New subspecies in *Eucalyptus caesia* and in *E. crucis* (Myrtaceae) of Western Australia

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Abstract

Brooker, M. I. H. and Hopper, S. D. New subspecies in Eucalyptus caesia and in *E. crucis* (Myrtaceae) of Western Australia. Nuytsia 4(1): 113-128 (1982). *Eucalyptus caesia* Benth. subsp. *magna* subsp. nov. and *E. crucis* Maiden subsp. *lanceolata* subsp. nov. of the informal subseries Orbifolinae are described and illustrated. Both taxa occur on granitic tors and ridges in an area north and east of Merredin in Western Australia. *E. caesia* subsp. *magna* has larger flowers, fruits and leaves than *E. caesia* subsp. *caesia*, and is widely known in the horticultural industry as the cultivar 'Silver Princess'. *E. crucis* subsp. *lanceolata* differs from the typical subspecies in having lanceolate or narrow-lanceolate adult leaves with distinct petioles 5-15 mm long, and in having erect stems up to 15 m tall. Each of the species in the subseries Orbifolinae has diagnostic seedling characters, and these are incorporated in a key to the four species and six subspecies of the Orbifolinae now recognised.

Introduction

Pryor and Johnson (1971) erected the informal subseries Orbifolinae which included four mallee eucalypts with the easily recognised red-brown over green bark, which partly decorticates longitudinally (or less often horizontally) remaining incompletely detached with the free margins becoming curled (Figure 1). This bark form does not occur elsewhere in the genus. It superficially resembles the rich red-brown crisped bark of some species of *Acacia*, for which the term 'Minni Ritchi' bark is now widely used. Because of this resemblance, we propose that the bark form characteristic of the subseries Orbifolinae in *Eucalyptus* should also be referred to as Minni Ritchi bark.

The Orbifolinae, with the subseries Leptopodinae and Macrocarpinae, compose the series Macrocarpae which consists of about 20 species and is based on the association of several characters, viz. 2 opercula, bisected cotyledons, and thick-walled, very woody fruit with a prominent, emergent, convex disc (apart from *E. caesia* Benth. in which the disc is descending).

For many years *E. caesia* has been known to exist in two fairly discrete variants (Gardner, 1954; Chippendale, 1973)—a typical form from, for example, Mount Caroline and Boyagin Rock, and a larger, coarser form from localities further to the north-east (Figure 2). This latter form has hitherto received no formal taxonomic status but it is a notable ornamental tree or mallee and has been known to horticulturalists as 'Silver Princess' (Molyneaux, 1978). Both forms as far as is known are restricted to certain granite rock sites.

Another species of the Orbifolinae also restricted to granite rocks is *E. crucis* Maiden. Maiden (1924) stated in the protologue for this species 'mature leaves rather thick, very shortly petiolate, from lanceolate to nearly ovoid and ovoid-lanceolate . . .'. The type specimen which was illustrated (Plate 242, no. 7) had shortly petiolate, ovate leaves (Figure 6) but specimens from some populations examined by us have been predominantly in the juvenile stage, i.e. the leaves of the mature plant were sessile, opposite, orbicular and strongly glaucous (Figure 5).

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Figure 1. Trunks of mallees of *E. caesia* subsp. *caesia* (upper left) and *E. orbifolia* (upper right, lower left) showing the variants of the 'Minni Ritchi' bark form characteristic of the species of subseries Orbifolinae.

Recent surveys in areas north and west of the known occurrences of *E. crucis* (e.g. at Chiddarcooping Hill) have resulted in the discovery or rediscovery of populations obviously related to, yet clearly distinct from typical *E. crucis* (Figures 5, 7). They are large erect-stemmed mallees (to 15 m tall as compared with 6 m for the more effuse *E. crucis)* and the canopy consists only of true lanceolate adult leaves that are distinctly petiolate.

We therefore consider that Maiden's circumscription in the protologue of *E. crucis* covers two forms recognizable by the nature of the leaves in the mature canopy, viz. the typical form (Figures 5, 6) which has ovate, juvenile and intermediate leaves, and a second form which bears lanceolate to narrow-lanceolate adult leaves. Both forms have associated habit features.

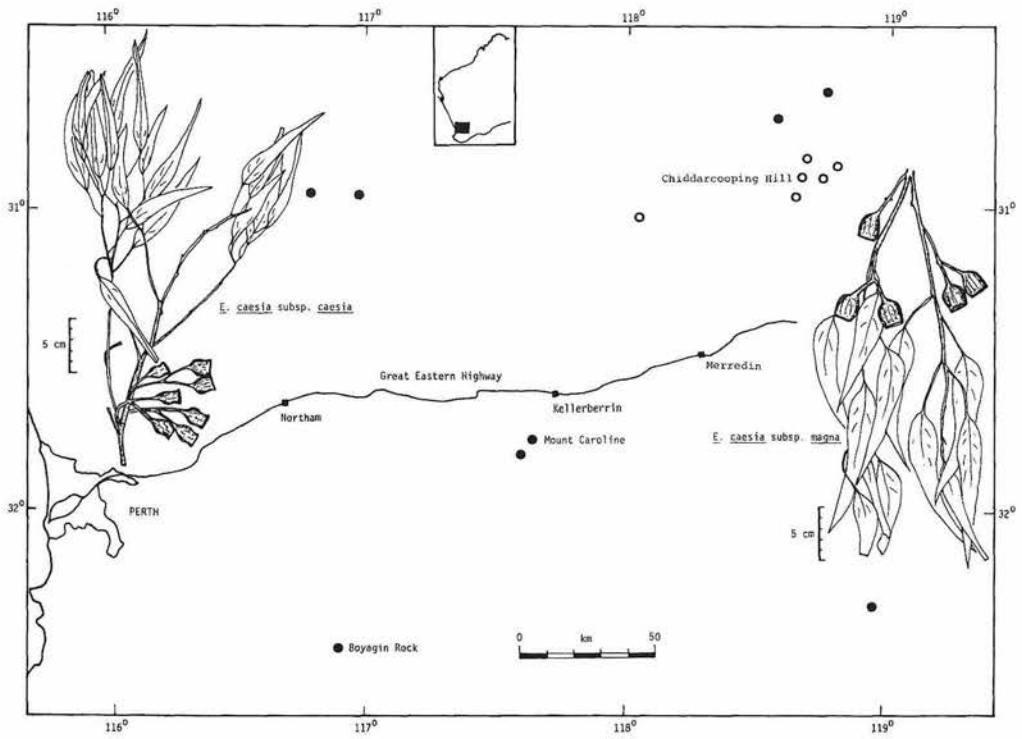

Figure 2. Geographical distributions of *Eucalyptus caesia* subsp. *magna* (open circles) and *E. caesia* subsp. *caesia* (closed circles) in the central wheatbelt of Western Australia. Also illustrated are line drawings of *E. caesia* subsp. *caesia (M.I.H. Brooker* 6738) and *E. caesia* subsp. *magna* (holotype).

From an examination of specimens annotated by Gardner at PERTH it is certain also that the reference to 'forms of *E. leptopoda*' (Gardner, 1954) are in fact this form of *E. crucis* with true adult leaves.

We believe that both the 'large-fruited *E. caesia*' and the large narrow-leaved mallees of *E. crucis* are worthy of formal taxonomic status. This view is supported both by the morphological considerations outlined below and by multivariate morphometric analyses of geographical variation that will be published elsewhere (Hopper, Campbell and Caputi, in press).

Figure 3. The holotype of *E. caesia* subsp. *caesia*, collected by James Drummond in 1847 in the Mt Caroline-Mt Stirling district.

Taxonomy

Eucalyptus caesia Benth. subsp. **caesia,** Fl. Aust. 3, 227 (1867); Maiden, Crit. Rev. Gen. Euc. 3, 31 (1917); Blakely, Key Eucs, 103 (1934); Gardner, W. Aust. Dept. Agric. Bull. No. 2123 (1954); Pryor & Johnson, Class. Eucs. 46 (1971); Chippendale, Eucs. W.A. Goldfields, 119 (1973)—Figures 2, 3 and 8b.

Typus: Drummond 5th coll., suppl. no. 36 (K)—Figure 3.

A small *mallee* to 10 m tall with imperfectly decorticated, crisped 'Minni Ritchi' bark. *Young branchlets* smooth, reddish and covered by glaucous bloom. *Seedling leaves* opposite for 5-6 pairs, petiolate, orbicular to broader than long or cordate. *Juvenile leaves* alternate, petiolate, cordate, to 8 x 6 cm, thick, bright shining green. *Adult leaves* alternate, on glaucous petioles 1-4 cm long, lanceolate or falcate, to 16 x 4 cm, dull grey-green or yellowish green. *Inflorescences* axillary, 3-flowered; *peduncles* and *pedicels* 10-35 mm long; *buds* clavate, glaucous, to 30 x 15 mm, hypanthium obconical, operculum conical or slightly beaked, outer operculum lost early in bud development. *Stamens* faded pink, to 20 mm long. *Fruit* on long stout pedicels, urceolate, glaucous, shallowly ribbed, to 31 x 28 mm; *disc* broad, descending; *valves* 5 or 6, below rim level.

Eucalyptus caesia Benth. subsp. **magna** Brooker et Hopper, subsp. nov. (Figures 2, 4 and 8a).

A subspecie typica habitu, foliis, alabastris et fructibus (plerumque > 2 cm latis) majoribus differt.

A subspecies differing from the typical subspecies in its larger habit, leaves, buds and fruit (usually > 2 cm broad). Pryor and Johnson code SIVCH.

Typus: Chutawalakin Hill, 24 August 1979, *M.I.H. Brooker* 6488 (holo: FRI; iso: PERTH).

A stout *mallee* to 15 m tall with imperfectly decorticated, crisped 'Minni Ritchi' bark. *Young branchlets* smooth, reddish and covered by glaucous bloom. *Seedling leaves* opposite for 5-6 pairs, petiolate, orbicular or cordate. *Juvenile leaves* alternate, petiolate, cordate, to 10 x 8 cm thick, bright, shining green. *Adult leaves* alternate, on glaucous petioles 2-6 cm long, lanceolate or falcate, to 24 x 5 cm, dull grey-green or yellowish green. *Inflorescences* axillary, 3-flowered; *peduncles* and *pedicels* 10-33 mm long; *buds* clavate, glaucous, to 40 x 20 mm, hypanthium obconical, operculum conical or slightly beaked, outer operculum lost early in bud development. *Stamens* red-pink, to 25 mm long. *Fruit* on long stout pedicels, bell-shaped, glaucous, shallowly ribbed, to 37 x 40 mm; *disc* broad descending; *valves* 5 or 6, below rim level.

Distribution. (Figure 2) Confined to a few granite tors (e.g. Chiddarcooping Hill, Chutawalakin Hill) in the eastern central wheatbelt of Western Australia.

Other collections examined. WESTERN AUSTRALIA: Chiddarcooping Rocks, N of Geelakin, 11 June 1928, *G. E. Brockway* s.n. (PERTH); Chiddarcooping Rock, 24 August 1979, *M. I. H. Brooker* 6485 (FRI); granite rock N of Westonia, September 1923, *C. A. Gardner* s.n. (PERTH); Warralakin, January 1964, *C. A. Gardner* s.n. (PERTH); 10 km N of Warralakin, 5 January 1965, *C. A. Gardner* s.n. (PERTH);

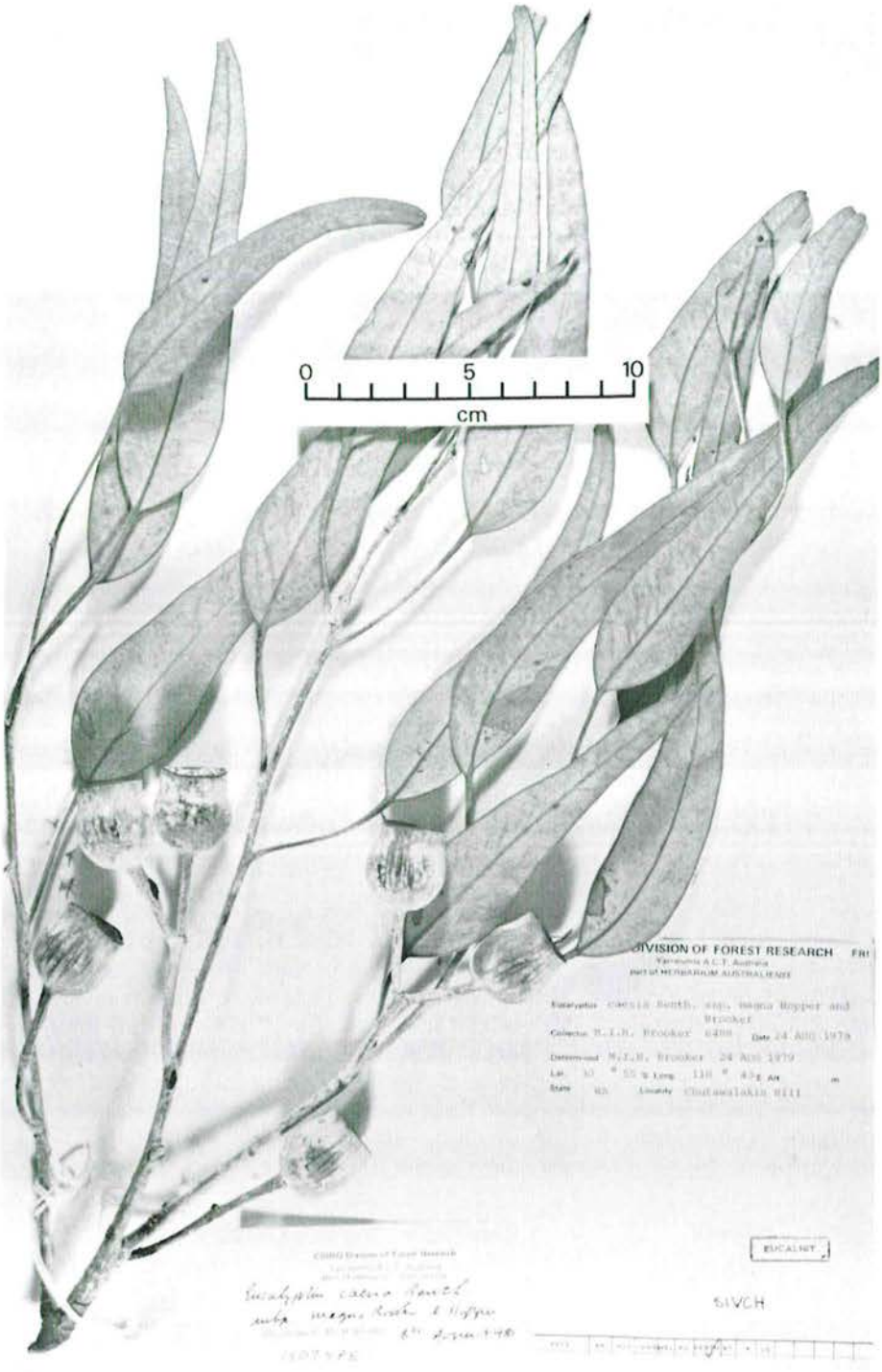

Figure 4. The holotype of *E. caesia* subsp. *magna*, collected by M.I.H. Brooker at Chutawalakin Hill on August 24, 1979. The specimen is mounted upside down, as the leaves and fruits of this subspecies are normally pendulous.

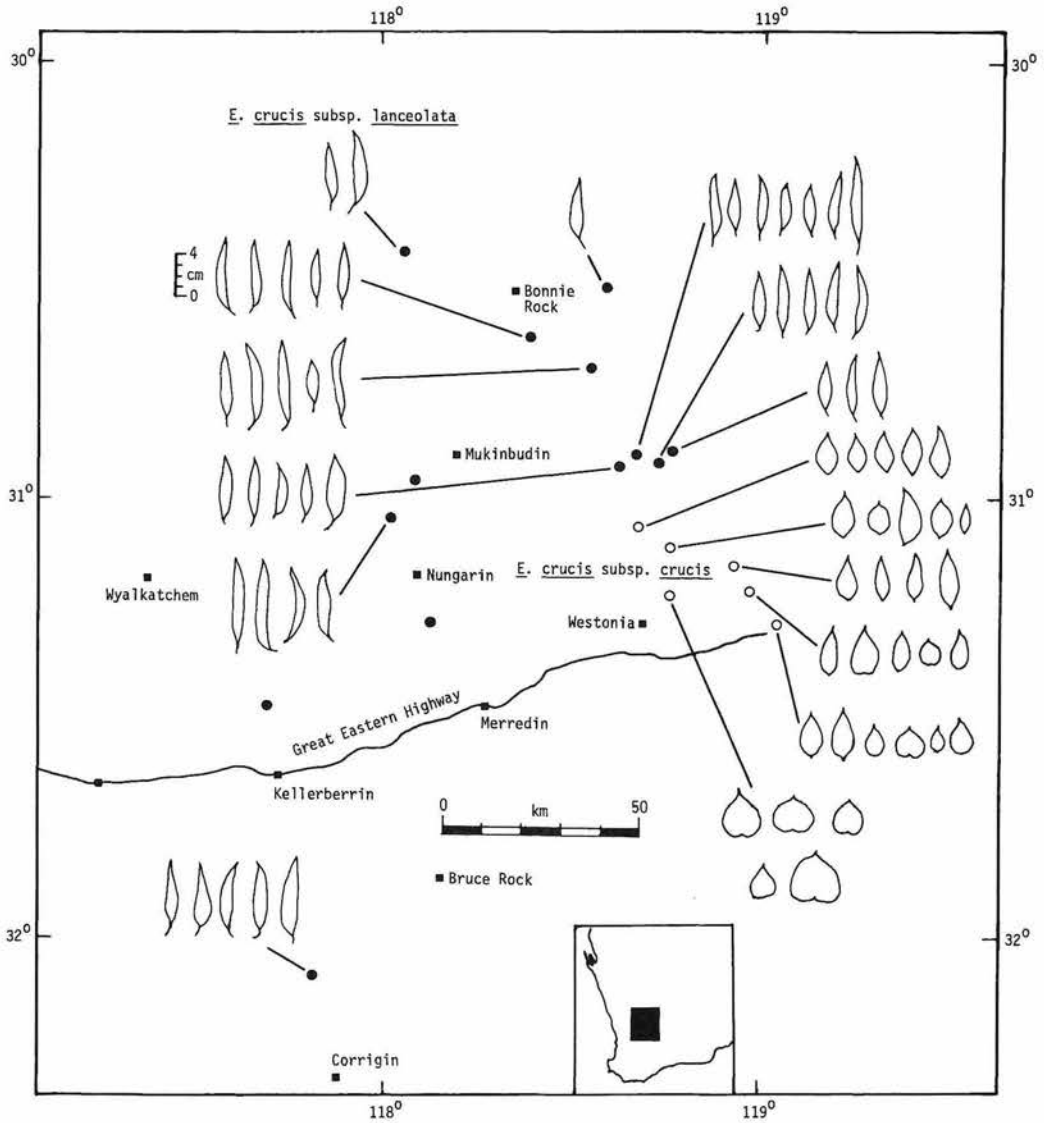

Figure 5. Geographical distributions of *Eucalyptus crucis* subsp. *lanceolata* (closed circles) and *E. crucis* subsp. *crucis* (open circles) in the central wheatbelt of Western Australia (*E. crucis* subsp. *crucis* also occurs at a few isolated localities outside the boundaries of this map). Line drawings of a range of leaves from populations of both subspecies are illustrated.

Billyacatting Hill, NE of Kununoppin, 1 September 1976, *A. M. George* 94 (PERTH); Billyacatting Hill, 16 km NW of Nungarin 31°03′S, 118°01′E, 7 June 1978, *S. D. Hopper* 1003 (PERTH); Chiddarcooping Hill 30°54′S, 118°41′E, 8 June 1978, *S. D. Hopper* 1006 (PERTH); Chutawalakin Hill 30°55′S, 118°44E, 9 June 1978, *S. D. Hopper* 1010 (PERTH); Coorancooping Hill 30°52′S, 118°41′E, 3 August 1978, *S. D. Hopper* 1044 (PERTH); Geelakin-Chiddarcooping, 17 August 1960, *H. Shugg* s.n. (PERTH).

Ecology. Eucalyptus caesia subsp. *magna* is known to occur only in shallow sandy loams at the base of granite rocks or in gullies bordered by ridges of sheet granite. Populations usually consist of less than 100 plants. It frequently occurs in pure

stands but is sometimes associated with *Eucalyptus crucis* subsp. *lanceolata* Brooker et Hopper. Some other prominent associated species are *Hakea petiolaris* Meissner and *Calothamnus quadrifidus.* R.Br.

Eucalyptus crucis Maiden subsp. **crucis.** Crit. Rev. Gen. Euc. 59, 514 (1923); Blakely, Key Eucs 272 (1934); Pryor & Johnson, Class. Eucs 46 (1971); Chippendale, Eucs. W.A. Goldfields 117 (1973)—Figure 5 and 8f, Table 1.

Typus: Southern Cross, April 1922, *H. Steedman* (NSW)—Figure 6.

An effuse *mallee* to 6 m tall with imperfectly decorticated, crisped 'Minni Ritchi' bark on stems to about 10 cm diameter. *Young branchlets* smooth, white, glaucous. *Seedling and juvenile leaves* remaining opposite for many nodes, sessile, orbicular or broader than long, conspicuously mucronate, to 5 x 4 cm, with minute black oil dots, greyish green. *Intermediate leaves* opposite or sub-opposite, sub-sessile or shortly (0.5-3.5 mm and distinctly petiolate, ovate, to 6.5 x 5.5 cm, grey-green.

Inflorescences axillary, 7-flowered; *peduncles* and *pedicels* slender; *buds* glaucous, to 6 x 4 mm, hypanthium hemispherical, operculum obtusely or acutely conical, outer operculum lost early in bud development. *Fruit* on long, slender pedicels, hemispherical, glaucous, to 6 x 4 mm; *disc* broad, flat or slightly ascending; *valves* 4, stout, strongly exserted.

Eucalyptus crucis subsp. **lanceolata** Brooker et Hopper subsp. nov. (Figures 5, 7 and 8e, Table 1).

A subspecie typica habitu majore et foliis adultis lanceolatis vel angusto-lanceolatis differt.

A subspecies differing from the typical subspecies in its larger habit and the canopy of lanceolate to narrow-lanceolate adult leaves (Table 1). Pryor and Johnson code SIVCF.

Typus: Chiddarcooping Rock, 24 August 1979, *M. I. H. Brooker* 6484 (holo: FRI; iso: PERTH, NSW).

A large erect *mallee* to 15 m tall with imperfectly decorticated, crisped 'Minni Ritchi' bark on stems to about 30 cm diameter. *Young branchlets* smooth, white, glaucous. *Seedling and juvenile leaves* remaining opposite for many nodes, sessile, orbicular or broader than long, conspicuously mucronate, to 5 x 3.5 cm, with minute black oil dots, greyish green. *Intermediate leaves* opposite or sub-opposite, sub-sessile or shortly and distinctly petiolate, ovate, to 6 x 2 cm, grey-green. *Adult leaves* alternate, on slender petioles 5-15 m long, lanceolate to narrow-lanceolate, to 10 x 2 cm, tapering to a fine, sometimes curved point, with many minute, black oil dots. *Inflorescences* axillary, 7-flowered; *peduncles* and *pedicels* slender; *buds* glaucous, to 6 x 4 mm, hypanthium hemispherical, operculum obtusely or acutely conical, outer operculum lost early in bud development. *Fruit* on long, slender pedicels, hemispherical, glaucous, to 16 x 10 mm; *disc* broad, flat or slightly ascending; *valves* 4, stout, strongly exserted.

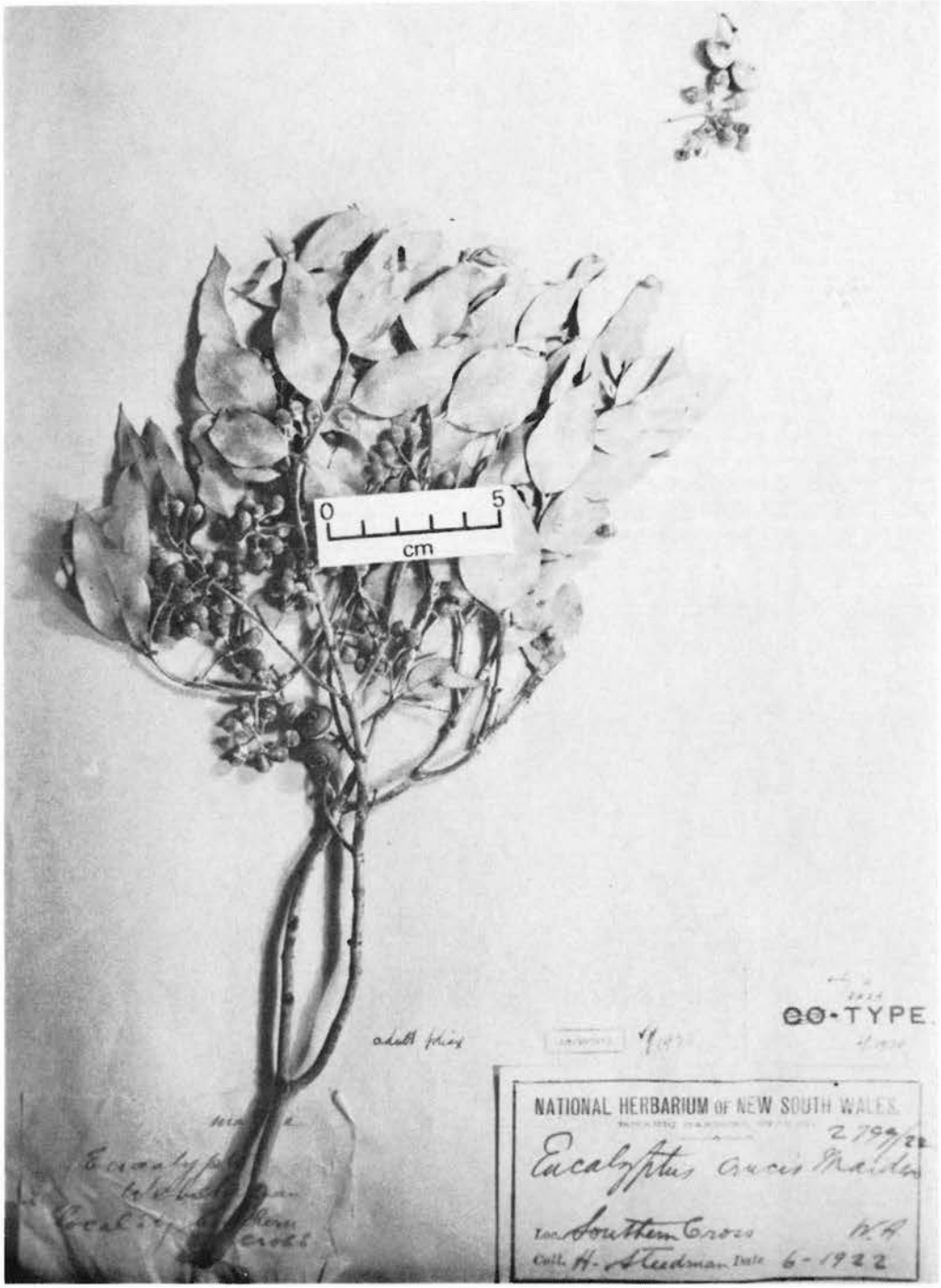

Figure 6. A paratype of *E. crucis* subsp. *crucis*, collected by H. Steedman from the Southern Cross district in June 1922. This specimen closely matches the holotype (D.F. Blaxell pers. comm.), which was also collected by H. Steedman from the same district but two months earlier in April 1922.

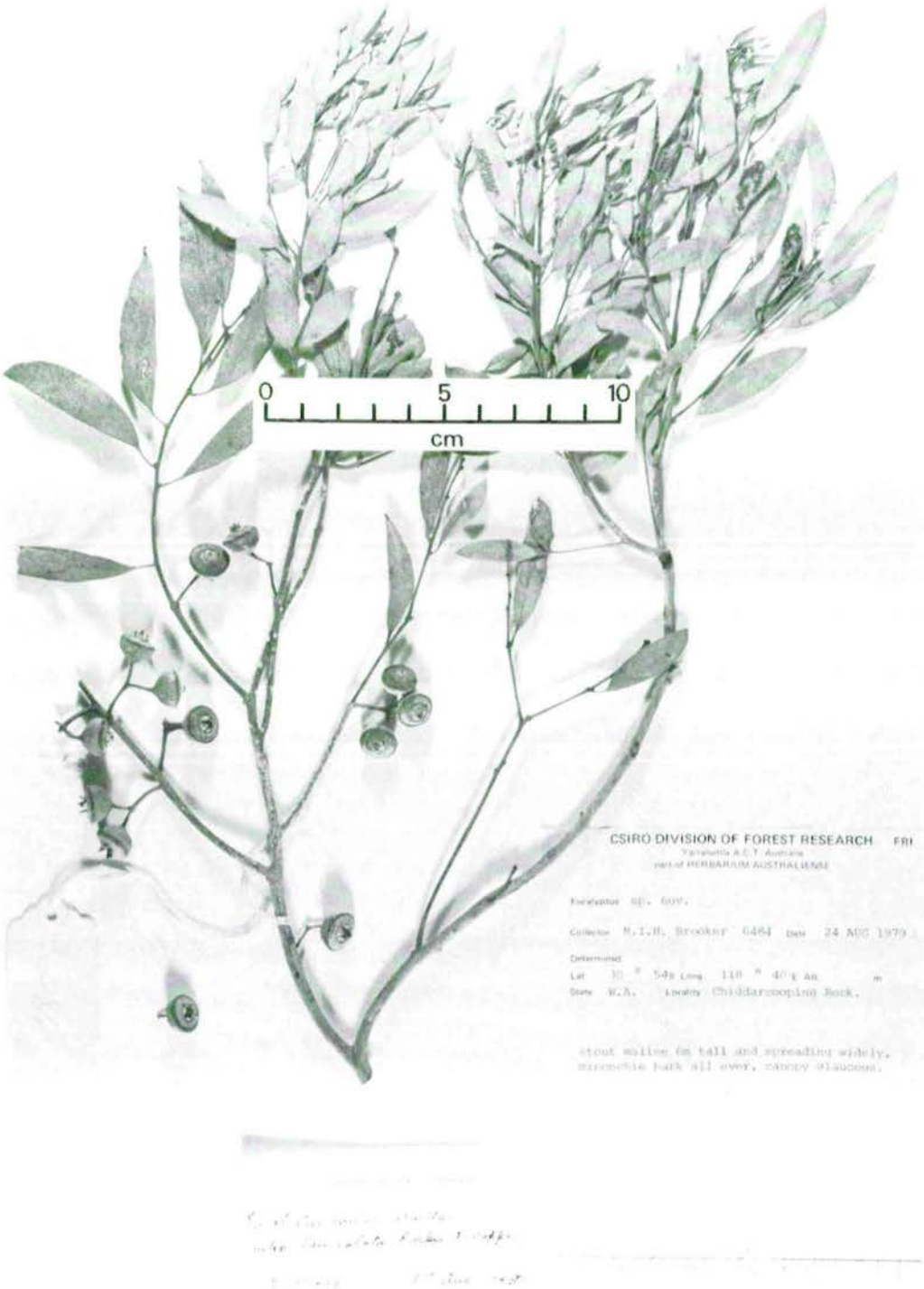

Figure 7. The holotype of *E. crucis* subsp. *lanceolata*, collected by M. I. H. Brooker from Chiddarcooping Hill on August 24, 1979.

Distribution. (Figure 5) Restricted to a number of granite rocks in the central wheatbelt of Western Australia.

Other collections examined. WESTERN AUSTRALIA: West of Nukarni, 20 Oct. 1946, *G. E. Brockway* 2 (PERTH); Chutawalakin Hill, 24 Aug. 1979, *M. I. H. Brooker* 6487 (FRI, PERTH, NSW); Kununoppin, Nov. 1929, *E. A. Cook* s.n. (PERTH); 6 miles N of Kununoppin, 22 Sept. 1975, *H. Demarz* 5605 (PERTH); Nalyering Well near Kellerberrin, 25 May 1961, *C. A. Gardner* s.n. (PERTH); 4 miles N Warralakin, 5 Jan. 1965, *C. A. Gardner* s.n. (PERTH); near Yorkrakine, 1 June 1957, *J. W. Green* 1356 (PERTH); Billyacatting Hill 31°03′S, 118°01′E, 7 June 1978, *S. D. Hopper* 1001 (PERTH); Chiddarcooping Hill 30°54′S, 118°41′E, 8 June 1978, *S. D. Hopper* 1005 (PERTH); 1 km SE of Chutawalakin Hill 30°56′S, 118°44′E, 9 June 1978, *S. D. Hopper* 1011 (PERTH); Yanneymooning Hill 30°43′S, 118°34′E, 28 June 1978, *S. D. Hopper* 1016 (PERTH); Jouerdine Hill 30°38′S, 118°24′E, 14 July 1978, *S. D. Hopper* 1022 (PERTH); 1 km SE of Chutawalakin Hill 30°56′S, 118°44′E, 2 Aug. 1978, *S. D. Hopper* 1033 (PERTH); 9.5 km E of Chiddarcooping Hill 30°54′S, 118°46′E, 2 Aug. 1978, *S. D. Hopper* 1041 (PERTH); c. 10 km NE of Chiddarcooping Hill, 3 Aug. 1978, *S. D. Hopper* 1042 (PERTH); Dajoing Rock 30°27′S, 118°04′E, 4 Aug. 1978, *S. D. Hopper* 1049 (PERTH); 8 km SW of Chiddarcooping Hill, 7 Sept. 1978, *S. D. Hopper* 1128 (PERTH); 30 km NNW of Corrigin 32°05′S, 117°44′E, 9 June 1979, *S. D. Hopper* s.n. (PERTH); Chiddarcooping Hill, N of Warralakin, 2 May 1978, *G. J. Keighery* 1602 (PERTH); Billyacatting Hill Reserve 17746, 11 km NE of Kununoppin, 3 Sept. 1977, *B. G. Muir* 102 (PERTH); Barbalin Rock, 2 Sept. 1969, *K. Newbey* 2871 (PERTH); Billyacatting Rock, 5 June 1976, *E. Wittwer* W1716 (PERTH).

Ecology. Eucalyptus crucis subsp. *lanceolata* occurs in shallow granitic sands and loams associated with large outcrops of granite rocks. It displays a clumped distribution at any particular location. It is sometimes associated with *Eucalyptus caesia* subsp. *magna* (e.g. at Chiddarcooping Hill, Billyacatting Hill), and with *E. orbifolia* at Jouerdine Hill. It has not been found in sympatry with *E. crucis* subsp. *crucis.*

Discussion. Eucalyptus crucis subsp. *lanceolata* and *E. crucis* subsp. *crucis* differ in having adult leaves and juvenile leaves respectively in their mature canopies. They show no obvious differences in the morphology of their fruits, buds or flowers. Elsewhere in *Eucalyptus,* related adult-leaved and juvenile-leaved taxa have been recognised as distinct species (e.g. *E. gamophylla* F. Muell.—*E. odontocarpa* F. Muell., *E. risdonii* Hook. f.—*E. tenuiramis* Miq., *E. fruticosa* M. I. H. Brooker—*E. foecunda* Schau.). However, in *E. crucis,* the typical subspecies shows a range in leaf form from populations stabilised for orbicular, apetiolate, fully juvenile leaves (e.g. at Sandford Rock) to populations with ovate, shortly petiolate leaves that are intermediate between the juvenile and adult conditions (e.g. at Moorine Rocks or Warren Double Cunyan) (Figure 5 and Table 1). These intermediate populations indicate that the genetic fixation of a fully juvenile-leaved form in all populations of *E. crucis* subsp. *crucis* has not yet occurred. Hence we feel it appropriate to recognise the two forms in *E. crucis* as subspecies rather than separate species.

Previously, *E. crucis* subsp. *lanceolata* has been confused with a number of species, including *E. leptopoda, E. drummondii* and *E. orbifolia* (e.g. Gardner, 1954). However, it is clearly distinct from the first two of these three taxa in having crisped 'Minni Ritchi' bark and in its restriction to granite rocks. It differs from *E. orbifolia* in having acute, non-emarginate, lanceolate to narrow-lanceolate leaves.

Table 1. Means, standard errors and ranges for three leaf measurements taken on the longest leaf of plants in populations of the two subspecies of *Eucalyptus crucis*.

Population	No. of leaves	Petiole length		Leaf length		Leaf width	
		Mean ±SE (cm)	Range (cm)	Mean ±SE (cm)	Range (cm)	Mean ±SE (cm)	Range (cm)
E. crucis subsp. *crucis*							
Sandford Rock	14	0.0	—	41.4±2.1	29.7-58.3	38.7±2.5	26.3-55.0
NW Moorine Rocks	12	1.1±0.3	0.0-2.7	39.0±2.6	26.2-55.5	22.5±1.2	15.2-30.5
Beacon Hill	10	0.7±0.4	0.0-2.6	42.7±3.3	29.0-62.4	23.0±1.5	14.9-31.3
SE Keokanie Rock	4	2.4±0.7	0.6-3.5	50.1±4.3	44.4-62.7	19.1±2.0	15.2-23.5
Moorine Rock	10	0.0	—	43.6±2.4	26.8-54.1	22.0±1.2	17.4-30.7
Warren Double Cunyan	5	0.8±0.8	0.0-4.1	50.2±2.3	44.0-54.6	19.1±1.5	15.2-24.0
E. crucis subsp. *lanceolata*							
Billyacatting Hill	7	8.0±0.5	6.1-9.1	79.6±3.5	69.7-97.9	11.5±0.8	8.9-13.6
Chiddarcooping Hill	12	7.8±0.7	4.7-12.1	62.9±3.3	49.5-92.6	10.1±0.6	7.1-12.7
S Chutawalakin Hill	5	7.1±1.1	5.1-10.1	64.5±3.1	55.9-72.4	11.2±0.7	8.3-12.1
Dajoing Rock	2	12.3±0.4	11.9-12.6	72.3±9.5	62.8-81.7	13.7±1.7	12.0-15.3
Geeraning Rock	1	11.5	—	67.8	—	13.6	—
Jouerdine Hill	13	9.0±0.6	5.9-12.5	68.6±2.6	54.5-85.8	9.3±0.4	7.8-11.7
S Kwolyin	6	9.4±0.5	8.5-11.8	75.7±2.1	71.3-85.9	14.0±0.8	12.1-17.0
N Python Rocks	3	9.4±0.3	8.7-9.7	60.0±4.1	51.8-64.3	10.2±1.3	8.5-12.7
SW Chiddarcooping Hill	8	9.0±1.0	6.9-14.4	61.8±3.5	42.1-75.2	12.0±1.1	9.6-19.5
Yanneymooning Hill	7	11.9±0.7	9.6-14.5	75.8±4.8	50.7-89.2	10.3±0.7	6.7-12.0

The patterns of subspecific variation in *E. crucis* and *E. caesia* differ considerably, the former species displaying interpopulational divergence from the juvenile-leaved to the adult-leaved condition, while subspecies in *E. caesia* have diverged primarily in the size of their buds, flowers, fruits and leaves. The evolutionary pressures responsible for these differing patterns of divergence warrant further investigation.

Notes on seedlings in the subseries Orbifolinae.

In eucalypts, the natural affinity between related species is often expressed by similarities in leaf ontogeny of the young plants. This is to be expected between sibling species of comparatively recent evolutionary divergence such as must be the case with *E. oleosa* F. Muell. and *E. longicornis* F. Muell. (a superspecies in the sense of Pryor and Johnson, 1971). The same can be said for some higher taxonomic categories, e.g. subseries Viminalinae, series Erythronemae, and more rarely at the section level, viz. Dumaria, the members of which have very similar seedlings.

It can probably be said for most subseries that seedling characters show little variation between species. Therefore it is surprising to observe the great variation in leaf ontogeny between species in the subseries Orbifolinae.

In this taxonomic study of the Orbifolinae, authenticated seed of all available collections were sown (Appendix 1) and the seedlings were grown in a glasshouse for 12 weeks by which time they were up to 30 cm tall and distinctions had become very obvious. Progeny of each number were remarkably uniform. Samples were harvested and pressed flat and photographed (Figure 8). After drying, the seedlings were mounted with the parent specimens at FRI.

The seedling observations provided a useful confirmation of the taxonomic levels recognised and formalised by this study and by Pryor and Johnson (1971) who suggest subspecies status for *E. orbifolia* and *E. websteriana.* Although there was variation within the 4 species (as now proposed) each was distinct from the others and identifiable (within the subseries) on the seedlings alone. Both members of the subspecies pairs (described and proposed), on the other hand, resembled each other closely and differed mainly in size.

The seedling leaves of *E. crucis* (both subspecies) are sessile, opposite for many nodes, orbicular, glaucous and thin. The seedling leaves of *E. orbifolia* and *E. websteriana* (proposed subspecies) are petiolate, opposite for few (5-10) pairs, orbicular to broader than long, glaucous to slightly glaucous, and thin. The seedling leaves of *E. ewartiana* are petiolate, opposite for very few (3-4) pairs, ovate, light dull green, and thin. The seedling leaves of *E. caesia* (both subspecies) are petiolate, opposite for very few (5-6) pairs, orbicular to broader than long, or cordate, bright shining green, and thick.

Even if the species in the series (as opposed to the subspecies) are of relatively ancient evolutionary divergence and a true seedling leaf phase has been suppressed in *E. ewartiana, E. caesia* sens. lat. and *E. orbifolia* sens. lat., it is difficult to relate the early leaves of these 3 species with the later leaves of *E. crucis* sens. lat. In other words the heterophyllous sequence and morphological distinction in leaf character at all ontogenetic stages has been remarkably different. This fortunately allows useful distinctions for a botanical key.

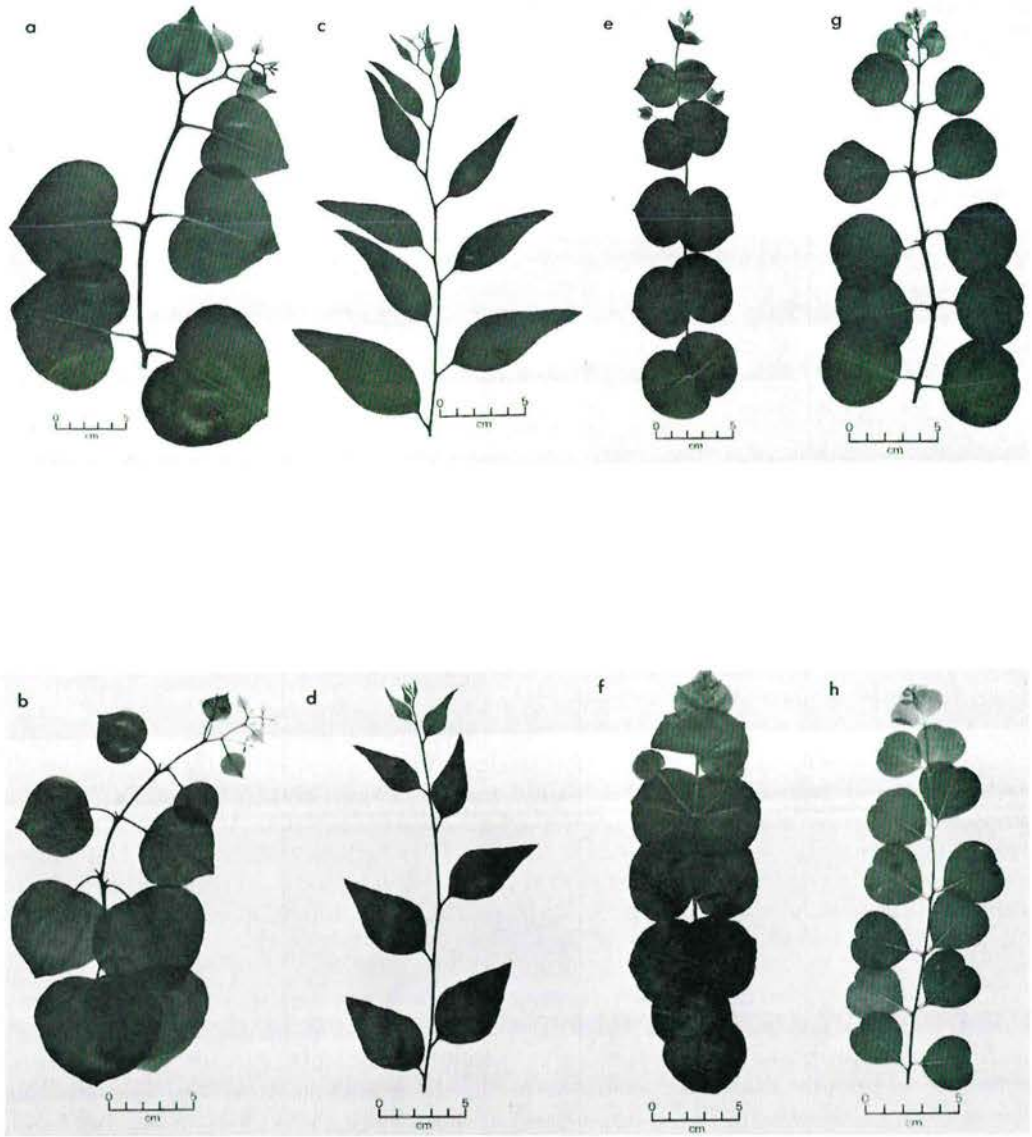

Figure 8. Pressed seedlings of (a) *E. caesia* subsp. *magna* (seed from *M. I. H. Brooker* 6488), (b) *E. caesia* subsp. *caesia* (FRI 14408), (c) and (d) *E. ewartiana* (*M. I. H. Brooker* 2424 and *M. I. H. Brooker* 6479), (e) *E. crucis* subsp. *lanceolata* (*M. I. H. Brooker* 6487), (f) *E. crucis* subsp. *crucis* (*M. I. H. Brooker* 2427), (g) *E. orbifolia* (*M.I.H. Brooker* 5114), (h) *E. Websteriana* (*M.I.H. Brooker* 2224).

Key to the species of subseries Orbifolinae

1. Disc of fruit descending; leaves of the seedling petiolate, shining green, thick

    2. Fruit usually urceolate, less than 2 cm broad, stamens faded pink..... *E. caesia* subsp. *caesia*

    2. Fruit usually bell-shaped, more than 2 cm broad, stamens red-pink..... *E. caesia* subsp. *magna*

1. Disc of fruit broad, ascending or horizontal; leaves of the seedling petiolate or sessile, glaucous or dull green, thin

    3. Operculum shorter than or equal to hypanthium, rounded, or pileate with buds constricted, pedicels stout and often angular; leaves of the seedling petiolate, dull green ..... *E. ewartiana*

    3. Operculum longer than hypanthium, pointed, buds not constricted, pedicels not strongly angular; leaves of the seedling petiolate or sessile, glaucous

        4. Leaves of mature plant lanceolate or narrow-lanceolate, petiolate, entire..... *E. crucis* subsp. *lanceolata*

        4. Leaves of mature plant orbicular or elliptical or ovate, sessile or petiolate, entire or emarginate

            5. Leaves of mature plant glaucous, sessile and orbicular or broader than long, or shortly petiolate and ovate, entire; seedling leaves sessile, tree or mallee ..... *E. crucis* subsp. *crucis*

            5. Leaves of mature plant green or glaucous, petioles to 2 cm long, elliptical or ovate to orbicular, emarginate; seedling leaves petiolate; usually a mallee

                6. Leaves ovate or orbicular, glaucous..... *E. orbifolia*

                6. Leaves longer than broad, green or yellow-green... *E. websteriana*

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Appendix 1. Seed source for seedling trial.

E. caesia subsp. *magna* Chutawalakin Hill, W.A. (*Brooker* 6488)
Chiddarcooping Hill, W.A. (*Hopper* 1006)

E. caesia subsp. *caesia* Mt Caroline, W.A. (FRI 14408)
Boyagin Rock, W.A. (*Brooker* 6753)

E. ewartiana 55 mi NE of Wubin, W.A. (*Brooker* 1978)
c. 60 mi SW of Sandstone, W.A. (*Brooker* 2424)
c. 85 mi N of Bullfinch, W.A. (*Brooker* 2452)
5 km NW of Bullfinch, W.A. (*Brooker* 6429)
4.5 mi W of Westonia, W.A. (FRI 15625)
58.5 mi N of Bullfinch, W.A. (FRI 15645)

E. crucis subsp. *lanceolata* Chutawalakin Hill, W.A. (*Brooker* 6487)
Chiddarcooping Rock, W.A. (*Brooker* 6484)

E. crucis subsp. *crucis* Sandford Rock, W.A. (*Brooker* 2427)
Moorine Rock, W.A. (*G. Moran* 3,4)
5 km SE of Keokanie, W.A. (*G. Moran* 11)

E. orbifolia c. 55 mi NE of Kalgoorlie, W.A. (*Brooker* 2581)
Serpentine Gorge, N. Terr. (*Brooker* 5095)
Krichauff Range, N. Terr. (*Brooker* 5114)
Mt Sonder, N. Terr. (*C. Dunlop* 2513)
Pigeon Rock, W.A. (FRI 15664)

E. websteriana Mt Edward, W.A. (*Brooker* 2224)
5.7 mi NW of Norseman, W.A. (*Brooker* 4537)
Comet Hill, W.A. (*Brooker* 6466)