

***Eucalyptus petraea* sp. nov. and *E. lucasii* (Myrtaceae) : two Western Australian boxes**

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Abstract

Carr, D. J. and S. G. M. *Eucalyptus petraea* sp. nov. and *E. lucasii* (Myrtaceae): two Western Australian boxes. Nuytsia 4(3): 279-292 (1983). A new species, *Eucalyptus petraea*, of the taxonomic group (section Adnataria) which includes the boxes and ironbarks, is described. Its morphology and that of *E. lucasii*, another of that group, is discussed in detail. Both are from the south-west of Western Australia. The new species is highly disjunct in distribution in a narrow latitudinal belt. It occurs around the base of, or on, some of the granite boulders which outcrop in the Eastern Goldfields. The ecological basis of its habitat preference is discussed. *Eucalyptus lucasii* has a more continuous distribution within the Austin Botanical District with a few more easterly outliers. The two species differ in a number of floral, fruit and leaf characters. The cuticular pattern of the adult leaves is characteristic of each species and is species-constant. *Eucalyptus petraea* is characterised by a marked tendency to androdioecism, the possible adaptive value of which is discussed.

Introduction

Until mid-century it was believed that the eucalypts commonly known as boxes and ironbarks (section Adnataria, Pryor and Johnson 1971) were restricted to the Eastern States of Australia (excluding Tasmania) and the tropics and were absent from extra-tropical Western Australia. It is true that Blakely (1934) had included a new species from that area, *E. lucasii*, in his section Porantheroideae, but doubts were expressed, particularly by Gardner, concerning the authenticity of the materials on which the new species was based (Johnston and Marryat 1965). The fact that *E. intertexta* R. T. Baker, now regarded as a box, had been collected by Helms in 1891 in the Cavenagh Range was not taken into account by Gardner (1953) because Blakely had placed it in another section (Paniculatae) of the genus. Specimens collected over the last thirty years have established that *E. lucasii* is a reasonably abundant and authentic species, and that *E. intertexta* occurs elsewhere in W.A. than in the Cavenagh Range. There is also a third species which we propose now to describe.

***Eucalyptus petraea* D. J. Carr et S. G. M. Carr, sp. nov.**

Ad 'boxes' et 'ironbarks' affinis, a qua coniunctione sequente characterorum differt: *operculum* exterius mox ante anthesin abscissum; *cicatrix operculina* sulcum circularem ad orificium fructus faciens; *staminodia* numerosa, filamenta staminum brevia; *medulla* caulis sine glandibus oleosis; *cortex* tenuis, in caule inferiore asper et fibrosus, ex et caule superiore et ramis a taeniis longis exfoliatus.

Typus: Gnarlbine Rock, 31°09'S 120°57'E, Western Australia, 29 Nov. 1980, D. J. Carr et S. G. M. Carr 2373 (holo: CANB).

A species allied to the 'boxes' and 'ironbarks' but distinguished by the following combination of characters: *outer operculum* abscising shortly before anthesis; *opercular scar* forming an annular groove at the orifice of the fruit; *staminodes*

numerous with long filaments; *stamens* with short filaments; *pith* of stem lacking oil glands; *bark* rough and fibrous but relatively thin on lower trunk, deciduous in long ribbons on the upper trunk and branches.

Lignotuberous tree to 14 m tall or a *mallee* (Figure 2A-D), with a finely-fissured, dark-grey, rough, fibrous *bark* (Figure 2D) which is persistent on the lower trunk to 3-10 m but deciduous in long ribbons from the upper trunk and branches. *Adult leaves* alternate, pendulous, concolorous, coarse-textured, dark-green and glossy when fresh, yellowish when dry, lanceolate, 7-12 cm long, 2-2.5 cm broad. Midrib distinct, lateral veins at an angle of $\pm 30^\circ$, intramarginal vein irregular, distant from the margin, with conspicuous minor venation between it and the margin. *Cuticle* of adult leaves thick, smooth and invariably without ornament on both surfaces (Figure 6 [1-6]) and quite different from that of *E. lucasii* (Figure 6 [7-12]). *Synflorescences* acrotonic, unit inflorescences (3-)7-flowered, the proximal ones in the axils of leaves, the distal ones paniculate. Flowers sometimes functionally male. *Peduncles* 1.3-1.8 cm long, angular in cross-section. *Pedicels* somewhat angular, 3-7 mm long. *Flower buds* with two opercula, the outer of which is shed only a few days before anthesis, leaving a wide, very obvious opercular scar. *Petaline operculum* shorter than broad and much shorter than the hypanthium plus pedicel, usually bluntly conical. *Stamens* very numerous in as many as eight rows; *filaments* very slender, all inflexed in bud, inserted on an annular staminophore which projects beyond the orifice of the flower; *outer stamens* anantherous (Figure 3C), their filaments very long, spreading at anthesis; *fertile stamens* with short, more or less erect filaments; *anthers* basifixed, not versatile, broader than long, dehiscent by pores (Figure 3A, B, D). *Nectary* lining the tube of the flower. *Style* shorter than the stamens but projecting beyond the orifice of the flower. *Ovary* with 4-6 loculi; ovular structures in 4 longitudinal rows on the placenta, ovules situated on the margins of the lower part of the placenta. *Capsule* deeply included in the hypanthium, dehiscent by loss of a styler stub or a lobed, circumscissile lid, valves of fertile fruits absent or incomplete. (The modes of dehiscence are as described by Brooker 1975, and by Carr and Carr 1980). *Hypanthium* thick-walled, coarsely wrinkled in the dry fruit, orifice not contracted, rim broad, marked by a circular groove in which the opercular scars are situated. *Seeds* hemitropous, dorsiventrally compressed, testa dark brown, surface netted. *Cotyledons* oval. *Seedling leaves* petiolate, relatively thin, early ones ovate, later ones lanceolate, acuminate (Figure 5), the intramarginal vein close to the margin of the leaf, especially near the base of the lamina. *Lignotubers* are formed at the cotyledonary node and nodes of the first 4-5 leaf pairs. *Seedling stem* above the 4th pair of leaves square in cross section and pink. Oil glands conspicuous on stem and petioles but not protuberant. *Intermediate leaves* and leaves on reversion shoots (Figure 5A) broadly ovate, sub-glaucous, intramarginal vein distant from the margin.

Selected specimens examined. 4.1 km N of Karonie on track to Cardunia Rocks, *D. Blaxell* 1746 (FRI); Chiddarcooping Rock, *M. I. H. Brooker* 6486 (FRI); Near Horse Rocks, *Carr & Carr* 1250 (CANB); Woolgangie, 30.8 mi. (49.3 km) from Bullabulling on rock, *Carr & Carr* 1254 (CANB); Boorabbin, on rock to N of road, *Carr & Carr* 1258, 1259 (CANB); Yellowdine Rock, *Carr & Carr* 1263 (CANB); Moorine Rock, *Carr & Carr* 1265 (CANB); Queen Victoria Rock, *Carr & Carr* 2367, 2368, 2369, 2375, 2376 (CANB); Baladjie rock, *Carr & Carr* 2377 (CANB); Yellowdine Rock. *S. G. M. Carr & P. G. Wilson* 4042 (PERTH); 1 mi. (1.6 km) E of Karonie, (as '*E. lucasi*') *R. D. Royce* 5245, 5247, 5248 (PERTH); 1 mi. (1.6 km) W of Warrachuppin, 25 Aug. 1981, *B. H. Smith* s.n.; Dulyalbin Rock, 10 Oct. 1981, *B. H. Smith*, s.n.

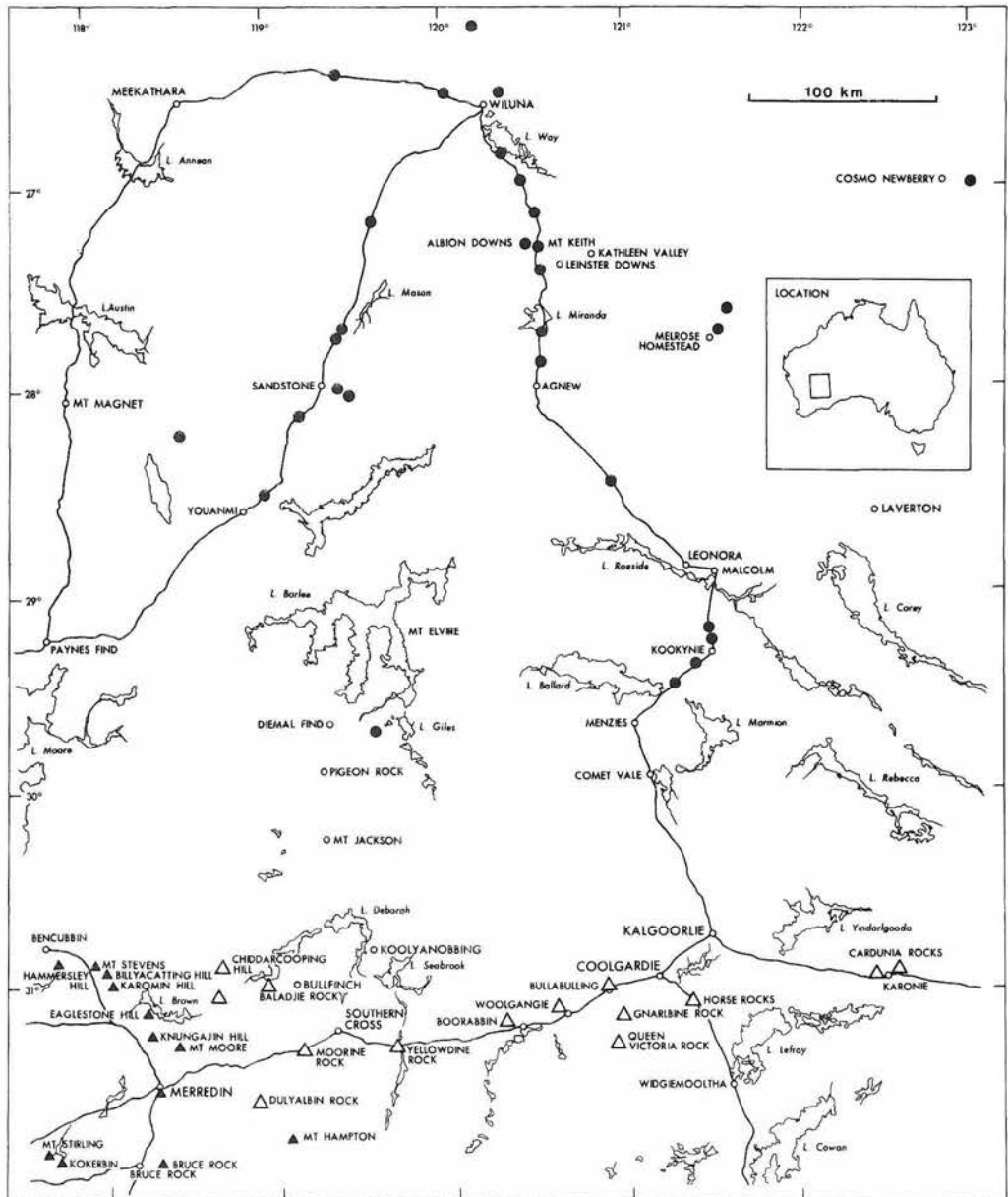


Figure 1. Map of distribution of *E. lucasii* (black circles) and *E. petraea* (large open triangles). Small black triangles represent localities (granite boulders) searched for, but lacking, *E. petraea*.

Distribution and habitat. The species occurs (Figure 1) as isolated populations in the vicinity of granitic boulders or "rocks" in an area bounded by latitudes 30°54' and 31°17', and longitudes 118°40' and 122°32', i.e. in parts of the wheat belt and transitional woodland, as defined by Erickson et al. (1973). Information on sites of its occurrence and on potential sites where it does not occur, together with additional

information of the same kind provided by Mr and Mrs Basil Smith of Manmanning appears to define all except the eastern boundary of its distribution. It is not known whether the species occurs east of the Karonie district.

A general account of the vegetation of the area in which *E. petraea* occurs has been published by Beard (1969) but he does not deal with the marked zonation of trees or tall mallees at the foot of the granitic 'domes' or boulders. The relatively bare rock surfaces form excellent catchments and the soil around the base of the dome receives a copious flow of rainwater. It is surprising that *E. petraea* was not collected or recognised long ago, for many of its localities (e.g. Moorine) were known a century or more ago to settlers and miners as places at which reliable supplies of water were available, either in gnamma holes or by sinking wells. The now disused but historic well or 'soak' at Gnarlbine is surrounded by tall trees of *E. petraea*. They, or their predecessors, were almost certainly present when the surveyor, H. Maxwell Lefroy, first camped there in 1863 (Harris 1942).

The vegetation peculiar to the granite rocks of South Western Australia has been described by Smith (1962) and by N. G. Marchant, in Erickson et al. (1973: 191-194). Notes with Brooker's Karonie specimen (2458 FRI), refer to its occurrence "in clefts of and near the top of granite rocks". At Yellowdine Rock a large tree of *E. petraea* has colonised such a crevice, but it is an unusual habitat for the species. It is evident from Figure 1 that *E. petraea* is restricted to only a few of the granitic boulders of the area, of which there are perhaps as many as a hundred. The east-west distribution of the sites of its occurrence bears no relationship to the geology of the district or to the size of the boulders. Some very large boulders such as those at Mt Hampton, Mt Stirling, Merredin and Hyden (the latter lying south of the area shown on the map) lack *E. petraea*, while it is present on some relatively small ones as at Horse Rocks, Gnarlbine and Boorabbin. The soils in which *E. petraea* grows are gravelly sands, evidently derived in part, as described in Erickson et al (1973), from exfoliation and ablation of the granite.

We suggest that the conformational relationship of the base of the rock to the surrounding soil is a main determining factor in the present distribution of *E. petraea*, which appears to require a considerable depth of soil at the immediate foot of the rock. At Mt Hampton, for instance, the soil is shallow for some distance away from the foot of the rock, as evidenced by the fact that the well has been dug some 200 m further out. In such shallow soils, trees of *Acacia lasiocalyx* C. Andrews, *Casuarina huegeliana* Miq., *Eucalyptus loxophleba* Benth. and *E. salmonophloia* F. Muell. occupy successive zones at the foot of the rock. Where it occurs in quantity, *E. petraea* displaces *Acacia lasiocalyx*. Similarly, small outcrops of rock, near which the soil is shallow, do not appear to provide suitable sites for *E. petraea*.

The present distribution of *E. petraea* may well have resulted from breakdown of a former wider distribution, as Erickson et al. suggest for other granite boulder species. If the rainfall and consequently the soil moisture storage were higher than at present, it is possible that *E. petraea* could successfully compete for sites away from deep soils at the base of granite rocks. Indeed, at Horse Rocks and at Karonie, the species occurs at some distance from the outcropping rocks themselves; at Horse Rocks, *E. petraea* grows in moist gravelly sand, at Karonie, according to notes with Blaxell's specimen 1746, it is a "locally abundant mallee to 6 m in scrub of this species, *E. kruseana* and *E. brachyphylla* in sandy loam over granite on a low rise".



Figure 2. *E. petraea* (A) At Queen Victoria Rock. (B) At Baladjie, near the base of the rock. (C) The zone of *E. petraea* around the base of the granite boulder at Baladjie. (D) Lignotuber of tree at Queen Victoria Rock. Note also the fibrous, rough bark.

If the breakdown of a more continuous distribution of *E. petraea* had occurred some thousands of years ago, morphological variation from locality to locality ought to be more apparent than it is (cf. Kirkpatrick 1976). The seedlings from different localities, for instance, are remarkably uniform (Figure 4B). In contrast, the inter-locality morphological variation of *E. orbifolia* and *E. caesia* is comparatively large (Hopper et al. 1982). Although the cuticular pattern of *E. petraea* is invariant from locality to locality, variation in stomatal size is not greater than it is in other eucalypts of a more continuous distribution, but on the other hand stomatal frequency varies considerably (unpublished data).

Discussion. The flowers and fruits of *E. petraea* are quite variable in shape, complicating the description of the species. But much of the variation can be understood as a dimorphism based on the fact that many of the flowers are functionally male. Male flowers and indeed male trees of eucalypts have already been described (Carr et al. 1971; Carr & Carr 1972). In *E. petraea* the male flowers are characteristically long, with a long hypanthium tapering into the pedicel; the functionally hermaphrodite flowers are more rounded and club-shaped. Fruits may be set from either type of flower; fruits from male flowers contain no viable seeds, because the ovules lack or have imperfect embryo sacs. Fruits derived from male flowers may remain closed, the valves not separating sufficiently to allow the contents of the loculi to be released. The percentage of male flowers varies from site to site and between individual trees, but probably not from season to season. The single tree of *E. petraea* at Yellowdine has been sampled on several occasions by different collectors over a period of at least 3.5 years, but in none of the collections do the fruits contain viable seeds and examination of a large sample of the flowers reveals them to be all functionally male. It would be desirable to extend the examination to individual trees at other sites and over a long period of years. The single male tree, perched high on the boulder at Yellowdine, may be the only survivor of a population exterminated for firewood or for mining timbers. The only collection from Chiddarcooping Rock (Brooker 6486) has no fruits and only male flowers. Such a marked tendency towards androdioecism may have its explanation in terms of as yet unknown or even now extinct pollinators. It seems unlikely that pollen from the tree at Yellowdine could reach the nearest hermaphroditic flowers at Boorabbin or Moorine Rock, over 80 km away, unless carried by wide-ranging pollinators such as lorikeets (Cleland 1969; Churchill and Christensen 1970). The paniculate masses of white flowers of *E. petraea* would be readily visible to dusk- and night-flying moths, which Main (1981) suggests as possible pollinators of the white-flowered forms of otherwise red-flowered Myrtaceae of the granite boulders. Accidental survival of only male trees at some localities following breakdown of a former continuous distribution seems a plausible explanation of their present occurrence; it is also likely that long-term survival in some localities may depend on repeated regeneration from the lignotuber and that some of the trees—e.g. that at Yellowdine—may be very old indeed, as is suggested by Marchant in Erickson et al (1973) for other granite boulder species.

The discovery and authentication of *E. lucasii*.

Eucalyptus lucasii Blakely ("Lucasi"), Key to the eucalypts, pp. 226-227 (1934).
Type: Lake Barlee, *Fitzgerald Fraser*, per W. C. Grasby, Sept. 1919 (holo: NSW 145672).

Tree to 10 m or mallee. *Bark* smooth, decorticating in short strips, coppery-brown when fresh, turning grey with age; if stocking of rough bark is present at the base, its height is much less than 2 m. *Bark* and *pith* of stem without oil glands. *Adult leaves* alternate, petiolate \pm lanceolate, thin-textured, grey-green or sub-glaucous (and remaining so when dried), 6-14 cm long, 0.8-2.1 cm wide, with conspicuous oil glands between the intramarginal vein and the margin of the leaf. *Intermediate* and *reversion leaves* ovate, petiolate, very glaucous, 4-5 cm x 2-2.7 cm. *Early seedling leaves* petiolate, ovate, later ones spatulate, relatively thick in texture in contrast with adult leaves, opposite or sub-opposite until at least the 9th pair. *Midrib* conspicuous, *intramarginal vein*, distant from the edge of the leaf in seedling (Figure 5[3]), intermediate and adult leaves. *Oil glands* markedly protuberant on the cylindrical seedling stem and petioles. *Synflorescence* acrotonic, forming a short terminal panicle, unit inflorescences 3-7-flowered. *Peduncles* terete. *Buds* clavate, pedicellate, the

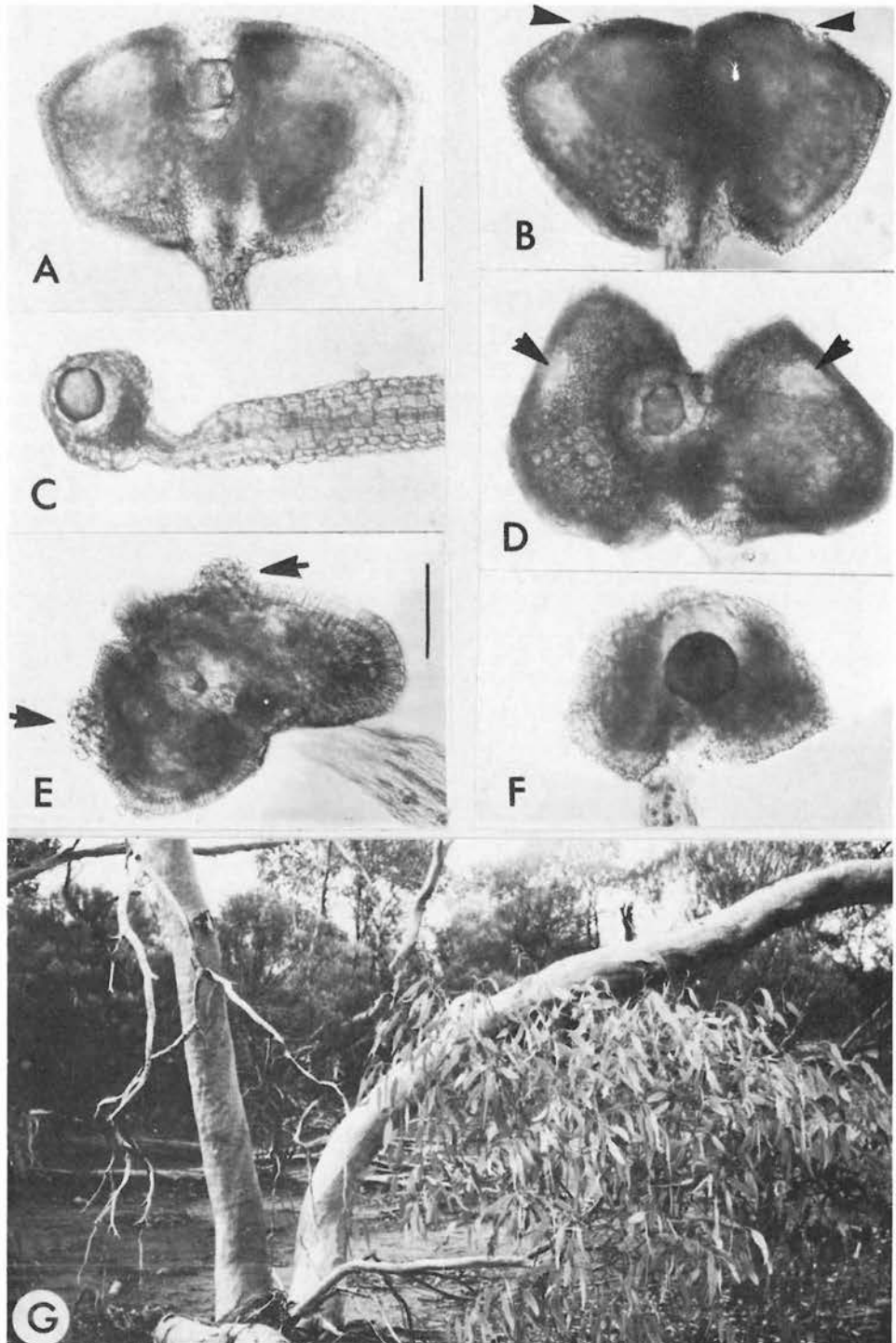


Figure 3. A, B, D, stamens of *E. petraea*, (A) from the back, (B) from the front and (D) seen from above. (C) is a staminode of *E. petraea*. (E) and (F), front and back views of a stamen from the holotype of *E. lucasii*. Arrows in (B) (D) and (E) indicate the pores from which pollen is exuded. Scale bars for A-F, 100 microns. (G) *E. lucasii* as a mallee in a typical habitat, a shallow, flat flood channel.



Figure 4. (A) Branches from Carr and Carr 2373, the type material of *E. petraea*. Scale, cm. (B) Seedlings of *E. petraea*, raised from seeds from four different localities.

outer operculum early deciduous, its scar inconspicuous at bud maturity. *Filaments of stamens* borne on a narrow staminophore which persists in fruit (but becomes eroded in old fruit). *Outer filaments* long, anatherous; *fertile stamens* with short filaments; *anthers* ovoid, basifixed, adnate to the filament, dehiscence poricidal (Figure 3E). *Fruit* ovoid-truncate tapering to a thin pedicel, less robust than those of *E. petraea*. *Valves* 4-5, truncate (incomplete), erect, situated well below the orifice.

Other specimens examined. 27 mi. (43.2 km) from Sandstone on Wiluna Rd., R. Aitken & D. Hutchinson, HA 26 (PERTH); 7 mi. (11.2 km) N of Melrose Homestead (as '*E. carnei*'), J. S. Beard 6533 (FRI); 38.5 km N of Wiluna, M. Blackwell 88 (FRI); Opposite Leinster Downs Station turnoff from Agnew to Wiluna Rd., M. Blackwell 110 (FRI); Sandstone to Payne's Find, 40 km, M. I. H. Brooker s.n. (FRI); 75 mi. (140 km) E of Mt Magnet towards Sandstone, M. I. H. Brooker 3689 (FRI); Sandstone to Wiluna Rd., 22.6 km, Carr & Carr 492, 493 (CANB); 52.6 km from Leonora on road to Kalgoorlie, Carr & Carr 522 (CANB); Batavia Goldmine, Kookynie, Carr & Carr 523 (CANB); Sandstone, 4 km *septentrionalis* versus, 27 Aug. 1963, C. A. Gardner s.n. (FRI); 40 km N of Sandstone, *in arenosis apertus*, C. A. Gardner 13417 (PERTH); Sandstone 5 km *in lutosi orientalem* versus, C. A. Gardner 13431 (PERTH); 12 mi. (19.2 km) S of Sandstone, 27 Aug. 1963, C. A. Gardner s.n. (PERTH); 5 mi. (8 km) N of Laverton, A. S. George 8083 (PERTH); Lake Throssel, A. S. George 8126 (PERTH); 56 mi. (89.6 km) E of Meekatharra, *E.*

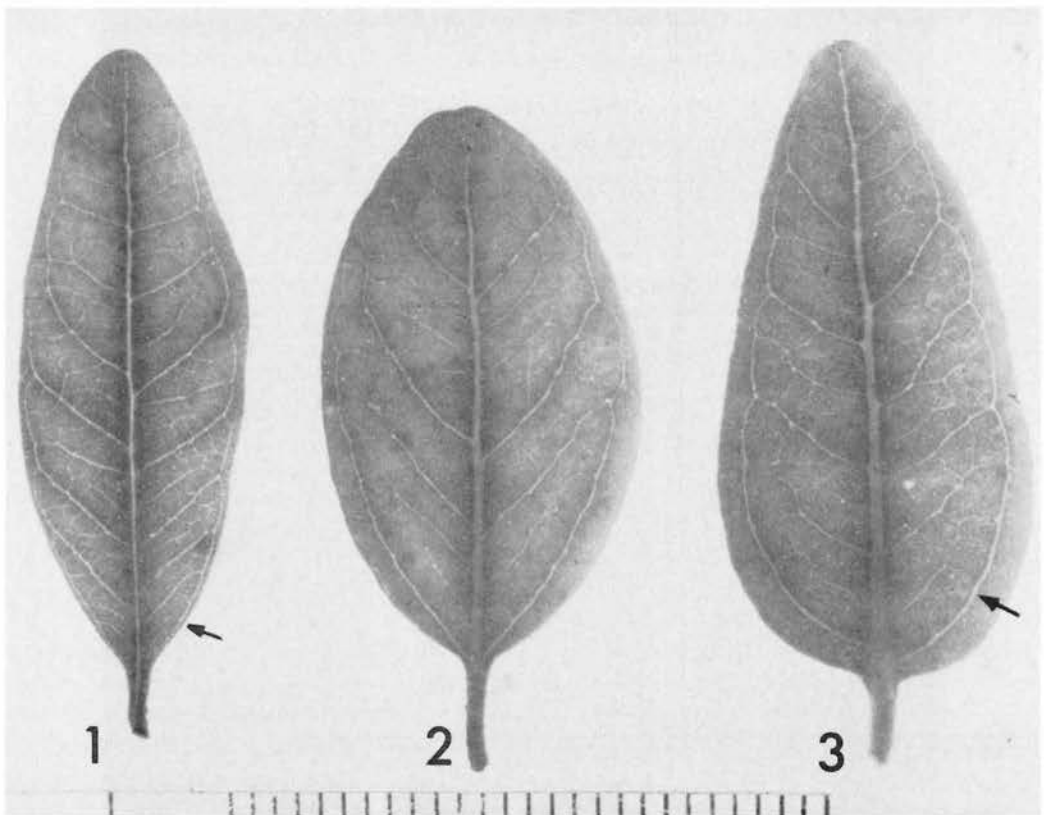


Figure 5. Seedling leaves: (2) an early and (1) a later leaf of *E. petraea*. (3) *E. lucasii*. The arrows indicate the proximity in *E. petraea* of the intramarginal vein to, and, in *E. lucasii*, its remoteness from, the margin of the leaf, especially near the leaf base. Scale markings, mm.

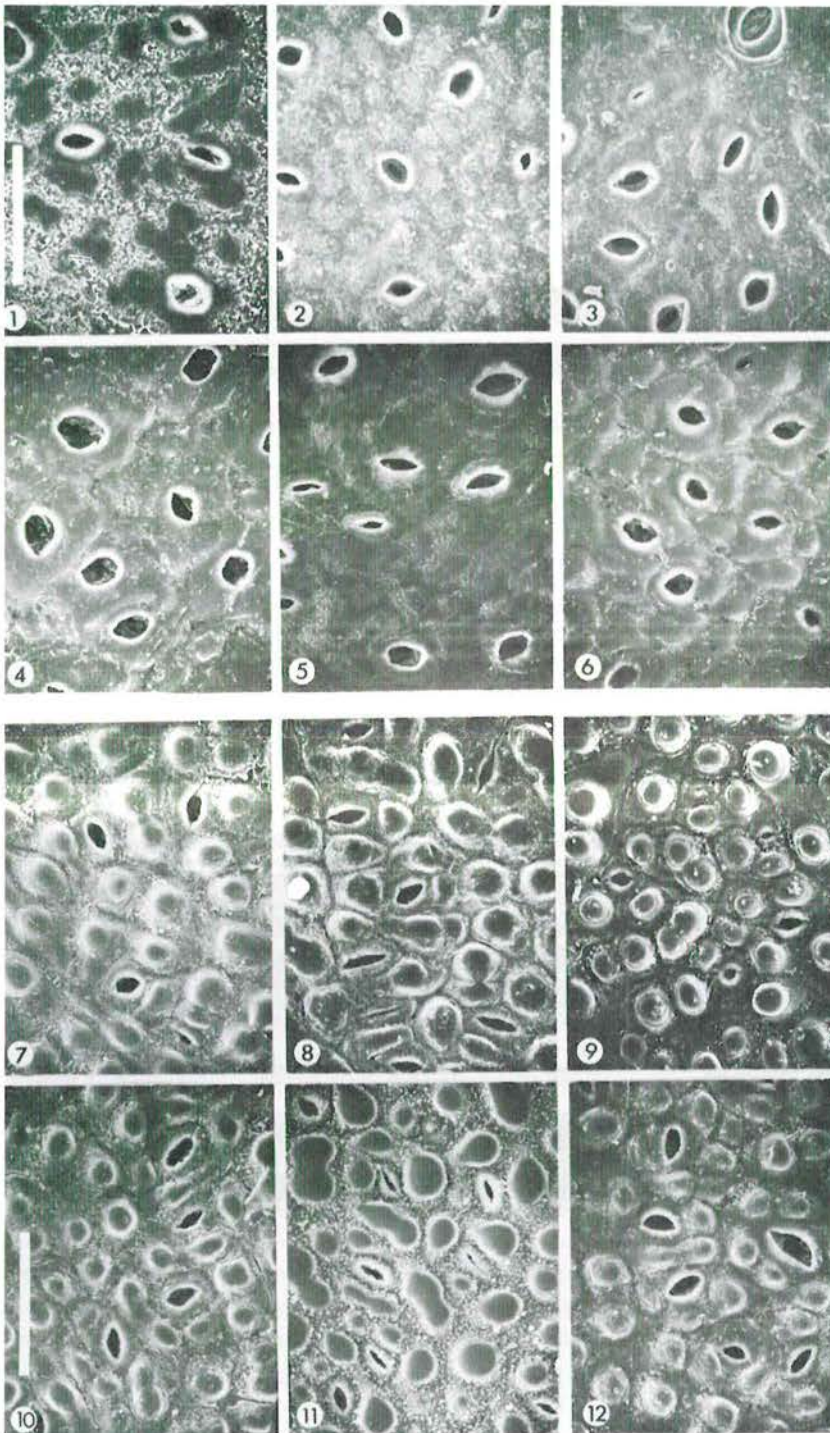


Figure 6. Scanning electron micrographs of adult leaf cuticles of Carr and Carr specimens of *E. petraea* (1-6) and *E. lucasii* (7-12): scale bar, 100 microns. (1) 1250, (2) 1254, (3) 1258, (4) 1263, (5) 2368 (all lower surfaces), (6) 2375 (upper surface). (7) 492, (8) (493), (9) 494, (10) 522 (all upper surfaces), (11) 523, and (12) 522 (lower surfaces).

Larsen 129 (FRI); 55 mi. (88 km) E of Meekatharra, *E. Larsen* 460 (FRI); c. 6 km E of Cosmo Newberry Mission on Warburton Rd., *B. Lay* 894 (FRI); 17 mi. (27.2 km) E of Payne's Find, *A. R. Main* s.n. (PERTH); 40 mi. (64 km) S of Wiluna, on Sandstone Rd., *N. H. Speck* 12456 (PERTH); 15 mi. (24 km) E of Mooloogool Homestead, Eremaean Province, *N. H. Speck* 1150 (PERTH).

Distribution and habitat. Figure 1 shows the distribution of the species in the Austin Botanical District (Beard 1976), with some specimens from a few more eastern localities. Beard does not mention it in his account of the vegetation of the Barlee Sub-region although he does record it in the Wiluna Sub-region. Beard 6533 was determined as '*E. carnei*' so perhaps his references to the occurrences of that species may in part imply *E. lucasii*. The westerly extension of the distribution shown in the maps in Hall and Brooker (1973) and Chippendale and Wolf (1981) is based on two incorrectly determined specimens. *Eucalyptus lucasii* is found in shallow flood channels (Figure 3G) with clayey soils. It also occurs on sand, together with *Triodia* sp., although not on the deep red sands of the District, which, as Beard comments, carry other species of *Eucalyptus*.

Discussion. *Eucalyptus lucasii* was first collected in September 1919 by Charles Fitzgerald Fraser (1883-1951) near Lake Barlee, not, as in Hall and Brooker, 1973, by W. Catton Grasby. The holotype of *E. lucasii* is accompanied by two rough labels presumably written in the field. The handwriting matches samples of Fitzgerald Fraser's handwriting kindly provided by Mrs Braid, his biographer (Braid 1972). The first label reads "Trees up to 40 ft high and 20-24 in. diameter. Generally distributed over country east of agricl. areas and to Lake Giles. Has black, rough bark up to 5 or 6 ft". The second label reads "Lake Barlee Sep 1919 big tree up to 50 ft. Good mining timber". The information was incorporated more or less verbatim into Blakely's description. Notes on the holotype sheet show that until about 1960, the suspicion was held by C. A. Gardner that the specimen of *E. lucasii* was most likely that of an Eastern States species which had somehow become associated with specimens of *E. loxophleba* Benth., an admixture which evidently took place in the field.

The description given in the protologue "a tree . . . with a rough, persistent bark on trunk for 5-6 feet or more" is incorrect, and derives from Fraser's labels; evidently Fraser was unable to discriminate between *E. loxophleba*, the bark of which fits his description, and *E. lucasii*. Almost all the collections which we have examined have been reported to be of small mallees or trees with the bark smooth to the ground or to within 30 cm of it. Oil glands in the pith of the stem are absent from *E. lucasii* but present in *E. loxophleba*.

All the specimens we have examined have been found to have a uniform pattern of the cuticle of the adult leaves, shown in Figure 6[7-12]. Each epidermal cell has a dome-shaped thickening of its cuticle; occasionally over daughter cells the thickenings coalesce to form a dumb-bell shape. Subsidiary cells of the stomata often have smaller thickenings, the guard cells have none. This cuticular patterning is the same on both surfaces of the leaf; it is constant for the species and of considerable help in identifying specimens lacking mature flowers or fruits. Hall and Brooker (1973) describe the flowers as "in 9-11-flowered umbels" but their illustration (and that of Stan Kelly 1978) shows groups of seven, the most common number. In our material the valves commonly number 4 and sometimes 5, not the "usually 3" of Hall and Brooker (1973).

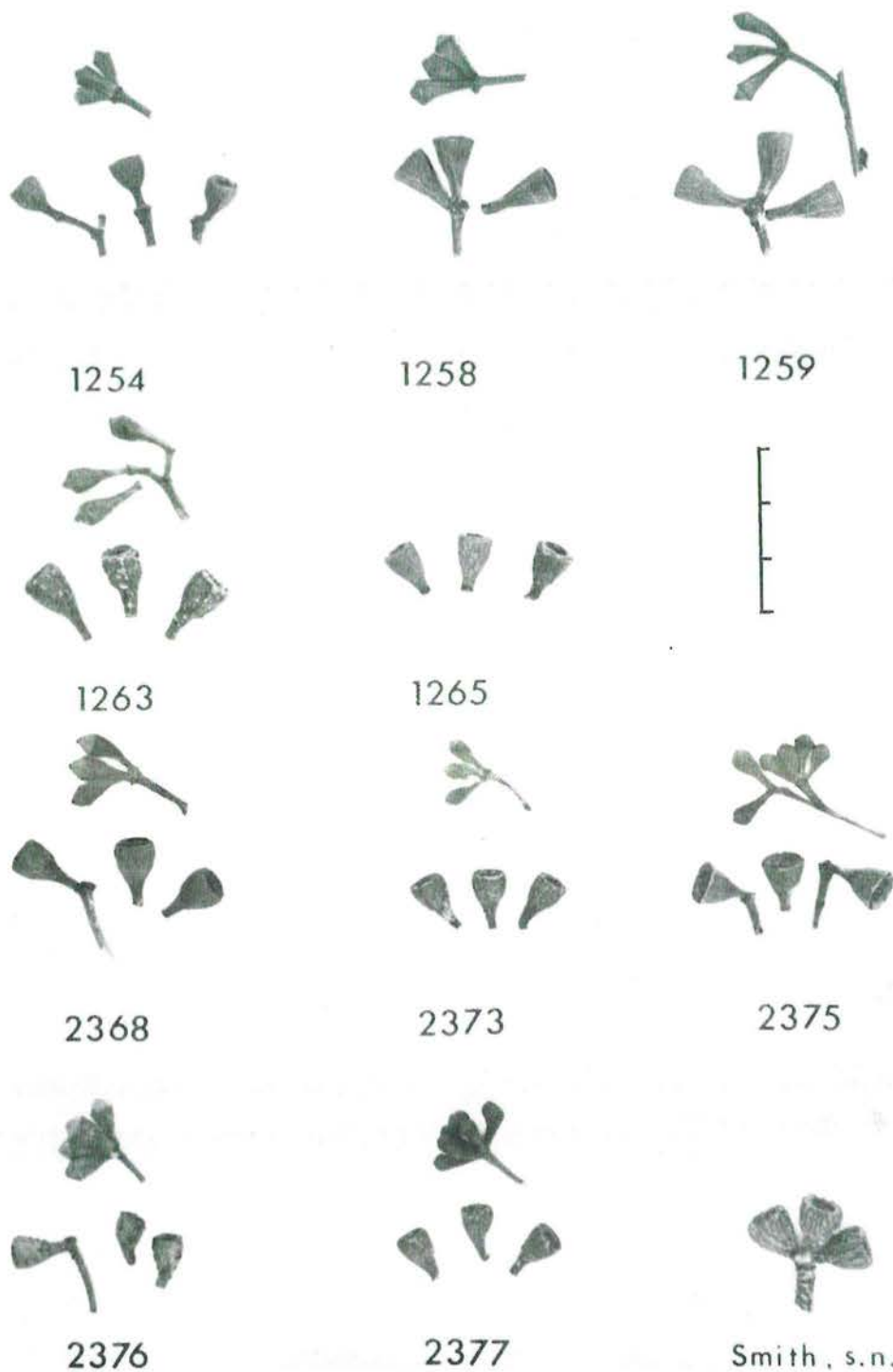


Figure 7. Representative flowers and fruits of Carr and Carr specimens of *E. petraea* and one collected by B. H. Smith (without flowers; Carr and Carr 1265 also lacks mature flowers). Scale, cm. The flowers and fruits of 1258 and 1259 are male.

Discussion

Although many early collections of *E. petraea* were designated as '*lucasii*' (e.g. the first collections by Royce in 1956 east of Karonie) or '*aff. lucasii*', they are not closely related. The two species are readily distinguishable by their bark and leaf characters in the field, and by their leaf cuticular characters (Figure 7 [1-12]), which are invariant in both species, and by flower and fruit characters, in the herbarium.

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