FIELD GUIDE TO THE CULTIVATED EUCALYPTS (MYRTACEAE) AND HOW TO IDENTIFY THEM[1]

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ABSTRACT

This paper provides identification keys that are based entirely on morphological features to commonly and widely cultivated eucalypts, encompassing *Eucalyptus* L'Hér., *Angophora* Cav., and *Corymbia* K. D. Hill & L. A. S. Johnson in the Myrtaceae Juss. The key includes 173 taxa: one species of *Angophora*, nine species of *Corymbia*, and 163 species of *Eucalyptus*. Evidence for cultivation was determined by accounts in the literature, herbaria, personal communications, and observations of living trees in cultivation in Europe, North America, Africa, and Australia. The locations, prevalence of cultivation, and naturalization of several eucalypt species are discussed.

Key words: *Angophora*, *Corymbia*, eucalypt, *Eucalyptus*, Myrtaceae.

In 1774, at the Royal Botanic Gardens at Kew, England, the messmate (*Eucalyptus obliqua* L'Hér.) became the first cultivated eucalypt. Since that time, hundreds of species have been introduced into cultivation in temperate, tropical, and subtropical countries worldwide. Eucalypts are now second only to the pines as the most extensively planted trees in the world. They are grown for lumber, paper pulp, pilings and posts, fuel wood, medicinal products, tannins, oils, and as windbreaks and ornamentals. More than 150 of the approximately 900 eucalypts are regularly and widely grown (McClatchie, 1902; Boland et al., 1980; Wrigley & Fagg, 2010). In many countries where cultivated eucalypts have become prominent features of the landscape, they are admired for their many uses and aesthetic value while at the same time demonized as foreign invaders, and over 70 species have been observed reproducing on their own outside cultivation (Hussey et al., 1997; Forsyth et al., 2004; Ritter & Yost, 2009; Rejmánek & Richardson, 2011a).

In the current, most widely accepted classification, the eucalypts constitute three genera: *Angophora* Cav. with 10 species, *Corymbia* K. D. Hill & L. A. S. Johnson with 95 species, and *Eucalyptus* L'Hér. with approximately 760 species (Slee et al., 2006). *Angophora* was segregated from *Eucalyptus* by Cavanilles (1797) on the basis of the opposite adult leaves, presence of sepals, and absence of an operculum (bud cap or fused perianth). Nearly 200 years later, two Australian botanists, Kenneth Hill and Lawrence Johnson, combined two *Eucalyptus* subgenera, *Blakella* L. D. Pryor & L. A. S. Johnson ex Brooker and *Corymbia* (K. D. Hill & L. A. S. Johnson) Brooker (bloodwoods, ghost gums, and spotted gums), and described the new genus *Corymbia* (Pryor & Johnson, 1971; Hill & Johnson, 1995). This taxonomy was corroborated by molecular phylogenetic work, revealing that *Corymbia* is more closely related to *Angophora* than to *Eucalyptus* (Ladiges et al., 1995; Udovicic et al., 1995; Steane et al., 2002). Subsequently, Brooker (2000) proposed a less widely accepted taxonomic scheme with one genus, *Eucalyptus*, divided into seven subgenera, including *Corymbia* and *Angophora*. In general, *Corymbia* can be distinguished from *Eucalyptus* by the presence of discolorous leaves (abaxially lighter), terminal inflorescences, and large, urn-shaped fruits. Unfortunately, there are species of *Corymbia* that lack one or more of these easily recognized characteristics and several species of *Eucalyptus* that exhibit them.

Eucalypts are cultivated in all tropical, subtropical, and Mediterranean climate areas of the world. Although they were initially grown as horticultural oddities, foresters quickly discovered their potential as commercial plantation trees. Social engineers, planners, and entrepreneurs have promoted worldwide eucalypt planting for the last 150 years because of their many valuable characteristics—they are

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readily propagated from seed, grow fast, thrive in degraded soils and dry climates, can sustain regular coppicing, and are generally pest free. Between 10 and 20 species are widely grown in large plantations destined for use in paper pulp and other forestry products, whereas hundreds of others are grown for honey production, for shade, and as windbreaks and ornamentals. The most commonly grown species are *Eucalyptus globulus* Labill. (primarily in Australia, Central and South America, California, Spain, and Portugal), *E. grandis* W. Hill and hybrids between *E. grandis* and *E. urophylla* S. T. Blake (primarily in wetter areas including Brazil, Uruguay, Hawaii, China, South Africa, Congo, Zimbabwe, and Southeastern Asian countries), and *E. camaldulensis* Dehnh. (primarily in more arid areas of Africa, western North America, Peru, and the Mediterranean sea basin). More than half of the approximately 20 million hectares under eucalypt cultivation are in India (20% of total cultivated area), Brazil (19%), and China (13%) (Wang & Brooker, 1991; Florence, 1996; Turnbull, 1999; Cossalter & Pye-Smith, 2003; Iglesias-Trabado & Wilstermann, 2009; FAO, 2010).

This long history of widespread eucalypt planting has resulted in several species becoming controversial in the regions where they are now conspicuous features of the landscape. Researchers continue to debate the effects of eucalypt plantations on the natural ecosystems, biodiversity, wildlife, and ecosystem services (Poore & Fries, 1985; Sax, 2002; Lindenmayer & Hobbs, 2004; Lockwood & Gilroy, 2004; Díaz-Balteiro & Rodríguez, 2006; Proença et al., 2010; Wang et al., 2011). In general, eucalypts are less successful at invading natural areas than are several species of pines (e.g., *Pinus radiata* D. Don and *P. pinaster* Besser), other tree species in the Myrtaceae (e.g., *Melaleuca* L. spp. and *Psidium* L. spp.), and tree species in the Fabaceae (e.g., species of *Acacia* Mill. and *Prosopis* L., *Leucaena leucocephala* (Lam.) de Wit, and *Robinia pseudoacacia* L.) (Bargali et al., 1993; Richardson, 1998; Pyšek et al., 2004; Mooney et al., 2005; Rejmánek & Richardson, 2011a, 2011b). Several hypotheses have been proposed for the poor performance of eucalypts as weeds, even though they are widely planted. Eucalypts have limited, short distance, wind-dispersed seeds; generally lack compatibility with soil mycorrhizal fungi; and exhibit low levels of seedling recruitment because of their small, exalbuminous seeds (Brooker & Kleinig, 1999, 2002, 2004; Williams & Woinarski, 1997; Pampolina et al., 2002; Díez, 2005; Forrester et al., 2006; Rejmánek & Richardson, 2011b).

Eucalypt identification, although crucial in many situations, is often difficult. This difficulty is exacerbated when the provenance of naturalized or cultivated trees is unknown. I present here an identification guide to the world's most widely grown eucalypts—a group of species that exhibit the gamut of diversity in the genus, with greatly varied bark, leaves, and reproductive structures. This identification key relies entirely on morphological characters (and not place of origin) and prioritizes nonreproductive structures that are perennially present. The correct identification of many species, however, will often require examination of flowers and fruit.

Materials and Methods

This study was based on the morphological analysis of living specimens of eucalypt species on several continents (Europe, North America, Africa, and Australia). Herbaria were visited, and vouchered specimens from cultivated and wild areas were used in morphological analysis for preparation of the key. Herbaria visited in which specimens were examined (cited, according to abbreviations from Holmgren et al., 1990) include: South Africa (BOL, CT, SAM), Hawaii (HAW, PTBG), Australia (BRI, MEL, KPBG, UWA), the continental United States (ASU, CAS, FTG, LA, OBI, SD, UC), and Europe (K, UNEX). Evidence for cultivation was determined by accounts in the literature, herbaria, personal communications, and observations of living trees.

Genus-level Description and Characters Important for Taxonomic Identification

The name *Eucalyptus* was originally published in 1788 by a French botanist living in London named Charles Louis L'Héritier de Brutelle in a description of plants growing at the Royal Botanic Garden at Kew. The genus name is derived from the Greek "eu," meaning "well," and "kalyptos," meaning "covered," referring to the bud cap or operculum (a fused perianth).

At maturity eucalypts become small to large trees (Fig. 1A–C), multistemmed small trees (mallees), or shrubs (Fig. 1D), sometimes with a fire-resistant basal burl or lignotuber (Fig. 2A). Their bark may be shedding, smooth to the ground or with rough bark persistent near the base, powdery to the touch, fibrous or hard, compacted, and rough to the smallest branches (Fig. 1E–I). Oil glands are usually present in the leaves (Fig. 2G, L, M) and sometimes present as a dark line or spots within the pith of smaller stems (Fig. 2C).

Figure 1. Growth forms and bark diversity in *Eucalyptus*. A–C, trees. —A. *Eucalyptus cladocalyx* F. Muell., showing typical tree form. —B. *Eucalyptus nicholii* Maiden & Blakely, with rough bark on trunk and small branches. —C. *Eucalyptus globulus* Labill., with smooth bark, sometimes with imperfectly shed rough bark on the basal area of trunk. —D. *Eucalyptus caesia* Benth., with multistemmed, shrubby mallee form. —E. *Eucalyptus parvula* L. A. S. Johnson & K. D. Hill, with bark shedding in long ribbons. —F. *Eucalyptus sideroxylon* A. Cunn. ex Woolls, showing typical ironbark trunk. —G. *Eucalyptus cladocalyx*, with bark shed in plates to the ground level. —H. *Eucalyptus robusta* Sm., showing rough, reddish brown bark. —I. *Eucalyptus deglupta* Blume, with smooth rainbow-colored bark to the ground level.

The leaves are of two different types in eucalypts. The juvenile leaves (leaves of seedlings, young plants, or new growth on mature plants after stems are cut or damaged) are generally attached oppositely, oriented horizontally, often sessile, heart-shaped or ovate to elliptical, clasping the stem, and glaucous (Fig. 2D). The adult leaves are generally attached alternately, hanging vertically, petiolate, linear to ovate, but most often lanceolate, and glossy or dull. Most often adult leaves are the same color on both sides, but many species have adult leaves that are discolorous and lighter on the underside (i.e., abaxially; Fig. 2F). Some species reproduce while the crown is in the juvenile leaf phase (Fig. 2E; see group 1 in the key for examples).

The inflorescences in eucalypts are unbranched umbels (sometimes condensed into heads) in leaf axils with three, seven, or more flowers (Fig. 2I), or highly branched, panicle-like clusters at branch tips (Fig. 2J) or in leaf axils, or rarely as solitary flowers in leaf axils. The peduncle can be round in cross-section (Fig. 3C) or flat and straplike (Fig 3F).

The outer floral organs (perianth) in eucalypts are sometimes fused into one or two opercula (bud caps), that are shed prior to or during flowering (Figs. 2N, 3A). A ring-shaped operculum scar on the developing bud is present when there are two opercula and the outer operculum is shed early in bud development (Fig. 2O, P). This operculum scar is absent when there is a single operculum or the outer operculum is held until near flowering (Fig. 3B). The operculum can be variously shaped, but most often it is beaked, conical, rounded, or horn-shaped (Fig. 3H). The stamens are numerous; in some species the outer stamens lack anthers (Fig. 3C, D); in others the stamens are in four clusters within the flower (Fig. 3G). The inferior ovary is sunken inside and fused with the hypanthium (Fig. 3E).

The fruit is a thick-walled, woody capsule that splits open at lines between three, four, or five valves at the top (Fig. 4). The hypanthium forms the hard outer layer; the pericarp is comparatively thin. After splitting open, the valves may be below the rim of the hypanthium (enclosed), exserted beyond the rim, or at the level of the rim (Fig. 4E). As the fruit develops, the hypanthium disk (the tissue between the ring where the stamens were attached and the top of the ovary) can be flat, ascending, or descending (Fig. 4F). Sometimes the valve tips remain fused across the fruit opening after dehiscence (Fig. 4C, H, *Eucalyptus cornuta* Labill. and *E. robusta* Sm., respectively). The fruit may be variously shaped at maturity (Fig. 4L). The seeds are generally 0.5 mm to 1.5 cm, cuboid or flattened, dark-brown or black, and surrounded by tan-colored, abundant chaff (unfertilized ovules) (Fig. 4K, *E. lansdowneana* F. Muell. & J. E. Br.).

Taxonomic Keys to Commonly and Widely Grown Eucalypts (*Angophora*, *Corymbia*, and *Eucalyptus*)

The following key to groups delineates the species treated here by easily recognized morphological characteristics. The nine species groupings are artificial, not based on any taxonomy or evolutionary relationships, and are used solely to make species identification easier. There is a description of the group and exemplar species for each group at the beginning of the key for each group. Several species appear in more than one group. *Eucalyptus* species occur in all group keys; *Angophora costata* is found in Key 3, and *Corymbia* species appear in Keys 3 and 4.

Key to Eucalypt Species Groups

1. Crown of mature reproductive tree made of mostly juvenile leaves; leaves mostly opposite, sessile, ovate, and glaucous ..... Group 1
1′. Crown of mature reproductive tree made of mostly adult leaves; leaves mostly alternate, sometimes opposite, clearly petiolate, lanceolate, and sometimes glaucous 2
2. Ironbarks, the bark rough, deeply furrowed, very hard (not easily pulled from tree), dark brown, gray, or black, retained on trunk and limbs ..... Group 2
2′. Not ironbarks, the bark smooth or rough, fibrous, shallowly furrowed, soft, brown to gray, retained on trunk and limbs or shedding in strips, plates, or sheets, leaving trunk smooth 3
3. Leaves discolorous, lighter on the underside (abaxial face) of leaves ..... Group 3
3′. Leaves concolorous, same color on both blade faces 4
4. Inflorescences compound, highly branched clusters at branch tips or in leaf axils ..... Group 4
4′. Inflorescences unbranched, single or paired umbels, or solitary flowers in leaf axils 5
5. Buds and fruits in clusters of 3 or solitary in leaf axils ..... Group 5
5′. Buds and fruits in clusters of more than 3 (usually 7 or more, some buds may be lost due to abortion or destruction) 6
6. Operculum scar absent from mature buds (buds have a single operculum with no circumferential scar on the bud surface caused by the shedding of the outer operculum, as happens in many other eucalypts); and buds and fruits usually in clusters of 11 or more; and disk of fruit level with rim, reddish brown, and shiny; and side leaf veins few, acutely angled, or parallel ..... Group 6

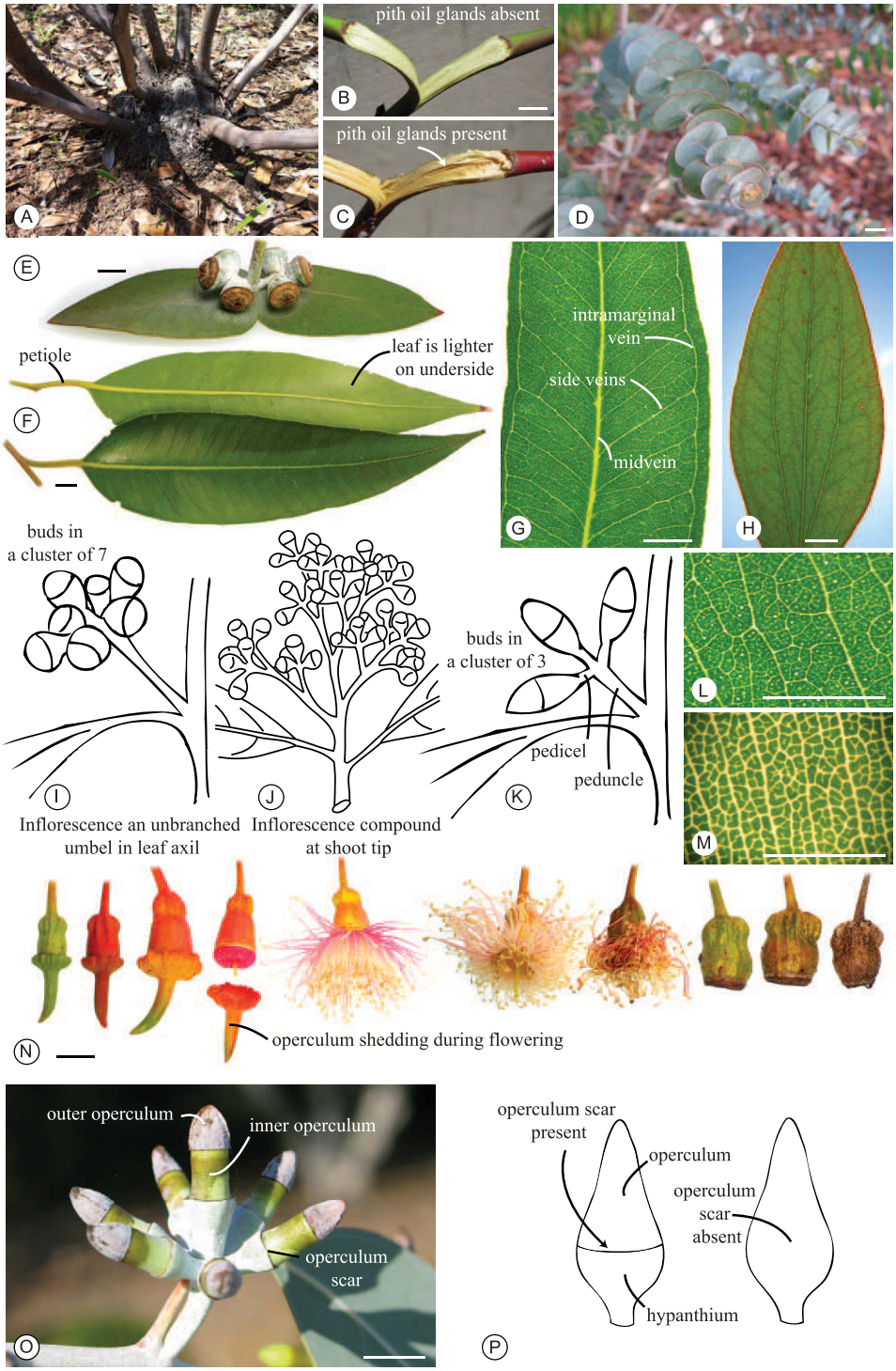

Figure 2. Lignotuber, pith, and leaf oil glands, as well as leaf and inflorescence characteristics in eucalypts. —A. Lignotuber of *Eucalyptus preissiana* Schauer. —B. Stem of *E. camaldulensis* Dehnh., without pith oil glands. —C. Stem of *E. torquata* Luehm., with pith oil glands. —D. Juvenile growth of *E. kruseana* F. Muell. —E. Opposite, sessile, juvenile leaves in the reproductive state, *E. cinerea* F. Muell. ex Benth. —F. Discolorous adult leaves in *E. robusta* Sm. —G. Typical eucalypt venation, with a midvein branching to side veins that converge near the leaf margin at the intramarginal vein, illustrated from *E. camaldulensis*. —H. Leaf venation, illustrating the prominently 3-veined characteristic, taken from *E. stellulata* Sieber ex DC.

6′. Operculum scar present on mature buds; buds and fruits in clusters of 7 or sometimes more; disk of fruit varying; side leaf veins varying 7
7. Peduncle broad, flattened, and straplike ..... Group 7
7′. Peduncle round or only slightly flattened in cross-section 8
8. Valves of mature fruit enclosed and sunken below fruit (hypanthium) rim or level with fruit rim ..... Group 8
8′. Valves of mature fruit clearly exserted beyond fruit rim ..... Group 9

Group 1, Trees, Mallees, or Shrubs with a Crown of Mostly Juvenile Leaves

This group contains species in which the reproductively mature crown (branched, leafy canopy with flowers and fruits) is made primarily of leaves that are arrested in the juvenile leaf phase. The leaves are generally attached oppositely, oriented horizontally, often sessile, cordate or ovate, clasping the stem, and glaucous (Fig. 2D, E, *Eucalyptus kruseana* F. Muell. and *E. cinerea*, respectively). Mature growth forms are trees (*E. melanophloia* F. Muell.), mallees (*E. kruseana* F. Muell.), and shrubs (*E. macrocarpa* Hook.).

1. Most leaves fused at the base, forming a disk 2
2. Buds and fruits in clusters of 3 ..... *Eucalyptus perriniana* (spinning gum)
2′. Buds and fruits in clusters of 7 or more ..... *E. risdonii* (Risdon peppermint)
1′. All leaves free (not fused) 3
3. Ironbark, the bark rough, deeply furrowed, very hard (not easily pulled from tree), dark brown, gray, or black, retained on trunk and limbs ..... *E. melanophloia* (silver-leaved ironbark)
3′. Not ironbarks, the bark smooth or rough, fibrous, shallowly furrowed, soft, brown to gray, retained on trunk and limbs or shedding in strips, plates, or sheets, leaving trunk smooth 4
4. Mallees or multistemmed shrubs 5
5. Stems square in cross-section 6
6. Leaves sessile, inflorescences compound, at branch tips (terminal) ..... *E. pruinosa* (silver box, silverleaf box)
6′. Leaves petiolate and sessile, inflorescences unbranched umbels, in leaf axils 7
7. Buds pedicellate, in clusters of 3 ..... *E. pleurocarpa* (tallerack)
7′. Buds sessile, in clusters of 7 or more ..... *E. neglecta* (Omeo gum)
5′. Stems round in cross-section 8
8. Buds and fruits in clusters of more than 3 9
9. Leaves crowded on stem; flowers greenish yellow; fruit < 0.75 cm wide; valves at rim level ..... *E. kruseana* (bookleaf mallee)
9′. Leaves not crowded on stem; flowers pale yellow or whitish; fruit > 1 cm wide; valves exserted ..... *E. crucis* (Southern Cross silver mallee)
8′. Buds and fruits in clusters of 3 or solitary in leaf axils 10
10. Buds and fruits solitary in leaf axils 11
11. Buds and fruits pedicellate on downturned peduncles .... *E. rhodantha* (rose mallee)
11′. Buds and fruits sessile on erect, stout peduncles ..... *E. macrocarpa* (mottlecah)
10′. Buds and fruits in clusters of 3 12
12. Buds and fruits sessile; flowers white; fruit < 1.5 cm wide ..... *E. pulverulenta* (silver-leaved mountain gum)
12′. Buds and fruits pedicellate; flowers pink or red or pale yellow; fruit > 2 cm wide ..... *E. pyriformis* (Dowerin rose)
4′. Trees 13
13. Bark smooth, shedding, sometimes with imperfectly shed rough bark on basal area of trunk 14
14. Inflorescence pendulous, fruit urn-shaped ..... *E. urnigera* (urn gum)
14′. Inflorescence erect, fruit barrel- or cup-shaped 15
15. Some leaf margins crenulate; fruit 1 cm wide, sessile ... *E. cordata* (heart-leaved silver gum)
15′. All leaf margins entire; fruit < 1 cm wide, very shortly pedicellate .... *E. gunnii* (cider gum)
13′. Bark rough, furrowed, retained on trunk and limbs 16
16. Buds and fruits in clusters of 3 ..... *E. cinerea* (mealy stringybark, Argyle apple)
16′. Buds and fruits in clusters of more than 3 17
17. Leaf margins crenulate ..... *E. crenulata* (Buxton gum)
17′. Leaf margins entire 18

←
I–K. Inflorescence characteristics. —L. Typical leaf with oil glands, taken from *E. camaldulensis*. —M. Leaf lacking oil glands, taken from *Corymbia ficifolia* (F. Muell.) K. D. Hill & L. A. S. Johnson. —N. Developmental series of flowering and fruit formation in *E. torquata*. —O. Flower bud characteristics, taken from *E. prava* L. A. S. Johnson & K. D. Hill. —P. Flower bud and operculum terminology. A–O scale bars = 1 cm.

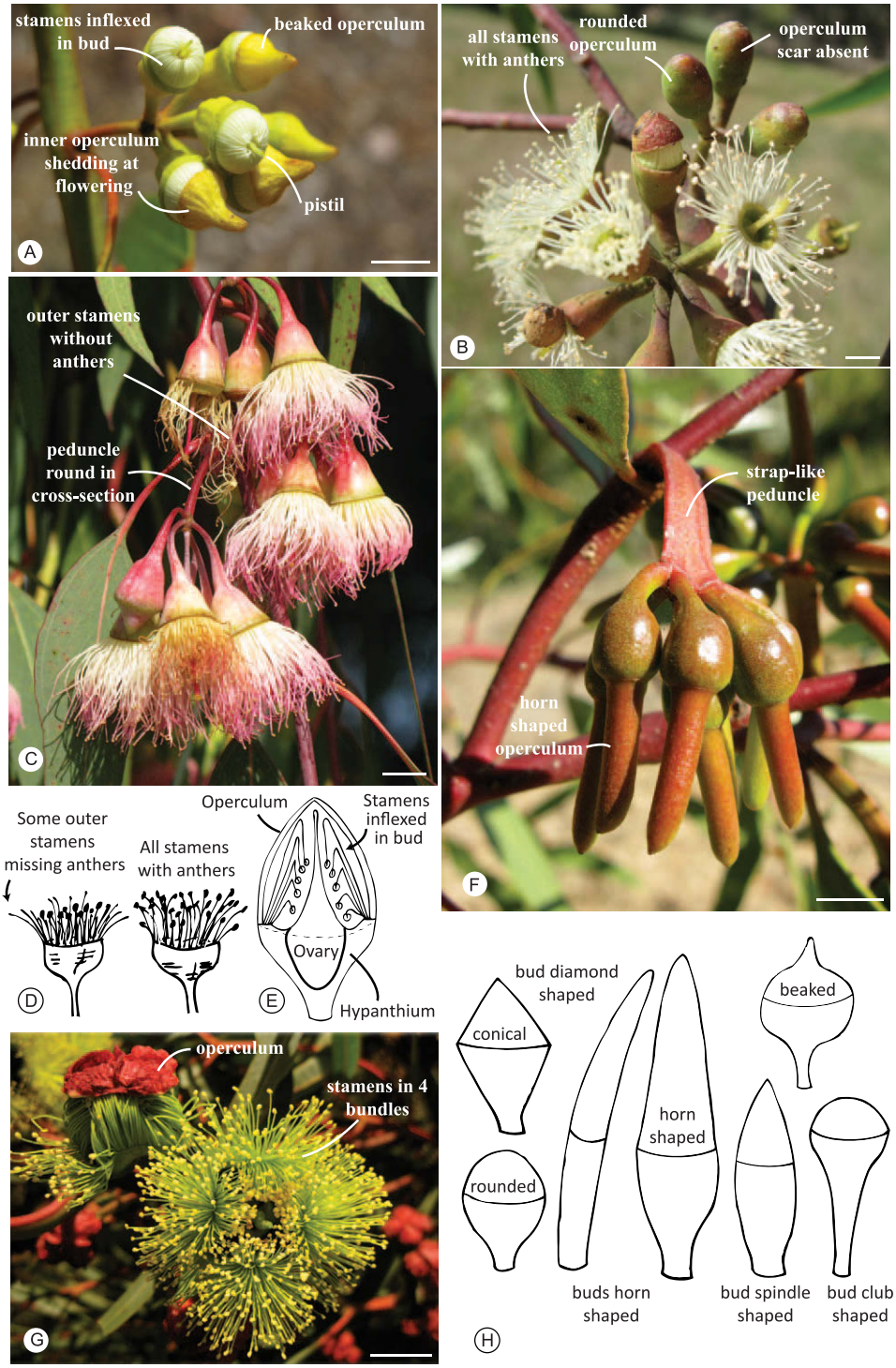

Figure 3. Inflorescence and flower characteristics in *Eucalyptus*. —A. Flower bud characteristics, showing the beaked operculum and stamens that are all bent inward under the operculum, taken from *E. incrassata* Labill. —B. Flower bud characteristics, illustrating the lack of an operculum scar, a rounded operculum, and stamens that are all fertile, taken from *E. diversicolor* F. Muell. —C. *Eucalyptus sideroxylon* A. Cunn. ex Woolls, showing umbels with a peduncle that is round in cross-section and flowers with outer stamens without anthers. —D, E. Stamen and floral bud characteristics. —F. *Eucalyptus eremophila* (Diels) Maiden, with the umbel showing a straplike peduncle and the flowers with horn-shaped opercula. —G. *Eucalyptus erythrocorys* F. Muell., with the flowers illustrating the bright red opercula and yellow stamens bundled in four groups within the flower. —H. Flower bud and operculum shapes. A–G scale bars = 1 cm.

18. Buds and fruits in clusters of 7 to 15, oval, sessile ..... *E. neglecta* (Omeo gum)
18′. Buds and fruits in clusters of 7, diamond-shaped, sessile or very shortly pedicellate ..... *E. conspicua* (Gippsland swamp-box)

Group 2, Ironbarks, Trees with Very Hard, Dark Bark

This group contains species called ironbarks in which the bark is impregnated with hardened kino (a dark gummy exudate), making the bark rough, thick, deeply furrowed, very hard (not easily pulled from tree), dark brown, gray, or black, and retained on trunk and limbs (Fig. 1F, *Eucalyptus sideroxylon* L. A. S. Johnson & K. D. Hill). These species primarily occur in eastern and northeastern Australia and are exemplified by *E. crebra* Labill. and *E. paniculata* Sm.

1. Leaves always opposite, glaucous on mature trees ..... *Eucalyptus melanophloia* (silver-leaved ironbark)
1′. Leaves mostly alternate, not glaucous on mature trees 2
2. Outer stamens without anthers 3
3. Adult leaves discolorous ..... *E. paniculata* (gray ironbark)
3′. Adult leaves concolorous 4
4. Buds and fruits in clusters of 7; leaves dull ..... *E. sideroxylon* (red ironbark)
4′. Buds and fruits in clusters of more than 7; leaves glossy ..... *E. sieberi* (silvertop ash)
2′. All stamens with anthers 5
5. Inflorescences unbranched umbels in leaf axils (not true ironbarks, but may be mistaken as such) ..... *E. bridgesiana* (apple box)
5′. Inflorescences compound (highly branched) clusters at branch tips 6
6. Operculum rounded; fruit valves enclosed ..... *E. crebra* (narrow-leaved ironbark)
6′. Operculum conical; fruit valves exserted 7
7. Operculum 1.5× hypanthium length; valves of mature fruit clearly exserted; fruit up to 1 cm wide ..... *E. fibrosa* (broad-leaved ironbark)
7′. Operculum equal to hypanthium; valves of mature fruit only slightly exserted or at rim level; fruit 0.5–0.7 cm wide ..... *E. siderophloia* (ironbark)

Group 3, Trees or Mallees with Discolorous Leaves

This group contains species with discolorous leaves (Fig. 2F, *Eucalyptus robusta*). The upper (adaxial) and lower (abaxial) surfaces of mature leaves are of different colors. The upper surface of the leaf is usually darker green than the lower surface. Examples of species with discolorous leaves are *Corymbia ficifolia* F. Muell. and *E. cladocalyx* F. Muell.

1. Adult leaves opposite; bark pink or orange, smooth to the ground; operculum absent ..... *Angophora costata* (apple gum)
1′. Adult leaves alternate; bark varying; operculum present 2
2. Mallee; sepals small, pointed, usually apparent on the buds and fruits ... *Eucalyptus curtisii* (Plunkett mallee)
2′. Tree; sepals fused into an operculum or sepals not apparent 3
3. Bark smooth and shedding completely, or bark rough on the trunk and shedding from the largest limbs and branches 4
4. Inflorescences compound, highly branched clusters at branch tips or in leaf axils 5
5. Bark multicolored, with orange and light green patches; fruit < 0.5 cm wide ..... *E. deglupta* (rainbow gum, Mindanao gum)
5′. Bark slaty green, dark green, or gray; fruit > 0.75 cm wide ..... *Corymbia torelliana* (blood-leaf gum, cadaghi)
4′. Inflorescences unbranched umbels in leaf axils 6
6. Valves of mature fruit clearly enclosed within fruit rim 7
7. Leaves highly shiny, leaf oil glands small, obscure; buds and fruits born on leafless sections of branchlets; operculum scar obvious; mature leaves often sickle-shaped; dried fruit with longitudinal ridges ..... *E. cladocalyx* (sugar gum)
7′. Leaves dull, leaf oil glands obvious; buds and fruits born in leaf axils; operculum scar obscure or absent; mature leaves lanceolate; dried fruit not ridged ... *E. diversicolor* (karri)
6′. Valves of mature fruit exserted beyond fruit rim or level with fruit rim 8
8. Valves of mature fruit at rim level or only slightly exserted 9
9. Bark shedding, mostly or completely smooth to the ground, occasionally with a short stocking of rough bark at the base ..... *E. deanei* (mountain blue gum)
9′. Bark retained on lower trunk, mostly rough and fibrous, smooth on upper branches ..... *E. urophylla* (Timor mountain gum)
8′. Valves of mature fruit strongly exserted 10
10. Bark gray, mottled, shed in patches, exposing orange, coppery new bark, usually smooth to the ground ..... *E. punctata* (gray gum)

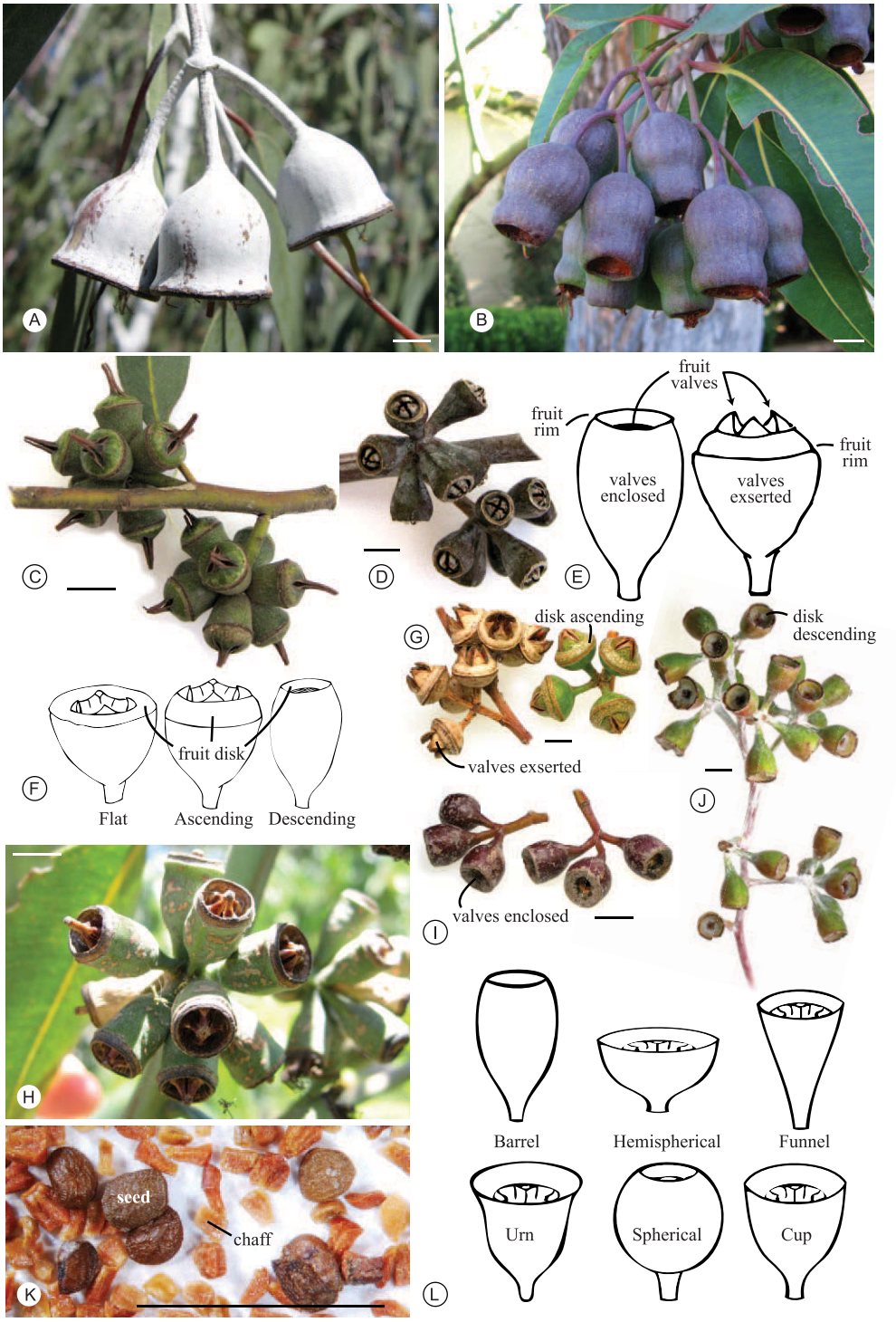

Figure 4. Fruit and seed diversity in eucalypts. —A. *Eucalyptus caesia* subsp. *magna* Brooker & Hopper, illustrating a 3-fruited cluster. —B. *Corymbia calophylla* (Lindl.) K. D. Hill & L. A. S. Johnson, with urn-shaped fruit. —C. *Eucalyptus cornuta* Labill., showing the exserted valve tips that are connected in mature fruit. —D. *Eucalyptus grandis* W. Hill, with mature fruits, each of which reveal four exserted and inward curved valves. —E. Fruit valve characteristics. —F. Fruit disk characteristics. —G. *Eucalyptus camaldulensis* Dehnh., with fruit having exserted valves and ascending disks. —H. *Eucalyptus robusta* Sm., with fruit valve tips connected in mature fruit, these valves persisting even after seeds are shed. —I. *Eucalyptus leucoxylon*

10′. Bark smooth and cream-colored, or pale gray, or white, sometimes fibrous and flaky at the base (to ca. 2 m above ground) or rough for most of the trunk and smooth on the branches 11
11. Valves of mature fruit 4 or 5, curved inward; buds often glaucous ..... *E. grandis* (rose gum)
11′. Valves of mature fruit usually 4, erect; buds not glaucous ..... *E. saligna* (Sydney blue gum)
3′. Bark rough, furrowed, retained on trunk and large limbs 12
12. Inflorescences as highly branched clusters at branch tips or in leaf axils 13
13. Valves of mature fruit level with fruit rim or exserted beyond fruit rim 14
14. Inflorescences compound, in leaf axils; all stamens with anthers; stamens not clustered ..... *E. cloeziana* (gympie messmate)
14′. Inflorescences at branch tips, outer stamens without anthers; stamens in 4 clusters ..... *E. microcorys* (tallowwood)
13′. Valves of mature fruit deeply enclosed 15
15. Fruit prominently ridged; buds scaly ..... *C. ptychocarpa* (swamp bloodwood)
15′. Fruit smooth; buds not scaly 16
16. Fruit < 1.5 cm wide ..... *C. gummifera* (red bloodwood)
16′. Fruit > 2 cm wide 17
17. Flowers pale orange to deep pink and red; seeds with a wing; leaf oil glands lacking or very sparse ..... *C. ficifolia* (red-flowering gum)
17′. Flowers white; seeds wingless; leaf oil glands numerous ... *C. calophylla* (marri)
12′. Inflorescences as unbranched umbels in leaf axils 18
18. Valves of the mature fruit fused across the fruit opening; fruit cylindrical to barrel-shaped ..... *E. robusta* (swamp mahogany)
18′. Valves of mature fruit free, not connected at the tips; fruit variously shaped 19
19. Valves of mature fruit clearly exserted beyond fruit rim 20
20. Fruit > 1.4 cm wide; fruit disk flat ..... *E. pellita* (large-fruited red mahogany)
20′. Fruit 1 cm or less wide; fruit disk ascending ..... *E. resinifera* (red mahogany)
19′. Valves of mature fruit enclosed, level with fruit rim, or slightly exserted 21
21. Buds and fruits glaucous; flowers bright orange ..... *E. miniata* (Darwin woollybutt)
21′. Buds and fruits green or brown; flowers white 22
22. Peduncles broad, flattened; buds and fruits sessile or nearly so; operculum scar present ..... *E. botryoides* (southern mahogany)
22′. Peduncles slender, round in cross-section; buds and fruits pedicellate; operculum scar absent 23
23. Leaves only slightly lighter on the underside 24
24. Leaves thin; operculum conical to beaked ..... *E. eugenioides* (thin-leaved stringybark)
24′. Leaves thicker, leathery; operculum rounded ..... *E. muelleriana* (yellow stringybark)
23′. Leaves distinctly lighter on the underside, leathery 25
25. Fruit > 1 cm wide; outer stamens erect under operculum when in bud ..... *E. marginata* (jarrah)
25′. Fruit 0.5–1 cm wide; outer stamens bent under operculum when in bud ..... *E. acmenoides* (white mahogany)

Group 4, Trees or Mallees with Compound, Highly Branched Inflorescences

This group contains species in which the flowers are formed in compound, panicle-like, highly branched clusters at branch tips (e.g., *Eucalyptus polyanthemos* Schauer) or in leaf axils (e.g., *Corymbia citriodora* (Hook.) K. D. Hill & L. A. S. Johnson) (cf. diagram, Fig. 2J).

1. Bark shedding, smooth to the ground 2
2. Outer stamens without anthers; inflorescences at branch tips (terminal) ..... *Eucalyptus polyanthemos* (red box, silver dollar gum)
2′. All stamens with anthers; inflorescences in leaf axils 3
3. Leaves lemon-scented when crushed ..... *Corymbia citriodora* (lemon-scented gum)
3′. Leaves with medicinal or spicy scent when crushed (but not like lemon) 4

←
F. Muell., with cup-shaped fruit that have enclosed valves, and fruit in clusters of three. —J. *Eucalyptus polyanthemos* Schauer, with fruit that have descending disks. —K. *Eucalyptus lansdowneana* F. Muell. & J. E. Br., seeds and chaff. —L. Diversity of fruit shapes. A–L scale bars = 1 cm.

4. Trunk uniformly smooth, not mottled, powdery to the touch; fruit thin-walled ..... *C. aparrerinja* (ghost gum)
4′. Trunk mottled, not powdery; fruit thick-walled ..... *C. maculata* (spotted gum)
1′. Bark rough, furrowed, retained on trunk and largest limbs (small branches may be smooth) 5
5. Mallee or multistemmed shrub; operculum scar absent 6
6. Flowers red to mauve to pink ..... *E. lansdowneana* (red-flowered mallee box)
6′. Flowers white, pink, or purple ..... *E. albopurpurea* (purple-flowered mallee)
5′. Tree; operculum scar present or absent 7
7. Bark yellowish or tan, flaky; leaves sickle-shaped; fruit barrel-shaped or urn-shaped; valves enclosed ..... *C. eximia* (yellow bloodwood)
7′. Bark gray, short-fibered, hard (box-type); most leaves lanceolate or ovate to elliptical; fruit variously shaped; valves enclosed or exserted 8
8. Valves of mature fruit clearly exserted beyond fruit rim ..... *E. coolabah* (coolibah)
8′. Valves of mature fruit enclosed or level with fruit 9
9. Operculum scar absent 10
10. Buds and fruits glaucous ..... *E. albens* (white box)
10′. Buds and fruits green or brown (not waxy) 11
11. Outer stamens without anthers; buds curved ..... *E. ochrophloia* (napunyah)
11′. All stamens with anthers; buds straight ..... *E. microcarpa* (inland box)
9′. Operculum scar present 12
12. Outer stamens without anthers; stamens shed together in a ring 13
13. Mature leaves glossy green ..... *E. baueriana* (round-leaved box)
13′. Mature leaves dull, gray-green, bluish green, or glaucous ..... *E. polyanthemos* (red box, silver dollar gum)
12′. All stamens with anthers; stamens shed individually 14
14. Bark of small branches rough 15
15. Leaves ovate to elliptical ..... *E. populnea* (Bimbil box)
15′. Leaves lanceolate ..... *E. largiflorens* (black box)
14′. Bark of small branches smooth, rough bark extending only to base of larger branches 16
16. Valves of mature fruit at rim level and sometimes slightly exserted; leaf oil glands obvious; intramarginal vein present ..... *E. microtheca* (tropical coolibah)
16′. Valves of mature fruit enclosed; leaf oil glands obscure or absent; intramarginal vein obscure or absent ..... *E. intertexta* (gum coolibah)

Group 5, Trees or Mallees with Buds and Fruits Solitary or in Clusters of Three in Leaf Axils

This group contains species in which the flowers are formed in clusters of three on a single stalk in the leaf axils (e.g., *Eucalyptus viminalis* Labill. and *E. cosmophylla* F. Muell.) or are formed solitarily in leaf axils (e.g., *E. globulus* Labill.) (cf. diagram, Fig. 2K).

1. Buds and fruits solitary 2
2. Buds and fruits glaucous; large tree ..... *Eucalyptus globulus* (blue gum, Tasmanian blue gum)
2′. Buds and fruits green, yellow, red, or brown (not waxy); small tree, mallee, or shrub 3
3. Buds round in cross-section, pear-shaped with many ribs ..... *E. stoatei* (scarlet pear gum)
3′. Buds square in cross-section, with 4 wings 4
4. Buds and fruits sessile, stiffly downturned; leaves thick; fruit > 2.5 cm wide ..... *E. tetraptera* (square-fruited mallee)
4′. Buds and fruits pedicellate, pendulous; leaves thin; fruit < 2.5 cm wide 5
5. Operculum slender and beaked ..... *E. dolichorhyncha* (fuchsia gum)
5′. Operculum flat and disklike ..... *E. forrestiana* (fuchsia gum)
1′. Buds and fruits in clusters of 3 6
6. Mallees or multistemmed shrubs 7
7. Operculum bright red; stamens in 4 clusters; adult leaves opposite or nearly so ..... *E. erythrocorys* (redcap gum, Illyarrie)
7′. Operculum red, brown, green, or glaucous; stamens not clustered; adult leaves alternate 8
8. Operculum smooth 9
9. Buds and fruits glaucous ..... *E. caesia* subsp. *magna* (silver princess)
9′. Buds and fruits green or brown (not waxy) 10
10. Valves of mature fruit strongly exserted; bark rough ..... *E. morrisii* (gray mallee)
10′. Valves of mature fruit only slightly exserted or level with fruit rim; bark smooth 11
11. Leaves < 4 cm long ..... *E. vernicosa* (varnished gum)
11′. Leaves > 6 cm long 12
12. Operculum rounded and flattened; fruit bell-shaped ..... *E. preissiana* (bell-fruited mallee)

12′. Operculum beaked or conical; fruit cup-shaped, cylindrical, or funnel-shaped 13
13. Flowers red to pale yellow; fruit funnel-shaped ..... *E. erythronema* (red-flowered mallee)
13′. Flowers white; fruit cup-shaped or cylindrical ... *E. cosmophylla* (cup gum)
8′. Operculum distinctly ribbed or warty 14
14. Operculum warty, scar absent 15
15. Valves enclosed; bark smooth ..... *E. coccifera* (Tasmanian snow gum)
15′. Valves exserted; bark rough ..... *E. serraensis* (Grampians stringybark)
14′. Operculum ribbed, scar present 16
16. Buds and fruits sessile or nearly so 17
17. Leaves glossy green; fruit cylindrical, < 2.5 cm wide ..... *E. angulosa* (ridge-fruited mallee)
17′. Leaves dull, green to blue-green; fruit disk-shaped, > 3 cm wide ..... *E. youngiana* (large-fruited mallee)
16′. Buds and fruits clearly pedicellate (pedicels as long as or longer than hypanthium) ... 18
18. Peduncles stout; fruit with 4 or 5 prominent ridges; bark usually smooth to the ground ..... *E. pyriformis* (Dowerin rose)
18′. Peduncles slender; fruit with > 5 prominent ridges; bark usually rough at the base ..... *E. kingsmillii* (Kingsmill's mallee)
6′. Trees 19
19. Bark rough, furrowed, retained on trunk and limbs ..... *E. longifolia* (woollybutt)
19′. Bark smooth, shedding (sometimes with imperfectly shed rough bark on the basal area of trunk) 20
20. Outer stamens without anthers; flowers red, pink, yellow, orange or white ..... *E. leucoxylon* (white ironbark)
20′. All stamens with anthers; flowers white 21
21. Buds and fruits distinctly square in cross-section ..... *E. steedmanii* (Steedman's mallet)
21′. Buds and fruits round in cross-section or only slightly angled 22
22. Operculum warty and with a central knob; peduncle stout or absent 23
23. Peduncles absent ..... *E. bicostata* (Victorian blue gum)
23′. Peduncles present ..... *E. pseudoglobulus* (Victorian eurabbie)
22′. Operculum smooth or warty, but without a central knob (a beak may be present); peduncle slender 24
24. Valves of mature fruit exserted; fruit disk raised 25
25. Buds and fruits glaucous ..... *E. rubida* (blackbutt candlebark)
25′. Buds and fruits green or brown (not waxy) 26
26. Juvenile leaves lanceolate, glossy, green ..... *E. viminalis* (manna gum, ribbon gum)
26′. Juvenile leaves ovate to elliptical, dull, blue-green ..... *E. dalrympleana* (broad-leaved ribbon gum)
24′. Valves of mature fruit enclosed or level with fruit rim; fruit disk descending or flat .. 27
27. Buds and fruits sessile or pedicels 0.2 cm or less 28
28. Juvenile leaves fused into a single disk; fruit 0.5–0.8 cm wide ..... *E. perriniana* (spinning gum)
28′. Juvenile leaves not fused; fruit 0.8–1.2 cm wide ..... *E. glaucescens* (Tingiringi gum)
27′. Buds and fruits pedicellate 29
29. Peduncles as long as or longer than buds, often downturned; fruit urn-shaped ..... *E. urnigera* (urn gum)
29′. Peduncles shorter than buds, erect; fruit hemispherical, barrel- or slightly urn-shaped 30
30. Leaves glossy with a hooked tip; operculum scar absent; buds warty ..... *E. coccifera* (Tasmanian snow gum)
30′. Leaves dull, gray-green or bluish green, with a pointed tip; operculum scar present; buds smooth ..... *E. gunnii* (cider gum)

Group 6, Trees without an Operculum Scar but with Acutely Angled or Parallel Leaf Veins, and Buds and Fruits in Clusters of More than Seven

This group contains species in which the mature flower buds do not have an operculum scar. Such buds have a single operculum with no circumferential scar on the bud surface caused by the shedding of the outer operculum, as happens in many other eucalypts (cf. Fig. 2P). In this group the buds and fruits are usually in clusters of 11 or more, the disk of the fruit is reddish brown, shiny, and level with the fruit rim (cf. diagrams in Fig. 4E, F). Species in this group also make leaves in which the side leaf veins are few, acutely angled, or parallel (Fig. 2H, *Eucalyptus stellulata* Sieber ex DC.). Exemplar species in the group are *E. pauciflora* Sieber ex Spreng. and *E.*

amygdalina Labill. Taxa in group 6 include the widely grown and naturalized members of *Eucalyptus* subg. *Eucalyptus*, but this is only a partial treatment of this subgenus, which contains approximately 120 taxa.

1. Buds and fruits in clusters of 7 2
   2. Buds green, pedicellate; outer stamens without anthers ..... *Eucalyptus melliodora* (honey box)
   2′. Buds glaucous, sessile; all stamens with anthers ..... *E. albens* (white box)
1′. Buds and fruits in clusters of more than 7 3
   3. Inflorescences usually paired umbels in leaf axils 4
      4. Bark rough, fibrous, retained on both the trunk and limbs ..... *E. fastigata* (brown barrel)
      4′. Bark rough on the lower trunk only; large limbs smooth ..... *E. regnans* (mountain ash)
   3′. Inflorescences always single umbels in leaf axils 5
      5. Leaves with side veins nearly parallel or prominently 3-veined 6
         6. Leaf side veins nearly parallel; buds club-shaped, rounded, sometimes warty ..... *E. pauciflora* (snow gum)
         6′. Leaves prominently 3-veined; buds spindle-shaped, pointed, smooth ..... *E. stellulata* (black sally)
      5′. Leaves with side veins angling toward leaf margin, not parallel-veined or 3-veined 7
         7. Bark rough, fibrous, retained on the entire trunk and large limbs, extending to the small branches ... 8
            8. Outer stamens without anthers ..... *E. sieberi* (silvertop ash)
            8′. All stamens with anthers 9
               9. Most leaves 0.4–1 cm wide ..... *E. amygdalina* (black peppermint)
               9′. Most leaves > 1 cm wide 10
                  10. Adult leaf bases clearly oblique; juvenile leaves pendulous, usually > 6 cm wide, glossy green, petiolate ..... *E. obliqua* (messmate stringybark)
                  10′. Adult leaf bases tapering evenly or almost evenly to the petiole, or occasionally oblique; juvenile leaves upright, usually < 5 cm wide, glaucous or green, sessile or petiolate 11
                     11. Juvenile leaves opposite, sessile; adult leaves always concolorous 12
                        12. Juvenile leaves ovate, gray-green to glaucous ... *E. dives* (blue peppermint)
                        12′. Juvenile leaves narrowly lanceolate or linear, green ..... *E. radiata* (narrow-leaved peppermint)
                     11′. Juvenile leaves alternate, petiolate; adult leaves slightly discolorous or concolorous 13
                        13. Leaves thin; operculum conical to beaked ..... *E. eugenioides* (thin-leaved stringybark)
                        13′. Leaves thicker, leathery; operculum rounded ..... *E. muelleriana* (yellow stringybark)
         7′. Bark smooth, shedding completely, or rough on lower trunk only, with smooth upper trunk and/or large limbs 14
            14. Bark rough on lower trunk only with smooth upper trunk or large limbs 15
               15. Fruit sessile or pedicel < 0.4 cm long ..... *E. olsenii* (Olsen's gum, Woila gum)
               15′. Fruit clearly pedicellate 16
                  16. Peduncles flattened ..... *E. pilularis* (blackbutt)
                  16′. Peduncles round in cross-section or slightly angular 17
                     17. Bark finely fibrous, gray or brown; fruit barrel-shaped; buds often glaucous ..... *E. delegatensis* (alpine ash)
                     17′. Bark furrowed, compact, brown-black; fruit cup-shaped; buds green ..... *E. elata* (river peppermint)
            14′. Bark completely smooth, shedding to the ground 18
               18. Young branches, buds, and fruits warty and glaucous ... *E. coccifera* (Tasmanian snow gum)
               18′. Young branches, buds, and fruits smooth, green or brown 19
                  19. Leaves linear or narrowly lanceolate, smelling of peppermint when crushed ... *E. pulchella* (white peppermint)
                  19′. Leaves lanceolate, without peppermint smell 20
                     20. Fruit 0.9 × 0.9 cm ..... *E. haemastoma* (scribbly gum)
                     20′. Fruit up to 0.6 × 0.7 cm ..... *E. racemosa* (scribbly gum)

Group 7, Trees, Mallees, and Shrubs with Flattened Straplike Peduncles

This group contains species in which the peduncle (the common stalk of the cluster of flowers) is broad, flattened, and straplike (Fig. 3F, *Eucalyptus eremophila* (Diels) Maiden) as opposed to being round in cross-section (Fig. 2C, *E. torquata*). Exemplar species in group 7 are *E. gomphocephala* A. Cunn. ex DC. and *E. utilis* Brooker & Hopper.

1. Valves of mature fruit clearly exserted beyond fruit rim 2
   2. Buds glaucous; operculum warty and with a central knob ..... *Eucalyptus maidenii* (Maiden's gum)

2′. Buds green, yellow, or brown; operculum without a central knob 3
3. Valve tips connected in mature fruit (after seed is shed) 4
4. Branchlet pith glandular ..... *E. cornuta* (yate)
4′. Branchlet pith without oil glands 5
5. Buds and fruits fused at the base 6
6. Apical bud at shoot tip 1–2.2 cm long, feeling triangular when rolled between finger and thumb; peduncle thick, 2–4 cm long; lacking a lignotuber ..... *E. conferruminata* (Bald Island marlock)
6′. Apical bud at shoot tip < 1 cm long, not triangular; peduncle thin; forming a lignotuber ..... *E. lehmannii* (bushy yate)
5′. Buds and fruits not fused at the base 7
7. Operculum smooth or only slightly warty; forming a lignotuber ... *E. talyuberlup* (pretty yate)
7′. Operculum very warty; lacking a lignotuber ..... *E. megacornuta* (warted yate)
3′. Valve tips free in mature fruit 8
8. Leaf veins obscured by numerous oil glands; fruit valves prominent, stout ..... *E. annulata* (open-fruit mallee)
8′. Leaf veins obvious; fruit valves slender 9
9. Bark rough at the base and smooth above; operculum 1.5 to 2.5× longer than hypanthium; forming a lignotuber ..... *E. occidentalis* (flat-topped yate)
9′. Bark smooth to the ground, sometimes with partly detached flakes; operculum equal in length to the hypanthium; lacking a lignotuber ..... *E. astringens* (brown mallet)
1′. Valves of mature fruit enclosed, level with fruit rim, or slightly exserted 10
10. Branchlet pith without oil glands 11
11. Operculum horn-shaped, 2 to 3× longer than hypanthium ..... *E. gardneri* (blue mallet)
11′. Operculum conical to beaked, equal in length to hypanthium ..... *E. cypellocarpa* (monkey gum)
10′. Branchlet pith glandular 12
12. Peduncles glaucous ..... *E. stricklandii* (Strickland's gum)
12′. Peduncles green, yellow, or brown (not waxy) 13
13. Bark rough, furrowed, retained on trunk and limbs; buds shaped like mushrooms ..... *E. gomphocephala* (tuart)
13′. Bark smooth, shedding (sometimes with imperfectly shed rough bark on the basal area of trunk); buds variously shaped 14
14. Buds and fruits usually in clusters of more than 7 15
15. Operculum conical or rounded ..... *E. accedens* (powder bark wandoo)
15′. Operculum horn-shaped 16
16. Leaves very glossy, green; flowers yellow ..... *E. macrandra* (river yate)
16′. Leaves dull, slightly blue-green; flowers white ..... *E. wandoo* (wandoo)
14′. Buds and fruits in clusters of 7 17
17. Some or all stamens inflexed in bud (bent downward under operculum); operculum rounded, conical or beaked 18
18. Operculum narrower than the rest of the bud; flowers red, yellow, or chartreuse ..... *E. cernua* (red-flowered moort)
18′. Operculum same width as the rest of the bud; flowers white ..... *E. incrassata* (ridge-fruited mallee)
17′. All stamens erect when in bud (not bent under operculum); operculum conical or horn-shaped 19
19. Buds smooth, not ridged ..... *E. eremophila* (sand mallet)
19′. Buds ridged or winged 20
20. Leaves lanceolate (usually > 5× longer than wide) ..... *E. utilis* (coastal moort)
20′. Leaves orbicular or ovate (usually < 3× longer than wide) 21
21. Operculum 1.5 to 3× longer than the rest of the bud; valves 4; flowers yellow ..... *E. platypus* (moort)
21′. Operculum same length as the rest of the bud; valves 5 or 6; flowers red ..... *E. nutans* (red-flowered moort)

Group 8, Trees and Mallees Having Fruit with Enclosed Valves or Valves Level with the Fruit Rim

This group contains species in which the mature fruit form valves (the distal end of the capsule that dehisces to allow for seed dispersal) are enclosed and do not emerge from inside the hypanthium (or fruit rim), or that extend to the level of the fruit rim, but not beyond it. Examples of species with valves of mature dehiscent fruit that are either sunken below (proximal to) the fruit rim (e.g., *Eucalyptus torquata* Luehm.) or level with fruit rim (e.g., *E. spathulata* Hook.) (cf. Fig. 4E, G, *E. camaldulensis* Dehnh., 4I, *E. leuoxylon* F. Muell.).

1. Mallees or multistemmed shrubs 2
2. Buds and fruits square in cross-section 3

3. Outer stamens without anthers, flowers white or pink ..... *Eucalyptus calycogona* (square-fruited mallee)
3′. All stamens with anthers, flowers yellow ..... *E. roycei* (Shark Bay mallee)
2′. Buds and fruits round in cross-section 4
4. Buds and fruits glaucous ..... *E. caesia* subsp. *caesia* (caesia)
4′. Buds and fruits not covered with wax 5
5. Leaves held upright on the stem (ascending) ... *E. cneorifolia* (Kangaroo Island narrow-leaved mallee)
5′. Leaves hanging vertically or perpendicular to the stem (spreading) 6
6. Leaves usually with lenticels (indentations) along the edges; buds usually ribbed; operculum beaked ..... *E. incrassata* (ridge-fruited mallee)
6′. Leaves lacking indentations on the distal margins; buds ribbed or not; operculum variously shaped 7
7. Branchlet pith glandular 8
8. Bark rough to the smallest stems 9
9. Peduncles slender, upright; buds pedicellate; flowers white ..... *E. loxophleba* (York gum)
9′. Peduncles stout, prominently downturned; buds sessile; flowers yellow ..... *E. grossa* (coarse-leaved mallee)
8′. Bark smooth, or rough only on the lower portion of the trunk 10
10. Flowers red or yellow; fruit funnel-shaped ... *E. erythronema* (red-flowered mallee)
10′. Flowers white; fruit cylindrical to barrel-shaped 11
11. Leaves glossy, linear to narrowly lanceolate, < 1 cm wide ..... *E. cylindrocarpa* (woodline mallee)
11′. Leaves dull, lanceolate, > 1.5 cm wide ..... *E. dumosa* (white mallee)
7′. Branchlet pith without oil glands 12
12. Bark smooth 13
13. Buds and fruits sessile or shortly pedicellate (< 0.2 cm) ..... *E. kitsoniana* (Gippsland mallee)
13′. Buds and fruits pedicellate ..... *E. flocktoniae* (merrit)
12′. Bark rough 14
14. Leaves with conspicuous black oil dots; operculum scar present ..... *E. gracilis* (white mallee)
14′. Leaves lacking black dots; operculum scar absent 15
15. Leaves linear or narrowly lanceolate, green; buds green ..... *E. viridis* (green mallee)
15′. Leaves lanceolate, bluish gray or bluish green; buds glaucous ..... *E. polybractea* (blue-leaved mallee)
1′. Trees 16
16. Buds and fruits sessile or shortly pedicellate (< 0.2 cm) 17
17. Crown of adult trees contain sessile juvenile leaves ..... *E. parvula* (small-leaved gum)
17′. Crown of adult trees with petiolate adult leaves only 18
18. Branchlet pith glandular ..... *E. dundasii* (Dundas blackbutt)
18′. Branchlet pith without oil glands 19
19. Bark rough to small branches ..... *E. goniocalyx* (long-leaved box)
19′. Bark mostly smooth 20
20. Inflorescence often subtended by a prominent bract; bark coppery in color; operculum rounded ..... *E. kitsoniana* (Gippsland mallee)
20′. Inflorescence not subtended by a bract; bark pale gray or cream-colored; operculum conical ..... *E. nitens* (silvertop)
16′. Buds and fruits pedicellate 21
21. Bark smooth, shedding completely to the ground 22
22. Flowers lemon yellow; bark white or gray; leaves lanceolate, dull; buds glaucous ..... *E. woodwardii* (lemon-flowered gum)
22′. Flowers white; bark coppery or pinkish gray; leaves linear or narrowly lanceolate, glossy; buds green 23
23. All stamens erect in bud (not bent under operculum); operculum horn-shaped; leaves linear, < 0.5 cm wide ..... *E. spathulata* (swamp mallet)
23′. Stamens inflexed in bud (bent downward under operculum); operculum rounded, beaked or conical; leaves lanceolate to narrowly lanceolate, > 0.5 cm wide 24
24. Buds conspicuously ribbed ..... *E. pterocarpa* (Norseman gum)
24′. Buds smooth ..... *E. cylindrocarpa* (woodline mallee)
21′. Bark rough, retained on lower trunk, bark on limbs rough or smooth 25
25. Outer stamens without anthers; branchlet pith without oil glands 26
26. Leaves with conspicuous black oil dots; operculum scar present; operculum rounded or flattened ..... *E. gracilis* (white mallee)
26′. Leaves lacking black dots; operculum scar absent; operculum beaked or conical ..... *E. melliodora* (honey box)
25′. All stamens with anthers; branchlet pith glandular 27

27. Bark rough to the smallest branches ..... *E. loxophleba* (York gum)
27′. Bark rough at the base, smooth and shedding on small branches 28
28. Flowers pink; leaves dull, bluish green; branchlets green, yellow or red ..... *E. torquata* (coral gum)
28′. Flowers white; leaves green; branchlets often glaucous ..... *E. lesouefii* (Goldfields' blackbutt)

Group 9, Trees and Mallees Having Fruit with Valves Clearly Exserted Beyond the Rim of the Fruit

This group contains species in which the valves of the mature fruit are clearly exserted beyond (distal to) the rim of the fruit or hypanthium (e.g., *Eucalyptus camaldulensis* Dehnh. and *E. mannifera* Mudie) (Fig. 4C, E, G).

1. Branchlets and buds glaucous 2
2. Leaves ovate to elliptical ..... *Eucalyptus orbifolia* (round-leaved mallee)
2′. Leaves lanceolate 3
3. Operculum longer than hypanthium ..... *E. blakelyi* (Blakely's red gum)
3′. Operculum equal in length to hypanthium ..... *E. dealbata* (hill red gum)
1′. Branchlets not covered with wax 4
4. Bark rough, furrowed, retained on most or all of the trunk, upper limbs either rough or smooth 5
5. Buds and fruits clearly sessile ..... *E. goniocalyx* (long-leaved box)
5′. Buds and fruits pedicellate, even if shortly so 6
6. Mallee or shrub 7
7. Leaves linear, < 0.5 cm wide ..... *E. formanii* (die hardy mallee)
7′. Leaves lanceolate, > 0.75 cm wide 8
8. Valves needlelike, fragile ..... *E. oleosa* (red morrell)
8′. Valves broad, 3-lobed ..... *E. mannensis* (Mann Range mallee)
6′. Tree 9
9. Bark shedding in long ribbons from upper limbs and sometimes upper part of the trunk ... 10
10. Bark loosely fibrous and fissured; fruit disk not prominent, flat or slightly raised ..... *E. macarthurii* (Paddy's River box)
10′. Bark rough and compact; fruit disk prominent, clearly ascending ..... *E. smithii* (blackbutt peppermint)
9′. Bark not shedding in ribbons, rough to the smallest branches or smooth on the smallest branches 11
11. Juvenile leaves very glaucous, crenulate ..... *E. bridgesiana* (apple box)
11′. Juvenile leaves only slightly waxy, or green, not crenulate (entire) 12
12. Fruit sessile or nearly so (pedicels < 0.2 cm long) ..... *E. aggregata* (black gum)
12′. Fruit pedicellate 13
13. Disk of fruit steeply ascending ..... *E. brassiana* (Cape York red gum)
13′. Disk of fruit level or only slightly ascending 14
14. Bark fibrous, brown; leaves narrowly lanceolate; disk of fruit thin, slightly ascending ..... *E. nicholii* (narrow-leaved black peppermint)
14′. Bark rough, compact, gray; leaves lanceolate to broadly lanceolate to ovate; disk of fruit broad, level ..... *E. rudis* (flooded gum)
4′. Bark smooth, shedding (sometimes with imperfectly shed rough bark on basal area); upper limbs smooth ... 15
15. Branchlet pith glandular 16
16. Flowers yellow or chartreuse; fruit with a prominent flange around the rim; bark brownish or greenish ..... *E. dielsii* (cap-fruited mallet)
16′. Flowers white; fruit without a flange; bark tan or coppery ..... *E. salubris* (gimlet)
15′. Branchlet pith without oil glands 17
17. Bark coppery, salmon-pink, or orange, shiny; leaves glossy, dark green, linear or narrowly lanceolate; fruit valves thin, needlelike ..... *E. salmonophloia* (salmon gum)
17′. Bark white, gray, tan, mottled, dull; leaves green, dull bluish green, or olive-green, lanceolate; fruit valves prominent, triangular 18
18. Bark white, powdery to the touch 19
19. Leaves dull, bluish green ..... *E. mannifera* (brittle gum, red spotted gum)
19′. Leaves glossy green ..... *E. scoparia* (Wallangara white gum)
18′. Bark gray or tan, sometimes white, not powdery 20
20. Fruit funnel-shaped; leaves glossy, often lacking oil glands ..... *E. ovata* (black gum, swamp gum)
20′. Fruit cup-shaped or hemispherical; leaves dull, with translucent oil glands 21
21. Juvenile leaves opposite for more than 10 pairs ..... *E. dunnii* (Dunn's white gum)
21′. Juvenile leaves opposite for fewer than 5 pairs 22

22. Operculum hemispheric, with a distinct beak, equal in length to hypanthium; branches often drooping ..... *E. camaldulensis* (red gum, river red gum)
22′. Operculum horn-shaped or conical, not beaked, 2× longer than hypanthium; branches often steeply ascending ..... *E. tereticornis* (forest red gum)

Taxonomic Treatment

Following the nomenclatural citation for those eucalypt species treated, common names are given. Each taxon is vouchered by a specimen and herbarium of deposit. Preceding the scientific name are two numbers that represent the taxon's position in the key. The key's group number is given first, followed by the particular couplet number in parentheses for the species considered. Both native ranges and the regional locations of naturalized populations, if known, are included. Eucalypt species without documented naturalized populations are included that are either persistent from cultivation or that are in wide horticultural use (e.g., plantations, honey production, shade, windbreaks, ornamentals).

I. Angophora Cav., Icon. 4: 21. 1797. *Eucalyptus* subg. *Angophora* (Cav.) Brooker, Austral. Syst. Bot. 13: 85. 2000. TYPE: *Angophora cordifolia* Cav.

Trees; bark rough or smooth. Leaves opposite, discolorous. Inflorescences compound, at branch tips. Flowers with the sepals persistent on woody fruit and the petals free within the inner floral whorl. Approximately 15 taxa, one of which is naturalized.

3 (1). Angophora costata (Gaertn.) Hochr. ex Britten, J. Bot. 54: 62. 1916. Basionym: *Metrosideros costata* Gaertn., Fruct. Sem. Pl. 1: 171. 1788.

Common name: apple gum.

Voucher: U.S.A. California, *Yost & Ritter 235* (OBI).

Native to: New South Wales, Queensland. Naturalized: California.

Trees; bark smooth, pink to orange. Leaves opposite, discolorous, lanceolate, petioled. Inflorescences compound, at branch tips. Flower buds with 5 small persistent sepal teeth; petals and stamens white. Fruits barrel-shaped to cylindrical, ribbed; valves enclosed.

II. Corymbia K. D. Hill & L. A. S. Johnson, Telopea 6: 214. 1995. *Eucalyptus* subg. *Corymbia* (K. D. Hill & L. A. S. Johnson) Brooker, Austral. Syst. Bot. 13: 85. 2000. TYPE: *Corymbia gummifera* (Gaertn.) K. D. Hill & L. A. S. Johnson [≡ *Metrosideros gummifera* Gaertn.].

Trees; bark rough or smooth. Leaves alternate, discolorous or concolorous, usually lanceolate, entire. Inflorescences compound, at branch tips or in leaf axils. Outer operculum held to just before flowering; operculum scar usually absent. Approximately 100 taxa, with nine species considered here.

4 (4). Corymbia aparrerinja K. D. Hill & L. A. S. Johnson, Telopea 6: 453. 1995.

Common name: ghost gum.

Voucher: Australia, Gosse Range, SW Macdonnell Ranges, May 1925, *H. Basedow s.n.* (type, NSW-10075, not seen).

Native to: North West Australia, North Australia, Queensland.

Trees; bark uniformly smooth, powdery, not mottled, white. Leaves alternate, concolorous, lanceolate, glossy. Inflorescences compound, in leaf axils. Flowers white, all stamens with anthers. Fruits cup-shaped, thin-walled.

3 (17′). Corymbia calophylla Lindl., Telopea 6: 240. 1995. Basionym: *Eucalyptus calophylla* Lindl., Edwards' Bot. Reg. 27(157): 72. 1841.

Common name: marri.

Voucher: U.S.A. California, *Ritter 93* (OBI).

Native to: South West Austrailia. Naturalized: Hawaii, New Zealand.

Trees; bark rough, flaky, brown. Leaves alternate, discolorous, broadly lanceolate. Inflorescences compound, at branch tips; operculum scar absent. Flowers white. Fruits urn-shaped, thick, woody, > 2 cm wide; valves enclosed; seeds wingless.

4 (3). Corymbia citriodora (Hook.) K. D. Hill & L. A. S. Johnson, Telopea 6: 388. 1995. Basionym: *Eucalyptus citriodora* Hook., J. Exped. Trop. Australia 235. 1848.

Common name: lemon-scented gum.

Voucher: U.S.A. California, *Eastwood s.n.* (CAS-45201).

Native to: Queensland. Naturalized: California, Hawaii, India, South Africa, South West Australia, Victoria, Zimbabwe.

Trees; bark smooth, white, cream, to pink. Leaves alternate, concolorous, narrowly lanceolate, lemon-scented. Inflorescences compound, in leaf axils. Flowers white. Fruits urn-shaped or barrel-shaped; valves enclosed.