

A new species and a new combination in the shining peppermint group of *Eucalyptus* and notes on the distribution of *Eucalyptus willisii sens. strict.*

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Abstract

Populations of shining peppermints in *Eucalyptus Series Radiatae* Chippend. occurring adjacent to the Gippsland Lakes region are described as a new species, *Eucalyptus arenicola* K.Rule. As well, populations of shining peppermints referred to as *E. willisii* subsp. *falciformis* Newnham, P.Ladiges & Whiffin are elevated to the rank of species as *Eucalyptus falciformis* (Newnham, Ladiges & Whiffin) K.Rule. *Eucalyptus falciformis* includes both populations of the Grampian Ranges and those of coastal and sub-coastal areas of south-west Victoria and adjacent areas of South Australia. Also discussed are the affinities, ecologies, distributions and conservation statuses of the new species and the new combination. Further, notes clarifying the distribution of *Eucalyptus willisii* Ladiges, Humphries & Brooker are given.

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Introduction

The names 'shining peppermint' and 'shiny-leaved peppermint' have been applied to a loose grouping of south-eastern Australian and Tasmanian peppermint eucalypts with somewhat lustrous, coriaceous adult leaves and smallish, thick-walled fruits (Willis 1970; Newnham *et al.* 1986; Rule 1999). The informal name shining peppermint includes some members of *Series Radiatae* (*E. dives* Schauer, *E. molyneuxii* K.Rule and *E. willisii* K.Rule) and also *E. nitida* Hook. from the *Series Insulanae* Brooker.

Eucalyptus nitida and *E. simmondsii* Maiden were early names given to Tasmanian populations. Willis (1970) regarded them as synonymous and included all Tasmanian, as well as similar Victorian and South Australian shining peppermint populations, under *E. nitida* which predated *E. simmondsii*.

Studies by Marginson and Ladiges (1982) and Ladiges *et al.* (1983) found that mainland populations had a close affinity with *E. dives* rather than with *E. nitida*. Ladiges *et al.* (1983) erected *E. willisii* as a new taxon primarily on the basis of morphological differences in the seedling stage. Populations of Tasmanian *E. nitida* were found to possess juvenile leaves with few or no oil glands but with protruding glands on the margins, whereas the juvenile leaves of mainland populations were found to be abundantly glandular but without protruding glands on the margins.

Newnham *et al.* (1986), in a study including *E. willisii sens. lat.*, erected *E. willisii* subsp. *falciformis* to cater for populations of peppermints occurring in the Grampian Ranges of western Victoria. These populations were found to differ from more typical populations by their reduced amounts of peppermint bark on the trunk, their earlier development of narrow, falcate, vertically-oriented, petiolate juvenile

leaves and their distinctive pattern of volatile oils (higher levels of cineole 1,8 than other populations). The authors regarded all other western populations of Victorian and South Australian shining peppermints as being more closely related to *E. willisii* subsp. *willisii* and retained them within that subspecies. However, Brooker and Slee (1996a), in their treatment of Victorian shining peppermints, apparently regarded these other western populations as differing only slightly from the Grampians' populations and placed them under *E. willisii* subsp. *falciformis*.

Rule (1999) erected *E. molyneuxii* as a new species for the restricted Little Desert populations, whose features included a depauperate habit and appreciably small leaves, buds and fruits, but recognised it as being closely related to *E. willisii* subsp. *falciformis* on the basis of some shared seedling features. Centre for Plant Biodiversity Research (2006) places *E. molyneuxii* under *E. willisii* subsp. *falciformis*, but Nicolle (2006) accepts it at species rank.

In a comprehensive study of the peppermints, including all the shining peppermints, Rankin (1998) analysed adult and juvenile leaf characters as well as chemical character such as flavonoids. On the basis of multivariate analysis of juvenile leaf characters, Rankin (1998) found that a number of *E. willisii* subsp. *falciformis* populations (from Western Victoria) were well separated from *E. willisii sens. strict.* (from Wilsons Promontory) and from a population from the Gippsland Lakes. The differences between these three entities were of the same order (or greater) as differences between established species of peppermints such as *E. pulchella* Desf., *E. amygdalina* Labill. and *E. radiata* Sieber ex DC. However, the population of *E. willisii* from Wilsons Promontory had very similar juvenile leaves to *E. dives*, while *E. willisii* subsp. *falciformis* populations had juvenile leaves that were close to those of *E. nitida*. For adult leaves, the population from Gippsland Lakes differed significantly from *E. willisii sens. strict.* and *E. willisii* subsp. *falciformis*, which both had similar morphology.

On the basis of flavonoid composition, in contrast to juvenile morphology, Rankin (1998) found that *E. willisii sens. strict.* was chemically linked to *E. nitida* (which had a large number of flavonoid compounds), particularly those populations occurring on the Bass Strait Islands, and that two other mainland shining peppermints, namely the populations occurring in the

Gippsland Lakes region and *E. willisii* subsp. *falciformis* were more closely related to *E. dives* (which produces relatively few flavonoids, particularly rutin). In fact, Rankin even suggested there is a case for submerging *E. willisii sens. strict.* within *E. nitida* on the basis that it is the end point of a gradation of chemical forms from western Tasmania where typical *E. nitida* occurs, through the Bass Strait Islands, to Wilsons Promontory.

Rankin (1998) synthesises his analyses of morphological and chemical data into a proposed phylogeny in which *E. willisii sens. strict.* was sunk within *E. nitida*, and *E. willisii* subsp. *falciformis* was placed near *E. dives*, and referred to as '*E. sp. aff. dives* (Western Victoria)'. The Gippsland Lakes population was also placed near to *E. dives*, as '*E. sp. aff. dives* (Eastern Victoria)'.

In regard to *E. willisii*, there are sufficient morphological grounds, particularly those identified by Marginson *et al.* (1982), Ladiges *et al.* (1983) and Rankin (1998), for its retention as a separate species, despite the similarity to *E. nitida* on chemical characters. This position has been further reinforced by Brooker (2000) who placed *E. nitida* with other Tasmanian peppermints in his newly erected Series *Insulanae*, but retained *E. willisii sens. lat.* in the Series *Radiatae*. In segregating the Tasmanian peppermints into a separate series Brooker saw as fundamentally important the differences in juvenile leaf gland patterns identified by Marginson *et al.* (1982) and Ladiges *et al.* (1983).

An examination of herbarium specimens, field studies of a large number of populations and seedling trials, representing all mainland and Tasmanian shining peppermints, has supported Rankin's findings that both the Gippsland Lakes populations and the western mainland populations (*E. willisii* subsp. *falciformis*) are morphologically distinctive from *E. willisii sens. strict.* to the extent that they warrant recognition as separate species.

Material and methods

Seedlings were raised in Debco native plant potting mix. Seedlots were collected from 20 populations, six from the Gippsland Lakes region and 14 from western Victoria and lower south-east South Australia. For each population a minimum of ten seedlings were examined. Leaf thickness was measured with a dial calliper on fresh adult leaves (Table 1).

Table 1: Morphological characters of shining peppermints

Character	<i>E. nitida</i>	<i>E. dives</i>	<i>E. willisii</i>	<i>E. molyneuxii</i>	<i>E. falciiformis</i>	<i>E. arenicola</i>
Habit	mallee or tree 5–40 m tall	tree 4–25 m tall	mallee or small tree to 15 m tall	mallee or small tree to 5 m tall	mallee or tree to 15 m tall	mallee or tree 4–12 m tall
Bark	fibrous to various heights on trunk	fibrous to secondary branches	fibrous to secondary branches	loose, sub-fibrous on trunk	smooth or fibrous on trunks to various heights	fibrous to the secondary branches
Juvenile Leaves						
Size	to 6 cm long, 4 cm wide	to 12 cm long, 7 cm wide	to 8 cm long, 3 cm wide	to 13 cm long, 1.5 cm wide	to 17 cm long, 7 cm wide	to 11 cm long, 1.6 cm wide
Shape	elliptical to ovate	cordate to broadly ovate	broadly lanceolate	narrowly lanceolate, falcate	narrowly lanceolate to ovate	narrowly lanceolate
Base	petiolate and discrete (amplexicaul on Bass Strait Islands)	amplexicaul for numerous pairs	amplexicaul for numerous pairs	discrete and petiolate	discrete and petiolate	amplexicaul for at least 10 pairs, sessile for numerous pairs
Orientation	vertical in early seedling development (horizontal for numerous pairs on Bass Strait Islands)	horizontal for numerous pairs	horizontal for numerous pairs	vertical in early seedling development	vertical in early seedling development	horizontal for numerous pairs
Colour/lustre	blue-green, dull	blue-grey to glaucous, dull	blue-grey, dull	sub-lustrous, green	blue-green, dull	blue-grey, dull
Protruding Marginal Glands	present	absent	absent	absent	absent	absent
Oil Gland Density	glands few or absent (high on Bass Strait Islands)	high	high	high	high	high
Adult Leaves						
Size	to 15 cm long, 2.0 cm wide	to 15 cm long, 4.0 cm wide	to 14 cm long, 2.0 cm wide	to 11 cm long, 1.6 cm wide	to 22 cm long, 3.5 cm wide	to 14 cm long, 1.7 cm wide
Thickness	not available	0.30–0.44 mm	0.20–0.30 mm	0.38–0.52 mm	0.30–0.42 mm	0.30–0.40 mm
Shape	lanceolate	broadly lanceolate or ovate-lanceolate	lanceolate	narrowly lanceolate, slightly falcate	lanceolate, falcate	narrowly lanceolate
Colour/lustre	green, lustrous	blue-green or green, dull or sub-lustrous	blue-green, dull or sub-lustrous	green, lustrous	blue-green, sub-lustrous	green, lustrous
Buds per inflorescence	11–21	11–21	15–21	11–15	11–17	11–17
Bud Size	4–5 mm long, 2–3 mm diam.	6–8 mm long, 3–4 mm diam.	5–7 mm long, 2–3 diam.	5–7 mm long, 3–4 mm diam.	6–9 mm long, 3–5 mm diam.	5–6 mm long, 3–4 mm diam.
Fruits						
Size	5–8 mm long, 5–9 mm diam.	5–7 mm long, 4–7 mm diam.	4–5 mm long, 4–6 mm diam.	4–5 mm long, 5–6 mm diam.	6–8 mm long, 6–8 mm diam.	5–7 mm long, 7–9 mm diam.
Shape	hemispherical to obconical	hemispherical, obconical or cupular	hemispherical to obconical	cupular or slightly obconical	obconical, cupular or sub-cylindrical	hemispherical to slightly cupular
Pedicle Length	1–3 mm	1–3 mm	1–3 mm	0–2 mm	3–6 mm	3–5 mm

Key to shining peppermints

1	Protruding glands present along the margins of juvenile leaves; juvenile leaves with few or no oil glands	<i>E. nitida</i>
1:	Protruding glands absent from margins of juvenile leaves; juvenile leaves with numerous oil glands	2
2	Juvenile leaves amplexicaul and horizontally-oriented for numerous pairs	3
2:	Juvenile leaves becoming basally discrete, petiolate and vertically-oriented in early seedling development	5
3	Juvenile leaves cordate to broadly ovate, 4-7 cm wide; adult leaves broadly lanceolate to ovate, 2-4 cm wide	<i>E. dives</i>
3:	Juvenile leaves lanceolate (narrow to broad), 0.8-3 cm wide; adult leaves narrowly lanceolate to lanceolate, < 2 cm wide	4
4	Adult leaves dull or slightly lustrous, blue-green; fruits 4-6 mm diam.....	<i>E. willisii</i>
4:	Adult leaves lustrous, green; fruits 7-9 mm diam.....	<i>E. arenicola</i>
5	Adult leaves green, to 1.6 cm wide; fruits 5-6 mm diam.....	<i>E. molyneuxii</i>
5:	Adult leaves blue-green, to 3.5 cm wide; fruits 6-8 mm diam.....	<i>E. falciformis</i>

Taxonomy

1. *Eucalyptus arenicola* K.Rule sp. nov.

E. willisii affinis *foliis juvenilibus angustioribus, foliis adultis nitentioribus viridioribus, fructibus majoribus differt, et affinis E. diviti sed foliis juvenilibus angustioribus, foliis adultis angustioribus nitentioribus viridioribus, fructibus majoribus differt.*

Type: VICTORIA. 5.1 km WSW of Loch Sport, 38°04'S 147°33'E, K. Rule 0421, 6.ii.2004 (holotype: MEL; isotype: AD, CANB, HO, NSW).

Small *mallee* or *trees*, 4–12 m tall. *Branchlets* pendulous. *Bark* greyish, finely fibrous, thick, longitudinally fissured, peppermint-type, extending to the secondary branches. *Seedling leaves* narrowly ovate or ovate-lanceolate, sessile, basally rounded, decussate, discolorous; upper surface, dull, blue-green; lower surface whitish; raised glands present on seedling stems only in early development. *Juvenile leaves* sub-linear to narrowly lanceolate and amplexicaul for at least 10 pairs, remaining horizontally-oriented, sessile and opposite for 15–20 pairs, acuminate or apiculate, discolorous, dull, blue-grey, non-pruinose, 5–11 cm long, 0.8–1.6 cm wide. *Intermediate leaves* lanceolate or broadly lanceolate, sometimes slightly falcate, petiolate, opposite, sub-opposite and alternate, sub-lustrous, blue-green or green. *Adult leaves* narrowly lanceolate or lanceolate, often slightly falcate, acuminate, uncinata, moderately reticulate, glandular, concolorous, lustrous, green, moderately coriaceous (0.3–0.4 mm

thick), 7–14 cm long, 0.9–1.7 cm wide; petioles to 1.6 cm long; lateral veins acute, diverging at < 25° from the mid-vein; intramarginal vein 1–2 mm from the margin; oil glands regular, relatively large, relatively dense, island. *Inflorescences* simple, axillary, 11–17-flowered; peduncles angled, 7–12 mm long. *Floral buds* clavate, shortly pedicellate, unscarred (outer operculum only), 5–6 mm long, 3–4 mm wide at anthesis; pedicels 4–6 mm long; operculum obtuse-conical, becoming hemispherical at anthesis; locules 3 or 4; ovules in 2 vertical rows; filaments white; stamens inflexed, all fertile; anthers versatile, sub-basifixed, reniform, dehiscent through oblique, confluent slits; flowering period winter. *Fruits* sub-sessile to pedicellate, hemispherical or slightly cup-shaped, 5–7 mm long, 7–9 mm wide; pedicels 3–5 mm long; disc at rim level, c. 2 mm wide; orifice small, 3–4 mm wide; valves 3 or 4. *Fertile seeds* black-brown, irregularly pyramidal; dorsal surface rounded; hilum ventral. (Fig. 1.)

Additional specimens examined: VICTORIA. GIPPSLAND LAKES REGION. Holey Plains S.P., c. 0.7 km along Wildflower Road from the intersection with the main NW-SE running track, 38°13'S 146°52'E, D.E. Albrecht 5023, 20.x.1992 (MEL 2133886); Gippsland Lakes Coastal Park, A.C. Beaglehole ACB74850 and W.R. Beaglehole, 27.x.1983 (MEL 1613401); 3.6 km along Redcourt Lane S from the Princes Hwy., 8 km W of Bairnsdale, 37°54'S 147°29'E, D.E. Albrecht 2446, 18.ii.1986 (MEL 112667); c. 1 km E of Loch Sport turnoff on the Longford-Paradise Beach Road, 38°11'05"S 147°21'09"E, M.I.H. Brooker 12209 and A.V. Slee, 23.iv.1995 (MEL 270931); Sperm Whale

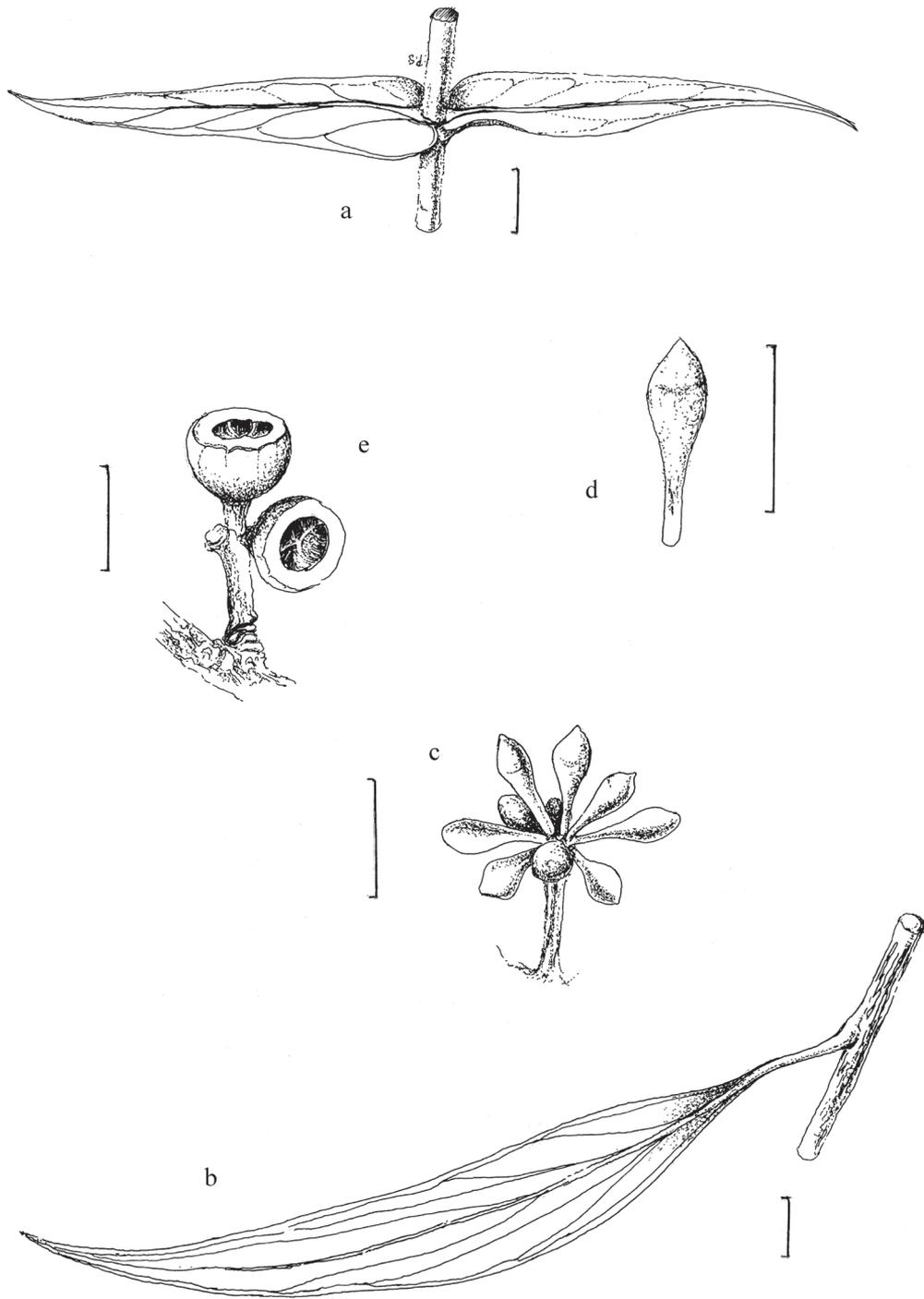


Figure 1. *Eucalyptus arenicola* (all from K. Rule 0421): **a.** juvenile leaves at 8th pair; **b.** adult leaf; **c.** inflorescence; **d.** bud; **e.** fruits. Scale bars = 1 cm.

Head Pen., Gippsland Lakes N.P. 37°58'S 146°51'E, *J.H. Willis*, 28.iv.1985 (MEL 686123); Providence Ponds, 37°55'S 147°17'E, *A.C. Beauglehole* and *K. Rogers*, 15.xi.1971 (MEL 519779); Holey Plains S. P., Chessum Road, 1.2 km NE of boundary within pine plantation near Willung, 38°14'02"S 146°50'07"E, *A.V. Slee* and *P. Downey* 4016, 11.xii.1996 (MEL 258587); Dutson to Loch Sport Road, 38°11'S 147°13'E, *B. Nicholson*, 28.v.1968 (MEL 27273); Lime Quarry Road, c. 5 km SSE of Rosedale, 38°12'30"S 146°51'00"E, *J.H. Willis*, 2.ii.1972 (MEL 502306); Longford Road, 3 mls. N of Gifford, 38°22'S 147°07'E, *J.H. Willis*, 24.i.1980 (MEL 574960); 3 mls. W of Loch Sport, 38°06'S 147°30'E, *A.C. Robinson*, 24.ii.1975 (MEL 161356).

Distribution and habitat: *E. arenicola* grows in sandy soils close to the Gippsland Lakes in both coastal and sub-coastal districts, from near Bairnsdale in the east to Holey Plains in the west (Fig. 2). The annual rainfall of Sale, which is within the distribution of the species, is slightly more than 600 mm and has a slight spring maximum.

Associated species: *E. arenicola* mostly grows in pure stands but occurs with or close to *E. pryoriana* L.A.S.Johnson, *E. croajingolensis* L.A.S.Johnson & K.D.Hill, *E. angophoroides* R.T.Baker, *E. cephalocarpa* Blakely or *E. polyanthemos* subsp. *vestita* L.A.S.Johnson & K.D.Hill. It also is associated with a form of *E. consideniana* Maiden which mimics its morphology.

Etymology: The epithet is derived from the Latin *arena* 'sandy' and *cola* 'dweller' in reference to the habitat of the species.

Conservation status: Where it occurs, *E. arenicola* is a dominant species. It is particularly abundant in the Gippsland Lakes Coastal Park in the vicinity of Loch Sport from where the type specimen has been collected. It is not considered at risk.

Discussion: *E. arenicola* is a shining peppermint distinguished within the Series *Radiatae* by the following combination of features; small habit; fibrous peppermint bark which extends to the secondary branches; numerous pairs of sub-linear to narrowly lanceolate, opposite, amplexicaul, horizontally-oriented juvenile leaves; lustrous and green, coriaceous adult leaves; 11–17-flowered inflorescences; and relatively large, thick-walled, hemispherical to slightly cupular fruits.

Eucalyptus arenicola shares features with *E. willisii* (which appears to be confined to Wilsons Promontory). Both species have a full peppermint bark, the same seedling ontogeny and fruits with a broad, flattened disc. However, *E. willisii* is distinguished by its broadly lanceolate juvenile leaves, thinner, duller adult leaves, usually more numerous buds per inflorescence and smaller buds and fruits. Further, *E. willisii* differs chemically from *E. arenicola* by its more complex pattern of flavonoid compounds (Rankin 1998).

Eucalyptus arenicola has an affinity with *E. dives*, which differs in its broader juvenile leaves, broader, often duller and bluish adult leaves and generally smaller fruits.

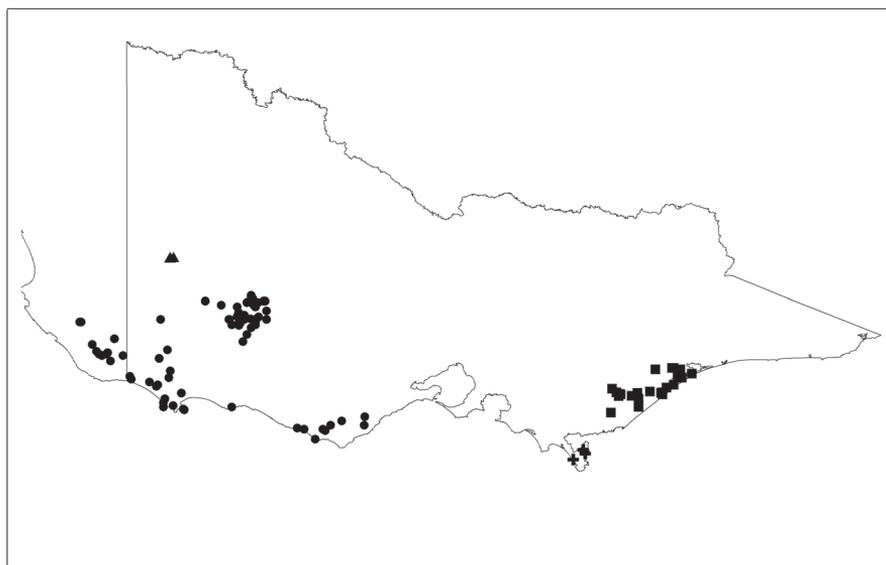


Figure 2. Distributions of *E. willisii* (cross), *E. arenicola* (square), *E. falciformis* (circle) and *E. molyneuxii* (triangle).

Eucalyptus falciformis (treated below) is another relative of *E. arenicola* but differs by its generally taller habit; variable peppermint bark, which is confined to the base of the trunk or extends to the upper trunk; broader, non-amplexicaul, vertically-oriented, petiolate, often disjunct juvenile leaves; larger, bluish adult leaves and slightly more elongated fruits.

Eucalyptus arenicola can grow with *E. consideniensis*, which may appear superficially similar at the adult stage, but differs in the petiolate, disjunct juvenile leaves and the yellow under bark.

2. *Eucalyptus falciformis* (Newnham, Ladiges & Whiffin) K. Rule *stat. nov.*

Eucalyptus willisii subsp. *falciformis* Newnham, Ladiges & Whiffin, *Australian Journal of Botany* **34**, 348 (1986)

Type: VICTORIA. Intersection of Taylor Rd. and Burrong Shortcut, W of Mt. Victory, Grampian Ranges, 37°10'40"S 142°14'40"E, 12.vi.1985, *M. Newnham* 64 (holotype: MEL 673439; isotype: FRI, NSW).

Slender *trees* or less often robust, spreading mallees, 5–15 m tall. *Branches* usually pendulous. *Bark* grey-brown, peppermint type, variable in height, as a short, basal stocking or extending to the upper trunk; basal bark often thick, crusty and deeply fractured; upper bark smooth, off-white or pale brown, decorticating in broad sheets and ribbons. *Seedling leaves* decussate, ovate or ovate-lanceolate, basally rounded, sessile, discolorous; upper surface green; lower surface whitish; raised glands present on seedling stems in early seedling development but later becoming inconspicuous. *Juvenile leaves* narrowly lanceolate, lanceolate, ovate-lanceolate or ovate, falcate, amplexicaul only for a few pairs but becoming basally discrete by the 6th node, twisting and becoming vertically-oriented and shortly petiolate usually by the 10th node, often becoming disjunct by the 13th node, slightly discolorous, dull, blue-grey, 8–17 cm long, 1.5–7 cm wide. *Intermediate leaves* broadly ovate to broadly lanceolate, usually falcate, disjunct, petiolate, becoming concolorous, dull, blue-green, larger than the juvenile and adult leaves. *Adult leaves* lanceolate, falcate, acuminate, uncinata, moderately reticulate, glandular, dull or sub-lustrous, blue-green, moderately coriaceous (0.30–0.42 mm thick), 10–22 cm long, 1.7–3.5 cm wide; petioles to 2.2 cm long;

lateral veins, markedly acute, diverging at < 20° from the mid-vein; intramarginal vein 2–3 mm from margin; oil glands regular, smallish, moderately dense, mostly island. *Inflorescences* simple, axillary, occasionally paired, 11–17-flowered; peduncles 8–12 mm long. *Floral buds* clavate, pedicellate, 6–9 mm long, 3–5 mm wide, unscarred conical or obtuse-conical, as wide as hypanthium; locules 3 or 4; ovules in 2 vertical rows; filaments white; stamens inflexed, all fertile; anthers dorsifixed, versatile, reniform, dehiscent through oblique, confluent slits; flowering period spring. *Fruits* pedicellate, slightly obconical, cup-shaped, or sub-cylindrical, 6–8 mm long, 6–8 mm diam.; pedicels 3–6 mm long; disc broad, c. 2 mm wide, slightly rolled, level with rim or slightly descending; valves 3 or 4 enclosed or flat. *Fertile seeds* black-brown, irregularly pyramidal; dorsal surface rounded; hilum ventral.

Additional specimens examined: VICTORIA: Moomowong Road, 2 km S of Carlisle River, 2.5 km from junction with Gellibrand River Road, 38°35'S 143°24'E, *K. Godfrey* 19, 21.v.2001 (MEL 2117489); near Wartook Res., Grampians, 37°04'S 142°28'E, *L.A.S. Johnson*, 28.i.1965 (MEL711215); Victoria Range, Grampians, east side of Victoria Valley Road, NE of Strachans, 37°22'S 142°18'E, *A.C. Beauglehole ACB1352*, 16.xi.1966 (MEL 531795); Victoria Gap, N of Gap Track, 37°10'S 142°17'E, *A.C. Beauglehole ACB17343* and *M. Corrick*, 1.x.1967 (MEL 531794); corner of Serra and Syphon tracks, 37°16'S 142°22'E, *P. Matthews*, 22.x.1976 (MEL 524561); Grampians N. P., Serra Range, 0.5 km W of top of Mirranatwa Gap, 37°25'S 142°27'E, *A.V. Slee* 3107, 29.viii.1990 (MEL 1588506); Goat Track, at the intersection with Victoria Range Road, 37°14'15"S 142°18'00"E, *D.E. Albrecht* 2534, 7.iii.1986 (MEL 112715); 6 km N from Wartook Road along Mt. Difficult Road, Mt. Difficult Range, 37°03'S 147°27'E, *V. Stajsic* 227, 2.iii.1991 (MEL 1597566); Parish of Carracut near Digby, 37°48'S 141°32'E, *R. Riley*, 8.ix.1947 (MEL 703723); Lower Glenelg River, 38°04'S 141°14'E, *J.H. Willis*, 29.x.1948 (MEL 703722); Little Moleside Creek, Lower Glenelg River, 38°07'S 141°19'E, *J.H. Willis*, 14.vi.1964 (MEL 703682); Portland Dist., SW Victoria, northern road into Bridgewater Lakes, 38°19'S 141°24'E, *F. Swindley* 1621, 4.iv.1963 (MEL 1254); Henty Hwy. C 100 m N of bridge over Surry R., 38°12'S 141°37'E, *N.G. Walsh* 5224, 23.viii.2000 (MEL 2089840); 1 km W of Chapple Vale on Lavers Hill Road E of Gellibrand River Road, 15 km W of Lavers Hill, 38°38'00"S 143°18'25"E, *B.J. Conn* 2941 and *J.A. Scott*, 22.v.1988 (MEL 1589119); Port Campbell N. P., 300 m above Ocean Road – London Bridge Road Junction, 38°37'S 143°00'E, *N.G. Walsh* 1249, 29.v.1984 (MEL 662257). SOUTH AUSTRALIA: Honan's Scrub, 37°37'S 140°33'E, *R.J. Bates* 32248,

17.iv.1993 (MEL 2055835); c 1.5 km NE of Nangwarry township, 37°33'S 140°49'E, *I.B. Wilson* 988, 2.iii.1969 (MEL 1614438); 3 km SSE of Glencoe in Honan's Scrub, 37°43'54"S 140°38'00"E, *P.J. Lang* 2464, 21.xi.1994 (MEL 249732); triangle W of Wandillo, 37°44'S 140°43'E, *M.I.H. Brooker* 3815, 29.xii.1972 (MEL 649519); 22.3 km E of Princes Hwy., between Robe and Penola, 37°21'S 140°24'E, *M.I.H. Brooker* 11549, 7.viii.1993 (MEL 722635); 3.8 km NE of Wandillo railway siding, *I.B. Wilson* 989, 17.iii.1969 (MEL 703689).

Distribution and habitat: *E. falciformis* usually occurs on impoverished, well-drained sandy soils in a variety of habitats across the moist, temperate regions of south-west Victoria, as well as the Grampian Ranges, and adjacent areas of South Australia, from the Otway Ranges in the east to Millicent in the west. Whilst populations in the Grampians occur as high as 1000 m altitude, others occur in undulating terrain or on cliff tops close to the ocean (Fig. 2).

Associated species: In the Grampians a common associate of the new species is *E. baxteri* (Benth.) Maiden & Blakely. Other associates include *E. alaticaulis* R.J.Watson, Ladiges & A.R.Griffin, *E. melliodora* A.Cunn. ex Schauer, *E. obliqua* L'Her., *E. aromaphloia* Pryor & J.H.Willis and *E. sabulosa* K.Rule. In coastal and sub-coastal regions *E. ovata* Labill. var. *ovata* and var. *grandiflora* Maiden, *E. baxteri*, *E. pauciflora* Sieb. ex Spreng. subsp. *pauciflora*, *E. viminalis* Labill. subsp. *viminalis* and subsp. *cygnetensis* Boomsma and *E. splendens* subsp. K.Rule *splendens* may occur in association with *E. falciformis*.

Conservation status: *E. falciformis* is abundantly present throughout its range and is not considered at risk.

Discussion

Eucalyptus falciformis is distinguished within the Series *Radiatae* by its smallish, usually tree-like habit; variable bark which does not extend to the major branches; falcate, basally discrete, petiolate, vertically-oriented, disjunct juvenile leaves; relatively large, coriaceous dull to sub-lustrous, bluish adult leaves; 11–17-flowered inflorescences; relatively long buds and relatively large, slightly elongated, thick-walled fruits.

Eucalyptus molyneuxii is considered to be the nearest relative of *E. falciformis* as both exhibit the early development of vertically-oriented, petiolate, basally-tapered, eventually falcate juvenile leaves. *Eucalyptus*

molyneuxii, however, differs by its smaller habit; greener, narrower juvenile leaves; smaller, thicker, more lustrous, greener adult leaves; smaller buds and smaller fruits which are borne on shorter pedicels.

Eucalyptus dives is also considered to be related to *E. falciformis* as the two are markedly similar in most adult features, particularly in their buds and fruits. However, *E. dives* is different primarily by its more persistent peppermint-type bark, which covers the major branches; cordate to broadly ovate, amplexicaul, horizontally-oriented, opposite, sessile, usually glaucous juvenile leaves and generally smaller fruits.

Eucalyptus willisii is distinguished from *E. falciformis* by its persistent pairs of opposite, sessile, horizontally-oriented juvenile, and by its thinner, more glandular adult leaves and smaller buds and fruits. With regard to oil gland density in adult leaves, Newnham *et al.* (1986) found that populations of western peppermints, including those of the Grampians (*E. falciformis*), contained approximately half the number oil glands than those found in *E. willisii sens. strict.* Further, as discussed above, *E. willisii* differs chemically from *E. falciformis* by its more complex pattern of flavonoid compounds.

Eucalyptus falciformis is a taxon which exhibits regional variation, not only in the amount of peppermint bark held on the trunk, in juvenile leaf shape and size and in patterns of volatile oils, but also in leaf lustre, fruit size and shape, and which may require further research with a view to describing new infraspecific taxa. Populations in the foothills to the north, north-west and west of the Otway Ranges are substantially rough-barked with relatively small fruits (c. 6 mm long, 6 mm diam.). Brooker and Slee (1996b) made reference to an intermediate form between *E. willisii* subsp. *falciformis* and *E. radiata* occurring in the northern Otway Ranges, but whether they were referring to this form is unclear. Depauperate trees occurring in the vicinity of Moonlight Head have duller adult leaves than typical. Populations occurring in the far south-west of Victoria and adjacent areas of South Australia are substantially rough-barked and have larger, less-elongated fruits than the typical form of the Grampians (fruits 7–8 mm long, 7–8 mm diam.). A small population occurring in Victoria near Curdie Vale to the west of Timboon has fruits of a similar size to more westerly populations.

Notes on the distribution of *Eucalyptus willisii*:

There are a number of collections housed in MEL of peppermints occurring in the regions of Central Victoria and south-west Gippsland which have been determined as *E. willisii* subsp. *willisii*, and the south-west Gippsland collections have been mapped as such by Brooker & Slee (1996b) and Nicolle (2006). After the careful examination of these specimens (Appendix 1, Part A), as well as visiting as many collection sites as possible and conducting seedling trials where necessary, most specimens should be determined as *E. radiata* subsp. *radiata* and none are *E. willisii*. In a few cases, where inadequate site information has been provided, searches of the general localities were conducted, and only *E. radiata* subsp. *radiata* was located.

There are also some collections in MEL which have been determined as intergrades between *E. willisii* subsp. *willisii* and *E. radiata* subsp. *radiata*. These are all regarded here as aberrant forms of the second taxon (Appendix 1, Part B).

Brooker and Slee (1996b) reported an occurrence of a pruinose form of *E. willisii* subsp. *willisii* to the south of Sale in the Longford area (M.I.H. Brooker 11126, 6.vi.1992, MEL 1616799). Field observations and seedling trials show that these plants are hybrids between *E. croajingolensis* and *E. arenicola*, both of which occur in the area.

Further, *E. willisii* has been reported anecdotally as occurring in south-west Gippsland in localities including Healesville, Bunyip State Park, Flinders, Walkerville, Liptrap, Yanakie, Leongatha, Grantville and Hedley. I have conducted searches of each of these localities and found only *E. radiata* subsp. *radiata*.

The best diagnostic features of *E. radiata* subsp. *radiata* include lanceolate, dull to slightly lustrous, light green juvenile leaves, relatively thin, usually dull, blue-green adult leaves and smallish, hemispherical to sub-globular, relatively thin-walled fruits. However, the taxon also exhibits a high degree of variability in leaf colour, lustre and width and in fruit size and disc orientation. In many cases it is reasonable to speculate that misidentifications have occurred where individuals or even small populations of *E. radiata* subsp. *radiata* have superficially resembled *E. willisii* by exhibiting lustrous and green adult leaves during the growing season or fruits with level and slightly broader discs

than typical. In a few cases, such as near Hedley and in the Liptrap area, the trees alleged to be *E. willisii* are *E. radiata* subsp. *radiata* in most respects but exhibit slightly different foliage to more typical forms of *E. radiata* subsp. *radiata* occurring in the region.

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Appendix 1

Some aberrant and otherwise previously mis-identified collections of *Eucalyptus radiata* subsp. *radiata*

PART A: collections previously determined as *E. willisii* subsp. *willisii*.

Mornington Peninsula, Dromana, along Boundary Road, between Shergolds Lane and Eatons Cutting Road, 38°22'S 144°58'E, *K. J. Marks* 3, 19.vii.1987 (MEL 1557728); 600 m W of Gumbya Park, 38°08'S 145°38'E, *M.I.H. Brooker 10941*, 7.ii.1992 (MEL 1616823); 4.4 km E of Foster centre on Welshpool Road, 38°39'S 145°15'E, *M.I.H. Brooker 1178*, 9.iii.1994 (MEL 1619208); c. 10 km along South Gippsland Hwy. (from the junction with the Bass Hwy.) towards Korumburra, 38°20'S 145°37'E, *M.I.H. Brooker 7789* (MEL 628653); Red Shirt Gully Road, St. Andrews, 37°36'S 145°16'E, *R.A. Kilgour* 286, 14.x.1982 (MEL 629395); Warrandyte State Park, Jumping Creek Road, 37°44'S 145°15'E, *D.J. Van Boekel*, 1990 (MEL 226956); near 90 km post on South Gippsland Hwy., behind Lang Lang Golf Club, 38°18'S 145°33'E, *D. McMahon* (MEL 226988); Dandenong, 37°59'S 145°13'E, (Collector unknown), 1861 (MEL 1607234); south of Gisborne at blue metal pile, 37°31'S 144°37'E, *M.I.H. Brooker 11980*, 30.viii.1994 (MEL 257822); heathland, Walkerville, Waratah Bay, 38°52'S 145°59'E, *C. Carbury*,

PART B: collections previously determined as *E. willisii* subsp. *willisii*-*E. radiata* subsp. *radiata* intergrades.

Gisborne-Bacchus Marsh Road, opposite Sunbury Water Filtration entrance, 3.2 km E of Waterloo Flat Road Turnoff, 37°29'S 144°34'E, *M.I.H. Brooker 11961*, 17.vii.1994 (MEL 2036918); 2.3 km S of Woodend towards Gisborne on Calder Hwy., 37°23'S 144°32'E, *G. Chippendale* and *M.J. Brennan*, 15.vii.1975 (MEL 706173); Wallan, 30 mls. N of Melbourne, c. 0.5 mls. N of Wallan Railway Station, 37°25'S 145°00'E, *H.L. Gray*, 11.i.1971 (MEL 1010207); Cranbourne Annex of the Melb. Bot. Gardens, 38°08'S 145°16'E, *K. Hill 1592*, *L.A.S. Johnson* and *K. Wilson*, 4.iii.1986 (MEL 698598); Eltham, 37°43'S 145°09'E, (collector unknown), viii.1910 (MEL 577553).