

# Muelleria

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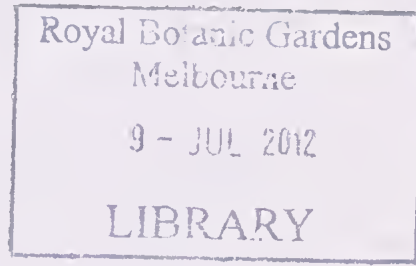
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# Five new endemic eucalypts for Victoria

K. Rule

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## Introduction

Throughout Victoria large tracts of eucalypt-dominated natural vegetation have been lost to clearing for agriculture and other commercial activities. In many parts of the state only remnant pockets remain in protected reserves, on public land, including state forests and roadside reserves, and on farms. In recent years extensive survey work of accessible remnants of eucalypts has been undertaken by this author and others, the result of which has been the discovery of several markedly restricted, previously overlooked eucalypts worthy of taxonomic consideration. Some new taxa have been described recently, some are still under investigation and five are here given formal treatments as new species.

All the new taxa are Victorian endemics and considered rare or threatened. These are *Eucalyptus bunyip*, a tallish, slender swamp gum from the Bunyip State Park in western Gippsland, *E. conferta*, a scentbark from the Fryers Range near Castlemaine in north-central Victoria, *E. carolaniae*, a mountain grey gum from Mt Martha on the Mornington Peninsula, *E. yarriambiack*, a mallee-box from near Brim in the southern part of the Victorian Mallee region, and *E. aurifodina*, a brown stringybark from the Goldfields region of north-central Victoria (Fig. 1).

## Taxonomy

### Series *Foveolatae* (Swamp Gum Complex)

As the common name suggests, the swamp gums form a group of eucalypts occurring in moist localities in south-east Queensland, New South Wales, Victoria, Tasmania and south-east South Australia. In this treatment 14 taxa, including the newly described *E. bunyip*, are included in the key. *E. ovata* Labill. was described in 1806 and a large-fruited form of the species, *E. ovata* var. *grandiflora* Maiden was described in 1916. *Eucalyptus aquatica* (Blakely) L.A.S. Johnson & K.D. Hill was first described as a variety of *E. ovata* in 1934 but elevated to a species in 1990. *Eucalyptus camphora* R.T. Baker was described in 1899 and two additional infraspecific taxa, namely subsp. *humeana* L.A.S. Johnson & K.D. Hill and subsp. *relicta* L.A.S. Johnson & K.D. Hill, were erected in 1990.

## Abstract

*Eucalyptus bunyip*, a tall swamp gum from the Bunyip State Park in west Gippsland, *E. conferta*, a small-leaved scentbark from the Fryers Range near Castlemaine in north-central Victoria, *E. carolaniae*, a rough-barked mountain grey gum from Mt Martha on the Mornington Peninsula, *E. yarriambiack*, an umbrageous mallee-box from near Brim in the southern part of the Mallee region, and *E. aurifodina*, a small-fruited brown stringybark from the Victorian goldfields in the Avoca-Castlemaine area, are described as new Victorian endemic species. The affinities, ecologies, distributions and conservation statuses of each new taxon are discussed.

**Key words:** short-range endemics, swamp gum, scentbark, mallee-box, mountain grey gum, stringybark

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**Figure 1.** Distribution map for new species: *Eucalyptus bunyip* (closed rectangle), *E. conferta* (cross), *E. carolaniae* (closed circle), *E. yarriambiack* (closed triangle), *E. aurifodina* (open circle).

*Eucalyptus aggregata* H.Deane & Maiden was described in 1900, *E. rodwayii* R.T.Baker & H.G.Sm. in 1912 and *E. yarraensis* Maiden & Cambage in 1922. *Eucalyptus barberi* L.A.S.Johnson & Blaxell was described in 1972, *E. brookeriana* A.M.Gray in 1979, *E. cadens* J.D.Briggs & Crisp in 1989 and *E. strzeleckii* Rule in 1992. Brooker (2000) included *E. macarthurii* H.Deane & Maiden (1899) in the Series *Foveolatae*. In my view, that species does not belong with the swamp gums and may be better placed elsewhere, possibly within the Series *Viminalis* Blakely on the basis that its seedling morphology and ontogeny are consistent with *E. viminalis* Labill. and its subspecies.

The Series *Foveolatae* is characterised by the following: The habit is usually a tree (small to tall) or rarely a mallee. The bark in most species is smooth, often with a stocking of accumulated loose strips, chunks or plates, or rough, usually box-like, and extending to the major branches. The juvenile leaves are disjunct, petiolate and mostly ovate. The adult leaves are ovate to lanceolate, green and lustrous in most species. The inflorescences are 7-flowered or rarely 7–11-flowered. The buds are usually pedicellate and diamond-shaped, or less often clavate or ovoid. The fruits are pedicellate and mostly obconical.

The species described here as *E. bunyip* was first brought to my attention by the late John Reid and Neville Walsh, both of MEL, whose survey work in the Bunyip State Park led them to regard it as a distinctive entity. Subsequent field studies and progeny trials endorsed their initial assessment and, thus, it is described here as a new species within the Series *Foveolatae*.

### *Eucalyptus bunyip* Rule sp. nov.

*Eucalypto strzeleckii affinis habitu elatiore graciliore, foliis juvenilibus minoribus, foliis mediis persistentibus, pedunculo delicato longiore, alabastris minoribus, pedicellis longioribus, fructibus subcampanulatis minoribus differt.*

**Type:** Victoria: Camp Road, Bunyip State Park, on the southern side of the creek crossing; 37° 59' 07" S., 145° 38' 30" E., K. Rule 10507, 5.vi.2007. HOLO: MEL; ISO: AD, CANB, NSW.

*Trees* slender, erect, to c. 40 m tall. *Bark* smooth, whitish to light brown, becoming yellow-orange in spring; a short, compact, corky dark grey stocking present at the base. *Seedling leaves* ovate, at first sessile, becoming shortly petiolate, slightly lustrous and green above, pale green below. *Juvenile leaves* elliptical, ovate or ovate-lanceolate, petiolate, apiculate, disjunct, discolorous, green to blue-green, sub-lustrous above, whitish below, 4–6 cm long, 1.6–3 cm wide; margins entire; nodes relatively remote; petioles 1–2 cm long. *Intermediate leaves* broadly elliptical or broadly-ovate, rarely obovate, dull or sub-lustrous, slightly discolorous or concolorous, blue-green, to 8 cm long, 5.5 cm wide, persisting in large numbers in the mature canopy. *Coppice leaves* with lightly glaucous growth tips. *Adult leaves* ovate, ovate-lanceolate or broadly lanceolate, slightly coriaceous, acuminate, undulate, concolorous, densely reticulate, sub-lustrous or lustrous, green, 10–17 cm long, 1.8–3.2 cm wide; nodes relatively remote; petioles 1.8–3.2 cm long; intramarginal vein 2–3 mm from margin; oil



## Key to the Swamp gums

- 1 Adult leaves dull, blue-green to glaucous ..... *E. cadens*
- 1: Adult leaves sub-lustrous or lustrous, green or slightly blue-green ..... 2
- 2 Rough, box-like bark persistent to at least major branches ..... 3
- 2: Rough bark, if present, extending only to mid-trunk ..... 5
- 3 Adult leaves ovate, to 3 cm wide ..... *E. yarraensis*
- 3: Adult leaves narrowly lanceolate or lanceolate, to 2 cm wide ..... 4
- 4 Intramarginal vein remote (to 3 mm from margin); peduncles to 4 mm long ..... *E. oggregoto*
- 4: Intramarginal vein close to margin (c. 1 mm from margin); peduncles 5–8 mm long ..... *E. rodwayi*
- 5 Fruits 9–12 mm long, 9–12 mm diam ..... *E. ovoto* var. *grandifloro*
- 5: Fruits 4–8 mm long, 4–8 mm diam ..... 6
- 6 Oil glands sparse or apparently absent from adult leaves ..... *E. ovoto* var. *ovata*
- 6: Adult leaves abundantly glandular ..... 7
- 7 Juvenile leaves crenulate; adult leaves discolorous ..... *E. brookeriona*
- 7: Juvenile leaves with entire margins; adult leaves concolorous ..... 8
- 8 Mallees or small, slender trees ..... 9
- 8: Robust, umbrageous trees or medium to tall upright trees ..... 12
- 9 Adult leaves lanceolate; fruits more or less cupular ..... *E. borberi*
- 9: Adult leaves ovate or sub-orbicular; fruits obconical ..... 10
- 10 Petioles of adult leaves > 2 cm long ..... *E. comphoro* subsp. *relictio*
- 10: Petioles of adult leaves to 2 cm long ..... 11
- 11 Juvenile leaves to 5 cm long, 3 cm wide; petioles of juvenile leaves to 5 mm long;  
petioles of adult leaves < 1 cm long ..... *E. oquotic*
- 11: Juvenile leaves to 11 cm long, 5 cm wide; petioles of juvenile leaves > 2 cm long;  
petioles of adult leaves 1–2 cm long ..... *E. comphoro* subsp. *camphoro*
- 12 Habit often an umbrageous tree, to 20 m tall; new season's growth tips non-pruinose;  
juvenile leaves to 8 cm wide ..... *E. comphoro* subsp. *humeono*
- 12: Erect trees to 40 m tall; new season's growth tips pruinose; juvenile leaves to 4 cm wide ..... 13
- 13 Mature canopy a mixture of broadly ovate intermediate leaves and ovate or broadly  
lanceolate adult leaves; pedicels equal to or longer than fruits; fruits 4–5 mm diam ..... *E. bunyip*
- 13: Mature canopy composed of ovate adult leaves; pedicels shorter than fruits; fruits 4–8 mm diam ..... *E. strzeleckii*

glands numerous, regular, island; new season's growth tips glaucous. *Inflorescences* simple, axillary, 7-flowered; peduncles slender and delicate, terete or angular, 9–14 mm long, c.1 mm thick, thickening slightly and contracting when bearing mature fruits. *Floral buds* clavate or slightly diamond-shaped, pedicellate, scarred, often faintly pruinose in early development, 7–9 (–10) mm long, 2.5–3.5 mm wide; pedicels slender, as long as buds or to 1.2 times longer; hypanthium tapered; operculum shortly rostrate, equal to or longer than the hypanthium; locules 3 or 4; ovules in 4 vertical rows; stamens irregularly flexed, all fertile; filaments white; anthers dorsifixed, versatile, oblong, dehiscing through longitudinal slits. *Fruits* sub-campanulate, distinctly pedicellate, 5–6 mm long, 4–5 mm diam; pedicels delicate and slender, longer than fruits, 6–10 mm long; disc slightly elevated and rolled; valves usually slightly exerted. *Fertile seeds* dark grey, elongated, flattened, finely pitted; hilum ventral (Fig. 2).

**Flowering Period:** Autumn.

**Distribution and Habitat:** *Eucalyptus bunyip* occurs in the narrow valleys of the Diamond and Black Snake creeks in the Bunyip State Park approximately 60 km to the east of Melbourne. Its habitat is highly specific, being along the narrow valley floors which are subject to seasonal inundation and prolonged impeded drainage. The mean annual rainfall of the catchment which feeds both the creeks exceeds 1200 mm (Fig. 1).

**Additional specimens examined:** VICTORIA: Bunyip State Park, 30 m S of Gembrook-Tonimbuc Road, 0.9 km E of Camp Road intersection, *J.C. Reid 2195*, 13.xi.1996 (MEL2109207); 100 m in a north-westerly direction from the intersection of the Black Snake Creek Road and Towt Road, *K. Rule 10707*, 5.vi.2007 (MEL); Tonimbuc Road, 3.8 km from Tonimbuc Hall towards Gembrook, *K. Rule, 10307*, 5.vi.2007 (MEL); Dyers Picnic Ground, Black Snake Creek Road, *K. Rule 10607*, 5.vi.2007 (MEL).

**Associated Species:** *E. bunyip* grows in pure stands and abuts forests of *E. cypellocarpa* L.A.S.Johnson,



**Figure 2.** *Eucalyptus bunyip* (a) tree; (b) adult leaf; (c) seedling; (d) buds and fruits.



*E. obliqua* L'Her. and a tallish form of *E. ignorabilis* L.A.S.Johnson & K.D.Hill which is currently under study. Other species occurring in the vicinity include *E. dives* Schauer, *E. cephalocarpa* Blakely, *E. radiata* Sieber ex DC. subsp. *radiata*, *E. fulgens* Rule, *E. ovata* var. *ovata*, *E. viminalis* subsp. *viminalis*, and *E. sieberi* L.A.S.Johnson.

**Conservation Status:** *Eucalyptus bunyip* has a distribution spread along several linear kilometres and entirely within a protected reserve, the Bunyip State Park, where an estimated 4000 mature trees exist. According to IUCN criteria (IUCN 2001) a recommended status for the species is 'vulnerable' (VU).

**Etymology:** The epithet, of Aboriginal origin, is used as a noun in apposition and refers to the Bunyip State Park, the locality to which the species is restricted.

**Discussion:** *Eucalyptus bunyip* is distinguished within the swamp gums by its tallish, slender habit, smooth bark with a short stocking that is compact and corky, its sub-lustrous green to blue-green, elliptical, ovate or ovate-lanceolate juvenile leaves, its relatively broad, blue-green intermediate leaves, which persist in the inner canopy of mature trees, its abundantly glandular, relatively narrow adult leaves, its lightly pruinose immature buds and growth tips, its relatively long, slender peduncles, its small, clavate to diamond-shaped buds with a rostrate operculum and long, slender pedicels and its small, sub-campanulate fruits. The species is regarded as being a part of a narrow complex within the swamp gums comprising *E. camphora* (and its subspecies) and *E. strzeleckii*, whose features include

**Table 1.** Comparisons between *E. bunyip* and related species.

Characters	<i>E. strzeleckii</i>	<i>E. camphora</i> subsp. <i>humeana</i>	<i>E. bunyip</i>
<b>Habit</b>	erect, robust trees to 40 m tall	usually umbrageous trees to 20 m tall	slender trees to 40 m tall
<b>Bark</b>	smooth	smooth with a box-like basal stocking often extending to mid-trunk	smooth with a short, compact, corky basal stocking
<b>Juvenile Leaves</b>			
Shape	lanceolate, ovate or ovate-lanceolate	broadly ovate to orbicular, often emarginate	elliptical, ovate or ovate-lanceolate
Size	5–8 cm long, 1.6–4 cm wide	4–8 cm long, 4–8 cm wide	4–6 cm long, 1.6–3 cm wide
Colour, lustre	green to blue-green, sub-lustrous	sub-glaucous, dull	green to blue-green, sub-lustrous
<b>Adult leaves</b>			
Shape	ovate	broadly ovate to sub-orbicular	broadly lanceolate to ovate
Size	8–20 cm long, 1.5–3 cm wide	8–15 cm long, 2.8–6.4 cm wide	10–17 cm long, 1.8–3.2 cm wide
Petiole length	1.6–3 cm long	2.2–4 cm long	1.8–3.2 cm long
Growth tips	pruinose	non-pruinose	pruinose
<b>Canopy composition</b>	adult leaves	adult leaves	inner canopy of intermediate leaves, outer canopy of adult leaves
<b>Peduncle length</b>	7–14 mm long	10–18 mm long	9–14 mm long
<b>Buds</b>			
Shape	ovoid or slightly diamond	diamond	clavate or slightly diamond
Size	5–8 mm long, 3–5 mm diam	5–7 mm long, 3–4 mm diam	7–10 mm long, c. 3 mm diam
Pedicel length	3–5 mm long	3–5 mm long	7–12 long
Operculum shape	shortly rostrate	conical	shortly rostrate
<b>Fruits</b>			
Size	4–6 mm long, 5–8 mm diam	4–6 mm long, 4–6 mm diam	5–6 mm long, 4–5 diam
Shape	obconical to sub-campanulate	obconical	sub-campanulate
Pedicel length	2–4 mm long	2–4 mm long	6–10 mm long

adult leaves that possess an abundance of island glands. *Eucalyptus strzeleckii* is considered to be its closest relative, but it also shares features with *E. camphora* subsp. *humeana*. Both of these taxa occur in the same region as *E. bunyip* (Table 1).

*Eucalyptus strzeleckii* has a more extensive distribution than *E. bunyip*, occurring in south and west Gippsland and in the western part of the Otway Ranges. Like *E. bunyip*, its growth tips are pruinose during the spring growing period, it has similar juvenile leaves (except those of *E. strzeleckii* are longer), abundantly glandular adult leaves and similar shaped fruits. However, it differs from *E. bunyip* by its preference for deep, fertile, intermittently wet soils in a variety of sites, including river banks, valley floors and slopes, rather than sites of constantly impeded drainage preferred by *E. bunyip*. It also differs by its more robust habit with a stout trunk and branches, the absence of the short stocking of compact, corky bark, its mature canopy consisting entirely of ovate-lanceolate or ovate adult leaves, its shorter peduncles, its broader, more or less ovoid buds with shorter pedicels and its generally larger fruits with shorter pedicels.

*Eucalyptus camphora* subsp. *humeana*, also a relative of *E. bunyip*, is a widespread swamp gum occurring along more or less elevated water courses of north-east Victoria and adjacent areas of New South Wales. It is less common in central and east Gippsland, but abundant in the Yarra Valley which is about 20 km to the north-west of the western-most population of *E. bunyip*. Prior to this study *E. bunyip* had been regarded by local observers as a forest form of *E. camphora*. The confusion between the two was understandable as the mature canopies of both contain relatively broad, richly glandular leaves and have similar sized buds and fruits. However, the mature canopy of *E. camphora* subsp. *humeana* consists entirely of broadly ovate or sub-orbicular adult leaves, whereas *E. bunyip* contains relatively broad intermediate leaves in the inner canopy and much narrower ovate or broadly lanceolate adult leaves at the ends of its branchlets. *Eucalyptus camphora* subsp. *humeana* further differs by its smaller, usually umbrageous habit (to 20 m tall), its often substantial stocking of persistent, compact, box-like bark, its larger, broadly ovate or orbicular, dull, bluish juvenile leaves, its broader, distinctly pendulous adult leaves borne on longer petioles, its non-pruinose buds and new season's growth tips and its obconical fruits borne on shorter, less delicate pedicels.

### Series *Acaciiformes* (Scentbark Complex)

The first descriptions for scentbarks, Series *Acaciiformes* Maiden, were for two species occurring in the New England region of New South Wales. They were for *E. acaciiformis* H.Deane & Maiden (1899) and *E. nicholii* Maiden & Blakely (1929). *E. aromaphloia* L.D.Pryor & J.H.Willis (1954) was described to accommodate populations in central Victoria and *E. corticosa* L.A.S.Johnson (1962) for populations near Rylstone to the north-west of Sydney and in the Grampians Ranges of western Victoria. In 1971 Pryor and Johnson, placed *E. corticosa*, under *E. aromaphloia*. It was not until 1989 that a study by Chappill *et al.* (1986) resurrected *E. corticosa* and identified three morphological and geographical forms within the populations which had been long-regarded as *E. aromaphloia* (as well as the typical form, forms for eastern Victoria and adjacent areas of New South Wales and for the Victorian Wimmera region). *Eucalyptus ignorabilis* L.A.S.Johnson & K.D.Hill was described in 1991 and *E. splendens* Rule (occurrences to the north-west of Portland), *E. sabulosa* Rule (populations in the Little Desert of the Wimmera region and the Grampians) and *E. fulgens* Rule (populations in west Gippsland) were described in 1996. In the case of *E. sabulosa*, Brooker and Slee (1996) redefined it as a subspecies within *E. aromaphloia* but Nicolle (2006) regarded it a distinct species. *E. arcana* (D.Nicolle & Brooker) Rule (restricted to the Carpenter Rocks area of Lower south-east South Australia) was first described as a subspecies of *E. splendens* in 2000 but was elevated to a species in 2009. The classification of both *E. splendens* and *E. arcana* have been somewhat controversial. Both were placed within the Series *Viminalis* adjacent to *E. viminalis*, the former by Brooker and Slee (1997), and the latter by Nicolle and Brooker (1998), but Nicolle (2006) regarded them as a part of the Series *Acaciiformes*. On the basis of their seedling ontogeny being consistent with members of the Series *Acaciiformes*, despite being lustrous and green as in *E. viminalis*, they are regarded here as allies of that series and thus are included in the key provided. In more recent times further studies have shown that the small but scattered population of scentbarks occurring in the Fryers Range near Castlemaine in central Victoria is sufficiently unique to be regarded as a separate species. These populations are treated here as *E. conferta*.



**Key for Scentbarks (Series *Acaciiformes*)**

- 1 Small, straggly trees with mature stems <20 cm diam; fruits tightly sessile ..... *E. arcana*
- 1: Robust trees with mature stems >50 cm diam; fruits pedicellate ..... 2
- 2 Juvenile leaves lustrous and green; seedling stems square in cross-section and winged ..... *E. splendens*
- 2: Juvenile leaves dull, pale green, blue or glaucous; seedling stems neither square in cross-section nor winged ..... 3
- 3 Juvenile leaves narrow (linear, narrow-elliptical, linear-lanceolate or narrow-lanceolate), <1 cm wide ..... 4
- 3: Juvenile leaves broad (elliptical, elliptical-ovate or elliptical-lanceolate), 1.5–3 cm wide ..... 7
- 4 Juvenile leaves pale green; seedling growth tips lustrous and green ..... *E. sabulosa*
- 4: Juvenile leaves blue-green or glaucous; seedling growth tips dull, blue-green or glaucous ..... 5
- 5 Adult leaves to 1 cm wide; fruits with a flat disc ..... *E. nichalii*
- 5: Adult leaves to c. 2 cm wide; fruits with an ascending disc ..... 6
- 6 Juvenile leaves linear, falcate, crenulate; fruits 3–4 mm diam ..... *E. conferta*
- 6: Juvenile leaves linear-lanceolate or narrowly lanceolate; fruits 4–6 mm diam ..... *E. corticosa*
- 7 Outer rough bark dark brown; adult leaves lustrous and green; new season's growth tips bright green ..... *E. fulgens*
- 7: Outer rough bark light grey; adult leaves dull or sub-lustrous, blue-green or grey-green;  
new season's growth tips blue-green to glaucous ..... 8
- 8 Fruits hemispherical or slightly obconical; disc flat ..... *E. acaciiformis*
- 8: Fruits ovoid or sub-globular; disc ascending ..... 9
- 9 Adult leaves sub-lustrous, blue-green; fruits with short, thick pedicels ..... *E. aromaphloia*
- 9: Adult leaves dull, blue-grey; fruits with slender pedicels (often as long as fruits) ..... *E. ignarabilis*

The adult features of taxa within the Series *Acaciiformes* show only subtle differences in bark textures, adult leaves (size, colour, lustre and oil gland density), and fruits (shape and size and pedicel length and thickness), which might suggest to some observers that some entities, particularly those occurring in Victoria, would be better placed as subspecies within *E. aromaphloia*. However, to the contrary, progeny studies have shown that the juvenile leaves of each contribute significantly to its distinctiveness; glaucous, elliptical to ovate in *E. aromaphloia*, sub-glaucous or glaucous, elliptical-lanceolate to narrow-ovate and falcate in *E. ignarabilis*, pale green, lanceolate to narrow-ovate, often falcate in *E. fulgens*, pale green, linear-elliptical and falcate in *E. sabulosa*, lustrous, green, lanceolate or ovate-lanceolate in *E. splendens*, lustrous, green, broadly ovate in *E. arcana*, sub-glaucous, elliptical in *E. acaciiformis*,

sub-glaucous, linear in *E. nichalii*, sub-glaucous, linear-lanceolate in *E. corticosa* and glaucous, linear and falcate in *E. conferta*.

***Eucalyptus conferta* Rule sp. nov.**

*Eucalypto aromaphloiae affinis habitu minore, foliis juvenilibus angusto-falcatis subcrenatis confertis, foliis adultis minoribus, pedunculo delicato, fructibus minoribus differt.*

**Type:** Victoria: Fryers Range, Vaughan Springs Road, c 700 m S of intersection with Green Gully Road, 37°12'53" S., 144°14'32" E., *K. Rule 0210*, 7.iv.2010. HOLO: MEL; ISO: AD, CANB, NSW.

Smallish, slender trees, to c. 15 m tall. Bark grey-brown or light brown, sub-fibrous, persistent to the upper trunk, longitudinally furrowed, often loosely attached



in short strips; bark on the lower trunk usually thick, moderately furrowed, crusty; inner bark light brown; upper bark decortivating in short ribbons; branches smooth, whitish to pale brown. *Seedling leaves* elliptical, sub-sessile, blue-green, discoloured; lower surface white. *Juvenile leaves* linear, moderately to markedly falcate, moderately crenulate, apiculate, sessile and opposite, becoming shortly petiolate, disjunct, crowded along the stem (not ericoid), slightly discoloured, dull, glaucous, 4–8 cm long, 0.5–0.9 cm wide; petioles 0–5 mm long; growth tips lightly pruinose. *Intermediate leaves* narrow-lanceolate or slightly ovate, often falcate,

crowded, petiolate, crenulate, slightly discoloured to concolorous, dull, blue-green to glaucous. *Adult leaves* narrow-lanceolate or lanceolate, sometimes falcate, acuminate, moderately reticulate, dull, blue-green or pale green, thin (0.18–0.27 mm thick), 7–11(–13) cm long, 1.2–1.8 cm wide; petioles 1.2–1.8 cm long; intramarginal vein <2 mm from margin; oil glands regular, numerous, mostly island; new season's growth tips light green to sub-glaucous. *Inflorescences* simple, axillary, 7-flowered; peduncles slender, slightly angular, 7–11 mm long. *Floral buds* ovoid, pedicellate scarred, 6–7 mm long, 2–3 mm wide; pedicels slender,



**Figure 3.** *Eucalyptus conferta* (a) foliage; (b) trunk with coppice leaves; (c) seedling; (d) buds; (e) fruits.



2–5 mm long; operculum conical, as wide as hypanthium, 3–4 mm long; stamens irregularly flexed, all fertile; filaments white; anthers dorsifixed, oblong-cuneate, versatile, dehiscing through longitudinal slits; locules 3 or 4; ovules in 4 vertical rows. *Fruits* slightly obconical to sub-globoid, pedicellate, 3–4 mm long, 3–4 mm wide; pedicels, slender, 1–3 mm long; disc ascending; valves slightly exerted. *Fertile seeds* black, irregularly oblong, flattened, lacunose; hilum ventral (Fig. 3).

**Flowering Period:** Autumn.

**Distribution and Habitat:** The new taxon is restricted to the Glenluce State Forest in the Fryers Range, about 17 km to the south of Chewton (Fig. 1). The population is disjunct from other scentbarks, particularly *E. aromaphloia*, which is known to occur approximately 20 km to the south in the Daylesford area. The species occurs on hilly terrain and favours dry, shallow skeletal soils that are sedimentary in origin. It is possible that other stands of the taxon occur on similar sites in the district. The mean annual rainfall of nearby Castlemaine is approximately 550 mm, most of which falls in winter.

**Additional specimens examined:** VICTORIA: c. 5 km SE of Vaughan, 0.5 km S of Sebastopol Ck., 10 m E of road on Crown land, *B. Kemp s.n.*, 11.v.1986 (MEL686536); Fryers Range, Vaughan Springs Road c. 100 m N of intersection with Green Gully Road, *K. Rule 11007*, 25.vi.2007 (MEL); Fryers Range, Vaughan Springs Road, at the end of the bitumen, *K. Rule 11207*, 25.vi.2007 (MEL); Fryers Range, Green Gully Road, 700 m from Vaughan Springs Road, *K. Rule 11407*, 25.vi.2007 (MEL); Fryers Range, Green Gully Road, 1.1 km from Vaughan Springs Road, *K. Rule 11507*, 25.vi.2007 (MEL).

**Associated Species:** *Eucalyptus dives*, *E. nortonii* (Blakely) L.A.S. Johnson, *E. melliodora* A. Cunn. ex Schauer, *E. polyanthemos* Schauer subsp. *vestita* L.A.S. Johnson & K.D. Hill, *E. macrorhyncha* F. Muell. ex Benth. and *E. obliqua* all occur within the range of *E. conferta*.

**Etymology:** The name is from the Latin *confertus* 'crowded' in reference to the numerous pairs of leaves occurring along the axis in the juvenile and intermediate stages of development.

**Conservation Status:** The number of mature trees of *E. conferta* is estimated to be between 400 and 500. Even though they occur in a state forest, which has no apparent value for timber extraction, its long-term security is not guaranteed. In accordance with IUCN criteria (IUCN 2001) a status of 'vulnerable' (VU) is suggested.

**Discussion:** *Eucalyptus conferta* is distinctive by its smallish, sometimes spindly habit, its often loosely

attached, usually crusty lower bark, its linear, falcate, glaucous, crenulate juvenile leaves, which become crowded in the advanced seedling stage, its smallish, thin, dull, blue-green to sub-glaucous adult leaves, its delicate peduncles and its small buds and small, sub-globular fruits that are borne on short, delicate pedicels.

*Eucalyptus conferta* is regarded as being closely related to *E. aromaphloia* which differs by its generally larger habit (stout-trunked, spreading trees), its thicker, more deeply furrowed bark, its broader, ovate to elliptical, non-falcate, non-crenulate, less crowded juvenile leaves, its more glossy, thicker, larger adult leaves, its generally shorter peduncles, its generally thicker, shorter pedicels and its larger buds and fruits (Table 2).

The narrow juvenile leaves of *E. conferta* resemble those of *E. nicholii*, a species from northern New South Wales, as do its delicate peduncles and pedicels. However, the appearance of its canopy differs from that species by its generally broader adult leaves. Further, the fruits of *E. conferta* are generally larger and more globoid than those of *E. nicholii* and have a shape similar to other southern scentbarks including *E. aromaphloia*, *E. sabulosa*, *E. ignorabilis* and *E. fulgens*. Similarly, it shares features with *E. corticosa*, namely its general appearance, particularly its mature canopy and its delicate peduncles and pedicels. However, *E. corticosa* differs from the new species by its broader, non-falcate, non-crenulate, less crowded juvenile leaves and its larger buds and fruits.

### Series *Globulares* (Mountain Grey Gum Complex)

In recent years several taxa regarded as mountain grey gums have been described. The complex features medium to tall or less often small trees, smooth bark or box-type bark on the lower trunk, seedling stems usually square in cross-section and sometimes winged, juvenile leaves usually opposite, sessile and amplexicaul for numerous pairs, green and glossy or glaucous in one species, long, glossy and green adult leaves, long, strap-like peduncles, pedicellate, usually cigar-shaped buds that are waisted at the mid-point and elongated fruits with the valves enclosed. This group is closely related to the long-leaf boxes (*E. goniocalyx* F. Muell. ex Miq. and its allies) which usually feature species with smaller habits, box-type bark over most of the trunk, orbicular, usually glaucous juvenile leaves, generally shorter adult leaves, shorter peduncles and mostly sessile buds and fruits.

Table 2. Comparisons between *E. conferto* and *E. oromophloio*

Characters	<i>E. aromophloio</i>	<i>E. conferto</i>
<b>Habit</b>	umbrageous tree to 25 m tall	slender tree to 15 m tall
<b>Bark</b>	sub-fibrous, thick, deeply furrowed	sub-fibrous, moderately furrowed
<b>Juvenile leaves</b>		
Size	2–6 cm long, 1–4 cm wide	4–8 cm long, 0.5–0.9 cm wide
Shape	elliptical to ovate	linear, falcate
Colour	glaucous	glaucous
Margins	entire	moderately crenulate
Density along the axis	not crowded	crowded
<b>Adult leaves</b>		
Shape	lanceolate	lanceolate
Size	8–18 cm long, 1–2.5 cm wide	7–13 cm long, 1.2–1.8 cm wide
Petiole length	1.2–2.2 mm	1.2–1.8 mm
Colour, lustre	blue-green, sub-lustrous	blue-green or pale green, dull
Thickness	0.24–0.39 mm	0.18–0.27 mm
<b>Peduncle</b>		
Length	4–9 mm	7–11 mm
<b>Buds</b>		
Size	4–7 mm long, 3 mm diam	3–5 mm long, 2–3 mm diam
Pediceal length	1–3 mm long	2–5 mm long
<b>Fruits</b>		
Shape	hemispherical to sub-globular	sub-globular
Size	4–7 mm long, 4–7 mm diam	3–4 mm long, 3–4 mm diam
Pediceal length	0–2 mm long	1–3 mm long

The name *E. goniocalyx* was previously incorrectly applied to tall forest trees which were named *E. cytellocarpa* in 1962. Until recently all known populations of mountain grey gums occurring in coastal and sub-coastal regions from northern New South Wales to western Victoria, were included with *E. cytellocarpa*. *Eucalyptus alaticaulis* R.J.Watson & Ladiges (1987) was described to cater for populations occurring in the Grampians Ranges of western Victoria and near Anglesea to the south-west of Melbourne. *Eucalyptus retinens* L.A.S.Johnson & K.D.Hill, *E. volcanica* L.A.S.Johnson & K.D.Hill (both 1990), *E. oresbia* J.T.Hunter & J.J.Bruhl and *E. quinniorum* J.T.Hunter & J.J.Bruhl (both 1999) are names applied to mountain grey gums occurring in northern New South Wales. *Eucalyptus litoralis* Rule was described to accommodate the Anglesea 'form' of *E. alaticaulis* and *E. pyrenea* Rule to cater for the disjunct occurrences of mountain grey gums on Mt Avoca in the Pyrenees Range of west-central Victoria (Rule 2004).

The mountain grey gum complex has been marked by controversy as there is no consensus regarding the acceptance of several of the taxa. In fact, Brooker and Slee (1997) did not accept *E. alaticaulis* and Brooker and Kleinig (2006) rejected *E. retinens*, *E. oresbia*, *E. quinniorum* and *E. pyrenea* as distinct taxa, all of which were regarded as synonymous with *E. cytellocarpa*. Nicolle (2006) chose to accept *E. alaticaulis* as a distinct taxon, but regarded *E. pyrenea* as a form of that species. He further regarded *E. oresbia* and *E. quinniorum* as forms of *E. cytellocarpa*. On the other hand, Hill (2002) accepted all taxa occurring in New South Wales whilst all Victorian taxa, including *E. alaticaulis* and *E. pyrenea*, were accepted by Walsh and Stajsic (2007). Obviously, a formal revision of the complex is required to eliminate this controversy. At this point, however, all taxa listed above are accepted and included in the key.

An additional taxon, which has long been regarded as a form of *E. goniocalyx*, is not only treated here as a new



## Key to the Mountain Grey Gums

1 Juvenile leaves lanceolate (narrow to broad).....	2
1: Juvenile leaves elliptical or ovate to orbicular.....	3
2 Mallees or rarely small, single-stemmed trees to 16 m tall; buds with operculum wider than hypanthium.....	<i>E. quinniorum</i>
2: Single-stemmed trees to 60 m tall; buds with operculum narrower than or as wide as the hypanthium.....	<i>E. cypellacarpa</i>
3 Bark smooth throughout; buds not waisted at the mid-point.....	<i>E. aresbia</i>
3: Rough bark persistent on lower trunk or higher; buds waisted at the mid-point.....	4
4 Juvenile leaves glaucous.....	<i>E. valcanica</i>
4: Juvenile leaves green or blue-green.....	5
5 Seedling stems without prominent wings.....	6
5: Seedling stems prominently winged.....	7
6 Longest adult leaves to 29 cm long.....	<i>E. carolaniae</i>
6: Longest adult leaves to 18 cm long.....	<i>E. retinens</i>
7 Fruits 5–6 mm diam.....	<i>E. pyrenea</i>
7: Fruits 7–11 mm diam.....	8
8 Operculum 4–8 mm long; fruits 9–13 mm long, 8–11 mm diam.....	<i>E. litaralis</i>
8: Operculum 3–4 mm long; fruits 6–10 mm long, 6–9 mm diam.....	<i>E. alaticaulis</i>

species, but is regarded as belonging to the mountain grey gum complex on the basis of both seedling and adult characters. It occurs on the Mornington Peninsula to the south-east of Melbourne and was first brought to my attention in the early 1990s by the late Ms. Pat Carolan, after whom it is named.

*Eucalyptus carolaniae* Rule sp. nov.

*Eucalypto cypellocarphae affinis habitu minore, cortice persistenti buxiformi, foliis juvenilibus latoribus griseo-  
viridibus, foliis adultis majoribus, fructibus sessilibus vel subsessilibus differt.*

**Type:** Victoria: Norfolk-Hopetoun Reserve, Mt Martha, 38°16' S. 145°01' E, *P Carolan s.n.*, 9.vi.1989. HOLO: MEL (3 sheets: MEL 117392, MEL 117393, MEL 117394).

Small-medium, robust, often spreading trees to 20 m tall. Bark sub-fibrous, box-like, grey-brown, deeply furrowed, often crusty, persisting on lower trunk or higher, graduating to thin, finely furrowed bark above; branches usually smooth, pale grey-brown; old bark

decorticating in ribbons. Seedling leaves broadly ovate, discolorous, pale green, sub-lustrous on the upper surface, whitish on the lower surface. Seedling stems initially square in cross section, becoming round by the 6<sup>th</sup> node. Juvenile leaves broadly ovate to broadly elliptical or sub-orbicular, opposite, sessile, amplexicaul for numerous pairs, apiculate, discolorous, lustrous and light green, becoming dull or sub-lustrous and blue-green with age, 6–10 cm long, 4–7 cm wide; growth tips faintly glaucous throughout the seedling stage. Intermediate leaves broadly ovate or ovate-lanceolate, shortly petiolate, disjunct, lustrous, green to blue-green, longer than juvenile leaves. Adult leaves lanceolate, falcate, pendulous, acuminate, concolorous, lustrous, green, 16–29 cm long, 2–4 cm wide; petioles 1.7–3.2 cm long; venation conspicuous, moderately dense; intramarginal vein remote, 3–5 mm from the margin; glands regular, scattered, island and intersectional. Inflorescences simple, axillary, 7-flowered; peduncles flattened, thickening with age, 12–20 mm long, 3–4 mm wide. Floral buds ovoid-cylindrical, waisted at

mid-point, scarred (outer operculum shed in early bud development), ribbed, shortly pedicellate, 7–10 mm long, 3–5 mm wide; pedicels 1–3 mm long; operculum sharply conical 3–4 mm long, flush with the hypanthium at the abscission zone; stamens inflexed; filaments white, all fertile; anthers oblong, sub-basifixed, versatile, dehiscent through longitudinal slits; locules (3–) 4, each with 4 ovular rows. *Fruits* cupular, sub-cylindrical or slightly obconical, basally-tapered, sessile or subsessile, moderately or prominently ribbed, thin-walled,

8–11 mm long, 6–9 mm diam, pedicels 0–2 mm long; disc descending; valves (3–) 4, enclosed. *Fertile seeds* dark brown or black, flattened, ovoid, 2–3 mm long, tapered at one end, lacunose; hilum ventral (Fig. 4).

**Flowering Period:** Summer.

**Distribution and Habitat:** The new taxon is known only from a single population located above Mt Martha township on the Mornington Peninsula approximately 60 km south-south-east of Melbourne (Fig. 1). It grows along a sheltered gully in deep soils derived from granite.



**Figure 4.** *Eucalyptus carolaniae* (a, b) trees; (c) bark; (d) juvenile leaves; (e) fruits.



The mean annual rainfall of the area is approximately 650 mm, most of which falls in winter.

**Additional specimens examined:** VICTORIA: Norfolk–Hopetoun Reserve, Mt Martha, K. Rule 0201, 20.i.2001 (MEL); Mt Martha Golf Course, K. Rule 0252, 15.v.2002 (AD, CANB, MEL, NSW).

**Associated Species:** *Eucalyptus radiata* subsp. *radiata*, *E. viminalis* subsp. *viminalis* and *E. ovata* var. *ovata* are sympatric with *E. carolanae*, whilst *E. obliqua*, and *E. pauciflora* Sieber ex Spreng. subsp. *pauciflora* occur in the vicinity. Hybrids with *E. viminalis* have been observed in the field.

**Etymology:** The epithet honours the late Ms Pat Carolan who collected the type specimen of the new taxon and who first brought the existence of the population to my attention. She is further recognised for her contributions to the understanding of Victoria's eucalypts, having been an enthusiastic collector and having lodged numerous specimens with MEL.

**Conservation Status:** An ecological study by Picone and McCaffrey (2006) estimated the population of *E. carolanae* as approximately 500 naturally occurring trees and saplings, nearly all of which occur along a linear strip of bushland forming the Norfolk–Hopetoun Reserve and extending on to a section of the lower extremity of the Mt Martha Golf Course. A large proportion of the population is sandwiched along a narrow easement between housing blocks between Norfolk and Hopetoun Roads. The habitat until recently has been infested with blackberries and other weeds. Its close proximity to the golf course and houses remains a concern as the long term impact of changes to nutrient levels and to drainage patterns is unknown. A revegetation program has reintroduced several hundred seedlings to an area of the golf course which abuts naturally occurring trees. The reserve and the golf course, which are managed by the Mornington Shire Council, offer some protection to the species. As the taxon's numbers are critically low and there are threats from changes to drainage patterns and nutrient levels, in accordance with IUCN criteria (IUCN 2001) a status of 'endangered' (EN) is considered appropriate.

**Discussion:** The combination of features which distinguish *E. carolanae* are its relatively small habit, its rough, box-type bark which usually extends to the upper trunk and sometimes to the major branches, its seedling stems that are square in cross-section in early

seedling development, its juvenile leaves that are ovate to broadly elliptical or sub-orbicular and initially lustrous and light green but become dull and blue-green with age, its large adult leaves, its long, flattened peduncles, its shortly pedicellate, cigar-shaped buds and its basally-tapered, sessile or sub-sessile, thin-walled fruits.

*Eucalyptus carolanae* shares features with both *E. cypellocarpa* and *E. goniocalyx* which may raise the possibility that it is derived from hybrid stock. Initially the proposition of hybridism had some merit as the adult trees exhibit slight variation in the amount of persistent rough bark on the trunk. Despite this, other adult features within the population are uniform and repeated seedling trials have consistently produced uniform seedlings, all of which supports *E. carolanae* as a true-breeding, distinct species (Table 3).

*Eucalyptus cypellocarpa* differs from *E. carolanae* by its taller, straighter habit, its smooth bark, except for strips and plates of old bark often remaining attached to the base or lower trunk, its more lustrous, greener, narrower (lanceolate) juvenile leaves, its generally shorter, narrower adult leaves and its consistently pedicellate buds and fruits.

*Eucalyptus carolanae* resembles *E. goniocalyx* in habit and bark and the type specimens were initially held under that name at MEL. However, it is here regarded as being a part of the mountain grey gum complex and closely related to *E. cypellocarpa*. It differs from *E. goniocalyx* by its seedling stems being initially square in cross-section in early seedling development (stems round in cross-section in *E. goniocalyx*), its broadly ovate to broadly elliptical, apiculate juvenile leaves (seedlings with some orbicular and emarginate juvenile leaves in *E. goniocalyx*), its longer adult leaves, its longer peduncles, its shortly pedicellate buds and its consistently basally-tapered fruits.

### Series *Buxaeles* (The Mallee-boxes)

A new box species, *E. yarriambiack*, is described below. It has close affinities with several other box species, some of which, until recently, had been referred to as mallee-boxes and placed in the Series *Subbuxaeles* Blakely (1934) by various commentators, for example, Chippendale (1988), Brooker and Slee (1997), Nicolle (2000) and Rule (2004). Such species include *E. odorata* Behr, *E. polybractea* R.T.Baker, *E. viridis* R.T.Baker,



**Table 3.** Comparisons between *E. carolanae* and related species. Included in the key are references to various subspecies of *E. goniocalyx*, three of which were described by Rule (2011).

Characters	<i>E. goniocalyx</i>	<i>E. cypellocarpa</i>	<i>E. carolanae</i>
<b>Habit</b>	single or few-stemmed trees to 15 m tall or mallees in subsp. <i>exposa</i> , to 25 m in subsp. <i>fallax</i>	trees to 60 m tall	single or few-stemmed trees to 20 m tall
<b>Bark</b>	box-type to minor branches or smooth in subsp. <i>exposa</i> , non-fractured in subsp. <i>fallax</i> , loosely attached in subsp. <i>laxa</i>	smooth except for old strips and plates on lower trunk	usually box-type to upper trunk
<b>Seedling stems</b>	round in cross-section	square in cross-section in Victorian populations	square in cross-section for a few pairs
<b>Juvenile leaves</b>			
Shape	broadly ovate to orbicular	lanceolate	broadly ovate to broadly elliptical or sub-orbicular
Apex	apiculate and emarginate	apiculate	apiculate
Size	14–11 cm long, 4–10 cm wide	10–17 cm long, 3–7 cm wide	6–10 cm long, 4–7 cm wide
Colour, lustre	blue-green to glaucous, dull or green, lustrous in subsp. <i>viridissima</i>	green, lustrous	green or blue-green, sub-lustrous
<b>Adult leaves</b>			
Size	8–20 cm long, 1.5–3.5 wide, to 25 cm long in subsp. <i>laxa</i>	11–20 cm long, 1–2.5 cm wide	16–29 cm long, 2–4 cm wide
Petiole length	1.6–3.3 cm	1.5–2.7 cm	1.7–3.2 cm
<b>Peduncle length</b>	6–15 mm long, to 18 mm long in subsp. <i>fallax</i>	8–22 mm long	12–20 mm long
<b>Buds</b>			
Shape	ovoid to cylindrical	ovoid to cylindrical	ovoid to cylindrical
Size	8–13 mm long, 3–6 mm diam	7–11 mm long, 3–5 mm diam	7–10 mm long, 3–5 mm diam
Pediceal length	sessile, rarely sub-sessile in subsp. <i>laxa</i>	2–3 mm	1–3 mm
<b>Fruits</b>			
Shape	cupular or cylindrical	cupular to barrel-shaped	cupular or slightly obconical
Size	5–10 mm long, 5–10 mm diam	5–10 mm long, 6–9 mm diam	8–11 mm long, 6–9 mm diam
Pediceal length	sessile, rarely sub-sessile in subsp. <i>laxa</i>	1–2 mm	0–2 mm

*E. wimmerensis* Rule, *E. oenea* K.D.Hill, *E. castrensis* K.D.Hill, *E. walshii* Rule, *E. filiformis* Rule and *E. hawkeri* Rule. Their shared features include a mallee or small, tree-like habit, either smooth bark throughout or persistent box-like bark present to various heights on the stems, adult leaves with numerous large, irregular island glands, inflorescences that are simple and axillary, buds with the outer operculum intact at anthesis and fruits that are 3- or 4-loculed.

Brooker (2000) in his revision of *Eucolyptus* discarded the Series *Subbuxeoles* and assigned the mallee-box species to the Supraspecies *Odoratae* within the Series *Buxeoales*. In the key provided, this treatment only partly adheres to Brooker's classification as it excludes

some species contained in his Supraspecies *Odoratae* (*E. albopurpurea* (Boomsma) D.Nicolle and *E. persistens* L.A.S.Johnson & K.D.Hill subsp. *persistens*, including *E. persistens* subsp. *tardecidens* L.A.S.Johnson & K.D.Hill) and other species that have been previously regarded as mallee-boxes (*E. poroso* F.Muell. ex Miq., *E. bosistoiana* F.Muell., *E. froggattii* Blakely and *E. silvestris* Rule) as they do not comply totally with the criteria for the mallee-box complex set out above. *Eucahyptus albopurpurea* has adult leaves with a dense reticulation with intersectional glands and paniculate inflorescences. Both subspecies of *E. persistens* have paniculate inflorescences. *E. porosa* has 5- or 6-loculed fruits and a uniquely remote intramarginal vein. *Eucahyptus bosistoiana* has paniculate

**Key to *E. odorata* and its allied Mallee-boxes**

1 Juvenile leaves <0.6 cm wide .....	2
1: Juvenile leaves 0.7–3.2 cm wide .....	3
2 Adult leaves lustrous and green; coppice leaves green .....	<i>E. viridis</i>
2: Adult leaves sub-lustrous and blue-green; coppice leaves glaucous .....	<i>E. filiformis</i>
3 Bark smooth throughout or rough bark as a short basal stocking on larger stems .....	4
3: Rough bark extending to upper stem or higher .....	8
4 Seedlings and buds pruinose .....	<i>E. polybractea</i>
4: Seedlings and buds non-pruinose .....	5
5 Juvenile leaves lustrous, green; fruits 2–4 mm diam .....	<i>E. aenea</i>
5: Juvenile leaves dull, blue-green; fruits 4–6 mm diam .....	6
6 Slender, pole-like trees .....	<i>E. walshii</i>
6: Mallees .....	7
7 Juvenile leaves 1–1.5 cm wide; adult leaves dull or sub-lustrous, blue-green .....	<i>E. wimmerensis</i>
7: Juvenile leaves 1.5–4 cm wide; adult leaves lustrous, green .....	<i>E. castrensis</i>
8 Mallees; juvenile leaves glaucous; immature fruits pruinose .....	<i>E. polybractea</i>
8: Trees; juvenile leaves green or blue-green; immature fruits non-pruinose .....	9
9 Slender, single or few-stemmed erect trees; adult leaves weeping; new season's growth tips lustrous, green .....	<i>E. hawkeri</i>
9: Robust, few-stemmed, spreading trees; adult leaves erect; new season's growth tips dull, blue-green or sub-glaucous .....	10
10 Buds lightly pruinose; fruits 3–4 mm diam .....	<i>E. yarriambiack</i>
10: Buds non-pruinose; fruits 4–7 mm diam .....	<i>E. odorata</i>

inflorescences and 5- or 6-loculed fruits. *Eucalyptus froggattii* has panicle inflorescences and lateral veins that do not connect with the intramarginal vein. Lastly, *E. silvestris* has adult leaves with a dense reticulation and sparsely distributed intersectional glands and in this respect is allied to *E. microcarpa* Maiden.

***Eucalyptus yarriambiack* Rule sp. nov.**

*Eucalypto wimmerensi affinis habitu arborescenti majore, cortice buxiforme, foliis juvenilibus viridibus, alabastris subpruinosis, fructibus minoribus differt et Eucalypto odorata affinis foliis juvenilibus angustioribus viridibus minoribus, foliis adultis angustioribus subnitentibus, alabastris subpruinosis minoribus, fructibus minoribus differt.*

**Type:** Victoria: Henty Highway, 1.6 km N of Brim, 36° 03' 41" S., 142° 25' 13" E., K. Rule 2605, 18.iii.2005. HOLO: MEL.

Robust, spreading small trees, usually with a few thick trunks, to 10 m tall, 10 m wide. *Bark* light grey-brown, box type, persisting to at least to the upper trunk, smooth, light grey-brown above; old bark decorticating in broad strips. *Seedling leaves* narrowly elliptical, petiolate, opposite for 3 or 4 pairs, green, discolorous. *Juvenile leaves* narrowly lanceolate or elliptical-lanceolate, alternate, shortly petiolate, rigid, coriaceous, slightly discolorous, sub-lustrous, green, becoming blue-green with age, 5–9 cm long, 0.7–1.1 cm wide; petioles 0.2–1.0 cm long. *Intermediate leaves* lanceolate, concolorous, lustrous, slightly blue-green, slightly



broader than the juvenile leaves. *Adult leaves* narrowly lanceolate or lanceolate, sometimes falcate, semi-erect, acuminate, uncinata, coriaceous (0.5–0.65 mm thick), erect along the axis, sub-lustrous olive-green or with a bluish tinge, 5–10 cm long, 0.8–1.5 cm wide; new season's growth tips sub-glaucous; petioles terete, 0.9–1.4 cm long; venation moderately acute (35°–45°), moderately reticulate; intramarginal vein c. 1 mm from the margin; oil glands large, numerous, irregular, island. *Inflorescences* simple, axillary, 7–11-flowered, along the main axis or along terminal, leafy branchlets; peduncles angular or terete, slender, 0.6–1.1 cm long. *Floral buds* ovoid to slightly clavate, petiolate, lightly pruinose at anthesis, unscarred (petaline and sepaline opercula intact), 4–6 mm long, c.3 mm wide; pedicels 2–4 mm long, operculum conical, c. 2/3 the

length of and as wide as the hypanthium; locules 3 or 4; ovules in 4 vertical rows; filaments white; stamens irregularly inflexed, all fertile; anthers sub-basifixed, adnate, globoid, dehiscing through lateral pores. *Fruits* hemispherical to cupular, rarely barrel-shaped, pedicellate, 4–6 mm long, 3–4 mm diam; pedicels 1–3 mm long; disc descending; valves 3 or 4, enclosed. *Fertile seeds* ovoid, slightly flattened, finely reticulate, dark brown; hilum ventral (Fig. 5).

**Flowering Period:** Autumn.

**Distribution and Habitat:** *Eucalyptus yarriambiack* is known from a single location between Brim and Beulah in the southern part of the Victorian Mallee region (Fig. 1). Its occurrence is on well-drained mallee loams close to the Yarriambiack Creek which, due to low rainfall of the area, is usually a dry water course.



Figure 5. *Eucalyptus yarriambiack* (a) tree; (b) bark; (c) seedling; (d) buds; (e) fruits

**Additional specimens examined:** VICTORIA: NNE of Brim, Wardles Road East, c. 200 m E of the railway line, *K. Rule 1108*, 1.vii.2008 (MEL); NW of Brim, Wardles Road West, c. 1.1 km W of Henty Hwy, *K. Rule 1208*, 1.vii.2008 (MEL); NNW of Brim, Starrocks Road, c. 600 m W of the Henty Hwy, *K. Rule 1308*, 1.vii.2008 (MEL); Henty Hwy N of Brim, c. 0.8 km S of creek crossing, *K. Rule 1408*, 1.vii.2008 (MEL); Henty Hwy, N of Brim, c. 2.7 km S of creek crossing, *K. Rule 1608*, 1.vii.2008 (MEL).

**Associated Species:** *Eucalyptus yarriambiack* occurs in pure stands but has contact with *E. dumosa* A.Cunn. ex J.Oxley and *E. largiflorens* F. Muell. on the boundaries of its distribution.

**Etymology:** The epithet, which is Aboriginal in origin, is used as a noun in apposition and refers to the Yarriambiack Creek close to where the new species occurs.

**Conservation Status:** The total known number of plants of *E. yarriambiack* is about 150, most of which are mature trees. Seedling recruitment is minimal and seedlings are absent along the stretch of the Henty Highway where several of the mature trees occur. As far as is known, all plants occur along roadside reserves and thus are exposed to a variety of threats. In accordance with IUCN criteria (IUCN 2001) the species is regarded as 'critically endangered' (CR).

**Discussion:** In habit and bark *E. yarriambiack* resembles *E. largiflorens*, black box, which occurs nearby in heavy soils along the Yarriambiack Creek. However, the two differ markedly in a wide range of features, particularly with the latter having duller, pendulous

foliage, terminal, compound inflorescences and scarred buds.

*Eucalyptus yarriambiack*, whose features include adult leaves with moderately reticulate venation and large, irregular island glands, simple, axillary inflorescences and 3–4-loculed fruits, clearly place it with the mallee-boxes, a large group of taxa within the Series *Buxuales*. The combination of features which distinguish the new species from its relatives are its robust, often spreading habit, its persistent box bark, its relatively narrow, greenish juvenile leaves, its sub-lustrous, blue-green or olive-green adult leaves, its sub-glaucous new growth during the growing season, its lightly pruinose buds and its small, pedicellate fruits.

Of the mallee-boxes, *E. wimmerensis*, which occurs approximately 50 km to the west of *E. yarriambiack*, is considered a close relative. Both have similar juvenile leaves in shape and size and similar adult leaves in shape, size and colour, as well as in venation and oil gland patterns. However, *E. wimmerensis* differs by its true mallee habit, its reduced amount of box bark or being completely smooth-barked and its generally larger fruits (Table 4).

The tree-like habit and persistent box bark also suggest *E. yarriambiack* has an affinity with *E. odorata*. However, that species differs by its broader leaves at all stages, its non-pruinose, larger buds and its larger fruits. Recent surveys of mallee-boxes in the Wimmera have revealed that small, rough-barked mallees, previously included within *E. wimmerensis*, are now considered

### Key to the Brown Stringybarks

- |   |                      |
|---|----------------------|
| 1 Operculum smooth or slightly scurfy (non-warty); locules 3 or 4 .....             | 2                    |
| 1: Operculum warty; locules 4–7.....  | 3                    |
| 2 Adult leaves lanceolate, to 13 cm long; fruits 8–11 mm diam .....                 | <i>E. arenacea</i>   |
| 2: Adult leaves elliptical to ovate, to 8 cm long; fruits 5–8 mm diam. ....         | <i>E. aurifodina</i> |
| 3 Bark stringy, extending to the secondary branches; buds shortly pedicellate ..... | <i>E. baxteri</i>    |
| 3: Bark on trunk smooth or flaky (box-type); buds sessile .....                     | 4                    |
| 4 Bark flaky, box-like; adult leaves broadly lanceolate; fruits 11–13 mm diam.....  | <i>E. victariana</i> |
| 4: Bark mostly smooth; adult leaves ovate to orbicular; fruits 11–25 mm diam.....   | 5                    |
| 5 Disc steeply ascending; fruits 11–16 mm diam. ....                                | <i>E. serraensis</i> |
| 5: Disc more or less level with the rim; fruits 16–25 mm diam. ....                 | <i>E. verrucata</i>  |



to be forms of *E. polybractea*. These and other forms of *E. polybractea* differ from *E. yarriambiack* by their mallee habit and their strongly pruinose seedlings.

### Series *Pachyphloiae* (Brown Stringybark Complex)

Until 1988 the brown stringybark complex had consisted of only two recognised taxa; the widespread, variable *E. baxteri* (Benth.) Maiden & Blakely ex J.M.Black, which occurs from Kangaroo Island to the south coast of New

South Wales, and the similarly variable *E. alpina* Lindley, which was regarded as being restricted to ridge-tops in the Grampians Ranges. In 1988 *E. arenacea* Marginson & Ladiges was segregated from *E. baxteri* to cater for populations of robust, spreading mallees occurring on inland sandy sites of western Victoria and adjacent areas of South Australia. With regard to *E. alpina*, studies by Marginson (1984), Ladiges and Humphries (1986) and Marginson and Ladiges (1988) indicated that it consisted of three species rather than one. Marginson (1984)

Table 4. Comparisons between *E. yarriambiack* and related species.

Characters	<i>E. wimmerensis</i>	<i>E. yarriambiack</i>	<i>E. adarata</i>	<i>E. polybractea</i>
Habit	mallee to 8 m tall	single or few-stemmed tree to 10 m tall	mallee or small tree to 15 m tall	mallee to 10 m tall
Bark	smooth or often with box-type stocking	box-type to major branches	box-type to major branches	smooth or a box-type stocking to various heights
Juvenile leaves				
Size	5–8 cm long, 0.8–1.6 cm wide	5–9 cm long, 0.7–1.1 cm wide	5–8–cm long 1–3 cm wide	4–10 cm long, 0.8–1.5 cm wide
Colour, lustre	dull, blue-green or sub-glaucous	sub-lustrous, green or blue-green	dull, blue-green or sub-glaucous	dull, blue-green or glaucous
Petiole length	0.6–1.2 cm	0.2–1 cm	0.4–1.2 cm	0.2–1.3 cm
Adult leaves				
Size	5–11 cm long, 0.8–1.5 cm wide	5–10 cm long, 0.8–1.5 wide	6–12 cm long, 0.9–2 cm wide	5–9 cm long, 0.9–1.7 cm wide
Colour, lustre	sub-lustrous or lustrous, green, blue-green or olive-green	sub-lustrous, blue-green or olive-green	dull or sub-lustrous, green or olive green	dull, glaucous or sub-glaucous
Intramarginal vein (distance from margin)	c. 1 mm	c. 1 mm	1–2 mm	c.1 mm
Petiole length	0.8–1.5 cm	0.9–1.4 cm	0.6–1.5 cm	0.6–1.5 cm
Colour of growth tips during growing season	dull, blue green	sub-glaucous	blue-green	glaucous
Buds				
Pruinosity	absent or light in one southern form	light	absent	strongly present
Shape	ovoid to slightly clavate	ovoid to slightly clavate	ovoid to clavate,	ovoid to slightly clavate
Size	4–6 mm long, 3–4 mm diam	4–6 mm long, c.3 mm diam	5–8 mm long, 3–5 mm diam	4–7 mm long, 3–5 mm diam
Pedicle length	2–4 mm	2–4 mm	2–4 mm	2–5 mm
Fruits				
Shape	cupular or sub-cylindrical	hemispherical to cupular, rarely barrel-shaped	cupular or barrel-shaped	cupular, sub-cylindrical or barrel-shaped
Size	6–8 mm long, 4–6 mm diam	4–6 mm long, 3–4 mm diam	6–9 mm long, 5–7 mm diam	4–7 mm long, 3–5 mm diam
Pedicle length	1–3 mm	1–3 mm	1–3 mm	1–4 mm

asserted that the materials used for the type specimen of *E. alpina*, collected from the summit of Mt William, were from a hybrid between *E. baxteri* and an unnamed, related taxon and that the name *E. alpina* could no longer be sustained. Chemical studies by Ladiges and Whiffin (1993) confirmed the findings of previous researchers and *E. serraensis* Ladiges & Whiffin, *E. verrucata* Ladiges & Whiffin (referred to as *E. verrucosa* in the paper) and *E. victoriana* Ladiges & Whiffin were subsequently erected in 1993. The earlier name *E. verrucosa* Colla rendered *E. verrucosa* Ladiges & Whiffin illegitimate and was replaced by *E. verrucata* Ladiges & Whiffin in 1995. In a concluding comment on *E. baxteri*, Whiffin and Ladiges (1995) were of the opinion that *E. baxteri* held no other segregate worthy of taxonomic recognition.

The distinguishing features upon which *E. arenacea* was segregated from *E. baxteri* included its juvenile leaves becoming glabrous later in seedling development (hispid leaves persisting to at least 13 pairs in the former and to 8 pairs in the latter), its leaves at all stages being narrower, with the adult leaves more tapering to the apex, its flower buds being non-warty with longer, narrower pedicels, its peduncles also being longer and narrower and its fruits being generally smaller, with a less raised disc.

Further research into the variable nature of *E. baxteri* has identified a new taxon occurring in the Victorian Goldfields, a region whose populations were not included in any of the studies of previous researchers (cited above). A treatment of this new taxon is provided below.

### ***Eucalyptus aurifodina* Rule sp. nov.**

*Eucalypto arenaceae affinis foliis juvenilibus minoribus, foliis intermediis ovatis vel sub-orbicularibus minoribus, foliis adultis ovatis vel ellipticis minoribus, alabastris ovoideis minoribus, fructibus minoribus differt et Eucalypto baxteri affinis foliis juvenilibus et adultis minoribus, pedunculis angustioribus longioribus, alabastris minoribus, operculis obtuso-conicis non-verrucatis, fructibus pedicellatis minoribus differt.*

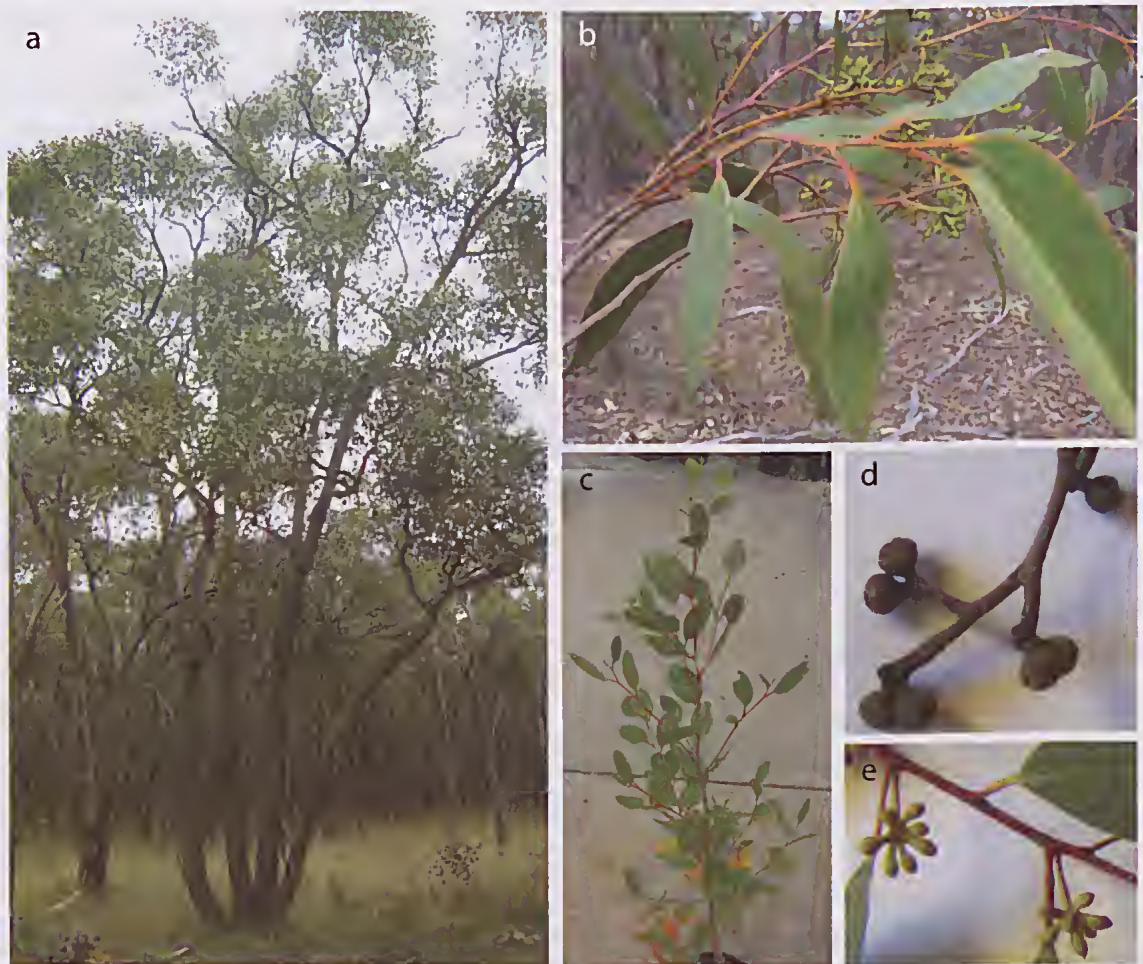
**Type:** Victoria: Maldon Historical Reserve, c. 200 m N of Smiths Reef Track along Tatt Town Track, 37° 01' 04" S, 144° 06' 02" E, K. Rule 3905 & E. Perkins 30.iv.2005. HOLO: MEL.

*Habit* small, single or multi-stemmed trees to 12 m tall. *Bark* grey, stringy, sometimes latticed, extending to secondary branches; inner bark reddish-brown. *Seedling leaves* ovate, sessile, discolorous, lustrous and green above, whitish below; hispid (hairs arising from raised oil glands); margins hispid; seedling stems hispid. *Juvenile leaves* ovate to broadly ovate, symmetrical, apiculate, opposite for a few pairs, petiolate, hispid for less than the 10<sup>th</sup> pair then becoming glabrous, discolorous, lustrous and green above, pale green below, 3–5.5 cm long, 2–4 cm wide; petioles 0.4–1.1 cm long. *Intermediate leaves* broadly elliptical to broadly ovate, often basally oblique, slightly discolorous, lustrous and green, regularly persisting in the mature canopy. *Adult leaves* elliptical or ovate, rarely ovate-lanceolate, often basally oblique, apiculate, coriaceous, moderately reticulate, lustrous and green, 4–8 cm long, 1.5–3 cm wide; petioles 1.2–2 cm long; lateral veins moderately acute, 35°–40° to the mid-vein; intramarginal vein c. 2 mm from the margin; oil glands numerous, regular, island. *Inflorescences* simple, axillary, 7–11-flowered; peduncles slender, terete or slightly angular, 5–12 mm long, contracting and thickening when bearing mature fruits. *Floral buds* ovoid or slightly clavate, pedicellate, unscarred (only a single operculum present), 5–7 mm long, 2.5–3 mm wide; pedicels 3–5 mm long; operculum conical (obtuse to moderately acute), smooth or slightly scurfy (non-warty), flush with the hypanthium at the abscission zone, 2.5–3.5 mm long, 2–3 mm wide; locules 3 or 4; ovules in 2 vertical rows; stamens inflexed, all fertile; filaments white; anthers sub-basifixed, versatile, reniform, dehiscent through oblique, confluent slits. *Fruits* hemispherical, shortly pedicellate, 5–7 mm long, 5–7(–8) mm wide; pedicels 1–3 mm long; disc broad, 1.5–2 mm wide, slightly ascending, rarely flat; valves 3 or 4, triangular slightly exerted or level with the disc. *Fertile seeds* black, irregularly sub-pyramidal, finely pitted; hilum terminal (Fig. 6).

**Flowering Period:** Early autumn.

**Distribution and Habitat:** *Eucalyptus aurifodina* occurs in dry woodland communities in north-central Victoria between Castlemaine and Avoca in areas once exploited for their gold deposits (Fig. 1). Its preferred habitat features gravelly soils on dry, stony slopes and rises.





**Figure 6.** *Eucalyptus aurifodina* (a) tree; (b) adult leaves and buds; (c) seedling; (d) fruits; (e) buds.

**Additional specimens examined:** VICTORIA: Dunach Nature Reserve, E of the Ballarat-Maryborough Road, *K. Rule* 15107, 2.xi.2007 (MEL); SW of Talbot, c. 700 m NW along Norburys Road from Lexton-Talbot Road, *K. Rule* 15207, 2.xi.2007 (MEL); 2.4 km NE of Lexton on Lexton-Talbot Road, *K. Rule* 15307, 2.xi.2007 (MEL); 1.8 km WNW of Lexton on Lexton-Ararat Road, *K. Rule* 15407, 2.xi.2007 (MEL); 100 m N of Lillicur West Road-Sunraysia Hwy intersection, *K. Rule* 15507, 2.xi.2007 (MEL); Muckleford Flora Reserve, 31.viii.1981, *A.C. Beauglehole* ACB68968 & *E. Perkins* (MEL); Porcupine Ridge Road, *K. Rule* 4105 & *E. Perkins*, 3.v.2005 (MEL).

**Associated Species:** *Eucalyptus microcarpa*, *E. nortonii*, *E. macrorhyncha*, *E. tricarpa* (L.A.S.Johnson) L.A.S.Johnson & K.D.Hill subsp. *tricarpa*, *E. melliodora*, *E. dives*, *E. polyanthemos* (subsp. *vestita* and subsp. *marginalis* Rule) and *E. leucoxyton* subsp. *pruinosa* (F. Muell. ex Miq.) Boland have been observed occurring with or adjacent

to the new species. Hybrids with *E. macrorhyncha* occur to the north-east of Lexton.

**Etymology:** The name is derived from the Latin *aurifer* 'gold-bearing' in reference to the new taxon being located in the goldfields of north-central Victoria.

**Conservation Status:** In the western part of the distribution the species has been collected from only small remnant populations whose numbers appear to have suffered from clearing for agriculture. A small population occurs in the Dunach Flora Reserve, which is administered by Parks Victoria. A second small population occurs in the Lillicur State Forest whilst the other western populations occur on roadside easements or in small pockets scattered on private land. On the other hand, the entire eastern part of the distribution occurs in reserves under the management

of Parks Victoria, namely the Smiths Reef Forest (Maldon Historical Reserve), the Muckleford Nature Conservation Reserve and the Castlemaine Diggings Nature Conservation Park. The Smiths Reef Forest population is by far the largest of the species, with numbers estimated at more than 200 trees. The total number of mature trees of the species in the known populations is estimated at between 800 and 1000.

Given that its numbers are sparsely scattered and probably amount to no more than a thousand plants, in accordance to IUCN criteria (IUCN 2001), a status of 'vulnerable' (VU) is recommended.

**Discussion:** *Eucalyptus aurifodina* is distinguished by its dry, gravelly, inland habitat, its habit of a small, single or multi-stemmed tree, its relatively small leaves at all stages, its slender, terete or slightly angular peduncles to 12 mm long, its pedicellate, small, ovoid buds with a smooth or slightly scurfy (non-warty), obtuse-conical operculum and its relatively small, hemispherical fruits with a moderately elevated disc and 3 or 4 valves. It is considered to have some features intermediate between *E. arenacea* and *E. baxteri* (Table 5).

The relatively long, slender peduncle, the non-warty, thinly pedicellate buds and 3–4-loculed fruits of

**Table 5.** Comparisons between *E. aurifodina* and related species.

Characters	<i>E. arenacea</i>	<i>E. baxteri</i>	<i>E. aurifodina</i>
<b>Habitat</b>	sub-coastal and inland sandy soils	coastal and sub-coastal heavy soils	inland gravelly soils
<b>Habit</b>	usually robust spreading mallees to 8 m tall	multi-stemmed coastal shrubs to trees to 40 m tall	small, often multi-stemmed trees to 12 m tall
<b>Juvenile leaves</b>			
Shape	broadly ovate	broadly elliptical to broadly ovate	broadly ovate
Size	6–10 cm long, 2–4 cm wide	6–13 cm long, 3–9 cm wide	3–5.5 cm long, 2–4 cm wide
Transition to glabrous leaves	by 14th node	by 8th node	by 10th node
<b>Adult leaves</b>			
Shape	lanceolate or ovate-lanceolate	broadly ovate or ovate-lanceolate	elliptical or ovate
Size	7–13 cm long, 2–3.5 cm wide	7–15 cm long, 2–5 cm wide	4–8 cm long, 1.5–3 cm wide
<b>Peduncles</b>			
Length	6–12 mm long	2–4 mm long	5–12 mm long
Thickness	1.5–2.5 mm thick	2–3.5 mm thick	1.5–2 mm thick
<b>Buds</b>			
Shape	clavate or slightly ovoid	clavate	ovoid or slightly clavate
Size	7–10 mm long, 3–4 mm diam	5–8 mm long, 4–5 mm diam	to 5–7 mm long, c. 3 mm diam
Pedice length	3–5 mm long	0–4 mm long	3–4 mm long
Operculum shape	hemispherical or obtuse conical	hemispherical or obtuse-conical	obtuse-conical, rarely conical
Operculum surface	non-warty	warty	non-warty
<b>Fruits</b>			
Shape	hemispherical	hemispherical or globose-truncate	hemispherical
Size	7–9 mm long, 9–11 mm diam	7–15 mm long, 8–15 mm diam	5–7 mm long, 5–8 mm diam
Disc orientation	level or slightly ascending	slightly to prominently ascending	slightly ascending
No of valves	3 or 4	4 or 5	3 or 4



*E. aurifodina* suggest a close relationship with *E. arenacea*. However, that species differs from the new taxon by its sandy habitat, its delayed transition from hispid to glabrous leaves during the seedling stage, its longer, narrower (lanceolate), tapering adult leaves, its larger buds and its larger fruits.

The new taxon shares some features with *E. baxteri*, namely the similar shaped pre-adult leaves and a similar period of transition from hispid to glabrous leaves during the seedling stage. However, *E. baxteri* differs by its wetter habitat (coastal and sub-coastal), its larger leaves at all stages, its thicker peduncles, its warty buds, which are often constricted at the abscission zone and its larger fruits that are either sessile or shortly pedicellate and have 4 or 5 valves.

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# A revision of eastern Australian *Bossiaea* (Fabaceae: Bossiaeeae)

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## Abstract

A revision of eastern Australian *Bossioeo* (Fabaceae: Bossiaeeae) is presented. Five new species, *Bossioeo olpino*, *B. dosycorpo*, *B. obovato*, *B. peninsularis*, and *B. sericea*, are described, *B. rhombifolio* subsp. *concolor* is raised to the rank of species as *B. concolor*, and *B. cinereo* var. *rigido* is resurrected and raised to the rank of species as *B. tosmónico*. *Bossioeo cordifolio*, *B. decumbens*, *B. distichocloido*, and *B. nummulorio* are resurrected as species. An informal infrageneric classification and keys to groups and species are presented, as well as illustrations, images, and distribution maps.

**Key words:** morphology, taxonomy, biodiversity, flowering plants, peas, legumes.

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## Introduction

Tribe Bossiaeeae (Fabaceae) is endemic in Australia and comprises seven genera and 101 species. The tribe has a widespread distribution in Australia, with most species occupying temperate and subtropical latitudes. Morphological features defining the tribe include: stamens all fused into an adaxially open sheath, anthers all dorsifixed and uniform in size, and seeds with a laterally connected and distinctively lobed aril. Standard and wing petals are fundamentally yellow, but commonly also have reddish markings.

*Bossiaea* Vent. is morphologically diverse and is by far the largest genus in tribe Bossiaeeae. It comprises 78 species (following the revision herein), with centres of diversity in south-eastern Australia and south-western Western Australia. Eastern species, with the exception of the desert-dwelling species *B. walkeri*, generally occur in regions with annual rainfall greater than about 500 mm and mostly form part of the shrubby understorey of open forests and woodlands. *Platylobium* Sm., which is endemic to south-eastern Australia, is clearly the closest relative of *Bossiaea*. The two genera share the following distinguishing features: unifoliolate leaves (when leaves are present), scales (fused stipule-pairs), terminal inflorescences that are mostly 1- or 2-flowered and mostly on contracted axes (and so appearing to be axillary), and brown, chartaceous bracts and bracteoles which resemble scales. *Bossiaea* can be distinguished from *Platylobium* by several features, including the less strongly compressed pods, the lack of or less conspicuous wing development on the upper margin of pods, and the stipules not both broad and deflexed. In addition, *Bossiaea* generally has smaller leaves, fewer inflorescence scales, upper calyx-lobes that are less conspicuously broader and longer than lower lobes, and bracteoles that are generally more proximally inserted on the pedicel. Within tribe Bossiaeeae, the lack of leaf development and the compressed and sometimes winged branchlets seen in some species of *Bossiaea* are unique. The leafy, eastern Australian species of *Bossiaea* have narrower leaves than those of *Platylobium*, their inflorescences are subtended by fewer inflorescence scales, and they tend to have smaller flowers.

The relationships within *Bossiaea*, and whether it constitutes a monophyletic group separate from *Platylobium* is unresolved. The



relatedness of eastern and western species is also unclear; however, in the course of this study, preliminary comparisons of the morphology of the eastern and western species suggest that *Bossiaea* had already diversified to a degree prior to the two regions becoming botanically isolated. In Western Australia, there is perhaps a greater amount of diversity than in the east, and this is reflected by the fact that two genera, *Lalage* Lindl. and *Scottia* R.Br., were erected in the early 1800s to accommodate some species. Bentham subsequently transferred these species to *Bossiaea* (Bentham 1864). The Western Australian species were recently revised (Ross 2006) and this resulted in an increase in the number of species of *Bossiaea* in Western Australia from 24 to 38. *Bossiaea bossiaeoides* (Benth.) A.B. Court occurs in northern Western Australia and was described in Ross (2006), but also extends across the Northern Territory and into far north-western Qld. This species is not included in the current revision.

The research described herein is the final taxonomic instalment in a study encompassing all genera in tribe Bossiaeeae. Revisions of *Goodia* Salisb. (Thompson 2011a), *Platylobium* (Thompson 2011b), *Muelleranthus*

Hutch., *Paragoodia* I.Thomps., *Aenictophyton* A.T.Lee and *Ptychosema* Benth. (Thompson 2011c) have recently been published.

**Taxonomic history** (see Table 1): The genus *Bossiaea* was erected in 1800 by the Frenchman Etienne Ventenat when he described the eastern Australian species *B. heterophylla* Vent. From that time through until the late 1880s, new taxa were named regularly, with Baron Ferdinand Mueller and George Bentham being the main contributors. Bentham in *Flora Australiensis* (Bentham 1864) named five new species, but also reduced to synonymy four previously described taxa, and reduced *B. rosmarinifolia* Lindl. to varietal rank. During this period, several taxa now assigned to either *Templetonia* R.Br. or *Cristonia* J.H.Ross in tribe Brongniartieae were initially placed in *Bossiaea*. In the first three decades of the 20<sup>th</sup> century three new varieties were recognised, but then there was a 53 year hiatus before the next new taxon, *B. oligosperma* A.T.Lee, was described (Lee 1981). In 1991 *Bossiaea arenicola* J.H.Ross was described (Ross 1991), and very recently there has been a burst of taxonomic activity, with five new leafless species described (Ross 2008; McDougall 2009).

**Table 1.** Chronology of publication of new taxa in eastern Australian *Bossiaea* prior to the current revision. Taxa that are treated as synonyms in the current revision, or that are unplaced, are presented in shaded boxes (See also Index of scientific names).

<i>heterophyllo</i> (1800) <i>obcordato</i> <sup>1</sup> (1803) <i>scolopendria</i> <sup>1</sup> (1808) <i>cinerea</i> (1812) <i>prostrata</i> (1812)	<i>foliosa</i> (1825) <i>buxifolia</i> (1825) <i>ensato</i> (1825) <i>lenticularis</i> (1825) <i>rhombifolio</i> (1825) <i>cordifolio</i> <sup>2</sup> (1827) <i>rosmarinifolio</i> <sup>3</sup> (1838) <i>nummulario</i> (1839)	<i>carinalis</i> (1848) <i>distichoclada</i> <sup>2</sup> (1855) <i>cordigera</i> (1856) <i>decumbens</i> <sup>2</sup> (1858)	<i>wolkeri</i> (1861) <i>brownii</i> (1864) <i>rupicolo</i> (1864) <i>riporio</i> (1864) <i>bracteoso</i> (1864) <i>kiamensis</i> (1864) <i>neo-anglica</i> (1865) <i>ormitii</i> (1879)	<i>scortechinii</i> (1883) <i>stephensonii</i> (1887)	<i>var. rigida</i> <sup>4</sup> (1903) <i>var. concolor</i> <sup>5</sup> (1908)
<i>microphyllum</i> <sup>1</sup> (1805) <i>lanceolotum</i> <sup>1</sup> (1808) <i>ovotum</i> <sup>1</sup> (1808) <i>coccineo</i> (1813)	<i>rotundifolio</i> (1825) <i>linnoeoides</i> (1832) <i>tenuicaulis</i> (1840)	<i>humilis</i> (1844)	<i>hendersonii</i> (1866)	<i>plumosa</i> (1893)	
<b>1800–1820</b>	<b>1821–1840</b>	<b>1841–1860</b>	<b>1861–1880</b>	<b>1881–1900</b>	<b>1901–1920</b>

			<i>oligosperma</i> (1981) <i>arenicola</i> (1991)	<i>vomboto</i> (2008) <i>bomboyensis</i> (2009) <i>fragrans</i> (2009) <i>milesioe</i> (2009) <i>groyi</i> (2009)
<i>var. stenoclada</i> <sup>6</sup> (1928)				
<b>1921–1940</b>	<b>1941–1960</b>	<b>1961–1980</b>	<b>1981–2000</b>	<b>2001–2010</b>

1. Originally placed in *Platylobium*.
2. Reduced to synonymy in *Flora Australiensis* (Bentham 1864).
3. Reduced in status in *Flora Australiensis* (Bentham 1864).
4. First described as a variety of *B. cinerea*, then treated as synonymous with *B. obcordata*.
5. First described as a variety of *B. rhombifolia*. Subsequently raised to *B. rhombifolia* subsp. *concolor* (Lee 1970).
6. Variety of *B. heterophylla*.



## Methods

This morphological study was based for the most part on examination of herbarium material with the aid of a dissecting microscope. In addition, trips into the field were undertaken in Victoria and south-eastern New South Wales to examine populations and to collect and examine fresh material. Flowers of some herbarium specimens were reconstituted using hot soapy water. Specimens from AD, BRI, CANB, HO, MEL, NE, and NSW were examined. All images presented in figures were taken by the author using a Canon PowerShot A2000 IS digital camera.

Type specimens cited have been seen by the author unless indicated with *n.v.* The author has not examined overseas material for purposes of typification except via images, mostly digital and accessed on-line, and further investigation is desirable in some instances. The majority of images examined have been from K, but images of material from G, BM and W have also been examined. Illustrations have been designated as the holotype of a species in several instances. Searches of herbaria in the future may reveal specimens associated with these illustrations, but there has been no indication of their existence in documents I have read.

Taxa with a current conservation classification are indicated in the *Distribution and habitat* sections below, and new taxa that are likely to warrant such a classification are also indicated here.

## Explanatory notes for keys and descriptions:

Measurements in keys and descriptions are based on pressed herbarium material and, unless otherwise specified, are based on branchlets (see Notes on morphology) and the structures borne on them. For leafless species, cladode-scale measurements refer to the longest scales of a branchlet, which occur in the middle third. Descriptions of stipules, bracts and bracteoles refer to their abaxial (outer) surface and width measurements of bracts and bracteoles were taken of the structures in their natural shape rather than flattened out. Descriptions of stipules refer to their appearance soon after maturity and before they become degraded with age. Also in the descriptions, the hairiness of stipules, scales, as well as bracts, bracteoles and calyces refer to their abaxial (outer) surface, not including the margins. The descriptions of convexity of bracts and bracteoles is also based on the abaxial view. The length of the calyx does not include the length of the receptacle (see Figure 1e). Descriptions of petal colour and marking pattern are partly based on field examination and examination of photographs and partly on interpretation of pressed specimens. The colour of wings and keel is that of their abaxial (outer) surface. Descriptions of petal colour and seed morphology are based on a limited survey of specimens for many species. The shape of pods given in descriptions is the two dimensional shape seen in profile.

Table 2. A new, informal classification of eastern Australian *Bassiaea*.

Group A	Group B	Group C	Group D
<b>Foliosa subgroup</b> 1. <i>B. faliasa</i> 2. <i>B. distichaclada</i> 3. <i>B. sericea</i> 4. <i>B. alpina</i>	<b>Cinerea subgroup</b> 5. <i>B. cinerea</i> 6. <i>B. rasmarinifolia</i> 7. <i>B. cordifolia</i>  <b>Kiamensis subgroup</b> <i>B. B. kiamensis</i>	<b>Cordigera subgroup</b> 9. <i>B. lenticularis</i> 10. <i>B. cordigera</i>  <b>Buxifolia subgroup</b> 11. <i>B. decumbens</i> 12. <i>B. buxifolia</i> 13. <i>B. neaanglica</i>	<b>Prostrata subgroup</b> 14. <i>B. nummularia</i> 15. <i>B. prastrata</i>  <b>Scortechinii subgroup</b> 16. <i>B. dasycarpa</i> 17. <i>B. scortechinii</i> 18. <i>B. abovata</i>  <b>Obcordata subgroup</b> 19. <i>B. tasmanica</i> 20. <i>B. abcardata</i>
Group E		Group F (Leafless)	
<b>Stephensonii subgroup</b> 21. <i>B. stephensanii</i>  <b>Heterophylla subgroup</b> 22. <i>B. heterophylla</i> 23. <i>B. rhambifolia</i> 24. <i>B. cancellar</i>	<b>Brownii subgroup</b> 25. <i>B. carinalis</i> 26. <i>B. rupicala</i> 27. <i>B. brownii</i> 28. <i>B. aligasperma</i>  <b>Arenicola subgroup</b> 29. <i>B. arenicola</i>	<b>Ensata subgroup</b> 30. <i>B. ensata</i> 31. <i>B. scalapendria</i> 32. <i>B. peninsularis</i> 33. <i>B. armitii</i> 34. <i>B. riparia</i>  <b>Fragrans subgroup</b> 35. <i>B. fragrans</i> 36. <i>B. milesiae</i>	<b>Bracteosa subgroup</b> 37. <i>B. bambayensis</i> 38. <i>B. grayi</i> 39. <i>B. vambata</i> 40. <i>B. bracteosa</i>  <b>Walkerii subgroup</b> 41. <i>B. walkerii</i>

The term l:w ratio refers to the length of a structure divided by its width and is here expressed as a quotient, e.g., l:w ratio 3 indicates that the structure is 3 times longer than wide, and l:w ratio 5–8 indicates that the structure ranges from being five times longer than wide to eight times longer than wide.

## Results

The results of this morphological study are presented in the taxonomic section below. In summary, the pattern of morphological variation identified calls for the recognition of eleven additional species, including five new species, one taxon elevated in rank, one taxon resurrected and elevated in rank, and four species resurrected. An informal two-tiered infrageneric classification has also been developed, and is summarised in Table 2.

The most taxonomically important characters identified in this study were: habit; branch architecture, compression and spininess; indumentum density; stipule dimensions, shape, texture and orientation; presence or absence of leaves and scales; phyllotaxy; leaflet size, shape and articulation; apiculum morphology; inflorescence-axis length; pedicel length and robustness; bracteole shape, persistence and insertion position; calyx-lobe shapes and relative sizes; petal lengths and coloration; pod length, thickness and indumentum; pod-stipe length; and aril morphology.

## Notes on morphological features

**BRANCHLETS:** Branchlets are here defined as the branches bearing inflorescences in their axils. They vary from terete to compressed. The branchlets and branches of leafless species are mostly broadly winged and are termed cladodes. Compressed branchlets generally become more terete in subsequent years. Ridges or leaf decurrencies are often evident on branchlets and when well-developed are generally pale. In leafy species, branchlets are sometimes moderately compressed but there is usually little or no wing development. *Bossiaea stephensonii* F. Muell. is an exception as it typically does develop narrow wings. The wings are mostly much wider than the terete or mildly compressed central region. The pale margins of the wings of these cladodes correspond to the decurrent ridges of leafy species.

In some species, branchlets are striate due to raised parallel venation or develop a whitish epicuticular wax as they mature. In leafless species in particular, this wax layer can ultimately lift in fragments varying from small flakes to large sheets, e.g., see Figure 12d.

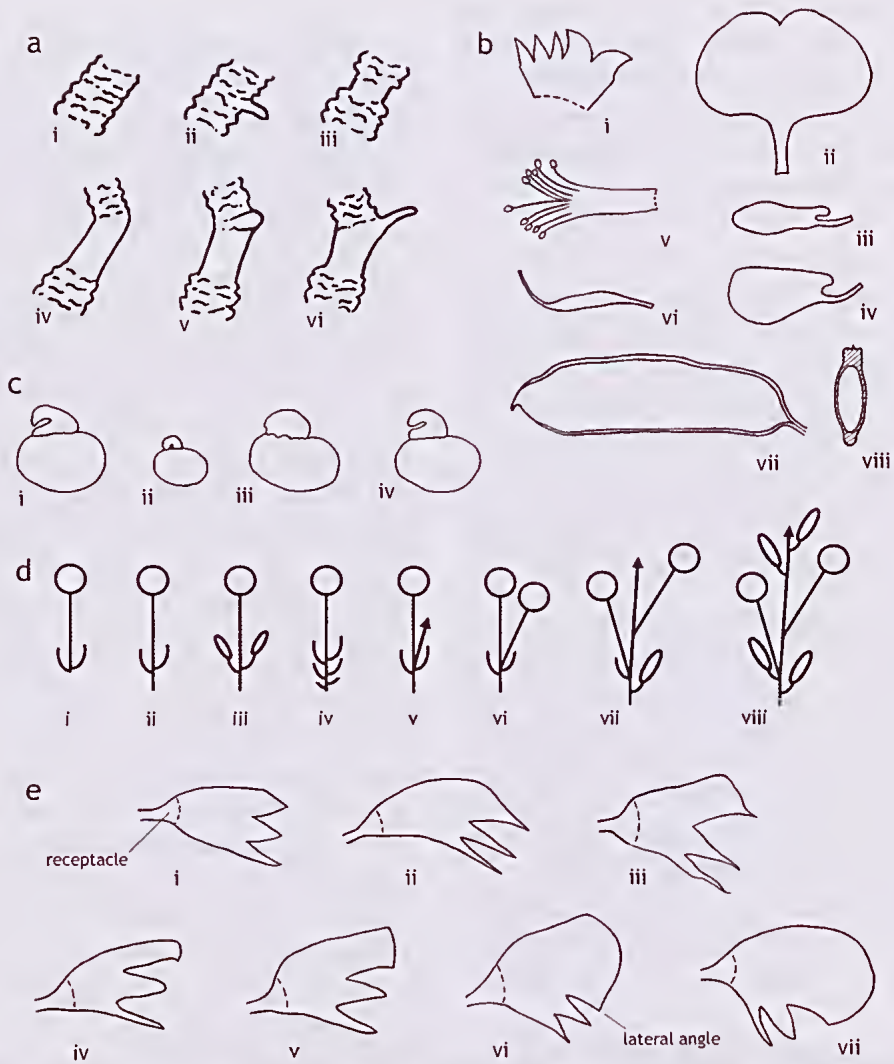
*Bossiaea kiamensis* Benth. is unique amongst eastern species in having minutely bulliform branchlets and branches (Fig. 4e).

**INDUMENTUM:** Hairs are simple, basifixed, straight, or less often curled, and 0.2 to 1 or rarely to 2 mm long. They are mostly white, but occasionally pale yellow or coppery. The inner surface of calyx-lobes has an indumentum of short, curled hairs, and the margins of scales, bracts, bracteoles and calyx-lobes are almost always ciliolate. Hairs are generally similar throughout a plant with the exception of pod-valves which often have hairs longer than on other structures. The orientation of hairs can vary within a species from antrorse-appressed to spreading. Some species more commonly have spreading hairs while others more commonly have appressed hairs, but orientation is not generally a reliable taxonomic character. The minute tubercles evident on upper surfaces and margins of leaves of several species are persistent hair-bases.

Taxa displaying a relatively distinctive indumentum include: the four species in the *Foliosa* subgroup (Group A), which have pale yellow or coppery hairs on ovaries and pods; *B. stephensonii*, which has relatively long hairs; *B. brownii* Benth. which has long hairs emerging from a layer of curled hairs; and *B. cordigera* Benth. ex Hook f. which has scattered short, curly hairs. Leafless species are commonly glabrous at maturity, but scattered hairs are generally present on developing cladodes, at least on the margins. Some members of the *Ensata* subgroup develop hairs on the apex of the keel-petals. Leafy species that are often virtually glabrous include *B. lenticularis* Sieber ex DC. and species in the *Heterophylla* subgroup.

**STIPULES AND SCALES:** Stipule morphology is quite variable. Most stipules have a ciliolate apex even if the surfaces are glabrous. Stipules are generally persistent, but generally darken and become degraded with age. Stipules are inserted on the lateral expansion of the branch on which a leaf is inserted. In all but one species insertion of the pair of stipules is opposite; however, in *B. cordifolia* they are inserted more adjacent to one another (Fig. 4f). The stipules of this species are also





**Figure 1. Aspects of morphology.** **a. Petiole and petiolule showing variation in their articulation.** (i) articulation obscure; (ii) as previous except for a spur, (iii) articulation marked by a change in diameter from petiole to petiolule, (iv) articulation geniculate, (v) as previous but also with a ridge, (vi) as previous but with petiole spurred; **b. Reproductive organs** (example species *Bossiaea heterophylla*). (i) calyx, cut and opened out, (ii) standard, (iii) wing, (iv) keel, (v) androecium, (vi) gynoecium, (vii) pod, (viii) cross-section of pod. All approximately  $\times 2$ ; **c. Seeds** (i) Aril-base broad (Cinerea subgroup), (ii) Small seed, aril-base narrow, strongly curved lobe (*Buxifolia* subgroup), (iii) Aril knobby and with lobe oblique, obscuring gap between lobe and base on one side (*B. walkerii*), (iv) Seed typical of several groups (drawn from *B. heterophylla*); **d. Inflorescences** (bracts and bracteoles not shown). (i) sessile, with one pair of inflorescence scales, (ii) as previous but with shoot development below scales, (iii) as previous except stipules and leaf developed instead of scales; (iv) as for (i) but with multiple pairs of inflorescence scales, (v) rudimentary on-growing of axis adjacent to flower, (vi) 2-flowered cluster, (vii) 2-flowered raceme-like inflorescence with rudimentary growing-on of axis, (viii) as previous but with on-growing axis leafy. Individual flowers could be interpreted as solitary and axillary in this arrangement; **e. Calyces** (showing one upper lobe, one lower lateral lobe and lower median lobe (appearing as half actual width due to the lateral view; base of calyx marked with a dashed line). (i) upper lobes triangular and the same size as lower lobes (*Bracteosa* subgroup), (ii) upper lobes triangular, broader than lower lobes (*B. arenicola*), (iii–vii) upper lobes c. quadrate: (iii) lower lobes relatively long and lobe-apices filiform (*Scortechinii* subgroup), (iv) upper lobes oblong, narrow (*Foliosa* subgroup), (v) upper lobes moderately broad, apex nearly truncate (e.g., *Heterophylla* subgroup), (vi) upper lobes broad, broadening markedly from base, with apex rounded (e.g., *Cinerea* subgroup), (vii) as previous but upper lobes relatively long (e.g., *Cordigera* subgroup). Drawings not precisely to scale, but all within the range  $\times 4$  to  $\times 5$ .

unusual in the degree of deflexion. The angle the stipule makes with the petiole varies within a small range in most species, but this measure can be useful taxonomically (e.g., see Figure 10h, i). The angle is difficult to assess if stipules are markedly recurved or deflexed.

In species of the *Brownii* subgroup of Group F, margins of stipules are clear and membranous and become recurved to revolute and generally distorted. In species of Groups B and C, stipules are commonly very narrowly triangular, often filiform distally, reddish, and tend to become recurved. *Bossiaea stephensonii* has exceptionally large, green, erect stipules. Stipules in the *Scortechinii* subgroup of Group D are significantly smaller than those of *B. stephensonii*, but are otherwise similar in appearance.

Scales are formed by the fusion of stipules and are present at nodes of the cladodes of leafless species and on the inflorescence axes of all species. They are also often present at the most basal nodes of branches of leafy species. At nodes occupied by a scale a leaf is not developed. The scales on cladodes of leafless species become progressively longer with distance from the base up to a certain point, and are longest in the middle third of the cladode. The basal scales of a cladode are sometimes clustered.

In leafy species there are two scales at the base of inflorescences; they are small and are mostly shorter than and often hairier than the adjacent bract. They are often only partially fused and sometimes a minute leaf rudiment is developed between the two scale halves to produce a trifid arrangement. Because of the small size and hairiness these inflorescence scales are difficult to observe. Occasionally stipules and a small to normal-sized leaf are present on the axis instead of a scale. In leafless species, there are often multiple, overlapping pairs of inflorescence scales and the most distal ones are relatively large.

**PHYLLOTAXY:** Phyllotaxy is mostly distichous in eastern Australian *Bossiaea*. Most species have regularly alternate leaves; however, three species have opposite leaves, and the three species in the *Cinerea* subgroup have variable phyllotaxy. Although leaves are inserted in a spiral arrangement in the *Cinerea* subgroup, the laminas tend to become oriented in one plane.

**LEAVES:** Leaves in eastern Australian *Bossiaea* are unifoliate, although in a small proportion of species the articulation, i.e., the articulation between the

petiole and the petiolulate leaflet, is obscure and the leaf appears to be simple (Fig. 1a, i). The articulation is recognisable in most species by either a change of angle (geniculate articulation; Fig. 1a, iv–vi), change in diameter (a non-pulvinate petiole terminus connecting to a pulvinate petiolule; Fig. 1a, iii), or by the presence of a ridge or spur on the petiole (Fig. 1a, v & vi and Fig. 4e). Species in the *Cordigera* subgroup have relatively slender petioles.

The laminas of leaflets are generally small, but are highly variable in shape. For branchlets, lengths range from a minimum of 1 mm in *B. alpina* I. Thoms. and *B. distichoclada* F. Muell. to a maximum of 30 mm in *B. rosmarinifolia*. *Bossiaea carinalis* Benth. has the broadest leaflets (to 13 mm). Species in the *Buxifolia* and *Brownii* subgroups have leaflets with asymmetric bases (Fig. 10e). The asymmetry is sometimes quite subtle and is often variably evident within a plant. Margins of leaflets are mostly flat or recurved, but are sometimes revolute, e.g., in the *Cinerea* subgroup, and rarely incurved to involute. In *B. rhombifolia* DC. *B. concolor* (Marden & Betche) I. Thoms. *B. heterophylla* Vent. and *B. stephensonii*, the margin generally has a fine pale rim that is generally only evident with microscopic examination. The apex of leaves is highly variable in shape and in the degree of development of an apiculus. The apiculus is either straight or downcurved. The stoutest and longest apicula are seen in the *Cinerea* subgroup and these are commonly pungent (Fig. 4).

Minute tubercles evident on the upper surface and margins of some species are hair-bases. Scattered pale dots, presumably glands, are sometimes evident on the upper surface of leaves of pressed specimens (when viewed under magnification); however, different pressing methods appear to influence the visibility of these dots. This gland-dotted appearance is perhaps most consistently seen in species in Group D.

**INFLORESCENCE ARCHITECTURE** (Fig. 1d): Inflorescences typically appear to be axillary; however, they are interpreted here as terminal inflorescences arising from contracted axes. The evidence for this axis is commonly no more than the presence of a pair of scales below the pedicel of a flower.

In a number of leafless species, a few to several overlapping pairs of inflorescence scales are developed, while in several species, e.g., species in the *Cordigera*



subgroup, the scales are separated from the axil by an axis up to c. 3 mm long. Less commonly, a short inflorescence axis is more obviously developed, with several, often leafy, nodes present. In most species, only a single inflorescence develops from an axil, but occasionally, and especially in the *Bracteosa* subgroup, multiple inflorescences arise from an axil.

Inflorescences are mostly single-flowered, with two-flowered clusters occurring occasionally in several species. However, in species in the *Scortechinii* subgroup a raceme-like arrangement of two or three flowers can develop, with the inflorescence axis continuing beyond the distalmost flower. This axis may be rudimentary at flowering or it may have developed into a leafy axis. Occasionally in this subgroup a solitary, truly axillary flower, subtended by a leaf or scale, may develop along an otherwise leafy shoot (as in Fig. 1d, viii but with only one flower).

**BRACTS AND BRACTEOLAS:** A single bract is present at the base of each pedicel and commonly is partly obscured by one of the subtending inflorescence scales. The two bracteoles are inserted on the pedicel at different points depending on the species, ranging from basal to almost at the summit. Bracts and bracteoles are commonly slightly to strongly convex abaxially and they always have ciliate margins. They are glabrous adaxially (on the inner surface) but are often hairy at first abaxially. Bracteoles are commonly opposite, but sometimes one is inserted up to c. 1 mm distal to the other. This sub-opposite arrangement is quite often seen in *B. carinalis*. In the *Buxifolia* subgroup bracteoles tend to be both inserted towards the upper side of the pedicel rather than on opposite sides, and they are often more widely divergent (Fig. 6d). In *B. ensata* Sieber ex DC. and *B. scolopendria* (Andrews) Sm. bracteoles are somewhat fleshy. In *B. arenicola* the two bracteoles fuse to form a single structure (Fig. 10n). In *B. distichoclada* bracteoles are relatively large and a colourless, recurved margin is sometimes evident.

In most leafy species bracteoles are persistent until well after anthesis and they often persist through to mature fruit stage. In contrast, seven of the 12 leafless species have caducous bracteoles. Because these species with caducous bracteoles have multiple pairs of inflorescence scales and because they are structurally very similar to bracts and bracteoles, it can be difficult to determine whether bracts and bracteoles have been shed. Sometimes, although abscised, they remain

lodged in position. In *B. milesiae* KL. McDougall and *B. walkeri* abscission scars are usually visible on the pedicel, but in other species these scars are concealed by scales.

**RECEPTACLE AND CALYX** (Fig. 1e): The receptacle is the dilated distal end of the pedicel and is a well-developed obconical structure 0.5–1 mm long (labelled in Figure 1e). The junction between receptacle and calyx is generally identifiable in pressed specimens. The calyx-tube is 1–4 mm long and is variously shorter than, equal to, or longer than the lobes. In a few species, e.g., *B. heterophylla* and *B. carinalis*, the calyx is often slightly glaucous and in others, notably *B. heterophylla*, *B. ensata* and *B. scolopendria*, the calyx-tube commonly has broad, longitudinal red stripes aligned with the inter-lobe sinuses.

Upper calyx-lobes are highly variable in eastern Australian *Bossiaea*. Except for four species with triangular lobes, the upper calyx-lobes are somewhat four-angled but with considerable variation in shape, mostly relating to broadening from the base and the degree of expansion beyond the lateral angle. Major variants are illustrated in Figure 1e. In the final two examples (Fig. 1e vi & vii) there is expansion of the lobe beyond the lateral angle. When this occurs the apex is always broadly rounded. The calyx shown in Figure 1e vii resembles the morphology of *Platylobium*. Lower calyx-lobes are triangular to narrow-triangular and are relatively uniform in morphology. In several species, notably *B. scortechinii* F. Muell. and *B. dasycarpa* CT. White ex I. Thomps. the apices of both lower and upper lobes have a filiform extension. In *B. scortechinii*, the lower median lobe is often distinctly longer than the lower lateral lobes. The calyx-lobes of the *Bracteosa* subgroup are distinctive in being all triangular and of similar size and shape as well as being largely brown and chartaceous.

**COROLLA:** Outlines of petal shapes of *B. heterophylla* are shown in Figure 1b and are fairly typical of the shapes in the majority of species. The standard-limb is generally slightly broader than long except in Group A species in which it is more or less circular. The unopened standard in Group A species is also folded so that the lateral margins merely touch rather than overlap as is typical of other species.

Two fairly common patterns of coloration of petals are shown in Figures 10l (*B. oligosperma* AT. Lee living) and 8d

(*B. prostrata* R.Br. pressed). In the former, the standard is yellow adaxially (internally) except for a red flare around the throat. Wings are flushed reddish or brownish abaxially over much of their length, and the keel is a darker purple-red distally. On the standard a red band sometimes runs vertically through the throat to divide it in two. The throat also commonly has red flecks at the base. The abaxial (outer) surface of the standard mostly has some degree of pink to red colouring. Sometimes, as is shown in Figure 8d, pale lines corresponding to the course of veins radiate from the flare and interrupt an otherwise red surface. Wings are sometimes entirely yellow except for some pink markings towards the base. Five species, *B. arenicola* and the four species in Group A, always have entirely yellow petals, while three species in the Scortechinii subgroup, especially *B. scortechinii*, are typically yellow or with relatively little red marking. Yellow-petalled mutant plants are occasionally recorded for species that normally have red markings.

**PODS:** The upper margin of pods is variable in thickness and in the degree of development of vertical ridges. Sometimes the ridge is restricted to the suture line only, and there may be a sulcus formed each side of this ridge. If the ridge is much higher than wide it approaches the dimensions of a wing, as the ridge is generally referred to in *Platylobium*. Pods of *B. carinalis* could almost be described as having wings (Fig. 10k). Pods with thickened valves and broadened upper margins are only seen in Group E and in a few species in Group F. In most groups the upper margin is 0.5–1 mm wide, whereas it ranges from 1 to 3 mm wide in species in Group E. Extremes in the range of widths of the upper margin are shown in Figure 10g with a pod of *B. rhombifolia* placed beside a pod of *B. buxifolia*.

The outer surface of valves commonly has slightly raised transverse venation evident with magnification; however, in species in Group B the venation is usually indistinct. The inner surface of pod valves is mostly smooth and glabrous; however, in several species in Group E spongy tissue forms between valves creating a partition between the seeds (Fig. 10f).

There appears to be some variation in the degree of revolute rolling of valves post-dehiscence. The rolling appears to gradually develop post-dehiscence. In some species the valves persist on the plant post-fruiting and are present in the next flowering period as cylinders with the exposed inner surface being silvery.

**SEEDS** (Figs 1c & 4g–i): Seeds are relatively uniform in shape and they range in length from 2 to 6 mm. Mature seeds are brown to blackish and are commonly mottled (Figs 4g–i, 10c). Seeds become considerably shorter but plumper just prior to maturity. When examining seeds of herbarium records it may be difficult to tell if that final change of shape had occurred. Some measurements of seed length may turn out to be excessively long for this reason. The aril is also fairly uniform in shape and relative size. There is some variation in the length of its base and the degree of overhang and curvature of the lobe. The oblique arching or asymmetry of the recurved margins of the lobe, which is a normal feature, is evident in Figure 4h. The aril of *B. walkeri* is unusual in being slightly knobbly and with the gap between lobe and base being hidden when viewed from one side.

## Taxonomy

In the descriptions below, species are ordered according to morphological similarity and, to further emphasise points of similarity, they have also been placed in six informal groups and 16 subgroups (Table 2). The groups are in some instances somewhat weakly defined, whereas the subgroups are well-defined and likely to reflect close relationships between members. The epithet of the most familiar or most widespread species in a subgroup is adopted for the name of the subgroup, e.g., The Prostrata subgroup is named after *B. prostrata*.

*Bossiaea* Vent., *Descr. Pl. Nouv.* 1: 7 (1800)

*Type:* *Bossiaea heterophylla* Vent.

*Bossieua*, orth. var. Pers.

*Boissiaea*, orth. var. Lem.

Scottia R.Br., in W.T. Aiton, *Hortus Kew.*, edn 2, 4: 268 (1812). *Type:* *S. dentata* R.Br. = *B. dentata* (R.Br.) Benth.

*Lalage* Lindl., in J. Lindley, *Edwards's Bot. Reg.* 20: t. 1722 (1834). *Type:* *L. ornata* Lindl. = *B. ornata* (Lindl.) Benth.

[All taxa historically placed in either *Scottia* or *Lalage* are endemic to Western Australia.]

## A circumscription of Eastern Australian species

*Subshrubs, shrubs or small trees*, sometimes leafless, sometimes rhizomatous. *Indumentum* commonly developed but variably persistent on branchlets and leaves, sometimes developed on pedicels and ovaries



**Key to informal groups of eastern Australian *Bossiaea***

1 Plants leafless (or occasionally with a few leaves developed from lower nodes of broadly winged stems).....	<b>Group F</b>
1: Plants leafy.....	<b>2</b>
2 Leaves all regularly opposite, with nodes well-spaced.....	<b>3</b>
2: Leaves all regularly alternate or arranged irregularly.....	<b>4</b>
3 Leaflets with l:w ratio $\geq 2$ .....	<b>Group B</b>
3: Leaflets with l:w ratio 0.8–1.2.....	<b>Group C</b>
4 Standard petal to c. 8 mm long, all yellow; upper calyx-lobes < 1 mm wide; pods < 10 mm long, hairy all over; ovaries and pods with hairs commonly pale yellow or coppery (mostly tablelands to alps).....	<b>Group A</b>
4: Standard petal > 8 mm long and/or with red markings, or if ever not with either feature then upper calyx-lobes > 1 mm wide; pods > 10 mm long, hairy all over or more often with valve faces glabrous; ovaries and pods with hairs white.....	<b>5</b>
5 Apex of leaflets narrowly acute with a robust, sometimes pungent apiculum; bracteoles to c. 1 mm long, not or hardly longer than broad, inserted more than halfway along pedicel.....	<b>Group B</b>
5: Apex of leaflets not entirely as above or if ever nearly so then branchlets compressed; bracteoles mostly > 1 mm long, longer than broad, inserted variously.....	<b>6</b>
6 At least some branchlets spinescent or subspsinescent (tapering to a blunt point).....	<b>Group D</b>
6: Branchlets not spinescent or tapering.....	<b>7</b>
7 Lower calyx-lobes at least as long as the calyx-tube AND the upper lobes; calyx hairy.....	<b>Group D</b>
7: Lower calyx-lobes shorter than calyx-tube and/or shorter than the upper lobes; calyx glabrous or hairy.....	<b>8</b>
8 Ovaries and pods hairy at least on margins; prostrate or weakly erect shrubs to c. 0.5 m high (higher if supported); pods thin, with upper margin < 1 mm wide; pod-stipe generally < 3 mm long.....	<b>Group C</b>
8: Ovaries and pods glabrous, or if ever hairy then tall shrubs with flowers entirely yellow and bracteoles fused into a single structure; generally erect shrubs, mostly > 0.5 m high; pods slightly to very thick, with upper margin > 1 mm wide; pod-stipe generally > 3 mm long.....	<b>Group E</b>

and abaxial surfaces of stipules, scales, bracts, bracteoles and calyces, rarely developed on the apex of keel-petals; margins of structures such as stipules, scales, bracts, bracteoles and calyx-lobes almost always ciliolate; hairs simple, mostly straight but occasionally curled or crumpled, white or rarely yellow or coppery. *Branchlets* terete or compressed, sometimes with leaf decurrencies, sometimes broadly winged (and then called cladodes), rarely spinescent, sometimes developing epicuticular wax. *Stipules* erect, reflexed or rarely deflexed, herbaceous or scarious, fused to form scales below inflorescences (inflorescence scales) and, in leafless species, at all nodes along cladodes. *Leaves* mostly distichous, alternate or less often opposite or irregularly arranged, unifoliate but with the articulation sometimes obscure, or leaves absent. *Inflorescences* mostly appearing axillary, but

interpreted as terminal on a contracted or very short or rarely more elongate axis bearing 2 or less often 4–10 scales; inflorescences mostly 1-flowered, occasionally 2-flowered, and very occasionally with flowers in a raceme-like arrangement; bract and bracteoles mostly scarious; bract at base of pedicel, slightly shorter than bracteoles; bracteoles variously inserted, persistent or caducous; receptacle obconical, generally distinct. *Calyx* with tube shorter than to longer than lobes; upper lobes partly fused, mostly broader and often longer than the triangular lower lobes; petals clawed; standard and wings yellow, commonly with reddish or purple-brown markings; standard with limb oblate or occasionally c. circular; standard mostly equal to or slightly longer than wings; keel equal to, slightly longer, or occasionally much longer than wings, pale or more often reddish

**Key to Group A**

- 1** Leaflet halves markedly convex, with margins commonly partly revolute, with upper surface generally with scattered minute tubercles all over; lower surface never covered by closely appressed hairs..... **2**
- 1:** Leaflet halves flat or only slightly convex, with margins not revolute, with upper surface lacking tubercles or tubercles near-marginally only; lower surface commonly with a close-appressed to sericeous indumentum..... **3**
- 2** Stipules < 1.5 mm long; leaves commonly broad-ovate; bracteoles ≤ 1 mm long, not exceeding receptacle..... **1. *B. folioso***
- 2:** Stipules > 1.5 mm long; leaves commonly transversely oblong-elliptic; bracteoles > 2 mm long, extending well onto the calyx..... **2. *B. distichoclodo***
- 3** Lower surface of leaflets largely to totally covered by a closely appressed, generally sericeous indumentum; bracteoles usually with some hairs, ≤ 1.5 mm long except in Brindabella Ranges and Coolamon Plain (Australian Capital Territory and New South Wales) where sometimes up to 2.5 mm long..... **3. *B. sericeo***
- 3:** Lower surface of leaflets glabrous or with scattered hairs near midline only; bracteoles glabrous, ≥ 2 mm long (Victoria only)..... **4. *B. alpina***

especially distally; stamens fused to form an adaxially open sheath; anthers all dorsifixed and ±uniform in size; ovary 2–20-ovulate; style slender, upcurved; stigma small. *Pods* stipitate; body compressed, with valves and margins variously thickened, glabrous, hairy on margins, or hairy all over, sometimes with spongy tissue partitioning seeds internally; upper margin often slightly to strongly ridged. *Seeds* plump, ellipsoid or slightly reniform, with a conspicuous aril; aril with a lobe arising at one end and arching over the aril-base.

**Group A**

*Shrubs*, mostly erect but sometimes nearly prostrate; branchlets terete, without decurrent ridges, commonly moderately hairy. *Stipules* often striate. *Leaves* with lamina small, generally not longer than broad, markedly discoloured, often lustrous or sublustrous above. *Inflorescences*: axes contracted, with scales 2; pedicels short; bracteoles persistent, inserted proximally, sometimes relatively large. *Flowers* relatively numerous, relatively small; upper calyx-lobes narrowly oblong, not expanded beyond lateral angle, with lateral angle acute; petals entirely yellow; anthers small (0.2–0.3 mm long). *Pods* short-stipitate; body circular to broad-elliptic, hairy all over, with hairs commonly pale yellow to coppery. *Seeds* 1 or 2 per pod (Fig. 2).

Group A is a well-defined and distinctive group of four species. It is also identified here as the *Foliosa* subgroup to emphasise the close relationship between members. It occurs in south-eastern New South Wales and eastern Victoria at moderate to high altitudes, and contains

the only species to extend into the alpine zone (Fig. 3). It is essentially synonymous with *B. foliosa* A. Cunn. as historically circumscribed, *i.e.*, in *Flora Australiensis* and in subsequent state floras. Descriptions in recent state floras erroneously state that *B. foliosa*, *i.e.*, in the historic sense, has caducous bracteoles.

**1. *Bossiaea foliosa* A.Cunn., in B.Field, Geogr. Memoirs New South Wales: 347 (1825)**

**Type:** not designated. [Protologue: 'Brushy forest-land near Bathurst.'] New South Wales. Near Bathurst, A.Cunningham, 1822; lectotype (here selected): K 000278308, image seen in Kew Herbarium Catalogue; probable isolectotypes: K 000278306, K 000278307, K 000278309, images seen in Kew Herbarium Catalogue, NSW 566395.

*Erect shrubs* to c. 1.5(–2) m high, with inflorescences borne typically on a ±regular series of short side-branchlets; branchlets erecto-patent to spreading, c. 0.4 mm wide, with a moderately dense indumentum of straight or wavy hairs c. 0.2 mm long; epicuticular wax not or hardly developed. *Stipules* triangular to narrow-triangular, 0.4–1(–1.5) mm long, erect, brown, often darker medially, hairy, glabrescent, 3 or more-nerved, but venation often obscure; stipule-petiole angle 60–90°. *Leaves*: petiole 0.3–0.7 mm long; articulation not or slightly geniculate, not ridged; lamina commonly broad-ovate, less often c. orbicular, squarish or transverse-oblong, 1.5–3 mm long, 1.5–3.5 mm wide, with l:w ratio mostly 0.8–1.1, with each lamina





**Figure 2. Group A.** a. *Bossiaea distichoclada* (J.H.Ross 3631 MEL); b. *B. distichoclada*, pod (R.J.Fletcher 376 MEL); c. *B. sericea* (R.O.Makinson 920 MEL); d. *B. alpina*, flowers and new growth (R.H.Barley, 19.xi.1980 MEL); e. & f. adaxial and abaxial views of leaves. Top row: *B. foliosa* (J.Crawford 769 MEL), and *B. distichoclada* (J.H.Ross 3632 MEL); bottom row: *B. sericea* (R.O.Makinson 920 MEL) and *B. alpina* (D.E.Albrecht 5195 MEL); g. *B. foliosa*, flowers (K.J.Fitzgerald 75 MEL). Scale bars: a, c = 10 mm, b, d-g = 2 mm.

half strongly convex, markedly discoloured; base symmetrical, truncate to cordate; margin often revolute each side of midline in distal two-thirds, otherwise recurved; apex broadly rounded or truncate; apiculum hardly developed, generally pointing down; upper surface minutely tuberculate, sometimes wrinkled (which may obscure tubercles), with venation not evident, with gland-dotting not evident, soon glabrescent; lower surface minutely white-dotted, with scattered hairs on midrib and extending laterally onto lamina, but often only sparsely hairy or glabrous towards periphery; hairs often slightly wavy, loosely appressed to somewhat spreading. *Inflorescences*: axes contracted; bract c. 0.5 mm long, c. 0.5 mm wide, strongly convex; pedicel 0.5–2.5 mm long, glabrous or occasionally with scattered hairs; bracteoles persistent, broad-ovate, 0.5–1 mm long, with l:w ratio c. 1, divergent, inserted at base, strongly convex, with venation obscure, glabrous or sparsely hairy distally, red-brown. *Calyx* 2–3.5 mm long, hairy, with tube c. equal to lobes; upper lobes

0.8–1.8 mm long, c. 0.8 mm wide; sinus 0.3–1.2 mm deep; lower lobes 0.6–1 mm long, c. 0.5 mm wide, flat; petals all similar in length, all entirely yellow; standard to c. 6 mm long; wings c. 1.5 mm wide; keel c. 2 mm wide; ovary hairy, 2-ovulate. *Pods*: stipe c. 1.5 mm long; body c. circular, 5–8 mm long, 5–7 mm wide, with scattered pale or light golden hairs c. 0.6 mm long on valves and margins; upper margin c. 0.5 mm wide, with ridge to c. 0.3 mm high. *Seeds* 2.0–2.8 mm long, 1.5–1.8 mm wide; aril 1–1.2 mm long, c. 0.8 mm high, with base c. 0.6 mm long, with lobe curving 60–120° (Fig. 2e–g).

**Selected specimens from c. 60 examined: NEW SOUTH WALES:** The Mullions Range, 10 km NE of Mullion Creek RS (c. 24 km NNE of Orange), *R.Coveny* 10234, 14.x.1978 (NSW); 29.2 km from Yass Rd along Nottingham Rd toward Tumut, *H.Thompson* 906 & *P.Ollerenshaw*, 27.i.1987 (CANB, MEL, NSW); Monaro Hwy between Nimmitabel and Bombala, 2 km S from turn-off to Snowy Mtns Hwy, *G.Stewart* 416, 4.xii.1984 (CANB, MEL); Tantangara turn-off, c. 16 km S of Kiandra, *E.Reiner* 494, 20.xii.1960 (CANB); Dry Plains Rd, c. 25 km from Cooma, *R.W.Purdie* 5623, 23.xi.2002 (CANB); Hume and Howell Walking

Track, Burrinjuck Nature Reserve, *K.J.Fitzgerald* 75, 8.xi.1997 (CANB, HO, MEL, NSW). **AUSTRALIAN CAPITAL TERRITORY:** Old Boboyan Rd (south), 1.2 km W of turn-off from Canberra–Adaminaby road, *M.D.Crisp* 9285 & *L.G.Cook*, 4.xii.2000 (CANB, NSW); between Canberra and Lake George, *E.Gaubau*, 30.x.1949 (CANB). **VICTORIA:** Craigie Bog Road S of New South Wales border, *A.C.Beauglehole* 34822, 23.xi.1970 (MEL); Limestone Creek, *J.Stirling*, 1.xii.1882 (MEL); source of Mitta Mitta River, *J.Stirling*, 1882 (AD).

**Flowering period:** Flowers from October to December.

**Distribution and habitat:** Occurs in the central and southern tablelands of New South Wales and in far eastern Victoria at altitudes of about 800–1200 metres a.s.l. (Fig. 3a). Grows in often stony soils in open forest and woodland.

**Notes:** *Bossiaea foliosa* is distinguishable from other species of the group by a combination of leaflet-shape, texture of the upper surface and indumentum of the lower surface of leaflets, small bracteoles with somewhat rounded apices, hairy calyces, and glabrous pedicels. The leaflets are commonly ovate because margins are revolute distolaterally. The leaflets of members of Group A are compared in Figure 2e–f. The bract and bracteoles of *B. foliosa* are inserted close together and are divergent; this creates a cupular arrangement from which the pedicel emerges and generally clearly exceeds. The bract is often trifid, an uncommon shape for bracts but commonly seen in inflorescence scales. *Bossiaea foliosa* and *B. distichoclada* have leaflets with a pale lower surface. Under magnification, this pallor is seen to be due to minute white rings closely crowded over the surface.

**Hybridisation:** A specimen collected from Haydons Bog near Delegate, in far eastern Victoria (*Bauerlen*, 1899 NSW) may be a hybrid between *B. sericea* I. Thomps. and *B. foliosa* A. Cunn.

**Typification:** There are two sheets at K with probable type material of *B. foliosa*. Although the collector's name is not specified for some pieces, I consider that all pieces were collected by Cunningham on his expedition from Port Jackson to Bathurst in 1822–1823, and were probably all from a single gathering near Bathurst. On one sheet a piece coded as K 278308 is labelled 'Brushy forest land near Bathurst' and so matches the description in the protologue. A.B. Court annotated this piece as 'the type' in 1967, but Lee (1970) while discussing 'the Holotype' did not clearly indicate

whether she was referring to this piece. All pieces are of similar diagnostic value, but I here formally designate K 278308 as the lectotype of *B. foliosa* based on the close correspondence between the label and the protologue. The contents of a small envelope on the sheet near the lectotype have not been seen. On the same sheet, the piece in the top right hand corner K 278307 is labelled as a Cunningham collection, *Cunningham* 130/1822, while for the two pieces of K 278309, the collector is not indicated. Both are probable isolectotypes. The second sheet at K bearing probable type material, coded as K 278306, has three pieces and is a duplicate of K 278307 based on similarities in the labelling, and so also probably an isolectotype. At the time of writing, the catalogue had incorrectly identified the collection number for this specimen as *Cunningham* 136. The number 130 is written on the label but a comma from the line above has caused it to appear like 136.

## 2. *Bossiaea distichoclada* F.Muell., *Trans. Phil. Soc. Victoria* 1: 39 (1855)

**Type:** not designated. [Protologue: 'In the Australian Alps from the Mitta Mitta to the tributaries of the Snowy River'.] Victoria. Bogong Mountains, *F.Mueller*, date unknown (probably 1854); lectotype (here selected): MEL 20321.

Residual syntypes: Victoria. Mitta Mitta, *F.Mueller*, i.1854: MEL 20323, MEL 20326, MEL 20327 (all *B. distichoclada*); Victoria. Upper Avon, Gippsland, *F.Mueller*, xi.1854, MEL 20320 (mixed sheet of *B. distichoclada* and *B. alpina*); Victoria/New South Wales. Snowy Mountains, *F.Mueller*, possibly i.1855: MEL 20322 (mixed sheet of *B. distichoclada* and *B. alpina*; locality given is possibly an error); Victoria. Locality unknown, *F.Mueller*: MEL 20324; Victoria. Mt Wellington, *F.Mueller*, xi.1854: MEL 20325 (mixed sheet of *B. sericea* and *B. alpina*).

*Bossiaea foliosa* sensu G.Bentham, *Fl. Austral.* 2: 160 (1864), and subsequent Australian authors, *pro parte*, *non sensu stricto*.

**Erect shrubs** to c. 1 m high, with inflorescences borne typically on a  $\pm$ regular series of short side-branchlets; branchlets sub-erect to erecto-patent, c. 0.6 mm wide, with a dense indumentum of straightish hairs c. 0.3 mm long; epicuticular wax not developed. *Stipules*



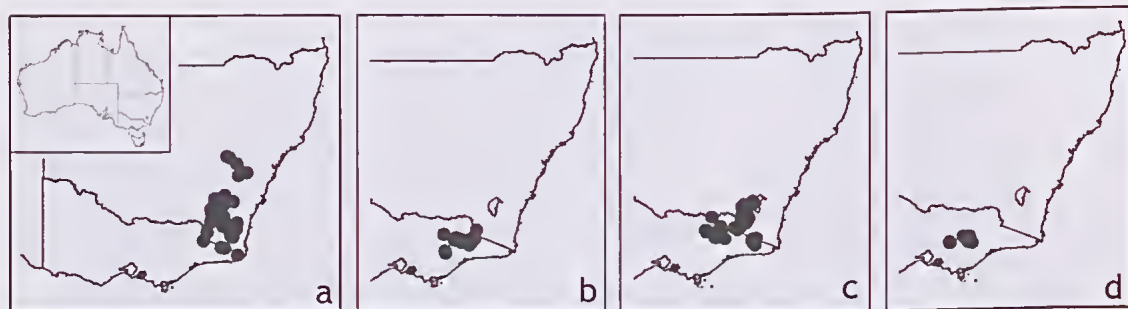


Figure 3. Distributions of species in Group A. a. *Bossiaea foliosa*; b. *B. distichoclada*; c. *B. sericea*; d. *B. alpina*.

triangular, 1.5–4 mm long, erect, divergent, sometimes slightly reflexed, brown, glabrous, 5–10-nerved, but venation generally obscure; stipule-petiole angle variable, difficult to assess. *Leaves*: petiole 0.2–0.5 mm long; articulation obscure; lamina obcordate, reniform, or c. circular, 1–2.5 mm long, 2–4 mm wide, with l:w ratio mostly 0.6–0.9, with each lamina half strongly convex, markedly discolorous; base symmetrical, broadly rounded to cordate; margin recurved proximally, generally revolute distally; apex broadly rounded, truncate or emarginate; apiculum not or hardly developed; upper surface minutely knobbly and often wrinkled, with venation obscure, with gland-dotting not evident; lower surface glabrous, or sometimes with hairs on midrib, often white-dotted. *Inflorescences*: axes contracted; bract 1.5–3 mm long, 1 mm wide, strongly convex abaxially; pedicel 1–2 mm long, hairy; bracteoles persistent, narrow-elliptic, (2–)2.5–4.5 mm long, with l:w ratio 2–3, loosely appressed to calyx, inserted near base, strongly convex, with venation obscure, hairy medially, brown. *Calyx* 2.5–3.5 mm long, hairy, with tube slightly longer than lobes; upper lobes 1–1.5 mm long, c. 0.8 mm wide; sinus c. 1 mm deep; lower lobes 1–1.5 mm long, 0.5–0.7 mm wide, flat; petals all similar in length, all entirely yellow; standard to c. 8 mm long; wings 1.5–2 mm wide; keel 2–2.5 mm wide; ovary hairy, 2-ovulate. *Pods*: stipe 1 mm long; body c. circular or broad-elliptic, 5–8 mm long, 5–6 mm wide, with rusty-orange hairs c. 1 mm long on valves and margins; upper margin c. 0.4 mm wide,  $\pm$ unridged. *Seeds* c. 2.5 mm long, 1.5–2 mm wide; aril 1–1.2 mm long, c. 0.7 mm high, with base 0.6–0.8 mm long, with lobe curving c. 90° (Fig. 2a, b, e, f).

**Selected specimens from c. 60 examined:** NEW SOUTH WALES: 9 km along Cascade Trail from the Alpine Way, 500 m S of Cascade Creek ford, A.J.Whalen 283, 14.xii.1998 (CANB,

DNA, MEL). VICTORIA: Blue Shirt Creek, 100 m downstream of Nunniong Rd, 5 km WSW of Mt Nunniong, K.Menkhorst s.n., 12.i.1985 (MEL); c. 16 km E of Mt Hotham on road to Omeo, J.Cullimore 246, 17.i.1968 (MEL); c. 9 km E of Little Mt Tambo, c. 3 km NE from junction of Currawong Rd and McDougall Spur Track, F.E.Davies 609, 10.xi.1988 (AD, CAN8, MEL, NSW); Brumby Point, Nunniong Plateau, c. 80 km NNE of Bairsdale, J.H.Willis, 13.xi.1964 (MEL); Forlorn Hope Track, S of Benambra–Wulgulmerang road, A.C.Beaglehole 36194, 18.i.1971 (MEL); Spring Hill Track, 12 km SSW of Mt Tambo, Splitters Range, G.W.Carr 10247, 8.xii.1984 (MEL).

**Flowering period:** Flowers from December to January.

**Distribution and habitat:** Occurs in eastern Victoria from Mt Hotham east to The Cobberas and in far south-eastern New South Wales where it occurs near Thredbo in Kosciusko National Park (Fig. 3b). There is a record of *B. distichoclada* labelled Buffalo (Robbins MEL 521828) which is part of a mixed collection with *B. sericea*. There is some doubt about the validity of the label. Grows in montane to subalpine woodland.

**Notes:** Bracteoles of *B. distichoclada* are large and have a conspicuous indumentum of appressed hairs which is densest medially (Fig. 2a). Bracteoles extend to the calyx-lobes or sometimes beyond this point. Bracts and bracteoles tend to be more brittle than in other species and often are split in pressed specimens. Margins of stipules and bracteoles tend to fray with age. The indumentum of pods (Fig. 2b) is more conspicuously coppery than in other species. Leaves are closest in most respects to those of *B. foliosa*, but the margins are rolled differently and do not create the ovate shape typically seen in the latter. Specimens with very long stipules and bracteoles have been recorded from the Nunniong Plateau in eastern Victoria.

**Hybridisation:** Probable hybridisation has been recorded between *B. distichoclada* and *B. sericea* in the

Bogong High Plains in north-eastern Victoria (*J.H.Ross* 3635–7, 3640, all MEL) and further east at Limestone Creek (*N.G.Walsh* 2867 CANB, MEL, NSW).

**Typification:** There are eight sheets at MEL, according to Lee (1970), which Mueller may have used when describing the species. Several of them have multiple pieces and are mixed collections. The majority of pieces conform to Mueller's description, but several pieces do not, and are in fact specimens of *B. alpina*, or in one case, *B. sericea*. Lectotypification is therefore required for *B. distichoclada*, and MEL 20321 is here selected. The sheet contains a single piece with pods, and was labelled as *B. distichoclada* Ferd Mueller by the author.

### 3. *Bossiaea sericea* I.Thomps., *sp. nov.*

*A. B. foliosa* A.Cunn. foliolis non ovatis laevibus superne sericeis inferne, leguminibus majoribus, seminibus majoribus differt.

**Type:** Victoria. 11.8 km by road from Rocky Valley Dam wall towards Omeo, *R.O.Makinson* 920, 3.xii.1991; holotype: MEL 234474; isotype: BRI, CANB 9106346.

*Bossiaea foliosa* sensu G.Bentham, *Fl. Austral.* 2: 160 (1864), and subsequent Australian authors, *pro parte*, *non sensu stricto*.

*Erect shrubs* to c. 2 m high, with inflorescences borne typically on a  $\pm$ regular series of short side-branchlets; branchlets erecto-patent, c. 0.5 mm wide, with a dense indumentum of straightish hairs c. 0.3 mm long; epicuticular wax not developed. *Stipules* triangular, 0.7–2 mm long, erect, brown, glabrous, 4–10-nerved; stipule-petiole angle 30–60°. *Leaves:* petiole 0.5–1.5 mm long; articulation slightly to strongly geniculate, not ridged; lamina c. circular, oblate, obcordate, broadly obovate, or broadly quadrangular, (1.5–)2–4 mm long, 1.5–5 mm wide, with l:w ratio mostly 0.8–1.0, flat to moderately folded, with each lamina half flat to slightly convex, markedly discolorous; base symmetrical, truncate to slightly cordate; margin flat to moderately recurved, smooth or tuberculate, with a pale rim; apex broadly rounded, truncate or emarginate; apiculum minute, generally pointing slightly down; upper surface smooth throughout or tuberculate at margins (visible in abaxial and sometimes adaxial view), with venation obscure, with gland-dotting not evident, glabrous; lower surface evenly sericeous, sometimes densely, or

with indumentum sparser near margins; indumentum usually somewhat persistent. *Inflorescences:* axes contracted; bract 0.7–2.2 mm long, 0.5–1 mm wide, strongly convex; pedicel 1–3.5 mm long, glabrous or hairy; bracteoles persistent, ovate, narrow-ovate or oblong, 0.7–2.5 mm long, with l:w ratio 1–3, mildly divergent, inserted near base, strongly convex, with venation mostly obscure, glabrous or with hairs towards apex, brown. *Calyx* 2–3.5 mm long, hairy throughout or glabrous except for lobes, with tube equal to or slightly longer than lobes; upper lobes 0.9–1.5 mm long, 0.8 mm wide; sinus 0.5–1 mm deep; lower lobes 0.5–1 mm long, 0.6 mm wide, flat; petals all similar in length, all entirely yellow (sometimes with pink tinges on margins); standard to c. 8 mm long, with limb as long as broad; wings 1.5–2 mm wide; keel 2–2.5 mm wide; ovary hairy, 2- or 3-ovulate; style 2.5–4 mm long. *Pods:* stipe 1–2.5 mm long; body broad-elliptic, 6–10 mm long, 4–8 mm wide, with rusty hairs or a mixture of pale and rusty hairs c. 1 mm long throughout; upper margin c. 0.5 mm wide, with ridge to c. 0.2 mm high. *Seeds* often reniform, (2.5–)3–4 mm long, c. 2 mm wide; aril 1.5–2 mm long, 1–1.2 mm high, with base 0.7–1.2 mm long, with lobe curving 90–140° (Fig. 2c, e, f).

**Selected specimens from c. 200 exomined:** AUSTRALIAN CAPITAL TERRITORY: Mt Gingera, Brindabella Range, *M.Evans* 2565, 29.xi.1966 (AD,BRI, CANB, MEL, NSW); Mt Franklin, c. 0.5 km from chalet in direction of peak, *T.R.Lally & B.Lofoy* 452, 23.xi.1994 (CANB, NSW); 22 km S of Picadilly Junction, *W.Bishop* 584, 29.xii.1987 (CANB, MEL, NSW); lower slope of Mt Ginini, Brindabella Range, *R.Coveny* 11549 & *P.Hind*, 19.i.1983 (CANB, MEL, NSW). NEW SOUTH WALES: Coolamon Plains, *G.Singh*, 29.xi.1979 (CANB); W side of Port Philip Fire Trail, 0.7 km from Long Plain Rd, 3.1 km N of Rules Point, *P.C.Jobson* 5439 & *P.H.Weston*; 21.i.1998 (NSW); 16.7 km along Geehi Dam Rd from the Alpine Way, Kosciusko National Park, *R.Johnstone* 1523 & *A.E.Orme*, 20.i.2005 (NSW); 9 km along Cascade Trail from the Alpine Way, Kosciusko National Park, *A.J.Wholen* 293, 14.xii.1998 (CANB, NSW); Maragle Range, Mt Black Jack, *F.E.Davies* 479 & *S.Wolton*, 21.i.1988 (CANB, MEL, NSW); Constance's hut site, Burrungubugge River, Kosciusko National Park, *A.M.Lyne* 230, 28.i.1991 (CANB, MEL, NSW); near Eucumbene Lookout, Snowy Mts, *R.A.Goode* 520, 17.xi.1961 (NSW); Mt Kosciusko, *J.M.Curron*, i.1896 (NSW); near Tooma Pond, Kosciusko National Park, *A.M.Ashby* 3718, 21.xi.1970 (AD). VICTORIA: Delegate River Fen, near Old Bendoc–Bonang road, *E.A.Chesterfield* 42, 13.xi.1983 (CANB, MEL); Mt Bogong, *G.Weindorfer*, xii.1903 (MEL); Wall of Death, Hotham Heights, *D.E.Albrecht* 4948, 8.iv.1992 (CANB,



MEL); High Plains Rd, 0.8 km N of Falls Creek village, *N.G.Wolsh* 3285, 5.ii.1992 (MEL); between Mt Anderson and Mt Pinnibar, *A.C.Beoughlehole* 41569 & *K.C.Rogers*, 24.ii.1973 (MEL); Stoney Creek Fire Trail, 4.5 km NNE of The Horn, Mt Buffalo, *N.G.Wolsh* 3294, 18.ii.1992 (MEL); E side of The Horn Rd, 1.6 km N (by road) of The Horn, Mt Buffalo National Park, *P.C.Jobson* 4032, 31.xii.1995 (MEL, NSW); Mt Buffalo beside Lake Catani, *M.A.Todd* 216, 26.xi.1974 (MEL); Camping Ground, Mt Buffalo, *K.Czornij* 387, 5.xii.1971 (AD); Mt Buffalo summit, *C.J.Shepherd* 203, 1.xii.1965 (CANB).

**Flowering period:** Flowers from December to January.

**Distribution and habitat:** Occurs in north-eastern and far eastern Victoria, far south-eastern New South Wales, and along the western margin of the Australian Capital Territory. In Victoria it extends from Mt Buffalo ESE to the Delegate River east of Bonang, and in New South Wales its range extends from the Kosciusko region NNE to the Brindabella Ranges (Fig. 3c). Grows in heaths, shrubland and woodland, often bordering grasslands. Grows mostly above c. 800 m a.s.l. and extends into the alpine zone.

**Etymology:** The epithet refers to the indumentum of the abaxial surface of the leaves (from Latin, *sericeus*, silky).

**Notes:** *Bossiaea sericea* is moderately variable in leaf shape and bracteole length, with three geographically segregated forms. Forms from Mt Buffalo in north-eastern Victoria and the Brindabella Ranges and adjacent Coolamon Plain in the A.C.T. and south-eastern New South Wales have smaller, more angular leaflets that are more tuberculate on margins and less densely sericeous than the larger, more rounded leaflet form from locations such as Mt Hotham, the Bogong High Plains and ranges in far east Gippsland in Victoria, and from Kosciusko National Park in New South Wales. The leaflet-apex of the Brindabella and Mt Buffalo forms is usually not emarginate, whereas the apex in the higher altitude form can be. In far eastern Gippsland, the rounded leaflet form generally has larger stipules than other populations. The leaf representing *B. sericea* in Figure 2e and f (bottom left) is of the form. The leaves of the other two forms range between this shape and the shapes shown for *B. alpina* (bottom right). The form from the Brindabella Ranges and Coolamon Plain differs from the other two by having relatively long bracteoles (1.6–2.5 mm long compared to 0.7–1.5 mm long).

Leaflets of *B. sericea* lack tubercles (persistent hair-bases) or the tubercles are only present near the margin.

The surface is commonly quite smooth but also can be slightly uneven, at least when dry, due to some faint dark ridges between secondary veins.

**Hybridisation:** Probable hybridisation between *B. sericea* and *B. distichoclada* q.v. has been recorded in the Bogong High Plains in north-eastern Victoria (*J.H.Ross* 3635–7, 3640 all MEL) and further east at Limestone Creek (*N.G.Walsh* 2867 CANB, MEL, NSW). A specimen from Haydons Bog near Delegate (*Bauerlen*, 1899 NSW) may be a hybrid between *B. sericea* and *B. foliosa*. A small sterile plant collected from an unknown locality (Australia felix) in Victoria (*F.Mueller* MEL 668111) is possibly a hybrid between *Bossiaea sericea* and *B. prostrata*.

#### 4. *Bossiaea alpina* I.Thomps., sp. nov.

*A. B. foliosa* A.Cunn. *plantis humilioribus, foliis laevibus superne, calyce glabro, bracteolis longioribus differt.*

**Type:** Victoria. Surveyors Creek Camp, *D.E.Albrecht* 5195, 15.xii.1992; holotype: MEL 2017313; isotype: CANB n.v.

*Bossiaea foliosa* sensu G.Bentham, *Fl. Austral.* 2: 160 (1864), and subsequent Australian authors, *pro parte, non sensu stricto.*

**Diffuse shrubs** to c. 0.5 m high, with inflorescences borne typically on a ±regular series of short side-branchlets; branchlets erecto-patent, c. 0.5 mm wide, with a moderately dense indumentum of straightish hairs c. 0.3 mm long; epicuticular wax not developed. *Stipules* triangular, 0.7–1.5 mm long, erect to divergent, brown, glabrous, 5–10-nerved; stipule-petiole angle 30–60°. *Leaves:* petiole 0.2–0.5 mm long; articulation slightly geniculate, not ridged, sometimes obscure; lamina c. square or transversely oblong to oblong-elliptic, 1–2 mm long, 1–2.5 mm wide, with l:w ratio mostly 0.8–1.0, flat or more often concave, with each lamina half flat or gently convex, markedly discolourous; base symmetrical, c. truncate; margin slightly recurved, smooth or minutely tuberculate; apex truncate or broadly rounded, apiculum to c. 0.2 mm long, pointing forwards or down; upper surface smooth, with venation obscure, with gland-dotting not evident, glabrous; lower surface glabrous or sparsely hairy and then glabrescent, without white-dotting. *Inflorescences:* axes contracted; bract 2–3 mm long, 1.5–2 mm wide, moderately convex; pedicel

1.5–2.5 mm long, glabrous or with scattered hairs; bracteoles persistent, narrow-ovate or narrow-oblong, 2–3.5 mm long, with l:w ratio 2–3, loosely appressed over calyx, becoming slightly divergent at anthesis, inserted near base, moderately convex, many-nerved, glabrous, brown. *Calyx* 3–3.5 mm long, glabrous or sparsely hairy near apex of lobes, with tube c. equal to lobes; upper lobes 1.5–2 mm long, 0.8 mm wide; sinus c. 1–1.5 mm deep; lower lobes c. 1.5 mm long, 0.8–1 mm wide, flat; petals all similar in length, all entirely yellow; standard to c. 8 mm long; wing 1.5–2 mm wide; keel 2–2.5 mm wide; ovary hairy, 2-ovulate. *Pods* (only immature pods seen): stipe c. 1 mm long; body c. circular, 6 mm long, 5 mm wide, with whitish hairs c. 0.5 mm long throughout; upper margin c. 0.4 mm wide, with ridge not evident. Seeds not seen (Fig. 2d–f).

**Selected specimens from c. 10 examined:** VICTORIA. Tamboritha Saddle, near Chester's Hut, S of Bennison Plain, *N.G. Walsh* 974, 20.xi.1980 (MEL, NSW); Echo Flat, Lake Mountain, *N.G. Walsh* 908, 17.xii.1981 (MEL); The Bluff, c. 13 km SE of Mt Buller, *T.B. Muir* 960, 28.xii.1959 (MEL); unnamed track 100 m NE of Howitt Rd, 1.5 km NW of Guy's Hut, *R.H. Barley*, 19.xi.1980 (MEL); near Moroka Gap, 1.6 km SW of Mt Wellington, *T.B. Muir* 3744, 13.i.1965 (MEL); Lake Mountain, *E.J. Carroll*, 22.xii.1965 (CANB); Dry Creek, Howitt Plains, *T.M. Whaite* 64, 8.i.1949 (NSW).

**Flowering period:** Flowers from December to January.

**Distribution and habitat:** Occurs in south-eastern Victoria at Lake Mountain, Mt Buller and the Howitt Plains area (Fig. 3d). May warrant recognition as a rare species. Grows in subalpine or alpine heathland or heathy woodland.

**Etymology:** The epithet refers to the occurrence of this species in alpine and subalpine environments.

**Notes:** *Bossiaea alpina* is most closely related to *B. sericea* but is distinguished from that species by its smaller more sparsely hairy leaves, shorter petioles, larger, more distinctly striate and glabrous bracteoles, and glabrous calyx (Fig. 2d). Based on label data and some field observations, *B. alpina* has a considerably more diffuse habit than other members of Group A.

## Group B

*Erect shrubs*; branchlets mostly terete, with decurrencies not well-developed, moderately hairy, with hairs straight. *Stipules* relatively narrow and often with apex filiform, commonly recurved or deflexed, reddish-brown, hairy abaxially. *Leaves* with phyllotaxy variable, with articulation often spurred; lamina markedly discoloured, with margins often recurved to revolute, with midrib and apiculum generally robust, sometimes pungent. *Inflorescences*: axes mostly contracted, with scales 2; bracts and bracteoles small, nearly flat; pedicels often long and slender; bracteoles persistent, 0.8–1.5 (–2) times longer than wide, inserted in middle or distal thirds of pedicel. *Calyx* mostly glabrous; upper lobes broadening markedly from the base, broader than long, generally expanded beyond lateral angle; standard generally 1–2 mm longer than wings and keel; wings c. equal to keel; anthers relatively large. *Pods* with stipe equal to or slightly longer than calyx; body generally c. elliptic or oblong-elliptic, ±glabrous, with valves smooth (transverse venation generally obscure). *Seeds* mostly 2 or 3 per pod; aril long-based. (Fig. 4.)

Group B contains four species divided into two subgroups. Members of the group are most readily

### Key to Group B

- 1 Leaves all regularly opposite, with nodes well-spaced ..... **8. *B. kiamensis***
- 1: Phyllotaxy not as above, irregular and varying from alternate, to ±opposite to whorled on a single plant ..... **2**
- 2 Leaflets with l:w ratio > 8, with upper surface smooth; leaflet-articulation marked by a spur and by being geniculate (Grampians Ranges, Victoria only) ..... **6. *B. rosmarinifolia***
- 2: Leaflets with l:w ratio < 8, with upper surface usually minutely tuberculate; leaflet-articulation obscure or marked by a spur but not geniculate ..... **3**
- 3 A small spur marking position of leaflet articulation in at least some leaves; leaflets with l:w ratio mostly > 3; stipules inserted opposite each other; wings purplish-brown; pedicels commonly with some hairs ..... **5. *B. cinerea***
- 3: Leaflet articulation obscure (spur not developed); leaflets with l:w ratio mostly < 3; stipules inserted relatively close to each other (commonly forming a deflexed V); wings yellow except for reddish streaks basally; pedicels usually glabrous ..... **7. *B. cordifolia***





**Figure 4. Group B.** a. *Bassia cinerea* (T.B.Muir 5545 MEL); b. *B. cordifolia* (T.B.Muir 5091 MEL); c. *B. kiamensis* (I.R.Telfard 237 CANB); d. *B. rasmariniifolia* (T.B.Muir 866 MEL); e. *B. kiamensis*, leaf and stipules (I.R.Telfard 237 CANB); f. *B. cordifolia*, leaf and stipules (H.Farde, x.1905 NSW); g & h. *B. cordifolia*, seed, left and right lateral views (I.R.Thompson 1466 MEL); i. *B. cinerea*, seeds attached inside pod (I.R.Thompson 1436 MEL). Scale bars: a, b, d = 5 mm, c = 10 mm, e, f, i = 2 mm, g, h = 0.5 mm.

identified by leaf and bracteole morphology. Species in Group B occur in south-eastern New South Wales, southern Victoria, far south-eastern South Australia, and Tasmania (Fig. 5).

The Cinerea subgroup (species 5–7) is well-defined. The three members have irregular phyllotaxy, with the arrangement varying from alternate to opposite to whorled on a plant, and all have long, slender pedicels and small, distally inserted bracteoles. *Bossiaea kiamensis* (8) forms a subgroup on its own and is placed in Group A because of similarities to the Cinerea subgroup in leaf and pod morphology. In other respects, notably its opposite leaves, it is closer to the Cordigera subgroup of Group C.

## The Cinerea subgroup

### 5. *Bossiaea cinerea* R.Br., in W.T.Aiton, *Hortus Kew.*, 2nd edn, 4: 268 (1812)

**Type:** not designated. [Protologue: 'Native of Van Diemen's Island, Robert Brown, Esq. Introd. 1805'] Tasmania. Port Dalrymple, R.Brown, 1.i.1804; lectotype (here selected): BM 000885933, image seen in JSTOR Plant Science.

Residual syntypes: Tasmania. Derwent River, R.Brown, 1802–05: BM 000885939, MEL 1528714, MEL 1528715, MEL 1528716; possible residual syntype: Tasmania. Locality unknown: CANB 00278253 (see discussion below).

*Bossiaea coccinea* Bonpl., in A.Bonpland, *Descr. Pl. Malmaison* 128, t. 52 (1813). **Type:** not designated. [Protologue: 'Habitat in Nova Hollandia'. Described from a plant presumably cultivated at Jardin de la Malmaison, Paris, France.] Holotype: t. 52 in Bonpland, *Descr. Pl. Malmaison* 128 (1813).

*Bossiaea tenuicaulis* Graham, *Edinburgh New Philos. J.* 29: 171 (1840); *B. cinerea* var. *tenuicaulis* (Graham) J.M.Black, *Fl. S. Australia* 2: 304 (1929). **Type:** not designated. [Protologue: 'This plant was raised at the Botanic Garden, Edinburgh, from Van Diemen's Land seeds sent by Mr Cooper, Wentworth House, in Apr. 1836.']

*Erect shrubs* to c. 2 m high, with inflorescences borne typically on longer branchlets rather than a regular series of short side-branchlets; branchlets erecto-patent, c. terete or angular, 0.5–1 mm wide, with hairs

0.3–0.8 mm long; epicuticular wax generally absent. *Stipules* narrow-triangular to filiform, 1–3 mm long, erect or more often becoming markedly recurved, reddish, hairy, with venation obscure; stipule-petiole angle mostly 30–60°. *Leaves* alternate, sub-opposite, opposite or in whorls of 3 in varying proportions on a single plant; petiole 0.2–0.5 mm long; articulation not geniculate, obscure except when marked by a spur 0.1–1 mm long; spur present on most leaves, or rarely uncommon on a plant; lamina narrow-ovate to narrow-lanceolate or narrow-triangular, 10–20 mm long, 1.5–6 mm wide, with l:w ratio mostly 3–8, slightly convex each side of midrib, becoming strongly convex laterally, markedly discolorous; base symmetrical, - broadly rounded or truncate; margin recurved or revolute, occasionally undulate, sometimes with a few persistent hairs; apex narrowly acute; apiculum 0.4–1.2(–2) mm long, sometimes pungent, sometimes somewhat brittle, pointing forward or slightly down; upper surface smooth or tuberculate, with venation commonly raised, with gland-dotting not evident, glabrescent; lower surface usually hairy. *Inflorescences:* axes contracted or rarely to c. 1 mm long; bract c. 1 mm long, c. 0.5 mm wide, slightly convex; pedicel 2–11 mm long, mostly sparsely hairy; bracteoles persistent, mostly broad-ovate, 0.2–1 mm long, with l:w ratio c. 1, appressed, inserted in middle or more often distal third, slightly convex, ±flat towards apex, faintly 1-nerved or with venation obscure, glabrous or with a few hairs distally, dull brown. *Calyx* 2.5–4.5 mm long, glabrous or less often hairy, with tube equal to or slightly longer than upper lobes; upper lobes 1.5–2 mm long, 2.5–3.5 mm wide, expanded beyond lateral angle by 0.3–1 mm; lateral angle acute or acuminate; sinus 1–1.5 mm deep; lower lobes 0.6–1 mm long, c. 0.6 mm wide, with lateral lobes flat; standard to c. 12 mm long, slightly longer than wings and keel; adaxially yellow with a red flare, with throat generally not or not fully bisected, abaxially reddish almost throughout; wings c. as long as keel, c. 2.5 mm wide, purplish brown, sometimes yellowish near apex, also variously streaked red proximally and ventrally; keel c. 3 mm wide, red throughout; anthers c. 0.4 mm long post-dehiscence; ovary glabrous or rarely with hairs along lower suture, commonly 4-ovulate; style 3–4 mm long. *Pods:* stipe 3–5 mm long; body c. elliptic, 10–16 mm long, 6–9 mm wide, glabrous or rarely sparsely hairy along lower suture; upper margin c. 0.8 mm wide, with



ridge to c. 0.5 mm high. *Seeds* 3–4 mm long, 2–3 mm wide; *aril* 1.5–2.5 mm long, 1–1.5 mm high, with base 1–2 mm long, with lobe curving 90–135° (Fig. 4a, i).

**Selected specimens from c. 250 examined:** **SOUTH AUSTRALIA:** W side of Mt Burr golf course, *P.Gibbons* 25, 4.x.1981 (AD, MEL); Hundred of Hindmarsh, section 455, c. 25 km NW of Mt Gambier, *B.Bloylock* 23, 5.ix.1965 (AD); Cave Range, c. 50 km S of Naracoorte, *D.Hunt* 476, 26.xi.1961 (AD). **VICTORIA:** Gippsland Hwy, c. 2 km SE of Cranbourne, *T.B.Muir* 1264, 29.ix.1960 (MEL); Rotamah Island, The Lakes National Park, *I.Crawford* 477, 11.ix.1986 (MEL); N margin of Holey Plains State Park, *M.G.Corrick* 10035, 24.xi.1986 (MEL); Five Mile Beach, Wilsons Promontory National Park, *P.G.Abell* 264 & *C.Herscovitch*, 4.xii.1986 (MEL, NSW); Forest Camp Track, Glenelg National Park, *R.J.Fletcher* 180, 15.ix.1993 (MEL); Yarram Gap, Grampians National Park, *A.C.Beuglehole* 3091B, 8.ix.1969 (AD, MEL); Jimmys Creek area, 26 km S of Halls Gap PO, *A.C.Beuglehole* 66934, 6.xii.1979 (MEL). **TASMANIA:** Track to E-shape Lagoon, Flinders Island, *J.S.Whinroy* 9213, undated (AD, CANB, HO, MEL, NSW); Waterhouse Reserve, near One Tree Hill, *A.M.Buchonon* 1521, 21.xi.1983 (HO); NE of Risdon Brook reservoir, *A.C.Rozefelds* 1427, 3.ix.1999 (HO).

**Flowering period:** Flowers in late July to November.

**Distribution and habitat:** Occurs in far south-eastern South Australia, southern Victoria and in Tasmania (Fig. 5a). An old record label giving West Pymble, in New South Wales (*Hellyer*, 1964 NSW) is considered to be an error. Grows in sandy to loamy soils in heathland, scrub, woodland and forest.

**Notes:** *Bossiaea cinerea* is unique in having leaves in which the leaflet-articulation is indistinct except in being marked by a spur. Other species that develop a spur also have a geniculate articulation. Yellow-flowered forms, *i.e.*, with red markings lacking, have been occasionally collected, *e.g.*, in Melbourne (*S.Rennick* 109

MEL) in south-central Victoria, and Edenhope in south-western Victoria (*Summerhayes*, MEL). All populations of *B. cinerea* in the Grampians Ranges in south-western Victoria differ from the typical form in having flowers with a hairy calyx and with several long hairs on the lower margin of the ovary. In addition, the leaves of the Grampians form generally have a more robust and more elongate apiculum.

**Typification:** Lee (1970) indicated that a sheet at BM, with labelling indicating Port Dalrymple was the site of collection, was presumed to be the holotype. Brown did not designate a type and is likely to have used material from both Port Dalrymple and the Derwent River. I do not consider that Lee effectively lectotypified this sheet in 1970 by her presumption. I here select this same sheet, now barcoded BM 000885933, as the lectotype of *B. cinerea*. It bears three pieces, with mature fruit evident on two of them as would be expected for January. CANB 278253, received from BM, has previously been identified as type material. The label gives Port Dalrymple, which suggests it may be an isolectotype; however, the single piece bears flower buds just prior to anthesis. I consider it impossible for this to have been collected in January by Brown, so it appears that a labelling error has been made. Nevertheless the material may still be type material; it may have been collected by Brown in late winter while still in southern Tasmania, or it may have been passed on to him.

**Hybridisation:** Probable hybrids between *B. cinerea* and *B. rosmarinifolia* have been recorded from the Grampians Ranges in south-western Victoria (*J.Westaway* 263 MEL; *H.Williamson*, xi.1902 NSW; *M.Corrick* 5317 AD, MEL).

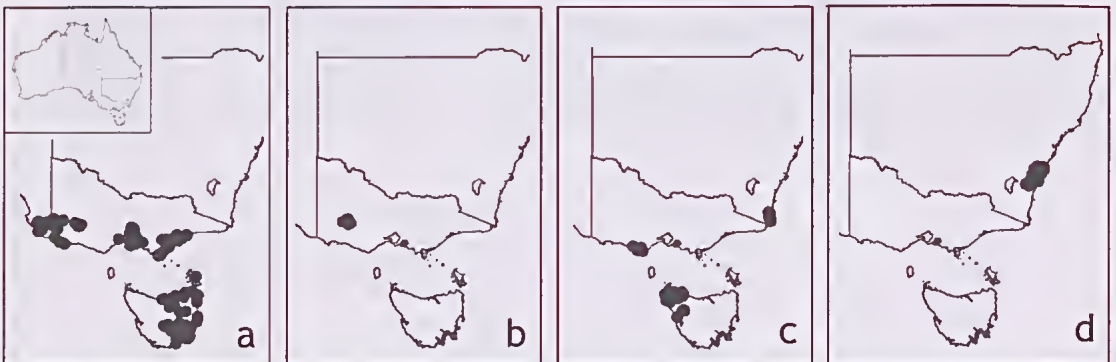


Figure 5. Distributions of species in Group B. a. *Bossiaea cinerea*; b. *B. rosmarinifolia*; c. *B. cordifolia*; d. *B. kiomensis*.

**6. *Bossiaea rosmarinifolia* Lindl., in T.L.Mitchell, *Three Exped. Australia* 2: 178 (1838)**

*Bossiaea cinerea* var. *rosmarinifolia* (Lindl.) Benth., *Fl. Austral.* 2: 160 (1864).

**Type:** not designated. [Protologue: No locality information with the description but deduced to be collected on Mt William in the Grampians Ranges from other commentary in the text.] Victoria. Mt William, T.L.Mitchell, vii.1836; probable isotype: K 000278329, *vide* A.S.George, *in sched.*, image seen in Kew Herbarium Catalogue. Type material likely to be located at CGE also, *n.v.*

*Erect shrubs* to c. 3 m high, with inflorescences borne typically on longer branchlets rather than a regular series of short side-branchlets; branchlets erecto-patent, terete, c. 1 mm wide, with hairs 0.5–0.8 mm long; epicuticular wax often developed. *Stipules* setaceous, 2–4 mm long, commonly recurved and somewhat twisted, reddish, soon glabrescent, with venation obscure; stipule-petiole angle mostly c. 30–60°. *Leaves* alternate or a smaller proportion sub-opposite, opposite or in whorls; petiole 0.5–1.2 mm long; articulation usually slightly geniculate, with a spur mostly 0.5–1 mm long; lamina narrow-lanceolate to narrow-linear, 20–30 mm long, 1–5 mm wide, with l:w ratio mostly 8–25, flat or slightly convex abaxially, markedly discolorous; base symmetrical, rounded; margin revolute, not undulate, glabrous; apex narrowly acute; apiculum 1–2 mm long, mostly pungent, not downcurved; upper surface smooth, with midrib distinct, but secondary venation generally obscure, with gland-dotting not evident, soon glabrescent; lower surface glabrescent. *Inflorescences:* axes contracted; bract 0.3–0.5 mm long, c. 0.4 mm wide, slightly convex abaxially, generally hidden by scales; pedicel 3–8 mm long, hairy, with hairs often extending onto receptacle; bracteoles persistent, mostly broad-ovate, 0.3–0.8 mm long, with l:w ratio c. 1, appressed, inserted in distal third, slightly convex, with apex flat, with venation obscure, sparsely hairy distally, dull brown. *Calyx* 3–4.5 mm long, glabrous, with tube equal to or slightly longer than upper lobes; upper lobes 1–2.5 mm long, 2.5–3 mm wide, expanded beyond lateral angle by 0.3–1 mm; lateral angle acute or more often acuminate; sinus c. 1 mm deep; lower lobes 0.6–1 mm long, c. 0.5 mm wide, with lateral lobes flat; standard to c. 12 mm long, slightly longer than wings and keel,

adaxially yellow with a red flare, abaxially similar or flushed red over most of surface; wings c. as long as keel, c. 2.5 mm wide, yellow except for red or brownish-red marks proximally or in lower half; keel c. 3.5 mm wide, red  $\pm$ throughout; anthers 0.5–0.6 mm long post-dehiscence; ovary glabrous except for a few long hairs commonly present in distal half and on lower margin, 3- or 4-ovulate; style 3–4 mm long. *Pods:* stipe 3–5 mm long; body c. elliptic, 10–15 mm long, 6–8 mm wide, glabrous or rarely with a few persistent hairs on lower margin; upper margin c. 0.8 mm wide, hardly ridged. *Seeds* 3–4 mm long, 2–2.8 mm wide; aril c. 2 mm long, c. 1.2 mm high, with base 1.5–2 mm long, with lobe curving c. 90° (Fig. 4d).

**Selected specimens from c. 30 examined:** VICTORIA: Silverband Rd, Grampians, T. & J. Whaité 1554, 31.x.1953 (NSW); Halls Gap–Dunkeld road, 19.2 km S of Halls Creek, R.C. Weston 114, 14.x.1984 (CANB, MEL); Mt Rosea, Grampians, M.E. Phillips 496, 4.xi.1971 (CANB, NSW); Bovine Creek crossing on Halls Gap–Dunkeld road, Grampians National Park, J.H. Ross 3803, 22.ix.1996 (MEL); Halls Gap, C.D. Alton, x.1923 (AD).

**Flowering period:** Flowers in September and October.

**Distribution and habitat:** Occurs in the Grampians Ranges of south-western Victoria (Fig. 5b). Categorized as rare in Australia (Walsh & Stajsic 2007). Grows in dry sclerophyll open forest.

**Notes:** *Bossiaea rosmarinifolia* is immediately distinguished from other eastern Australian species by the high length to width ratio of its leaves. It is also distinguished from *B. cinerea*, probably its closest relative, by its longer petioles, geniculate articulation, smooth leaf-lamina, and standard and wing petals that are less extensively marked red or purplish-brown. The flower-bud often has a very pronounced beak, which is formed from the filiform apices of the calyx-lobes. It usually has a few hairs nearer the distal end of the lower suture of the ovary and these hairs can persist until the developing fruit is more or less a mature size. These hairs distinguish it from the other members of the subgroup except for the Grampians form of *B. cinerea*.

**Typification:** Type material is likely to be housed at CGE, where Lindley's herbarium is housed, but unfortunately this has not been verified at this time. I have seen an image of K 000278329 which is labelled as Mt William, July, 37 ½ S, 142 ¾ E, New South Wales, Mitchell's Expedition 1835. No. 256. It was annotated



as probable isotype by Alex George in 2005. The date on the label is a mistake as the year of Mitchell's third expedition was 1836. The origin of another piece on the same sheet, K 000278330 is unclear from the label.

**Hybridisation:** Probable hybrids between *B. cinerea* and *B. rosmarinifolia* have been recorded from the Grampians Ranges in south-western Victoria (*J. Westaway* 263 MEL; *H. Williamson*, xi.1902 NSW; *M. Corrick* 5317 AD, MEL).

**7. *Bossiaea cordifolia* Sweet, *Fl. Australas.* (Sweet): 20, pl. 20 (1827)**

**Type:** not designated. [Protologue: '... raised from seed, sent by Mr. Henschman's Collector, Mr. William Baxter, who collected them on the south coast of New Holland ...'] Holotype: pl. 20 in *Fl. Australas.* (Sweet): 20 (1827). Epitype (here selected): New South Wales. Pambula, *H. Forde*, x.1905: NSW 43671.

*Bossiaea cinerea sensu* G. Bentham, *Fl. Austral.* 2: 160 (1864), and subsequent Australian authors, *pro parte*, *non sensu stricto*.

*Erect shrubs* to c. 3 m high, with inflorescences borne usually on longer branchlets rather than a regular series of short side-branchlets; branchlets erecto-patent to almost spreading, terete, c. 0.5 mm wide, with hairs 0.3–0.8 mm long; epicuticular wax not developed. *Stipules* narrow-triangular to filiform, 1–3 mm long, recurved or deflexed, reddish, hairy at first, with venation obscure; stipule-pair somewhat adjacent, forming an angle of c. 30–140° with each other; stipule-petiole angle not generally measurable due to deflexing. *Leaves* variously arranged along a branch, mostly alternate, but also c. opposite or in whorls; petiole 0.3–0.8 mm long; articulation obscure; lamina triangular-ovate, 5–12 mm long, 2–7 mm wide, with l:w ratio mostly 1.2–2, but occasionally up to 4, convex laterally, markedly discolorous; base symmetrical, cordate, truncate or broadly rounded; margin recurved or slightly revolute, often undulate, occasionally with a few hairs; apex narrowly acute; apiculum 1–2 mm long, pungent, not downcurved; upper surface smooth or minutely tuberculate, with venation generally slightly raised, glabrous or sparsely hairy; lower surface commonly glabrous except for veins, sometimes hairy throughout. *Inflorescences:* axes contracted or to

c. 2 mm long; hairy; bract c. 0.5 mm long, c. 0.3 mm wide, slightly convex; pedicel 3–15 mm long, glabrous, or occasionally sparsely hairy proximally; bracteoles persistent, variously shaped, 0.3–0.6 mm long, with l:w ratio 0.5–1, ± appressed, inserted in distal third mostly, slightly convex, with apex flat or slightly recurved, with venation obscure, glabrous, dull brown. *Calyx* 3–4 mm long, glabrous, with tube longer than upper lobes; upper lobes 1.5–2.5 mm long, 2.5–3.2 mm wide, often expanded beyond lateral angle by up to c. 0.5 mm; lateral angle acuminate; sinus c. 1 mm deep; lower lobes c. 1 mm long, c. 0.6 mm wide, with lateral lobes ± flat; standard to c. 11 mm long, slightly longer than wings and keel, adaxially yellow with a red flare, abaxially often red over much of surface; wings c. 2.5 mm wide, yellow, sometimes with a small red mark proximally; keel 3–3.5 mm wide, red ± throughout; anthers 0.5–0.6 mm long post-dehiscence; ovary glabrous, 3- or 4-ovulate; style 3–4 mm long. *Pods:* stipe 3–7 mm long; body c. elliptic, 15–20 mm long, 5–7 mm wide, glabrous; upper margin c. 0.8 mm wide, with ridge 0.5 mm high. *Seeds* 3–4 mm long, 2–2.5 mm wide; aril 1–2 mm long, 1–1.5 mm high, with base c. 1.2 mm long, with lobe curving 60–120° (Fig. 4b, f–h).

**Selected specimens from c. 50 examined:** **NEW SOUTH WALES:** c. 2 km W by track from Lennards Island, NE of Eden, *D.E. Albrecht* 998, 26.ix.1984 (MEL, CANB); opposite aerodrome, Merimbula, *E.F. Constable* 5494, 3.xi.1964 (CANB, NSW); 3 km N of Merimbula, on Merimbula–Tathra road, *T.B. Muir* 5091, 26.viii.1973 (MEL); junction of Chipmill Rd and road to Boyd's Tower, *M.G. Corrick* 6030, 18.ix.1978 (CANB, HO, MEL). **VICTORIA:** 5 km WNW of Lavers Hill PO, *A.C. Beauglehole* 67375, 19.xii.1979 (MEL); c. 5 km S of Chapple Vale, *H.I. Aston* 814, 16.xi.1960 (MEL); Black Range, *E. Ashby*, xi.1937 (AD). **TASMANIA:** Rocky Cape, *L. Richley*, 13.x.1975 (HO); Exploration Creek, Newhaven Track, *A.M. Buchanan* 15452, 29.vi.1999 (HO); Lake Ashwood, 6 km NE of Strahan, *A.E. Orchard* 5739, 6.xii.1981 (AD, HO); 5 km S of Marawah, *A.M. Buchanan* 14003, 4.x.1995 (CANB, HO).

**Flowering period:** Flowers from late winter to early summer.

**Distribution and habitat:** Occurs in far south-eastern New South Wales, the Otway Ranges of south-western Victoria and in western Tasmania (Fig. 5c). Grows in open forest and heathland.

**Notes:** *Bossiaea cordifolia* has a distinctive stipule orientation. Stipules are inserted somewhat adjacent to one another, rather than on opposite sides of the leaf

attachment point, and they tend to become deflexed with age (Fig. 4f). The angle formed by the deflexed stipules varies from about 30° to 140°, and often they appear to be connected via a slender rim. In other species stipules do not usually become deflexed, even though they may be strongly reflexed, and they are always inserted opposite each other. *Bossiaea cordifolia* can also be distinguished from other two species in the Cinerea subgroup by the leaflets which have an obscure articulation and are more triangular-ovate and with a lower length:width ratio. Its longer, more pungent leaf-apiculum, glabrous pedicels, and yellow wing petals usually distinguishes it from *B. cinerea*. It is geographically well-separated from both *B. cinerea* and *B. rosmarinifolia*.

A sterile specimen from Nelson Bay River on the west coast of Tasmania (F.E.Davies 1153 CANB) has leaves intermediate between those of *B. cordifolia* and *B. cinerea*. Further collections from this area are desirable.

**Typification:** The holotype illustration is recognisable as likely to be *B. cordifolia* rather than *B. cinerea* based on the leaflet shape and the yellow wing petals. However, to make the application of the name more certain, I here select an epitype, H.Forde, x.1905, NSW 43671, for the holotype illustration.

## The Kiamensis subgroup

### 8. *Bossiaea kiamensis* Benth., *Fl. Austral.* 2: 158 (1864)

**Type:** [Protologue: 'N. S. Wales. Near Kiama, Illawarra, Backhouse!'] New South Wales. Near Kiama, Illawarra, J.Backhouse, date unknown; lectotype (here selected): K 000278246, image seen in Kew Herbarium Catalogue; isolectotype: K 000278247, image seen in Kew Herbarium Catalogue.

*Erect shrubs* to c. 3 m high, with inflorescences borne on longer branchlets or on a regular series of short side-branchlets; branchlets erecto-patent, mildly compressed at first, c. 1 mm wide, with hairs 0.2–0.5 mm long, glabrescent; epicuticular wax sometimes developed. *Stipules* narrow-triangular, 1.5–4 mm long, erect, red-brown, gradually glabrescent, 1–3-nerved; stipule-petiole angle 30–80°. *Leaves* opposite; petiole 1–1.5 mm long; articulation strongly geniculate, with a spur 0.3–0.8 mm long; lamina narrow-elliptic, 10–35

mm long, 2–7 mm wide, with l:w ratio 2–6, or rarely to c. 10, flat or gently convex each side of midrib, markedly discolorous; base symmetrical, rounded; margin almost flat to recurved, glabrous, minutely knobby; apex subacute to acute; apiculum 0.3–1 mm long, generally brittle, pointing forwards; upper surface smooth, with venation raised, brochidodromous, glabrous; lower surface glabrescent. *Inflorescences:* axes contracted or more often to c. 2 mm long, densely hairy; bract 0.5–1 mm long, c. 0.5 mm wide, gently convex; pedicel 3–7 mm long, hairy or glabrous, usually wrinkled longitudinally below receptacle; bracteoles persistent, ovate, 0.4–1 mm long, with l:w ratio 1–2, ±appressed, inserted in distal half, convex, nearly flat at apex, with venation obscure, glabrous or with a few medial hairs, mid-brown or red-brown. *Calyx* 4–5 mm long, glabrous, with tube as long as or shorter than upper lobes; upper lobes 2–3 mm long, 3–4 mm wide, expanded beyond lateral angle by 1–2 mm; lateral angle acuminate; sinus 1–2 mm deep; lower lobes 1–1.5 mm long, c. 0.5 mm wide, with lateral lobes convex; standard to c. 12 mm long, slightly longer than wings and keel, adaxially yellow with a red flare, with throat bisected, abaxially generally red, with pale radiating nerves medially; wings as long as or marginally longer than keel, 2–3 mm wide, light purplish-brown with red streaks, sometimes grading to dirty yellowish distally; keel 3–4 mm wide, red throughout; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, 3-ovulate; style c. 3 mm long. *Pods:* stipe 3–4 mm long; body c. elliptic, 10–15 mm long, 7–8 mm wide, glabrous; upper margin c. 0.7 mm wide, with ridge to c. 0.5 mm high. *Seeds* 3–3.5 mm long, 2–2.5 mm wide; aril 1.5–2.5 mm long, c. 1 mm high, with base 1–1.5 mm long, with lobe curving 90–130° (Fig. 4c, e).

**Selected specimens from c. 90 examined:** **NEW SOUTH WALES:** The Castle, Budawang Range, I.R.Telford 237, 22.ix.1967 (CANB); car park at end of Tin Mine Rd (off 12 Mile Rd), Morton National Park, K.L.McDougall 961, 5.ix.2001 (MEL); Clyde Mountain, O.D.Evans 1703, 15.ix.1926 (CANB); Budderoo National Park, Barren Grounds Nature Reserve, F.E.Davies 409 & T.Mulcahy, 7.xii.1987 (CANB, NSW); Round Hill, c. 5 km S of Sassafras, SW of Nowra, E.F.Constable, 20.ix.1961 (MEL, NSW).

**Flowering period:** Flowers in September and October.

**Distribution and habitat:** Occurs from Kiama south to Batemans Bay in south-eastern New South Wales, on near-coastal slopes and mountains (Fig. 5d). Grows in open forest.



**Notes:** *Bossiaea kiamensis* is readily identified by its regularly opposite leaves, a strongly discolorous leaflet which is much longer than wide, and a petiole that is strongly spurred at the articulation (Fig. 4e). Apart from opposite leaves, *B. kiamensis* has a number of other features linking it to the *Cordigera* subgroup, including the retrorsely-directed lateral angle of the upper calyx-lobes and the short axis on which inflorescence scales and inflorescences are raised. Pedicels in *B. kiamensis* are stouter and fleshier than those of the *Cinerea* subgroup and have conspicuous decurrencies below the bracteoles. Other distinctive features of *B. kiamensis* are the convex lower calyx-lobes and verrucose branches and branchlets. The verrucosities become exposed as the indumentum is lost. Two inflorescences, one per axil, are frequently developed at a node. In contrast, in *B. cordigera* and *B. lenticularis* (*Cordigera* subgroup), the other two species with opposite leaves, an inflorescence usually only develops in one of the axils.

**Typification:** There is one sheet available for viewing in the Kew Herbarium Catalogue containing type material of *B. kiamensis*. I believe all the pieces on the page to be from the original collection by Backhouse and would have been seen by Bentham. The specimens bear flowers. The material is split into two groups (two barcode identifiers), with three pieces associated with a Herbarium Hookerianum stamp designated as K 000278246, and two pieces associated with a Herbarium Benthamianum stamp designated as K 000278247. The label associated with K 000278246 matches the protologue better and I therefore choose it as the lectotype of *B. kiamensis*. Lee in (1970) indicated that A.B. Court had seen 'the Holotype'; however, it is unclear whether Lee was referring to the sheet described above or to another sheet that I have not seen.

## Group C

*Prostrate or low-growing subshrubs or weakly erect shrubs*; branchlets in 1 or 2 regular series, short, widely divergent to spreading; terete, with decurrencies absent or poorly developed. *Stipules* relatively narrow, brown or reddish, often with apex filiform, commonly recurved. *Leaves* small, not or not much longer than broad, with articulation sometimes obscure, with apiculum sometimes slender and recurved. *Inflorescences*: axes with scales 2; bracteoles persistent, 1–2 times longer

than wide, sometimes divergent, generally inserted beyond mid-pedicel. *Calyx* with upper lobes broadening from the base, broader than long, mostly expanded well beyond lateral angle; standard often completely reddish or brownish abaxially; keel with red marking restricted to distal half. *Pods* commonly narrow-oblong. *Seeds* often 4 or more per pod, small; aril with a short base and strongly arched lobes (Fig. 6).

Group C contains five species, and occurs in south-eastern Queensland, eastern New South Wales, southern Victoria, and Tasmania (Fig. 7). It comprises two well-defined subgroups, the *Cordigera* subgroup and the *Buxifolia* subgroup. Generally speaking, it is similar to Group B in stipule, bracteole and calyx morphology and in having markedly discolorous leaves. The *Cordigera* subgroup has similarities to *B. kiamensis* in particular. The *Buxifolia* subgroup has similarities to group D and to the *Brownii* subgroup of Group E.

The *Cordigera* subgroup (species 9 & 10) differs from all other eastern species in its branching pattern and in a combination of leaf characters: leaves are opposite, small, as broad as long, and with slender petioles (0.1–0.2 mm in diameter; Fig. 6e, f). Elongation of the inflorescence axis below the inflorescence scales is typical in this subgroup. Compared to the *Buxifolia* subgroup they have pods with longer stipes, larger anthers, and upper calyx-lobes with the lateral angle pointing retrorsely. The shapes and relative sizes of calyx-lobes in this subgroup as well as that of *B. decumbens* in the *Buxifolia* subgroup are reminiscent of the morphology seen in *Platylobium*.

The *Buxifolia* subgroup (species 11–13) has bracteoles that are distinctive in tending to be inserted somewhat adjacent to each other on the upper side of the pedicel rather than on opposite sides of the pedicel, and in being more divergent from the pedicel (Fig. 6d). The apiculum of leaves is often slender, dark and brittle, and often recurved to slightly hooked (Fig. 6c). Flowers are often relatively few and sporadic later flowering appears to occur more often than in other leafy species of eastern *Bossiaea*. The pod-stipe is much shorter than the calyx. The *Buxifolia* subgroup resembles the *Prostrata* and *Scortechinii* subgroups of Group D in being prostrate to generally low-growing plants with short-stipitate, narrow-oblong pods with hairy margins, but also resembles the *Brownii* subgroup of Group E in having almost terete branchlets and leaflets with asymmetric bases.



**Figure 6. Group C.** a. *Bossiaea decumbens* (N.G. Walsh 1848 MEL); b. *B. lenticularis*, (R. Coveny 11912o CANB); c. *B. neaanglica*, leaves (P.C. Jabson 5203 MEL); d. *B. buxifolio*, bracteales (G.W. Corr 10143 MEL); e. *B. cardigero*, leaves and flower buds (A. Simsan 1819 HO); f. *B. lenticularis*, inflorescence shortly after anthesis showing inflorescence axis with elongation below the scales, and reflexed upper calyx lobes. Arrow is pointing to the two scales and the bract (R. Coveny 11912o CANB). Scale bars: a, b = 10 mm, c-f = 2 mm

## The *Cordigera* subgroup

### 9. *Bossiaea lenticularis* Sieber ex DC., *Prodr.* 2: 117 (1825)

**Type:** [Protologue: 'Sieb! pl. exsic. nov.-holl. n. 425'] New South Wales. Location unknown, *F. Sieber* 425, date unknown; holotype: G-DC, images seen MEL; isotypes: MEL 668121, MEL 668122, NSW 606082.

*Sprawling to erect shrubs* to c. 1.5 m high, with inflorescences borne on a regular series of very short, side-branchlets which in turn are produced along a regular series of spreading side-branches; branchlets spreading, terete, c. 0.4 mm wide, glabrous or sparsely hairy, glabrescent; hairs 0.1–0.2 mm long; epicuticular

wax absent. *Stipules* narrow-triangular, 0.4–1(–3) mm long, erect, brown, glabrous, with venation obscure; stipule-petiole angle 30–90°. *Leaves* opposite; petiole 0.4–1.2 mm long; articulation usually slightly to strongly geniculate, ridged; lamina circular, oblate, broad-ovate, occasionally broad-obovate or rhomboid-elliptic, 2–5 (–8) mm long, 2–6(–8) mm wide, with l:w ratio mostly 0.8–1.1, flat, markedly discolorous; base symmetrical, broadly rounded, truncate or shallowly cordate; margin slightly recurved, sometimes minutely tuberculate; apex broadly rounded to subtruncate; apiculum not developed; upper surface smooth, with venation mostly obscure, glabrous; lower surface glabrous. *Inflorescences:* axes usually 1–5 mm long, with scattered hairs or glabrous; bract 0.5–1 mm long, c. 0.3 mm wide, convex;



## Key to Group C

- 1 Leaves opposite.....2  
 1: Leaves alternate.....3
- 2 Leaflets c. orbicular, with base not or only slightly cordate; branchlets and pedicels glabrous; pedicel < 5 mm long (New South Wales)..... **9. *B. lenticularis***
- 2: Leaflets mostly broad-ovate, with base cordate; branchlets and pedicels hairy, pedicel > 5 mm long (Victoria and Tasmania)..... **10. *B. cordigera***
- 3 Pedicels < 6 mm long; ovary and pod hairy on valves and margins, or if sometimes hairs absent or very few on valves then calyx glabrous; leaflet apiculum typically > 0.5 mm long..... **13. *B. neoanglica***
- 3: Pedicels mostly > 6 mm long; ovary and pod with hairs on margins only; calyx hairy; leaflet apiculum typically < 0.5 mm long.....4
- 4 Upper lobes of calyx 1.5–3 mm longer than lower lobes; keel > 6 mm long; style 2.5–6 mm long..... **11. *B. decumbens***
- 4: Upper lobes of calyx c. 0.5 mm longer than lower lobes; keel < 6 mm long; style 1–2 mm long..... **12. *B. buxifolia***

pedicel 3–7 mm long, glabrous; bracteoles persistent, ovate, 0.5–1 mm long, with l:w ratio c. 1–1.5, appressed, inserted in middle third, mostly beyond mid-pedicel, convex, with venation usually obscure, glabrous, brown or red-brown. *Calyx* 4–5 mm long, glabrous, with tube c. as long as upper lobes; upper lobes 2–2.5 mm long, 3–4 mm wide, expanded beyond lateral angle by 1.5–2.5 mm; lateral angle acute or occasionally acuminate; sinus c. 2 mm deep; lower lobes c. 1 mm long, c. 0.5 mm wide, with lateral lobes often slightly convex; standard to c. 12 mm long, similar in length to wings and keel, adaxially yellow with a red flare, abaxially often flushed red medially; wings c. as long as keel, c. 2 mm wide, yellow; keel c. 3 mm wide, pale proximally, red distally; anthers c. 0.6 mm long post-dehiscence; ovary glabrous, 4–6-ovulate; style 2.5–4 mm long. *Pods*: stipe 5–12 mm long; body elliptic, rhomboidal or oblong, 10–20 mm long, 5.5–8 mm wide, glabrous; upper margin c. 0.7 mm wide, with ridge to c. 0.3 mm high. *Seeds* 2.5–3.5 mm long, 1.5–2 mm wide; aril 1.2–2 mm long, c. 1 mm high, with base c. 1 mm long, with lobe curving 90–130° (Fig. 6f).

**Selected specimens from c. 60 examined:** NEW SOUTH WALES: Mt Wilson, C.Burgess, 9.xi.1962 (CANB); Thirlmere, C.Burgess, 11.x.1961 (CANB); road to Oakdale State Coal Mine, c. 5 km NNW of Oakdale, R.Coveny 11912 & P.Weston, 27.ix.1984 (CANB, NSW); South Maroota, c. 0.9 km along Paulls Rd from the Windsor–Wisemans Ferry Rd, A.E.Orme 176 & R.G.Coveny, 27.x.2001 (BRI, CANB, MEL); Morts Gully, Lithgow, J.L.Boorman, 30.x.1914 (NSW); Burragarang Valley, R.H.Comboge 2311, 8.x.1909 (NSW); Grassy Hill, Colo–Putty Rd, E.F.Constable,

7.ix.1948 (NSW); Loughtondale Gully Rd, c. 1 km E of junction with the Great Northern Rd, Maroota, R.G.Coveny 15522, 22.viii.1991 (AD, BRI, CANB, HO, MEL, NSW, PERTH).

**Flowering period:** Flowers in spring.

**Distribution and habitat:** Occurs in near coastal parts of central eastern New South Wales, including the Blue Mountains from Howes Valley in the north to Thirlmere in the south (Fig. 7a). The label on a 1924 collection (Welch, NSW565910), which gives Tumut as the location, must be considered doubtful. Grows in sand on sandstone, often in swampy sites.

**Notes:** *Bossiaea lenticularis* is most closely related to *B. cordigera* and, like the latter, is readily identifiable by its divaricate branching, small, opposite leaves with a circular lamina, relatively slender branchlets and petioles, and folded upper calyx-lobes. The two species also have some similarities to species in Group B, particularly in bracteole, calyx and pod morphology.

### 10. *Bossiaea cordigera* Benth. ex Hook.f., *Fl. Tasman.* 1(2): 95, pl. 16 (1856)

**Type:** [Protologue: 'Widely distributed over the northern parts of the Island, from the sea-level to 4000 feet, Lawrence, Gunn'. The island is Tasmania, but was given as V.D.L. (Van Diemen's Land) by the collectors.] Tasmania. Locality unknown, R.Gunn [171], date unknown; lectotype (here selected): K 000278235, image seen in Kew Herbarium Catalogue.

Residual syntypes (all in Tasmania): Locality unknown, *R.Gunn* [171]: K 000278226; Patricks River, *R.Gunn* [171], 14.xii.1844: K 000278230; York Town, *R.Gunn* [171], 25.i.1844: K 000278231; George Town, *R.Gunn* [171], 1842: K 000278232; Lake Arthur, Western Mts, *Lawrence*: K 000278236; Circular Head, *R.Gunn* [171], 1842: K 000278237; Locality unknown, *R.Gunn* s.n.: MEL 651106 (possibly).

*Bossiaea hendersonii* Regel, *Gartenflora* 15: 322, pl. 523, 3d, e (1866), as *Hendersoni*. **Type**: not designated. [Protologue: Translated from German as 'Cultivated from the garden of James Booth and Sons, Hamburg, Germany.'] Holotype: pl. 523, 3d, e in *Gartenflora* 15: 322 (1866).

*Erect or sprawling shrubs* to c. 1.5 m high, with inflorescences borne on a regular series of very short side-branchlets which in turn are produced along a regular series of spreading side-branches; branchlets spreading, terete, 0.3–0.5 mm wide, sparsely to moderately hairy; hairs c. 0.2 mm long, wavy to curly; epicuticular wax not developed. *Stipules* narrow-triangular, 0.5–2 mm long, erect, brown, glabrous, 1-nerved or venation obscure; stipule-petiole angle 30–70°. *Leaves* opposite; petiole 1–2 mm long, very slender; articulation slightly to moderately geniculate, ridged; lamina ovate to broad-ovate, occasionally c. circular, 2.5–6 mm long, 2.5–6 mm wide, with l:w ratio mostly 0.9–1.0, flat or slightly convex laterally, markedly discolorous; base symmetrical, cordate or less often broad-cuneate to truncate; margin slightly recurved, sometimes with hairs persisting,  $\pm$ smooth; apex subacute to rounded; apiculum to c. 0.2 mm long, downcurved, or not developed; upper surface smooth, with venation obscure, glabrous; lower surface glabrous or with hairs on midrib. *Inflorescences*: axes contracted or to c. 3 mm long, hairy, with a small leaf and stipules often developed instead of scales, occasionally with 2 or more nodes below the flower; bract 0.5–1 mm long, c. 0.5 mm wide, slightly convex; pedicel 15–30 mm long, hairy; bracteoles persistent, ovate, 0.5–1 mm long, with l:w ratio 1–1.5,  $\pm$ appressed, inserted at or more often beyond mid-pedicel, convex, apex nearly flat, 1-nerved, glabrous, light brown. *Calyx* 5–6 mm long, glabrous, with tube shorter than upper lobes; upper lobes 2.5–3.5

mm long, 3–3.5 mm wide, expanded beyond lateral angle by 2–3 mm; lateral angle acuminate; sinus 2 mm deep; lower lobes 1–1.7 mm long, c. 0.8 mm wide, with lateral lobes flat; standard to c. 12 mm long, similar in length to wings and keel, adaxially yellow with red flare, abaxially brownish-red except towards margins; wings 3–3.5 mm wide, mostly brownish-red, sometimes yellow distally; keel c. 4 mm wide, pale proximally, red distally; anthers c. 0.7 mm long post-dehiscence; ovary glabrous, 4–8-ovulate; style 3–4 mm long. *Pods*: stipe 5–8 mm long; body narrow-oblong, 15–30 mm long, 5–6 mm wide, glabrous; upper margin c. 0.7 mm wide, hardly ridged. *Seeds* 2–2.5 mm long, c. 1.5 mm wide; aril 1–1.2 mm long, c. 0.5 mm high, with base c. 0.7 mm long, with lobe curving 120–160° (Fig. 6e).

**Selected specimens from c. 80 examined:** VICTORIA: Farm Rd, 0.8 km from Horgan Track, Wombat State Forest, *J.H.Ross* 3693, 13.xii.1995 (CANB, HO, MEL); Buangor Forest Park, 27 km E of Ararat PO, *A.C.Beauglehole* 61498, 10.xi.1978 (MEL); Boiler Swamp Rd, Portland district, *C. & D.Woolcock* 1537, 28.xi.1983 (MEL); Lyonville, *H.B.Williamson*, i.1916 (MEL); Benwerrin, Otway Ranges, *A.C.F.Gates*, xi.1922 (MEL); Domino Rd, c. 6 km WSW of Trentham, *I.R.Thompson* 1470, 19.i.2012 (CANB, MEL). TASMANIA: Tomahawk River, *D.I.Morris* 8171, 12.x.1981 (HO, MEL); Picketts Plains, *A.Moscal* 3998, 12.xi.1983 (HO, MEL); Cradle Mountain Reserve, *A.M.Olsen*, 3.i.1937 (HO); Port Sorell, *W.M.Curtis*, x.1944 (AD, HO, MEL); Penstock, *A.V.Giblin*, xii.1929 (HO).

**Flowering period:** Flowers in spring and early summer.

**Distribution and habitat:** Occurs in south-western and south-central Victoria from Portland east to Healesville and in northern two-thirds of Tasmania (Fig. 7b). Categorized as rare in Victoria (Walsh & Stajsic 2007). Grows in open forest, often beside streams or in damp environments.

**Notes:** *Bossiaea cordigera* is mostly closely related to *B. lenticularis* q.v. It is readily distinguished from the other species in Group C by the combination of its sparse, short and mostly curly hairs, opposite leaves, ovate, cordate-based leaflets, long pedicels and long pod-stipes. Calyx-lobes become strongly deflexed after flowering. A yellow-flowered mutant has been recorded from Wombat State Forest SE of Daylesford in south-central Victoria. Several features of *B. cordigera*, especially the opposite, ovate leaves and the greatly



enlarged upper calyx-lobes, are reminiscent of species in the genus *Platylobium*.

Mature seeds have only been seen from a few collections. The aril-lobe is relatively slender and relatively strongly rotated laterally as it arches over. As is typical of the group the lobe is strongly curved and the apex often reaches to the seed surface.

Baron Ferdinand von Mueller cited the name *B. horizontalis* in First General Report of the Government Botanist on the Vegetation of the Colony in 1853, but it appears that the name *B. horizontalis* was never published. The name appears on several labels of specimens of *B. cordigera* at MEL suggesting that Mueller was planning to describe it himself, in which case Hooker was named as the future author in the report by mistake, or he was expecting J.D.Hooker to name the undescribed species as *B. horizontalis* rather than *B. cordigera*. In 1862, Mueller wrote a description of *B. cordigera* in *Fragmenta Phytographiae Australiae* without making any reference to *B. horizontalis*.

**Typification:** From a number of similarly suitable possibilities, K 000278235 is selected here as the lectotype of *B. cordigera*. It is a large single piece in the upper right of the sheet, and bears flowers and immature fruit.

## The *Buxifolia* subgroup

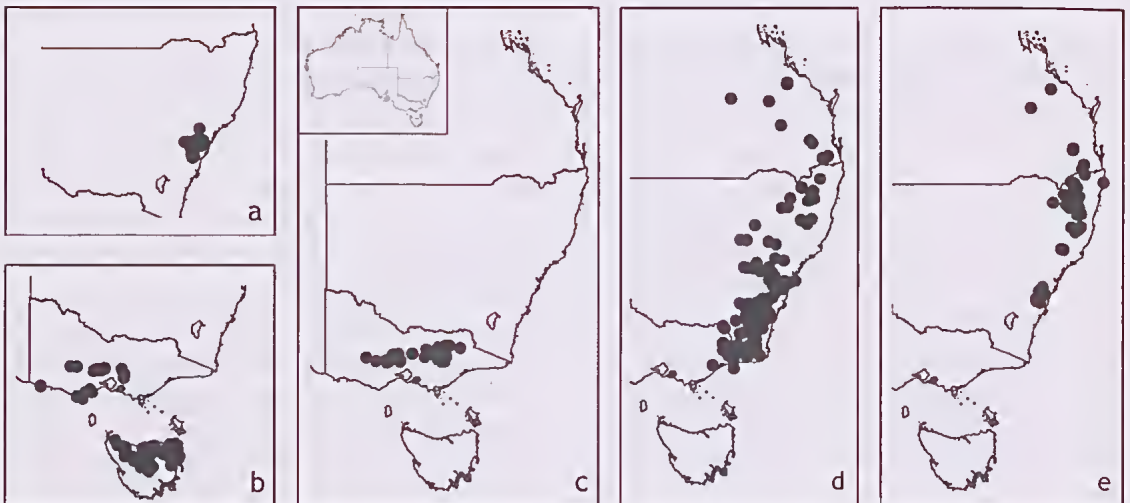
### 11. *Bossiaea decumbens* F.Muell., *Fragm.* 1(1): 9 (1858)

**Type:** [Protologue: 'Mount Macedon. Dallachi. In collibus ad amnem Delatite'. Translation: Hills beside the Delatite River.] Victoria. Mount Macedon, *J.Dallachy*, viii.1849; lectotype (here selected): MEL 18885.

Residual syntypes: Victoria. Mount Macedon, collector unknown, date unknown: MEL 18886; Victoria. Delatite River, *F.Mueller*, 18.iii.1853: MEL 18887, MEL 18888, MEL 18889.

*Bossiaea buxifolia* sensu G.Bentham, *Fl. Austral.* 2: 163 (1864) and subsequent Australian authors, *pro parte*, *non sensu stricto*.

*Prostrate to sprawling shrubs* to c. 0.3 m high, with inflorescences typically borne on a regular series of short side-branchlets; branchlets erecto-patent to almost spreading, terete, 0.3–0.5 mm wide, mostly sparsely hairy; hairs 0.2–0.3 mm long; epicuticular wax not developed. *Stipules* narrow-triangular, 0.5–2 mm long, erect or becoming incurved or recurved distally, red-brown, glabrous, with venation obscure; stipule-petiole angle 60–90°. *Leaves* alternate; petiole 0.3 mm long; articulation obscure; lamina elliptic to broad-elliptic, 2–5 mm long, 1.5–4 mm wide, with l:w ratio



**Figure 7.** Distributions of species in Group C. a. *Bossioeo lenticularis*; b. *B. cordigera*; c. *B. decumbens*; d. *B. buxifolia*; e. *B. neoanglica*.

1.1–1.8,  $\pm$ flat, markedly discolorous; base often slightly asymmetrical, slightly cordate to rounded; margin slightly recurved, glabrescent, smooth; apex rounded to obtuse, often recurved; apiculum to c. 0.4 mm long, slender, brittle, recurved; upper surface smooth, with venation variably raised, mostly soon glabrescent; lower surface glabrescent. *Inflorescences*: axes contracted; bract 0.8–1.5 mm long, c. 0.5 mm wide, flat to slightly convex; pedicel 10–25 mm long, hairy; bracteoles persistent, oblong to oblong-elliptic or obovate, 0.7–2 mm long, with l:w ratio 1.5–2, slightly to markedly divergent, inserted beyond mid-pedicel, mostly in distal third, fairly flat, sometimes recurved distally, with margins sometimes recurved, with apex flat or convex, 1-nerved, glabrous, light or red-brown. *Calyx* 3–5.5 mm long, hairy, with tube much shorter than upper lobes; upper lobes 2.5–3.5 mm long, 2.5–3 mm wide, expanded beyond lateral angle by 1–2 mm; lateral angle subacute to rounded; sinus 1–2.5 mm deep; lower lobes 1–1.5 mm long, 0.8 mm wide, with lateral lobes flat; standard to c. 10 mm long, slightly longer than wings and keel, adaxially yellow with a red flare, with throat not bisected, abaxially brownish-red throughout; wings c. as long as keel, 2–2.5 mm wide, light purplish-brown throughout; keel 3–4 mm wide, pale except for pink markings in distal quarter; anthers c. 0.5 mm long post-dehiscence; ovary with hairs on margins, sometimes hairs rather few, 6–10-ovulate; style 3–6 mm long. *Pods*: stipe 1–3 mm long; body narrow-oblong, 20–30 mm long, 5.5–7 mm wide, with appressed or spreading hairs on margins, occasionally glabrescent; upper margin c. 0.6 mm wide, hardly ridged. *Seeds* 2–3 mm long, 1.2–1.8 mm wide; aril 1–1.5 mm long, 0.6–0.8 mm high, with base 0.5–0.8 mm long, with lobe curving 135–180° (Fig. 6a).

**Selected specimens from c. 50 examined:** VICTORIA: Wonnangatta Valley, c. 1 km NW of the junction of the Wonnangatta River and Zeka Creek, *D.E. Albrecht 3885*, 30.xi.1989 (MEL); Cheshunt–Dandongadale Rd, 4.8 km from Rose Valley, *T.J. Entwisle 1725 & S. Bodsworth*, 9.x.1990 (CANB, MEL, PERTH); S bank of Howqua River, c. 400 m downstream from Sheeppark Flat, *N.G. Walsh 1848*, 28.v.1987 (CANB, MEL, NSW); Eagle Point, Mt Buffalo, *J.H. Willis*, 20.ii.1963 (MEL); Tipperary Track, S of Bryces Flat, E side of Sailors Creek, SW of Hepburn, *J.H. Ross 3807*, 12.x.1996 (MEL); 3 km SE of Beaufort, *A.C. Beaughlehole 61687*, 19.xi.1978 (MEL).

**Flowering period:** Flowers from spring to early summer.

**Distribution and habitat:** Occurs in southern Victoria from Ararat east to Bright (Fig. 7c). Grows in open forest.

**Notes:** *Bossiaea decumbens* differs from *B. buxifolia* in floral morphology with flowers having a longer calyx and corolla, upper calyx-lobes that are more expanded beyond the lateral margin, larger anthers, and a longer style. The red markings of the keel are also generally paler, stipules are generally less recurved, and leaflets are flatter and with margins less recurved. The two species are geographically separated.

**Typification:** From the type material at MEL, I have selected MEL 18885 as the lectotype as this sheet is the only one that contains good examples of the flowers. The original label specifies the collector as Dallachy; however the date of collection given in the type details above is based on a recent annotation. Although also collected from Mt Macedon, it is uncertain whether MEL 18886 is an isolectotype. The single piece has a different look to the pieces of the lectotype. However, this sheet has also been recently annotated indicating that the collector was Dallachy and the collection was in August 1849.

## 12. *Bossiaea buxifolia* A.Cunn., in B.Field, *Geogr. Memoirs New South Wales: 348 (1825)*

**Type:** [Protologue: 'Upon rocky, brushy hills.'] New South Wales. Blue Mountains, *A. Cunningham*; lectotype: K 000278436, *vide* Lee (1970).

*Prostrate to weakly erect shrubs* to c. 0.5 m high, with inflorescences typically borne on a regular series of short side-branchlets; branchlets erecto-patent to almost spreading, terete, 0.3–0.5 mm wide, sparsely to moderately hairy; hairs 0.2–0.5 mm long; epicuticular wax sometimes developed. *Stipules* narrow-triangular to setaceous, 1–2 mm long, erect or more often widely divergent and/or becoming recurved, red-brown, hairy, glabrescent, with venation obscure; stipule-petiole angle 60–90°. *Leaves* alternate; petiole 0.2–0.5 mm long; articulation obscure; lamina elliptic or c. circular, mostly 2.5–5 mm long, 2–5 mm wide, with l:w ratio 1.1–1.6,  $\pm$ flat or sometimes slightly concave proximally, markedly discolorous; base usually slightly asymmetrical, cordate or truncate; margin slightly recurved to slightly revolute, hairy at first, with persistent tubercles; apex rounded to obtuse, straight or slightly recurved; apiculum hardly



developed or to 0.5(–0.8) mm long, setaceous, generally brittle, mostly recurved, sometimes slightly hooked; upper surface smooth or minutely tuberculate, with venation variably raised, glabrescent; lower surface hairy throughout or glabrous except for veins. *Inflorences*: axes contracted or to c. 3 mm long; bract 0.5–1 mm long, c. 0.5 mm wide, strongly convex; pedicel (3–)6–20 mm long, hairy; bracteoles persistent, elliptic, broad-elliptic, oblong-elliptic, or obovate, 0.6–1.2 mm long, with l:w ratio 1.2–2, loosely appressed or divergent, mostly inserted in distal half, flat or slightly convex, sometimes with margins recurved with apex  $\pm$ flat, 1-nerved or with venation obscure, glabrous or hairy, brown or red-brown. *Calyx* 3–4.5 mm long, hairy, with tube shorter than or equal to upper lobes; upper lobes 1.5–2.5 mm long, 2–3 mm wide, expanded beyond lateral angle by 0.5–1.5 mm; lateral angle subacute, sometimes minutely acuminate; sinus 1–1.5 mm deep; lower lobes 1–2 mm long, 0.6 mm wide, with lateral lobes flat; standard to c. 9 mm long, c. 2 mm longer than wings and keel, adaxially yellow with a red flare, with throat not bisected, abaxially dark red throughout; wings c. as long as keel, c. 2 mm wide, red and purplish, sometimes yellowish distally; keel c. 3 mm wide, pale proximally, dark red in distal half; anthers c. 0.4 mm long post-dehiscence; ovary with hairy margins, 5–12-ovulate; style 1.5–2 mm long. *Pods*: stipe 1–2 mm long; body narrow-oblong or narrow oblong-elliptic, 15–30 mm long, 4.5–7 mm wide, with appressed or occasionally spreading hairs on margins; upper margin c. 0.6 mm wide, not ridged. *Seeds* 2–3 mm long, 1.2–1.5 mm wide; aril 1–1.2 mm long, 0.6–0.8 mm high, with base c. 0.7 mm long, with lobe curving c. 180° (Figs 6d, 10g).

**Selected specimens from c. 150 examined:** **QUEENSLAND:** Catchment of Precipice Creek, Precipice National Park, *P.I.Forster* 19736, 25.ix.1996 (BRI, MEL, NSW); Kroombit Creek, SW of Annes Gorge, Kroombit National Park, *J.Brushe* 665 & *R.Hendry*, 31.xii.1996 (BRI); State Forest 665, 4 km SE of Crows Nest, *A.R.Bean* 7953 & *J.Thompson*, 13.x.1994 (BRI); Barakula State Forest, *V.Hando* 13, 3.x.1978 (BRI). **NEW SOUTH WALES:** Tia Falls, 100 m E of picnic area, Oxley Wild Rivers National Park, *L.M.Copeland* 4478, 2.xi.2010 (BRI, CANB, MEL, NSW); Tinderry Mountains, Tinderry Nature Reserve, *G.Stewart* 293 & *P.Whigham*, 13.xi.1984 (CANB, MEL, NSW); c. 14 km from Delegate toward Bombala, *E.J.Carroll*, 16.xii.1965 (CANB, MEL); Intersection of Oellen Ford and Yarralaw Rds, c. 10 km N of Windellama, *I.R.Thompson* 1279, 30.ix.2010 (BRI, CANB, MEL).

**VICTORIA:** Mail-box Gully, near Wulgulmerang Creek, on road to Deddick, *J.H.Willis*, 29.xi.1962 (MEL); Yambullah peak track, 4.8 km E of Mt Cooperacabra, *N.G.Walsh* 1218, x.1983 (MEL); Buchan River at Diggers Hole Track crossing, 6 km SW of Mt Seldom Seen, *S.J.Forbes* 3200, 3.xi.1986 (CANB, MEL, NSW); Providence ponds FFR, *A.C.Beoughlehole* 78751, 22.x.1987 (CANB, HO, MEL).

**Flowering period:** Flowers from spring to early summer.

**Distribution and habitat:** Occurs in south-eastern Queensland south from Kroombit Tops, in eastern New South Wales, and in eastern Victoria (Fig. 7d). Grows in dry sclerophyll forest and woodland.

**Notes:** *Bossiaea buxifolia* is a widespread species which exhibits a moderate amount of variation in habit, flower size, pedicel length and pod size and ovule number. It is not always easily distinguished from *B. neoanglica* q.v. and *B. decumbens* q.v.

**Typification:** There appears to have been several specimens that Cunningham would have had access to when describing the species. As Cunningham did not cite a specimen or location when naming *B. buxifolia*, the selection of the three pieces barcoded as K000278436 by Alma Lee in concert with A.B.Court (Lee 1970; sheet annotated by Court) as the holotype, in effect lectotypified this sheet.

### 13. *Bossiaea neoanglica* F.Muell., *Fragm.* 5(32): 106 (1865), as *Neo-Anglica*

**Type:** [Protologue: 'In collibus lapidosis Novae Angliae haud procul ab origine fluvii McLeay's River. C. Moore'. Translation: In stony hills of New England near the origins of the Macleay River.] New South Wales. Head of the Macleay River, *C.Moore* 131, date unknown; holotype: MEL 18890; possible isotype: NSW 43644 *n.v.*, *vide* Lee (1970).

*Prostrate to weakly erect shrubs* to c. 0.5 m high, or higher when supported, with inflorescences typically borne on a regular series of short side-branchlets; branchlets erectopatent to almost spreading, c. terete, 0.3–0.5 mm wide, moderately hairy; hairs sometimes curly, 0.5–0.8 mm long; epicuticular wax not developed. *Stipules* narrow-triangular to filiform, 2–3.5 mm long, mostly recurved or almost decurved, red-brown, hairy, glabrescent, faintly 1-nerved; stipule-petiole angle 60–90°. *Leaves* alternate; petiole 0.5–0.8 mm long, articulation sometimes slightly

geniculate and/or slightly ridged, sometimes obscure; lamina ovate or broad-ovate, 2–8 mm long, 2–7 mm wide, with l:w ratio mostly 1.2–1.8, flat or sometimes slightly concave proximally, markedly discoloured; base mostly asymmetrical, cordate or truncate; margin slightly recurved to slightly revolute, glabrescent, finally minutely tuberculate; apex rounded to acute, flat or recurved; apiculum mostly 0.5–1 mm long, setaceous, brittle, mostly recurved, often slightly hooked; upper surface smooth or minutely tuberculate, with venation variably raised, glabrescent; lower surface generally hairy. *Inflorescences*: axes contracted or rarely to c. 2 mm long; bract 0.7–1 mm long, c. 0.6 mm wide, convex; pedicel 1–6 mm long, glabrous or hairy; bracteoles persistent, oblong to elliptic or obovate, 1–1.2 mm long, with l:w ratio 1.5–2, divergent, inserted c. mid-pedicel or occasionally more distally, nearly flat or gently convex, with apex sometimes slightly incurved, faintly 1-nerved, glabrous, red-brown. *Calyx* 3–4 mm long, glabrous or hairy, with tube shorter than or equal to upper lobes; upper lobes 2–2.5 mm long, 2–3 mm wide, expanded beyond lateral angle by c. 1 mm; lateral angle subacute or obtuse, sometimes minutely acuminate; sinus 1–2 mm deep; lower lobes 1–1.5 mm long, c. 0.7 mm wide, with lateral lobes flat; standard to c. 8 mm long, similar in length to wings and keel, adaxially yellow with a red flare, abaxially red  $\pm$ throughout; wings c. as long as keel, c. 2 mm wide, red streaked, variously pale purplish-brown or yellow distally; keel 2.5–3 mm wide, pale proximally, red distally; anthers c. 0.4 mm long post-dehiscence; ovary hairy throughout or on margins, 6–8-ovulate; style 2–3 mm long. *Pods*: stipe 1–2 mm long; body oblong, 15–25 mm long, 6–8 mm wide, with long, spreading hairs on valves and margins or valves sometimes glabrous (a few hairs usually present early in development); upper margin c. 0.7 mm wide, not or hardly ridged. *Seeds* 2.5–3 mm long, 1.5–2 mm wide; aril 1–1.3 mm long, 0.8 mm high, with base c. 0.6 mm long, with lobe curving c. 180° (Fig. 6c).

**Selected specimens from c. 60 examined:** QUEENSLAND: Kroombit Tops State Forest, 2.1 km S of Locked Gate sign on loop road to Annies Gorge, *J.Brushe* 680 & *R.Hendry*, 30.xii.1996 (BRI); Mt Bangalora, Main Range National Park, *P.I.Forster* 12229 & *G.Leiper*, 29.x.1992 (BRI, MEL, NSW); New England Hwy, B.B. km S of Crows Nest, *A.R.Bean* 17310, 26.i.2001 (BRI). NEW SOUTH WALES: Gibraltar Range, c. 59.5 km NE of Glen Innes, *J.B.Williams*, xi.1959 (NE); track to Dandahra Falls, Gibraltar

Range National Park, *R.G.Coveny* 16686 & *A.J.Whalen*, 19.x.1993 (BRI, MEL, NE, NSW); 60 Foot Falls track, freeway underpass, [Mittagong], *G.T.Chandler* 963, 27.ix.1999 (CANB); 0.7 km S of the S lake picnic area, Thirlmere Lakes National Park via Buxton, *A.V.Slee* 2302, 1B.x.1988 (CANB); Gloucester Tops, c. 59 km from Gloucester, *J.Pulley* 711, 11.li.1971 (CANB); Doughboy Range, Ebor area, *R.W.Jessup* 237, 1B.xi.1953 (CANB); 1.1 km along track to Basket Swamp rest area, 16.9 km NE of Tenterfield, Boonoo State Forest, *P.C.Jobson* 5203 & *S.A.Mills*, 25.x.1997 (MEL, NSW); 11.4 km NNW of Oakdale, *P.C.Jobson* 3758, 17.ix.1995 (BRI, MEL, NSW); c. 1.5 km E of Cobcrofts Rd along Mesa Management Trail, Werrikimbe National Park, c. 60 km SE of Walcha, *L.M.Copeland* 4476, 2.xi.2010 (CANB, MEL, NSW).

**Flowering period:** Flowers sporadically, but mostly in spring.

**Distribution and habitat:** Occurs in south-eastern Queensland south from Kroombit Tops, and in north-eastern and central-eastern New South Wales as far south as Fitzroy Falls (Fig. 7e). Grows in open forest and woodland.

**Notes:** *Bossiaea neoanglica* is superficially very similar to *B. buxifolia* but, apart from differences indicated in key, has longer stipules, leaves that are more markedly asymmetrical, more strongly discoloured, and with a usually more distinct articulation (under magnification), and a usually longer apiculum. The long apiculum is brittle and on herbarium sheets a high proportion are reduced in length due to breakage. A form from central-eastern New South Wales differs fairly consistently from the type form from north-eastern New South Wales and south-eastern Queensland in having glabrous or near-glabrous pedicels and calyces, and ovaries/pods glabrous or only sparsely hairy on the faces.

## Group D

*Subshrubs* or *shrubs*, often prostrate; branchlets mostly compressed, with decurrencies sometimes well-developed but not winged, sometimes spinescent. *Stipules* narrow-triangular, generally erect, sometimes green, generally  $\pm$ glabrous. *Leaves* with articulation generally markedly geniculate; lamina with gland-dotting generally evident; apiculum generally inconspicuous. *Inflorescences*: axes with scales 2, or sometimes leafy; inflorescences sometimes somewhat elongated; bract and bracteoles generally strongly convex, often striate, bracteoles sometimes caducous, often relatively slender, inserted in proximal or middle



thirds. *Calyx* mostly hairy, with lobes often filiform apically and with lower lobes as long as or longer than upper lobes and tube; upper lobes mostly  $\pm$ oblong, as long as or longer than broad, often abruptly broadening at apex, not expanded beyond lateral angle. Corolla sometimes almost entirely yellow. *Pods* short-stipitate, mostly hairy on margins, sometimes hairy on valve faces also. Aril mostly small, with base short and lobe moderately to strongly arched (Fig. 8).

Group D contains seven species divided into three subgroups. It occurs in south-eastern Queensland, eastern New South Wales, south-eastern and southern Victoria, Tasmania, and south-eastern South Australia (Fig. 9).

The Prostrata subgroup (species 14 & 15) is distinguished from the Scortechinii subgroup by the more or less flat leaflet-margins, narrower, more scarious stipules, more consistently suppressed inflorescence axes, and the typically glabrous pod-valves.

The Scortechinii subgroup (species 16–18) has leaflets with recurved to revolute margins, stipules that are somewhat persistently green at least in part, inflorescences that sometimes become markedly elongated, filiform calyx-lobe apices, petals with relatively little or no red coloration, and hairy pod-valves. The stipules in this subgroup are similar in form to the much larger stipules of *B. stephensonii* (Group E).



**Figure 8. Group D.** a. *Bossioeo nummulario* (A.A.Homilton NSW 43654); b. *B. obovato* (L.M.Copelond 4483 MEL); c. *B. scortechinii* (L.M.Copelond 4493 MEL); d. *B. prostrato* (I.R.Thompson s.n., 6.xi.2010 MEL); e. *B. prostrato*, scale, bract and bracteoles (R.V.Smith 59/247 MEL); f. *B. scortechinii*, pod (L.M.Copelond 4493 MEL); g. *B. obcordato*, spinescent branch (N.M.Tows 527 CANB); h. *B. tosmonico*, sub-spinescent branch; i. *B. obcordato* (M.E.Phillips 3 CANB); j. *B. tosmonico* (Leomon, 8.xii.2010 MEL).

Scale bars: a-d = 10 mm, e, f, i, j = 5 mm, g, h = 2 mm.

The Obcordata subgroup (species 19 & 20) is distinguished from all other eastern species by its spinescent or subspinescent branchlets. There are several Western Australian species of *Bossiaea* with spinescent branchlets, and there is generally not a lot of difference, with the exception perhaps of their woolly keel-apices and more setaceous stipules, between these western and eastern species. *Bossiaea tasmanica* has more features in common with the other subgroups of Group D, while *B. obcordata* has more features that link it to Group E. The branching pattern in *B. obcordata* is also similar to that seen in the *Cordigera* subgroup of Group C.

## The Prostrata subgroup

### 14. *Bossiaea nummularia* Endl., in S.L. Endlicher & E. Fenzl, *Nov. Stirp. Dec. 3: 22 (1839)*

**Type:** not designated. [Protologue: 'Colitur in horto Hügelianno'. Translation: Cultivated in gardens of C. von Hügel, Vienna, Austria.] Probable holotype: W 0031366, image seen in Naturhistorisches Museum Wien, Virtual Herbaria.

*Bossiaea prostrata pro parte sensu* A.T. Lee, *Contr. New South Wales Natl Herb.* 4(3): 102 (1970); A.T. Lee & J. Thompson, *Fl. New South Wales* 101(2): 106 (1984); T.A. James & G.J. Harden, *Fl. New South Wales*, rev. edn 2: 515 (2002).

*Prostrate or decumbent subshrubs* to c. 0.2 m high, with inflorescences borne on branchlets of various lengths, sometimes on a regular series of short side-branchlets; branchlets erecto-patent, slightly to moderately compressed, 0.6–1 mm wide, without decurrent ridges, moderately hairy; hairs c. 0.3 mm long; epicuticular wax sometimes developed. *Stipules* narrow-triangular, sometimes filiform distally, 1–2.5 mm long, erect or slightly divergent, sometimes partly herbaceous at first, becoming brown, glabrous or hairy, 1-nerved; stipule-petiole angle 45–90°. *Leaves:* petiole 0.5–1 mm long; articulation slightly to moderately geniculate, sometimes obscure, not ridged; lamina broad-elliptic, or less often suborbicular or slightly broad-ovate, 2–12 mm long, 2–6 mm wide, with l:w ratio mostly 1–2, ±flat, mildly discolourous; base symmetrical, broadly rounded to slightly cordate; margin flat or

### Key to Group D

- |    |   |                            |
|----|---|----------------------------|
| 1  | Branchlets not spinescent .....   | 2                          |
| 1: | Branchlets spinescent or subspinescent (tapering to a blunt point).....   | 6                          |
| 2  | Ovaries and pods with hairs restricted to sutures (rarely with hairs all over in <i>B. prostrata</i> ); leaflet margin nearly flat; standard extensively marked red abaxially; stipules generally brown;..... | 3                          |
| 2: | Ovaries and pods with hairs all over; leaflet margin recurved to revolute; standard yellow or flushed pink abaxially; stipules commonly substantially green; (northern New South Wales and Queensland) .....  | 4                          |
| 3  | Petioles ≤ 1 mm long; bracteoles generally persistent, mostly inserted in middle third of pedicel; standard-limb ± solidly red abaxially.....   | 14. <i>B. nummularia</i>   |
| 3: | Longest petioles > 1 mm long; bracteoles generally caducous, inserted in proximal third of pedicel; standard-limb with long pale streaks interrupting the red markings abaxially.....                         | 15. <i>B. prastrata</i>    |
| 4  | Leaflets predominantly obovate; pedicels mostly < 5 mm long.....  | 18. <i>B. abavata</i>      |
| 4: | Leaflets predominantly narrow-oblong to narrow-elliptic; pedicels mostly > 5 mm long .....  | 5                          |
| 5  | Petioles > 1 mm long; leaflets with l:w ratio mostly < 3; bracteoles narrow-elliptic; pods 6–8 mm wide.....   | 16. <i>B. dasycarpa</i>    |
| 5: | Petioles ≤ 1 mm long; leaflets with l:w ratio mostly > 3; bracteoles very narrow-oblong; pods 4–5.5 mm wide.....  | 17. <i>B. scartechinii</i> |
| 6  | Prostrate or low-growing shrubs; calyx hairy; keel-apex greenish-yellow, sometimes tinged pink; pod valves hairy (Tasmania) .....   | 19. <i>B. tasmanica</i>    |
| 6: | Erect shrubs; calyx glabrous or nearly so; keel-apex dark red; pod valves glabrous (mainland states).....   | 20. <i>B. abcardata</i>    |



slightly recurved, glabrescent, sometimes sparsely and minutely tuberculate; apex broadly rounded to obtuse, or occasionally acute, sometimes minutely acuminate, sometimes downcurved; apiculum to c. 0.3 mm long, brittle, pointing forward to moderately downward; upper surface smooth, with venation generally obscure, with gland-dotting usually evident, with appressed hairs or glabrescent; lower surface gradually glabrescent. *Inflorescences*: axes contracted or rarely to c. 1 mm long, inflorescences rarely with a short rachis developed when 2-flowered; bract 1–1.5 mm long, 0.6–0.8 mm wide, moderately convex; pedicel 3–15 mm long, commonly > 8 mm long, hairy, with hairs commonly appressed; bracteoles generally persistent, ovate to narrow-ovate or narrow-oblong, 1–2 mm long, with l:w ratio 1.5–3, loosely appressed or divergent, inserted in middle third of pedicel, or occasionally more proximally, moderately convex, 1-nerved or with venation obscure, usually hairy, especially distally, red-brown. *Calyx* 3.5–4.5 mm long, hairy, sometimes near-glabrous proximally, with tube c. equal in length to lobes; upper lobes 1.3–2.5 mm long, 1.5–2 mm wide; lateral angle acute or acuminate; sinus 1–1.5 mm deep; lower lobes 1.3–2.5 mm long, c. 0.8 mm wide, with lateral lobes flat; standard to c. 9 mm long, slightly longer than wings and keel, adaxially yellow with a red flare, abaxially ±entirely red; wings c. as long as keel, 2–2.5 mm wide, brownish-red throughout or nearly so; keel 2.5–3 mm wide, pale proximally, red distally; anthers c. 0.5 mm long post-dehiscence; ovary with hairy margins, 6–8-ovulate; style 1.5–2.5 mm long. *Pods*: stipe 1–3 mm long; body narrow-oblong, 20–30 mm long, 6–7 mm wide, with margins hairy, rarely with a few hairs on valves; upper margin c. 0.7 mm wide, not ridged. *Seeds* 2.5 mm long, 1.5 mm wide; aril c. 0.8 mm long, c. 0.5 mm high, with base c. 0.4 mm long, with lobe curving 150–180° (Fig. 8a).

**Selected specimens from c. 25 examined:** NEW SOUTH WALES: Parramatta, *W.Woolfs* (MEL); Whalan, *R.Coveny 11873* & *S.Goodwin*, 13.ix.1984 (MEL, NSW); Duck River, Clyde, *A.A.Hamilton*, ix.1914 (NSW); Marayong, *P.Hind s.n.*, ix.1967 (NSW); Lumley Rd, 1 km N of Jacqua Rd, c. 30 km direct S of Goulburn, *I.R.Thompson 1331*, 24.xi.2010 (CANB, MEL, NSW); near Crookwell, *J.M.Downes*, 25.xi.1983 (NSW); 1.5 km E of Gara River crossing on Armidale–Grafton road, *B.J.Wallace 012/86* & *P.G.Abell*, 22.iv.1986 (NSW).

**Flowering period:** Flowers from August to October.

**Distribution and habitat:** Occurs in south-eastern and central-eastern New South Wales, mostly south of Goulburn and in the Sydney region, with an outlier in north-eastern New South Wales near Armidale (Fig. 9b). Grows in woodland and open forest.

**Notes:** *Bossiaea nummularia* is superficially similar to *B. prostrata*, but differs from that species by having smaller leaves with a more uniform shape, shorter petioles, a less geniculate leaflet-articulation, narrower bracts, and more persistent bracteoles that are inserted mostly in the middle third rather than proximal third of the pedicel. In addition, the abaxial surface of the standard is a solid red rather than with long, radiating pale streaks as in *B. prostrata*. Branchlets are generally slightly less compressed than those of *B. prostrata* and can become more extensively covered with epicuticular wax. *Bossiaea nummularia* can develop a series of short side-branchlets similar to that seen in *B. buxifolia*, whereas *B. prostrata* does not generally do so.

The distribution of *B. nummularia* overlaps that of *B. prostrata* and there are several mixed collections containing these two species. *Bossiaea nummularia* also approaches *B. buxifolia* in some respects and these two species also overlap in distribution. *Bossiaea buxifolia* differs in having branchlets more nearly terete, stipules darker red, more slender and more recurved, an always obscure leaflet-articulation, a slightly asymmetric leaflet-base, more recurved leaflet-margins, and bracteoles that are inserted more distally, more divergent and tending to be inserted towards the same side of the pedicel.

**Typification:** The evidence from probable type material of *B. nummularia* housed at W, and the description in the protologue is sufficient I believe to assign the name *B. nummularia* to the taxon described above. The main anomaly is the apparent colour of the petals in the holotype material which appear to be all yellow rather than with red markings. *Bossiaea linnaeoides* is another potential synonym for this taxon, and this name was published earlier than *B. nummularia*; however, it is unclear from the description of *B. linnaeoides* to which taxon Don was referring, and no specimens or illustrations are known to the author.

## 15. *Bossiaea prostrata* R.Br., in W.T.Aiton, *Hortus Kew.*, 2nd edn, 4: 268 (1812)

**Type:** not designated. [Protologue: 'Native of New South Wales. Robert Brown, Esq.]: New South Wales.

Port Jackson, *R. Brown*, 1803; lectotype: BM 000885986, *vide* Lee (1970).

Residual syntypes: MEL 1528713, MEL 1528712, NSW171069 [These sheets are either mixtures of *B. prostrata* and *B. nummularia* or are entirely of *B. nummularia*.]

*Prostrate or decumbent subshrubs* to c. 0.2 m high, with inflorescences borne on branchlets of various lengths, but not typically on a regular series of short side-branchlets; branchlets erecto-patent, moderately compressed, 0.2–0.8 mm wide, sometimes with decurrent ridges, mostly sparsely hairy, glabrescent; hairs c. 0.3 mm long; epicuticular wax sometimes weakly developed. *Stipules* narrow-triangular, 0.8–1.5 mm long, with l:w ratio 1.5–2, erect, herbaceous at first, becoming brown, glabrous, 1-nerved or obscurely multinerved; stipule-petiole angle 30–60°. *Leaves*: petiole 1–5 mm long; articulation strongly geniculate, generally slightly ridged; lamina circular, oblong to elliptic, or ovate to lanceolate, 4–15(–25) mm long, 2–15 mm wide, with l:w ratio mostly 1–3, generally flat or convex each side of midrib distally, mildly discolorous; base symmetrical, truncate to slightly cordate; margin  $\pm$ flat, glabrescent,  $\pm$ smooth or tuberculate; apex broadly rounded to obtuse, or occasionally acute, sometimes minutely acuminate; apiculum to c. 0.3 mm long, brittle, pointing forwards or down; upper surface smooth, with venation commonly slightly raised, with gland-dotting usually evident, glabrous or glabrescent; lower surface glabrescent. *Inflorescences*: axes contracted or to c. 2 mm long; bract 1.5–2.5 mm long, 1–1.5 mm wide, strongly convex abaxially, generally conspicuously striate, often caducous; pedicel (2–)5–20 mm long, hairy, with hairs commonly spreading; bracteoles caducous before or after anthesis, narrow-elliptic, narrow- to very-narrow oblong, or oblanceolate, 1.5–3.5 mm long, with l:w ratio 1.5–5, loosely appressed or divergent, inserted mostly in proximal third, often close to base, strongly convex, 4–8-nerved, usually hairy, especially medially and distally, red-brown. *Calyx* 3–4.5 mm long, hairy, with tube equal to or shorter than lobes; upper lobes 2–3 mm long, 1.5–2 mm wide, abruptly broadening at apex; lateral angle acuminate; sinus 0.5–1 mm deep; lower lobes 1.5–3 mm long, filiform distally, c. 0.8 mm wide, with lateral lobes flat; standard to c. 9 mm long, slightly longer than wings and keel, adaxially yellow with a

red flare, abaxially red except for pale radiating lines; wings c. as long as keel, 2–2.5 mm wide, brownish-red throughout or giving way to yellow distally; keel 2.5–3 mm wide, pale proximally abruptly giving way to red in distal half; anthers c. 0.4 mm long post-dehiscence; ovary with hairy margins, 8–10-ovulate; style 2–3 mm long. *Pods*: stipe 1–3 mm long; body narrow-oblong, 20–30 mm long, 5–7 mm wide, mostly with one or both margins hairy, rarely glabrous, rarely hairy on valves; upper margin 0.7 mm wide, flat to gently convex, occasionally with a small sutural ridge. *Seeds* 2–3 mm long, 1–1.8 mm wide; aril 0.8–1.2 mm long, 0.5–0.8 mm high, with base c. 0.5 mm long, with lobe curving 150–180° (Fig. 8d–e).

**Selected specimens from c. 300 examined:** **SOUTH AUSTRALIA:** 6.8 km WSW of Terka, Mt Remarkable National Park, Flinders Ranges, *W.R. Telfer & C. Oats BS104-4747*, 22.xi.1999 (AD); Mt Magnificent Conservation Park [Southern Lofty], *B.M. Grivell 140*, 14.x.1984 (AD); Mt Beevor, [Murray], *D.E. Murfet 4225 & R.L. Toplin*, B.xi.2002 (AD); Hindmarsh Waterfall Rd, road junction c. 15 km N of Victor Harbor, *J.Z. Weber 617*, 24.x.1967 (AD); Big Heath National Park, c. 1 km NW of cairn, *C.R. Alcock 2887*, 3.xi.1969 (AD). **QUEENSLAND:** Widgee Mountain, *P.I. Forster 12121 & P. Mochin*, 25.x.1992 (BRI); Kroombit Tops, State Forest 316, 48 km E of Biloela, *N. Gibson TO433*, 17.ix.1988 (BRI). **NEW SOUTH WALES:** along Wog Link, Coolangubra State Forest, *C. Gibson*, 29.x.1989 (NSW); Tumblong State Forest, *G. Burrows*, 12.viii.1995 (NSW); 6 km WNW of Mittagong, *J. Thompson 1656*, 24.ix.1972 (NSW); track to Green Cape, *M.E. Phillips*, B.x.1961 (CANB). **AUSTRALIAN CAPITAL TERRITORY:** Gibraltar Creek, *N.T. Burbidge 7360*, 21.xi.1962 (CANB, NSW); Black Mountain, *E. Goubo*, 22.xii.1952 (CANB). **VICTORIA:** Heathcote Junction Railway Reserve, *J.C. Kissarie*, 13.x.1984 (CANB, MEL, NSW); turnoff to Genoa Creek, 4.6 km W of Genoa on Princes Hwy, *J.H. Ross 3516*, 23.x.1991 (AD, BRI, CANB, HO, MEL, NSW); slopes between Great Ocean Rd and Harvey St, Anglesea, *R.V. Smith 59/247*, 15.x.1959 (CANB, HO, MEL); Blacknose Point, 5 km SW of Portland, *M.D. Crisp 6925*, 1B.xi.1980 (CANB). **TASMANIA:** Charlotte Cove, *A. Moscal 8660*, 14.x.1984 (HO, MEL); 1.5 km S of Cleveland on Midlands Hwy, *D.I. Morris B0105* (HO); Petal Point, Cape Portland, *A. Moscal 3207*, 7.x.1983 (HO, MEL); Knights Bush near Launceston, *A. Simson 2264*, 1BB9 (HO).

**Flowering period:** Flowers in spring.

**Distribution and habitat:** Occurs in south-eastern South Australia, south-eastern Queensland, eastern New South Wales, southern Victoria and Tasmania (Fig. 9a). Grows in grassland, woodland and open forest.

**Notes:** *Bossiaea prostrata* is the most widespread species in the eastern half of Australia. It can be



distinguished from all other species in Group D by its broad bracts and relatively proximally inserted and caducous bracteoles, and, except for *B. dosycorpo*, by its longer petioles. Two-flowered inflorescences are more common than in other species, and occasionally appear to be arranged in paniculate conflorescences due to reduction or absence of subtending leaves. The two inflorescence scales are relatively large and entire in *B. prostrata*, i.e., they more closely resemble the bract than in other species. In many species of *Bossioeo* inflorescence scales are trifid rather than entire.

Although the vast majority of collections show the faces of ovaries/valves of fruit to be glabrous, some specimens with hairs throughout have been collected, e.g., from Strathewen in south-central Victoria (*Kilgour* 466 MEL), the Grampians in south-western Victoria (*D.Symon* 1771 AD) and the Southern Lofty region of South Australia (e.g., *Blaylock* SG34 AD). The first two of these records are in multi-piece collections and the atypical indumentum was only present in some of the pieces. Occasional collections with very short pedicels, e.g., Orbost, in south-eastern Victoria (*Shoobridge* CANB) are thought to be aberrant development rather than being typical of the population.

**Hybridisation:** A probable hybrid between *B. prostrata* and *B. ensata* has been recorded from near Bermagui (*N.Schultz* 132 CANB). It is leafy throughout and has winged branchlets approaching the width of those of *B. ensata*. A small sterile plant collected from an unknown locality (Australia felix) in Victoria (*F.Mueller* MEL 668111) is possibly a hybrid between *Bossioeo sericeo* and *B. prostrata*.

## The Scortechinii subgroup

### 16. *Bossiaea dasycarpa* I.Thomps., sp. nov.

A. *B. scortechinii* F.Muell. *petiolo longiore, foliolis ad marginem minus recurvatis, leguminibus latoribus differt*; o *B. prostrata* R.Br. *stipulis latoribus, foliolis od marginem recurvatis, bracteis ongustioribus, bracteolis pedicello in medio insertis persistentibus, valvis leguminis semper hirsutis differt*.

**Type:** Queensland. Barrett's Rd, c. 200 m N of Bruce Highway, *K.M.Sporshott* 666 & *K.Eornshaw*, 3.xi.1995; holotype: BRI 640339; isotype: MEL 2087102.

*Bossioeo prostrata* var. *Tuon Creek* (*M.S.Clemens* AQ22827).

*Prostrate or decumbent subshrubs* to c. 0.4 m high, with inflorescences mostly borne on longer branchlets rather than a regular series of short side-branchlets; branchlets erecto-patent, mildly compressed, 0.5–0.8 mm wide, with decurrent ridges sometimes distinct, sparsely hairy; hairs 0.3–0.5 mm long; epicuticular wax sometimes present. *Stipules* triangular to narrow-triangular, 1.5–3 mm long, with l:w ratio 2–3, erect, herbaceous, glabrous, 1–3-nerved; stipule-petiole angle 45–90°. *Leaves:* petiole 1.5–4 mm long; articulation strongly geniculate, not ridged; lamina narrow-oblong, narrow oblong-elliptic or slightly obovate, 10–20 mm long, 3–7 mm wide, with l:w ratio mostly 1.5–3.5, flat or slightly convex each side of midrib, mildly discolorous; base symmetrical, slightly cordate to rounded; margin recurved to revolute, variably hairy and tuberculate; apex truncate to subacute, sometimes minutely acuminate with acuminate region recurved; apiculum variably distinct, to c. 0.3 long, often brittle, pointing down; upper surface smooth, with venation usually raised, with gland-dotting evident, soon glabrescent; lower surface glabrescent. *Inflorescences:* axes contracted or short, sometimes multinoded, sometimes with a leaf and stipules developed instead of scales; inflorescences sometimes of a few flowers in a raceme-like arrangement, with a rudimentary or a leafy axis beyond flowers, or sometimes a solitary axillary flower subtended by a leaf or scale arising along a leafy branch; bract 1–1.5 mm long, 0.6–1 mm wide, strongly convex; pedicel mostly 5–30 mm long, hairy; bracteoles persistent or sometimes caducous at or soon after anthesis, very narrow-elliptic, very-narrow oblong, or lanceolate, 2–3 mm long, with l:w ratio 2–6, mostly loosely appressed, inserted mostly in middle third, convex, with apex nearly flat, 1–3-nerved, usually sparsely hairy, orange-brown. *Colyx* 4–5 mm long, hairy, with tube c. equal to lobes; upper lobes 2–2.5 mm long, 2 mm wide, abruptly broadening at apex; lateral angle acuminate; sinus 1.5–2 mm deep; lower lobes 2–3 mm long, filiform distally, c. 1 mm wide, with lateral lobes flat; standard to c. 10 mm long, slightly longer than wings and keel, adaxially yellow with a narrow flare, abaxially often flushed red; wings c. as long as keel, c. 2 mm wide, mainly yellow; keel c. 3 mm wide, pale proximally, usually red in distal third; anthers c. 0.5 mm long post-dehiscence; ovary hairy, 8–10-ovulate; style 3–4 mm long. *Pods:* stipe 1–2 mm long; body narrow-oblong,

20–30 mm long, 6–8 mm wide, hairy all over; hairs to c. 0.8 mm long on valves and c. 0.5 mm long on sutures; upper margin c. 0.7 mm wide, gently convex, sometimes minutely ridged along suture. Seeds 2.5–3 mm long, 2 mm wide; aril c. 0.8 mm long, c. 0.5 mm high, with base c. 0.4 mm long, with lobe curving 100–150°.

**Selected specimens from c. 12 examined:** QUEENSLAND: Gheerulla West LA, Mapleton State Forest, NW of Mapleton, A.R.Bean 10758, 21.ix.1996 (BRI); Childers, C.H.Gittins 280, viii.1959 (CANB); State Forest 1294 (Kullagum), c. 25.S km SE of Childers, K.M.Sparshott 735 & R.J.Price, 31.i.1996 (BRI); Maryborough, M.S.Clemens, 1948 (MEL); Tuan Creek near Maryborough, M.S.Clemens, 12.x.1948 (BRI); Coast Range, 9 km S of Biggenden, P.Young 673, ix.1983 (BRI); Mt Barney slapes, Macpherson Range, E.F.Constable s.n., 15.xi.1952 (NSW). NEW SOUTH WALES: E side of Emmaville Rd, 20.5 km NW of Glen Innes, P.C.Jabsan 5154 & S.A.Mills, 23.x.1997 (CANB, MEL, NSW); Bundjalung National Park, 1.6 km S of Evans Head, R.Coveny

5116, 2.ix.1973 (NSW); c. 14 km SE of Hillgrove on Lang Paint Rd, J.B.Williams, 12.x.1972 (NE); Wollomambi Falls, H.Wissman, 23.x.1963 (NSW).

**Flowering period:** Flowers in mid to late spring.

**Distribution and habitat:** Occurs in south-eastern Queensland south from the Maryborough district and in north-eastern New South Wales as far south as Hillgrove (Fig. 9c). Grows in woodland and grassland. Recorded from areas of sandstone and rhyolite geology.

**Etymology:** The epithet refers to the pods which are hairy all over (from Greek, *dasys*, hairy and *carpos*, fruit).

**Notes:** *Bossiaea dasycarpa* is similar to *B. scortechinii* but has leaves with a longer petiole, less recurved margins and a lower length to width ratio, and pods are markedly broader. In addition bracteoles of *B. dasycarpa* tend to be less linear than those of *B. scortechinii*, and the keel is more strongly marked red. *Bossiaea dasycarpa*

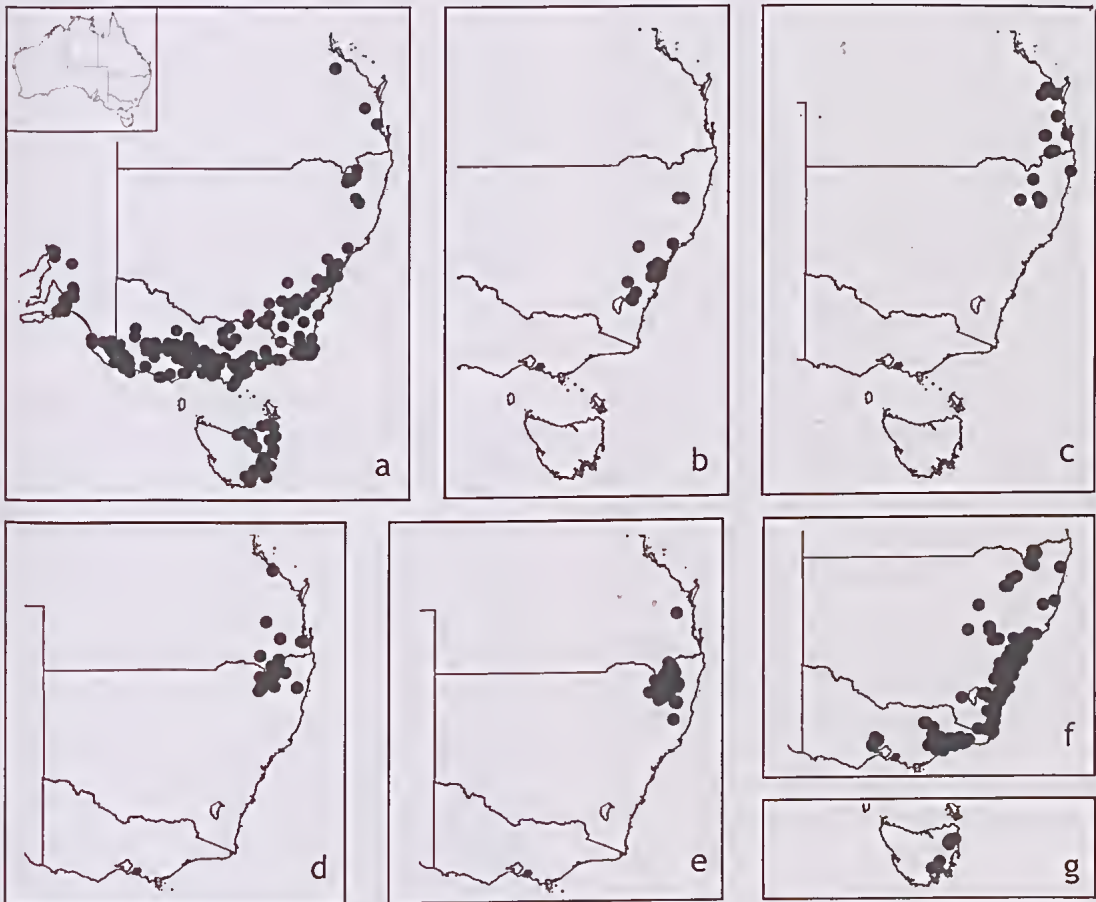


Figure 9. Distributions of species in Group D. a. *Bossiaea praetrata*; b. *B. nummularia*; c. *B. dasycarpa*; d. *B. scortechinii*; e. *B. abovata*; f. *B. abcordata*; g. *B. tasmanica*.



is also similar to *B. prostrata* but has leaves with recurved margins, petals with smaller amounts of red markings, narrower bracts and bracteoles, firmer herbaceous stipules, and, in most cases, hairy pod-valves. Hairy pod-valves have been recorded for *B. prostrata* in South Australia and Victoria but not in the region of distributional overlap with *B. dasycarpa*.

Specimens of *B. dasycarpa* have historically been identified as either *B. scortechinii* or *B. prostrata*. Based on annotations on a few herbarium specimens at BRI, C.T.White planned to name *B. dasycarpa* as *B. prostrata* var. *pubicarpa*; however, this name was never published. More recently, it has been informally identified as *B. prostrata* var. *Tuan Creek* (*M.S.Clemens* AQ22827).

### 17. *Bossiaea scortechinii* F.Muell., *S. Sci. Rec.* 3(1): 1 (1883), as *Scortechinii*

**Type:** [Protologue: 'On the Dumaresq River; Rev. B. Scortechini'] Queensland. Dumaresq River, Stanthorpe, *B.Scortechini* 369, date unknown; holotype: MEL 18891.

*Prostrate or decumbent subshrubs* to c. 0.4 m high, with inflorescences borne on branchlets of various lengths, but not typically on a regular series of short side-branchlets; branchlets erecto-patent to almost spreading, mildly compressed, 0.3–0.8 mm wide, with decurrent ridges, moderately hairy; hairs c. 0.5 mm long; epicuticular wax sometimes developed. *Stipules* narrow-triangular, 1–3 mm long, with l:w ratio 2–3, erect or distally recurved, herbaceous, glabrous, 1–3-nerved; stipule-petiole angle 45–80°. *Leaves:* petiole 0.5–0.8 mm long; articulation strongly geniculate, not ridged; lamina mostly narrow-oblong, sometimes oblong-elliptic or slightly obovate, 5–15 mm long, 2–5 mm wide (juvenile leaves broad-cuneate, c. 10 mm wide), with l:w ratio mostly 3–5, mostly convex each side of midrib, markedly discolorous; base rounded; margin mostly revolute, moderately hairy, tuberculate; apex truncate rounded or subacute, commonly strongly recurved; apiculum to c. 0.5 mm long, generally brittle, pointing down; upper surface smooth, with venation commonly raised, with gland-dotting not evident, with scattered hairs or glabrescent; lower surface with scattered hairs. *Inflorescences:* axes contracted or short, sometimes multinoded, sometimes with a leaf and stipules developed instead of scales; inflorescences sometimes with a few flowers in a raceme-like arrangement,

with a rudimentary or a leafy axis beyond flowers, or sometimes a solitary axillary flower subtended by a leaf or scale arising along a leafy branch; bract 1–2 mm long, 0.5–0.8 mm wide, moderately convex; pedicel (4–)6–20 mm long, hairy; bracteoles persistent or sometimes caducous soon after anthesis, narrow-oblong to linear, 1–2.5 mm long, with l:w ratio 3–10, mostly loosely appressed or mildly divergent, inserted mostly in middle third, strongly convex, with apex slightly convex or flat, sometimes filiform, 1-nerved, sparsely hairy or glabrous, pale yellowish or light orange-brown. *Calyx* 3–5 mm long, hairy, with tube c. equal to lobes; upper lobes 2–3 mm long, 1.5–2 mm wide, abruptly broadening at apex; lateral angle acuminate; sinus c. 1 mm deep; lower lobes 2–3 mm long, filiform distally, 0.7–1 mm wide, with lateral lobes flat, with median lobe often slightly longer than laterals; standard to c. 10 mm long, slightly longer than wings and keel, yellow, possibly without a flare; wings c. as long as keel, c. 1.5 mm wide, yellow; keel 2–3 mm wide, pale throughout or with pink tinges apically; anthers c. 0.3 mm long post-dehiscence; ovary hairy, c. 8-ovulate; style 2–3 mm long. *Pods:* stipe 1–2 mm long; body narrow-oblong, 19–25 mm long, 4–6 mm wide, hairy on margins and valves; hairs on valves to c. 1 mm long, commonly appressed; hairs on sutures c. 0.5 mm long; upper margin c. 0.7 mm wide, not ridged. *Seeds* 2–3 mm long, 1.5–2 mm wide; aril 0.8–1 mm long, c. 0.5 mm high, with base c. 0.4 mm long, with lobe curving 120–180° (Fig. 8c, f).

**Selected specimens from c. 70 examined: QUEENSLAND:** Jibbinbar Mountain, N boundary of Sundown National Park, *P.I.Forster* 19801, 12.x.1996 (BRI, MEL); c. 1.5 km S of Dalveen on Stanthorpe Rd, Darling Downs, *S.L.Everist & L.J.Webb* 1299, 21.xi.1946 (BRI, CANB); 11.5 km E of Miriam Vale, *E.J.Thompson* MIR213 & *D.Baumgartner*, 4.ix.1996 (BRI, MEL). **NEW SOUTH WALES:** Goonooowigall State Conservation Area, c. 5 km S of Inverell, 1 km E of picnic area, *L.M.Copeland* 4493, 8.xii.2010 (BRI, CANB, MEL, NSW); c. 15 km S of Grafton, *J & P. Edwards*, 2001 (NSW); Jennings, *J.H.Maiden & J.L.Boorman*, xii.1903 (NSW); W end of Goonooowigall Nature Reserve, 10 km S of Inverell, *G.J.White*, 30.xi.1992 (NE); 'Strathbogrie' 11 km W of Emmaville, *E.J.McAlister*, 7.iv.1977 (NE); Demon Nature Reserve, c. 30 km SE of Tenterfield, *J.T.Hunter* 4894, 15.iii.1997 (NE).

**Flowering period:** Flowers mostly in spring, but also at other times, presumably in response to rainfall.

**Distribution and habitat:** Occurs in south-eastern Queensland south from Miriam Vale, and in north-

eastern New South Wales as far south as Howell near Inverell (Fig. 9d). Grows in sandy soils over granite in heath, woodland and forest.

**Notes:** Species in the Scortechinii subgroup, and in particular *B. scortechinii*, develop a number of inflorescence variations not seen in other eastern Australian species (see Fig. 1d). These variations are evident, however, in a number of Western Australian species, e.g., *B. laxa* J.H.Ross (illustrated in Ross 2006). Typical inflorescences terminating suppressed or very short axes are fairly commonly seen in the Scortechinii subgroup. However, in some plants the axis is elongated beyond the first flower, and if two or three flowers are present the inflorescence is raceme-like. Sometimes these axes grow on and become leafy shoots. Sometimes an axis appears like a normal leafy shoot, but at a node somewhere along the axis a solitary, truly axillary flower is borne. This flower may be subtended by a leaf or a scale.

The Scortechinii subgroup has distinctive calyx-lobe morphology, with lobes tapering to filiform apices. In the upper lobes these are directed forwards. *Bossiaea scortechinii* generally has the most conspicuously filiform calyx-lobes of the subgroup, and the median lower calyx lobe is often distinctly longer than the other lobes. It also generally has the most slender bracteoles.

**Hybridisation:** A specimen from the Gara River east of Armidale (Wallace 012/86 NSW) may be a hybrid between *B. neoaंगlica* and *B. scortechinii*.

### 18. *Bossiaea obovata* I.Thomps., sp. nov.

A *B. scortechinii* F.Muell. *foliolis obovatis*, *pedicellis brevioribus*, *leguminibus brevioribus*, *pillis leguminis patentibus plerumque differt*.

**Type:** New South Wales. 1 km along road to Stanthorpe from turn-off 0.5 km N of Wilson's Downfall on Mt Lindsay Highway, M.D.Crisp 7313 & I.R.Telford, 28.ix.1974; holotype: MEL 668918; isotypes: CANB n.v., NSW 567111.

*Prostrate or decumbent subshrubs* to c. 0.2 m high, with inflorescences borne on short to long branchlets, but not typically on a regular series of short side-branchlets; branchlets erecto-patent, moderately compressed, 0.3–0.8 mm wide, with well-developed decurrent ridges, sparsely to moderately hairy; hairs 0.3–0.5 mm long; epicuticular wax commonly developed. *Stipules* narrow to very narrow-triangular, 1–2 mm long, erect or distally

recurved, herbaceous, glabrous, 1–3-nerved; stipule-petiole angle mostly 45–80°. *Leaves:* petiole 0.5–1 mm long; articulation strongly geniculate, not ridged; lamina mostly obovate or cuneate, 2–10 mm long, 1–8 mm wide, with l:w ratio mostly 1–2, flat or concave grading to folded distally, moderately discolorous; base symmetrical, broad-cuneate to rounded; margin recurved to revolute, with scattered hairs and/or tuberculate; apex truncate to subacute, or occasionally emarginate, sometimes recurved; apiculum to 0.3 mm long, mostly pointing down; upper surface smooth or tuberculate, with venation raised, with gland-dotting not evident, with scattered hairs; lower surface with scattered hairs. *Inflorescences:* axes contracted or short, or sometimes multinoded, sometimes with a leaf and stipules developed instead of scales; inflorescences sometimes with a few flowers in a raceme-like arrangement, with a rudimentary or a leafy axis beyond flowers, or sometimes a solitary axillary flower subtended by a leaf or scale arising along a leafy branch; bract 1–1.5 mm long, 0.3–0.6 mm wide, moderately convex; pedicel (1–)2–5(–7) mm long, hairy; bracteoles persistent or sometimes caducous soon after anthesis, elliptic to narrow-oblong, 1–2 mm long, with l:w ratio 2–8, mostly loosely appressed, inserted mostly in middle third, slightly to strongly convex, with apex flat or slightly convex, 1-nerved or venation obscure, glabrous, orange-brown or reddish-brown. *Calyx* 3–4.5 mm long, hairy, with tube c. equal to lobes; upper lobes 2–2.5 mm long, c. 1.5 mm wide, abruptly broadening at apex; lateral angle acute or acuminate; sinus 1.5–2 mm deep; lower lobes 2–3 mm long, 0.8–1 mm wide, with lateral lobes flat; standard to c. 10 mm long, slightly longer than wings and keel, adaxially yellow with a slender flare, abaxially sometimes flushed red; wings c. as long as keel, 1.5–2 mm wide, yellow; keel 2.5–3 mm wide, pale throughout or pink at apex; anthers 0.3–0.4 mm long post-dehiscence; ovary hairy, 5- or 6-ovulate; style 3–4 mm long. *Pods:* stipe 1–2 mm long; body ±oblong, 12–18 mm long, 5–7 mm wide, hairy on margins and valves, with hairs commonly spreading; hairs on valves 1–1.5 mm long, hairs on margins 0.5–0.8 mm long; upper margin c. 0.7 mm wide, ±flat. *Seeds* 2.5–3 mm long, c. 2 mm wide; aril c. 0.8 mm long, c. 0.5 mm high, with base c. 0.4 mm long, with lobe curving c. 90° (Fig. 8b).

**Selected specimens from c. 80 examined:** QUEENSLAND: State Forest 639, Wrattens Forest, 22 km SSE of Kilkivan,



*L.Pedley* 5560, 15.x.1990 (BRI); Wyberba, *D.Hockings*, x.1963 (BRI); c. 1.6 km W of Jollys Falls, c. 8 km N of Stanthorpe, *L.Pedley* 1525, 30.x.1963 (BRI); Girraween National Park, *C.E.Woolcock*, 3.xi.1983 (MEL). **NEW SOUTH WALES:** Burra Swamp, c. 35 km SE of Tenterfield via Spirabo Way in Forestland State Forest, *P.C.Jobson* 5255 & *S.A.Mills*, 27.x.1997 (NSW); Wellingrove area, *M.Groy* 2879, 12.iii.1954 (CANB, NSW); 11 km from Torrington along road to Silent Grove, *M.D.Crisp* 7347 & *I.R.Telford*, 29.ix.1984 (AD, CANB, MEL); c. 1.5 km E of Cobcrofts Rd along Mesa Management Trail, Werrikimbe National Park, *L.Copeland* 4474, 2.xi.2010 (BRI, CANB, MEL, NE, NSW).

**Flowering period:** Flowers from October to December, occasionally also in autumn.

**Distribution and habitat:** Occurs in south-eastern Queensland, in the Stanthorpe district and also west of Gympie, and in north-eastern New South Wales as far south as Werrikimbe National Park, south-east of Walcha (Fig. 9e). Grows in sandy soils on granite, in open forest and woodland.

**Etymology:** The epithet refers to the typical shape of the leaflet lamina.

**Notes:** *Bossiaea obovata* differs from the other two species in the *Scortechinii* subgroup by having obovate leaves, short pedicels and pod-valves with spreading hairs. Specimens of *B. obovata* have in the past been assigned to *B. scortechinii*.

## The Obcordata subgroup

### 19. *Bossiaea tasmanica* I.Thompson, *nom. et stat. nov.*

*Bossiaea cinerea* var. *rigida* Rodway, *The Tasmanian Flora*: 36 (1903).

**Type:** [Protologue: 'The Rocks, near New Norfolk,'] Tasmania. The Rocks, near New Norfolk, *L.Rodway* 168, x.1895; holotype: HO 12753.

*Bossiaea obcordata* sensu W.M.Curtis & D.I.Morris, *Student's Fl. Tasmania*, 2nd edn, 1: 148 (1975).

*Prostrate or decumbent shrubs* to c. 0.3 m high, generally densely and irregularly branched, with inflorescences mostly borne on short side-branchlets; branchlets erecto-patent to almost spreading, often recurving, mildly compressed or c. terete, 0.5–0.8 mm wide, with decurrent ridges mostly obscure, tapering distally, spinescent or with apex blunt, sparsely to moderately hairy, glabrescent; hairs 0.3–0.5 mm long; epicuticular

wax commonly developed. *Stipules* narrow-triangular or subulate, 0.8–1.5 mm long, erect, divergent or slightly recurved distally, orange-brown or slightly greenish at first, soon withering to red-brown, glabrous, faintly 1-nerved; stipule-petiole angle 0–60°. *Leaves:* petiole c. 0.5 mm long; articulation strongly geniculate, sometimes ridged; lamina elliptic to obovate, 3–7 mm long, 2–5 mm wide, with l:w ratio mostly 1.2–2, flat or concave grading to more strongly concave or somewhat folded distally, mildly discolorous; base symmetrical, rounded-cuneate; margin flat or more often recurved, with scattered hairs, glabrescent, scarcely tuberculate; apex subacute to truncate, commonly recurved; apiculum to c. 0.2 mm long, pointing down; upper surface smooth, with venation sometimes slightly raised, with gland-dotting generally evident, glabrescent; lower surface glabrescent. *Inflorescences:* axes contracted; stipules and small leaves sometimes developed instead of scales; bract 1–1.3 mm long, strongly convex; pedicel 2–3(–6) mm long, glabrous or sparsely hairy, glabrescent; bracteoles commonly caducous by anthesis, narrow-elliptic, narrow-oblong, narrow-obovate or narrow-spathulate, 1–1.5 mm long, with l:w ratio 2–4, divergent, inserted in proximal half, abaxial surface moderately convex, 1–3-nerved, glabrous or sparsely hairy distally, red-brown. *Calyx* 2.5–4 mm long, hairy, sometimes sparsely so, with tube slightly longer than lobes; upper lobes 1.5–2 mm long, 1.5–2 mm wide; lateral angle acute or acuminate; sinus 0.5–1 mm deep; lower lobes 1.2–2.5 mm long, 0.8 mm wide, with lateral lobes flat; standard to c. 10 mm long, c. as long as keel, adaxially yellow with a red flare, abaxially largely brownish-red except for pale radiating lines; wings slightly shorter than keel, 2–2.5 mm wide, purplish-brown throughout or in distal half; keel c. 3 mm wide, pale grading to greenish-yellow, sometimes pink-tinged at apex; anthers c. 0.6 mm long post-dehiscence; ovary hairy, 4-ovulate; style c. 3 mm long. *Pods:* stipe 1–2 mm long; body ±oblong, 15 mm long, 6 mm wide, with hairs to 1.5 mm long on valves and sutures; upper margin c. 0.7 mm wide, with ridge to c. 0.3 mm high. *Seeds* 2.5–3 mm long, c. 1.5 mm wide; aril c. 0.8 mm long, c. 0.8 mm high, with base c. 0.4 mm long, with lobe curving 150–180° (Fig. 8h, j).

**Selected specimens from c. 14 examined: TASMANIA:** Devil Creek headwaters, *R.Barnes*, 15.xi.2004 (HO); Tower Hill Rd, *M.Neyland*, 12.xi.1991 (HO); 4 km S of Tunnack, *B.French* 628,

7.iv.2002 (HO); Rocks near New Norfolk, *L.Rodway*, xii.1898 (HO); Rossarden Rd, Mangara, *T.Leaman s.n.*, 8.xii.2010 (MEL).

**Flowering period:** Flowers in November and December.

**Distribution and habitat:** Occurs in north-eastern Tasmania near Mathinna, and in south-eastern Tasmania south of Oatlands. Originally collected from New Norfolk west of Hobart but not currently known from this locality (Fig. 9g). Rare, and likely to warrant recognition as a threatened species. Grows in loamy, gravelly or skeletal soils derived from mudstone, in forest and woodland.

**Etymology:** In raising *B. cinerea* var. *rigida* to species rank, the epithet *rigida* could not be used as the name *Bossiaea rigida* Turcz. had already been published. The new epithet reflects the fact that the species is endemic to Tasmania, and *B. tasmanica* is in fact Tasmania's only endemic species of *Bossiaea*.

**Notes:** *Bossiaea tasmanica* appears to be more closely related than *B. obcordata* to other species in Group D. It can be distinguished from *B. obcordata* by its more prostrate habit, more wax-encrusted branchlets with obscure decurrencies, blunter, branchlets that are hardly spinous, relatively narrower leaves, narrower bracteoles, hairy calyx and hairy pods, longer petal claws and different petal colours. The leaves are similar in shape to those of *B. obovata* of the *Scortechinii* subgroup.

Specimens of *B. tasmanica* from the type locality of New Norfolk near Hobart in south-eastern Tasmania have a denser indumentum than is seen in other collections. 'The Rocks' as given in the protologue is thought likely to be Derbyshire Rocks.

**20. *Bossiaea obcordata* (Vent.) Druce, *Rep. Bot. Soc. Exch. Club Brit. Isles* 1916, suppl. 2: 610 (1917)**

*Platylobium obcordatum* Vent., *Jard. Malmaison*: subt. 31 (1803)

**Type:** not designated. [Cultivated in Le Jardin de la Malmaison, France from seed collected during the voyage of Baudin, 1802.] Holotype: G, image seen in Geneva Herbarium Catalogue.

*Platylobium microphyllum* Sims, *Bot. Mag.* 22: 863, pl. 863 (1805); *Bossiaea microphylla* (Sims) 5m., *Trans. Linn. Soc. London* 9: 303 (1808). **Type:** not designated. [Protologue: No information about the provenance of seeds. Cultivated in a private garden in Berkshire,

England.] Holotype: pl. 863 in Sims, *Bot. Mag.* 22: 863 (1805).

**Erect shrubs** to c. 1 m high, with inflorescences typically borne on a regular series of very short, side-branchlets which in turn are produced along a regular series of short erecto-patent side-branches; branchlets erecto-patent, mildly compressed, 0.5–1 mm wide, with well-developed decurrent ridges, spine-tipped, with spine glabrous, orange-brown, sparsely to moderately hairy; hairs to c. 0.5 mm long; epicuticular wax sometimes developed. *Stipules* narrow-triangular, 1–2 mm long, ±erect, brown, sparsely hairy, glabrescent, 3-nerved; stipule-petiole angle c. 30–60°. *Leaves:* petiole 0.5–1.5 mm long; articulation strongly geniculate, with ridge absent or obscure; lamina broad-obovate, obcordate or circular, 3–6 mm long, 2–6 mm wide, with l:w ratio 0.9–1.3, flat or gently convex each side of midrib, mostly markedly discolorous; base symmetrical, rounded to cuneate; margin recurved, glabrescent, ±smooth; apex rounded, truncate or emarginate, sometimes slightly downcurved; apiculum not or hardly developed; upper surface smooth, with venation generally raised, with gland-dotting sometimes evident, glabrescent; lower surface glabrescent. *Inflorescences:* axes contracted or to c. 1 mm long; bract caducous, c. 0.8 mm long, 0.6 mm wide, strongly convex; pedicel 2–4 mm long, glabrous or sparsely hairy proximally; bracteoles caducous or sometimes persisting to anthesis, elliptic to obovate, 1–1.5 mm long, with l:w ratio 1.5–2, loosely appressed, inserted in middle or proximal thirds, slightly to moderately convex, 3- to 5-nerved, glabrous, red-brown. *Calyx* 2.5–4.5 mm long, glabrous, or occasionally very sparsely hairy, with tube slightly to much longer than lobes; upper lobes 1–2 mm long, 1.2–2 mm wide; lateral angle acute; sinus 0.5–1 mm deep; lower lobes 1–1.5 mm long, c. 0.8 mm wide, with lateral lobes flat; standard to 10 mm long, slightly longer than wings and keel, adaxially yellow with a red flare, and with throat bisected, abaxially red, mainly medially; wings 0.5–1 mm shorter than keel, c. 2.5 mm wide, purplish-brown throughout or sometimes dirty yellow distally; keel 3–4 mm wide, pinkish grading to darker red; anthers c. 0.4 mm long post-dehiscence; ovary glabrous or sparsely hairy along upper margin, 4-ovulate; style 3–4 mm long. *Pods:* stipe 2–3 mm long; body elliptic or rhomboid-



elliptic, 10–20 mm long, 5–9 mm wide, glabrous; upper margin c. 0.7 mm wide, with ridge to c. 0.5 mm high. Seeds 3–3.5 mm long, c. 2 mm wide; aril 1–1.5 mm long, 1–1.5 mm high, with base c. 1 mm long, with lobe curved 60–150° (Fig. 8g, i).

**Selected specimens from c. 100 examined: QUEENSLAND:**

Girraween National Park, *I.R.Thompson 181*, 21.x.1995 (MEL); Bald Rock Creek, 10 km N of Wallangarra, *I.R.Telford 3180*, 26.ix.1973 (CANB); Granite National Park, Wyberba, *M.S.Clemens 44729*, xi.1944 (BRI). **NEW SOUTH WALES:** Pacific Hwy, c. 20 km S of Kempsey, *R.Coveny 2151*, 29.ix.1969 (BRI, NSW); Cumberland State Forest, West Pennant Hills, *R.Coveny 8630*, 29.x.1976 (NSW); Corner of Forest Way and Mona Vale Rd, Belrose, *R.Coveny 11902 & T.James*, 20.ix.1984 (BRI, CANB, MEL, NSW, PERTH); c. 3 km NE of Ulan, *R.Story 6818*, 10.x.1959 (BRI, CANB). **VICTORIA:** Brisbane Ranges National Park, c. 250 m SW of Aeroplane Rd turnoff on Reids Rd, *V.Stajsic 616*, 26.x.1992 (MEL); W of Buchan South, *A.C.Beauglehole 77082*, 16.ix.1984 (MEL); near Lochsport rubbish dump, The Lakes National Park, *A.C.Beauglehole 62840*, 19.xii.1978 (MEL).

**Flowering period:** Flowers from August to October.

**Distribution and habitat:** *Bossiaea obcordata* occurs in far south-eastern Queensland, eastern New South Wales, and southern Victoria extending as far west as the Brisbane Ranges (Fig. 9f). Grows in open forest and woodland.

**Notes:** In northern New South Wales and Queensland flowers are generally slightly larger. *Bossiaea obcordata* has leaves with distinctive broad-obovate, generally gland-dotted leaflets, moderately long petioles and a strongly geniculate articulation. The erect, three-nerved stipules resemble those in the *Scortechinii* subgroup but are scarious and red-brown rather than green. Floral and aril morphology and is more similar to that seen in Group E than Group D.

The protologue of *P. obcordatum* in *Le Jardin de la Malmaison* appears in the text associated with Plate 31, and is written in a smaller typeface. Plate 31 is an illustration of *Platylobium formosum*.

## Group E

*Erect shrubs*, sometimes moderately tall; branchlets compressed or terete, sometimes with decurrencies, sometimes very narrowly winged. *Stipules* generally erect, sometimes with recurved, distorted, membranous margins. *Leaves* with petiole mostly adaxially sulcate, with articulation generally geniculate; lamina sometimes

asymmetrical, generally not markedly discolorous, with margins commonly flat and sometimes minutely pale-rimmed, with apiculum absent or inconspicuous. *Inflorescences:* axes with scales 2; bracts and bracteoles moderately convex; pedicels relatively stout, slightly fleshy (commonly wrinkled on drying), becoming stouter as fruit develops; bracteoles mostly inserted proximally. *Calyx* glabrous, often fleshy, drying blackish, sometimes glaucous or glossy; upper lobes oblong or slightly broadening from the base, mostly broader than long, mostly not or only mildly expanded beyond lateral angle; keel sometimes markedly elongate; wings generally shorter than the keel; anthers relatively small. *Pods* generally long-stipitate; body glabrous, with valves mostly relatively thick and with a broad thickened upper margin, often with seeds partitioned by spongy tissue internally (Fig. 10).

Group E contains nine species with seven of these divided into two well-defined subgroups, while the remaining two are placed in subgroups of their own. The group extends from far north Queensland south to Moruya in south-eastern New South Wales, and from the coast to as much as c. 500 km inland (Fig. 11).

The *Heterophylla* subgroup (species 22–24) is distinguished by compressed branchlets, short stipules, strongly convex, basally inserted bracteoles, a calyx with upper lobes longer than the lower lobes and moderately expanded, and wings distinctly shorter than the keel.

The *Brownii* subgroup (species 25–28) is distinguished by terete, commonly moderately hairy branchlets, often distorted stipules with revolute membranous margins, and leaves with an asymmetrical base. Within the subgroup, *B. carinalis* and *B. rupicola* are clearly distinct in having flowers with an elongate keel. The only other species of eastern *Bossiaea* to have flowers with an elongated keel is the leafless, arid-zone species *B. walkeri* (Group F).

The remaining two species of Group E have a number of peculiar features and form subgroups of their own. *Bossiaea stephensonii* (21) from central-eastern New South Wales has cladode-like branchlets, very large erect green stipules, strongly geniculate and spurred leaves, and an indumentum entirely of relatively long fine hairs, while *B. arenicola* (29) from far northern Queensland has bracteoles fused into a single structure, a markedly striate calyx with distinctive triangular lobes, and flowers with entirely yellow petals.



**Figure 10. Group E.** a. *B. rhombifolio* (D.E.Albrecht 5336 MEL); b. *B. rupicolo* (J.H.Ross 3125 MEL); c. *B. brownii*, pod, seed among leaves (A.N.Rodd 4173 MEL); d. *B. orenicolo* (J.Clarkson 7819 MEL); e. *B. brownii*, stipules, base of leaflet, inflorescence (P.I.Forster 24775 MEL); f. *B. heterophyllo*, pod-valve, inner surface (A.C.Beoughlehole 75827 MEL); g. comparison of upper margin of pods of *B. rhombifolio* (top Woolfs MEL1528730) and *B. buxifolio* (A.C.Beoughlehole 68637 MEL); h. *B. rhombifolio*, stipules (D.E.Albrecht 5336 MEL); i. *B. concolor*, stipules (I.R.Thompson 486 MEL); j. *B. stephensonii* (M.Tindole s.n. NSW 55359); k. *B. corinolis*, pod (P.I.Forster 7290 MEL); l. *B. oligospermo*, flower (I.R.Thompson 1278 MEL); m. *B. oligospermo*, leaves and immature pod (I.R.Thompson 1333 MEL); n. *B. orenicolo*, flowers (J.Clarkson 7819 MEL); o. *B. orenicolo*, pod (L.J.Webb & J.G.Trocey 13610 MEL).

Scale bars: a–d = 5 mm, e, f, j, k, m–o = 2 mm, g–i = 1 mm.



## The Stephensonii subgroup

### 21. *Bossiaea stephensonii* F.Muell., *Proc. Linn. Soc. New South Wales, ser. 2, 1(4): 1107 (1887)*

**Type:** [Protologue: 'Near Wollongong (L. Stephenson, B.A.)'] New South Wales. Near Wollongong, *L. Stephenson*, x-xi.1886; holotype: MEL 20329.

*Erect shrubs* to c. 1 m high, with inflorescences variously borne on longer branchlets or on a regular series of shorter side-branchlets; branchlets erecto-patent, strongly compressed, 1–3 mm wide, with decurrent

ridges well-developed, often narrowly winged, sparsely to moderately hairy, generally glabrescent; hairs 1–2 mm long; epicuticular wax not or hardly developed. *Stipules* narrow-ovate to lanceolate, mostly 4–8 mm long, erect, flat, herbaceous, glabrous, conspicuously 4–8-nerved; stipule-petiole angle c. 45°. *Leaves:* petiole 1.5–3 mm long; articulation strongly geniculate, prominently ridged or with spur to c. 0.5 mm long; lamina narrow-elliptic or occasionally narrow-oblong or lanceolate, 7–20(–25) mm long, 2–7 mm wide (juvenile leaves to c. 10 mm wide), with l:w ratio mostly 2.5–5, slightly convex each side of midrib, slightly to moderately

#### Key to Group E

- 1 Branchlets compressed, glabrous or with a sparse covering of hairs; stipules without membranous often distorted margins .....2
- 1: Branchlets terete, generally moderately covered by a close indumentum; stipules with membranous margins.....5
- 2 Stipules mostly > 4 mm long, green; indumentum with hairs 1–2 mm long .....21. *B. stephensonii*
- 2: Stipules to 1.5 mm long, brown; indumentum with hairs generally < 1 mm long, often glabrous or nearly so .....3
- 3 All or most leaflets with l:w ratio > 2; upper calyx-lobes > ½ the length of calyx-tube; body of pods > 2.5 cm long.....22. *B. heterophylla*
- 3: Leaflets with l:w ratio < 2; upper calyx-lobes < ½ the length of calyx-tube; body of pods < 2.5 cm long.....4
- 4 Stipules to c. 0.5 mm long, c. as long as broad, with apex pointing in almost the same direction as petiole; wing petals 10 mm long, largely brownish-red; leaves with l:w ratio mostly < 1.3 .....23. *B. rhombifolia*
- 4: Stipules 0.7–1.5 mm long, longer than broad, with apex pointing almost at right angles to petiole; wing petals 6 mm long, largely yellow; leaves with l:w ratio mostly > 1.3.....24. *B. concolor*
- 5 Keel 12–25 mm long, exceeding standard by several mm; persistent stamen-tube > 12 mm long; pod-stipe 10–20 mm long.....6
- 5: Keel to c. 10 mm long, not or hardly exceeding standard; persistent stamen-tube < 12 mm long; pod-stipe 4–10 mm long.....7
- 6 Leaflets with l:w ratio mostly < 4, with adaxial surface smooth, with secondary venation almost as robust as the midrib; pedicels glabrous or with hairs generally somewhat divergent or curly .....25. *B. carinalis*
- 6: Leaflets with l:w ratio mostly > 4, with adaxial surface minutely granular, with secondary venation markedly more slender than the midrib; pedicels with straight, appressed hairs.....26. *B. rupicola*
- 7 Bracteoles fused to form a single structure; petals lacking red or purple markings; calyx conspicuously striate; ovary hairy (northern Queensland) .....29. *B. arenicola*
- 7: Bracteoles free from each other; petals with red or purplish markings; calyx not conspicuously striate; ovary glabrous (southern Queensland; New South Wales) .....8
- 8 Leaflets ovate, with base asymmetrical; body of pods 15–40 mm long, partitioned internally (Queensland).....27. *B. brownii*
- 8: Leaflets c. circular, with base c. symmetrical; body of pods 10–12 mm long, not partitioned internally (New South Wales).....28. *B. oligosperma*

discolourous; base symmetrical, rounded to truncate; margin flat to recurved, usually knobby and pale; apex acuminate, tapering into an apiculum; apiculum to c. 0.1 mm long, generally pointing slightly down; upper surface smooth or slightly tuberculate, with venation raised, brochidodromous, with gland-dotting generally evident, glabrescent; lower surface glabrescent. *Inflorescences*: axes contracted; bract persistent, 2 mm long, c. 1 mm wide, convex; pedicel 3–10 mm long, glabrous; bracteoles persistent until flowering, narrow-oblong or narrow-elliptic, 2–2.5 mm long, with l:w ratio 2.5–3, appressed, inserted near base of pedicel, strongly convex, 3–8-nerved, glabrous, red-brown. *Calyx* 3–4 mm long, glabrous, with tube equal to or longer than lobes; upper lobes 1.2–1.8 mm long, c. 1.5 mm wide; lateral angle acuminate; sinus 1–1.5 mm deep; lower lobes 1–1.8 mm long, 0.8–1 mm wide, with lateral lobes flat; standard to c. 12 mm long, similar in length to or slightly longer than wings and keel (shorter before opening), adaxially yellow with a red flare, with throat bisected; abaxially reddish interrupted by pale radiating nerves; wings c. equal to keel, c. 2 mm wide, reddish proximally, generally yellow in distal half; keel c. 3 mm wide, pink grading to dark red; anthers c. 0.3 mm long post-dehiscence; ovary glabrous, 4–6-ovulate; style 3–4 mm long. *Pods*: stipe 3–4 mm long; body narrow-oblong, 15–25 mm long, 6–9 mm wide, glabrous, without spongy tissue internally; upper margin 1–1.5 mm wide, with a ridge to c. 0.5 mm high, sometimes ridged along suture only. *Seeds* 2.5–3 mm long, 1.5–1.8 mm wide; aril 0.8–1.2 mm long, c. 0.8 mm high, with base 0.7–1.2 mm long, with lobe curving c. 90° (Fig. 10j).

**Selected specimens from c. 50 examined:** NEW SOUTH WALES: Port Macquarie, *E.R. Brown*, ii.1897 (NSW); Gan Gan Hill, Nelsons Bay, *R. Payne* 2/3, viii.1993 (NSW); outskirts of Gateshead near Newcastle, *R. Story* 6570, 8.viii.1959 (CANB, MEL); Morisset, *J.L. Boorman*, x.1899 (NSW); Caley Range, Blue Mountains National Park, *W.A. Cherry* 576, 5.xi.2004 (NSW); Royal National Park, just E of Engadine Railway Station, *M.D. Crisp* 7167, 4.x.1983 (AD, CANB, MEL); Scouters Mountain, Heathcote National Park, *R. Coveny* 11607 & *W. Bishop*, 1.ix.1983 (MEL, NSW).

**Flowering period:** Flowers in winter and spring. Most flowers opening more or less simultaneously.

**Distribution and habitat:** Occurs near the coast in north-eastern and central-eastern New South Wales from Port Macquarie in the north to Wollongong in the south (Fig. 11a). Grows in open forest, woodland

and heathland, often in sandy soils on sandstone, but sometimes also in clay soils.

**Notes:** *Bossiaea stephensonii* is readily identified by its large, erect, green stipules, narrowly winged branchlets, and long hairs. It approaches species in Group D in terms of the relative length of lower calyxlobes, the relatively large, erect stipules, thin pods, long petioles and geniculate leaflet-articulation. The bracts and bracteoles are similar in size and colour to those of *B. prostrata*.

**Hybridisation:** The type specimen of *B. humilis* Meisn. (see under Names of uncertain application) is possibly a hybrid involving *B. stephensonii*. *Bossiaea obcordata* is a likely candidate as the other parent.

## The Heterophylla subgroup

### 22. *Bossiaea heterophylla* Vent., *Descr. Pl. Nouv.* 1: 7, t. 7 (1800)

**Type:** not designated. [Protologue: '... originaire de Botany-Bay, introduit chez Cels en 1792, ...' Cultivated plant, grown, presumably, from seeds collected at Botany Bay, New South Wales.] Holotype: t. 7 in *Descr. Pl. Nouv.* 1: 7 (1800).

*Platylobium lanceolatum* Andrews, *Bot. Repos.* 3: pl. 205 (1802); *Bossiaea lanceolata* (Andrews) Sm., *Bot. Mag.* 28: 1144, t. 1144 (1808). **Type:** not designated. [Protologue: 'Our drawing was made in November 1801, at the Nursery of Messrs. Le[e] and Kennedy, Hammersmith, by whom it was first raised in 1792.'] Holotype: pl. 205 in *Bot. Repos.* 3 (1802).

*Platylobium ovatum* Andrews, *Bot. Repos.* 4: pl. 266 (1802); *Bossiaea ovata* (Andrews) Sm., *Trans. Linn. Soc. London* 9: 303 (1808). **Type:** not designated. [Protologue: 'No locality information for source of seeds provided. Cultivated at Nursery of Messr. Lee & Kennedy, Hammersmith.'] Holotype: pl. 266 in *Bot. Repos.* 4: (1802).

*Bossiaea heterophylla* var. *stenoclada* Domin, *Biblioth. Bot.* 22(89): 728 (1928). **Type:** [Protologue: 'N. S. Wales: in der Nahe von Leura in den Blue Mts. (Domin IV. 1910)'. Near Leura, Blue Mountains, New South Wales.] Holotype: possibly PR, *n.v.*

*Semi-prostrate to erect shrubs* to c. 2 m high, with inflorescences typically borne on longer branchlets rather than a regular series of short side-branchlets; branchlets sub-erect to erecto-patent, moderately



compressed, 1–3 mm wide, with decurrent ridges variably well-developed, occasionally narrowly winged, sparsely to moderately hairy, often glabrescent; hairs c. 0.2 mm long; epicuticular wax sometimes developed. *Stipules* triangular, 0.5–0.8 mm long, appressed, soon withering to dark-brown, glabrous, with venation indistinct; stipule-petiole angle 10–30°. *Leaves*: petiole 0.7–2.0 mm long, sulcate and hairy adaxially; articulation strongly geniculate, often ridged; lamina narrow oblong-elliptic, sometimes appearing almost linear due to rolling, 4–25 mm long, 1.5–6 mm wide, (juvenile leaves to 20 mm wide), with l:w ratio mostly 2–10, flat, incurved or involute, slightly discoloured; base symmetrical, rounded to truncate; margin flat, glabrous, with a smooth pale border; apex subacute to rounded, often recurved; apiculum not developed; upper surface smooth, with venation variably raised, brochidodromous, with gland-dotting not evident, glabrous; lower surface soon glabrescent. *Inflorescences*: axes contracted or to c. 3 mm long, moderately hairy, occasionally with leaves instead of scales; bract 0.8–1.5 mm long, 0.8 mm wide, strongly convex; pedicel 3–8 mm long, glabrous; bracteoles persistent, oblong to elliptic or ovate, 0.8–2 mm long, with l:w ratio 1.5–2, generally appressed, mostly inserted at or below mid-pedicel, convex, with venation obscure or faintly 1-nerved, glabrous, brown or red-brown. *Calyx* 3–6 mm long, glabrous, with tube mostly slightly longer than lobes; upper lobes 1.2–2 mm long, 1.5–3 mm wide, sometimes slightly expanded beyond lateral angle; lateral angle acute; sinus 1–2 mm deep; lower lobes 1–2 mm long, c. 0.8 mm wide, with lateral lobes flat; standard to c. 15 mm long, slightly longer than keel (slightly shorter prior to opening), adaxially yellow with a red flare, with throat bisected; abaxially mostly flushed pink; wings 2–3 mm shorter than keel, 1.5–2.5 mm wide, yellow throughout or flushed pink; keel 3–4 mm wide, pink grading to red; anthers c. 0.3 mm long post-dehiscence; ovary glabrous, 5- or 6-ovulate; style 2–5 mm long. *Pods*: stipe 5–9 mm long; body narrow-oblong, 30–45 mm long, 6–10 mm wide, glabrous; upper margin 1.2–2 mm wide, not ridged or with ridge to 1.5 mm high, sometimes only finely ridged along suture; valves with transverse venation generally obscure, with dense spongy tissue internally. *Seeds* 3–4 mm long, 2–2.5 mm wide; aril 1–2 mm long, 1–1.5 mm high, with base 1–1.5 mm long, with lobe curving 90–120° (Fig. 10f).

**Selected specimens from c. 200 examined: QUEENSLAND:** near Coonarr Beach, 16 km SE of Bundaberg, *L.Pedley* 4425, 24.iii.1977 (BRI, CANB, NSW); Moreton Island, c. 6.5 km NE of Tangalooma, *L.Durrington* 1285, 14.iv.1974 (BRI); 5 km WNW of Orchid Beach, Fraser Island, Great Sandy National Park, *P.J.Forster* 30253 & *G.Leiper*, 4.ix.2004 (BRI); Pine Ridge Wildflower Reserve, c. 8 km NNW from Southport, *B.Lebler* & *P.Baxter*, 30.iv.1968 (BRI). **NEW SOUTH WALES:** Mororo, NW of Iluka, *R.J.Fensham* 4921, 20.viii.2003 (BRI); Blackheath, *E.Gaub* 832, 5.iii.1953 (CANB); Jervis Bay, *M.E.Phillips* 1109, 3.v.1961 (CANB); Cowan to Jerusalem Bay, *H.Salasoo* 2126, 2.iv.1961 (NSW); Yena Fire Trail, Captain Cook Drive, Kurnell Peninsula, Botany Bay National Park, *D.M.Crayn* & *R.G.Coveny* 938, 28.ix.2005 (NSW); Warrah Trig Station, Gosford, *D.Gibbons*, 29.iv.1987 (NSW). **VICTORIA:** N margin of Holey Plains State Park, *M.G.Corrick* 10034, 24.xi.1986 (MEL); near Clinton Rocks track, Captain Cook National Park, *A.C.Beauglehole* 33490, 20.vii.1970 (MEL); railway line between Munro and Fernbank, c. 5 km W of Fernbank, *J.Jeanes* 169, 29.iii.1995 (MEL); Spermwhale Head, *N.A.Wakefield* 4741, 18.iv.1953 (MEL).

**Flowering period:** Flowers in autumn and winter mostly.

**Distribution and habitat:** Occurs towards the coast in south-eastern Queensland, south of Bundaberg, in New South Wales, and in eastern Victoria (Fig. 11b). Categorized as rare in Victoria (Walsh & Stajsic 2007). Grows in heath, woodland and open forest.

**Notes:** *Bossiaea heterophylla* is a widespread species distinguished from the other two species in the subgroup by its broader branchlets, leaflets with a higher length to width ratio and incurved margins, and longer calyx-lobes. In the Sydney area there is a form with broader branchlets and leaves and larger flowers. Domin named a new variety for a narrower-branched and narrower-leaved form; however, the distinction between the forms appears to be insufficiently discrete to warrant formal taxonomic status. A third form, and the predominant form in Queensland, differs from forms occurring further south by having pods with a markedly ridged upper margin, shorter keels with paler markings, and shorter styles.

### 23. *Bossiaea rhombifolia* Sieber ex DC., *Prodr.* 2: 117 (1825)

**Type:** [Protologue: 'Sieb! pl. exs. nov. holl. n. 354;'] New South Wales. Location unknown. *F.Sieber* 354; holotype: G-DC, photo seen NSW; isotypes: MEL (4 sheets) 1528739 to 1528742), NSW 566031.

*Bossiaea rotundifolia* DC., *Prodr.* 2: 117 (1825). **Type:** not designated. [Protologue: 'in Novâ-Hollandiâ orient.']. Holotype: G-DC, image seen MEL, NSW.

*Bossiaea lenticularis* Lodd., G.Lodd. & W.Lodd., *Bot. Cab.* 13: 1238, pl. 1238 (1827), *nom. illeg.* **Type:** not designated. [Protologue: 'A native of New Holland: we raised it in 1823 from seeds ...']

*Erect shrubs* to c. 2 m high, with inflorescences typically borne on a regular series of short to medium-length side-branchlets; branchlets erecto-patent, moderately compressed, 0.5–1 mm wide, with decurrent ridges generally not well-developed, not winged, ±glabrous; epicuticular wax generally not developed. *Stipules* asymmetrically triangular, with side nearest branch larger, 0.2–0.5 mm long, appressed, brown, glabrous, 1-nerved or venation obscure; stipule-petiole angle 10–20°. *Leaves:* petiole 0.5–1 mm long, sulcate adaxially, densely hairy in the sulcus; articulation strongly geniculate, prominently ridged; lamina slightly obovate, circular, rhomboid, or occasionally broad-obovate, 4–12 mm long, 3–12 mm wide, with l:w ratio 0.9–1.4(–1.8), flat or gently concave, slightly or hardly discolorous; base symmetrical, rounded or broad-cuneate; margin flat, glabrous, smooth, with a pale rim; apex rounded, obtuse, acute or acuminate, sometimes slightly recurved; apiculum not developed; upper surface smooth, with venation sometimes slightly raised, with gland-dotting not evident, glabrous; lower surface glabrous. *Inflorescences:* axes contracted; bract 0.5–0.8 mm long, c. 0.5 mm wide, strongly convex; pedicel 1–4 mm long, glabrous; bracteoles persistent, ovate, 0.8–1.5 mm long, with l:w ratio 1.5–2, loosely appressed or slightly divergent, inserted mostly in proximal third, especially near-basal, strongly convex, 1-nerved, or sometimes obscurely 2- or 3-nerved, glabrous, often pale at anthesis, becoming mid-brown. *Calyx* 2.7–5 mm long, glabrous, often glaucous, with tube much longer than lobes; upper lobes 0.6–1.5 mm long, 1.5–2.5 mm wide, sometimes expanded beyond lateral angle by up to c. 0.5 mm; lateral angle usually minutely acuminate; sinus 0.5–1 mm deep; lower lobes 0.5–1 mm long, 0.7–1 mm wide, with lateral lobes flat or slightly convex, with a medial ridge; standard to c. 12 mm long, slightly longer than keel (but slightly shorter prior to opening),

adaxially yellow with red flare patches each side of throat, with throat bisected, abaxially partly flushed red; wings c. 1 mm shorter than keel, 2.5–3 mm wide, predominantly but sometimes patchily brownish-red; keel 3–4 mm wide, pinkish grading to dark red; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, 4–6-ovulate; style 4–5 mm long. *Pods:* stipe 5–7 mm long; body oblong or oblong-elliptic, (10–)13–18 mm long, 8–11 mm wide, glabrous, glaucous; upper margin broadened by rounded lateral ridges; upper margin 2–3 mm wide, with sutural ridge to c. 1 mm high; valves with transverse venation slightly raised, with spongy tissue usually partitioning seeds internally. *Seeds* 3.5–4.5 mm long, 2.5 mm wide; aril 1.5–2.2 mm long, 1–1.2 mm high, with base 1–1.2 mm long, with lobe curving c. 135° (Fig. 10a, g, h).

**Selected specimens from c. 150 examined: QUEENSLAND:**

Darling Downs: c. 6 km NNE of Wallangarra, 1.8 km SSE of Mt Norman, *M.D.Crisp 7325 & I.R.Telford*, 28.ix.1984 (BRI, CANB, MEL, NSW); Dr Roberts Waterhole, Girraween National Park, *N.G.Walsh 3884*, 15.ix.1994 (MEL, NSW); Jollys Falls, near The Summit, *M.E.Phillips*, 20.ix.1966 (BRI). **NEW SOUTH WALES:** Fortis Creek, 24 km N of Grafton on road to Coaldale, *D.B.Foreman 902*, 23.viii.1985 (MEL, NE, NSW); Nelson Bay, 50 km NE of Newcastle, *T.J.McDonald 1916*, 21.viii.1976 (BRI); Warrimoo, lower Blue Mountains, *K.A.McColl*, 20.viii.1997 (CANB, NSW); Flagstone Creek Rd, 2 km off the Gulf Rd, *P.I.Forster 17530*, 25.viii.1995 (BRI, MEL, NSW); N side of Timor Rd, 14.4 km W of Coonabarabran, Warrumbungles National Park, *P.C.Jobson 4851 & S.A.Mills*, 3.ix.1997 (AD, CANB, MEL, NSW); 10 km W of Coonabarabran, *H.Streimann 599*, 6.xii.1973 (BRI, CANB); Donalds Creek, c. 1.8 km due S of the confluence of Burra and Donald Creeks, *D.E.Albrecht 5336*, 2B.viii.1993 (MEL).

**Flowering period:** Flowers in late winter and spring.

**Distribution and habitat:** Occurs in eastern New South Wales north from Moruya, and in the Stanthorpe district in far south-eastern Queensland (Fig. 11c). Grows in woodland and open forest.

**Notes:** *Bossiaea rhombifolia* is mostly easily recognisable by the shape of its leaves, although occasionally their length:width ratio becomes as high as those of its closest relative *B. concolor*. The very short stipules of *B. rhombifolia* are also distinctive with only those of *B. heterophylla* being similar. The stipules are often asymmetrically triangular with the more expanded half tending to cover the leaf-axil.



## 24. *Bossiaea concolor* (Maiden & Betche)

### I. Thomps., *comb. et stat. nov.*

*Bossiaea rhombifolia* var. *concolor* Maiden & Betche, *Proc. Linn. Soc. New South Wales*, series 2, 33: 307 (1908); *B. rhombifolia* subsp. *concolor* (Maiden & Betche) A.T.Lee, *Contr. New South Wales Natl Herb.* 4(3): 97 (1970).

**Type:** [Protologue: 'Araluen (J. L. Boorman; August, 1907)'. Locality incorrectly cited.] New South Wales. Narrabri, J.L.Boorman, viii.1907; holotype: NSW 43872; isotypes: MEL 1528717, MEL 1528718.

*Erect shrubs* to c. 3 m high, with inflorescences typically borne on a regular series of short to medium-length side-branchlets; branchlets sub-erect to erecto-patent, moderately compressed, 0.5–1 mm wide, with decurrent ridges not well-defined, not winged, sometimes transiently moderately hairy, glabrescent; hairs often curled, c. 0.3 mm long; epicuticular wax generally not developed. *Stipules* narrow-triangular, 0.7–1.5 mm long, flat, erect or slightly divergent, mid-brown, glabrous, 1-nerved, stipule-petiole angle 45–90°. *Leaves:* petiole 0.5–1 mm long, sulcate and hairy adaxially; articulation not or only slightly geniculate, mostly slightly ridged; sometimes articulation obscure; lamina elliptic, oblong-elliptic, or obovate, 3–8 mm long, 2–5 mm wide, with l:w ratio mostly 1.2–1.8, flat or more often gently concave or folded, nearly concolorous; base symmetrical, rounded or broad-cuneate; margin flat, glabrous, smooth, with a pale rim; apex rounded, subtruncate or slightly retuse, sometimes slightly recurved; apiculum absent; upper surface smooth, with venation mostly slightly raised, with gland-dotting sometimes faintly evident, glabrous; lower surface glabrous. *Inflorescences:* axes contracted; bract 0.6–1 mm long, 0.4–0.5 mm wide, strongly convex; pedicel 1–4 mm long, glabrous; bracteoles persistent, ovate or elliptic, 0.7–1 mm long, with l:w ratio 1.5–2, loosely appressed, inserted near base, strongly convex, with venation obscure, glabrous, red-brown. *Calyx* 2–4 mm long, glabrous, with tube longer than lobes; upper lobes 0.5–1.2 mm long, 1.2–1.8 mm wide, expanded beyond lateral angle by up to 0.5 mm; lateral angle acuminate; sinus c. 0.5 mm deep; lower lobes 0.5–1.5 mm long, 0.5–1 mm wide, with lateral lobes flat or more often convex, often with a medial ridge; standard to c. 9 mm long, slightly longer than keel, adaxially yellow with a red flare, with throat bisected, abaxially generally all yellow except for flare; wings 1–2 mm shorter than

keel, 1.5–2 mm wide, yellow; keel c. 3 mm wide, pale proximally abruptly becoming red in distal half to two-thirds; anthers c. 0.4 mm long post-dehiscence; ovary glabrous, 4–6-ovulate; style 1.5–4 mm long. *Pods:* stipe 3–5 mm long; body oblong to elliptic, 15–25 mm long, 6–9 mm wide, glabrous; upper margin; upper margin 1.5–2 mm wide, broadened by rounded lateral ridges, with or without sutural ridge to c. 1 mm high; valves with transverse venation slightly raised, with spongy tissue usually forming partitions internally. *Seeds* 3–3.5 mm long, 2–2.5 mm wide; aril 1.5–2 mm long, c. 1 mm high, with base c. 0.8 mm long, with lobe curving 100–150° (Fig. 10i).

**Selected specimens from c. 100 examined: QUEENSLAND:** Burnett: 'Melrose', 15 km W of Eidsvold, *A.R.Bean* 2294, 15.ix.1990 (BRI); near Western Creek, 'Mt Owen', c. 140 km N of Mitcheli, *A.R.Bean* 257B3, 27.xi.2006 (BRI, NSW); Auburn State Forest, 18 km WSW of Mundubbera, *P.I.Forster* 36171, 30.viii.2009 (BRI, MEL, NSW); 0.7 km S of Booroondoo Creek, Dingo Fence, SE of Moonie, *A.R.Bean* 123B1, 6.ix.1997 (BRI, MEL, NSW); Precipice National Park, *P.I.Forster* 196B3, 25.ix.1996 (AD, BRI, MEL, NSW); S end of Fraser Island, *I.P.Little* JTB53, 9.x.1979 (BRI); 23.2 km N of Chinchilla–Wondai Rd on Burncluth Rd c. 31.5 km NNE of Chinchilla, *B.J.Lepschi* & *A.V.Slee* 1269, 23.x.1993 (AD, BRI, HO, MEL); Darling Downs: Stretchworth State Forest, 5F155 Austin, Block 30/31, *M.Bennie* 156, 6.viii.2000 (BRI). **NEW SOUTH WALES:** Pilliga Nature Reserve, 1.4 km E of Borah Creek Rd along Kerringle Rd, *S.Donaldson* 2417 & *B.A.Bell*, 19.ix.2000 (CANB, NSW); Warialda State Forest 417, *P.I.Forster* 1B234, 15.xii.1995 (BRI, MEL, NSW); 2 km W of Coonabarabran, *H.I.Aston* 2406, 28.viii.1983 (MEL, NSW); Narrabri, *J.L.Boorman*, vi.1907 (NSW).

**Flowering period:** Flowers in late winter and spring.

**Distribution and habitat:** Occurs mostly inland from the Great Divide, in south-eastern Queensland south from Shoalwater Bay, and in north-eastern and central-eastern New South Wales as far south as Mudgee (Fig. 11d). Grows mostly in sandy soils in woodland and open forest.

**Notes:** *Bossiaea concolor* is similar to *B. rhombifolia* but can be distinguished from that species by the following: narrow-triangular stipules that form a large angle with the petiole (compare Figure 10h & 10i), smaller flowers and petals with different markings. In addition, leaflets and pods on average have a higher length to width ratio (leaflets c. 1.5 compared to c. 1.2; pods c. 3 compared to c. 1.8), the cavities formed by spongy tissues in the

Pods are shallower, and seeds are smaller. Branchlets in *B. concolor* are often slightly flexuose. The petiolule is short with the articulation often almost in contact with the lamina. The articulation also lacks the prominent ridge that is typical of *B. rhombifolia*.

*Bossiaea concolor* is similar to *B. nummularia* in leaf-shape and articulation and stipule morphology. Flowers of *B. concolor* are relatively small in the Mundubbera district of south-eastern Queensland, e.g., in *A.R.Bean* 27977 and 28063, both BRI.

## The Brownii subgroup

### 25. *Bossiaea carinalis* Benth., in T.L.Mitchell, *J. Exped. Trop. Australia*: 289 (1848)

**Type:** [Protologue: 'on Balmy Creek'. Balmy Creek is in central Queensland, SE of Emerald.] Queensland. Locality unknown (label states Sub-Tropical New Holland), *T.L.Mitchell* 275, 31.viii.1846; lectotype (here selected): K 000278379, image seen in Kew Herbarium Catalogue.

Residual syntypes: MEL 664781; MEL 665573; K 000278378, image seen in Kew Herbarium Catalogue.

*Erect shrubs* to c. 3 m high, with inflorescences borne variously on long branchlets or on a  $\pm$ regular series of short to medium-length side-branchlets; branchlets erecto-patent, terete, 0.8 mm wide, without decurrent ridges, moderately to very densely hairy; hairs mostly c. 0.3 mm long, straight or curly, sometimes also with short-lived spreading hairs to c. 1 mm long; epicuticular wax sometimes developed. *Stipules* narrow-triangular, 2–3(–6) mm long, generally erect but sometimes distorted, with membranous margins becoming revolute, red-brown, hairy medially, with venation obscure; stipule-petiole angle 80–90°. *Leaves* alternate; petiole 0.5–1 mm long; articulation mostly slightly to moderately geniculate, sometimes knobby, sometimes obscure; lamina narrow-ovate to lanceolate, mostly 5–25 mm long, 2–13 mm wide, with l:w ratio mostly 2–4, flat, moderately discolorous; base asymmetrical, rounded to cordate; margin flat, glabrescent, smooth, with a pale rim; apex acute, subacute or occasionally rounded, minutely rounded at very tip; apiculum not developed; upper surface smooth, with venation often slightly raised, brochidodromous, with gland-dotting evident, soon glabrescent; lower surface glabrescent.

*Inflorescences:* axes contracted; bract 1–1.5 mm long, c. 1 mm wide, moderately convex; pedicel 3–7 mm long, glabrous or hairy; bracteoles persistent, oblong-ovate, 0.8–1.5 mm long, with l:w ratio 1.5–2, loosely appressed, inserted near base, often sub-opposite, deeply convex, with venation generally obscure, glabrous or hairy distally, red-brown. *Calyx* 5–9 mm long, glabrous or hairy, glaucous or glossy, with tube equal to or slightly longer than upper lobes; upper lobes 3–3.5 mm long, 3–4 mm wide, expanded beyond lateral angle by 1–2 mm; lateral angle acute or minutely acuminate; sinus 0.5–1.5 mm deep; lower lobes 1.5–2.5 mm long, 1.2–1.5 mm wide at base, with lateral lobes flat; standard to c. 12 mm long, adaxially yellow, nature of flare unknown (area dries blackish in pressed specimens), abaxially sometimes flushed red; wings slightly longer than standard, 4–5 mm wide, yellow or red; keel 5–10 mm longer than standard, 4–7 mm wide, pale proximally, pink to red distally; anthers 0.8 mm long post-dehiscence; ovary glabrous, 6-ovulate; style c. 10 mm long. *Pods:* stipe 10–20 mm long; body mostly  $\pm$ oblong, 25–40 mm long, 12–18 mm wide, glabrous; upper margin with a thick wing 2–3 mm high abruptly broadening at the summit to be 1.5–2 mm wide, summit flat or gently convex; valves with transverse venation slightly raised, with spongy internal partitions. *Seeds* c. 5 mm long, 2.5–3 mm wide; aril c. 2.5 mm long, c. 1.5 mm high, with base c. 1.5 mm long, with lobe curving c. 150° (Fig. 10k).

**Selected specimens from c. 100 examined: QUEENSLAND:** Coles Rd, Coomingleh State Forest, W of Monto, *A.R.Bean* 8848, 17.viii.1995 (BRI, CANB, MEL); slopes of junction ridge, N of Marlong Arch, Mt Moffatt bp via Injune, *A.R.Bean* 14310, 27.x.1998 (BRI); Ka Ka Mundi section, Carnarvon National Park, SE of Mt Mooloolong, *M.B.Thomas* 3803, 28.viii.2008 (BRI, MEL, NSW); Bertunya Gorge, 4 km W of Warrang homestead, White Mountains National Park, Burke district, *G.Anchen* 182, 17.i.1995 (BRI, DNA, MEL); Side gorge off Rugged Gorge, c. 7 km upstream from junction with Flinders River, White Mountains, Burke district, *M.B.Thomas* 1631B, 13.iv.2000 (BRI); Lake Elphinstone, ridge at southern end, *P.I.Forster* 7290, 26.viii.1990 (BRI, CANB, MEL).

**Flowering period:** Flowers at most times of year, but mainly in late autumn, winter, and early spring.

**Distribution and habitat:** Occurs in eastern Queensland between Bundaberg in the south and Townsville in the north (Fig. 11f). Grows on sandstone in woodland and open forest.



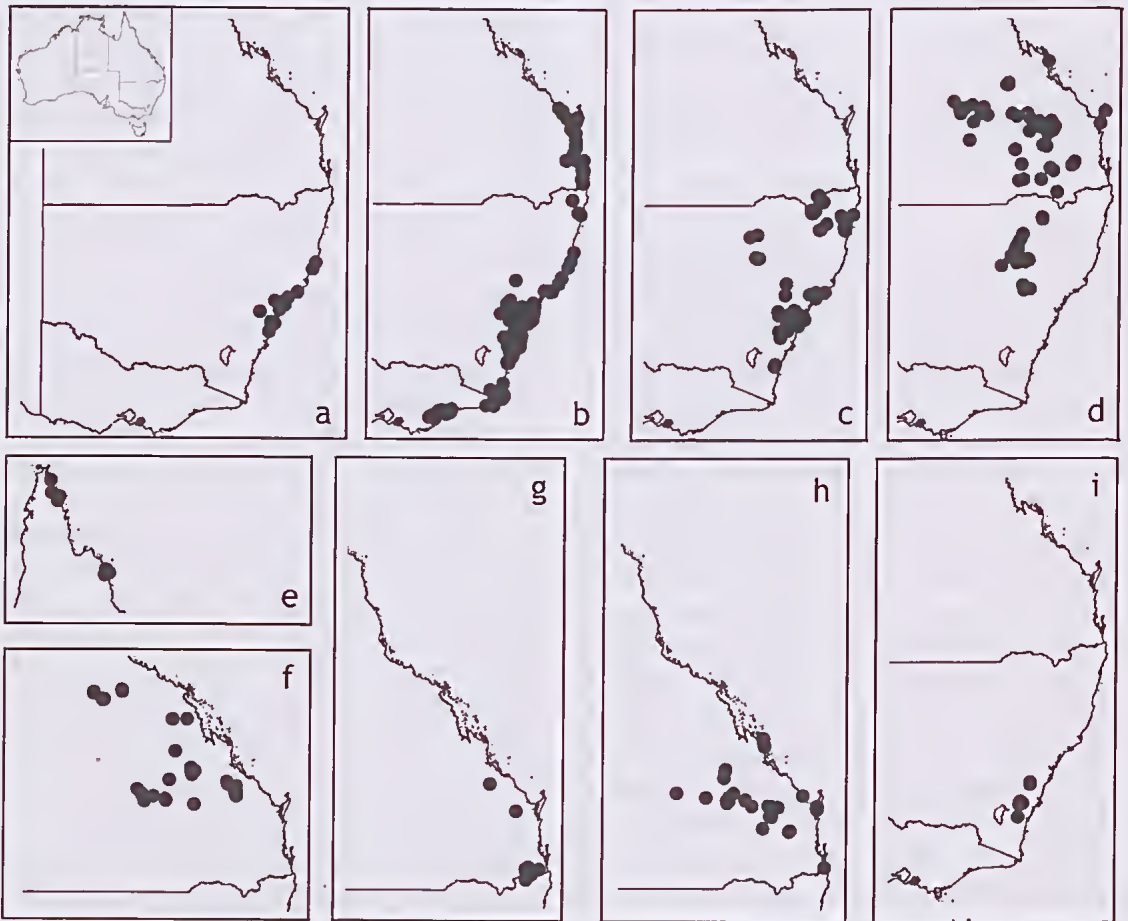
**Notes:** *Bossiaea carinalis* and *B. rupicola* are very similar and are not always easily distinguished. In most cases, however, specimens can be assigned comfortably to one or other species based on leaf length to width ratio and differences in the indumentum on various parts. The greater prominence of leaf venation in *B. carinalis* is also a fairly reliable character as is the greater smoothness of the adaxial surface. The calyx of *B. carinalis* is sometimes glabrous, in which case it is immediately distinguishable from *B. rupicola*; however, sometimes the calyx has an indumentum like that of *B. rupicola*. Fresh flowers have not been seen by the author. The description of petal colour varies considerably in *B. carinalis*, with perhaps the majority indicating that there is some yellow evident in standard and/or wings. In contrast, all specimen labels indicate that these petals are red in *B. rupicola*.

Pods of *B. carinalis* and *B. rupicola* exhibit two raised and broad longitudinal nerves on valves, one approximately 2 mm in from the upper margin and the other a similar distance in from the lower margin. These mark the internal limit of the fusion zones between valves; these zones are relatively broad in these species. These nerves are not evident or are poorly defined in other species.

**Typification:** From the type material I have seen, K 000278379 is the specimen showing the best example of the flowers, and it was undoubtedly seen by Bentham. I here select it as the lectotype of *B. carinalis*.

**26. *Bossiaea rupicola* A.Cunn. ex Benth., Fl. Austral. 2: 162 (1864)**

**Type:** [Protologue: 'Queensland. Brisbane River; Fraser; Mount Lindsay at an elevation of 5700 ft., A. Cunningham!']



**Figure 11.** Distributions of species in Group E. a. *Bossioea stephensonii*; b. *B. heterophyllo*; c. *B. rhombifolia*; d. *B. concolor*; e. *B. orenicolo*; f. *B. corinolis*; g. *B. rupicola*; h. *B. brownii*; i. *B. oligospermo*.

New South Wales-Queensland border. Mount Lindesay, *A.Cunningham* 159, vii.1828; lectotype (here selected): K 000278380; isolectotypes: K 000278381, NSW 578605. Images of K material seen in Kew Herbarium Catalogue.

Residual syntype: Queensland. Brisbane River, *C.Fraser* 134, 1829: K 000278383. Image seen in Kew Herbarium Catalogue.

*Shrubs* or small trees to c. 4 m high, with inflorescences borne on long branchlets or on a  $\pm$ regular series of short to medium length side-branchlets; branchlets erecto-patent, terete, c. 0.8 mm wide, without decurrent ridges, moderately hairy; hairs 0.1–0.3 mm long, typically appressed; epicuticular wax not developed. *Stipules* narrow-triangular, 2–3(–6) mm long, erect or variously recurved or distorted, with membranous margins becoming revolute, red-brown, hairy medially, with venation obscure; stipule-petiole angle 80–90°. *Leaves* alternate; petiole 0.5–1 mm long; articulation mostly obscure, sometimes slightly geniculate, not ridged; lamina oblong-lanceolate, narrow-oblong or narrow-elliptic, 12–20 mm long, 3–6 mm wide, with l:w ratio mostly 4–8, flat, slightly discolorous; base asymmetrical, rounded to slightly cordate; margin flat, glabrescent, smooth, with a rim variably distinct, often greenish; apex acute, minutely rounded at very tip; apiculum absent; upper surface minutely granular, with venation obscure or slightly raised, brochidodromous, with gland-dotting generally obscure, early glabrescent; lower surface glabrescent. *Inflorescences*: axes contracted; bract 1–1.5 mm long, c. 0.8 mm wide, moderately convex; pedicel 4–7 mm long, with appressed straight hairs; bracteoles persistent, ovate, 1–2 mm long, with l:w ratio 1.5–2,  $\pm$ appressed, inserted near base, strongly convex, with venation obscure, hairy, often hairy all over, pale brown aging to red-brown. *Calyx* 5–7 mm long, hairy, with tube equal to or slightly longer than upper lobes; upper lobes 2.5–4 mm long, c. 3 mm wide, expanded beyond lateral angle by up to c. 0.5 mm; lateral angle acute; sinus 1–2 mm deep; lower lobes 2–3 mm long, 1.5 mm wide, with lateral lobes flat; standard to c. 10 mm long, adaxially yellow, with presence of flare not known (flare zone slightly fleshy, drying brown), abaxially red; wings slightly longer than standard, 4–5 mm wide, red; keel 5–8 mm longer than standard, c. 6 mm wide, red

grading to darker red; anthers c. 0.8 mm long post-dehiscence; ovary glabrous, 6–8-ovulate; style 8–12 mm long. *Pods*: stipe 10–20 mm long; body mostly  $\pm$ oblong, 25–40 mm long, 12–18 mm wide, glabrous; upper margin with a thick wing 2–2.5 mm high, sometimes broadening near the summit, c. 1.5 mm wide; summit convex or with a broad ridge c. 0.5 mm high; valves with transverse venation slightly raised, with spongy partitions internally. *Seeds* c. 5 mm long, c. 3 mm wide; aril c. 2.2 mm long, c. 1.2 mm high, with base c. 1.2 mm long, with lobe curving 150° (Fig. 10b).

**Selected specimens from c. 80 examined:** QUEENSLAND: Kroombit Tops, State Forest 316, Parish of Clifford, SW of Gladstone, *E.A.Epp*, vii.1985 (BRI); near summit of Mt Walsh, Mt Walsh National Park, Wide Bay district, *J.Stanton*, 2.viii.1978 (BRI); Knapps Peak, *P.I.Forster* 11996, 15.x.1992 (BRI); upper slope of Mt French on road to Mt French 9.8 km W of Boonah, *J.H.Ross* 3125, 21.viii.1985 (AD, BRI, CANB, HO, MEL); Kroombit State Forest 316, 51 km SSW of Calliope, *N.Gibson* *TOI408*, 15.x.1988 (BRI, MEL); Mt Gillies, 16 km SW of Rathdowney, *I.R.Telford* 12131 & *S.Donaldson*, 28.vii.1996 (CANB, MEL, NE); Mt Ernest, Mt Barney National Park, *I.R.Telford* 12484, 7.x.2001 (NE, NSW). NEW SOUTH WALES: Battery Hill, *C.J.Dunn* 122, 21.xi.1987 (AD, BRI, CANB, MEL, NSW, PERTH).

**Flowering period:** Flowers in winter.

**Distribution and habitat:** Occurs mostly in the McPherson Range in far south-eastern Queensland and far north-eastern New South Wales, but also much further north at Kroombit Tops National Park near Biloela and Mt Walsh near Biggenden (Fig. 11g). Grows often amongst rocks on rhyolite, in open forest, woodland and heathland.

**Notes:** *Bossiaea rupicola* is closely related to *B. carinalis* but in most cases can be distinguished from the latter by the higher length to width ratio of the leaflets. Further comparisons between the two species are made in the notes for *B. carinalis*.

## 27. *Bossiaea brownii* Benth., *Fl. Austral.* 2: 163 (1864)

**Type:** [Protologue: 'Port Bowen, *R.Brown*, also in *Leichhardt's* collection'.] Locality unknown, date unknown, *L.Leichhardt*: lectotype (here selected): K 000278446, image seen in Kew Herbarium Catalogue; probable isolectotype: MEL 95092.



Residual syntypes: Queensland. Port Clinton, *R. Brown*, 22.viii.1802; BM 000885941, BRI 424996, CANB 278252, CANB 371247, K 000278447, image seen in Kew Herbarium Catalogue Brown also collected at nearby Pine Port (Shoalwater Bay, and more specifically Akens Island) in 1802; however, Bentham did not cite this locality in the protologue.

*Erect shrubs* to c. 3 m high, with inflorescences typically borne on a  $\pm$ regular series of short to medium-length side-branchlets; branchlets erecto-patent to almost spreading, terete, 0.5–0.8 mm wide, without decurrent ridges, moderately hairy with a mix of hair-types; hairs c. 0.3 mm long, curly and loosely appressed hairs and 1–2 mm long, straight, spreading; epicuticular wax not developed; internodes 1–3 mm long. *Stipules* narrow-triangular, 1–3 mm long, mostly distorted and oriented variously, with membranous margins becoming revolute, red-brown, hairy, with venation obscure; stipule-petiole angle c. 80–90°. *Leaves* alternate; petiole 0.5–0.8 mm long; articulation mostly slightly geniculate, not or hardly ridged, often obscured by hair; lamina ovate to narrow-ovate, mostly 3–12 mm long, 2–8 mm wide, with l:w ratio 1.3–1.8, flat, slightly discoloured; base asymmetrical, cordate or with one side sometimes truncate; margin flat, gradually glabrescent,  $\pm$ smooth, with a pale rim; apex subacute to rounded; apiculum absent; upper surface smooth, with venation often slightly raised, with gland-dotting not evident, glabrescent; lower surface with loosely appressed hairs to c. 1 mm long, occasionally glabrescent. *Inflorescences*: axes contracted or rarely to 2 mm long; bract 1–2 mm long, c. 1 mm wide, moderately convex; pedicel 0.5–6 mm long, glabrous or hairy; bracteoles persistent, narrow-ovate, lanceolate or narrow oblong-elliptic, 1–1.5 mm long, with l:w ratio 1.5–2, divergent, inserted in proximal third, often subopposite to alternate, strongly convex, but with apex hardly convex, 1-nerved or venation obscure, glabrous, red-brown. *Calyx* 3.5–4 mm long, glabrous, with tube longer than lobes; upper lobes 1–1.8 mm long, c. 2 mm wide, sometimes expanded slightly beyond lateral angle; lateral angle acute or minutely acuminate; sinus c. 0.5–1 mm deep; lower lobes 0.8–1.5 mm long, 1 mm wide at base, with lateral lobes flat; standard 10 mm long, slightly longer than keel, adaxially yellow with a red flare and with red

mark dividing throat, abaxially flushed red medially; wings 0.5–2 mm shorter than keel, 2–3 mm wide, mostly purplish; keel 3–4 mm wide, pink grading to dark red; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, 3- or 4-ovulate; style 3–5 mm long. *Pods*: stipe 5–10 mm long; body oblong to elliptic, 15–40 mm long, 8–15 mm wide, glabrous, glaucous or glossy; upper margin broadened by rounded lateral ridges, 1.2–1.8 mm wide, with medial ridge to c. 1 mm high; valves with transverse venation raised, with spongy partitions internally. *Seeds* c. 4.5 mm long, c. 2.5 mm wide; aril 2–2.5 mm long, c. 1.8 mm high, with base 2–2.5 mm long, with lobe curving 45–100° (Fig. 10c, e).

**Selected specimens from c. 100 examined: QUEENSLAND:** Rainbow Falls, Blackdown Tableland, *I.R. Telford 5701 & R.K. Ellyard*, 11.vi.1977 (CANB, NSW); track 5 km E off Auburn Rd, 52 km N of Warrego Hwy, N of Chinchilla, *A.N. Rodd 4173*, 27.xi.1984 (BRI, CANB, MEL, NSW); Myola, SW of Mundubbera, *P.I. Forster 25177*, 7.xi.1999 (AD, BRI, MEL); Curtis Rd, Kingaroy, *A.R. Bean 10645*, 9.ix.1996 (BRI, CANB, MEL, NSW); Gurgeena, 6 km N of Burnett Hwy, NE of Mundubbera, *A.R. Bean 8807*, 13.viii.1995 (BRI, CANB, MEL); camping area at SW of Lake Boomingin, Fraser Island, *N.G. Walsh 1398*, 24.viii.1984 (BRI, MEL).

**Flowering period:** Flowers most times of the year.

**Distribution and habitat:** Occurs in central-eastern and south-eastern Queensland south from the Shoalwater Bay area, extending inland as far W as Mt Playfair, SW of Springsure (Fig. 11h). Grows in sandy or sandy-loam soils, commonly over sandstone, often in gorges, in woodland and forest.

**Notes:** The indumentum of branchlets of *B. brownii* is distinctive in that it comprises a mixture of long and short hairs. The calyx is variously glaucous or glossy. Leaves have a similar shape to those of *B. carinalis* but are generally smaller, hairier, with a more strongly cordate base, and with the articulation not as markedly geniculate. Populations in the Mundubbera district have smaller leaflets and a less hairy leaflet-articulation.

**Typification:** A flowering specimen from a collection by Eichhardt and designated as K 000278446 is here selected as the lectotype of *B. brownii*. It was sent by F. Mueller to Bentham. Sheets bearing Robert Brown's collections at Port Clinton (Port Bowen) housed at BM (BM 000885941) and K (K 000278447) represent material probably also seen by Bentham; however, there is no specific indication of this.

**28. *Bossiaea oligosperma* A.T.Lee, *Telopea* 2(2): 215 (1981)**

**Type:** New South Wales. Tonalli River landing towards Byrnes Creek, Warragamba, *A.L.Mitchell* 434, 20.ix.1966; holotype: NSW 285041; isotypes: BRI 278956, CANB 306843, MEL 596958.

*Bossiaea* sp. *A sensu* S.W.L.Jacobs & J.Pickard, *Plants of New South Wales* (1981).

*Erect shrubs* to c. 1 m high, with inflorescences borne typically on a  $\pm$ regular series of short side-branches; branchlets erecto-patent to almost spreading, terete, 0.7–1 mm wide, without decurrent ridges, densely hairy; hairs to c. 0.8 mm long, straight or wavy; epicuticular wax not developed. *Stipules* narrow-triangular, 1–2 mm long, flat, erect or recurving, with thinner margins generally not recurved, brown or red-brown, glabrous except near base, 1-nerved or with venation obscure; stipule-petiole angle 60–90°. *Leaves* alternate; petiole 0.3–0.8 mm long; articulation slightly geniculate, ridged, often obscured by hair; lamina c. circular, mostly 3–6 mm long, 3–6 mm wide, with l:w ratio mostly c. 1,  $\pm$ flat or becoming concave distally, slightly discolorous; base c. symmetrical, rounded to truncate; margin flat, hairy,  $\pm$ smooth, with a pale rim; apex rounded to truncate, or abruptly recurved and acuminate; apiculum to c. 0.1 mm long; upper surface smooth, with venation sometimes slightly raised, with gland dotting generally obscure, generally soon glabrescent; lower surface with somewhat persistent hairs, often moderately dense. *Inflorescences:* axes contracted; bract persistent, 1 mm long, 0.5–0.8 mm wide, slightly to moderately convex; pedicel 1.5–3 mm long, glabrous; bracteoles persistent, ovate, 1–1.5 mm long, with l:w ratio 1.5–2, loosely appressed or divergent, inserted near base of pedicel, moderately convex, 1-nerved or venation obscure, glabrous, orange-brown. *Calyx* 3–4 mm long, glabrous, sometimes slightly glaucous, with tube slightly longer than lobes; upper lobes 1.2–1.8 mm long, 1.5–2 mm wide, not expanded beyond lateral angle; lateral angle acute or minutely acuminate; sinus c. 0.5 mm deep; lower lobes 1–1.3 mm long, c. 0.8 mm wide at base, with lateral lobes  $\pm$ flat but with a distal ridge; standard to c. 10 mm long, slightly longer than keel (shorter prior to opening); adaxially yellow with a red flare, with throat bisected, abaxially flushed red medially; wings c. 1 mm shorter than keel, 2.5–3 mm wide, flushed purple-brown

throughout or mainly yellow apically; keel c. 3.5–4 mm wide, pink grading to dark red; anther c. 0.4 mm long post-dehiscence; ovary glabrous, 2-ovulate; style 3–4 mm long. *Pods:* stipe 4–5 mm long; body c. elliptic, 10–12 mm long, 7–8 mm wide, glabrous; upper margin 1–1.3 mm wide, with ridge to c. 0.8 mm high; valves with transverse venation raised, without spongy tissue internally. *Seeds* 3–3.5 mm long, c. 2 mm wide; aril 1.5–2 mm long, c. 1.2 mm high, with base c. 1 mm long, with lobe curving c. 180° (Fig. 10l, m).

**Selected specimens from c. 20 examined:** NEW SOUTH WALES: 2.5 km S along Claypit Rd from Windellama to Nerriga Rd, *R.Johnstone* 2477 & *A.E.Orme*, 8.xii.2008 (MEL, NSW); Araluen Valley, *Mr & Mrs Shooobridge*, ix.1964 (CANB); corner of Oellen Ford & Jacqua Rds, *I.R.Thompson* 1333, 24.xi.2010 (MEL); Tonalli River Landing, towards Byrnes Creek, Warragamba, *A.L.Mitchell* 277, 17.xi.1964 (CANB, NSW).

**Flowering period:** Flowers mostly from late winter to spring.

**Distribution and habitat:** Occurs in central-eastern and south-eastern New South Wales, between Warragamba in the north and Araluen Valley, NE of Moruya in the south (Fig. 11i). Rare, and listed as vulnerable under the Threatened Species Conservation Act of New South Wales. Grows in sand and loam, sometimes in shallow stony soils, in dry sclerophyll forest.

**Notes:** *Bossiaea oligosperma* is characterised by a moderately dense indumentum on branchlets and leaves, circular leaves, and short, few-ovulate pods. Unlike other members of the *Brownii* subgroup, *B. oligosperma* does not develop spongy tissue inside pods. This is probably at least partly associated with the fact that pods are only 2-ovulate. It appears to be most closely related to *B. brownii*.

## The *Arenicola* subgroup

**29. *Bossiaea arenicola* J.H.Ross, *Muelleria* 7(3): 371 (1991)**

**Type:** Queensland. Cook District, 4.3 km E of the Hopevale-Starke road on the track to the Mclvor River mouth, *J.R.Clarkson* 5322, 14.vi.1984; holotype: MEL 665930; isotypes: MEL 1576791, NSW 787940. Also designated as being in BRI, CANB, DNA, K, PERTH, QRS but these *n.v.*



*Shrubs or trees* to c. 8 m high, with inflorescences typically borne on a regular series of side-branchlets; branchlets erecto-patent, terete, c. 0.6 mm wide, without decurrent ridges, moderately hairy, variably glabrescent; hairs to c. 0.5 mm long; epicuticular wax commonly developed. *Stipules* c. triangular, c. 1 mm long, erect, brown, with the broad margins recurving, wavy, glabrous, with venation obscure; stipule-petiole angle 30–60°. *Leaves*: petiole 1–2 mm long, not sulcate adaxially; articulation strongly geniculate, ridged; lamina circular, broad-elliptic, somewhat rhomboidal, ovate or broad-obovate, 8–15 mm long, 7–15 mm wide, with l:w ratio mostly 1–1.2, flat, moderately discolorous; base symmetrical, truncate, rounded or cuneate; margin flat, glabrous, smooth; apex broadly rounded; apiculum not developed; upper surface smooth, with venation sometimes raised, soon glabrescent; lower surface soon glabrescent. *Inflorescences*: axes contracted; bract 1–1.5 mm long, 0.8 mm wide, strongly convex; pedicel 1–5 mm long, glabrous or occasionally hairy; bracteoles fused to form a single structure, persistent, 1–3 mm long, with l:w ratio 2–3, sometimes with apex bilobed, divergent, commonly inserted  $\pm$ at base of receptacle, sometimes c. mid-pedicel, convex, several-nerved, glabrous, greenish-yellow or light brown. *Calyx* 4–5 mm long, glabrous, with conspicuously raised parallel longitudinal venation, with tube longer than the lobes; upper lobes c. triangular, 1.5–2 mm long, 2 mm wide; lateral angle narrowly acute or acuminate; sinus 1–2 mm deep; lower lobes 1.3–2 mm long, 0.5–0.8 mm wide, with lateral lobes acuminate, flat; standard to c. 13 mm long, c. equal in length to keel, yellow; wings 1–2 mm shorter than keel, c. 2.5 mm wide, yellow; keel c. 4 mm wide, pale greenish-yellow; anthers c. 0.6 mm long post-dehiscence; ovary hairy, 2- or 3-ovulate; style 5–8 mm long. *Pods*: stipe 6–8 mm long; body oblong to elliptic, 20 mm long, 9–12 mm wide, with hairs 1–1.5 mm long on valves, c. 0.5–1 mm long on sutures, usually caducous well before maturity; upper margin c. 2 mm wide, gently convex but hardly ridged; valves with transverse venation markedly raised, usually with numerous bands of papery tissue internally. *Seeds* 4 mm long, 3 mm wide, brown; aril c. 1 mm long, c. 1 mm high, with base c. 1 mm long, with lobe curving 90–130° (Fig. 10d, n, o).

**Selected specimens from c. 20 examined:** QUEENSLAND: 6.5 km W of Shelburne Bay, 5.5 km W of Messum Hill, Cape

York Peninsula, *P.I. Forster* 33944, 18.vi.2008 (BRI, MEL); Hopevale Mission near Cooktown, *J. Hacker* BH471, 31.vii.1983 (BRI); near Logan Jack Creek [Jardine River National Park], *H. Gitay* 108, 2.viii.1987 (BRI).

**Flowering period:** Flowers from April to June.

**Distribution and habitat:** Occurs in far north Queensland from the tip of Cape York Peninsula south to Cooktown (Fig. 11e). Grows in sand dunes in closed heath and shrublands.

**Notes:** *Bossiaea arenicola* is readily identified by its unique calyx and bracteole morphology. It is similar to the *Brownii* subgroup in having stipules with membranous margins. The pattern of new growth is similar to that of Group A in which there are numerous new nodes with fully-developed stipules but underdeveloped leaves crowded along an axis.

## Group F

*Leafless shrubs*, often extensively rhizomatous; cladodes slightly to moderately compressed centrally, winged, mostly broadly so, mostly  $\pm$ glabrous, with epicuticular wax sometimes lifting in flakes. *Scales* replacing stipules at all nodes. *Inflorescences*: axes often with scales 4 or more; multiple inflorescences sometimes arising from an axil; pedicel mostly short; bracts and bracteoles markedly convex, sometimes large, sometimes caducous; bracteoles mostly inserted proximally. *Calyx* glabrous, with upper lobes not or only slightly expanded beyond lateral angle, sometimes triangular (Fig. 12).

Group F contains the 12 leafless species in eastern Australia, and is divided here into four subgroups. It is the most widespread of the groups, with the bulk of the species occurring between far north Queensland and Victoria. Extensions to this range are provided by *B. riparia* which occurs in Tasmania, *B. peninsularis* which occurs on the Eyre Peninsula in south-central South Australia, and *B. walkeri* which extends across South Australia and into Western Australia.

The *Ensata* subgroup (species 30–34) contains five species with generally persistent bracts and bracteoles, mostly only one pair of inflorescence scales, and generally only one inflorescence per axil.

The other three subgroups differ from the *Ensata* subgroup by having multiple pairs of inflorescence scales, caducous bracts and bracteoles, and often

developing 2 or 3 inflorescences per axil. Out of the three subgroups, the *Fragrans* subgroup (species 35 & 36) is probably closest to the *Ensata* subgroup.

The *Bracteosa* subgroup (species 37–40) is distinct in having large bracts, bracteoles and distal inflorescence scales, triangular upper calyx-lobes, and calyx-lobes that are brown and chartaceous. Prior to some very recent publications, Ross (2008) and McDougall (2009), specimens from this subgroup and the *Fragrans* subgroup had been referred to *B. bracteosa*.

*Bossiaea walkeri* (41) forms a subgroup of its own and is distinguished from other leafless species by its striate bracts and bracteoles, large flowers with an elongate keel, and pods that are long, many-ovulate and with hairs on margins.

## The *Ensata* subgroup

### 30. *Bossiaea ensata* Sieber ex DC., *Prodr.* 2: 117 (1825)

**Type:** [Protologue; 'Sieb! pl. exs. nov.-holl. n. 434!.. in Novâ hollandiâ;] New South Wales. Location unknown [between Port Jackson and Blue Mountains], *F.Sieber* 434, date unknown; holotype: G-DC, image seen MEL, photo NSW, *vide* Lee (1970); isotypes: MEL 651294, MEL 651295, MEL 651296.

*Sprawling to erect rhizomatous leafless shrubs* to c. 1 m high, with cladodes to c. 20 mm wide, with inflorescences borne on both long and shorter branchlets, sometimes on a regular series of side-branchlets; inflorescence-bearing cladodes erect to erecto-patent, 1–5 mm wide,



**Figure 12. Group F.** a. *Bossiaea vombo* (J.H.Ross 3648 MEL); b. *B. scolopendria* (R.G.Coveny 15495 MEL); c. *B. peninsularis* (P.Tucker, 11.x.2000 AD); d. *B. riporia* (N.G.Wolsh 5530 MEL); e. *B. groyi*, (J.R.Telford 8553 CANB); f. *B. milesiae*, inflorescence axes with flowers in bud (scales present but bract and bracteoles have fallen; arrow points to abscission scar of bracteole; J.Miles, 9.ix.1997 MEL); g. *B. bomboyensis*, pod, scales and calyx (J.R.Thompson 1327 MEL). Scale bars: a–e = 5 mm, f, g = 2 mm.



## Key to Group F

- 1 Bracteoles generally falling before anthesis ..... 2
- 1: Bracteoles generally persistent ..... 8
- 2 Flowers > 15 mm long, with keel clearly longer than standard; pods 50–60 mm long (arid regions) ..... 41. *B. walkeri*
- 2: Flowers < 15 mm long, with keel shorter than or c. equal to standard; pods 20–40 mm long (not arid regions) ..... 3
- 3 Upper calyx-lobes somewhat quadrate, calyx-lobes not chartaceous; longest inflorescence-scale to c. 1 mm long; bracts and bracteoles < 2 mm long ..... 4
- 3: Upper calyx-lobes triangular (resembling lower lobes); calyx-lobes distally brown and chartaceous; longest inflorescence-scale > 1 mm long; bracts and bracteoles > 2 mm long ..... 5
- 4 Cladodes greyish at flowering due to epicuticular wax; pedicels 1–2.5 mm long, with bracteole abscission scars concealed by scales ..... 35. *B. fragrans*
- 4: Cladodes green at flowering; pedicels 2–4 mm long; bracteole abscission scars generally visible (c. at level of scale apices or slightly more distal) ..... 36. *B. milesiae*
- 5 Largest scales of cladodes > 1 mm wide from midrib to margin, with conspicuous branching venation; cladodes with recess at nodes up to 5 mm deep ..... 40. *B. bracteosa*
- 5: Scales of cladodes < 1 mm wide from midrib to margin, with venation obscure; cladodes with recess at nodes absent or < 1 mm deep ..... 6
- 6 Longest cladode-scales  $\geq$  2 mm long; cladodes green; plants generally infertile (Victoria only) ..... 39. *B. vombata*
- 6: Longest cladode-scales mostly < 2 mm long; cladodes greyish-green or if green then all cladodes < 5 mm wide; seeds commonly set ..... 7
- 7 Cladodes green; pods < 6 mm wide ..... 37. *B. bombayensis*
- 7: Cladodes grey-green; pods > 6 mm wide ..... 38. *B. grayi*
- 8 Petals without red markings except for a small flare on standard (northern Queensland) ..... 33. *B. armitii*
- 8: Petals more extensively marked than above (southern Queensland, New South Wales, Victoria) ..... 9
- 9 Bracteoles inserted on distal third of pedicel; cladodes with longest scales 2–2.5 mm long, with a tuft of hairs in axils (Eyre Peninsula, South Australia) ..... 32. *B. peninsularis*
- 9: Bracteoles inserted proximal to mid-pedicel or occasionally on middle-third; cladodes with longest scales 1–1.5(–2) mm long, glabrous or nearly so in axils (far eastern Australia) ..... 10
- 10 Keel dark red, glabrous; pods < 25 mm long,  $\leq$  7 mm wide, with upper margin c. 0.7 mm wide; seeds 1.5–2 mm long; new growth with scattered hairs on faces; inflorescence scales commonly 4 or more ..... 34. *B. riparia*
- 10: Keel pale (or sometimes with a pink tinge), with some apical hairs; pods > 25 mm long, 7–12 mm wide, with upper margin 1–2 mm wide; seeds 3–4 mm long; new growth glabrous or with hairs  $\pm$  restricted to margins; inflorescence scales 2 ..... 11
- 11 Upper calyx-lobes < 2.5 mm wide; wings largely yellow (sometimes tinged red); bracteoles mostly < 1.5 mm long; upper margin of pod 1–1.2 mm wide, with ridge angular ..... 30. *B. ensata*
- 11: Upper calyx-lobes > 2.5 mm wide; wings purplish-brown; bracteoles mostly > 1.5 mm long; upper margin of pod 1.5–2 mm wide,  $\pm$  rounded ..... 31. *B. scalapendria*

not recessed at nodes and sometimes slightly widening,  $\pm$ glabrous; marginal ridges well-defined, smooth or with occasional tubercles; new growth  $\pm$ linear in profile, glabrous or sparsely hairy on margins; epicuticular wax sometimes weakly developing, shed in smallish flakes, with cladodes green at flowering. *Scoles* 0.6–1.5 mm long, 0.3–0.5 mm wide from midrib to margin, greenish apart from midrib and margins, sometimes few-nerved apart from midrib, glabrous or with a few hairs along midrib, with margin glabrous. *Leaves* occasionally developed and persisting towards base of stems; lamina nearly circular, to 12 mm long. *Inflorescences*: axes contracted; scales 2, 0.6–1 mm long; bract persistent, 1–1.5(–2) mm long, 0.3–0.6 mm wide, strongly convex; pedicel 2–6 mm long, glabrous; bracteoles persistent, ovate to narrow-ovate or narrow-oblong, 0.8–1.5(–2) mm long, with l:w ratio 1.5–3, appressed, inserted in proximal half, strongly convex, few-nerved, with venation often obscure, glabrous, commonly slightly fleshy, dark-brown. *Calyx* 3–4.5 mm long, glabrous, often with dark stripes, with tube longer than lobes; upper lobes sometimes broadening slightly from base, 1.5–2.2 mm long, 1.5–2.4 mm wide; lateral angle acute or acuminate; sinus 0.5–1.4 mm deep; lower lobes 1–1.8 mm long, 0.7–1 mm wide; lateral lobes flat or convex; standard to c. 11 mm long, a few mm longer than wings and keel, adaxially yellow with a red flare, abaxially largely reddish, with pale radiating bands in medial third; wings c. as long as keel, 2–2.5 mm wide, yellow, sometimes also tinged red; keel c. 2.5 mm wide, pale greenish-yellow, sometimes tinged pink apically, often with hairs at distal end of fusion zone; anthers c. 0.3 mm long post-dehiscence; ovary glabrous, 6–8-ovulate; style 2.5–3 mm long. *Pods*: stipe 3–5 mm long; body narrow-oblong, 30–40 mm long, 7–11 mm wide; upper margin c. 1 mm wide, with ridge 0.3–0.6(–1) mm high; valves with transverse venation hardly raised. *Seeds* 3–3.5 mm long, 2–2.5 mm wide; aril 1.5–1.8 mm long, c. 1 mm high, with base 0.8–1 mm long, with lobe curving 90–180°.

**Selected specimens from c. 150 examined:** QUEENSLAND: Between Lake Benaroon and Lake Boemingen, Fraser Island, *D.A.Smith*, 15.viii.1971 (BRI); Noosa, *C.T.White*, 21.viii.1949 (BRI); Little Canalpin Swamp, North Stradbroke Island, *K.M.Stephens* 07030713, 7.iii.2007 (BRI, NSW). NEW SOUTH WALES: c. 1.5 km N of Lake Cathie, near Port Macquarie, *D.Verdon* 157, 17.viii.1969 (CANB); Anzac Pde, Matraville, *R.Coveny* 11290, 15.ix.1982 (MEL, NSW); Jervis Bay, Canberra Botanic Gardens annexe, near Lake

McKenzie, *C.Tyrrel* 168, 6.x.1978 (CANB); track to Green Cape, *M.E.Phillips* 83, 8.x.1961 (CANB); Tarougra Forest Rd, 2 km E of Bodalla along Potato Point Rd, *E.Mullins* 708, 6.x.1986 (CANB, MEL, NSW). VICTORIA: entry to tip on Betka Rd, Mallacoota, *S.J.Forbes* 2884, 14.ix.1985 (CANB, MEL); Marlo Racecourse Reserve, c. 12 km SE of Orbost, *W.Hunter* 22, x.1951 (MEL); c. 0.5 km N of the mouth of Seal Creek, *D.E.Albrecht* 4844, 22.x.1991 (CANB, MEL, HO).

**Flowering period:** Flowers in spring.

**Distribution and habitat:** Occurs in near-coastal areas of south-eastern Queensland, New South Wales and far eastern Victoria (Fig. 13a). Categorized as rare in Victoria (Walsh & Stajsic 2007). Grows in sandy soils in heathland and open forest.

**Notes:** The bracts and bracteoles of *B. ensota* and *B. scolopendrio* usually appear less scarious than those of most other species, and are sometimes slightly fleshy medially (drying blackish). *Bossioea ensota* is closest to *B. scolopendrio* but compared to that species has smaller and generally fewer flowers, shorter bracteoles, wing-petals that are largely yellow, and pods that are thinner and with the upper margin more angular. The calyx morphology of *B. ensota* and *B. scolopendrio* is similar to that of species in Group E. A mutant with pure yellow flowers has been recorded from Mororo in northern New South Wales (*Fenshom* 4923 BRI).

**Hybridisation:** A probable hybrid between *B. prostrato* and *B. ensota* has been recorded from near Bermagui (*N.Schultz* 132 CANB). It is leafy throughout and has winged branchlets approaching the width of those of *B. ensata*.

### 31. *Bossiaea scolopendria* (Andrews) Sm., *Trans. Linn. Soc. London* 9: 303 (1808)

*Platylobium scolopendrium* Andrews, *Bot. Repos.* 3: pl. 191 (1801), as *scolopendrum*.

**Type:** not designated. [Protologue: No locality or collection details for seeds. A cultivated plant in the Hibbertian collection.] Holotype: pl. 191 in *Bot. Repos.* 3 (1801); epitype (here selected): New South Wales, St. Ives, *C.Burgess*, 29.vii.1963: CANB 0006531.

*Erect rhizomatous leafless shrubs* to c. 1 m high, with cladodes to c. 25 mm wide, with inflorescences borne predominantly on long branchlets, occasionally on a regular series of short side-branchlets; inflorescence-



bearing cladodes mostly sub-erect, mostly 3–12 mm wide, with no recession and sometimes a slight widening below nodes, glabrous or sparsely hairy on margins; marginal ridges  $\pm$ smooth; new growth linear in profile; epicuticular wax not developing, with cladodes green at flowering. *Scales* 1–2 mm long, 0.4–0.6 mm wide from midrib to margin, greenish between pale midrib and pale margin, sometimes few-nerved apart from midrib, with margin glabrous. *Leaves* occasionally developed and persistent towards base of stems; lamina elliptic, to c. 25 mm long. *Inflorescences*: axes contracted; scales 2, 0.5–1 mm long; bract persistent, 1.5–2.5 mm long, 0.8 mm wide, strongly convex; pedicel 2–3 mm long, glabrous; bracteoles persistent, narrow-ovate, narrow-elliptic or narrow-oblong, 1.5–2.5 mm long, with l:w ratio 1.5–3, appressed, inserted in proximal half, strongly convex, usually obscurely nerved apart from ridged midline, glabrous, slightly fleshy, brown to dark brown. *Calyx* 4–7 mm long, glabrous, often with dark stripes, with tube equal to or slightly longer than lobes; upper lobes broadening slightly from base, 2–3 mm long, 2.6–3.5 mm wide, sometimes slightly expanded beyond lateral angle; lateral angle acute or acuminate; sinus 0.5–1 mm deep; lower lobes 1.5–2.5 mm long, 1–1.3 mm wide; lateral lobes  $\pm$ flat; standard to c. 15 mm long, a few mm longer than wings and keel, adaxially yellow with a red flare, abaxially reddish grading to purplish throughout except for pale radiating bands medially extending partway to margins; wings 3–4 mm wide, purplish-brown throughout or at least in distal half; keel 3–4 mm wide, pale greenish-yellow, with hairs at distal end of fusion zone; anthers c. 0.3 mm long post-dehiscence; ovary glabrous, 10-ovulate; style 3–3.5 mm long. *Pods*: stipe 1–4 mm long; body narrow-oblong, 30–45 mm long, 10–12 mm wide; upper margin 1.5–2 mm wide, with a low rounded ridge; valves with transverse venation not or hardly raised. *Seeds* 3–4 mm long, 2–3 mm wide; aril 1–1.8 mm long, 1–1.5 mm high, with base 1–1.8 mm long, with lobe curving c. 90° (Fig. 12b).

**Selected specimens from c. 150 examined:** NEW SOUTH WALES: Greenmans Valley Rd, W of Mt White, *R.Coveny* 11221, 10.viii.1983 (CANB, NSW); Muogamarra Nature Reserve, c. 3 km S of the Hawkesbury River, *B.J.Lepschi* 3971, 6.xii.1998 (CANB); 21 km from Tomerong on Turpentine Rd, N side of the road, *FW.Howe* 69, 12.ix.1983 (CANB, MEL, NSW); Ku-Ring-Gai Chase, c. 25 km N of Sydney, *T.R.N.Lothion*, 24.viii.1952 (AD); Maroota Forest, W of Old Northern Rd, 2 km S of Forest Glen, *R.G.Coveny* 15495, 22.viii.1991 (AD, CANB, HO, MEL, PERTH).

**Flowering period:** Flowers in spring.

**Distribution and habitat:** Occurs in near-coastal areas of central and southern New South Wales (Fig. 13b). Grows predominantly on sandstone, in heathland and forest.

**Notes:** *Bossiaea scolopendria* is similar to *B. ensata* q.v. and there is some overlap in their distributions. These two species differ from the other two species in the *Ensata* subgroup by having bracteoles inserted more proximally on the pedicel. *Bossiaea scolopendria* typically develops very long straight cladodes bearing numerous, often 10–30, flowers. The cladode margin of *B. scolopendria* often has a distinct cellular pattern which is discernible under moderate magnification. The midline of cladode scales of *B. scolopendria* and *B. ensata* is more or less a continuation of the marginal ridge of cladodes, and is thus more prominent than in other leafless species. The scales of *B. scolopendria* and *B. ensata* are reminiscent of the stipules of *B. rhombifolia* and *B. heterophylla*.

**Typification:** The holotype illustration shows a good general likeness to *B. scolopendria* but cannot be considered diagnostic. Furthermore, it is strange that the ovary is drawn with hairs on margins as neither *B. scolopendria* nor any other similar species such as *B. ensata* have been seen to develop hairs on the ovary. An epitype, *C.Burgess*, 29.vii.1963, CANB 0006531, to the holotype illustration of *B. scolopendria* is therefore selected here to aid the application of the name.

### 32. *Bossiaea peninsularis* I.Thomps., sp. nov.

*A. B. ensata* DC. squamis longioribus, indumento axillaribus densioribus, bracteolis pedicello in medio insertis differt.

**Type:** South Australia. 10 km E of Karkoo on the south side of Mount Isabella Rd, *P.Tucker s.n.*, 11.x.2000; holotype: AD 110381.

*Bossiaea ensata* sensu J.Z.Weber, *Fl. S. Australia* 4<sup>th</sup> edn 2: 689 (1986).

*Erect rhizomatous leafless shrubs* to c. 0.5 m high, with cladodes to c. 14 mm wide, with inflorescences borne on both long and shorter branchlets; inflorescence-bearing cladodes erecto-patent, 2–5 mm wide, not recessed at nodes and sometimes slightly dilating below scale, glabrous except for hairs on margins above scale-axils; marginal ridges mostly with occasional tubercles; new

growth often very narrow-elliptic in profile, moderately hairy along margins; epicuticular wax developing, with crusts sometimes lifting in small patches, with cladodes grey-green at flowering. *Scales* 2–2.5 mm long, 0.3–0.5 mm wide from midrib to margin, brown, 3–5-nerved, glabrous, with margin hairy or glabrous. *Inflorescences*: axes contracted or to c. 2 mm long; scales 2, bract-like, 1–1.5 mm long, acute; bract persistent, 2–2.5 mm long, 0.5–1 mm wide, moderately convex; pedicel 3–4 mm long, glabrous; bracteoles persistent, narrow-ovate, 2–2.5 mm long, with l:w ratio 2–2.5, appressed or divergent, inserted mostly in distal third, strongly convex, several-nerved, glabrous, red-brown. *Calyx* 3.5–4 mm long, glabrous, with tube longer than lobes; upper lobes 1.5–1.8 mm long, c. 1.8 mm wide; lateral angle acute or minutely acuminate; sinus 0.5–1 mm deep; lower lobes 1.5 mm long, 1–1.2 mm wide; lateral lobes flat; standard to c. 10 mm long, c. 1 mm longer than wings and keel, adaxially yellow with a red flare, abaxially reddish to purplish with pale radiating bands in medial third; wings slightly longer than keel, c. 2 mm wide, pale proximally, purplish distally; keel c. 2.5 mm wide, pale proximally, red distally, often with a few hairs at distal end of fusion zone; anthers c. 0.4 mm long post-dehiscence; ovary glabrous, c. 6-ovulate; style c. 2 mm long, abruptly upcurved at base, with stigma elevated well above anthers, conspicuously hairy. *Mature pods and seeds* not seen; immature pods: stipe c. 2 mm long, body elliptic or oblong, c. 15 mm long (Fig. 12c).

**Selected specimens from c. 10 examined:** SOUTH AUSTRALIA: Hundred of Brooker, c. 70 km N of Port Lincoln, C.R. Alcock 737, 28.x.1965 (AD, MEL, NSW); 33°57' S, 135°27' E, Eyre Peninsula, S. Wright 4, 26.viii.1981 (AD).

**Flowering period:** Flowers from August to October.

**Distribution and habitat:** Occurs on the Eyre Peninsula in south-central South Australia (Fig. 13d). Rare, and likely to warrant recognition as a threatened species. Grows in mallee woodland.

**Notes:** *Bossiaea peninsularis* is perhaps closest to *B. ensata*, in which specimens were formerly included, and *B. scolopendria*, but differs from both of these by having distally inserted, more striate and less fleshy bracts and bracteoles, slightly longer cladode-scales with the base more sharply delineated, and the adjacent cladode margin moderately hairy. One collection (P. Tucker s.n. AD) has a high proportion of 2-flowered inflorescences.

### 33. *Bossiaea armitii* F. Muell., *Fragm.* 9(74): 44 (1879)

**Type:** [Protologue: 'Ad amnem Cave-Creek fluminis Gilberti in rupium fissuris; R. Daintree; ad cataractas fluminis Herberti; W.E. Armit.']. Queensland. Herbert River, W.E. Armit 4, date unknown; lectotype (here selected): MEL 651099; isolectotypes: MEL 651100, MEL 651101.

Residual syntype: Queensland. Cave Creek, Gilbert River, R. Daintree, date unknown: MEL 651297.

*Erect rhizomatous leafless shrubs* to c. 3 m high, with cladodes to c. 40 mm wide, with inflorescences borne on both long and shorter branchlets; inflorescence-bearing cladodes erecto-patent, 6–14 mm wide, not recessed at nodes or recession up to 1 mm deep, sometimes appearing recessed due to dilation of cladode below node, glabrous except for hairs on margin immediately above axil; marginal ridges smooth or minutely uneven; new growth elliptic in profile; epicuticular wax often developing, lifting in large thin flakes or sheets, with cladodes green or greyish at flowering. *Scales* 1–3 mm long, 0.3–1 mm wide from midrib to margin, brown, several-nerved, with margin glabrous. *Inflorescences*: axes contracted or compressed, to 2 mm long; scales 2–4(–8), with cluster 1–1.5 mm long; bract persistent, 0.7–1 mm long, 0.5 mm wide, convex; pedicel 4–12 mm long, glabrous; bracteoles persistent, ovate, 0.5–1.2 mm long, with l:w ratio 1.2–2, appressed, inserted in middle third, or rarely proximal third, strongly convex, 3–5-nerved, glabrous, red-brown. *Calyx* 4.5–7 mm long, glabrous, with tube longer than lobes; upper lobes 1–2.5 mm long, 2–3.5 mm wide, sometimes slightly expanded beyond lateral angle; lateral angle acute; sinus 0.5–2.5 mm deep; lower lobes 1–2 mm long, 0.8–1.5 mm wide; lateral lobes flat; standard to c. 17 mm long, similar in length to keel, adaxially yellow with a narrow red flare, similar abaxially; wings 1–4 mm shorter than keel, c. 3 mm wide, yellow; keel c. 5 mm wide, yellow, sometimes with hairs at distal end of fusion zone; anthers c. 1 mm long post-dehiscence; ovary glabrous, 8–10-ovulate; style 4–5 mm long. *Pods*: stipe 5–7 mm long; body narrow-oblong, 25–30 mm long, 7–10 mm wide, glabrous; upper margin c. 1 mm wide, minutely ridged along suture. *Seeds* 3–4 mm long, 2–2.5 mm wide; aril 1.5 mm long, 0.8 mm high, with base 0.7 mm long, with lobe curving 120–180°.



**Selected specimens from c. 80 examined:** **NORTHERN TERRITORY:** Robinson River, *L.Brass*, vii.1925 (BRI). **QUEENSLAND:** Jowalbinna, c. 32 km SW of Laura, Garden Creek, *W.Hinton* 92, ii.1978 (BRI); E of Baal Gammon mine, c. 1 km by road N of Herberton, to Irvinebank Rd, c. 7 km W of Herberton, *B.J.Conn & J. de Campo* 1294, 1.vi.1983 (BRI, CANB, MEL, NSW); 44 km from Walsh River crossing on the Mungana-Wrotham Park Rd, *J.R.Clarkson* 2806, 7.ii.1980 (DNA, NSW, PERTH); Mount Mulligan, c. 40 km NW of Dimbulah, *J.R.Clarkson* 5796, 15.iv.1985 (BRI, MEL, PERTH); 26.4 km by road towards Forsyth from Einasleigh, Newcastle Range, *K.R.McDonald* 3803, 6.iii.2005 (BRI, MEL); 34 km E of Forsyth towards Einasleigh, *R.J.Cumming* 23617 (BRI, DNA, MEL); SW of "Silver Plains" channel of Dinner Creek, *A.Kanis* 2025, 19.viii.1978 (BRI).

**Flowering period:** Flowers summer to autumn.

**Distribution and habitat:** Occurs in far north Queensland from the Iron Range south to Mount Bohle near Charters Towers, and in the far east of the Northern Territory where there is a single record from Robinson River (Fig. 13c). Grows in woodland and shrubland, often riparian and/or amongst rocks.

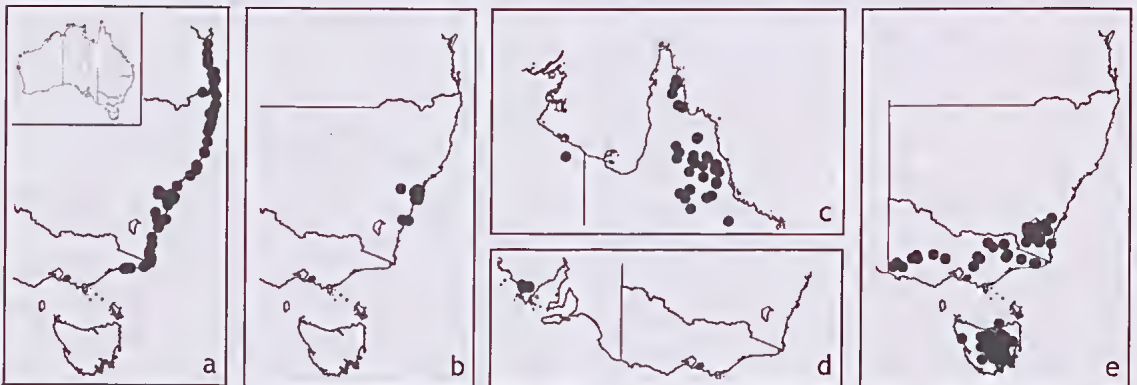
**Notes:** *Bossiaea armitii* is fairly uniform in floral and fruit morphology but with some variation in cladode shape and width. In some specimens cladodes are distinctly elliptic and then often relatively broad, whereas in others they are more linear as is typical of cladodes of most species of *Bossiaea*. Differs from other species in the *Ensata* subgroup by having longer flowers, petals almost devoid of red markings, and wing petals markedly shorter than the keel. It has shorter bracteoles than *B. scolopendria* and *B. peninsularis* and they are inserted mostly in the middle third of the pedicel rather than proximal or distal thirds.

**Typification:** I here select MEL 651099 as the lectotype of *B. armitii*. It is preferred over the other type material as it bears a pod as well as a flower.

**34. *Bossiaea riparia* A.Cunn. ex Benth., *Fl. Austral.* 2: 166 (1864)**

**Type:** [Protologue: 'Victoria. Maneroa, *F.Mueller*. Tasmania. Derwent River, *R. Brown*; ... throughout ..., *J. D. Hooker*. South Australia. Port Lincoln, *F.Mueller*.] New South Wales. Downs of Minera, 5 miles SW from Lake George, *A.Cunningham* 59, iv.1824; lectotype: K, *n.v.*, *fide* Lee (1970); isolectotype: K 000278532, *fide* A.S.George, *in sched.* (piece a), image seen in Kew Herbarium Catalogue.

*Semi-prostrate to erect leafless shrubs* to c. 1 m high, with cladodes to c. 5 mm wide, with inflorescences borne predominantly on side-branchlets, sometimes on a regular series of short side-branchlets; inflorescence-bearing cladodes sub-erect to erecto-patent, mostly 1–4 mm wide, with recession at nodes up to 0.4 mm deep, occasionally with a sparse indumentum; marginal ridges generally poorly defined, smooth or minutely uneven; new growth linear in profile, with evenly scattered straight hairs c. 0.3 mm long; epicuticular wax sometimes developing, with crusts often lifting in flakes or sheets, with cladodes green or grey-green or grey at flowering. *Scales* 0.7–1.5 mm long, 0.3–0.5 mm wide from midrib to margin, coppery-brown, 1–3-nerved. *Inflorescences:* axes contracted; scales 4–8, with cluster 0.5–1.5 mm long; bract persistent until after anthesis, 0.8–1.2 mm long, c. 0.8 mm wide, strongly convex; pedicel 1.5–5 mm long,



**Figure 13.** Distributions of species in the *Ensata* subgroup of Group F. a. *Bossiaea ensata*; b. *B. scolopendria*; c. *B. armitii*; d. *B. peninsularis*; e. *B. riparia*.

glabrous or hairy proximally; bracteoles persistent until after anthesis, then variably caducous, ovate, elliptic or obovate, 0.8–2 mm long, with l:w ratio 1–3, basally appressed but commonly then divergent, inserted mostly in middle third, strongly convex, 3–5-nerved or with venation obscure, glabrous, red-brown. *Calyx* 2.5–4 mm long, glabrous or with scattered appressed hairs on lobes, with tube much longer than lobes; upper lobes 0.8–1.3 mm long, 1–1.5 mm wide; lateral angle acute; sinus c. 0.5 mm deep; lower lobes 0.5–1.2 mm long, 0.6–1 mm wide; lateral lobes flat except for a distal medial ridge; standard to c. 12 mm long, similar in length to wings and keel, adaxially yellow with a red flare, with throat bisected, abaxially reddish throughout or reddish medially grading to yellow laterally; wings 2–2.5 mm wide, yellow throughout or brownish-red throughout; keel c. 3 mm wide, red throughout; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, 4–6-ovulate; style 3–4 mm long. *Pods*: stipe 2–4 mm long; body narrow-oblong or narrow-obovate, 12–24 mm long, 4–7 mm wide, glabrous; upper margin c. 0.7 mm wide, flat or with fine sutural ridge to c. 0.3 mm high. *Seeds* 1.5–3 mm long, 1–1.8 mm wide; aril 0.7–1 mm long, 0.5–1.2 mm high, with base 0.7–1 mm long, with lobe curving 45–90° (Fig. 12d).

**Selected specimens from c. 100 examined:** **NEW SOUTH WALES:** 5 side of Cave Creek, 1.5 km downstream of Blue Waterholes, Kosciusko National Park, *N.G.Walsh* 4880, 9.xii.1998 (MEL); Snowy Mountains Hwy, c. 10 km E of Adaminaby, *A.Duncan s.n.*, 3.xi.1994 (MEL, NSW); 'Mirrunga', W bank of Murrumbidgee River, 6.5 km S of A.C.T. border, *I.Crawford* 3175, 13.x.1995 (CANB, NSW); Near Cooma, *E.Gauga*, 7.vii.1951 (AD, CANB). A.C.T.: Pond Creek, Upper Cotter Valley, *P.Gilmour* 6263, 17.xi.1987 (CANB, NSW). **VICTORIA:** Wannon River at 4 posts bridge, c. 22 km W of Hamilton, *M.G.Corrick s.n.*, 1965 (MEL); Big River, W bank, c. 300 m downstream from Fryers Creek confluence, c. 7.5 km direct SW from Jamieson, *N.G.Walsh* 5771, 5.xii.2003 (CANB, MEL, NSW); Tipperary Track, E side of Sailors Creek, SW of Hepburn, *J.H.Ross* 397B, 11.i.1997 (CANB, MEL); Mitta Mitta River, 3 km S by road from Mitta Mitta township, *N.G.Walsh* 6120, 14.x.2004 (MEL, NSW). **TASMANIA:** East Risdon Nature Reserve, *A.Moscal* 165B2, 9.x.1988 (HO, CANB); Lake Augusta Rd, junction with old quarry track, *R.Burns* 147, 29.i.1990 (CANB); S side of Mersey River near Alum cliffs, *A.M.Buchanan* 7553, 28.xi.1985 (HO); Lake Sorell, *A.M.Buchanan* 12661, 30.xi.1992 (HO); Pumphouse Point Rd, Lake St Clair, *R.A.Burns*, 6.ii.2003 (HO).

**Flowering period:** Flowers from August to December.

**Distribution and habitat:** Occurs in far south-eastern New South Wales, southern and eastern Victoria and Tasmania (Fig. 13e). Categorised as rare in Victoria (Walsh & Stajsic 2007). Grows in open forest and woodland at low altitudes or up to c. 1000 m a.s.l.

**Notes:** *Bossiaea riparia* is a variable species, with variation in habit, width of cladodes, epicuticular wax development, and petal markings. A form widespread in the Southern Tablelands of New South Wales differs reasonably consistently from other populations in being more prostrate, having greyer, narrower cladodes, and in having brownish rather than yellow wings. In Tasmania, there is marked variation depending on location, with some populations looking similar to the Victorian form and others resembling the New South Wales Southern Tablelands form. Much of the variation is thought to be due to environmental factors.

Bracteoles of *B. riparia* are quite variable in shape; however, a fairly consistent and distinctive feature is the rather abrupt widening from a narrow basal portion which has glabrous margins. Beyond this zone of widening, the margins have the usual ciliate appearance.

*Bossiaea riparia* also differs from other species in the *Ensata* subgroup in having scattered hairs on the faces of developing cladodes and 2 or more pairs of inflorescence scales below a flower. In the other species hairs are mostly restricted to margins and there is a single pair of scales. *B. bombayensis*, while differing in several important respects, shows some affinity to *B. riparia* in having slender cladodes, narrow pods with a slender wing/ridge, and hairs on faces rather than margins of new growth. *B. bombayensis* shows some affinity to *B. riparia* in having narrow pods with a slender wing/ridge, and hairs on faces rather than margins of new growth. It is also similar in cladode width.

**Typification:** Lee lectotypified a specimen based on loosely attached fragments with diagnostic reproductive material, and she gave details of the label for the lectotype as 'Stony banks of rivulets winding through the downs of Minera, 5 miles SW. from Lake George 'Bossiaea riparia' C.v.mss.' This specimen surprisingly is not located in the on-line Kew Herbarium Catalogue, and there may be some mistake. The collection details given above are based on details presented on the label of the islectotype.



## The *Fragrans* subgroup

### 35. *Bossiaea fragrans* K.L.McDougall, *Telopea* 12(3): 356 (2009)

**Type:** New South Wales. Central Tablelands: Abercrombie Karst Conservation Area, *K.L.McDougall* 1268, 21.ix.2007; holotype: NSW 785656; isotypes: CANB 766110, MEL 2318267.

*Erect rhizomatous leafless shrubs* to c. 2.5 m high, with cladodes to c. 20 mm wide, with inflorescences borne on both long and short branchlets, but not generally on a regular series of short side-branchlets; inflorescence-bearing cladodes erecto-patent, mostly 5–10 mm wide, with recession at nodes 0.5–1 mm deep, glabrous; marginal ridges well-defined, minutely uneven or tuberculate; new growth somewhat elliptic in profile, sparsely hairy on margins; epicuticular wax developing, lifting in small flakes, with cladodes typically greyish at flowering. *Scales* 1–2.5 mm long, 0.3–0.7 mm wide from midrib to margin, coppery-brown, obscurely few-nerved. *Inflorescences:* axes contracted; scales 4 or 6, with largest c. 1 mm long, 0.7–1 mm wide, with scale-cluster 1–1.5 mm long; bract caducous or persistent, 1–1.3 mm long, 0.8 mm wide, moderately convex; pedicel 1–2.5 mm long, glabrous; bracteoles caducous before or after anthesis, oblong-elliptic, 1–1.3 mm long, with l:w ratio c. 2, divergent, inserted near base, strongly convex, with venation obscure, glabrous, orange-brown. *Calyx* 3–4.5 mm long, glabrous, with tube much longer than lobes; upper lobes 0.8–1 mm long, 1.2–1.6 mm wide, not or hardly expanded beyond lateral angle; lateral angle acute; sinus 0.5–0.8 mm deep; lower lobes 0.7–1 mm long, not or hardly chartaceous distally; lateral lobes 0.8 mm wide, ±flat but with a medial ridge; median lobe similar to laterals; standard to c. 12 mm long, similar in length to wings and keel, adaxially yellow with red marks at sides of throat, abaxially yellow, sometimes with a red medial stripe; wings 2.5–3 mm wide, yellow; keel c. 3 mm wide, ±red throughout; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, 5- or 6-ovulate; style 2.5–4 mm long. *Pods:* (based on McDougall 2010) stipe 2.5–3.5 mm long; body narrow-oblong, 24–38 mm long, 8–10 mm wide, glabrous. *Seeds* c. 3 mm long, c. 2 mm wide; aril not seen mature.

**Selected specimens from 3 examined:** NEW SOUTH WALES: Abercrombie Caves, E of Grove Creek, *K.L.McDougall* 999, 25.x.2001 (MEL); Abercrombie Caves, E of Grove Creek, *P.Carmen* 309, 1.x.2006 (CANB).

**Flowering period:** Flowers from September to October.

**Distribution and habitat:** Occurs in the vicinity of Abercrombie Karst Conservation Area, south of Bathurst in central-eastern New South Wales (Fig. 14a). Rare, and listed as a critically endangered species under the Threatened Species Conservation Act of New South Wales. Grows on slate and volcanic substrates in White Box woodland.

**Notes:** *Bossiaea fragrans* is similar to *B. milesiae* q.v. The vexillary stamen of *B. fragrans* is free at flowering, based on the few samples examined. This feature has not been recorded in other species of eastern Australian *Bossiaea*.

### 36. *Bossiaea milesiae* K.L.McDougall, *Telopea* 12(3): 356 (2009)

**Type:** New South Wales. South Coast, Brogo River, c. 25 km NNW of Bega (c. 1 km downstream from Brogo Dam), *K.L.McDougall* 1193, *J.Miles & P.Jeuch*, 12.ix.2006; holotype: NSW 785654; isotype: CANB, MEL 2318264.

*Erect rhizomatous leafless shrubs* to c. 2 m high, with cladodes to c. 10 mm wide, with inflorescences borne mostly on short side-branchlets; inflorescence-bearing cladodes sub-erect to erecto-patent, mostly 4–8 mm wide, with recession at nodes 0.5–0.8 mm deep, glabrous or sometimes with hairs on margins somewhat persistent, especially in scale-axils; marginal ridges well-defined, minutely uneven; new growth slightly elliptic in profile, sparsely hairy on margins; epicuticular wax not developing, with cladodes green at flowering. *Scales* 1.5–2 mm long, c. 0.5 mm wide from midrib to margin, red-brown, obscurely few-nerved. *Inflorescences:* axes contracted; occasionally 2 or 3 inflorescences arising from a single axil; scales 4–8, with largest c. 1 mm long, 0.7–1 mm wide; scale-cluster 1.5–2.2 mm long; bract caducous or persistent until anthesis, 1.3–1.5 mm long, c. 0.8 mm wide, moderately convex; pedicel 2–4 mm long, glabrous, becoming stout in fruit; bracteoles caducous, often before anthesis, oblong-elliptic, 1.5–2 mm long, with l:w ratio c. 2, loosely appressed, inserted

0.5–1 mm from base, strongly convex, with venation obscure, glabrous, orange-brown. *Calyx* 3.5–5 mm long, glabrous, with tube much longer than lobes; upper lobes 1–1.2 mm long, 1.5 mm wide, sometimes minutely chartaceous distally; lateral angle commonly acuminate; sinus c. 1 mm deep; lower lobes 1–1.2 mm long, minutely chartaceous distally; lateral lobes c. 0.8 mm wide, slightly convex and ridged; median lobe similar to laterals; standard to c. 11 mm long, similar in length to wings and keel, adaxially yellow with a red flare, mostly as two lateral patches, abaxially yellow; wings c. 3 mm wide, yellow; keel c. 3.5 mm wide, red  $\pm$ throughout; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, 8-ovulate; style 3.5–5 mm long. *Pods*: stipe 3–5 mm long; body narrow-oblong, 25–35 mm long, 7–9 mm wide, glabrous; upper margin 0.8–1 mm wide, with ridge to c. 0.5 mm high. *Seeds* 2.5–3.5 mm long, 2–2.5 mm wide; aril 1.5–1.8 mm long, 1–1.3 mm high, with base c. 1 mm long, with lobe curving 90–150° (Fig. 12f).

**Selected specimens from 5 examined:** NEW SOUTH WALES: lower banks of Brogo River, 0.5 km downstream from wall of Brogo Dam, *J.Miles s.n.*, 9.ix.1997 (MEL).

**Flowering period:** Flowers from August and September.

**Distribution and habitat:** Occurs in the Brogo River catchment W of Bega in far south-eastern New South Wales (Fig. 14b). Grows in riparian open forest.

**Notes:** *Bossiaea milesiae* is very similar to *B. fragrans* and there are very few collections of the two species available for comparison. Based on the material seen, *B. milesiae* differs in having cladodes always green, longer pedicels, bracteoles inserted further from the base of pedicel so that the abscission scars are generally not concealed by scales (Fig. 12f), upper calyx-lobes with the lateral angle acuminate, a longer pod-stipe, and a standard that does not have a red stripe abaxially.

## The Bracteosa subgroup

### 37. *Bossiaea bombayensis* K.L.McDougall, *Telopea* 12(3): 351 (2009)

**Type:** New South Wales. Southern Tablelands: Shoalhaven River, Bombay, 9 km W of Braidwood, *K.L.McDougall 1325 & C.L.McDougall*, 10.x.2008; holotype: NSW 777997; isotypes: CANB, MEL 2312599.

*Erect rhizomatous leafless shrubs* to c. 1.5 m high with cladodes to c. 5 mm wide, with inflorescences borne on both long and short cladodes, but not generally on a regular series of short side-branchlets; inflorescence-bearing cladodes sub-erect to erecto-patent, mostly 2–5 mm wide, not recessed at nodes or with recession to c. 0.7 mm deep, mostly soon glabrescent; marginal ridges poorly to moderately defined, mostly minutely uneven; new growth narrow-linear in profile, with scattered hairs adjacent to scales, and occasional hairs elsewhere along margins and sometimes also on faces; hairs occasionally persisting; epicuticular wax occasionally developing, lifting in flakes, with cladodes dark green or grey-green. *Scales* 1–1.5(–2) mm long, c. 0.5 mm wide from midrib to margin, brown, with venation obscure, with base sometimes minutely cordate. *Inflorescences*: axes contracted; scales 4 or 6, with largest 1.5–2 mm long, 1–1.5 mm wide; scale cluster 2–2.5 mm long; bract mostly caducous at anthesis, 2–3 mm long, c. 1.3 mm wide, strongly convex; pedicel 1.5–3 mm long, glabrous, not exceeding scale cluster or exceeding by up to 1 mm; bracteoles caducous before anthesis, c. elliptic, 2.5–3.2 mm long, with l:w ratio 1.5–2, appressed, inserted near base, strongly convex, with venation obscure, glabrous, brown. *Calyx* 3.5–4.5 mm long, glabrous, with tube longer than lobes; upper lobes triangular, 1–1.5 mm long, 1–1.2 mm wide, slightly acuminate, chartaceous distally; sinus 1–1.5 mm deep; lower lobes 1.5–2 mm long, chartaceous distally; lateral lobes 1 mm wide, flat except for distal median ridge; median lobe slightly longer, wider and more convex than laterals; standard to c. 8 mm long, similar in length to wings and keel, adaxially yellow with a red flare, abaxially largely suffused red but streakily pale medially and yellow towards lateral margins; wings 2.5 mm wide, brownish-red proximally, but largely yellow; keel 3.5 mm wide, grading from pale to pink to red; anthers c. 0.6 mm long post-dehiscence; ovary glabrous, 6–8-ovulate; style 3.5–4 mm long. *Pods*: stipe 1–2.5 mm long; body narrow-oblong, 20–26 mm long, 4–6 mm wide; upper margin 0.7–1 mm wide, flat or with a fine sutural ridge to c. 0.3 mm high; valves with transverse venation obscure. *Seeds* 2–2.5 mm long, 1.3–1.5 mm wide; aril c. 1 mm long, c. 0.5 mm high, with base 0.6–0.8 mm long, with lobe curving c. 90° (Fig. 12g).

**Selected specimens from c. 10 examined:** NEW SOUTH WALES: Shoalhaven River at Warri Bridge on Kings Hwy, c. 12 km



direct NNW of Braidwood, *I.R.Thompson 1327*, 24.xi.2010 (CANB, HO, MEL); Shoalhaven River, Little Bombay, *K.L.McDougall 1198*, 21.ix.2006 (NSW).

**Flowering period:** Flowers in September and October.

**Distribution and habitat:** Occurs north-west of Braidwood in far south-eastern New South Wales (Fig. 14c). Rare, and listed as vulnerable under the Threatened Species Conservation Act of New South Wales. Grows in riparian woodland.

**Notes:** *Bossiaea bombayensis* has the typical inflorescence-scale, bract, bracteole and calyx features of the Bracteosa subgroup, but has more slender cladodes and more slender pods than the other species.

### 38. *Bossiaea grayi* K.L.McDougall, *Telopea* 12(3): 354 (2009)

**Type:** Australian Capital Territory. Murrumbidgee River, 1 km downstream from Kambah Pool, *I.R.Telford 8553*, ix.1980; holotype: CANB 8007070; isotypes: CANB 8007070 (sheet 2); MEL 641512, NSW 567291.

*Erect rhizomatous leafless shrubs* to c. 1.5 m high, with cladodes to c. 8 mm wide, with inflorescences borne on long or short cladodes, but not generally on a regular series of short side-branchlets; inflorescence-bearing cladodes typically sub-erect, mostly 3–5 mm wide, not recessed at nodes or with recession to c. 0.5 mm deep, glabrous except for a few hairs often persisting in axils; marginal ridges generally smooth; new growth generally linear in outline, glabrous except for scattered hairs on margins adjacent to scales; epicuticular wax developing, lifting in small flakes, with cladodes grey-green at flowering. *Scales* 1.3–2(–2.2) mm long, 0.5–0.8 mm wide from midrib to margin, appressed, red-brown with pale margins, faintly 1–3-nerved. *Inflorescences:* axes contracted; scales 4–8(–12), with largest 1.5–2 mm long, c. 1.5 mm wide; scale-cluster 2.5–3.5 mm long; bract variably persistent at anthesis, 3–3.5 mm long, 1.5–1.8 mm wide, strongly convex; pedicel 2–2.5 mm long, glabrous; bracteoles mostly caducous before anthesis, 3–3.5 mm long, with l:w ratio c. 2, appressed, inserted near base, strongly convex, with venation obscure, glabrous, brown. *Calyx* 4.5–5.5 mm long, glabrous, with tube equal to or slightly longer than lobes; upper lobes triangular, 1.5–2 mm long, 1–1.5 mm wide, acute, chartaceous distally; sinus 1.5–2 mm deep; lower lobes

2–2.5 mm long, chartaceous distally; lateral lobes 1.2 mm wide, flat, with medially ridge distally; median lobe slightly longer, broader and more convex than laterals; standard to c. 11 mm long, similar in length to wings and keel, adaxially yellow with a red flare, abaxially partly flushed red with pale radiating nerves; wings c. 2 mm wide, reddish proximally, yellow distally; keel c. 3 mm wide, grading from pale to pink to red; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, c. 6-ovulate; style 4–5 mm long. *Pods:* stipe 2–4 mm long; narrow-oblong, 20–30 mm long, 6–9 mm wide; upper margin c. 0.7 mm wide, not ridged. *Seeds* c. 3 mm long, c. 1.8 mm wide; aril c. 1 mm long, c. 0.7 mm high, with base c. 0.6 mm long, with lobe curving c. 150° (Fig. 12e).

**Selected specimens from c. 8 examined:** AUSTRALIAN CAPITAL TERRITORY: Cotter Pumping Station, *E.Gauba*, 29.ix.1953 (CANB); Paddy's River, *L.Pryor*, 1937 (CANB); Molonglo River, directly S of Lower Molonglo Sewage Treatment Plant, *N.Taws 310*, 1B.xii.1993 (CANB, MEL); Murrumbidgee and Cotter Rivers junction, *R.Cabbage 2990*, 5.xi.1911 (NSW). VICTORIA: Limestone Track, c. 1.2 km from the Benambra-Wulgulmerang Rd, *J.A.Jeanes 2336*, 03.ii.2010 (CANB, MEL).

**Flowering period:** Flowers in spring.

**Distribution and habitat:** Occurs in the Australian Capital Territory along the banks of the Murrumbidgee River and its tributaries, and in far north-eastern Victoria (Fig. 14d). Rare, and listed as an endangered species in the Australian Capital Territory. Grows in woodland, with most records describing it as growing in sand or amongst boulders on river banks.

**Notes:** *Bossiaea grayi* is very similar to *B. vombata* q.v. The record given for Victoria is tentatively identified as *B. grayi* based on vegetative features as it lacks flowers and fruit. In this specimen, galls (which appear to be replacing flowers) are formed at nodes, and these are subtended by normal inflorescence scales that are typical of *B. grayi*. The pattern of epicuticular wax on cladodes is also typical of *B. grayi*.

### 39. *Bossiaea vombata* J.H.Ross, *Muelleria* 26: 54 (2008)

**Type:** Victoria. Wombat State Forest, Farm Rd, 3.9 km from junction of Back Settlement Rd and the Ballan-Daylesford Rd at Korweinguboora, *J.H.Ross 3647*, 26.x.1995; holotype: MEL 2043441.

*Erect rhizomatous leafless shrubs* to c. 1.2 m high, with cladodes to c. 12 mm wide, with inflorescences borne on both long and shorter branchlets, but not generally on a regular series of short side-branchlets; inflorescence-bearing cladodes erecto-patent, 2–10 mm wide, with recession at nodes 0.2–1 mm deep, mostly soon glabrescent; marginal ridges well-defined, usually slightly uneven; new growth  $\pm$ linear in outline, usually transiently sparsely hairy along margins and sometimes on the face; epicuticular wax hardly developed, not lifting in sheets, with cladodes green at flowering. *Scales* 2–4 mm long, 0.7–1 mm wide from midrib to margin, pale yellow, with venation obscure. *Inflorescences*: axes contracted; occasionally 2 or 3 inflorescences arising from a single axil; scales 4–10, with largest 1.5–2 mm long, c. 1.5 mm wide; scale-cluster 2–3 mm long; bract often persistent until after flowering, 2–3 mm long, c. 1 mm wide, strongly convex; pedicel c. 2 mm long, glabrous; bracteoles caducous, narrow oblong-elliptic, 2.8–3.7 mm long, with lw ratio 3–4, loosely appressed, inserted near base, strongly convex, with venation obscure, glabrous, brown. *Calyx* 4–5 mm long, glabrous, with tube equal to or longer than lobes; upper lobes triangular, 1.7–2.2 mm long, 1.5–2 mm wide, slightly acuminate, chartaceous distally; sinus 1.5–2 mm deep; lower lobes 1.5–2.2 mm long, chartaceous distally; lateral lobes 1 mm wide, flat or slightly convex distally associated with medial ridge; median lobe slightly longer, broader and more convex than laterals; standard to c. 10 mm long, similar in length to wings and keel, adaxially yellow with a red flare or flare absent, abaxially yellow or partially suffused red; wings 2.5 mm wide, all yellow or patchily suffused red; keel 3.5 mm wide, pale or red throughout; anthers c. 0.6 mm long post-dehiscence; ovary glabrous, 4–6-ovulate; style 3–4 mm long. *Pods*: stipe c. 3 mm long; body glabrous (not seen mature). *Seeds* (one collection only) 2.5 mm long, 1.8 mm wide; aril 1.5 mm long, 0.8 mm high, with base 0.8 mm long, with lobe curving c. 135° (Fig. 12a).

**Selected specimens from c. 10 examined:** VICTORIA: Spargo-Blakeville Rd, 120 m W of Cairns Rd intersection, adjacent to road on N side, *L.Macaulay*, 24.x.2009 (MEL); Bendoc, *W.Hunter*, ix.1941 (MEL); Snowy River, behind W Tree, *L.Hodge*, xi.1957 (MEL).

**Flowering period:** Flowers in spring.

**Distribution and habitat:** Occurs in south-central Victoria near Daylesford and in far eastern Victoria at

Bendoc and W.Tree (Fig. 14e). Specimens from eastern Victoria (*Hodge* MEL 1529684; *Hunter* MEL 1509814) cannot be identified with certainty as they are sterile; however, they are a good match for *B. vombata* vegetatively. Rare, and likely to warrant recognition as a threatened species. Grows in open forest.

**Notes:** When first described, only pure yellow-flowered populations of *B. vombata* at the type locality were known. Subsequently, nearby populations with red markings have been found. Isolated plants with an absence of red pigmentation have also been recorded for *B. ensata*, *B. cinerea* and *B. cordigera*.

*Bossiaea vombata* is very similar to *B. grayi* but consistently has green cladodes, longer cladode-scales, and is almost always infertile.

#### 40. *Bossiaea bracteosa* F.Muell. ex Benth., *Fl. Austral.* 2: 166 (1864)

**Type:** not designated. [Protologue: 'In the Australian Alps, on the Mitta-Mitta and Macalister rivers, at an elevation of 3000 to 4000 ft., and on Mt Latrobe'] Victoria. Mitta Mitta River, *F.Mueller*, date not known; lectotype: MEL 20333, *vide* Lee (1970).

Residual syntypes: Victoria. Macalister River, *F.Mueller*, date unknown: MEL 20330, MEL 20331, MEL 20332, MEL 20334; Victoria. Mitta Mitta River, *F.Mueller*, i.1854: MEL 20336; Mt Latrobe (now Mt Loch), *F.Mueller*, date unknown: MEL 20335.

*Erect rhizomatous leafless shrubs* to c. 2 m high, with cladodes to c. 20 mm wide, with inflorescences borne on both long and shorter branchlets; inflorescence-bearing cladodes erecto-patent, mostly 4–12 mm wide, with recession at nodes up to 5 mm deep, mostly soon glabrescent; marginal ridges sharply defined, smooth; new growth often narrowly oblong-elliptic in outline, very sparsely hairy on margins, soon glabrescent; epicuticular wax developing, lifting in sheets, with cladodes green at flowering. *Scales* 3–5 mm long, 1–2.5 mm wide from midrib to margin, generally inset from cladode margin, divergent, brown, multiveined, with numerous radiating and branching veins, with base sometimes cordate. *Inflorescences*: axes contracted; occasionally 2 or 3 inflorescences arising at an axil; scales 6–10, with largest 1.5–2 mm long, 1.5–2 mm wide; scale-cluster 2–2.5 mm long; bract caducous, 2.5–3.5 mm long,



1–1.5 mm wide, strongly convex; pedicel 1.5–3 mm long, glabrous, becoming stout in fruit; bracteoles caducous before anthesis, narrow oblong-elliptic, 3.5–4.5 mm long, with lw ratio 2.5–3.5, loosely appressed, inserted near base, strongly convex, but  $\pm$ flat near margins, with venation obscure or with midrib distinct, glabrous, brown. *Calyx* 3.5–4.5 mm long, sometimes with a few hairs near lobe apices, with tube slightly longer than upper lobes; upper lobes c. triangular, 1.4–2 mm long, 1–1.3 mm wide, acute, chartaceous distally; sinus 1.5–2 mm deep; lower lobes 2–2.5 mm long, chartaceous distally; lateral lobes 1.2 mm wide, flat, with medial ridge distally; median lobe slightly longer, broader and more convex than laterals; standard to c. 11 mm long, similar

in length to wings and keel, adaxially yellow with a red flare, mostly as two lateral patches, abaxially yellow or flushed red; wings 2.5–3 mm wide, yellow apart from proximal red streak; keel c. 3 mm wide, red  $\pm$ throughout; anthers c. 0.5 mm long post-dehiscence; ovary glabrous, 6–8-ovulate; style 4–5 mm long. *Pods*: stipe 2 mm long; body narrow-oblong, 20–32 mm long, 6–10 mm wide, glabrous; upper margin c. 0.7 mm wide, with a ridge to c. 0.5 mm high. *Seeds* 3–3.5 mm long, 1.5–2 mm wide; aril 1–1.5 mm long, 1–1.2 mm high, with base 1–1.2 mm long, with lobe curving 150–200°.

*Selected specimens from c. 40 examined*: VICTORIA: Mount Hotham area, S.J.Forbes 410, 20.xi.1979 (HO, MEL); Mount Hotham development area, slope falling to Swindlers Creek,



**Figure 14.** Distributions of species in the Fragrans, Bracteosa and Walkeri subgroups of Group F. a. *Bossiaea fragrans*; b. *B. milesiae*; c. *B. bombayensis*; d. *B. grayi*; e. *B. vombata*; f. *B. bracteosa*; g. *B. walkerii*.

*N.G. Walsh 542*, 27.xi.1980 (AD, MEL); 2.9 km along road to Dargo from Hotham Rd [Great Alpine Rd], *I.R. Thompson s.n.*, 12.ii.1994 (MEL); Dargo High Plains, Long Spur Track, c. 2 km S from 4WD track to Mayfield, *N.G. Walsh 5716*, 2.i.2003 (CANB, MEL).

**Flowering period:** Flowers from November to early January.

**Distribution and habitat:** Occurs in the Dargo High Plains and near Mt Hotham and near the headwaters of the Macalister River in eastern Victoria (Fig. 14f). Categorized as rare in Victoria (Walsh & Stajsic 2007). Grows at 1000–1600 m above sea level in shallow soils in Snow Gum woodland.

**Notes:** *Bossiaea bracteosa* is one of a group of four species, the others being *B. bombayensis*, *B. grayi* and *B. vombata*, which have triangular upper calyx-lobes, calyx-lobes distally chartaceous, and large, caducous bracts and bracteoles. The scales of cladodes of *B. bracteosa*, in addition to being larger than in other leafless species, have much more conspicuous reticulate venation, are sometimes cordate-based, are inserted more deeply within the nodal recesses and are more divergent. The scales are also unique in that their insertion is commonly inset relative to the cladode margin. The bract and bracteoles have recurved, membranous margins.

The recognition by McDougall (2009) of four new species of *Bossiaea* from material previously placed in *B. bracteosa* has considerably narrowed the current circumscription of *B. bracteosa*.

## The Walkeri subgroup

### 41. *Bossiaea walkeri* F. Muell., *Fragm.* 2(15): 120 (1861)

**Type:** [Protologue: 'In pinetis montium Peel-Range inter flumina Lachlan et Murrumbidgee. Alex. Walker'. The Peel Range is now known as the Cocoparra Range.] New South Wales. Cocoparra Range, *A. Walker s.n.*, 10.xi.1860; lectotype: MEL 20337, *vide* Ross (2006).

**Erect leafless shrubs** to c. 3 m high, with cladodes to c. 7 mm wide, with inflorescences typically borne on short side-branchlets; inflorescence-bearing cladodes erecto-patent, mostly 2–6 mm wide, with recession at nodes 0.3–1 mm deep, glabrescent; marginal ridges well-defined, generally smooth; new growth linear in profile, sparsely or occasionally densely hairy all over, glabrescent; epicuticular wax generally developed, with

crusts lifting in sheets, grey-green at flowering. *Juvenile leaves* sometimes present near base of stems, with lamina broad-elliptic, to c. 16 mm long. *Scales* 1.5–2.5 mm long, 0.6–1 mm wide from midrib to margin, dark brown, with multiple veins faintly evident. *Inflorescences:* axes contracted; scales 4–10, with cluster 1.5–2 mm long; bract caducous before anthesis, 3 mm long, 1.5–2 mm wide, convex; pedicel 2–7 mm long, glabrous or hairy proximally; bracteoles caducous before anthesis, elliptic, c. 3 mm long, with l:w ratio 2–2.5, divergent, inserted in proximal third, convex, with margins outcurved, many-nerved, glabrous, orange-brown. *Calyx* 7–10 mm long, with tube slightly longer than upper lobes; upper lobes 4–5 mm long, 3–4 mm wide, mostly expanded beyond lateral angle by 0.5–1 mm; lateral angle acute; sinus 0.5–1 mm deep; lower lobes 3–4 mm long; lateral lobes 1.5 mm wide, flat; median lobe similar to laterals; standard 15–20 mm long, adaxially yellow with a red flare, abaxially suffused red; wings 1 or 2 mm shorter than keel, 3.5–4 mm wide, brownish-red; keel 3–5 mm longer than standard, 5–6 mm wide, red; anthers c. 0.7 mm long post-dehiscence; ovary hairy, c. 20-ovulate; style c. 8 mm long. *Pods:* stipe 3–4 mm long; body narrow-oblong, 50–60 mm long, 7–12 mm wide; upper margin c. 0.8 mm wide, with a ridge to c. 0.5 mm high. *Seeds* 3–4 mm long, c. 2 mm wide; aril 2–2.5 mm long, 1.5 mm high, with base c. 1 mm long, with lobe curving 180°.

**Selected specimens from c. 200 examined:** **SOUTH AUSTRALIA:** Yellabinna Regional Reserve, Nullarbor Region, *F.J. Badmon 12224*, 11.viii.2006 (AD, CANB, MEL); 37.6 km from Yardea homestead on road to Minnipa, *J.D. Briggs 1137*, 7.ix.19B3 (AD, CANB, MEL, NSW); Chowilla Station, c. 20 km NE of Renmark, *E. Robertson*, 26.viii.1974 (AD, BRI, CANB). **NEW SOUTH WALES:** Mandleman station on Cobb Hwy to Mildura Rd, *R.C. Weston 142*, 21.viii.1988 (AD, BRI, CANB); Bundure Station, N of Mt Hope, *P. Mortensz 158*, 22.v.1969 (CANB, NSW). **VICTORIA:** Wyperfeld National Park, c. 1 km E of Cambacanya clearing, *A.C. Beauglehole 2BB34*, 2.x.1968 (AD, MEL); Boundary Bend, c. 30 km N of Kenley, *A. Egg*, 29.vii.1962 (AD, MEL).

**Flowering period:** Flowers in winter and spring.

**Distribution and habitat:** Occurs in arid regions of southern Western Australia, South Australia, western New South Wales and far north-western Victoria (Fig. 14g). Grows mostly in mallee woodland, often in red sandy soils.

**Notes:** *Bossiaea walkeri* is distinguished from other leafless species in eastern Australia by large flowers with an elongate keel, thin, outrolling cladode-scale margins,



hairy pod-margins, and seeds with a knobby aril. Bracts and bracteoles are distinctively striate, and margins of these and inflorescence scales are relatively long-ciliate. It is the only species of *Bossiaea* in eastern Australia to occupy arid regions.

The closest relative amongst the eastern leafless species to *B. walkeri* is unclear. From the Riparia subgroup, *Bossiaea riparia* is similar in having cladodes with hairy faces, while *B. peninsularis* is similar in terms of its striate bracts and bracteoles. However, in terms of caducous bracts and bracteoles and numbers of inflorescence scales, *B. walkeri* is closer to the Bracteosa subgroup.

## Names of uncertain application

### *Bossiaea humilis* Meisn., in J.G.C. Lehmann, *Plantae Preissianae* 1(1): 85, adnot. (1844)

**Type:** [Protologue: 'Circa Sydney, ora orient., legit Anderson, n. 78 (v. s. in Herb. Shuttleworth.)'] New South Wales. Sydney region, *Anderson* 78, 1837; holotype: BM 939751, image seen MEL.

The type specimen does not match any other material seen in the course of this revision. It may be a hybrid as it appears to be somewhat intermediate between *B. stephensonii* q.v. and several other species that occur in the Sydney region, including *B. obcordata*, *B. nummularia* and *B. prostrata*.

### *Bossiaea linnaeoides* G. Don, *Gen. Hist.* 2: 129 (1832)

**Type:** not designated. [Protologue: 'Native of New Holland'] There is insufficient information from the protologue to identify this taxon and there is no known type material.

### *Bossiaea plumosa* Hort. ex Har., *Dict. Hort.* [Bois] 1(7): 195 (1893)

**Type:** not designated. [Protologue has no locality or collector information.] There is insufficient information from the protologue to identify this taxon and there is no known type material.

## Acknowledgements

I am grateful to Collections staff at the Royal Botanic Gardens Melbourne for their assistance with mapping, loan requests and processing, to Dr Lachlan Copeland for making some valuable field collections, and to AD, BRI, CANB, HO, MEL, NE and NSW for making their collections available for study. This study was funded by Australian Biological Resources Study (ABRS Grant no. 207-01), which is a program within the Department of Sustainability, Environment, Water, Population and Communities.

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## Appendix: Index of scientific names

Epithets of accepted names are in roman typeface, and also in bold if the taxon is new, has new status, or has been resurrected in this revision. Epithets of synonyms are in italics.

Name	Number ref.	Page no.
<i>Bossiaea</i> Vent.		
<b>alpina</b> I.Thomps. (new species)	4	120
arenicola J.H.Ross	29	157
armitii F.Muell.	33	163
bombayensis K.L.McDougall	37	167
bossiaeoides (Benth.) A.B.Court	Introduction	107
bracteosa F.Muell. ex Benth.	40	169
brownii Benth.	27	155
buxifolia A.Cunn.	12	133
carinalis Benth.	25	153
cinerea R.Br.	5	123
<i>cinereo</i> var. <i>rigida</i> Rodway	19	144
<i>cinereo</i> var. <i>rosmarinifolia</i> (Lindl.) Benth.	6	125
<i>cinereo</i> var. <i>tenuicoulis</i> (Graham) J.M.Black	5	123
<b>concolor</b> (Maiden & Betche) I.Thomps. (new status)	24	152
<i>coccineo</i> Bonpl.	5	123
<b>cordifolia</b> Sweet (resurrected)	7	126
cordigera Benth. ex Hook.f.	10	130
<b>dasycarpa</b> I.Thomps. (new species)	16	140
<b>decumbens</b> F.Muell. (resurrected)	11	132
<b>distichoclada</b> F.Muell. (resurrected)	2	117
ensata Sieber ex DC.	30	159
foliosa A.Cunn.	1	115
fragrans K.L.McDougall	35	166
grayi K.L.McDougall	38	168
<i>hendersonii</i> Regel	10	130
heterophylla Vent.	22	149
<i>heterophyllo</i> var. <i>stenocloda</i> Domin	22	149
<i>horizontalis</i> (unpublished)	10	130
<i>humilis</i> Meisn.	Uncertain appl.	172
kiamensis Benth.	8	127
<i>lonceolato</i> (Andrews) Sm.	22	149
lenticularis Sieber ex DC.	9	129
<i>lenticularis</i> Lodd., G.Lodd. & W.Lodd.	23	150
<i>linnaeoides</i> G.Don	Uncertain appl.	172
<i>microphylla</i> (Sims) Sm.	20	145
milesiae K.L.McDougall	36	166
neoanglica F.Muell.	13	134
<b>nummularia</b> Endl. (resurrected)	14	137
obcordata (Vent.) Druce	20	145
<b>obovata</b> I.Thomps. (new species)	18	143
oligosperma A.T.Lee	28	157
ovoto (Andrews) Sm.	22	149



Name	Number ref.	Page no.
<i>peninsularis</i> I.Thomps. (new species)	32	162
<i>plumoso</i> Har.	Uncertain appl.	172
<i>prostrata</i> R.Br.	15	138
<i>prostrato</i> var. <i>Tuon Creek M.S.Clemens AQ22827</i>	16	140
<i>rhombifolia</i> Sieber ex DC.	23	150
<i>rhombifolio</i> subsp. <i>concolor</i> (Maiden & Betche) A.T.Lee	24	152
<i>rhombifolio</i> var. <i>concolor</i> Maiden & Betche	24	152
<i>riparia</i> A.Cunn. ex Benth.	34	164
<i>rosmarinifolia</i> Lindl.	6	125
<i>rotundifolio</i> DC.	23	150
<i>rupicola</i> A.Cunn. ex Benth.	26	154
<i>scolopendria</i> (Andrews) Sm.	31	161
<i>scortechinii</i> F.Muell.	17	142
<i>sericea</i> I.Thomps. (new species)	3	119
<i>sp. A sensu</i> S.W.L.Jacobs & J.Pickard	28	157
<i>stephensonii</i> F.Muell.	21	148
<i>tasmanica</i> I.Thomps. (resurrected, new status, new name)	19	144
<i>tenuicoulis</i> Graham	5	123
<i>vombata</i> J.H.Ross	39	168
<i>walkeri</i> F.Muell.	41	171
<b>Platylobium</b>		
<i>lonceolotum</i> Andrews	22	149
<i>microphyllum</i> Sims	20	145
<i>obcordotum</i> Vent.	20	145
<i>ovatum</i> Andrews	22	149
<i>scolopendrium</i> Andrews	31	161

# Genetic analysis suggests a wide regional provenance distribution for *Epacris impressa* (Ericaceae)

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## Introduction

*Epacris impressa* Labill. is a woody heathland shrub common to parts of south-eastern Australia. It is the floral emblem of Victoria and its range covers most of Victoria, parts of South Australia, Tasmania and southern New South Wales. Until recently, the strategy of 'local is best' has traditionally been accepted as best-practice for the collection of germplasm for native plant restoration projects. However, current studies have introduced the use of genetic fingerprinting techniques to establish plant provenance including Random Amplified Polymorphic DNA (RAPDs), Inter Simple Sequence Repeats (ISSR) and Amplified Fragment Length Polymorphism (AFLP) (Bussell *et al.* 2006; Krauss & Koch 2004; Krauss *et al.* 2005). ISSRs and RAPDs have been used together to determine phylogenetic relationships (Awasthi *et al.* 2004; Isshiki *et al.* 2008; Iruela *et al.* 2002; Levi & Rowland 1997; Mattioni *et al.* 2002; Pharmawati *et al.* 2004) and assess genetic diversity (Awasthi *et al.* 2004; Ayres & Strong 2001; Esselman *et al.* 1999; Jain *et al.* 1999). Three collection ranges were suggested for a 22,000 km<sup>2</sup> area in the Sydney basin using combined genetic and morphological assessment techniques: 1) narrow collection range - an area as close to the planting site as possible; 2) intermediate collection range - extending the collection area to fragmented remnants that were once contiguous with the site; 3) regional collection range - widening the geographic area to include a larger region (Burgin *et al.* 2005; Mortlock 2000). In this study, RAPDs and ISSR were performed to determine relatedness among and within geographic sites and floral colour races of *E. impressa*.

The size of heathland ecosystems has been drastically reduced and continues to be at risk due to continued land clearing. Threats to heathland areas include property and pasture development, forestry, mining, fire control in urbanised areas and infection by *Phytophthora cinnamomi* (The State of Victoria 2002; Williams *et al.* 2001). Very little research has been

## Abstract

*Epacris impressa* has showy flowers that fall into three general colour races: red, pink and white. It is primarily an outcrossing species with some examples of selfing occurring in each population. Genetic fingerprinting techniques were used to examine relationships between geographic sites and flower colour populations and to aid provenance determination. Results indicated that *E. impressa* has a high level of genetic diversity between and amongst sites and floral colour races. This suggests a wide provenance distribution for the species which would concur with earlier morphological studies conducted in the 1970's.

**Key words:** ISSR, RAPDs, provenance, Ericaceae, heathland

*Muelleria* 30(2): 175–182 (2012)







**Figure 1.** *E. impressa* falls into three general floral colour races: a) red (Angahook-Lorne Site A); b) pink (Cranbourne Site CA) and c) white (Cranbourne Site C).

conducted into the genetic provenance of plant species in these shrinking areas of heathland and provenance is often assigned by local anecdotal information rather than on the basis of genetic traits.

A major study by Stace and Fripp in 1977 described polymorphism in *E. impressa* (Stace & Fripp 1977a, 1977b, 1977c). The flowers of *E. impressa* fall into three general races: red (fuchsia/deep pink), pink (light pink) and white (Fig. 1). Populations of *E. impressa* are often polymorphic for flower colour with monomorphic populations occurring less frequently (Stace & Fripp 1977c). Polymorphic populations exist geographically between monomorphic populations and appear to provide a conduit for gene flow (Stace & Fripp 1977b). Soil pH has been shown not to be a determining factor in flower colour and it is possible that gene flow is influenced by vector selection (Stace & Fripp 1977b, 1977c). Flowering times of different flower colours overlap at polymorphic sites but are staggered between locations by flower colour in monomorphic populations (Stace & Fripp 1977b).

Polymorphism could be an ancient trait present in *E. impressa* or a more recent development caused by hybridization between populations (Stace & Fripp 1977a, 1977c). The consistencies between corolla colour, length, and anther colour led Stace and Fripp (1977a, 1977b) to postulate that riation in the species may be an early indicator of species division. However, further work by Fripp (1982) concluded that *E. impressa* is primarily an outcrossing species with no disparity between seedset or viability when races were crossed. Fripp (1982) self-pollinated and cross-pollinated individuals of different

races from a variety of populations over a five-year period. Morphological study of germinated plants indicated that the diverse races were not separate species (Fripp 1982). The evidence suggested that riation was probably a long-standing trait rather than an early sign of species divergence. This correlates with later genetic research that included the genus *Epacris* in Ericaceae due to early genetic links. This research was the first to use the Inter Simple Sequence Repeat (ISSR) method with a member of the Southern Hemisphere Ericaceae.

## Methods

Six research sites with remnant populations of *E. impressa* were selected based on their geographic separation and to provide examples of both polymorphic and monomorphic flower-colour demes. The research sites used for genetic studies were Angahook-Lorne State Park, Victoria (Site A) (38°37'S, 143°53'E), Braeside Park Heathland (Site B), Victoria (37°59'S, 145°08'E), two sites at the Royal Botanic Gardens Cranbourne, Victoria (sites C and CA) (38°07'S, 145°16'E and 38°08'S, 145°15'E), the Grampians National Park, Victoria (site G), Sundial track (37°10'S, 142°30'E), and a privately-owned site in Tullah, Tasmania (site T) (41°44'S, 145°37'E). No white-flowered plants were observed at Angahook-Lorne State Park during the collection period and Braeside Park Heathland was monomorphic for white-flowered plants.

Genetic fingerprinting using RAPDs and ISSR was conducted in two experiments with samples from each

of the three flower colour races (white, pink and red) found at each site. After initial primer screening, ISSRs and RAPDs were performed on a subset of red, pink and white samples from each site using primers that produced the clearest reproducible banding patterns as per the following protocols.

Cuttings consisting of 10–20 cm of new tip growth and flowers were collected from flowering *E. impressa* plants from Angahook-Lorne State Park and the RBG Cranbourne sites in September 2001, from the Grampians in November 2001 and from Braeside Park Heathland and Tullah, Tasmania in September 2002. Each sample was given an alphanumeric identification according to site (A = Angahook-Lorne State Park, B = Braeside Heathland, C and CA = Royal Botanic Gardens Cranbourne sites, G = Grampians National Park, T = Tullah, Tasmania), colour (W = White, R = Red, or P = Pink) and the plant of origin. Flower colours were further identified using the *Royal Horticultural Society Colour Chart* (c1995). Plant material collected at each site was stored at -20°C until required (Table 1). Herbarium specimens were lodged at the National Herbarium of Victoria (MEL) after DNA isolation from material.

DNA was isolated from the *E. impressa* flowers using the Qiagen DNeasy® Plant kit according to the manufacturer's instructions. Electrophoresis was performed on a Horizon®58 Life Technologies™ Gibco BRL Horizontal Gel Electrophoresis Apparatus gel tray with 1% agarose in TBE stained with ethidium bromide and run at 96 V for 30 minutes. Bands of DNA were visualised on a UV transilluminator and photographed

with a Kodak Digital Science DC120 digital camera. The RAPD OPB primer set was found to be successful with the ericoid, *Vaccinium macrocarpon* Ait. (Stewart & Nilsen 1995) and was selected for screening with *E. impressa*. The Operon OPB set of 20 primers (OPB1 GTTTCGCTCC, OPB2 TGATCCCTGG, OPB3 CATCCCCCTG, OPB4 GGACTGGAGT, OPB5 TGCGCCCTTC, OPB6 TGCTCTGCCC, OPB7 GGTGACGCAG, OPB8 GTCCACACGG, OPB9 TGGGGGACTC, OPB10 CTGTGGGAC, OPB11 GTAGACCCGT, OPB12 CCTTGACGCA, OPB13 TTCCCCCGCT, OPB14 TCCGCTCTGG, OPB15 GGAGGGTGTT, OPB16 TTTGCCCGGA, OPB17 AGGGAACGAG, OPB18 CCACAGCAGT, OPB19 ACCCCCGAAG) was screened initially with two DNA samples, one a red-flowered plant from Angahook-Lorne State Park (site A) and the other a white-flowered plant from Cranbourne (site C), using the protocol outlined below. Each sample and primer was run twice to test for reproducibility. Bands were obtained for both samples with the RAPD primers OPB1, OPB3, OPB4, OPB5, OPB6, OPB7, OPB15, and OPB19. From these, the two primers that yielded the clearest reproducible bands, OPB6 and OPB19, were chosen for RAPD experiments

Each RAPD/PCR reaction consisted of the following: 3.2 µl 1.25 mM dNTP, 0.8 µl 25 mM MgCl<sub>2</sub>, 2 µl Tris-HCl reaction buffer, 12 µl milli-q H<sub>2</sub>O, 1 µl Operon OPB series sequence primer, and 0.5 µl QIAGEN Taq DNA Polymerase. The RAPD reactions were run in a Biometra® Personal Cycler top-heating thermocycler using a 4-minute strand separation cycle at 94°C, then 45 cycles of one minute at 94°C, two minutes at 36°C, and two minutes at 72°C and a final 72°C extension step for 10 minutes. A negative control with no DNA was included in each run to test for contamination. Gels were run as previously described.

Six standard ISSR primers, 812 (GAG AGA GAG AGA GAG AA), 814 (CTC TCT CTC TCT CTC TA), 824 (TCT CTC TCTCTCTCG), 835 (AGA GAG AGA GAG AGA GYC), 836 (AGA GAG AGA GAG AGA GYA) and 857 (ACA CAC ACA CAC ACA CYG) were screened with two DNA samples as for RAPD screening. The primers were selected based on their ability to amplify loci in a variety of plant genera and species (Casasoli *et al.* 2001; Ge *et al.* 2003; Levi & Rowland 1997; Mattioni *et al.* 2002; Nan *et al.* 2003; Pharmawati *et al.* 2004; Qiu *et al.* 2004; Wang *et al.* 2004; Xiao & Berch 1996). ISSR reactions were prepared as

**Table 1.** Accession numbers for herbarium vouchers. An indicative sample was submitted for each flower colour race for sites G (Grampians National Park), CA (Royal Botanic Gardens Cranbourne), and A (Angahook-Lorne State Park). All plant material was used for DNA Isolation from samples collected at sites B (Braeside Heathland), C (Royal Botanic Gardens Cranbourne), and T (Tullah, Tasmania). No white-flowered plants were observed at Angahook-Lorne State Park during the collection period.

MEL Accession numbers			
Site	Red/Fuchsia	Pink	White
A	2337596	2337597	-
CA	2337594	2337595	2337593
G	2337591	2337592	2337590



**Table 2.** Similarity matrix for the entire sample set using the Jaccard coefficient. A = Angahook-Lorne State Park, B = Braeside Heathland, C and CA = Royal Botanic Gardens Cranbourne sites, G = Grampians National Park, T = Tullah, Tasmania. The site letters are followed by a letter indicating floral colour race W (white), R (red) or P (pink) and sample number.

	AR 18	AR 19	AP 34	BW1 1	BW1 2	CW1 9	CW2 0	CR 133	CR 134	CP 101	CP 105	CP 121	CA W24	CA W27	CA W34	CAR 4	CAP 15	CAP 17	GW 118	GW 119	GW 120	GR 137	GP 110	GP 127	TW1	TW3	TR1	TR2	TP1	TP2	TP4							
AR18	1.00																																					
AR19	0.75	1.00																																				
AP34	0.00	0.00	1.00																																			
BW11	0.00	0.00	0.00	1.00																																		
BW12	0.00	0.00	0.00	0.57	1.00																																	
CW19	0.33	0.38	0.29	0.18	0.08	1.00																																
CW20	0.25	0.29	0.40	0.22	0.20	0.58	1.00																															
CR133	0.25	0.13	0.00	0.33	0.31	0.27	0.21	1.00																														
CR134	0.29	0.14	0.25	0.15	0.14	0.29	0.23	0.75	1.00																													
CP101	0.18	0.20	0.20	0.13	0.29	0.42	0.36	0.20	0.10	1.00																												
CP105	0.13	0.14	0.33	0.17	0.40	0.30	0.38	0.11	0.00	0.56	1.00																											
CP121	0.09	0.10	0.25	0.13	0.29	0.33	-0.40	0.20	0.10	0.89	0.63	1.00																										
CAW24	0.00	0.00	0.33	0.00	0.00	0.27	0.20	0.21	0.33	0.14	0.00	0.14	1.00																									
CAW27	0.00	0.00	0.33	0.00	0.09	0.27	0.20	0.21	0.33	0.14	0.00	0.14	0.71	1.00																								
CAW34	0.00	0.00	0.33	0.00	0.10	0.18	0.10	0.21	0.36	0.00	0.00	0.00	0.57	0.83	1.00																							
CAR4	0.20	0.25	0.20	0.14	0.29	0.15	0.09	0.08	0.18	0.10	0.00	0.00	0.13	0.29	0.33	1.00																						
CAP15	0.20	0.20	0.50	0.25	0.25	0.29	0.33	0.67	0.33	0.50	0.60	0.57	0.00	0.00	0.00	0.00	1.00																					
CAP17	0.25	0.25	0.50	0.33	0.33	0.33	0.40	0.33	0.00	0.38	0.75	0.43	0.00	0.00	0.00	0.00	0.75	1.00																				
GW118	0.00	0.00	0.25	0.20	0.17	0.20	0.25	0.29	0.14	0.22	0.00	0.25	0.14	0.14	0.00	0.00	0.17	0.00	1.00																			
GW119	0.00	0.00	0.25	0.20	0.17	0.20	0.25	0.29	0.14	0.22	0.00	0.25	0.14	0.14	0.00	0.00	0.17	0.00	1.00	1.00																		
GW120	0.00	0.00	0.25	0.20	0.17	0.20	0.25	0.29	0.14	0.22	0.00	0.25	0.14	0.14	0.00	0.00	0.17	0.00	1.00	1.00	1.00																	
GR137	0.11	0.13	0.20	0.25	0.22	0.29	0.36	0.45	0.36	0.25	0.10	0.27	0.10	0.10	0.11	0.00	0.40	0.20	0.33	0.33	0.33	1.00																
GP107	0.00	0.00	0.33	0.00	0.00	0.27	0.20	0.25	0.50	0.38	0.17	0.43	0.29	0.29	0.33	0.11	0.40	0.20	0.11	0.11	0.11	0.43	1.00															
GP127	0.00	0.00	0.33	0.00	0.00	0.08	0.09	0.25	0.50	0.22	0.00	0.25	0.29	0.29	0.33	0.11	0.17	0.00	0.25	0.25	0.25	0.50	1.00															
TW1	0.25	0.25	0.25	0.20	0.17	0.33	0.43	0.29	0.14	0.38	0.40	0.43	0.00	0.00	0.00	0.00	0.75	0.50	0.33	0.33	0.33	0.60	0.25	0.11	1.00													
TW3	0.25	0.25	0.20	0.25	0.20	0.33	0.43	0.14	0.00	0.38	0.40	0.43	0.00	0.00	0.00	0.00	0.40	0.50	0.14	0.14	0.14	0.60	0.25	0.11	0.60	1.00												
TR1	0.00	0.00	0.33	0.17	0.17	0.30	0.22	0.43	0.29	0.40	0.43	0.44	0.20	0.20	0.25	0.00	0.60	0.40	0.17	0.17	0.17	0.38	0.40	0.17	0.40	0.17	1.00											
TR2	0.00	0.00	0.00	0.17	0.17	0.18	0.10	0.43	0.29	0.27	0.25	0.30	0.20	0.20	0.25	0.00	0.60	0.40	0.40	0.40	0.38	0.40	0.40	0.40	0.17	0.67	1.00											
TP1	0.50	0.50	0.17	0.00	0.14	0.56	0.33	0.11	0.13	0.50	0.33	0.38	0.13	0.29	0.14	0.25	0.33	0.40	0.11	0.11	0.11	0.20	0.00	0.25	0.25	0.14	0.14	1.00										
TP2	0.50	0.50	0.25	0.00	0.10	0.55	0.36	0.18	0.33	0.50	0.33	0.38	0.33	0.50	0.38	0.30	0.33	0.40	0.08	0.08	0.08	0.08	0.36	0.25	0.18	0.18	0.14	0.14	0.67	1.00								
TP4	0.50	0.50	0.20	0.00	0.00	0.63	0.38	0.00	0.00	0.50	0.33	0.38	0.14	0.14	0.00	0.13	0.33	0.40	0.13	0.13	0.13	0.13	0.22	0.00	0.29	0.29	0.14	0.14	0.83	0.56	1.00							

for RAPDs and run with an initial three-minute cycle at 94°C, then 45 cycles of one minute at 94°C, 4S seconds at 54°C, one minute at 72°C, then a final extension step of 10 minutes at 72°C.

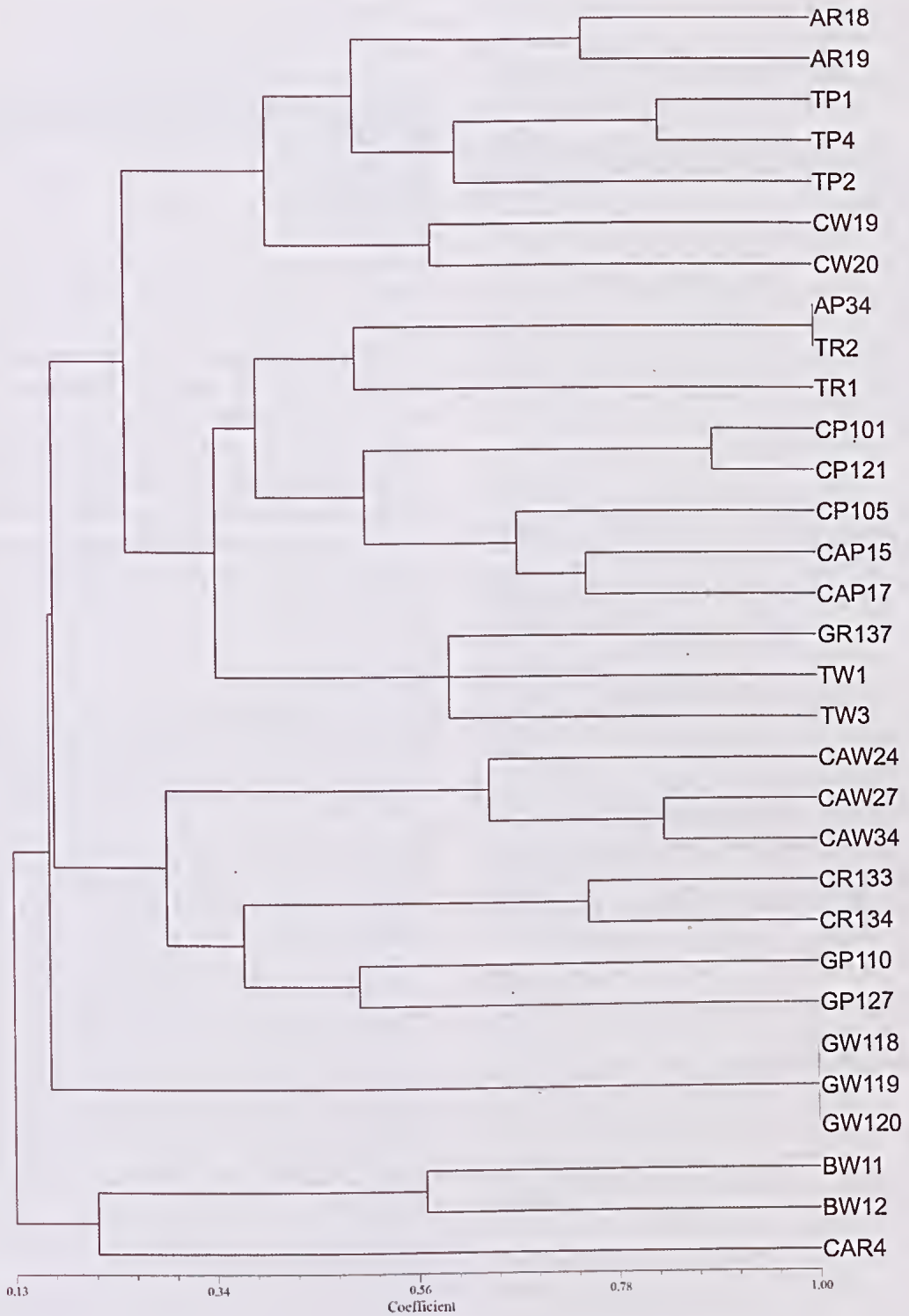
Bands were obtained for both samples with ISSR primers 812, 824, 835, and 836. From these, the two primers that yielded the clearest reproducible bands, 812 and 836, were chosen for ISSR experiments as per previously described protocols. Gel photos were visually reviewed and faint ambiguous bands were removed from the data set (Williams *et al.* 1990; Zawko *et al.* 2001). All of the gel photos were reviewed with their corresponding loci information from the Kodak1D analysis program. High (1500, 2000 and 3000 base pairs) and low (100, 200, 300 base pairs) molecular weight bands were also removed from the analysis to minimise the possibility of the inclusion of nested inverted repeats (Stewart & Excoffier 1996; Stewart & Nilsen 1995). Any individuals with no bands were excluded from the data analysis. Monomorphic bands were not present in any of the RAPD or ISSR results. A total of 182 polymorphic bands were scored with four primers for 31 individuals.

The molecular weights were then converted into binary data for presence (1) or absence (0) of bands.

Any samples that were missing data from more than one primer were removed and the Exeter software program NTSYSpc 2.20e was used for statistical analyses. A similarity matrix was generated from the data set using the Jaccard coefficient,  $a/(n-d)$  (Table 2). Reduced similarity matrices were created with data sub-sets by site (Table 3) and floral colour race (Table 4) to compare the average similarities between and amongst populations. A dendrogram was created using a clustering algorithm with an unweighted pair-group method, arithmetic average (UPGMA) formula to illustrate relationships between individuals in the entire sample group (Fig. 2).

**Results**

ISSR and RAPD analyses showed a high level of genetic variability both between and amongst geographic and race populations of *E. impressa*. Individuals did not cluster (Fig. 2) by site or flower colour (except for small clusters of 2-3 individuals from the same site and flower colour) and inter-site similarity coefficients ranged from 13-30% and inter-colour similarity coefficients from 19-31%, with intra-site coefficients similar. The results



**Figure 2.** Dendrogram illustrating phylogenetic relationships between individuals in the entire population sample. The first letter or letters represent the collection site (A, B, C, CA, G, T) and the second letter the flower colour race (R, P, W). The number corresponds to the plant identification number.



**Table 3.** Reduced similarity matrix showing average percentages of similarity by site. A = Angahook-Lorne State Park, B = Braeside Heathland, C and CA = Royal Botanic Gardens Cranbourne sites, G = Grampians National Park, T = Tullah, Tasmania.

SITE	A	B	C	CA	G	T
A	0.13					
B	0.00*	0.19				
C	0.22	0.21	0.26			
CA	0.20	0.15	0.24	0.17		
G	0.10	0.13	0.23	0.14	0.30	
T	0.30	0.12	0.33	0.25	0.23	0.24

\* white-flowered plants were not found at site A at the time of collection for DNA isolation.

indicated a 20% average genetic similarity between geographic populations and a 22% average similarity between colour races. The pink-flowered race had the highest average intra-population polymorphic similarity at 31%. The red and white races had the lowest inter-race and intra-race average genetic similarities (19–23%).

The percentages of similarity ranged from 10% between sites A and G to a 33% average possibility of relatedness between individuals at sites C and T (Table 3). Site A had the lowest percentage of genetic similarity (13%) of plants within its population, followed by sites CA (17%) and B (19%). Site G had the highest amount of intra-site genetic similarity (30%) followed by site C (26%) and site T (24%). There was a 20% inter-site average polymorphic similarity between plants.

Plants of the pink-flowered race had the highest average percentage (31%) of intra-race genetic similarity (Table 4). White-flowered and red-flowered plants had lower average probabilities of being genetically similar to other plants of the same flower-colour race (21% and 19% respectively). Pink-flowered plants had a 21% average genetic similarity to white-flowered plants and a 23% similarity to the red-flowered race. Red-flowered plants had an equal average probability (19%) of being related to either other red-flowered or to white-flowered plants. There was a 22% average genetic similarity between plants of any one flower-colour to those of any other race.

Clustering can be seen between individuals of the same flower colour race within populations, with the Grampians white-flowered plants (GW118–120)

**Table 4.** Reduced similarity matrix showing average percentages of similarity by floral colour race (W = white, R = red, P = pink).

	W	R	P
W	0.21		
R	0.19	0.19	
P	0.21	0.23	0.31

showing the highest similarity coefficient (Fig. 2). Individuals from each site are primarily clustered at low similarity coefficients or are seen grouped with members of other site populations indicating a high level of genetic variability. Clustering at the highest similarity coefficients is shown primarily by small but separate groups of red, pink, and white flowered plants. The smaller discreet colour alignments, rather than three major groupings by floral race, suggest a relatively high level of genetic variability within floral races and within sites.

### Discussion

During this research and previous studies, (Stace & Frupp 1977a) plants of different flower colours in populations that were polymorphic for flower colour were observed to have separate but overlapping periods of flowering, which would have an influence on the genetic composition of the separate floral races. Native and introduced vectors that select by flower colour during overlapping periods of flowering of the three floral races would not be cross-pollinating between the floral races (Castellanos *et al.* 2003; Meléndez-Ackerman *et al.* 1997; Streisfeld & Kohn 2006). Differences in the time of flowering between flower-colours in the same population could also have an influence on pollination patterns. Research is currently being undertaken at LaTrobe University on pollinator flower-colour preference with *E. impressa* (Webster N., Edwards T. & Hoebee S. pers. comm. 2012). This may provide further insight into vector influence on flower colour composition of polymorphic populations.

The geographic isolation of the Grampians has created many unique taxa and it was not surprising that the Grampians population (site G) showed the highest level of intra-site genetic similarity (30%). A 26% average polymorphic similarity between individuals

was recorded at the Royal Botanic Gardens, Cranbourne, site C. This site primarily contained plants of the white-flowered race, which may account for the high level of intra-site genetic similarity. The Tullah site in Tasmania demonstrated a 24% average intra-site similarity. The site consisted of an area of remnant vegetation not directly geographically linked to other populations.

Angahook-Lorne site A had primarily red and pink flowered populations, and demonstrated the lowest average genetic similarity within its own population (13%). This concurs with Stace and Fripp's (1977b) findings of high levels of polymorphism for flower-colour race within linked 'mosaics' of populations. The site was also part of a large coastal range of linked *E. impressa* populations within a protected state park region. This has provided the opportunity for genetic dispersal to other geographically linked populations not sampled. Genetically, the site appears to be part of a larger population or one of a series of linked populations that share genetic traits. The recent creation of the Otways National Park will help to preserve the genetic integrity of this large polymorphic group.

Braeside site B and Cranbourne site CA also had low average intra-site polymorphic similarities at 13% and 17% respectively. These results were surprising since both sites were geographically removed from other populations. Site B comprised all white-flower race plants which could explain the polymorphic similarities. Site CA had a robust mix of races but all *E. impressa* plants at the site died during this research due to long-term drought conditions.

*Epacris impressa* appears to have a large regional provenance distribution. These findings concur with Stace and Fripp's (1977a; 1977b; 1977c) earlier work on riation of the species which found high levels of polymorphism for flower colour race, corolla colour and corolla length. While geographic populations showed high levels of inter-site genetic diversity, morphological characteristics should still be considered when collecting propagative material for revegetation. Since genetic fingerprinting techniques target unknown regions of the genome, locally adaptive traits may not be represented by the loci in RAPD and ISSR analysis (O'Brien *et al.* 2007). A combination of genetic fingerprinting and traditional morphologic observation is recommended to determine provenance (Krauss *et al.* 2005) and plant propagules should still be collected from populations of

similar floral colour race (Stace & Fripp 1977b). Hence, when trying to re-establish a population of all white-flowered plants, it is suggested that cutting material is collected from another site of all white-flowered plants. Geographic proximity of populations does not appear to be an issue in provenance determination based on the regional genetic spread of *E. impressa*. This has been found to be the case in other Australian studies where large regional areas of provenance have been established with DNA fingerprinting techniques (Krauss & Koch 2004; Krauss *et al.* 2005).

Based on this research, *E. impressa* has a high level of both intra-race and inter-race genetic diversity. The inter-site genetic similarities indicate that *E. impressa* populations have probably been geographically interconnected until recently. Further work will be required on Tasmanian populations to determine their genetic links to mainland South-eastern Australia plants and additional studies in southern New South Wales and South Australia would be valuable.

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# *Cyclosorus interruptus* (Thelypteridaceae): new to Victoria

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## Introduction

During recent botanical survey work in south-western Victoria (Sinclair and Sutter 2008), a fern not referable to any species recorded previously in Victoria was encountered (Fig. 1). Examination of the material confirmed the identity of the species as *Cyclosorus interruptus* (Willd.) H.Ito (Thelypteridaceae). This species occurs in the tropics and sub-tropics of all continents as well as New Zealand (Bostock 1998). In Australia, prior to the current discovery, it was known to occur in tropical central Australia, and southward along the margins of the continent about as far south as Sydney and Perth.

In Victoria the family Thelypteridaceae is represented by four species in four genera: *Christella dentata* (Forssk.) Brownsey & Jermy, *Cyclosorus interruptus* (Willd.) H.Ito (here reported), *Pneumatopteris pennigera* (G.Forst.) Holttum, and *Thelypteris confluens* (Thunb.) C.V.Morton. *Cyclosorus interruptus* can be distinguished from *Christella dentata* and *Pneumatopteris pennigera* by the presence of scattered, papery, broad, flat scales on the pinnae midribs on the lower surface of mature fronds (Fig. 2a), which are absent in *Christella* and *Pneumatopteris*; similar scales are present in *Thelypteris confluens*, and pale brown ovate scales are sometimes present on the lower surface of young fronds in *Pneumatopteris pennigera*. The upper surfaces of the pinnae in *Cyclosorus interruptus* are virtually hairless (occasional, minute, pointed hairs on veins present), whereas in *Christella dentata* the upper surface of pinnae have many short, pointed hairs. *Cyclosorus interruptus* also has stalkless, spherical orange or orange-red glands on the veins on the lower surface of the fronds, which are absent in *Christella dentata* and *Pneumatopteris pennigera* (Fig. 2b). The texture of the fronds of *Cyclosorus interruptus* is harsh, whereas the fronds of *Pneumatopteris pennigera* are softer-textured. When sori are present, *Cyclosorus interruptus* is easily distinguished from *Pneumatopteris pennigera* by its indusiate (i.e. protected) sori; the sori of *P. pennigera* lack indusia. The absence of sori

## Abstract

A new fern, *Cyclosorus interruptus*, is reported for Victoria. Information is provided as to how this species can be distinguished from closely-related Victorian ferns. Its Victorian distribution is discussed, along with its habitat, the threats to its persistence and its conservation significance in Victoria.

**Key words:** Ferns, *Cyclosorus*, identification, ecology, Australia.

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on the lowermost 1 (-2) of the basal pair of veins (the pair that unite below the sinus) is also diagnostic. The sori are usually present in the corresponding position in *Christella dentata* and *Pneumatopteris pennigera*. *Cyclosorus interruptus* differs from *Thelypteris* in that the pinnae are lobed for about one-half to one-third of the distance to the pinnae midribs, with the basal veins in adjacent pinnae lobes always branching to produce a long excurrent vein passing to the sinus membrane,

whereas in *Thelypteris* the pinnae are lobed almost to the pinnae midribs, and all veins are free (Bostock 1998) (Fig. 2c).

Many ferns are readily dispersible and popular in cultivation, making it potentially difficult to determine whether some species are historically indigenous to a given area (e.g *Pteris umbrosa* at sites such as Yellingbo, Victoria, distant from its conventionally recognised distribution in eastern Victoria, Stajsic



Figure 1. *Cyclosorus interruptus* in situ.

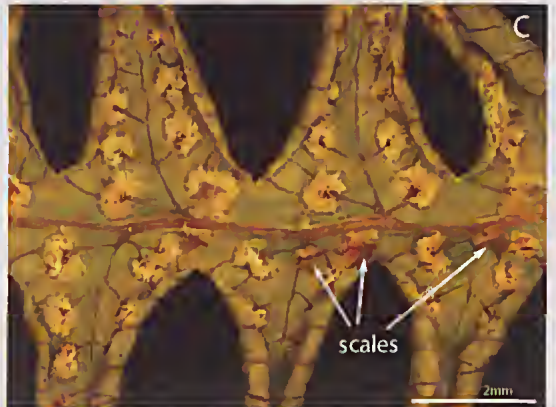
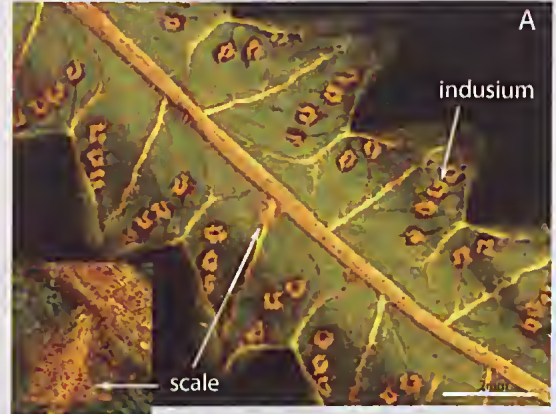


Figure 2. Frond under-surfaces, showing diagnostic features.

A: *Cyclosorus interruptus*, with the broad scales indicated (absent in *Pneumatopteris* and *Christella*), and the pinnae division clearly evident; B: *C. interruptus* with the sessile glands highlighted; C: *Thelypteris confluens*, showing the absence of glands, the presence of scales and the relatively deeper pinnae division.



pers. obs.). We consider *Cyclosorus interruptus* to be indigenous in Victoria, since the species is apparently very rarely (although easily) cultivated (on the basis of internet searches and published literature, e.g. Jones & Clemesha 1993), the individual plants appear long-established, and the area of occurrence is sparsely inhabited (although two farmhouses are within 1 km). The site is unfenced and the possibility that it may have been introduced with stock, although remote, cannot

be discounted. However, given the remarkable disjunct Australian occurrence of *Thelypteris confluens* in north-eastern Victoria, otherwise known with certainty only in south-eastern Queensland, the occurrence of *Cyclosorus interruptus* in south-western Victoria is perhaps less surprising given the far greater natural range of this species in Australia. As is often the case with *Cyclosorus interruptus*, *Thelypteris confluens* has a preference for swampy habitats (Wilson 1990; Bostock 1998).



**Figure 3.** The Victorian habitat of *Cyclosorus interruptus* when A. dry; and B. inundated.



**Table 1.** Species associated with *Cyclosorus interruptus* in Victoria, taken from two quadrats (D0076200, D0076300). The abundance values are consistent with the Victorian Flora Site Database (2007), where the information from these quadrats is stored. The species are listed by their abundance, then alphabetically. The nomenclature for botanical names follows Walsh & Stajsic (2007). Vernacular names follow the Victorian Flora Site Database.

Species	Common name	D0076200	D0076300
<i>Leptospermum lonigerum</i>	Woolly Tea-tree	2	3
<i>Cyclosorus interruptus</i>	Swamp Shield-fern	2	2
<i>Ronunculus</i> sp.	Buttercup	2	2
<i>Rumex bidens</i>	Mud Dock	2	2
<i>Stellario angustifolio</i>	Swamp Starwort	2	2
<i>Urtica inciso</i>	Scrub Nettle	2	2
* <i>Sonchus asper</i>	Rough Saw-thistle	3	+
<i>Carex appressa</i>	Tall Sedge	1	2
<i>Crossulo helmsii</i>	Swamp Crassula	1	2
<i>Eleocharis acuta</i>	Common Spike-sedge	2	1
<i>Hydrocotyle sibthorpioides</i>	Shining Pennywort	1	2
<i>Persicaria decipiens</i>	Slender Knotweed	1	2
<i>Triglochin alcockiae</i>	Southern Water-ribbons	2	1
<i>Hydracotyle muscosa</i>	Mossy Pennywort	2	+
* <i>Paspalum distichum</i>	Water Couch	2	+
<i>Glyceria australis</i>	Australian Sweet-grass	1	1
* <i>Nasturtium officinale</i>	Watercress		2
<i>Poa lobillardierei</i> subsp. <i>lobillardierei</i>	Common Tussack-grass	1	1
<i>Juncus praeceus</i>	Tall Rush	1	+
<i>Lachnograssia filiformis</i>	Common Blown-grass	1	+
<i>Leptinella reptans</i>	Creeping Cotula	1	+
* <i>Aster subulotus</i>	Aster-weed	1	
<i>Baumea articulata</i>	Jointed Twig-sedge		1
<i>Calystegia sepium</i> subsp. <i>roseoto</i>	Large Bindweed	1	
? <i>Nasturtium microphyllum</i>	Brown Watercress	1	
<i>Carex fascicularis</i>	Tassel Sedge		1
* <i>Cuscuta suaveolens</i>	Fringed Dodder	1	
* <i>Cynodon dactylon</i> var. <i>dactylon</i>	Cauch		1
<i>Lilaeopsis palyantha</i>	Australian Lilaeopsis	1	
* <i>Rumex conglomeratus</i>	Clustered Dock	1	
* <i>Cirsium vulgare</i>	Spear Thistle	+	+
* <i>Rumex crispus</i>	Curled Dock	+	+
<i>Triglochin procera</i>	Water Ribbons	+	+
<i>Alternanthera denticulata</i>	Lesser Joyweed		+
<i>Asperula canferto</i>	Common Waadruff	+	
<i>Carex gaudichaudiana</i>	Fen Sedge		+
<i>Dichandra repens</i>	Kidney-weed		+
<i>Lobelia pedunculata</i>	Matted Pratia		+
* <i>Solanum nigrum</i>	Black Nightshade		+
<i>Solanum</i> sp.	Kangaroo Apple		+

## Habitat and threats

The Victorian plants grow along the flats of Darlot Creek, near Tyrendarra. Interestingly, the Tyrendarra population of *Cyclosorus* occurs within a distance of ca. 11 km from the similarly rare and restricted *Pneumatopteris pennigera*. The surrounding landscape at the site consists of weathered calcareous dunes, however *Cyclosorus* grows on alluvial deposits of silt/clay. The habitat is open, with occasional patches of *Leptospermum lanigerum* (nearby but not directly associated), and on some occasions is subject to partial shallow inundation (Fig. 3). Two floristic quadrats were taken around patches of *Cyclosorus*, in order to characterise its habitat (Table 1).

*Cyclosorus* is long-rhizomatous, and it is difficult to determine the number of individual plants that make up the Victorian population without genetic analysis. We counted 42 fairly distinct clumps, some of which cover several square metres. These are distributed along ca. 400 m of creek-line.

Livestock presumably pose a long-term threat to this species. The streamside habitat is unfenced and accessible to stock (currently sheep). It appears, however, that this species has tolerated stock for many years, and is probably secure in the immediate-short term in Victoria if the current management doesn't change.

Given that the plants grow about 2 km from the coast (less than 5 m above sea level) with obviously estuarine elements nearby (e.g. *Juncus kraussii* occurs in extensive beds shortly downstream), the Victorian population of *Cyclosorus* is potentially at risk from rising sea levels which may occur as a result of climate change. We do not have direct evidence for the tolerance of *Cyclosorus* of saline conditions; however it would seem that this species is tolerant of brackish conditions. Vegetation studies from other states show that *Cyclosorus interruptus* frequently occurs in brackish-saline, estuarine or near-coastal areas, often in paperbark swamps (e.g., *Melaleuca quinquenervia*, Kingston *et al.* 2004). In New Zealand it grows near thermal springs (Bostock 1998). Unpublished data from salinity tests over several seasons show that Darlot Creek, including waters in the vicinity of the *Cyclosorus* plants, is generally slightly brackish (often EC ca 2 dS/m) and of neutral pH (in the

range 6.5–7.5) (J. Macdonald, Arthur Rylah Institute, pers. comm.). Measurements on two soil samples (ca 5–15 cm depth) and a surface water sample taken from among the *Cyclosorus* plants in May 2008 support this (pH 6.5–7.7; EC 0.6–1.2 dS/m). It remains to be seen how much salinity *Cyclosorus* can tolerate.

Weed invasion may also present a threat to *Cyclosorus*, but probably not in the immediate future. Currently, the abundance of weeds is relatively low in the area where *Cyclosorus* occurs. Furthermore, the long-lived, strongly rhizomatous habit of the plant might make established plants resilient to the effects of some competition. Weeds may, however, in future alter the site to the extent that the germination of new plants is suppressed.

It would seem that the most pressing threat to the persistence of *Cyclosorus* is its very small population size and area of occupation, making it highly vulnerable to extinction from chance events. Presumably, the small and isolated Victorian population has low genetic diversity, reducing its ability to adapt, and increasing its vulnerability to environmental change.

Assuming that the species is indigenous to Victoria (which we assume to be the case), we recommend that it be assigned a Victorian conservation status of Critically Endangered, using IUCN criteria. In the standard notation of the IUCN Red List (IUCN, 2001): CR B1ab(i,ii,iii,v)+2ab(i,ii,iii,v); C1+2a(i,ii); D. The National Herbarium of Victoria recently classified the species as 'endangered' in Victoria (Walsh & Stajsic 2007).

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