, narrow-ovoid, 4–4.5 mm long, 3–4-flowered; glumes 3 or 4, ovate-lanceolate, 2.2–3.5 mm long, membranous, pale brown, truncate to acuminate, glabrous or ciliate toward the apex, mucro to 1.0 mm long. Female spikelets on branchlets much shorter in fruiting stage than sterile branchlets, narrow-ovoid, 3.5–6.0 mm long, 1-flowered; glumes 2 or 3, ovate to lanceolate, acute, 1.8–4 mm long, light brown, margins pilose, abaxial surface glabrous or pilose toward the apex, mucro to 2.2 mm long. Male flowers: tepals 5 or 6, acute, linear-lanceolate, equal in length or inner tepals shorter, 2.5–4.0 mm long; anthers 1.5–2.3 mm long. Female flowers lacking tepals. Nut ovoid, c. 1.5 mm long, dark brown with pale lateral lines, shortly stipitate, the style base persistent as a blunt apical beak. (Fig. 5a, 6b, 6c).

The epithet is from the Latin *castaneus*, chestnut-coloured, referring to the often conspicuous chestnut-brown basal scales and the usually chestnut-brown culm sheaths.

Allied to *D. fasciculatus* (Figs 5b, 6a) but distinguished by its tufted habit without an extended horizontal rhizome, the colour of the basal sheaths and culm sheaths, the lowest culm internode less than twice as long as upper culm internodes, and the sparser indumentum.

Distribution: occurs in Western Australia in a discontinuous distribution; from near Badgingarra southwards to the Scott R. east of Augusta, and from the Stirling Range eastwards to Cape Le Grand National Park (east of Esperance). Locally abundant in heath and shrubland on sands, often with laterite gravel, in regions of moderate or low rainfall; sites seasonally moist. Unlike *D. fascicularis* which resprouts, *D. castaneus* regenerates by seed after fire (Meney, Pate & Hickman 1999) but seed viability declines rapidly with time (Meney, Dixon & Pate 1999).

In the eastern area of occurrence most, but not all, plants are compact with culms 5–15 cm tall, internodes 2.5–3 cm long and crowded branchlets 1–2 cm long (e.g. Fig. 6b). Plants in the western segment of the range are mostly taller with culms to 25 cm tall, internodes 4–5 cm long and branchlets 2–3.5 cm long (e.g. Fig. 5a, 6c). *D. castaneus* was referred to as '*Loxocarya* sp. D' by Rye (1997), as indicated by Briggs & Johnson (1999). The plant illustrated in Morley & Toelken (1983, p. 371), under the name *Loxocarya fasciculata*, is *D. castaneus*.

Conservation status: widespread and locally common, though unevenly distributed; not at risk.

Selected specimens examined: Western Australia: Irwin: c. 13 km (direct) SSW of Badgingarra, Bibby Rd, c. 2 km W of Brand Hwy toward Cervantes, 6 Sep 1990, Briggs 8580a, Johnson, Meney, Linder & Pate ♂ (NSW, BOL, MEL, PERTH), 8580b ♀ (NSW, BOL, MEL, PERTH). Darling: Serpentine, Sep 1901, Fitzgerald ♂ (NSW 48058); Pinjarra, 30 Sep 1901, Morrison ♂ (K); 1.1 km E of Scott River Rd, on Governor Broome Rd, c. 16 km ENE of Augusta, 11 Sep 1990, Briggs 8673, Johnson, Meney, Pate & Linder ♂ (BOL, KPBG, PERTH), 8674 ♀ (KPBG, PERTH). Eyre: 2 km E of South Stirling, 8 Oct 1984, Briggs 7659 & Johnson ♂ (NSW, AD, MEL, NBG, PERTH, RSA), 7660 ♀ (NSW, A, AD, BOL, CANB, K, L, MEL, MO, NBG, PE, PERTH, RSA); 17 km NNW of Young R. crossing on Ravensthorpe–Esperance Rd, 27 Sep 1968, Donner 2798 ♂ (AD); 39 miles (c. 60 km) W



Fig. 5. a, *D. castaneus*, male (Briggs 6052). b, *D. fasciculatus*, male (Wattle Grove, R. & E.F. Melville & A.S. George NSW 257377). Scale bar: = 4 cm.

of Esperance on Eyre Hwy, 11 Sep 1966, *Briggs* 418 ♂ (NSW, PERTH), 419 ♀ (NSW); Lucky Bay, Cape Le Grand Natl Park, 10 Sep 1966, *Briggs* 400 ♀ (NSW, MEL, PERTH).

7. *Desmocladus elongatus* B.G. Briggs & L.A.S. Johnson, sp. nov.

A *D. fasciculatus* et *D. castaneus* combinatione characterum sequentium distinguitur: culmi (18–)25–40 cm longi; ramuli 5–9 cm longi; ramuli floriferi plantarum feminearum ramulos steriles aequantes. A *D. fasciculatus* etiam habitu caespitoso, internodiis superioribus internodia inferioria aequantia distinguitur.

Type: Western Australia: Coomallo picnic area 24 km NNW of Badgingarra, opposite junction Brand Hwy and Jurien Rd (33°13'30"S 115°23'30"E), 29 Sep 1984, B.G. Briggs 7481 & L.A.S. Johnson ♂ (holo NSW; iso AD, CANB, MEL, PERTH, RSA).

Caespitose, often with some development of short densely intertwined horizontal rhizomes to 2.5 cm long, c. 3 mm diam. Culms unbranched but with clusters of 5–8 branchlets at most nodes, erect, terete to semi-terete, often longitudinally furrowed, minutely tuberculate, sparsely villous, to 40 cm tall, 1.0–1.7 mm diam., internodes 6–9; branchlets straight, 5–9 cm long, laterally flattened and rectangular in cross section. Basal sheaths short, pale brown, to 15 mm long. Culm sheaths broad obovate, 7–18 mm long, sparsely villous; lamina erect, 2–7 mm long. Male spikelets borne singly, terminal on branchlets, elliptic, 7.0–9.5 mm long, 14–20-flowered; glumes 14–21, ovate-lanceolate, 2.8–4.5 mm long, membranous, glabrous, acute, mucro 0.6–1.5 mm long. Female spikelets borne singly, terminal on branchlets as long in fruiting stage as sterile branchlets, ellipsoid, 8.0–9.3 mm long, 1-flowered; glumes 4 or 5, ovate-lanceolate, acute, 3.5–7.0 mm long, dark brown, glabrous, mucro to 1.0 mm long; the uppermost glume reduced, lanceolate. Male flowers: tepals 5, linear-lanceolate, ± equal in length, 2.7–4.2 mm long, acute; anthers 1.3–1.9 mm long. Female flowers: tepals (0–1–)2(–3), narrow linear, 2.0–4.5 mm long. Nut oblong, c. 2 mm long, brown with pale lateral lines, stipitate, the style base persistent as a conical beak. (Fig. 6d–6g).

The epithet is from the Latin *elongatus*, referring to the culms and branchlets which are longer than in related species.

Distribution: occurs from north of Eneabba to Cataby in the west of Western Australia. Locally frequent on deep sand over laterite, in heath, mostly in well-drained sites. Regenerates by seed after fire (Meney, Pate & Hickman 1999) but seed viability declines rapidly with time (Meney, Dixon & Pate 1999).

Distinguished from *D. fasciculatus* (Figs 5b, 6a) and *D. castaneus* (Figs 5a, 6b, 6c) by the long culms (18–)25–40 cm tall, branchlets 5–9 cm long and few (5–8) at each node, female spikelets on branchlets as long in fruiting stage as sterile branchlets. Distinguished from *D. fasciculatus* also by the tufted habit and uniform length of internodes. *D. fasciculatus* has culms mostly 8–20 cm long, branchlets 1–2.5 cm long and 14–19 at each node; the lowest internode is more than twice as long as upper internodes.

Conservation status: locally common, not considered to be at risk. It received the conservation code 2KC (referred to as '*Loxocarya elongata* ms.') of Briggs and Leigh (1996), but it is more widespread than originally known. *D. elongatus* was also referred to as '*Loxocarya* sp. C' by Rye (1987).

Selected specimens examined: Western Australia: Irwin: 12 km N of Eneabba, 27 Oct 1981, *Newby* 9403 ♂ (PERTH); Eneabba, 28 Aug 1984, *Bates* 3860 ♂, ♀ (PERTH); Coomallo Picnic area (details as for type) *Briggs* 7483 & *Johnson* ♀ (NSW, A, CANB, K, L, MO, PE, PERTH, PRE, RSA); Boothendarra Rd N of Badgingarra 7 Nov 1988, *Griffin* 5465 ♂ (PERTH); 4 km N of Old Badgingarra, Winjardie Rd 4 km N of junction with North West Rd, 29 Sep 1984, *Briggs* 7489 & *Johnson* ♀ (NSW, CANB, K, MO, NBG, PERTH); 5.6 km E of Brand Hwy along Mullering Rd, 2 Jul 1992, *Cranfield* 8294 & *Spencer* ♂ (PERTH); c. 100 km NNW of Gingin, 2 Sep 1970, *Coveny* 3166 & *Aplin* ♂ (NSW, AD, K, PERTH).

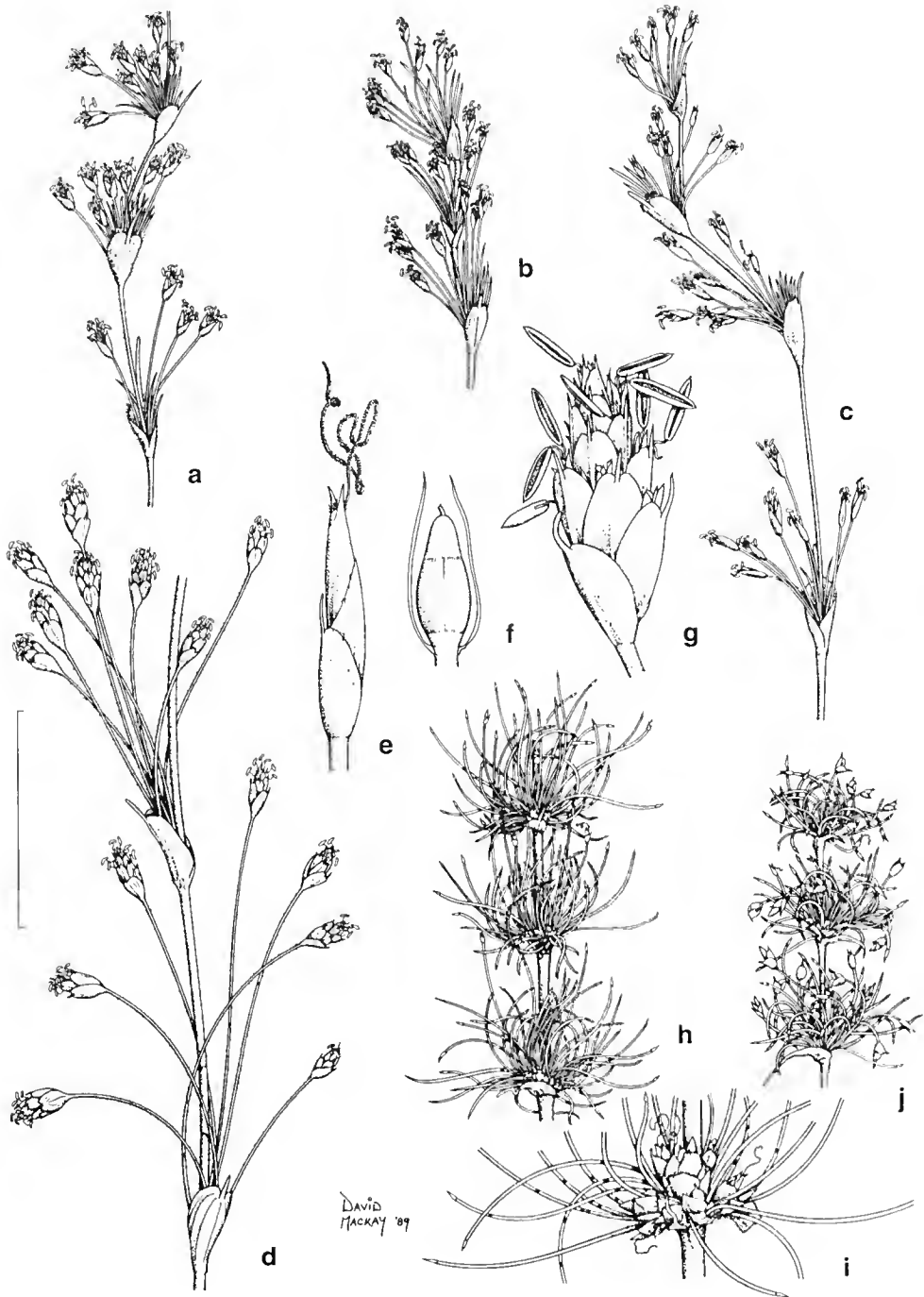


Fig. 6. Portions of inflorescences. a, *D. fasciculatus*, male (Wattle Grove, R. & E.F. Melville & A.S. George NSW 257377). b & c, *D. castaneus*, b, male (Briggs 418); c, male (Briggs 6052). d–g, *D. elongatus*, d, male (Briggs 7481); e, female spikelet (Briggs 7483); f, fruit with attached tepals (Briggs 7483); g, male spikelet (Briggs 7481). h & i, *D. parthenicus*, h, part of flowering culm (Briggs 6323); i, single node of fertile culm. j, *D. diacolpicus*, part of flowering culm (Symon 6271). Scale bar: a, b, c, d, h, j = 3 cm; e, f, g = 6 mm; i = 1.5 cm.

8. *Desmocladus parthenicus* B.G. Briggs & L.A.S. Johnson, sp. nov.

A *D. fasciculatus* et *D. castaneus* combinatione characterum sequentium distinguitur: plantae parthenocarpae; ramuli numerosi (c. 40 in quoque nodo); spiculae sessiles. A *D. fasciculatus* etiam habitu caespitoso distinguitur.

Type: Western Australia: 3 km N of New Badgingarra on Brand Hwy, just S of Hill R. crossing (30°22'S 115°30'E), 25 Sep 1976, B.G. Briggs 6323 ♀ (holo NSW; iso PERTH, RSA).

Caespitose; plants all female. Culms unbranched but with clusters of c. 40 branchlets at most nodes, erect, terete, minutely tuberculate, pubescent, to 40 cm tall, 1.0–1.4(–2.5) mm diam.; internodes 5–17, 1–6 cm long, often largely exposed and not hidden by branchlets; branchlets numerous, straight to reflexed, slender, to 2.5 cm long, laterally flattened and rectangular or narrow deltoid in section. Basal sheaths short, to 10 mm long. Culm sheaths 7–13 mm long, sparsely pilose, often reflexed, lamina erect, 2–6 mm long. Female spikelets mostly sessile among the bases of branchlets, numerous at each culm node, occasionally terminal on branchlets, ovoid, 4.0–6.0 mm long, 1-flowered; glumes 4–6, broad-ovate, obtuse, 1.7–3.0 mm long, straw-coloured, abaxial surface glabrous or pilose, mucro to 0.8 mm long; the uppermost glume imbricate and persistent around the fruit after dehiscence forming a striate cone-like cap or coat. Female flowers lacking tepals. Nut ellipsoid, c. 2.0 mm long, shed enclosed in the innermost glume, with a short stipe below that glume and also a very short stipe below the ovary. Setting abundant seed apomictically (parthenocarpic); male plants not known. (Fig. 6h, 6i).

The epithet is from the Greek *parthenos*, a virgin, referring to the parthenogenetic breeding system.

Distribution: occurs in Western Australia from near Kalbarri, inland and south to Tambellup, Ongerup, east of Lake King and near Mt Ragged. Locally frequent to occasional in heath and woodland on sands in low rainfall regions; sites seasonally moist. Regenerates by seed after fire (Meney, Pate & Hickman 1999).

Conservation status: widespread and common.

Distinguished from *D. fasciculatus* (Figs 5b, 6a) and *D. castaneus* (Figs 5a, 6b, 6c) by the dense clusters of numerous (c. 40 per node) branchlets, the mostly sessile spikelets and parthenogenetic breeding system (Pate & Meney 1999). Distinguished also from *D. fasciculatus* by the tufted habit and lack of an elongated basal culm internode.

Selected specimens examined (all ♀): Western Australia: Irwin: 10.5 km E of Kalbarri, 24 Oct 1981, Newbey 9362 (PERTH); 3.7 km from Baline on road to Binnu, 13 Aug 1991, Briggs 8880 & Johnson (NSW); 'Burma Rd' c. 30 miles [48 km] SE of Geraldton, 29 Sep 1962, Phillips 1563 (CANB, NSW); c. 29 km W of Mingenew on Dongara Rd, 1 Oct 1979, Wilson 2673 (NSW); Strawberry–Walkaway Rd, 46 km S of Walkaway, 28 Sep 1976, Briggs 6420 (NSW, AD, MEL, PERTH); Coomallo picnic area, 24 km NNW of Badgingarra opp. junction of Brand Hwy and Jurien Rd, 29 Sep 1984, Briggs 7486 & Johnson (NSW); Watheroo Natl Park, W of Watheroo, 6 Oct 1971, Royce 9631 (PERTH). Darling: 4.5 km W of Mogumber on Regans Ford Rd, 2 Oct 1984, Briggs 7789 & Johnson (NSW). Avon: 5.5 km N of Wongan Hills on Craig Rd, 2 Nov 1988, Briggs 8552 & Johnson (NSW, K, PERTH); 15 miles [24 km] S of Tanumin, 2 Aug 1968, Royce 8444 (PERTH); Tutanning Reserve, 32 km ENE of Pingelly (Possum Rd near Echidna Rd), 4 Sep 1966, Briggs 183 (NSW, BRI, CANB, HO, K, L, NBG); 10 km WNW of Jitarning, 13 Jan 1978, Huatiuk 780070 (PERTH); Near Lime Lake c. 13 km S of Wagin, 30 Aug 1959, Eichler 15873 (AD). Roe: c. 16 miles [26 km] SE of Ongerup, 13 Sep 1966, Briggs 481 (NSW, A, CANB, US); Between Gibson and Salmon Gums near 531 mile peg, 8 Sep 1966, Briggs 307 (NSW).

9. *Desmocladus diacolpicus* B.G. Briggs & L.A.S. Johnson, sp. nov.

Plantae parthenicarpaе, a *D. parthenicus* ramulis c. 20 in quoque nodo, spiculis plerumque ramulos laterales terminantibus distinguitur.

Type: South Australia: Hinks National Park, the inner NW angle on the Reserve, S of Verran Hill road exit, 9 Oct 1969, D.E. Symon 6271 ♀ (holo AD; iso CANB, NSW).

Caespitose; plants all female. Culms unbranched but with clusters of c. 20 branchlets at most nodes, erect, terete, minutely tuberculate, glabrous or densely pubescent with short hairs, to 20 cm tall or rarely taller, 0.7–1.2 mm diam.; internodes 6–10, often partly exposed and not hidden by branchlets; branchlets slender, straight to flexuose or tightly recurved, to 2.5 cm long, laterally flattened and rectangular or narrow deltoid in cross section. Basal sheaths reddish brown, to 15 mm long. Culm sheaths 8–13 mm long, glabrous or sparsely pilose, often reflexed; lamina erect, c. 5 mm long. Female spikelets single and terminal on branchlets, sometimes appearing sessile at flowering stage but branchlets elongating by fruiting stage, ellipsoid, c. 5.0 mm long, 1-flowered; glumes 3–6, broad-ovate, acute, 1.5–4.3 mm long, brown, abaxial surface glabrous or partially pilose, mucro to 0.6 mm long, the uppermost glume imbricate and persistent around the fruit at dehiscence forming a pubescent cone-like cap or coat. Female flowers lacking tepals. Nut narrow ellipsoid, c. 2.0 mm long, shed enclosed in the innermost glume, with a short stipe below that glume and also a very short stipe below the ovary. Setting seed apomictically (parthenocarpic); male plants not known. (Fig. 6j).

The epithet is from the Greek *dia*, through or between, and *kolpos*, bay or gulf, referring to the species occurrence on both sides of the Great Australian Bight.

Distribution: occurs in South Australia in the Eyre Peninsula and collected from the Ongerup district of Western Australia, c. 130 km NNE of Albany. In heath with mallee eucalypts on sand.

Conservation status: endangered; conserved in part of the range but presumed extinct elsewhere. In South Australia very restricted in occurrence but conserved in Hinks National Park. In Western Australia rare if surviving, restricted in occurrence and in a region subject to extensive clearing of natural vegetation and salinisation; reported as most probably extinct in Western Australia (Meney, Pate & Hickman 1999; Meney, Pate, Dixon, Briggs & Johnson 1999; Pate 2000).

Resembling *D. parthenicus* (Fig. 6h, 6i), especially in the parthenocarpic breeding system and fruit dispersed enclosed in a glume, but distinguished by the shorter culms (mostly less than 20 cm tall), fewer branchlets (c. 20) per culm node and female spikelets mostly terminating branchlets rather than sessile among the bases of the branchlets. Further information on morphology and anatomy of *D. diacolpicus* is given by Pate & Delfs (1999).

Specimens examined (all ♀): South Australia: Eyre Peninsula: along Verran Hill track, Hinks National Park, 8 Oct 1968, *Wheeler 884* (AD); near Mt Verran, 9 Dec 1959, *Specht 2001* (AD); Roadside between sec's 90 & 97, Hundred of Wanilla, 25 Nov 1968, *Alcock 2567* (AD, B, CANB); 25 miles [40 km] NW of Port Lincoln, 10 Oct 1909, *Griffith* (MEL); N end of Boston Harbour, 14 km NNE of Port Lincoln, 12 Jan 1976, *Copley 4929*, (AD); Port Lincoln, 10 Oct 1909, *Griffith* (AD).

Western Australia: Eyre: 10.5 km N of Ongerup, on road to Lake Pingarnup, 13 Sep 1966, *Briggs 477* (NSW); 35 km SE of Ongerup, 13 Sep 1966, *Briggs 493a* ♀ (NSW).

Acknowledgments

Thanks go to the many people who assisted the study of Restionaceae over the years. Carolyn Porter, Siegfried Krauss, Barbara Wiecek, Louisa Murray, Anna-Louise Quirico, Vivian Shanker and others gave technical help. David Mackay prepared the illustrations and Peter Wilson advised on the Latin diagnoses. The opportunity to examine specimens on loan or in other herbaria assisted the work. Cooperation and joint fieldwork with John Pate (University of Western Australia), and Kathy Meney and Kingsley Dixon (Kings Park and Botanic Garden, Perth) gave valuable insights, as did associated DNA sequencing studies with Adam Marchant, Simon Gilmore and Carolyn Porter. Grants from the Australian Research Council and Australian Biological Resources Study supported part of the study.

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Manuscript received 31 January 2000

Manuscript accepted 24 Aug 2000

New species of *Harperia*, *Loxocarya*, *Onychosepalum*, *Platychora* and *Tremulina* (Restionaceae) in Western Australia

Barbara G. Briggs and L.A.S. Johnson†

Abstract

Briggs, Barbara G. and Johnson, L.A.S. (Royal Botanic Gardens, Mrs Macquaries Road, Sydney, NSW 2000, Australia) 2001. New species of *Harperia*, *Loxocarya*, *Onychosepalum*, *Platychora* and *Tremulina* (Restionaceae) in Western Australia. *Telopea* 9(2): 247–257. Five new species of Restionaceae in the southern half of Western Australia are described; all having rare, vulnerable or endangered conservation status. *Harperia eyreana*, from the coastal southeast of that State, is the fourth species of its genus. *Loxocarya gigas*, from north of Perth is the largest of Australia's Restionaceae and the fifth species now referred to that genus, which until recently was confused with *Desmocladus*. *Onychosepalum nodatum*, also from north of Perth, brings to three the members of its genus. *Platychora rivalis* and *Tremulina cracens* are plants of moist habitats in the south-west; the only other members of these genera, *P. applanata* and *T. tremula*, were recently excluded from *Restio*.

Introduction

The species described below all occur in the southern half of Western Australia. All were listed in our classification of Restionaceae (Briggs & Johnson 1999), in advance of formal description, and further information on most of them is given by Meney, Pate and Hickman (1999), who also provide excellent illustrations. An account of all species of the genera concerned will be given in the *Flora of Australia* (Briggs, Johnson, Porter & Krauss, in preparation).

Descriptions of new species

Harperia W. Fitzg.

Until recently *Harperia* was considered to be monotypic, with only the single species, *H. lateriflora* W. Fitzg. It has been enlarged by the description of the very rare species *H. ferruginipes* K.A. Meney & J.S. Pate (Meney et al. 1996) and the transfer from *Restio* of *H. confertospicatus* (Steud.) B.G. Briggs & L.A.S. Johnson. One further, recently discovered, species from the south-east of Western Australia is here described. These additional species widen the diversity of features within the genus to include caespitose as well as rhizomatous species and ones with much-branched culms, whereas the type species shows little culm branching. All share spikelets of generally similar form and distinctive culm anatomy with extensive development of sclerenchyma in the central ground tissue (Linder et al. 1998; Briggs & Johnson 1999; Meney, Pate & Hickman 1999) and all occur in the southern half of Western Australia.

† Deceased 1 August 1997.

Harperia eyreana B.G. Briggs & L.A.S. Johnson, sp. nov.

A *Harperia ferruginipes* combinatione characterum sequentium distinguitur: habitus caespitosus; pili basales pallidi; culmi 1–1.5 mm diametro, ramosissimi flexuosique; vaginae basales glabrae; vaginae culmorum appressae.

Type: c. 20 km SW of Cocklebidy, Twilight Cove road, 32°11'S 126°03'E, 3 Dec 1993, S. Jacobs 7045 ♀ (holo NSW; iso K, MEL, MO, PERTH).

Caespitose, forming large, dense or rather open, many-stemmed tussocks, 25–120 cm across. Rhizome pubescent with white or pale tan hairs; basal scales glabrous, scarious or hyaline, ovate, 0.5 cm long, ± glossy. Culms erect or ± spreading, terete, 35–120 cm tall, 1–1.5 mm diam., finely tuberculate, bright green, glabrous; internodes numerous, 1.5–4.5 cm long; repeatedly branched, the branches slender, highly flexuose. Culm sheaths: appressed, oblong, 7.5–12 mm long, red-brown, apex obtuse or truncate, often with soft, white axillary hairs projecting beyond the sheath, lamina 1.0–2.5 mm long. Spikelets usually solitary on branches; glumes glabrous, tan-brown. Male spikelets narrow-cylindrical, 5–8.5 mm long; glumes 1.4–3.0 mm long, 3–5 lower glumes rigid, broad-ovate, apex obtuse to obcordate, with a black mucro to 1.5 mm long; upper glumes 15–22, blunt, hyaline, ovate to oblong, not mucronate, only c. 5 uppermost subtending flowers. Female spikelets narrow ovoid-cylindrical, 6.5–8.5 mm long, 1-flowered; glumes 5–7, narrow-ovate, acute, 1.8–5.0 mm long; mucro rigid, black, 1.1–2.5 mm long. Male flowers: tepals 5, hyaline, filiform, 1.6–2.5 mm long; filaments c. 3 mm long; anthers 1 mm long. Female flowers: tepals (4–)5, hyaline, narrow elliptic, obtuse, shed with the nut, 4.0–5.5 mm long. Nut narrow oblong, 3.5–4.5 mm long, pale brown, with a short thick stipe above the tepals. Seed oblong, c. 2.5 mm long. (Fig. 1a–1d.)

The epithet commemorates Edward John Eyre who, despite great difficulties, in 1841 first explored the region in which it occurs. This region was designated the Eyre botanical district by Diels (1906), but has subsequently been subdivided into several phytogeographic areas.

Distribution: occurs in Western Australia south of Cocklebidy. On deep white sand or calcareous loamy sand in tall shrubland of mallee eucalypts and *Callitris*. On crest and leeward side of white calcareous stabilised dune and on sand over limestone pavement.

Conservation status: listed as Rare, Western Australian Department of Conservation and Land Management (CALM) code Priority 2 (P2) (Meney, Pate, Dixon, Briggs, & Johnson 1999). Known from very few localities in a very restricted area, but occurring in a nature reserve and in a remote region where the vegetation may not be subject to gross disturbance or clearing.

The culms and spikelets of *H. eyreana* resemble those of *H. ferruginipes* but the former is distinguished by the caespitose habit; basal scales glabrous; basal hairs pale; culms more slender, more intricately branched and flexuose; culm sheaths appressed. *H. ferruginipes* has dark, ginger-brown hairs on its stout rhizomes and on basal scales, culms 1.5–2 mm diam., and culm sheaths that become lax with age (Fig. 1 e).

Specimens examined: Western Australia: Eucla: 20 km SSW of Cocklebidy along track to Twilight Cove, 4 Jan 1979, Crisp 4774 ♀ (CANB, NSW); 20 km SW of Cocklebidy (details as for type) 7040 ♂ (NSW), 7043 ♂ (NSW, PERTH), 7051 ♂ (NSW, CANB, PERTH), 7046, 7050 ♀ (NSW); 25 km SE of Cocklebidy, 13 Dec 1986, Newby 11428 ♀ (PERTH, NSW); 36 km SE of Cocklebidy on road to Eyre Bird Observatory, c. 19 km S of Hwy, 4 Dec 1993, Jacobs 7052 ♂, 7053 ♀ (NSW, AD, PERTH); 19.7 km from Eyre Hwy on road to Eyre Bird Observatory, Nuytsland Nature Reserve, 26 Oct 1995, Johnstone 619 & Sweedman ♀ (NSW, AD, CANB, K, MEL, MO, NBG, NY, PERTH, RSA).

Loxocarya R. Br.

The past confusion between *Loxocarya* and *Desmocladus*, which have superficial similarities in some of their species but are not closely related, is outlined by Briggs & Johnson (this issue, and references therein). *Loxocarya* includes two species distinguished early in studies of Australian Restionaceae, *L. cinerea* R. Br. and *L. striata* (F. Muell.) B.G. Briggs & L.A.S. Johnson, and two that have been recently named, *L. magna* K.A. Meney & K.W. Dixon and *L. albipes* J.S. Pate & K.A. Meney. One further species has been distinguished and is described here.

***Loxocarya gigas* B.G. Briggs & L.A.S. Johnson, sp. nov.**

Inter species *Loxocarya statura* majore distinguitur; rhizomata 7–10 mm diametro; culmi ad 2(–2.5) m longi; spiculae femineae 3–5 cm longae; ramuli inflorescentiarum feminearum 25–45 cm longis; fructus c. 10 mm longi.

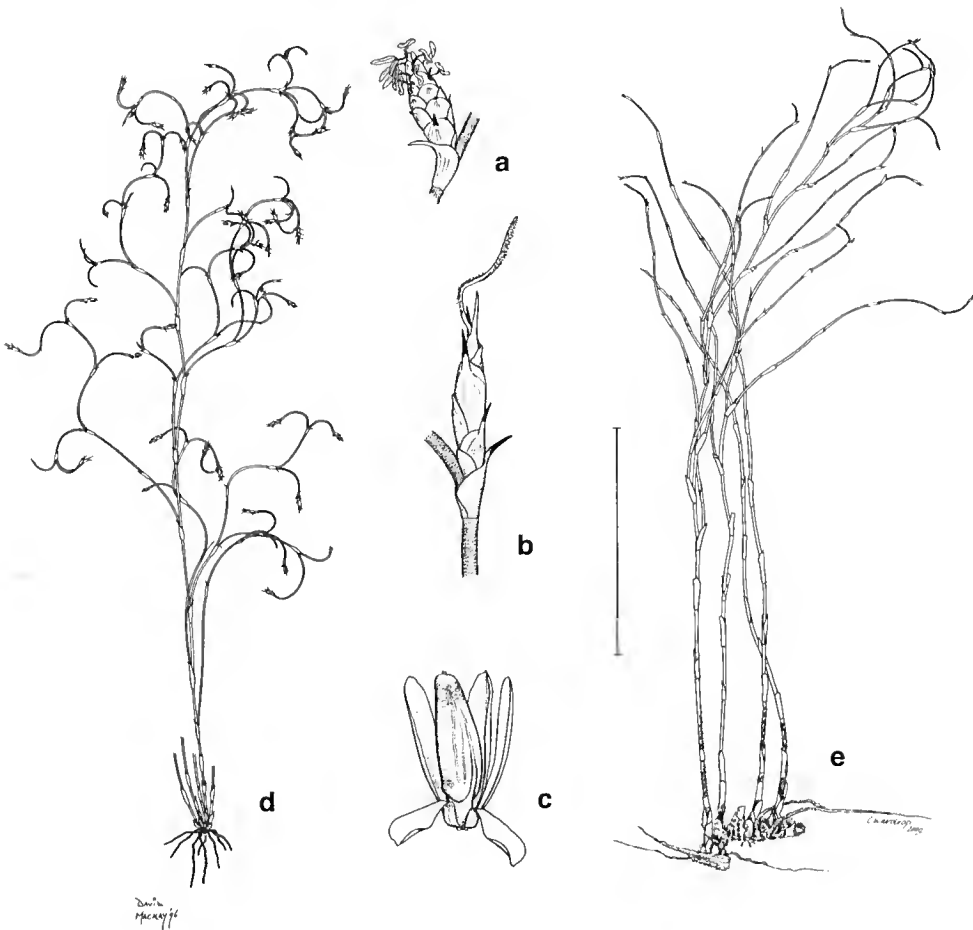


Fig. 1. a–d, *Harperia eyreana*, a, male spikelet (Jacobs 7043); b–d, female: b, spikelet; c, nut with bract and tepals; d, habit (Jacobs 7045). e, *Harperia ferruginipes*, habit female (5 km S of Geraldton–Mullewa Rd, Pate NSW 363212). Scale bar: a & b = 9.5 mm; c = 6.7 mm; d & e = 10 cm.

Type: Western Australia: 22.8 km E of Brand Hwy on Green Head–Coorow Road, Alexander Morrison Natl Park, 30°01'S 115°20'E, 30 Sep 1984, B.G. Briggs 7727 & L.A.S. Johnson ♀ (holo NSW; iso AD, BRI, CANB, DNA, K, MEL, MO, NBG, PERTH, RSA).

Forming large tussocks of numerous culms linked by interlacing rhizomes. Rhizomes stout, to 20 cm long, 7–10 mm diam.; sheaths straw-coloured, partly covering a dense white pubescence. Culms spaced c. 2 cm apart, stout, erect, terete to sub-terete, finely striate, 1.5–2(–2.5) m long, 7–8 mm diam. at the base, 4.5–5.0 mm diam. mid-culm, internodes 9–12 cm long, fistular, bright green or yellow-green, glabrous above, hoary-tomentose basally; upper branches flattened adaxially, concavo-convex; culm branches dimorphic: floriferous branches long, straight; sterile branches short, mostly 5–20 cm long, densely branched into filiform segments with short internodes. Sheaths of culms and fertile branches 2–3 cm long, brown, glabrous or shortly hoary, often apically shortly ciliate, apex acute to obtuse; lamina erect, 4–15 mm long, caducous; sheaths of sterile branches green or tan, auriculate, 2–5 mm long with a linear lamina 5–12 mm long and a tuft of white axillary hairs. Male inflorescences to 50 cm long, with very numerous spikelets; several secondary inflorescence branches of different lengths and degrees of branching arising at each upper culm node. Male spikelets on pedicels to 2 cm long, ovoid or obconical, 7–11(–25) mm long, 2.5–4 mm wide, with 2–4 sterile lower glumes and c. 30–50 fertile upper glumes; glumes ovate, 3.0–3.7 mm long, light brown, pubescent, apex obtuse to acute; mucro erect, terete, 1.8–2.6 mm long. Female inflorescence with slender lateral branches 25–45 cm long, of several internodes, mostly arising singly at culm nodes. Female spikelets terminal on branches, 3–5 cm long, 1.0–1.5 cm wide, with 1–3 sterile lower glumes and 1–5 fertile upper glumes; glumes rigid, becoming woody, broadly ovate, c. 1.5 cm long, brown, striate, pilose on abaxial surface and apex when young, becoming glabrous, apex aristate; mucro erect, c. 1–1.5 cm long. Male flowers: tepals 6, lanceolate, brown, hyaline, 2.5–3.3 mm long; 2 lateral outer tepals keeled; filaments 2.5–2.7 mm long; anthers 2.3 mm long, exserted. Female flowers: tepals apically pubescent; outer tepals rigid, elliptical, 6–10 mm long with an awn c. 10 mm long; inner tepals hyaline, ovate, truncate, 3–6 mm long; staminodes minute; ovary 2-locular; styles 2, shortly connate at base. Capsule c. 10 mm long, 4–7 mm wide; 1–5 capsules per spikelet developing. Seed oblong, furrowed on one side, 4.2–5.2 mm long, 2–3 mm wide. Chromosome number; $2n = 24$ (Briggs unpublished, voucher *Gittins 1696*). (Fig. 2d–e).

The epithet is from the Greek *giga-*, giant, very large, referring to the size of the plant and its component parts.

Distribution: occurs in a few sites near and north of Badgingarra, including the Alexander Morrison National Park. Grows in shrubland and tall heath, on sand or sand over laterite, on elevated sites.

Conservation status: rare but represented in a conservation reserve, code 2KCa (Briggs & Leigh 1996, listed as *Restio gigas*). Declared endangered rare flora, CALM code R (Mency, Pate, Dixon, Briggs, & Johnson 1999). Endangered especially since it is an obligate seeder species killed by fire, and since plants take more than ten years after germination to reproductive maturity. This vulnerability is increased by the short period of viability of the seeds.

This is the largest of Australia's Restionaceae, with culms to 2.5 m tall. It is surprising that it was not distinguished until recent decades and described until now, especially since one area of occurrence is in the road reserve adjoining a major (though recently constructed) highway.

Distinguished from other species of *Loxocarya* (Fig. 2a–2c, 2f–2h) by the large size of all its parts, including stout rhizomes and culms; male spikelets numerous in much-branched inflorescences; female spikelets and fruits large, on long inflorescence



Fig. 2. Species of *Loxocarya*. a–c, *L. striata*. a, fruiting spikelet (Tutanning Reserve, Briggs 172, NSW); b, flowering female spikelet; c, habit (SE of Tambellup, Briggs 8497 & Johnson, NSW). d & e, *L. gigas*, d, male spikelet (Briggs 8584 et al.); e, fruiting spikelet (Briggs 8585 et al.). f–h: fruiting spikelets: f, *L. albipes* (E of Wongan Hills, Pate NSW 280360); g, *L. magna* (ENE of Augusta, Briggs 8668, NSW); h, *L. cinerea* (near Karridale, Krauss 158 & Howitt, NSW). Scale bar: a, b, d, f, g, h = 5 mm; c = 8 cm; e = 1.6 cm.

branches. Strong dimorphism of much-branched non-flowering culm branches and elongated flowering branches is a pronounced and constant feature. Culm dimorphism has not been observed in *L. albipes* (with culms all fertile, strait and unbranched below the inflorescence) and *L. magna* (all or most culms fertile and branched, with curled or sinuous laterals). Dimorphism in *L. striata* and *L. cinerea* ranges from not evident to pronounced (e.g. Fig. 2c).

Selected specimens examined: Western Australia: Irwin: 5 km NW of junction of Brand Hwy and Coorow–Greenhead Rd, 19 May 1995, *Corbyn 3500* ♂, ♀ (PERTH, NSW); Alexander Morrison Natl Park, Dec 1972, *Passfield s.n.* ♂, ♀ (PERTH); c. 25 km E of Brand Hwy on Green Head to Coorow road, Alexander Morrison Natl Park, 30 Sep 1984, *Briggs 7742 & Johnson* ♀ (NSW, CANB, RSA); 20 km E of Brand Hwy on road to Coorow, 22 Apr 1989, *Krauss 155 & Howitt* ♂ (NSW); 37 miles [60 km] W of Coorow, Sep 1967, *Gittins 1696* ♀, 1696b ♂ (NSW); Reserve 27 miles [43 km] SW of Coorow, Feb 1967, *Chapman s.n.* ♂, ♀ (NSW 101134); Brand Hwy, 11.6 km N of Jurien turn-off (near Tootbardi Farm), c. 28 km (direct) NNW of Badgingarra, 6 Sep 1990, *Briggs 8584, Johnson, Meney, Pate & Linder* ♂ (NSW, BOL, CANB), 8585 ♀ (NSW, BOL).

Onychosepalum Steud.

Like the related genus *Harperia*, *Onychosepalum* was considered to be monotypic until recently, including only *O. laxiflorum* which occurs south of the Stirling Range. The discovery of *O. microcarpum* K.A. Meney & J.S. Pate (Meney, Pate & Dixon 1996) and recognition of the species now described attest the great increase in knowledge gained in recent decades of the flora of the region between Perth and Geraldton.

Onychosepalum nodatum B.G. Briggs & L.A.S. Johnson, sp. nov.

Ab *O. laxiflorum* combinatione characterum sequentium distinguitur: culmi plerumque nodo unico vaginae parva instructi, vaginae basales pallidiores; mucrones bractearum glumarumque breviores.

Type: Western Australia; Strathmore Road Reserve (No. 26248), S of Badgingarra (30°34'S 115°21'E), 5 Nov 1975, *A. George 14196* ♀ (holo PERTH; iso NSW).

Caespitose, forming small, many-culmed tussocks. Culms erect, 8–27 cm long, c. 0.5 mm diam., yellow-green. Basal sheaths glossy, tan-brown, appressed, 0.4–2.0 cm long, with a pale mucro to 2 mm long; culm sheath: a single hyaline to scarious sheath present on most culms, at or usually above the culm midpoint, appressed or slightly lax, 5–12 mm long, mucro c. 3 mm long. Spikelets terminating culms, subtending bract 2–5 mm long with a mucro 0.8–1.8 mm long; glumes green or pale brown. Male spikelets ovoid, becoming loose and spreading, 7–8 mm long, 4–5 mm wide; glumes c. 40, all fertile, scarious to hyaline, ovate, 3.0–4.0 mm long, glabrous, truncate or auriculate, mucro 1–1.5 mm long. Female spikelets narrow ellipsoid, 7–9 mm long, c. 4 mm wide; glumes c. 12, several lower ones sterile, obovate, c. 4 mm long; apex auriculate, shortly pilose with white hairs, mucro c. 1.5 mm long. Male flowers: tepals 4, glabrous, hyaline, narrow spatulate, c. 3 mm long; 2 outer tepals keeled, inner tepals flat; anthers c. 1 mm long, exserted. Female flowers: tepals 0–3, similar to males, c. 2.5 mm long. Fruit not seen. (Fig. 3a–c.)

The epithet is from the Latin *nodus*, a node, and *-atus*, provided with, referring to the presence of a node and sheath on the culms.

Distribution: occurs in Western Australia at a few sites north and northwest of Cataby.

Conservation status: vulnerable, CALM code Priority 3 (Meney, Pate, Dixon, Briggs, & Johnson 1999). Known from very few sites but poorly known, in an area subject to local mining but perhaps not yet affected by very extensive land clearance. The conservation status of this species needs further survey and monitoring. Lacking subterranean rhizomes, it would be killed by fire.

Similar to *O. laxiflorum* but distinguished by one node and small sheath near the mid-point or usually in the upper half of most culms, the paler basal sheaths and glumes; bracts and glumes with shorter mucros. The mucro of the subtending bract of both male and female spikelets is 0.8–1.2 mm long, cf. (2–)3–5 mm in *O. laxiflorum*. Plants of *O. nodatum* may generally be slightly taller and have larger male spikelets than *O. laxiflorum*, but the collections are too few to determine the extent of variation. *O. microcarpum* differs in its lesser height, paler basal scales and glumes, and the females often having several spikelets per culm.

Specimens examined: Western Australia: Irwin: 10 km N of Cataby, Dec. 1995, *D. Woodman* TW 17 ♀ (PERTH), Jan 1996, *D. Woodman* DWT 24 ♀ (PERTH); N Woolka Road, c. 8 km W of junction with Cooljarloo Road, 6 Nov 1988, *B. Keighery* 521b ♂ (PERTH); N Woolka Road, c. 8 km W of junction with Cooljarloo Road, 16 Oct 1990, *G. Keighery* 11908 ♂ (PERTH, NSW); Eneminga Reserve, Mar 1966, *Bowler s.n.* ♂ (PERTH, NSW 259316).



Fig. 3. a–c. *Onychosepalum nodatum*. a & b, female: a, habit; b, spikelet (*George* 14196); c, male spikelet (*Keighery* 521B). d, *O. laxiflorum*, female spikelet (*South Stirling, Briggs* 6583 & *Johnson*, NSW). Scale bar: a = 3 cm; b–d = 5 mm.

Platychorda B.G. Briggs & L.A.S. Johnson

The recognition that *Restio* is a member of an African clade, which has no genera in common with the Australasian members of the family, led to the description of several genera (Briggs & Johnson 1998) to accommodate the diverse Australian species formerly named under *Restio*. Among these is *Platychorda*, restricted to the high rainfall region of the south of Western Australia. It is distinguished from other related genera by the six tepals, trilocular ovary and three style branches in the female flowers. The type species, *P. applanata* (Sprengel) B.G. Briggs & L.A.S. Johnson, occurs in seasonally inundated heaths and swamps from Augusta to Albany (Meney, Pate & Hickman 1999). In the same region, but known from only a single locality, is the only other species of the genus, which is now described.

Platychorda rivalis B.G. Briggs & L.A.S. Johnson, sp. nov.

A *Platychorda applanata* combinatione characterum sequentium distinguitur: vaginae culmorum et glumae pallidiores, non nitidae; spiculae masculinae acutae; spiculae femineae longiores, acutae, flore solitario.

Type: Western Australia: Spearwood Creek, 8.3 km W of Sues Rd along Denny Rd, W of Nannup, 34°04'12"S 115°18'35"E, 24 Nov 1995, T.D. Macfarlane 2560 & A.R. Annels ♀ (holo PERTH; iso NSW).

Caespitose, forming dense tussocks c. 20 cm across; base pilose with pale hairs; basal sheaths similar to culm sheaths, glabrous. Culms erect, straight, compressed, unbranched, 60–85 cm long, 1.3–2.2 mm wide, striate, glabrous, bright green; internodes few, 8–25 cm long. Sheaths closely appressed, c. 7–15 mm long, glabrous, scarious-hyaline, brown; lamina 5–10 mm long, 2–2.5 mm broad, blunt, often weathering away. Inflorescence with short, slender, erect branches at several closely-spaced upper nodes; branches bearing several spikelets on filiform pedicels. Male spikelets narrow acute-ovoid, 4–5 mm long; glumes lanceolate, acute, dull tan-brown, glabrous or very shortly ciliate, to 4 mm long, lower glumes shorter. Female spikelets ovoid, 5–7 mm long, 2–3 mm wide, with 9–15 sterile lower glumes and 1 fertile upper glume; glumes similar to males; a few of the lowest glumes with a very short, blunt mucro. Male flowers: tepals 6, narrow-lanceolate, hyaline, glabrous; 2 outer tepals keeled, 3–3.5 mm long; 3rd outer tepal and inner tepals flat, slightly shorter; stamens 3; filaments c. 1 mm long; anthers c. 1.3–1.8 mm long, not exerted. Female flowers: tepals 6, concave, glabrous, red-brown with broad hyaline margins, lanceolate, acute, 3–5 mm long; staminodes 3; ovary trilocular; styles 3, shortly connate at the base. Capsule c. 1.2 mm long. Seed ellipsoid, c. 0.9 mm long, pale brown. (Fig. 4a–e).

The epithet is from the Latin *rivalis*, pertaining to brooks or streams, referring to the habitat of the species.

Distribution: known only from Spearwood Creek, a tributary of Blackwood River, east of Margaret River. Grows on moist peaty sand in sedgeland with tall shrubs; site constantly moist with considerable seepage through the substrate.

P. rivalis is similar to *P. applanata* in culm anatomy, with culm chlorenchyma lacking pillar cells but interrupted by narrow, radially elongated sclerenchyma girders. The species are also similar in their seed surfaces, having an irregular pattern of subangular flat or slightly convex cells. *P. rivalis* is distinguished by the paler culm sheaths; glumes paler tan-brown, not glossy; male spikelets acute; female spikelets longer (5–7 mm long), acute, with only one flower. *P. applanata* has mostly tan-brown culm sheaths; glossy, dark brown glumes; male spikelets blunt; female spikelets ovoid to globular, blunt, with several flowers.



Fig. 4. a–e. *Platychorda rivalis*. a, b & c male: a, culm sheath; b, inflorescence; c, spikelet (Macfarlane 2494 & Annels); d & e, female: d, inflorescence, e, capsule with tepals and glumes (Macfarlane 2560 & Annels). f–j, *Tremulina cracens*. f & g, male: f, inflorescence; g, spikelet (Meney 911 & Pate); h–j, female: h, inflorescence, i, culm sheath, j, capsule (Briggs 6931b). Scale bar: a = 2 cm; b, d, f, h = 3 cm; c, e, g, j = 3.75 mm; i = 1 cm.

Conservation status: known from only a very few plants in a single valley swamp, but poorly known (Meney, Pate, Dixon, Briggs, & Johnson 1999). In the CALM conservation categories a classification of vulnerable (P2) applies, at least until further study and monitoring is done. It occurs in a habitat of restricted extent but in an area where natural vegetation has been retained over a considerable region.

Specimens examined: Western Australia: Spearwood Creek, 5 Feb 1990, *McCutcheon* 2200 ♀ (PERTH); Spearwood Creek, (details as for type), *McFarlane* 2594, 2599 ♂, 2591 ♀ & *Annels* (PERTH, MJP, NSW), 2598 (PERTH); Spearwood Swamp, Denny Rd. 9 km W of Sues Rd., 28 Aug 1998, *Briggs* 9439 ♂ (NSW, CANB, MEL, PERTH), 9438 ♀ (NSW, PERTH).

Tremulina B.G. Briggs & L.A.S. Johnson

As with *Platychorda*, *Tremulina* was established (Briggs & Johnson 1998) to accommodate a species that had originally been named within *Restio*, and another related to it but unnamed. *Tremulina* is distinguished by the following combination of features: tepals 5 or 6, ovary loculi 2, style branches 2, culm chlorenchyma lacking pillar cells but interrupted by sclerenchyma girders, seeds with a distinctive regular pattern of flat rectangular cells. It is typified by *T. tremula* (R. Br.) Briggs & Johnson, which occurs in seasonally wet sites from Perth to Albany. *T. cracens*, described below, is limited to part of the same region.

Tremulina cracens B.G. Briggs & L.A.S. Johnson, *sp. nov.*

A *Tremulina tremula* combinatione characterum sequentium distinguitur: culmi graciliores, 0.8–1.0 mm diametro; vaginae culmorum breviores, 10–30 mm longae, laminae 2–3 mm longis; spiculae masculinae 3.5–5 mm longae; spiculae femineae 2–4.5 mm longae.

Type: Western Australia: Thomson Road c. 8 km NW of Mt Frankland, c. 20 km N of Walpole, 20 Nov 1977, B.G. Briggs 6931b ♀ (holo NSW; iso PERTH).

Caespitose, forming slender tussocks. Base with short (to 1 cm), pale brown, scarios scales partly covering a pale brown woolly pubescence. Culms erect, straight, slender, terete to slightly compressed, unbranched and with 2–4 internodes below the inflorescence, 20–60 cm long, 0.8–1.0 mm diam., striate, green, glabrous, 4–10 cm long. Culm sheaths closely appressed, 7–12 mm long, green, striate; apex truncate with a linear, erect or slightly incurved lamina, 2–3 mm long; apical margin narrowly membranous, shortly ciliate. Inflorescence: 1–6 filiform branches arising at each upper culm node; branches to 3.5 cm long but often much shorter, often with several internodes, occasionally branched, with a single terminal spikelet or both axillary and terminal spikelets. Spikelets globose to ovoid; glumes lanceolate-ovate, scarios, glossy, dull tan-brown, acute, shortly ciliate, 2.0–2.5 mm long; with or without a small mucro. Male spikelets 3.5–5.0 mm long, 2–3 mm wide, with 1–4 sterile lower glumes and 6–25 fertile upper glumes. Female spikelets 2–4.5 mm long, 2–3 mm wide; 1–2-flowered, with up to 4 sterile lower glumes. Flowers: tepals 6, linear-lanceolate, acute, glossy, tan-brown, hyaline; 2 outer tepals keeled, with a few hairs along keel; inner tepals flat, slightly shorter, glabrous. Male flowers: tepals 1.8–2.3 mm long; stamens 3; filaments c. 2.0 mm long; anthers c. 1 mm long, exerted; pistillode minute or absent. Female flowers: staminodes 3; styles 2, very shortly connate. Capsule smooth, brown, 1.5–2 mm long. Seed ellipsoid, glossy, dark brown, c. 1.2 mm long. (Fig. 4f–j).

The epithet is from the Latin, *cracens*, slender, graceful; the plants are slender and graceful in comparison with the robust *T. tremula*.

Distribution: occurs in Western Australia on the Scott River Plains from Augusta to south of Manjimup, Windy Harbour, and to near Walpole. Grows in sand or peat, seasonally inundated, near permanent watercourses.

Conservation status: rare, CALM priority code P3 (Meney, Pate, Dixon, Briggs, & Johnson 1999). Known from only a few sites, in habitats of limited occurrence, but in an area where much natural vegetation has been retained.

T. cracens differs from *T. tremula* in the slender culms which are terete to slightly compressed (0.8–1.0 mm diam), lamina of culm sheaths linear and 2–4(–7) mm long, and spikelets small (male spikelets 3.5–5.0 mm long, 2–3 mm wide; females 2–4.5 mm long, 2–3 mm wide). *T. tremula* has strongly compressed culms 2.0–4.5 mm broad, lamina of culm sheath broad and blunt (3–11 mm long), and spikelets larger (male spikelets 4–6.5 mm long, 3–4 mm wide; females 4.5–5.0 mm long, 3–5 mm wide).

Specimens examined: Western Australia: Darling: 24.4 km S of Manjimup on South Western Hwy, 7 Jan 1989, *Meney & Dixon* ♂ (KPBG); Muirs Hwy, 1993 *Meney 914b* ♂ (KPBG, NSW); Scott River Plain, 24 Oct 1948, *Royce 2931* ♂, 2932 ♀ (PERTH); Lake Jasper, 21 Feb 1992, *McCutcheon 2468* ♂ (PERTH); Windy Harbour, 28 Sep 1954, *Main* ♂ (PERTH); Lower Shannon flats, W of Shannon R., 20 Mar 1995, *Hearn ARA 5370* ♂ (PERTH, NSW); N of Walpole (details as for type) *Briggs 6931a*, 6932 ♂ (NSW), 6933 ♂, 6934 ♀ (NSW, PERTH); Weld Rd and Rainbow End, Walpole, Jan 1991, *Meney 911 & Pate* ♂, ♀ (KPBG, NSW).

Acknowledgments

Many colleagues assisted our studies on Restionaceae. Peter Wilson advised on the Latin diagnoses; Carolyn Porter, Siegfried Krauss, Barbara Wiecek and others gave technical assistance; David Mackay, Lesley Elkan and Catherine Wardrop were responsible for the illustrations. Kathy Meney of Kings Park and Botanic Garden and John Pate of the University of Western Australia shared information with us most generously and assisted in the field. The Western Australian Herbarium made available its resources of specimens; Terry Macfarlane and colleagues at its regional herbarium at Manjimup provided collections and assistance in the field. Our thanks go to all who assisted in these many ways.

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Systematic studies in the eucalypts. 11 — New taxa and combinations in *Eucalyptus* Section *Dumaria* (Myrtaceae)

K.D. Hill, L.A.S. Johnson[†] & D.F. Blaxell

Abstract

Hill, K.D., Johnson, L.A.S. & Blaxell, D.F. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW 2000 Australia) 2001. *Systematic studies in the eucalypts. 11. New taxa and combinations in Eucalyptus Section Dumaria (Myrtaceae)*. *Telopea* 9(2): 259–318. New taxa and combinations in *Eucalyptus* Section *Dumaria* from Western Australia and South Australia are presented (some species occur in adjacent regions of Victoria and New South Wales). New species described are *Eucalyptus capitanea*, *E. grossifolia*, *E. singularis*, *E. laevis*, *E. pleurocorys*, *E. trachybasis*, *E. planipes*, *E. spreta*, *E. valens*, *E. wubinensis*, *E. assimilans*, *E. infracorticata*, *E. redimiculifera* and *E. paralimnetica*. New subspecies are recognised in *E. costata* F. Muell. (subsp. *murrayana*), *E. leptocalyx* Blakely (subsp. *petilipes*), *E. scyphocalyx* (F. Muell. ex Benth.) Maiden & Blakely (subsp. *triadica*), *E. fraseri* (Brooker) Brooker (subsp. *melanobasis*) and *E. obtusiflora* DC. (subsp. *cowcowensis*). A new combination is made for *E. obtusiflora* subsp. *dongarraensis* (formerly *E. dougarraeensis* Maiden & Blakely), and circumscription and typification of *E. incrassata* and *E. angulosa* are discussed. Multiple entry tables are provided as an aid to identification.

Introduction

New taxa described here are from section *Dumaria* (as defined by Pryor and Johnson, 1971, with amendments discussed below), occurring mainly in Western Australia and South Australia. All are taxa defined during the studies led by the late L.A.S. Johnson as a part of an evaluation of the classification and relationships of the eucalypts. Several of these taxa are treated as undescribed species or subspecies in the semi-popular account of south-western taxa by Brooker and Kleinig (1990). The new taxa discussed both here and by Brooker and Kleinig were delineated by us during a comprehensive revisionary study of the eucalypts, and were freely discussed with Ian Brooker in order to allow their treatment in Brooker and Kleinig. A number of other new species in this section have also been formally described by other workers (e.g. Brooker & Hopper, 1991, 1993, Nicolle 1997), rendering keys presented by Chippendale (1988) obsolete. Multiple entry tables are provided as an aid to identification and as a supplement to keys presented by Brooker and Kleinig (1990).

Terminology and nomenclature are as in previous papers in this series (see Hill & Johnson 1994, 1995). Rare or threatened species are allocated conservation status codes according to the system of Briggs and Leigh (1996).

We are acquainted with all the new and related taxa in the field, and all new taxa have been interpreted on the basis of both herbarium collections and field observations of populations in situ.

[†] Deceased 1 August 1997.

Section *Dumaria*

Section diagnosed as follows: oil glands in pith (sometimes sparse or absent in series *Incrassatae*); oil glands absent from bark; outer calyptra shed early; filaments inflexed; anthers dorsifixed, versatile, cuneate (shorter and more cuboid in series *Merrickianae*, *Leptocalyces* and *Deflexae*), apically truncate, regularly radially arranged and apically packed against nectary disc, dehiscent by parallel slits; cotyledons rounded or shallowly obreniform; ovules in 4 rows (4–8 in series *Incrassatae*).

All species included here are part of section *Dumaria*, itself a component of the large subgenus *Symphylomyrtus* (Pryor & Johnson 1971, Brooker 2000). This section is substantially Western Australian in distribution. The section is characterised by the regularly inflexed filaments with cuneate anthers that are regularly closely packed with their apices appressed to the nectary disc in unopened buds. The group is otherwise highly diverse, and has so far not been clearly demonstrated to be monophyletic. A number of distinctive and clearly defined series are recognisable, however, within the section *Dumaria* (Table 1). Series *Incrassatae*, *Torquatae*, *Leptocalyces* and *Obtusiflorae* are discussed separately below.

Table 1. A classification of Section *Dumaria*

Section *Dumaria*

- Series *Incrassatae*
 - Subseries *Incrassatosae*
 - Subseries *Tetrapterosae**
- Series *Rigentes**
- Series *Pimpinianae**
- Series *Torquatae*
 - Subseries *Laevosae*
 - Subseries *Corrugatosae*
 - Subseries *Torquatosae**
- Series *Leptocalyces*
- Series *Deflexae**
- Series *Merrickianae**
- Series *Obtusiflorae*
- Series *Cometaevallares**
 - Subseries *Ovularosae*
 - Subseries *Cylindrocarposae*
 - Subseries *Cometaevallarosae*

*Not treated in this paper

Series *Incrassatae*

Treated as Series *Tetrapterae* by Blakely (1934: 73) and by Chippendale (1988), but with the inclusion of *E. pimpinianna* Maiden. The latter was excluded from this series by Brooker and Kleinig (1990), a view with which we concur. Brooker (2000) separated the *E. tetraptera* group into a separate series on the basis of autapomorphic novelties, ignoring informative grouping characters that clearly place it with the taxa here included in the series.

Series distinguished as follows: oil glands usually present in pith, sometimes sparse or absent; juvenile leaves disjunct, petiolate; anthers angular or somewhat rounded; ovules in varying numbers of rows depending on species; seeds dark brown or black,

regularly reticulate, irregularly circumferentially winged or flanged, more or less pyramidal or flattened-pyramidal, with winged ribs radiating from the paler, ventral hilum; stomata large and translucent, giving a bluish sheen to the leaves.

Two subseries are distinguishable within the series (Table 2). Subseries *Incrassatosae* is made up of a number of species that have all been included in a broad application of *E. incrassata* at some time or other. Several of these have already been clarified (Table 3, and see Chippendale 1988, Brooker & Hopper 1993), and others are discussed below. The subseries is widely distributed across the 'mallee country' of southern Australia, from south-western Western Australia east to south-western New South Wales and western Victoria (Figs. 2, 3) This account and classification summarises our revisionary studies of this series, although further study of the variation in, and geographic extent of, *E. captiosa* Brooker & Hopper is still required. A tabular comparison of characters is provided to facilitate identification within the series, rather than a dichotomous key (Table 4).

Table 2. A classification of Series *Incrassatae*

Series *Incrassatae*

Subseries *Incrassatosae* (*E. incrassata* sens. lat.)

- E. captiosa*
- E. incrassata*
- E. angulosa*
- E. ceratocorys*
- E. costata*
 - subsp. *murrayana*
 - subsp. *costata*
- E. capitanea*
- E. grossifolia*
- E. singularis*

Subseries *Tetrapterosae*

- E. tetraptera*
- E. stoatei*
- E. forrestiana*
- E. dolichorhyncha*

Table 3. Published names in Series *Incrassatae* (accepted names in **Bold type, taxonomic synonyms represented by '=', nomenclatural synonyms represented by '≡').**

- E. incrassata*** Labill., *Nov. Holl. Pl. Sp.* 2: 12 (1806).
- E. angulosa*** Schauer in Walp., *Repert. Bot. Syst.* 2: 925 (1843).
- E. cuspidata* Turcz., *Bull. Soc. Nat. Mosc.* 22(2): 22 (1849); = *E. angulosa*.
- E. tetraptera*** Turcz., *Bull. Soc. Nat. Mosc.* 22(2): 22 (1849).
- E. acutangula* Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersbourg* 10: 337 (1852); = *E. tetraptera*.
- E. costata*** F. Muell., *Trans. Victorian Inst.*, 33 (1855).
- E. forrestiana*** Diels in Diels & Pritzel, *Bot. Jahrb. Syst.* 35: 439 (1904).
- E. angulosa* Schauer var. *ceratocorys* Blakely, *Key Eucalypts*, 174 (1934); ≡ *E. ceratocorys*.
- E. stoatei*** C. Gardner, J. & *Proc. Roy. Soc. Western Australia* 22: 126 (1936).
- E. forrestiana* subsp. *dolichorhyncha* Brooker, J. & *Proc. Roy. Soc. Western Australia* 56(3): 74 (1974); ≡ *E. dolichorhyncha*.
- E. ceratocorys*** (Blakely) L.A.S. Johnson & K.D. Hill, *Fl. Australia* 19: 508 (1988).
- E. dolichorhyncha*** (Brooker) Brooker & Hopper, *Nuytsia* 9: 57 (1993).
- E. captiosa*** Brooker & Hopper, *Nuytsia* 9: 55 (1993).

Table 4. Subseries *Incrassatosae* (all measurements in mm).

	<i>E. incrassata</i>	<i>E. captiosa</i>	<i>E. angulosa</i>	<i>E. ceratocorys</i>	<i>E. capitanea</i>
Habit	mallee	mallee	mallee	mallee	mallee
Substrate	noncalcareous sands, gravels	white sand over laterite	calcareous sands coastal	red or white sand over sandy loam	red desert sands
Juvenile leaves	elliptical to ovate	ovate to lanceolate	broad-elliptical	ovate to broad-lanceolate	broad-elliptical to ovate
Adult leaves	broad-lanceolate to elliptical	narrow-lanceolate	broad-elliptical	broad-lanceolate	broad-lanceolate
- size (LxB)	50–110 × 9–30	50–70 × 8–10	80–140 × 25–50	70–120 × 10–25	70–130 × 14–45
Petiole	terete	terete	terete	terete to slightly flattened	flattened
Petiole (L)	15–20	10–20	15–30	20–25	14–30
Peduncle	flattened	slightly flattened	flattened, broad	flattened	flattened
Peduncle (L)	10–28	8–20	to 20	10–25	18–27
Pedicel	terete to slightly quadrangular	slightly flattened	terete to quadrangular	terete, winged	terete
Pedicel (L)	15–23	5–8	3–5	5–8	2–6
Buds - size (LxB)	12–16 × 4–7	10–12 × 4	11–17 × 7–9	9–11 × 6–7	9–22 × 6–9
- calyptra	beaked, ribbed	strongly beaked	conical, not beaked	beaked, not ribbed	conical, beaked
- hypanthium	slightly ribbed	slightly ribbed	coarsely ribbed	ribbed	strongly ribbed
Fruits	cupular to cylindrical	cupular	cupular	suburceolate to cylindrical	urceolate
- size (LxB)	8–13 × 7–13	6–10 × 8–10	15–25 × 15–25	17–25 × 10–15	16–22 × 12–15
- ribbing	slight	slight	strong	slight	distinct
Valves	to rim level	to rim level	below rim	deeply enclosed	deeply enclosed
Seeds	black	grey-black	black	black	dark grey-brown to black
	not winged	prominent wing	not winged	narrow wing	narrow wing

Table 4. Subseries *Incrassatosae* (all measurements in mm) cont.

	<i>E. costata</i> <i>subsp. costata</i>	<i>E. costata</i> <i>subsp. murrayana</i>	<i>E. grossifolia</i>	<i>E. singularis</i>
Habit	mallee	mallee	mallee	tree ('mallet')
Substrate	red sand or sandy loam	red sandy loam & desert sand	laterite or silicious sands	sand over laterite
Juvenile leaves	ovate to broad-lanceolate	ovate to broad-lanceolate	ovate to elliptical	elliptical to broad-lanceolate
Adult leaves	lanceolate	lanceolate	lanceolate to ovate	narrow-lanceolate
- size (L×B)	60–110 × 13–28	to 120 × 15–25	50–120 × 20–50	70–130 × 18–20
Petiole	terete to slightly flattened	terete	flattened to terete	terete
Petiole (L)	12–20	15–25	11–26	10–20
Peduncle	angular, thick	terete to slightly flattened	flattened, broad	flattened
Peduncle (L)	12–18	10–20	12–30	15–30
Pedicel	terete	terete,	terete	quadrangular
Pedicel (L)	3–10	3–5	0–4	5–10
Buds - size (L×B)	9–18 × 5–8	to 15 × 6	9–17 × 6–8	9–20 × 5–8
- calyptra	conical, beaked	conical, beaked	conical, beaked	long-beaked, ribbed
- hypanthium	slightly ribbed	ribbed	strongly ribbed	strongly ribbed
Fruits	ovoid to cupular	cylindrical	cupular to obconical	cylindrical
- size (L×B)	11–16 × 9–12	9–13 × 7–10	10–20 × 9–15	15–20 × 8–10
- ribbing	distinct	slight to almost smooth	distinct	distinct
Valves	deeply enclosed to slightly below rim	rim level or slightly below rim	deeply enclosed	slightly below rim
Seeds	grey-brown to black narrow wing	dark brown slight wing	dark grey-brown to black narrow wing	dark brown to black narrow wing

1. *Eucalyptus incrassata* Labill., Nov. Holl. Pl. Sp. 2: 12 (1806), tab. 150; non Sieber ex DC., Prodr. 3: 217 (1828), nom. illegit.

Type: south-western Australia, *J.J.H. Labillardière s.n.* (holo FI; iso BM, G, LINN, MEL). Cited as 'Habitat in terra Van-Leeuwin', and specimen annotated 'Nova Hollandia'.

The type of *E. incrassata* matches specimens of the taxon we are designating as *E. incrassata* sens. strict., which is intermediate in morphology between *E. angulosa* and *E. captiosa* (Fig. 1, and see Table 4). It occurs sporadically from the Stirling Ranges to east of Esperance along the south coast of Western Australia (Fig. 2), but appears to form distinct populations in a complex geographic mosaic with *E. angulosa* near the coast and *E. captiosa* further inland.

Mallee to 6 m tall. Bark smooth, grey to grey-brown, shedding in ribbons. Juvenile leaves disjunct, elliptical to ovate, to 8 cm long, 5 cm wide. Adult leaves disjunct; broad-lanceolate to elliptical, acuminate, glossy bright green, 5.0–11.0 cm long, 9–30 mm wide; petioles terete, 15–20 mm long; lateral veins at 35–45° to midrib, moderately spaced, ± degenerate; oil glands dense and distinct; intramarginal vein 1–3 mm from margin. Umbellasters axillary, 3–7-flowered; peduncles flattened, apically expanded, 10–28 mm long; pedicels terete to slightly quadrangular, 15–23 mm long. Mature buds ovoid, weakly to moderately costate, 12–16 mm long, 4–7 mm diam.; calyptra conical, often beaked, c. ½ as long to as long as hypanthium. Fruits cup-shaped to cylindrical, weakly costate, 3–4-locular, 9–16 mm long, 7–12 mm diam.; calyptra scar and stemonophore flat, c. 0.5–1 mm wide; disc steeply depressed, 1.5–3 mm wide; valve tips raised to rim level. Seeds ± pyramidal, deeply and regularly pitted, not winged, black, 1.0–2.0 mm long; hilum ventral; chaff red brown, smaller, angular (Fig. 1a, b)

Selected specimens (from 24 examined): Western Australia: c. 15 km S of Ravensthorpe on Hopetoun road and then 2 km along side road to Esperance, *Blaxell 1701 & Pryor*, 23 June 1978 (NSW, PERTH); between Twilight Cove and Pink Lake, Esperance, *Brooker 9516*, 7 Nov 1986 (CANB, NSW); 200 m E of Lol Gray Picnic Site, *Brooker 9893*, 8 Mar 1988 (CANB, NSW); Along Southern Ocean West rd, west of Hopetoun, *Carr 658 & Carr*, 2 Apr 1968 (CANB, AD, NSW, PERTH); Stirlings Range, *Diels 2990*, 31 May 1901 (B, NSW); Western Australia, *Drummond 65*, 1845 (BM, NSW); c. 2 km from Nunijup on Koonjie road, *Hill 2451, Johnson & Blaxell*, 13 Nov 1986 (NSW, PERTH); 31.7 km from Old Ongerup Rd on Hammersley Drive, *Hill 3145*, 7 Sep 1988 (NSW); between Young [River] and Oldfield (halfway Esperance to Ravensthorpe), *Johnson W 208*, 18 Dec 1960 (NSW); 1 mile [1.6 km] N of Kundip, *Johnson W 221*, 19 Dec 1960 (NSW); Esperance, *Maiden NSW 353217*, Nov 1909 (NSW); 3.5–4 miles [5.6–6.4 km] N of Mt Bland, Fitzgerald River National Park, *Tindale 3854a p.p.*, 30 Aug 1973 (NSW); between Albany and Williams River, *Webb s.n.*, (MEL, NSW).

Intergrades: *E. angulosa* ↔ *E. incrassata*

Selected specimens (from 2 examined): Western Australia: 14.2 km S of highway on track to Eyre telegraph station (now Eyre bird observatory), *Hill 2171 & Johnson*, 3 Nov 1986 (NSW, CANB, MEL, PERTH).

2. *Eucalyptus angulosa* Schauer, in Walp., Repert. Bot. Syst. 2: 925 (1843).

Type: Western Australia: Swan River Colony, *J. Drummond 4: 75* (lectotype BM, here designated; isolecto CGE, FI, K, PERTH, W). No type was cited in the protologue, and Schauer may have used collections by Brown, A. Cunningham, Labillardière or Drummond in drawing up the description. This typification clearly fixes the name to the coastal taxon generally understood to be represented by this name.

≡ *E. cuspidata* Turcz., Bull. Soc. Nat. Mosc. 22(2): 22 (1849). Also based on *Drummond 4: 75*.

E. angulosa was reduced to a variety of *E. incrassata* by Bentham (1867), which treatment was followed by Maiden (*Crit. Revis. Eucalyptus 1903–1933*, 1: 101). Blakely reverted to Schauer's treatment, then Burbidge (1947) followed Bentham with a narrower circumscription. Pryor and Johnson (1971) included *E. angulosa* in

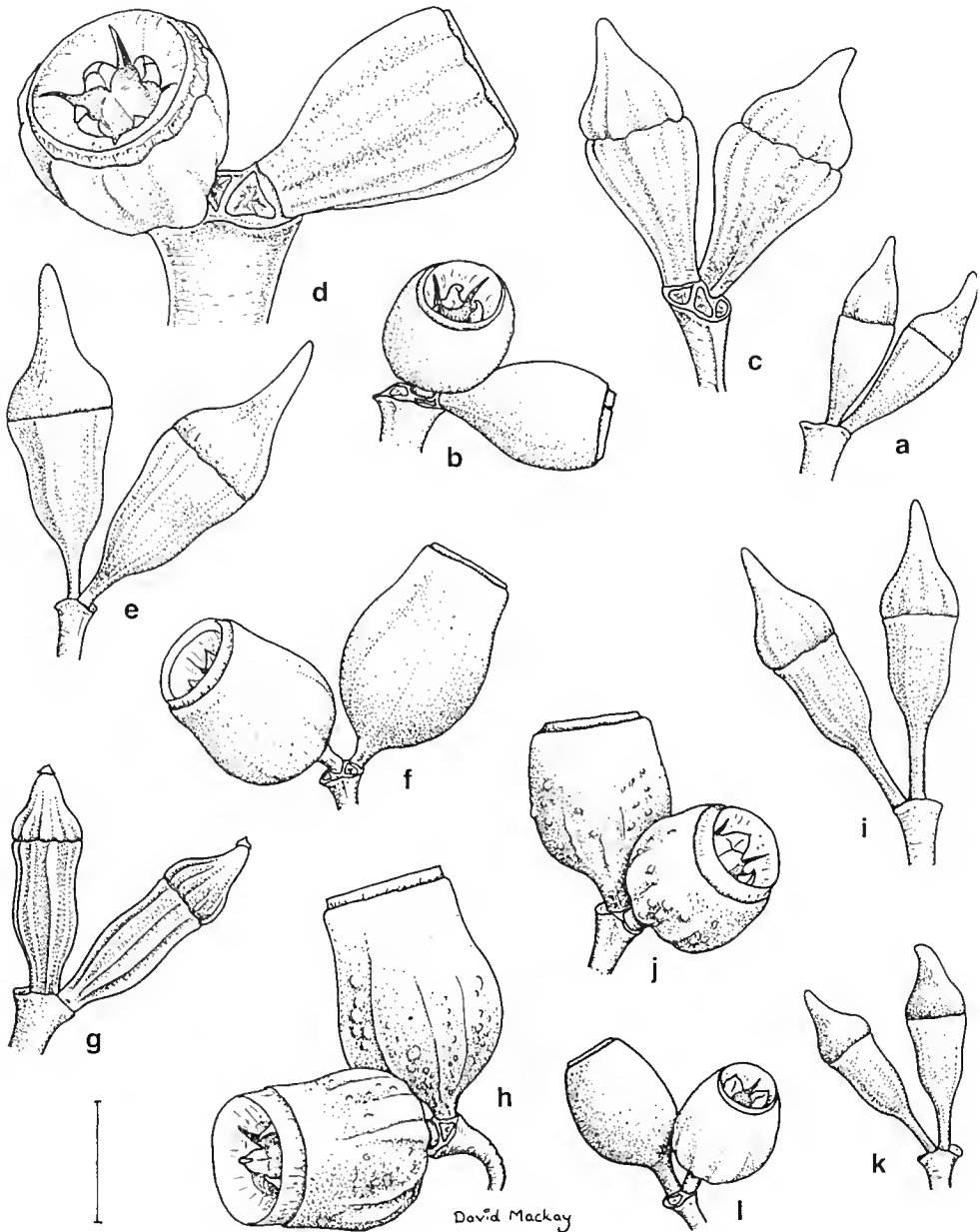


Fig. 1. *E. incrassata*. a, buds; b, fruits (from Maiden NSW 353217); *E. angulosa*. c, buds; d, fruits (from Brooker 8046). *E. ceratocorys*. e, buds. f, fruits (from Brooker 9088, Cometvale, W.A. Booker 9088, 13 Nov 1985 (PERTH, CANB, NSW). *E. capitanea*. g, buds. h, fruits (from Brooker 8466). *E. costata* subsp. *costata*. i, buds. j, fruits (from Carrick 3187). *E. costata* subsp. *murrayana*. k, buds. l, fruits (from Gaiba CANB 000253). Scale bar = 1 cm.

E. incrassata as a local variant of a highly variable species. Following more detailed studies, we now consider that a number of taxa can be distinguished within *E. incrassata* sens. lat., of which *E. angulosa* is one (Table 2). Chippendale (1988) applies essentially the same circumscription of *E. angulosa* in his treatment.

Mallee to 6 m tall. Bark smooth, grey to grey-brown, shedding in ribbons. Juvenile leaves disjunct, broad-elliptical, to 10 cm long, 7 cm wide. Adult leaves disjunct; broad-elliptical, apiculate, glossy bright green, 8.0–14.0 cm long, 25–50 mm wide; petioles terete, 15–30 mm long; lateral veins at 35–45° to midrib, moderately spaced, \pm degenerate; oil glands dense and distinct; intramarginal vein 2–4 mm from margin. Umbellasters axillary, 3–7-flowered; peduncles flattened, broadly apically expanded, 10–20 mm long; pedicels terete to quadrangular, 3–5 mm long. Mature buds ovoid, coarsely distinctly costate, 11–17 mm long, 7–9 mm diam.; calyptra conical, usually not beaked, c. $\frac{1}{2}$ as long to as long as hypanthium. Fruits cup-shaped, distinctly broadly costate, 3–4-locular, 15–25 mm long, 15–25 mm diam.; calyptra scar and stemonophore flat, c. 1–2 mm wide; disc steeply depressed, 2–5 mm wide; valves enclosed. Seeds \pm pyramidal, deeply and regularly pitted, not winged, black, 2–3 mm long; hilum ventral; chaff red brown, smaller, angular (Fig. 1c, d).

E. angulosa is a coastal taxon, occurring in dense shrub thickets, usually on calcareous substrates, along the southern coast of Western Australia from West Cape Howe east past Israelite Bay, and in southern Eyre and Yorke Peninsulas and Kangaroo Island in South Australia (Fig. 2). It is distinguished within the series by the coarse leaves, buds and fruits (see also Table 4).

Selected specimens (from 69 examined): South Australia: Encounter Bay, *Cleland* 16, Feb 1921 (NSW); between Fishery Bay and Cape Wiles, *Blaxell* 2063 & *Johnson*, 17 June 1983 (NSW, CANB); Stamford Hill, *Maiden s.n.*, Jan 1907 (NSW); Port Lincoln to Coffins Bay, *Maiden s.n.*, Jan 1907 (NSW); Mt Hope, *Noble* 7 & *Bawden*, Feb 1981 (NSW); 4 km S Mt Hope Post Office 85 km NW Port Lincoln, *Pickard* 2522, 10 Dec 1973 (NSW); Porter Bay, S of Port Lincoln, Erosion control area between Bay and Point, *Symon* 13712, 20 Dec 1983 (AD, CANB, NSW, US).

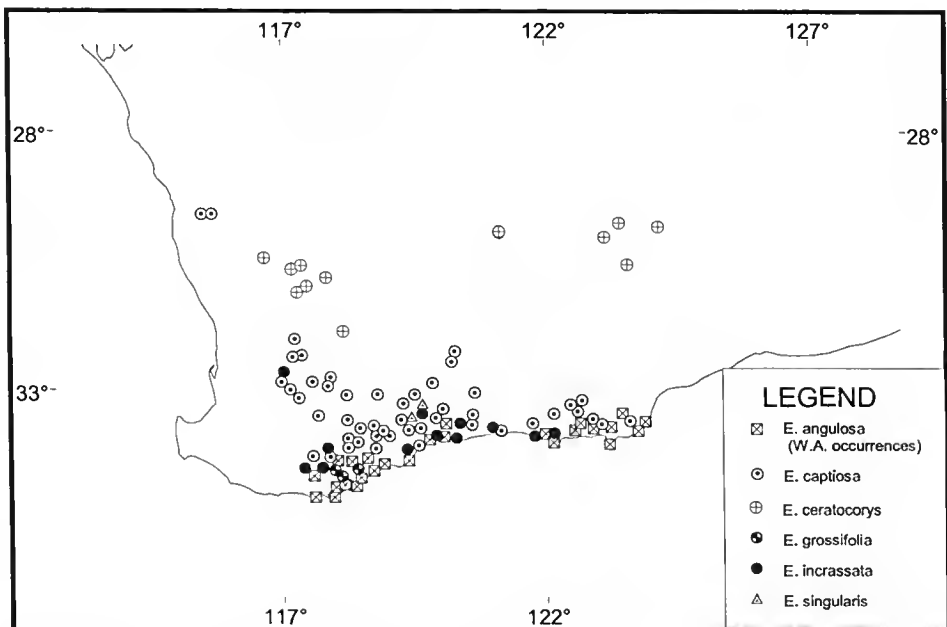


Fig. 2. Distribution of *E. angulosa* p.p., *E. captiosa*, *E. ceratocorys*, *E. grossifolia*, *E. incrassata*, *E. singularis*.

Western Australia: N of Mt Le Grand, Cape le Grand National Park, *Blaxell 1742, Pryor & J. Briggs*, 15 Sep 1978 (NSW, PERTH); 6 km south of Fisheries Road on Duke of Orleans Bay Road, *Blaxell 86-077 & Brooker*, 6 Nov 1986 (NSW, CANB, PERTH); 22 km (direct) north of Wellstead, 2 km north-west of Rams Head on Monjebup road, *B. Briggs 7877 & Johnson*, 11 Oct 1984 (NSW, CANB, PERTH); Cheyne Beach (east), *Brooker 6686*, 28 Dec 1979 (CANB, NSW, PERTH); Sandy Hook Island near Esperance, *Brooker 7494*, 1 May 1982 (CANB, NSW); Kojoneerup Springs road corner with Chillinup road, *Brooker 8046*, 23 Mar 1983 (CANB, NSW); Along Southern Ocean West road, W of Hopetoun, *Carr 659 & Carr*, 2 Apr 1968 (CANB, BRI, CANB, MEL, NSW, PERTH); Bremer Bay, just out of town on Borden road, *Carr 1129 & Carr*, 4 Sep 1969 (CANB, AD, BRI, CANB, MEL, NSW); Rotary Lookout, Esperance, *Chippendale 183*, 14 Mar 1967 (CANB, NSW); Warriup Rd, 15.2 km E of junction with Hassell Rd, c. 76 km (by road) NE of Albany, *Conn 3363 & Scott*, 10 Oct 1989 (NSW); Stirling Range, junction of East Pillenorup and South Isongerup Tracks, *Crisp 5277*, 18 Jan 1979 (CBG, NSW, PERTH); Nova Hollandia, *Druumond 75*, (K, NSW); Culham Inlet W of Hopetoun, *George 7596 & Carr*, 22 Feb 1966 (CANB, DNA, BRI, NSW, MEL, AD, PERTH, HO); Mt Ragged turnoff, 128.7 km S of Balladonia roadhouse on track to Israelite Bay, *Hill 251 & Johnson*, 20 Oct 1983 (NSW, CANB); Mount Melville Garbage Tip (16.5 km from Highway), *Hill 2430, Johnson & Blaxell*, 12 Nov 1986 (NSW, PERTH); West Cape Howe, Bruce Tarbottom memorial walk, on eastern slope of ridge, *Hill 3078*, 5 Sep 1988 (NSW, CANB, PERTH); Isthmus Hill trig. Flinders Peninsula, south of Albany, *Powell 3216, Everett & Bedford*, 15 Nov 1985 (NSW, PERTH); Cape Riche, dunes above beach, *Powell 3247*, 16 Nov 1985 (NSW, PERTH, CANB); 8.4 km W of the ruins at Israelite Bay, *Pryor 177 & J. Briggs*, 26 Oct 1978 (CANB, NSW); 131.8 km S of Balladonia (at turnoff to Israelite Bay), *Pryor 186 & J. Briggs*, 26 Oct 1978 (CANB, NSW).

3. *Eucalyptus costata* F. Muell., Trans. Victorian Inst.: 33 (1855).

Type: South Australia: Angaston, *Behr s.n.*, Dec 1848 (lecto MEL 1552443; here designated; isolecto K). Cited as: 'Behr & Muell. Coll.'; 'In the Mallee scrub, from the Murray River to Spencer's Gulf.' This specimen was labelled *E. incrassata* var. *angulosa* by Mueller, but is the only specimen in MEL which can fit this citation.

Maiden (*Crit. Revis. Eucalyptus* 1903–1933, 1: 102) gave the authority for this name as R. Br., but Mueller did not acknowledge Brown or cite Brown's collection. Mueller did specifically cite Behr and Mueller as collectors, so the authority must remain as above, and Maiden's statement treated as below. The name has no connection with *Metrosideros costata* Gaertn. (= *Angophora costata* (Gaertn.) Britten).

E. costata was included in *E. incrassata* var. *angulosa* by Bentham (1867) and Maiden (*Crit. Revis. Eucalyptus* 1903–1933, 1: 101), and in *E. angulosa* by Blakely (1934). Burbidge (1947) recognised it as a variety of *E. incrassata*, and Pryor & Johnson (1971) included it in a broadly circumscribed *E. incrassata*. We now divide *E. incrassata* sens. lat. into several taxa, one of which is *E. costata*.

Mallee to 5 m tall. Bark smooth, grey to grey-brown, shedding in ribbons. Juvenile leaves disjunct, ovate to elliptical, to 10 cm long, 5 cm wide. Adult leaves disjunct; lanceolate to broad-lanceolate or narrow-elliptical, acuminate, glossy bright green, 6.0–11.0 cm long, 13–28 mm wide; petioles terete or slightly flattened, 12–20 mm long; lateral veins at 35–45° to midrib, moderately spaced, ± degenerate; oil glands dense and distinct; intramarginal vein 1–2 mm from margin. Umbellasters axillary, 3–7-flowered; peduncles flattened, apically expanded, 12–18 mm long; pedicels terete, 3–10 mm long. Mature buds ovoid, weakly to moderately costate, 9–18 mm long, 5–8 mm diam.; calyptra conical, often beaked, c. ½ as long to as long as hypanthium. Fruits ovoid or cup-shaped to cylindrical, weakly to moderately costate, 3–4-locular, 9–16 mm long, 7–12 mm diam.; calyptra scar and stemonophore flat, c. 0.5–1 mm wide; disc steeply depressed, 1.5–3 mm wide; valves deeply enclosed to just below rim level. Seeds ± pyramidal, deeply and regularly pitted, narrowly winged, dark grey-brown to black, 1.0–1.5 mm long; hilum ventral; chaff red brown, smaller, angular (Fig. 1).

Distinguished within the series by the following: mallee; juvenile leaves medium to large (to 10 × 5 cm); adult leaves lanceolate to broad-lanceolate; calyptra short (l:b <

2:1); fruits shallowly ribbed to almost smooth, urceolate, medium size (9–16 mm long, 7–21 mm diam., see also Table 4).

Two subspecies are recognised, as follows

3A. *Eucalyptus costata* F. Muell. subsp. *costata*

Fruits ovoid to cup-shaped, large (11–16 mm long, 9–12 mm diam.), distinctly ribbed, valves deeply enclosed to slightly below rim level (Fig. 1i, j).

Restricted to South Australia, on red sand or sandy loam, central Eyre Peninsula, Yorke Peninsula and the upper and lower Murray Mallee regions, east almost to the Victorian border (Fig. 3).

Intergradation occurs in marginal regions with *E. angulosa* and hybrids are known with *E. rugosa* R. Br. ex Blakely.

Conservation status: not considered to be at risk.

Selected specimens (from 57 examined): South Australia: c. 10 km N of Cummins, *Blaxell* 2062 & *Johnson*, 17 June 1983 (NSW, CANB); c. 16 km south of Curramulka, *Blaylock* 1801, 30 Apr 1973 (AD, NSW); Goolwa, c. 65 km south-south-east of Adelaide, River Murray Lakes, *Boomsma*, 9 Nov 1967 (AD, NSW); Padthaway, ca. 40 km SSW of Bordertown, *Canty*, 23 Oct 1980 (AD, NSW); Mt Weedind, about 15 miles [24 km] South from the Gawler Ranges and 125 miles [200 km] a little west of north from Port Lincoln, *Gill*, Dec 1912 (NSW); 74 km from Whyalla on Cowell road, *Hill* 2145 & *Johnson*, 1 Nov 1986 (NSW, AD, CANB, MEL, PERTH); 7 km north of Arno Bay on Lincoln Highway, *Hopton* 21, 21 Oct 1988 (AD, NSW); c. 17 km S of Bordertown on Naracoorte road, *Johnson* 7920 & *Wilson*, 20 Feb 1975 (NSW); 7 miles [11 km] south of Monarto South, *McKern*, 24 Aug 1958 (NSW); Murray Bridge, *Maiden*, Jan 1907 (NSW); 9 miles [14 km] from Port Broughton, towards Bute, *Phillips*, 11 Nov 1962 (CANB, NSW); 23 miles [36.8 km] from Bordertown, towards Keith, *Phillips*, 21 Oct 1966 (CANB, NSW); stock route 14 km SW Buckleboo HS [homestead], 150 km WNW Port Augusta, *Pickard* 2496, 9 Dec 1973 (NSW); between Bordertown and Keith, 8 miles (13 km) WNW of Bordertown, *Smith* 67/201, 17 Nov 1967 (MEL, NSW); area between Oak Dam (Frenchs Dam) and Gypsum Hills c. 32 miles [51 km] N of Overland Corner, *Symon* 3631, 9 Oct 1965 (AD,

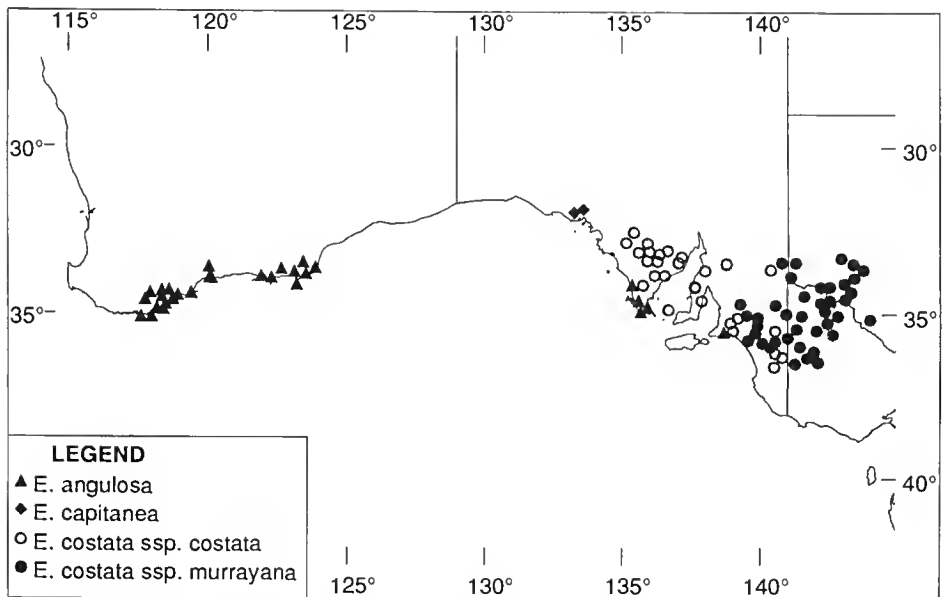


Fig. 3. Distribution of *E. angulosa*, *E. capitanea*, *E. costata* subsp. *costata*, *E. costata* subsp. *murrayana*.

(NSW); Hambidge Reserve, NW and NNW from Prominent Hill, *Symon 4186*, 8 Oct 1966 (AD, NSW); Hincks National Park, the inner NW angle of the reserve, S of the Verran Hill road exit, *Symon 6265*, 9 Oct 1968 (AD, CANB, NSW); Gawler Ranges, 21 km SW of Yardea on road to Minnipa, *Symon 8106*, 2 Oct 1972 (AD, MO, NSW); 8 miles [13 km] N of Arno Bay, *Tindale 467*, 12 Sep 1970 (NSW, AD, PERTH); 3 miles [4.8 km] south of Pine Point, *Waterhouse 1374 a*, 7 Feb 1970 (NSW); 7 miles [11 km] out of Moonta on Maitland Rd, *Waterhouse 1384*, 9 Feb 1970 (NSW).

Intergrades: *E. angulosa* ↔ *E. costata* subsp. *costata*

Selected specimens (from 6 examined): South Australia: near Waitpinga, *Brooker 6927*, 9 May 1980 (CANB, AD, NSW); 2.5 km N of Waitpinga Beach towards Victor Harbour road, *Chippendale 1342 & Brennan*, 18 July 1975 (CANB, NSW); S from Sandergrove Siding towards Milang on abandoned railway line, between second & third road crossings, *Pearce 275*, 22 Sep 1982 (AD, CANB, NSW); Newland Head to Waitpinga, Fleurieu Peninsula, *Schodde 5185*, 2 July 1967 (AD, NSW); 3 miles [4.8 km] E of Wanillo on North Shields Rd, *Tindale 554*, Sep 1970 (NSW, AD, K).

Hybrids: *E. costata* subsp. *costata* × *E. rugosa*

Specimens examined: South Australia: Eyre Peninsula, between Fishery Bay and Cape Wiles, *Blaxell 2063 & Johnson*, 17 June 1983 (NSW).

3B. *Eucalyptus costata* F. Muell. subsp. *murrayana* L.A.S. Johnson & K.D. Hill, subsp. nov.

Ab *E. costata* subsp. *costata* distinguitur fructibus cylindricis relative minoribus (9–13 mm longis, 7–10 mm diametro) et paene laevibus.

Type: Victoria: 42 km E of Ouyen on Manangatang road, *J.D. Turner 125 & H. Vos*, 16 Sep 1977 (holo NSW; iso CANB, MEL, AD, PERTH).

Distinguished from subsp. *costata* by the cylindrical, small fruits (9–13 mm long, 7–10 mm diam.) that are almost smooth with valves at or slightly below rim level (Fig. 1k, l, see also Table 4).

Scattered but locally frequent on red sandy loams and desert sands, from the Murray Mallee and 90-mile Desert of South Australia through Victoria almost to Swan Hill, and north to Pooncarie and Koraleigh in New South Wales (Fig. 3).

Extensive zones of intergradation occur between the two subspecies in the south-east of the range, from Dimboola and Mt Arapiles west to the Victorian border, and through the 90-mile Desert to the lower Murray in South Australia. A complete breakdown occurs in this area in South Australia, with a full range between the two end points evident.

Conservation status: not considered to be at risk.

The epithet is from the Murray region, where this taxon occurs.

Selected specimens (from 93 examined): New South Wales: S. Far W. Plains: 3 km Sth Prungle on Rd to Hwy, *Cunningham 2477 & Milthorpe*, 24 July 1974 (NSW); 24 miles [38 km] from Pooncarie towards Darnick along Pooncarie to Darnick road, *Dunlop 1465*, 31 Aug 1969 (CANB, NSW); 2.5 km W of Bidura Homestead, *Fox 7910015*, 4 Oct 1979 (NSW); 12 km NE of Prungle Homestead, *Fox 7910024*, 5 Oct 1979 (NSW); 16 km east of Tarawi homestead, *Fox 8304092 & Falling*, 29 Apr 1983 (NSW); *E. incrassata* site just off Bicentennial Rd & Belmore Rd, *Fox 8411329*, Nov 1984 (NSW); about 12 miles [19 km] E of Wampo towards Borce Plns (between Turlee and Hatfield), *Johnson & Constable*, 19 Mar 1959 (NSW); 12 miles [19 km] E of Turlee, ENE of Mildura *Johnson B 2794 & Briggs*, 26 May 1969 (NSW); 18 miles [29 km] W of Euston, *Mulham s.n.*, 22 Sep 1970 (NSW); near Tapalin mail-run turn-off on Sturt Highway, about 30 km east of Euston, *Noble 1036*, 5 May 1977 (NSW); Birdwood Station, Pooncarie, *Noble 4*, 11 Apr 1979 (NSW); Mylatchie via Balranald, *Semple 1357*, 25 May 1982 (NSW); 13 km NE Belmore homestead on Belmore to Belvedere Road, *Turner 31 & Vos*, 5 Aug 1976 (CANB, NSW); 3 miles [4.8 km] E Gal Gal along track to Mandleman, *Whaite 2051*, 15 Nov 1956 (NSW); 11 km SW of Bellnar homestead on Arumpo to Buronga road, *Wilson 3270*, 4 Dec 1980 (NSW).

SW. Plains: ca. 1.5 km SE of Hypurna homestead on main road, ca. 39 km by road N of Wentworth to Renmark road, *Conn 1034*, 14 Sep 1980 (AD, NSW); roadside ca. 2.5 km south of Cambrai, *Jackson 3782*, 6 Aug 1980 (AD, NSW); c. 3 miles [4.8 km] E of Koraleigh, on road to Lake Poomah (c. 1 mile [1.6 km] from Lake Poomah), *Johnson s.n.*, 28 May 1969 (NSW 353325).

South Australia: Ki Ki, about 30 miles [48 km] SE of Tailern Bend, *Banks B 1273*, 4 June 1968 (CANB, NSW); Tintinarra [Tintinara], *Cabbage*, 23 Mar 1901 (NSW); 90 Mile (Murray Desert), *Gill s.n.*, Mar 1901 (NSW 353569); mallee heath 2 miles [3.2 km] E of Adelaide University Experimental Plot, Dark Island, about 10 miles [16 km] NE of Keith, *Melville 462 & Specht*, 14 Aug 1952 (K, NSW); 5 km W of Murray Bridge, *Nordenstam 1069 & Anderberg*, 7 Nov 1989 (NSW); Block 75 near old Telegraph Reserve, on oil search rd County Hamley, *Symon 3808*, 11 Oct 1965 (AD, HUI, K, NSW); Belacre Simpson property, c. 24 km SE of Meningie, *Symon 8553*, 9 June 1973 (AD, CANB, NSW); 18 km N Pinaroo towards Paruna, *Turner 18 & Vos*, 3 Aug 1976 (CANB, NSW); 13 km S Paruna turnoff to Pinaroo, *Turner 106 & Vos*, 14 Sep 1977 (CANB, AD, MEL, NSW, PERTH); 10 km along road to Bow Hill from Mannum Road, *Whibley 8717*, 1 Nov 1983 (NSW, BRI, CANB, NSW).

Victoria: 3.3 km north-east of McCabes Hut ruin near Dimboola, *Abell 531 & Herscovitch*, 17 Dec 1986 (NSW); Hattah Lakes National Park, between Hattah Station & Hattah Lake, *Beauglehole 19909*, 11 Sep 1960 (MEL, NSW); Grampians, Mt Arapiles, SW side, *Beauglehole 30886*, 5 Sep 1969 (MEL, NSW); plain SW of Mt Arapiles, *Brooker 5966*, 23 Aug 1978 (CANB, MEL, NSW); 8.3 km S of Werrimul at abandoned channel, *Brooker 10320*, 11 Oct 1989 (CANB, AD, MEL, NSW); along Konardin Tank Road, 0.4 km from the junction of Mourmpoul Road, Hattah National Park, *D'Aubert 484, Hind & Duggan*, 23 Jan 1989 (NSW); near Mildura, *Gauba s.n.* (CANB 000253, NSW); 26 km S of Murrayville along the road-track to Nhill, N border of the Big Desert Wilderness, *Greuter 20910*, 22 Sep 1988 (NSW); 33.7 km northwest of Horsham on Dimboola road (eastern edge of Dimboola), *Hill 1661, Johnson & Wilson*, 8 Mar 1986 (NSW); 2.4 km east of Gerang Gerung on highway, *Hill 1669, Johnson & Wilson*, 8 Mar 1986 (NSW); Lawloit Range, on Western Highway, 18.0 km SW on Nhill, *Jobson 3702*, 27 Aug 1995 (MEL, AD, BRI, CANB, NSW); Little Desert National Park, on road to camping area, c. 16 km SE of Nhill, *Lyne 601 & Hadlow*, 10 Nov 1991 (CANB, AD, MEL, NSW, PERTH); Hattah, 35 m W of high voltage power line in swale between 1st and 2nd tower S of Last Hope Track, *Macfarlane 116*, 21 Aug 1996 (MEL, AD, CANB, HO, NSW); Big Desert, Pengana Parish, 35 miles [56 km] NE by N of Kaniva, *Melville 1097, Morris, Hicks & Williams*, 19 Sep 1952 (K, NSW); Sandhill c. 10.5 km from Sunset Tank along road to Cowangie (Grid B 3), *Short 1281*, 29 Sep 1981 (MEL, NSW); 42 km Ouyen to Manangatang, *Turner 125 & Vos*, 16 Sep 1977 (CANB, AD, MEL, NSW, PERTH).

Intergrades: *E. costata* subsp. *costata* ↔ *E. costata* subsp. *murrayana*

Selected specimens (from 11 examined): Victoria: Mt Arapiles, SW side, *Beauglehole 30886*, 5 Sep 1969 (MEL, NSW); plain SW of Mt Arapiles, *Brooker 5966, 5967*, 23 Aug 1978 (CANB, MEL, NSW); 2.4 km east of Gerang Gerung on highway, *Hill 1669, Johnson & Wilson*, 8 Mar 1986 (NSW); Little Desert Nat. Park, 6 miles [9.6 km] S of Kiata, *Muir s.n.*, Mar 1970 (CANB, NSW 154289); Dimboola, *Reader s.n.*, (MEL, NSW 353722).

4. *Eucalyptus capitanea* L.A.S. Johnson & K.D. Hill, sp. nov.

Inter species ex affinitate *E. incrassatae* combinatione characterum sequentium distinguitur: habitus multicaulis; calyptra brevis (longitudo: diameter < 2:1); fructus costati, urceolati, magni (15–20 mm longi, 12–14 mm diametro).

Type: South Australia: 8.4 km N of Koonibba towards Yumbarra Conservation Park, M.I.H. *Brooker 8466*, 9 Mar 1984 (holo NSW; iso CANB, PERTH, MEL, AD).

Mallee to 4 m tall. Bark smooth, grey to grey-brown, shedding in ribbons. Juvenile leaves not seen. Adult leaves disjunct; lanceolate to broad-lanceolate or narrow-elliptical, acuminate, glossy bright green, 7.0–13.0 cm long, 14–45 mm wide; petioles flattened, 14–30 mm long; lateral veins at 35–45° to midrib, moderately spaced, ± degenerate; oil glands dense and distinct; intramarginal vein 1–2 mm from margin. Umbellasters axillary, 3–7-flowered; peduncles flattened, apically expanded, 18–27 mm long; pedicels terete, 2–6 mm long. Mature buds ovoid, distinctly costate, 9–22 mm long, 6–9 mm diam.; calyptra conical, shortly beaked, ½–¾ as long to as long as

hypanthium. Fruits urceolate, distinctly costate, 3-4-locular, 15–22 mm long, 12–15 mm diam.; calyptra scar and stemonophore raised, 1–2 mm wide; disc steeply depressed, 3–4 mm wide; valves deeply enclosed. Seeds \pm pyramidal, deeply and regularly pitted, narrowly winged circumferentially and with ventral ridges, dark grey-brown to black, 3–4 mm long; hilum ventral; chaff red brown, smaller, angular. (Fig. 1g, h).

E. capitanea is distinguished within the *E. incrassata* complex by the following combination of characters: mallee; calyptra short (l:b < 2:1); fruits ribbed, urceolate, large (15–22 mm long, 12–15 mm diam.). See also Table 4.

Locally frequent but at present known from one site only, on the crests of red desert dunes near Koonibba (Fig. 3). Associated taxa include *E. yumbarrana* Boomsma and *Triodia*, with *E. oleosa* subsp. *repleta* L.A.S. Johnson & K.D. Hill and *E. brachycalyx* Blakely lower on dune slopes and on swales.

Conservation status: a species of restricted occurrence, although the extent is not known (2K).

The epithet is from the Latin *capitaneus*, head or chief, in reference to the larger size of this species in all parts in comparison to related taxa.

Specimens examined: South Australia: 8.4 km N of Koonibba towards Yumbarra Conservation Park, *Brooker 8466*, 9 Mar 1984 (CANB, NSW); c. 2 km NW of Koonibba Hill on access track to new wheatlands, c. 30 km E of Penong, *Hill 714 & Blaxell*, 15 Nov 1983 (NSW, AD, CANB, PERTH); 7.3 km N of highway to N of Charra turnoff (30 km E of Penong, 40 km W of Ceduna), *Hill 2157 & Johnson*, 2 Nov 1986 (NSW, AD, CANB, MEL, PERTH).

5. *Eucalyptus grossifolia* L.A.S. Johnson & K.D. Hill, sp. nov.

E. angulosam plusminusve approximans sed habitu erecto, sparso, emergenti nec humile nec denso differt.

Type: Western Australia: 1.3 km from Kambellup on Woogenellup rd (34°S 117°59'E), *K.D. Hill 2444*, L.A.S. Johnson & D.F. Blaxell, 12 Nov 1986 (holo NSW; iso PERTH).

Mallee to 6 m tall. Bark smooth, grey to grey-brown, shedding in ribbons. Juvenile leaves disjunct, ovate to elliptical, to 10 cm long, 5 cm wide. Adult leaves disjunct; lanceolate to broad-lanceolate or narrow-elliptical to ovate, acuminate, glossy bright green, 5.0–12.0 cm long, 20–50 mm wide; petioles flattened, 11–26 mm long; lateral veins at 35–45° to midrib, moderately spaced, \pm degenerate; oil glands dense and distinct; intramarginal vein 1–2 mm from margin. Umbellasters axillary, 7-flowered; peduncles flattened, apically expanded, 12–18 mm long, to 10 mm wide apically; pedicels terete, 0–4 mm long. Mature buds ovoid, sessile or shortly pedicellate, distinctly irregularly costate, 9–17 mm long, 6–8 mm diam.; calyptra conical, often beaked, $\frac{1}{3}$ – $\frac{1}{2}$ as long to as long as hypanthium. Fruits cup-shaped to obconical, distinctly irregularly costate, 3-4-locular, 10–20 mm long, 9–15 mm diam.; calyptra scar and stemonophore flat, c. 1 mm wide; disc steeply depressed, 2–4 mm wide; valves enclosed. Seeds \pm pyramidal to patelliform, deeply and regularly pitted, narrowly winged circumferentially and with ventral ridges, dark grey-brown to black, 2–3 mm long; hilum ventral; chaff brown, smaller, angular (Fig. 4).

E. grossifolia is most similar to *E. angulosa*, differing mainly in the slender, sparse, erect, emergent habit in contrast to the low, dense, bushy habit of the latter (see also Table 4). *E. angulosa* is also largely restricted to calcareous sand deposits on or near the coast, whereas *E. grossifolia* occurs on lateritic residuals, often with a shallow siliceous sand mantle, some distance from the coast.

A component of rich mixed mallee shrublands, associated species including *E. uncinata* Turcz., *E. falcata* Turcz., *E. pleurocarpa* Schauer, *E. pachyloma* Benth., *E. tetraptera* Turcz.

and *E. preissiana* Schauer. Known occurrences are mainly on white siliceous sand over laterite, apparently restricted to the Kalgan Plain region (Fig. 2).

Conservation status: known from a few small stands, all of which have been partly or substantially cleared (2V).

The epithet is from the latin *grossus*, thick, coarse, and *folium*, leaf, in reference to the thick, coarse foliage.

Selected specimens (from 8 examined): Western Australia: 1.3 km from Kambellup on Woogenellup road, *Hill 2444*, Johnson & Blaxell, 12 Nov 1986 (NSW, PERTH); 0.8 km south of Johnson Road on Palmdale Road, *Hill 3090*, 5 Sep 1988 (NSW); 4.5 km from Chester Pass Road on Tackalarup Road, *Hill 3091*, 5 Sep 1988 (NSW); 12.6 km W of Chester Pass Rd on Woogenellup N Rd, *Hill 3094*, 6 Sep 1988 (NSW); 35.2 km from Chester Pass Rd on Chillinup Rd, *Hill 3101*, 6 Sep 1988 (NSW); 12 miles [19 km] from Porongorup on road to Borden, *Hindmarsh s.u. & Waterhouse*, 11 Aug 1973 (UNSW 2525, NSW).

6. *Eucalyptus singularis* L.A.S. Johnson & D.F. Blaxell, sp. nov.

Ab *E. incrassata* et speciebus cognatis habitu non fruticoso ('mallee'), canopeo angusto et habitatione differt.

Type: Western Australia: Fitzgerald Road. 4.9 km SW of the junction with Koornong Road, at 'Urara' property rd, c. 42 km WNW of Ravensthorpe (33°32'S 119°37'E), *B.G. Briggs 7828 & L.A.S. Johnson*, 10 Oct 1984 (holo NSW; iso AD, CANB, PERTH).

Slender tree ('mallet') to 6 m tall. Bark smooth, grey, shedding in ribbons. Juvenile leaves disjunct, ovate to elliptical, to 8 cm long, 2.5 cm wide. Adult leaves disjunct; narrow-lanceolate to lanceolate, with a curved, acuminate and prominent tip, glossy dark green, 7.0–13.0 cm long, 8–20 mm wide; petioles terete, 10–20 mm long; lateral veins at 30–45° to midrib, irregularly spaced; oil glands not distinct; intramarginal vein

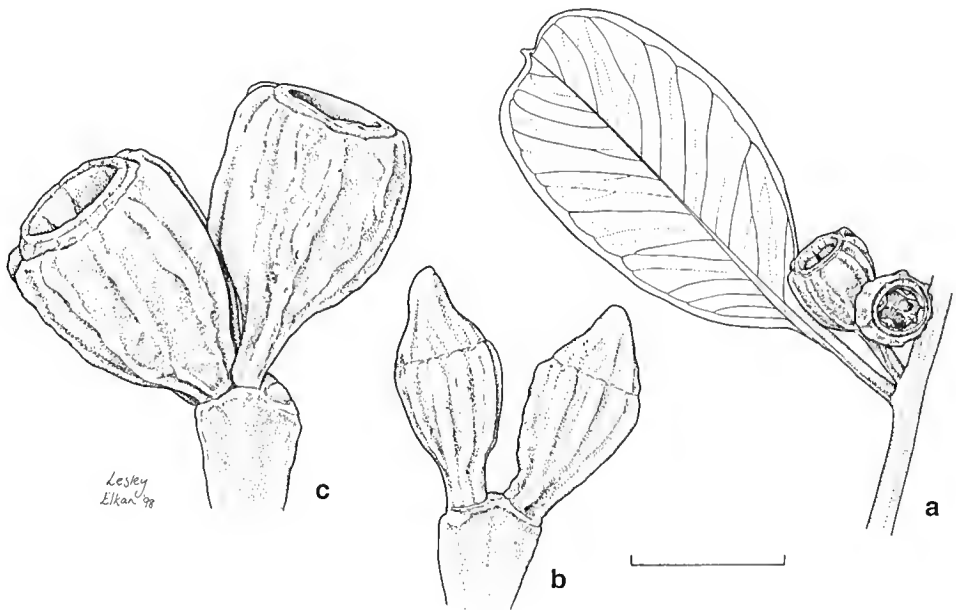


Fig. 4. *E. grossifolia*. a, adult leaves, inflorescence and fruits; b, inflorescence and buds; c, inflorescence and fruits. (from *Hill 3101*). Scale bar = 1 cm.

c. 1 mm from margin. Umbellasters axillary, 7-flowered; peduncles flattened, apically expanded, decurved, 12–30 mm long, to 10 mm wide apically; pedicels vaguely quadrangular, ridged, to 8 mm long. Mature buds ovoid, distinctly costate, 15–20 mm long, 5–8 mm diam.; calyptra conical, long-beaked, 1.5–2 times as long as hypanthium. Fruits cup-shaped to cylindrical, distinctly costate, 3-locular, 15–20 mm long, 8–10 mm diam.; calyptra scar and stemonophore slightly raised, 1 mm wide; disc level with rim; valves just below rim. Seeds \pm pyramidal, distinctly pitted, very narrowly winged circumferentially and with ventral ridges, dark grey-brown to black, 2–3 mm long; hilum ventral; chaff red-brown, angular (Fig. 5).

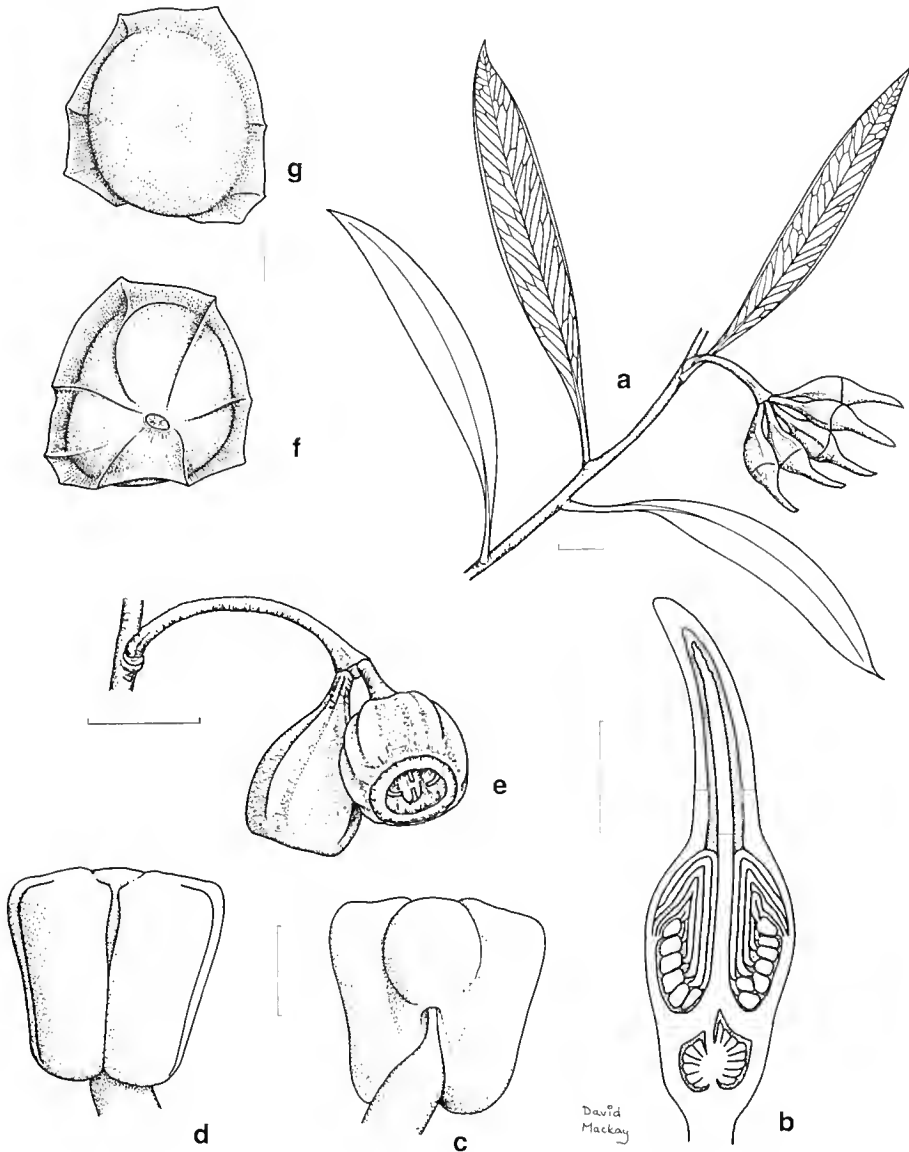


Fig. 5. *E. singularis*. a, adult leaves, inflorescences and buds; b, longitudinal section of bud. c, d, anther; e, inflorescence and fruits; f, g, seed (from B. Briggs 7828). Scale bars: a, e = 1 cm; b = 5 mm; c, d, f, g = 0.5 mm.

E. singularis is distinguished within the *E. incrassata* complex by its habit, a non-lignotuberous tree of 'mallet' form; its narrow crown and its substrate, shallow sand on lateritic rises (see also Table 4).

Only known from two (or three) populations in the region WNW of Ravensthorpe (Fig. 2). Associated species is predominantly *E. argyphaea* L.A.S. Johnson & K.D. Hill, but, at one locality, *E. phaenophylla* Brooker & Hopper and *E. dissimulata* Brooker are present.

Conservation status: a species of very restricted distribution, although further searching may increase its range. Probably at risk because of its occurrence along road verges in farming land (2K).

The epithet is from the Latin *singularis*, alone, solitary, in reference to the habit of this species in contrast to all other members of the *E. incrassata* complex.

Specimens examined: Western Australia: 4.8 km from Koornong Road on Fitzgerald Road, *Brooker 8809*, 18 Jan 1985 (CANB, NSW, PERTH); Mallee Road, south of Lake King, *Brooker 8888*, 13 Mar 1985 (CANB, NSW, PERTH); Old Ravensthorpe Road, *Brooker 10146*, 12 Dec 1988 (CANB, NSW, PERTH); 4.5 km from Millstead Road on Mallee Tree Road, *Hill 2396, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW, CANB, MEL, PERTH).

Series *Torquatae*

Series distinguished as follows: seeds ovoid-angular, wingless, dull, dark brown, grey or black, with regular deep sharp-edged pits; hilum indistinct; umbellasters 3–11-flowered; filaments \pm slender, basally \pm constricted, apically gradually tapered to connective.

The first taxa described in this series as now circumscribed were *E. corrugata* Luehm. and *E. torquata* Luehm. (Luehmann 1897), although Robert Brown had earlier delineated two other taxa as *E. anceps* and *E. rugosa* in manuscript (both names were later adopted by Blakely (1934) for the taxa more or less as Brown delineated them). These were followed by *E. griffithsii* Maiden (1911). Maiden had earlier confused many different taxa including *E. anceps* (R. Br. ex Maiden) Blakely and *E. rugosa* in a complicated and flawed attempt to circumscribe *E. dumosa* (*Crit. Revis. Eucalyptus* 1: 101), an impossible task in those times of no or little information on many of the taxa.

The additional taxa in this group were described by Maiden (*E. melanoxylo*n Maiden, *Crit. Revis. Eucalyptus* 1922, 6: 351, *E. concinna* Maiden & Blakely, *Crit. Revis. Eucalyptus* 1929, 8: 49) and then Blakely (*E. brachycalyx* Blakely (1934: 119), *E. rugosa* R. Br. ex Blakely (1934: 120).

Recognition and circumscription of this series has occurred only in recent years. Maiden placed some of the species known in section *Macrantherae* subsection *Tereticornes* on the basis of anther morphology, in different series based on bark characters and together with quite unrelated taxa. Blakely placed the different species then known (except *E. melanoxylo*n Maiden) in section *Macrantherae* subsection *Subtruncatae* series *Dumosae*, primarily on the basis of the more or less costate fruits, but in several subseries and in each case together with other species now placed in different series. *E. melanoxylo*n was wrongly removed by him to series *Exsertae* with a group of Red Gums.

Pryor and Johnson (1971) recognised a series *Torquatae*, including the then known species of the series as now treated, but also including a number of other related taxa. The related taxa were removed to series *Merrickiae* and *Ovulares* by Brooker (1979, 1981), to leave section *Torquatae* as discussed here (Table 5). The group was formally described as series *Torquatae* by Chippendale (1988), although he included *E. deflexa* Brooker, which was not included in a subsequent discussion of this series by Brooker

and Hopper (1993), and which we also would now regard as quite distinct and belonging in a separate series (see Table 1). Brooker (2000) separated *E. torquata* into a separate series on the basis of autapomorphic novelties, ignoring informative grouping characters that clearly place it with the taxa here included in the series.

The following account and classification conclude our revisionary studies of this series, except that glaucous forms of *E. concinna* Maiden & Blakely occurring sporadically between Mulline and Mussons Soak require further field investigation.

A noteworthy circular pattern of intergradation around the Nullarbor Plain is evident in this group, starting with *E. melanoxyton* in the southern Goldfields of Western Australia intergrading with *E. pleurocorys*, running east into *E. brachycalyx* to the south and south-east of the Nullarbor Plain to Eyre Peninsula, then into *E. concinna* in the northern Eyre Peninsula and north-west through the Great Victoria Desert, then into *E. planipes* west of the Nullarbor and into *E. griffithsii* Maiden in the Western Australian Goldfields.

Table 5. A classification of Series *Torquatae*

Series *Torquatae*

Subseries *Laevosae*

E. laevis

Subseries *Corrugatosae*

E. melanoxyton

E. brachycalyx

E. rugosa

E. pleurocorys

E. concinna

E. trachybasis

E. planipes

E. griffithsii

E. corrugata

Subseries *Torquatosae*

E. torquata

7. *Eucalyptus laevis* L.A.S. Johnson & K.D. Hill, sp. nov.

E. melanoxyton affinis sed fructibus laevibus ovoideisque et calyptra brevior obtusaque distinguitur.

Type: Western Australia: 3.3 km W. of highway on track turning off 11 km N. of Norseman (32°09'S, 121°39'E), K.D. Hill 587, L.A.S. Johnson, D.F. Blaxell, M.I.H. Brooker & S.D. Hopper, 6 Nov 1983 (holo NSW; iso CANB, PERTH).

[*E. species* W, Brooker & Kleinig 1990: 343 (1990)]

Tree to 15 m tall, sometimes mallee. Bark persistent on trunk and base of larger branches, grey, shortly fibrous-flaky; smooth, grey, shedding in ribbons above. Juvenile leaves not known. Adult leaves disjunct; narrow-lanceolate, acuminate, glossy bright green, 6.0–14.0 cm long, 8–15 mm wide; petioles terete or slightly flattened, 7–10 mm long; lateral veins at 30–45° to midrib, moderately spaced, ± degenerate; oil glands dense and distinct; intramarginal vein 0.5–1.5 mm from margin, ± degenerate. Umbellasters axillary, 7–11 flowered; peduncles terete, 9–17 mm long; pedicels terete, 3–5 mm long. Mature buds ovoid, 6–7 mm long, c. 4 mm diam.; calyptra conical,

strongly convex, obtuse, faintly ribbed, c. $\frac{1}{2}$ as hypanthium. Fruits ovoid, apically \pm truncate, constricted, 3–4-locular, 6–7 mm long, 5–6 mm diam.; calyptra scar and stemonophore flat, c. 0.5 mm wide; disc vertically depressed, 1.0–1.5 mm wide; valves deeply enclosed, vertically raised, ultimate tips rim-level or slightly exerted. Seeds \pm rounded, deeply and regularly pitted, dark grey-brown, 1.0–1.5 mm long; hilum ventral; chaff red brown, smaller, angular (Fig. 6).

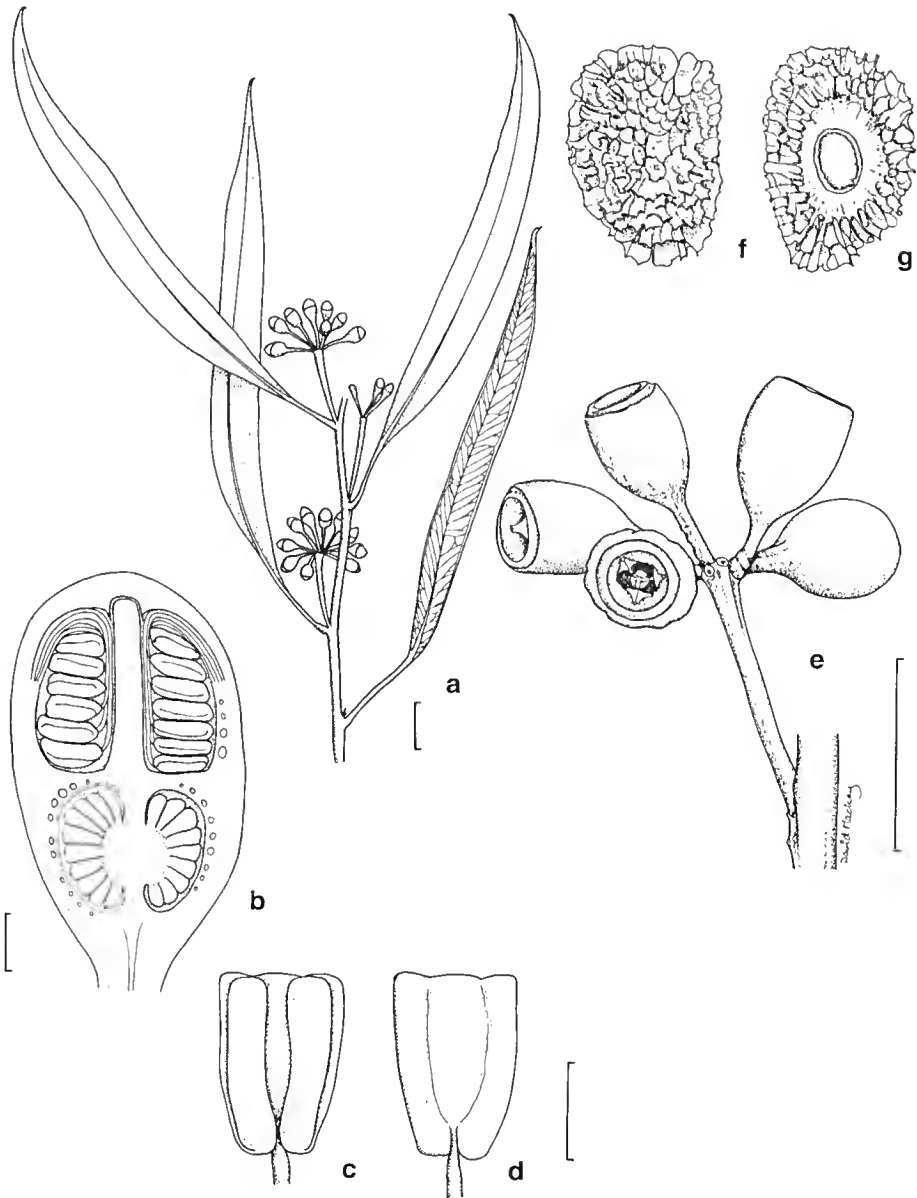


Fig. 6. *E. laevis*. a, adult leaves, inflorescences and buds; b, longitudinal section of bud; c, d, anther; e, inflorescence and fruits; f, g, seed (from Hill 587). Scale bars: a, e = 1 cm; b, f, g = 1 mm; c, d = 0.5 mm.

E. laevis is distinguished from *E. melanoxyton* by the smooth, ovoid to cylindrical fruits with less or non-exserted valves, and the shorter, obtuse calyptra.

A medium to large woodland tree of 'morrel' habit, occurring on heavy calcareous loams in more or less flat country, often associated with *E. flocktoniae* (Maiden) Maiden, *E. lesouefii* Maiden and a range of other woodland species. Widespread and relatively abundant between Norseman and Balladonia (Fig. 7).

Conservation status: not considered to be at risk.

The specific epithet is from *laevis*, a variant, commonly used in botanical Latin, of the classical *levis*, 'smooth'. It refers to the smooth calyptra.

Selected specimens (from 15 examined): Western Australia: 33.6 miles [54 km] west of Balladonia towards Norseman, *Brooker 2481*, 14 Feb 1970 (PERTH, NSW); 3.3 km W of Coolgardie to Norseman road, *Brooker 8347*, 6 Nov 1983 (CANB, NSW); 0.5 miles [0.8 km] SW of Pioneer, *Chippendale 148*, 11 Mar 1967 (CANB, NSW); 67.2 miles [110 km] E of Norseman, *Chippendale 159*, 12 Mar 1967 (CANB, NSW); Fraser Range, 84 km W of Balladonia roadhouse on Highway 1, *Hill 231 & Johnson*, 19 Oct 1983 (NSW, CANB, PERTH); 3.3 km west of Highway on track turning off 11 km north of Norseman, *Hill 587, Johnson, Blaxell, Brooker & Hopper*, 6 Nov 1983 (NSW, CANB, PERTH); 24.6 km E of Norseman on highway, *Hill 677 & Blaxell*, 14 Nov 1983 (NSW, CANB, PERTH); 10.6 km W of Balladonia roadhouse on highway, *Hill 2182 & Johnson*, 4 Nov 1986 (NSW, CANB, MEL, PERTH); 124.3 km W of Balladonia roadhouse on highway, *Hill 2833*, 24 Aug 1988 (NSW); on Highway 1, 53 km W of Balladonia Roadhouse, *Whaite 4042 & Whaite*, 7 Sep 1976 (NSW).

8. *Eucalyptus pleurocorys* L.A.S. Johnson & K.D. Hill, sp. nov.

E. melanoxyton affinis sed calyptra latiore costataque, fructibus longioribus conicisque et regione basali quasi fibrosa cortice minus extensiva distinguitur.

Type: Western Australia: Junana Rock, 121 km S of Balladonia roadhouse on track to Mt Ragged (33°23'S, 123°24'E), *K.D. Hill 240 & L.A.S. Johnson*, 20 Oct 1983 (holo NSW; iso CANB, PERTH).

Mallee to 5 m tall, sometimes tree to 10 m tall. Bark persistent, grey, fibrous-flaky at base (to 3 m); smooth, grey above. Adult leaves disjunct, lanceolate, often falcate, glossy bright green, acute or acuminate, 5.0–12.0 cm long, 0.8–2.0 cm wide. Petioles ± flattened, 0.9–1.7 cm long; young stems angular. Lateral veins at c. 45° to midrib,

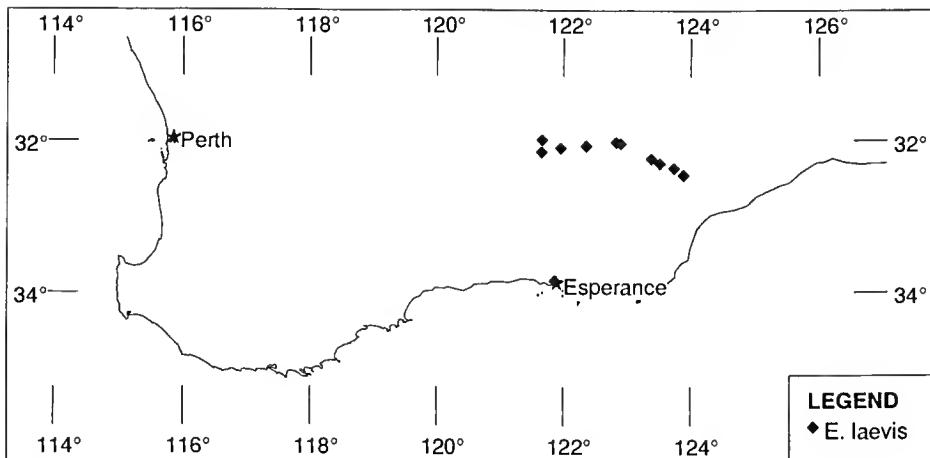


Fig. 7. Distribution of *E. laevis*.

moderately spaced, somewhat obscure and irregular; intramarginal vein 0.5–1.0 mm from margin, present but obscure. Umbellasters axillary, 7–11-flowered. Peduncles \pm flattened 9–17 mm long. Pedicels \pm ribbed, 3–6 mm long. Mature buds ovoid, 8–10 mm long, 4–5 mm diam.; calyptra \pm cup shaped, obtuse, faintly ribbed, slightly shorter than hypanthium, distinctly narrower than hypanthium. Fruits obconical, tapered into pedicel, slightly constricted apically, 3-4-locular, 5–7 mm long, 6–8 mm diam.; calyptra scar and stemonophore flat or slightly raised, 0.5–1.0 mm wide; disc depressed at c. 45°, 0.5–1.0 mm wide; valves narrowly triangular, acuminate, basally enclosed, apically ultimately vertically exserted, often broken at disc level. Seeds \pm angular, convex, deeply and regularly pitted, \pm fringed, dark grey-brown, 1.5–2.0 mm long; hilum ventral; chaff lustrous red-brown, smaller, angular (Fig. 8).

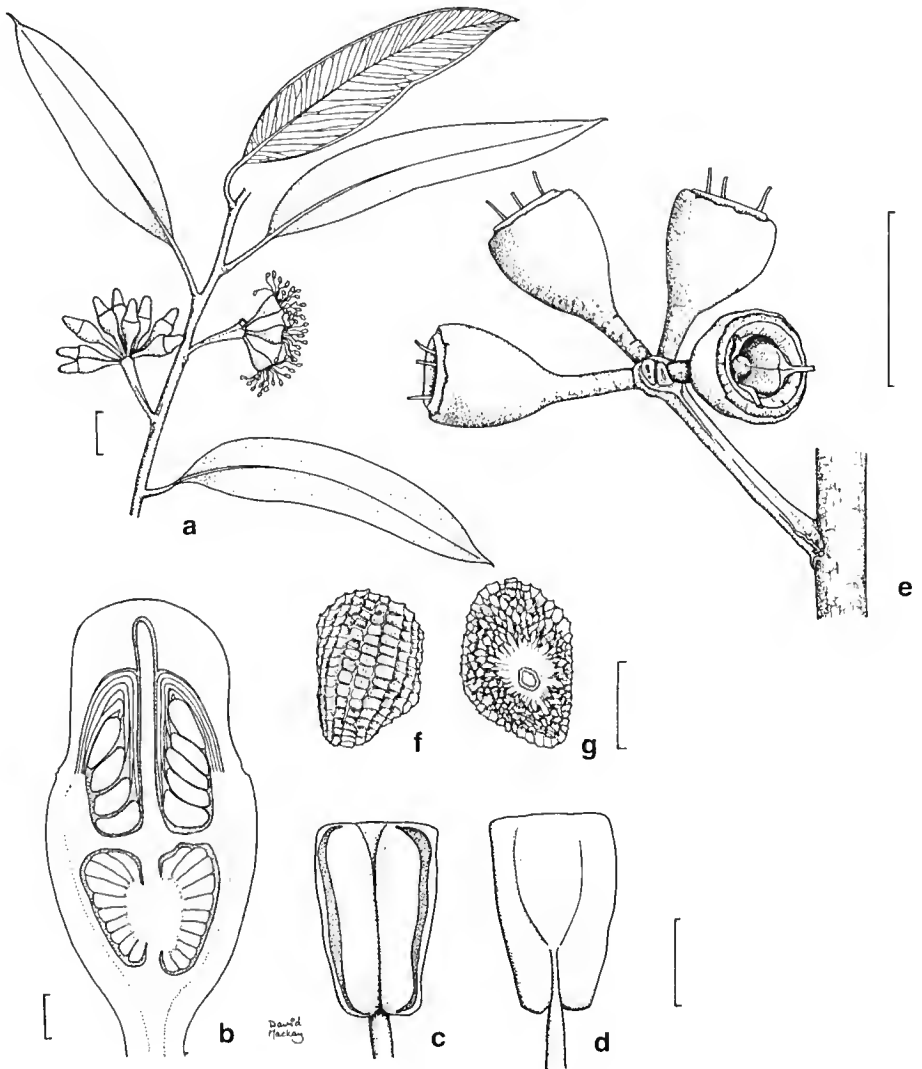


Fig. 8. *E. pleurocorys*. a, adult leaves, inflorescences, buds and flowers; b, longitudinal section of bud; c, d, anther; e, inflorescences and fruits; f, g, seed (from Hill 240). Scale bars: a, e = 1 cm; b, f, g = 1 mm; c, d = 0.5 mm.

E. pleurocorys is distinguished from *E. melanoxyton* by the broader, ribbed calyptra, the longer, conical fruits and the less extensive rough bark (see also Table 6).

This species occurs in a wide range of habitats, from mallee scrub on heavy calcareous soil over limestone to woodland on calcareous loam, and mallee heath on skeletal white sandy soil over quartzite. Associated species include *E. gracilis* F. Muell., *E. oleosa* F. Muell. ex Miq., *E. flocktoniae* and *E. cooperiana* F. Muell..

E. pleurocorys is recorded from near Mt Ragged and near Caiguna (Fig. 9). The intervening country is poorly explored and it is likely to occur throughout the region.

This taxon has in the past been included in *E. rugosa*, but its affinities are more with *E. melanoxyton*. *E. rugosa*, as here circumscribed, does not extend into Western Australia.

Conservation status: not considered to be at risk.

The epithet is from the Greek *pleuron*, 'a rib', and *corys*, 'helmet', referring to the ribbed calyptra.

Selected specimens (from 30 examined): Western Australia: 21.1 miles [34 km] south of Mt Ragged on track to Israelite Bay, *Allan 756*, 16 Sep 1971 (PERTH, NSW); 130 km S of Balladonia, SW of Mt Ragged, *Brooker 5637*, 3 Apr 1977 (CANB, AD, MEL, NSW, PERTH); 1.5 km from Israelite Bay track to Mt Ragged track, *Brooker 8913*, 8 Apr 1985 (CANB, NSW); 20.1 km from Israelite Bay track on Mt Ragged track, *Brooker 8918*, 8 Apr 1985 (CANB, NSW); c. 3 km S of Bandalup Hill, *Brooker 9481*, 11 Apr 1985 (CANB, NSW); c. 0.2 km E of Lake King turnoff on Ravensthorpe to Albany road, *Brooker 9643*, 19 May 1987 (CANB, NSW); Junana Rock, 121 km S of Balladonia roadhouse on track to Mt Ragged, *Hill 244 & Johnson*, 20 Oct 1983 (NSW); 4.5 km along track from Mount Ragged turnoff towards Israelite Bay, *Hill 259 & Johnson*, 20 Oct 1983 (NSW); 25.0 km S of highway on track to Eyre telegraph station (now Eyre bird observatory), *Hill 2176 & Johnson*, 3 Nov 1986 (NSW, CANB, MEL, PERTH); 9.2 km south of highway on Mason Bay road (south of Bandalup Hill), *Hill 2365, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW, CANB, MEL, PERTH); 9.3 km W of Ravensthorpe to Hopetoun road, on Road 11, *Hill 2373, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW, PERTH); Hamersley Inlet, at picnic area, *Hill 3151*, 7 Sep 1988 (NSW, CANB, PERTH); 2 miles [3.2 km] N of Ravensthorpe, *Johnson W 225*, 19 Dec 1960 (NSW); 33.5 km W of the ruins at Israelite Bay, *Pryor 183 & J. Briggs*, 26 Oct 1978 (CANB, NSW).

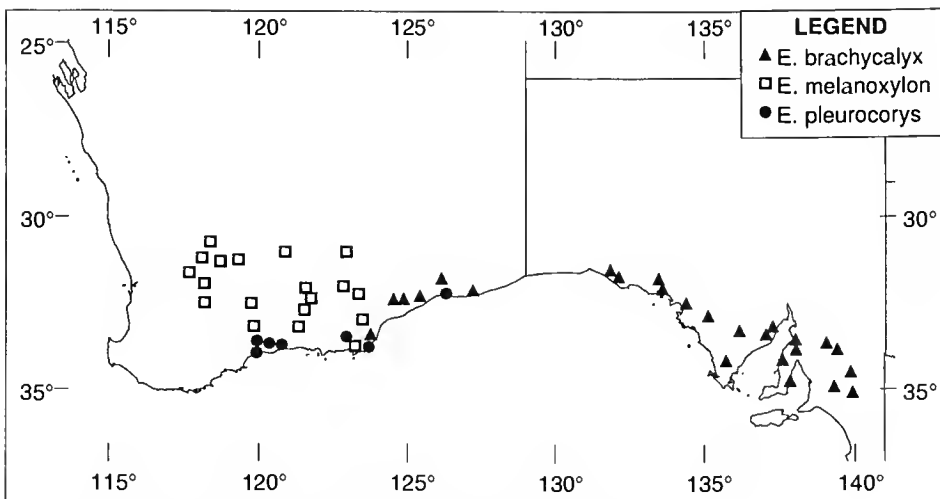


Fig. 9. Distribution of *E. brachycalyx*, *E. melanoxyton*, *E. pleurocorys*.

Table 6. Subseries *Corrugatosae* - the *E. melanoxylo*n complex (all measurements in mm).

	<i>E. melanoxylo</i> n	<i>E. laevis</i>	<i>E. brachycalyx</i>	<i>E. rugosa</i>	<i>E. pleurocorys</i>
Habit	tree ('morrel'), rough bark on trunk	tree, occ. mallee, rough bark on trunk & large branches	mallee, rarely tree rough bark on trunk	mallee, smooth bark	mallee, rarely tree rough bark on trunk
Substrate	gravelly loams & heavy soils	heavy calcareous loams	gravelly loams & heavy soils	calcareous coastal sands	calcareous coastal sands
Juvenile leaves	ovate to lanceolate	?	elliptical to ovate, light green	elliptical to ovate, green	
Adult leaves	narrow-lanceolate,	narrow-lanceolate,	narrow-lanceolate,	lanceolate to broad- lanceolate,	lanceolate, often falcate,
- colour	glossy green	glossy green	glossy green	glossy green	glossy green
- size (LxB)	60-130 x 5-15	60-120 x 8-15	60-105 x 7-17	65-120 x 10-30	50-120 x 8-20
Peduncle	angular to flattened	terete	slightly flattened	flattened, thick	slightly flattened
Peduncle (L)	6-15	9-17	5-15	6-20	9-17
Pedicle	terete to slightly angular	terete	terete to slightly angular	broad, flattened, costate	slightly angular
Pedicle (L)	3-5	3-5	0-5	0-4	3-6
Buds	ovoid	ovoid	ovoid	ovoid to clavate	ovoid
- size (LxB)	5-8 x 3-5	6-7 x 4	6-9 x 4-5	6-16 x 5-8	8-10 x 4-5
- calyptra	obtusely conical	conical, strongly convex, obtuse, faintly ribbed	hemispherical, ribbed, narrower than hypanthium	hemispherical, ribbed narrower than hypanthium	raised hemispherical, ribbed,
- hypanthium	cupular to obconical	cupular to obconical	cupular, slightly ribbed	obconical, strongly ribbed	obconical
Fruits	obconical	ovoid	cupular to obconical	cupular to obconical	obconical
- size (LxB)	4-6 x 4-7	6-7 x 5-6	5-8 x 5-8	6-15 x 6-10	5-7 x 6-8
- ribbing	not ribbed	not ribbed	slightly ribbed	strongly ribbed	not ribbed

Intergrades: *E. brachycalyx* ↔ *E. pleurocorys*

Specimens examined: Western Australia: 15.2 km S of highway on track to Eyre telegraph station (now Eyre bird observatory), Hill 2173 & Johnson, 3 Nov 1986 (NSW, CANB, MEL, PERTH).

9. *Eucalyptus trachybasis* L.A.S. Johnson & K.D. Hill, sp. nov.

E. planipedis affinis sed alabastris fructibusque in pedunculo pedicellisue minus applanatis, et cortice plus minusve persistenti distinguitur. Ramuli saepe plus minusve pruinosi (haud in *E. planipede*). Umbellastreae triflorae ambas species ab *E. concinna* (non pruinosa) distingunt.

Type: Western Australia: 5.0 km N. of Widgiemooltha on highway (31°27'S, 121°04'E), K.D. Hill 2639 & L.A.S. Johnson, 27 Nov 1986 (holo NSW; iso PERTH).

Tree to 10 m tall, sometimes several-stemmed; bole short, branches spreading. Bark persistent, grey, fibrous-flaky at base (to 2–4 m); smooth, grey, often mottled brown or reddish above. Twigs usually pruinose. Juvenile leaves not seen. Adult leaves disjunct, narrow-lanceolate to lanceolate, often falcate, glossy bright green, acute or acuminate, 5.0–14.0 cm long, 0.8–2.9 cm wide; petioles terete, 0.9–1.8 cm long; lateral veins at 30–45° to midrib, moderately spaced; intramarginal vein 0.5–1.0 mm from margin, present but obscure. Umbellasters axillary, 3-flowered. Peduncles terete to slightly flattened apically, 5–10 mm long. Pedicels flattened, 3–7 mm long. Mature buds pyriform to clavate, 8–13 mm long, 7–10 mm diam.; calyptra hemispherical to patelliform, distinctly regularly costate, c. 1/3–1/2 as long as hypanthium, distinctly wider than hypanthium. Fruits obconical, tapered into pedicel, irregularly costate, 3–4-locular, 8–11 mm long, 8–10 mm diam.; calyptra scar and stemophore flat or slightly raised, 1–1.5 mm wide; disc level to depressed to c. 45°, 1.5–3 mm wide, valves narrowly triangular, acuminate, basally enclosed, apically ultimately vertically exerted, often broken at disc level. Seeds ovoid, smooth, shallowly and regularly pitted, dark grey- to red-brown, 1.5–2.0 mm long; hilum ventral; chaff dark red-brown, smaller, angular (Fig 10a, b, c).

Distinguished from *E. planipes* by the smaller buds and fruits with more slender and less flattened peduncles and pedicels, and the stocking of persistent bark. Twigs are also often weakly pruinose in *E. trachybasis*, and not so in *E. planipes*. The 3-flowered inflorescences separate both taxa from *E. concinna* (7-flowered), which is also not pruinose (see also Table 7).

Locally frequent on shallow calcareous soils on rocky greenstone ridges in the region from Widgiemooltha to north of Coolgardie (Fig. 11). Often locally dominant in open communities with a sparse understorey, frequently with chenopods.

Conservation status: not considered to be at risk.

The epithet is from the Greek *trachy-*, rough, and *basis*, base, in reference to the characteristic stocking of rough bark.

Selected specimens (from 9 examined): Western Australia: along Kambalda Rd, 1 mile [1.6 km] N of Kambalda to Coolgardie turnoff junction, 83 miles [133.1 km] N of Norseman, Baker 14, 9 Nov 1970 (CANB, NSW); 20 miles [32 km] N of Coolgardie, Beard 6243, 9 Sep 1970 (KPBG, NSW); 10–20 km N of Widgiemooltha, Blaxell 333848 4 Nov 1986 (NSW); Widgiemooltha, Carr 1247 & Carr, 9 Apr 1969 (CANB, NSW, PERTH); 3.7 km W of Callion towards Mussons Soak, Hill 2653 & Johnson, 28 Nov 1986 (NSW, PERTH).

10. *Eucalyptus planipes* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. griffithsii* nunc separata alabastris fructibusque non glaucis et plus prominenter alatis. *E. griffithsii* saepe differt habitu plus minusve arborescenti et cortice prope basin plus minusve fibrosa.

Table 7. Subseries *Corrugatae* — the *E. corrugata* complex (all measurements in mm).

	<i>E. concinna</i>	<i>E. trachybasis</i>	<i>E. planipes</i>	<i>E. griffithsii</i>	<i>E. corrugata</i>
Habit	mallee, rough persistent stocking	tree persistent stocking	mallee, smooth bark	mallee or tree, persistent stocking	tree, rarely mallee, persistent stocking
Substrate	red sandy loam	calcareous loam on greenstone	red calcareous loam on greenstone or metamorphics	gravelly soils, laterite	red loams and sands
Pruinosity	—	+(twigs)	—	+	+
Juvenile leaves	?	?	broad-lanceolate, grey-green	?	broad-lanceolate, glossy green or slightly glaucous
Adult leaves	lanceolate, often falcate	narrow-lanceolate to lanceolate, often falcate	lanceolate to broad-lanceolate, often falcate	narrow-lanceolate to lanceolate	broad-lanceolate
- colour	highly glossy green	glossy green	glossy green	dull green	highly glossy green
- size (L×B)	50–120 × 10–20	50–140 × 8–29	50–140 × 8–30	50–150 × 12–20	70–120 × 7–25
Peduncle	terete	terete to slightly flattened apically	narrowly flattened	terete to slightly angular	terete to slightly angular
Peduncle (L)	8–15	5–10	8–16	8–12	8–12
Pedicele	terete to slightly flattened	flattened	strongly flattened or winged	strongly flattened or winged	strongly flattened or winged
Pedicele (L)	2–6	3–7	2–12	2–6	8–12
Buds	ovoid	pyriform to clavate	pyriform to clavate	pyriform to clavate	pyriform to clavate
- size (L×B)	5–8 × 5–8	8–13 × 7–10	11–16 × 9–13	8–15 × 8–12	11–18 × 8–13
Fruit	cupular	obconical, costate	obconical, costate	cupular to obconical, strongly costate	cupular to obconical, strongly costate
- size (L×B)	7–10 × 6–9	8–11 × 8–10	8–15 × 8–14	8–15 × 8–15	8–15 × 9–19
Valves	3–4, enclosed, tips protruding	3–4, enclosed, tips protruding	3–4, enclosed, tips protruding	4, enclosed, tips protruding	4–5, exerted

Type: Western Australia: 7.1 km east of Coolgardie on road to Kalgoorlie, *K.D. Hill 576, L.A.S. Johnson, D.F. Blaxell, M.I.H. Brooker & S.D. Hopper*, 6 Nov 1983 (holo NSW; iso CANB, PERTH).

Mallee to 8 m tall. Bark smooth, white or pale grey. Twigs not pruinose. Juvenile leaves disjunct, grey-green, broad-lanceolate, to 7 cm long, 2.5 cm wide, petioles to 15 mm long. Adult leaves disjunct, lanceolate to broad-lanceolate, often falcate, glossy bright green, acute or acuminate, 5.0–14.0 cm long, 0.8–3.0 cm wide; petioles \pm flattened, 0.9–2.5 cm long; lateral veins at 30–45° to midrib, moderately spaced; intramarginal vein 0.5–2.0 mm from margin, present but obscure. Umbellasters axillary, 3-flowered. Peduncles narrowly flattened, 8–16 mm long. Pedicels strongly flattened or winged, 2–12 mm long. Mature buds pyriform to clavate, 11–16 mm long, 9–13 mm diam.; calyptra hemispherical to patelliform, distinctly regularly costate, c. $\frac{1}{4}$ – $\frac{1}{3}$ as long as hypanthium, distinctly wider than hypanthium. Fruits obconical, tapered into

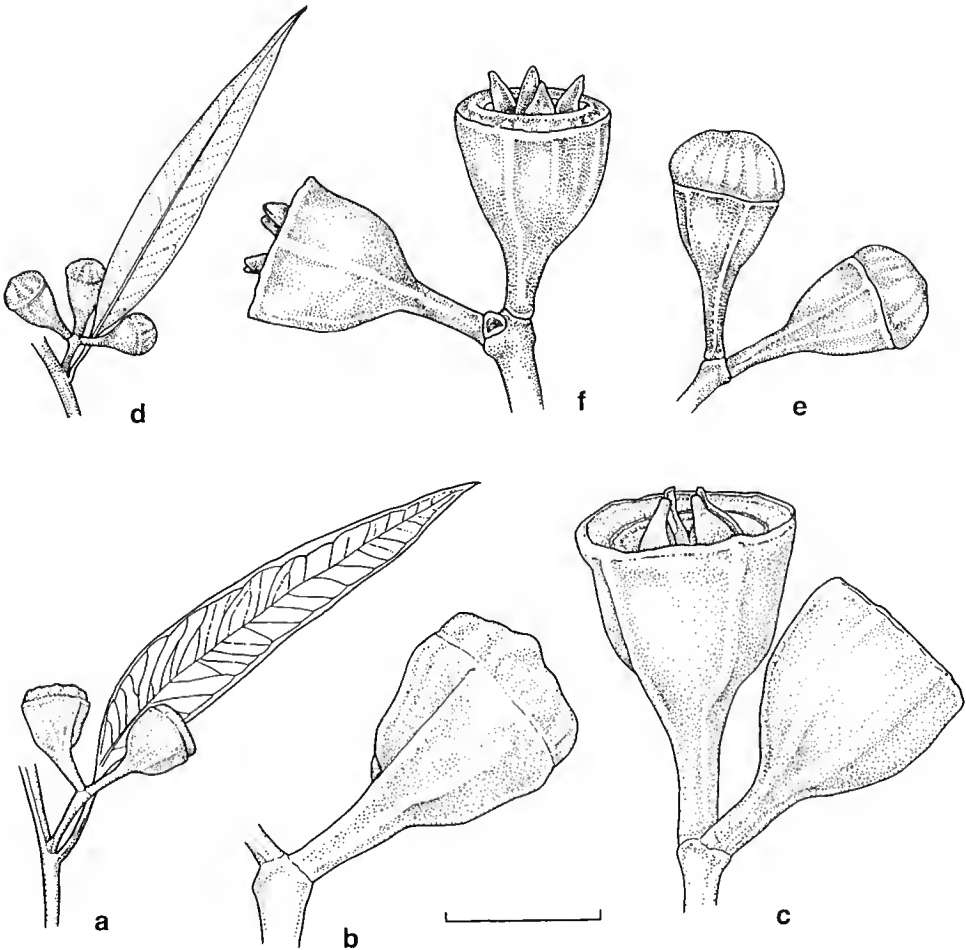


Fig. 10. *E. trachybasis*. a, adult leaf, inflorescence and fruits. b, inflorescence and bud. c, inflorescence and fruits. (from NSW 333848). Scale bar = 1 cm. *E. planipes*. d, adult leaf, inflorescence and buds. e, inflorescence and buds. f, inflorescence and fruits. (from *J. Baker 128*). Scale bar = 1 cm.

pedicel, irregularly costate, 3-4-locular, 8-15 mm long, 8-14 mm diam.; calyptra scar and stemonophore flat or slightly raised, 1.5-2.5 mm wide; disc level to depressed to c. 45°, 2-4 mm wide, valves narrowly triangular, acuminate, basally enclosed, apically ultimately vertically exerted, often broken at disc level. Seeds ovoid, smooth, shallowly and regularly pitted, dark grey- to red-brown, 1.5-2.5 mm long; hilum ventral; chaff dark red-brown, smaller, angular (Fig. 10d, e, f).

Previously included in a broader concept of *E. griffithsii* Maiden, now separated from the latter by the non-glaucous, more prominently winged, buds and fruits. *E. griffithsii* is also often a small tree with a short stocking of persistent fibrous bark. Individuals of *E. planipes* with smaller buds and fruits have also been confused with *E. concinna*, which is readily distinguished by the 7-flowered inflorescences (see also Table 7). Extensive intergradation occurs with *E. concinna*, with a spectrum of intermediate forms, and occasional intermediates are known with *E. griffithsii*.

Frequent on red loamy calcareous soils over metamorphics or greenstones, often a mallee among woodland trees such as *E. torquata* Luehm., *E. clelandii* (Maiden) Maiden, *E. saluonophloia* F. Muell., *E. salubris* F. Muell., *E. oleosa* or *E. dundasii* Maiden, with an open shrubby understorey often including *Cratystylis* and *Atriplex* spp.

Distributed across the region south and west of Kalgoorlie, from Norseman to around Coolgardie and some distance west of there (Fig. 11). The related *E. griffithsii* has a somewhat more restricted distribution around Kalgoorlie and a little further north.

Conservation status: not considered to be at risk.

The epithet is from the Latin *planus*, flat, and *pes*, foot, from the distinctively flattened pedicel.

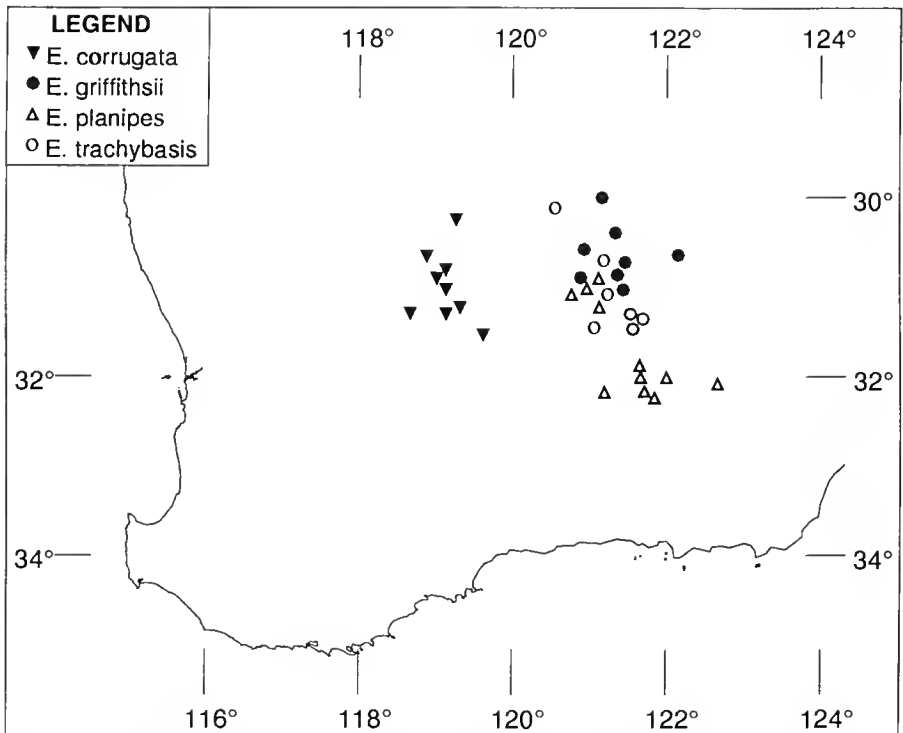


Fig. 11. Distribution of *E. corrugata*, *E. griffithsii*, *E. planipes*, *E. trachybasis*.

Selected specimens (from 25 examined): Western Australia: 0.5 mile [0.8 km] W of Coolgardie, along Gt Eastern Highway, then (L) along Gnarlbine Rd for 7.8 miles [12.6 km], *Baker 128*, 23 Nov 1970 (CANB, NSW); 0.2 mile [0.4 km] (R) of Eyre Highway, 4.2 miles [6.7 km] E of Norseman, at foot of Mt Jembaluna [Mt Jemberlana], *Baker 57*, 13 Nov 1970 (CANB, NSW); SW of Lake Cowan, *Beard 6276*, 12 Sep 1970 (KPBG, NSW); c. 5 km S of Norseman on Esperance road, *Blaxell 1666 & Pryor*, 21 June 1978 (NSW, PERTH); 4.6 km W of Bullabulling, *Brooker 6398*, 20 Aug 1979 (CANB, NSW, PERTH); 44.5 km S of Widgiemooltha, *Brooker 6410*, 21 Aug 1979 (CANB, NSW); Comet Hill, SW of Coolgardie, *Brooker 6461*, 23 Aug 1979 (CANB, NSW); 5.4 miles [8.6 km] W on road 6.8 miles [11 km] NW of Norseman, *Chippendale 155*, 12 Mar 1967 (CANB, NSW); 16 km SSW of Coolgardie along road to Gnarlbine Rock, Kangaroo Hills, *Crisp 5617*, 31 Jan 1979 (CANB, NSW, PERTH); 9 km east of Norseman on highway, *Hill 2224 & Johnson*, 4 Nov 1986 (NSW, CANB, MEL, PERTH); 9 miles [14.4 km] SW of Coolgardie, towards Gnarlbine Rocks, *Phillips CBG25327*, 6 Sep 1968 (CANB, NSW).

Intergrades:

E. concinna ↔ *E. planipes*

Intergrading populations between *E. concinna* and *E. planipes* with varying degrees of backcrossing occur over a wide area in the eastern Goldfields.

Selected specimens (from 7 examined): Western Australia: 18 miles [29 km] south of Norseman towards Esperance, *Brooker 2490*, 15 Feb 1970 (PERTH, NSW); Grants dam, Hampton Hill Station [37 km ESE of Kalgoorlie], *Coveny 8417 & Habersley*, 14 Sep 1976 (NSW, CANB, K, PERTH); 52 km E of Karonie along railway, *Hill 559, Johnson, Blaxell, Brooker & Hopper*, 5 Nov 1983 (NSW, CANB, PERTH); crest of Fraser Ra, 95 km E of Norseman on Highway 1, *Hill 700 & Blaxell*, 14 Nov 1983 (NSW, CANB, PERTH); 2 km E of Zanthus, then 29 km S of track towards Balladonia, *Pryor 159 & J. Briggs*, 24 Oct 1978 (CANB, NSW).

E. concinna ↔ (*E. concinna* ↔ *E. planipes*)

Specimens examined: Western Australia: 7.1 miles [11.4 km] E of Karalee, *Chippendale 106*, 7 Mar 1967 (CANB, NSW).

(*E. concinna* ↔ *E. planipes*) ↔ *E. planipes*

Specimens examined: Western Australia: 65.5 km W of Balladonia roadhouse on highway, *Hill 2825*, 24 Aug 1988 (NSW); 40 miles [64 km] N of Kalgoorlie (35 miles [56 km] S of Menzies), *Phillips CBG21974*, 13 Sep 1962 (CANB, NSW).

E. griffithsii ↔ *E. planipes*

Selected specimens (from 2 examined): Western Australia: Coolgardie, *Helms 103*, June 1899 (NSW).

Series *Leptocalyx*

Series distinguished as follows: seeds ovoid, ± angular, black, glossy, regularly reticulate, ventral surface not ribbed; hilum paler, distinct; anthers cuboid, almost as broad as long; filaments stout, stiffly spreading, basally uniformly thick, apically abruptly narrowed to connective.

A wholly Western Australian series, here considered to consist of three species only (*E. leptocalyx*, *E. scyphocalyx* and *E. platycorys*).

The first taxon of this group recognised was *E. scyphocalyx*, as a variety of *E. dumosa* by Mueller, in a manuscript that was published by Bentham (1867). Bentham placed *E. dumosa* in series *Normales* subseries *Robustae*, which was a heterogeneous group including species from three different subgenera of those proposed by Pryor and Johnson (1971).

Maiden and Blakely (in Maiden 1929) elevated Mueller's variety to species rank, at the same time recognising the second species in the group, *E. platycorys*. The third species, *E. leptocalyx*, was recognised by Blakely (1934).

Both Mueller (1882, 1884, 1889) and Maiden (*Crit. Revis. Eucalyptus* 6, 7) omitted *E. dumosa* and its varieties from their classification systems.

Blakely (1934) placed the three species in section *Macranthlicrae* subsection *Longiores* series *Dumosae*, but in three different subseries with other members of section *Dumaria* as we now recognise it (together with some species from section *Bisectaria*).

Pryor and Johnson (1971) placed all three species in section *Dumaria* series *Torquatae*, based in part on studies of Blakely's *Dumosae* by Carr and Carr (1969) and Brooker (1971). Brooker subsequently suggested further subdivision of this group on the basis of differences in seed and androecial structure (1979, 1981), placing the three species in series *Merrickianae* (and confusing *E. scyphocalyx* with *E. merrickiae*). Subsequent field studies have established the distinctive nature of these two species.

Chippendale (1988) followed Brooker (1979), but recognised *E. scyphocalyx* and *E. merrickiae* as distinct species, and formally erected series *Merrickianae* to accommodate the three taxa here included in series *Leptocalyces* together with the quite distinct *E. merrickiae*. Brooker (2000) coined the series name *Furfuraceae* for the group as constituted herein.

We now recognise the three species as distinct and closely related, but with clinal patterns of intergradation and considerable geographic variation that can be recognised at intraspecific rank. The series *Leptocalyces* is limited to only these three species, and this account concludes our revisionary studies of this series.

11. *Eucalyptus leptocalyx* Blakely, Key Eucalypts: 118 (1934).

Type: Western Australia: Nine-mile tank from Hopetoun, J.H. Maiden, Nov 1909 (lecto NSW; here designated). Cited as: 'W.A. - Nine-Mile Tank from the Hopetoun, J.H. Maiden, November, 1909; Grasspatch, C.A. Gardner, No. 2221'.

Mallee to 6 m tall. Bark smooth, grey, pink, whitish, shedding in ribbons. Adult leaves disjunct, lanceolate, falcate, acuminate, glossy, 6.0–12.0 cm long, 1.0–2.0 cm wide; petioles terete or ± angular, 1.5–3.0 cm long; lateral veins at c. 30° to midrib, moderately spaced, irregular and ± obscure; intramarginal vein c. 1.0–1.5 mm from margin. Umbellasters axillary, 7–11-flowered. Peduncles terete to slightly flattened, 6–11 mm long. Pedicels terete or ± angular, 2–4 mm long. Mature buds ovoid, 7–10 mm long, 4–8 mm diam.; calyptra conical, strongly convex, obtuse, smooth to faintly ribbed, c. ½ as long as hypanthium. Fruits ovoid to cup-shaped, apically constricted, 3–4-locular, 6–10 mm long, 5–8 mm in diameter; calyptra scar and stemophore flat, 0.5–1.0 mm wide; disc vertically depressed, c. 1.0 mm wide; valves deeply enclosed. Seeds ± flattened, angular; semi-glossy grey-black, shallowly and regularly reticulate, c. 1.5 mm long; hilum ventral; chaff smaller, angular, glossy red-brown.

Distinguished within the series by the following: umbellasters 7–11 flowered; buds small, ovoid, green; calyptra hemispherical to conical, as wide as hypanthium, not ribbed; fruits small, ovoid.

Two subspecies are recognised.

11A. *Eucalyptus leptocalyx* Blakely subsp. *leptocalyx*

Mallee to 5 m tall. Adult leaves 6.0–12.0 cm long, 1.0–3.4 cm wide; petioles terete or ± angular, 0.9–2.7 cm long. Umbellasters axillary, 7–11-flowered. Peduncles angular, apically flattened, 3–11 mm long, to 4 mm wide. Pedicels 2–4 mm long. Mature buds 8–11 mm long, 6–8 mm diam.; calyptra smooth or faintly ribbed. Fruits 7–11 mm long, 6–9 mm diam.

Frequent in mixed mallee shrubland on medium sandy soils from Fitzgerald River to Israelite Bay and probably east of there, usually near the coast, but not on coastal formations (Fig. 12).

Conservation status: not considered to be at risk.

Selected specimens (from 28 examined): Western Australia: 25 miles [40 km] NE of Condingup, *Beard* 6353, 16 Sep 1970 (KPBG, NSW); Fitzgerald River National Park, Hamersley Drive 14.1 km S of Old Ongerup road, *Briggs* 7690, 7691, 7692, 7695 & *Johnson*, 9 Oct 1984 (NSW, CANB, PERTH); 4 road miles [6.4 km] south of the Norseman to Esperance Road on turnoff to Ravensthorpe, *Brooker* 3603, 21 Apr 1972 (CANB, NSW); 12.1 km E of Telegraph track on Hamersley Drive, Fitzgerald [National Park], *Brooker* 8763, 18 Dec 1984 (CANB, NSW); 8.4 km from Israelite Bay track on Mt Ragged track, *Brooker* 8916, 8 Apr 1985 (CANB, NSW); 5.3 km N of Jerdacuttup North road towards Bandalup Hill, *Brooker* 8940, 11 Apr 1985 (CANB, NSW); corner of Murray and Gordon Inlet roads, *Brooker* 9855, 12 Jan 1988 (CANB, NSW); 45.1 miles [72.7 km] E of Esperance, *Chippendale* 407, 25 Mar 1968 (CANB, NSW); 15.4 miles [25 km] SSE of Ravensthorpe, *Chippendale* 418, 26 Mar 1968 (CANB, NSW); near junction of Exchange Road and Merivale Road, 8–10 km south of Esperance to Israelite Bay Road (towards Cape Arid National Park), *Foreman* 1297, 28 Nov 1985 (MEL, CANB, NSW, PERTH); 3.1 km past Mt Ragged turnoff on track to Israelite Bay from Balladonia, *Hill* 258 & *Johnson*, 20 Oct 1983 (NSW, PERTH); Devil's Creek Rd, 10.0 km NW of Fitzgerald Nat. Park entrance, *Hill* 3114, 6 Sep 1988 (NSW); 9 m. [9 mile=14.4 km] tank from Hopetoun, *Maiden s.n.*, Nov 1909 (NSW 17786); 22.2 km W of the ruins at Israelite Bay, *Pryor* 182 & *J. Briggs*, 26 Oct 1978 (CANB, NSW).

11B. *Eucalyptus leptocalyx* Blakely subsp. petilipes L.A.S. Johnson & K.D. Hill, subsp. nov.

Ab subspecie *leptocalyce* fructibus minoribus et ovideis, pedunculi pedicellique longi tenuisque, et foliis alabastrisque aliquanto minora distinguitur.

Type: Western Australia: 5 km NW of Coolinup Road on Kau Rock Road, NE of Esperance (33°34'S, 122°25'E), *M.I.H. Brooker* 7548, 12 Aug 1982 (holo NSW; iso CANB, PERTH).

Mallee to 6 m tall. Adult leaves 6.0–12.0 cm long, 1.0–2.0 cm wide; petioles terete, 1.5–3.0 cm long. Umbellasters axillary, 7-flowered. Peduncles terete to slightly flattened, 6–11 mm long. Pedicels 2–4 mm long. Mature buds 7–9 mm long, 4–5 mm diam.; calyptra faintly ribbed. Fruits 6–9 mm long, 5–8 mm diam. (Fig. 14).

Subsp. *petilipes* differs from subsp. *leptocalyx* in the smaller, ovoid fruits with long, slender pedicels and peduncles, and the generally smaller leaves and buds.

This subspecies occurs on light soils on slightly elevated sites, in mixed mallee shrubland, frequently associated with *E. uncinata* Turcz. and *E. indurata* Brooker & Hopper. To date, it is known from a small area north east of Esperance and slightly inland (Fig. 12). This region is poorly explored, and extensions of range are probable.

Intermediate populations between *E. leptocalyx* and *E. scyphocalyx* occur north of Esperance (around Salmon Gums). Although intermediate in most characters, these populations are often much coarser in foliage characters than either parent. These are stable breeding populations with their own unique genetic makeup developed from a mixing of the parent species.

Conservation status: not considered to be at risk.

The epithet is from the Latin *petilis*, slender, and *pes*, foot, from the slender pedicel.

Selected specimens (from 8 examined): Western Australia: 20 miles [32 km] NE of Mt Ney, *Beard* 6386, 17 Sep 1970 (KPBG, NSW); 4 km along Mt Ney Rd NE of Kau Rock Rd turnoff, NE of Esperance, *Brooker* 8164, 5 June 1983 (CANB, NSW); 19.9 km NE from Mt Ridley turnoff on Dempster road, *Brooker* 8921, 9 Apr 1985 (CANB, NSW); 44.4 km NE of Logans road on Mt Ney road, *Hill* 2263 & *Johnson*, 5 Nov 1986 (NSW, CANB, MEL, PERTH); 15.3 km SE of Mt Ney road on Clyde Rock road, *Hill* 2271 & *Johnson*, 6 Nov 1986 (NSW, CANB, MEL, PERTH).

Intergrades: *E. leptocalyx* subsp. *leptocalyx* ↔ *E. leptocalyx* subsp. *petilipes*

Selected specimens (from 3 examined): Western Australia: 26.2 km from Mt Burdett towards Mt Ney, *Brooker 7090*, 11 Nov 1981 (CANB, NSW, PERTH); 5 km NW of Coolinup Rd on Kau Rock Rd, NE of Esperance, *Brooker 7548*, 12 Aug 1982 (CANB, NSW); Mt Burdett about 50 km north east of Esperance, *Foreman 1232*, 26 Nov 1985 (MEL, AD, CANB, NSW, PERTH).

Intergrades between species in Series *Leptocalyces*

E. leptocalyx ↔ *E. scyphocalyx*

Selected specimens (from 15 examined): Western Australia: 5 miles [8 km] E of Scaddan, *Beard 6345*, 15 Sep 1970 (KPBG, NSW); 38 miles [61.2 km] south of Salmon Gums, *Brooker 2773*, 8 Aug 1970 (PERTH, NSW); 0.5 mile [0.8 km] N of Grasspatch, *Chippendale 394*, 24 Mar 1968 (CANB, NSW); 5 miles [8 km] S of Salmon Gums, *Johnson W 192*, 18 Dec 1960 (NSW); Pullitup Swamp area, at SE corner of Fitzgerald River National Park, c. 10 km NE of Bremer Bay, *Pullen 10,042*, 15 Dec 1974 (CANB, NSW); 3.6 km S from Rollonds road on Fields road, *Hill 2307*, *Johnson & Blaxell*, 7 Nov 1986 (NSW, PERTH).

E. leptocalyx subsp. *petilipes* × *E. scyphocalyx* subsp. *triadica*

Specimens examined: Western Australia: 13 km NE of Mt Ridley turnoff on Dempster road, *Brooker 8793*, 16 Jan 1985 (CANB, NSW).

12. *Eucalyptus scyphocalyx* (F. Muell. ex Benth.) Maiden & Blakely, *Crit. Revis. Eucalyptus* 8: 45 (1929). Figured in *Crit. Revis. Eucalyptus* 1, Plate 3, fig. 5.

= *Eucalyptus dumosa* A. Cunn. ex Schauer var. *scyphocalyx* F. Muell. ex Benth., *Fl. Austral.* 3: 230 (1867).

Type: Western Australia: Eyre's Relief, *Maxwell s.n.* (lecto K?, here designated; isolecto MEL?, NSW). The original citation was: 'W. Australia, Eyre's Relief, Maxwell. Another form, very much like this one, but with longer, not much flattened peduncles, and the fruit nearly ½ in. long, in Herb. R. Br., gathered in Baudin's Expedition on the Ile les Amiraux.' Maiden and Blakely elevated the variety to specific rank, stating 'it has only been found at Eyre's Relief Camp, Great Australian Bight, Western Australia. Collector not known.' They thus knowingly, or unknowingly, excluded the specimen in Herb. R. Br. cited by Bentham. In order to avoid any future confusion, the Maxwell specimen is here designated the Lectotype. This species has not been confirmed at this site subsequently, and it must be assumed that some confusion exists over the original site of Maxwell's collection.

Maiden initially included this taxon in *E. incrassata* (*Crit. Revis. Eucalyptus* 1903–1933, 1: 97), although he later reconsidered, and Maiden and Blakely elevated it to specific rank. Gardner (1960) regarded it as synonymous with *E. merrickiae* although this view was not generally followed.

Mallee to 6 m tall, rarely a small tree. Bark smooth, grey, pink, whitish, shedding in ribbons, rarely with a short basal stocking of persistent fibrous bark. Juvenile leaves disjunct, ovate, grey-green, dull, to 8 cm long, 4 cm wide. Adult leaves disjunct, lanceolate to broad-lanceolate, often falcate, acuminate, more or less glossy, 4.0–120.0 cm long, 0.8–2.5 cm wide; petioles terete or ± angular, 0.8–2.0 cm long; lateral veins at c. 30–40° to midrib, moderately spaced, irregular and ± obscure; intramarginal vein c. 1–2 mm from margin. Umbellasters axillary, 3–7-flowered. Peduncles terete or angular, 5–13 mm long. Pedicels terete or ± angular, 1–7 mm long. Mature buds ovoid, often distinctly red or cream, 8–12 mm long, 6–8 mm diam.; calyptra shallowly hemispherical, sometimes broadly apiculate, smooth or faintly ribbed, ½–½ as long as hypanthium, wider than hypanthium. Fruits ovoid to cup-shaped and campanulate, 3–4-locular, 8–12 mm long, 7–11 mm in diameter; calyptra scar and stemophore flat, 0.5–1.0 mm wide; disc steeply depressed, 1–2 mm wide; valves deeply enclosed. Seeds

± pyramidal, angular; semi-glossy grey-black, shallowly and regularly reticulate, 2–3 mm long; hilum ventral; chaff smaller, angular, red-brown.

Two geographic subspecies are recognised, as below.

Hybrids are recorded between *E. platycorys* and both subspecies.

12A. *Eucalyptus scyphocalyx* (F. Muell ex Benth.) Maiden & Blakely subsp. *scyphocalyx*

Adult leaves lanceolate to broad-lanceolate, glossy to semiglossy, 4.0–12.0 cm long, 0.8–2.5 cm wide; petioles 0.8–2.2 cm long. Umbellasters 7-flowered. Peduncles 3–13 mm long. Pedicels 1–7 mm long. Mature buds 8–12 mm long, 6–8 mm diam. Fruits ovoid to cup-shaped or campanulate, smooth or shallowly ribbed, 8–12 mm long, 7–11 mm diam.

Locally frequent on grey or white sandy soils over laterites on flat country in the area from Jerramungup to Ravensthorpe and northeast towards Salmon Gums, occupying a zone to the north and west of *E. leptocalyx* subsp. *leptocalyx* (Figs. 12, 13). Associated species include *E. uncinata*, *E. cylindriflora* Maiden & Blakely, *E. calycogona* Turcz., *E. eremophila* (Diels) Maiden and *E. spathulata* Hook.

Conservation status: not considered to be at risk.

Selected specimens (from 15 examined): Western Australia: 29 km W of Jerramungup, *Brooker* 8373, 23 Nov 1983 (CANB, NSW); E side of Lake Magenta, NE of farmhouse, *Brooker* 8783, 14 Jan 1985 (CANB, NSW); 37 km SE of Lake King, North road, 6 km N of junction with Hayes Road, *Crisp* 4994, 10 Jan 1979 (CANB, NSW, PERTH); 17 km S of Pingrup on rd to Ongerup, *Hill* 329, *Johnson & Blaxell*, 23 Oct 1983 (NSW, CANB, PERTH); 47.8 km past Fields road (5 ways) on Ravensthorpe track, *Hill* 2342, *Johnson & Blaxell*, 8 Nov 1986 (NSW, PERTH); 5.2 km W of Giles road (Findley road), on Magenta road, *Hill* 2399, *Johnson, Blaxell & Brooker*, 10 Nov 1986 (NSW, PERTH); 100 m S of S shore of Lake Chinocup, *Hill* 2461, *Johnson & Blaxell*, 13 Nov 1986 (NSW, PERTH); 43.8 km N of Lake King to Norseman rd on Rabbit Proof Fence rd, *Hill* 3045, 1 Sep 1988 (NSW); 6.7 km E on Needilup Nth Rd on Ryans Rd, *Hill* 3137, 7 Sep 1988 (NSW).

12B. *Eucalyptus scyphocalyx* (F. Muell ex Benth.) Maiden & Blakely subsp. *triadica* L.A.S. Johnson & K.D. Hill, subsp. nov.

Ab subspecies *scyphocalyx* umbellastris trifloras, fructus aliquanto breviores et distincte costati distinguitur.

Type: Western Australia: 15.3 km south-east of Mount Ney road on Clyde Rock road, *K.D. Hill* 2268 & *L.A.S. Johnson*, 6 Nov 1986 (holo NSW; iso CANB, MEL, PERTH).

Adult leaves lanceolate, semiglossy, 5.0–12.0 cm long, 1.0–2.2 cm wide; petioles 1.0–2.2 cm long. Umbellasters 3-flowered. Peduncles 3–10 mm long. Pedicels 1–7 mm long. Mature buds 8–12 mm long, 6–8 mm diam. Fruits cup-shaped or campanulate, often distinctly shallowly ribbed, 8–12 mm long, 8–11 mm diam. (Fig. 15).

Three-flowered umbellasters readily distinguish subsp. *triadica* from the type subspecies. Fruits also tend to be more squat and more distinctly ribbed, and foliage is less coarse.

Locally frequent on loamy calcareous soils in flat country in the area northeast of Esperance, in a zone lying to the east of subsp. *scyphocalyx* and to the north of *E. leptocalyx* subsp. *petilipes* (Fig. 13). Associated species include *E. uncinata*, *E. ovalaris* Maiden & Blakely, *E. oleosa*, *E. eremophila* and *E. gracilis*.

Conservation status: not considered to be at risk.

The epithet is from the Latin *triad*, a group of three, from the 3-flowered inflorescences.

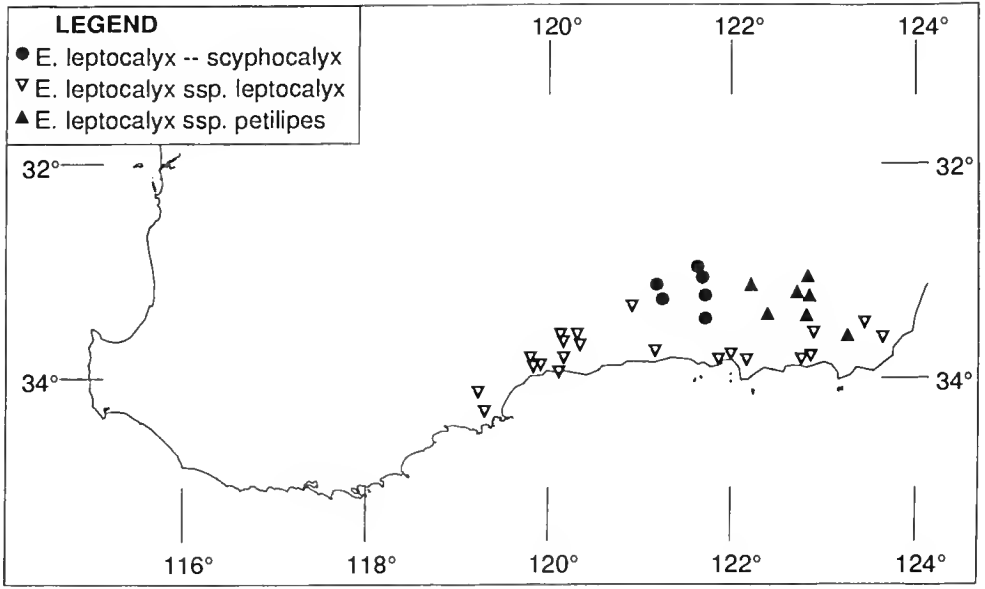


Fig. 12. Distribution of *E. leptocalyx* subspp. *leptocalyx* and *petilipes*, *E. leptocalyx* – *scyphocalyx* intergrades.

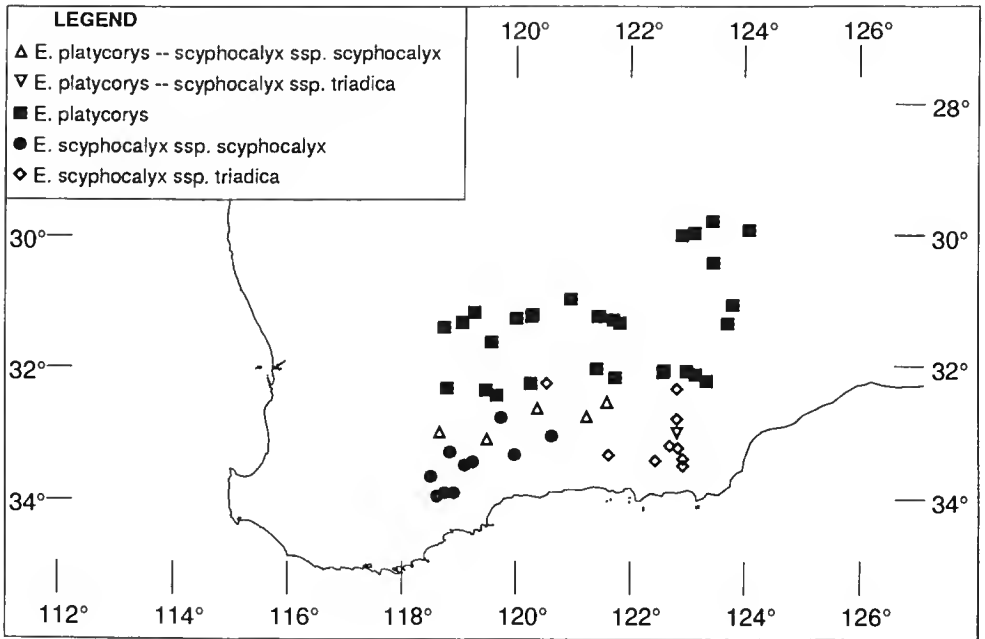


Fig. 13. Distribution of *E. platycorys*, *E. scyphocalyx* subspp. *scyphocalyx* and *triadica*, *E. platycorys*–*E. scyphocalyx* subspp. *scyphocalyx* intergrades and *E. platycorys*–*E. scyphocalyx* subspp. *triadica* intergrades.



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Fig. 14. *E. leptocalyx* subsp. *petilipes*. a, adult leaves; inflorescence and fruits; b, inflorescence and fruits; c, d, seed. (from Brooker 8921). Scale bars: a, b, = 1 cm; c, d = 1 mm.

Selected specimens (from 15 examined): Western Australia: Southern Hills Station, *Beard* 6307, 13 Sep 1970 (KPBG, NSW); 30 miles [48 km] NE of Condingup, *Beard* 6357, 16 Sep 1970 (KPBG, NSW); 30 miles [48 km] NE of Mt Ney, *Beard* 6375, 17 Sep 1970 (KPBG, NSW); 6.6 km E of Truslove, *Brooker* 7080, 10 Nov 1981 (CANB, NSW); 35.6 km along Howick rd to NW of Muntz rd crossing, E of Esperance, *Hill* 288 & *Johnson*, 21 Oct 1983 (NSW, CANB, PERTH); 132.0 km W of Coolgardie to Norseman rd on Hyden track, *Hill* 2868, 25 Aug 1988 (NSW, CANB, PERTH).

Intergrades and hybrids:

E. scyphocalyx subsp. *scyphocalyx* ↔ *E. scyphocalyx* subsp. *triadica*

Selected specimens (from 2 examined): Western Australia: Double Tank, between Fraser Range and Esperance, *Beard* 6332, 13 Sep 1970 (KPBG, NSW); 177.1 km W of Norseman to Coolgardie rd on Hyden track (20.7 km E of crossroads), *Hill* 2875, 26 Aug 1988 (NSW);

E. platycorys ↔ *E. scyphocalyx* subsp. *scyphocalyx*

Selected specimens (from 6 examined): Western Australia: 7.4 miles [11.8 km] W of Lake King village on main road from Newdegate, *Tindale* 3776, 28 Aug 1973 (NSW); 30 km W of 90 mile tank, *Aplin* 5922, June 1974 (PERTH, NSW); 1 mile [1.6 km] north of Bumgup, *Brooker* 2276, 5 Nov 1969 (PERTH, NSW); road to Peak Charles, *Brooker* 7503, 2 May 1982 (CANB, NSW); 43.4 km S of Norseman on Esperance highway, *Hill* 2229, *Johnson*, *Brooker* & *Blaxell*, 5 Nov 1986 (NSW, PERTH, CANB, MEL, CANB).

E. platycorys ↔ *E. scyphocalyx* subsp. *triadica*

Specimens examined: Western Australia: 44.4 km NE of Logans road on Mt Ney road, *Hill* 2262 & *Johnson*, 5 Nov 1986 (NSW, PERTH, CANB, MEL, CANB).

E. deflexa × (*E. platycorys* ↔ *E. scyphocalyx*)

Specimens examined: Western Australia: 0.5 km W of Hatters Hill road, on Lake King road, *Hill* 2350, *Johnson*, *Blaxell* & *Brooker*, 8 Nov 1986 (NSW).

E. deflexa × *E. scyphocalyx*

Specimens examined: Western Australia: c. 200 m W of Hatters Hill road on Lake King to Norseman road, *Brooker* 8765, 18 Dec 1984 (CANB, NSW).

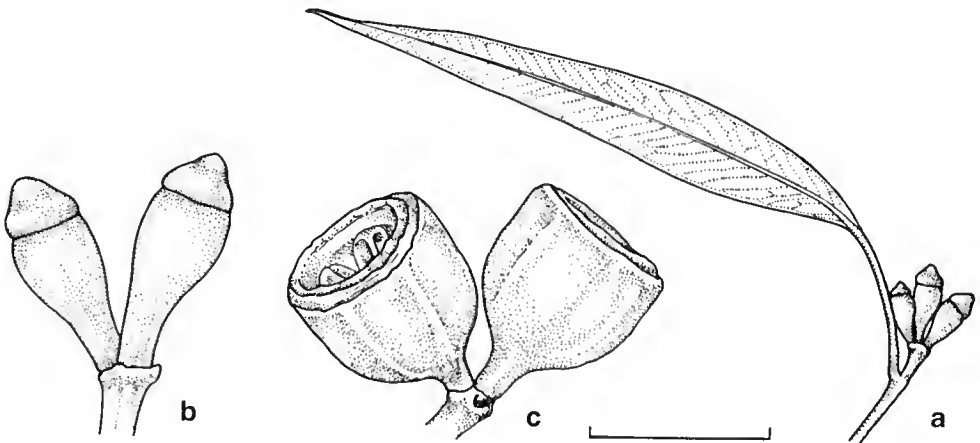


Fig. 15. *E. scyphocalyx* subsp. *triadica*. a, adult leaf, inflorescence and buds; b, inflorescence and buds; c, inflorescence and fruits. (a from *Hill* 2868, b from *Johnson* 228, c from *Hill* 2864). Scale bar = 1 cm.

Table 8. Published names in Series *Obtusiflorae* (accepted names in *Bold type*, taxonomic synonyms represented by ‘=’, nomenclatural synonyms represented by ‘≡’).

- E. obtusiflora* DC., *Prodr.* 3: 220 (1828).
- E. dumosa* A. Cunn. ex Oxley, *J. Two Exped.* 63 (1820); Schauer in Walp., *Repert. Bot. Syst.* 2: 925 (1843).
- E. lamprocarpa* F. Muell. ex Miq., *Ned. Kruidk. Arch.* 4: 129 (1856); = *E. dumosa*.
- E. muelleri* Miq., *Ned. Kruidk. Arch.* 4: 130 (1856); = *E. dumosa*.
- E. dumosa* A. Cunn. ex Schauer var. *conglobata* R. Br. ex Benth., *Fl. Austral.* 3: 230 (1867); ≡ *E. conglobata*.
- E. incrassata* Labill. var. *dumosa* (A. Cunn. ex Schauer) F. Muell., *Eucalyptographia*, Dec. 5 (1879–1884); ≡ *E. dumosa*.
- E. incrassata* Labill. var. *conglobata* (R. Br. ex Benth.) Maiden, *Crit. Revis. Eucalyptus* 1: 100 (1904); ≡ *E. conglobata*.
- E. striaticalyx* W.V. Fitzg., *J. Proc. Mueller Bot. Soc. Western Australia* 1: 20 (1904).
- E. woodwardii* Maiden, *J. Nat. Hist. Sc. Soc. Western Australia* 3: 2 (1910).
- E. goniantha* Turcz. var. *clelandii* Maiden, *Proc. Western Australian Nat. Hist. & Sci. Soc.* 3: 176 (1911); ≡ *E. clelandii*.
- E. clelandii* (Maiden) Maiden, *Crit. Revis. Eucalyptus* 2: 189 (1912). Plate 69, fig. 8.
- E. lesouefii* Maiden, *Crit. Revis. Eucalyptus* 2: 187 (1914).
- E. sheathiana* Maiden, *J. Proc. Roy. Soc. New South Wales* 49: 312 (1915).
- E. conglobata* R. Br. ex Maiden, *Crit. Revis. Eucalyptus* 6: 273 (1922).
- E. kondininensis* Maiden & Blakely, *J. & Proc. Roy. Soc. New South Wales* 59: 189, (1925).
- E. dongarraensis* Maiden & Blakely, *J. & Proc. Roy. Soc. New South Wales* 59: 184 (1925); ≡ *E. obtusiflora* subsp. *dongarraensis*.
- E. pileata* Blakely, *Key Eucalypts*, 120 (1934).
- E. conglobata* (R. Br. ex Benth.) Maiden subsp. *fraseri* Brooker, *Nuytsia*, 1: 251 (1972). ≡ *E. fraseri*
- E. fraseri* (Brooker) Brooker, *Australian Forest Res.* 7: 65 (1976).
- E. cyanophylla* Brooker, *Trans. & Proc. Roy. Soc. South Australia* 101(1): 15 (1977).
- E. georgei* Brooker & Blaxell, *Nuytsia* 2(4): 224 (1978).
- E. calcareana* Boomsma, *J. Adelaide Bot. Gard.* 1(6): 361 (1979).
- E. pterocarpa* C. Gardner ex P. Lang, *Fl. Australia* 19: 510 (1988).
- E. percostata* Brooker & P. Lang, *J. Adelaide Bot. Gard.* 13: 65 (1990).
- E. cretata* P. Lang & Brooker, *J. Adelaide Bot. Gard.* 13: 71 (1990).
- E. georgei* subsp. *fulgida* Brooker & Hopper, *Nuytsia* 9: 47 (1993).
- E. tenuis* Brooker & Hopper, *Nuytsia* 9: 48 (1993).
- E. polita* Brooker & Hopper, *Nuytsia* 9: 51 (1993).

Series *Obtusiflorae*

Treated as series *Rufispermae* Maiden by Chippendale (1988) and Brooker (2000).

Series distinguished as follows: seeds elliptical, dorsiventrally flattened, glossy red or red-brown, very shallowly regularly reticulate; hilum ventral, indistinct in colour.

A large and complex series with over 50 constituent species, primarily Western Australian, but with a number of species in South Australia and a few species extending into New South Wales and Victoria. Further division into subseries is somewhat problematical, and is not attempted at this stage.

The first species described in this series was *E. obtusiflora* DC., although confusion with the eastern Australian species *E. obstans* has existed since (see below). This was followed by *E. dumosa*, although the name *E. dumosa* had been published without description even earlier. *E. dumosa* has also been a confused concept for a long period,

with many distinct species at one time or another being included as synonyms or varieties (e.g. see Maiden, *Crit. Revis. Eucalyptus* 1903–1933, 1).

A large number of taxa were added during the time of Maiden and Blakely, as in many other eucalypt groups. This was followed by a period of inactivity, then a resurgence of interest with many new taxa described by various authors in the past 20 years (Table 8). The group still requires intensive study of several complexes, and additional taxa beyond the ten described below await definition.

The *Eucalyptus pileata* complex

This is a group of 5 species occurring in the southern wheatbelt and southern goldfields regions of Western Australia. All are trees except *E. pileata* Blakely, and all display distinctively smooth bark that sheds in long, durable ribbons and typically hangs in trees long after shedding. See Table 9 for species included and their identification.

13. *Eucalyptus spreata* L.A.S. Johnson & K.D. Hill, *sp. nov.*

Ab *E. fraseri* distinguitur: alabastra minora, saepe elongata plus minusve rostrata; fructus minores; habitu arborescenti ramis a trunco brevi adscendentibus ('marlock').

Type: Western Australia: 60 km E. of Norseman on Highway 1 (32°04'S 122°22'E), K.D. Hill 692 & D.F. Blaxell, 14 Nov 1983 (holo NSW; iso CANB, K, PERTH).

[*E. species* U, Brooker & Kleinig 1990: 329 (1990)]

Tree to 10 m tall, branched near base ('Marlock' habit). Bark smooth to base, white, grey and pink, shedding in ribbons. Juvenile leaves ovate to broad-lanceolate, dull. Adult leaves disjunct, lanceolate, acute, glossy, 6.0–12.0 cm long, 1.0–2.5 cm wide; petioles terete or ± flattened, 0.8–2.0 cm long; young stems ± quadrangular; lateral veins at c. 30–45° to midrib, moderately spaced, ± degenerate; intramarginal vein present, indistinct and slightly degenerate, 0.5–1.5 mm from margin. Umbellasters axillary, 7-flowered. Peduncles terete or vaguely ribbed, 3–8 mm long, c. 2 mm thick. Pedicels ± ribbed, 0.5–2.0 mm long. Mature buds ovoid to ± fusiform, 10–12 mm long, c. 4 mm diam.; calyptre conical, acute, with a pronounced median constriction, ribbed, about as long as hypanthium. Fruits obconical, 4-locular, 6–8 mm long, 6–7 mm diam.; calyptre scar and stemophore flat, c. 0.5 mm wide; disc sharply depressed, 1.0–1.5 mm wide; valves broadly triangular, enclosed, raised at c. 45°. Seeds irregular, flattened, shallowly reticulate, glossy deep red brown, 1.5–2.0 mm long; hilum ventral; chaff similar, angular, smaller (Fig. 16).

E. spreata differs from *E. fraseri* in the smaller, often elongate and ± rostrate buds and the smaller fruits, and the 'marlock' habit. The 'marlock' habit (a low-branching tree with steeply ascending branches and a short bole) is also different from the habit of the related taxa *E. fraseri* and *E. valens*, and foliage is also distinctively stiff and erect. *E. spreata* has been included in a somewhat confused concept of *E. pileata* to date; the latter is a mallee species from further west with distinctively clavate buds with broad, flat calyptre (see also Table 9).

Locally frequent south and east of Norseman to west of Balladonia (Fig. 17). Not well collected and probably more widespread. Hybrids with *E. fraseri* are known.

Restricted to woodlands on calcareous loams or sandy loams, associated with various species including *E. gracilis*, *E. flocktoniae*, *E. valens* and *E. fraseri*.

Conservation status: not considered to be at risk.

The epithet is from the Latin *spretus* (past participle of *spreno*), separated or removed, referring to the geographic separation from *E. pileata*, with which has been confused in the past.

Selected specimens (from 52 examined): Western Australia: along Eyre Highway, 28.3 miles [52.5 km] S of Norseman, *Baker 65*, 13 Nov 1970 (CANB, NSW); on Telegraph line, S of Fraser Range, *Beard 6316*, 12 Sep 1970 (KPBG, NSW); 30 miles [48 km] NE of Mt Ney, *Beard 6373*, 17 Sep 1970 (KPBG, NSW); 28.2 km NW of Balladonia towards Norseman, *Brooker 8839*, 10 Feb 1985 (CANB, NSW);

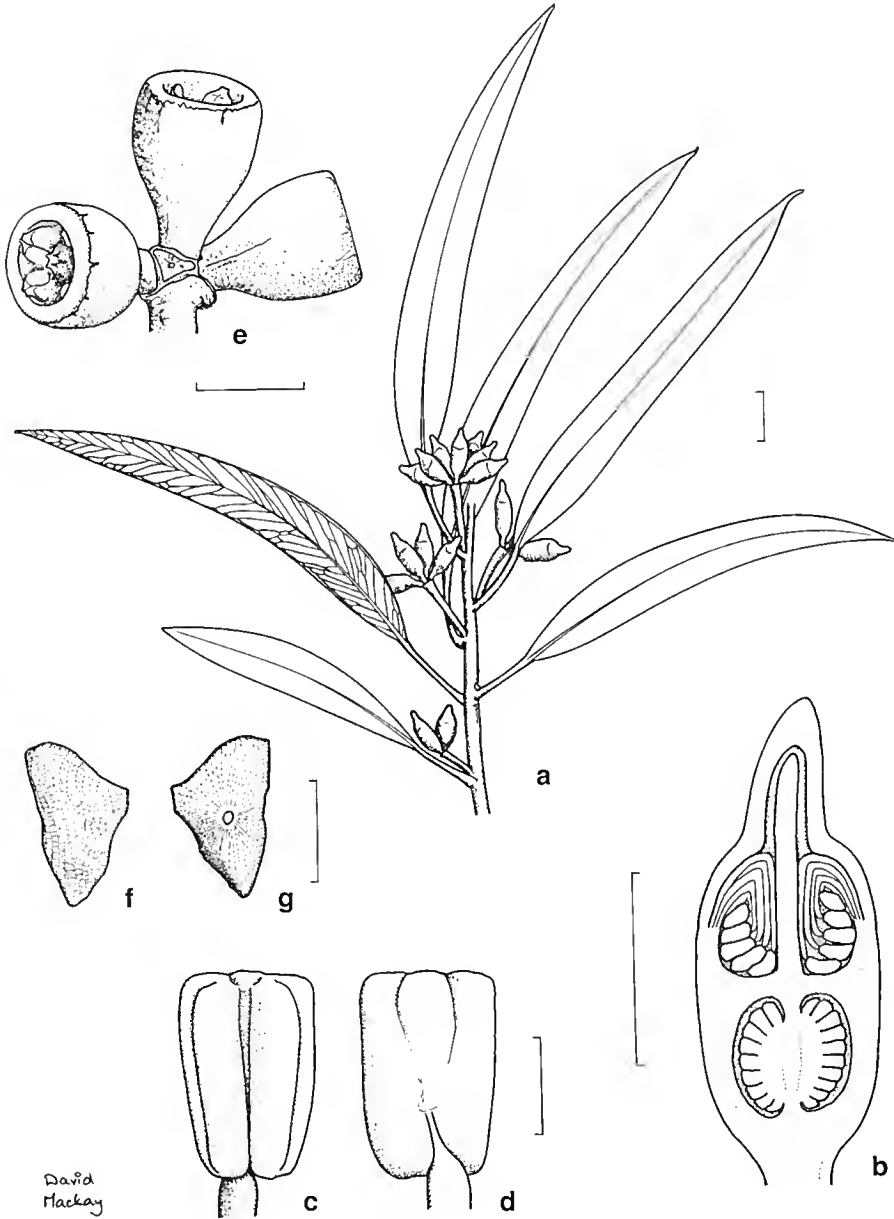


Fig. 16. *E. spreta*. a, adult leaves, inflorescence and buds; b, longitudinal section of bud; c, d, anther; e, inflorescence and fruits; f, g, seed (from *Brooker 8839*). Scale bars: a = 1 cm; b, e = 5 mm; c, d = 0.5 mm; f, g = 1 mm.

1–2 km west of Kumarl on Peak Charles road, *Brooker 8906*, 7 Apr 1985 (CANB, NSW); 14.4 miles [22.8 km] NNW of Salmon Gums, *Chippendale 172*, 13 Mar 1967 (CANB, NSW); 71 km from Balladonia Motel along Eyre Highway towards Norseman, *Crisp 5646*, 2 Feb 1979 (CANB, AD, NSW, PERTH); 11.7 km south of Balladonia roadhouse on track to Mount Ragged, *Hill 234 & Johnson*, 20 Oct 1983 (NSW); 66.5 km N of Esperance on rd to Norseman, *Hill 298, Johnson & Blaxell*, 22 Oct 1983 (NSW, CANB, PERTH); 60 km E of Norseman on Highway 1, *Hill 692 & Blaxell*, 14 Nov 1983 (NSW, CANB, PERTH); 22.9 km W of Balladonia roadhouse on highway, *Hill 2194 & Johnson*, 4 Nov 1986 (NSW, CANB, MEL, PERTH); 54.5 km W of Balladonia roadhouse on highway, *Hill 2207 & Johnson*, 4 Nov 1986 (NSW, CANB, MEL, PERTH); 10.7 km north of Salmon Gums on Norseman to Esperance highway, *Hill 2240, Johnson, Brooker & Blaxell*, 5 Nov 1986 (NSW, CANB, MEL, PERTH); 14 km north of Rollonds road on Fields road, *Hill 2312, Johnson, Blaxell & Brooker*, 7 Nov 1986 (NSW, CANB, MEL, PERTH); Dowak (N of Salmon Gums), *Johnson W 189*, 18 Dec 1960 (NSW); 65.8 km S of Balladonia towards Israelite Bay, *Pryor 172 & J. Briggs*, 25 Oct 1978 (CANB, NSW).

14. *Eucalyptus fraseri* (Brooker) Brooker, Australian Forest Res. 7: 65 (1976).

Basionym: *Eucalyptus conglobata* (R. Br. ex Benth.) Maiden subsp. *fraseri* Brooker, *Nuytsia*, 1: 251 (1972).

Type: Western Australia: 14 miles west of Balladonia, *M.I.H. Brooker 2472*, 14 Feb 1970 (holo PERTH; iso PERTH, AD, GAUBA, BRI, CANB, K, MEL, NSW).

Tree to 25 m tall. Bark smooth, white with brown or bronze stripes, shedding in long ribbons (with a persistent 'stocking' in subsp. *melanobasis*). Juvenile leaves disjunct, petiolate, ovate to orbiculate, glaucous, to 15 cm long, 10 cm wide. Adult leaves disjunct, lanceolate to broad lanceolate, acute, glossy, dark green, coriaceous, 10.0–25.0 cm long, 1.5–4.0 cm wide; petioles ± flattened or quadrangular, ± decurrent into 4-angled young stems, 1.5–4.0 cm long; lateral veins at 20–30° to midrib, moderately closely spaced, ± degenerate; intramarginal vein present, indistinct, c. 1.0 mm from margin. Umbellasters axillary, 7-flowered. Peduncles thick, angular, 2–12 mm long. Buds and fruits sessile, rarely shortly pedicellate with thick pedicels up to 3 mm long. Mature

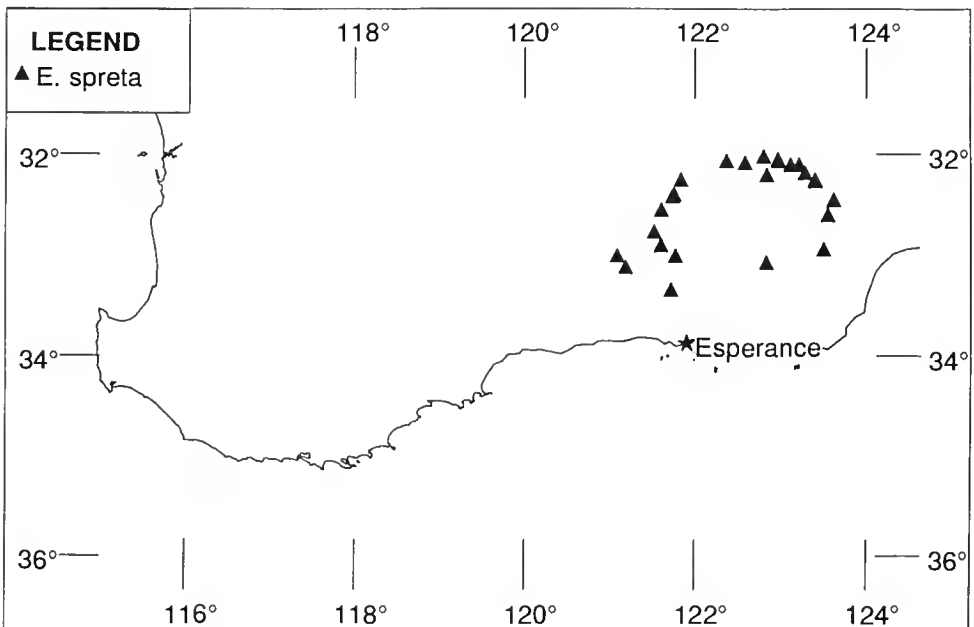


Fig. 17. Distribution of *E. spreta*.

Table 9. The *E. pileata* complex (all measurements in mm).

	<i>E. pileata</i>	<i>E. spreata</i>	<i>E. tenuis</i>	<i>E. fraseri</i> subsp. <i>fraseri</i>	<i>E. fraseri</i> subsp. <i>melanobasis</i>	<i>E. valens</i>
Habit	mallee	tree (marlock)	whipstick mallee, rarely tall mallee	tree	tree	tree
Habitat	mallee heath on gritty yellow loam	woodland on calcareous or sandy loam	mallee to shrub heath on granite or laterite	tall woodland on pale brown 'puffy' calcareous earths	woodland on heavy red loam on metamorphics + to 4 m	woodland on heavy soils
Bark (stocking)	-	-	-	-	-	-
Juvenile leaves	ovate to broad-lanceolate, dull lanceolate	ovate to broad-lanceolate, dull lanceolate	narrow-lanceolate to lanceolate	ovate to orbiculate, glaucous lanceolate to broad-lanceolate	ovate to orbiculate, glaucous lanceolate to broad-lanceolate	ovate to orbiculate, glaucous lanceolate
Adult leaves						
- gloss	semi-glossy	glossy	glossy	glossy	glossy	glossy
- size (LxB)	50-100 x 10-25	60-120 x 10-25	40-70 x 25-45	100-250 x 15-40	100-250 x 20-40	80-140 x 15-35
Pruinosity	-	-	-	+	-	-
Petiole (L)	10-20	8-20	15-18	15-40	15-40	20-35
Peduncle	terete	terete/ vaguely ribbed	terete/ slightly flattened	angular, thick	angular, thick	terete
- size (LxB)	5-10 x 1-2	3-8 x 2	8-50 x 1-2	2-12 x 3-4	2-8 x 3-6	3-5 x 3-6
Pedicel	quadrangular	± ribbed	terete, ± ribbed	-	-	-
Pedicel (L)	2-4	5-20	5-10	0-3	0	0
Buds	ovoid - fusiform	ovoid - fusiform, constricted	clavate	ovoid	ovoid	ovoid
- size (LxB)	12-16 x 4-7	10-12 x 4	11 x 8	9-15 x 5-6	10-15 x 5-7	9-11 x 6-7
Calyptra	conical, deeply ribbed	conical, ribbed	conical, deeply ribbed	rounded, ribbed	conical - rounded, ribbed	conical, obtuse / slightly apiculate
Hypanthium	ribbed	slightly ribbed	strongly ribbed	ribbed / ± winged	ribbed	± winged
Fruits	cup	obconical	obconical	cup to obconical	cup to obconical	cup
- size (LxB)	8-12 x 7-9	6-8 x 6-7	10 x 10	7-11 x 6-10	8-11 x 8-10	8-10 x 8-11
Valves	tips exerted	tips exerted	rim level	enclosed	rim level	tips exerted
Umbellasters	3-7	7	3-7	7	7	7

buds ovoid, 9–15 mm long, 5–6 mm diam.; calyptra ± cup-shaped, rounded, often with a pronounced median constriction, ribbed, ± as long as hypanthium or slightly shorter. Fruits cup-shaped or obconical, slightly constricted apically, 4-locular, 7–11 mm long, 6–10 mm diam.; calyptra scar and stemonophore flat or somewhat raised, c. 1.0 mm wide; disc depressed at c. 45°, 1.0–1.5 mm wide; valves broadly triangular, enclosed, raised at c. 45°. Seeds irregular, flattened, shallowly reticulate, glossy deep red-brown, c. 2.0 mm long; hilum ventral. Chaff similar, angular, smaller.

Two subspecies are recognised, as follows (see also Table 9).

14A. *Eucalyptus fraseri* (Brooker) Brooker subsp. *fraseri*

Tree to 15 m tall. Bark smooth throughout. Adult leaves 9–14 cm long, 1.5–3.0 cm wide; petioles 1.5–3.5 cm long. Umbellasters axillary, 7-flowered. Peduncles 5–13 mm long. Buds and fruits sessile or shortly pedicellate. Mature buds ovoid, 9–13 mm long, 5–6 mm diam. Fruits 7–9 mm long, 6–9 mm diam.

Locally frequent but sporadic, in tall woodland on pale brown 'puffy' calcareous earths from east of the Fraser Range to east of Balladonia, and somewhat north of there (Fig. 18).

Conservation status: not considered to be at risk.

Selected specimens (from 20 examined): Western Australia: 5 km west of Balladonia [roadhouse], *Boomsma* 359, 28 July 1978 (AD, NSW); 9 miles [14.4 km] N of Tower Hill corner on road to Balladonia, *Brooker B* 4532, 10 Apr 1974 (CANB, NSW); 8.3 km S of Balladonia towards Mt Ragged, *Brooker* 5627, 3 Apr 1977 (CANB, AD, MEL, NSW, PERTH); 156 km W of Cocklebidy, *Brooker* 5624, 2 Apr 1977 (CANB, AD, MEL, NSW, PERTH); Cape Arid National Park, 16 km S of Juranda Rock Hole along road to Mt Ragged (Tower Peak), *Crisp* 4800, 5 Jan 1979 (CANB, NSW, PERTH); 102 km west of Caiguna on Highway 1, *Hill* 204 & *Johnson*, 19 Oct 1983 (NSW, CANB, PERTH); 81 km E of Balladonia roadhouse on Highway 1, *Hill* 2180 & *Johnson*, 3 Nov 1986 (NSW, CANB, MEL, PERTH); 16.9 km W of Balladonia roadhouse on Highway 1, *Hill* 2189 & *Johnson*, 4 Nov 1986 (NSW, CANB, MEL, PERTH); 50.3 km W of Balladonia roadhouse on Highway 1, *Hill* 2204 & *Johnson*, 4 Nov 1986 (NSW, PERTH, CANB, MEL, CANB); 30.7 km N of Israelite Bay turnoff at Mt Ragged on track to Balladonia, *Hill* 3172, 9 Sep 1988 (NSW, CANB, PERTH).

Intergrades: *E. fraseri* subsp. *fraseri* ↔ *E. spreata*

Specimens examined: Western Australia: Coragina Rock, *Beard* 5283, 27 Oct 1967 (KPBG, NSW); Pine Hill, *Beard* 6405, 18 Sep 1970 (KPBG, NSW).

14B. *Eucalyptus fraseri* (Brooker) Brooker subsp. *melanobasis* L.A.S. Johnson & K.D. Hill, subsp. nov.

A subsp. *fraseri* distinguitur: fructus majores, sessiles in pedunculis brevioribus; calyptra constricta, folia majora coriaceque, et cortex basaliter asper induratusque.

Type: Western Australia: Fraser Range, 87.7 km W of Balladonia Roadhouse on Highway 1 (32°01'S 172°49'E), *K.D. Hill* 701 & *D.F. Blaxell*, 14 Nov 1983 (holo NSW; iso CANB, K, PERTH)

[*E. fraseri* subsp. 'blackbutt', Brooker and Kleinig (1990: 325)]

Tree to 15 m tall. Bark smooth, with a persistent thick hard black basal 'stocking' for 1.5–4 m. Adult leaves 10.0–25.0 cm long, 2.0–4.0 cm wide; petioles 1.5–4.0 cm long. Umbellasters axillary, 7-flowered. Peduncles 2–8 mm long. Buds and fruits sessile. Mature buds ovoid, c. 15 mm long, c. 6 mm diam. Fruits 8–11 mm long, 8–10 mm diam (Fig. 19).

Subsp. *melanobasis* is distinguished from subsp. *fraseri* by the larger, sessile fruits on shorter peduncles, the constricted calyptra, the larger, leathery leaves and the distinctive stocking of hard, rough black bark.

Distributed for a few kilometres along Highway One on the eastern slopes and crest of the Fraser Range, and probably extending north and south along the range (Fig. 18). This distribution lies to the west of that of subsp. *fraseri*, and also appears to be restricted to outcrops of basic metamorphic rocks.

This taxon is locally dominant on calcareous red loam over basic metamorphic rocks, usually in association with *E. optima* L.A.S. Johnson & K.D. Hill and *E. laevis*.

Conservation status: restricted to a small area, although not at risk within this area (2R).

The epithet is from the Greek *melas*, *melanos*, dark, and *basis*, base, in reference to the characteristic stocking of black persistent bark.

Selected specimens (from 6 examined): Western Australia: 83 km W of Balladonia, *Brooker* 7487, 28 Apr 1982 (CANB, NSW); 67.4 miles [108.5 km] E of Norseman, *Chippendale* 158, 12 Mar 1967 (CANB, NSW); Fraser Range, 84 km west of Balladonia roadhouse on Highway 1, *Hill* 230 & *Johnson*, 19 Oct 1983 (NSW).

15. *Eucalyptus valens* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. fraseri* distinguitur: fructus et alabastra sessiles in pedunculis brevioribus crassioribus.

Type: Western Australia: 1 km W of Norseman to Esperance road on Lake King Road (32°12'S, 121°47'E), *M.I.H. Brooker* 5658, 5 Apr 1977 (holo NSW; iso AD, CANB, MEL, PERTH).

[*E. species* T, Brooker & Kleinig 1990: 323 (1990)]

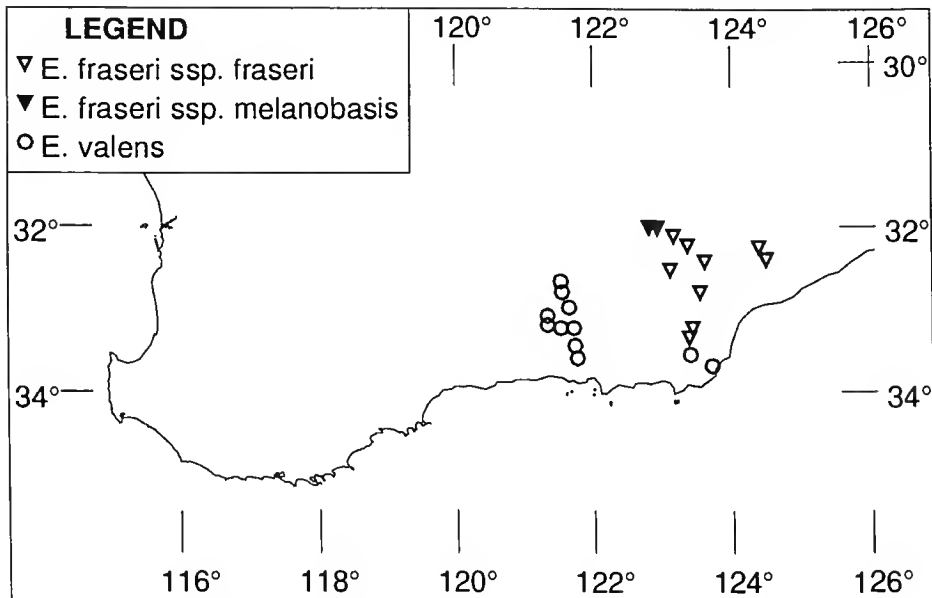


Fig. 18. Distribution of *E. fraseri* subsp. *fraseri*, *E. fraseri* subsp. *melanobasis*, *E. valens*.

Tree to 10 m tall, characteristically with a long, straight bole. Bark smooth, white to base, shedding in long ribbons. Juvenile leaves ovate to orbiculate, glaucous. Adult leaves disjunct, lanceolate, acuminate, glossy, coriaceous, 8.0–14.0 cm long, 1.5–3.5 cm wide. Petioles flattened, 2.0–3.5 cm long. Lateral veins at c. 30–45° to midrib, moderately spaced, somewhat degenerate, intramarginal vein present, \pm indistinct, 1.0–2.0 mm from margin, Umbellasters axillary, 7-flowered. Peduncles 3–5 mm long, 3–6 mm diam. Buds and fruits sessile. Mature buds ovoid,

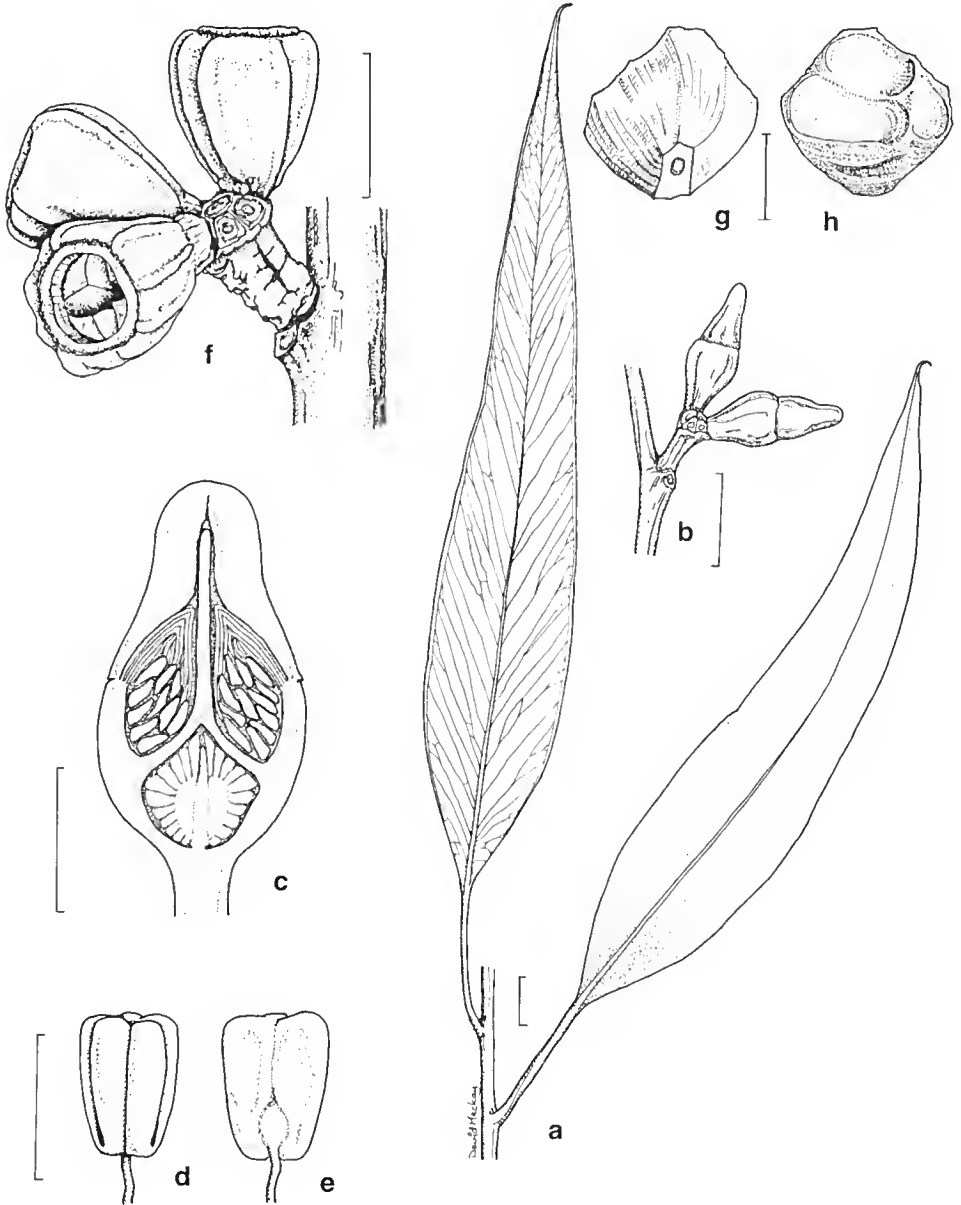


Fig. 19. *E. fraseri* subsp. *melanobasis*. a, adult leaves; b, inflorescence and buds; c, longitudinal section of bud; d, e, anther; f, inflorescence and fruits; g, h, seed (from Hill 230). Scale bars: a, b, f = 1 cm; c = 5 mm; d, e, g, h = 1 mm.

0.9–1.1 cm long, 0.6–0.7 cm in diameter. Calyptra conical, strongly convex, obtuse, slightly shorter than hypanthium. Fruits cup shaped, 4-5-locular, often \pm 2-winged, 0.8–1.0 cm long, 0.8–1.1 cm diam. Calyptra scar and stemophore raised, sometimes vertically, c. 1 mm wide. Disc depressed, from near horizontal to near vertical. Valves broadly triangular, enclosed, tips rim-level or slightly exerted, incurved. Seeds irregular, flattened, shallowly reticulate, glossy deep red-brown, c. 2.0 mm long; hilum ventral. Chaff similar, angular, smaller (Fig. 20).

E. valens differs from *E. fraseri* in the sessile, usually shorter buds and fruits and the shorter; thicker peduncles (see also Table 9).

Distributed through the wheat belt areas north of Esperance, away from the coast (Fig. 18).

A woodland species of heavier, 'harder' soils, often associated with *E. longicornis* (F. Muell.) F. Muell. ex Maiden, *E. transcontinentalis* Maiden, *E. flocktoniae* and to a lesser extent many other southern woodland species.

Conservation status: not considered to be at risk.

The epithet is from the Latin *valens*, strong or vigorous, referring to the robust tree habit.

Selected specimens (from 25 examined): Western Australia: 10 miles [16 km] SW of Mt Ragged, *Beard 6401*, 18 Sep 1970 (KPBG, NSW); between 26 and 58 miles [42–92.4 km] south of Norseman towards Esperance, *Brooker 2495*, 15 Feb 1970 (PERTH, NSW); ca. 6 miles [9.6 km] east of Scaddan, *Brooker 2772*, 8 Aug 1970 (PERTH, NSW); 1 km W of Norseman to Esperance road on Lake King road, *Brooker 5658*, 5 Apr 1977 (CANB, AD, MEL, NSW, PERTH); between Bishops road and Lort River on Belgian road, *Brooker 7125*, 12 Nov 1981 (CANB, NSW, PERTH); 2 km E of Lort Road on Rollonds road, *Brooker 7126*, 12 Nov 1981 (CANB, NSW, PERTH); 1.5 km from Israelite Bay track on Mt Ragged track, *Brooker 8910*, 8 Apr 1985 (CANB, NSW); 14.4 miles [23 km] NNW of Salmon

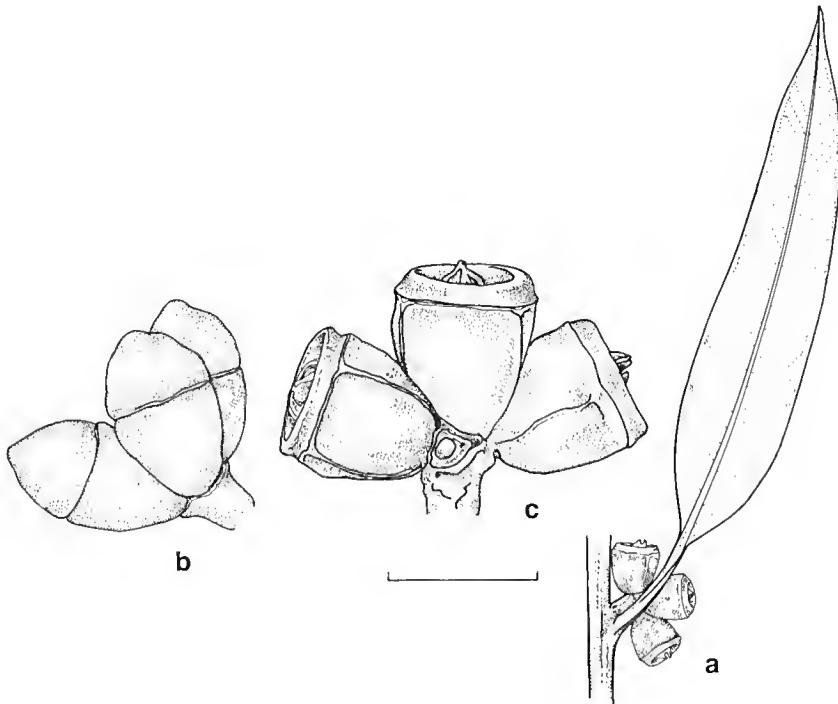


Fig. 20. *E. valens*. a, adult leaf, inflorescence and fruits; b, inflorescence and buds; c, inflorescence and fruits. (from Hill 2246). Scale bar = 1 cm.

Gums, Chippendale 171, 13 Mar 1967 (CANB, NSW); ca. 50 km north of Esperance, Diels 5448, 5 Nov 1901 (B, NSW); Grasspatch, Gardner 2220, 23 May 1924 (PERTH, NSW); 2 miles [3.2 km] southward from Beete, Gardner 11161, 7 Nov 1953 (PERTH, NSW); 16 km west of Grasspatch on Grasspatch road, Hill 299, Johnson & Blaxell, 22 Oct 1983 (NSW, CANB); 19 km south of Salmon Gums on Norseman to Esperance road, Hill 2246, Johnson, Brooker & Blaxell, 5 Nov 1986 (NSW, CANB, MEL, PERTH); 5 miles [8 km] S of Salmon Gums, Johnson W 191, 18 Dec 1960 (NSW).

The *Eucalyptus obtusiflora* complex

Four species in Western Australia and South Australia, including *E. repullans* Nicolle and *E. gypsophila* Nicolle, which we would place here rather than near *E. striatocalyx* W.V. Fitzg. on the basis of the mallee habit and similarities in bark and fruit morphology. See Table 10 for species included and their identification.

16. *Eucalyptus obtusiflora* DC., Prodr. 3: 220 (1828).

Type: cited as 'in Nova-Hollandia ad oram orientalem.' The corresponding specimen held in G-DC (Port Jackson, F.W. Sieber 473, 1823) is not the same as replicates of Sieber 473 held elsewhere, which represents the eastern Australian species (of section *Renantheria*) since described as *E. obstans* L.A.S. Johnson & K.D. Hill. The specimen held in G represents the Western Australian species discussed here; the 'replicates' can only be the result of the mixing of specimens.

Mallee, sometimes a small tree, to 10 m tall. Bark persistent on lower trunk, grey, shortly fibrous-flaky, smooth above, or smooth to base, white or greyish, shed in long, brown ribbons. Twigs, buds and fruits sometimes glaucous. Juvenile leaves disjunct, ovate to orbiculate, petiolate, glaucous, to 7 cm long, 5 cm wide. Adult leaves disjunct, narrow- to broad-lanceolate, acuminate, \pm falcate, dull, mid-green to grey-green or glaucous 5.0–14.0 cm long, 1.2–3.0 cm wide; petioles terete or slightly flattened, 1.0–2.5 cm long. Lateral veins indistinct, at c. 30° to midrib, moderately spaced; intramarginal vein indistinct, 0.5–1.0 mm from margin. Umbellasters axillary, 7–11-flowered. Peduncles terete or angular, 5–20 mm long. Pedicels terete or angular, 1–15 mm long. Mature buds ovoid, 10–20 mm long, 5–8 mm diam.; calyptra hemispherical to broadly conical, striate, $\frac{1}{2}$ as long as hypanthium, distinctly narrower than hypanthium at join. Fruits cylindrical to obconical, not ribbed, 4–5-locular, 8–15 mm long, 5–12 mm diam. Calyptra scar and stemophore c. 1 mm wide, raised at c. 45°. Disc steeply depressed, 1.5–2.0 mm wide. Valves broadly triangular, obtuse, enclosed. Seeds irregular, flattened, shallowly reticulate, glossy deep red brown, 2–2.5 mm long; hilum ventral; chaff similar, angular, smaller.

Distributed from Shark Bay to Yorkkrakine Hill. Subcoastal in the north of the range, extending inland to the south, and entirely inland south of Enneabba (Fig. 21).

Three geographically separated subspecies are recognised (see Table 10 for identification).

16A. *Eucalyptus obtusiflora* DC. subsp. *obtusiflora*

Mallee, usually with a short persistent stocking of fibrous bark. Buds and fruits non-glaucous. Peduncles slender. Buds and fruits slender. Calyptra rounded (Fig. 22a, b, c).

Distributed from Shark Bay to Watheroo, in coastal regions to the north but extending inland to the east of subsp. *dongarraensis* in the south (Fig. 21).

Locally frequent but sporadic, on red sandy soils.

Conservation status: not at risk.

Selected specimens (from 24 examined): Western Australia: 10 miles [16 km] N of Murchison River on NE Coastal Highway, Beard 6738, 7 Oct 1973 (PERTH, NSW); 30 miles [48.3 km] E of Binu, Beard 6871, 19 Oct 1973 (PERTH, NSW); 25 miles [40.3 km] N and W of Yuna, Beard 6869, 10 Oct 1973

(PERTH, NSW); 11.5 km NNW of Coburn Station, *Brooker 5010 & Blaxell*, 8 Oct 1975 (CANB, NSW); 23 km NW of Strawberry on Burma Road, *Brooker 7947*, 26 Jan 1983 (CANB, NSW); Madden road NE of Gutha, *Brooker 8655*, 1 Sep 1984 (CANB, NSW); 5 km E of Highway 1 along State Barrier Fence, NE of Binu, *Brooker 8724*, 31 Oct 1984 (CANB, NSW); breakaway SSE of Mount Horner, N of Pincher's road, *Brooker 8816*, 4 Feb 1985 (CANB, NSW); corner of Kalbarri on highway, *Brooker 9464*, 8 Oct 1986 (CANB, NSW); 19.3 km W of Denham road on Useless Loop road, *Brooker 9469*, 8 Oct 1986 (CANB, NSW); 15.3 miles [24.6 km] SW of Mullewa, *Chippendale 47*, 20 Oct 1966 (CANB, NSW); White Peak, pr. Champion Bay, *Diels 3226*, 28 June 1901 (NSW); 3.9 km SE of Peter rd on Yuna rd, *Hill 2943*, 28 Aug 1988 (NSW); c. 4 miles [6.4 km] N of Watheroo, *Johnson W 20*, 10 Dec 1960 (NSW); 19.5 km south west of Denham Road on Useless Loop Road, *Johnson 9379 & B. Briggs*, 10 Aug 1991 (NSW, PERTH); 11.6 miles [c. 18.5 km] N of Murchison R Crossing on NW Coastal Highway, *Tindale 2726*, 21 Aug 1973 (NSW, PERTH).

Hybrids: *E. arachnaea* subsp. *arachnaea* × *E. obtusiflora* subsp. *obtusiflora*

Selected specimens (from 3 examined): Western Australia: c. 15 km from Three Springs on Eneabba road, *Hill 2558, Johnson, Brooker & Blaxell*, 21 Nov 1986 (NSW, PERTH).

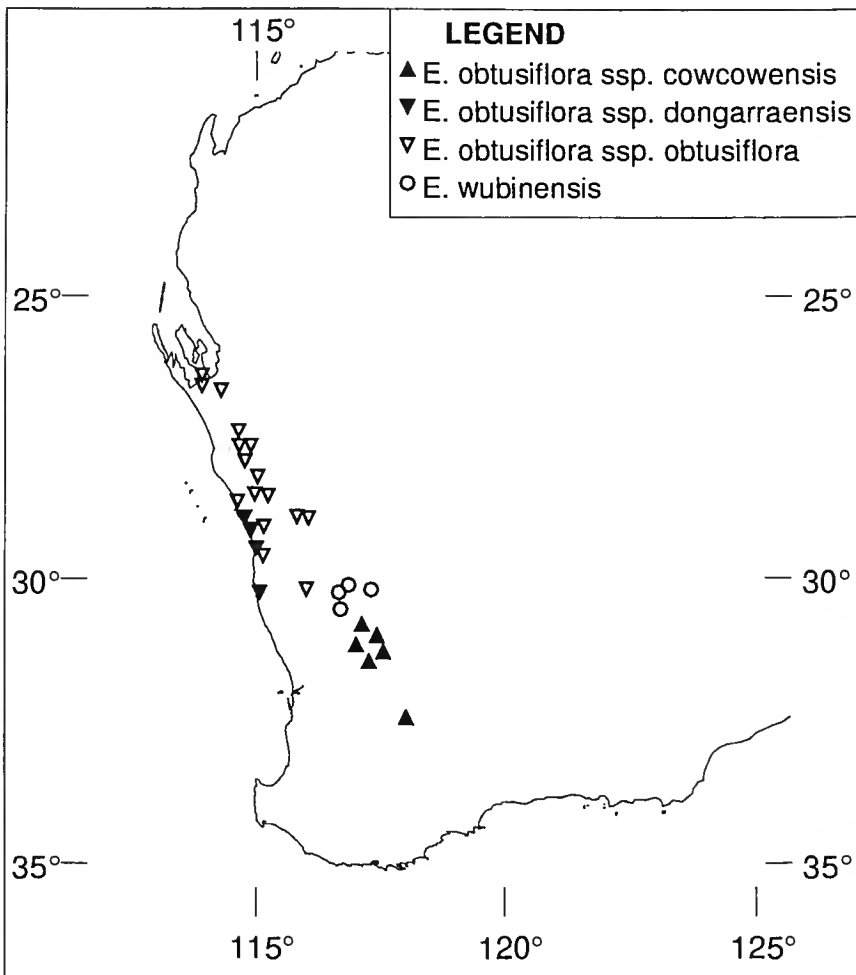


Fig. 21. Distribution of *E. obtusiflora* subsp. *cowcowensis*, *dongarraensis*, *obtusiflora*, *E. wubinensis*.

Table 10. The *E. obtusiflora* complex (all measurements in mm).

	<i>E. obtusiflora</i> subsp. <i>obtusiflora</i>	<i>E. obtusiflora</i> subsp. <i>dongarraensis</i>	<i>E. obtusiflora</i> subsp. <i>cowcowensis</i>	<i>E. wubinensis</i>	<i>E. repullans</i>	<i>E. gypsophila</i>
Habit	mallee persistent stocking	mallee smooth bark	tall mallee or tree, smooth bark	tall mallee, smooth bark	slender mallee, smooth bark	mallee persistent stocking
Substrate	red sandy soils, calcareous	calcareous coastal sands	red-brown sandy to loamy soils	yellow sand plains	red loam on rocky rises, calcareous	calcareous loam near salt lakes
Juvenile leaves	?	green	dull green	glauous	dull green	blue-grey, pruinose
Adult leaves	narrow-lanceolate to broad-lanceolate	narrow-lanceolate to broad-lanceolate	narrow-lanceolate to lanceolate	narrow-lanceolate to lanceolate	narrow-lanceolate to broad-lanceolate	lanceolate to broad- lanceolate
- size (LxB)	70-120 x 10-25	50-110 x 15-25	60-140 x 10-20	50-100 x 8-22	70-125 x 12-30	90-130 x 18-25
Petiole (L)	20-25	20-25	10-25	9-18	15-20	10-20
Peduncle	terete	terete to slightly flattened, thick	terete	terete or angular	terete or angular	terete, thick
Peduncle (L)	8-20	10-20	5-15	6-15	12-14	4-18
Pedicel	terete to slightly angular	terete to slightly flattened	terete, slightly winged	terete to slightly angular	terete	terete
Pedicel (L)	4-12	1-15	10-15	2-5	2-4	2-4
Buds	elongate-ovoid	elongate-ovoid	ovoid	ovoid	ovoid	ovoid
- size (LxB)	12-18 x 5-8	15-20 x 5-8	10-15 x 5-7	7-9 x 4-5	7-11 x 5-6	7-12 x 5-7
- glaucescence	-	+	-	-	+	-
- calyptra	hemispherical, weakly striate, 1/3 hypanthium	hemispherical, weakly striate, 1/2 hypanthium	conical, weakly striate, 1/2 hypanthium	hemispherical, weakly striate, 1/2 hypanthium	conical, ribbed	hemispherical to conical, smooth to weakly striate
- hypanthium	cupular to cylindrical	cupular	cupular to cylindrical	cylindrical	cupular to cylindrical	cupular to cylindrical
Fruits	cupular	cupular	cupular to cylindrical	cylindrical to obconical	cupular to campanulate	cupular to shortly cylindrical
- size (LxB)	10-15 x 5-10	8-15 x 5-12	10-15 x 6-10	6-8 x 5-7	6-9 x 6-9	6-10 x 6-11
- ribbing	not ribbed	not ribbed	not ribbed	not ribbed	smooth to weakly striate	smooth to weakly striate
Valves	enclosed	enclosed	enclosed	enclosed	enclosed	rim level
Umbellasters	7	7	7	7	7-9	7-11

16B. *Eucalyptus obtusiflora* DC. subsp. *dongarraensis* (Maiden & Blakely) L.A.S. Johnson & K.D. Hill, comb. et stat. nov.

Basionym: *Eucalyptus dongarraensis* Maiden & Blakely, J. & Proc. Roy. Soc. New South Wales 59: 184 (1925).

Type: Western Australia: Dongarra, J.H. Maiden, Oct 1909 (holo NSW; iso CANB, K, MEL, PERTH — 2 sheets).

Mallee. Bark smooth. Peduncles and pedicels thick. Buds and fruits broad, glaucous. Calyptra low, hemispherical (Fig. 22d, e, f).

Distributed from a short distance south of Geraldton south almost to Cliff Head (Fig. 21).

Locally frequent in dense mallee shrubland on calcareous coastal dunes.

Conservation status: not at risk.

Selected specimens (from 9 examined): Western Australia: between Georgina and Greenough, Beard 6919, 25 Oct 1973 (PERTH, NSW); Cliff Head turn-off from Highway 1, Blaxell W75/91, 7 Oct 1975 (NSW); Cliff Head road, W of Brand Highway, Brooker 8404, 23 Jan 1984 (CANB, NSW); 10 miles [16.1 km] NE from Yuna, Gardner 14263, 20 Dec 1962 (PERTH, NSW); Drovers Cave National Park, near Jurien, George 14266, 11 June 1976 (PERTH, NSW); Dongarra, Maiden s.n., Oct 1909 (NSW 42723, CANB, K, MEL, PERTH).

16C. *Eucalyptus obtusiflora* DC. subsp. *cowcowensis* L.A.S. Johnson & K.D. Hill, subsp. nov.

Inter subspecies *E. obtusiflorae* distinguitur: habitus 'malleeformis' vel arborescens; cortex laevis; nec alabastra nec fructus glauci; pedicelli longi graciles; alabastra angusta; calyptra conica, acuta.

Type: Western Australia: 3.3 miles [5.5 km] W. of Wyalkatchem, G.M. Chippendale 252, 9 Aug 1967 (holo NSW; iso CANB, PERTH).

Tall mallee or tree. Bark smooth. Buds and fruits not glaucous. Peduncles long and slender. Buds narrow. Calyptra conical, pointed (Fig. 22g, h, i).

Scattered and sporadic, from near Wongan Hills to Yorkrakine (Fig. 21).

Conservation status: not at risk.

The epithet is from the Cowcowing district of Western Australia, where this taxon occurs. The syllable 'ing' is deliberately omitted for brevity and euphony.

Selected specimens (from 13 examined): Western Australia: 4.3 km N of Dowerin on Cadoux Road, Brooker 7610, 14 Sep 1982 (CANB, NSW); 3.3 miles [5.1 km] W of Wyalkatchem, Chippendale 252, 9 Aug 1967 (CANB, NSW); 2 miles [3.2 km] S of Yorkrakine, Chippendale 335, 18 Mar 1968 (CANB, NSW); 25.3 km from Kondinin on Corrigin road, Hill 2479, Johnson & Blaxell, 15 Nov 1986 (NSW, PERTH); 38.2 km south of Koorda on Wyalkatchem road, Hill 2921, 27 Aug 1988 (NSW, CANB, PERTH); 26.7 km N of Cunderdin on Wyalkatchem rd, Johnson 9114 & Johnson, 18 May 1988 (NSW, PERTH); Cowcowing, Koch 987, Aug 1904 (NSW); Next to Ninghan location 1716, Smith 643, 13 Feb 1986 (MEL, NSW).

Intergrades: *E. obtusiflora* subsp. *cowcowensis* ↔ subsp. *obtusiflora*

Selected specimens (from 6 examined): Western Australia: W slope of Mt O'Brien, NW of Wongan Hills, Briggs 8996, 7 Oct 1992 (NSW); track to tower, Wongan Hills, Brooker 8189, 30 June 1983 (CANB, NSW); 25 km from Piawaning along road to Wongan Hills town, 1 km S of road, Crisp 5486, 26 Jan 1979 (CANB, NSW, PERTH); Wongan Hills, N slope of Mt O'Brien on track to radio tower, Hill 2933, 27 Aug 1988 (NSW).

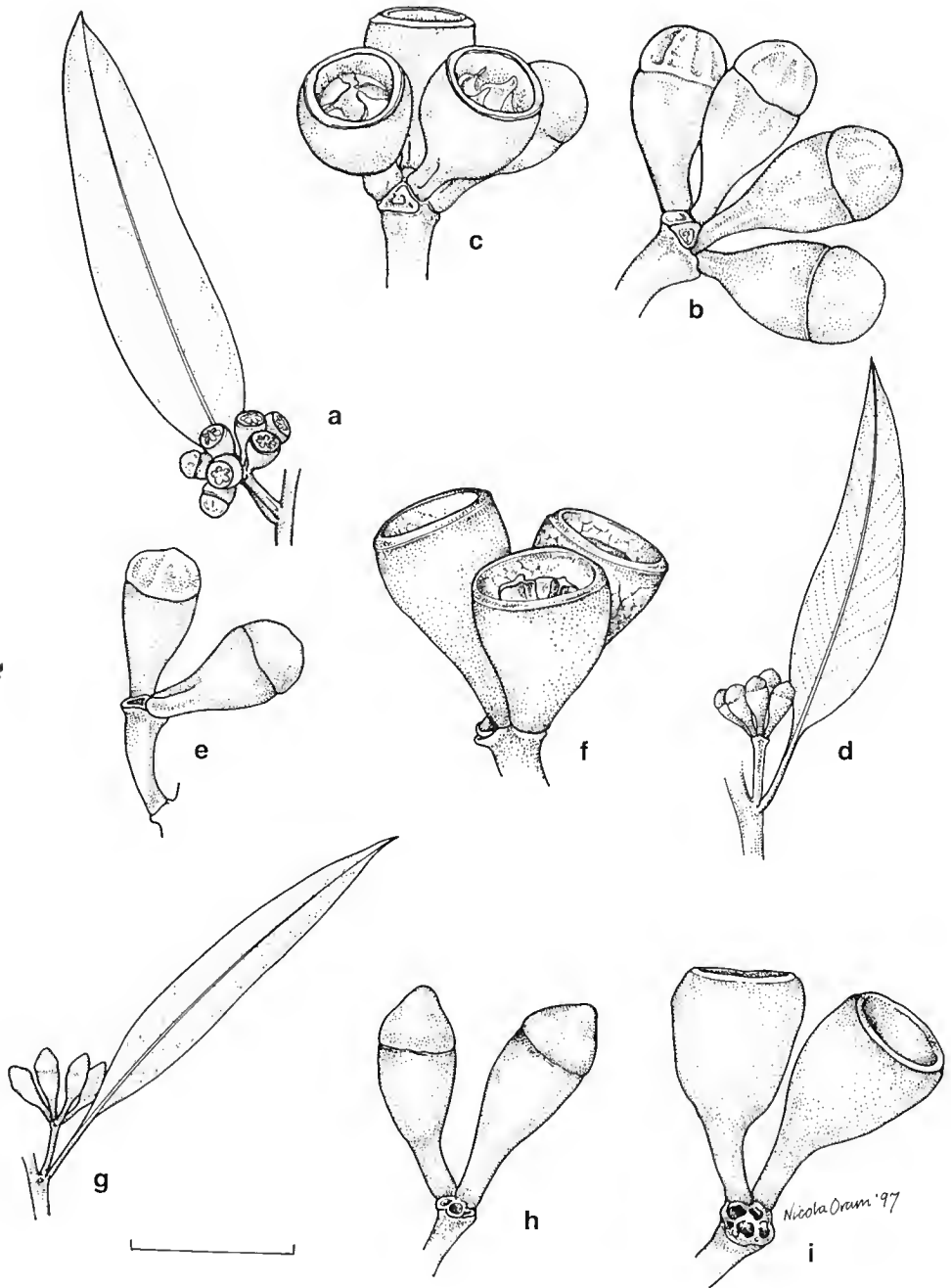


Fig. 22. *E. obtusiflora* subsp. *obtusiflora*. a, adult leaf, inflorescence and immature fruits; b, inflorescence and buds; c, inflorescence and fruits (from Johnson W20). *E. obtusiflora* subsp. *dongarraensis*. d, adult leaf, inflorescence and buds; e, inflorescence and buds; f, inflorescence and fruits (from Blaxell W75/91). *E. obtusiflora* subsp. *cowcowensis*. g, adult leaf, inflorescence and buds; h, inflorescence and buds; i, inflorescence and fruits (from Hill 2921). Scale bar = 1 cm.

17. *Eucalyptus wubinensis* L.A.S. Johnson & K.D. Hill, sp. nov.

Affinis *E. obtusiflora*, distinguitur: habitus 'malleeformis', cortex laevis non glauca; fructus parvi (ad 7 × 6 mm) non costatae.

Type: Western Australia: 6.8 km E of Rabbit Proof Fence rd along Glamoff rd, SE of Wubin, Hill 378, Johnson, Blaxell & Brooker, 26 Oct 1983 (holo NSW; iso CANB, PERTH).

Mallee to 8 m tall. Bark smooth to base, white or greyish with brown or bronze streaks, shedding in long ribbons. Twigs, buds and fruits not glaucous. Juvenile leaves disjunct, ovate to orbiculate, petiolate, glaucous, to 7 cm long, 4.5 cm wide. Adult leaves disjunct, narrow-lanceolate to lanceolate, acuminate, ± falcate, dull, mid-green to grey-green, not glaucous, 5.0–10.0 cm long, 0.8–2.2 cm wide; petioles terete or slightly flattened, 0.9–1.8 cm long. Lateral veins distinct, at 30–40° to midrib, moderately spaced; intramarginal vein distinct, 0.5–1.0 mm from margin. Umbellasters axillary, 7-flowered. Peduncles terete or angular, 6–15 mm long. Pedicels terete or angular, 2–5 mm long. Mature buds ovoid, 7–9 mm long, 4–5 mm diam.; calyptra hemispherical, weakly striate, ½ as long as hypanthium, distinctly narrower than hypanthium at join. Fruits cylindrical to obconical, not ribbed, 4–5-locular, 6–8 mm long, 5–7 mm diam. Calyptra scar and stemophore c. 1 mm wide, raised at c. 45°. Disc steeply depressed, 1.5–2.0 mm wide. Valves broadly triangular, obtuse, enclosed. Seeds irregular, flattened, shallowly reticulate, glossy deep red brown, c. 2 mm long; hilum ventral. Chaff similar, angular, smaller (Fig. 23).

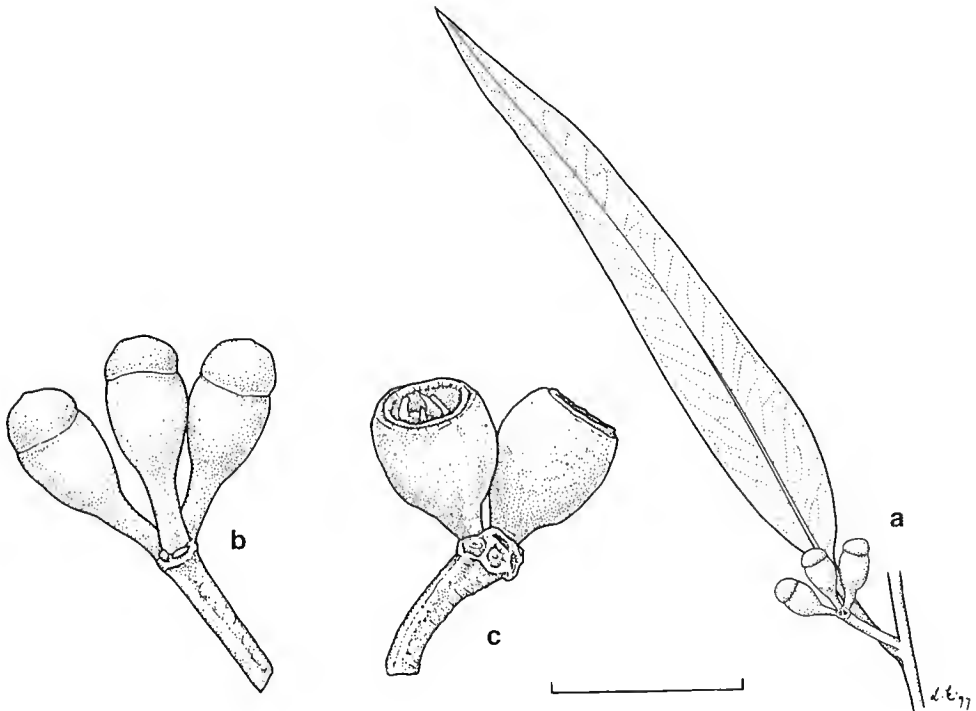


Fig. 23. *E. wubinensis*. a, adult leaf, inflorescence and buds; b, inflorescence and buds. c, inflorescence and fruits. (a, b from Hill 378, c from Brooker 8303). Scale bar = 1 cm.

Nearest to *E. obtusiflora*, from which it can be distinguished by the following combination of characters: mallee; bark smooth; juvenile leaves glaucous; buds and fruits not glaucous; fruits small (to 8 × 7 mm), not ribbed (see also Table 10). Although various of these character states are shared with the subspecies of *E. obtusiflora* in different combinations, it is the combination of characters that distinguishes this taxon.

Distributed over a restricted area from east of Wubin to Ballidu, east to Kulja (Fig. 21).

Locally frequent in mallee shrubland on yellow sandplain country. Often associated with *E. plenissima* (C. Gardner) Brooker and *E. dolichocera* L.A.S. Johnson & K.D. Hill, although about 15 other eucalypt species have been recorded as associates.

Conservation status: not at risk.

The epithet is from the occurrence in the Wubin district.

Selected specimens (from 10 examined): Western Australia: between Damboring and Ballidu, at rail crossing, 8.6 km N of Ballidu, *Brooker 7923*, 12 Jan 1983 (CANB, NSW); 6.6 km E of old rabbit proof fence on Glamoff road, E of Wubin, *Brooker 8302*, 25 Oct 1983 (CANB, NSW); on old rabbit proof fence, south of Glamoff road, *Brooker 8303*, 26 Oct 1983 (CANB, NSW); 1.3 km S of Glamoff Road on RPF [Rabbit Proof Fence] road E of Wubin, *Brooker 8429*, 25 Jan 1984 (CANB, NSW); c. 3 km SE of Karrakatta [Karrakutata] hill, *Brooker 8431*, 25 Jan 1984 (NSW); 1.2 km E of highway on Goatcher rd (N of Dalwallinu), *Hill 2938*, 27 Aug 1988 (NSW, CANB, PERTH); Watheroo Rabbit fence, *Koch 1608*, Sep 1905 (NSW).

18. *Eucalyptus assimilans* L.A.S. Johnson & K.D. Hill, sp. nov.

Affinis *E. sheathiana*, distinguitur: folia, alabastra et fructus multum majores; pedunculi pedicellique proportione longiores.

Type: Western Australia: 20.2 km W. of Balladonia Roadhouse on Highway 1 (32°15'S 123°26'E), *K.D. Hill 218 & L.A.S. Johnson*, 19 Oct 1983 (holo NSW; iso CANB, K, PERTH)

Tree to 15 m tall. Bark smooth to base, white or greyish, shed in long, broad pale brown ribbons. All parts glaucous. Juvenile leaves ovate to broad-lanceolate, markedly acuminate. Adult leaves disjunct, lanceolate, acuminate, ± falcate, dull or slightly glossy, 7.0–18.0 cm long, 1.5–4.0 cm wide; petioles terete or slightly flattened, 2.0–3.3 cm long; lateral veins indistinct, at c. 30° to midrib, moderately spaced, ± degenerate; intramarginal vein indistinct, 0.5–1.0 mm from margin. Umbellasters axillary, 7-flowered. Peduncles terete or vaguely angular, 10–22 mm long. Pedicels terete or vaguely angular, 4–8 mm long. Mature buds ovoid, c. 15 mm long and 7 mm diam. (or more); calyptra conical, convex, obtuse, slightly shorter than hypanthium. Fruits obconical, 5-locular, 9–12 mm long, 8–9 mm diam.; calyptra scar and stemonophore c. 1 mm wide, raised at c. 45°; disc depressed at c. 45°, 1.5–2.0 mm wide; valves broadly triangular, obtuse, enclosed. Seeds irregular, flattened, shallowly reticulate, glossy deep red brown, 2.5–3.0 mm long; hilum ventral. Chaff similar, angular, smaller (Fig. 24).

Scattered along the highway from the type locality west to around Newman's Rock (Fig. 25). The country away from the highway is poorly explored, and further exploration will probably extend the range of this species.

A sporadic woodland species on somewhat sandy calcareous loams in gently undulating country. Associated with *E. optima*, *E. melanoxylon*, *E. indurata* and *Triodia* sp.

E. assimilans differs from *E. sheathiana* Maiden in the much larger leaves, buds and fruits with proportionally longer peduncles and pedicels.

Conservation status: not considered to be at risk.

The epithet is from the Latin *assimilans*, a variant of *assimulans*, making like, in a sense resembling, from the species general resemblance to *E. sheathiana*.

Selected specimens (from 13 examined): Western Australia: 32.1 km NW of Balladonia towards Norseman, *Brooker 8837*, 10 Feb 1985 (CANB, NSW); On road between Norseman and Balladonia, *Carr 1237 & Carr*, 9 Sep 1969 (CANB, AD, MEL, NSW, PERTH); 20.2 km W of Balladonia roadhouse on Highway 1, *Hill 710 & Blaxell*, 14 Nov 1983 (NSW, AD, CANB, K, MEL, PERTH); 52.5 km W of Balladonia roadhouse on Highway 1, *Hill 2205 & Johnson*, 4 Nov 1986 (NSW, CANB, MEL, PERTH); 16.9 km west of Balladonia roadhouse on Highway 1, *Hill 2188 & Johnson*, 4 Nov 1986 (NSW, CANB, MEL, PERTH).

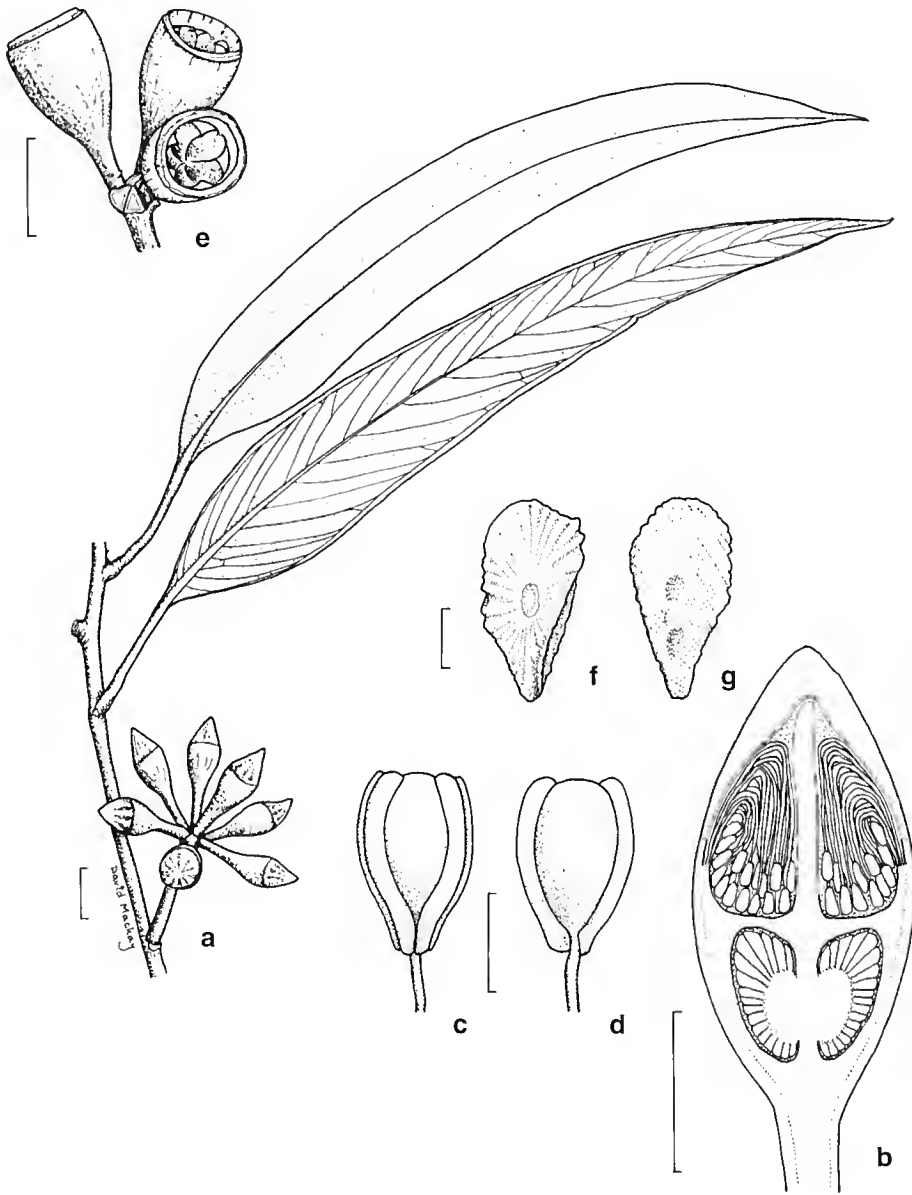


Fig. 24. *E. assimilans*. **a**, adult leaves, inflorescence and buds; **b**, longitudinal section of bud. **c**, **d**, anther; **e**, inflorescence and fruits; **f**, **g**, seed (from *Hill 218*). Scale bars: **a**, **e** = 1 cm; **b** = 5 mm; **c**, **d** = 0.5 mm; **f**, **g** = 1 mm.

19. *Eucalyptus infracorticata* L.A.S. Johnson & K.D. Hill, sp. nov.

Habitus 'malleiformis' (multicaulis); cortex in regione basali (usque ad medium trunci) persistens, quasi-fibrosa; ramuli et alabastri glauci. Affinitates aliquanto incertae, forsan *E. striatocalyx* affinis, sed calyptra laevi et hemisphaerica differt. Alternative aliquanto assimilatur *E. sheathianam* quae cortice toto laevi longe decorticanti differt.

Type: Western Australia: 8.6 km S of Queen Victoria Spring on Cundeelee track, K.D. Hill 2648 & L.A.S. Johnson, 30 Oct 1986 (holo NSW; iso PERTH).

Mallee. Bark persistent on lower to half trunk, finely fibrous-flaky, pale grey, yellow-brown under. Twigs glaucous. Juvenile leaves not known. Adult leaves disjunct, broad-lanceolate, dull, 6–11 cm long, 1.5–2.5 cm wide; petioles terete, 1.5–3.0 cm long; lateral veins distinct, regular, moderately spaced, at 30–45° to midrib; reticulation incomplete; intramarginal vein continuous, distinct, within 0.5 mm of margin. Umbellasters simple, axillary, 7–11-flowered. Peduncles terete or ribbed, 8–15 mm long. Pedicels terete or slightly angled, 2–5 mm long. Buds glaucous, pyriform, 9–10 mm long, 5–6 mm diam.; calyptra shorter than hypanthium, as wide as hypanthium and lacking any constriction at the join, not striate, hemispherical. Fruits cylindrical, 4–5 locular, 7–9 mm long, 5–6 mm diam.; calyptra scar and stemophore flat, narrow (less than 0.5 mm wide); disc initially raised but sharply incurved and depressed for most of width, 1.5–2 mm wide (Fig. 26).

Diagnosed as follows: mallee; bark persistent on lower trunk; adult leaves dull; twigs and buds glaucous. Relationships are unclear, but it may be allied to *E. striatocalyx* W.V. Fitzg., from which it is distinguished by the smooth hemispherical calyptra. Alternatively, there are resemblances to *E. sheathiana*, which differs in the wholly smooth bark shedding in long streamers.

Known only from a small population at the type locality (Fig. 27).

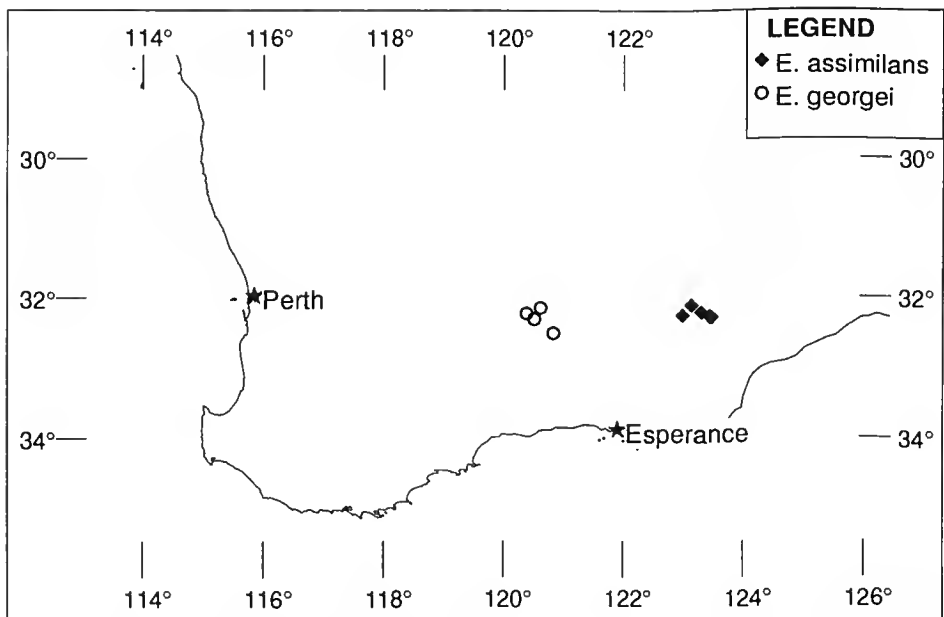


Fig. 25. Distribution of *E. assimilans*, *E. georgei*.

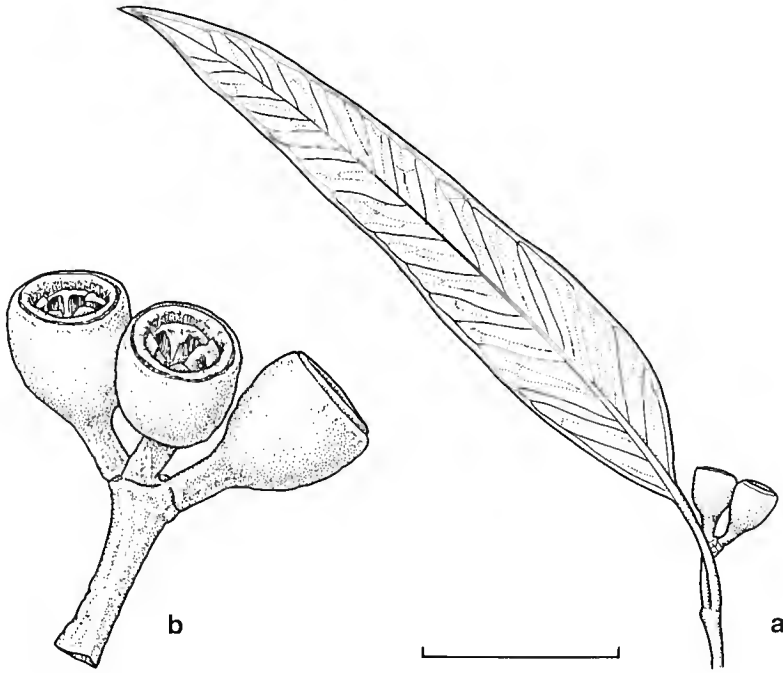


Fig. 26. *E. infracorticata*. a, adult leaf, inflorescence and fruits; b, inflorescence and fruits (from Hill 2684B). Scale bar = 1 cm.

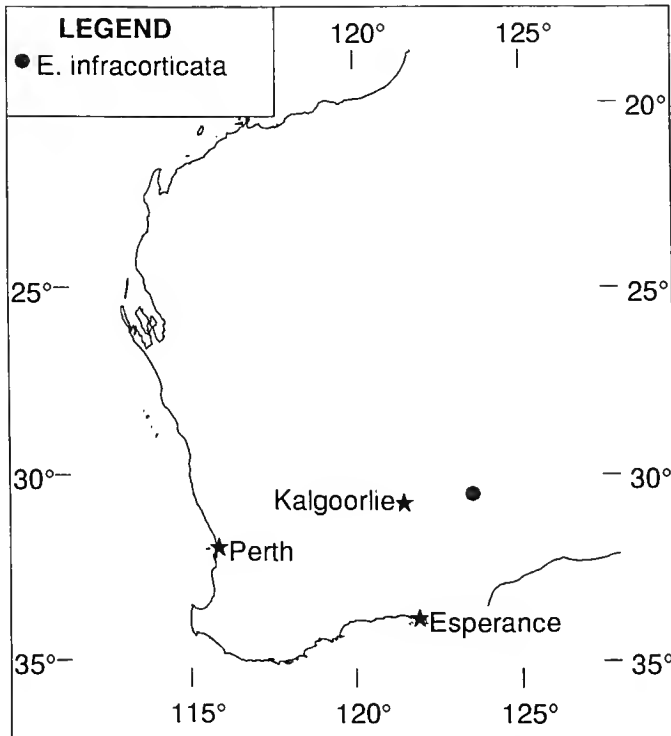


Fig. 27. Distribution of *E. infracorticata*.

This species occurs in open mallee shrubland with *Triodia* understorey on red sandy desert loam.

Conservation status: not sufficiently known (K).

The epithet is from the Latin *infra*, below, and *corticatus*, covered with bark, from the persistent bark over the lower trunk.

Specimens examined: Western Australia: 8.6 km S of Queen Victoria Spring on Cundeelee track, Hill 2684B & Johnson, 30 Nov 1986 (NSW).

The *Eucalyptus kondininensis* complex

There are four recognisable entities in this group. These could conservatively be treated as a single species, but this would take no account of differences in habitat and morphology (see Table 11). Three of the four were included in *E. polita* by Brooker and Hopper (1993), based solely on the bark differences from *E. kondininensis*. We here choose to treat them as four separate, although closely related, species. Three of the four occur in the undeveloped country east of Hyden, south of Southern Cross and west of the Coolgardie-Esperance road. They are consequently little-collected and poorly understood in the field.

20. *Eucalyptus kondininensis* Maiden & Blakely, J. & Proc. Roy. Soc. New South Wales 59: 189, (1925).

Type citation: 'Collected at Kondinin, between Bending and Gnarming, on loam flats forming open forest with *E. salmonophloia* and *E. flocktoniae* (C. A. Gardner, Nos. 1843 and 1966).'

Type: syn NSW; isosyn K (1966), MEL (1843), PERTH (1843 & 1966).

Tree to 15 m tall. Bark smooth, pale grey with grey, brown and pink streaks, shedding in long ribbons, with a clearly defined scaly black persistent stocking to up to 4 m. Juvenile leaves disjunct, ovate, subglaucous. Adult leaves disjunct, narrow-lanceolate to lanceolate, strongly glossy, 5–12 cm long, 0.7–1.5 cm wide; petioles slightly channelled, 1.0–2.0 cm long; lateral veins indistinct, regular, at 30–40° to midrib; intramarginal vein indistinct, continuous, within 1 mm of margin. Inflorescences simple, axillary. Umbellasters 7-flowered. Peduncles angular, 4–10 mm long. Buds and fruits sessile or shortly pedicellate, pedicels to 2 mm long. Mature buds ovoid to fusiform, 6–8 mm long, c. 4 mm diam.; calyptra conical, often distinctly apiculate, about as long as hypanthium, as wide as hypanthium, but slightly narrowed at junction, distinctly regularly ribbed; hypanthium indistinctly ribbed or smooth. Fruits cup-shaped to obconical, 3–4-locular, 4–6 mm long, 4–6 mm diam.; calyptra scar and stemonophore slightly raised, less than 0.5 mm wide; disc level or slightly depressed, ultimately incurved, c. 1 mm wide; valves broadly triangular, rim-level (Fig. 28).

Diagnosed as follows: tree with a clearly defined black stocking of persistent bark; leaves glossy; buds and fruits not glaucous; fruits conical to cup-shaped, sessile or subsessile (see also Table 11). Fruits tend to be pedicellate and conical in the north of the range, becoming cup-shaped and sessile in the south.

Known from the Kondinin district to Lake Magenta and Lake King (Fig. 29).

Restricted to low sites on heavy pale grey calcareous loams, often near salt lakes.

E. kondininensis is a 'blackbutt', but its affinities are not with the other blackbutt taxa in the *Obtusiflorosae*, *E. clelandii* and *E. lesouefii* (which are related rather to *E. striatocalyx*), but with *E. redimiculifera* and its allies.

Conservation status: not considered to be at risk.

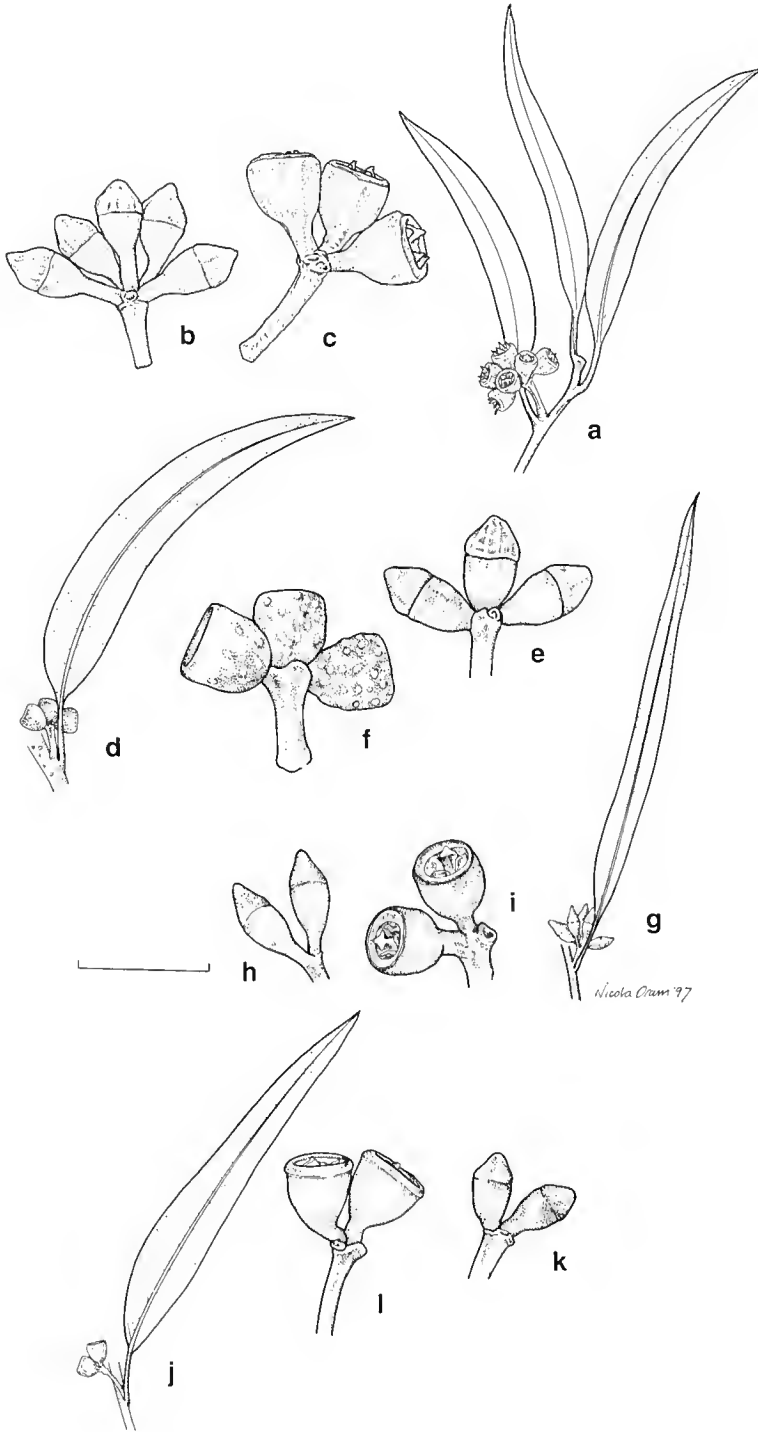


Fig. 28. *E. polita*. a, adult leaf, inflorescence and fruits; b, inflorescence and buds; c, inflorescence and fruits (from Johnson 9099B). *E. paralimnetica*. d, adult leaf, inflorescence and buds; e, inflorescence and buds; f, inflorescence and fruits (from Crisp 5954). *E. redimiculifera*. g, adult leaves, inflorescence and fruits; h, inflorescence and buds; i, inflorescence and fruits (from Gardner 11153). *E. kondimnensis*. j, adult leaf, inflorescence and fruits; k, inflorescence and buds; l, inflorescence and fruits (from Gardner 1843). Scale bar: a, d, g, j = 3 cm, b, c, e, f, h, i, k, l = 1 cm.

Selected specimens (from 26 examined): Western Australia: ca. 1 miles [1.6 km] east of Buniche, *Brooker 2278*, 5 Nov 1969 (PERTH, NSW); 32.2 km west of Hyden towards Kondinin, *Brooker 8362*, 8 Nov 1983 (CANB, NSW); E side of Lake Magenta, on track, *Brooker 8779*, 14 Jan 1984 (CANB, NSW); 19.8 km north-west of Varley turnoff towards Hyden, *Brooker 8889*, 13 Mar 1985 (CANB, NSW); Lake Pallarup, south side, *Brooker 8895*, 21 Mar 1985 (CANB, NSW); Soldiers Road, E of Narembeen, *Brooker 9635*, 8 May 1987 (CANB, NSW); 9.3 km from Brookton to Corrigin Road on Quairading Road, *Brooker 9710*, 15 July 1987 (CANB, NSW); 2.7 km from Wickepin towards Pingelly, *Brooker 9830*, 16 Dec 1987 (CANB, NSW); 1 km N of Lake Bryde Road on Needilup Road, *Brooker 10006*, 21 July 1988 (CANB, NSW); corner Tincurrin Nth Road and Stock Route 3, c. 20 km W of Harrismith, *Brooker 10141*, 12 Dec 1988 (CANB, NSW); 1.5 miles [2.4 km] E of Newdegate, *Chippendale 226*, 17 Mar 1967 (CANB, NSW); S side of Kondinin township, *Chippendale 260*, 10 Aug 1967 (CANB, NSW); 8 km W of Lake Grace town, E edge of Lake, *Crisp 5541, 5542*, 28 Jan 1979 (CANB, NSW, PERTH); Kondinin, *Gardner 1843*, 30 Oct 1922 (PERTH, NSW); Pingrup, *Gardner 10310*, 22 Feb 1952 (PERTH, NSW); 3.4 km W of Lake King township on rd to Lake Grace, *Hill 320, Johnson & Blaxell*, 22 Oct 1983 (NSW); 31.8 km W of Hyden on rd to Kondinin, *Hill 642*, 8 Nov 1983 (NSW); 0.9 km S of Brookton to Corrigin rd on Dudinin rd, *Hill 2984*, 31 Aug 1988 (NSW); S side of Lake Varley, 6.7 km W of Lake King to Hyden rd on Holt Rock to Kulin rd, *Johnson 9186 & B. Briggs*, 1 Nov 1988 (NSW, CANB).

21. *Eucalyptus polita* Brooker & Hopper, *Nuytsia* 9: 51 (1993).

Type: Western Australia: 62.7 km west of Mt Day road on Hyden-Norseman track (32°21'S 119°54'E), *M.I.H. Brooker 8361*, 7 Nov 1983 (holo PERTH; iso AD, CANB, MEL, NSW).

Tree to 12 m tall. Bark smooth, pale grey and pink, shed in long ribbons, with a irregular scaly black persistent stocking on older plants. Juvenile leaves disjunct, ovate, subglaucous, to 7 cm long, 4 cm wide, petioles to 1.5 cm long. Adult leaves

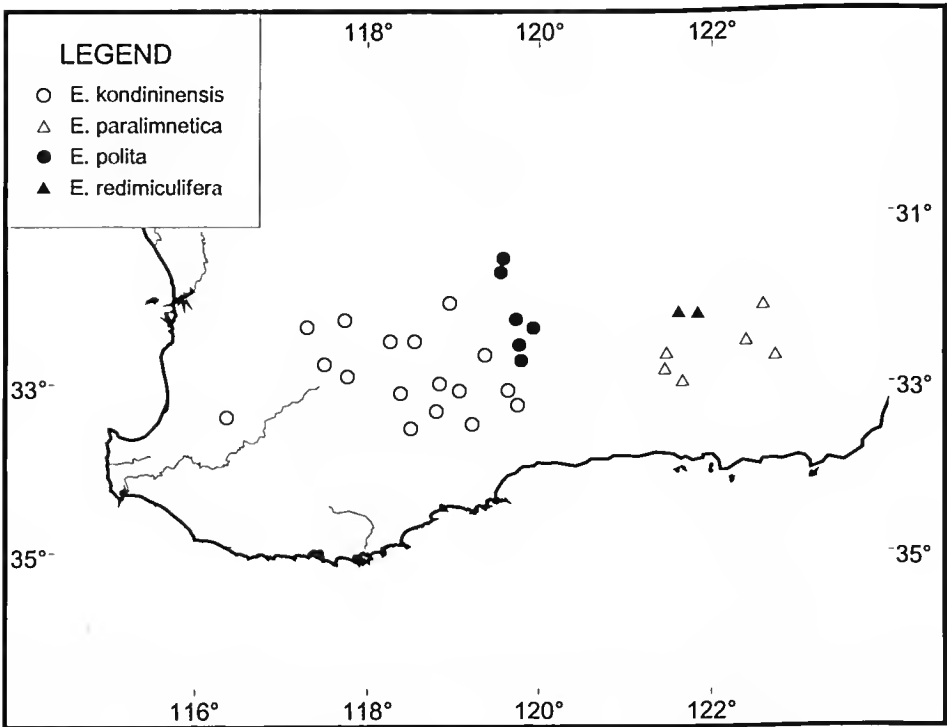


Fig. 29. Distribution of *E. kondininensis*, *E. paralimnetica*, *E. polita*, *E. redimiculifera*.

disjunct, lanceolate, strongly glossy, 5–10 cm long, 0.8–1.8 cm wide; petioles slightly channelled, 0.7–1.8 cm long; lateral veins indistinct, regular, at 30–40° to midrib; intramarginal vein indistinct, continuous, within 1 mm of margin. Inflorescences simple, axillary. Umbellasters (3-)7-flowered. Peduncles angular, 5–10 mm long. Buds and fruits sessile. Mature buds ovoid, 6–8 mm long, 4–5 mm diam.; calyptra inflated conical, about as long as or slightly shorter than hypanthium, as wide as hypanthium or slightly wider, but slightly narrowed at junction, distinctly regularly ribbed; hypanthium smooth to indistinctly ribbed. Fruits obconical to campanulate, 3-4-locular, 4–7 mm long, 4–6 mm diam.; calyptra scar and stemonophore slightly raised, less than 0.5 mm wide; disc level or slightly depressed, ultimately incurved, c. 1 mm wide; valves broadly triangular, rim-level or with remnants of style exerted (Fig. 28).

Diagnosed as follows: tree; bark smooth or persistent in a short stocking; adult leaves glossy; fruits conical to campanulate, sessile (see also Table 11).

The circumscription by Brooker and Hopper in the protologue included the taxa described below as *E. redimiculifera* and *E. paralimnetica*, and the illustrations more reflect these taxa than *E. polita*. Distinguishing features of *E. redimiculifera* and *E. paralimnetica* are given below and in Table 6.

Known from the Forrestania district and some distance north and east of there (Fig. 29). The known distribution is very sporadic in poorly-explored country, and this taxon is probably more widespread.

Locally abundant but restricted in extent, in mallet woodlands on red lateritic loam or clay-loam. This contrasts to the habitat of *E. kondininensis*, usually on calcareous substrates, often around salt pans.

Conservation status: rare, although not under immediate threat (2R).

Selected specimens (from 9 examined): Western Australia: 10 km S of Marvel Loch (SE of Southern Cross) on road to Hyden, *Blaxell 1728, Pryor & J. Briggs*, 13 Sep 1978 (NSW, PERTH); 62.7 km west of Mt Day road on Hyden to Norseman track, *Brooker 8361*, 7 Nov 1983 (CANB, NSW); 0.7 km S of Cross-roads, E of Hyden, *Brooker 9570*, 28 Jan 1987 (CANB, NSW); 187 km W of Norseman to Coolgardie rd on track to Hyden, *Hill 637, Johnson, Blaxell, Brooker & Hopper*, 7 Nov 1983 (NSW); 184.5 km W of Norseman to Coolgardie rd on Hyden track (13.3 km E of crossroads), *Hill 2877*, 26 Aug 1988 (NSW); 8.4 km N of Coolgardie to Hyden rd on Varley to Southern Cross rd, *Hill 2883*, 26 Aug 1988 (NSW); 91.6 km north of Coolgardie to Hyden road on Varley to Southern Cross road, *Hill 2906*, 26 Aug 1988 (NSW, CANB, PERTH); 7.8 km east of Rabbit Proof Fence on Varley to Southern Cross road, *Hill 3054*, 1 Sep 1988 (NSW, CANB, PERTH); 13.5 km N of Varley crossroads on Southern Cross rd, *Hill 3061*, 1 Sep 1988 (NSW); 98.5 km east of Hyden on Hyden to Norseman road (ie 11.7 km east of Crossroads), *Johnson 9099B & Johnson*, 17 May 1988 (NSW, PERTH).

22. *Eucalyptus paralimnetica* L.A.S. Johnson & K.D. Hill, sp. nov.

Arbor; cortex toto laevis, longe decorticans; folia adulta nitida, linearia ad angustolanceolata; fructus cupuliformes brevipedicellati.

Type: Western Australia: 8.3 km from highway on Peak Charles road (32°46'S 121°28'E), *K.D. Hill 2318, L.A.S. Johnson & D.F. Blaxell*, 8 Nov 1986 (holo NSW, iso CANB, MEL, PERTH).

Tree to 10-m tall. Bark smooth, pale pink-grey, shed in long ribbons. Juvenile leaves disjunct after node 6, ovate, becoming narrow-lanceolate by node 8, subglaucous. Adult leaves disjunct, linear to narrow-lanceolate, strongly glossy, 5–10 cm long, 0.5–1.1 cm wide; petioles slightly channelled, 1.0–1.5 cm long; lateral veins indistinct, regular, at 40–50° to midrib; intramarginal vein indistinct, continuous, within 0.5 mm of margin. Inflorescences simple, axillary. Umbellasters 7-flowered. Peduncles angular,

5–8 mm long. Pedicels angular, 1–4 mm long. Mature buds ovoid, 6–7 mm long, c. 3 mm diam.; calyptra inflated conical, about as long as hypanthium, as wide as hypanthium but slightly narrowed at junction, distinctly regularly ribbed; hypanthium indistinctly ribbed. Fruits cup-shaped, 3–4-locular, 4–5 mm long, 4–5 mm diam.; calyptra scar and stemonophore slightly raised, less than 0.5 mm wide; disc level or slightly depressed, ultimately incurved, c. 1 mm wide; valves broadly triangular, rim-level (Fig. 28).

Diagnosed as follows: tree; bark wholly smooth; adult leaves strongly glossy; fruits cup-shaped, shortly pedicellate (see also Table 11).

At present known from a band of country from around Peak Charles to the southern extension of the Fraser Range (Fig. 29). Known distribution is very sporadic but in remote country, and future extensions of range are likely.

A locally common species in open woodland on pale brown calcareous loam, often at the edges of salt pans.

Conservation status: not considered to be at risk.

The epithet is from the Greek, *para*, beside, and *limneticos*, relating to lakes, in reference to the occurrence adjacent to salt lakes.

Selected specimens (from 8 examined): Western Australia: on Telegraph line, S of Fraser Range W of Norseman, *Beard* 6317, 13 Sep 1970 (KPBG, NSW); between Clear Streak and Double Tank on an old track from Fraser Range to Esperance, *Beard* 6325, 13 Sep 1970 (KPBG, NSW); c. 109 km W of Balladonia (81.5 km E of Norseman), *Brooker* 6458, 22 Aug 1979 (CANB, NSW); c. 55 km SSW of Norseman, 5 km from highway towards Peak Charles, *Crisp* 5954, 20 Sep 1979 (CANB, MEL, NSW, PERTH); 107.6 km W of Balladonia roadhouse on highway, *Hill* 2832, 24 Aug 1988 (NSW, CANB, PERTH).

23. *Eucalyptus redimiculifera* L.A.S. Johnson & K.D. Hill, sp. nov.

Arbor; cortex toto laevis; folia adulta obscura vel plus minusve nitida; ramuli, alabastra et fructus aliquantulo pruinosi; alabastra distincte pedicellata; fructus mediocres (ad 7 × 6 mm), ovoidei.

Type: Western Australia: 5.6 km west of highway on track turning off 11 km north of Norseman, *K.D. Hill* 589, *L.A.S. Johnson*, *D.F. Blaxell*, *M.I.H. Brooker* & *S.D. Hopper*, 6 Nov 1983 (holo NSW; iso CANB, PERTH).

Tree to 10 m tall. Bark smooth, white, pale grey and pink, shed in long ribbons. Juvenile leaves disjunct, broad-lanceolate, subglaucous, to 9 cm long, 2.5 cm wide, petioles to 0.8 cm long. Branchlets, buds and fruits weakly pruinose. Adult leaves disjunct, lanceolate, dull to semi-glossy, 4–10 cm long, 0.6–1.2 cm wide; petioles slightly channelled, 0.7–1.8 cm long; lateral veins indistinct, regular, at 30–50° to midrib; intramarginal vein indistinct, continuous, within 0.5 mm of margin. Inflorescences simple, axillary. Umbellasters 7-flowered. Peduncles angular, 4–11 mm long. Pedicels 2–4 mm long. Mature buds ovoid, 6–7 mm long, c. 4 mm diam.; calyptra hemispherical, slightly shorter than hypanthium, as wide as hypanthium slightly narrowed at junction, distinctly regularly ribbed; hypanthium indistinctly ribbed. Fruits ovoid, 3–4-locular, 5–7 mm long, 5–6 mm diam.; calyptra scar and stemonophore slightly raised, c. 1 mm wide; disc level or slightly depressed, c. 1 mm wide; valves broadly triangular, steeply raised, tips vertically exerted but fragile and usually broken at rim-level (Fig. 28).

Diagnosed as follows: tree; bark wholly smooth; adult leaves dull to semiglossy; slight pruinosity present on twigs, buds and fruits; buds distinctly pedicellate; fruits medium (to 7 × 6 mm), ovoid (see also Table 11).

Table 11. The *E. kondininensis* complex (all measurements in mm)

	<i>E. kondininensis</i>	<i>E. polita</i>	<i>E. redimiculifera</i>	<i>E. paralimnetica</i>
Habit	tree	tree	tree	tree
Bark (stocking)	+	+	–	–
Juvenile leaves	ovate	ovate	broad-lanceolate	broad-lanceolate
Adult leaves	glossy	glossy	dull semi-glossy	glossy
- size (L×B)	50–120 × 7–15	50–100 × 8–18	40–100 × 6–15	50–100 × 5–11
Pruinosity	–	–	+	–
Petiole (L)	10–20	7–18	7–18	10–15
Peduncle (L)	4–10	5–10	4–11	5–8
Pedicel (L)	0–2	0	2–4	1–4
Buds				
- size (L×B)	6–8 × 4	6–8 × 4–5	6–7 × 4	6–7 × 3
Fruits	cup to conical	conical to campanulate	ovoid	cup
- size (l×b)	4–6 × 4–6	4–7 × 4–6	5–7 × 5–6	4–5 × 4–5

Gardner had distinguished this species as new and a specimen with his manuscript name 'redimiculiphloia' is in NSW (*Gardner 11153*). Since Gardner's name is a mixture of Greek and Latin, we have coined the new name 'redimiculifera', from the Latin, *redimiculum*, a band or fetter, and *-fera*, bearing, referring to the 'bracelets' of shed bark encircling the twigs and smaller branches

Known from a few scattered populations near Norseman (Fig. 29).

Locally abundant in open woodland on heavy, calcareous loams.

Conservation status: restricted in occurrence and apparently nowhere in large stands, although no immediate threat is evident (2R).

Selected specimens (from 9 examined): Western Australia: ca. 6 miles [9.6 km] by road from the Norseman to Coolgardie road, 6.6 miles [10.6 k] from Norseman, *Brooker 4539*, 6 Apr 1974 (CANB, NSW); 5.5 km W of highway on track 15 km S of Hyden turnoff, *Brooker 7060*, 9 Nov 1981 (CANB, AD, MEL, NSW, PERTH); 5.6 km W of Coolgardie to Norseman road, *Brooker 8349*, 6 Nov 1983 (CANB, NSW); 8 miles [12.8 km] NW from Norseman, *Gardner 11153*, 6 Nov 1953 (CANB, NSW).

Acknowledgments

Thanks are due to Leonie Stanberg, who has provided extremely valuable technical and editorial assistance throughout the project, and prepared the maps. Also David Mackay, Nicola Oram and Lesley Elkan who prepared the illustrations, and Peter Wilson for editorial advice and assistance with Latin diagnoses, as well as an anonymous referee for helpful critical comments.

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Manuscript received: 6 Jan 2000

Manuscript accepted: 1 Nov 2000

Acacia dealbata subsp. *subalpina* (Fabaceae: Mimosoideae), a new subspecies from south-eastern Australia

Phillip G. Kodela and Mary D. Tindale

Abstract

Kodela, Phillip G. and Tindale, Mary D. (National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquaries Road, Sydney NSW 2000, Australia) 2001. Acacia dealbata subsp. subalpina (Fabaceae: Mimosoideae), a new subspecies from south-eastern Australia. Telopea 9(2): 319–322. Acacia dealbata subsp. subalpina (Acacia sect. Botrycephalae), is described from south-eastern New South Wales and northeastern Victoria. It occurs at higher altitudes of the tablelands, being distinguished from subsp. dealbata mainly by its smaller stature and leaves.

Introduction

Acacia dealbata Link is often characterised as a tree up to 30 m high, with bluish grey or silvery foliage. The bipinnate leaves are hairy with orbicular jugary glands. It occurs mainly on the tablelands (south from Guyra) and western slopes (south from Mudgee) of New South Wales, as well as being widespread in Victoria and eastern Tasmania. There are naturalised records from the Mount Lofty Range, South Australia, and south-western Western Australia. At higher altitudes (mainly above 700 m) in New South Wales and Victoria there is often a shrub to small tree form with smaller leaves; this is described here as subsp. *subalpina*.

Taxonomy

Acacia dealbata Link subsp. *subalpina* Tindale & Kodela, subsp. nov.

Differt ab *A. dealbata* subsp. *dealbata* statura minore, arbusculae vel fruticis habitu ad 5 m (raro 10 m) alto, foliis 1.5–8.5 cm longis, pinnis plerumque 0.5–2.5 mm longis, pinnulis 0.7–4 mm longis, capitulis saepe aureis et floribus in capitulo 13–34.

Holotype: New South Wales: Southern Tablelands: Tinderry Mountains, 13.2 km by road ESE of Michelago, R.G. Coveny 6589, P.D. Hind & M. Parris, 2 Aug 1975 (NSW). Isotypes: A, AD, BRI, CANB, HO, K, MEL, MO, NE, NY, PERTH, UC, US, Z.

Straggly or dense, sometimes several stemmed shrub 1–3 m high or small tree to 5 m high (rarely to 10 m high); bark smooth, grey, grey-green or brown, usually mottled by lichens; branches sometimes pendulous. *Branchlets* slightly angular towards apices, becoming terete with low ridges, densely puberulous to pubescent with short and long white hairs (similar indumentum occurs on the leaves and inflorescence axes), glabrescent with age. *Young foliage-tips* white, cream-coloured or rarely yellowish. *Leaves* bipinnate, glaucous, bluish grey or silvery; petiole to 0.5 cm long, hairy; rachis (0.8–) 1–8 cm long, hairy, with an orbicular, ± tomentose jugary gland (with a round aperture) at the base of each pair of pinnae, interjugary glands absent; pinnae (4–) 6–20 (–22) pairs, 0.5–2.5 (–3) cm long (the lowermost pair of pinnae often smaller than others and sometimes only c. 0.3 cm long), hairy; pinnules (6–) 10–37 pairs, herbaceous,

narrowly oblong or oblong-elliptic, 0.7–3 (–4) mm long, (0.4–) 0.5–0.6 (–0.7) mm wide, silvery-puberulous, the upper surface sometimes \pm glabrous, the apex obtuse or subacute. *Inflorescences* in axillary and/or terminal racemes and panicles; axes often slightly zig-zagged, hairy; peduncles 1.5–4 (–5) mm long, hairy; bract at base of peduncles ovate to broadly ovate, brown, ciliolate, puberulous (sometimes only at base). *Capitula* yellow to bright yellow, 13–34-flowered, 3–8 mm diam. (when dried); bracteoles dark brown, \pm peltate or spatulate, lamina ciliolate and often with minute white hairs on upper surface, claw glabrous or with a row(s) of white hairs. *Flowers* 5-merous; calyx cupular, 0.6–1.2 mm long, dissected to c. $\frac{1}{2}$ its length, sepals white-ciliolate and often with minute white hairs especially towards apices, tube \pm glabrous except ribs often tomentulose especially towards the apex; corolla 1.1–1.6 mm long, petals acute, sometimes with a few hairs near the apex; ovary glabrous or with numerous white hairs in the upper half. *Legumes* 2–9.5 cm long, 7–12 mm wide, subcoriaceous, straight-sided or indented between the seeds, flat except convex over seeds, pruinose, glabrous. *Seeds* 2–10 arranged longitudinally in the legume, obloid to broadly obloid, 3.5–5 mm long, dark brownish black to black, dull to subglossy; areole open, same colour as rest of the seed; funicle cream-coloured to fawn, filiform, expanded into a cap-like aril.

Phenology: flowers (July–) August to November (–December); fruits November to February (–April).

Habitat: grows in sandy to clayey, often loam or stony soils, on granite, basalt, shale, sandstone and metamorphics, mainly in tall open forest, open forest, tall woodland and woodland (understorey of tall moist eucalypt forest or drier open forest, to Snow Gum woodlands), on mountain ridges, gentle to steep slopes, in gullies and near creeks.

Distribution: occurs at higher altitudes (mainly above 700 m alt. but down to 300 m alt.) of the tablelands mainly south from the Brindabella Range–Braidwood area, New South Wales, to Mt Disappointment, Victoria; common in the Snowy Mountains. There are large stands of *A. dealbata* subsp. *subalpina* on the Tinderry Mountains (near Michelago), Big Badja Mountain, the Brindabella Range and Tuross River (near the Tuross Falls).

Conservation status: occurs in several national parks and other reserves; presently not considered threatened.

Etymology: refers to the often subalpine habitat of this subspecies.

Chromosome counts: $2n = 26$, *vide* B.G. Briggs, on *M. Gray & M.D. Tindale NSW64114*, 23 Jan 1964, Bulls Head, on the road to Mt Franklin, A.C.T. (B, CANB, MO, NSW, NY, US); $3n = 39$, *vide* B.G. Briggs, on *M. Gray & M.D. Tindale NSW64113*, 23 Jan 1964, 3 miles [4.8 km] beyond Bulls Head on Mt Franklin road, A.C.T. (BRI, CANB, K, MEL, NSW). A chromosome count of $2n = 26$ has been recorded for subsp. *dealbata*, *vide* B.G. Briggs, on *E.F. Constable NSW107046* (NSW).

Notes: subsp. *subalpina* differs from subsp. *dealbata* by its smaller stature, the habit being a small tree or shrub up to 5 m (or rarely 10 m) high, generally smaller leaves (1–) 1.5–8.5 cm long with shorter pinnae, and commonly brighter yellow flower-heads often with fewer flowers.

Intermediates between the two subspecies are common in areas where subsp. *dealbata* occupies the lower mountain slopes and subsp. *subalpina* the upper slopes. This has been observed by M.D.T. at Mt Franklin, Australian Capital Territory, where subsp. *dealbata* occurs in groves as trees up to about 14 m high and subsp. *subalpina* in large stands as a bushy shrub or small tree to 3 m high. Some specimens from the Liverpool Range (e.g. Norfolk Island Ck Falls, *I.R. Telford 9829 & M.D. Crisp*, 26 Sep 1984; AD, CANB, MEL, NSW) and Barrington Tops (e.g. near Mt Polblue, *H. Salasoo 1785*; NSW)

on the Northern Tablelands of New South Wales are somewhat intermediate between the two subspecies and require further investigation in the field.

Further research could be undertaken to investigate possible edaphic and other environmental factors that might influence the characteristics (e.g. foliage size and growth habit differences) and distribution of the subspecies. For example, the reduced growth habit in subsp. *subalpina* might be a response to colder climate or shallower soils. Population studies and seedling trials would help determine whether the variation between the subspecies is continuous or if any morphological differences are genetically fixed. Some information is already available from specimens cultivated in Canberra from seed collected from near Bulls Head, Brindabella Range, which have retained the small leaf character of subsp. *subalpina* (L.D. Pryor s.n., Nov 1953, NSW107055 & 107056), and there are specimens of subsp. *dealbata* with shrub and small tree habits from higher altitudes outside the distribution range of subsp. *subalpina*. Field studies of intermediate populations may lead to a better understanding of the boundaries of the two taxa.

Key to subspecies

- 1 Leaves mostly 5–14 cm (or sometimes more) long; pinnae mostly 1.5–5.5 cm long; pinnules 1.5–6 mm long, (14–) 19–68 pairs. Capitula 22–42-flowered, pale yellow to yellow or sometimes bright yellow. Tree to 30 m high, occasionally a shrub subsp. *dealbata*
- 1* Leaves mostly 1.5–8.5 cm long; pinnae 0.5–2.5 (–3) cm long; pinnules 0.7–4 mm long, mostly 10–37 pairs. Capitula 13–34-flowered, yellow to bright yellow. Shrub or tree to 5 (or rarely 10 m) high subsp. *subalpina*

Selected specimens: New South Wales: Southern Tablelands: S of Big Badja Mtn, L.G. Adams 2962 & 2963, 4 Feb 1973 (CANB, MEL, NSW); Quidong Stn, c. 18 km W of Bombala, L.G. Adams 3953, 2 Oct 1985 (CANB, NSW); Fiery Ra., 12 miles [19.3 km] SSW of Brindabella, B.G. Briggs NSW84579, 25 Dec 1960 (NSW); Tinderry Mountains, 8 miles [12.8 km] E of Michelago, B.G. Briggs NSW84568, 26 Dec 1965 (NSW); Tinderry Ra., B.G. Briggs 2644 & 2646, 24 Mar 1969 (NSW); between Bulls Head and Bendora, N.T. Burbidge 6416, 10 July 1959 (CANB, K, NSW, PERTH); Corang R., Braidwood, E. Cheel NSW8176, June 1917 (NSW); Bendora Hut, 5 miles [8 km] SW of Bulls Head Camp, Brindabella Ra., E.F. Constable NSW44252, 29 Apr 1958 (BRI, K, MEL, NSW, PERTH); Gudgenby to Naas R., A.C.T., M. Gray 5954 (CANB, HO, MEL, NSW); Sawpit Creek, [near Jindabyne, Kosciusko Natl Park], M. Hancock 438, Jan 1992 (CANB, NSW); N of Boboyan, Rendezvous Ck district, R.D. Hoogland 6435 & 6437, 23 Sep 1959 (CANB, NSW); Tuross R., c. 2 miles [3.2 km] above Tuross Falls, L.A.S. Johnson NSW130114, 26 Apr 1968 (NSW, PERTH); 0.5 km due NE of Wyandene Caves Mtn Trig., Deua Natl Park, P.G. Kodala 119, 20 Sep 1991 (CANB, MEL, NSW); c. 21 km SSE of Captains Flat, Tallaganda State Forest, R.O. Makinson 852 & H. Streimann, 13 Sep 1991 (CANB, K, L, NSW, US); Brindabella Rd, A.C.T., H.S. McKee 7321, 25 Sep 1960 (NSW); Boboyan Rd, c. 3 miles [4.8 km] S of Gudgenby Crossing, R. Pullen 2556 & 2558, 25 Jan 1961 (CANB, NSW); c. 1 mile [1.6 km] NW of Big Badja Mill, A.N. Rodd 662 & L.A.S. Johnson, 28 Apr 1968 (A, AD, BRI, HO, K, MEL, MO, NSW, NY, US); 12 km W of Condor Creek crossing on Brindabella Rd, G.M. Stewart 224 & B. O'Shea, 18 Oct 1984 (CANB, MEL, MO, NSW); near Lake Eucumbene, M.D. Tindale 711, 8 Oct 1972 (NSW).

Victoria: Snowfields: 17 miles [27.4 km] S of Mt Hotham, B.G. Briggs NSW72257, 28 Dec 1964 (NSW); Cobberas Tingaringy Natl Park, Nunniong Plateau, F.E. Davies 666, M.J. Winsbury & S. Donaldson, 13 Nov 1988 (CANB, MEL, NSW). Eastern Highlands: Mt Disappointment, J.S. Beard 912, 3 Sep 1957 (NSW); 30 miles [48.2 km] E of Tallangatta, M. McDermott s.n., Jan 1977 (NSW). East Gippsland: Boundary Ck, 30 miles [48.3 km] by road N of Buchan, E.F. Constable 5344, 30 Oct 1964 (AD, CANB, MEL, MO, NSW, PERTH); Mt Delegate, H. van Rees 084, 25 Oct 1979 (MEL, NSW).

Acknowledgments

This research was funded by the Australian Biological Resources Study (ABRS), Canberra, the Royal Botanic Gardens and Domain Trust, Sydney, and the Janet Cosh Bequest (NSW). We are grateful to Dr B.G. Briggs for the chromosome counts and to the late Dr L.A.S. Johnson for checking the Latin diagnosis. A better understanding of the *Acacia dealbata* subspecies would be gained from the suggestions for further investigations that were provided by an anonymous referee.

Manuscript received 1 July 1999
Manuscript accepted 1 November 2000

Dillwynia rupestris (Fabaceae: Mirbelieae), a new species from the New England Tableland of New South Wales

Peter C. Jobson and Peter H. Weston

Abstract

Jobson, Peter C.^{1,2} and Weston, Peter H.¹ (¹National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW 2000, Australia, ²Dept. of Environmental Sciences, University of Technology, Sydney, Gore Hill, NSW 2065, Australia) 2001. *Dillwynia rupestris* (Fabaceae: Mirbelieae), a new species from the New England Tableland of New South Wales. *Telopea* 9(2): 323–327. *Dillwynia rupestris* Jobson and P.H. Weston, a new species from the New England Tableland of New South Wales is described along with its ecology, distribution and conservation status. *Dillwynia rupestris* closely resembles *D. acicularis*, but differs in having broader, mostly shorter leaves, mucros being paler and less conspicuous; and inflorescences having more flowers and being tightly arranged in structure.

Introduction

The 'granite country' of the New England Tableland runs for approximately 400 kilometres in length from Stanthorpe in southern Queensland to near Tamworth in central New South Wales. The communities associated with these outcrops are both diverse and significant in the number of rare and restricted taxa present (Hunter & Clarke 1998). This new species is endemic to this 'granite country'.

Dillwynia rupestris Jobson & P.H. Weston is a member of the section *Xeropetalum*. This species has been recognised informally for the last thirty years, and for the *Flora of New South Wales* treatment (Weston 1990) was called *Dillwynia* species A. Strangely, Beadle (1976) did not include it in his treatment for his *Student's Flora of North Eastern New South Wales*, although collections made in the 1960s by J.B. Williams, are housed at the N.C.W. Beadle Herbarium (NE). One of us (PCJ) has examined this species in the field and was able to make observations of its habit and habitat. We name this new species below, provide information on its distribution and ecology, and assess its conservation status. We also compare it with species that appear to be its closest relatives.

Taxonomy

Dillwynia rupestris Jobson & P.H. Weston, sp. nov.

Frutex erectus 0.5–2.5 m altus; folia ad extremitates ramulorum saepe fasciculata, teretia, leviter carinata, 0.7–2.1 cm longa, 0.7–2.1 cm lata; inflorescentia terminalis, triflora vel multiflora; bracteolae ovatae, extra pubescentes, intra glabrae marginibus grosse fimbriatis in dimidio inferiore; calyx pubescens, cinereus vel fuliginosus; fructus testaceus vel pallide rubiginosus pilis albi vestitus.

Holotype: New South Wales: Northern Tablelands: S side of Gwydir Hwy, 64.4 km ENE of Glen Innes in Gibraltar Range National Park, 29°32'20"S 152°16'08"E, P.C. Jobson 5522 & C.C. Simpson, 12 September 1998 (NSW 437843). Isotypes: AD, BRI, CANB, CHR, E, K, MEL, MO, NY, W.

[*Dillwynia* sp. A. in Weston (1990)]

Erect, single-stemmed shrub 0.5–2.5 m high. Bark slightly fissured, red-brown to dark brown becoming grey to black with age, with olive flanges (the remnants of the persistent decurrent leaf bases). Branches and branchlets with prominent flanges (from persistent decurrent leaf bases), light brown to yellow-brown, branchlets occasionally grey, with antrorse appressed white hairs 0.1–0.5 mm long, occasionally glabrous. Leaves ascending to loosely antrorse-appressed, linear, subterete, slightly keeled, covered with dirty white hairs when young, becoming glabrous with age, occasionally retaining white antrorse hairs on lower surface of the basal half of the leaf, colliculate to papillate, often clustered towards upper ends of branches; young leaves lime green; petiole 0.75–1.75 mm long, yellow; decurrent leaf bases yellow and covered with dirty white hairs, becoming glabrous with age, often colliculate at swollen apex, 0.5–2.0 mm long; lamina with a longitudinal adaxial groove, curving concavely, 0.6–1.9 cm long, 0.75–1.0 mm wide; apex mucronate, micro (0.25–)0.5–0.75 (–1.0) mm long, yellow or with brown tip; stipules present, inconspicuous, brown to black, scarious, c. 0.25 mm long. Inflorescences terminal, 3–18-flowered. Pedicels covered in silky white hairs, 1–3 mm long; peduncles absent; rachis covered in silky white hairs, 3.0–6.5 mm long. Bracts broad-ovate, c. 2 mm long, often caducous before anthesis; apex acuminate; adaxial surface covered in long, silky white to light red-brown hairs; abaxial surface glabrous, dark red-brown. Bracteoles broad-ovate, attached to pedicel 0.5–2.0 mm below calyx tube, c. 1.5 mm long; margins coarsely fimbriate in lower half; apex recurved outwards and scarious, dark brown to black; adaxial surface covered in long, silky, white to dirty white hairs; abaxial surface glabrous except for a tuft of white hairs at base, red-brown, colliculate. Buds grey with blackish lobes, upper calyx lobes deeply cucullate. Calyx grey to greyish black, often with the calyx lobes black, covered with grey to dirty white hairs, 3.5–6.0 mm long, ribs inconspicuous; calyx tube campanulate; lobes shorter than or roughly equal to tube; lower lobes broad-acute to triangular; upper lobes v-shaped notched, strongly divergent, margins with white crisped hairs. Standard with basal narrow rectangular claw and lamina broad-ovate with a shallow U-notch separating lobes; lamina concave with undulating margin, 6.0–9.0 mm long, 8.0–14.0 mm wide; lobes broad-obovate to almost circular, yellow with narrow red band (crescent) and occasional veining above claw; claw yellow, occasionally with a longitudinal groove, 2.0–3.0 mm long, 0.5–1.25 mm wide. Wings oblong to broad-obovate, completely obscuring the keel, imbricate, obtuse, occasionally emarginate towards upper margin, yellow at apex grading to rosy pink midway to base, base often cream; lamina 6.0–9.0 mm long, 3.0–5.0 mm wide; claw 2.5–3.5 mm wide. Keel linear-lanceolate in overview, spatulate in lateral view, with apex cucullate, shortly acute, yellow-green at apex grading to rosy pink or red midway to base and yellow-green at base, 4.5–6.5 mm long, 2.0–3.0 mm wide; upper margin papillate; claw c. 2 mm long. Stamens articulated onto a sessile basal ring, filaments 3.0–5.5 mm long; anthers 0.5–1.0 mm long. Gynoecium 5.0–6.5 mm long; ovary white-pubescent, 2.0–3.0 mm long; stipe glabrous c. 1 mm long; style hooked, glabrous, 2.0–2.5 mm long; stigma capitate. Pod ovoid, turgid, yellow-brown to light red-brown, covered with white, loosely appressed hairs, occasionally becoming glabrescent with age but always retaining a tuft of hairs at apex, 4.5–6.0 mm long, 3.75–5.0 mm wide; petals persistent until fruit dehiscence. Seeds ovoid, smooth, olive-brown, 2.0–2.5 mm long; aril cream.(Fig. 1).

Phenology: flowers in mid-September to early October; fruits, with seed, from late October to early February, pods persistent to March.

Distribution: known only from granite outcrops within the Gibraltar Range, and the Serpentine Nature Reserve, south of Ebor (L. Copeland, pers. comm.).

Habitat: in either shrubland bordering open forest or low heaths or in pavements of granite outcrops. The associated species found in these low heaths on granite pavements often include *Conospermum burgessiorum*, *Angophora floribunda*, *Grevillea acerata*, *Comesperma ericinum*, *Calytrix tetragona*, *Mirbelia confertifolia*, *M. speciosa* subsp. *speciosa*, *Boronia amethifolia* and *Acacia* sp. aff. *conferta*. The shrubland communities are often composed of *Eucalyptus notabilis*, *E. codonocarpa*, *Angophora floribunda*, *Acacia* spp., *Acrotriche aggregata*, *Pultenaea* sp. B (Flora of NSW), *Telopea aspera* and *Dampiera lanceolata* var. *lanceolata*.

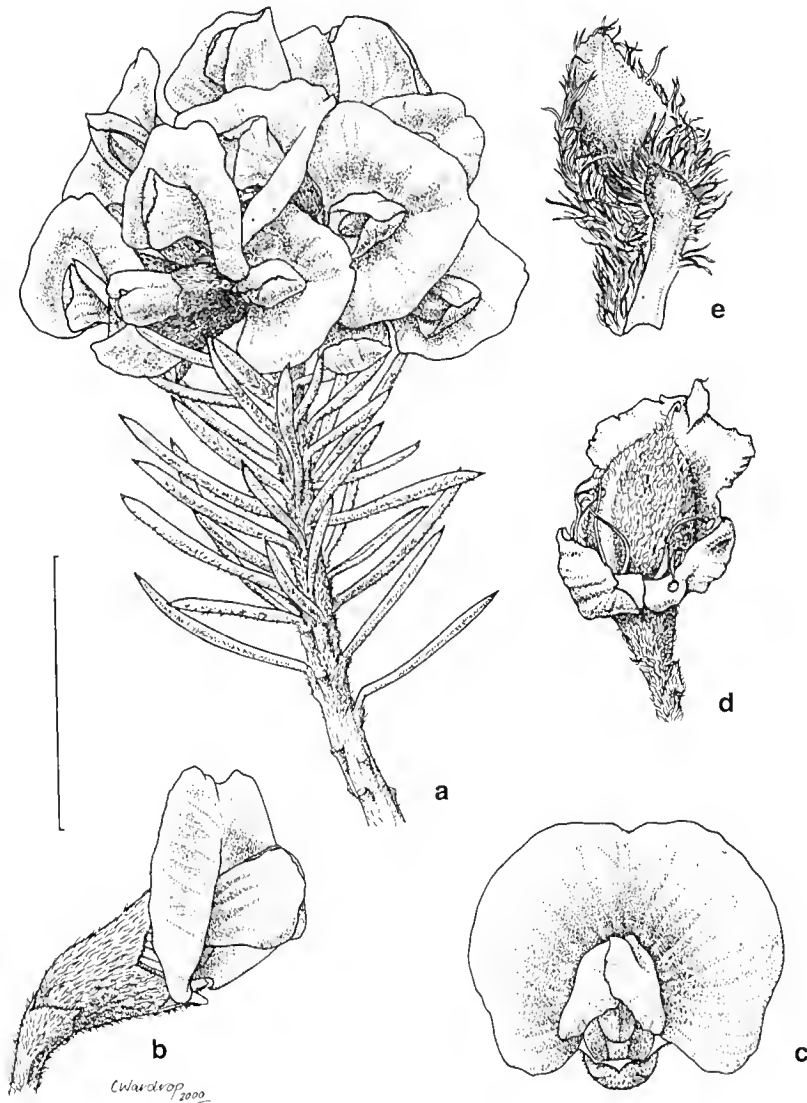


Fig 1. *Dillwynia rupestris*. a, flowering branch; b, side view of flower; c, front view of flower; d, pod; e, bract. (a, d, e from Crisp 7567 & Taylor; c and b from Jobson 5522 & Simpson). Scale bar: a = 1.5 cm; b = 2.5 mm; c-e = 1 cm.

Conservation Status: the confirmed populations of this species are wholly conserved within the Gibraltar Range National Park and Serpentine Nature Reserve. The main threat to this species is road widening; a number of individuals occur close to the Gwydir Highway. An inappropriate fire regime may also be a threat as this species appears to regenerate only from the soil seed bank. None of the individuals observed appeared to be lignotuberous. This species, because of its narrow distribution, should be coded 3RCt (Briggs & Leigh, 1996).

Etymology: the epithet *rupestris* is Latin meaning 'rocky' and refers to its preferred habitat of granite outcrops.

Notes: *Dillwynia rupestris* only came to the attention of botanists in the mid 1950s after the Gwydir Highway was constructed between Bald Knob and Jackadgery. The previous main road between Glen Innes and Grafton went through Newton Boyd and Dalmorton, some 50 kilometres south of the Gibraltar Range.

Dillwynia rupestris has long been regarded as distinct from *D. acicularis* Sieber ex DC. although obviously closely related; they can also be easily distinguished in the field. *Dillwynia rupestris* also morphologically closely resembles the Western Australian endemic *D. pungens* (Mackay ex Sweet) Benth., which also prefers granite outcrops. Table 1 compares these three species highlighting the morphological differences between them. The phylogenetic relationships of these three species are currently under study.

Table 1. Comparison of morphological characters and distribution between *Dillwynia rupestris*, *D. acicularis* and *D. pungens*.

Character	<i>Dillwynia rupestris</i>	<i>Dillwynia acicularis</i>	<i>Dillwynia pungens</i>
Habit	Stout, small tree-like shrub (single stemmed)	Slender filiform, multi-stemmed shrub	Stout, small tree-like shrub (single stemmed)
Leaves	0.6–2.1 cm long, 0.75–1.0 mm wide Mucros: 0.5–0.75 mm long, yellow or with brown tip	1.0–3.5 cm long, 0.5–0.75 mm wide Mucros: 0.5 mm long, yellow with brown tip or dark brown	1.3–2.1 cm long, 0.75–1.0 mm wide Mucros: 0.75–1.0 mm long, yellow with light brown tips
Leaf base scars	Present	Absent	Absent
Inflorescences	3–18 flowers Compact & tightly arranged	3–9 (–15) flowers Widely spaced & loosely arranged	3–9 flowers Compact & tightly arranged
Distribution & soil preference	NSW – New England Tablelands, prefers granite outcrops	NSW – Coxs Gap to Bargo, prefers sandstone screes	WA – Mt Manypeaks to Cape Arid, prefers granite outcrops

Unsuccessful attempts were made in 1997 and 1998 to find the population at approximately 56–58 km from Glen Innes along the Gwydir Highway (e.g. *Burgess s.n.* (CBG 2758) and other collections made near there in the mid 1960s). That section of the Gwydir Highway is flanked by dense eucalypt forest, heavy clay soil and no obvious granite outcrop, conditions unsuitable for *D. rupestris*.

Selected specimens examined: New South Wales: Northern Tablelands: Gibraltar Range National Park, The Needles Lookout, 1.5 km NE of Dandahra Falls, 29°31'S 152°23'E, *Crisp 7567 & Taylor*, 2 Nov 1984 (fr.)(AD, CANB, MEL, NSW); Gibraltar Range National Park, 1 km S of Boundary Trig, 29°33'S 152°16'E, *Crisp 7373 & Telford*, 30 Sep 1984 (fl.)(CANB, MEL, NSW); Gibraltar Range

National Park, c. 67 km (42 miles) E of Glen Innes, *Coveny* 2243 3 Oct 1969 (fl.) (NSW); Gibraltar Range, 61 km NE of Glen Innes, crest of high ridge, 0.4 km S of road, *J.B. Williams* s.n., 26 Dec 1985 (fr.) (NE 42596A); New Gwydir Hwy, 36 miles [58.0 km] from Glen Innes, *C. Burgess* s.n., 25 Sep 1960 (CBG 2758); Gibraltar State Forest, 35 miles [56.4 km] E of Glen Innes, *J.B. Williams* 645, 4 Oct 1958 (fl.) (NSW, UNE).

Acknowledgments

Stewart Mills and Chris Simpson assisted in collecting type material and in establishing the distributional limits of this species, Dr Jeremy Bruhl (UNE) allowed access to Chris Gentle's Honour's thesis and provided facilities at the NCW Beadle Herbarium (NE), Peter Wilson checked the Latin diagnosis and Catherine Wardrop drew the illustration. This research was funded by an Australian Biological Resources Study Research Grant.

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Manuscript received 22 February 2000

Manuscript accepted 8 February 2001

The lichen genera *Phaeographis* and *Phaeographina* (Graphidaceae) in Australia 2: *Phaeographina* — new reports and new species

Alan W. Archer

Abstract

Archer, Alan W. (Royal Botanic Gardens Sydney, Mrs Macquaries Road, Sydney 2000, Australia) 2001. The lichen genera *Phaeographis* and *Phaeographina* (Graphidaceae) in Australia 2: *Phaeographina* — new reports and new species. *Telopea* 9(2) 329–344. An account is given of the species in the lichen genus *Phaeographina* (Graphidaceae) in Australia, other than those taxa based on Australian type specimens. An additional 14 species are recognised and of these seven are described as new species: *Phaeographina atromaculata* A.W. Archer, *P. fuscescens* A.W. Archer, *P. hadrospora* A.W. Archer, *P. impudica* A.W. Archer, *P. litoralis* A.W. Archer, *P. montiscalvi* A.W. Archer and *P. wilsonii* A.W. Archer. *Phaeographina arechavaletae* Müll. Arg., *P. caesioradians* (Leight.) Redinger, *P. exilior* (Vain.) Zahlbr. and *P. utontagnei* (v.d. Bosch) Müll. Arg. are reported as new to Australia. *Phaeographina banksiae* Müll. Arg. is reported as a synonym of *P. arechavaletae* Müll. Arg. and *Phaeographina contexta* (Pers.) Müll. Arg. is shown to belong to the genus *Graphina*. The epithets 'chrysentera' and 'quassiicola' have been corrected to 'chrysenteron' and 'quassicola' respectively. A key to all the *Phaeographina* species in Australia is given.

Introduction

Part 1 (Archer 2000) dealt with species in the genera *Phaeographis* and *Phaeographina* that were based on Australian type specimens. The two genera were created by Müller to segregate species with brown ascospores from the genus *Graphis* (Müller 1882); the two genera are distinguished from each other by the septation in the ascospores, simple in *Phaeographis* and muriform in *Phaeographina*. Three new species of *Phaeographina* have recently been described (Archer & Elix 1999; Archer 2000; Archer 2001) and an additional 14 species found in Australia are described here, seven of which are new species. A key to the genus *Phaeographina* in Australia is provided.

Material and methods

This account is based on the chemical and morphological examination of type and other specimens from B, BM, BRI, CHR, GZU, H, MEL, NSW and TUR, and in particular the recent collections made by J.A. Elix, H. Streimann and D. Verdon (CANB). In addition specimens from the private herbaria of J. Hafellner (Graz), H.T. Lumbsch (Essen) and K. Kalb (Neumarkt) were examined. The techniques used were described previously (Archer 1999, 2000).

Key to the lichen genus *Phaeographina* in Australia

- 1 Ascospores densely muriform, > 75 μm long 2
 1* Ascospores not densely muriform, < 75 μm long 10
 2 Carbonised proper exciple absent 3
 2* Carbonised proper exciple present 4
 3 Lichen compounds absent; ascospores 155–212 μm long *P. hadrospora*
 3* Norstictic acid present; ascospores 100–135 μm long *P. atromaculata*
 4 Proper exciple partly carbonised 5
 4* Proper exciple completely carbonised, concealed in thalline margin 8
 5 Proper exciple laterally carbonised 6
 5* Proper exciple apically carbonised; ascospores 1/ascus, 145–180 \times 30–40 μm
 *P. muelleri*
 6 Exciple exposed; lichen compounds absent 7
 6* Exciple concealed in thalline margin; ascospores 162–200 μm long; echinocarpic acid
 present *P. echinocarpica*
 7 Exciple sulcate; ascospores 125–180 μm long *P. impudica*
 7* Exciple not sulcate; ascospores 75–100 μm long *P. caesiopruinosa*
 8 Hymenium red; disc red; ascospores 125–155(–175) μm long *P. montagnei*
 8* Hymenium hyaline 9
 9 Lirellae open; ascospores 75–100 μm long; lichen compounds absent
 *P. quassiicola*
 9* Lirellae closed; ascospores 102–130 μm long; hirtifructic acid present *P. elixii*
 10 Carbonised proper exciple present 11
 10* Carbonised proper exciple absent 13
 11 Proper exciple apically carbonised; ascospores 13–18 μm long, 4 \times 2 locular
 *P. fuscescens*
 11* Proper exciple laterally carbonised or completely carbonised; ascospores > 25 μm
 long 12
 12 Proper exciple completely carbonised; ascospores 38–53 μm long, 8–10 \times 4–5
 locular; stictic acid present *P. wilsonii*
 12* Proper exciple laterally carbonised; ascospores 25–35 μm long, 6 \times 2–3 locular lichen
 compounds absent *P. archavaletae*
 13 Ascospores 40–60 μm long, 10–14 \times 2–3 locular 14
 13* Ascospores < 40 μm long 15
 14 Proper exciple absent; lirellae open, with white pruinose disc; thalline margin thick,
 lichen compounds absent..... *P. litoralis*
 14* Proper exciple red-brown, complete; lirellae closed; thalline margin thin; stictic acid
 present *P. chryseron*
 15 Ascospores 16–18 μm long, 4 \times 2 locular *P. exilior*
 15* Ascospores 23–35 μm long, 6–8 \times 2–3 locular 16
 16 Lirellae open; lichen compounds absent *P. caesioradians*
 16* Lirellae closed; stictic acid present *P. montiscalvi*

Phaeographina species.

Phaeographina arechavaletae Müll. Arg. (Fig. 1a, 2a)

(Müller 1888a: 5).

Type: Uruguay. Montevideo, *J. Arechavaleta, s.n.*, no date (lecto G, *vide* Hayward 1977)

Phaeographina banksiae Müll. Arg.

(Müller 1893a: 59).

Type: Australia. Victoria: Maffra, on *Hymenanthera banksii*, *F.R.M. Wilson 879*, 1892 (holo G; iso NSW).

Thallus pale greenish grey, thin, corticolous, surface smooth and slightly shiny; apothecia lirelliform, black, numerous, conspicuous, sessile to slightly immersed, lips closed, becoming slightly open, straight or curved, rarely branched, 1–3(–4) mm long, 0.2–0.3(–0.4) mm wide, with a thin evanescent thalline margin; proper exciple laterally carbonised; hymenium 125–150 µm tall; ascospores 8 per ascus, pale brown, ellipsoid, (20–)24–31(–39) µm long, (10–)12–15(–17) µm wide, 4–6 × 2–3 locular.

Chemistry: no compounds found.

Distribution: occurs in Uruguay, Paraguay, Argentina, New Zealand and eastern Australia. Reported substrates in Australia include *Bursaria*, *Grevillea* and *Hymenathera*.

Notes: A comparison of the holotype of *P. arechavaletae*, the isotype of *P. banksiae*, and specimens of *P. banksiae* from Australia and *P. arechavaletae* from New Zealand (Hayward 1977) showed them to be identical. The species is characterised by a laterally carbonised proper exciple, small muriform ascospores and the absence of lichen compounds.

Specimens examined: Queensland: Upper Coomera, *Wilson 1547*, no date (NSW 438672); Goomburra Forest Park, *Everett L 603*, Sep 1984 (NSW 438469).

New South Wales: Jenolan Caves, *Wilson s.n.*, Sep 1897 (NSW 38688); Buckenbowra River estuary, 7.5 km W of Batemans Bay, *Elix 10963*, May 1983 (CANB).

Victoria: Maffra, *Wilson s.n.* (NSW 438683); Sale, *Wilson 879*, Sep 1886 (NSW 438682); bank of Yarra River, Kew, *Wilson s.n.*, Dec 1884 (NSW 438686).

New Zealand. South Island: Kaikoura, *Healy 64/99* (CHR 378244); Peel Forest, Rangitata River, *Healy 64/94* (CHR 378242); between Winchester and Geraldine, *Healy 64/504* (CHR 378243).

Phaeographina atromaculata A.W. Archer, sp. nov. (Fig. 1b, 2b)

Phaeographina nilgiriensi similis sed lirellis apertis et acido norstictico praesenti differt.

Type: Australia. New South Wales: track to Dangar falls, ca. 2 km N of Dorrigo, 30°19'30"S, 152°42'E, alt. c. 700 m, *A.W. Archer G 319*, Oct 1998 (holo NSW).

Thallus off-white, thin to evanescent, corticolous, surface smooth and dull; apothecia lirelliform, black, conspicuous, scattered, sessile, open, with a conspicuous thalline margin, elongate to substellate, 0.5–1(–1.5) mm wide; disc matt black, epruinose; proper exciple absent; hymenium 120–150 µm tall; ascospores 1 per ascus, ellipsoid, pale brown, (hyaline when immature), 100–135 µm long, 30–45 µm wide, densely muriform.

Chemistry: norstictic acid.

Distribution: the species is so far known only from the type specimen collected in New South Wales.

Notes: *Phaeographina atromaculata* is characterised by conspicuous, black, open lirellae with conspicuous thalline margins, asci with one ascospore and the presence of norstictic acid. The species somewhat resembles *P. nilgiriensis* K. Singh & Awasthi (1978) but that species has closed lirellae and lacks norstictic acid.

Etymology: The epithet *atromaculata*, is from the Latin *atro*, black and *maculata*, spotted, a reference to the conspicuous, black, scattered apothecia on the thallus.

Phaeographina caesiopruinosa (Fée) Müll. Arg. (Fig. 1c, 2c)

(Müller 1887: 49)

Arthonia caesiopruinosa Fée

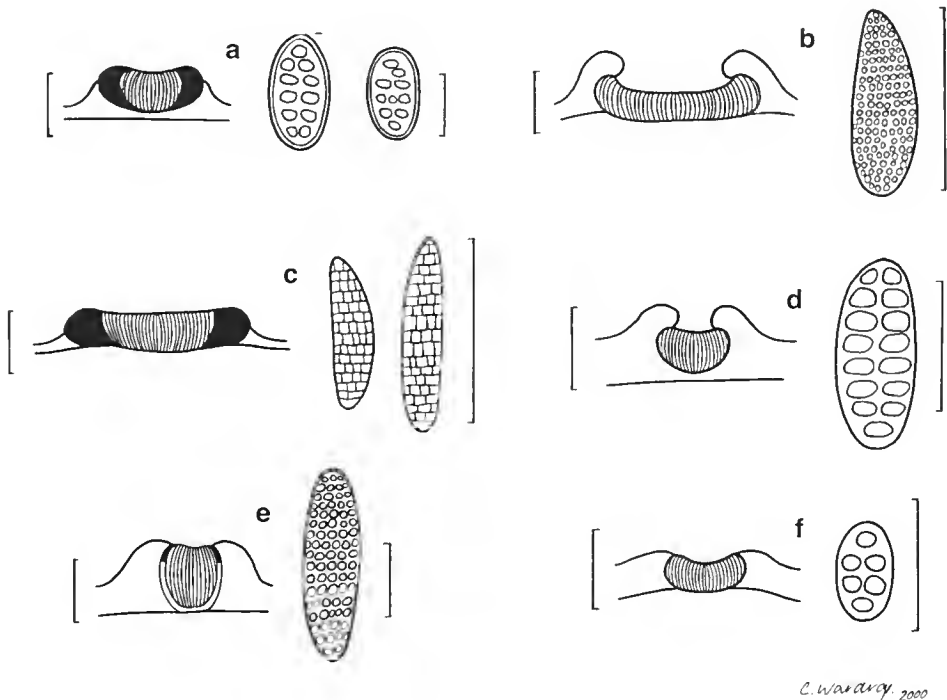
(Fée 1837: 36)

Type: South America. *s. loc.*, no collector (lecto G, *vide* Wirth & Hale 1978).

Thallus pale fawn to pale greenish fawn, thin, corticolous, surface smooth and shiny; apothecia lirelline, conspicuous, scattered or clustered, sessile, open, linear to oval or irregular in outline, 1–4 mm long, 0.3–0.6 mm wide, lacking a thalline margin; proper exciple laterally carbonised; hymenium 150–200 µm tall; disc black, densely white pruinose; ascospores elongate ellipsoid, pale brown (sometimes remaining hyaline), 75–100 µm long, 16–22 µm wide, densely muriform.

Chemistry: no lichen compounds found.

Distribution: occurs in Brazil, Mexico and Dominica, and in Australia, in Queensland. Reported substrates in Australia are *Acacia* and *Flindersia*.



C. W. Arora, 2000

Fig.1. Cross-sections of lirellae and ascospores. a, *Phaeographina archavaletae*; b, *P. atromaculata*; c, *P. caesiopruinosa*; d, *P. caesioradians*; e, *P. chrysenteron*; f, *P. exilior*; lirellae: scale bar = 200 µm; ascospores: scale bar = 20 µm (a, d, e, f); scale bar = 100 µm (b, c).

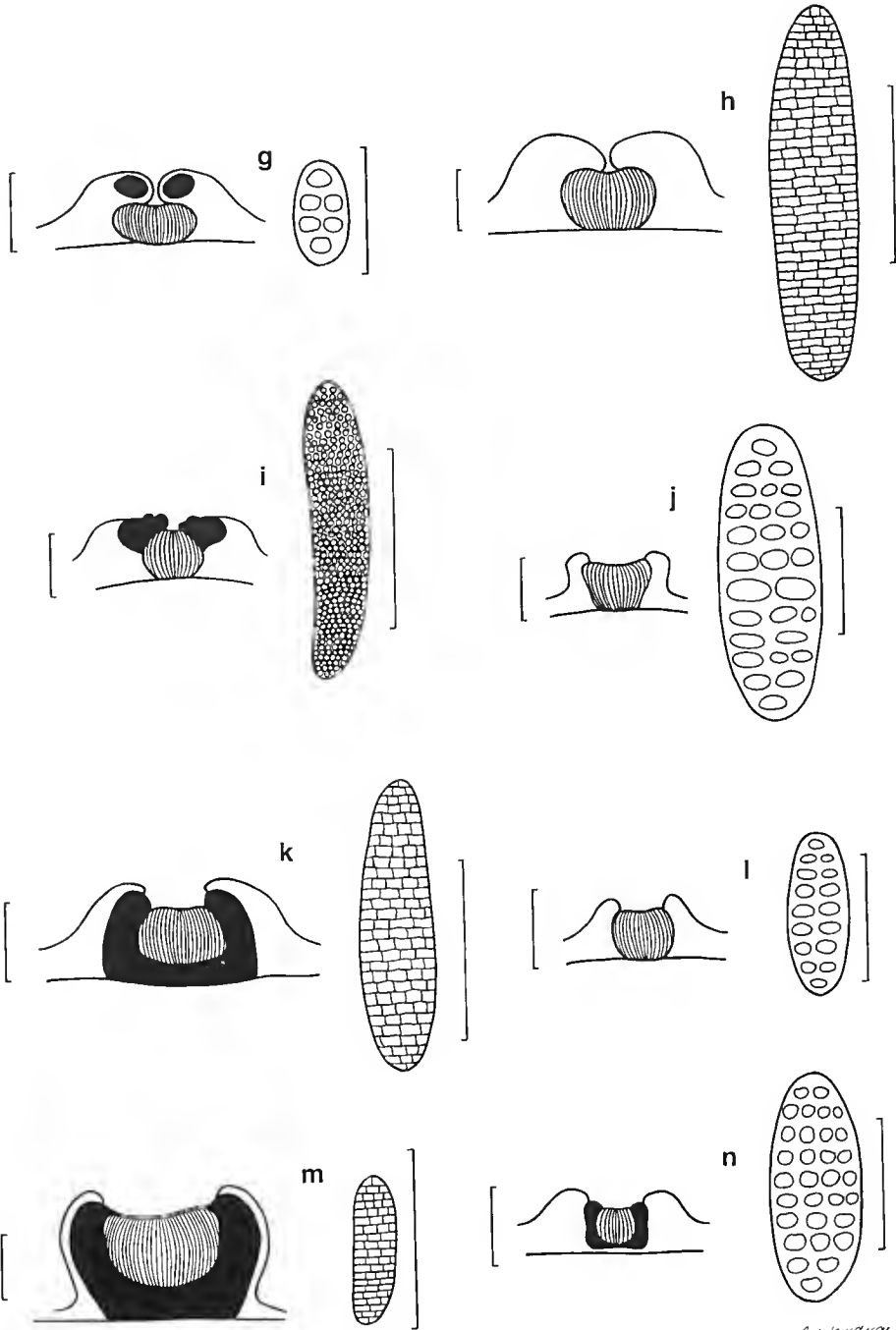
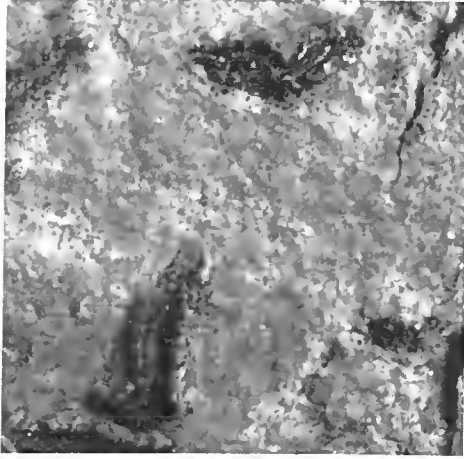
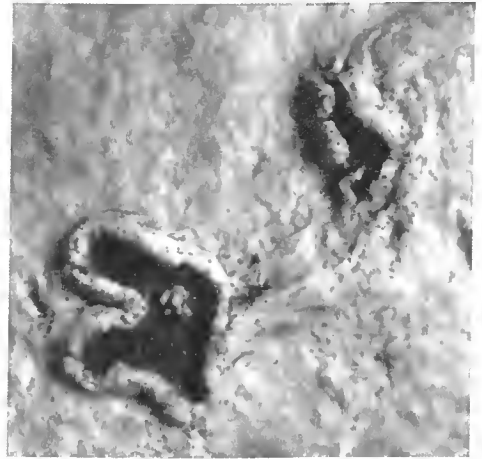


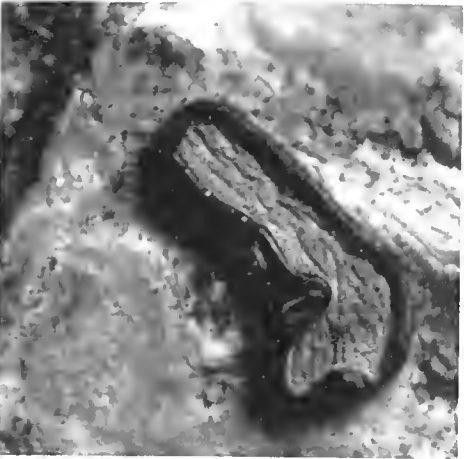
Fig. 1. cont. Cross-sections of lirellae and ascospores. **g**, *P. fuscescens*; **h**, *P. hadrospora*; **i**, *P. inopudica*; **j**, *P. litoralis*; **k**, *P. montagnei*; **l**, *P. montiscalvi*; **m**, *P. quassiiicola*; **n**, *P. wilsonii*. lirellae: scale bar = 200 μ m; ascospores: scale bar = 20 μ m (g, j, l, n); scale bar = 100 μ m (h, i, k, m).



a



b



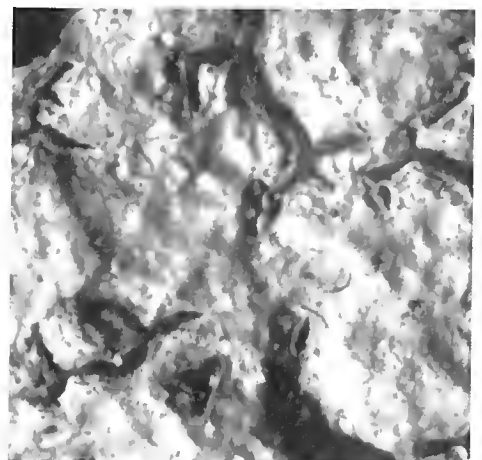
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Fig. 2. a, *Phacographina archavaletae* Müll. Arg., lectotype (G); b, *Phacographina atromaculata* A.W. Archer, holotype (NSW); c, *Phacographina caesiopruinosa* (Fée) Müll. Arg., Elix 17548 (CANB); d, *Phacographina caesioradians* (Leight.) Redinger, holotype (BM); e, *Phacographina chryseuterou* (Mont.) Müll. Arg., Elix 17505 (CANB); f, *Phacographina exilior* (Vain.) Zahlbr., holotype (TUR-V 27142). All $\times 17$.

Notes: *Phaeographina caesiopruinosa* is characterised by conspicuous open lirellae with white pruinose discs bordered by the black exciple, the large muriform ascospores and the absence of lichen compounds. The ascospores are initially hyaline and may remain so for sometime (Redinger 1933) before becoming pale brown to brown. Specimens with hyaline muriform ascospores may be mistaken for *Graphina* species but old, brown, shrivelled ascospores are also usually present in *Phaeographina* specimens. The recent specimen from Brisbane (cited below) has hyaline ascospores but the older specimens from Kuranda and Mt French have pale brown ascospores; otherwise the three specimens are morphologically and chemically identical. *Phaeographina caesiopruinosa* was first reported from Australia by Müller (1891). In a recent examination of Bailey's specimen (BRI 492631), on which Müller based his report, no ascospores were found although the specimen superficially resembled *P. caesiopruinosa*.

Specimens examined: Queensland: Mt French, 6 km SW of Boonah, *Verdon 5181*, Jan 1983 (CANB); Black Mountain, 25 km NW of Kuranda, *Elix 17548*, Jul 1984 (CANB); Ennogara Dam, c. 10 km WNW of Brisbane, *Stevens s.n.*, Nov 1999 (herb. Stevens).

Phaeographina caesioradians (Leight.) Redinger (Fig. 1d, 2d)

(Redinger 1933: 99).

Graphina caesioradians (Leight.) Mull. Arg.

(Müller 1894: 92).

Graphis caesioradians Leight.

(Leighton 1869: 176).

Type: Ceylon [Sri Lanka]: Central Province, *G.H.K Thwaites CL 71* (holo BM).

Phaeographina caesiohians (Nyl.) Redinger

(Redinger 1936a: 100).

Graphis caesiohians (Nyl.) Zahlbr.

(Zahlbruckner 1923: 296).

Fissurina caesiohians Nyl.

(Nylander 1891: 13).

Type: North Borneo. Labuan: *s. loc. E. Almquist s.n.* (holo H-NYL).

Thallus pale olive green, thin, corticolous, surface smooth and shiny; apothecia lirelliform, conspicuous, numerous, scattered, straight, curved or sinuous, often branched, sessile, lips open, disc white pruinose, with a conspicuous thalline margin, 1–4 mm long, 0.3–0.4 mm wide; carbonised proper exciple absent, or rarely weakly apically carbonised; hymenium 75–100 µm tall; ascospores 8 per ascus, pale brown, ellipsoid, 23–35 µm long, 10–13 µm wide, 6–8 × 2–3 locular.

Chemistry: no lichen compounds found.

Distribution: occurs in Brazil, Labuan, Sri Lanka and Hawaii; in Australia it is found in the Northern Territory and northern Queensland. The only reported substrate in Australia is *Alphitonia*.

Notes: *Phaeographina caesioradians* is characterised by open lirellae with a conspicuous thalline margin, small ascospores and the absence of both a carbonised exciple and any lichen compound. These features distinguish the species from the new species *P. montiscalvi* which has closed lirellae and contains stictic acid. The species resembles

Graphina mendax (Nyl.) Müll. Arg. but that species has larger hyaline ascospores and contains norstictic acid.

Specimens examined: Northern Territory: Wangi Road, Walker Creek, 68 km SSW of Darwin, *Streimann 8800*, Jan 1985 (CANB); Melville Island, Conder Point, *Streimann 42494*, Apr 1989 (CANB).

Queensland: 2 km S of Forrest Beach, 15 km SE of Ingham, *Elix 15975 p.p.*, June 1984 (CANB).

Phaeographina chrysenteron (vide infra) (Mont.) Müll. Arg. (Fig. 1e, 2e)

(Müller 1891: 52).

Graphis chrysenteron Mont.,

(Montagne 1842: 268).

Type: Guyana Gallica: *s. loc.*, *Leprieur 23*; (holo P) *fide* K. Kalb, *in litt.*

Thallus pale olive green, corticolous, surface smooth and shiny; apothecia lirelliform, white, numerous, conspicuous, crowded, sessile, straight, curved or sinuous, sometimes branched, 1–3(–5) mm long, 0.5–0.6 mm wide; proper exciple complete, reddish brown; hymenium 150–200 µm tall; ascospores 8 per ascus, brown, 50–60 µm long, 12–16 µm wide, 10–12 × 2–6 locular.

Chemistry: stictic acid (*fide* K. Kalb *in litt.*)

Distribution: occurs in New Caledonia, Indonesia, Hawaii and Brazil and, in Australia, in Queensland. The only reported substrate in Australia is *Acacia*.

Notes: *Phaeographina chrysenteron* is characterised by the conspicuous lirellae, the large brown muriform ascospores and the presence of stictic acid. The species was first reported from Australia by Müller (Müller 1891) who based his report on specimens collected on Mt Bellenden Ker and sent to him by the Colonial Botanist F.M. Bailey. A recent examination of Bailey's specimen (BRI 492632) found it to contain stictic acid but no ascospores were seen. Another older specimen from Queensland labelled *Phaeographina chrysenteron* [J. Shirley AQ 721319 (BRI)] lacked lichen compounds and is identified as *Graphina repleta* (Stirt.) Shirley. *Phaeographina chrysenteron* resembles *Graphina repleta* var. *stictica* A.W. Archer (Archer 1999) but is distinguished from that taxon by the smooth lirellae and the pale brown ascospores.

Müller's epithet 'chrysentera' has been corrected to 'chrysenteron' as chrysenteron is a Greek noun in apposition and does not change.

Specimen examined: Queensland: Black Mountain, 25 km NW of Kuranda, *Elix 17505*, Jul 1984 (CANB).

Phaeographina exilior (Vain.) Zahlbr. (Fig. 1f, 2f)

(Zahlbruckner 1923: 438).

Graphis exilior Vain.

(Vainio 1920: 200).

Type: Philippines. Luzon, Bataan Province: Lamao River, Mount Mariveles, *H.N.*

Whitford 1089, Feb 1905, on *Shorea polysperma* (holo TUR-V 27142).

Thallus pale greyish-white, thin, corticolous, surface smooth and dull; apothecia lirelliform, numerous, crowded, inconspicuous, immersed, lips open with a thin conspicuous thalline margin, curved or sinuous, much branched, 1–2 mm long, 0.1 mm wide; proper exciple absent; hymenium 75–100 µm tall; disc pale reddish brown,

epruinose; ascospores 8 per ascus, irregularly 2-seriate, ellipsoid, pale brown, 15–18 µm long, 7–9 µm wide, 4 × 2 locular.

Chemistry: no lichen compounds found.

Distribution: occurs in the Philippines and, in Australia, in Queensland. The only reported substrate in Australia is *Acacia*.

Notes: *Phaeographina exilior* is characterised by the inconspicuous, immersed, brown, epruinose lirellae, the small ascospores and the absence of lichen compounds. The species resembles *Graphina brachyspora* Mull. Arg. but the lirellae are smaller and less conspicuous and less well-defined than those in the *Graphina* species.

Specimen examined: Queensland: Big Tableland, 26 km S of Cooktown, *Streimann 30884*, Jul 1984 (CANB).

***Phaeographina fuscescens* A.W. Archer, sp. nov.** (Fig. 1g, 3a)

Phaeographina isidiosa similis sed acido norstictico deficienti differt.

Type: Australia. Norfolk Island: Mount Pitt Reserve, track from Red Road to Mount Bates, 29°0'40"S, 167°56'40"E, alt. 220 m, on treelet stem, *H. Streimann 34499*, Dec 1984 (holo CANB).

Thallus pale to dark fawn, thin, corticolous, surface smooth and somewhat shiny; apothecia lirelliform, brown, numerous, crowded, initially fissurine and indicated by a thin brown line on the thallus surface, becoming sessile to sessile, straight, curved or sinuous, sometimes branched, lips closed, 1–3(–4) mm long, 0.15–0.3 mm wide; proper exciple apically carbonised, covered by a thin thalline layer; hymenium 125–150 µm tall; ascospores 8 per ascus, ellipsoid, pale brown, 13–18 µm long, 6–10 µm wide, 4 × 2 locular.

Chemistry: no lichen compounds found.

Distribution: endemic; known only from north-eastern Queensland and Norfolk Island.

Notes: *Phaeographina fuscescens* is characterised by the fawn thallus, the brown lirellae, the apically carbonised proper exciple, the small brown muriform ascospores and the absence of lichen compounds. The apically carbonised exciple is covered with a thin thalline margin as in the more conspicuous *P. quassicola*. The new species is distinguished from the similar *P. insidiosa* (Vain.) Zahlbr. by the absence of norstictic acid, present in *P. insidiosa* (Wirth & Hale 1963), and is distinct from *P. exilior* (Vain.) Zahlbr. which has immersed open, black lirellae.

Etymology: The epithet *fuscescens*, becoming brown, refers to the brown colour of the thallus and lirellae.

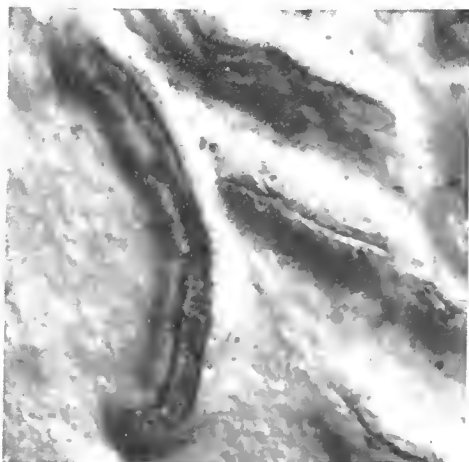
Specimen examined: Queensland: W of Palm Cove, ca. 25 km N of Cairns, *Kalb 19966*, Aug 1988 (herb. Kalb).

***Phaeographina hadrospora* A.W. Archer, sp. nov.** (Fig. 1h, 3b)

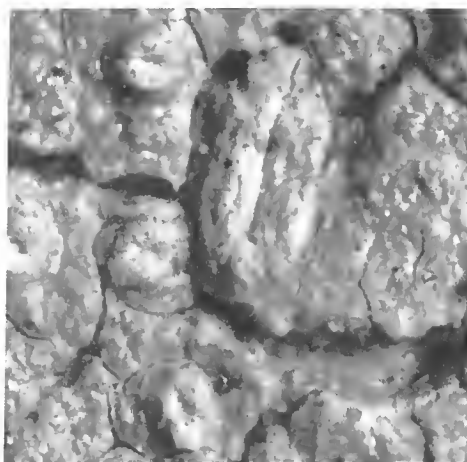
Phaeographina tumulata similis sed ascosporiis majoribus differt.

Type: Australia. Queensland: Goodna, *F.R.M Wilson s.n.*, no date (holo NSW 426677).

Thallus pale greenish fawn, thin, corticolous, surface subtuberculate, cracked and shiny; apothecia lirelliform, inconspicuous, scattered, concolorous with the thallus, sessile, short, straight or curved, unbranched, lips closed, 1–2(–3) mm long, 0.5–0.8 mm wide, with a conspicuous, swollen thalline margin; proper exciple lacking; hymenium 250–300 µm tall; ascospores 1 per ascus, elongate-ellipsoid, pale brown, 155–225 µm long, 40–65 µm wide, densely muriform.



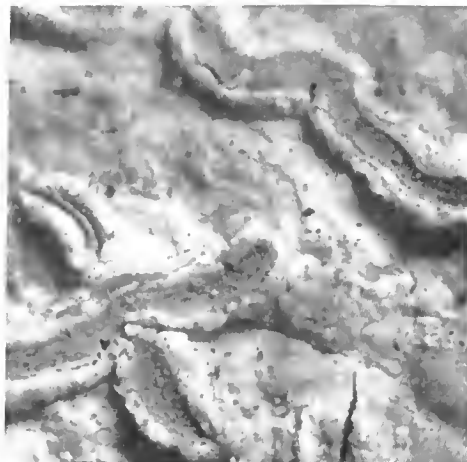
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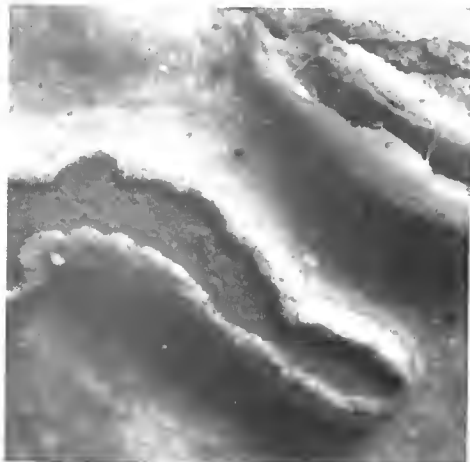
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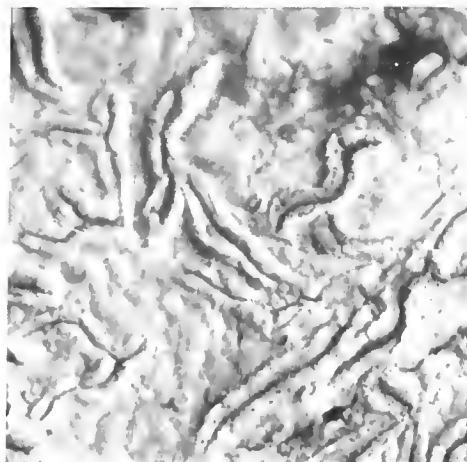
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Fig. 3. a, *Phaeographiina fuscescens* A.W. Archer, holotype (CANB); b, *Phaeographiina hadrospora* A.W. Archer, holotype (NSW); c, *Phaeographiina inipudica* A.W. Archer, holotype (CANB); d, *Phaeographiina litoralis* A.W. Archer, holotype (CANB); e, *Phaeographiina montagnei* (Bosch) Müll. Arg., Elix 18807 (CANB); f, *Phaeographiina montiscalvi* A.W. Archer, holotype (CANB). All $\times 17$.

Chemistry: no lichen compounds found.

Distribution: endemic; known only from north-eastern Queensland.

Notes: *Phaeographina hadrospora* is characterised by the inconspicuous lirellae (hidden by the large thalline margins), the absence of lichen compounds and the large pale brown, muriform ascospores. Immature ascospores are smaller and hyaline. This new species resembles *P. tumulata* (Nyl.) Müll. Arg. but the ascospores in that species are 14–18 µm long, 9–11 µm wide and 4 × 1–3-locular (Nylander 1868).

Large ascospores (c. 200 µm long) are uncommon in the genus *Phaeographina*; one species with large ascospores, *P. balfourii* Müll. Arg., was described from Socotra (Müller 1888b), but that species has much-branched, immersed lirellae and a reddish brown proper exciple. *Phaeographina hadrospora* is thus distinct from this species.

Etymology: The epithet *hadrospora* is from the Greek, *hadros*, large, well-developed, a reference to the large ascospores.

Specimens examined: Queensland: Kirrima State Forest, 26 km WNW of Cardwell, *Elix* 15665 Jun 1984 (CANB); Windsor Tableland, 45 km NW of Mossman, *Streimann* 29656 Jun 1984 (CANB, US); Cardwell Range, Blencoe Creek, 48 km NW of Cardwell, *Streimann* 36868 Jun 1986 (CANB); Clarke Range, 46 km SSW of Proserpine, *Elix* 20872, Jun 1986 (CANB).

***Phaeographina impudica* A.W. Archer, sp. nov.** (Fig. 1i, 3c)

Phaeographina platyloma similis sed ascosporis majoribus et lirellis sulcatis differt.

Type: Queensland: McIlwraith Range, Lankelly Creek, 11 km from Coen, 13°57'S, 145°15'E, *G. Butler* 562A, Aug 1978 (holo CANB).

Thallus pale greyish green, thin, corticolous, surface subtuberculate and slightly shiny; apothecia lirelliform, conspicuous, scattered, sessile, black, lips closed, slightly sulcate, straight, curved or sinuous, rarely branched, 1–4 mm long, 0.4–0.6 mm wide, to 0.4 mm tall, with a conspicuous thalline margin; proper exciple laterally carbonised; hymenium 180–220 µm tall; ascospores 1 per ascus, pale brown, elongate-ellipsoid, (125–)135–180 µm long, (25–)30–40 µm wide, densely muriform.

Chemistry: no lichen compounds found.

Distribution: endemic; known only from north-eastern Queensland. The only reported substrate is *Alphitonia*.

Notes: *Phaeographina impudica* is characterised by conspicuous lirellae with the proper exciple laterally carbonised, exposed and sulcate, the large ascospores and the absence of lichen compounds. The species is thus distinguished from *P. pudica* (Mont. & Bosch) Zahlbr., described from Indonesia, which has barely exposed lirellae (hence the epithet) which are not sulcate (Redinger 1936a; Nakanishi 1977). The ascospores in that species are reported to be 100–150(–180) µm long and 20–32(–40) µm wide. *Phaeographina platyloma* Müll. Arg. (Müller 1882) resembles *P. impudica* but the lirellae in that species are not sulcate and the ascospores are smaller, 78–117 µm long, 26 µm wide (Nakanishi 1977). *Phaeographina muelleri* A.W. Archer (Archer 2000) has similar ascospores and lacks lichen compounds but that taxon has conspicuously open lirellae with an apically carbonised proper exciple.

Specimens examined: Queensland: Big Tableland, 26 km S of Cooktown, *Elix* 17284, July 1984 (CANB); Eungella National Park, *Day* 87.13, July 1987 (CANB); Atherton Tableland, between Ravenshoe and Atherton, *Lumbsch* 5432a, Aug 1987 (herb. Lumbsch).

***Phaeographina litoralis* A.W. Archer, sp. nov.** (Fig. 1j, 3d)

Phaeographis dendroide similis sed ascosporiis majoribus muriformisque, et acido stictico deficienti differt.

Type: Australia. Queensland: Forrest Beach, 15 km SE of Ingham, 18°42'S, 145°18'E, alt. 2 m, on *Alphitonia*, *H. Streimann* 28868, June 1984 (holo CANB).

Thallus pale greenish fawn, corticolous, surface subtuberculate and shiny; apothecia lirelliform, conspicuous, scattered, straight, curved or sinuous, sometimes branched, sessile, open, often with conspicuous thalline margins, 1–3 mm long, 0.4–0.5 mm wide; disc fine white pruinose; proper exciple absent; hymenium 120–150 µm tall; ascospores 8 per ascus, irregularly 2-seriate, ellipsoid, pale brown, 40–60 µm long, (12–)15–17 µm wide, 10–14 × 2–3 locular.

Chemistry: no lichen compounds found.

Distribution: endemic; known only from one specimen from north-eastern Queensland.

Notes: *Phaeographina litoralis* is characterised by conspicuous lirellae with pruinose epithecium and the absence of lichen compounds. The species resembles *Phaeographis dendroides* but that species has smaller locular ascospores and contains stictic acid. The new species is so far known only from the type specimen.

Etymology: The epithet *litoralis*, pertaining to the sea shore, refers to the type locality, Forest Beach.

Phaeographina montagnei (Bosch) Müll. Arg. (Fig. 1k, 3e)

(Müller 1882: 399).

Graphis montagnei Bosch,

(van den Bosch 1855: 472)

Type: Indonesia. Java, s.loc., *F.W. Junghuhn* 112 (syntype L, *vide* Nakanishi 1977).

Thallus dull green, thin, corticolous, surface smooth and somewhat shiny; apothecia lirelliform, numerous, conspicuous, scattered, initially fissurine, becoming sessile with a conspicuous thalline margin, straight, curved or sinuous, rarely branched, 1–5(–8) mm long, 0.5–1.0 mm wide; proper exciple completely carbonised, concealed in thalline margin; hymenium pale red, 200–300 µm tall; disc bright red; ascospores 1 per ascus, ellipsoid, initially hyaline, becoming pale brown, 125–155(–175) µm long, 35–45(–50) µm wide, muriform.

Chemistry: no lichen compounds found; isohypocrelline, a red perylene quinone (Mathey et al. 1994) is reported to be present (Staiger & Kalb 1999).

Distribution: occurs in Japan, the Philippines and Indonesia, and in Australia, in Queensland and New South Wales and also on Norfolk Island, where it is not uncommon. The only reported substrates are *Citrus*, *Elaeodendron* and *Nestigia* on Norfolk Island.

Notes: *Phaeographina montagnei* is characterised by the conspicuous lirellae with bright red discs, the large ascospores and the absence of lichen compounds other than the red pigment; the species is unlikely to be confused with any other *Phaeographina* species. Montagne (1856: 346) described the species as “species splendidissima cum nulla confundenda”. The species is illustrated in colour by Yoshimura, Plate 44, Fig. 469 (Yoshimura 1979).

Specimens examined: Queensland: Mount Stewart, 10 km SSW of Townsville, *Streimann* 31305, Jul 1984 (CANB); Mount Fox, 43 km S of Ingham, *Elix* 20354, Jun 1986 (CANB); Clarke Range, 46 km SSW of Proserpine, *Elix* 20902, Jun 1986 (CANB). New South Wales: Broken Head, 8 km S of Byron Bay, *Archer* G 270, Nov 1998 (NSW). Norfolk Island. Mt Pitt Reserve, just S of the summit of Mt Pitt, *Elix* 18807, Dec 1984 (CANB); *ibid.*, track at end of Selwyn Pine Road, *Elix* 18446, Dec 1984 (CANB); *ibid.*, Filmy Fern Trail, *Streimann* 32195, Dec 1984 (CANB); track between Mt Pitt and Mt Bates, *Elix* 27385, Jun 1992 (CANB).

***Phaeographina montiscalvi* A.W. Archer, sp. nov.** (Fig. 11, 3f)

Phaeographina caesioradianti similis sed labiis convergentibus et acido stictico praesenti differt.

Type: Australia. Queensland: Great Dividing Range, Mount Baldy, 4 km SW of Atherton, 17°17'S, 145°27'E, alt. 1080 m, on fallen tree branch, *H. Streinmann* 29212, June 1984 (holo CANB; iso US).

Thallus off-white, thin, corticolous, surface smooth and slightly shiny; apothecia lirelliform, conspicuous, dark brown, numerous, scattered or crowded, sessile, lips closed, with a conspicuous thalline margin, straight, curved or sinuous, sometimes repeatedly branched, 1–4(–6) mm long, 0.15–0.25 mm wide; proper exciple ill-defined, pale yellowish brown; hymenium 120–150 µm tall; disc pale brown to brown; ascospores 8 per ascus, ellipsoid, pale brown, 25–35 µm long, 8–10 µm wide, 6–8 × 2–3 locular.

Chemistry: stictic acid.

Distribution: endemic; known only from the type specimen from north-eastern Queensland.

Notes: *Phaeographina montiscalvi* is characterised by the conspicuous, dark brown lirellae, the small ascospores and the presence of stictic acid. The new species is so far known only from the type specimen. It is distinguished from the similar *P. caesioradians* by the closed lirellae and the presence of stictic acid. The species is so far known only from the type specimen.

Etymology: The epithet *montiscalvi* is from the Latin, *mons*, mountain, *calvus*, bald, a reference to the type locality, Mount Baldy.

***Phaeographina quassiicola* (vide infra) (Fée) Mull. Arg.** (Fig. 1m, 4a)

(Müller 1887: 47)

Thecaria quassiicola Fée as '*quassiaecola*' (vide infra)

(Fée 1824: 97)

Graphis quassiaecola (Fée) Vain.

(Vainio 1920: 197)

Type: Madagascar, *s. loc.* *Abel Aubert du Petit-Thouars*, no date, *fide* Mull. Arg. 1887 (holo G).

Phaeographina exserta (Nyl.) Müll. Arg.,

(Müller 1882: 398)

Graphis exserta Nyl.

(Nylander 1868: 73)

Type: New Caledonia. Lifu, *Deplanche s.n.*, 1864 (holo H-NYL 7537).

Graphina pyelodes F. Wilson

(Wilson 1891: 32)

Type: Australia. Queensland, Blackall Range, *F. Wilson s.n.*, no date (not found).

Thallus pale fawn, thin, corticolous, surface smooth and shiny; apothecia lirelliform, conspicuous, pale grey, numerous, scattered, conspicuously sessile, straight, curved or sinuous, rarely branched, 0.5–3(–4) mm long, 0.5–0.8 mm wide, 0.5–0.6 mm tall, lips initially closed, becoming open to reveal a white pruinose disc; proper exciple thick,

completely carbonised with a thin, complete thalline margin; hymenium 150–200(–250) μm tall; ascospores 8 per ascus, irregularly 2-seriate, ellipsoid, pale brown, (65–)75–100 μm long, (18–)22–28 μm wide, 18–23 \times 2–6 locular.

Chemistry: no lichen compounds found.

Distribution: Sri Lanka, Japan, Indonesia, New Caledonia and Fiji. In Australia it occurs in Queensland and is also found on Norfolk Island. Reported substrates, in Australia and Norfolk Island, include *Citrus*, *Mallotus* and mangroves.

Notes: *Phaeographina quassiicola* is characterised by the conspicuous pale grey, raised, open (cup-like) lirellae, the completely carbonised proper exciple, the large ascospores and the absence of lichen compounds. The colour of the lirellae is due to the thin thalline exciple covering the thick black proper exciple. The species is illustrated in colour by Yoshimura, Plate 44, Fig. 468 (Yoshimura 1979). *Graphina pyelodes* F. Wilson was described by Wilson (Wilson 1891) who referred to a specimen collected in the Blackall Ranges but the only specimen seen labelled 'G. pyelodes Wils.' [AQ721316 (BRI)] had no further information on the label and may not be the specimen referred to by Wilson. *Graphina pyelodes* was reported as a synonym of *P. quassiicola* by Müller (1893b).

Fée's epithet '*quassiacola*' has been corrected to '*quassiicola*' cf ICBN (Tokyo Code) Article 60.8, example 11.

Specimens examined: Queensland: Russell River, *Sayer L37*, 1886 (MEL 515683); Korunda [Kuranda], *Wilson s.n.*, July 1893 (NSW 438711); Brisbane, Chiefswood, *Wilson s.n.*, Aug 1896 (NSW 438712); Brisbane, Peachey's Scrub, *Wilson s.n.*, Aug 1896 (NSW 438706); Edmonton, 9 km S of Cairns, *Elix 17614*, Jul 1984 (CANB); Bloomfield River, 56 km N of Mossman, *Streimann 45730*, Dec 1990 (CANB); Eungella National Park, *Lumbsch 11057b*, Jul 1996; (herb. Lumbsch); Wooroonooran National Park, Henrietta Creek Camping area, *Lumbsch 11114d*, Jul 1996 (herb Lumbsch).

Norfolk Island. Mt Pitt Reserve, S of the summit of Mt Pitt, *Elix 18805*, Dec 1993 (CANB); *ibid.*, Mt Bates summit trail, *Elix 18589*, Dec 1984 (CANB); *ibid.*, Red Road track to Mt Bates, *Elix 18607*, Dec 1984 (CANB); *ibid.*, track leading W from Mt Bates, *Streimann 34299*, Dec 1984 (CANB, US).

Fiji: Suva, *Wilson s.n.*, Aug 1892 (NSW 438692).



a



b

Fig. 4. a, *Phaeographina quassiicola* (Fee) Müll. Arg., Lumbsch 11057b (herb. Lumbsch); b, *Phaeographina wilsonii* A.W. Archer, holotype (NSW). All $\times 17$.

***Phaeographina wilsonii* A.W. Archer, sp. nov.** (Fig. 1n, 4b)

Phaeographina stramineoglauca similis sed lirellis sessilis conspicuisque, et acido stictico praesenti differt.

Type: Australia. Queensland: Upper Coomera, *F. Wilson s.n.*, no date [c. 1890] (holo NSW 439104).

Thallus pale greenish brown, thin, corticolous, surface smooth and shiny; apothecia lirelliform, conspicuous, scattered, black, sessile, lips closed, straight, curved or sinuous, often branched, with conspicuous thalline margin, the carbonised exciple becoming white pruinose, 1–5 mm long, 0.3–0.5 mm wide; proper exciple thin, completely carbonised, very thin at the base; hymenium 100–130 µm tall; ascospores ellipsoid, pale brown, muriform, 36–53 µm long, 15–22 µm wide, 8–11 × 2–5 locular.

Chemistry: stictic acid.

Distribution: endemic; known only from the type specimen from south-eastern Queensland.

Notes: *Phaeographina wilsonii* is characterised by black lirellae with conspicuous white thalline margins, the completely carbonised proper exciple and the presence of stictic acid.

The species resembles *P. stramineoglauca* (Vain.) Zahlbr. (Vainio 1920) as the lirellae in both species have a completely carbonised proper exciple and the ascospores are of similar size, 45–52 × 18–25 µm in *P. stramineoglauca*. However, the lirella in this species are somewhat immersed and the thallus contains no lichen compounds. The species also superficially resembles *P. caesioradians* (Leight.) Redinger but that species also lacks lichen compounds and has smaller ascospores.

Etymology: The species is named after F.R.M. Wilson (1832–1903), an early collector of lichens in Australia.

Excluded Species

Phaeographina contexta (Pers.) Müll. Arg.

(Müller in Balfour 1888b: 379)

Emblemia contexta Pers.

(Persoon in Gaudichaud 1826: 184)

This species has hyaline, muriform ascospores (Nylander 1868; Leighton, 1869; Vainio 1920) and is more properly placed in the genus *Graphina*. The combination *Graphina contexta* (Pers.) Redinger was made (Redinger 1936b) but erroneously attributed to Müller (Müll. Arg.). The species was reported from Australia by Müller (1891) but his specimen lacked ascospores.

Acknowledgments

The author is grateful to the Herbaria cited above for the loan of type and other specimens, and to the National Herbarium of New South Wales (NSW) for funding provided through the New South Wales Diversity Strategy, for permission to use the facilities of the Herbarium and for arranging the loan of the specimens cited above, and to Dr. P. Wilson for help with Latin and Greek, and to Ms. C. Wardrop (NSW) for the drawings.

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The species of *Scaevola* (Goodeniaceae) in Tasmania

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Abstract

Rozefelds, A.C. (Tasmanian Herbarium, GPO Box 252-04, Hobart, Tasmania, 7001 Australia) 2001 The species of *Scaevola* (Goodeniaceae) in Tasmania. *Telopea* 9(2): 345–352. At least three species of *Scaevola* occur in Tasmania. *Scaevola albida* is extremely rare, and is known from two localities on Flinders Island and also from near Temma on the West Coast of Tasmania, and is restricted to coastal sandy soils. *Scaevola aemula* is uncommon in the State being restricted to doleritic soils in eastern Tasmania, and appears to have a disturbance-based ecology, appearing after fire or disturbance. *Scaevola hookeri* is a widespread, variable taxon in Tasmania, occurring from sub-alpine communities to sea level. Although *S. calendulacea* has been recorded from Tasmania, no supporting collections are lodged in the Tasmanian Herbarium. A key to the species in Tasmania is included, and recommendations are also provided regarding the appropriate conservation status for *S. aemula*, *S. albida* and *S. calendulacea* under the Tasmanian Threatened Species Protection Act (1995).

Introduction

Scaevola is a genus of c. 100 mainly tropical species, that is predominantly Australian (Carolin 1992a). In Tasmania, the number of species has been somewhat unclear. Curtis (1963) recorded four species; *S. hookeri* (de Vriese) F.Muell. ex Hook.f., *S. aemula* R.Br., *S. albida* (Smith) Druce and *S. calendulacea* (Andrews) Druce. Carolin (1992a), in *Flora of Australia*, only listed *S. hookeri* as occurring in the State, although in the *Flora of New South Wales* (Carolin 1992b) he also recorded *S. albida* var. *pallida* from Tasmania. Buchanan (1999) noted that *S. aemula* also occurs in Tasmania, and in the absence of any verified collections of *S. calendulacea* and *S. albida* in the Tasmanian Herbarium concluded that both species had been recorded in error from the State. Recent collections have confirmed the presence of *S. albida* in Tasmania and provided new information on the ecology of these species

In this paper the morphology, distribution, ecology and conservation status of these species in Tasmania is discussed. Flowers were examined with a scanning electron microscope and the specimens were critical-point dried, and placed onto aluminium stubs with tape. They were then sputter coated with gold and examined with a Philips Electroscan Environmental Scanning Electron Microscope 2020, under high vacuum operated at 10–15 kV.

Collections in the National Herbarium of Victoria (MEL) have provided additional information on the ecology of *S. aemula*, and also the distribution of both *S. aemula* and *S. albida* in Tasmania. As this is the precursor treatment to the revised State flora, the descriptions are based primarily upon Tasmanian material. The nomenclature and classification follows Carolin (1992a) unless otherwise stated, and the Tasmanian biogeographical regions are those of Orchard (1988). Notes are included if the mainland Australian material differs from the Tasmanian collections.

Scaevola L.

Perennial herbs, shrubs and scramblers. *Leaves* alternate, rarely opposite, entire or dentate, sessile or petiolate, often with axillary hair tufts, entire or irregularly serrated. *Flowers* strongly zygomorphic, solitary or in few-flowered cymes, with paired bracteoles, in leafy or bracteate spikes. *Calyx* adnate to ovary, lobes often obscure or absent. *Corolla* with tube split to the base on the upper side expanding distally into an open fan of five lobes, lobes winged white, blue, mauve, rarely yellow; throat often with hairs, hairs simple and/or multicellular (barbulae). *Stamens* free. *Ovary* inferior, 1–2(–4) locular, style simple, stigma surrounded by an indusium, indusium oval to ± horizontal, usually pubescent. *Fruit* indehiscent, mesocarp fleshy or ± dry, endocarp hard, sculptured, containing one or two seeds. Seeds ovoid, wingless.

Key to Tasmanian species

1. Flowers shortly pedunculate, plant prostrate rooting at nodes, lacking bristles around the distal end of the indusium *S. hookeri*
1. Flowers sessile, plant procumbent or ascending not rooting at nodes, conspicuous bristles around the distal end of the indusium 2
2. Leaves > 15 mm long, margin dentate, flowers lilac or bright blue with yellow throat, conspicuous tuft of hairs on back of indusium *S. aemula*
2. Leaves < 15 mm long, margin basal half entire, upper half occasionally dentate, flowers light blue to white, throat white or yellow, lacking conspicuous tuft, but a few scattered hairs may be present on the back of indusium *S. albida*

Section *Xerocarpa* G. DonSubsection *Pogonantha* (G. Don) Carolin

Scaevola hookeri (de Vriese) F. Muell. ex Hook.f. (Fig. 1)

Merkusia hookeri Vriese, *Ned. Kruidk. Arch.* 2: 159 (1851). Type: Hampshire Hills, Tas., Feb. 1837, R.C.Gunn 848, lectotype K, *vide* Carolin (1992a: 333); isolectotype HO6975!

Herb prostrate, mat forming, stoloniferous, stems to c. 15 cm long, rooting at nodes. *Stem* sparingly hispid with spreading simple hairs. *Leaves* sessile, ovate to oblong, 8–11(–25) mm long, 3–7(–8.5) mm wide, apex usually obtuse, margins entire or dentate with the proximal margin usually more strongly toothed, both surfaces sparsely appressed-pubescent to almost glabrous. *Flowers* solitary in leaf axils, on short stalk, 2–10 mm long, with a pair of elliptical to oblong bracteoles, 3–5 mm long. *Sepal lobes* absent or minute. *Corolla* 5–8 mm long, hispid outside, elliptical, 3–4 mm long, white to pale pink, throat, yellow-white, sparsely pubescent inside. *Stamens* 5, anther oblong, glabrous, c. 0.7 mm long. *Ovary* glabrous or sparingly hirsute, c. 1.0 mm long, style 3–4 mm long, indusium c. 1.4 mm wide, with a few bristles on the back and on the style and lacking conspicuous bristles around the elliptical orifice. *Fruit* oval in outline, 3.3–3.5 mm long, rugose, distally pubescent, white.

Selected specimens examined: Tasmania: North East: George Town, 41°06'S 146°50'E, R.C. Gunn s.n., 10 Jan 1843 (HO6976); Blue Tier, A. Simson s.n., 1878 (HO6960). Midlands: Harford, heathy lands, 41°15'S 146°33'E, H.J. Hamilton 18, 1 Feb 1932 (HO6978). East Coast: Friendly Beaches Road, 42°00'S 148°15'E, altitude 10 m, A. Moscal 6155, 10 Feb 1984, (HO400485); Bellerive, L. Rodway s.n., Jan 1892, (HO6977); Bellerive, L. Rodway s.n., 22 Feb 1913 (HO6980); Flagstaff Marsh, R. Schalingher s.n., 24 Jan 2001 (HO). Furneaux: Lime Pit Road, N of Lady Barron, Flinders Island, 40°11'S 148°14'E, coastal heath, altitude 10 m, Rozefelds 735, 11 Dec 1997, (HO324535). North West: Rocky Cape, R.C.Gunn s.n., 1 Mar 1837 (HO6973). Ben Lomond: Mt Barrow near road, altitude 1100 m, 41°23'S 147°28'E, M.G. Noble 28989, 28 Jan 1980, (HO74223); Ben Lomond 41°33'S 147°40'E,

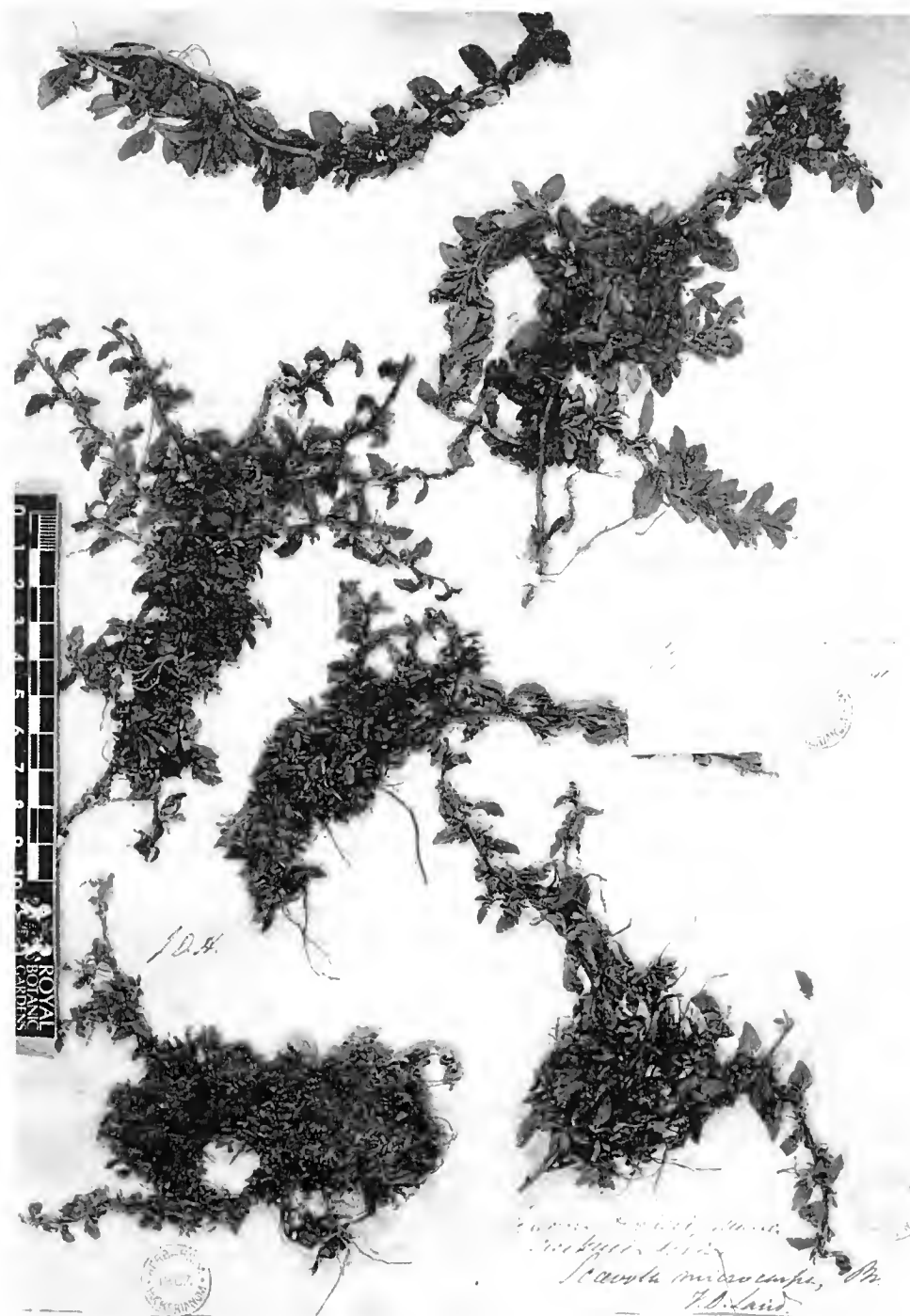


Fig. 1. Lectotype of *Scaevola hookeri* (de Vriese) F. Muell. ex Hook. f. (Gunn 848, K). The lectotype is the bottom right hand specimen.

J.B. Kirkpatrick s.n., Jan 1979 (HO29551). North West: The Guardians, *H.D. Gordon? s.n.*, 28 Dec 1937 (HO6981). South West: Abbotts Lookout, 42°46'S 146°39'E, altitude 1000 m, *A. Moscal 10348*, 24 Mar 1985 (HO143809); Saddle Bight, Port Davey 43°18'S 145°55'E, *A. Moscal 13910*, 12 Jan 1987 (HO143315); 1 km W of Whalers Point, Port Davey, 43°18'S 145°55'E, *A.M. Buchanan 9389*, 12 Jan 1987 (HO405235); Hartz Mtns, 42°12'S 146°46'E altitude c. 900 m, *H.F. Comber 2250*, 4 Apr. 1930, (HO6982); Arve Moor, near Hartz Hut, 42°14'S 146°46'E, *J. Somerville s.n.*, 20 Jan 1939 (HO6961). Central Highlands: Below Eldon Bluff, 41°58'S 145°49'E, altitude 1080 m, *A.M. Buchanan 9966*, 5 Feb 1987 (HO122172); Lake St Clair, 42°07'S 146°11'E, *R.C. Gunn s.n.*, 13 Feb 1845 (HO6972). Mount Field: Near Lake Dobson, 42°41'S 146°35'E, altitude 1030 m, *J.M.B. Smith 256*, 6 Jan 1978 (HO36372); Level of Lake Fenton Huts, *W.M. Curtis s.n.*, 18 Jan 1959 (HO6965); Mount Field, 42°41'S 146°53'E, altitude 3400 feet (c. 1000 m), *L. Rodway s.n.*, Feb 1926 (HO6962); Golden Stairs, above Lake Dobson, 42°41'S 146°35'E, altitude c. 1100 m, *J.M.B. Smith 293*, 6 Jan 1978 (HO36424). Mount Wellington: The Bend at c. 3700 feet [1000 m], *W.M. Curtis s.n.*, 7 Feb 1947 (HO53397); Mt Wellington, 42°54'S 147°14'E, *J. Milligan s.n.*, Mar 1849 (HO6979);

Remarks: The species is morphologically variable in regard to leaf size and shape, the degree in which the leaves are serrated, and the hairiness of the leaves, with montane populations often sparingly hirsute and the coastal forms usually more conspicuously hirsute. The indusium and style is conspicuously hairy (Fig. 2A).

Distribution and Ecology: *Scaevola hookeri* occurs from sub-alpine communities down to sea level in Tasmania (Fig. 3B); and also in Victoria and New South Wales (Carolin 1992a).

Flowering: December–April.

Conservation: common and widespread.

Subsection *Biloculatae* K. Krause Series *Pogogynae* Benth.

Scaevola aemula R. Br.

Lobelia aemula (R.Br.) Kuntze, *Revis. Gen. Pl.* 2: 378 (1891). Type: Bay X, South Coast, [Port Lincoln, S. Australia] R. Brown, Mar 1802, lectotype BM; isolectotypes K, MEL, *vide* Carolin (1992a:127)

Herb ascending to decumbent, to 60 cm tall, stems with coarse antrorse strigose hairs. *Leaves* tapering towards base, obovate, 15–35 mm long, 8–13 mm wide, apex usually obtuse, margin dentate, antrorse strigose hairs scattered on upper surface, and mainly on main vein and margins on lower surface. *Flowers* solitary in leaf axils, sessile, with

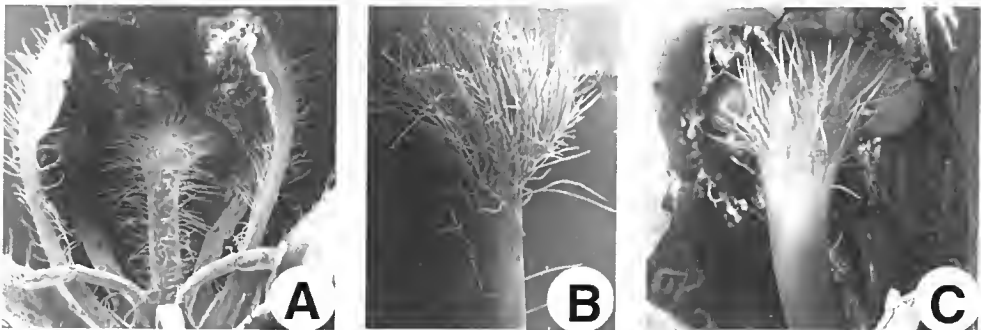


Fig. 2. Indusia of the three species. A, *S. hookeri* (*Schahinger s.n.*), partial flower, note hairs on style, and five stamen filaments $\times 8$. B, *S. aemula* (*Rozefelds 1671*), indusium dissected from flower, note prominent bristles extend beyond the distal margin of the indusium $\times 10$. C, *S. albida* (*Schahinger s.n.*, HO510838), note few short, scattered hairs $\times 10$.

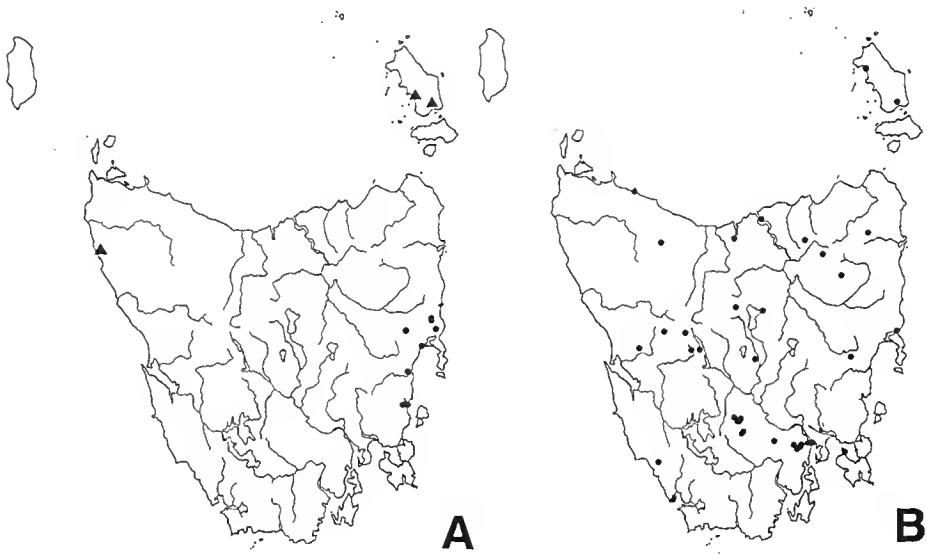


Fig. 3. A, Distribution map of *Scaevola aemula* (circles) and *S. albida* (triangles) based upon Tasmanian Herbarium (HO) and National Herbarium of Victoria (MEL) records. B, Distribution map of *Scaevola hookeri* based upon Tasmanian Herbarium (HO) records.

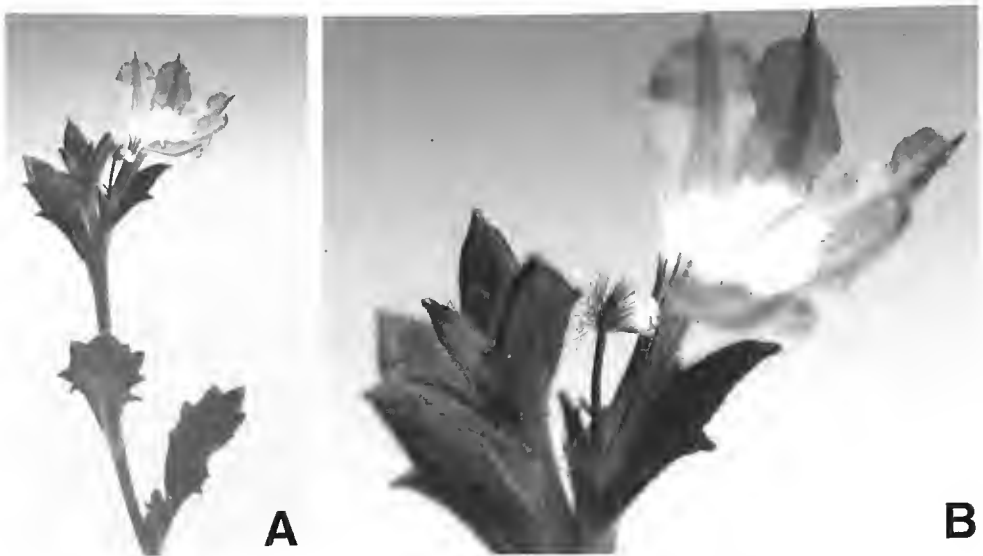


Fig. 4. *Scaevola aemula* A, Flowering shoot, $\times 0.9$. B, Detail of flower, note the tuft of hairs on the back of the indusium. $\times 3$. (Rozefelds 1671, HO503400)

a pair of bracteoles, narrowly oblanceolate, almost linear in dried specimens, 5–6 mm long, with conspicuous antrorse hairs along margins and on both surfaces, flowers usually restricted to the ends of leafy and bracteate spikes up to c. 45 cm long. *Sepal lobes*, triangular, c. 0.5 mm long, with antrorse hairs. *Corolla* 16–20 mm long, with appressed hairs outside, narrowly oblong, 8–12 mm long, purple (when fresh) often blue or white when dried, with a few barbulae near the basal margins of the lobes, throat yellow or white, sparsely pubescent inside. *Stamens* 5, anther oblong, glabrous, c. 1.0 mm long. *Ovary* pubescent or sparingly hirsute, 2–3 mm long, 2-locular, style 8–9 mm long, indusium c. 1.5 mm wide with a posterior tuft of long mauve-brown bristles, and white bristles around elliptical orifice. *Fruits* not seen. (Fig. 4)

Selected specimens examined: Tasmania: East Coast: On Top of Tiers, Swansea, *Storey s.n.* (MEL1520774); Swanport, *Storey s.n.* (MEL1520757); Prosser River, 42°33'S 147°52'E, *F. Hood s.n.*, Mar 1979 (HO29298); Apsley River, 41°53'S 148°11'E, *P. Collier s.n.*, 2 Nov 1985 (HO116784); On or near convict road between Prosser Dam and Triabunna, 42°33'S 147°55'E, *D. Gregson s.n.*, 5 Mar 1979 (HO29234); Swanport, 42°05'S 148°05'E, *L. Rodway* 480, Dec 1892 (HO6957); Douglas Apsley National Park, 41°52'S 148°11'E, altitude 80m, *K. Johnson s.n.*, 16 Mar 1997, (HO321292); Small hill SW of Cusicks Hill, 41°57'46"S 148°14'26"E, altitude 100m, area previously burnt by fire, *Rozefelds 1671*, 5 Apr 2000 (HO503400). Victoria: Mallee sandhills W of Lake Albacutya, 35°44'S 141°55'E, area burnt by wildfire in Dec 1977, *A. Morton s.n.*, 17 Nov 1979 (MEL562061); 6 mls [= 9.6 km] W of Annuello, burnt three or four years ago, *N. MacFarlane s.n.*, 8 Feb 1971 (MEL1520822).

Remarks: The species has a prominent tuft of hairs on the top surface of the indusium. No fruiting material has been collected from Tasmanian plants. Jeanes (1999) recorded that the fruits in mainland material are ovoid, 3–4 mm long, rugose and pubescent.

Distribution and Ecology: *Rozefelds 1671* records the species growing in a *Eucalyptus amygdalina* community on dolerite. *Scaevola aemula* in Tasmania is restricted to the Great Oyster Bay region which was recognised by Kirkpatrick & Brown (1984a, b) as a centre of higher-plant endemism in Tasmania (Fig 2A). The Tasmanian populations of *S. aemula*, along with *Eucalyptus barberi*, *Ozothamnus lycopodioides*, *Lasiopetalum micrantheum* and *Melaleuca pustulata* are restricted to doleritic soils in this region. *Scaevola aemula* is also known from South Australia, Victoria and New South Wales (Carolin 1992a).

Flowering: recorded in flower in November and December, and March and April.

Conservation Status: The species is currently listed as 'endangered' in the Tasmanian Threatened Species Protection Act (1995). *Scaevola aemula* in both Tasmania and Victoria appears to have a disturbance-based ecology and is recorded as appearing after fire or disturbance due to land clearing. Some specimens show evidence of having been grazed, although it is unknown whether this is by native marsupials or introduced mammals. It is also unknown whether this grazing pressure could be impacting negatively on the species.

Scaevola albida (Smith) Druce

Goodenia albida Smith, *Trans. Linn. Soc. London, Bot* 2: 348 (1794). Type: Port Jackson, N.S.W., J. White, holotype Linn-SM, *vide* Carolin (1992a: 122).

Prostrate to ascending herb to 20 cm high, forming irregular clumps, stems with antrorse strigose hairs. *Leaves* shortly petiolate to sessile, obovate to elliptical, 7–14 mm long and 2.2–5.0 mm wide, apex acute, margin of basal half of leaf entire, upper half occasionally dentate, a few to scattered antrorse strigose hairs on upper surface, and on leaf margins and main vein on undersurface. *Flowers* solitary in leaf axils, sessile, with a pair of narrow oblanceolate bracteoles, 9–10 mm long, with a few antrorse hairs along margins, flowers usually restricted to the ends of leafy and bracteate spikes up to c. 7 cm long. *Sepal lobes* deltoid, c. 0.6 mm long, margin sparsely ciliate. *Corolla* 8–12 mm

long, with appressed hairs outside, narrowly elliptical to oblong, 5–6 mm long, blue or white, throat white or yellow, sparsely pubescent inside. *Stamens* 5, anther oblong, glabrous, c. 1 mm long. *Ovary* glabrous, c. 1.5 mm long, 1-locular, single ovule, style 3–5 mm long, indusium c. 2 mm wide, glabrous on the back or with a few scattered hairs and short white bristles occur around the triangular orifice. *Fruits* ellipsoid, glabrous with rugose mesocarp, 2.5 mm long, c. 1.5 mm wide.

Selected specimens examined: Tasmania: Furneaux Group: Lime Pit Road, N. of Lady Barron, Flinders Island, 40°11'S 148°15'E, Rozefelds 736 and S. Harris, 11 Dec 1997 (HO324559); and L. Gilfedder *s.n.* (HO); Blue Rocks District, Flinders Island, J.S. Whinray 2128, 10 Nov 1970 (MEL576015); Flinders Island (MEL1520889); Tasmania (no specific locality) (HO53395); Inland from Hazard Bay, near Temma, upper slopes and crest of stabilised sand dune, very low open heath with ground covered by short *Poa rodwayi*, 41°15'S 144°42' E altitude 20m, R. Schahinger *s.n.*, 22 Nov 2000 (HO510838) and R. Schahinger *s.n.*, 10 Jan 2001 (HO510839). Victoria: Point Lonsdale, K. Cowle (MEL579650); Wannon, Cape Nelson, c. 700m E of the lighthouse, 38°25'14"S 141°33'15"E, D.E. Albrecht 5177, 3 Dec 1992 (MEL2017295).

Remarks: The material of *S. albida* collected from Tasmania, with its small leaves which are less 20 mm long and white to light blue flowers is probably referable to var. *pallida* (R.Br.) Carolin. Cooke and Carolin (1986) recorded that the back of the style was glabrous in var. *pallida*, although in the Tasmanian collections it is glabrous or has a few scattered hairs (Fig. 2C). In mainland Australia the species is heteromorphic and Jeanes (1999) considered that as intermediates between the type variety and var. *pallida* occurred there was little point in recognising varieties. Carolin (1992b) recorded the species from Tasmania, but no additional collections were found in NSW (J. Everett pers. comm. 2001).

Distribution and Ecology: *Scaevola albida* was collected from heath communities, and is known from two localities on Flinders Island (Furneaux Group), of which at least one is on Quaternary sediments, and it was recently found near Temma on calcareous sands on the West Coast of Tasmania (Fig. 3A). The Temma population consists of over 200 plants (R. Schahinger pers. comm., 9 Feb 2001). It also occurs in Victoria, New South Wales, Queensland and South Australia (Carolin 1992a).

Flowering: November–January.

Conservation: It is currently listed as 'rare' in the Tasmanian Threatened Species Protection Act (1995). As the species is currently known from only three localities, a higher conservation status, such as, 'endangered' is appropriate. Further fieldwork in the Furneaux Group and the West Coast of Tasmania is needed to ascertain the distribution and hence the rarity of this species.

Conclusions

Three *Scaevola* species are recorded from Tasmania. *Scaevola hookeri* is common, while both *S. albida* and *S. aemula* are poorly represented in herbarium collections and are considered to be threatened in the State. *Scaevola calendulacea* has not been verifiably recorded from the State, although as it occurs along the coast in Victoria it could be expected to be found on some of the Bass Strait Islands. In Victoria, it is recorded from coastal sand dunes and can be distinguished from other Tasmanian species by its fleshy fruits and more or less entire, thick-textured leaves (Jeanes 1999). Extensive collecting from the Bass Strait Islands, by Tasmanian Parks and Wildlife staff, however, has not yielded any collections. As there are no collections of this species known from Tasmania (Buchanan 1999), it is appropriate to delete this species from the list of 'rare' species in the Threatened Species Protection Act (1995) for the State.

Acknowledgments

Material collected for this study was obtained during fieldwork in 1997 with Stephen Harris (Tasmanian Parks and Wildlife Service). This research was supported by funding from the Australian Biological Resources Study towards the Flora of Tasmania Project. The Australian Botanical Liaison Officer, Prof Rod Seppelt (2000–2001) provided Cibachromes of type material in K, and extracts from papers unavailable in Tasmania. Simon Cuthbert (Tasmanian Museum and Art Gallery) took the photos used in Fig 4. Alex Buchanan and Richard Schahinger provided comments on the manuscript.

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Manuscript received 29 September 2000

Manuscript accepted 15 March 2001

Indigofera adenotricha (Fabaceae: Faboideae), a new species from western Arnhem Land

Peter G. Wilson

Abstract

Wilson, Peter G. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW 2000, Australia) 2001. *Indigofera adenotricha* (Fabaceae: Faboideae), a new species from western Arnhem Land. *Telopea* 9(2): 353–355. A new species, *Indigofera adenotricha*, is described, illustrated and its affinities discussed; it is apparently restricted to western Arnhem Land in the Northern Territory, Australia. Although it seems to be a member of the sect. *Viscosae*, it does not appear to be closely related to the widespread *I. colutea*. *I. adenotricha* is distinguished from *I. colutea* by the plentiful, longer glandular hairs, the fewer and larger leaflets, the longer terminal leaflets and the pink-purple flowers.

Introduction

Three specimens of an *Indigofera* species, collected in the Northern Territory, have recently come to light that show a very distinctive combination of characters. Most noticeably, this plant has relatively long, gland-tipped hairs on all parts, rather reminiscent of the widespread species, *I. colutea*, but differs from the latter in many floral and pod characters. It is unlikely to be an introduction: Schrire (1995) lists the character-state 'multicellular gland-tipped hairs' as present in only two groups of species (one being sect. *Viscosae*, the Type of which is *I. colutea*) but this plant does not match the circumscription of any described species.

Indigofera adenotricha Peter G. Wilson, sp. nov.

Omnes partes pilis glandulosis numerosis instructa; folia pinnata foliolis plerumque 5–7, ellipticis, foliolo terminali quam ceteris manifeste longiore; inflorescentiae longae, folia excedentes; flores malvacei.

Holotype: Northern Territory: Darwin & Gulf: East Alligator River, 4 km S of Cahills Crossing, *Russell-Smith 570*, 25 Apr 1983 (DNA).

[*Indigofera* sp. 1, Brennan (1996: 53)]

Spreading shrub, to 1 m high; young stems terete, covered with stalked glandular hairs 0.1–1 mm long, and scattered to dense, spreading, subequally biramous hairs. Leaves pinnate, (3–)5–7 leaflets; stipules linear, ± persistent, 2–3 mm long and bearing biramous and glandular hairs; petiole 5–27 mm long; rachis furrowed, multicellular hairs between leaflet pairs absent. Leaflets opposite; stipellae absent or linear, 0.6–1.2 mm long; lamina elliptical to narrowly elliptical, the laterals (7.5–)9–17 mm long, 4.5–10.5 mm wide, the terminals 16–24(–28) mm long, (5–)6.5–11.5 mm wide; upper surface greyish, with sparse to moderately dense, appressed to slightly spreading hairs and occasional shortly stalked glandular hairs; lower surface greenish, with scattered biramous hairs and frequent glandular hairs; apex acute to obtuse with a short mucro; veins not prominent. Inflorescences 120–230 mm long, longer than leaves; peduncle 14–24 mm long; bracts narrowly triangular to linear, 0.8–1.5 mm long; flowers pink to purple; pedicel c. 1 mm long. Calyx 2.5 mm long, with subequal to equal lobes equal to or

longer than the length of the tube, clothed with moderately dense, white, spreading hairs with scattered glandular hairs (many sepals terminated by a gland). Standard pink-purple, broadly obovate to suborbicular, 5–6.5 mm high, 4–5.5 mm wide. Wings broadly obovate, 3.5–4 mm long, 1.5–2 mm wide. Keel c. 6 mm long, 2 mm deep; apex acute; lateral pockets c. 1 mm long; hairs sparse, hyaline, restricted to the bottom near the tip. Staminal tube 3–3.5 mm long, probably colourless. Ovary glabrous. Pod spreading to descending, terete, 16–18 mm long, 2.5–3 mm deep, brown, covered in gland-tipped hairs, with occasional spreading biramous hairs; apex shortly beaked or pointed; endocarp spotted. Seed 3–4 per fruit. (Fig. 1).

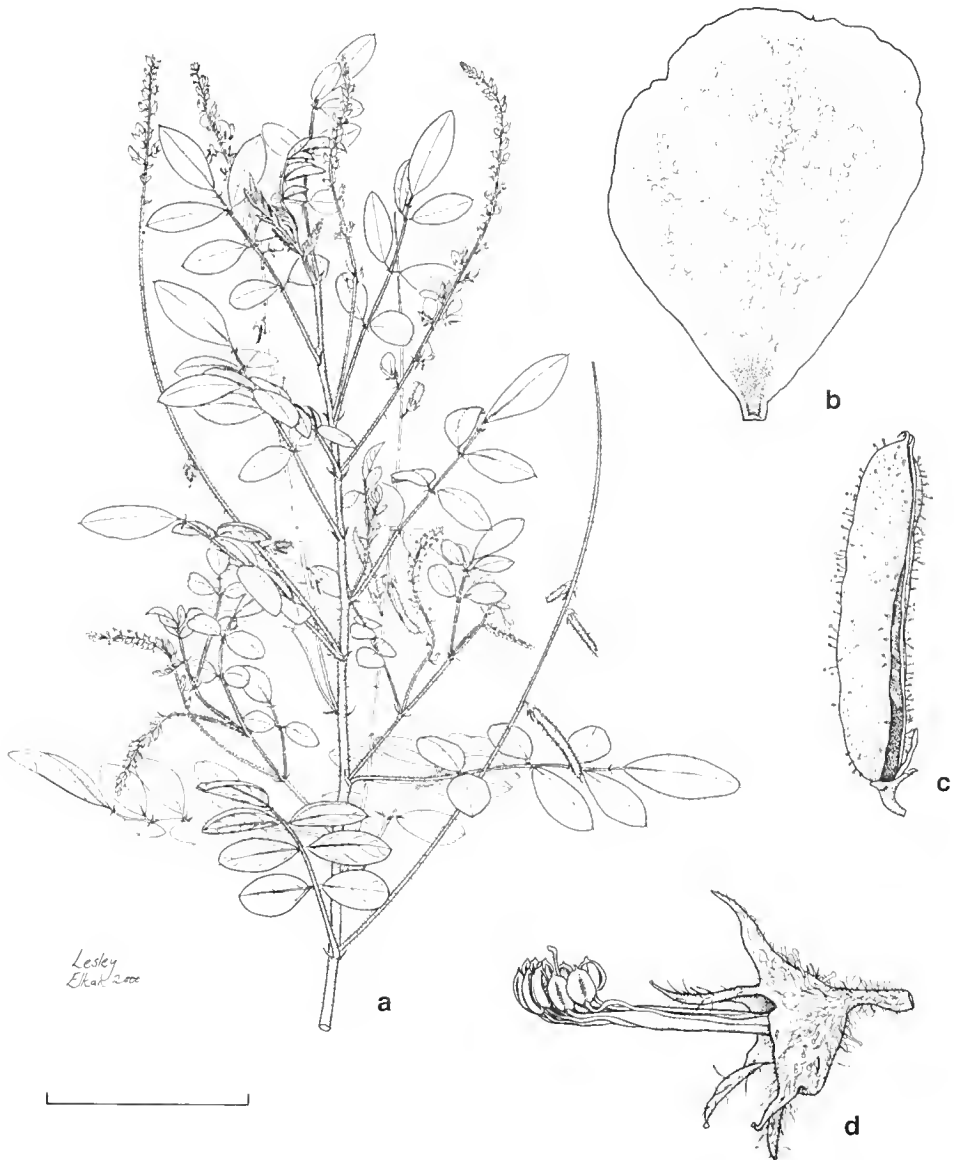


Fig. 1. *Indigofera adenotricha*. a, habit; b, standard; c, fruit; d, lateral view of calyx and androecium. (a, b, d from Russell-Smith 570; c from Brennan 1370). Scale bar: a = 40 mm; b, d = 2.5 mm; c = 10 mm.

Notes: despite the presence of stalked glands, this species does not appear to be very closely related to *I. colutea*; members of the group of species close to *I. colutea* have red flowers and narrow pods usually only up to 2 mm diam. (rarely to 2.5 mm). This species is somewhat similar to *I. scabrida*, a glandular-haired species described from the province of Yunnan, China, but differs from that species in having pink to purple (rather than red) flowers, fewer leaflets and glandular (rather than glabrescent) pods. The plant is also notable for having rather long terminal leaflets, up to twice the length of the laterals. In this latter feature, it resembles another Northern Territory species, *I. verruculosa*, which also has pink to purple flowers; this species also has wart-like glands on its pods, stems and leaves, but these are sessile and non-viscid.

The epithet is derived from the Greek *aden*, *adenos*, gland, and *thrix*, *trichos*, hair, in reference to the stalked glands of this species.

Distribution and habitat: restricted to the Northern Territory (western part of Arnhem Land) where it is recorded from sandstone outcrops.

Conservation status: apparently uncommon, but conserved within Kakadu National Park. Staff from the Northern Territory herbarium, Darwin, searched for it in April/May 1999, but failed to find it and have suggested (C. Dunlop pers. comm.) that it may only appear after disturbance or fire.

Other specimens examined: Northern Territory: Darwin & Gulf: c. 5 km S of Cahills Crossing, East Alligator River, *Thompson* 295, 25 Apr 1983 (CANB); on Bowerbird Track, near Magela Creek, *Brennan* 1370, 5 Aug 1991 (DNA).

Acknowledgments

I am indebted to Brian Schrire who very kindly confirmed the distinctness of this species, drew my attention to significant morphological features and suggested possible affinities. Thanks also to Clyde Dunlop and Ian Cowie for assistance in attempting to relocate this species and to Lesley Elkan for the excellent illustration.

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Manuscript received 30 October 2000
Manuscript accepted 15 March 2001

The genus *Juncus* (Juncaceae) in Malesia and allied septate-leaved species in adjoining regions

K.L. Wilson and L.A.S. Johnson[†]

Abstract

K.L. Wilson and Johnson L.A.S. (Royal Botanic Gardens, Mrs Macquaries Road, Sydney NSW 2000, Australia) 2001. The genus *Juncus* (Juncaceae) in Malesia and allied septate-leaved species in adjoining regions. *Telopea* 9(2): 357–397. The Malesian species of the genus *Juncus* are reviewed. *Juncus durus* and *J. decipiens* subsp. *medianus* are described as new, and the new combination *J. decipiens* subsp. *sundaicus* is made. Distinctions between the Australasian *J. prismatocarpus* and allied Malesian and continental Asian septate-leaved species are outlined.

Introduction

Backer (1951) published a treatment of the family Juncaceae in the *Flora Malesiana* series. He had published an account of the Javanese species in Dutch (Backer 1924) and subsequently an account for Java in English (Backer and Backhuizen f. 1968). Since then, there has been extensive collecting of and much research into the family in Malesia and neighbouring regions, particularly in Australia and New Zealand by E. Edgar and the late L.A.S. Johnson over the last 40 years. The first author (KLW) worked closely with LASJ on the study of the genus *Juncus* in Australia, New Zealand and New Guinea. The full Australasian study is still being prepared for publication, both as a separate paper and as part of the *World Flora* treatment of the family being coordinated by J. Kirschner (Pruhonice). It seemed useful to publish on the Malesian species separately from the Australian and New Zealand species since there are only eight species in Malesia and there is only one native species in common. *Juncus prismatocarpus* R. Br. is also discussed because of the persistent confusion of that Australian and New Zealand species with its allies in Malesia and Asia. Only the most relevant of the references mentioned in Backer (1951) are repeated here.

The subgeneric arrangement used is that of Kirschner et al. (1999). The subgroupings are largely the same as those used by Buchenau in his various publications (e.g. 1906), but with Buchenau's subgenera grouped as sections under two subgenera, which are based on his major informal subdivision of 'eprophyllati' and 'prophyllati'. These two informal subdivisions were based on the presence or absence of bracteoles (confusingly called prophylls by Buchenau — see Novara 1976 and discussion below) under each flower. Buchenau's subgeneric names are added in parentheses, so that those names can be correlated with the currently accepted names. Subgenus *Juncus* (Buchenau's 'Flores eprophyllati') is represented in Malesia by *Juncus leschenaultii* J. Gay ex Laharpe, *J. sandwiliu* Lourteig and *J. wallichianus* Laharpe, which belong to sect. *Ozophyllum* (Buchenau's subgen. *Septati*). Subgenus *Poiophylli* (Buchenau's 'Flores prophyllati') is represented by the introduced *J. bufouius* L. sens. lat. in sect. *Tenageia* (subgen. *Poiophylli* p.p.) and a mixture of native (*J. decipiens* (Buchenau) Nakai, *J. durus* sp. nov. and *J. nupela* Veldkamp) and introduced (*J. inflexus* L.) species belonging to sect. *Juncotypus* (subgen. *Genuini*).

[†] Deceased 1 August 1997.

All collections cited have been seen unless otherwise indicated.

Characteristics of the plants

The characteristics of the plants will be discussed more fully in the paper on Australian and New Zealand species. Here, only brief explanations of characters used in the key and species descriptions are given. Balslev (1996) gives a useful outline of morphological and anatomical characters in the family.

Culm length is measured from the base of a plant to the lowest involucral bract at the base of an inflorescence. This taken together with the inflorescence measurement gives an overall size for the plants. *Culm diameter* has been measured about halfway along the length of the culm, as have counts of number of longitudinal striations, and assessment of whether the pith is dense or loose, continuous, interrupted or absent, and whether septa (transverse or longitudinal) are present. *Culm hardness* is also assessed at that point by compressing the culm with the fingers; culms are often softer near their apex than their base. The surface *longitudinal striations*, which are the external reflection of the internal tissue patterns, are useful in separating species in section *Juncotypus*. They are more prominent when the plants are dried. *Pith density* is also characteristic for species in section *Juncotypus*. Density seems to be determined by the size of the stellate parenchymatous pith cells and the length of their arms: dense pith equating to small cells with short arms and loose pith to bigger cells with long arms. *Culm colour* is useful in discriminating taxa, but that is best assessed from fresh material, which has not been seen for all of the taxa dealt with here.

Leaf blade form and diameter or width are given in descriptions as seen about halfway along the lamina unless otherwise indicated. The transverse and longitudinal septa in species of section *Ozophyllum* (*J. leschenaultii*, *J. sandwithii* and *J. wallichianus*) are more obvious in dried specimens, but are best checked by splitting a leaf longitudinally to see the interior of the leaf. 'Unitubulose' leaves (Fig. 1h) are those with only transverse septa (also called 'perfect septa' by some authors), while 'pluritubulose' leaves (Fig. 1g) have both longitudinal and partial transverse septa ('imperfect septa'). Leaves in section *Juncotypus* consist of a minute mucro-like blade on a well-developed open sheath; such leaves are called cataphylls.

Leaf sheaths are more or less uniformly straw-coloured near the apex of the outer surface in all species, hence description of colour refers to the middle and basal portions, which range from pale yellowish to dark red-brown externally; all sheaths can become blackish in standing water. In section *Juncotypus*, the colour of the outer (abaxial) and of the inner (adaxial) surfaces of the cataphyll are diagnostic characters for a species. The adaxial surface has a whitish pearly sheen in most species, but some have darker adaxial surfaces that are darkish golden brown but still often with a pearly sheen. Whether the cataphylls in section *Juncotypus* tightly enclose the base of the subtended culm or are loose around it is characteristic for each species.

Inflorescences are terminal but appear lateral in the section *Juncotypus* because of the well-developed lowermost involucral bract that usually pushes the associated inflorescence to one side. Their structure is racemose in subgenus *Juncus* and cymose in subgenus *Poiophylli* (see discussion and references in Novara (1976) and Balslev (1996)), corresponding to the absence or presence of bracteoles under each flower.

Each branch of an inflorescence is subtended by a bract. The lowermost one or two *involucral bracts* in most species are much larger and more leaf-like in form than those higher in the inflorescence (which are often scale-like, and are termed *floral bracts* when they subtend the ultimate inflorescence branches, each bearing a flower). In section

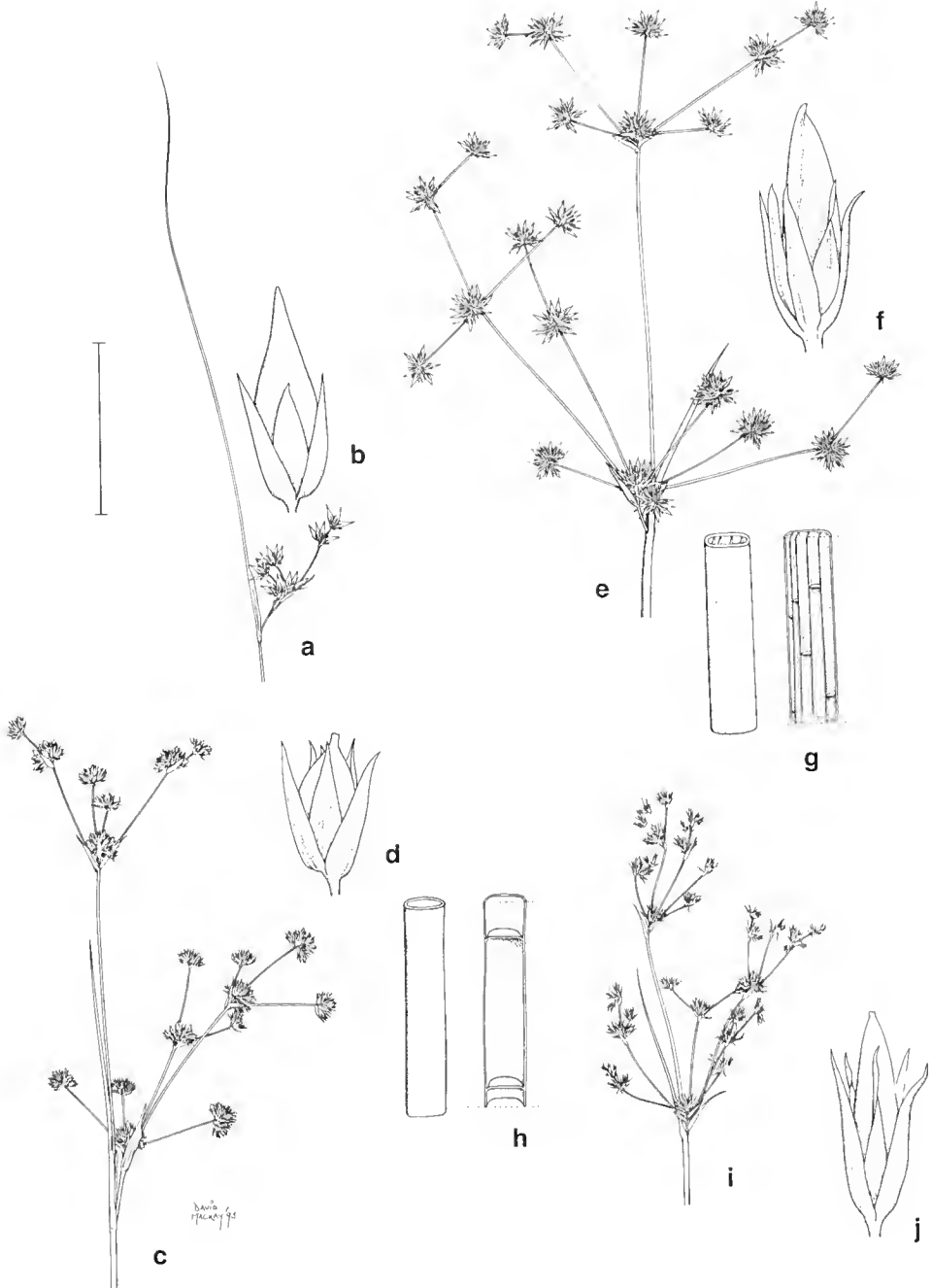


Fig. 1. *Juncus sandwithii*: a, inflorescence; b, flower (from A.C. Beauglehole 25006 (NSW)). *J. wallichianus*: c, inflorescence; d, flower (R.D. Hoogland and R. Schodde 7478 (NSW)). *J. prismatocarpus*: e, inflorescence; f, flower; g, pluritubulose leaf and cross-section (e, f from C. Fraser (NSW 241448); g from L.A.S. Johnson 7621 et al. (NSW)). *J. holoschoenus*: h, unitubulose leaf and cross-section (from A. Meebold 21882 (NSW)). *J. leschenaultii*: i, inflorescence; j, flower (from J. Ohwi and T. Koyama NSM 310, Japan (NSW)). Scale bar = 4 cm (a, c, e, i), = 3.5 mm (b, d, f, j), = 7.5 mm (g, h).

Juncotypus, the lowest involucre bract is culm-like and appears to be a continuation of the culm. The length of these involucre bracts relative to the associated inflorescence is often characteristic for a species. A specialised 2-keeled bract, the *prophyll*, is present adaxially above the bract at the base of inflorescence branches. Prophylls are most readily seen on the main inflorescence branches of fresh specimens with expanded inflorescences.

Flowers are generally numerous in an inflorescence, but are occasionally reduced to just a few flowers, as in *J. sandwithii*; this, of course, can also be the case with depauperate individuals of other species. Flowers are solitary or in dense (many-flowered) or loose (few-flowered) clusters. There is some intraspecific variation in number of clusters and in number of flowers per cluster. Each flower is on a pedicel (ultimate inflorescence branch), which is subtended by a small rather papery floral bract. Besides the bract, two small, papery bracteoles are present below each flower in subgenus *Poiophylli* (represented in Malesia only by sections *Teuageia* and *Juncotypus*). These bracteoles are what Buchenau (1890, 1906 and other references therein) confusingly referred to as prophylls. In some species, there may appear to be three bracteoles below the flower, which Barnard (1958) explains as (2 bracteoles + 1 bract), resulting from abortion of a lateral branch below the flower leaving only the floral bract associated with that lateral branch. In other species, the number of 'extra' bracts below the flower may be as high as three (e.g. in the Australian *J. homalocaulis* F. Muell. ex Benth., pers. obs.). Inexperienced observers may even count the 2-keeled prophyll in small, crowded inflorescences as an extra bracteole since the keels are sometimes obscure and the prophyll is often of similar colour and texture to the bracts and bracteoles. Given the difficulty of interpretation, using bracteoles as a key character for identification may cause confusion and should not be relied on.

The six *tepals* are in two whorls, which often differ in their features. The outer three tepals tend to be somewhat convex and may be cucullate towards the apex, while the inner three tepals are usually more or less flat and are often broader and more obtuse than the outer. For the descriptions, the length of convex tepals is measured *around* the curve. Nearly all tepals begin green but by maturity have usually become straw-coloured (this is, of course, accentuated when dried) or in some species red-brown, rarely so dark as to appear black. Only colour at maturity is given in descriptions.

The loculidial *capsules* are unilocular (e.g. *J. leschenaultii*), 3-locular (e.g. *J. decipiens*) or 3-septate (i.e. incompletely 3-locular; *J. uupela* fide J.F. Veldkamp 1977), with corresponding parietal or axillary placentation (Satake 1933 and references therein). As pointed out by Balslev (1996), the septa (called placentas or partitions by some authors) occasionally develop late, so care is needed in interpreting the structure of immature capsules, especially when dried. In some species, the capsule is 3-locular but with the septa separating near the apex so that it looks 3-septate apically (as discussed and illustrated for *J. confusus* by Catling and Spicer 1987: fig. 7).

Capsule length relative to the tepals is characteristic for a species. The *apex of the capsule* is acute to obtuse and mucronate in most species, but in some species in section *Ozophyllum* (notably *J. leptospermus* Buchenau, *J. papillosus* Franch. & Sav., *J. prismatocarpus*, *J. sandwithii* and *J. wallichianus* p.p.) the capsule is elongated into a beak that often much exceeds the tepals.

All Malesian species are wind-pollinated so far as known, except that *J. bufonius* is mostly or possibly exclusively cleistogamous (Buchenau 1906: 27; Knuth 1909; Arber 1925; Snogerup 1985; Keighery 1985, fig. 1). Barros (1953: 286) and Keighery (1985) suggested that species are generally cross-pollinated, owing to flower development being usually protogynous (Müller 1883: 561) but that all are also capable of self-fertilization, particularly through cleistogamy. In practical terms, this can often be

inferred from the presence of old anthers adhering to the old stigmas near the apex of the capsule, the anthers having stuck to the moist papillate stigmas within the closed flower then having been ripped off the filaments by the enlargement of the ovary into the capsule — seen, for example, in *J. capillaceus* (pers. obs.) and noted in *J. bufonius* by Arber (1925: 187).

The genus *Juncus* in Malesia

Previous treatment

Backer (1951) recognised four *Juncus* species in Malesia: *J. bufonius* L., *J. effusus* L., *J. inflexus* L. and *J. prismatocarpus* R. Br.

As he noted, *J. bufonius* is probably an adventive species in that region. It is known only from a few disturbed localities on Mt Kinabalu (Borneo) and Mt Santo Tomas (Luzon).

He did not comment on the status of the occurrence of *J. inflexus* in eastern Java, but that is probably also an introduction, since the species has its main native distribution in Europe, northern Africa, southwestern and central Asia (it is sporadically adventive in Australia and New Zealand). He regarded some collections from eastern Java (Tengger and Jang Plateau, 2100–2300 m alt. (Backer 1924)) with continuous pith but otherwise like typical *J. inflexus* as possibly representing the hybrid *J. effusus* × *J. inflexus*, but with doubt since they produced abundant fruit (Backer and Backhuizen f. 1968).

J. effusus is a similarly widespread species in Europe, Western Asia and North America, and is also introduced in other parts of the world such as Australia and New Zealand. What Backer regarded as *J. effusus* in Malesia is here separated as *J. decipiens* (Buchenau) Nakai, a species native to continental Asia and Malesia.

Confusion has surrounded the limits of *J. prismatocarpus*, with a wide range of names treated as synonyms or as infraspecific taxa in Asia and Malesia, including at times both unitubulose and pluritubulose taxa, for example in Buchenau (1890, 1906) and Van Royen (1979). We regard *J. prismatocarpus* as a pluritubulose-leaved species restricted to Australia and New Zealand. The Malesian material that Backer put under that name is referable partly to *J. leschenaultii* J. Gay ex Laharpe (with pluritubulose leaves) and partly to *J. wallichianus* Laharpe (with unitubulose leaves). Both species are also in continental Asia. Given the confusion about the limits of *J. prismatocarpus*, a separate discussion of this and morphologically similar species in Malesia and continental Asia follows this Malesian treatment.

More recently, Veldkamp (1977) described a new species from Papua New Guinea, *J. impela*, and recorded the occurrence of *J. bufonius* on Mt Kinabalu (Veldkamp 1982).

The only known collection of *J. sandwithii* from Papua New Guinea was made in 1974 by J. Croft. Wilson (1986) mentioned the occurrence of the species in that country but without giving any details since the collection was from a non-alpine locality and therefore not the subject of the paper.

Key to species found in Malesia

Note. The non-Malesian *J. prismatocarpus* is included in the key for ease of comparison. This key is designed to be used with fertile, preferably fruiting, specimens. It is difficult to identify immature specimens of this genus when parts have not reached their maximum size. When bracteoles are present under a flower, the number is

constantly two (see discussion above under **Characteristics**), but this may be difficult to discern in small or dense inflorescences or where there has been abortion of some flowers leaving extra bracts on a branch.

- 1 Leaves flat, canaliculate, terete, or filiform, spread along the culms or all basal (if terete, leaves septate and spread along culms); inflorescence obviously terminal [capsules 1- or 3-locular]
 - 2 Leaves neither septate nor loosely pith-filled, flat or slightly canaliculate, mostly basal; auricles absent but often with hyaline margins narrowing abruptly at top of sheath; annuals; flowers subtended by 2 bracteoles; capsule 3-locular (Section *Tenageia*) – 4. *J. bufonius*
 - 2* Leaves septate (if filiform, septa are not obvious), hollow or with very loose pith between septa, terete or dorsiventrally flattened, spread along culms; auricles present; perennials; flowers not subtended by bracteoles; capsule 1-locular (Section *Ozophyllum*)
 - 3 Leaves unitubulose (i.e. with transverse septa only) and/or leaves less than 1 mm in diameter and therefore not easy to determine position of septa
 - 4 Stamens 6; dwarf plants with culms to c. 10 cm long at maturity; leaves more or less filiform, usually less than 1.0 mm diam., with septa usually not obvious; auricles 0.5–0.8 mm long; capsule golden brown, usually much exceeding tepals, with long, tapering beak 0.5–1.3 mm long 1. *J. sandwithii*
 - 4* Stamens 3; plants with culms mostly 30–60 cm long; leaves 1.0–1.4 mm diam., with septa obvious; auricles 0.7–3 mm long; capsule golden brown to red-brown, shortly exceeding or equalling tepals, extending into a shortish beak (0.2–0.5 mm long) 2. *J. wallichianus*
 - 3* Leaves pluritubulose, more or less compressed [stamens 3 (rarely 6)]
 - 5 Capsule apex acute to broad-acute, without beak or with short beak to 0.2 mm long; capsule slightly exceeding (to 1 mm) or equalling tepals; upper margins of leaf sheaths more or less narrow (to 0.8 mm wide); culms 1.0–1.5 mm wide 3. *J. leschenaultii*
 - 5* Capsule tapering more or less evenly to long-acuminate apex, with slender beak c. 0.3 mm long; capsule exceeding tepals by 1–3 mm (to twice as long); upper margins of leaf sheaths usually broad (to 1.5 mm wide); culms 1.3–3 mm wide 9. *J. prismatocarpus*
- 1* Leaves reduced to basal sheathing non-septate cataphylls (but pseudo-leaf shoots [= sterile culms] can be long, terete and leaf-like); inflorescence apparently lateral, with the lowest involucral bract well-developed and appearing superficially to be a continuation of the culm; capsules 3-locular or 3-septate [flowers subtended by 2 bracteoles (bracteoles can appear to be more numerous by abortion of lateral flowers, leaving relictual bracts — see text); perennials] (Section *Juncotypus*)
- 6 Culms glaucous, with few (10–22) broad striations, widely spaced (c. 0.2 mm apart) [pith interrupted or rarely continuous] 6. *J. inflexus*
- 6* Culms not glaucous, with 20–c. 50 fine striations or striations not obvious (*J. nupela*), closely packed
 - 7 Culm striations obvious, strongly defined at least on the dried culm surface; tepals 2–4 mm long; stamens 3; capsules 3-locular
 - 8 Culms soft, easy to compress between the fingers; pith continuous; cataphylls dark red-brown at least near base abaxially 5. *J. decipiens*
 - 8* Culms hard to compress between the fingers; pith interrupted; cataphylls dark golden brown abaxially 7. *J. durus*
 - 7* Culm striations faint, not clearly defined on culm surface; tepals 5.5–6 mm long; stamens 6; capsules 3-septate [pith continuous; cataphylls dark golden brown] 8. *J. nupela*

Description of species found in Malesia

Juncus L.

(Linnaeus 1753: 325; 1754: 152).

Type: *Juncus acutus* L.; lecto Coville in Britton and Brown (1913: 465).

Perennial or annual herbs. Culms terete or occasionally compressed. Leaves basal or occasionally 1–3 cauline, auriculate (except in reduced leaves and *J. bufonius*); blades flat, terete, channelled, compressed or reduced to a mucro on a sheath (a cataphyll; in sect. *Juncotypus*), internally septate or hollow or filled with loose pith. Lowest 1 or 2 involucre bracts leaf- or culm-like. Flowers bisexual or rarely unisexual (not in Malesia), clustered or solitary, subtended by 1 papery bract and a 2-keeled adaxial prophyll, with or without 2 papery bracteoles (may appear more numerous owing to abortion of lateral flowers). Outer whorl of tepals exceeding to shorter than inner whorl. Stamens 3–6. Capsule loculicidal, 1- or 3-locular or 3-septate. Seeds numerous, occasionally with appendages (not in Malesia). World: c. 300 spp., cosmopolitan. Rushes.

In Malesia: 6 native species (2 endemic), plus 2 introduced species.

1. *Juncus sandwithii* Lourteig

(Lourteig 1968: 44, figs 1E, 3B)

Type: Australia: Tasmania: Arthurs Lake, *R. Gunn 1414*, 17 Jan 1845; holo P; iso BM (n.v.), C (n.v.), HO, K, L (n.v.), P, S (n.v.), WU (fide J. Kirschner, pers. comm.).

Small, shortly rhizomatous perennial, more or less mat-forming. Culms terete, yellow-green, 1–10(–15) cm long, 0.3–0.8 mm diam. Leaves unitubulose, spread along culms, greater than or equalling or occasionally much exceeding culms (to three times as long), terete, 0.2–0.7(–1.2) mm diam.; auricles c. 0.5 (–0.8) mm long. Inflorescence terminal, 1–2(–9) cm long, diffuse, with flowers clustered or solitary, 2–4(–10) flowers per cluster and 1–4(–6) clusters per inflorescence, with branches to 3.5 cm long; 1 well-developed involucre bract, 0.4–5.0(–15) cm long, lateral, usually equalling to much exceeding inflorescence (occasionally shorter). Flowers without bracteoles. Tepals acute, straw-brown, occasionally red-tinged, usually with broad (c. 0.2 mm wide) hyaline to membranous margins; outer tepals (1.7–)2.0–3.3 mm long, slightly exceeding to slightly shorter than inner tepals. Stamens 6, shorter than outer tepals; anthers (0.4–)0.5–0.7 mm long, shorter than filaments. Capsule 1-locular, usually much exceeding outer tepals, ellipsoid to ovoid, golden brown, acuminate, very long-beaked (0.5–1.3 mm long). Seeds 0.4–0.5 mm long.

Illustrations: Fig. 1a, b; also Lourteig (1968: figs 1E, 3B); Wilson et al. (1993: 287).

Distribution and habitat: In Malesia, only one record from a swamp-grassland on the SE slopes of Mt Victoria (Papua New Guinea) at 2700 m altitude. It is recorded as growing there at the edge of water in a small stream. Its main distribution is in Australia (New South Wales, Victoria, Tasmania; Lourteig 1968: map 1)); from Bald Rock on the Queensland–New South Wales border south, at higher altitudes including subalpine areas, to the Grampians in western Victoria; more widespread in Tasmania.

Notes: This dwarf species is distinctive in having the capsule about twice as long as the perianth, with a very long, tapering beak 0.5–1.3 mm long. It previously included the Australian species *J. curtisiae* L.A.S. Johnson, *J. thompsonianus* L. A.S. Johnson and *J. ratkowskyanus* L.A.S. Johnson (Johnson 1991).

The description is based on the full range of variation seen in this species. The flowers of the only New Guinean collection fall at the upper end of the size range, with tepals about 3 mm long, the anthers are about 0.6 mm long and the beak on the capsule about 1 mm long. Its culms are of middling height (3–5 cm) and the leaves exceed the culms by 3–6 cm.

Selected collections examined: PAPUA NEW GUINEA: SE end Iusani grassland, SE slopes to Mt Victoria, 2700 m, J.R. Croft LAE 61840, 6 July 1974 (A (n.v.), BISH (n.v.), BRI, CANB, E (n.v.), K, L (n.v.), LAE (n.v.), M (n.v.), NSW, US (n.v.)).

AUSTRALIA: New South Wales: c. 3.5 km S of Conways Gap, Wadbilliga National Park, D. Albrecht 1706, 27 Mar 1985 (MEL, NSW); Gloucester Tops, R. Coveny s.n., 1 Jan 1967 (NSW 94865, P); Corin Dam road, near Kangaroo Creek, M. Gray 5873, 18 Jan 1966 (CANB, NSW); Luthers Creek, c. 15 km from Jenolan Caves, Kanangra Boyd National Park, R. Coveny 17473, P. Jobson and M. Muasya, 11 Jan 1997 (CANB, K, NSW, NY); Diggers Creek, Kosciusko district, L. Johnson and E. Constable, 26 Jan 1951 (NSW 19334, P); Prussian Creek, Kosciusko National Park, J. Thompson 2455 p.p., 24 Jan 1976 (AD, BRI, CBG, CHR, HO, K, L, MEL, MO, NSW); NE edge of Bald Rock dome, Bald Rock National Park, K. Wilson 6962, 27 Nov 1986 (BRI, HO, NSW).

Victoria: Jimmys Creek, Grampians road, A. Beauglehole 16432, 12 Dec 1967 (MEL, NSW); Lake Catani, Mt Buffalo National Park, E. Canning 1789, 15 Jan 1969 (CANB, NSW); Cumberland Falls road, E of Marysville on Main Divide, L. Johnson 7671 and A. Johnson, 24 Apr 1973 (NSW); Upper Delegate River, near Bidwell, R. Melville 2955, N. Wakefield and E. Hunter, 19 Jan 1953 (K, NSW).

Tasmania: Scotts Peak Road E Fawcett Creek, D. and A. Ratkowsky s.n., 25 Feb 1974 (HO, NSW 276209) of Lake Pedder, W. Curtis s.n., 20 Feb 1970 (HO, NSW 276213); Mt Wellington, D. Ratkowsky JS 111 and A. Ratkowsky, 4 Jan 1974 (NSW); junction of Scotts Peak road and Condominium Creek, South West National Park, P. Short 1798, 21 Jan 1983 (MEL, NSW); Douglas Creek, just N of Arm River Track crossing, Cradle Mtn–Lake St Clair N.P., K. Wilson 8308 a, 24 Mar 1992 (HO, MEL, MO, NSW).

2. *Juncus wallichianus* Laharpe

(Laharpe 1825: 51 [1827: 139])

J. prismatocarpus [var. *leschenaultii*] subvar. β *unitubulosus* Buchenau (Buchenau 1890: 311).

Type citation: 'envoyé du Napaul, par M. Wallich, à M. le professeur De Candolle'.

Type: Nepal, Wallich, 1821; holo LAU?; probable iso G, TI (n.v.), W (hb. Buchenau ex hb. E. Meyer). No number is cited for the Wallich collection but it is apparently a sheet of Wallich 8999 (accepted as such by Buchenau (1885: 205, 1890: 312, 486) and J.F. Veldkamp, pers. comm.). One sheet is in the general herbarium at G, labelled as 'Herbier de Candolle' and determined by Buchenau in 1884 as '*J. wallichianus* Laharpe specimen authenticum'. Another sheet of this collection is the type of *J. indicus* (q.v. below).

?*J. sinensis* J. Gay ex Laharpe (Laharpe 1825: 49 [1827: 137]). Type citation: 'la Chine (Staunton, in herb. Lambert et DC.) et le Japon (Thunberg in hb. De Less.) ... (V.s.sp. in herb. DC. et De Lessert.)'. Types: China, Staunton; syn G (n.v.), P. Japan, Thunberg; syn G (n.v.). We have not seen the syntypes apart from one sheet of Staunton in P that is a possible isosyntype, and that is of *J. leschenaultii*. However, from the description, *J. sinensis* seems to fit within *J. wallichianus*, a view supported by its inclusion (with some doubt, owing to the poor specimens) by Buchenau (1906: 182) as a synonym under *J. prismatocarpus* subvar. *unitubulosus*.

J. monticola Steud. (Steudel 1855: 301). Type citation: 'Hb. Hohenkr. nr. 951. In montibus Nilagiri Ind. or. (Japon ? Hrbr. Goering nr. 136 sect. II).' Type: India: in montibus Nilagiri, R.F. Hohenacker Pl. Indiae ... 951, 1851; lecto (*here chosen*) P; isolecto K, L, P, W.

The Goering collection is cited in brackets and with a question mark, so it is appropriate to lectotypify the name on the Hohenacker collection. In Steudel's

herbarium in P there are three sheets of that collection and one of the Goering collection. The sheet chosen as lectotype is that fully labelled in Steudel's hand. There are five more sheets of the Hohenacker collection in P that are not identified as being from Steudel's herbarium.

J. indicus Royle ex D. Don (Don 1840: 323). Type citation: 'Juncus indicus ... Royle mss. α. In Nepalia ad Katmandu (Wallich) ... (vs.sp. in Herb. Wallich ...)'. Type: Nepal, Wallich 8999, 1821; syns G (n.v.), K (3 sheets; one shown on IDC microfiche 7394). Another sheet of this Wallich collection is the type of *J. wallichianus* (q.v. above). Don also cited a Royle specimen but referred it to his var. *nanus* (q.v. below under *J. leschenaultii*). *J. indicus* is often said to have been published in Don (1849: 10) under the wrong date of 1839, which was actually the date on which the paper was read to the Society (Raphael 1970).

J. koidzumii Satake (Satake 1936: 89). Type citation: 'Honsyu: Prov. Settu — circa Takarazuka (N. Ui, Aug. 4 1934 — Typus in Herb. Imperial Univ. Tokyo)'. Type: Japan: Honshu: Hyogo Pref., Takarazuka, N. Ui s.n., 4 Aug 1934; holo TI; iso K.

J. ohwianus M.T. Kao (in Kao and De Vol 1978: 150, pl. 1303). Type citation: 'Hsinchu: Supachian, Simada 1027 (Type in TAI)'. Type: Taiwan: Sintiki (18 sen[?]), Y. Simada 1027A, 12 Aug 1923; holo TAI.

J. prismatocarpus subsp. *teretifolius* K.F. Wu (Wu 1994: 456). Type citation: 'Guandong: Conghua, Sanjiao Shan, satis communis in arenosis et paludibus, 1932-05-31, W.T. Tsang 20636 (holotypus, IBSC)'. Type: China: Guandong (Kwangtung): Sam Kok Shan, Tsungfa-Lungmoon District, Kwangtung, W.T. Tsang 20636, 31 May 1932; holo IBSC (n.v.); iso K. Note that the transliteration of the Chinese ideograms for the locality is very different in 1932 and 1994, but the ideograms themselves are the same on the label and in the publication.

[*J. prismatocarpus* auct. non R. Br.: Backer 1951: 213 p.p.; Larsen 1972: 168, p.p.; Van Royen 1979: 815 p.p.]

Tufted or shortly rhizomatous perennial. Culms terete, ?mid-green, 30–60 cm long, 1.0–1.8 mm diam. Leaves unitubulose, spread along culm, more or less equalling culms, terete, 1.0–1.4 mm diam.; auricles 1.5–2.0 mm long. Inflorescence terminal, 1–12 cm long, diffuse, with flowers clustered, 4–40 per cluster and 6–20 clusters per inflorescence; 1 well-developed involucre bract, 2.5–7 cm long, lateral, shorter than inflorescence. Flowers without bracteoles. Tepals acuminate, the tips spreading to recurved at maturity, straw-brown (often red-tinged at apex) to red-brown, with more or less broad (0.1–0.2 mm wide) hyaline margins; outer tepals (2.3–)2.5–3.5(–3.7) mm long, more or less equalling inner tepals. Stamens 3, shorter than outer tepals; anthers 0.4–0.7 mm long, shorter than filaments. Capsule 1-locular, shortly (occasionally greatly) exceeding or equalling outer tepals, ovoid to narrow-ellipsoid, golden brown to red-brown, acute to broad-acute, with more or less short beak (0.2–0.5 mm long). Seeds 0.6–0.8 mm long.

Illustrations: Fig. 1c, d; also Kao and De Vol (1978: pl. 1303, as *J. ohwianus*).

Distribution and habitat: In Malesia, at higher altitudes (1500–2900 m) on the islands of New Guinea, Java (West and Central), Sumatra (West; only one collection); also in Sri Lanka, India, Bhutan, Nepal, Thailand, China (Yunnan), and Japan. Recorded also for North Korea, Eastern Manchuria, the Sachalin Islands and the Kuriles by Kitagawa (1979: 163), but we have seen no specimens from these regions. Recorded as growing in swamps and along small streams and ditches. According to Backer (1924: 44; Backer and Bakhuizen f. 1968: 451), '*J. prismatocarpus*' (that is, either *J. leschenaultii* or *J. wallichianus* or both in this context) occurs on the mountains in West, Central and East Java. However, Backer (1951: 214) does not mention East Java for this 'taxon' and

we have not seen specimens of either species from East Java. *J. wallichianus* seems to be more common in Central Java than in West Java and vice versa for *J. leschenaultii*.

Notes: Despite having unitubulose leaves, this species has been confused in New Guinea and elsewhere with the more robust, pluritubulose Australasian *J. prismatocarpus*. Buchenau also linked it with the more slender, pluritubulose *J. leschenaultii* as infraspecific taxa together under *J. prismatocarpus*. This species differs from both *J. prismatocarpus* and *J. leschenaultii* in having terete, unitubulose leaves and culms, tepals that are frequently reddish or red-tinged, and a broader capsule. It also differs from *J. leschenaultii* in being generally more robust, and having tepals with broader hyaline margins (especially so in New Guinea), usually broader (1–2 mm wide) yellowish membranous or chartaceous leaf margins (narrower and hyaline or whitish membranous in *J. leschenaultii*), and a capsule that is usually acute to broad-acute, contracting rather abruptly to a shortish beak.

This is a variable species, as currently recognised by us, including several possibly distinct forms in India, Nepal, Yunnan, Java and New Guinea. More material is needed to better assess the extent of this variation. The New Guinea material differs from much of the other material in having the capsule only slightly exceeding the tepals whereas elsewhere it often greatly exceeds the tepals. The New Guinea material has rather broader capsules and tepals 2.5–3 mm long. The Javan material matches material from southern India (equating to *J. monticola* Steud., if that taxon is ever separated from *J. wallichianus*), with the capsule usually exceeding or equalling the tepals, the capsule more or less long-acute, the tepals 3–3.7 mm long and pale. The concept of *J. monticola* has been confused in the literature by some authors who have used the name for a pluritubulose species, for example, Walker (1976) used it instead of *J. wallichianus*, putting the latter into its synonymy.

Satake (in Hara 1966: 403) cited his own species *J. koidzumii* Satake as a synonym of '*J. monticola*'. The type of *J. koidzumii* (seen on loan from TI) fits within the variation that we recognise here within *J. wallichianus*. It is proliferous, but that is not unusual in *J. wallichianus*, which often proliferates from the flower clusters.

Selected collections examined: SUMATRA: En route from Simpangtanjungnanempat to Danau (Lake) Talang, Kabupaten Solok, 1650–1740 m, *H. Nagamasu* 3738, 25 Feb 1989 (L).

JAVA: Dieng Plateau, *R. Brinkman* 877a, Apr 1938 (L); SE Java, *H. Forbes* 923, 1880–82 (BM, P); Marais de Dieng, 2050 m, *B. Hochreutiner* 2444, 6 Nov 1904 (L); s. loc., *T. Horsfield* 1074, – (BM); Dieng Plateau, Talaga Warna near Sulphur Springs, 2000 m, Central Java, *W. Meijer* 2778, 30 Apr–1 May 1954 (K, L); Res. Priangan, G. Papandajan, 2400 m, *C. van Steenis* 4090, 21 Jan 1930 (K).

NEW GUINEA: West Papua: 3225 m camp, Lake Habbema, *L. Brass* 9046, Aug 1939 (BRI, CANB, K, L); Wissel Lake region, 1750 m, *P. Eyma* 4388, 22 Jan 1939 (L); Angi Lakes, 7000 ft [1235 m], *L. Gibbs* 5927, Dec 1913 (BM, K); Arfak, Angigita Lake, 1800 m, Vogelkop, *A. Kostermans* 2209, 9–22 Oct 1948 (L); Baliem–Wamena river valley, N of Mt Trikora, grassland at 3100 m, *J.-F. Mangen* 617, 25 Aug 1983 (L); Anggi Gita Lake, Bivouac Noordpool, 1850 m, *H. Steuener* BW 14019 and *W. Vink*, 9 Jan 1962 (CANB, L); E foot of Pekeglbaro, Kebo, Wissel Lakes, 1760 m, *W. Vink* BW 8960 and *E. Schran*, 28 May 1960 (CANB, L, LAE).

Papua New Guinea: Urunu, Vanapa Valley, *L. Brass* 4804, July–Aug 1933 (BRI); Kosipi, near Weitape, 1860 m, Central Distr., *L. Craven* 2805, 2829, 28 June 1974 (CANB); Lake Inim, 8300 ft [2660 m], *J. Flenley* ANU 2157, Dec 1964 (CANB, L); Ibiwara, Tari Gap, 8400 ft [2700 m], *A. Gillison* NGF 25104, 8 June 1966 (CANB, K, L, LAE (n.v.)), NGF 25169, 17 June 1966 (L, LAE (n.v.)); near Miruma village, Upper Asaro Valley, c. 1800 m, Goroka Subdistrict, *R. Hoogland* and *R. Pullen* 5394, Jun 1956 (BM, BRI, CANB, K, L, MEL); near Tomba village, S slope of Mt Hagen Range, c. 2650 m, Hagen Subdistrict, *R. Hoogland* 6024 and *R. Pullen*, Aug 1956 (BM, BRI, CANB, L, MEL); along Komum River, E of Korn, Upper Wahgi Valley, c. 1500 m, Hagen Subdistrict, *R. Hoogland* 6244 and *R. Pullen*, Sep 1956 (CANB, L); Sugarloaf complex [along Wapu River], c. 9500 ft [c. 2900 m], Wabag Subdistrict, *R. Hoogland* 7176 and *R. Schodde*, July 1960 (CANB, L); Yobobos grassland area [source

of Lagaip River], Laiagam Subdistrict, *R. Hoogland* 7478 and *R. Schodde*, Aug 1960 (CANB, L, NSW); Mannasat, Cromwell Mtns, Huon Peninsula, Morobe District, *R. Hoogland* 9436, July 1964 (CANB, L); Kosipe Swamp, Wharton Range, 1936 m, Central Prov., *G. Hope* ANU 28035, 28 Dec 1979 (CANB); Manki Trig, Bulolo, Wau Subdistrict, *A. Kairo* NGF 30957 and *H. Streimann*, Dec 1967 (CANB, L, LAE (n.v.)); pass between Mt Ne and Mt Kerewa, 2905 m, Tari Subdistrict, *C. Kalkman* 4843, 11 July 1966 (CANB, K, L, LAE (n.v.)); Korfina, 6700 ft [2050 m], Goroka Subdistrict, *A. Millar* NGF 15947 and *P. Van Royen*, Aug 1963 (CANB, K, L, LAE (n.v.)); near Kusipi, N of Waitape, *K. Pajmans* 710, Aug 1970 (CANB); Ogelbeng–Gumanch road, c. 5000 ft [c. 1500 m], Hagen Subdistrict, *R. Robbins* 86, June 1957 (CANB, LAE, NSW); road above Tomba, 8000 ft [2450 m], Hagen Subdistrict, *R. Robbins* 273, July 1957 (CANB); Tambil, 7500 ft [2300 m], Kaugel Valley, Hagen Subdistrict, *R. Robbins* 379, July 1957 (CANB, L), 391, July 1957 (CANB, NSW); Sirunki, Lake Iviva, Wabag area, 8200 ft [2500 m], *R. Robbins* 3165, 3170, Aug 1960 (CANB); Kandep Valley, 7500 ft [2300 m], 20 miles [32 km] S of Laiagam, Wabag area, *R. Robbins* 3237, Aug 1960 (CANB); Soak Zone, Lake Onim, 2250 m, *A. Vinas* UPNG 2535, 9 Sep 1983 (L); Sirunki, c. 8400 ft [c. 2550 m], *D. Walker* ANU 381, July 1962, ANU 511, Aug 1962 (CANB, L, LAE (n.v.)); Lake Iviva, 8300 ft [2550 m], *J. Womersley* NGF 15295, July 1962 (L, LAE).

CHINA: S. Fukien, *H.H. Chung* 1706, 1923 (K); Hong Kong, *U. Faurie* 15823, 19 Mar 1895 (K); Yunnan, Sjemon, W. Mts, 5000 ft [1500 m], *A. Henry* 11920, – (K); Lin Yin Temple, Hang Chow, Chekiang Prov., *E.D. Merrill* 11297, 20 June 1922 (K); Canton, *T. Sampson*, 30 Apr 1884 (K); Haishan, Yuintaishan Ku, *Shantung University Collection*, Aug 1924 (K); Shiuchow Region, Kwong Tung Province, *To Kang P'eng* 2870 and *E.H. Groff*, Apr 1919 (K); Sam Kok Shan (Tsunga-Lungmoon Districts), *W.T. Tsang* 20636, 31 May 1932 (K, P).

JAPAN: Sado, *U. Faurie* 1794, 26 Sep 1898 (P); Plaine d'Hakodate, *U. Faurie* 3208, 18 Oct 1887 (K, P), *U. Faurie* 3343, 27 Sep 1888 (K); Hidaka, Fuyushima, Hokkaido, *H. Hara*, 10 Aug 1933 (TI); Aida, Prov. Higo, *K. Mayebar* 2042, 17 July 1927 (TI); Yokohama, Kiusiu, *C. Maximowicz*, *Iter Secundum*, 1863 (K ex LE, 2 sheets (2nd with Yokohama crossed out)); Naruto Shima, Prov. Kazusa, *H. Migo*, 4 July 1932 (TI); Hakodate, Yezo, Hokkaido, *T. Satow* 5311, 1926 (TI); Hyogo Pref., Takarazuka, Honshu, *N. Uli*, 4 Aug 1934 (TI); Kushi-nura, along Henoko River, Kunigami, Okinawa (Ryukyus), *E. Walker et al.* SIRI 6445, 7 Aug 1951 (L); Ikeda, Tokachi, *H. Yotoyama* 3189, 3 Aug 1936 (TI).

THAILAND: Chiang Mai: Doi Intanon, alt. 1400–1700 m, *K. Larsen and S. Larsen* 34514, 13 Sep 1974 (AAU (n.v.), P); Om Koi to Om Haet, 1100 m, *B. Hansen* 10857, *G. Seidenfaden and T. Smitinand*, 1964 (AAU (n.v.), L).

LAOS: Mau Cay Ep, Tourbière Ho Trucbach, — 645, 12 May 1967 (P).

BHUTAN: Rechi La, 10,000 ft [3050 m], Bhutan, *H.H. Haines* 2025, Sep 1904 (K; 2 sheets; very immature specimen).

NEPAL: Descent from Buje Danda to the Tamur River, 2000 m, *Kew–Edinburgh–Kathmandu Expedition* 130, 31 Aug 1989 (K); near Gurjakhani, alt. 8500 ft [2600 m], *Stainton, Sykes and Williams* 3681, 30 July 1954 (P ex BM); Nepal, *N. Wallich* 8999, 1821 (K, 2 sheets — type no. of *J. indicus*); Nepal, *N. Wallich* (W ex LE).

INDIA: Pykaia, Nilgiris District, 6000 ft [1830 m], Madras, *J.S. Gamble* 12050, June 1883 (K); Pl. Indiae or. (M. Nilagiri), *R.F. Hohenacker* 951 – *Juncus monticola* Steud. var. *capitulis nudis* (K, L, NSW, P, W); in montibus Nilagiri, Madras, *R.F. Hohenacker* 951a – *Juncus monticola* Steud. var. *capitulis foliolata-proliferis*, 1851 (K, P, W); Sikkim, 9–10,000 ft [2750–3050 m], *J.D. Hooker*, 3 Aug 1849 (K); Khasia, 4–6000 ft [1220–1830 m], *J.D. Hooker and T. Thomson* (K, W); Lailynkat, Khasi Hills, c. 6000 ft [1830 m], Assam, *Thakur Rup Chand* 1819A, 16 July 1949 (L ex MICH); Kodaikanal [Palni Hills – SW Peninsula], 5000 ft [1500 m], *B. Nijalingappa* 36, 30 Dec 1966 (K); Shembaganur, 6000 ft [1830 m], Madras, *A. Sauvière* 2, 20 May 1913 (K).

SRI LANKA: Horton Plains, stream near Farr Inn, Badulla District, 2300 m, Province of Uva, *D. Clayton* 5518, 27 Jan 1970 (K); Central Province, Horton Plains, 7000 ft [2100 m], *G. Davidse* 7605, 17 Oct 1974 (K); Ceylon, *Gardner* 927 (K, 2 sheets); Ceylon, 6000 ft [1830 m], *Col. Walker* 99, – (K–hb. Hook. 1867).

3. *Juncus leschenaultii* J. Gay ex Laharpe

(Laharpe 1825: 49 [1827: 137])

J. prismatocarpus var. β *leschenaultii* (Laharpe) Buchenau (Buchenau 1885: 205).
J. prismatocarpus [var. β *leschenaultii*] subvar. α *pluritubulosus* Buchenau (Buchenau 1890: 311).

Type citation: India: 'Recuellie dans les montagnes de Nelly-gerry (presqu'île occidentale de l'Inde) par M. Leschenault ... (V. s. sp. in herb. Mus. Par).'

Type: India: les montagnes de Nelly-gerry [Nilgiri Mountains], *Leschenault*; holo P; iso K.

?*J. indicus* var. β *nanus* D. Don (Don 1840: 323). Type citation: ' β in Emodi montibus ad Mussooree, Royle ... (v.s.sp. ... in Herb. ... Royle).' Type: Nepal, *Royle*; holo LIV? (n.v.); ?iso K. We have not seen the holotype but the probable isotype in K is *J. leschenaultii* (it is labelled as 'NW India, Hb. Royle'). This agrees with Buchenau's opinion (1890: 313; 1906: 181) that this and *J. unibracteatus* were examples of 'subvar. *pluritubulosus*' flowering in the first year of growth. On the other hand, the description suggests that this is possibly a small example of *J. wallichianus*, as implied by Don himself in the protologue in likening it to a small example of *J. indicus*. The holotype needs to be examined to solve this.

?*J. unibracteatus* Griff. (Griffith 1851a: 232; 1851b: pl. CCLXX fig. 8a–e). Type citation: 'Mogur, every where about in the sands of the Brahmaputra. March 29th, 1835.' Type: India, *W. Griffithi*, 29 Mar 1839; holo K? (n.v.). From the description (especially the membranous, hyaline leaf margins), this name may be a synonym of *J. leschenaultii*, as indicated by Buchenau (1906: 181) who placed it as a synonym of *J. prismatocarpus* subvar. *pluritubulosus*. However, the illustrations for this species are on a plate (pl. CCLXX, fig. 8) that mainly shows floral development in another species, *Philydrum lanuginosum*. Figure 8 is a cross-section of an ovule, plus two floral diagrams without captions: the right-hand diagram is triangular in outline with three stamens, while the left-hand diagram has a hexagonal outline and four stamens. The former could refer to a *Juncus* sp. but the other refers to an unknown plant. The type needs to be found and checked to be certain of this synonymy.

J. leschenaultii var. β *major* Miq. (Miquel 1867a: 164; also issued as *Prolusio Florae Japonicae*: 328 (1867b)). Type citation: 'Legerunt Siebold et Buerger; similia e Khasia habeo.'

We have not seen either of the Japanese specimens collected by Siebold and Bürger or the Indian specimen (collector unknown) cited by Miquel. However, J.F. Veldkamp has seen the Siebold collection and regards it as satisfactory as a lectotype, which he designates here.

Lectotype (here designated by J.F. Veldkamp): *Von Siebold s.n.*; L sheet 904.144-388. Note by Veldkamp: 'This collection was seen by Buchenau on 9 Sep 1883, but the name was not cited, although he did give a reference to Miquel's paper (Buchenau 1890: 310). This name automatically created the autonym 'var. *leschenaultii*', which when the two are regarded as synonymous has priority, hence *J. prismatocarpus* var. *leschenaultii* may be correct.'

J. leschenaultii var. *radicans* Franch. & Sav. (Franchet and Savatier 1879: 533). Type citation: 'in uliginosis, circa Yokoska'. Type: Japan: circa Yokoska, *Savatier 1356*; ?holo P. The Savatier sheet in P is annotated as '*Juncus leschenaultii* varietas' (?by Savatier or Franchet) and is a slightly proliferous plant of *J. leschenaultii*. It has been annotated in 1994 by Miyamoto as possibly the type of the varietal name. There are two other sheets of *Savatier 1356* in P but neither is annotated in the same way, nor is the sheet in K.

J. prismatocarpus [var. *leschenaultii*] subvar. γ *thermalis* Buchenau (Buchenau 1890: 312). Type citation: 'In den Saanschen heissen Quellen auf Kamschatka; gesammelt von Rieder.' Type: Kamchatka, J.G. von Rieder; syn ?E, ?FI, ?LE, ?W (n.v.).

?*J. yakeisidakensis* Satake (Satake 1933: 189, fig. 21). Type citation: 'Honsyu: Mt Yakeisidake, prov. Rikutyu (*H. Iwabuchi*, 1931 — type in Herb. Imperial Univ. Tokyo).' Type: Japan: Mt Yakeisidake, Honshu, *H. Iwabuchi*, 1931; holo TI (n.v.).

J. latior Satake (Satake 1936: 90). Type citation: 'Honsyu: Prov. Sagami — circa Zimmuzi (*Y. Momiyama*, Jun. 6, 1929, no. 454 — Typus).' Type: Japan: Zimmuzi, Honshu, *Y. Momiyama* 454, 6 June 1929; holo TI? (n.v.); iso K.

[*J. prismatocarpus* auct. non R. Br.: Backer 1951: 213 p.p.; Larsen 1972: 168; Van Royen 1979: 815; Harriman 1991: 389; Noltie 1994: 254]

Tufted perennial. Culms compressed to more or less terete, yellow-green, 8–15(–30) cm long, 0.7–1.5 mm diam. Leaves pluritubulose, spread along culms, shorter than to exceeding culms, compressed to more or less terete, acute to obtuse, 0.7–1.5 mm diam.; auricles to 0.5 mm long. Inflorescence terminal, 1–5 cm long, diffuse, with flowers clustered, 3–8[–20] per cluster and 3–9 clusters per inflorescence, often proliferating; 1 well-developed involucre bract, 1.5–4 cm long, lateral, shorter than or equalling inflorescence. Flowers without bracteoles. Tepals acute to acuminate, the tips spreading to recurved at maturity, straw-brown to slightly red-tinged, with more or less broad hyaline margins; outer tepals 2.8–4.0(–4.5) mm long, more or less equalling inner tepals. Stamens 3 (rarely to 6), shorter than outer tepals; anthers 0.3–0.8 mm long, shorter than filaments. Capsule 1-locular, slightly exceeding (to 1 mm) or occasionally equalling outer tepals, very narrow-ellipsoid to narrow-ovoid, golden brown, acute to broad-acute, not or shortly beaked (to 0.2 mm long). Seeds 0.3–0.4 mm long.

Illustrations: Fig. 1e, f; also Backer (1951: fig. 2a); Van Steenis (1972: pl. 24-2); Van Royen (1979: fig. 279); all as *J. prismatocarpus*.

Distribution and habitat: In Malesia, in the Cameron Highlands of Peninsular Malaysia and on the islands of Sumatra (North and West), Java (West and Central), Philippines (Luzon and Mindanao) and New Guinea; also from India and Sri Lanka to China, Kamchatka and Japan. Adventive in Mauritius in one area (Coode 1978: 3). In Malesia, only at higher altitudes (1400–3200 m) in swamps and on stream banks. No collections have been seen from Mindanao, but Backer (1951) included this island in its distribution (as *J. prismatocarpus*). According to Backer (1924: 44; Backer and Bakhuizen f. 1968: 451), '*J. prismatocarpus*' (that is, either *J. leschenaultii* or *J. wallichianus* or both, in this context) occurs on the mountains in West, Central and East Java. However, Backer (1951: 214) does not mention East Java for this 'taxon' and we have not seen specimens of either species from East Java. In fact, *J. wallichianus* seems to be more common in Central Java than in West Java and vice versa for *J. leschenaultii*.

The Cameron Highlands records are all relatively recent (1956 and later), but Kern (1958; as *J. prismatocarpus*) argues convincingly that the species is just as likely to be native there as introduced, surmising that the species has spread more widely there since the area has been cleared as a holiday area. This would be similar to the situation with many native *Juncus* species in Australasia, which seem to have spread much more widely thanks to human disturbance in the last two centuries (Johnson 1991).

Notes: Plants may proliferate from the flowers, as seen also in *J. wallichianus*; this is illustrated by Van Royen (1979: fig. 279). This species has been confused in Malesia and elsewhere (see, e.g., Backer 1951, Noltie 1994) with *J. prismatocarpus*, which is a more robust pluritubulose species that is confined to Australia and New Zealand.

From its description, *J. yakeisidakensis* Satake is probably a synonym of *J. leschenaultii*. Ohwi (1965: 277) accepted *J. yakeisidakensis* (as '*yakeishidakensis*'). We have not seen the type, but we have seen other collections determined as this species by Satake himself, and they are referable to *J. leschenaultii*.

Most of the collections from the Philippines (e.g. Merrill 4517, *Rauos and Edaño BS 40417*, and *Mearns BS 4261*) are very slender and weak, looking like they might have been growing in water. They superficially resemble rather coarse plants of *J. sandwithii* but differ in being proliferous, having pluritubulose leaves (so far as seen in the slender leaves) and in having a much less angled and shorter, broader capsule. The septa are hard to see in the slender leaves and the compressed state is not obvious (in fact, they are terete at the apex), but the presence of longitudinal striations as well as the transverse septa is indicated externally by the more striate appearance of the leaves (at least when dry). In general, the leaves of *J. wallichianus* have a much smoother (less striate) appearance than in *J. leschenaultii* and *J. prismatocarpus*. Duistermaat (manuscript at Leiden; Veldkamp pers. comm.) planned to recognise the slender material as a variety (var. *luzoniensis* [sic] ined.) but that has never been published. In our view this is not justified since the slender Philippines collections are similar to other material of *J. leschenaultii* (see, for example, *Li et al.* 1243 from China) and seem to be no more than a montane form of that taxon, and merely show convergent resemblance to *J. sandwithii*.

Selected collections examined: MALAYSIA: Pahang: Summit Batu Brinchang, 6660 ft [2030 m], Cameron Highlands, *H.M. Burkill 783*, 1 Sep 1956 (K, L, SING (n.v.)); Break Pressure Tank Hill, 4900 ft [1500 m], Cameron Highlands, *H.M. Burkill 823*, 5 Sep 1956 (K, L, SING (n.v.)); Gunong Brinchang, Cameron Highlands, 6100 ft [1850 m], *M.E.D. Poore 470*, 15 Nov 1960 (K); Gunong Batu Brinchang, 6666 ft [2030m], Cameron Highlands, *J. Sinclair 9935*, 4 Nov 1958 (E (n.v.), K, L, SING (n.v.)).

SUMATRA: Hariarapintu, S of Sidikalang, Res. Tapanuli, *A.H.G. Alston 14895*, 28 Mar 1954 (BM); Lalang bench [sic] S of Asahan River, Tapianoeli, *H.H. Bartlett 7771*, 14–27 May 1927 (L, NY ex MICH and US); Gunung Batu Lopang, c. 10 km ESE of Prapat (Lake Toba), 1400–1500 m, *W.J.J.O. de Wilde 13521 and B.E.E. de Wilde-Duyffes*, 8 July 1972 (K, L); Sibolangit, 1300 m, *J. Loerzing 6020*, 28 Aug 1918 (L); Karo Plateau, Berastagi, 1350–1450 m, *J. Loerzing 15059*, 27 Jan 1929 (K ex BO, L); Alakan Panjang, 5000 ft [1500 m], *C.G. Matthew*, Jan 1914 (K); Danau Kota Baru, N of Bukittinggi, *W. Meijer 5688*, 29 Apr 1957 (L); Pintu Angin above P. Tinggi – Lubuh Selasih, *W. Meijer 6013*, 15 July 1956 (L); Aek Na Oeli, 1200 m, Distr. Prapat, *L. Otto-Surbeck 84*, 31 Jan 1954 (L); Aek Rimau, Toba (a stream E of Loemban Lobo), Res. Tapianoeli, *Rahmat Si Boeca 10902*, 13 Nov–14 Dec 1936 (L, NY ex MICH); Toetoeapan, Res. Tapianoeli, Subdiv. Toba, Distr. Toetoeapan, *Rahmat Si Boeca 6000*, 4–11 Nov 1933 (L); Berastagi Marsh, *H.N. Ridley*, 8 Feb 1921 (K); by the hot sulphurous stream from volcano Sibayak Berastagi, *H.N. Ridley*, 11 Feb 1921 (K).

JAVA: Gunung Patoeha, 2200–2300 m, *C. Backer 12653*, 26 Mar 1914 (L); Ondern. Tjigoea, Beuzenbo ['Preanger boven' was intended here, fide J.F. Veldkamp] Tji Reunghas, *C. Backer 15114*, 1914 (K, L ex BO); Garoet, *W. Burck 32*, 20 June 1891 (K ex BO); Java, *H. Forbes 923*, 1880–82 (L); Java, *F. Junghuhn 496*, – (L); Res. Priangan, Gunung Papandajan, Tegal Pandjang, 2041 m, *C. van Steenis 4258*, 29 Mar 1930 (L); Res. Priangan, G. Papandajan, 2400 m, *C. van Steenis 4100*, 21 Jan 1930 (L).

NEW GUINEA: West Papua: Camp Vlb (Utakwa Expedition to Mt Carstensz), *C. Boden-Kloss s.n.*, 9 Jan 1913 (BM, K); 9 km NE of Lake Habbema, *L. Brass 10737*, Oct 1938 (BRI, L); Wissel Lake region, Ekkadide-Koempa in Arandora, *P. Eyma 4579*, 23 Feb 1939 (K, L); Wolo, *J. Raynal 17055*, 9 Apr 1973 (L); Vogelkop Peninsula, Arfak Mtns, Anggi Gigi Lake, Soererei village, 1920 m, *H. Sleumer BW 4363 and W. Vink*, 21 Jan 1962 (K, L); Wissel Lake region, Arupa, c. 1750 m, *C. Versteegh BW 3047*, 23 Mar 1955 (BRI, CANB ex LAE, K, L, NSW); Enarotali, Wissel Lakes, 1760 m, *W. Vink BW 8587 and F. Schraau*, 12 May 1960 (CANB, L, LAE).

Papua New Guinea: Marafunga, c. 20 miles [32 km] NW of Goroka, E Highlands, *T. Hartley 13242*, 11 Oct 1964 (CANB, K, L, LAE (n.v.)); Suongot near Telefomin, 5500 ft [1670 m], Sepik District, *E. Henty NGF 20875*, 10 Jan 1965 (BRI, CANB, L, LAE (n.v.)); near Miruma village, Upper Asaro Valley, c. 1900 m, Goroka Subdistrict, E Highlands, *R. Hoogland 5392 and R. Pullen*, June 1956 (A, BM, BRI, CANB, G, K, L, LAE (n.v.), MEL, NSW); near Poio village, middle Tale Valley, c. 7000

ft [c. 2100 m], Wabag Subdistrict, *R. Hoogland* 6767 and *R. Schodde*, 25 Jun 1960 (CANB); Sugarloaf Complex (along Wapu River), Wabag Subdistrict, *R. Hoogland* 7177 and *R. Schodde*, 20 Jul 1960 (A, BH (n.v.), CANB, L, LAE (n.v.)); Tigibi, 1600 m, Tari Subdistrict, *C. Kalkman* 5225, 30 Aug 1966 (L); Telabo area, Haibuga Marsh, 5200 ft [1580 m], Tari Subdistrict, *J.M. Powell* UPNG 2460, 20 June 1972 (CANB, UPNG (n.v.)); road above Tomba, 8000 ft [2400 m], Hagen Subdistrict, *R. Robbins* 280, 6 Jul 1957 (CANB, L, LAE (n.v.), NSW); near Ebenda, Anga Valley, c. 6500 ft [c. 2000 m], S Highlands District, *R. Schodde* 1646, 28 Jul 1961 (A, BM, CANB, K, L, LAE (n.v.)); Mt Giluwe, above Klareg, c. 8800 ft [c. 2670 m], S Highlands District, *R. Schodde* 2056, 30 Aug 1961 (A, CANB, L, LAE (n.v.)); Mt Giluwe, c. 9700 ft [c. 2950 m], S Highlands District, *R. Schodde* 2007, 25 Aug 1961 (A, BM, BRI, CANB, L, LAE, MEL); Guru nigl, 1970 m, Simbu Prov., Gembogl Subprov., *J. Sterly* 1645, 29 Sep 1983 (L); Mt Kerigomna, 3180 m, Goroka Subdistrict, E Highlands, *P. Stevens* LAE 54657 and *P. Grubb*, 24 Jun 1971 (CANB, L, LAE (n.v.)); Sirunke, inflow stream to Lake Iviva, c. 8300 ft [c. 2550 m], *D. Walker* ANU 616, 28 Aug 1962 (CANB, L, LAE (n.v.)); 12 miles [19 km] N of Wabag, 7000 ft [2100 m], *J. Womersley* NGF 11203, Jul 1959 (BRI, K, L, LAE (n.v.), NSW).

PHILIPPINES: Luzon: Pauai, Benguet Prov., *M. Mearns* BS 4261, July 1907 (L, 2 sheets); 'Hights in the Oaks' (7000 ft [2130m]), Benguet, Luzon, *M. Mearns* BS 4261, July 1907 (NY); Pagio, Benguet, *A. Lohr*, - (K); Mt Data, Lepanto District, *E.D. Merrill* 4517, Nov 1905 (K, L, NSW, NY, P); Panai, Benguet Province, *E.D. Merrill* 4739, Oct-Nov 1905 (K, NY); Mt Natoo, Benguet Sub-province, *M. Ramos* and *G. Edaño* BS 40417, Sep 1921 (K, L, P); Baguio, Benguet, *R.S. Williams* 1974 bis, 5 Oct 1904 (NY).

TAIWAN: In sulfuris Hokuto, Formosa, *U. Faurie* 150, Sep 1914 (P); Lu-su-tann, near Kan-kou to Msiao-ko-tou, 600–400 m, Taipei Co., *Chien-chang Hsu* 5333, 11 May 1969 (TAI); Chu-chih, Taipei, *M.T. Kao* 9751, 23 May 1982 (TAI); Prov. Taihoku, Mt Schchiseizan, *J. Ohwi* 2040, May 1933 (K); Formosa, *R. Oldham* 579, 1864 (K, P); Fuhsing, Taoyuan Co., *Yang* 2680, 10 May 1979 (TAI).

CHINA: Chiu Hua Shan, Anhwei Province, *R.C. Ching* 8482, 28 June 1925 (K); Yenping: Cha-ping, 730 m, Fukien, *H.H. Chung* 2836, 31 July 1924 (K); marshy meadows in the Mingkwong Valley, 7000 ft [2130 m], *G. Forrest* 8453, June 1912 (K); Patung district, *A. Henry* 2471, 1887 (K, P); Ma Liu Shui Hill, Hong Kong, *Shiu Ying Hu* 11577, 29 Feb 1972 (K); Tai Hon, Hainan, *F.A. McClure* CCC 9224, 21 Apr 1922 (K, P); Pakhoi, South China, *G.M.H. Playfair* 50, Apr 1883 (K); Fang Shan, Nanking, Kiangsu Province, *A.N. Steward* 2102, 3 June 1922 (K); Pin Shan Shue, Fung Muk Shan (Taam Chau District), Hainan, *W.T. Tsang* 217 u.u. 16962, 3 May 1928 (K); Naam Kwan Shan (Tsengshing District), Kwangtung, *W.T. Tsang* 20071, 3 Apr 1932 (K, TI); Tai-po, Hong Kong New Territories, *M.M. Whiting* 251 and *K.J. Stewart*, 12 Mar 1935 (K).

KOREA: Ouen-san, *U. Faurie* 896, Aug 1901 (P); Quelpaert [Island = Cheju-Do], *E. E. Taquet* 1861, 9 Nov 1908 (K), *E. E. Taquet* 1869, 12 Aug 1908 (K); Tsu-sima Island, St. of Corea, *C. Wilford* 809, May 1859 (K).

RUSSIA: Kamchatka : Peninsula Kamczatka, *V.L. Komarov* *Iter Kamczaticum* I, 25 Aug 1908 (K, P); Syd - Kamtchatka - the hot springs at Sikir River, 29.5 m, *E. Hultén* 3046, 5 Sep 1921 (K).

JAPAN: Yokohama, *J. Bisset* 407, June 1876 (K); Ile de Sado, *U. Faurie* 1794, 26 July 1898 (K), 1795 (P); Miyagi Pref., (Prov. Kikuzen), Mt Kurikoma, Honshu, *H. Kiriya* 17, 9 July 1932 (TI); Kiusiu, Ko-isi-wara, *C. Maximowicz*, *Iter Secundum*, 1863 (K, P ex LE); Kawamura, Prov. Higo, *K. Mayebara* 2048, 30 May 1926 (TI); Fukushima Pref., Ozegahara, Shimotashiro, *M. Mizushima*, 15 July 1950 (TI); Narutoshima, Prov. Kayusa, *H. Migo*, 4 July 1932 (TI); between Kuji and Kudadon, alt. 10 m, Amami-ohshima, Ryukyus, *Noguchi* 3461, 25 Jan 1957 (L); Doai in Kotsuke, Hondo, *J. Ohwi* and *T. Koyama* NSM 310, 24 Aug 1951 (K, L, NSW, TI); Nagasaki, *R. Oldham* 897, June 1862 (K, P); Okinawa, *Sonohara et al.* SIRI 6271 (L, 2 sheets); Yokoska, *P. Savatier* 1356, 1866–74 (K, P); Iwakura, north of Kyoto, Pref. Kyoto, *M. Tagawa* 3228, 22 May 1950 (TI); Loo-Choo Islands, Ryukyus, *C. Wright* 329, 1853–56 (K).

VIETNAM: Prov. Kon Tum, District Dak Gley, c. 12 km to N of Dak Gley town (24 km by road), near Mang Khen village, 1100–1200 m alt., *L. Averyanov et al.* VH1791, 17 Nov 1995 (P); Hanoi, *B. Balansa* 2829, 29 May 1886 (K, P).

CAMBODIA: Mont de l'Eléphant, *E. Poilane* 23114, 5 Dec 1933 (K ex P).

THAILAND: Chiang Mai; Doi Intanon, alt. 1400–1700 m, *K. Larsen* and *S. Larsen* 34513, 13 Sep 1974 (AAU (n.v.), P); 5 km W of Bo Luang, 1100 m, *B. Hansen*, *G. Seidenfaden* and *T. Smitinand* 10967,



Fig. 2. *Juncus bufonius*: a, habit; b, flower (from M.D. Tindale (NSW 18459)). *J. decipiens* subsp. *medianus*: c, inflorescence; d, flower (from L.A.S. Johnson (NSW 75499)). *J. inflexus*: e, inflorescence; f, flower (from D.E. Albrecht 1594 (NSW)). *J. durus*: g, inflorescence; h, flower (from R.D. Hoogland 7595 and R. Schodde (NSW)). *J. nupela*: i, inflorescence; j, flower (from J.F. Veldkamp 6369 (NSW)). Scale bar = 6 cm (a), = 3.5 mm (b, d, f, h, j), = 4 cm (c, e, g, i).

29 Jan 1964 (AAU (n.v.), K); Ban Pong Yeng, 750 m, *A. Kerr* 3587, 1 Apr 1915 (BM, K, L); Doi Intanon, 2100 m, *T. Sorenson* 3316, *K. Larsen* and *B. Hansen*, 9 May 1958 (AAU (n.v.), L, P); env. Ban Pha Mon (Chom Thong), Prov. Chiang Mai, 900 m, *J. Vidal*, *Y. Vidal* and *C. Niyomdham* 6254, 31 May 1979 (P).

LAOS: Entre Tafa et Ban Hosei Sai, *E. Poilane* 24425, 4 June 1936 (K ex P).

BURMA: Birma [sic], *Hb. Griffith* 5460, – (K – hb. of late East India Company no. 5460; distributed at Kew 1863–64).

BHUTAN: Bootan [sic], *Hb. Griffith* 5459, – (K; distributed by K 1863–4).

NEPAL: Above Sukhet village 6 miles [10 km] NW Pokhara, 3600 ft, *Sir Colville Barclay* 2201 and *P.M. Syngé*, 22 May 1971 (K).

INDIA: Sowra, Khasia, 4000 ft [1220 m], *C.B. Clarke* 15163, 26 Nov 1871 (K); Mt Bani (main coast range c. 25 km from Tourane), Annam, *M. S. Clemens* 4076, May–July 1927 (P); forest by Pamba Reservoir, 1100 m, Prov. Quilon, Kerala State, *C.D.K. Cook* 199, *E.M. Rix* and *J. Schmeller*, 11 Sep 1973 (K); Sikkim, 8–10,000 ft [2450–3050 m], *J.D. Hooker* and *T. Thomson*, – (K, L); Panchaki, Chota Nagpur, 2600 ft [790 m], Jashpur State, *H.F. Mooney* 2216, 9 May 1943 (K); Kamaleswarpur, Mainpat, 3600 ft [1100 m], Surguja State, *H.F. Mooney* 2228, 5 June 1943 (K); Kasipur, S. Kalahandi, 2900 ft [880 m], Orissa, *H.F. Mooney* 3242, 26 Jan 1949 (K); Shillong Lake, Assam, *G. Panigrahi* 3925, 20 May 1957 (L); near Uchangi, Hassan District, Mysore, *T.P. Ramamoorthy* HFP 1294, 26 Jan 1971 (K, P); NW India, *Hb. Royle*, – (K – hb. Hook. 1867); Nilghiris, *Schuidt* 51, – (K); Shillong, Khasi Hills, 5500 ft [1670 m], Assam, *Thakur Rup Chand* 7546, 15 Apr 1954 (L ex MICH).

SRI LANKA: Ascent to Horton Plains, Nuwara Eliya District, 2000 m, *M. Jayasuriya* 184 and *L.C. Wheeler*, 20 May 1971 (K ex US); Tothulagalle Estate above Haputale, 1600 m, *A. Kostermans* 23383A, 7 May 1969 (L); Kandy District, Central Province, Knuckles Range (Wet Zone Highlands), 1815 m, *M. Lazarides* 7203, 3 Sep 1970 (K ex CANB, US (n.v.)); c. 2 miles [3 km] from Rasagulla, Patnapura district, Sabaragamuwa Prov., *S. Sohmer* and *S. Waas* 10497, 9 Nov 1975 (P); s. loc., *Thuaites* CV844, – (K, P); Enselwatte, Matara District, Southern Province, c. 1000 m, *S. Waas* 1487, 14 Feb 1976 (K).

*MAURITIUS: Le Pétrin, 650 m, *K. Lye* 5979, 13 Apr 1971 (K).

4. **Juncus bufonius* L. sens. lat.

(Linnaeus 1753: 328)

Type: Europe, *Herb. Van Royen s.n.*, *L sheet* 904,145-433; lecto (Cope and Stace 1978: 121) L (image on Leiden website (through <http://nhncml.leidenuniv.nl/rhb/#collection>) and microfiche IDC BT-341).

J. plebeius R. Br. (Brown 1810: 259). Type: Australia: New South Wales: Port Jackson, *R. Brown* (Bennett 5783), 1803; holo BM, photo NSW; iso BRI.

Tufted annual. Culms terete, pale yellow-green, 2–20(–40) cm long, 0.4–1.0(–2.0) mm diam. Leaves basal and cauline, shorter than culms, flat or slightly canaliculate, 0.2–1.2 mm wide; auricles absent; sheaths pale yellow or occasionally red-brown. Inflorescence terminal, 2–25 cm long (often much longer than culm), diffuse, with flowers solitary or clustered (2–4 per cluster), 4–60 flowers per inflorescence; 1 or occasionally 2 well-developed involucre bracts, 2.5–7 cm long, lateral, generally shorter than or equalling inflorescence. Flowers with 2 bracteoles. Tepals straw-brown, occasionally with red-brown bands beside midrib, with broad hyaline margins; outer tepals 4.0–9(–12) mm long, much exceeding inner, long-acuminate, often excurved; inner tepals acute, erect. Stamens 3 (–4–6), shorter than outer tepals; anthers (0.2–)0.5–1.0 mm long, shorter than or equalling filament length or occasionally (as in Sabah, fide J.-F. Veldkamp) to 1.8 times as long as filaments. Capsule 3-locular, shorter than inner tepals, obovoid to narrow-ellipsoid, straw-brown to dark red-brown, obtuse to acute, umbonate to shortly beaked (to 0.2 mm long). Seeds 0.3–0.5 mm long.

Illustrations: Fig. 2a, b; also Podlech (1979: fig. 203a, b); Snogerup (1985: fig. 1(22); Keighery (1985: fig. 1); Brooks and Kuhn (1986: figs 22, 23); Balslev (1996: fig. 11E, F [SEM of seed], fig. 38F, G); Wilson et al. (1993: 274).

Anatomy illustrated: Buchenau (1890: pl. 2, fig. 3, pl. 3, fig. 5); Cutler (1969: fig. 2A–D; Fernández-Carvajal (1982b: figs 67–71).

Distribution and habitat: Most probably adventive in the Philippines, where it is only known from Mt Santo Tomas on Luzon, at 1900 m altitude, along bridle-trails in mossy forests (Backer 1951). Also recorded from Mt Kinabalu (Borneo), where it is most probably also adventive, growing at 3500 m altitude in cleared areas beside huts. Now a cosmopolitan weed, but probably originally native to Europe, the Mediterranean region, temperate Asia and perhaps eastern North America (Cope and Stace 1978).

Notes: The above description is based on the full range of variation seen in this very variable, cosmopolitan taxon. The plants are often up to about 30 cm high, the inflorescence being about $\frac{3}{4}$ of this height, as in the Sabah specimens. The Philippines collection fits well within this range, but the Sabah specimens are extreme in having strongly excurved tepals 6–12 mm long (some to 20 mm fide Veldkamp), and anthers 0.6–1.8 times as long as filaments (Veldkamp 1982 and pers. comm.). The extremely long tepals result from the tendency to proliferation and the ‘conversion’ of the tepals into a more leaf-like form as in, for example, a few Australian collections that we have seen (e.g. *F. Rodway s.n.*, Nowra, Sep 1929 (K)). This extreme morphology may result from isolation and enforced inbreeding instead of facultative inbreeding. As described by Veldkamp, these plants may become prostrate and proliferate at the nodes. Cope and Stace (1978) found that proliferation could be induced by crowding in experimental populations, although not found by them in the wild.

Various forms have been recognised at infraspecific or specific level, in part based on ploidy level (Cope and Stace 1978, 1983, 1985; Snogerup 1971, 1985). However, there is not a wholly satisfactory treatment as yet, perhaps because it has been spread so widely around the world, making it difficult to distinguish native from naturalised forms and occurrences. Thus, even though the Sabah specimens are morphologically extreme, neither J.F. Veldkamp (pers. comm.) nor we have considered it appropriate to describe the Sabah variation under a formal name at this time.

The species is often (?usually) cleistogamous (Buchenau 1906: 27; Knuth 1909; Snogerup 1985; Keighery 1985: fig. 1), with its stamens, stigmas and styles seldom exposed. Müller (1883) quoted studies suggesting that it was cleistogamous in Russia but in Germany was generally out-breeding, with some terminal cleistogamous flowers in an inflorescence. Arber (1925) considered it to be always cleistogamous. Cope and Stace (1985) suggested that it tends more to cleistogamy in colder regions.

Collections examined: BORNEO: Sabah: Between Carson’s Camp and Panalaban, 2700–3400 m, *M. Hotta* 3905, 16 Jan 1969 (Lex KYO (n.v.)); southern slope of Mt Kinabalu, 11,000 ft [3500 m], *J.M.B. Smith s.n.*, 12 Aug 1967 (K); Panar Laban ‘old’ huts, 3300 m, *J.M.B. Smith* 464, 28 Jul 1978 (Lex KLU (n.v.)); Sayat-Sayat Hut, 3760 m, *J.M.B. Smith* 520, 29 Jul 1978 (Lex KLU (n.v.)).

PHILIPPINES: Luzon: Mt Santo Tomas, Benguet Subprovince, Luzon, *E.D. Merrill* 7794, May 1911 (BM, K).

5. *Juncus decipiens* (Buchenau) Nakai

(Nakai 1928: 35).

J. effusus var. *decipiens* Buchenau (Buchenau 1890: 229). Type citation: ‘Japan (prope Yokohama, Nagasaki et Hakodate leg. cel. C.J. Maximowicz; Yokoska, Nippon; Savatier, 1353 (!; forma intermedia).’

Types: Japan: Yokohama, *C. Maximowicz, Iter Secunduum*; syn ?LE, ?W (n.v.). Nagasaki, *C. Maximowicz, Iter Secundum*, 1863; syn K, L (2 sheets), ?LE, P, ?W (n.v.). Hakodate, *C. Maximowicz, Iter Secundum*; syn ?LE, ?W (n.v.). Yokoska, *P. Savatier 1353*, P, ?W (n.v.).

A specimen of Maximowicz annotated by Buchenau should be chosen as lectotype since Buchenau clearly indicated in two places in the text that he considered the Savatier specimen to be intermediate between *J. decipiens* and *J. effusus* sens. strict., that is, not typical. Duplicates of the Nagasaki collection, made in 1863 by Maximowicz, are held in L (L sheet 904,130-575 ex LE) and P but they are not annotated by Buchenau.

Nakai's paper is written completely in Japanese (including page numbers) except for the title, photograph captions and plant names. It does not give any indication of basionym for *J. decipiens* Nakai, which is not surprising given that it is an ecological paper. The combination is valid despite this, since the rules about citing basionyms only apply from January 1953 (ICBN Article 33.2).

[*J. effusus* auct. non L.: Backer 1951: 211]

Shortly rhizomatous perennial. Culms terete, soft, mid-green, 20–120 cm long, 1.1–2.2(–3.0) mm diam.; striations 20–50; pith continuous, very loose. Sterile leaf-like culms present but real leaves reduced to cataphylls 3–19 cm long, more or less tightly clasping the culm, abaxially pale straw-coloured above to darkish red-brown at least at base, shining towards base but more or less dull above, adaxially whitish with a pearly sheen. Inflorescence 2–9 cm long, diffuse, with numerous solitary flowers; lowest involucre bract 5–35 cm long, apparently continuous with culm, exceeding inflorescence. Flowers with 2 bracteoles. Tepals acuminate to acute, straw-coloured, often with a dark red-brown stripe on each side of midrib, with narrow to more or less broad hyaline margins; outer tepals 1.7–4.0(–4.5?) mm long, greater than or equalling inner tepals. Stamens 3, shorter than outer tepals; anthers 0.3–0.8 mm long, shorter than to exceeding filament length. Capsule 3-locular, slightly shorter than to slightly exceeding outer tepals, narrow-ellipsoid to ovoid or occasionally obovoid, golden brown to very dark red-brown, obtuse, not or scarcely beaked. Seeds 0.4–0.6 mm long.

Distribution and Habitat: In Malesia: in Peninsular Malaysia and on the islands of Sumatra (Aceh province), Java, Borneo (Sabah), Philippines (Luzon and Mindanao), and New Guinea. Also in eastern Asia: Japan, China, Taiwan, Korea, Thailand, and eastern India (Assam). Found in wet places, at higher altitudes in the tropical areas: in Malesia from 1400 to 3300 m. As pointed out by Hämet-Ahti (1980), this species does not occur in North America; what has been identified there as *J. decipiens* are slender collections of *J. pylaei* Laharpe.

Notes: This species is similar to *J. effusus* sens. strict., with continuous, loose pith in the culms. It differs in having slightly more close-packed / dense pith than in *J. effusus*, and in being generally more slender than that species. The cataphylls have shining surfaces abaxially in *J. decipiens*, at least at the base and are adaxially whitish with a pearly sheen (dull abaxially, and adaxially golden to copper-coloured in *J. effusus*). *J. decipiens* has 20–50 striations around the circumference of the culms while *J. effusus* has 35–65 striations. *J. decipiens* differs from *J. inflexus* in having non-glaucous culms with continuous pith and more closely packed culm striations.

Three intergrading subspecies are here recognised. The type subspecies is found in eastern Asia (eastern India, China, Korea, Japan, Thailand) and possibly in Peninsular Malaysia (one incomplete specimen seen), the other two are in other parts of Malesia (Philippines, Borneo, New Guinea, Java and Sumatra) and subsp. *mediams* is also in Taiwan. The subspecies can be keyed out as follows:

- 1 Tepals 1.7–3.0 mm long, straw-coloured, occasionally with red-brown bands beside the midrib; capsule golden brown to red-brown; cataphylls straw-coloured for $\frac{1}{4}$ – $\frac{3}{4}$ of their length, red-brown only near the base
- 2 Tepals 1.7–2.2 mm long; capsule golden to dark golden brown; cataphylls straw-coloured for upper $\frac{1}{2}$ – $\frac{3}{4}$ of their length. (Eastern Asia, ?Peninsular Malaysia) subsp. *decipiens*
- 2* Tepals 2.1–3.1 mm long; capsule dark golden brown to red-brown; cataphylls straw-coloured for upper $\frac{1}{4}$ – $\frac{1}{2}$ of their length. (Taiwan, Philippines, Borneo, Java, New Guinea) subsp. *medianus*
- 1* Tepals 3.0–4.0(?–4.5) mm long, straw-coloured with dark red-brown bands beside midrib; capsule very dark red-brown; cataphylls straw-coloured in upper $\frac{1}{4}$ – $\frac{1}{3}$ but usually red-brown for rest of their length. (Sumatra) subsp. *sundaicus*

J. *decipiens* subsp. *decipiens*

Culms 30–80 cm long, 1.0–2.0 mm diam.; striations c. 20–50. Cataphylls 8–16 cm long, abaxially straw-coloured for $\frac{1}{2}$ – $\frac{3}{4}$ of their length above to red-brown at base. Inflorescence 2–3 cm long; lowest involucre bract 8–20 cm long. Tepals acuminate to acute, straw-coloured, with more or less broad hyaline margins; outer tepals 1.9–2.2 mm long. Anthers 0.3–0.5 mm long, shorter than filament length. Capsule slightly exceeding to equalling outer tepals, narrow-ellipsoid to ovoid, golden brown to dark golden brown, umbonate. Seeds 0.4–0.5 mm long.

Illustrations: Makino (1964: 821, 822, as *J. effusus* var. *decipiens* and forma *utilis* respectively); Kao and De Vol (1978: pl. 302, as *J. effusus* var. *decipiens*).

Distribution: Eastern Asia (Thailand, eastern India, China, Korea, Japan). It is possibly in the Cameron Highlands of Peninsular Malaysia, but only one incomplete specimen (*Sinclair 4956*) purportedly from there has been seen. It is known only from a couple of higher altitude localities in northern Thailand (Larsen 1972).

Notes: This has usually been treated in Asian Floras as *J. effusus* var. *decipiens*, for example, in Ohwi (1965: 275) and Kao and De Vol (1978).

This typical subspecies has shorter tepals than the other two subspecies, lacks red coloration on the capsule, and has less red coloration on the external (abaxial) surface of the cataphylls than in the other subspecies. It is used for making tatami mats in Japan and also as a source of medicinal drugs in China and Malaysia (Walker 1976: 302; Burkill 1935: 1272). In Malaysia, Burkill (1935) regarded material of this species as being imported from China by merchants.

Selected collections examined: ?MALAYSIA: Cameron Highlands, *Sinclair 4956*, – (L).

CHINA: Hong Kong, Tai Mo Shan Peak, *Shiu Ying Hu 7607*, 17 May 1969 (K); Flora of Chumbi, Too-li-la, *Dr King's Collector 607*, 28 May 1884 (MEL); near the White Cloud Monastery, Canton, *T. Sampson 843*, 4 May 1879 (MEL); Din Shum Tso, P'ing T'ou Shan, T'ang Wan Village, Hunan, *W.T. Tsang 23609*, 17–30 Apr 1934 (NSW); Tsun-Wan, New Territory, *W.T. Tsang 29767*, 29 Apr 1940 (UC).

JAPAN: Hakodate, *O. Menzel*, 1861 (NSW 451169); Honshu, Yamanashi Pref., Uchino-mura, Minamitsuru-gun, 950 m alt., *M. Togashi 38*, 29 July 1985 (K ex TNS); Honshu, Mt Zaozan in Echigo, *M. Togashi TNS 1757*, 13 June 1958 (K, NSW, P ex TNS); Simoda, *Tolkin*, – (MEL ex LE).

KOREA: Quelpaert, *U. Faurie 2246*, Aug 1907 (P); ?loc., *Gilbert*, 1903 (UC); c. 1000 yards [1 km] S of Imjan River, *J. Smail*, 3–4 June 1952 (NSW 451168).

THAILAND: Doi Ngao Ng Chen, c. 1200 m, *A.F.G. Kerr 5438*, 13 May 1921 (BM, K, L); Doi Pakom Pok, Ng Fang, c. 1600 m, *A.F.G. Kerr 5185*, 2 Apr 1921 (BM, K, L).

LAOS: Muang Cha, Chingkwang, c. 1100 m, *A.F.G. Kerr 20989*, 9 Apr 1932 (BM, K); Phou San, Prov. Xieng Khiuang, *J. Vidal 1584*, 8 Apr 1952 (P).

INDIA: Cherrapunjee, Khasi Hills, 4000 ft [1220 m], *Thakur Rup Chand 5500*, 28 Apr 1952 (L).

***J. decipiens* subsp. *medianus* L.A.S. Johnson et K.L. Wilson, subsp. nov.**

Inter ambas subspecies ceteras intermedius ut videtur; a subspecie typica tepalis longioribus, cataphyllis rufioribus differt; a subspecie *sundaica* tepalis brevioribus, cataphyllis distaliter stramineis non nisi basi rufis, differt.

Type: Papua New Guinea: J. Leahey's mill site, Goroka Subdistrict, 7,300 ft [2200 m], A.G. Floyd and J.S. Womersley 6297, 18 Nov 1954; holo NSW; iso CANB, K, L, LAE.

Culms 25–120 cm long, 1.1–2.5(–3.0) mm diam.; striations 23–47. Cataphylls 3–19 cm long, abaxially straw-coloured or pale red-brown for ¼–½ of its length grading to red-brown or dark red-brown towards base. Inflorescence 2–9 cm long; lowest involucre bract 9–35 cm long. Tepals acute to acuminate, straw-coloured, often with darker yellow-brown or red-brown band on each side of midrib, with broad hyaline margins; outer tepals 2.1–2.7(–3.1) mm long. Anthers 0.4–0.8 mm long, shorter than to exceeding filament length. Capsule slightly shorter than to slightly exceeding outer tepals, ellipsoid to oblong or ovoid, dark golden brown to red-brown, umbonate. Seeds 0.4–0.5 mm long.

Illustrations: Fig. 2c, d; also Backer (1951: fig. 1); Kao and De Vol (1978) (as *J. effusus* var. *decipiens*); Van Steenis (1972: pl. 24-3).

Distribution: In Malesia found at higher altitudes (1,200–3,000 m) on the islands of New Guinea (West Papua and Papua New Guinea), Philippines (Luzon and Mindanao), Borneo (only Mt Kinabalu so far as known), Java (West and Central); also in Taiwan.

Notes: The epithet is taken from the Latin *medius* (neo-Latin *medianus*), the middle [adjective]; referring to the apparently intermediate position of this taxon morphologically between the type subspecies and subsp. *sundaicus*. For example, the tepals of subsp. *medianus* are intermediate in length between those of the other subspecies, although the hyaline to membranous tepal margins differ in being usually slightly broader (to 0.2 mm wide) than in either other subspecies. The cataphylls are also intermediate between the other subspecies in the extent of red coloration (the upper ¼–½ is straw-coloured in this subspecies).

Selected collections examined: JAVA: s. loc., *P. Goering* 344, 1851 (P); s. loc., *T. Horsfield* 1070, – (BM); Dieng, *F. Junghuhn* 602, – (L); Preanger, Pangentjongan, *S. Koorders* 26505, 26 Jan 1897 (K, L); Priangan, Tegal Kirinjoeh, Papandajan, 2060 m, *L. van der Pijl* 567, 17 May 1936 (K); Preanger River, Afd. Tjikakapa v.d. Gouv. Kina Ond., 2000 m alt., *D. van Slooten* 751, 3 Jan 1923 (K, L ex BO); Preanger, boven Bergtuin Tjibodas, Rawa Gajongjong, 1700 m, *C. van Steenis* 12331, 9–16 Nov 1940 (L).

NEW GUINEA: West Papua: 9 km NE of Lake Habbema, 2800 m, *L. Brass* 10745, Oct 1938 (BRI, K, L); Bele River 18 km NE of Lake Habbema, 2200 m, *L. Brass* 11473, Nov 1938 (BRI, K, L); Saruwaged-Gebirge, 2400–3000 m, *C. Keysser s.n.* (BM); Wamena, Baliem River, 1800 m, *A. Kostermans* 813, 30 Aug 1966 (L ex BO); N of Mt Trikora, 3040 m, Baliem-Wamena river valley to the east, *J.-F. Mangan* 734, 25 Aug 1983 (L); Vogelkop Peninsula, Arfak Mountains, Anggi Gigi Lake, Soererei village, 1920 m, *H. Sleumer and W. Vink* BW 4358, 21 Jan 1962 (K, L); Wamena, 1701 m, *Ir. Soelhoed Sosrodihardjo* 58, 6 Apr 1973 (L ex BO); Arupa, Wissel Lake region, *C. Versteegh* BW 3020, 22 Mar 1955 (CANB, L, LAE (n.v.)).

Papua New Guinea: Lake Onim, Subdistrict Ialibu, 2300 m, *M. Andrew* LAE 57133, Dec 1972 (L, LAE (n.v.), NSW); Murray Pass, Wharton Range, Central Division, NG, *L. Brass* 4699, June-Sep 1933 (BRI); above Aijura, *B. Conn and Akakauaro* 404, 24 July 1977 (L); Lake Myola No. 1, Subdistrict Kokoda, *J. Croft et al.* LAE 61941, July 1974 (K, L, LAE (n.v.), NSW); Mt Kenive (Nisbet), Subd. Kokoda, *J. Croft* LAE 65172, Aug 1974 (K, L, LAE (n.v.), NSW); Chimbu district, ridges c. 10 km SSE of Kundiawa, c.1900 m, *P. Heyligers* 1868 and *J. Saunders*, 16 Apr 1971 (CANB); Mannasat, Cromwell Mountains, Huon Peninsula, *R. Hoogland* 9445, July 1964 (CANB, L, LAE (n.v.), US); Momanemambuno, Mt Wilhelm, 2650 m, *G. Hope* ANU 10638, 1970 (CANB); Goroka subdistrict, 10 km SE of Mt Kerigomna, 2500 m, *K. Pajmans* 1293, 16 Apr 1971 (CANB); western grasslands of

Mt Giluwe, c. 9700 ft [3000 m], *R. Schodde 2008* (BRI, CANB, K, L, LAE); Pengagl Valley, near Mt Wilhelm track, *J. Smith ANU 15199*, 30 Sep 1971 (CANB, K, L); Gembogl ambi nigl, 1970 m, Simbu Prov, Gembogl Subprov., *J. Sterly 1655*, 30 Oct 1983 (L); Chimbu Valley, Konatna, 2080 m, *J. Sterly 80-160*, 29 Aug 1980 (L); Chimbu Valley, Aragli, 2200 m, *J. Sterly 75-456*, 4 Jan 1976 (L); Bomkane, 2150 m, Simbu Prov., Gembogl Subprov., *J. Sterly 1666*, 29 Nov 1983 (L); Milne Bay District, Pumpunipon, Mt Suckling complex, 2015 m, *P. Stevens and J. Veldkamp LAE 54156*, 20 Jun 1972 (CANB, L, LAE (n.v.)); Kegsugl to Mt Wilhelm, along Pengagl Creek, c. 8500 ft [2600 m], *J.H. Willis*, 2 July 1970 (MEL).

PHILIPPINES: Manille (Mont Igorrotes), *M. Calléry*, 1840 (P); Mt Apo, Mindanao, *M.S. Clemens BS 15665*, June 1924 (MEL), nearly 10,000 ft [3000 m], *M.S. Clemens BS 15651*, 7 June 1924 (BM, UC); Mt Pulog and vicinity, Benguet Province, Luzon, *M.S. Clemens 5075*, 24-27 Feb 1925 (UC); Pauai Benguet to Mt Data, Bontoc Province, Luzon, *M.S. Clemens 16259B*, Dec 1925 (UC); Baguio, Benguet Prov., Luzon, *A. Elmer 5763*, Mar 1904 (K, L (n.v.), NSW, P); Todaya, Mt Apo, *A. Elmer 11436*, Aug 1909 (BM, K, L (n.v.), NSW); Mt Pulog, 2350-2450 m, Luzon, *M. Jacobs 7063*, 22 Jan 1968 (K ex L); Pauai, c. 2100 m, Luzon, *R.C. McGregor BS 8413*, June 1909 (MEL, NSW); Suyoc to Pauai, Prov. Benguet, Luzon, *E. Merrill 4763*, Oct-Nov 1905 (P); Mt Data, Lepanto subprovince, Luzon, *M. Ramos and G. Edaño BS 40202*, Sep 1921 (BM, K, MEL, NSW, UC); Mt Pulog, *M. Ramos and G. Edaño BS 45007*, Feb-Mar 1925 (BM, UC); Pauai, Luzon, *J. Santos BS 31864*, Apr-June 1918 (NSW).

BORNEO: **Sabah:** Mosilau, district Ranau, *Amin et al. SAN 123533*, 5 Sep 1988 (K ex SAN); Mesilau [as Masilau] River, upper Mt Kinabalu, 7000-8000 ft [2100-2450 m], *J. and M.S. Clemens 51674*, 26 Dec 1933 (BM, K, L, UC).

TAIWAN: Keelung, *U. Faurie 152*, Mar 1914 (P); Mt Ta-tung, Taipei Co., *H.O. Lee and M.T. Kao K3951*, 11 Jan 1961 (L); Prov. Taihoku, Mt Shichiseizan, *J. Ohwi 2034*, May 1933 (K); Tamsuy, *R. Oldham 580*, 1864 (K, P); Mt Ali, 2200 m, Central Formosa, *C. van Steenis 20833*, 12 Aug 1966 (L).

J. decipiens subsp. *sundaicus* (*Ridley*) *L.A.S. Johnson et K.L. Wilson*, comb. nov.

Basionym: *Juncus sundaicus* *Ridley* (1935: 342).

Type: Indonesia: Sumatra: Korinchi Peak [now Mt Kerinci], 7300 ft [2225 m], *H.C. Robinson and C.B. Kloss*, 25 May 1914; holo K; iso BM. The K sheet is a duplicate distributed from BM, and there are two minor differences in label information that probably result from transcription errors between the original and duplicate: the BM sheet bears a collectors' number '82' and the month of collection is given as April. However, all other details tally and the material appears to have come from the same collection, so it is assumed that the BM sheet is indeed an isotype.

Culms 20-50 cm long, 1.0-2.0 mm diam.; striations c. 20-30. Cataphylls 5-10 cm long, abaxially more or less evenly red-brown to dark red-brown. Inflorescence 2-4 cm long; lowest involucre bract 7-15 cm long. Tepals acuminate, straw-coloured centrally with a broad darker red-brown band each side of midrib, and with broad to more or less narrow hyaline to whitish margins; outer tepals 3.0-4.0(-4.5?) mm long. Anthers c. 0.5 mm long, shorter than filament length. Capsule slightly shorter than to equalling outer tepals, obovoid to narrow-ellipsoid, very dark red-brown, scarcely beaked. Seeds c. 0.6 mm long.

Illustrations: *Backer* (1951: fig. 2b), as *J. effusus*.

Distribution: Endemic to Malesia: probably only on the island of Sumatra (Aceh Province). *Ridley* cited four collections from Java, three of which we consider to be referable to subsp. *medianus* or to *J. inflexus*, while the fourth is an incomplete cultivated specimen from West Java (*Clemens 30421*) — see below.

Notes: *Ridley* (1935) clearly designated the type specimen, which is a good example of this taxon. However, he had a mixed concept of the taxon, as indicated by the range of collections cited in the protologue. Of the other four collections cited by him, all from Java, three have been seen on loan from K. Of these, *Koorders 26505* (mis-cited by *Ridley* as '26505B') is referable to *J. decipiens* subsp. *medianus* and *Koorders 37457*

(mis-cited by Ridley as '3745') is *J. inflexus*. *Clemens* 30421 is a poor and not readily assigned collection. It has the long (3.5 mm), more strongly red-brown tepals and red-brown capsules of subsp. *sundaicus* but lacks bases to check the cataphylls. We have not seen this last collection side by side with the supposed original voucher for these cultivated plants (see below) so we cannot at this time resolve the question of whether this *Clemens* collection is indeed this subspecies, cultivated in Java, or is instead subsp. *medianus*, which is native in Java.

The fourth collection (*van Steenis*, Papandayan, Java) was not seen in K but apparently equates to *Van Steenis* 12331 (J.F. Veldkamp, pers. comm.), which we have seen in L and which is also referable to subsp. *medianus*. That collection from Mt Papandayan was cultivated at Mt Gedeh, which plants in turn were the source of *Clemens* 30421 according to the annotation on the latter sheet by Van Steenis. He did not indicate the number of his original Papandayan specimen, but J.F. Veldkamp (pers. comm.) confirms that the specimen cited by Ridley, *Van Steenis* 12331, and the source of the cultivated plants are one and the same collection.

As noted in the key to subspecies, this subspecies differs from the others in having longer tepals that consistently have dark red-brown bands of colour beside the midrib (bands only occasionally present, a very dark red-brown capsule and cataphylls that are usually red-brown for most of their length).

Selected collections examined: SUMATRA: Gunung Bandahara, Camp 4, 2400–2600 m, Camp 6, *W. de Wilde and D. de Wilde-Duyffes* 15174, 22 Feb 1975 (K, L), 2600 m, *W. de Wilde and D. de Wilde-Duyffes* 13328, 24 June 1972 (K, L); Gunung Leuser West top, camp 1, 2000–2300 m, *W. de Wilde and D. de Wilde-Duyffes* 15944, 31 Mar 1975 (K, L), camp 2–3, 2300–2600 m, *W. de Wilde and D. de Wilde-Duyffes* 16029B, 2 Apr 1975 (K, L); Laut Poepandji, Atjeh, *C. van Steenis* 6396, 3–5 Sep 1934 (K ex BO, L); Mt Losir, c. 2200 m, *C. van Steenis* 8411, 28 Jan 1937 (L); Gaju and Alas Lands, Mt Kemiri, east slope, 3250–3314 m, *C. van Steenis* 9605, 7 Mar 1937 (L).

?*JAVA: cult. Mt Gedeh [plants originally collected on Mt Papandayan, by *C. van Steenis*, fide annotation by Van Steenis; voucher for those original live plants is *Van Steenis* 12331, fide J.F. Veldkamp, pers. comm.], *J. and M.S. Clemens* 30421, 7 Sep 1932 (K).

6. **Juncus inflexus* L.

(Linnaeus 1753: 326)

Type citation: 'southern Europe'.

Shortly rhizomatous perennial. Culms terete, more or less soft, blue-green to grey-green, glaucous, 25–70[–120] cm long, 1.0–1.5(–2.0) mm diam.; striations [10–]17–22; pith regularly interrupted, moderately dense, rarely continuous. Sterile leaf-like culms present but real leaves reduced to cataphylls 6–10 cm long, more or less loose around culms, abaxially pale brown at apex to very dark red-brown or blackish at base, adaxially pale straw-coloured above to dark golden brown towards base. Inflorescence 3–9 cm long, diffuse, with numerous solitary flowers; lowest involucral bract 12–20 cm long, apparently continuous with culm, exceeding inflorescence. Flowers with 2 bracteoles. Tepals acuminate, straw-brown, often with red-brown bands each side of midrib, usually with narrow (less than 0.2 mm wide) hyaline margins; outer tepals [2.5–]3.0–4.0 mm long, exceeding inner tepals. Stamens 6, shorter than outer tepals; anthers 0.7–1.2 mm long, generally greater than or equalling filament length. Capsule 3-locular, slightly shorter than to slightly exceeding outer tepals, elliptic to narrow-ovate, dark red-brown to blackish, acute, shortly beaked (c. 0.3 mm long). Seeds 0.4–0.6 mm long.

Illustrations: Fig. 2e, f; also Edgar (1964: figs 13, 27); Podlech (1979: figs 188, 189); Healy and Edgar (1980: fig. 17); Snogerup (1985: fig. 1(8)); Clemants (1990: 9).

Anatomy illustrated: Buchenau (1890: pl. 3, figs 8, 13, as *J. glaucus*); Cutler (1969: fig. 4H–K, pl. 1A); Nilsson and Snogerup (1971: fig. 52G); Fernández-Carvajal (1982a: figs 25–28).

Distribution and habitat: In Malesia, it is only known from wet places at 2100–2700 m altitude on three mountains in eastern Java. Backer (Backer 1924, 1951; Backer and Backhuizen f. 1968) did not comment on its status in eastern Java, but it seems likely to have been introduced there, as it is also in Australia and New Zealand. Its native range includes Europe, Africa, southwestern and central Asia. Neither we nor J.F. Veldkamp (pers. comm.) have seen any specimens from Mt Kawi, which is west of Mt Tengger and Jang Plateau; Backer (1924) mentioned that the species (as *J. glaucus* Ehrh.) occurred there but without citing any specimens.

Backer regarded some collections from far eastern Java (Tengger and Jang Plateaux, 2100–2300 m alt.; Backer 1924, 1951) that had continuous pith in the culm but otherwise were like typical *J. inflexus* as possibly representing the hybrid *J. effusus* × *J. inflexus*, but he was doubtful since they produced abundant fruit (Backer and Backhuizen f. 1968). This doubt is reinforced by Nilsson and Snogerup's comment (1971: 184) that this hybrid does not produce viable seed in its native Europe. Podlech (1979: 364) describes *J. inflexus* as occasionally having continuous pith in Europe. The three collections that we have seen from Java, cited below, have interrupted pith, including Koorders 43479, which was originally named as *J. effusus* × *J. glaucus* [= *J. inflexus*]. We have not seen any Javan collections with continuous pith.

Notes: Differs from other species in the region in having glaucous culms with very broad, flat striations that are widely separated (by 0.1–0.2 mm; versus up to 0.1 mm in the other species in section *Juncotypos*); very dark red-brown, glossy cataphylls; and very dark red-brown to blackish capsules.

Selected collections examined: JAVA: prope Ngadisari, 2300 m, S.H. Koorders 37457, 24 Oct 1899 (K, L (n.v.)); Besoeki, Jangplateau, c. 2100 m, S.H. Koorders 43479, 11 Aug 1916 (K, L (n.v.), P); Besoeki, Jang Plateau, Lake Tondjoeng, SW of Sekassor, 1900 m, C. van Steenis 11000, 17 July 1938 (K, L (n.v.), NY).

IRELAND: Casteldaly, Co. Clare, L. Johnson 8285, July 1976 (NSW).

ENGLAND: Fetcham, Surrey, A. Melderis 541, 19 July 1953 (NSW ex BM).

DENMARK: Jestehaven, Kalö, S. Jeppesen 577, 7 Aug 1969 (NSW ex AAU).

IRAN: Chalus Gorge, B. Briggs 6252, 18 Aug 1975 (NSW).

*AUSTRALIA: Victoria: c. 1 km directly SW of Sheeppark Flat, D. Albrecht 1563, 27 Jan 1985 (MEL, NSW).

*NEW ZEALAND: North Island: Te Mata Peak, Havelock North, 800 ft [240 m], A. Druce CHR 16543, Jan 1967 (CHR); near Taradale, A. Healy 50/101, Feb 1950 (CHR, NSW).

South Island: Marsden, A. Healy 61/81, Jan 1961 (CHR); Kokonga, A. Healy 58/379, Feb 1958 (CHR, NSW); above Cromwell, road to Loburn Gully, E. Edgar CHR 149591, Nov 1964 (CHR).

7. *Juncus durus* L.A.S. Johnson et K.L. Wilson, sp. nov.

Inter species in sectione *Juncotyphi* characterum combinatione sequenti distinguitur: culmi rigidissimi, medulla culmis lacunis bene interrupta, stomata superficialia, stamina 3.

Type: Papua New Guinea: Western Highlands: Yobobos grassland area (source of Lagaip River), Laiagam subdistrict, c. 8,500 ft [2,590 m], R.D. Hoogland and R. Schodde 7595, 25 Aug 1960; holo NSW; iso BM, CANB, L, LAE.

Shortly rhizomatous perennial. Culms terete, hard, mid-green?, 120–145 cm long, 1.8–3.0 mm diam.; culm striations c. 50; pith strongly interrupted, dense. Sterile leaf-like culms present but real leaves reduced to cataphylls 15–20 cm long, lax, shiny (less so towards apex), abaxially yellow-brown to very dark golden brown towards base, adaxially dark golden brown. Inflorescence 2–5 cm long, diffuse, with more or less densely clustered flowers, 5–10 per cluster and 2–10 clusters per inflorescence; lowest involucre bract 13–18 cm long, apparently continuous with culm, exceeding inflorescence. Flowers with 2 bracteoles. Tepals acute to acuminate, straw-brown, with more or less broad hyaline margins; outer tepals 2.0–2.5 mm long, slightly longer than or equalling inner tepals. Stamens 3, shorter than outer tepals; anthers c. 0.4 mm long, shorter than filament length. Capsule 3-locular, equalling or slightly exceeding outer tepals, elliptic to obovate, golden brown, acute to obtuse, not or scarcely beaked. Seeds c. 0.5 mm long.

Illustrations: Fig. 2g, h.

Distribution and habitat: Known only from two collections from the Yobobos grassland area of the Western Highlands, Papua New Guinea; in treefern grasslands at about 2,600 m altitude.

Notes: The epithet is derived from the Latin *durus*, hard, referring to the tough culms.

Apparently related to the Australian *J. gregiflorus* L.A.S. Johnson and New Zealand *J. edgariae* L.A.S. Johnson & K.L. Wilson. All three species have tough culms with dense pith (variously interrupted) and loose cataphylls that are dark golden brown both abaxially and adaxially. *J. durus* differs from *J. edgariae* in having finer culm striations (about 0.05 mm wide) that are all similar (in the latter, the striations are mostly broader (to about 0.1 mm wide) but mixed with some finer as well. The striations in *J. gregiflorus* are similar to those of *J. durus*. The pith in *J. durus* culms has larger lacunae than in *J. edgariae*, while the pith in *J. gregiflorus* differs from both in being usually much reduced to mere septa-like plates of pith separating very large lacunae.

It differs from *J. decipiens*, its closest relative in New Guinea, in having more rigid, thicker culms with much denser pith, which is frequently interrupted, and with lax dark golden brown cataphylls.

The local name in the Enga language (Kepilan) is given as Guli on the label of the type collection.

Collection examined: PAPUA NEW GUINEA: Yobobos grassland area (source of Laiagam River), c. 8,500 ft [2590 m], *R. Hoogland* and *R. Schodde* 7460, 17 Aug 1960 (CANB, LAE).

8. *Juncus nupela* Veldkamp

(Veldkamp 1977: 415)

Type: Papua New Guinea: Star Mountains, West Sepik, Tel Basin, Camp 2, 2900 m, *J.F. Veldkamp* 6369, 8 Apr 1975; holo L; iso LAE (n.v.), NSW.

Rhizomatous perennial. Culms terete, soft, grey-green?, 35–60 cm long, 1–1.5 mm diam.; striations 30–50; pith continuous, more or less dense. Sterile leaf-like culms present but real leaves reduced to cataphylls c. 10 cm long, lax, abaxially dark golden brown, adaxially golden brown. Inflorescence c. 1–3 cm long, diffuse, with flowers solitary or loosely clustered, c. 6 flowers per inflorescence; lowest involucre bract 5–8 cm long, apparently continuous with culm, exceeding inflorescence. Flowers with 2 bracteoles. Tepals long-acute, red-brown on sides, green or straw-brown on midrib, with very narrow hyaline margins; outer tepals 5.5–6.0 mm long, greater than or equalling inner tepals. Stamens 6, shorter than outer tepals; anthers 1.5–1.8 mm long, exceeding filament length. Capsule 3-septate; mature features unknown.

Illustrations: Fig. 2i, j.

Distribution and habitat: Endemic in New Guinea (known only from the type from the Star Mountains). Said to be growing on the bank of a rivulet in tall grassland, where it was locally common. The culms were described on the label as being 'single flattened, sometimes twisted, culms from the rootstock.'

Notes: Compared to the other species of section *Juncotypus* in New Guinea, this species is easily distinguished by its long, slender tepals and fine, much less prominent striations that are irregular along the length of the culms (in the other species, the striations are prominent and usually in a straight line along the length of the culms).

It is apparently related to a Eurasian–American group of species (*J. arcticus* Willd., *J. balticus* Willd., etc.) rather than to the other New Guinean species or those of Australia and New Zealand. In that group it seems closest to the North American *J. ater* Rydb. from North America and *J. laenkei* E. Mey. (found from northeastern Asia to Alaska and the NW coast of North America), and could even be conspecific with one of those species although its pith is rather denser than in those two taxa. Veldkamp considered that the whole population was possibly sterile (no capsules were seen by him), which may indicate a single, relatively recent introduction or possibly even a hybrid origin. Veldkamp (pers. comm.) regards this as most likely to be native there since that very remote area had had very few visitors from other parts of the world before his visit in 1975. There are various species in a range of other families with a similar disjunct distribution in high altitude regions in Malesia as well as in temperate eastern Asia or Australia, or in all three regions. One such example is *J. sandwithii*, which has its main distribution in higher altitude mountain areas of south-eastern mainland Australia and at various altitudes in Tasmania. Other examples include *Carplia alpina* R. Br. (Wilson 1986) and 21 species of *Carex* (Kern and Nootboom 1979) in the family Cyperaceae, also grasses such as *Anthoxanthum redolens* Vahl (Schouten and Veldkamp (1985: 343) and *Trisetum bifidum* (Thunb.) Ohwi (Veldkamp and Van der Have 1983).

Collection examined: PAPUA NEW GUINEA: Known only from the type collection.

***Juncus prismatocarpus* and allied species in continental Asia and Malesia**

In revising the species of this genus in Australia, New Guinea and New Zealand, it was necessary to look at various taxa in Asia and Malesia that have been either confused with the Australasian *J. prismatocarpus* R. Br. or said to be allied to it. Many Flora treatments have used this name in a very broad sense, including Buchenau (1890, 1906), Hooker (1892), Backer (1951), Makino (1964), Backer and Bakhuizen f. (1968), Larsen (1972), Harriman (1991) and Wu (1994), although others have recognised species such as *J. leschenaultii* and *J. wallichianus* as being separate from *J. prismatocarpus*. We reviewed all the Asian and Australasian septate species lacking seed-appendages that were covered under '*Junci septati*' by Buchenau (1906), plus other names that had been published subsequently in this group. The Australasian species will be covered in a separate paper. Here we summarise our (sometimes tentative) conclusions about the Asian and Malesian species, based on examination of the literature and of specimens in B, BM, BRI, CANB, K, L, MEL, NSW, P, TAI, TI and W.

Careful study and comparison of morphological characters suggest that about 12 septate-leaved species without appendages to the seeds should be recognised in Asia and Malesia (the number depends in part on further study of the variation in *J. leschenaultii* and *J. wallichianus*). The following synoptic key to these taxa indicates

what we see as critical characteristics in separating them, but it is not intended as a practical key for identifying all specimens because we have not seen much material of some Asian species, our focus having been on Malesian species. However, we regard this as an opportunity to provide an interim discussion of taxa to stimulate further regional studies. A description of *J. prismatocarpus* is included here to facilitate comparison; descriptions of *J. leschenaultii*, *J. sandwichii* and *J. wallichianus* are given above.

Key to species

- 1 Pluritubulose leaves; culms more or less compressed (?occasionally unitubulose or apparently so in very slender *J. leschenaultii*)
 - 2 Stamens 3
 - 3 Plants robust with culms 2–3 mm wide below the inflorescence; leaf sheaths usually with broad (0.8–1.5 mm wide) hyaline to membranous margins; flower clusters usually with numerous (10–30) flowers, occasionally fewer; tepals 0.8–1.0 mm wide.
 - 4 Capsule very narrow and strongly elongated, tapering evenly to the short apical beak (Australia and New Zealand) 9. *J. prismatocarpus*
 - 4* Capsule relatively broader and shorter, contracting more sharply near the short apical beak 12. *J. diastrophanthus*
 - 3* Plants slender with culms 0.7–1.5 mm wide below the uppermost node; leaf sheaths usually with narrow (to 0.8 mm wide) hyaline to membranous margins; flower clusters usually with few (3–8) flowers; tepals 0.5–0.7 mm wide 3. *J. leschenaultii*
 - 2* Stamens 4–6
 - 5 Culms strongly flattened and winged; capsule more or less acute (to obtuse), dark golden brown, often with a reddish tinge; tepals 2.5–3(–3.5?) mm long, with 3 more or less prominent veins 10. *J. alatus*
 - 5* Culms usually not winged (rarely winged); capsule rather elongated-acute to broad-acute, straw-coloured or slightly reddish; tepals 2.7–4 mm long, with only 1 more or less faint vein, longer and narrower than in *J. alatus* 3. *J. leschenaultii*
- 1* Unitubulose leaves; culms more or less terete
 - 6 Plants dwarf (culms less than 10 cm long) 1. *J. sandwichii*
 - 6* Plants may be slender but culms more than 10 cm long (commonly 20–50 cm)
 - 7 Ultimate branches of inflorescence short, so that flower-clusters are themselves clustered; tepals more or less incurved and broad, [2–3.2 mm long]; stamens (3–)4–6 13. *J. krameri*
 - 7* Flower-clusters spread out more or less remotely on branches in inflorescence; tepals more or less erect or excurved; stamens 3 (occasionally 4 in *J. virens*)
 - 8 Capsules usually red-brown to dark red-brown; [tepals 2–3(–3.5) mm long;] stamens 6 11. *J. articulatus*
 - 8* Capsules usually straw-coloured to dark golden brown, occasionally with reddish tinges; stamens 3(–4 in *J. virens*)
 - 9 Tepals 1.5–2.3(–2.6 in *J. papillosus*) mm long
 - 10 Inner tepals narrow, acuminate, with very narrow hyaline margins; tepals reddish; capsule very long-acuminate and slender, with slender beak 0.5–0.7 mm long 15. *J. papillosus*
 - 10* Inner tepals broad-acute to more or less obtuse, with broad hyaline margins; tepals straw-coloured; capsule abruptly acuminate with short beak 0.2–0.3 mm long 16. *J. virens*
 - 9* Tepals (2.3–)2.5–3.7 mm long

- 11 Leaf sheath margins broad, yellow, chartaceous; tepals (2.3–)2.5–3.7 mm long, all of similar length; capsule acute to broad-acute with beak 0.2–0.5 mm long, exceeding (occasionally greatly so) to equalling tepals 2. *J. wallichianus*
- 11* Leaf sheath margins more or less narrow, yellow, chartaceous; tepals 2.4–3 mm long, outer tepals shorter (occasionally much shorter) than to equalling inner tepals; capsule long-acuminate with beak 0.5–0.7 mm long, much exceeding tepals 14. *J. leptospermus*

A description of the Australasian pluritubulose-leaved *J. prismatocarpus* is provided here since there has been so much confusion over its limits. This is followed by a brief enumeration of the Asian septate-leaved species mentioned in the synoptic key above. The three species that occur in Malesia are treated above.

In a recent paper on Chinese species of *Juncus*, Wu (1994) recognised two new species in 'Subgen. *Septati* sect. *Articulati* ser. *Articulati*' — *J. sphaerocephalus* K.F. Wu and *J. auritus* K.F. Wu — of which we have seen no material. From the descriptions and illustrations, these probably both fall within the variation of *J. wallichianus* as recognised by us. He described a new subspecies, *J. prismatocarpus* subsp. *teretifolius* K.F. Wu, of which we have seen a duplicate of the type number (*Tsang* 20636) in K; that specimen belongs to *J. wallichianus*.

We have not seen type material of *J. bombonanzensis* Satake (from Taiwan; type in TI?). This name was given as a synonym of *J. wallichianus* by Kao and De Vol (1978), but that seems unlikely since Satake (1933: 182) described it as having imperfectly septate (= pluritubulose) leaves. This suggests that it is referable to *J. leschenaultii*, as does the elongated capsule illustrated by Satake (1933: fig. 18), and the habit (1933: pl. 1) is reminiscent of *J. leschenaultii*.

9. *Juncus prismatocarpus* R. Br.

(Brown 1810: 259)

J. prismatocarpus var. *α genuinus* Buchenau (Buchenau 1885: 204), nom. inval.

Type: Australia: New South Wales: Port Jackson, R. Brown (*Bennett* 5784); holo BM, photo NSW.

Juncus commutatus Steud. (Steudel 1855: 301). Type citation: 'Juncus prismatocarpus Sieb. nr. 431 Hrb. n. H. [Nov. Holl.] et 630 hrb. mixt. et R. S. Syst. VII 213.' Type: New South Wales: *Sieber Herb. Nov. Holl.* 431; lecto (*here designated*) P (herb. Steudel); isolectos BM, BREM (n.v.), K, L (sheet 904.144–370), MEL. Residual syntype: *Sieber Herb. Mixt.* 630; syn L, P (herb. Steudel).

The sheet of *Sieber* 431 that is in Steudel's herbarium bears elongated but not quite mature capsules. Steudel had named this sheet as *J. prismatocarpus*. Despite being in not particularly good condition, it is more suitable as a lectotype than *Sieber Herb. Mixt.* 630 since it is much more mature than the latter and therefore more recognisable. This choice is supported by Steudel's description of capsules for this taxon (the other specimen is too immature to have capsules). Sheets of 431 seen in other herbaria are generally in better condition. In L, there is one sheet of 431 (sheet 904.144–373) that bears an immature specimen of a unitubulose species (perhaps the Australian *J. fockei* Buchenau or *J. holoschoenus* R. Br.) that obviously does not belong to *J. prismatocarpus*. The plants on the sheets of *Sieber Herb. Mixt.* 630 in P and L are pluritubulose but very immature; that number has not been seen elsewhere. Steudel had named the sheet in P as *J. commutatus*.

Tufted perennial. Culms more or less flattened, yellow-green, 10–40 cm long, 1.3–3.0 mm diam. Leaves pluritubulose, spread along culms, shorter or equalling culms, compressed, 1.3–3.2 mm wide; auricles 0.3–1.0 mm long. Inflorescence terminal, 5–17 cm long, diffuse, with flowers clustered, 5–25 per cluster and 4–40 clusters per inflorescence; 1 well-developed involucre bract, 3–14 cm long, shorter than or rarely as long as inflorescence. Tepals acuminate, often spreading to recurved at maturity, straw-brown to red-brown, with narrow hyaline margins; outer tepals 2.5–3.5(–4.1) mm long, more or less equalling inner tepals. Stamens 3, shorter than outer tepals; anthers 0.4–0.7 mm long, shorter than filaments. Capsule exceeding outer tepals by 1–3 mm (to twice as long), very narrow-ovoid, golden brown, long-acuminate, tapering evenly then narrowing abruptly at apex into slender beak c. 0.3 mm long. Seeds 0.4–0.5 mm long.

Illustrations: Fig. 1e–g; also Buchenau (1906: fig. 89) as var. *genuinus*; Wilson et al. (1993: 289).

Anatomy illustrated: Buchenau (1906: fig. 89C); Cutler (1969: fig. 7J, K).

Distribution and habitat: In Australia, found in temperate regions of Queensland, New South Wales, Victoria, Tasmania and South Australia. There is one old specimen purportedly from Western Australia – Murchison River, *Oldfield* – but that is regarded as a doubtful record. In New Zealand, this is widespread on the North Island, scattered on the South Island, in swampy situations. Introduced in Hawaii. Widespread in wet sites: margins of dams, swamps, marshes and creeks.

Notes: Confused with *J. leschenaultii* and *J. wallichianus* in Malesia and Asia (see, e.g., Backer 1951). It differs from both species in its very long, acuminate capsule, which is up to about twice as long as the tepals. For other differences, see the comments above under the treatments of those two taxa and the key.

Selected collections examined: AUSTRALIA: Queensland: Windsor Tableland, N of Mt Carbine, *A. Beam* 4562, 7 June 1992 (BRI, NSW); Rainbow Creek, Blackdown Tableland, *L. Johnson and D. Blaxell* 741, 26 Nov 1972 (NSW); near Beenleigh, c. 1 mile [1.6 km] along Waterford Road, *L. Smith* 12236, 4 Nov 1964 (BRI, NSW).

New South Wales: Bell Bird Creek, 4 miles (6.5 km) N of Eden, *R. Melville* 2742 and *N. Wakefield*, 8 Jan 1953 (K, NSW); Busbys Flat Road 27 km SW of Casino, in Royal Camp State Forest, *K. Wilson* 8553, 22 Oct 1992 (BRI, K, NE, NSW); Etoo Creek 7 km along Kellys Lane from Pilliga – Gwabegar Road, *K. Wilson* 6042, 15 Nov 1984 (CHR, NSW); NW side of Castlereagh State Forest, SE of Londonderry, *K. Wilson* 7997, *L. Johnson and P. Bankoff*, 5 Feb 1992 (CHR, NSW).

Victoria: Woori Yallock Picnic Ground, c. 0.5 km NW of Yellingbo, *A. Beanglehole* 50411, 22 Mar 1976 (MEL, NSW); Reedy Creek, 5 km by road E of Cann River, *L. Johnson* 7438 and *E. Edgar*, 21 Oct 1971 (NSW); 4 Mile Creek, near Warburton, *R. Melville* 3832, 3 May 1953 (K, NSW); c. 4 km from Genoa on Mallacoota road, *K. Wilson* 2214, 8 Feb 1979 (MEL, NSW).

Tasmania: S. Esk River at Perth, *W. Curtis s.n. and Cameron*, 7 Feb 1979 (HO, NSW 241536).

South Australia: Myponga, *J.M. Black*, Mar 1923 (AD).

NEW ZEALAND: North Island: Scott Point, North Cape, *Kelly*, Apr 1967 (CHR 178242); Bethells Swamp, Waitakere Range, *R. Gardner* 888, 10 May 1974 (AKU, NSW); Rotokare, near New Plymouth, *A. Druce* CHR 158503, Feb 1964 (CHR); Palmerston North waterworks, *Zotov*, Dec 1932 (CHR 4547).

South Island: Pakihi E of Collingwood–Rockville road, *R. Mason and N. Moar*, Feb 1957 (CHR 95785); near Lake Rotoiti, *R. Mason and N. Moar*, Feb 1957 (CHR 95995); Marsden, *Healy* 61/73, Mar 1961 (CHR); near lower Wairau River, *R. Mason* 3098, Jan 1955 (CHR).

*HAWAII: Kohala Mountains, Kahua Ranch, 3300 ft [1000 m], *P. Rubtzoff*, 2 Aug 1956 (NY ex CAS).

10. *Juncus alatus* Franch. et Sav.

(Franchet and Savatier 1877–78: 98, 534)

Type citation: 'In orizetis: Nippon media, ad Simoda (Savatier, n. 1357); ad pedem montis Fudsi yama (id., n. 3477).'

Types: *P. Savatier* 1357; syn ?K, ?P (*Savatier s.n.*, Simoda). *P. Savatier* 3477; syn ?K, ?P (*Savatier s.n.*, ad pedem montis Fudsi yama).

Illustrations: Makino (1964: 823).

This pluritubulose-leaved species is native to China and Japan. It has very strongly winged, flattened culms (commonly 3–4 mm wide), 6 stamens, and the capsule only shortly exceeding the tepals. The capsule shape is broader and less elongated than that of *J. prismatocarpus* and *J. diastrophanthus* and there are generally fewer flowers per cluster than in those species. The capsule shape is similar to that of *J. leschenaultii* but that species has much narrower, scarcely winged culms and stamens usually 3 (occasionally to 6).

Selected collections examined: CHINA: Nanking, Spirit-Valley, Kiangsu Province, C.Y Chiao 14895, 3 Feb 1927 (K, 2 sheets); Su-tchuen oriental, district de Tchen-Kéou-Tin, alt. 2500 m, R. Farges 1256, 3 July 1899 (P); Patung district, A. Henry 1794, 1887 (K); Lushan, Lulin (Jiangxi), 900 m, Nie M.-X. 92152, 31 May 1992 (K ex PE); Tai Pei Shan, W. Purdom, 1910 (K); Tai pai Shan – Shansi, W. Purdom, – (K); Kewkiang, Dr Shearer, 1873 (K); P'ing T'ou Shan, T'ang Wan Village (Yi Chang district), Hunan, W.T. Tsang 23760, 1–13 May 1934 (NSW, P ex A); Si Chuan, Guan Xian, Qishuping, 1350 m, Wang Z. – T. et al. 870221, 29 July 1987 (NSW ex PE).

JAPAN: Japan, F.V. Dickins, July 1876 (K); Japan, U. Faurie 1808, 1898 (K, P); Kiusiu, Maximowicz Iter Secundum, 1862 (K, P); Ogura prope Kyoto, Hondo, J. Ohwi 9198, 13 June 1937 (K); Simoda, Savatier Plantae Japonicae 1866–1871 (series prima) no. 1978, – (P); Akabane, Bank of River Arakawn, Tokyo, Hondo, S. Suzuki 438–1, 30 May 1937 (K).

KOREA: Quelpaert, U. Faurie 2251, Aug 1907 (P).

11. **Juncus articulatus* L.

(Linnaeus 1753: 327)

Type: Europe.

J. lampocarpus Ehrh. ex Hoffm. (Hoffmann 1800: 166). Type citation: Ehrhart 'gram. 126'.

Note that the 1791 edition of this work includes brief but adequate treatments of various species but not of *J. lampocarpus*. In the 1800 edition, *J. lampocarpus* is described in a note following *J. acutiflorus* on p. 166. The epithet has often been misspelt as 'lamprocarpus'.

Illustrations: Nilsson and Snogerup (1972: fig. 74); Snogerup (1985: fig. 1(32)); Clemants (1990: 43); Wilson et al. (1993: 286).

This unitubulose-leaved species is probably native to Europe, Central and Southwest Asia, northern Africa, and temperate North America but introduced very widely in other regions, including eastern Asia, Australia (Queensland, New South Wales, Victoria, Tasmania, South Australia, Western Australia) and New Zealand (North Island, South Island, Stewart Island, Chatham Islands, Auckland Island, Campbell Island). It has 6 stamens, whereas the native unitubulose Asian species have 3 stamens except *J. krameri* Franch. & Sav., which often has 6 stamens. The capsule of *J. articulatus* is usually red-brown to dark red-brown, with an acuminate to obtuse apex, and shortly exceeding the tepals. This combination of features is not seen in the native species.

Selected collections examined: *CHINA: Yunnan, prope Lichiang, 3100 m, C. Schneider 2832, Oct 1914 (K); Tibet, ravine above Sungnam, Kanawar, 12-1400 feet [3600-4200 m], T. Thomson, 22 Aug 1847 (K); Shansi, Huohsien, Kuo-yueshan, T. Wang 3949, 30 Sep 1935 (K).

BHUTAN: Paro, 2286 m, Ramesh Bedi 698, 18 Aug 1971 (K).

PAKISTAN: Gumbar Ravine, below Kasauli, J. Drummond 5001, 13 Mar 1886 (K); near Madian, Swat State, c. 5000 feet [1500 m], R. Rodin 5527, 15 Aug 1952 (K).

TURKMENISTAN: Pr. Ashabad, Bogyr, D. Litvinov 2139, 25 June 1898 (NSW ex LE).

TADJIKISTAN: Siyakukh Research Station, Gissar Range below Anzob Pass, L. Johnson and B. Briggs, July 1975 (NSW 451170).

LEBANON: Dschebel Sannin, E. Hartmann, Kneucker 85, 27 July 1900 - Sep 1901 (NSW).

TURKEY: Prov. of Rize, Baskoy (Cimil)-Cermanin Y., D. Davis 21037, 28 Aug 1952 (NSW ex BM).

HUNGARY: Herkulesbad im Banat, L. Richter, Kneucker 85a, 21 Aug 1901 (NSW).

GERMANY: Kahlberg, R. Gross, July 1902 (NSW 541172).

FINLAND: Tarttila village, Saarioisjarvi Lake, R. Thorne 47025 and R. Alava, 13 July 1975 (NSW ex RSA).

CANADA: Shawnigan Lake, British Columbia, J. Anderson 766, 18 Aug 1897 (NSW).

U.S.A.: Orono, Maine, M. Fernald 188, 29 July 1908 (NSW).

*AUSTRALIA: New South Wales: Armidale, R. Coveny 16379 and A. Whalen, 19 Jan 1993 (BRI, CHR, NE, NSW); Cave Creek via Blue Waterholes fire trail, Kosciuszko National Park, P. Kodala 412, P. Jobson and R. Coveny, 26 Jan 1997 (CANB, MO, NE, NSW); Wentworth Falls, K. Wilson 7987a, L. Johnson and P. Bankoff, 5 Feb 1992 (B, MO, NSW).

Victoria: Crawford River crossing of the Hotspur-Condah Road, D. Albrecht 32, 16 Dec 1983 (NSW, AD, BRI, CANB, HO, MEL,); Central Little Desert National Park, A. Beauglehole 87738 and Huebner, 17 Dec 1986 (NSW, MEL); Wonwondah East, K. Wilson 1065 and L. Johnson, 16 Feb 1975 (NSW).

Tasmania: Outskirts of Hobart, Knocklofty, A. Orchard 5009, 16 Apr 1978 (HO, NSW); 3 miles [4.8 km] E of Hastings, P. Raven 25929, T. Engelhorn and D. Morris, 21 Feb 1970 (MO, CHR, NSW); c. 9 km E of Low Head town, K. Wilson 6440, 19 Feb 1986 (NSW, CHR, HO, MEL).

South Australia: Wellington, mouth of River Murray, H. Eichler 15672, 26 Jan 1959 (AD, NSW); near Furner, D. Symon 1205, 9 Mar 1961 (ADW, CANB, B, K, NSW).

Western Australia: 1.5 miles [2.4 km] S on Lake Muir turnoff (on Rocky Gully-Manjimup road), A. and J. McComb 1727, 27 Dec 1971 (UWA, NSW).

*NEW ZEALAND: North Island: Waitakere Ranges, B. Briggs, Jan 1966 (NSW 90870).

South Island: Lake Lyndon, W of Christchurch, B. Briggs, 6 Feb 1966 (NSW 90848); Motueka Valley, T. Cheeseman 24, Jan 1881 (K); Eyre Creek, R. Melville 6472, Feb 1962 (CHR, K); Ship Creek, near Haast on the road to Fox Glacier, M. Tindale 7041 and W. Sykes, 13 Feb 1983 (CHR, NSW).

12. *Juncus diastrophanthus* Buchenau

(Buchenau 1890: 309)

Type citation: 'Hakodate, Japan; gesammelt von Prof. Maximowicz und Dr Albrecht.'

Type: Hakodate, C. Maximowicz, *Iter Secundum*, 1861; syn K ex LE, W ex LE. Circa Hakodate, Dr Albrecht, 1861-63; syn W ex LE. Both syntypes in W came there as part of Buchenau's herbarium. The Maximowicz collection in K was determined by Buchenau as *J. prismatocarpus* rather than *J. diastrophanthus* but, despite this, it is probably a duplicate of the W collection, which Buchenau had first determined as *J. prismatocarpus* and later as *J. diastrophanthus*.

? × *J. togakushiensis* Léveillé (1912: 352). Type citation: 'Togakushi, septembr. 1898 (Urb. Faurie, 1796)'. Type: Togakushi, *U. Faurie 1796*, Sep 1898; holo E (n.v.; cited by McKean 1988: 156); iso? K, P.

Illustrations: Makino (1964: 825).

This pluritubulose-leaved species has rather broad, strongly flattened leaves and culms, similar to those of *J. prismatocarpus* and *J. alatus*, all three of them being coarser than in *J. leschenaultii*. The capsule of *J. diastrophanthus* is very narrow and elongated like that of *J. prismatocarpus*; the capsule in *J. leschenaultii* and *J. alatus* is shorter and relatively broader. There is some variation in number of flowers per cluster and therefore of perceived density of the clusters in the material of this species seen. The two syntypes are relatively few-flowered, as is much other material, but some other collections differ in having much denser clusters and often rather more elongated capsules (e.g. *U. Faurie 1796* (K, P)). That Faurie collection is the type number for × *J. togakushiensis* Léveillé. However, neither of the sheets seen by us (in K and P) has been annotated by Léveillé, and we have not yet seen the holotype sheet (which is cited by McKean (1988: 156) as being in E with the rest of Léveillé's herbarium). It seems unlikely to be a hybrid of *J. leschenaultii* with the distantly related *J. ensifolius* Wikstr. (*J. xiphioides* auct.) as suggested by the original author. McKean identified the holotype specimen as being *J. ensifolius*. We have not seen the holotype but the two probable isotypes seen by us in K and P are *J. diastrophanthus*.

Selected collections examined: JAPAN: Kuroishi, *U. Faurie 1292 p.p.*, 29 Sep 1889 (K, P); Togakushi, *U. Faurie 1796*, 17 July 1898 (K, P); Tidesan, *U. Faurie 1798*, 30 Aug 1898 (K); Aomori Pref., Tsugaru Peninsula, Nishitsugaru-gun, Kakure-numa, *H. Hara et al.*, 15 Sep 1974 (K); Omagari, Tanabu-machi, Shimokita Peninsula, Prov. Matsu, Hondo, *M. Mizushima 1650*, 4 Aug 1955 (TI); Aomori Pref., Simokitagun, Saimura, *H. Mora 16689*, 22 Sep 1956 (K); Hakodate, Yezo, *T. Satow 5324*, 1926 (TI); Komazawa, Setagaya, Tokyo, Hondo, *S. Suzuki 438-2*, 18 Aug 1937 (K); Shiramine in Kaga, Honshu, *M. Togasi TSM 1077*, 6 Sep 1954 (NSW ex TNS); Yunokawa, Prov. Oshima, *I. Yamamoto 8377*, 6 Aug 1937 (TI).

13. *Juncus krameri* Franch. et Sav.

(Franchet and Savatier 1877–78: 99, 534).

Type citation: 'In orizetis: Nippon, circa Simoda (*Savatier*, n. 1354).'

Type: Japan: Simoda, *P. Savatier 1354*; holo K?, P? (n.v.).

Illustrations: Makino (1964: 824).

This unitubulose-leaved species is native to Japan and China. It is also recorded for Korea and the Kuriles by Kitagawa (1979: 162). It is distinctive in having a more compact inflorescence, i.e. with more densely clustered flower-clusters, and more strongly incurved tepals than the other species discussed here. Its culms are distinctive in looking minutely but strongly punctulate and somewhat scaberulous (at least when dried). Franchet and Savatier (1877–78: 535) described the culms and leaves as being covered in 'petites aspérités blanches papilleuses'. We have not seen live plants of this taxon, but cross-sectioning dried culms shows that stomates have large air-spaces under them, so the external appearance of the culm is apparently owing to the 'collapse' of tissues into the air-spaces at least when dried (see also discussion under *J. papillosus* below). The capsule of *J. krameri* shortly exceeds the tepals, as in *J. articulatus*, *J. wallichianus* and *J. virens* Buchenau. Stamens are usually 4–6 (rarely 3), whereas *J. articulatus* has 6 stamens and the other species have 3 stamens (occasionally 4 in *J. virens*).

Selected collections examined: CHINA: Tai Ping Kung, Lao Shan, 600 m, Shantung, C.Y. Chiao 2823, 18 July 1930, (K).

JAPAN: Niigata, U. Faurie 1805, 24 Sep 1898 (K); Asamayama, U. Faurie 1806, 14 July 1898 (K); Ile de Kunashiri, U. Faurie 5134, 8 Oct 1889 (K, P); Hondo, Katakai in Kadzusa, I. Ito and T. Koyama TSM 973, 10 Sep 1953 (K, NSW ex TNS); Hakodate Mohidzi, Maximowicz *Iter Secundum*, 1861 (K ex LE); Tokyo, T. Terasaki, Aug 1905 (K, 2 sheets).

14. *Juncus leptospermus* Buchenau

(Buchenau 1885: 203)

Type citation: 'Assam (Khasia) am unteren Brahmaputra; 4–6000 Fuss; gemässigte Region; J.D. Hooker und T. Thomson; – von C.B. Clarke daselbst an verschiedenen Orten in Höhen von 4000 bis 5500 Fuss im Oktober mit entwickelten Früchten gesammelt. – East Bengal (vielleicht ist damit dieselbe Gegend gemeint); gesammelt von Griffith (Herbarium of the late East-India-Company, Nr. 5455 et pro pte 5459).'

Types: India: Khasia, 4–6000 ft, J.D. Hooker and T. Thomson; syn K. Khasia, 4000–5500 ft, C.B. Clarke; syn ?K (n.v.). East Bengal, Griffith 5455; syn ?K (n.v.). East Bengal, Griffith 5459; syn ?K, L (n.v.).

Illustrations: Buchenau (1906: fig. 95).

We have only seen a few collections of this unitubulose-leaved species, from the eastern part of India and Yunnan, but Noltie (1994) records it also for Bhutan. The collections from Yunnan have rather more strongly mucronate tepals than the Indian specimens but do not differ in other ways. The *Hooker and Thomson* syntype in K was determined by Buchenau as *J. leptospermus*. The *Clarke 18607* collection in K cited below was not determined personally by Buchenau but presumably Clarke sent a duplicate to him since it is labelled in Clarke's script '*leptospermus* Buchenau fide Buchenau', and this number is cited as the basis of Buchenau's figure cited above. The capsule of *J. leptospermus* usually much exceeds the tepals, as also in *J. papillosus* (q.v.), differing from that species in its long, usually reddish tepals and generally darker (golden to red-brown) capsule.

Collections examined: CHINA: Yunnan, river near Zhongdian (Chungtien), alt. 3240 m, *Chungtien-Lijiang-Dali Expedition 258*, 27 Sep 1990 (K); Yunnan, Yulong Shan, above the Lan gon Lake, 3200 m, *Chungtien-Lijiang-Dali Expedition 1140*, 11 Oct 1990 (K).

INDIA: Mairung, 4,500 ft [1370 m], Khasia C.B. Clarke 16089, 30 Oct 1871 (K); Mairung, 4,000 ft [1200 m], C.B. Clarke 16103, 30 Oct 1871 (K); Madphlang [spelling?], Khasia, 5500 ft [1670 m], C.B. Clarke 18607, 19 Oct 1872 (K).

15. *Juncus papillosus* Franch. et Sav.

(Franchet and Savatier 1877–78: 98, 533).

Type citation: 'In montibus Hakone (*Savatier*, n. 1355); circa Yokoska, in scrobibus (*Savatier*, n. 2521).'

Types: Japan: Hakone, P. Savatier 1355; syn K? (n.v.), P. Yokoska, P. Savatier 2521; syn K? (n.v.), P.

J. niponensis Buchenau (Buchenau 1890: 340). Type citation: 'von Maximowicz bei Yokohama, von Professor Yatabé bei Tokyo gesammelt, warscheinlich auch auf Yesso (Maries in hb. Kew)'

Types: Japan: Yesso, *Maries*; syn K. Yokohama, C. Maximowicz *Iter Secundum*; syn ?LE (n.v.), P, ?W (n.v.). Tokyo, *Yatabé*; syn ?LE (n.v.), ?W (n.v.).

?*J. niponensis* var. *hakodatensis* Léveillé (Léveillé 1912: 352). Type citation: 'Japonia; Yezo, circa Hakodate, 29 sept. 1902 (Urb. Faurie, 5236)'. Type: Japan: Yezo near Hakodate, *U. Faurie* 5236, 29 Sep 1902; holotype? P? (n.v.).

Illustrations: Krechetovich and Goncharov (1935, pl. 30 fig. 8), as *J. niponensis*; Makino (1964: 824).

Satake (1933) reported this slender, wiry, unitubulose-leaved species as occurring in Japan and also in 'Manchuria, China and Amur'. Kitagawa (1979) also mentions Korea and the Kuriles. Its capsule is about twice as long as the tepals (tepals c. 1.5–2 mm long), similar to that of *J. leptospermus* (q.v.), whereas the capsule only shortly exceeds the tepals in *J. krameri*, *J. virens* and *J. wallichianus*. Franchet and Savatier (1877–78: 533) named this species because of its supposed white papillae on leaves and culms, but in the discussion they accepted that this was not a feature unique to this species and that it was variable with age of plants. The surface resembles the irregular, scaberulous surface seen in other species such as *J. krameri*, *J. striatus* Schousboe ex E. Mey. (illustrated by Cutler 1969: fig. 6G, H) and various species in sect. Graminifolii. Buchenau (1890: 341) equated the supposed papillae with the stomates, which occur in longitudinal rows and which appear to be on prominent longitudinal ridges when a specimen is dried. We have not sectioned all of the relevant species but, in this species and at least some of the others, cross-sectioning of leaves and culms shows that the 'white-papillose' appearance relates more to variation in size of epidermal cells (generally large) and to large stomates that often have large air-spaces underlying them rather than to actual protuberances on the surface. On drying, irregularities are emphasized by collapse of these large cells, as is the 'whiteness' of the epidermal cells and stomates in contrast to other denser cells.

The only probable syntype of *J. niponensis* that we have seen has not been annotated by Buchenau, so it is not appropriate to select it as lectotype without further searching, at least in W. It is a specimen of *J. papillosus*. Similarly, the *Maries* specimen was only cited with doubt by Buchenau; he annotated it as 'probably *J. niponensis*'. It is an immature specimen of *J. papillosus*. *J. niponensis* was regarded as a synonym of *J. papillosus* by Satake (1933: 186), Ohwi (1965: 278) and Kitagawa (1979: 162). Buchenau (1890) had not seen the type of *J. papillosus* when he described *J. niponensis* – he listed *J. papillosus* under 'Species dubia', as possibly just a young plant of *J. niponensis* flowering in the first year (Franchet and Savatier (1877–78: 533) had described it as being an annual). He still had not seen this type some years later (Buchenau 1906).

Léveillé's *J. niponensis* var. *hakodatensis* was described as differing in being more slender than the typical form and more pallid in colour, with yellow seeds. McKean (1988: 157) did not find the type amongst Léveillé's herbarium in E, nor have we seen the type. The description does not seem to differ in significant detail from that of *J. papillosus*.

Selected collections examined: JAPAN: Kuroishi, *U. Faurie* 1292 p.p., 1248, 29 Sep 1889 (K, P); Plaine d'Hakodate, *U. Faurie* 1411, 25 Sep 1886 (K, P); Sendai, *U. Faurie* 1800, 14 Oct 1898 (K); au pied du Fujiyama, *U. Faurie* 6556, 10 Aug 1890 (K, P); to Toga from Kamo Toga-machi Oga-shi, Pref. Akita, Hondo (Prov. Ugo), *M. Furuse* 26741, 28 Sep 1953 (K); Tomakomai-shi, Yufutsu Hokkaido, H. Hara, S. Kurosawa and Y. Tateishi, 6 Sep 1974 (TI); Honshu, Pref. Hyogo, Tonomine-hills, Ohkawauchi-cho, Kanzaki-gun, 800 m, K. Iwatsuki and T. Koyama *PJE* 798, 17 Oct 1966 (K, NSW, P ex KYO); Hondo, Yamanakako in Kai, K. Okamoto *NSM* 585, 3 Aug 1952 (K, NSW, P ex TNS); Saitama Pref., Hiki-gun, Ogawa-machi, Uchide-Kuriyama, 100–400 m, Hokkaido, Y. Tateishi 456 and J. Murata, 1 Nov 1974 (TI); Kyushu, Nakatsu in Buzen, M. Togasi *TNS* 1412, Oct 1956 (K, NSW, P ex TNS).

CHINA: Manchuria, *D. Litvinov* 3408, 23 July 1903 (K); Deutsch China, *Zimmerman* 512, 1901 (P).

KOREA: Ouen-san, *U. Faurie* 895, Aug 1901 (P); Quelpaert, *U. Faurie* 2250, June 1907 (P), 700 m, E. Taquet 1962, 4 Sep 1908 (K), 1600 m, E. Taquet 1998, 7 Sep 1908 (K).

RUSSIA: Prov. Austro-Ussuriensis, in paludosis ad Paschkowa, Manchuria Rossica, V.L. Komarov *Fl. Manshuriae* 354, 29 July 1895 (K, P ex LE); distr. Chabarowsk, I.W. Kusnezow, *Iter Bolon-Odshalense* 687, 22 Aug 1910 (NSW ex LE).

16. *Juncus virens* Buchenau

(Buchenau 1906: 220)

Type citation: 'bei Blagowjestschensk im Amurgebiete (7 August 1898, F. Karo n. 89).'

Type: Blagowjestschensk im Amurgebiete, F. Karo 89, 7 Aug 1898; holo W (n.v.); iso K, L (n.v.), LE (n.v.). The label on the sheet in L states that the collection date was 'VII. VIII', i.e. July–August (Veldkamp, pers. comm.).

Illustrations: Krechetovich and Goncharov (1935: pl. 30, fig. 3).

This slender, unitubulose-leaved species is apparently restricted to the Russian Far East. Its capsule usually only shortly exceeds the tepals (occasionally much exceeding them), and is relatively short and broad as in *J. articulatus*, *J. wallichianus* and *J. krameri* (q.v.). Its tepals are shorter than in the more robust *J. wallichianus*, while its capsule is not red-brown as in the introduced *J. articulatus*, and the inflorescence has longer branches and is therefore less clustered than in *J. krameri*.

Collections examined: **RUSSIA: Manchuria:** circa Blaurestschenksk, Provincia Amurensis, F. Karo 353, July 1905 (K); Blagowjestschensk, Amur, F. Karo s.n., July 1899 (NSW); Bergweisen um Zea, F. Karo s.n., July 1900 (NSW).

Acknowledgments

We thank the keepers of the following herbaria for access to specimens and library resources either on loan or by visiting: B, BM, BRI, CANB, G, K, L, LAE, MEL, TAI, TI, UC and W. We also thank the Australian Biological Resources Study for a grant towards our work on the Australian species of *Juncus*; David Mackay for drawing the figures; JeF Veldkamp (L) for sharing his extensive knowledge of Malesian *Juncus* species, specimens and localities; Jan Kirschner and Alistair Hay for helpful comments; and Peter Bankoff for assembling part of the descriptive detail while employed on the ABRs grant.

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Manuscript submitted 8 September 2000

Manuscript accepted 15 March 2001

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ALA = *J. alatus*ART = *J. articulatus*BUF = *J. bufonius*DEC = *J. decepiens* subsp. *decepiens*DIAS = *J. diastrophanthus*DMED = *J. decepiens* subsp. *medianus*DSUN = *J. decepiens* subsp. *sundaicus*DUR = *J. durus*INF = *J. inflexus*KRA = *J. krameri*LEP = *J. leptospermus*LES = *J. leschenaultii*NUP = *J. nupela*PAP = *J. papillosus*PRIS = *J. prismatocarpus*SAND = *J. sandwithii*VIR = *J. virens*WALL = *J. wallichianus*

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Ohwi 2034 (DMED), 2040 (LES), 9198 (ALA); *Ohwi & T. Koyama* NSM 310 (LES); *Okamoto* NSM 585 (PAP); *Oldham* 579 (LES), 580 (DMED), 897 (LES); *Orchard* 5009 (ART); *Otto-Surbeck* 84 (LES).

Paijmans 710 (WALL), 1293 (DMED); *Panigrahi* 3925 (LES); *Playfair* 50 (LES); *Poilane* 23114 (LES), 24425 (LES); *Poore* 470 (LES); *Powell* UPNG 2460 (LES); *Purdom*, 1910 (ALA), *Tai pai Shan - Shansi* (ALA).

Rahmat Si Boeca 1090 (LES), 6000 (LES); *Raniamoorthy* HFP 1294 (LES); *Ramesh Bedi* 698 (ART); *Rauos & Edaño* BS 40202 (DMED), BS 40417 (LES), BS 45007 (DMED); *D. Ratkowsky* NSW 276209 (SAND), *JS 111 & A. Ratkowsky* (SAND); *Rau* 18 (DMED); *Raven* 25929, *Engelhorn & Morris* (ART); *Raynal* 17055 (LES); *Richter*, *Kneucker* 85a (ART); *Ridley*, 8 Feb 1921 (LES), 11 Feb 1921 (LES); *Robbins* 86 (WALL), 273 (WALL), 379 (WALL), 280 (LES), 3165 (WALL), 3237 (WALL); *Robinson & Kloss*, 25 May 1914 (DSUN); *Rodin* 5527 (ART); *Hb. Royle*, NW India (LES); *Rubtzoff*, 2 Aug 1956 (PRIS).

Sampson 843 (DEC), 30 Apr 1884 (WALL); *Santos* BS 31864 (DMED); *Satow* 532 (DIAS), 5311 (WALL); *Saulière* 2 (WALL); *Savatier* 1353 (DEC), 1354 (KRA), 1355 (PAP), 1356 (LES), 1978 (ALA), 2521 (PAP); *Schmidt* 51 (LES); *Schneider* 2832 (ART); *Schodde* 205 (LES), 1646 (LES), 2007 (LES), 2008 (DMED); *Shantung University Collection*, Aug 1924 (WALL); *Shearer*, 1873 (ALA); *Shiu Ying Hu* 11577 (LES); *Short* 1798 (SAND); *Sieber*

Herb. Mixt. 630 (PRIS), *Herb. Nov. Holl.* 431 (PRIS); *Siebold s.n.* (LES); *Simada* 1027A (WALL); *Sinclair* 4956 (DEC), 9935 (LES); *Slemmer & Vink* BW 4358 (DMED), 4363 (LES), BW 14019 (WALL); *Smail* NSW 451168 (DEC); *Smith, L.*, 3020 (ART); *Smitth, J.M.B.*, 464 (BUF), 520 (BUF), ANU 15199 (DMED), 12 Aug 1967 (BUF); *Suitinand and Alsterlund* 6688 (LES), 6721 (LES); *Sochoed Sosrodihardjo* 58 (DMED); *Solmer et al.* LAE 75534 (LES); *Solmer and Waas* 10497 (LES); *Sonohara et al.* SIRI 6271 (LES); *Sorenson* 3316, *Larsen & Hansen* (LES); *Sterly* 1645 (LES), 1655 (DMED), 1666 (DMED), 75-456 (DMED), 80-160 (DMED); *Stainton, Sykes and Williams* 3681 (WALL); *Stevens* LAE 54156 & *Veldkamp* (DMED); *Stevens* LAE 54657 & *Grubb* (LES); *Steward* 2102 (LES); *Suzuki* 438-1 (ALA), 438-2 (DIAS); *Symon* 1205 (ART).

Tagawa 3228 (LES); *Takeuchi* 5888 (DMED); *Taquet* 1861 (LES), 1869 (LES), 1962 (PAP), 1998 (PAP); *Tateishi* 456 & *J. Murata* (PAP); *Terasaki*, Aug 1905 (KRA); *Thakur Rnp Chaud* 1819A (WALL), 5500 (DEC), 7546 (LES); *Thompson* 2455 p.p. (SAND); *Thomson*, Aug 1847 (ART); *Thorue* 47025 & *Alava* (ART); *Thwaites* CV844 (LES); *Tindale* 7041 & *Sykes* (ART); *To Kang P'eng* 2870 & *E.H. Groff* (WALL); *Togashi* 38 (DEC); *Togasi* TNS 1412 (PAP), TNS 1757 (DEC); *Tolkin*, *Simoda* (DEC); *Tsang* 20071 (LES), 20636 (WALL), 217 n.n. 16962 (LES), 23609 (DEC), 23760 (ALA), 29767 (DEC).

Ui, 4 Aug 1934 (WALL).

Van Balgooy 388 (DMED); *Van der Pijl* 567 (DMED); *Van Slooten* 751 (DMED); *Hb. Van Royen* L sheet 904,145-433 (BUF); *Van Steenis* 4090 (WALL), 4100 (LES), 4258 (LES), 6396 (DSUN), 8411 (DSUN), 9605 (DSUN), 11000 (INF), 12331 (DMED), 20833 (DMED); *Veldkamp* 6369 (NUP); *Verdcourt* 5182 (WALL), 5188 (WALL); *Versteegh* BW 3020 (DMED), BW 3047 (LES); *Vidal* 1584 (DEC); *Vidal et al.* 6254 (LES); *Vinas* UPNG 2535 (WALL); *Vink* 16452 (DMED); *Vink* 8587 & *Schram* (LES), BW 8960 (WALL).

Waas 1487 (LES); *Walker, D.*, ANU 381 (WALL), ANU 511 (WALL), ANU 554 (DMED), ANU 616 (LES); *Walker, Col.*, 99 (WALL); *Walker, E., et al.* SIRI 6445 (WALL); *Wallich* 8999 (WALL), 1821 (WALL); *Wang, T.* 3949 (ART); *Wang Z.-T. et al.* 870221 (ALA); *Whiting* 251 & *Stewart* (LES); *Widjaja* EAW 4479 (DMED); *Widjaja et al.* EAW+EW6375 (DMED); *de Wilde, W.J.J.O., & de Wilde-Dnyffes* 13328 (DSUN), 13521 (KLES), 15174 (DSUN), 15944 (DSUN), 16029B (DSUN); *Wilford* 809 (LES); *Williams* 1974 bis (LES); *Willis*, 2 July 1970 (DMED); *Wilson* 2214 (PRIS), 6042 (PRIS), 6440 (ART), 6962 (SAND), 8308a (SAND), 8553 (PRIS); *Wilson et al.* 1065 (ART), 7987a (ART), 7997 (PRIS); *Womersley* NGF 11203 (LES), NGF 15295 (WALL), NGF 15298 (MDEC); *Wright* 329 (LES).

Yamamoto 8377 (DIAS); *Yaug* 2680 (LES); *Yao* 8713 (LES); *Yotoyama* 318 (WALL); *Zotov* CHR 4547 (PRIS).

Zimmerman 512 (PAP).

Juncus edgariae (Juncaceae) — a new species from New Zealand

L.A.S. Johnson[†] and K.L. Wilson

Abstract

L.A.S. Johnson and K.L. Wilson. (Royal Botanic Gardens, Mrs Macquaries Road, Sydney NSW 2000, Australia) 2001. *Juncus edgariae* (Juncaceae) — a new species from New Zealand. *Telopea* 9(2): 399–402. The new species *Juncus edgariae* (in section *Juncotypus*) is described from New Zealand. It is allied to *J. gregiflorus* (Australia) and *J. durus* (New Guinea).

Introduction

The genus *Juncus* in Australasia was studied over many years by the first author, with assistance from the second author. The death of LASJ in 1997 left half-completed manuscripts of a revision of the genus in Australasia and Malesia and also a *Flora of Australia* treatment, which KLW is now completing. Publication of this new species in the 'leafless' (i.e. with leaves reduced to cataphylls) section *Juncotypus* (formerly known as section *Genuini* — Kirschner et al. 1999) is needed in advance of the main papers so that it can be included in the family treatment in the IOPI Species Plantarum Project's *Flora of the World* series being completed by a team led by Jan Kirschner (Pruhonice).

Juncus edgariae L.A.S. Johnson et K.L. Wilson, *sp. nov.*

Affinis *J. gregifloro* sed culmis flavovirentibus nitentioribusque, medulla culmi densiori, minus interrupta, lacunis plusminusve ellipsoideis, capsulis fuscantioribus, differt.

Type: New Zealand: South Island: S of Waimakariri River mouth, *E. Edgar* 8, 25 May 1960; holo NSW; iso CHR 113606.

Strongly rhizomatous perennial. Culms terete, more or less hard (i.e. relatively difficult to compress), shining, yellow-green, 40–130 cm long, 0.6–2.5 mm diam.; striations 22–60; pith interrupted with irregular, more or less circular or longitudinally ellipsoidal gaps, occasionally continuous above. Leaves reduced to basal cataphylls (mucro plus sheath) 5–18 cm long, lax around the culm, abaxially golden brown to dark yellow-brown or dark red-brown at base, adaxially golden brown. Inflorescence 2–6 cm long, diffuse, with densely clustered flowers, 3–20 per cluster and 1–20 clusters per inflorescence; lowest inflorescence bract erect, culm-like, 6–21 cm long, exceeding inflorescence. Flowers subtended by 2 bracteoles. Tepals 6, acute to acuminate or mucronate, straw-brown, occasionally tinged red-brown; outer tepals 1.7–2.6 mm long, exceeding inner tepals, with very narrow hyaline margins; inner tepals with broad hyaline margins. Stamens 3, shorter than outer tepals; anthers 0.4–0.6 mm long, less than or equalling filament length. Capsule 3-locular, slightly shorter than to slightly exceeding outer tepals, ellipsoid, dark golden brown, obtuse, shortly apiculate. Seeds 0.4–0.5(–0.6) mm long.

Illustrations: Figure 1; also Edgar (1964: figs 4, 18); Edgar in Moore & Edgar (1970: fig. 13); Healy (1970: fig. 34) (all as *J. gregiflorus*).

[†] Deceased 1 August 1997.



Fig. 1. *Juncus edgariae*: a, flower; b, inflorescence; from B.G. Briggs, 5 Feb 1966 (NSW 90837). *J. gregiflorus*: c, flower; d, inflorescence; from K.L. Wilson 953 & L.A.S. Johnson (NSW). *J. durus*: e, flower; f, inflorescence; from R.D. Hoogland 7595 & R. Schodde (NSW). Scale bar = 3.5 mm (a, c, e), = 4 cm (b, d, f).

Distribution and habitat: Endemic to New Zealand (North Island, South Island, Stewart Island, Kermadec Islands, and Chatham Islands), at altitudes ranging from sea level to 1000 m; in damp, often disturbed, open areas such as roadside ditches, pastures and margins of swamps, in soils ranging from sandy to clay-loam. This is the most widely occurring and abundant of the 'leafless' rush species in New Zealand according to Healy and Edgar (1980: 98, as *J. gregiflorus*), who also comment that it is the most weedy of the native species in this group. This situation is similar to that in Australia, where many of the native *Juncus* species seem to have spread much more widely thanks to human disturbance in the last two centuries (Johnson 1991), and some are considered weedy in pastures (commonly in those that are over-grazed). Introduced to Great Britain in wool shoddy, but probably not persistent there.

Notes: This common New Zealand species was formerly included in the concept of *J. gregiflorus* L. Johnson, which is here considered to be restricted to Australia. Records of *J. gregiflorus* in New Zealand (e.g. Edgar (1970), Healy (1970), Healy and Edgar (1980)) and most or possibly all wool shoddy records under that name in Great Britain refer to this new species. This species is also morphologically similar to the New Guinean *J. durus* L. Johnson & K.L. Wilson, ined. (Wilson and Johnson, this issue). All three species have tough culms with dense pith (variously interrupted) and loose cataphylls that are dark golden brown both abaxially and adaxially.

In the *Flora of New Zealand* (vols 2 and 3; Edgar 1970, Healy and Edgar 1980) and in Healy (1970), this species would key to *J. gregiflorus*.

Juncus edgariae differs from *J. gregiflorus* sens. strict. in having culms that are more yellow-green and shinier when dried, with the pith in the culms denser and less interrupted, with the lacunae in the pith more or less circular to longitudinally ellipsoid in shape. Capsules are usually darker golden brown at maturity. The new species also tends to have the abaxial brown colour of the cataphylls extending higher towards the stramineous apex and tapering off more gradually than in *J. gregiflorus*. *J. durus* and *J. gregiflorus* differ from *J. edgariae* in having finer culm striations (c. 0.05 mm wide) that are all similar (in the latter, the striations are mostly broader (to c. 0.1 mm wide) but mixed with some finer as well). The pith in *J. edgariae* culms has smaller lacunae than in *J. durus*, while the pith in *J. gregiflorus* differs from both in being usually much more reduced: to mere septa-like plates of pith separating very large lacunae. The pith of *J. edgariae* is illustrated in Healy (1970: fig. 34, as *J. gregiflorus*), both a section that has partly continuous pith (presumably from near the apex of a culm) and also a more typical section with irregular gaps.

Sykes (1977: 180) discussed the occurrence of the species on the volcanic Kermadec Islands, where he considered it to be native on Raoul Island. Specimens seen from there have consistently small flowers (outer tepals only 2.0–2.2 mm long), but occasional specimens from other areas also have smallish flowers. The significance of this needs further study in the field - it may be the consequence of a limited genetic base in the Raoul Island population.

The species is named for Dr Elizabeth Edgar of Christchurch, who has contributed so greatly over many years to systematic knowledge of numerous monocot groups in New Zealand, including this family and particularly the genus *Luzula*, which she has also studied in Australia.

Selected collections examined: NEW ZEALAND: North Island: Lake Tutira, *Braggins*, Feb 1967 (WELTU); Moanatuatua Swamp, S of Hamilton, *Briggs*, 31 Jan 1966 (CHR, NSW 90828); Kaiaka, *Carse K14*, 25 Dec 1913 (K); Wallaceville, Upper Hutt, *Harris*, 12 Aug 1944 (CHR 83485, 83488, NSW); Awanui, Northland, *Johnson 7499*, 15 Nov 1971 (CHR, NSW); Marchant Ridge, Tararua Range, *McNeill-Adams*, Jun 1968 (WELTU); Tangitaroria, 12 miles [19 km] ENE of Dargaville, Hobson County, *Melville 5187 and Moore*, 6 Nov 1961 (CHR, K, NSW); Manukau County, c. 10 miles [16 km] ESE of Clevedon, *Orchard 3284*, 25 Apr 1972 (AK, K, NSW); Bunnythorpe, *Zotov*, 6 Mar 1930 (CHR 3611, NSW).

South Island: Cobden, *Allan*, 26 Feb 1941 (CHR 33291, NSW); 4 miles [6.4 km] SE of Kumara, West Coast, *Briggs*, 9 Feb 1966 (CHR, NSW 90820); Devils Staircase, Lake Wakatipu, c. 14 miles [22 km] N of Kingston, *Briggs*, 18 Feb 1966 (CHR, NSW 90821, 90855); east foothills of Porters Pass, 1 mile [1.6 km] W of crossing of Kowhai River, *Briggs*, 6 Feb 1966 (CHR, NSW 90853); 4 miles [6 km] SE of Kumara, West Coast, *Briggs*, 9 Feb 1966 (CHR, NSW 90820); Glenhu Bay, Lake Wanaka, *Briggs*, 11 Feb 1966 (CHR, NSW 90809); Lincoln near golf course, *Edgar* 18, 20 Dec 1960 (CHR, NSW); Lake Georgina, Canterbury, *Edgar* 26, 27, 4 Jan 1961 (CHR, NSW); Saltwater Creek, *Edgar*, Nov 1960 (CHR 113614, CHR 113615, NSW); summit road above Gebbies Pass, c. 500 ft [150 m], Banks Peninsula, *Johnson* NZ3, 27 Sep 1969 (CHR, NSW 106568); Lake Rotoiti, *Mason* 9722, 21 Jan 1963 (CHR 145761); 2 miles [3.2 km] W of Motukarara, 10 miles [16 km] SE of Lincoln, Canterbury, *Melville* 5741A and *Melville*, 25 Dec 1961 (K, NSW); near Pearl Harbour, Lake Manapouri, *Tindale*, 25 Jan 1962 (NSW 60738); Stewart Island, *CHR* 120162 (CHR).

Chatham Islands: Chatham Islands, *Burke*, Apr 1967 (WELTU); Maunganui, *Entomology Division Expedition*, Mar 1967 (CHR 176535).

Kermadec Islands: Sunday Id, *Oliver*, Nov 1908 (K); Denham Bay, Raoul Id, *Sorenson* 127, 1944 (CHR); crater, Raoul Id, *Sykes* 696/K, 17 Jul 1969 (CHR 193681); Blue Lake, Raoul Id, *Sykes* 1222/K, 3 Dec 1976 (CHR 309181).

*GREAT BRITAIN: Wyboston, *Eaton*, *Dony*, 11 July 1948 (K); East Bedford, *Dony*, Sep 1946 (K); 4 km E of Bedford, gravel pit, Vice-County 30, *Melville* 54/22, 54/28, 54/30 and *Dony*, 23 July 1954 (K, NSW); Cople, *Milne-Redhead* and *Dony* 718, Dep 1945 (LUTON); Eaton Socon, *Taylor* 718/0763, 20 July 1946 (K), *Wilmott and Dony* s.n., Aug 1945 (LUTON).

Acknowledgments

We thank the keepers of the following herbaria for access to specimens and library resources either on loan or by visiting: AK, CANB, CHR, HO, K, LUTON, MEL, SYD, WELTU. We also thank the Australian Biological Resources Study for a grant towards our work on the Australian species of *Juncus*; David Mackay, who drew the figure; and Peter Bankoff, who assembled part of the descriptive detail while employed on the ABRS grant.

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Manuscript received 6 October 2000

Manuscript accepted 15 April 2001

Eucalyptus saxicola (Myrtaceae), a new species from the Central Tablelands of New South Wales (section Maidenaria series Bridgesianae)

John T. Hunter

Abstract

Hunter, John T. (75 Kendall Rd, Invergowrie, NSW 2350, Australia) 2001. *Eucalyptus saxicola* J.T. Hunter (Myrtaceae), a new species from the Central Tablelands of New South Wales (section Maidenaria series Bridgesianae) *Telopea* 9(2): 403–407. ***Eucalyptus saxicola*** J.T. Hunter, a new species from Mt Canobolas within the Central Tablelands of New South Wales is described and notes are provided on its distribution and conservation status. The species is distinguished from the similar *Eucalyptus bridgesiana* by its smaller buds and fruits and generally smaller stature and juvenile leaves.

Introduction

During a survey of the population size and distribution of *Eucalyptus canobolensis* in June 1998 (Hunter 1998), specimens were collected of an unusual eucalypt found restricted to the margins of acid volcanic outcrops near the summit of Mt Canobolas. A further investigation of this entity was conducted during a vegetation survey of the Mt Canobolas State Recreation Area (Hunter 2000), confirming its status as a highly restricted unnamed species. Although the morphologically similar *Eucalyptus bridgesiana* has been collected from Mt Canobolas in the past this highly restricted species had not previously been collected.

Key to species

An excerpt from the key to *Eucalyptus* species presented by Hill (1991) is amended to include *E. saxicola*.

Group 5

33 Juvenile leaves orbiculate.

33a Juvenile leaves 1.5–4 cm wide *E. saxicola*

33a* Juvenile leaves 4–8 cm wide

34 Fruit > 5 mm long *E. bridgesiana*

34* Fruit < 5 mm long *E. nova-anglica*

33* Juvenile leaves narrow-elliptic *E. ignorabilis*

Taxonomy

***Eucalyptus saxicola* J.T. Hunter, sp. nov.**

Ab *E. bridgesiana* habitu, foliis juvenilibus, alabastris fructibusque minoribus, et calyptis hemisphaericis differt.

Type: New South Wales: Central Tablelands: Mt Canobolas State Recreation Area, c. 14 km south-west of Orange, 33°20'11" 154°58'22", on margin of trachyte outcrop, 1200 m altitude, *J.T. Hunter 8556*, 2 June 1998 (holo NSW; iso BRI, CANB, MEL).

Small tree 6–15 m tall with a box bark persistent to larger branches, then shed in long strips. *Stems* terete, glandular to erect-warty on juvenile and sucker stems. Juvenile leaves orbicular becoming broadly ovate, glaucous, 1.5–4 cm long, 1.5–4 cm wide, margins crenulate and slightly recurved, opposite becoming subopposite at about the fourth internode, apex rounded and mucronate to shortly acute, base deeply cordate, sessile. Intermediate leaves broadly ovate elliptic to broad lanceolate, 4–13 cm long, 3–6.5 cm wide, falcate, alternate, ± glaucous, apex acuminate and ± hooked, base rounded to attenuate and oblique, with petioles 1–4 cm long. Adult leaves alternate, linear to narrow lanceolate, 12.5–23 cm long, 1.1–2.3 cm wide, with conspicuous oil dots, conspicuously glossy and dark green, never glaucous, falcate, margins entire, apex acuminate and often hooked, base attenuate and oblique, petiole terete to flattened, channeled, 2–4 cm long, venation 25–35 degrees to midrib, intramarginal vein 0.8–1.4 mm from the margin, midrib flat to channelled above. *Inflorescence* of 7-flowered axillary umbellasters. Peduncle flattened to ovoid in section, 1–4 mm long in bud, 3–9 mm long in fruit; pedicel 1–2.4 mm long in bud, absent or to 3 mm long in fruit. Buds turbinoid to clavoid, 3.5–4.5 mm long, 2.3–2.7 mm wide, not glaucous; calyptra hemispherical to shortly beaked hemispherical, 1.5–2.3 mm long, 2.3–2.7 mm wide; hypanthium obovoid, 1.5–2.4 mm long, 2.2–2.6 mm wide. Ovules in 4 rows; style terete, 2–3 mm long. Stamens irregularly inflexed; filaments 2.5–3.5 mm long; anthers dorsifixed, parallel, 0.5–0.6 mm long, white, dehiscence longitudinal; connective oil gland orbicular and abaxial. *Fruits* hemispherical, 3.5–5.2 mm long, 4.3–6 mm wide, slightly ribbed, often splitting on one side, disc level to convex, 0.4–0.8 mm wide, scar distinct; valves 3–4, level to exserted. *Seeds* smooth to shallowly reticulate, red-brown to yellow-brown, cuboid, strongly angular, rounded terminal or central hilum on flat polygonal surface, 0.9–1 mm long, 0.5–0.8 mm wide. Cotyledons bilobed. (Fig. 1).

Selected specimens examined: New South Wales: Central Tablelands: Mt Canobolas State Recreation Area, c. 14 km south-west of Orange, on margin of trachyte outcrop, 1200 m altitude, *Hunter 8568-8569*, 3 June 1998; *Hunter 17502*, 20 Sept 1999; *Hunter 17565*, *Bryant and Beckers*, 23 Sept 1999 (all MEL, NSW).

Distribution: small and closely scattered stands of *Eucalyptus saxicola* occur on the northern slope of Mt Canobolas near the summit. The species dominates the shallow soils on acid volcanic outcrops and their margins. The population is only known from a handful of small outcrops scattered over a distance of about 1 km long and 0.3 km wide. These populations are dissected by three major access roads to the summit.

Habitat: *Eucalyptus saxicola* is found in open and exposed situations on and around the margins of trachytic rock outcrops between 1150–1300 m above sea level. The mean annual rainfall of this area is 850–950 mm. Associated species include *Eucalyptus canobolensis* in the overstorey and *Cassinia uncata*, *Phebalium squamulosum*, *Mirbelia oxylobioides*, *Dodonaea viscosa*, *Calytrix tetragona*, *Leptospermum myrtifolium* and *Leucopogon attenuatus* in the understorey.

Notes: bilobed cotyledons, axillary inflorescences and versatile anthers place *E. saxicola* within the Section *Maidenaria*, while sessile and ovate juvenile leaves and the annular disc of the fruit place the species within the Series *Bridgesianae* (Pryor & Johnson 1971). The fibrous persistent bark and the distinctly crenulate juvenile leaves allies this species with *Eucalyptus angophoroides* and *E. bridgesiana* (Chappill & Ladiges 1996). In general morphology *E. saxicola* is most similar to *E. bridgesiana*, particular fruit shape. *E. bridgesiana* is common particularly at lower altitudes within the Mt Canobolas State Recreation Area but is ecologically distinct from *E. saxicola* in occurring on deeper soils. *E. saxicola* differs morphologically from the co-occurring

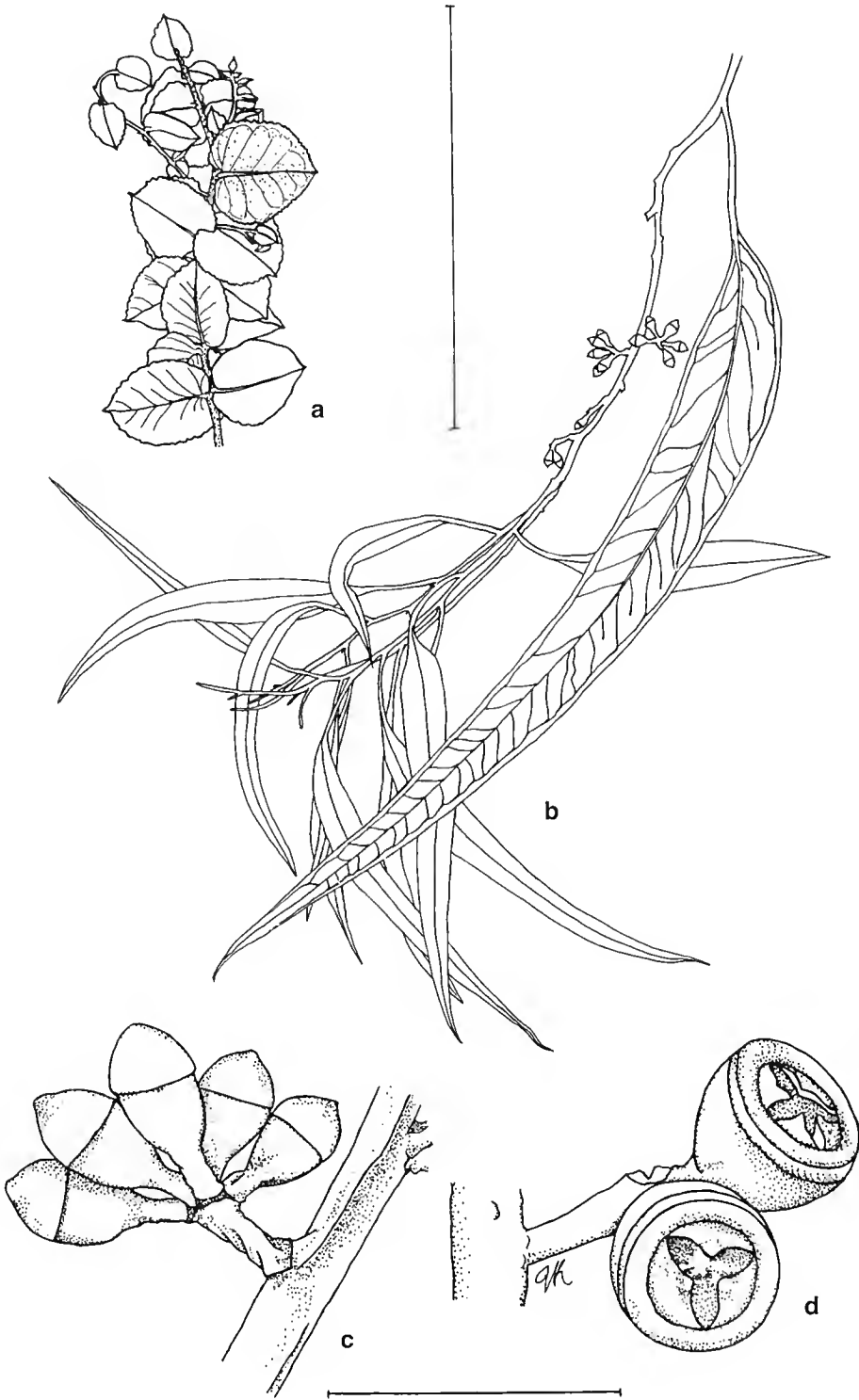


Fig 1. *Eucalyptus saxicola* J.T. Hunter. a, juvenile foliage; b, adult leaf and bud arrangement; c, bud; d, fruit (all from JTH 8556). Scale bar, a & b = 10 cm; c & d = 1 cm. Illustration by Vanessa Hunter.

E. bridgesiana in its overall smaller stature and smaller parts such as juvenile leaves, buds and fruit (Table 1). Unlike *E. bridgesiana*, the calyptra is hemispherical rather than conical, being distinctly broader than long.

Table 1. Comparison of selected characters for *Eucalyptus saxicola* and *Eucalyptus bridgesiana*.

E. bridgesiana measurements based on measurement of material held at UNE and the sources Chippendale (1988), Hill (1991) and Brooker & Kleinig (1999).

	<i>Eucalyptus saxicola</i>	<i>Eucalyptus bridgesiana</i>
Plant height (in m)	6–15	8–22
Juvenile leaf length (in cm)	1.5–4	4–10
Juvenile leaf width (in cm)	1.5–4	4–8
Juvenile & sucker stems	Strongly glandular to erect warty	Smooth to glandular (some distinctly so)
Peduncle	Flattened to ovoid	Terete to angular
Pediceal length (in mm)	0–3	2–5
Calyptra length (in mm)	1.5–2.3	3–5
Calyptra width (in mm)	2.3–2.7	3–5
Calyptra shape	Hemispherical, broader than long	Conical, as long or longer than broad
Fruit length (in mm)	3.5–5.2	5–7
Fruit valves	Level or rarely exerted	Exserted

Conservation status: *Eucalyptus saxicola* has a population estimated to be fewer than 200 individuals. The stands are not continuous and are scattered over an almost linear 1 km stretch on the northern flank of Mt Canobolas. The metapopulations of this species are likely to have been reduced in size due to road works with three major access trails passing through stands. Of particular importance is the main access road to the summit that cuts through the largest occurrence of this species. The road itself is built up and may still cause major impacts on the species. Other threats are also apparent including high visitor pressure, dumping of cars and their incineration is a regular practice, blackberry invasion and the small total population size. Other populations may have existed outside of the reserve in similar habitats that are now under extensive *Pinus radiata* plantation. Due to the highly restricted distribution, low population size and current impacts on the population by road works and visitor pressure an initial ROTAP code of 2ECt according to the criteria of Briggs and Leigh (1996) is suggested. Inclusion on the *Threatened Species Conservation Act 1995* as Endangered would be desirable.

Etymology: the specific epithet is from the Latin, *saxum* meaning stone, rock and *cola*, dweller, and is in reference to the highly restricted occurrence of this species on and around the margins of rock outcrops.

Acknowledgments

Project management of the two surveys was by Amanda Bryant and assistance in the field was given by Steve Woodall both of the Central West Region of the New South Wales National Parks and Wildlife Service of New South Wales. Thanks to Vanessa

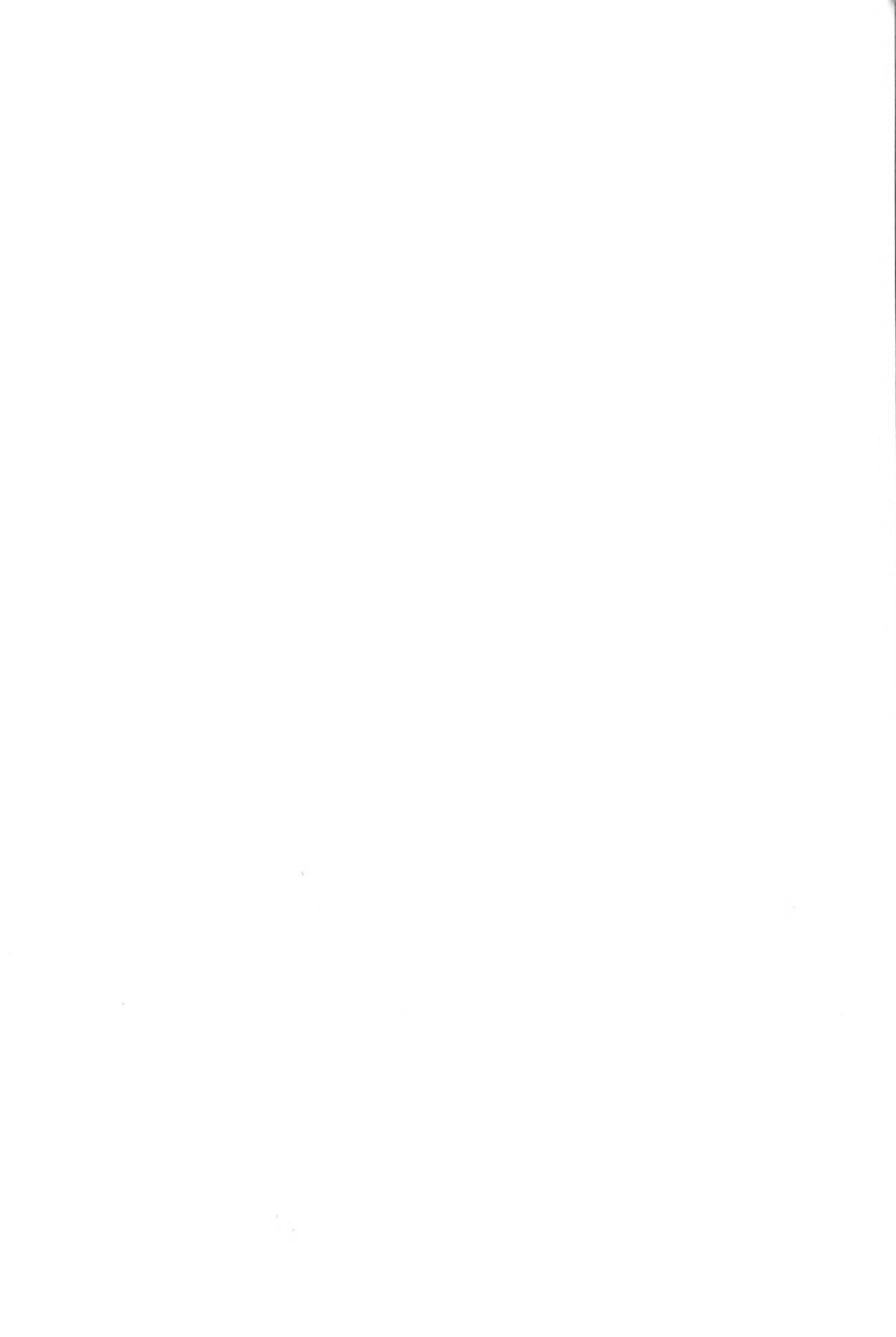
Hunter for illustrations. Thanks also to the heads of NSW and CANB for allowing access to collections of *Eucalyptus* during the threatened species of the Central Tablelands project. The resources of UNE herbarium were used for measurements of *E. bridgesiana*.

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Manuscript received 14 August 2000

Manuscript accepted 29 March 2001



Eucalyptus boliviana (Myrtaceae), a distinctive new species of stringybark from New England, New South Wales

J.B Williams & K.D. Hill

Abstract

Williams, J.B. (Botany Division, University of New England, Armidale NSW 2351, Australia) and Hill, K.D. (National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquaries Road, Sydney, NSW 2000, Australia) 2001. *Eucalyptus boliviana* (Myrtaceae), a distinctive new species of stringybark from New England, New South Wales. *Telopea* 9(2): 409–413. *Eucalyptus boliviana*, a distinctive new species allied to *E. williamsiana*, is described and illustrated. A distribution map is provided, and the conservation status of the new species is discussed.

Introduction

A distinctive new species of *Eucalyptus* from New South Wales is described. The new species is classed as rare or threatened and a formal name is required in order to facilitate appropriate listing and action for conservation purposes.

Eucalyptus boliviana J.B. Williams & K.D. Hill, sp. nov.

E. williamsiana affinis sed ramulis quadrialatis glaucis, alabastris fructibusque brevioribus, pedunculis crassioribus, staminibus flavis, fructibus quadrialvibus annulatis, petiolis longioribus tortilibus, foliis juvenilibus hebetibus plusminusve glaucescentibus differt

Type: New South Wales: Northern Tablelands: high part of Bolivia Hill, c. 33 km S of Tenterfield, E of New England Highway, J.B. Williams 99187 & P.J. Clarke, 22 Sep 1999 (holo NSW; iso NE).

Shrub or mallee to 5 m tall, sometimes a tree to 12 m. Bark persistent, long-fibrous ('stringy') with included thin scales, branches to c. 2 cm diam. smooth, weakly glaucous, quadrangular. Seedling leaves not seen. Juvenile leaves elliptical, dull green, glaucous, glabrous, 8–11 cm long, 3–6 cm wide, petioles 2–3 cm long. Adult leaves semi-glossy green with a bluish sheen, becoming glossy green with age, glabrous, highly coriaceous, similifacial, broad-lanceolate, acute or apiculate, oblique at base, 8–13 cm long, 2.0–5.0 cm wide; petioles 2.0–3.0 cm long, strongly flattened to quadrangular, usually several times twisted, decurrent into strong ribs on branchlets. Inflorescences axillary; umbellasters 7-flowered. Peduncles thick and broadly flattened, 4–10 mm long, to 7 mm wide. Mature buds sessile, glaucous, ovoid to rhomboid, often curved, strongly 3–4-angular, 7–10 mm long, 6–7 mm diam., calyptra as long as hypanthium. Flowers yellow. Filaments irregularly flexed, stamens all fertile, anthers reniform. Fruits sessile, tightly clustered, flattened-globular, weakly angular, distinctly flanged at top of hypanthium, glaucous, 4–(rarely 5)-locular, 7–11 mm long, 9–15 mm diam. Calyptra scar and stemonophore raised, 0.5–1 mm wide. Disc raised, 2–4 mm wide. Valves broadly triangular, obtuse, raised at a low angle, tips exerted. Seeds dark brown, semiglossy, pyramidal or D-shaped, 1.5–2 mm long; chaff similar, smaller. (Fig. 1).

Notes: *E. boliviana* is nearest to *E. williamsiana* L.A.S. Johnson & K.D. Hill, from which it is readily distinguished by the 4-winged, glaucous stems, the shorter buds and fruits and the thicker peduncles, the usually 4-valved fruits with a medial flange, the flowers with yellow stamens, the longer, flattened, twisted petioles and the dull more-or-less glaucous juvenile leaves (Table 1). *E. boliviana* is also frequently a mallee or shrub.

Table 1. Comparison of *E. boliviana* and *E. williamsiana*.

	<i>E. boliviana</i>	<i>E. williamsiana</i>
Habit	mallee to 5 m tall or tree to 12 m	tree to 20 m tall
Branchlets	strongly winged, glaucous	weakly ridged, not glaucous
Juvenile leaves (cm)	elliptical 8–11 × 3–6	ovate to orbicular 15 × 13
Petioles (cm)	2–3	to 1.3
Adult leaves (cm)	broad-lanceolate 8–13 × 2.0–5.0	broad-lanceolate 8–18 × 1.6–5.0
Petioles (cm)	2.0–3.0	0.9–1.5
Peduncles (mm)	4–10	3–12
Pedicels (mm)	0	0–2
Buds (mm)	7–10 × 6–7	9–12 × 6–7
Fruits (mm)	7–11 × 9–15	9–13 × 10–15
Locules	usually 4	usually 3

E. boliviana and *E. williamsiana* are placed in Section *Renantherae* of subgenus *Monocalyptus* (Pryor & Johnson 1970) by the renantherous anthers. Within the section, they are placed in Series *Capitellatae* (the stringybarks - alternatively known as series *Pachyphloiae* Blakely or *Pachyphloius* Brooker) by the stringy bark and the hispid early juvenile leaves. Both taxa are distinguished within that series by the broad, highly coriaceous juvenile leaves that become glabrous at an early stage, the sessile, angular buds and the closely clustered and more or less sessile fruits. *E. boliviana* is uniquely characterised in this series by the glaucous juvenile leaves, branchlets and buds, and the yellow flowers.

Distribution: known only from a small stand near the crest of the Bolivia Hill in the New England region of north-eastern New South Wales (Fig. 2).

Ecology: locally frequent in one small area at the foot of a low scarp on the upper slopes of a steep east-facing ridge (altitude 1200 m), on gritty sandy soils over granite (Bolivia Hill Leucoadamellite) and among outcropping boulders. In low dry sclerophyll woodland with *Eucalyptus prava*, *Callitris endlicheri*, *Acacia pycnostachya*, *A. adunca* and many shrubs.

Flowering: September.

Conservation status: a species of apparently limited distribution and small population size, appropriately regarded as potentially vulnerable, code 2V (after Briggs & Leigh 1996). The total known population is in an area recently purchased for conservation reserve purposes by the New South Wales National Parks and Wildlife Service, but the full population extent is still unknown and requires further study.



Fig. 1. *E. boliviana*. a, Juvenile leaves. b, adult leaves and inflorescences. c, inflorescence and buds. d, anther. e, inflorescence and fruit. f, seed. (from Williams 99187 & Clarke). Scale bar: a, b = 8 cm, c = 2 cm, d = 2.5 mm, e = 3 cm, f = 4 mm.

The epithet is from the occurrence on Bolivia Hill.

Specimens examined: New South Wales: Northern Tablelands: top of Bolivia Hill, E of New England Highway, L.F. Fulloon & P.J. Clarke 29, 7 Nov 1998 (NE, NSW).

Acknowledgments

Peter Clarke and Lindsay Fulloon are gratefully acknowledged for drawing attention to this species. Thanks are due to Lesley Elkan for the illustration.

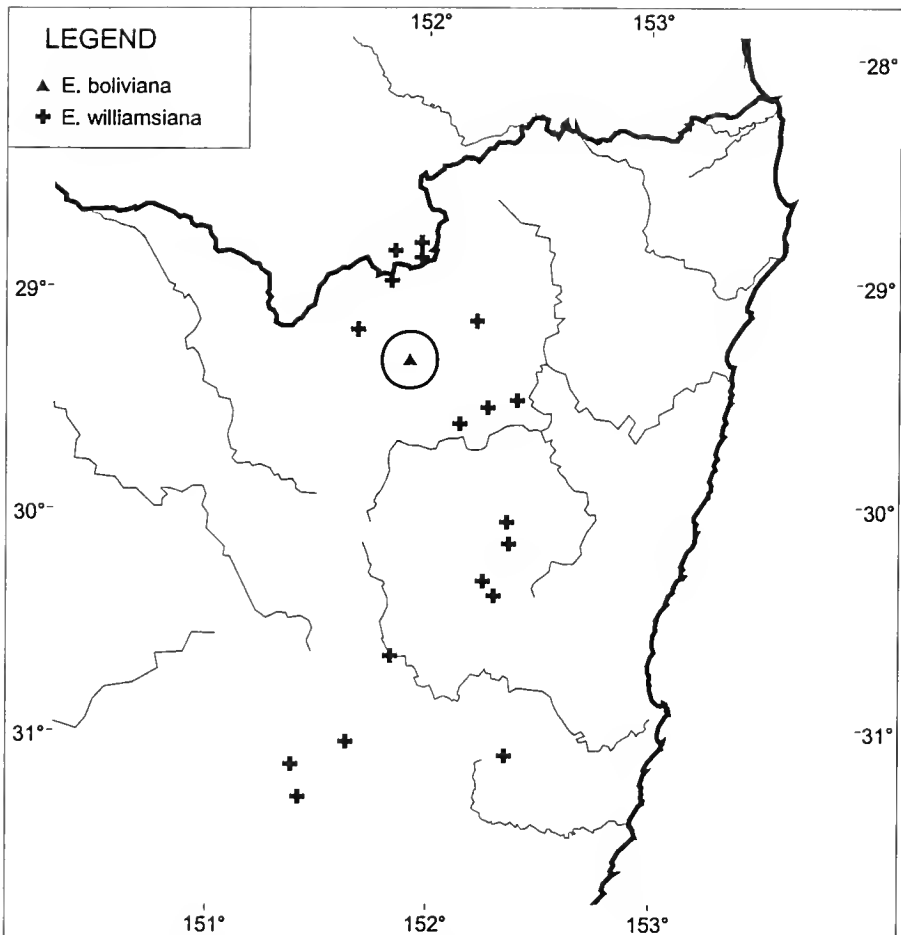


Fig 2. Distribution of *E. boliviana* and *E. williamsiana*.

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Manuscript received 26 October 2000

Manuscript accepted 29 March 2001

Acacia atrox (Fabaceae: Mimosoideae), a new rare species from the North Western Slopes, New South Wales

Phillip G. Kodela

Abstract

Kodela, P.G. (National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquaries Rd, Sydney, NSW 2000, Australia) 2001. *Acacia atrox* (Fabaceae: Mimosoideae), a new rare species from the North Western Slopes, New South Wales. *Telopea* 9(2): 415–419. *Acacia atrox*, a new species, is described and illustrated. It does not appear to have any particularly close relatives, but may have some affinities with *A. carneorum* Maiden from which it is readily distinguished by its glabrous branchlets, pale-coloured flower-heads and especially by its phyllodes which are characteristically markedly splayed or dilated at their base. *Acacia atrox* is restricted to the Inverell region on the North Western Slopes of New South Wales and is provisionally listed as an endangered species, requiring planning and management for its conservation.

Introduction

During the year 2000 specimens of an unusual *Acacia* from the Inverell region with sessile, pungent-pointed phyllodes were sent to the National Herbarium of New South Wales by NSW Agriculture staff for identification. Perhaps the most distinctive feature of these plants was the base of their phyllodes which were conspicuously splayed, a most unusual (but not unique) character for an *Acacia*. The landholder of the property from where these specimens originated had concerns that this *Acacia* was spreading and could become a weed hazard for agricultural activities on his property. Some control methods had been practised in the past but the wattle prevailed and strategies for its management were being sought by the landholder and NSW Agriculture. It soon became apparent, however, that the *Acacia* in question had not been previously collected and was an undescribed species. Furthermore, it is known only from the type locality and has since been Provisionally Listed as an Endangered Species in the NSW *Threatened Species Conservation Act*, 1995.

Taxonomy

Acacia atrox Kodela sp. nov.

Frutex gregarius fortasse clonalis vulgo usque ad 2 m altus; phyllodia glabra quadrangularia vel teretia, sessilia, basi dilatata apice pungentia; capitula globularia, flavida, 17–25-flora, plerumque bina axi brevissimo insidentia; legumina ignota.

Type: New South Wales: North Western Slopes: Myall Creek Station, c. 18 km S of Delungra, W of Inverell, W. Haves, P. O'Keefe & J. Kewley NSW445997, 17 July 2000 (holo: NSW; iso: CANB, K, MEL, MO, PERTH).

Dense, much branched shrub normally 0.5–1.5 (–2) m high, oldest plants to 4 m high; main stem less than 10 cm diam. at breast height, sometimes twisted; spreading by suckering. *Bark* grey-brown, becoming dark grey and vertically fissured with age.

Branchlets terete, pale green and slightly pruinose to pale yellowish green when dry, occasionally with a pinkish tinge when young, sometimes becoming encrusted with a brownish to blackish material with age, glabrous, with very low rounded ridges; axillary branchlets subtended by two caducous bracts (which usually leave fine scars on the stem when shed). *Phyllodes* sessile, patent to slightly inclined, \pm straight, \pm quadrangular in section (to \pm terete), with a yellow or pale-coloured vein at apex of each angle and a less prominent vein on the intervening faces (\pm 8-veined altogether, however, the intermediate veins are often incomplete not reaching the apex, obscure, wrinkle-like or not apparent, hence the phyllodes often appearing c. 4-veined), (1.5–) 2–4 (–4.5) cm long, 1–1.2 (–1.3) mm wide, rigid, light green (dry), glabrous (immature phyllodes with scattered, appressed, white-hyaline hairs), gradually tapered towards a pungent-pointed apex (the fine tip orange-brown and 1.5–3.5 mm long), abruptly broadened or splayed at base 2–6 mm wide (leaving an oval-obovate scar on branchlet when lost), with a small \pm circular gland on upper margin or vein near (or to 3 mm above) base and often a second minute gland c. $\frac{1}{3}$ – $\frac{2}{3}$ from base; galls with a shape that is hakea fruit-like are commonly formed within some phyllodes. *Inflorescences* normally paired (often one of the peduncles missing) or sometimes single on a rudimentary raceme axis to 1 mm long (often appearing simple); peduncles 5–21 mm long, glabrous; bracts at base of peduncles deeply convex, \pm broadly ovate, often with a split or minor lobe/peak about midway below either side of the apex, to 2 mm long, sparsely ciliolate, often caducous; heads globular, 17–25-flowered, 5–7 mm diam. (dry), cream-coloured to pale yellow. *Bracteoles* \pm obovate to broadly spatulate, 0.9–1.1 mm long, ciliolate, with scattered minute hairs also on the outer surface of the claw especially along midline (which is often not central). *Flowers* 5-merous; calyx cupular, 0.8–1.2 mm long, dissected for $\frac{1}{4}$ (– $\frac{1}{3}$) or less, with minute hyaline-white hairs at base and often scattered on tube or concentrated along ribs, ciliolate along the obtuse to broadly rounded lobes; corolla dissected for $\frac{1}{3}$ – $\frac{1}{2}$ or more, probably splitting towards base with age, the petals 1.5–1.9 mm long, 1-veined, glabrous or with inconspicuous, minute hairs or granules at apex mainly on margin, acute and often purplish in upper half; ovary glabrous to white-puberulous. *Pods* and seeds not seen. (Fig. 1).

Phenology: flowers recorded in May and July. No pod formation was observed during latter stages of flowering in mid-July 2000 (Hawes et al. 2000) and no pods were found in early November 2000 (T. Tame, pers. comm.). Although *A. atrox* has often been seen in flower in past years, pods have not been observed (W. Pollock, pers. comm.) and it is possible that they are rarely, if ever, produced.

Etymology: the specific epithet reflects the fierce or severe character of the plant created by the prominent pungent-pointed foliage.

Distribution: known only from a single collection site on Myall Creek Station, 18 km S of Delungra, west of Inverell, North Western Slopes, New South Wales.

Habitat: grows in deep clay soils, on basalt, on the upper slope and crest of a low hill, at head of a drainage depression, in a partly cleared paddock with *Eucalyptus moluccana*–*E. albens* Box woodland with a scattered understorey of *Callitris glaucophylla* and *Notelaea microcarpa* and a dense native grassy groundcover. Although the area has been used as native pasture for grazing stock, much of the woodland community is of mixed age and healthy condition with minor weed invasion (Hawes et al. 2000).

Conservation status: known only from the type locality. Provisionally listed under the informal name *Acacia* sp. 'Myall Creek' (Millar s.n. 25 May 2000) as an Endangered Species on Part 1 of Schedule 1 of the NSW *Threatened Species Conservation Act*, 1995. *Acacia atrox* warrants a 2E or 2V classification on the ROTAP list (Briggs & Leigh 1996), depending on the degree of risk posed by present and future land uses in the area.

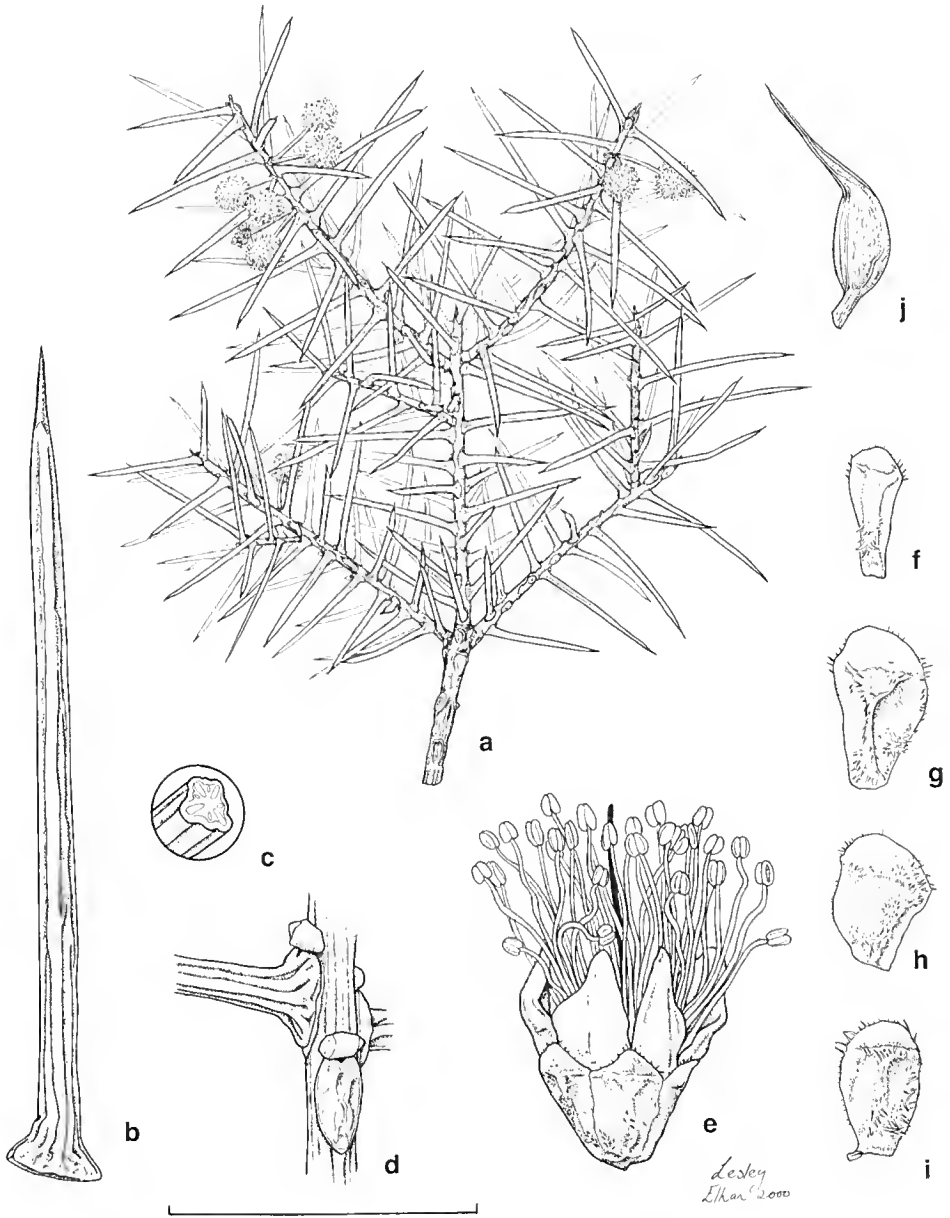


Fig. 1. *Acacia atrox*. a, branch with inflorescences; b, phyllode (Hawes et al. NSW445997); c, phyllode cross-section; d, part of branchlet showing dilated phyllode base and scar left by a shed phyllode (Millar NSW441449); e, flower; f-i, bracteoles (Hawes et al. NSW445997); j, gall formed within phyllode (Hawes et al. NSW445999). Scale bar: a, j = 4.2 cm; b, d = 1.2 cm; c = 6 mm; e-i = 2.4 mm.

Other specimens examined: New South Wales: North Western Slopes: Myall Creek Station: *W. Hawes, P. O'Keefe & J. Kewley* NSW445999–446002, 17 July 2000 (NSW); *F. Millar* NSW441449, 25 May 2000 (BRI, NSW, PERTH); *K. Stevens* NSW443828, 23 Feb 2000 (NSW); *T. Tame* 6285, 4 Nov 2000 (BRI, CANB, Hunter Region Botanic Gardens, MEL, NE, NSW, PERTH).

Discussion

Acacia atrox is distinguished by the markedly splayed or dilated base of its phyllodes. It does not appear to have any particularly close relatives, but may have some affinities with *A. carneorum* Maiden from central-eastern South Australia and the North and South Far Western Plains of New South Wales, which is superficially similar in its gregarious suckering habit, rigid, pungent phyllodes, globular flower-heads and united sepals. *Acacia carneorum* appears to produce few fruits, which may also be the case for *A. atrox* where pods have not been observed. *Acacia carneorum* mainly differs from *A. atrox* by not having splayed phyllode bases, and by having often thicker, 4-veined phyllodes (distinctly quadrangular in section), hairy branchlets and phyllodes (especially when young), simple inflorescences and yellow to bright yellow flower-heads.

The phyllodes of *Acacia colletioides* Benth. (which occurs in Western Australia, South Australia, New South Wales and Victoria) are superficially similar to those of *A. atrox*, however, they are strongly 8-veined, have raised stomata, are not splayed at the base and are inserted on distinct raised stem-projections; also the sepals are free in *A. colletioides*. *Acacia pickardii* Tindale (restricted in north-eastern South Australia and south-eastern Northern Territory) is superficially similar to *A. atrox* in that it has pungent phyllodes, spreads by suckering, produces hakea fruit-like galls in some phyllodes and appears to rarely produce fruit, but differs most obviously by the phyllodes being \pm erect, terete and obscurely 4-veined, the stipules conspicuously spinose, the inflorescences simple and the sepals free. *Acacia pachypoda* Maslin from Western Australia is superficially similar to *A. atrox*, especially because it also has pungent phyllodes with prominently dilated bases, however, the relationship between these two species is not close. *Acacia pachypoda* is a small shrub which differs significantly in having its short racemes subtended by conspicuous imbricate bracts which enclose the young heads, no bracteoles subtending the flowers, shorter peduncles, shorter phyllodes, and more. In the absence of *A. atrox* pods and biochemical or genetic (DNA) studies it is difficult to further assess possible relationships of this unusual species.

Hawes et al. (2000) estimated a population of 50 000–100 000 individual plants (or more correctly, stems, if clonal) of *A. atrox* in an area of approximately 10 ha., and T. Tame (pers. comm.) estimated 20 000 plants in an area of approximately 2 ha. However, many of the plants, if not the whole population, could be clonal since younger plants appear to be suckering from existing roots and the plants are morphologically very uniform (Hawes et al. 2000; T. Tame, pers. comm.). According to Hawes et al. (2000), vegetative reproduction and apparent poor seed production in this species is also indicated by the absence of any individuals further down the local catchment.

There is a history of habitat disturbance, including the 'thinning' of vegetation, grazing (cattle until very recently), pasture improvement (most recently 2 years ago) and stick raking (4 years ago) (Hawes et al. 2000). These activities may well have promoted the apparent expansion of *A. atrox* in recent years through disturbance of the soil and surface roots stimulating extensive suckering (Hawes et al. 2000). There is the possibility that the area might be burned with the aim of controlling the spread

of *A. atrox*. However, the impact of fire on *A. atrox* is unknown and might have the opposite effect. The situation calls for a monitoring program and studies aimed to assist the landholder and authorities maintain a balance between productive farming and conservation of this endangered species.

Further field surveys in the region should be carried out to determine if there are other populations of *A. atrox* and possible threats to the species. More information is required on its biology and ecology, including reproduction strategies and life cycles. This could be assisted by propagation *ex situ*, which may also be necessary to help protect the species. Specimens with pods remain to be found and would provide further insights on the species biology and possible related species. Furthermore, flavonoid studies on the wood may provide results that help suggest relationships. There is also the possibility for phylogenetic and population genetic studies, as well as entomological studies on the galls. The known population of *A. atrox* and its habitat should be managed to help protect this very rare and possibly ancient or relic species.

Acknowledgments

Thankyou to Mr Fred Millar, Myall Creek Station, for bringing attention to this new rare species and for his observations, as well as for allowing access and field studies on his property. I am very grateful to Wendy Hawes, Paul O'Keefe and James Kewley of the NSW Department of Land and Water Conservation, Inverell, for their specimen collections and report. Many of the details in this paper are based on findings from their thorough site inspection. Comments on *A. atrox* and/or the manuscript were provided by Terry Tame (Hunter Region Botanic Gardens & NSW), Bruce Maslin (PERTH), NSW Agriculture, Mr K. Stevens, Wayne Pollock and Doug Benson (NSW). John Benson (NSW) assisted with liaising with collectors and government departments. Dr Peter Wilson (NSW) kindly provided the Latin description. Lesley Elkan (NSW) is gratefully acknowledged for drawing the illustration.

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Manuscript received 6 December 2000

Manuscript accepted 4 April 2001

The name of the apple

D.J. Mabberley, C.E. Jarvis and B.E. Juniper

Abstract

Mabberley, D.J. (*Nationaal Herbarium Nederland, University of Leiden, The Netherlands, and Royal Botanic Gardens Sydney, Mrs Macquaries Road, Sydney, NSW, Australia 2000*), Jarvis, C.E. (*Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, UK*), and Juniper, B.E. (*Department of Plant Sciences, University of Oxford, South Parks Road, Oxford OX1 3RB, UK*) 2001. *The name of the apple*. *Telopea* 9(2): 421–430. It is shown that the correct name to be applied to orchard apples (if *Malus* is to be maintained as a distinct genus) is, once again, *Malus pumila* Mill.: cultivars should be written as, e.g., *Malus pumila* 'Granny Smith'. Names used for apples by Linnaeus are typified (five neotypifications). The native apple of northern Europe is *Malus sylvestris* (L.) Mill., though many 'wild' apples there are derived from cultivated forms of the Asiatic *M. pumila*.

Introduction

In preparing an account of the watercolour drawings of Arthur Harry Church (Mabberley 2000), the first author was confronted with the fact that there is no consensus on the Latin binomial to be applied to the common apple. Despite apples being the most important temperate fruit crop, not only in Australia, but worldwide (Zohary & Hopf 1988: 151), this seemingly simple matter has not been resolved.

For some 70 or 80 years, apples have been referred to the genus *Malus* Mill. (Rosaceae), though Church, the Edwardian botanist and artist, like most of his contemporaries, worldwide, referred to it as *Pyrus malus* L.

Apples in Australia

No *Malus* (or *Pyrus*) species is native in Australia but, since early colonial times, apples have become naturalised and some cultivars of world importance have been raised here. The most famous is, perhaps, 'Granny Smith'. By 1924, Herbert Rumsey, a Dundas orchardist and local historian (Rumsey 1924, also *Sydney Morning Herald* 6 Nov 1936 [see Tucker & Co. [1938]]) could write that the 'Granny Smith' apple was "the most valuable of all apples grown in Australia". However its origin was even by then anecdotal, according to those who could remember the first grower, Maria Ann Smith (1799–1870), née Sherwood, of Peasmarsh, Sussex, UK, who had arrived in Australia in November 1838 (Spurway n.d.). Her husband, Thomas, bought land in what is now Eastwood, a suburb of Sydney, in 1855 and 1856. According to the story related to Rumsey, Mrs Smith returned from the Sydney Markets with some gin crates, which had contained the rotting remains of some 'French Crab' apples from Tasmania. She tipped the mess into a creek on her land and, by 1868, she was able to show visitors the resulting tree from which all 'Granny Smith' apple trees have been derived.

Until recently, 'Granny Smith', like all orchard apples, was thought to have had a complex hybrid ancestry involving a number of species native in Central Asia, *M. sieversii* (Ledeb.) M. Roem. being important in the lineage. DNA studies and fieldwork (Robinson et al., 2001) have shown on the one hand that there is no evidence from nuclear ITS and chloroplast *matK* sequence analysis to support the view that

hybridisation with other *Malus* spp. took place during the westerly migration of the orchard apple and, on the other, that '*M. sieversii*' is just one aspect of very variable but monospecific wild apple populations in Central Asia. In these populations forms can be found resembling the major groups of cultivated apples seen in Europe and taken thence around the world; for a popular account of these stands where 'every tree is a different variety', see Browning (1998: 60).

Latin names for orchard apples

'Granny Smith' is therefore a cultivar of that Asiatic wild *Malus*, but what is the correct binomial to apply to the species? It may seem almost incredible to laypeople that scientists cannot agree on the name for so common and important a plant as the apple (cf. Corner 1946), for, despite the fact that some authors have recently settled on (the illegitimate) name, *M. domestica* Borkh., following Korban & Skirvin (1984), though the most recent published opinion (Kartesz & Gandhi 1992) argues for *M. sylvestris*, there is disarray in the popular as well as systematic and floristic literature. In current use are a number of names, used as species or as hybrid names — *M. communis* Desf. (e.g. the *International Book of Fruit* and used consistently in many French books in the nineteenth century), *M. domestica* (Mansfeld 1986: 355–63; Given & Sykes 1988; Terpó 1988; Harden & Rodd 1990; Vaughan & Geissler 1997: 52–61), *M. pumila* (Rehder 1949; Zohary & Hopf 1988, 1994; Le Bon Jardinier ed. 153 1992; Ghjora & Panigrahi 1995), *M. sylvestris* (Browicz 1972; Symon 1986; Maxwell et al. 1988, as subsp. *mitis*); yet other names have been used in the past.

Linnaeus's apple names

Most of these names ultimately rest on names published in the works of Linnaeus, who included apples under the genus *Pyrus*. It is therefore necessary to examine Linnaeus's names and to typify them, thereby typifying *Malus* names based on them. These typifications refer to the Linnaean names and do not affect 'standards' for cultivar names.

As with citrus fruit (Mabberley 1997b), DJM needed to clarify this matter for updating *The Plant-book* (Mabberley 1987, 1997a), as well as for the book on Church's work, and approached CEJ, coordinator of the Linnaean Plant Name Typification Project, and BEJ, pomologist and supervisor of the DNA work in Oxford.

2. PYRUS foliis ferratis, pomis basi concavis. *Hort. cliff. Malus.*
 189. *Hort. upf.* 130. *Fl. suec.* 402. *Mat. med.* 237.
Roy. lugdb. 266. *Hall. herb.* 351.
Malus sylvestris. *Baub. pin.* 435. *Dod. pempt.* 790. *sylvestris.*
 β. *Malus pumila*, quæ potius frutex quam arbor. *Baub. paradisiaca.*
pin. 433.
 γ. *Malus prafomila.* *Baub. pin.* 433. *prafomila.*
 δ. *Malus fativa*, fructu sanguinei coloris ex austero sub-*rubelliana.*
dulci. *Tournef. inst.* 635.
 ε. *Mala curtispendula dicta.* *Baub. hist.* 1. p. 21. *cestiana.*
 Epirotica. ζ. *Poma orbiculata.* *Ruell. stirp.*
Habitat in Europa. 5

Fig. 1. Linnaeus's entry for *Pyrus malus*.

Pyrus malus L., Sp. Pl.: 479, 1200 (1753) = *Malus pumila* Mill., Gard. Dict. Ed. 8: Malus n. 3 (1768), (unidentified cv.)

Type: Cultivated in Europe, Herb. Linn. 647.3 (LINN, fiche seen; lecto selected by Ghora & Panigrahi, Fam. Rosaceae in India 2: 375, t. 72A (1995)).

Malus pumila is the earliest specific name in *Malus* for any plant, wild or cultivated, derived from the variable wild apple populations of Central Asia. See below.

Some, at least, of the varieties Linnaeus recognised seem to represent what might be thought of today as cultivar groups, now 'typified' by particular cultivars:

Pyrus malus L. var. *cavillea* L., Sp. Pl. ed. 2, 1: 686 (1762) = *Malus pumila* Mill. 'Calville Rouge d'Automne'

cavillea. ζ. Mala fativa, fructu magno intense rubente, viola odore. *Tournef. inf.* 635.

Fig. 2. Linnaeus's entry for *Pyrus malus* var. *cavillea*.

Type: Cultivated at National Fruit Collection [Accession 1949011 – ex *W. Barnes*, Bexhill, England, Oct. 1949], Brogdale, Faversham, Kent, England, 20 May 1999, *E.-J. Lamont 1309 p.p.(fl.)*, (neo, designated here: NSW; isoneo: BM, FHO; epitype [same tree, lvs, 5 Aug. 1999, *E.-J. Lamont 1309 p.p.*]: NSW; iso-epi: BM, FHO).

There is no extant original material; none survives in any of Linnaeus's herbaria, and although Linnaeus cited a Tournefort binomial, it cannot be linked to anything other than a generalised illustration describing a number of different taxa. He did not study Tournefort's specimens (in any case no material of this taxon survives in Tournefort's herbarium at P). Poiret (1804) noted, "On distingue le *calvil d'automne* & le *calvil blanc* ou *calvil d'été*", grouping them under 'Le Calvil' with Linnaeus's and Tournefort's names as synonyms.

Although it was being grown in at least South Australia around 1916, this apple is apparently no longer in Australia, though other 'Calville' cultivars are still found here (Clive Winmill, pers. comm.).

Pyrus malus L. var. *cestiana* L., Sp. Pl. 1: 479 (1753) = *Malus pumila* Mill. 'Court-Pendu Plat'

Type: Cultivated, from material grown in Badger's Keep Nursery, Chewton, Victoria, Australia, 31 Mar. 1999, fr. [dried and in spirit], *D.J. Mabberley, K. Robertson & C. Winmill 2474* (neo designated here: NSW; isoneo: BM, FHO, L, MEL).

There is no extant original material in any of the Linnaean herbaria. Linnaeus cited Bauhin & Cherler (1650: 21) but that is not accompanied by an illustration, nor can any supporting material be found at UPS, or at BAS (Heinz Schneider, pers. comm.). A neotype has therefore been designated. This apple has been known in cultivation for some 400 years.

Pyrus malus L. var. *epirotica* L., Sp. Pl. 1: 480 (1753) = *Malus pumila* Mill. 'Pomme d'Api'

Type [icon]: 'Pomme d'Api' — R. Hogg, *Herefordshire Pomona* t. 74, f. 2 (1876-85) (neotype selected here).

There is no extant original material in any of the Linnaean herbaria. The name is based on a description (without any illustration) of *Poma orbiculata* by Dioscorides (1552). Poiret (l.c.) added the Tournefort synonym *Malus sativa, fructu orbiculata, odorato ... Pomme Rose* and referred the plant to his 'La pomme-rose', noting 'Cette pomme est toute ronde, d'une couleur de rose assez jolie, d'une faveur parfumée'. 'Le gros api, pomme rose' was listed by Audibert Frères (1825) in their catalogue and considered a form of the 'Pomme d'Api' by Decaisne & Naudin (n.d.: 433, t. 168). Selection of the 'Pomme d'Api' was attributed to the Greeks with Claudius Appius saying it came from the Peloponnese (Société National d'Horticulture de France, Section Pomologique [1907: 454]).

Although grown in Australia up to World War I, as the Lady Apple, it is apparently no longer in cultivation here, though allegedly represented at Brogdale, England (Clive Winmill, pers. comm.) but we have seen no European material, hence our choosing to designate an (excellent) illustration as neotype.

Pyrus malus L. var. *paradisiaca* L., Sp. Pl. 1: 479 (1753) = *Malus pumila* Mill. 'Malling VIII' ('M8').

Type: Cultivated ('*Malus* M8 rootstock'), Horticultural Research International East Malling, Kent, England, 25 April 2000, fl., *A. King s.n* (neo designated here: NSW; isoneo: BM, FHO).

There is no extant original material in any of the Linnaean herbaria. The name is based on a polynomial from Bauhin (1623), but there are no specimens in the Burser Herbarium (UPS) associated with it. Bauhin in turn cited Bock who referred to it as 'Paradisiac, in German Paradeisopffel'. Worlidge (1676: 159) wrote, 'The Paradise Apple is a curious Fruit, produced by grafting a Permain [sic] on a Quince'. It is difficult to be sure whether early authors were using the name for the grafted plant as a whole or as it was later used as the common name applied worldwide to some grafting stocks. The epithet 'Paradise' is associated with things Persian, the word being derived from the Old Persian *pairi daiza* meaning a walled garden, suggesting an origin for the plant, many authors considering it introduced to Britain from Armenia via France.

Linnaeus himself may not have had any particular selection of dwarfing stock in mind and there was great confusion about the stocks in any case (Hatton 1917). According to Carrière (1879), there were three sorts of grafting stocks in use on the Continent of Europe in the nineteenth century — *franc*, *doucin* and *paradis*, of which the latter two were propagated by cuttings; Carrière added that the old 'Paradis ordinaire' (Malling VIII, though Malling IV was common in Holland and Germany), which was not reliable under all conditions, was in his time being replaced by the 'Paradis jaune (de Metz)', i.e. Malling IX ('M9') (Hatton 1917). The latter, which was selected by the firm of Simon-Louis at Plantières-les-Metz in 1828, is the common stock now used in Australia. Malling VIII has probably never been grown here and we have found no herbarium material of it from any country, so we have had specimens from the East Malling stock prepared to serve as neotype.

Pyrus malus L. var. *prasomila* L., Sp. Pl.: 479 (1753) = *Malus pumila* Mill. 'Reinette Franche'

Type: Cultivated at National Fruit Collection, Brogdale, Faversham, Kent, England [Accession 1947288 ex *A. Vienmois*, Odenas, Rhone, France, Mar. 1947], 20 May 1999 (fls), *E.-J. Lamont 1308 p.p.* (neo designated here: NSW; isoneo: BM, FHO; epitype [same tree, 5 Aug. 1999 (lvs), *E.-J. Lamont 1308 p.p.*]: NSW; iso-epi: BM, FHO).

There is no extant original material in any of the Linnaean herbaria. The name is based on a polynomial from Bauhin (1623) but there are no associated specimens in the Burser Herbarium (UPS). The Bauhin reference is to the 'Granicher' apple. Known from before 1650, it is Tournefort's *Malus sativa*, *fructu subrotundo, è viridi pallescente, acido-dulci* and *Renette blanche, ou franche* (Tournefort 1700: 634), referred to 'Renette Blanche' (white or French Renette) by Miller (1768). Linnaeus himself annotated his own copy (in LINN) of *Species plantarum* with 'Renette' after 'Bauh. pin. 433'. Desfontaines (1809: 140) had var. *prasouilla* for the 'reINETte' and Poiret (l.c.) refers both Tournefort's and Linnaeus's names to his 'La reINETte', adding, 'C'est la plus estimée de toutes: on en distingue de plusieurs sortes: la *reINETte blanche* ... la *reINETte grise* ... la *reINETte franche*'. According to the Société National d'Horticulture de France, Section Pomologique (1907: 510), 'ReINETte commune' and 'ReINETte blanche' are synonyms of 'ReINETte Franche'.

Although several 'ReINETtes' are grown in Australia, 'ReINETte Franche' seems never to have been grown here, though it is still in England, e.g. at Brogdale, where the neotype material was gathered.

Pyrus malus L. var. *rubelliana* L., l.c. = *Malus pumila* Mill. cv.

There is no extant original material in any of the Linnaean herbaria. The name is based on a polynomial from Tournefort (1700: 635), who, in turn cited *Poma rubelliana* of Dioscorides (1552: 252), which is the source of Linnaeus's epithet. Tournefort called such trees 'Pommes de Rouveau', 'rouveau' probably being an archaic French word for reddish (Aymonin, P, pers. comm.), cognate with Ruellius's name for Dioscorides' plant which Tournefort cites. Linnaeus took up very few of the horde of apple cultivars discussed by Tournefort, so this one must have seemed distinctive to him, though perhaps he was using the name to cover the pearmaines of the time in general (see above). Poiret, l.c., referred both the Linnaean and Tournefortian names to his 'Le rouveau', and included the illustration 'Zahmer [= domestic] Apfel baum') of Blackwell (1750-52: t. 141), which was apparently of one of the standard pearmaines of the period, and was referred here at least as early as the 1770s (Reichard [1779: 502], who wrote, 'Ce fruit est d'un rouge sanguin, assez agréable par sa saveur douce, aigrette'). It is not discussed by Desfontaines (l.c.), and 'rouveau' does not appear in the French catalogues we have examined or in modern dictionaries. Perhaps the original 'Greek' plant of Dioscorides is long lost.

Pyrus malus L. var. *sylvestris* L., Sp. Pl.: 479 (1753) = *Malus sylvestris* (L.) Mill.

Type: Latvia, 'Dist. Madonensis, prope villula Grasi', V. Langenfelds 105 (neo-: RIG, photo seen; selected by Langenfelds, Apple-trees: 186, 1991).

Desfontaines (l.c.) had *Malus communis* var. *sylvestris* for the 'sauvageon' but Moench (1794: 680) used *M. sylvestris* for *Pyrus malus* and Poiret (op. cit.: 560) included '*M. sylvestris* Bauh.' under *M. communis*. Indeed, in advance of the latest findings the recent problem over not using *M. communis* or *M. domestica* for the orchard apple largely stemmed from the interpretation of *P. malus* var. *sylvestris* L. Without a Greek letter in the protologue, var. *sylvestris* might appear to be referring to the 'typical' (autonymic) variety and might therefore be a superfluous name for var. *malus* (Kartesz & Gandhi 1992). However, Dick Brummitt (K, pers. comm.), wrote, "my feeling is that [Linnaeus] had no concept of autonyms, and that any infraspecific epithet he published should be accepted as a validly published varietal name. I know that it is odd that he did not publish the alpha sign, but if he had done so I would feel that '*sylvestris*' is still an atypical variety, and when he left out the sign I am not inclined to think that the epithet should be treated any differently ... Then I would be inclined to treat Miller's specific name as a new one".

Dan Nicolson (US, pers. comm.) suggested, "Linnaeus did not view species as being composed of nothing but varieties alpha onward but what we would call "typical" he did not number. To this element he attached what he numbered (in Greek) what we call varieties that he sometimes named. I do not know why he did not number the alpha attachment but it, like the beta, gamma, delta, etc. varieties are not "typical" in the modern sense ... I note that *Pyrus Malus*, surely the cultivated taxon, would not have been called "*sylvestris*" (the forest or wild apple). By the same token, the preceding species involving the cultivated pear, *Pyrus communis*, surely should not be typified on an element Bauhin called *Pyrus sylvestris* and Linnaeus called [var.] *pyraster* (false pear)".

We agree: in this interpretation, var. *sylvestris* is therefore not a superfluous renaming of the 'typical' variety and can continue to be used for the native apple of Europe - as *Malus sylvestris* (L.) Mill. If the contrary view is taken, *M. sylvestris* Mill. is a new name for *Pyrus malus* L., i.e. it would be a contender for the name for the cultivated orchard apple, as used long ago by, e.g. Moench (1794), though perhaps he was then referring to apples in the wild that were derived from orchard apples. In this case, the European plant would have to bear a different name: this is not in the interests of nomenclatural stability. The synonymy for the native European tree is therefore:

Malus sylvestris (L.) Mill., Gard. Dict. Ed. 8: *Malus* n. 1 (1768).

Type: see above.

≡ *Pyrus malus* L. var. *sylvestris* L., Sp. Pl.: 479 (1753).

≡ *M. communis* Desf. var. *sylvestris* (L.) Desf., Hist. Arb. 2: 140 (1809), nom. illeg.

Europe to C Asia. This is a rare and rather invariable species armed with spines.

The name of orchard apples

In publishing *Malus pumila*, Miller (1768) cited as a synonym *M. pumila quae potius frutex quam arbor* Bauhin (1623: 433) and referred to the his plant as "Paradise Apple". This synonym is shared with *Pyrus malus* var. *paradisiaca* L. Although Miller did not explicitly cite Linnaeus's name, he "applied Linnaeus's method entirely" in the eighth edition of *The gardeners dictionary* (Miller 1768). Under the ICBN (Greuter et al., 2000), Arts 32. 1(c), 32. 3, 32. 4 and 32 Ex. 7, in citing the Bauhin polynomial and linking it to the Paradise Apple, Miller provided an indirect but clear reference to *P. malus* var. *paradisiaca*. We therefore accept *M. pumila* as a *nomen novum* for *P. malus* var. *paradisiaca*, with which it is therefore homotypic. *Malus pumila* is, in consequence, the correct binomial, in *Malus*, for the orchard apple and its wild antecedents. Commonly used names and the Linnaean names discussed above are included in the synonymy below (* = additions to *Index Kewensis* and other lists):

Malus pumila Mill., Gard. Dict. ed. 8: *Malus* n. 3 (1768); Rehder, Bibl. Cult. Trees Shrubs: 267 (1949).

Type: as for *Pyrus malus* var. *paradisiaca* (see above).

≡ *P. malus* L. var. *paradisiaca* L., Sp. Pl.: 479 (1753).

≡ *M. paradisiaca* (L.) Medik., Gesch. Bot.: 78 (1793), nom. superfl.

≡ *M. communis* Desf. var. *paradisiaca* (L.) Desf., Hist. Arb. 2: 140 (1809), nom. illeg.

≡ *P. pumila* (Mill.) Mill. ex Steud., Nomencl. Bot.: 670 (1821).

[≡ *P. paradisiaca* (L.) Steud., l.c., nom. in synon.]

≡ *M. paradisiaca* (L.) Medik. var. *pumila* (Mill.) Koehne, Deut. Dendr.: 259 (1893), nom. illeg.

≡ *M. pumila* Mill. var. *paradisiaca* (L.) C.K. Schneid., Ill. Handb. Laubh. 1: 715 (1906).

- ≡ *P. malus* L. var. *pumila* (Mill.) A. Henry in Henry & Elwes, Trees Brit. Irel. 6: 1570 (1912), nom. superfl. pro *P. malus* var. *paradisiaca*.
- ≡ *M. sylvestris* (L.) Mill. var. *paradisiaca* (L.) L.H. Bailey, Hortus Sec.: 457 (1941).
- ≡ *M. sylvestris* (L.) Mill. subsp. *paradisiaca* (L.) Soó, Acta Bot. Acad. Sci. Hung. 18: 175 (1973).
- ≡ *M. praecox* (Pall.) Borkh. var. *paradisiaca* (L.) Valev, Fl. Reip. Pop. Bulg. 5: 347 (1973).
- ≡ *M. domestica* Borkh. var. *paradisiaca* (L.) Lich., Trudy Prikl. Bot. Genet. Selekt. 52(3): 21 (1974), nom. illeg.
- ≡ *M. domestica* Borkh. subsp. *pumila* (Mill.) Likh., Fl. Kul't. SSSR 14: 69 (1983), nom. illeg.
- = *P. malus* L., Sp. Pl. 1: 479, 2: 1200 (1753).
- Type: see above.
- ≡ *Sorbus malus* (L.) Crantz, Stirp. Austr. Fasc. 2: 57 (1763).
- ≡ *M. sylvestris* Moench, Meth.: 680 (1794); Karstesz & Gandhi, Phytol. 73: 131 (1992); non (L.) Mill. (1768).
- ≡ *M.* communis* Desf., Fl. Atlantica 1: 398 (1798).
- ≡ *M. domestica* Borkh., Theor-Prakt. Handb. Forstbot. 2: 1271 (1803), nom. illeg., superfl.; Korban & Skirvin, HortSci. 19: 177 (1984).
- ≡ *Pyrenia malus* (L.) [Clairv.], Man. Herb. Suisse: 162 (1811).
- ≡ *Pyrus sylvestris* Gray, Nat. Arr. Brit. Pl.: 2: 562 (1821), nom. superfl.
- ≡ *M. pumila* Mill. var. *domestica* (Borkh.) C.K. Schneid., Ill. Handb. Laubh. 1: 715, t. 396 (1906).
- ≡ *P. pumila* (Mill.) Steud. var. *domestica* (Borkh.) Asch. & Graebner, Syn. Mitt. Fl. 6, 2: 77 (1906).
- ≡ *M. dasyphylla* Borkh. var. *domestica* (Borkh.) Koidz., Acta Phyt. Geob. 3: 189 (1934).
- Note. Of the names in *Malus* based on *Pyrus malus* L., and therefore on its type specimen, the earliest (but see *P. malus* var. *sylvestris* above) are *M. communis* Desf. (1798) and *M. domestica* Borkh. (1803). *Malus communis*, despite being published in a major Flora, has been overlooked (it is not listed in *Index Kewensis* for example) and *M. domestica* was long considered to be a species of *Sorbus* (see, e.g., *Index Kewensis*). The latter, a superfluous name, has only relatively recently been resuscitated, though Borkhausen (1803) implied it was in use, if not in print, before 1803. Although earlier he (Borkhausen 1797) had followed Medikus (1793) in splitting off *Malus* from *Pyrus*, he himself certainly did not use *M. domestica* then. *Index Londinensis* lists *Malus communis* as published in 1797, though the cited plate actually appeared in 1794, but its accompanying letterpress with the name *M. communis* was not published in the work cited until 1819.
- = *Pyrus malus* L. var. *cestiana* L., Sp. Pl.: 479 (1753).
- Type: see above.
- = *Pyrus malus* L. var. *epirotica* L., Sp. Pl.: 480 (1753).
- Type: see above.
- [≡ *P. epirotica* (L.) Steud., l.c., nom. in synonym.]
- = *Pyrus malus* L. var. *prasomila* L., Sp. Pl.: 479 (1753).
- Type: see above.
- ≡ *Malus communis* Desf. var. *prasomila* (L.) Desf., l.c.
- ≡ *P. parasomila* Steud., op. cit: 671 (1821).
- ≡ *P. prasomila* (L.) Steud., l.c.
- ≡ *M.* prasomila* (L.) Poit. & Turpin in Duhamel, Traité nouv. éd. 5: t. 111 (1810 'prasomila').

= *Pyrus malus* L. var. *rubelliana* L., Sp. Pl.: 479 (1753).

Type: see above.

= *Pyrus malus* L. var. *cavillea* L., Sp. Pl. ed. 2, 1: 686 (1762).

Type: see above.

≡ *Malus communis* Desf. var. *cavillea* (L.) Desf., l.c.

[≡ *P. cavillea* (L.) Steud., Nomencl. Bot.: 670 (1821), nom. in synonym.]

≡ *M. domestica* Borkh. var. *cavillea* (L.) Likh., Fl. Kul't SSSR 14: 65 (1983).

= [= *Malus vulgaris* Pallas, Reise 3: 653 (1776), nom. nud.]

= *Pyrus sieversii* Ledeb., Fl. Alt. 2: 222 (1830).

Type: 'Siberia', [1790-4], J.E. Sievers s.n. (LE?, n.v.).

≡ *Malus sieversii* (Ledeb.) M. Roem., Syn. 3: 216 (1847).

Native in Central Asia, *M. pumila* is now much restricted in the wild, but selected forms have been carried throughout the temperate world as orchard apples and become naturalised widely. Wildings in Europe include trees named in Floras *M. acerba* Mérat, for example.

It was the habit of early European voyagers to Australia to plant seeds of European crops, so that apple seeds may well have been sown before the First Fleet arrived in 1788. Cultivars growing in England about the time of the Fleet are listed in Weston (1775: 220), but others introduced to Australia then or before could have been picked up at ports of call on the voyages from Europe. Those apples likely to have been brought by the Fleet (Surrey Jacobs, NSW, pers. comm.) include *M. pumila* 'Court-Pendu Plat' (see above), still grown, and 'French Crab', from which arose 'Granny Smith'.

Conclusion

The foregoing demonstrates how intricate ascertaining the correct nomenclature for economic plants can be. In recent years there has been much ink spilled in ascertaining the correct name in *Lycopersicon* (Solanaceae) for the common tomato, *L. esculentum* Mill. (see Terrell et al., 1983), but all that has now been superseded in that the tomato has been returned to where Linnaeus had it — in *Solanum*, so that it is now *S. lycopersicum* L. once more (Spooner et al., 1993). Similarly, although *Malus pumila* is now, once again, seen to be the correct name in *Malus* for the common apple, it is likely that the narrowly defined genera of this group coming from folk taxonomy (Walters 1961), will also ultimately be recombined following phylogenetic work. In this case, the folk taxonomy was enshrined, for example, by Tournefort (as in citrus fruit [Mabberley 1997b] and the strawberry and its allies: *Potentilla* to include *Fragaria*), then rejected by Linnaeus, and later resurrected by Miller, Medikus and Jussieu.

In following the re-amalgamation of the other Rosaceous genera *Amygdalus* L., *Armeniaca* Scop., *Cerasus* Mill., *Laurocerasus* Duham., *Padus* Mill. and *Persica* Mill., into *Prunus* L., so that the name of the almond is once more referred to *Prunus*, as *P. dulcis* (Mill.) D.A. Webb, and that of the peach becomes *P. persica* L. once more, the name of the apple would then revert to just what Linnaeus (and most early C20 authors including Church) had — *Pyrus malus* L., or even *Sorbus malus* (L.) Crantz, with concomitant changes in the names of other species presently accommodated in *Malus*.

Acknowledgments

We are indebted to Clive Winmill of Badger's Keep Nursery, Chewton, Victoria and Keith Robertson (Creswick, Victoria), apple enthusiast, for help and hints on old apple cultivars in Australia, to Emma-Jane Lamont and Alison Lean of Wye College, University of London for collecting material at Brogdale, to Dick Brummitt (K) and Dan Nicolson (US) for nomenclatural guidance, to Stefan Dressler for information on old German texts, to Stephen Heyworth for guidance in the works of Pliny, to Surrey Jacobs, who kindly shared with us the fruits of his researches connected with the planting of the First Farm Display in the Royal Botanic Gardens Sydney, to G. Aymonin (P) for help with old French words and to M. and Mme J.-P. Boivin of the Service des Cultures, Jardin des Plantes, Paris, for their help with getting to grips with the French pomological literature. Thanks are also due to Heinz Schneider (BAS), Arnis Seisums (RIG), Walter Gams (Baarn), Sarah Juniper (UK), and an anonymous reviewer, who provided very helpful comments on the first draft of the paper.

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Manuscript received 30 November 1999

Manuscript accepted 4 April 2001

Homoranthus binghiensis (Myrtaceae: Chamaelaucieae), a new species from the North Western Slopes of New South Wales

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Abstract

Hunter, John T.¹ and Copeland, Lachlan M.² (175 Kendall Rd, Invergowrie, NSW 2350, Australia, ²Division of Botany, University of New England, Armidale, NSW 2351, Australia) 2001. Homoranthus binghiensis (Myrtaceae), a new species from the North Western Slopes of New South Wales Telopea 9(2): 431–433. Homoranthus binghiensis J.T. Hunter, a new species from the Torrington region of the North Western Slopes of New South Wales is described and notes are provided on its distribution and conservation status. The species is distinguished from its putative sister taxa by particularly thick leaves and a combination of ovule and sepal laciniae number.

Introduction

During a vegetation survey of the Torrington State Recreation Area (Clarke et al. 1998) an unusual and very distinctive *Homoranthus* was discovered. The specimens collected of this entity were shown to represent a geographically restricted unnamed species, which seems not to have been previously collected. This species is described in this paper and notes are given on its distribution, conservation status and putative affinities.

Homoranthus binghiensis J.T. Hunter, *sp. nov.*

Similis *H. croftianus*, frutex folia 8–22 mm longa, 0.4–0.9 mm lata, 1.3–2.6 incrassatus; flores in ramulis non specialis; pedunculis 0.4–1.2 mm longis; bracteolis caducis, 4–6.8 mm longis; hypanthium 4–7 mm longum, 1.4–2.4 mm latums; sepala 3–4.5 mm longa; stylus 5–6.5 mm longus differt.

Type: New South Wales: North Western Slopes: Torrington State Recreation Area, 300 m SW of junction of Tin Pot Gully and Carpet Snake Creek, 29°14'44"S, 151°30'18"E, 800 m altitude, Copeland 2741 & Clarke, 14 Nov 2000 (holo NSW; iso BRI, CANB, MEL, NE).

Shrub to 3 m tall, erect, fruticous to 2 m wide. *Stems* yellow-orange when young turning grey-brown. *Leaves* opposite, decussate, 8–26 mm long, 1.3–2.6 mm thick and 0.4–0.9 mm wide; incurved to falcate in side view, narrow oblanceolate to oblanceolate, flat in transverse section, pale lime-green to glaucous, apex curved, with a mucro or apiculum, 0.2–0.4 mm long; petiole 0.7–1.7 mm long. *Flowers* solitary in axils but appearing paired in pseudoflorescences, yellow to pale green turning red with age. *Peduncles* 0.4–1.2 mm long; bracteoles caducous, 4–6.8 mm long, yellow-brown. *Hypanthium* 5-costate, ± runcate between the costae but becoming smooth with age, 4–7 mm long, 1.4–2.4 mm wide. *Sepals* 3–4.5 mm long, 0.4–1.3 mm wide, apex variously divided into (2-) 3 (-6) laciniae, often with two major divisions and further divisions along primary division, gland dotted at the base. *Petals* broadly ovate to circular, sometimes erect and clawed, 1.4–2.4 mm long, 1.4–1.8 mm wide, the margin entire. *Stamens* 10; filaments 0.4–0.7 mm long; anthers 0.2–0.4 mm long; staminodes 10,

free, 0.3–0.6 mm long. *Style* 5–6.5 mm long, trichomatous in upper region; ovules 7–8, collateral in two longitudinal rows. *Fruit* a simple, dry indehiscent nut, 4.4–7 mm long, 1.5–2.4 mm wide, caducous after seed set, red-brown.

Additional specimens: New South Wales: North Western Slopes: Jonquil Knob, 500 m north of Carpet Snake Trail, Torrington State Recreation Area, south-west of Tenterfield (29°11'21"S 151°32'14"E), in shrubland on shallow soils on granite outcrop, 800 m altitude, *Hunter & Croft*, 20 Nov 1998 (BRI, CANB, MEL, NSW); Jonquil Knob, 500 m north of Carpet Snake Trail, Torrington State Recreation Area, south-west of Tenterfield, *Hunter*, 15 Jun 1999 (BRI, CANB, MEL, NSW); Torrington SRA, 2.5 km south of Tin Pot Gully on Carpet Snake Trail, 29°15'S, 151°29'E, 900 m altitude, *Copeland 808 & Clarke*, 17 Nov 1997 (BRI, CANB, MEL, NSW, NE).

Distribution: *Homoranthus binghiensis* is restricted to the northern and western fall of the Torrington State Recreation Area, which lies within the North Western Slopes of New South Wales south west of Tenterfield. The known distribution of the species is highly scattered and disjunct over 10–15 km.

Flowering: November to January.

Habitat: found in open and exposed situations on and around the margins of granite outcrops between 700–950 m above sea level. The mean annual rainfall of this area is 700–800 mm. The species is found in shrublands and heath on shallow soil depressions on granite outcrops or on shallow soils around their margins. Associated species include *Eucalyptus prava*, *Eucalyptus dealbata* and *Callitris endlicheri* in the overstorey and *Calytrix tetragona*, *Babingtonia odontocalyx*, *Leptospermum triervinum*, *Knuzea bracteolata*, *Leucopogon melalencoides*, and *Leptospermum novae-angliae* in the shrub layer.

Notes: *Homoranthus binghiensis* is easily distinguished morphologically from its congeners in New South Wales by its large stature and thick leaves. Affinities are uncertain at this stage but probably lie with *H. biflorus*, *H. croftianus* and *H. montanus*. *Homoranthus binghiensis* can be also be distinguished from *H. croftianus* and *H. biflorus* by having fewer ovules and from *H. montanus* by having 2–6 sepal laciniae (Table 1). Craven and Jones (1991) considered the former character to be particularly useful in determining relationships within the genus. Clarke and Fulloon (1999) have shown that *H. binghiensis* is an obligate seeder.

Table 1. Diagnostic characters for *Homoranthus binghiensis* and putative sister taxa.

	Sepal laciniae	Ovule number	Leaf thickness: width
<i>H. binghiensis</i>	2–6	7–8	> 4:1
<i>H. biflorus</i>	3–5	8–11	1:1
<i>H. croftianus</i>	1–3	10–11	2:1
<i>H. montanus</i>	1	6–9	1:1

Conservation status: in the vegetation survey report for Torrington State Recreation Area (Clarke et al. 1998) a ROTAP code (Briggs & Leigh 1996) of 2K was proposed for the species. However, based on only five currently known populations, the small size of each population, the limited distribution and threats from inappropriate fire regimes, a ROTAP code of 2Vct is recommended.

Etymology: the area to the west of Torrington that is part of a granite batholith surrounded in the south, west and north by Permian sedimentary rocks has for some time been known as Binghi. Hence, the specific epithet is in reference to the type locality.

Acknowledgments

Thanks to Peter Croft, Senior Ranger with the New England Tablelands Region of the New South Wales National Parks and Wildlife Service for assistance in the field. Cathy Nano also provided assistance in the field. Lyn Craven and Peter Wilson are thanked for discussion of *Homoranthus* taxa.

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Manuscript received 17 August 2000

Manuscript accepted 3 May 2001

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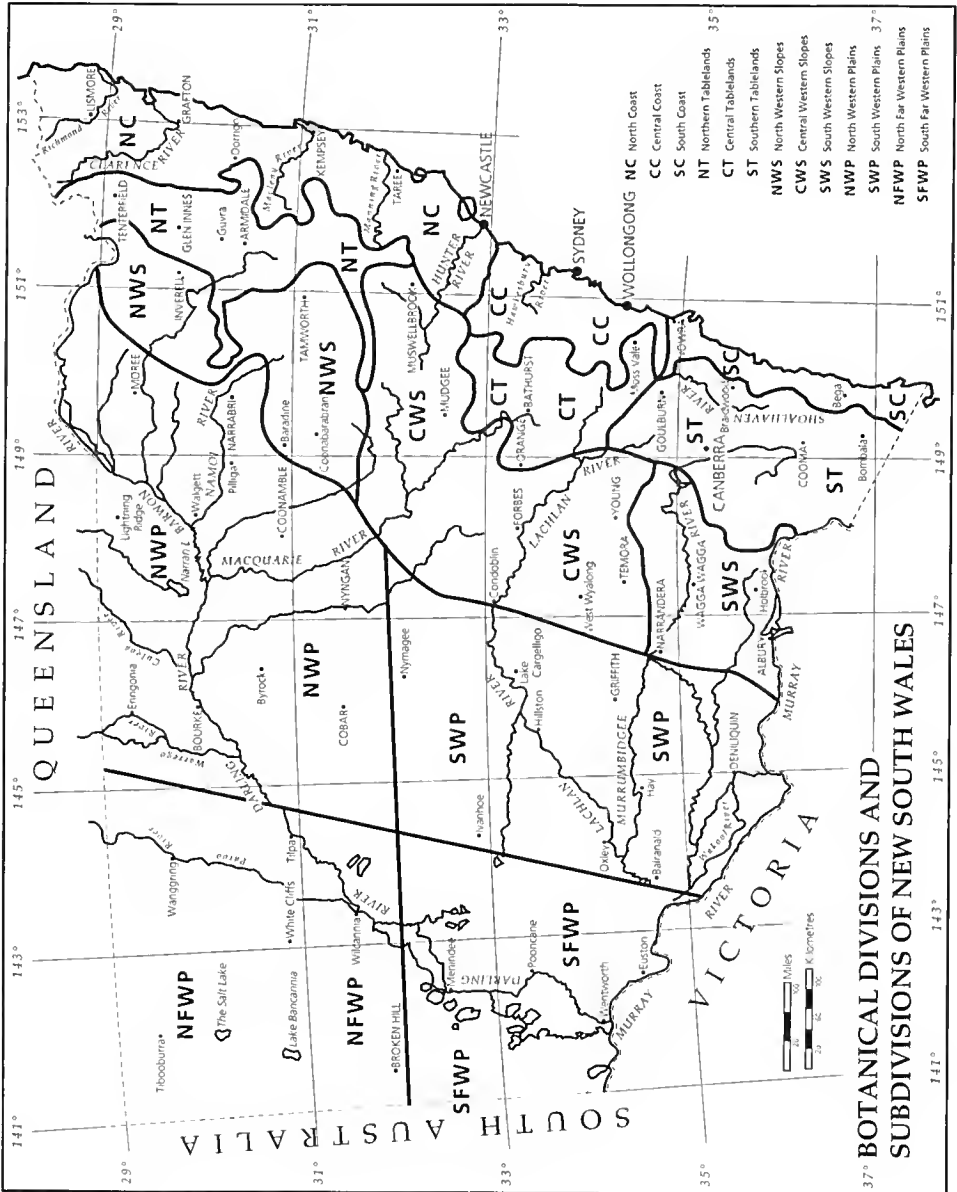
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