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Volume 6: Parts 51-60

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Critical revision of the genus eucalyptus volume 6 (Government Botanist of New South Wales and Director of the Botanic Gardens, Sydney)

“Ages are spent in collecting materials, ages more in separating and combining them. Even when a system has been formed, there is still something to add, to alter, or to reject. Every generation enjoys the use of a vast hoard bequeathed to it by antiquity, and transmits that hoard, augmented by fresh acquisitions, to future ages. In these pursuits, therefore, the first speculators lie under great disadvantages, and, even when they fail, are entitled to praise.”
Macaulay's “Essay on Milton”

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Part 51

CCLXXXVII. E. Sheathiana Maiden.

In *Journ. Roy. Soc. N. S. W.,* xlix, 312 (1915).

FOLLOWING is the original description :—

Arbuscula gracilis nunc 10 feet alta, erecta, cortice longis tenuibus lamellis secedente. Ramulis glaucis, plerumque subteretibus sed ultimus ramulis angulatiusculis. Foliis maturis obscuro-viridibus, rigidissimis petiolatis (petiolis 1–1·5 cm.) lanceolatis, paullo falcatis usque ad 8 cm. longis et 2 vel 3 cm. altis. Venis lateralibus patentibus. Venis haud prominentibus. Foliis valde oleosis. Floribus plurimis. Umbellis usque ad 7 capitulo, pedunculis 1 cm. pedicellis dimidio aequilongis. Operculo fere hemisphaerico, umbonato, plus dimido cupula aequilongo. Cupula conoidea plerumque 2-angulata. Antheris amplis, paralleliter aperientibus, glandula dorsum fere adhaerente. Fructibus subcylindroideis, maturis non visis.

A specimine culta solum nota.

A slender young tree, 10 feet or more high, at the present time, erect in habit, the bark falling off in long thin flakes (ribbons).

Glaucous, branchlets generally round, though ultimate branchlets somewhat angular.

Juvenile leaves.— Not available.

Mature leaves.— Dull green, of the same colour on both sides, rather rigid, petiolate (petioles 1–1·5 cm.), lanceolate, only slightly falcate, up to 8 cm. long and 2 or 3 cm. broad. Lateral veins spreading, roughly parallel, disposed at an acute angle to the midrib. Venation not very prominent, the leaves covered with oil-dots, and evidently rich in oil.

Flowers.— Very floriferous, umbels leaf-opposed to the last leaf, the umbels up to seven in the head, with peduncles of 1 cm. and pedicels of half that length. The operculum pointed when half ripe, but when ripe nearly hemispherical and with an umbo, rather longer than half the length of the calyx tube, which is conoid, has (usually) two angles, and tapers into the distinct pedicel.

Filaments pale yellow or cream-coloured, which dry orange-red and exhibit a pretty contrast with the cream-coloured anthers. Anthers large, creamy-white, opening in parallel slits, the gland nearly filling up the back, and the filament attached almost at the base.

Fruits.—Subcylindroid, but not seen ripe. Thin, defined rim. The tips of the valves, now represented by a persistent style and unexpended stigma, will, when ripe, probably become awl-like and will protrude beyond the orifice, in this respect becoming reminiscent of *E. oleosa.*

I name this plant in memory of Mr. Sheath, a first-class horticulturist, who was keen on the cultivation of native plants.

In April, 1917, I received spontaneously grown specimens from Dr. F. Stoward, who described it as "A Mallee, 15–20 feet high and 1 foot or more at some distance from the ground. Bark rough on old trees, smooth on saplings."

Range.

Known only from a cultivated specimen in the King's Park, Perth, Western Australia. (The late Mr. J. Sheath, Superintendent up to 1913.) Mr. Sheath informed me that he received the seed from "the Eastern Gold-fields, near the South Australian border" (of Western Australia). He further informed me that it had been sent to him as *E. erythronema.* I have received additional specimens from the same plant from Mr. Sidney William Jackson, of Sydney, and from Dr. F. Stoward, Government Botanist of Western Australia, whose attention I had invited to the plant. (Original description.)

In April, 1917, I received flowering twigs, still without juvenile foliage and perfectly ripe fruit, from the Kunonoppin district, "grows on various classes of soil" (Dr. F. Stoward, No. 145). Kunonoppin is a railway station 174 miles from Perth in an easterly direction, on the Northam-Merredin railway line, and this will give a clue to the locality of the species. I trust that our Western Australian friends will soon be able to secure adequate material.

Affinities.

This species belongs to the *Macrantheroe,* of which there are many members, and, in the absence of ripe fruits, I hesitate to indicate any close affinities. I am very anxious to get seeds.

CCLXXX VIII. E. striaticalyx W. V. Fitzgerald.

In *Journ. W. A. Nat. Hist. Soc.,* i, 20 (May, 1904).

Following is the original description:—

Arborescent, attaining a height of 40–50 feet or more with a stem diameter of 11/2 feet; bark dark grey, moderately thick, rough, persistent on the lower portion of the trunk, upwards thin and decorticating in small sheets, that on the cylindrical branches and branchlets whitish and smooth. Leaves alternate, conspicuously petiolate, ovate-lanceolate to lanceolate, straight or falcate, shortly acuminate, thick, almost coriaceous, 3–6 inches long, veins numerous, very fine, divergent, circumferential one close to the edge, dull-greyish on both sides. Peduncles axillary or lateral, solitary, or forming short terminal panicles through leaf-suppression, terete or hardly angular, erect or spreading, 1/2–3/4 inch long, each bearing an umbel 6–8 moderate-sized flowers. Calyx-tube turbinate, in bud above 3 lines long, smooth or scarcely striate, tapering into a short pedicel, lid hemispherical, terminating in a straight obtuse beak, broader than and as long as or longer than the tube, with 10–15 longitudinal raised lines; stamens pale-coloured, inflected in the bud; anthers broadly oblong, with parallel distinct cells. Ovary shortly conical in the centre. Fruit obovoid, about 5 lines long, 3–31/2 lines across, faintly and irregularly striate, slightly or not at all contracted at the summit, border thin, concave; valves usually 4, subulate, the points included. Seeds brown, irregular, without appendages, fertile ones 1 line long, 3/4 line broad, sterile, about as long as broad.

In the same Journal, iii (January, 1911), I wrote:—

I found this species at Milly's Soak, near Cue, one of the type localities, and following are the notes taken by me on the spot:

E. striaticalyx is far less numerous than *E. microtheca,* and is on the edge of the *microtheca* belt. Called "York Gum" by local people, but they are free-and-easy with their names for trees. It was plentiful on a donga. Stumps are now seen 12–18 inches in diameter between Milly's Soak and Jack's Well, and it was formerly extensively cut for firewood, but the neighbourhood of Milly was made a recreation reserve and the remaining trees were saved.

Tree of 30–40 feet. Bark dark grey or blackish, flaky, thin, yellow inside, covering the whole of the trunk and part of the branches.

Timber very hard, pinky pale brown or pale brown when fresh. Rather erect in habit. Would be called a Black Box in Eastern Australia. Neither Mr. Fitzgerald nor I found flowers, but I collected timber and juvenile leaves, which he did not.

Range.

Milly's Soak, and about 4 miles east of Nannine, September,. 1903 (W. V. Fitzgerald). The localities are in the Murchison district of Western Australia.

So far as observed, the new plant is confined to calcareous areas, with a permanent supply of fresh water at shallow depths. It appears to reproduce readily from seeds, suckers freely, and is apparently a moderately fast grower. Roughly, it covers an area of 5 square miles at Milly's Soak, and about 4 square miles east of Nannine. Both areas have in years past been largely drawn on for use in the various mines, and for fuel, and are now practically denuded of all matured examples. In the first-named locality the species is associated with *E. microtheca* F.v.M., in places being almost superseded by that species. Near Nannine the accompanying congener consists of irregularly grown examples of *E. rostrata* Schlecht. The presence of these Eucalypts offers a pleasing variation to the monotony of the greyish-foliaged "Mulga" (Acaciae), which cover a vast proportion of these districts. It may be remarked that the so-called "White Gum" at Milly's Soak is the *E. microtheca* F.v.M., and the "Flooded Gum" east of Nannine is *E. rostrata* Schlecht, partly. (Original description.)

Affinities.

1. With *E. foecunda* Schauer.

The new species constitutes one of the "Flooded Gums," or the "York Gum" of the Cue and Nannine mining districts. In cortical characters, the crooked nature of the trunk and in the wood is not very different from that of the true "York Gum" (*E. foecunda* Schauer, var. *loxopheba*), but the foliage, flowers, and fruit are very different. (Original description.)

2. With *E. incrassata* Labill.

In the latter characteristics (flowers and fruit) it more closely approximates *E. incrassata* Labill., and differs chiefly from that species in habit, bark, and in the calyx lid being broader than the tube and conspicuously ribbed. (Original description.)

In the same Journal, iii (January, 1911), I wrote:—

In my opinion this is a variety of *E. incrassata.* The juvenile leaves are as nearly as possible the same as those of var. *dumosa* collected by me at Dongarra. The Dongarra trees are large, so are those of the same species at Kangaroo Island, South Australia. The Milly's Soak trees are exceptionally large for *E. incrassata,* so are those of the two localities I have quoted. The timbers of the two species appear to be similar.

The fruits are those of *E. incrassata,* while the ribs of the opercula are characteristic of those of *E. incrassata.*

I shall be glad if any correspondent can favour me with flowers, but at present I see no grounds for separating it from the protean and widely-diffused *E. incrassata* Labill.

3. With *E. dumosa* A. Cunn.

In the last paragraph, under *E. incrassata,* I really referred to *E. dumosa,* for many years, by Bentham and others, included in *E. incrassata.* The two species are very close (see Part IV, p. 97, Plate 16, and Part XXXVIII, p. 223), and some botanists may be unwilling to separate them. The buds and fruits of *E. striaticalyx* are larger, and the pedicels more distinct, but I cannot find that the leaves and floral organs are specifically different from those of *E. dumosa.* I give it the benefit of the doubt at present, because of its geographical distribution.

CCLXXXIX. E. taeniola Baker and Smith.

In *Papers and Proc. Roy. Soc., Tasmania,* 198 (1912), with a plate.

FOLLOWING is the original description :—

Arbor mediocra, altudinem 40–50 pedes attinens; ramusculi teretes, graciles. Cortex trunci in laminis duris, similiter "Peppermint" generis. Folia alternata, semi-coriacea, angusta lanceolata v. lineata (taeniola) 12 uncias longa, 1/2 uncia lata; venis parum insignis acutis obliquis, vena peripherica a folii margine conspicue remora. Pedunculis axillaris, solitariis 5–9 floris pedicellis vix ullis. Calyx turbinatis operculum hemisphericum v. conicum. Fructus turbinatus, margo contracto, concavo, 1/2 uncia longa, 1/4 uncli lata, valvae prorsus inclusae.

A tree about 40 to 50 feet high and 2 feet in diameter, with a "Peppermint" bark. "Sucker" leaves linear-lanceolate, straight, 4 to 6 inches long, 1/2 inch wide, opposite or alternate. Normal leaves narrow-linear to linear, lanceolate, up to nearly 1 foot long, thin, venation not pronounced, but best seen in larger leaves, lateral veins very oblique, intramarginal vein removed from the edge. Peduncles axillary, but (through the falling off of the leaves) the inflorescence sometimes appears paniculate. Flowers few in the head. Calyx pyriform; operculum small, compressed, slightly pointed.

Fruits pear-shaped, 1/2 inch long and 1/4 inch wide, tapering into a short pedicel, rim countersunk, valves not exserted.

Range.

The specimens upon which this species is founded were obtained by Mr. L. G. Irby, at St. Mary's Pass, Tasmania.

Affinities.

1 and 2. With *E. Sieberiana* F.v.M., and *E. amygdalina* Labill.

In its native habitat—

It was found growing amongst trees of *E. virgata* and *E. amygdalina* Labill., and from which he (Mr. Irby) states the species is easily differentiated in the field from its congeners. The bark is finer checked than *E. virgata,* running more closely to the "Peppermint" bark in texture than the latter species.

The leaves, both "sucker" and normal, are much narrower than those of *E. virgata,* and of a different appearance altogether. They are long and linear, varying greatly in length on the same tree, being from 4 to 11 inches long—7 to 8 inches long being common. It is on the ribbony appearance of the leaves that the specific name is founded.

The fruits, however, are almost identical with those of *E. virgata,* and yet the general appearance of the tree is more like that of *E. amygdalina.* (L. G. Irby.)

"These results indicate that this form is somewhat closely associated with the Tasmanian *E. virgata.* The oil from the latter, however, contained more eucalyptol and more eudesmol, while that of *E. taeniola* had more phellandrene, as indicated by the rotation figures." (Original description.)

In the above passages, for *E. virgata* Sieb. (a shrubby tree as its name denotes), read *E. Sieberiana.* For an account of the confusion that has grown up between *E. virgata* and *E. Sieberiana* see Part XXXIX, p. 283. *E. virgata* is not found in Tasmania. *E. taeniola* seems sufficiently separated from *E. Sieberiana* by its fibrous or "peppermint" bark, and from *E. amygdalina* by its long linear juvenile leaves.

The following note by L. Rodway, the Government Botanist of Tasmania, expresses a view which will doubtless be borne in mind :—

In the neighbourhood of St. Mary's Pass, Mr. Irby observed in the forest of mixed Mountain Ash and Black Peppermint (*E. Sieberiana* and *E. amygdalina*—J.H.M.) a few trees which differed from either, but were called Black Peppermint by local inhabitants. The trees were medium-sized, with a rough, persistent, semi-fibrous bark. The juvenile leaves were narrow, opposite, and sessile, very like those of Black Peppermint. The mature leaves also resembled the leaves of that species, only tended to grow much longer. Flowers and fruit smaller than, but much like those of Mountain Ash. Fruit is pear-shaped, much restricted at the orifice, rim narrow, valves deeply sunk; stalks slightly flattened. R. T. Baker described it as a new species under the name of *E. toeniola,* but it seems probable it is a hybrid between Black Peppermint and Mountain Ash. (*Proc. Roy. Soc.* Tas., 12, 1917.)

LXXXII. E. Stricklandi Maiden.

IN the original description, copied at Part XVI, p. 202, this little-known species is presumed to be a shrub. The following statement by Mr. C. E. Lane-Poole, Conservator of Forests of Western Australia, shows that it is really a medium-sized tree.

It does not grow to a large size. In fact, the one photographed is the largest that I was able to find (the photograph, which will be reproduced later, shows an erect tree perhaps 50 feet in height, and with a stem diameter of, say, 2 feet J.H.M.). It has the largest fruit of any of the tree-Eucalypts as opposed to the Mallees, the fruit being as large as, if not larger than, the Tuart, *E. gomphocephala,* of the South-West. The bark adheres for 2 or 3 feet from the ground. The rest of the stem is, however, perfectly clean. The leaves are more coriaceous than any of the other Eucalypts, the nearest being *E. torquata* (Mr. Lane-Poole is of course speaking of the local or Gold Fields Eucalypts, J.H.M.), though, owing to the decorticating bark, there is no difficulty in distinguishing between the two, even in the distance. It is used for fuel, and is known as Blackbutt; indeed, the cutters see no difference between it and *E. Le Souefii.*

The rough part of the bark, at the butt, is hard and flaky. The timber is of a rich deep brown colour, with a touch of red in it; it is very hard and interlocked, and there is no doubt it is of a high class. It seems a pity that practically its only use at present is for fuel.

Range.

It is confined to Western Australia, and the only previous locality known is Hampton Plains, near Coolgardie. Mr. C. E. Lane-Poole sends it from 4 miles south of Higginsville, on the Norseman road. It is fairly common along the Norseman road.

I have received from Prof. T. G. B. Osborn, of Adelaide, a specimen labelled :—

1. *Eucalyptus obcordata* Turcz. Elder Exploring Expedition, 40 miles south-west of Fraser Range, Western Australia. (R. Helms, 5th November, 1891.) This is evidently referred to by Mueller and Tate in *Journ. Roy. Soc. S.A.,* xvi, 358.

In the Journal of the Expedition, p. 128, I find under 4th (not 5th) November—

. . . when we came to a big patch of splendid Blackbutt timber the natives turned off for this rock-hole. The Blackbutt timber is of the Eucalyptus species; it is a useful timber, splitting easily. The natives make their long spears out of this wood.

On the following day the Journal speaks of a “Morrell Gum-tree.” The latitude for the two days was given at 31° 35' 45" and 26' 20", and the locality about 100 miles south-east of Coolgardie.

E. Stricklandi could readily be taken for a Morrell.

2. In Part XXXV, p. 122, and XVI, p. 204, of this work, I refer to a specimen labelled similarly to No. 1 as belonging to *E. Campaspe* Moore. Both specimens were collected on the same date and at the same place.

CCXC. E. unialata Baker and Smith.

In *Papers and Proc. Roy. Soc., Tasmania,* 177, 1912.

FOLLOWING is the original description :—

Arbor altitudineum 40 pedes attinens, ramulis validis superne quadrangulatis. Folia opposita sessile oval v. cordata acuminata 2–3 uncias longa, v. falcato-lanceolata 9 inches longa, 1 inch lata, obscure pennivena, vena peripherica a margina remotiuscula. Pedunculi axillari, brevi 3 uncias longi, complanati 3 flori; calyx tubus compressus circiter 2 uncias longus cum operculo conico obtuso.

Fructus hemispherici, vitrei unialata, 6 inches longi; margo crassus valva exserta.

Systematic Description.—A tree attaining a height of 30 to 40 feet and a diameter of 12 inches, with a flaky bark at the butt. Sucker leaves, sessile, opposite, oval at the first, the lower pairs nearly always so, up to 2 inches long and 1 inch wide, then cordate, acuminate, up to 3 inches long and 11/2 inch wide. Normal leaves lanceolate, falcate, up to 9 inches long and 1 inch wide, subcoriaceous, occasionally shining on the upper surface. Venation distinct, lateral veins moderately oblique, intramarginal vein removed from the edge. Branchlets in sucker growth terete, but angular at first on the others. Peduncles axillary, flattened, short, thick, 1/4 inch long, three sessile flowered. Calyx compressed, angular, under 1/2 inch long; operculum conical.

Fruit hemispherical, 1/2 inch in diameter, shining, rim thickened, convex with a very narrow groove below it, valves well exserted.

Synonym.

E. viminalis Labill., var. *macrocarpa.* Rodway in "Tasmanian Flora," p. 57 (1903). This is dealt with under *E. viminalis* at p. 9.

Range.

It is confined to Tasmania, the only localities known at present being the Government Domain at Hobart, Mount Nelson Range, overlooking the Derwent, and Colebrook.

Affinities.

1. With *E. goniocalyx* F.v.M.

In the angularity of the buds are traces of a resemblance to *E. goniocalyx,* but as these mature in the fruit the angles disappear, but traces remain and form distinct convex ridges extending from the rim to the base, and as one is generally much more pronounced than the others, it is upon this character that the specific name is bestowed. (Original description.)

Many years ago (1902) I held the opinion that an affinity was with *E. goniocalyx,* but thought it was *E. Maideni* F.v.M., as shown in the next paragraph.

2. With *E. Maideni* F.v.M.

I have been favoured with an excellent series of specimens from Mr. Rodway, and they match *E. Maideni* F.v.M., from a type locality (Colombo, Lyttleton, N.S.W.) exactly. Whether *E. Maideni* is an extreme form of *E. globulus* or not is worthy of further examination, and Mr. Rodway's specimens and observations (*infra*) are worthy of note in connection with any experiments to reproduce certain species from cultivation of existing forms. My present view is that *E. Maideni* is as near midway as can be between *E. globulus* and *E. goniocalyx,* and therefore I am unable to reduce it to a form of either. If my determination is correct, and I have no doubt about it in my own mind, then another species is added to the flora of Tasmania. (Maiden in *Rep. Aust. Assoc. Adv. Science* (Hobart), ix, 374 (1902)).

While in 1902 I had considered this a form of *E. Maideni,* I had dropped this view in *Proc. Linn. N.S.W.,* xxx, 499 (1905), and my three years later opinion should have been quoted by Messrs. Baker and Smith. I came round to Mr. Rodway's view that it was a hybrid, and added, "Some of the juvenile foliage in my possession is coarser than any I have seen in *E. viminalis,* and I think that Mr. Rodway's statement that this form only occurs in plantations of *E. viminalis* growing with *E. globulus* is a sufficient explanation." From that day to this I understood that the specimens came from a plantation, and in view of the fact that Messrs. Baker and Smith state that only two trees were found, they require further examination, which I will give on my next visit to Tasmania. (Maiden in *Proc. Roy. Soc. Tas.,* xxix, 1914).

3. With *E. viminalis* Labill.

Mr. Rodway is, however, of opinion that his specimens belong to *E. viminalis,* and he proposes to call the variety *macrocarpa,* and the remarks of such an experienced observer require the most careful attention. I am of opinion that the sucker-leaves are of *E. Maideni* rather than *E. viminalis.* The locality is Domain, Hobart, and Mount Nelson Range, and the plant is worthy of further inquiry.

Habit and leaves as in typical *viminalis* to rather more erect, and leaves slightly larger. Mature bud 1·5 cm. long by 8 mm. Operculum sub-hemispheric to conical, smooth. Fruit of the type only 1·2 cm. diameter, often obscurely 2-ribbed.

This form I have only found in plantations of *E. viminalis* growing with *E.*

globulus. I take it to be a hybrid. Of six seedlings grown from seed of the same tree, four were closely approximating *E. viminalis,* one *E. globulus,* and the sixth intermediate. (Maiden, *loc. cit.*).

Three years later I wrote—

E. viminalis Labill. var. *macrocarpa* Rodway (in his "Tasmanian Flora," p. 57 (1903) (*E. globulus* Labill. x *viminalis* Labill.).

Some time ago I expressed the opinion that the above form is identical with *E. Maideni* F.v.M. Having received better seedlings from Mr. Rodway than I originally possessed, I incline to Mr. Rodway's view that it is nearer *viminalis,* and I also accept the view, which I resisted at the time, that it is a hybrid Some of the juvenile foliage in my possession is coarser than any I have seen in *E. viminalis,* and I think that Mr. Rodway's statement that this form only occurs in plantations "of *E. viminalis* growing with *E. globulus*" is a sufficient explanation.

The seedlings of *E. Baeuerleni* F.v.M. are identical with those of Mr. Rodway's variety. The fruits also have much in common, but those of Mr. Rodway are usually more domed. The rim of the junction of the calyx and operculum is very prominent in *E. Baeuerleni;* I have not ripe buds. The ripe buds of var. *macrocarpa* are rounded and glaucous.

The two forms (so called) of *E. viminalis,* viz., var. *macrocarpa* and var. *Baeuerleni* are undoubtedly closely related. I think var. *macrocarpa* is a hybrid of *E. viminalis* x *globulus.* Whether *E. Baeuerleni* is also a hybrid I cannot say, but I incline to think it is, the parents being possibly *E. viminalis* and *E. Maideni* F.v.M. (*Proc. Linn. Soc. N.S.W.,* 499 (1905)).

4. With *E. globulus* Labill.

This (*E. unialata*) is referred to as *E. viminalis* var. *macrocarpa* by Rodway in "The Tasmanian Flora," p. 57 (1903), where it is first suggested as a cross between *E. globulus* and *E. viminalis.*

In this Journal, p. 29 (1914) I suspended my judgment as to its systematic position until I could see the trees growing naturally. Rodway, this Journal, p. 17 (1917), again refers to this tree.

In February, 1918, under Mr. Rodway's guidance, I observed a number of the trees in the Domain at Hobart. I may say that I had long been satisfied that the trees were different from *E. viminalis* and *E. globulus,* but I had understood that they had only been found in a plantation and were not spontaneous; I desired to see them before I wrote again. I am quite satisfied that they are spontaneous, and that they are natural hybrids, and that it is expedient that they should have a distinctive name. I therefore concur in Messrs. Baker and Smith's action.

The Domain trees are large, and there are many of them. They also occur at

Nelson's Range, near Sandy Bay, and Mr. Rodway informs me that they are not uncommon at Colebrook (late Jerusalem) on the main line, 25 miles from Hobart. In all cases *E. unialata* occurs intermixed with *E. globulus* and *E. viminalis.* Doubtless they will be found in many other localities.

Mr. Rodway's observation that it is a hybrid between these two species (first recorded in 1903) is quite obvious, and it is one of the simplest cases of natural hybridisation in the genus known to me. The cross is seen in the tree generally, in juvenile leaves, buds, and fruits.

It is testimony to the sound judgment of the late M. Naudin of the Villa Thuret, Antibes, in the South of France, that he detected it as something different from *E. viminalis,* and only last year M. Trabut described it as new, under the name of *E. antipolitensis,* and I append a translation of his description. This is not the first occasion I have had the pleasure of drawing attention to the excellent Eucalyptus work of these French botanists. (Maiden in *Proc. Roy. Soc. Tas.,* 89, 1918.)

I have no doubt that we have here a natural hybrid, of which *E. globulus* is one of the parents. Its relations to *E. antipolitensis* Trabut will be discussed when the general question of Hybridisation is dealt with in the next Part (LII).

XXXI. E. Planchoniana F.v.M.

A NOTE on this species will be found in Part IX of the present work, and it has been represented to me that a figure would be desirable. There is a figure in Plate 90, Part XXIV of my "Forest Flora of New South Wales," but the present figures add something.

The flowers are pale yellow or creamy white, and notes in regard to bark and timber will be found under Range. Besides the note in the "Forest Flora" quoting the dedication to M. Planchon, see also under *E. globulus* in the "Eucalyptographia."

Range.

It is a coast species, and I am not aware that it has been recorded from further south than Camden Haven. It extends along the coast as far as Queensland. Immediately opposite Laurieton, on the other side of the Camden Haven River, near the coast, are some trees of this, then a rather rare species. It is here found over an area of about a mile, by half a mile broad.

In the Brisbane district it attains a height of, perhaps, 100 feet, and a diameter of (say) 3 feet (Bailey). The same dimensions were given in regard to trees near Kempsey, New South Wales. About Camden Haven the trees are poor and pipy; a solid one could not be found. Their height goes up to (say) 30 feet, with a diameter of 15 inches, but the trees are of stunted growth.

The following notes include additional particulars :—

It has also been found in a more inland locality by Mr. E. C. Andrews, viz., Glen Elgin, about 30 miles north-easterly from Glen Innes, or about 20 miles easterly from Deepwater, and on the eastern watershed. He adds the following note :—

The more precise locality is Pheasant Creek, 18 miles north-north-east from Glen Elgin. Occurs at an altitude of 3,000 feet on an extremely acid variety of granite. Very rocky and sandy country, almost indistinguishable from Hawkesbury sandstone tope, around National Park and Hornsby.

Habit.—Tall, upright, thin tops. Huge bunches of fruits, very noticeable from ground (50–70 feet below).

Associates.—*E. corymbosa, E. pilularis,* Stringybark (species unknown), *Pimeleas, Styphelias, Boronias, Waratahs, Xanthorrhoeas,* and various other sand-loving plants.

Mr. J. L. Boorman, Collector, Botanic Gardens, visited Mr. Andrews' locality, and furnished the following note :—

It occurs with the Waratah (*Telopea speciosissima*) more or less over an area of 100 square miles, *i.e.,* from Boundary Creek east to Pheasant Creek, north to Moojam, south to Tindale, and to the west, following the Dividing Range. It is known locally as Red Mahogany, because of the similarity of its bark to that of *E. resinifera,* but it has not a red timber like that tree; it is also known as Needle Bark, because it is prickly to rub down with the hands. The name Porcupine Stringybark is also applied to it for the same reason.

"I have found it growing from Coff's Harbour to close to South Grafton; the range seems to be extensive. I have not found it growing off the gravelly (ironstone) ridges, and never on flat country. It attains a height of 60 to 70 feet, straight trunks; the matured trees are very unsound (large pipes). The average length of logs 24 feet, the girth 6 feet 6 inches. There is no abundant supply of good trees, though they grow in clumps. I have seen the logs sold for White Mahogany when barked. On one occasion a hauler had the audacity to dispose of a log as Blackbutt, which was converted and sold on the Sydney market as such." (A. H. Lawrence, Forest Guard.)

Found at Corindi Creek, 8 miles north of Woolgoolga, on the Grafton road. Is plentiful in Woolli Woolli State Forest, between Woolgoolga and the Clarence. It is used for general hardwood purposes, weather-boards, flooring, &c. It is a tree attaining a height of 120 feet. It resembles Tallow-wood at a distance, but the bark is of a more stringy nature, resembling stringybark. It is known as "Messmate."

The above particulars were obtained from a report by Assistant Forester C. O. Love.

Mr. Forest Guard G. Boyd reports on the same area. He says it is known as "Yellow Stringybark." It has light yellow flowers, and although called Stringybark, the bark is short-grained and of no value for roofing as our other Stringybarks. It occurs at Woolli Woolli State Forest, No. 23, Bookram Creek, eastern slopes of Coast Range, at 10–200 feet in elevation above the sea. Height 50–80 feet, diameter up to 3 feet.

The type came from Eight Mile Plains, Brisbane (F. M. Bailey) and W. Baeuerlen recorded it from the Evans River, near the Richmond.

XXI. E. marginata Sm.

See Part VIII, p. 241 (1907).

THE following additional statement was published by me in *Journ. W.A. Nat. Hist. Soc.,* vol. iii, January, **1911** :—

These notes are based on field observations made by me in Western Australia from September to December, 1909, but I have taken the opportunity of incorporating a few notes from other sources.

Mr. William Dunn, a native of Albany, over 60 years of age, says that Mahogany is the name given by the old settlers to the timber later on known as Jarrah; that he does not remember the name Jarrah ever having been employed until the introduction of saw-milling machinery; he has sawn timber from boyhood.

In bark, and somewhat in general appearance, the Jarrah resembles the *E. resinifera* of coastal New South Wales and Queensland. It flowers as a shrub.

Following is a description of the juvenile leaves. They were received from Mr. Max Koch, and have not been previously described :—

Lanceolate, sharply acuminate, slightly oblique, rounded at the base, petiolate; thin in texture, pale on the underside, glabrous on both sides; margin thickened and slightly recurved, the intra-marginal vein distinctly removed from the edge; midrib distinct, lateral veins fairly distinct, pinnate, at an approximate angle of 45 degrees with the midrib, smaller veins anastomosing and obvious; oil-dots not obvious.

The irregularly striate appearance sometimes seen in fruits of this species and in a few others, *e.g., E. diversicolor,* is the result of the contraction of subsucculent vascular tissue over longitudinal bands of fibro-vascular tissue.

E. marginata is termed "Mahogany" or "Jarrail" (can it be a misprint or an early spelling of Jarrah?) ("Discoveries in Australia," J. Lort Stokes, ii, 132, 1835).

Variety.

E. marginata Sm., var. *Staerii,* Maiden in *Journ. Roy. Soc. N.S.W.,* xlvii, 230 (1913).

King River road, near Albany, Western Australia (J. Staer, August, 1911).

The fruits of the normal species, as figured by Mueller in the "Eucalyptographia" are depicted as 1·5–2 cm. long and 1·7 cm. broad, and tapering somewhat into a thickened pedicel. I have received from Mr. J. Staer, specimens of *E. marginata* with fruits in the well-dried state rather more than 2 cm. long and broad, and not tapering into the pedicel. Some of the fruits have a well-defined rim. The foliage is coarser than that of the type, and this handsome, large fruited form is evidently a product of special environment.

In the same Journal, liii, 70 (1919) I published the following additional note concerning this variety :—

Dr. F. Stoward, under No. 111, April, May, 1917, sends this form with the following note—"Stunted Blackbutt," tree 30–35 feet, up to 2 feet in diameter. Grows in the Albany and Denmark districts in large and sandy flats, and is of a stunted nature.

Mr. C. E. Lane Poole points out the similarity of the fruits to those of *E. Todtiana,* but the anthers and the timbers sharply separate the two species. The relation of this proposed variety to the normal form (the Jarrah, *E. marginata*) is worthy of local inquiry.

CCXCI. E. Irbyi Baker and Smith.

In "Research on the Eucalypts," 2nd edition, 242 (1920).

FOLLOWING is the original description :—

A small tree, with a smooth, pale or ashy-coloured bark. Abnormal leaves broad-ovate to ovate, sometimes mucronate, petiolate, base rounded, truncate or slightly cordate, fairly thick and coriaceous. Normal leaves coarse, lanceolate to broad-lanceolate, or even ovate, acuminate, up to 8 inches long, mostly straight, on unusually long petioles; venation often indistinct, intramarginal vein looped, well removed from the edge, lateral veins spreading, distant, inclined at an angle of 30–40 degrees to the midrib. Peduncles angular, axillary, 1 to 2 lines long, bearing umbels of mostly three flowers. Buds shortly-pedicellate; calyx-tube turbinate, 2 lines in length; operculum blunt, conical, often slightly broader than and more than half as long as the tube.

Fruit hemispherical to sub-cylindrical, glaucous, or shining; rim flat to convex, often somewhat depressed, cracked transversely; valves more or less exserted; 3 lines long and 3 lines in diameter.

Range.

The type comes from Alma Tier, Interlaken, Tasmania, growing amongst *E. Gunnii* (L. G. Irby, now Conservator of Forests of that State) and so far it has not been found out of that island.

Affinities.

1. With *E. Gunnii* Hook., f.

Some of the fruits are so like the hemispherical form of *E. Gunnii,* that when the material was first collected it was placed tentatively with that species until other characters could be worked out, but it is, however, a much coarser plant morphologically than that species . . . . , from which species it differs in the physical features of its bark—lacking the sweet nature of the sap of *E. Gunnii,* which can always be obtained by cutting the bark, and from which it derives its common name of "Cider Gum." In foliage it is not unlike *E. Dalyrmpleana* J.H.M. Its affinities lie equally between *E. viminalis,* on the one hand, and *E. Gunnii,* on the other, so that, in a systematic arrangement, it might be placed between these two. (Original description.)

2. *With E. viminalis* **Labill.**

Mr. L. G. Irby: " . . . . thought at first it was *E. viminalis* from the abnormal (juvenile, J.H.M.) leaves, but noted its differences in other respects from the normal material of that species collected in other localities in Tasmania during his trip. An exhaustive oil determination, made since publishing our Research on the Eucalypts of Tasmania in *Journ. Roy. Soc.* (Tas.), 1912, confirmed our suspicion that it was new. In that paper it was placed tentatively under *E. viminalis.* The chief specific differences from this latter are the broader abnormal (juvenile, J.H.M.) and normal leaves, both of which are much coarser than those of *E. viminalis,* and are always affected with a fungus, which is never so in *E. Gunnii* or *E. viminalis,* and which gives the whole plant a black, dirty-looking appearance. This is evidently a specific character by which it can be determined, just as in the case of *E. camphora.* The fruits are, however, identical in shape with those of *E. Gunnii.*" (Original description.)

3. *With E. Dalrympleana* **Maiden.**

(See above under No. 1, *E. Gunnii*). This species will be found described in Part XLIX of this work. The foliage of *E. Irbyi* is glaucous, even dull-coloured.

CCXCII. E. Yarraensis Maiden and Cambage, n.sp.

FOLLOWING is the original description:—

Arbor formae modicae. Cortex trunci et ramorum breviter fibratus.

Folium maturum.—Undulatum, nitens, paulo obliquum, late lanceolatum. Systema venarum lucida, diffusa; angulus venis secundariis cum costa centrali factus circiter 30°; vena intra marginem satis magno intervallo a labro est.

Flores.—Modus florescere paniculatus, umbellae cum parvis tribus ad quinque floribus qui in pedunculis et pediculis gracilibus geruntur. Et operculum tubus-que calycis conoidales, cum linea maxima dimetiente infra quinque mm. Antherae aperientes in fissuris parallelis.

Fructus.—Linea dimentiens infra sex mm; in forma hemisphaerii; valvularum apices (tres ant quatuor) clare exserti.

A leafy tree of medium size, branches and branchlets terete and pendulous, the bark shortly fibrous (woolly) on the trunk and branches (Rhytiphloiae). Timber pale.

Leaves not seen in their earliest stage, but the lowest leaf in Plate 211 probably closely resembles the juvenile leaf.

Mature leaf.—Undulate, shining, equally green on both sides, thinnish, petiolate, somewhat oblique, broadly lanceolate, terminating at the apex in a blunt point, gradually tapering at the base into a petiole of about 2 cm. The length of the leaves is under 1 dm., with the greatest average width of 2–3 cm. Venation distinct, spreading, the secondary veins making an angle with the midrib of about 30 degrees, the intramarginal vein at a considerable distance from the edge, and looped, meeting the tips of the secondary veins.

Flowers.—Inflorescence paniculate, the umbels of 3–5 flowers being supported by slender peduncles of about 5 mm. supporting pedicels of half that length. The buds symmetrical, both operculum and calyx-tube conoid, the greatest diameter under 5 mm. Anthers opening in parallel slits, a large gland at the back, versatile; filaments creamy-white.

Fruits.—Small, under 6 mm. in diameter, hemispherical, tapering abruptly into the pedicels, rims narrow, the tips of the valves (3 or 4) distinctly exsert.

Range.

Valley of the Yarra, near Healesville, Victoria (R. H. Cambage, No. 4340, January, 1921). The type. It will probably be found to occur moderately extensively in Victoria, and perhaps also in Tasmania, when its relations to other species are understood.

Affinity.

With *E. ovata* Labill.

E. ovata seems the nearest affinity to *E. Yarraensis.* The former has rough butts, with, in largish trees, flattish ribs of fibrous bark, reminding one of the Turpentines of New South Wales (*Syncarpia laurifolia*), but with smooth branches, and sometimes the upper part of the bark is smooth. *E. Yarraensis,* on the other hand, has the trunk and branches rough throughout. Mr. Cambage wrote at the time of collection, "The typical *E. ovata* is common on the flats around the Upper Yarra, and is quite distinct from No. 4340" (the present species). Again, the secondary veins of the leaves of *E. ovata* are more transverse than those of *E. Yarraensis,* more approaching an angle of 45 degrees. Further, the inflorescence of *E. Yarraensis* is smaller in all its parts, and, speaking generally, the fruits are more hemispherical.

No. II. The Bark.

(Continued from p. 331, Part L.)

FOLLOWING is the remainder of my 1921 Classification. It will be seen that I have adhered to Mueller's 1859 classification as closely as possible, but for the modifications of it, and the species I have placed in the various groups, I am alone responsible :—

1. LEIOPHLOIae (Smooth barks or gums).

Mueller's original Group 1 indicated Gums or Smooth Gums. By "Yarra trees" he meant *E. rostrata.* The reason why he stated "Blue Gum trees *partim*" and "Red Gum trees *partim*" in his definition, was because he was aware that the Gums had more or less hardy-flaky or even sub-fibrous bark up the butt. I have below pointed out that a perfectly smooth Gum is an ideal, and, as regards these roughnesses at the lower part of the butt, I have only considered it useful to pick out the "W.A. Blackbutts" for special enumeration as such. This is but one indication that the roughness may be very considerable in a Gum.

The usual or most elementary kind of bark is the smooth one, called the "Gum," and it is more or less glaucous, and more or less thick; we find this bark from the sandy coastal flats to the bleak swamps and mountain areas and away to the arid interior, *e.g.,* White Gum (*E. hoemastoma* Sm.), Red Gum (*E. rostrata* Schlecht). In the interior this is the prevalent kind of bark, with more or less (generally not very much) blackish or hard scaly or flaky-fibrous bark at the butt.

The term Gum is often used as if it were synonymous with Eucalyptus, but this is by no means the case. It is usually only applied to species with barks smooth or nearly so. As a matter of fact, the barks of very few indeed are quite smooth, most species having more or less rough bark (usually hard-scaly or ribbony) at the butt. The word Gum is usually prefixed by an adjective, which is not employed according to a fixed rule. Thus, if the bark be white, the tree may be called White Gum (*hoemastoma, coriacea*); if the foliage be glaucous or blue, we have Blue Gum (*globulus*); if the bark be, by comparison, bluish, we have also Blue Gum (*saligna*); yet no timber is called Red Gum because of the colour of its bark, but of its timber (*rostrata, tereticornis*); while in Western Australia the Red Gum (*calophylla*) is so called because of neither timber nor bark, but because of the profusion of kino which exudes. As a matter of fact it would not in the eastern States be called Gum (certainly not Red), since it is a rough-barked tree and has pale timber. It is, in fact, a Bloodwood.

Some obvious character, such as Broad-leaved, Poplar-leaved, Narrow-leaved, Lead-coloured, is occasionally prefixed to Gum, while to indicate softness or sappiness of bark or timber, or perhaps of both, the prefix Cabbage is not rarely applied (*hoemastoma* var. *micrantha, coriacea*). This by no means exhausts all the designations, for the bushman feels himself at liberty to apply almost any prefix to a Gum (see the indexes to the various volumes of the present work).

Very few barks, perhaps none, are perfectly smooth down to the ground. The perfectly smooth-barked Gum is an ideal. Even in the case of many reputedly smooth barks we have flaky indurated or sub-fibrous bark at the butt, to a varying height up the stem. Most smooth barks are more or less patchy, a typical instance being the Spotted Gum (*E. maculata* Hook. f.). In such barks a roughness in patches becomes visible. At first it is a mere discoloration, but as development proceeds, the area becomes darker and rougher and finally peels off, leaving a pure, new, clean surface, in contrast to which the remainder of the bark appears discoloured. Meantime the process of induration goes on, and the surface last to be new, first peels off or is next to do so, and so the whole of the bark, in its order, goes through the cycle of new, smooth surface, bark of varying degree of roughness, and finally exfoliation. In some cases the patches are long and the older bark contains more fibre, with sufficient tenacity to form long ribbons (*e.g.,* Ribbony Gums, *E. viminalis* Labill.). These are commonly found in the cooler tablelands of the southern and eastern States, and, when rendered supple by the rain and blown about by a strong wind, they stand out like the arms of a semaphore.

The exfoliations referred to fall off in especially great numbers in dry weather. These remarks also apply to the smooth-barked portions (stem and larger branches) of those species which are more or less rough barked. It is frequently difficult to say where a bark commonly described as “flaky” can be separated from a “ribbony” one. In other words, it is impossible to separate “Ribbony Gums” as a distinct section.

The following sections of Gums will, it is hoped, have some value, but, being largely based on the results of environment (moisture, shelter and soil, all variables), they run into each other :—

A.—*Shaft-like or Columnar,* with smooth, usually white bark, more or less (usually less) rough bark, often ribbony, at the butt. Trunks tending to be cylindrical and tall. Timbers mostly pale and fissile, sometimes red. Rain-forest species. Found on river banks with good soil, and in sheltered valleys generally.

a. With *pale timbers:*—

E. Benthami Maiden and Cambage.
E. cordata Labill.
E. Dunnii Maiden.
E. globulus Labill.
E. goniocalyx F.v.M.
E. linearis A. Cunn.
E. Maideni F.v.M.
E. Muelleri T. B. Moore.
E. nitens Maiden.
E. oreades R. T. Baker.
E. regnans F.v.M.
E. unialata Baker and Smith.

E. BENTHAMI Maiden and Cambage.

A large White Gum, up to 60 or 100 feet and diameter of 6 feet, with more or less rough, flaky bark at the butt. Such rough bark may be almost wholly absent, or sometimes extending to the first fork, but essentially it is a Gum, and can be readily picked out as such along the Nepean Valley, New South Wales. The rough bark is rather hard, but rarely almost fibrous, and terminating in short ribbons. The presence of rough bark, the result of injury (ringbarking in this case) may be very marked in this species, as will be shown in a photograph to be published later.

E. CORDATA Labill.

Usually a tree with glaucous foliage, but said to exceptionally attain a large size. Bark smooth. Mr. L. Rodway, of Hobart, writes to me that at Cape Frederick Henry, Brown Mountain, and Ridgeway it is a scrambling to semi-erect shrub, of about 4–5 feet. In the south-western gully at Chimney Pot Hill (close to Ridgeway) it is a small tree up to say 20 feet high. At Uxbridge he has seen trees of it approximating

100 feet, and Mr. Fenton, of that town, an experienced timber-cutter, brought him a specimen in typical foliage and flower from a tree he said was 200 feet high with a clean branchless bole for 100 feet, and with timber light-yellow ochre in colour.

E. DUNNII Maïden.

An erect species, attaining a very great size. A White Gum with more or less fibrous-flaky bark at butt. Resembling *E. saligna* in habit a good deal.

E. GLOBULUS Labill.

A lofty Gum, called Blue Gum because of its glaucousness, with more or less deciduous ribbony bark.

E. GONIOCALYX F.v.M.

A tall tree, bark smoothish, but with ribbons and more or less roughish and even flaky bark at butt.

E. LINEARIS Dehnh.

A Gum tree of medium size, say up to 100 feet or less, clean-looking tree with clean-looking branches and light tops of narrow leaves. Foliage erect, not pendulous.

E. MAIDENI F.v.M.

A tall Gum, called Blue Gum because of its glaucousness, with more or less deciduous ribbony bark. It is closely related to *E. globulus.*

E. MUELLERI T. B. Moore.

A tall, erect tree, attaining 200 feet. Bark smooth, blotched with red brown, scaly at base, smooth above, often glaucous.

E. NITENS Maiden.

This tree, near Bombala, was measured (by W. Baeuerlen in 1889) by tape 3 feet above the ground and found to be 50 feet in circumference. It is a very large tree, growing to a height of 200–300 feet. It is a Gum with a good deal of deciduous bark hanging in strips, and more or less rough at the butt, the upper portion, which usually includes nearly the whole of the trunk, smooth and even shining.

E. OREADES R. T. Baker.

A tall tree with a smooth, whitish bark down to the ground, or sometimes leaving a lighter rough bark 6–8 feet from the ground. Timber fissile.

E. REGNANS F.v.M.

A tall, shaft-like species, with more or less rough, ribbony bark at the butt. In some cases the amount of rough bark is very small, giving the impression of a Gum, in others, in drier situations, the bark is dark coloured and peppermint-like. Timber specially fissile. This is probably the highest tree in Australia, attaining a height (measured) well over 300 feet. See my “Forest Flora of New South Wales,” vol. ii, p. 161, and also Part VII, p. 183, of the present work.

E. UNIALATA Baker and Smith.

A medium-sized or tall Gum tree, with usually a good deal of deciduous, ribbony bark.

b. With red timbers:—

E. Deanei Maiden.

E. diversicolor F.v.M.

E. grandis (Hill) Maiden.

E. Naudiniana F.v.M.

E. saligna Sm.

E. DEANEI Maiden.

A very large, bulky tree, up to 200 feet. Sometimes gnarled and scrambling in habit, but usually a straight tree with more or less rough bark at butt, and a large umbrageous head. It is closely allied to *E. saligna.* Sometimes called "Silky Gum" because of the sheen of its bark.

E. DIVERSICOLOR F.v.M.

One of the largest species of the genus. A Gum with more or less flaky-ribbony bark at the butt. Already referred to in Part XX, p. 298, of the present work.

E. GRANDIS (Hill) Maiden.

The principal Flooded Gum of eastern Australia. It is a majestic tree, which attains a height of 90–140 feet, and a diameter of 40–60 inches. Its timber is red and in high repute for strength, lightness, and durability. It is closely allied to *E. saligna.*

E. NAUDINIANA F.v.M.

One of the few species which is extra-Australian. See Part XII, p. 81. A tall tree attaining the height of 100 feet, with a smooth bark.

E. SALIGNA Sm.

A tall, shaft-like tree, with smooth, but more or less sub-fibrous or dark-coloured, scaly bark at the butt.

B.—*More or less erect in habit, but not shaft-like.* Tending to branch, and with more or less rough bark at butt and flaky or ribbony bark on trunk. Denizens of more exposed situations than A.

a. With pale timbers:—

Mostly belonging to the Renantherae and eastern. Speaking generally, the timbers of the Renantherae are more fissile (which implies a certain degree of toughness) than the rest.

E. Dalrympleana Maiden.

E. fraxinoides Deane and Maiden.

E. haemastoma Sm.

E. leucoxylon F.v.M.

E. linearis Dehn.
E. maculosa R. T. Baker.
E. Mitchelli Cambage.
E. numerosa Maiden.
E. Perriniana F.v.M.
E. praecox Maiden.
E. Risdoni Hook. f.
E. rubida Deane and Maiden.
E. scoparia Maiden.
E. Smithii R. T. Baker.
E. viminalis Labill.
(Also a var. of *viminalis,* Dorrigo, New South Wales.)

E. DALRYMPLEANA Maiden.

A massive White Gum, displaying considerable resemblance to *E. viminalis.*

E. FRAXINOIDES Deane and Maiden.

A tall tree, smooth barked, the outer layer falling off in ribbons; the bark blotched, reminding one somewhat of Spotted Gum (*E. maculata*) as regards its blotches, and *E. viminalis* (Ribbon Gum) as regards the stripping of the outer bark. Timber both pale-coloured and fissile, hence often called "Mountain Ash."

E. HaeMASTOMA Sm.

A tree of medium size, with a smooth, white bark, with usually a little thin, hardy, flaky bark at the butt. Often not a long barrel, the trunk being often branched. Canopy moderate. Timber pale-coloured to pink.

E. LEUCOXYLON F.v.M.

A medium-sized to a large tree, smooth-barked, but with more or less deciduous flaky bark, falling away in patches.

E. LINEARIS Dehn.

Tree of medium size, say up to 100 feet, with smooth, slightly ribbony bark (the smooth portion of a yellowish cast) and very little scaly bark except perhaps a little at the lowest portion of the butt. Clean-looking tree, with clean-looking branches and light tops of narrow leaves. The foliage rather erect, certainly not pendulous, although occasionally slightly so. This is a White Peppermint, according to the Adventure Bay people and also Mr. Rodway. This tree differs from *E. amygdalina* as we know it, in two important points:—

(1) An erect, smooth-barked (not rough-barked) tree.
(2) Foliage erect, not pendulous.

E. MACULOSA R. T. Baker.

A White or blotched Gum, rarely exceeding 60 feet in height.

E. MITCHELLIANA Cambage.

An umbrageous tree up to 50 feet high, with a stem-diameter of 2 feet. Bark smooth and white, except for a few rough flakes at the base.

E. NUMEROSA Maiden.

A medium-sized to rather tall, rather slender tree, essentially a White Gum, with sub-fibrous or Peppermint butt, succeeded by especially long ribbons, so tough that they were used by the aborigines for tying purposes. It is known as Ribbony Gum. The timber is white and fissile.

E. PERRINIANA F.v.M.

A semi-pendulous small, or medium-sized White Gum, with the usual deciduous patches. Timber brittle.

E. PRaeCOX Maiden.

A small Gum tree of drooping habit.

E. RISDONI Hook. f.

A smooth-barked tree of medium size, but always more or less scaly at the butt.

E. RUBIDA Deane and Maiden.

A medium-sized tree, perfectly smooth for the most part, the outer layer of bark falling off in ribbons. The "bole and limbs very white, as if whitewashed." The name "Candle-bark" is also excellently descriptive of the appearance of the bark in the most southern parts of New South Wales and north-eastern Victoria. It frequently exhibits reddish or plum-coloured patches (hence the specific name); this is a colour rarely, if ever, seen in *E. viminalis.*

E. SCOPARIA Maiden.

A slender tree of 30–40 feet, with narrow, pendulous foliage, and an entirely smooth white bark.

E. SMITHII R. T. Baker.

A ribbony-barked tree of considerable size. It has smooth limbs, and most of the butt is smooth.

E. VIMINALIS Labill.

A tree usually of moderate size, but sometimes attaining a great height, with a rough, persistent bark, at least on the trunk and main branches; that of the smaller branches often smooth and deciduous, and sometimes the whole described as deciduous. Mueller quotes it up to 320 feet high, with a diameter of 17 feet or 20 feet. While it is undoubtedly a large tree, I would like such an extreme size to be authenticated. It is a White Gum, with more or less hard, dark bark at the butt. It is also called Ribbony Gum, the ribbons being sometimes very long. While it is usually smooth and white from the base, sometimes the trunk is coarsely scaly, or scaly-fibrous, even to the upper branches. See Part XXVIII, p. 167.

b. With red or reddish-brown timbers:—

It is sometimes very difficult to say where red ends and reddish-brown begins, particularly because the latter tint is often a sign of over-maturity of a normally red timber.

E. accedens W. V. Fitzgerald (reddish-brown).
E. amplifolia Naudin.
E. Blakelyi Maiden.
E. Dawsoni R. T. Baker.
E. intertexta R. T. Baker.
E. Lane-Poolei Maiden (reddish-brown).
E. microtheca F.v.M. (in part).
E. Parramattensis Hall.
E. rostrata Schlecht.
E. Seeana Maiden.
E. tereticornis Sm.

E. ACCEDENS W. V. Fitzgerald.

A medium-sized tree, a sturdy White Gum, attaining a height of 60 feet and a diameter of 2 feet. Bark greyish or white, with the usual lenticular patches, hence the name "Spotted Gum"; called a "powder bark" because of the pulverulence of the outer surface. The timber is pale-reddish brown when fresh, and of course darkens with age.

E. AMPLIFOLIA Naudin.

A medium-sized tree with coarse foliage. Bark smooth or more or less ribbony.

E. BLAKELYI Maiden.

An erect tree of medium size with smooth, more or less, blotched bark.

E. DAWSONI R. T. Baker.

A tall tree with smooth bark more or less falling away in lenticular flakes. Closely allied to *E. polyanthemos.*

E. INTERTEXTA R. T. Baker.

A large tree, up to 80 feet and 3 feet in diameter. It is sometimes called "White Gum"; it is always blotched, and sometimes has rough bark up to 20 feet from the ground. The upper part of the trunk and the branches are smooth.

E. LANE-POOLEI Maiden.

A White Gum, attaining a height of from 40 to 50 feet, and from 21/2 to 3 feet in diameter. Being of stunted appearance, has a rather short bole and crooked appearance, although some are 20 feet in length and perfectly straight; the limbs are generally very crooked. The colour of the outside of the trees and branches is whitish in appearance, with a tinge of salmon colour towards the sunny side. There is also a fine white powder on the bark which is easily rubbed off. The bark on some of the trees is of a brownish colour. There is very little deciduous rough bark. Sapwood pale-coloured and thick; timber interlocked and rich reddish-brown.

E. MICROTHECA F.v.M.

Although this tree is normally a rough-barked species, I invited attention to a form of it which is a White Gum—a Powder Bark. See Part XI, p. 53, and also below, p. 39.

E. PARRAMATTENSIS Hall.

A small or medium-sized tree; the bark smooth, whitish, or greyish with deciduous flakes. Timber "pale, pink-coloured," inferior, *i.e.,* brittle and not durable, but it is really red, for it is only pale in saplings.

E. ROSTRATA Schlecht.

A large, picturesque tree, whose bark is mainly smooth, with more or less flaky, deciduous bark. It has the great merit, for a tree yielding a valuable timber, of flourishing in flooded land.

E. SEEANA Maiden.

A smooth-barked tree of medium or large size, with blotches on the bark.

E. TERETICORNIS Sm.

A tall tree with a thick trunk. Smooth bark with deciduous patches or ribbons.

c. With brown timbers:—

E. ochrophloia F.v.M.

E. redunca Schau.

E. Thozetiana F.v.M.

E. OCHROPHLOIA F.v.M.

A somewhat erect tree of 40–50 feet. Has usually an erect trunk for 20–30 feet, then it branches obliquely into moderately umbrageous branches. The trunks are up to 3 ft. 6 in. in diameter. It is a Gum, with clean branches, but at the butt of the tree it is very rough scaly, peeling off and very black. Called "Yellow Jacket" owing to the yellow cast of the bark.

E. REDUNCA Schau. var. *elata.*

A large White Gum, the trunk generally swelling out suddenly near the ground.

E. THOZETIANA F.v.M.

An erect, slender, graceful tree, attaining a height of 70 feet. It is a smooth-barked species with but little rough, flaky bark at the butt. "The trunk is beautifully fluted, which appears to be a constant character of this species." (O'Shanesy.) "It is like a Mallee, but I do not think it has the bulbous stock of a Mallee." (C. C. Chapman.)

C. *Scrambling in habit.*—In the present state of our knowledge, B. and C. appear to run into each other, and both into A.

a. With pale timbers:—

E. cladocalyx F.v.M.
E. Cooperiana F.v.M.
E. coriacea A. Cunn.
E. de Beuzevillei Maiden.
E. Gunnii Hook, f.
E. Irbyi Baker and Smith.
E. Kitsoniana (J. G. Luehmann) Maiden.
E. megacarpa F.v.M.
E. stellulata Sieb.

E. CLADOCALYX F.v.M.

An umbrageous tree, a White Gum, more nor less scaly barked like the eastern *E. hoemastoma.* Sometimes the bark more closely resembles that of a Grey Gum (*E. punctata*). Usually called Sugar Gum.

E. COOPERIANA F.v.M.

Particulars concerning this species are not known. It is closely allied to *E. cladocalyx.*

E. CORIACEA A. Cunn.

A White Gum, variable in habit from tall and erect to more or less pendulous, when it is known as Weeping Gum. Sometimes it may be scrambling, and then earns the name of "Tumble-down Gum." It often has a scribbled bark, owing to insect action. This tree is exclusively found at the "tree-line" at Mount Kosciusko in its variety *alpina.*

E. DE BEUZEVILLEI Maiden.

A tree of medium size, up to 60 feet high, a White Gum, more or less glaucous, and more or less rough-flaky bark at the butt.

E. GUNNII Hook, f.

A White Gum, of somewhat scrambling habit, and with the usual deciduous lenticular patches.

E. IRBYI Baker and Smith.

A small tree, with a smooth, pale or ashy-coloured bark.

E. KITSONIANA (J. G. Luehmann) Maiden.

A dwarf Gum tree, up to 30 feet. Bark smooth in texture and ashy-grey in colour, which becomes lighter in the upper branches.

E. MEGACARPA F.v.M.

A medium-sized gouty Gum tree with stems up to 3 feet. Bark thickish, like a

White Gum, or perhaps like a Grey Gum (*E. punctata* of eastern New South Wales). Timber pale-coloured, brownish near the heart; brittle. See also page 40.

E. STELLULATA Sieb.

A forest tree of medium size in the Monaro (New South Wales) and Gippsland (Victoria), forming a shapely tree of 50 feet in height and more, with a stem-diameter of 2 or 3 feet, and with dense foliage. Sometimes it takes on a straggling habit. It is a Gum, and the bark (see Part V, p. 129) often coloured green, olive-green, or lead-coloured, giving it an unusual appearance.

b. With dark-coloured timbers, red to reddish-brown:—

E. alba Reinw.
E. Bancrofti Maiden.
E. cosmophylla F.v.M.
E. dealbata A. Cunn.
E. Drummondii F.v.M.
E. fasciculosa F.v.M.
E. pallidifolia F.v.M.
E. salmonophloia F.v.M.
E. squamosa Deane and Maiden.

E. ALBA Reinw.

A typical White or Cabbage Gum. Though not a very tall tree, it has a good trunk, though often scrambling; branches brittle. An entirely smooth bark without flakes. Timber red or reddish-brown, coarse fibred.

E. BANCROFTI Maiden.

A tree of medium size, often crooked and gnarled, bark smooth, falling away in irregular patches. Very similar in appearance to *Angophora lanccolata.* It may be phytogenetically a form of *E. tereticornis.*

E. COSMOPHYLLA F.v.M.

A smooth-barked tree, the exfoliating bark coming off in irregular patches, never hanging in strips.

E. DEALBATA A. Cunn.

A scraggy, small tree, never quite a Gum, but with the bark falling from the greater part of the trunk and branches in flakes or small ribbons. Often (particularly north and north-west of New South Wales) it is of a Mallee habit.

E. DRUMMONDII F.v.M.

A White Gum, small in size, with the usual flaky-deciduous bark.

E. FASCICULOSA F.v.M.

A White Gum of medium size, the bark somewhat flaky at the butt. Timber deep reddish-brown.

E. PALLIDIFOLIA F.v.M.

A crooked tree, bark white to-the ground and brittle.

E. SALMONOPHLOIA F.v.M.

"Salmon Gum;" "Nankeen-coloured Gum" of the old writers. A tree up to 100 feet, with a stem-diameter of 3 feet, bark smooth, shining, greyish with a purplish tinge, or sometimes blotched. A very characteristic-looking bark, sometimes a little rough-flaky bark at butt. Timber reddish-brown, "red with crimson in it."

E. SQUAMOSA Deane and Maiden.

A medium-sized Gum, with a scrambling and drooping habit, often stunted. Doubtless a depauperate or decaying species. Bark smooth or scaly, often blotched. Timber deep red.

C. *Western Australian Blackbutts.*—This type is essentially a "Gum," and I would again remind my readers that all Gums practically have some rough, hard, flaky, or ribbony bark on the butt. This class of Blackbutt is not to be confused with the Blackbutt of south-western Australia (*E. patens*) or the more numerous Blackbutts of eastern Australia, of which *E. pilularis* is a type. The latter are characteristic by their sub-fibrous or fibrous barks, and belong to the rough-barked series.

The true Western Australian Blackbutts are trees of medium size, with a diameter of 2 or 3 feet, and have usually a cigar-brown timber. The following go under the name of Blackbutt in Western Australia:—

E. celastroides Turcz.
E. Clelandi Maiden.
E. confluens (W. V. Fitzgerald) Maiden.
E. corrugata Luehmann.
E. Dundasi Maiden.
E. Flocktonioe Maiden.
E. gracilis F.v.M. (a form).
E. Griffithsii Maiden.
E. Houseana (W.V.F.) Maiden.
E. Mooreana (W.V.F.) Maiden.
E. le Souefii Maiden.
E. Stricklandi Maiden.
E. transcontinentalis Maiden.
E. Woodwardi Maiden.

E. CELASTROIDES Turcz.

A medium-sized tree, with a trunk 2 feet in diameter. A "White Gum" or "Blackbutt," a little rough bark, which may be Box-like at the butt, smooth above.

E. CLELANDI Maiden.

A Blackbutt. A tree of medium size, bark hard-flaky or fibrous-flaky and blackish at butt, the rest of the trunk and all the branches smooth. Branchlets glaucous, as likewise the whole of the saplings.

E. CONFLUENS (W.V.F.) Maiden.

A small tree, up to 30 feet high, with a diameter up to 1 foot. Bark "persistent, white and smooth." By this I understand that it is mainly a smooth-barked tree, but there is a certain amount of "persistent" bark on the butt. Timber red to brownish-red.

E. CORRUGATA Luehmann.

A tree attaining about 30 feet in height, with a smooth, ashy-grey bark.

E. DUNDASI Maiden.

A species but imperfectly known at present.

E. FLOCKTONIae Maiden.

An erect, many-stemmed shrub of 6–8 feet as originally described, but Mr. C. E. Lane-Poole has kindly sent me an admirable photograph by Prof. E. H. Wilson of the Arnold Arboretum, U.S.A., which shows an erect tree of 40 feet with a diameter of 8 inches. Bark almost perfectly smooth, with the exception of a few flakes. The colour of the timber is indicated by its local name of "Redwood."

E. GRACILIS F.v.M. (the W.A. form).

"Snap and Rattle." Over 2 feet in diameter and up to 60 feet high. It grows in divaricate clumps, but is not Mallee-like. Its timber is cigar-brown. Often it is dwarf and crooked, and with the usual hard, dark-coloured bark found on the short trunk of a Mallee of this size. See also "Mallee," p. 325, Part L.

E. GRIFFITHSII Maiden.

A large White Gum, attaining a trunk diameter of 2 feet in the case of the type at Kalgoorlie. The bark is somewhat ribbony, box-scaly at butt. A photograph at Widgiemooltha shows a tree of 60 feet high with a diameter of 2 ft. 6 in., with the rough bark about 12 feet up.

E. HOUSEANA (W.V.F.) Maiden.

A tree up to 70 feet high, with a diameter up to 21/2 feet, bark persistent, white to greyish-white, smooth. By this I understand a White Gum, but I do not understand the meaning of the word "persistent" in this case. Timber reddish.

E. MOOREANA (W.V.F.) Maiden.

A small, crooked tree, up to 30 feet high, glaucous all over. A White Gum with reddish timber.

E. LE SOUEFII Maiden.

A tree of medium size, bark flaky at the butt, the greater portion of the trunk and the whole of the branches smooth. So far the type and a photograph of a tree by

Prof. E. H. Wilson at Widgiemooltha shows a tree of 50 feet with a diameter of 2 feet, with the rough bark up to the first fork, say 10 feet.

E. STRICKLANDI Maiden.

I have excellent photographs both by Prof. E. H. Wilson and by Mr. C. E. Lane-Poole. The former gives the measurements of his tree as 35 feet, with a diameter of under 2 feet; the latter says it does not grow to a large size. The bark adheres for 2 or 3 feet from the ground; the rest of the stem, however, is perfectly clean. Timber rich deep brown.

E. TRANSCONTINENTALIS Maiden.

A medium-sized tree. It is a White Gum or Blackbutt, with blotched bark, and more or less short, flaky ribbons on the trunk. I have excellent photographs by both Prof. E. H. Wilson and Mr. C. E. Lane-Poole. The height of the tree in the former's photograph is given at 65 feet with a stem diameter of over 2 ft. 6 in. Mr. Lane-Poole speaks of it as "a fine, clean-stemmed tree mixed with Gimlet (*E. salubris*) and Salmon Gum (*E. salmonophloia*) all through the Coolgardie district. It is difficult to distinguish it outwardly from *E. Flocktonioe.* Both are known as Redwood (colour of timber rich reddish-brown), and are used indiscriminately as fuel for the mines."

E. WOODWARDI Maiden.

A tree of 40–50 feet, bark smooth, somewhat scaly at the butt, all parts very glaucous, almost mealy.

D. *Gimlet Gums.*—So called because the stem is twisted like a gigantic corkscrew rather than a gimlet. The typical species (*salubris*) belongs to Western Australia.

E. salubris F.v.M.

E. Campaspe S. Moore.

E. occidentalis Endl. var. *astringens* Maiden (note only).

E. Thozetiana F.v.M.

E. SALUBRIS F.v.M.

Gimlet Gums. A medium-sized or tall tree, the whole stem often twisted like a gigantic corkscrew, less like a gimlet. Bark smooth, shining, ash-coloured. They have a peculiar olive-green hard bark (reminding one of *E. stellulata* of the east a little). Sometimes Gimlet trees have short uniform ribbons all up the trunk; they stick out, and such Gimlets are termed "feathery." Timber pale brown.

E. CAMPASPE S. Moore.

Very glaucous. "It has no trunk, but the limbs appear to grow and spread from the ground much like a very large Mallee. (Probably because of local circumstances, J.H.M.) Up to 40 feet, and its branches spread and droop like a willow." Has a smooth, thin bark with ribbons. Timber hard, pale coloured, with a little brownish centre. “White Gum with a ribbony bark” (Dr. Webster).

Called “Silver-topped Gimlet” by Mr. Lane-Poole. He says it does not grow to the same size as the true Gimlet (*E. salubris*). I have excellent photographs by Mr. Lane-Poole. Another by Prof. E. H. Wilson gives the dimensions as 35 feet high, with a diameter of 6 inches, will be published later.

In regard to *E. Campaspe,* the stem is just as twisted as that of the Gimlet; if it is not so in the photograph it is simply because that particular tree was a straight one. Wood-cutters can never tell the difference; they call them both Gimlets, so I suggest “Silver-topped Gimlet” to make the distinction. (C. E. Lane-Poole, 2nd September, 1919.)

From the photo you will see that *E. Campaspe* is not a Mallee. It grows to a much larger size and the stem is single. (1st September, 1919.)

E. OCCIDENTALIS Endl. var. ASTRINGENS Maiden.

Trees of this variety seem to somewhat resemble *E. salubris* in general appearance.

E. THOZETIANA F.v.M.

Speaking of this species, O'Shanesy says: “The trunk is beautifully fluted, which appears to be a constant character of this species.”

E. *Grey Gums.*—The term Grey Gum is applied to *E. punctata* (which is a typical form) because of the dull grey appearance of the bark. The bark has a roughish or raspy appearance, in contradistinction to a smooth and even shiny one, possessed by so many of our Gums. It has smooth, white patches in places, caused by the outer layer of bark falling off. These white patches in their turn become grey, and the process of exfoliation of the bark is repeated until probably the whole of the bark on the trunk is shed at one time or another. Although rather difficult to properly describe, the bark of the Grey Gum is so characteristic that, when once pointed out, it could not be confused with the bark of any other hardwood tree. They are all large trees, and the first three have red timbers:—

E. adjuncta Maiden.
E. propinqua Deane and Maiden.
E. punctata DC.
E. canaliculata Maiden.
E. maculata Hook.

E. maculata is an anomalous member of the Bloodwood Group; it has a bark reminiscent of the Grey Gums and a pale-coloured timber. It may be looked upon as a transit form between the Grey Gums and the Bloodwoods. *E. canaliculata* is a Grey Gum with pale-coloured timber, and in some respects connects the Grey Gums with *E. maculata.*

E. ADJUNCTA Maiden.

A tree attaining a height of 80 feet, with a diameter of 3 or 4 feet.

E. PROPINQUA Deane and Maiden.

A Grey Gum, very closely allied to *E. punctata.*

E. PUNCTATA DC.

The typical Grey Gum. Bark dull grey in appearance, has a roughish or raspy appearance, in contradistinction to a smooth and even shiny one, possessed by so many of our Gums. It has smooth white patches in places, caused by the outer layer of bark falling off.

E. CANALICULATA Maiden.

A tall species, over 100 feet in height, with a diameter of 4 feet. Timber pale coloured, somewhat coarse-fibred, interlocked and tough.

E. MACULATA Hook.

A tall, smooth-barked tree, more or less blotched, giving it a spotted or mottled appearance, hence the name "Spotted Gum," which was originally applied to this species. Timber pale coloured.

2. HEMIPHLOIae (Half-barks).

The illustrative instances Mueller quotes in his 1859 paper are Moreton Bay Ash (*E. tessellaris*), the Blackbutted Gum (a term now archaic and shortened to Blackbutt, of which *E. pilularis* is the type, and Box-trees *partim,* amongst which he probably intended to include *E. hemiphloia,* the tree which was first named Box, but he badly mixed it up when he described it later. See this work, Part XI, p. 14. It includes most of the Peppermints.

The outstanding fact is that the average bushman unhesitatingly does not greet the Hemiphloiae as Gums, but realises that the rough, sub-fibrous bark proceeds a considerable distance up the butt, often to the first fork. As a rule, the upper part of the butt, and always the limbs, are smooth. The Hemiphloiae are intermediate between the Leiophloiae and the Rhytiphloiae. There are no abrupt stages in Nature, and so it is that sometimes an exceptional member of the Leiophloiae may have so much rough bark that it verges towards the Hemiphloiae, while a member of the Hemiphloiae tends to the rough-barkedness of the Rhytiphloiae. Nevertheless, the Hemiphloiae afford us a useful practical classification.

It is remarkable that the vast preponderance of the Hemiphloiae have pale timbers.

My provisional grouping is—

A.—*Renantherae.*—Eastern species. Timbers pale. Different members are known, chiefly as Peppermint, but also as Blackbutt and Mountain Ash. The bareness of the branches is sometimes emphasised in the name White Top.

Following is the list :—

E. amygdalina Labill.
E. Andrewsi Maiden.
E. Consideniana Maiden.
E. dives Schauer.
E. gigantea Hook.
E. Laseroni R. T. Baker.
E. Penrithensis Maiden.
E. pilularis Sm.
E. piperita Sm.
E. radiata Sieb.
E. Sieberiana F.v.M.
E. taeniola Baker and Smith.
E. vitrea R. T. Baker.

E. AMYGDALINA Labill.

"Black Peppermint." Often the dimensions of a small shrub, but attaining the size of a small tree. Seems to be confined to Tasmania, so far as we know at present, but I confidently look for it on the mainland. It is undoubtedly a Peppermint with sub-fibrous bark, though smooth when quite small, and with the branches always smooth.

E. ANDREWSI Maiden.

A large tree, known both as Peppermint and Blackbutt. Large trees measure from 150–180 feet. Diameter at least 8 feet. The shape and habit of the tree is a good deal like that of *E. pilularis* with the branches and branchlets more or less smooth. On a low elevation on basalt, bark more fibrous than on higher granite soils.

E. CONSIDENIANA Maiden.

A medium-sized tree with grey tough bark to the tips of the branches, said bark being of that sub-fibrous character well-known in Australia as Peppermint. At the same time it is not a typical Peppermint, and it was once described contemptuously by my driver as having a "mangy-looking bark."

E. DIVES Schauer.

A tree of medium size. A typical Peppermint, usually rather scrambling in habit, with smooth limbs. In southern New South Wales it attains a larger size and grows more erect.

E. GIGANTEA Hook.

Has tall, clean, tapering trunks. The bark on the lower half of the stem very thick and woolly, like Stringybark. This ceases abruptly about half the height of the stem or barrel, no matter what height the tree or length of stem may be. Above this the bark is quite clean, very thin, the old bark peeling off in long, thin strips. Yields a specially fissile timber.

E. LASERONI R. T. Baker.

A medium-sized tree, not quite a Stringybark, and hence known as Bastard Stringybark. The fibrous bark covers the trunk and decorticates in long strips from the main branches, which are otherwise smooth.

E. PENRITHENSIS Maiden.

A tree of medium size, bark hard-fibrous on the trunk, branches smooth, intermediate in character between a Stringybark and a Peppermint.

E. PILULARIS Sm.

This is the tree which most usually goes under the name of "Blackbutt," and sometimes by way of distinction, for it attains enormous size, the "Great Blackbutt." It is a stately, shapely tree, and perhaps the best known of all the genus to Sydney residents, as it is so abundant. Its rough outer bark is confined to the trunk of the tree, the branches being smooth and white. From the latter circumstance it shares with some other species the designation of "White-top." The outer bark of this tree is fibrous and closely matted, forming a sort of middle link between such fibrous-barked trees as the Stringybarks, and such smooth ones as our White Gum. I do not know that the term "black," as applied to the butt, is particularly appropriate; the word "grey" would be better, though exception could be taken to this adjective also.

E. PIPERITA Sm.

Not very dissimilar to *E. pilularis* in general appearance, but a smaller tree, denizen of rockier conditions and with far inferior timber. Bark sub-fibrous on the trunk, with smooth branches. Sometimes decidedly a ribbony Gum.

E. RADIATA Sieb.

A tree usually moderate sized, but sometimes attaining a considerable height the bark fibrous and persistent, not so fibrous as that of a Stringybark, and of a looser texture than that of a Box of the character usually known as Peppermint. The fibrous bark occurs only on the trunk or at most on the largest branches. The branches are usually quite smooth or ribbony.

E. SIEBERIANA F.v.M.

Looked at from some little distance most people would pronounce it an Ironbark, and, because of the clean white branches, it is sometimes known as White Ironbark. Sometimes the rough bark only reaches half way up the stem. The young branches and upper parts of the trunk are often glaucous—indeed, this seems always a character of the species. The bark is, however, by no means so hard as the Ironbarks, nor are the ridges so sharp or well sculptured; the bark is something between that of the Ironbarks and the Stringybarks; indeed it varies in texture between that of these two groups.

E. TAENIOLA Baker and Smith.

A tree of 40–50 feet, with a Peppermint bark.

E. VITREA R. T. Baker.

A shrub or small tree to one of medium size, the bole with persistent bark, the branches smooth. The bark is variously described; thus (1) “Bastard Stringybark, ribbony tops, hard scaly bark, not fibrous”; (2) “Rough and thin and of a dark brown colour, hanging loosely from the stem, in short loose pieces” (Wingello, J.L.B.). “Peppermint. Rough bark about 15 or 20 feet high. Near Oberon, on Hampton-road.” (R. H. Cambage). “Smooth bark, except just at butt. Black chippy bark. Three miles south of Marulan, on side of gravelly ridge.” (A. Murphy).

It is nearest to a Peppermint.

B. *Boxes, i.e.*, trees with sub-fibrous, interlaced bark and interlocked timber. Eastern Australia; some tropical. Timbers pale-coloured, or at all events not dark-brown, although, if one keeps a timber long enough, it will become very dark. This remark is of general application. The name arose because of the interlocked timber of some of them. This was associated with a certain type of bark, and then we obtained the “box” bark, sometimes irrespective of the boxy nature of the timber.

As regards bark alone, some species may be termed Woollybutts, but the true Woollybutts have red timber.

E. aggregata Deane and Maiden.
E. Banksii Maiden.
E. Bosistoana F.v.M.
E. cinerea F.v.M.
E. hemiphloia F.v.M.
E. Howittiana F.v.M.
E. Macarthurii Deane and Maiden.
E. melliodora A. Cunn.
E. nitens Maiden.
E. Normantonensis Maiden and Cambage.
E. ovata Labill.
E. Pillagaensis Maiden.
E. pruinosa Schau.
E. quadrangulata Deane and Maiden.
E. Yarraensis Maiden and Cambage.

E. AGGREGATA Deane and Maiden.

“Black Gum.” Usually a small, gnarled tree, but may be straighter, up to 40 feet, with a trunk of 2 feet. The bark of the butt box-like or rather more flaky, with smooth, dark-green branches.

E. BANKSII Maiden.

"Tenterfield Woollybutt." A very large tree, up to 100 feet, reminding one of *E. goniocalyx* in habit. Bark of a dull uniform grey (not quite smooth, but almost a Grey Gum), woolly or fuzzy (not as soft and as boxlike as *E. Stuartiana*) along the butt, hence the name "Woollybutt." This is a species which runs insensibly into the *Rhytiphloioe.*

E. BOSISTOANA F.v.M.

An upright-growing large tree, with a flaky, sub-fibrous bark growing on the trunk to a varying height. The branches smooth, and often the upper part of the trunk. It presents a good deal of general similarity to *E. hemiphloia.* The adjective Yellow refers to the timber, and not to the bark, as in *E. melliodora.*

E. CINEREA F.v.M.

A moderate sized or large tree, with a matted, persistent bark, the foliage more or less glaucous. Ragged, fibrous, reddish-brown on trunk and larger limbs, then on smaller limbs, coming off in strips and curling inwards, leaving creamy-white smooth branchlets.

E. HEMIPHLOIA F.v.M.

"White or Grey Box," the species to which the name Box was first applied in Australia. Erect in habit, the trunk with a grey, sub-fibrous, compact (Box-like) bark, the branches smooth, or with short ribbons.

Var. *albens* F.v.M.

Glaucousness is a character of this variety.

Var. *microcarpa* Miaden.

A medium-sized or large tree, rather erect in habit, the bark sub-fibrous, rather compact, and greyish or whitish on the trunk, the limbs smooth.

E. HOWITTIANA F.v.M.

A tree attaining a height of about 100 feet, with a girth at the butt of 12 feet "Bark less fissured than that of some of the Box-Eucalypts; more resembling that of the Stringybark trees."

E. MACARTHURI Deane and Maiden.

A tall tree, of beautiful form, with a rounded head. The bark rough, somewhat box-like, but very woolly, the upper branches smooth. Like *E. Banksii,* this might be termed a Woollybutt.

E. MELLIODORA A. Cunn.

One of the most beautiful of our medium-sized or larger trees, because of the density and grace of its pendulous foliage. Its trunk is usually somewhat crooked or forks early, the bark is sub-fibrous or box-like (often somewhat ragged), varying in texture and in the height to which it extends. As a rule it covers the trunk and thicker branches. The cast of the bark is yellow; the colour of the inner bark bright yellow.

E. NITENS Maiden.

A fine large Gum up to 150 feet, with a symmetrical barrel of 3 or 4 feet diameter. Rough bark about one-third of the way up, and then peeling into ribbons.

E. NORMANTONENSIS Maiden and Cambage.

Small Box-trees of 10–30 feet, sometimes suggestive of a Mallee. Box-bark on trunk and large branches. Upper branches sometimes smooth and greenish.

E. OVATA Labill.

Large trees, with rough butts, with flattish ribs of fibrous bark reminiscent of Turpentine (*Syncarpia laurifolia*). Branches smooth, but they are rough-barked trees on the whole.

E. PILLIGAENSIS Maiden.

A medium-sized tree, with whitish-grey bark and persistent, as in *E. hemiphloia*, on the trunk and main branches. Timber pale-brownish and interlocked. Known as "Narrow-leaved Box."

E. PRUINOSA Schau.

Silver-leaved Box. A medium-sized tree, with diameter of about a foot, bark persistent, grey, thin and fibrous. A tropical species.

E. QUADRANGULATA Deane and Maiden.

A tree of 80–100 feet and diameter of 2–4 feet. Very much resembles the ordinary Box (*hemiphloia*) in general appearance, but bark more fuzzy and less soft than the latter. The branches have smooth tips.

E. YARRAENSIS Maiden and Cambage.

A medium-sized tree with woolly bark on trunk and branches.

C. *With red or reddish-brown timbers:—*

E. bicolor A. Cunn.
E. Brownii Maiden and Cambage.
E. Cambageana Maiden.
E. polyanthemos Schauer.
E. microtheca, F. v. M.

These five timbers are put in their present place because of their red or reddish-brown colour. They all seem to be rightly placed in the Hemiphloiae, but additional experience may show that they may be fitly placed in another Group.

E. BICOLOR A. Cunn.

A large tree with pendulous branches, which are more or less smooth. Bark dark coloured, very thick, and even furrowed like an Ironbark when old, though not so hard, flaky-fibrous, sometimes even reminiscent of a Stringybark. "Close and even, resembling a typical Grey Box in younger trees." Timber red, rarely reddish-brown.

E. BROWNII Maiden and Cambage.

A medium-sized Box-tree, about 40 feet high, erect rather than drooping, with hard, thin flaky Box-bark on the trunk and large branches, the ultimate branchlets smooth. Timber dark red in colour.

E. CAMBAGEANA Maiden.

A medium-sized tree, up to from 50 to 80 feet high, with long pendulous branches. Bark scaly up to 3 or 4 feet from the ground, hard and dark-coloured, hence the name "Blackbutt." The remainder of the stem and branches are smooth and white. Timber deep red or chocolate, said to resemble that of Red Box (*E. polyanthemos*).

E. POLYANTHEMOS Schauer.

"Red Box" par excellence. Usually a medium-sized, scrambling tree, the amount of "boxy" or scaly bark on the trunk varying. (See Part XLII, p. 58).

E. MICROTHECA F.v.M.

The description of no Eucalyptus bark has given me more trouble than this species.

The description of the original species says: "With a dirty brownish-white bark full of wrinkles and cracks, persistent on the trunk, deciduous on the upper branches, *leaving them ashy white*."

Bentham (B.Fl. iii, 223, 1866), in the well-known confusion with *E. brachypoda* Turcz., referred to in Part XI, p. 51, of the present work, says:—

A tall shrub or small or moderate sized tree, the bark varying from smooth and whitish to dark and rugged, persistent or shed in large patches (Oldfield), dark and rough on the trunk, smooth, whitish and deciduous on the branches (F. Mueller).

Mr. R. H. Cambage, in *Journ. Roy. Soc. N.S.W.*, xlix, 433 (1915), refers to the uncertainty in regard to the bark at some length. He rightly points out that the Bourke (N.S.W.) tree has "smooth, perfectly white branches" and "brownish-red" timber. The Gulf of Carpentaria tree is entirely covered with Box bark, but there are some intermediate forms going northward from Bourke. The Gulf Coolabah has timber of a shade darker than that of the Bourke tree.

I have referred to the subject in Part XI, p. 53, of the present work, and also in my "Forest Flora of New South Wales," Part LI, p. 20.

Mr. W. V. Fitzgerald (MSS.) speaks of the Kimberley (North-west Australia) tree as "30–50 feet, trunk to 25 feet, diameter 1–2 feet, branches often pendulous, bark persistent on stem and branches, dark gray, rather thick, rough and longitudinally fissured, often of a fibrous texture, timber red, hard and tough." This could also be taken as a description of the tree as we usually find it in eastern Australia, but we have on the Murchison River (limestone and vicinity of fresh water) and also in tropical coastal Western Australia, an undoubted white gum with a white-washed bark. The environments which have brought about these changes have not yet been explained. Perhaps we have a second species. (Maiden in *Journ. Roy. Soc., N.S.W.*, LI, 453 (1917).

Summarising, I think the position of the species is something like this:—

A tree of medium or large size (up to 70 or 80 feet, with a diameter of 4 feet), but generally much smaller, often more or less crooked, branches pendulous, and the trunk, to a varying height, covered with a sub-fibrous, shaggy bark, to scaly or flaky bark, the branches smooth and perfectly white. In tropical and sub-tropical Western Australia we have the extreme form of the whole of the trunk being smooth and white.

D. Western Australian Species.—This provisional group contains three tropical species, of whose bark and habit we are but imperfectly informed. When we know more about some of the members included in it, it will be revised. The timbers are all brown, or believed to be so.

E. argillacea W. V. Fitzgerald.
E. cornuta Labill.
E. foecunda Schau.
E. gamophylla F.v.M.
E. Guilfoylei Maiden.
E. megacarpa F.v.M.
E. occidentalis Endl.
E. oligantha Schau.

E. ARGILLACEA W. V. Fitzgerald.

A tree of 25–40 feet, 9–12 inches diameter. Bark dark grey, persistent on the trunk and semi-fibrous, approaching that of a Box. We know very little of this species; perhaps it would be better with the Western Australian Blackbutts, see p. 29.

E. CORNUTA Labill.

A tree of medium size, spreading, with rough, boxy, fibrous, dark bark, with vertical fissures close to each other, limbs ribbony and smooth. An old Yate resembles an Ironbark at the butt.

E. FOECUNDA Schau.

A tree of medium size, the trunk with rough bark up to the branches, which are usually spreading. It has black flaky to almost ribbony bark on trunk, smooth limbs. Sometimes when it is young it grows in clumps from one root, thus showing affinity to the Marlocks.

E. GAMOPHYLLA F.v.M.

A glaucous shrub or small tree, widths of timber not exceeding 8 inches being available. Notes on the bark are not available to me.

E. GUILFOYLEI Maiden.

A tall tree, with fibrous or stringy bark to within a few feet of the branches. It seems to resemble *E. acmenioides* of the eastern States a good deal.

E. MEGACARPA F.v.M.

This is locally known as "Blue Gum" in South-Western Australia. It is a gouty, useless timber tree, which may exceptionally attain a diameter of 3 feet. The bark is like a White Gum, or perhaps like a Grey Gum (*E. punctata*, eastern New South Wales) to some extent; that is to say, white and smooth, with patches of bark of sand-paper-like texture, which peel off and present a smooth surface, which, in its turn, roughens and exfoliates. Bark rather thick, wood not hard, with large gum-veins, and becoming brownish towards the heart.

E. OCCIDENTALIS Endl.

This species, like some others, is variable alike in height and bark. It may be:—

(1) An erect, small, or large tree with flat top, hence the name "Flat Top Yate," the bark blackish and furrowed (on lower half of the trunk), then flaky or feathery, with black twisted strips, like a French fowl, for approximately the remaining half, then with smooth branches. Timber brown.

(2) The Mallets, which are smooth-barked trees of medium size, and the bark of some of them is used for tanning.

E. OLIGANTHA Schau.

A tropical tree about 40 feet in height, with a trunk up to 15 feet, and diameter of 1 foot; bark greyish, thin and smooth.

3. Rhytiphloiae (Rough Barks).

These are rough barked all over, that is to say, not half-barked, like the Hemiphloiae.

In Mueller's original definition (1859) he included Bloodwood trees, Box trees (in part), Peppermint trees (in part).

In the "Eucalyptographia," as I have already shown in Part L, he introduced a number of species which are still recognised as Rhytiphloiae, but includes the Hemiphloiae (which he abolishes as such), together with one member of the Leiophloiae (*E. stellulata*), one a South Australian Peppermint (*E. odorata*), not an eastern one, and large numbers of the Bloodwoods. Indeed his classification of 1884 is very much worse than that of 1859; it is retrograde.

In his original group, if Mueller had not cited some examples, it would not have had to be so much modified now. But his group is still useful (without his examples). He defined it as: “With wrinkled persistent bark, rather solid.” It may be defined as: With certain rough barks, which extend to the tips of the branches, or very close thereto, and not half-way in the case of the Hemiphloiae, and not absent in the case of the Leiophloiae.

The Bloodwood trees must be excluded, as they come better in Section 6—Lepidophloiae. Most of the Peppermints (but not all of them) must be excluded too, and it must be remembered that over sixty years ago we knew less of the Peppermints than we do now.

It includes a number of trees which the bushmen give separate names to, but, even in the present state of our knowledge, the Rhytiphloiae is the least satisfactory of Mueller's six groups.

In considering the Rhytiphloiae, it is worth emphasising that it is intended to include trees (not otherwise disposed of in the almost natural rough-barked groups of Stringybarks, Ironbarks, and Bloodwoods), which have rough bark to the ends of the branches, in contradistinction to the Hemiphloiae. I think it will be found a useful broad group, as the time goes on, but, as in all groups, the difficulties start with what shall be included in it, and how it shall be subdivided. When we know more of the trees of our own country, these difficulties will largely disappear.

a. With Pale Timbers:—

E. acacioeformis Deane and Maiden.
E. angophoroides R. T. Baker.
E. Baueriana Schauer.
E. Cloeziana F.v.M.
E. conica Deane and Maiden.
E. decipiens Endl.
E. eloeophora F.v.M.
E. gomphocephala DC.
E. microcorys F.v.M.
E. Mundijongensis Maiden.
E. notabilis Maiden.
E. nova-anglica Deane and Maiden.
E. odorata Behr, and Schlecht.
E. patens Benth.
E. Planchoniana F.v.M.
E. populifolia Hook.
E. rariflora F. M. Bailey.

E. Raveretiana F.v.M.
E. rudis Endl.
E. striaticalyx W. V. Fitzgerald.
E. Stuartiana F.v.M.
E. Todtiana F.v.M.
E. torquata J. G. Luehmann.

E. ACACIaeFORMIS Deane and Maiden.

Bark dark, hence the name "Black Peppermint;" fibrous, and sometimes so rough and furrowed as to resemble an Ironbark at a little distance.

E. ANGOPHOROIDES R. T. Baker.

A medium-sized tree with a white box bark, persistent to the ultimate branches.

E. BAUERIANA Schauer.

A tree of medium or large size, with a rounded head of dense foliage when in full vigour. Rough greyish or dark soft bark on the trunk and ultimate branchlets.

E. CLOEZIANA F.v.M.

"Messmate." A tall tree, the bark flaky-fibrous and furrowed. Its bark has been described as brown, deeply furrowed, flaky, resembling that of *E. siderophloia*, but, of course, not hard. Pale-coloured, drying yellowish-brown.

E. CONICA Deane and Maiden.

A tree of medium size, say 40–60 feet, with a fuzzy bark almost to the tips of the limbs, but the covering of the rough bark varies in amount. Timber pale brown.

E. DECIPIENS Endl.

A "Swamp" or "Flooded Gum." The Fremantle tree (the type), attaining 30–50 feet, but usually much less, the branches spreading or almost pendulous, and very much like *E. gomphocephala* DC. in appearance. Bark thick, persistent and rough, of an ash-grey colour, the bark of the upper portions sometimes smooth.

The southern form varies from a shrub to a small or large tree, but on the banks of creeks or rivers it attains the height of 60–70 feet, with a diameter of 3 feet, but is never an erect tree. The bark is fuzzy-fibrous, the outer layers softish, flaky and furrowed, very much like that of *E. Stuartiana*.

E. ELaeOPHORA F.v.M.

A medium or large tree. A Box, the rough bark as that of an Ironbark in old trees. Persistent rugose bark, dirty ash-grey.

Rough scaly bark, persistent on stem and branches is another description.

E. GOMPHOCEPHALA DC.

The bark is sub-fibrous (matted), reminding one of the "Box" trees (Hemiphloiae) of eastern Australia, except that the branches are not smooth, and therefore have no ribbons. The superficial resemblance is perhaps closer to *E. Stuartiana*, the Apple-tree of eastern Australia.

E. MICROCORYS F.v.M.

Bark fibrous, flat-furrowed, reminding one of a Turpentine (*Syncarpia laurifolia*), or a Jarrah (*Eucalyptus marginata*), but paler. It can be further described as subfibrous, of loose and even woolly texture. In colour it is of a sort of brick or rusty red, and is persistent even to the smallest branches. It is often of a corrugated appearance, particularly in old trees.

E. MUNDIJONGENSIS Maiden.

A tall tree of 80–100 feet, 5 feet in diameter. Fine adherent bark at base, top clean. Hard flaky, breaking off in long woody strips. Bark of smaller branches smooth. It is reminiscent, of *E. gomphocephala*, the Tuart.

E. NOTABILIS Maiden.

A tree of medium size, with dark umbrageous foliage. Bark flaky-stringy or fibrous-flaky in young trees. It is rough to the tips of the branches. Timber palecoloured, of the palest brown when freshly cut, fissile.

E. NOVA-ANGLICA Deane and Maiden.

A tree of medium size, much branched. It is a Peppermint with rough bark, fibrous to scaly or flaky, branches smooth.

E. ODORATA Behr.

Dark grey, rough, persistent bark. Fairly large tree, trunk 18 inches in diameter. Bark black, scaly or rough, hard, furrowed in the case of the largest trees. Branches smooth or nearly so. Timber pale-coloured to brown, and hard.

E. PATENS Benth.

A large tree, with rough bark all over the trunk and branches. Said bark is soft rather than hard, thick, greyish, black. In Western Australia such a bark is called Blackbutt. In eastern Australia it would be called a Woollybutt.

E. PLANCHONIANA F.v.M.

A tree attaining a height of 100 feet. Although sometimes termed Stringybark, the bark is short-grained and cannot be used for roofing purposes, hence it is called Messmate. It is rough to the branchlets. It has a flat-fibrous bark, somewhat resembling that of *E. resinifera*. It has also been compared with that of *E. robusta*. The timber is pale-coloured and is sent to market sometimes as a substitute for Tallowwood (*E. microcorys*).

E. POPULIFOLIA Hook.

“Bimble Box.” A small to medium-sized, sometimes umbrageous, tree, often rather erect in habit, but with more or less pendulous branches. Bark sub-fibrous and somewhat matted (box-like); persistent on both trunk and branches. Timber pale brown.

E. RARIFLORA F. M. Bailey.

A tall tree, the trunk and large branches covered with hard-fibrous, black, corrugated bark such as would merit the name of Black Box. Timber pale brown.

E. RAVERETIANA F.v.M.

A "Box." A large and sturdy tree, somewhat scrambling in habit. It has flaky or hard scaly bark on the trunk or main branches. The flakes or furrows are not deep. The smaller branches are dirty blue-grey in colour. Timber brownish.

E. RUDIS Endl.

Bark darkish grey, not deciduous like *E. rostrata*; corky and thin flaky, *i.e.*, the rough bark, which is flattish and not thick, is so much fissured, both longitudinally and transversely, that it breaks into small flakes with but slight violence.

E. STRIATICALYX W. V. Fitzgerald.

Tree of 30–40 feet. Bark dark grey or blackish, flaky, thin, yellow inside, covering the whole of the trunk and part of the branches. Perhaps a Black Box. Timber pale brown.

This is unquestionably allied to *E. dumosa*, placed with the Mallees.

E. STUARTIANA F.v.M.

A large, often scrambling tree, with soft, white (often superficially discoloured) box-like bark, rough to the extremity of the branchlets. Bark thickish, often zigzagged or wrinkled, and reminding one of the shorn back of a sheep.

E. TODTIANA F.v.M.

A Woollybutt. A medium-sized, spreading or scrambling tree, attaining a stem-diameter of 3 feet. Bark sub-fibrous, extending to the branchlets.

E. TORQUATA J. G. Luehmann.

Trees of 20–30 feet, with trunks of usually 4–10 feet to first branches. Bark rough, flaky, dark coloured on the butt, the branches smooth. Timber undescribed.

(*b*) *With red timbers*:—

These red timbers include the Mahoganies, and Mahoganies prefixed by other adjectives. *E. marginata* (Jarrah) is often known by old hands as Mahogany. The Mahoganies are, as regards their barks, in some respects intermediate between the Stringybarks (Pachyphloiae) and the Bloodwoods (Lepidophloiae). *E. longifolia* is known as Woollybutt. Tentatively I place here *E. longicornis*.

All these species (with the possible exception of *E. longicornis*) are confined to coastal areas, or at all events to districts not very far inland.

E. botryoides Sm.

E. exserta F.v.M.

E. Jacksoni Maiden.

E. Kirtoniana F.v.M.

E. leptophleba F.v.M.
E. longicornis F.v.M.
E. longifolia Link and Otto.
E. marginata Sm.
E. patellaris F.v.M.
E. pellita F.v.M.
E. resinifera Sm.
E. robusta Sm.
E. Rudderi Maiden.

E. BOTRYOIDES Sm.

Beautifully umbrageous, varies as to the extent of persistency of the rough bark, whether it extends to the ultimate branchlets or not. Bark thick, softish, sometimes called Woollybutt, but usually Bastard Mahogany. A description of the Gippsland trees, where they attain fine development, is—"Bark dark, rough scaly, and persistent on the stems and main branches, smooth on the smaller branches, the outer bark on these peeling off in thin flakes."

E. EXSERTA F.v.M.

A medium-sized tree, with rough bark, not a typical Peppermint, rather more scaly, yet not scaly enough to be a Bloodwood. In the fruit, very closely allied to *E. rostrata* and *E. tereticornis*.

E. JACKSONI Maiden.

"Red Tingle Tingle." A noble forest tree up to 200 feet high with a long trunk which attains a diameter of 15 feet. Bark fibrous, reddish, thick, of a stringybark character, but somewhat brittle, covering the trunk and branches. Timber rich red, reminding some of *E. resinifera*.

E. KIRTONIANA F.v.M.

A medium-sized tree, with furrowed, fibrous bark or described as a Stringybark, resembling that of *E. resinifera*.

E. LEPTOPHLEBA F.v.M.

A large tree, bark of a dirty grey, rugose, fissured on the trunk and persistent on the branches. It is known in North Queensland as Blackbutt. It is a flaky-barked Box, the rough bark extending to the branchlets. Timber reddish-brown.

E. LONGICORNIS F.v.M.

"It is a magnificent tree, and, unlike the other allies of *E. oleosa*, it carries its rough bark right up to the base of the crown." (C. E. Lane-Poole sending a photograph from Westonia State Forest.) Timber red and exceptionally tough.

Mueller originally described it with "a rugose, ash-coloured bark (Rhytiphloiae) on the trunk, persistent on the branches."

E. LONGIFOLIA Link and Otto.

A handsome, large tree. Bark of a dirty grey, brittle, fibrous character, and when thick thought to be of a woolly texture, hence the name Woollybutt. It often resembles box bark a good deal. Sometimes the bark on the branches is deciduous, when it is known as Peppermint.

E. MARGINATA Sm.

Bark rough, persistent, fissured-flat. In bark it gave me the impression somewhat of *E. resinifera* of the eastern States, or, perhaps of the Turpentine (*Syncarpia laurifolia*).

The above was written by me standing in front of characteristic trees. At the same time, while noting there were local differences (as is common in most Eucalypts), I could not understand the following official statement by Mr. Simpson of Bunbury:—

VARIETIES OF JARRAH.

There are three distinct varieties. A botanist might not be willing to admit that this is the case, but the practical sawyer of large experience recognises the difference between these varieties at a glance.

The *Salmon-bark*, as its name indicates, is mottled like the king of fish. The wood is straw-coloured (!), close in the grain, and freer from gum-veins than Jarrah usually is. The smooth straight trunk rises from 30 to 40 feet before branching out, the crown being formed by three or four limbs spreading out nearly opposite each other. This kind yields by far the best wood for planking, and bends readily in almost any way that may be required. I have seen a board of this kind of Jarrah 7 in. x 1 in. and 30 feet in length bent into a complete circle, without the slightest sign of breakage.

For ships' planking or in any position where tenacity is required, that is by far the best kind of Jarrah. It is, however, less plentiful than other varieties.

Another kind is usually called *Plum-pudding wood* by the sawyers, from its mottled appearance when cut into scantlings. This peculiarity extends nearly all the length of the trunk, but becomes less noticeable towards the crown end of the log. Black stripes radiate star-like from the centre; these get gradually fainter as they approach the outside of the log, but are clearly defined and very uniform in the centre. Some trees of this class make handsome furniture, but their timber is generally too dark coloured. This variety is much more free to work than either of the other.

The *Rough-Bark* is another kind, its bark is very coarse, and twice as thick at least as that of the *Salmon-Bark*. The wood is dark. The seed pod, leaves and habits of all Jarrah trees are alike. (Government of Western Australia, "General Information respecting the present condition of the Forests and Timber Trade," 1882, pp. 10–11).

In asking the kind attention of Mr. C. E. Lane-Poole, Conservator of Forests of Western Australia, to the puzzle, I suggested that perhaps in the reference to the "Salmon-bark" there might be some confusion with *E. salmonophloia*. Mr. Lane-Poole replies:—

I, of course, only recognise one Jarrah; at the same time, there is no question that there is a certain difference in the bark of certain Jarrahs. The salmon-bark Jarrah is quite recognisable, and it appears to me to be a case of deciduous bark. I have examined a great number of the trees, and in all cases the bark has peeled off naturally, leaving the bright clean bark underneath, hence the name, "Salmon Bark." I have not yet been able to find out whether the tree casts its bark regularly or periodically. The bushman tells me it does it once a year.

In regard to "Plum-pudding" wood, I have never heard the term, but I know exactly what he means. I prefer this type of wood to any other for furniture making, but I do not think that it comes from a different variety of tree, but merely that the tree is very old and the wood is, if anything, overmature.

I have sent the extract down to my Chief Timber Inspector, who is a man of very wide knowledge of our timbers, and I hope to get some more satisfactory information from him for you.

The Chief Timber Inspector's report is as follows:—

I think there are two kinds of Jarrah trees, viz., Salmon and common.

Salmon Trees vary according to soils and drainage. When growing on coastal sand-hills the wood is generally interlocked, the crown well branched and healthy, but too heavy in proportion to the trunk; the wood is fairly clear of gum-veins; the tree is not high.

When growing on the western top of the Darling Range, say 3 miles east of Keysbrook, in semisand and gravel soil, amongst Table-top or hill Banksia, the trees are of medium height with nice healthy trunks and crowns, exactly as described by Mr. Simpson. They are subject to bendy heart, the same as common Jarrah, in fact, I think more so. 6 in. to 12 in. deep of the sap side wood is a pretty red. The inner wood is straw-coloured (!). The inner and outer wood is practically clear of gum-veins or gum-pockets. The bark and wood are long fibred.

As you travel eastward into the forest the bark becomes thicker and rougher, especially in fair soil, the trunk is longer, the crown smaller, and the wood a little less clear of gum, especially towards the crown, and it becomes very difficult, except on true Salmon Jarrah soil, to distinguish the tree from the common Jarrah. Salmon Jarrah is generally associated with Banksia and very little Redgum (Marri)

(*E. calophylla*).

Plum-pudding Wood.—This wood occurs in both kinds of Jarrah, caused, in my opinion, by senile or natural decay.

Mottled Wood.—This occurs in both kinds of Jarrah, and is caused, in my opinion, by two reasons, first ⅜-inch navel-like folding growths; second, senile decay of less duration than in the Plum-pudding wood. Both woods are useful for furniture and mouldings, piano and skirting boards, but very little good for sleepers.

Generally speaking, both the common Jarrah tree and the Salmon Jarrah trees, prior to the plum-pudding stage, are tougher and harder inside than outside; they are also tougher towards the crown than they are at the butt, and contain more gum-veins and faults, such as more knots between the crown.

Sometimes both kinds of trees have the following kinds of winds—

Right-hand 1 in. to full radius; left-hand the same. The trunk is sometimes windy inside and straight-grained outside, and the opposite, as mentioned above. (H. McCoy, Bunbury.)

E. PATELLARIS F.v.M.

“A fairly tall tree, like *E. microtheca* in habit. Bark dirty grey, wrinkled and cracked, persistent on the trunk and branches.” A tropical species, not seen since the type was collected. We know nothing of its timber.

E. PELLITA F.v.M.

A tree of 40–50 feet, with a rough dark-grey bark (Dallachy).

“Branches smooth.” “Glabrous tree.” “Woolly bark.” “Fibrous bark.” “Mahogany.” “Short, stringy bark.”

E. RESINIFERA Sm.

“Forest Mahogany.” A large tree, the bark rough and persistent, very rough on the old trees, running right out on to the smaller branches.

E. ROBUSTA Sm.

“Swamp Mahogany.” A moderate sized tree, bark in furrows, brownish, sub-fibrous, almost soft, scaly.

E. RUDDERI Maiden.

A tall tree, attaining a height of over 100 feet. The bark persistent, and like that of *E. hemiphloia*, but, unlike that tree, extending up to the small branches.

4. Pachyphloiae (Stringybarks).

This is one of the most natural of Mueller's groups, but even it may be variously interpreted. With the genuine Stringybarks are sometimes included *E. resinifera*, particularly in South Queensland, but the fibre is shorter than that of the true

Stringybarks. In some States *E. obliqua* is, for the same reason, called Messmate in some districts, rather than Stringybark, the meaning of the word being that it is associated with, or rather reminiscent of, the true Stringybarks. These are included in barks which do not peel off, as do the Gums and half-barks, but which make provision for the expansion of the stem through growth in another way. Thus the Stringybarks and the Ironbarks belong to this category, and we have but little to say in regard to them.

In 1859 Mueller simply defined the Pachyphloiae as "Stringybarks." In 1884, as we have seen (Part L, p. 312), he called the Group Inophloiae (in which nobody ever followed him), and included in it the ordinary Stringybarks, as well as others which, had his field-memories not failed him, he would certainly not have placed with those trees. In the Pachyphloiae, in 1884, he had only one species, rather an absurd arrangement, viz., *E. ptychocarpa*, which I have placed in the Lepidophloiae.

The timbers vary from almost white to pale reddish brown, but never become a real red.

I place the following in the Pachyphloiae:—

E. acmenioides Schauer.

E. Blaxlandi Maiden and Cambage.

E. capitellata Sm.

E. eugenioides Sieb.

E. laevopinea R. T. Baker.

E. macrorrhyncha F.v.M.

E. Muelleriana Howitt.

E. obliqua L'Herit.

E. umbra R. T. Baker.

As a sub-section we have:—

a. Mallee-like or dwarf forms, comprising:—

E. alpina Lindl.

E. Camfieldi Maiden.

E. ligustrina DC.

Small as these species are, they have flattish, thin barks, which can be at once seen to be Stringybarks.

E. ACMENIOIDES Schauer.

"White Mahogany." A tall, erect tree, with fibrous bark, thinner than that of a Stringybark—between that and a Peppermint, but, on the whole, belonging to the former.

E. BLAXLANDI Maiden and Cambage.

A medium-sized tree. A typical Stringybark. This and the following four species are very closely related.

E. CAPITELLATA Sm.

A medium-sized tree, a typical Stringybark.

E. EUGENIOIDES Sieb.

A medium-sized tree, a typical Stringybark.

E. LaeVOPINEA R. T. Baker.

A medium-sized tree, with sub-glaucous foliage, which gives it the name of “Silver-topped Stringybark.”

E. MACRORRHYNCHA F.v.M.

A rather tall, typical Stringybark, with exceptionally slender, pendulous branchlets.

E. MUELLERIANA Howitt.

A Stringybark of rather large size. Bark often yellow, particularly the inner bark.

E. OBLIQUA L'Herit.

A medium-sized tree, much disposed to lateral branching, particularly in Tasmania, where the type comes from. It is rough-barked to the ends of the branches, the bark of the trunk and branches is decidedly fibrous, but the fibres are not so clean and tenacious as those of the true Stringybarks, and the bark is not so suitable for roofing. It and *E. Muelleriana* are more closely related to each other than to the others.

E. UMBRA R. T. Baker.

“Stringybark.” This Stringybark is closely related to *E. acmenioides*, and both are known as White Mahogany (in contradistinction to *E. resinifera*, the Red Mahogany, with red timber).

Mallee-like or dwarf species:—

E. ALPINA Lindl.

This local species is allied to the Stringybarks, and Mr. A. J. Campbell says that local residents in the Grampians look upon it as a dwarf Stringybark.

Under cultivation in the Centennial Park it attained the height of about 20 feet, with gnarled, spreading branches, and the trunk and branches covered with soft, stringy bark.

E. CAMFIELDI Maiden.

A low branching shrub or stunted tree, almost Mallee-like, and under 12 feet in height. Bark scaly-fibrous or fibrous, flattish, tough—a Stringybark.

E. LIGUSTRINA DC.

A small species, with rather flat, stringy bark, usually forming Mallee-like clumps from 3–12 feet high; when solitary may attain a height of 15 feet.

5. Schizophloiae (Ironbarks).

This is a classification of 1859, but, as usual, as regards the classification, Mueller did not improve on it in the "Eucalyptographia" in 1884, by means of his examples. On that occasion he only included three true Ironbarks, viz., *crebra, siderophloia* and *melanophloia*. We have already seen that he omitted the two most characteristic ones, viz., *paniculata* and *sideroxylon*, because he thought that they included smooth-barked species (*fasciculosa* and *leucoxylon*).

We must beware of false Ironbarks. For example, *E. stellulata* and *E. cornuta* may often be seen with a large amount of dark-coloured, indurated bark on the trunk. The so-called Ironbark of Tasmania (*E. Sieberiana*) native also of eastern Victoria and New South Wales, has a furrowed bark remarkably like Ironbark at a little distance, but much softer than that of the true Ironbark. Mueller, however, looked upon *E. Sieberiana* as an Ironbark in 1884, and even included *E. Cloeziana* and a couple of Bloodwoods (*E. ficifolia* and *E. calophylla*).

Following is an early note on Ironbarks:—

Every being renews its epidermis (or the appendages thereof) occasionally, either periodically and all at once—as snakes—or more gradually—as in the moulting of birds and other animals—while in the case of some animals with naked skins, this process is in continual operation, scales being constantly thrown off. Among vegetables also, we find analogous processes; in some cases—dependent on the renewal of the composing members and the death of others—the bark is shed gradually, that is, the outer portion slowly decays, so that its thickness remains nearly invariable; but in other instances, and dependent upon the same conditions, the whole bark is shed annually and almost simultaneously, as in many Eucalypti, some of which, however, come under the former category, though in some species the process proceeds so slowly that the bark acquires an immense thickness, as in *E. sideroxylon*, a condition probably due to the vast amount of antiseptic gum which pervades it. To meet this order of things, the bark being sometimes 15 inches in thickness, the bark cracks longitudinally, so that the trunk is marked by raised ridges and intervening deep grooves, which proceed in an interruptedly spiral manner from the ground to the head of the tree. (MSS. of Augustus Oldfield, circa 1864, pp. 452-3).

Ironbarks have corrugated, indurated barks, either grey or black externally. They include *E. paniculata* (White or Grey Ironbark), with pale-coloured timber, and the commonest Ironbark about Sydney. *E. siderophloia* (Broad-leaved Ironbark) with coarse foliage, found in the western suburbs and further afield, especially on the Northern Rivers, and also in western New South Wales, a glaucous form. *E. crebra*

(Narrow-leaved Ironbark), has pendulous foliage and is widely diffused over New South Wales. Both this and the preceding one are known as Red Ironbarks from the colour of their timber. *E. melanophloia* (Silver-leaved Ironbark) is a somewhat straggly tree, found chiefly in the north-west of New South Wales, in regions of low rainfall; it does not occur near Sydney. *E. sideroxylon* is found in the Sydney district to the south, sparingly, but chiefly on the western slopes of the State. There are other species, of less importance. The Ironbarks attain their greatest development in New South Wales, but three which do not occur in that State are endemic to Queensland.

Following are the Ironbarks:—

E. Beyeri R. T. Baker.
E. Caleyi Maiden.
E. crebra F.v.M.
E. Culleni Cambage.
E. decorticans Bailey.
E. drepanophylla F.v.M.
E. melanophloia F.v.M.
E. paniculata Sm.
E. siderophloia Benth.
E. sideroxylon A. Cunn.
E. Staigeriana F.v.M.

E. BEYERI R. T. Baker.

A typical Ironbark found, as far as we know, in a limited area a few miles west of Sydney. Bark hard, heavy, very thick, permeated with kino.

E. Caleyi Maiden.

A tall tree, often glaucous, and finally becoming glabrous, but remaining dull-coloured. Called "Broad-leaved Ironbark" in comparison with narrower-leaved Ironbarks (*E. sideroxylon* and *E. crebra*) and sometimes "Drooping Ironbark," a character it possesses in common with *E. crebra*.

E. CREBRA F.v.M.

A tall tree, with drooping branches. Very deeply furrowed, in depth only (if at all) inferior in that respect to *E. sideroxylon*. Timber red.

E. CULLENI Cambage.

Bark hard, rough, furrowed. A Queensland species. Timber red.

E. DECORTICANS Bailey.

"Naked-top Ironbark" or "Gum Top." This is remarkable because of its deciduous branches. Bark on the butt with flattish ridges reminiscent of *E. siderophloia*.

E. DREPANOPHYLLA F.v.M.

A typical Ironbark, long confused with a Box (*E. leptophleba*).

E. MELANOPHLOIA F.v.M.

An Ironbark, inferior for economic purposes, which often goes under the name of Silver-leaved.

E. PANICULATA Sm.

An erect tree, Pale or Grey Ironbark, the king of all Ironbarks, because it possesses all the best characteristics of typical Ironbark timber, viz., strength, durability, weight. Bark often pale-coloured, even grey. Furrows often anastomosing.

E. SIDEROPHLOIA Benth.

The ridges the flattest of those of any Ironbark. Examination of the photo of the trunk from Wyong, New South Wales, in Part XXXIX of my "Forest Flora of New South Wales," shows that the bark of this species may be not furrowed, but flaky. Usually, however, it is an indubitable Ironbark.

E. SIDEROXYLON A. Cunn.

A small, medium-sized, or even tall tree, often gnarled. Dark, the deepest furrowed of the Ironbarks. It often occurs on the Goldfields of New South Wales and Victoria. "Mugga."

E. STAIGERIANA F.v.M.

A medium-sized tree, with glaucous, lemon-scented foliage, from which a perfume oil is distilled. It is, however, rather a scarce species.

Let us now consider the *Ironbark-Boxes*.

These are intermediate species connecting the Ironbarks with the Boxes.

The present seems a natural place to put them in. They have something of the Ironbark character and the Ironbarks readily cross with the Boxes. The subject will be further pursued under Hybridisation in Part LIII, where, amongst other crosses, are some striking ones between these two groups of Eucalypts.

E. AFFINIS Deane and Maiden.

"Ironbark Box." A tree of moderate size, attaining a height of 80 feet and a diameter of 2 ft. 6 in.

In appearance it looks half Ironbark and half Box; and has strong affinities to both. Often the butt in old trees is nearly as rough as that of *E. sideroxylon*, but seldom quite, while the upper part resembles *E. hemiphloia* var. *albens*, but in general it has a dark brown, fairly rough bark an inch thick. The bark is thinner and softer than that of *E. sideroxylon*, but harder and thicker than that of *E. hemiphloia* var. *albens*.

E. BOORMANI Deane and Maiden.

"Black Box." A large tree, a good deal similar in general appearance to *E.*

siderophloia. The bark dark in colour, often very dark grey and even black. In texture scaly, sometimes hard-scaly, and even in parts nearly as rugged as an Ironbark, but never so soft as a Box. The rough bark extends to the small branches. It possesses characters intermediate between *E. siderophloia* and *E. hemiphloia*.

E. HYBRIDA Maiden.

"Ironbark Box." An erect tree of about 50 feet, the tips of the branches smooth, the butt with a sub-fibrous (Peppermint-like) or flaky-fibrous, or more or less flat-corrugated bark—indeed, between the Boxes and the Ironbarks. Evidence is adduced to show that the two species which probably cross to form this interesting species are *E. paniculata* and *E. hemiphloia*. Timber pale coloured, hard, interlocked.

6. Lepidophloiae (Barks friable and lamellar).

Mueller, in 1859, defined this group as lamellar, friable and persistent on the trunk. He quoted as examples "Melaleuca Gum trees, Mica trees." These are really *E. miniata* and *E. phoenicea*. I did not at first understand the meaning of this kind of bark, but subsequently explained it under Part XXII, p. 37. The type is a very brittle bark, with a large number of layers.

In his 1884 classification he let his two 1859 species remain, and added *E. peltata*, a Queensland Bloodwood or Yellow-jacket.

I think that the Lepidophloiae should have transferred to it the "Bloodwood trees" from the Rhytiphloiae. This will render both sections more natural. I think the Lepidophloiae might be termed "Flaky barks," but one must be careful not to confuse them with barks which are Gums, and which have part of the butt covered with hardish flakes which are not in comparatively regular scaly pieces.

They may be divided into two groups:—

(*a*) Dark barked, and with red timber.
(*b*) Yellow-jackets and other pale barks, with pale timber.

In considering (*a*) it is to be borne in mind that, as the tropics are reached, the colour of the Bloodwood bark gets toned down or lighter, so that we may have the term "whitish" applied to such.

(*c*) *E. calophylla* and *E. ficifolia* are provisionally put into a separate group; they have pale timbers, but the barks are nearer those of (*a*).

a. Dark barks and with red timber:—

E. Abergiana F.v.M.
E. Cliftoniana W. V. Fitzgerald.
E. corymbosa Sm.
E. dichromophloia F.v.M.
E. ferruginea Schau.
E. Foelschiana F.v.M.
E. hoematoxylon Maiden.
E. Hilliana Maiden.
E. latifolia F.v.M.
E. perfoliata R.Br.
E. ptychocarpa F.v.M.
E. pyrophora Benth.
E. setosa Schau.
E. terminalis F.v.M.

E. ABERGIANA F.v.M.

A tree whose height is not certainly known, with rough bark, probably of the usual flaky character.

E. CLIFTONIANA W. V. Fitzgerald.

A tree up to 30 or 40 feet with a diameter of 1 foot. Bark persistent on the stem and branches, dark coloured, rough and longitudinally furrowed.

E. CORYMBOSA Sm.

This is the original Australian Bloodwood. Its bark is rough, both trunk and branches, with both longitudinal and transverse fissures forming flakes rather than tesserae. The wood is red and fissures in it exude a reddish kino, which is so abundant that it often runs down the tree, and, when freshly exuded, gives it the appearance of a stream of blood.

E. DICHROMOPHLOIA F.v.M.

This is a Bloodwood, and therefore with a bark more or less scaly. Mueller gave the specific name because of the "top layer (presumably the outer layer) of the bark as smooth and sub-papyraceous, cinereous, slowly breaking away from the interior red portion." This perhaps indicates transition between the ordinary Bloodwood barks and the "micaceous" barks of *E. miniata* and *E. phoenicea*. It doubtless has a bark similar to the tropical or deciduous bark of *E. terminalis*.

E. FERRUGINEA Schau.

A medium-sized tree with a rough, dark grey bark persisting all over the trunk. In describing a synonym, Mueller says "the outer bark . . . separating in small pieces." My note is "*E. ferruginea* seems to connect with the Corymbosae through *E. Torelliana*." I do not know the colour of the timber, but assume that it is red, like *E.*

setosa.

E. FOELSCHIANA F.v.M.

Not a large tree, usually crooked, and large leaved. There is some confusion in regard to the barks of different trees, but they appear all to belong to the Corymbosae, *i.e.*, flaky barks.

E. HaeMATOXYLON Maiden.

A small tree, attaining a height of 20 feet, with a trunk diameter of 18 inches. Much resembling *E. calophylla* in general appearance, but much smaller. Bark that of a typical Bloodwood.

E. HILLIANA Maiden.

A broad-leaved tree of medium size, the bark somewhat tesselated or soft-scaly, the branches smooth. Timber rich reddish-brown.

E. LATIFOLIA F.v.M.

A small or medium-sized tree with the ordinary friable Bloodwood bark. Timber pale red, but that probably refers to a young tree.

E. PERFOLIATA R.Br.

A small tree, attaining a height of 40 feet, and a diameter of 1 foot. Bark persistent on stem and branches, dark grey, rough, lamellar and longitudinally fissured.

E. PTYCHOCARPA F.v.M.

Bark like *E. terminalis* to topmost branches. Trunk 15 inches in diameter. Small tree, with spreading, somewhat stunted, growth.

E. PYROPHORA Benth.

A medium-sized Bloodwood, with more or less scaly bark, and often known as Desert Gum because of the interior localities it prefers, and because of the comparatively pale colour presented after the scaly portion has fallen. Timber reddish-brown.

E. SETOSA Schau.

A low, shapely, spreading tree of 30 to 40 feet, seemingly closely related to the Angophoras. Bark rough and somewhat scaly. Timber red.

E. TERMINALIS F.v.M.

A medium-sized tree with a scaly bark. In tropical areas the scales may be deciduous, giving the tree a pale-coloured and comparatively smooth appearance, so that it may go under the name "White-stemmed Gum tree." It would appear that the scales subsequently develop on such trees Compare *E. dichromophloia* and *E pyrophora*.

b. Yellow-jackets and other pale barks, with pale timber:—

E. eximia Schauer.

E. intermedia R. T. Baker.

E. lirata (W.V.F.) Maiden.
E. miniata A. Cunn.
E. peltata Benth.
E. phoenicea F.v.M.
E. similis Maiden.
E. trachyphloia F.v.M.
E. Watsoniana F.v.M.

E. EXIMIA Schauer.

A medium-sized tree, attaining a height of 50 feet and more, conspicuous by its dirty-yellow bark, variously described as Snuff-coloured and Rusty. It is pulverulent and soft-flaky, not as hard as that of *E. corymbosa*. Timber pale-brown, becoming darker towards the centre of the tree.

E. INTERMEDIA R. T. Baker.

A medium-sized tree, with a light-brown fibrous bark, which is more or less scaly. Timber pale-coloured in comparison with that of *E. corymbosa*, but has often some red in it. This seems an exceptional species.

E. LIRATA (W.V.F.) Maiden.

Height 30–40 feet, diameter 1–11/2 feet. Bark rough and greyish, but soft and almost friable, persistent on trunk and limbs. Timber brown.

E. MINIATA A. Cunn.

A tree of 50–100 feet high, with a diameter up to 3 feet, bark greyish to reddish, woolly fibrous to lamellar, persistent on the lower half of the trunk and sometimes covering the whole of it; the limbs always white and smooth. This bark has been described in such detail at Part XXII, p. 37, that I must refer my readers to it.

E. PELTATA Benth.

A medium-sized tree, known as Yellow-Jack from the yellowish colour of its scaly bark, a little more flaky than that of *E. corymbosa*. The timber is pale towards the outside of the tree, but dark brown towards the centre of the tree.

E. PHOENICEA F.v.M.

Bark resembling that of *E. miniata* a good deal, which see.

E. SIMILIS Maiden.

A tree of medium size; notes on bark and timber uncertain, but probably closely related to *E. peltata*.

E. TRACHYPHLOIA F.v.M.

A medium-sized or tall tree, attaining a height of 80 feet. Bark whitish or yellowish, flaky or flaky-fibrous. Timber pale-coloured, somewhat like that of Spotted Gum (*E. maculata*).

E. WATSONIANA F.v.M.

A tree of medium size, only known from one locality. Bark of a dirty pale-yellow colour, thick, scaly-fibrous, in layers. Timber not dark-coloured.

c. Provisional Group, with dark scaly bark and pale timber:—

E. calophylla R.Br.

E. ficifolia F.v.M.

E. CALOPHYLLA R.Br.

A very large, spreading, umbrageous tree. In bark and general appearance it resembles the Bloodwoods of eastern Australia. The timber is pale-coloured.

E. FICIFOLIA F.v.M.

Small tree, up to 30 feet, usually, however, of much smaller size, forming impenetrable thickets. Bark scaly and of a dark-brown colour, the inner bark of a pale brown. This is probably an indication of transit towards the Pale Bloodwoods or Yellow-jackets.

I suggest the following subdivisions of Lepidophloiae:—

d. Eudesmioe (excluding the Marlocks):—

E. Baileyana F.v.M.

E. tetrodonta F.v.M.

Later on, perhaps, the whole of the Eudesmiae may be kept in a separate classification, as they have so much in common in other directions.

E. BAILEYANA F.v.M.

Bark hard, thick, rather interlocked. An inferior Stringybark.

“Bark dark, fibrous, and transversely interlocked, very hard.”

Timber of a light grey colour when fresh, interlocked in grain. “Bastard Ironbark.”

E. TETRODONTA F.v.M.

Tree of 40–50 feet, with a diameter of 1–11/2 feet, bark persistent on trunk and branches, greyish, fairly rough and very stringy, timber pale, fissile (reddish brown, R. H. Cambage). Known as Messmate or Stringybark in the tropics, and should be compared with Pachyphloiae.

e. Tessellatoe:—

In this section, the scales or flakes of the true Bloodwoods are more defined and deciduous, tending to form tesserae. But they do not cover the whole of the trunk only the lower portion. The trees, therefore, form a connecting link with the Hemiphloiae. From another point of view they are a section of Leiophloiae (Gums).

Following are the proposed species:—

E. grandifolia R.Br.

E. papuana F.v.M.

E. Spenceriana Maiden.

E. tessellaris F.v.M.

E. Torelliana F.v.M.

The above have affinities to the Angophoroideae, with the exception of *E. Torelliana*, which is closer to the Corymbosae, and especially to *E. maculata*. The timbers seem all to be brown or brownish.

This section seems to have bark-affinity with *E. rudis, E. gomphocephala, E. Hillii*, and perhaps others. Perhaps *E. papuana* connects with *E. alba* and *E. Raveretiana*.

E. GRANDIFOLIA R.Br.

A small tree, with the outer bark brown and deciduous, the inner whitish and very smooth (R.Br.).

That it is usually known as "Moreton Bay Ash" indicates that its bark resembles that of *E. tessellaris*. "Timber very inferior"—probably pale-coloured.

E. PAPUANA F.v.M.

A medium-sized tree, the largest ones being about 50 feet high and 1 foot in diameter in Northern Queensland (Dr. T. L. Bancroft). It is known as "Cabbage Gum." The bark is white or greyish, and there is no rough bark as in *E. tessellaris*. Mueller puts the species in the Leiophloiae.

On the other hand, the North-west Australian tree is stated to have the rough bark "persistent and tessellated for a short distance up from the butt, and thence white and smooth, but oftener smooth and white almost to the ground." (Part XXXVII, p. 194.) This means, probably, that the species has exceptionally a little tessellated bark like *E. tessellaris*. At all events this shows that the line between the Leiophloiae and its sub-group Tessellatae must be very cautiously drawn.

Timber dark brown.

E. SPENCERIANA Maiden.

A tree of moderate height, say 50 feet, with a trunk diameter of 2–3 feet. Bark more or less rugged and flaky, particularly near the butt, such flakes being lenticular, thin and dry. This rough bark extends to a variable extent over the trunk and larger branches. Timber dark reddish brown.

E. TESSELLARIS F.v.M.

Bark totally persistent on the lower part of the stem only, thin, dark-coloured, and by longitudinal and transverse fissures broken up into small angular masses; hence the specific name; the rest of the stem and branches ashy grey and smooth, rarely the whole stem so to the base, according to Mueller.

E. TORELLIANA F.v.M.

A tall tree, resembling *E. tessellaris* somewhat. It has bark black and scaly up to about 10 feet from the ground, thence upwards dark green and glossy. The scaly portion in thin tesserae.

Timber fissile, pale-coloured, reminding one of that of *E. maculata*.

f. Angophoroideoe:—

E. aspera F.v.M.

E. brachyandra F.v.M.

E. clavigera A. Cunn.

This section connects with the true Angophoras (so-called Apple trees) in hispid foliage, paper-like fruits, and in other respects.

E. ASPERA F.v.M.

The type described as a small tree, with smooth greyish-white (ashy-white) bark. Again, it has been described as "A dwarf Gum with white smooth bark," yet with the trunk described up to 2 ft. 6 in. in diameter. It has hispid foliage.

E. BRACHYANDRA F.v.M.

A scrambling, small tree of 25–30 feet; bark grey, rough, longitudinally fissured, persistent on trunk and limbs.

E. CLAVIGERA A. Cunn.

In its typical form (North-west Australia) not more than 40 feet high, but in better conditions in Northern Queensland it may attain a larger size. The former tree has been described as bark somewhat rough and greyish on the trunk, soon peeling off in plates, leaving the under surface white and smooth—a Cabbage Gum. In Queensland it has been given the same name, and the bark described as tessellated for about 10 feet, then white and smooth. It has tessellated bark at the foot of Astrolabe Range, Papua, according to Mr. C. T. White. Colour of timber deep rich brown.

Explanation of Plates (208–211.)

Plate 208.

Plate 208: EUCALYPTUS SHEATHIANA Maiden (1). E. STRIATICALYX W. V. Fitzgerald (2, 3). Lithograph by Margaret Flockton.

E. Sheathiana Maiden.

1*a*. Flowering twig, including mature leaves, buds and flowers; 1*b*, front and back views of anther; 1*c*, different views of fruits which are, however, not perfectly ripe. From a cultivated plant in the King's Park, Perth, Western Australia. (J. Sheath). The type. The tree stated to have grown from seed brought from the “Eastern Goldfields” (of Western Australia).

E. striaticalyx W. V. Fitzgerald.

2*a*. Juvenile leaf; 2*b*, juvenile leaf a little further advanced; 2*c*, mature leaf; 2*d*, twig-bearing fruits and rather a broad, mature leaf. Milly's Soak, Cue, Western Australia, from the clump of trees which produced the type (J.H.M.).
3*a*. Almost juvenile leaf; 3*b*, mature leaf; 3*c*, buds, showing striae on both calyces and opercula; 3*d*, front and back views of anthers. From a tree in the Botanic Gardens, Sydney, raised from seed brought by Mr. Maiden from Milly's Soak.

Plate 209.

Plate 209: EUCALYPTUS TEANIOLA Baker and Smith (1). E. UNILATA Baker and Smith (2, 3). E. STRIKLANDI Maiden (4). [See also Plate 71, Part XVI.] Lithograph by Margaret Flockton.

E. toeniola Baker and Smith.

1*a*. Juvenile foliage, not quite in the youngest stage; 1*b*, a twig showing buds and flowers; 1*c*, front and back views of anthers; 1*d*, fruits. St. Mary's, Tasmania (L. G. Irby). The type.

E. unialata Baker and Smith.

2*a*. Mature leaf; 2*b*, buds; 2*c*, front and back views of anthers. Mount Nelson, near Hobart (L. Rodway).
3*a*, 3*b*. Juvenile leaves of various widths and shapes; 3*c*, fruits. The Domain, Hobart (J.H.M.).

E. Stricklandi Maiden.

4. Two pairs of juvenile leaves. Note how full of oil-glands they are. (C. E. Lane-Poole.)

Plate 210.

Plate 210: EUCALYPTUS PLANCHONIANA F.v.M. (1, 3). E. MARGINATA Sm., var. STAERII Maiden (4). Lithograph by Margaret Flockton.

E. Planchoniana F.v.M.

1*a*. Flowering twig; 1*b*, cluster of fruits, small and undeveloped. Laurieton, New South Wales (Forester G. R. Brown).
2. Fruits, Woolgoolga-road, New South Wales, on the Coast Range (E. H. F. Swain).
3*a*. Juvenile leaf (the earliest I have ever seen); 3*b*, fruit, with well-developed ribs and rim. Coff's Harbour, New South Wales (Assistant Forester A. H. Lawrence).

E. marginata, Sm. var. *Staerii* Maiden.

4*a*. Mature leaf; 4*b*, large, thick-rimmed, nearly spherical fruits; 4*c*, fruit in elevation, showing the valves. King's River road, Albany, Western Australia (J. Staer). I have not figured normal *E. marginata*, relying on the "Eucalyptographia" plate, but, as it has been pointed out to me that this work is almost unprocurable, I will endeavour to furnish a figure later.

Plate 211.

Plate 211: EUCALYPTUS IRBYI Baker and Smith (1, 2). E. YARRAENSIS Maiden and Cambage, n.sp. (3). Lithograph by Margaret Flockton.

E. Irbyi Baker and Smith.

1*a*, 1*b*. Juvenile leaves; 1*c*, intermediate leaf; 1*d*, mature leaf; 1*e*, twig with mature leaf and buds; 1*f* fruits. Alma Tier, Interlaken, Tasmania (L. G. Irby). The type, received from Mr. R. T. Baker.
2 Smaller fruits, as figured in Baker and Smith's "Research," &c., 2nd Edition, p. 242.

E. Yarraensis Maiden and Cambage, n.sp.

3*a* Twigs, showing mature leaves of various sizes; 3*b*, buds and flowers; 3*c*, front and back views of anther; 3*d*, fruits. Valley of the Yarra, near Healesville, Victoria (R. H. Cambage).

Part 52

Hybridisation in the Genus.

A.—Historical.

THE following notes are given, as far as convenient, in chronological order:—

Caley (1800–1810).—In *Agric. Gaz., N.S.W.*, xiv, p. 988, October, 1903, I have an article "George Caley, Botanical Collector in New South Wales, 1800–1810," which contains determinations of Eucalypts based on some of Caley's specimens in the Vienna Herbarium. At p. 990 it is recorded that Caley gives the name "Burryagro—A hybrid between Barilgora and Derrobarry"—to the species *E. Boormani* Deane and Maiden, which (*Proc. Linn. Soc., N.S.W.*, xxvi, 339, 1901), we had expressed the opinion might be a hybrid, although in ignorance that Caley had expressed a similar opinion nearly a century before. Now "Barilgora" was the aboriginal name for *E. hemiphloia* F.v.M. and "Derrobarry" for *E. siderophloia* Benth.

The blacks had but one name for *E. Boormani* and for *E. siderophloia*; but Caley saw they were different, and his surmise as to hybridisation was marvellously shrewd. He was undoubtedly the discoverer of hybridisation in this genus. He studied the trees in the bush, made his pronouncement, and produced his specimens to back up his statement. Compare also, in connection with *E. Boormani* (*Proc. Linn. Soc., N.S.W.*, xxv, 339, 1901; *op. cit.*, xxx, 494, 1905).

In my work, "Sir Joseph Banks, the Father of Australia," p. 140, I say—"Recently I dedicated a New England Ironbark, *Eucalyptus Caleyi*, to his memory, to remind botanists of his discovery of hybridisation in the genus, in which he showed an Ironbark to take a part."

I followed up my *Agric. Gazette* paper (1903) by what may be termed a manifesto conveying whole-hearted belief in hybridisation in the genus. This was a paper in *Rep. Aust. Assoc. Adv. Science*, vol. x, pp. 297–303, 1904, which was translated into French, and published in *Rév. Hort. de l'Algérie*, Sept., 1905, pp. 211–216.

Bentham, 1863.—In his preface to vol. I of the "Flora Australiensis," p. 17, Bentham, not specially referring to Eucalyptus, remarks:—

Little as we know, for instance, of the influence of natural hybridising in Europe, it has been still less, if ever, observed in Australia; and many other causes may have produced apparent passages between species really distinct. I have, therefore, whenever there is a difference of opinion between Dr. Mueller and myself, adopted the conclusion which has appeared to me the most probable, and mentioned the objection to it for the consideration and, if possible, the decision of future botanists.

The best known Australian case of description of a non-Eucalyptus hybrid as a species is that of *Brachychiton populneo-acerifolium* F.v.M., in *Journ. Linn. Soc., N.S.W.*, ix, 379 (1884).

Woolls, 1867.—The late Rev. Dr. Woolls refers to the subject:—

Even in the Grey Gum or Hybrid Box (*E. tereticornis*), which appears more subject to variation than any Gum in New South Wales, there is sufficient uniformity in the seed-vessel to mark the species. The leaves are subject to great diversity. . . . It is in this Gum that workmen speak so much of hybridisation, as they imagine that the flowers of the Grey Gum are sometimes inoculated by the pollen of the Box, so that an intermediate variety springs up. . . . My own impression is that the varieties of the Grey Gum, to whatever causes they may be due, are not transmissible from generation to generation, and that they do not extend beyond the individuals so circumstanced; whilst I regard one of the kinds at least which workmen consider hybrid as a true species, for it has a uniform seed-vessel of its own, and prevails to too great an extent to admit of the supposition that it is the result of fortuitous impregnation. ("A Contribution to the Flora of Australia," pp. 219-20.)

The above remarks were published in 1867, and as the author died in 1893 it is obviously unfair to quote him as a non-believer in hybridisation in Eucalyptus. I do not, however, know any published statement of his in which he expressed different views, and at least up to within a few years of his death he leaned to his views of 1867. (Maiden in *Report Aust. Assoc. Adv. Science*, 1904, p. 298.) In future this reference will be given as Maiden, 1904.

The following passage: "If nature does not admit of crossing in the genus Eucalyptus . . . " (Woolls in *Proc. Linn. Soc. N.S.W.*, xvi, 61, 1891), shows that he remained in doubt on the general question of hybridism in the genus.

Mueller, 1880–1890.—Mueller always seemed to fight shy of the question, both in conversation and in his writings. Here follow two observations from his pen:—

Also in the particular series of Eucalyptus species to which *E. Foelschiana* belongs, some forms occur, the originals of which may possibly be traceable to hybridism, notwithstanding that in this genus the contact of the anthers with the stigma commences already, while stamens and pistils are still covered by the lid, &c. ("Eucalyptographia," under *E. Foelschiana*)

Again:—

On the summit of Mount Wellington I collected a state of *E urnigera*, with all leaves nearly oval and with simply truncate-ovate fruits. Hybridism does not seem to explain the origin of these aberrant forms in a genus, where cross fertilisation is guarded against by a calycine lid, though, as pointed out by Mr. W. Sh. Macleay, the possibility of such a process is thereby not absolutely excluded, as parrots, &c ("Eucalyptographia" under *E. cordata*.) (Maiden, 1904, p. 299.)

This reference to Mr. W. S. Macleay probably originated with Rev. Dr. Woolls, see below, p. 69.

Mueller published, without comment, in 1889, a statement that Mr. W. Baeuerlen had sent from near the Clyde, New South Wales, "Specimens of an Eucalypt which he considers a hybrid between *E. corymbosa* and *E. maculata*, in which case the characteristics of the former are prevailing." He then goes on to describe some of the points in which the specimens in question partake of the character of the two species referred to. "Mr. Baeuerlen was then, as now, Collector for the Technological Museum at Sydney the botanical collections of which were founded by me. It is only proper to say that Mr. Baeuerlen was, during the period that he served under me, a consistent advocate for recognition of the principle of hybridism in Eucalypts. In taking up the position I do now, of freely recognising the principle, I bear testimony to the fact that Mr. Baeuerlen, in correspondence with me, confidently asserted it at a time when I felt myself unable to definitely commit myself to an opinion without further evidence than I then possessed." (Maiden, 1904, p. 302.)

It is not easy for the present generation to understand the position of the younger botanists in the earlier eighties, in regard to Mueller's attitude concerning hybridisation. He had been writing on Eucalypts for thirty years, had described many new species, was the assistant of Bentham in regard to the "Flora Australiensis," was the author of "Eucalyptographia," but was most sensitive to what he termed "opposition," or, as we would call it nowadays, "free inquiry." He was most autocratic, and had founded and was in charge of the Melbourne Herbarium, in which were thousands of types and critical plants. When one day in October, 1885, I broached the subject to him in his private house, I was a little surprised at the vehemence with which he told me he almost did not believe in hybridisation in the genus, and then read me a homily on loyalty, *i.e.*, the impropriety of holding opinions different to his own. This interview had the effect of causing me to drop the subject, at all events within the hearing of Australia's benevolent botanical autocrat.

Naudin, 1883.—The late M. Charles Naudin, of Antibes, southern France, distinguished both for his researches on hybridisation in plants and for work on the cultivated forms of Eucalyptus, was a correspondent of Mueller, and he distinctly states ("Mémoire sur les Eucalyptus introduits dans la Région Méditerranéenne," *Ann. des Sciences Naturelles*, 6e série, Bot. t. xxv, 337–430 (1883), p. 355 (quoted by me as "1st Mem.") that the latter does not believe in hybridisation in

Eucalyptus:—

M. le baron Müller ne croit pas à l'hybridation dans les Eucalyptus, cependant il existe des formes si parfaitement intermédiaires entre des espèces acceptéés par tous les botanistes, qu'on ne peut guère douter qu'il ne s'y forme des hybrides, comme dans tant d'autres genres, les Saules et les Rosiers par exemple. (Maiden, 1904, p. 299.)

My readers are invited to peruse more extended notices of the work of Naudin and Trabut from my paper in question, pp. 299–300, in the direction of promoting a knowledge of hybridisation in the genus.

It is, indeed, to the French that we owe full statements in regard to the question. Cordier was the pioneer amongst these; Naudin later on adduced valuable evidence, and demonstrated it, while Trabut submitted overwhelming evidence. The French botanists planted long lines of Eucalypts in Algeria, and as they grew, flowered and fruited and shed seed, it became easy to see, when their progeny flowered and fruited, that some of them possessed obvious intermediate characters derived from their parents alongside. When I saw buds and fruits of *E. gomphocornuta* from trees adjacent to *E. gomphocephala* and *E. cornuta*, and noticed their intermediate character, the last trace of doubt as to hybridisation in the genus passed from my mind. Having quoted Naudin briefly, let me quote Trabut, who gives a condensed historical sketch.

Trabut, 1917.—Dr. L. Trabut, *Bull. de la Station de Recherches Forestières Nord de l'Afrique* (Alger), tome i, p. 140 (1917). The paper contains an admirable *résumé* of the history of the work of French botanists.

Following is a translation, from which it would appear that M. Cordier was the rediscoverer of hybridism in the genus, and first gave it importance:—

Eucalypts were introduced into France about 1854, and since 1862 several plantations have been made in Algiers, notably at the Jardin d'Essai. About this time, Ramel, who studied the works of. Mueller, of Australia, was the apostle of Eucalyptus in Algiers. Trottier[1] and Cordier not only planted *E. globulus*, but established collections of numerous species, with the view to a comparative study.

The collection of Cordier, a former President of the Botanical Society of France, established on the estate of El Alia à Maison-Carree, was begun in 1864. In 1876 it amounted to 10,000 trees. An equal number had been planted by Cordier at his estate of Hadjadjs at Reghaia. Cordier received the seeds of 130 species, and, in 1876, 120 species more or less prospered at El Alia. The determinations were not rigorous, and under the same name very different forms occurred, and, under different names, there were representatives of the same species.

Cordier, desirous of giving precision to his studies, appealed to botanists who had given attention to this genus, and I have had occasion to repeatedly go through the Cordier collections with Naudin and H. de Vilmorin. A certain number of plants difficult to determine resulted from sowings made with seeds collected on the estate, seed which were largely distributed to horticulturists and amateurs.

Hybridisation.—Cordier thought that the multiplicity of variations indicated hybridisation, and made the observation that the indeterminate plants grew more vigorously. At this time the role of hybridisation in the multiplicity of forms of Eucalyptus was not admitted, Mueller being categorically against it. Meanwhile Naudin, who had devoted to the study of hybridisation a good portion of his scientific career, did not hesitate to admit the ideas of Cordier, an observer who was without prejudices in the matter.

(Here follows descriptions of a number of hybrid species, reproduced below, beginning with *E. Trabuti*, see p. 79).

Like a certain number of genera well known by the multiplicity of their forms, and the uncertain limits between the groupings named as species, the genus Eucalyptus offers to descriptive botanists an opportunity for exercising their perspicacity in the finding out and appraisement of characters said to be specific.

Without wishing to prejudge what may happen in Australia, I do not hesitate to state that with us (Algiers) the introduced Eucalypts, brought together in our collections, cross with the greatest facility, and this results in the variation that Naudin called “desordonnée” (irregular).

The several hybrids that I have indicated at a time when specialists in Eucalyptus denied the existence, and even the possibility of hybridisation in the species, are only isolated cases fortuitously observed; methodical search will reveal a much larger number.

Besides the scientific interest that this verification presents, it has an important practical interest, for some hybrid species, already under observation for twenty years, are more vigorous and better adapted to our country than their parents. It is incontestable with these hybrids that they will constitute wooded areas which will one day relieve us from a large importation of wood and fuel from abroad.

Under the influence of cultivation there is also produced, very likely, variations that one would not be able to attribute with certainty to a recent crossing.

It may be objected, perhaps, that in the genus Eucalyptus species may produce themselves by mutation. But it will always be very difficult to eliminate from the causes of these mutations the action of a foreign pollen.

There remains now to practice artificial hybridisation. I am convinced that the scientific and practical results of it would be considerable. The raising of Eucalypts (Eucalyptus breeding) is important for the Mediterranean region, where this tree should render most important services.

Kinney, 1895.—Abbot Kinney ("Eucalyptus," Los Angeles, Cal., p. 23, 1895), says:—

Mr. L. Stengel, an experienced and careful nurseryman, is of opinion that Eucalyptus has a strong tendency to hybridise. He then refers to certain seedlings obtained from a sowing of reputed *E. robusta* seed:—"The vast majority were true to the parent tree. . . . One specimen was identical with *globulus*, several were like *amygdalina* var. *regnans*; in fact, about fifteen distinct species apparently came from these *robusta* seed." This is not evidence of hybridisation, but of mixed seed; at the same time I have seen Californian specimens which, in my opinion, indicate hybridisation. (Maiden, 1904, p. 303.)

Cambage, 1900.—R. H. Cambage:—

In view of the prominence given to the question of hybridisation of Eucalypts by Messrs. Deane and Maiden in the *Proc. Linn. Soc.*, vol. xxv, p. 111, where they deal with *E. affinis*, which grows among *E. sideroxylon* and *E. albens*, also with another tree growing among *E. siderophloia* and *E. hemiphloia* at Homebush and Liverpool, it occurred to me that if cross-fertilisation exists between the above trees, the same sort of thing may take place in other species, notably between *E. sideroxylon* and the western Box tree recently described by Mr. R. T. Baker as *E. Woollsiana*. Knowing that I should meet with these two species growing together in several places, I decided to make diligent search for trees which would answer the required conditions of hybrids. After coming into the Ironbarks and Box a few hundred yards, these trees were found which seem intermediate in every respect between *E. sideroxylon* and *E. Woollsiana* both in the colour and texture of the bark and wood, as well as in the size of the fruits, which are larger than those of *E. Woollsiana*, but smaller than those of *E. sideroxylon*. This doubtful looking tree was found again several times before reaching the Lachlan, but never in great numbers, and invariably associated with the same two species. These are points of circumstancial evidence which suggest hybridisation.

He proceeds to discuss the flowering periods of Eucalypts in relation to hybridisation, a subject touched upon somewhat casually by the Rev. Dr. Woolls some years before (*Proc. Linn. Soc. N.S.W.*, xxv, p. 716).

Cambage, 1901.—Reference to a supposed hybrid box in the Condobolin district (*E. sideroxylon* x *E. Woollsiana*) (*ib*., xxvi, 324).

A supposed hybrid between *E. sideroxylon* and *E. hemiphloia* var. *albens*, and discussion of *E. affinis* Deane and Maiden, a reputed hybrid, and which Mr. Cambage stated had been under his notice for about ten years (p. 691).

Cambage, 1902.—A supposed hybrid between *E. sideroxylon* and *E. Woollsiana* at Barmedman (*ib.*, xxvii, 195).

Baker and *Smith*, 1902.—Messrs. Baker and Smith, "Research on the Eucalypts," p. 15 (1902), under the heading "Hybridisation," say:—

Some attention has been given to this subject, but so far without any measure of success, as it appears difficult to understand how natural hybridisation pertains in the origin of Eucalyptus species, the essential organs being protected by an operculum, and in almost every instance pollen grains are found adhering to stigmas before the operculum falls off.

Baron von Mueller at one time did not regard hybridisation as impossible, but thought that all ordiary chances are against it, for he states "Hybridism does not seem to explain the origin of these aberrant forms (this investigation shows that most of these supposed aberrant forms are really distinct species) in a genus, where cross-fertilisation is guarded by a calcyine lid." ("Eucalyptographia," under *E. cordata*.)

Of course, the opening of the flower serves some purpose in nature, and no doubt insects and other agencies assist or contribute in cross-fertilisation in very rare cases, but in such instances the possible sterility of these hybrids must be taken into consideration.

Cross-fertilisation in the case of eucalypts is, in our opinion, quite exceptional, especially when we know at this present time that millions of these trees are growing intermixed, and although often flowering at the same time, yet preserve throughout extensive ranges their specific characters with remarkable constancy.

Maiden, 1903, 1904.—I have already referred to my papers on hybridisation under these dates.

See also my paper "Further Notes on Hybridisation in the genus Eucalyptus" (*Proc. Linn. Soc., N.S.W.*, xxx, 492, 1905) which contains specific instances attributed to this phenomenon, also "On a Eucalypt Hybrid (*E. calophylla* x *E. ficifolia*)," (*ib.* xli, 185, 1916). I have published other brief notes on hybridism in the present and other works.

Hall, 1912.—

In considering the question of hybridisation between Eucalypts, full consideration should always be given to the time of the year at which they flower. Thus, crossing of *E. robusta*, which blooms in winter, with *E. hemiphloia*, which is out in summer, would be impossible, though there is a chance of such crossing occurring between *E. tereticornis* and *E. paniculata*, or *E. saligna* and *E. acmenioides*. But the mere fact of two species growing together and flowering at the same time, yet maintaining constant and specific characteristics over a great range, points to the conclusion that hybridisation is most unlikely or impossible between them. In fact, I think the law may be laid down, that natural hybridisation is unlikely to occur between two species growing freely together and flowering at the same time. If I were attempting to hybridise Eucalypts, I should expect greater chances of success from two species growing widely apart, as say from Western and Eastern Australia, than from two growing together and blooming simultaneously. (Cuthbert Hall, *Proc. Linn. Soc. N.S.W.*, xxxvii, 566, 1912.)

See also Dr. Trabut's remarks, written in 1904, quoted at p. 73, below.

Hall, 1914.—

Again as to hybridism, I have been keenly on the alert to discover instances of this, but, after examining thousands of seedlings from different species, I have not seen one single instance of it so far. Although the seedlings of many species differ so markedly from one another, that they could be detected at once, I have hitherto found them uniform throughout, though there may be slight differences in size, vigour, &c. Still, knowing that hybridism has actually been proved in the genus *Acacia* (*Proc. Linn. Soc. N.S.W.*, xxxv, Part II), of which, as of the Eucalypts, so many species occur in Australia, we may hope soon for actual demonstration of such occurring in the latter. Up to the present, though much has been said as to one species being a hybrid of two others, we have had no actual proof. (Cuthbert Hall, *Proc. Linn. Soc. N.S.W.*, xxxix, 475, 1914.)

At the same time Dr. Hall, in his description of *E. Marsdeni* (*Proc. Linn. Soc. N.S.W.*, xliii, 747, 1918) shows that he does not exclude the role of hybridisation in the genus.

Maiden, 1914.—I give copy of an extract ("Hybridism in the Genus") from a paper I read before the British Association for the Advancement of Science at its Sydney meeting in August, 1914, and a paper by Mr. Cambage and myself entitled "Observations on some reputed Natural Eucalyptus Hybrids" (*Journ. Roy. Soc. N.S.W.*, xlviii, 415, 1914), may be turned to.

Hybridism in the genus.—The most convincing illustrations of hybridism in Eucalyptus (which is not very obvious as a rule, and hence has been denied), to me personally were afforded by a Eucalyptus plantation in Algeria, where intermediate forms of planted species displaying pronounced morphological characters were obtained from spontaneous seedling trees. We rarely cultivate Eucalypts in Australia on a large scale, and some of the exceptions are the plantations at Wirrabara and other places under the direction of the Conservator of Forests of South Australia. Study of these plantations would doubtless afford valuable data in regard to the evolution of new forms.

Hybridisation in wild species has apparently not been much investigated in any part of the world[1] . As regards Eucalyptus I have brought together a considerable number of facts[2] bearing on the subject, and have referred to the matter from time to time in my "Critical Revision of the genus Eucalyptus," and other works. As in Australia the evidence as to Eucalyptus hybrids is mainly based on inference, it appeared to me best, when I shall have cleared the ground by a critical examination of each species, to devote some parts of that work to consideration of the question of hybridisation alone, since, in my view, pictorial illustration is necessary to a proper understanding of it.

I am redeeming my promise in the present and following Part.

Perez, 1919 *et ante*.—The late Dr. G. V. Perez was for a number of years a firm believer in hybridisation in the genus. See under *E. ficifolia* x *calophylla* at p. 281, Part XLIX of the present work.

Baker and *Smith*, 1920.—In "Research on the Eucalypts," 2nd edition, p. 13, there is a note headed "Hybridisation." On reading this page, it is difficult to understand whether Mr. Baker believes that hybridisation occurs in the genus under natural conditions. At all events, the admission, if made, is done very grudgingly. I do not complain of the exercise of caution in the matter, for, as a botanist who has perhaps given more attention to the subject than any other Australian worker, I freely admit that the subject is full of pitfalls, which particularly beset those who have not endeavoured to view it from every direction that presents itself. At the same time much evidence has been available for a good many years now.

B.—Birds and Fertilisation.

Here is an appropriate place to refer to the remarks of A. G. Hamilton, one of the most distinguished of Australian workers on fertilisation. I quote from two of his presidential addresses before the Linnean Society of New South Wales, as contained in the Journals of the Society. The whole of the addresses should be read.

Little that is definite is on record about the pollination of *Eucalyptus*, or, with one exception, of *Acacia*. I looked up both orders in Hermann Muller's and Knuth's books, and was greatly astonished to find that neither book has any reference at all to the Myrtaceae. The order seems to have been passed over by inquirers into pollination methods. And very few observations are recorded on *Acacia*. In the case of *Eucalyptus*, we know that the flowers are visited by the brush-tongued lories and by some of the honey-eaters. In a paper by Mr. Swinnerton "On Short Cuts by Birds to Nectaries" (*Journ. Linn. Soc.* (Bot.), vol. xliii), being observations made in South Africa, he mentions *E. ficifolia* as being visited by Sunbirds, and also by other birds, as well as insects. He believes that in South Africa this species is chiefly pollinated by hive bees and Sphingidae. The Eucalyptus flower being of a shallow, open type, with much nectar, it seems rather extraordinary that it should be pollinated by Sphinges. The lories, having a short tongue, are certainly well adapted for the work, but I should have thought that slender-billed birds and long-tongued moths would not be likely to pollinate the flowers.

Nowadays, introduced hive-bees are usually the most conspicuous visitors, both to garden plants, and, in localities not too remote from settlement, also to native plants, including Eucalypts, Banksias, and Grevilleas. Bee-keepers are glad to have Eucalypt forest in proximity to their apiaries. In some cases, doubtless, the hive-bees are instrumental in effecting pollination. But in others they merely deprive the flower-frequenting birds of their birthright, without accomplishing anything for the benefit of the plants. (Vol. xlii, p. 14, 1917.)

The profession of pollinator seems in the main to be confined to a few families of birds. In America the humming-birds (*Trochilidae*) and sugar-birds (*Coerebidae*) are chiefly concerned. In Hawaii the *Drepanididae* (35 spp. in 17 genera) and *Meliphagidae* (5 spp. in 2 genera) are the agents. In Australia we have *Meliphagidae* (72 spp. in 23 genera) and seven species of brush-tongued Lorikeets. Africa has its Sunbirds (*Cinnyridae*) and Flower-peckers (*Dicaeidae*). In New Zealand are the *Meliphagidae* and a few parrots. But there is no doubt that other birds at times pollinate flowers. Whether they visit the flowers in search of insects or nectar is not quite apparent. (xli, 18, 1916.)

A correspondent, Mr. S. T. Turner, in a letter mentions that at the time of writing parrots were very busy biting off the opercula of Eucalypt-buds. (p. 26.)

I have already alluded to the want of systematic observations on the method of pollination in Acacia and Eucalyptus. It is a very lamentable thing that no one has taken these genera up. Here we have two very large, and, from either the scientific or the economic points of view, very important and characteristic genera, and yet no one seems to have attempted to solve these important problems. Certainly some observations have been made in America and South Africa, but it is obvious that these are of little value from an Australian point of view. The agents of pollination are not the same, though of course we may get suggestive hints which will assist the local worker when he arrives. (*ib.*, p. 21.)

Now we come to some observations by a well-known Western Australian worker:—

Species of Eucalyptus come next on my list. Sepals and petals are discarded at anthesis in the form of a calyptra (operculum) in this genus, and the open blossom is in some respects very simple in structure. A ring of numerous thread-like stamens surrounds the top of the ovary, which is surmounted by a slender terete style, whose apex is stigmatic. A few figures recently obtained from a flower of *Eucalyptus* *macrocarpa* Hook., will be much more effective than a long description in revealing the character of the flowers. I estimated the number of stamens at 1,400. Their bases occupied a band round the ovary top 21/2 mm. wide, while their anther-bearing tops spread to a width of about 25 mm. The middle circumference of the stamen ring taken over the anthers was 140 mm. The stigma was less than a millimetre in diameter! The area of the pollen-*bearing* surface was therefore over 3,000 times the area of the surface adapted for *receiving* pollen. In this estimate I have included the spaces between the anthers; but even if that inclusion be disallowed, the ratio would still be enormously disproportionate. What could be more eloquent of the low degree of specialisation of this flower? I have no positive knowledge that birds are the chosen agents of pollination in this particular species, but I feel no doubt whatever such is the case. While the above is perhaps an extreme case in all species of Eucalyptus, the area of the pollen-bearing surface is enormously out of proportion to the area of the stigma, which is always minute. This points, I think, to a pollinator of comparatively large size. The top of the ovary secretes nectar, often very copiously, so that it falls in drops from the flowers. Birds seeking this nectar would certainly be liberally dusted with pollen, and could scarcely fail to bring some of their pollen-bearing feathers into contact with the stigma. I have many times seen small parakeets busy on the flowers of *E. redunca Schau.*, and *E. accedens W. V. Fitz.* Once I observed *Zosterops gouldi* sipping nectar from the flowers of *E. loxophleba* Benth. The only species I have observed at all closely is *E. calophylla* R.Br. Its flowers are freely visited by insects seeking the very copious nectar or pollen. Various honey-eating birds are also frequent visitors. The latter appear to be efficient pollinators; but the insects seem useless. I have never seen one brush against a stigma, though I have watched long and carefully. I have found Eucalypts troublesome to observe, and I regard my present knowledge of their flower biology as very incomplete. Yet, what I have so far seen has impressed upon me the belief that birds are the chief pollinators of the genus. The small size of some of the flowers at first led me to regard them as entomophilous, but I am now satisfied that birds could and would take nectar from the smallest, and in so doing would almost certainly effect pollination. (O. H. Sargent in "Annals of Botany," vol. xxxii, pp. 217–218, 1918.)

The zoologist, W. Sharpe Macleay, early in the last century, remarked (Woolls, "A Contribution to the Flora of Australia," 1867, p. 219) "that parrots and other birds occasionally bite off the flower buds, and may accidentally uncover a stigma and remove the anthers; and, again, insects may then finish off their work and carry pollen across from another species."

After consultation with Mr. J. J. Fletcher, editor of the Macleay Memorial

Volume (Linnean Society of New South Wales, 1893), which contains an account of Mr. W. Sharpe Macleay's work, and careful search by him of the latter's papers, he says that he is satisfied that Mr. Macleay's observation, to which Rev. Dr. Woolls refers, was contained in a private letter or a verbal communication.

The Australian Museum Catalogue of birds (A. J. North) dealing with the *Meliphagidoe*, and the Brush-tongued Lorikeets, give lists of honey-eating brids so far as Australian species are concerned.

A list of Australian insects found on *Angophora cordifolia* during December, 1912, at Como, will be found in *Aust. Naturalist*, vol. iii, p. 18 (1914). They may be captured on Eucalyptus also. A list of honey-eating insects of Australia would comprise approximately half the described species. Reference may also be made to the insects which frequent Eucalyptus in Parts 65 and 66 of my "Forest Flora of New South Wales."

A. G. Hamilton makes the following observation, and I think it is concurred in by the majority of Australian observers:—

I do not think that there is any foundation for the opinion that Eucalypt-flowers are fertilised in the bud. They are conspicuous flowers when open, scented, and contain a large amount of nectar, all of which would point to pollination by insects or birds. (*ib.* xli, p. 26.)

Anyone who will examine a number of Eucalyptus flowers of any species freshly opened will see that in the vast majority the stigma is quite free and clear of any pollen, while all the anther cells (the pollen vessels) are still closed, so much so that one often has to look for other flowers in order to find out the anther group to which these particular anthers belong. A number have the filaments so much incurved when the flowers open, that it is practically impossible in that position for the anthers to come into contact with the stigma, and even if they did, it would not cause fertilisation at that stage, since the pollen is still enclosed, and it is the *free pollen*, and *not the anthers* that ensure fertilisation. So much is clear to my mind; the proof some require is as to whether fertilisation takes place before the throwing off of the operculum. I doubt it.

There are differences in the styles as regards length, some being well protruded beyond the stamens. The stigma also may be punctiform; on the other hand it may be more or less capitate or dilated. The stigma may be protected by fitting, as if moulded, into the top of the operculum. In other words, the operculum may act as a sheath to the stigma. This is readily seen in species with large flower-buds such as *E. pyriformis* and *E. macrocarpa*. I will return to the subject when dealing with the organs concerned.

C.—Hybrids and Aberrant Forms.

The hybrids already and to be described are interesting for the reason that they may be assumed to be incipient species, and their history will be watched in the future.

I look upon these hybrids as subordinate species, and I would gladly give them names to indicate inferiority (in botanical rank) to the ordinary species. But it seems to me that I have no choice between naming them like ordinary species, or continuing to refer to them by circumlocution, which is in the highest degree inconvenient.

One must not rely too much on the plates, in this and the next Part, which, of course, can only display morphological characters. One must consider the other characters referred to in the text, and, indeed, on consideration of these, the botanist who suggests hybridism as an explanation, has pointed out the differences from the species he considers it most closely to resemble, and yet to substantially depart from.

There are pitfalls in assuming a species may be a hybrid, *e.g., E. amplifolia* Naudin. In this case a plant showed characters sufficiently different from *E. tereticornis* for Naudin to note an undescribed species. He made the natural mistake, however, to attribute the differences to hybridisation, when, as a matter of fact, his French Algerian plants arose from seeds of Australian plants sent as *E. tereticornis*.

There is another aspect of the question of the ever-varying morphological aspect of a species. Variation in Eucalyptus (and, indeed, all other genera) is going on all around us. I have in mind coming across in a *E. saligna* area a tree with very rough flaky, exfoliating bark, similar to that which is usually seen to but a very small extent on the butts of trees of that species. The buds and fruits seemed to be similar to those of the rest of the *salignas* about. But might it not have been that the tree was under the influence of saline conditions of soil? We know that *E. botryoides*, which sometimes has the organs so similar to those of *E. saligna*, that we say they "run" into each other, that is to say, it is very difficult and perhaps impossible to separate them on morphological grounds, and it is a rough-barked species and often grows in soil more or less saline. Perhaps this rough-barked *saligna* is evolving into *botryoides*, and that the rough, exfoliating bark is an expression of intolerance to salinity.

A perfectly smooth gum of any species is an ideal; indeed, what we call "typical" barks of any class are ideals; they vary, and we try to explain the variation, and, when the variation has proceeded far, we cut the knot, and constitute a new species.

A valuable historical review, entitled "The Founders of the Art of Breeding," by

Herbert F. Roberts, will be found in *Journal of Heredity*, x, 99, 147 (March and April 1919).

After giving due credit to Koelreuter and others for their pioneer work in regard to sexuality in plants, he draws attention to what he terms “the revelations of Sprengel,” who published (in German) his work “The Newly Revealed Secret of Nature in the Structure and Fertilisation of Flowers” (Berlin, 1793). It was Sprengel's chief merit to discover the fact of insect fertilisation. Roberts goes on to say that to Sprengel we owe the discovery of dichogamy, *i.e.*, the maturing of the stamens and pistils of flowers at different times. His conclusion that Nature, in most cases, intended that flowers should not be fertilised by their own pollen, and that the peculiarities of flower structure can only be understood when studied in relation to the insect world were revolutionary for his time. Roberts proceeds to point out that it remained for Darwin to show how the results from such perpetual crossings are limited and held in check by the operation of natural selection. And not long afterwards (though neglected for a generation) came the work of Mendel, and then the scientific age of plant-breeding and the development of “genetics.”

Dr. D. T. MacDougall's paper (“Hybridisation of Wild Plants,” *Bot. Gaz.*, lxiii, 45, 1907) begins—

The number of forms of plants which have been or are regarded as hybrids by systematists is a large one and includes several oaks, of which two have been examined during the last two seasons. Attention has been called previously to the untrustworthiness of the custom prevalent among botanists of attributing a hybrid origin to certain plants because they appear to exhibit halved, fused characters, or a mosaic of qualities derived from the two supposititious ancestors. In some instances such deductions have been made by which the ancestry of a questionable plant has been made to include three or even four species. The argument of distribution is the main one offered in such attempted demonstrations. In many cases this, together with other circumstantial evidence, may amount to almost positive conviction, but unless this close relation of well-joined facts is furnished, assertions as to the hybridity of a plant must be taken simply as a suggestion to be tested by cultural or experimental methods.

He points out—

The reformation of a hybrid by the cross-pollination of the parents to which it may be ascribed is by no means simple in all instances, nor is it always easy of accomplishment. In the first place, the original cross-pollination may have taken place possibly under an exceedingly rare combination of favourable physiological conditions difficult to secure or duplicate in experimentation.

Dr. MacDougal's own experiments to illustrate his paper are based on *Quercus*, and it concludes with references to a large number of natural plant hybrids of North America, based on a list originally prepared by Dr. David George. It takes cognisance of 117 hybrids distributed over twenty-four families. The paper is most suggestive.

See also A. R. Rolfe's remarks on hybridisation in Orchids (*Orchid Review*, 1916, 1917).

Although the number of artificially produced hybrid trees is small, compared to the number of crosses among other species, several noteworthy trees have been described from time to time which do not conform to any known kinds, and they have been attributed to an assumed hybrid ancestry.

Then follows a select list of trees which "have been regarded upon reasonably good evidence as natural hybrids." The whole paper, on a Hybrid Catalpa is well worth study. (Jones and Filley in *Journal of Heredity*, January, 1920, p. 16.)

French (particularly Algerian) Hybrids.

Let us now proceed to consideration of forms which have been looked upon as hybrids. The names have been arranged, for convenience, in alphabetical order, and the descriptions and remarks have been translated by me from Dr. L. Trabut's paper "Bulletin de la Station des Récherches Forestières du Nord de l'Afrique (Alger)," tome i, p. 140 (1917), except in the case of *E. jugalis* Naudin.

E. algeriensis Trabut.
E. amplifolia Naudin.
E. antipolitensis Trabut.
E. Bourlieri Trabut.
E. Cordieri Trabut.
E. gomphocornuta Trabut.
E. jugalis Naudin.
E. occidentalis Endl. var. *oranensis*.
E. pseudo-globulus (Hort.) Naudin.
E. Trabuti Vilmorin.
E. Stuartiana x *globulus* Trabut.

1 See Trottier—De l'accroissement et de la valeur progressive de l'Eucalyptus. Alger, 1871. 8 vo. See also my "Forest Flora of New South Wales," Part LXVIII, p. 374.

1 "Hybridisation of Wild Plants." D. T. MacDougal, *Bot. Gaz.* xliii, 45 (1907).

2 "On Hybridisation in the genus Eucalyptus," *Proc. Aust. Ass. Adv. Science* x, 297 (1904); *Proc. Linn. Soc., N.S.W.*, xxx, 492 (1905); *Pro. Roy. Soc., N.S.W.*, xlvii, 233, (1913).

CCXCII. x E. algeriensis Trabut.

Reputed parents, *E. rudis* Endl., and *E. rostrata* Schlecht.

Another hybrid form seems to me worthy of attention. It is intermediate between *E. rudis* Endl, and *E. rostrata* Schlecht.

After a certain leaning towards *E. globulus*, one decides to give the preference to the "Red Gum" Eucalypts. Under this name have been propagated *E. rostrata, E. rudis*, and *E. tereticornis*. These three species are found together in the plantations made towards 1880, in which *E. rostrata* is in greatest quantity. These trees have almost the same appearance. *E. rudis* has always a trunk covered with scaly bark, while the two others have a smooth bark, because of the exfoliation of the outer bark, as in the case of the Plane. *E. tereticornis* has an elongated bud, with a long operculum, the filaments of the stamens are not folded back, but straight. *E. rostrata* has a little bud with a hemispherical operculum surmounted by a long beak; the stamens have the filaments bent back before expansion.

These three species are hybridised so well that in their descent it is difficult enough to make an exact determination. One of these forms, well characterised, is to-day very widely spread, and further it acclimatises itself, for one finds numerous specimens of it growing spontaneously everywhere on the banks of streams.

In 1904 I described it under the name of *E. algeriensis* in the *Rev. Hort. d'Algérie*.

I well know that it is inconvenient to name as legitimate species forms of hybrid origin, which have been produced under cultivation. But it is also very inconvenient not to clearly and simply indicate plants distinguished by horticulturalists and agriculturalists who propagate them.

It is also a difficult matter for botanists—the presence of a new species of Eucalyptus, foreign to Australia, and reproducing itself like a native plant in North Africa. That is, however, the case of *E. algeriensis*.

E. algeriensis is an example of acclimatisation by means of hybridisation; the hybrid descent offers more facility, by its variations it has a greater facility for adapting itself to a new milieu.

Here is a description of this hybrid:—

E. algeriensis Trabut. *Rev. Hort. Alg.*, 1904. *E. rostrata* x *rudis* Pl. xii.

Lofty tree with a pyramidal shape when young, trunk with smooth bark coming away in pieces; leaves glaucescent, pendent, straight or falciform, lanceolate, oval, large on young specimens; inflorescence in axillary umbels of seven to nine flowers, rarely more; flowers pedicellate, white with an operculum terminated by a short umbo, capsule small, exsert, exceeding the calyx-tube by a little less than half, and opening by erect valves.

E. algeriensis differs from *E. rudis* in its smooth trunk, its smaller flowers, in its hemispherical operculum, not rostrate, or only shortly rostrate; it differs at first sight from *E. rostrata* in its white buds, like those of *E. rudis*. *E. rudis* flowers in winter till December, *E. algeriensis* flowers in the spring, while *E. rostrata* only flowers in July-August, and has a special odour.

The winter flowering of *E. rudis* seems an obstacle to its pollination by *E. rostrata*, which flowers in summer, but it is observed in *E. rostrata*, as in *E. rudis*, that there are several delayed flowers, which are sufficient for a cross-pollination. The number of *E. algeriensis* trees to-day is very considerable. There exists notably a large number at the Forestry Station at Bainen, and the Forestry Service, which has recognised its merit, has propagated it for several years as Red Gum. (This Australian name is in the original.)

In this group of Eucalypts, after the fall of the operculum, the stigma emerges above the stamens when bent back; also at this time cross-fertilisation is very easy.

If one examines the Eucalypts which reproduce themselves spontaneously, especially along the banks of streams, one will recognise that they belong to this species of hybrid origin. It is for this reason that the name *algeriensis* has been chosen. In the near future this tree will take an important place amongst the spontaneous vegetation of Algeria, where it is well acclimatised and naturalised.

The wood of *E. algeriensis* does not differ from the wood of other Red Gums. It is a red or pink timber; it is easier to work than that of *E. globulus*, with straighter fibre, and less subject to split. *E. algeriensis* seems to accommodate itself to all soils, but it prefers those which are somewhat damp. At the Duperre Railway Station can be seen one of the largest of Algerian Eucalypts, which is *E. algeriensis*.

This hybrid must have been produced as the result of the first sowings of Red Gum from seed of Algerian origin, for one finds it in most of the plantings made about 1880. There are some specimens of it with a trunk from 2·50 to 3 metres in circumference.

With reference to Dr. Trabut's remarks *re* species which pass as Red Gum in Algiers, it is not proper to include *E. rudis* in such a list. It is not known as Red Gum in Australia, its timber being rather pale and very inferior. See Part XXXIII, p. 75 of the present work.

CLX. E. amplifolia Naudin.

I have shown, p. 20, Part XXXI, Plate 131, that this species is a valid Australian one. Dr. Trabut is under a misapprehension in looking upon it as a hybrid. I continue the translation.

In the Red Gum plantations one also finds, with an infinite number of forms of *E. rostrata*, some *tereticornis* very polymorphous, and verging towards *E. rostrata*. Amongst this evidently hybrid descent Naudin thought he could distinguish as a species a very fine tree which he has named *E. amplifolia*, and of which the following are the characteristics:—

E. amplifolia Naudin (Pl. xiii).

A strong tree with a smooth trunk; young leaves very large, oval, leaves of the adult tree oblique, lanceolate, pointed or oval; floral umbels with long peduncles, from nine to fifteen flowers borne on pedicels as long as the flowers; calyx-tube short, bearing a white operculum elongated into a long attenuated rostrum, and twice the length of the calyx-tube; the outer stamens straight, the inner ones with flexuose filaments; fruits spherical, capsule small, jutting out above the very thick calyx-tube; opening by three to four straight valves, seeds not very numerous.

E. amplifolia varies greatly in its seeds. One can distinguish it from the *E. tereticornis* type by its umbels with more numerous flowers, by the bud surmounted by a shorter operculum, contracted into a beak.

It is presumed that, by the constant action of hybridisation, it will become more and more difficult to distinguish the primitive species comprised under the general denomination of Red Gum.

E. rudis, rostrata, tereticornis, under the influence of cultivation, have given and will give new forms, which are very interesting on account of their great vigour and perfect adaptation. For the multiplication of these trees it is important to collect seeds from well-grown specimens, which are generally hybrids.

CCXCIII. x E. antipolitensis Trabut.

Reputed parents, *E. globulus* L'Her., and *E. viminalis* Labill.

In *Proc. Roy. Soc., Tas.*, 1918, p. 89, I have stated that I look upon it as conspecific with *E. unialata* Baker and Smith. I am of opinion that they both originally arose from a cross or crosses between *E. globulus* and *E. viminalis*, but whether they are really indentical I prefer to suspend my judgment.

At the Villa Thuret at Antibes (Southern France), where there is a collection of Eucalypts made by Naudin, I have especially observed a very fine subject, worthy of propagation. Naudin had provisionally labelled it *E. viminalis* var. *longifolia*. The examination of the organs of reproduction as of vegetation leave no doubt as to the parentage of this form with *E. globulus*. I propose to call it the Antibes Eucalyptus.

E. antipolitensis n. sp. (Plate XV bis.).

A tall tree, trunk covered with fissured bark; branches smooth by reason of the falling of the old bark; young leaves sessile, alternate, opposite, often in threes on the same branch, broad and obtuse at the base of the branch, then oval, glaucescent, with the odour of *E. globulus*; adult leaves thick, long-lanceolate, falciform, dark green, dotted with large essential oil dots, umbels axillary, with three flowers on a short peduncle, buds sessile, verrucose, hoary, calyx-tube angular, operculum slightly longer than the calyx-tube, hemispherical, mucronate, fruit from 12 mm. in diameter, with 3–4 valves not erect or very slightly so; fertile seeds black, angular, without appendages. Villa Thuret, Antibes.

This Eucalyptus was sown by Naudin very probably as *E. viminalis*; he called it var. *longifolia*.

At first sight it is distinguished from *E. viminalis* by its habit, its stem, its foliage, reminding one *E. globulus*. The buds and the fruits are much larger than those of *E. viminalis* and strongly resemble those of *E. globulus*; the fruits are much smaller than in this species, always in threes; they are slightly verrucose, and show a slightly different mode of dehiscence. The young leaves resemble those of *E. globulus* and have the same odour, but they are distinguished from it, however, in not being stem-clasping; the branches which bear it are angular, but not nearly so quadrialate as in *E. globulus*.

E. antipolitensis is a very fine tree, which has not yet been propagated; it has numerous capsules in which the number of the fertile seeds is restricted, but quite sufficient to insure propagation.

CCXCIV. x E. Bourlieri Trabut.

Reputed parents, *E. globulus* Labill., and (?).

E. globulus Labill has given several hybrids easy to recognise by the young leaves, which have preserved more or less the character of *globulus*, and also the content of Eucalyptol. One of the most interesting is a fine Eucalypt which appeared in a sowing of *globulus* at my colleague's place (Dr. Bourlier's) at La Reghaia.

E. Bourlieri Trab. *Rev. Hort. Alg.*, 1903, p. 327, Plate XIV.

(Preliminary note *op. cit.* August, 1901, p. 239).

A tree of large stature, biform in the juvenile stage, branches pruinose, leaves opposite, sessile, oval, oblong; stem straight, covered with a network of fine dry bast, which easily comes away; leaves long, lanceolate, pointed straight or curved, pendent, dark green, petiolate, attaining 15–27 cm. long by 22–24 mm. broad; the angle of divergence of the secondary nerves is about 25 degrees; the two faces equally have stomata, 175 to the square mm.; the inflorescence is in an axillary cyme of three flowers borne on a flattened peduncle of 5–6 mm.; the bud is sessile, 15 mm. long with an angular, verrucose, pruinose, whitish, broad, conical operculum, surmounted by a protuberance; fruit generally solitary in the axils of the leaves, hemispherical, barely marked with two angles, pruinose, glandular, punctate, attaining barely 10 mm.; opening by 3–4 slits which let the brown non-appendiculate seeds escape.

This Eucalypt differs greatly from *E. globulus* in the capsule, but the young bud and the young leaves recall this species. It is not possible to ascertain the male parent.

This Eucalypt is not very fertile; the tree has an exuberant foliage and a very fine appearance.

CCXCV. x E. Cordieri Trabut.

Reputed parents, *E. globulus* Labill., and *E. goniocalyx*, F.v.M.

From 1873 M. Cordier observed in the sowings of *E. goniocalyx* F.v.M. specimens having a good deal of resemblance to *E. globulus*, and he made a figure in a fine Atlas which he bequeathed to the Botanical Laboratory of the School of Agriculture, a form that he called a *E. goniocalyx* hybrid of *E. globulus*.

There still exists in the Cordier collection a certain number of these specimens, intermediate between *E. goniocalyx* and *E. globulus*. I propose to call them *E. Cordieri*, in memory of the first botanist who recognised the important role played by hybridisation in the multiplication of forms of Eucalyptus obtained in X cultures.

E. Cordieri Trab. (*E. goniocalyx* x *globulus*) (Cordier, *Atlas Eucalypt*, 1873, pl. 28 (Plate XV)).

A tall tree, with the appearance of *E. globulus*. Young leaves opposite, rounded, cordate, with the same odour as *E. globulus*; adult leaves thick, lanceolate, falciform, very like those of *E. globulus*; umbels axillary, from 3–7 flowers; peduncles compressed, short; flowers sessile, bud pruinose, calyx-tube angular, operculum slightly exceeding the calyx-tube, hemispherical, mucronate; fruit very variable, often with an angle of 8–10 mm. in diameter, with 3–4 triangular valves, which are not erect, sometimes included, most often at the level of the edge of the calyx-tube.

It seems that this form appeared in the sowings of seeds coming from Australia, which leads me to think that Australian botanists did not appear quite certain as to the limits of *E. goniocalyx*, and if a close observation of this species had led them to separate, notably *E. Cambagei* Deane and Maiden (*E. elaeophora* F.v.M.), *E. paludosa* R.T.B., and from another side to separate from *E. globulus E. Maideni* F.v.M., they would find themselves confronted with forms arising from hybridisation. It even seems that *E. goniocalyx* is joined to *E. botryoides* by other intermediate forms.

E. elaeophora F.v.M. (*E. Cambagei* Deane and Maiden) is a species quite distinct from *E. goniocalyx*. See p. 275, Part XIX of the present work. *E. paludosa* R.T.B., is a synonym of *E. ovata* Labill. See p. 134, Part XXVII. *E. goniocalyx* and *E. botryoides* are widely different. The former is a Gum with pale-coloured timber; the latter is a rough-barked species with red timber. (This last paragraph by J. H. Maiden.)

CCXCVI. x E. gomphocornuta Trabut.

Reputed parents, *E. gomphocephala* DC., and *E. cornuta* Labill.

Several other hybrid Eucalypts have made their appearance in Algerian cultivations, and are worthy of note.

One of the most interesting is *E. gomphocornuta* Trabut. This Eucalypt has been noticed in a plantation of *E. gomphocephala* D.C., made by Dr. Bourlier at La Reghaia, the seeds coming from the Cordier collection.

Eucalyptus gomphocornuta Trab. *Rev. Hort. Alg.*, 1904. See August, 1901, p. 239, and 1903, p. 326.

A tree of good pyramidal shape, with abundant dark green foliage; trunk with a persistent bark, finely fissured; leaves unequal, oval, pointed, bent, pendent, shining, coriaceous, dark green, with long petioles, attaining to a length of 20 cm. by 22 mm. broad, the angle of divergence of the secondary nerves varies from 30 degrees in the narrow adult leaves, to 50 degrees in the short large leaves, the two faces with an equal number of stomata, about 288 to the square mm. The inflorescence is in axillary umbels, borne on a peduncle of 3 cm. long, flattened the whole length. The flowers, to the number of 3–7, are borne on a thick short pedicel; the bud, which before expansion is 25 mm. broad, is covered by an operculum which is at first cylindro-conic, and then swelling at the base so as to project over the calyx-tube; fruit campanulate, elongated, from 15 mm. long to 10 mm. broad, opening by four pointed fragile valves; the seeds without appendages are of the colour of dark mahogany; the cotyledons are deeply bifid.

E. gomphocornuta, which has a general appearance of *E. gomphocephala* DC., is distinguished very easily by its very short buds, and surmounted by a long conical operculum not hemispherical, projecting like the cap of a mushroom, and by its campanulate capsule bearing pointed valves which recall its relation to *E. cornuta* Labill (Fig. 3).

In the plantation of Reghaia the *gomphocornutas* are distinguished by a greater height and a thicker trunk.

I have already (1904) recorded the fact that it was contemplation of specimens of *E. gomphocornuta*, which so obviously partook of the well-marked characters of the reputed parents, that removed the last haze of doubt from my mind as to hybridisation in the genus.

CCXCVII. x E. jugalis Naudin.

In "Description et Emploi des Eucalyptus introduits en Europe principalement en France et en Algérie" (Second Mémoire par Charles Naudin, Antibes, 1891, p. 37).

Reputed parents, *E. melanophloia* F.v.M. and (?).

FOLLOWING is the original description:—

Petit arbre de 5 à 6 mètres, à en juger par les exemplaires qui me sont connus, biforme, tout entier d'un gris blanchâtre pruineux. A l'état juvénile, les feuilles sont opposées, sessiles, ovales ou même largement ovales, aiguës ou obtuses, cordiformes à la base, longues de 4 à 5 centimètres, larges de 3 à 4. A l'état adulte, elles sont alternés, pétiolées, ovales-oblongues et même lancéolées, et dans ce cas elles peuvent avoir 10 à 12 centimètres de longueur, sur 1 à 2 de largeur. Les fleurs sont en cymes axillaires, le plus souvent triflores, mais qui portent quelquefois 5 ou 7 fleurs courtement pédicelées, de forme ovoïde avant leur épanouissement, très pruineuses, et dont l'opercule arrondi, terminé par un court mamelon, se distingue à peine du tube du calyce avant sa chute. Le fruit, à peu près hémisphérique, largement ouvert, de la grosseur d'un pois, contient une capsule à 5 ou 6 loges, aplatie à son sommet et dont les valves, à sa maturité, arrivent à peine au niveau du bord du tube calycinal.

Cette espèce, qui me paraît jusqu'ici bien caractérisée, existe dans divers jardins de la Provence, ainsi que dans les plantations de l'administration forestière de Roquebrune, près de Fréjus. Nous en avons plusieurs exemplaires adultes à la villa Thuret, très semblables les uns aux autres. Malgré toutes mes recherches, je ne l'ai trouvé décrit nulle part. Quelques horticulteurs lui donnent le nom de *fissilis*, qui n'est cité dans aucune Mémoire d'eucalyptographie. Pour ne rien préjuger, je l'ai nommé *jugalis*, qui rappelle la disposition par paires des feuilles du premier âge.

At p. 16 Naudin puts it in the group "Espèces biformes dont les ombelles axillaires contiennent plus de trois fleurs, sauf les cas d'avortement ou de chûte prématurée (ils sont frequents dans l'*E. jugalis*):—

E. coccifera, goniocalyx, myrtiformis, Huberiana, Mazeliana, jugalis, gracilipes Risdoni."

Eucalyptus occidentalis Endl., var. oranensis Trabut.

E. occidentalis Endl. var. nov. *oranensis*. The typical form is a medium-sized and irregular tree In the Department of Oran there is a race very different and worthy of a name. The flowers and the capsules are borne on long and slender peduncles and pedicels. The tree is of fine appearance as one can see in the Domain of L'Habra. This form, or one very closely related to it, has been distinguished in America under the name of *E. californica* Hort.

CCXCVIII. x E. pseudo-globulus (Hort.) Naudin.

Reputed parents, *E. globulus* Labill, and (?).

E. pseudo-globulus Hort. In the sowings of M. Trottier one may observe a *globulus* with very long leaves, with flowers in threes on a rather long compressed peduncle, with fruit half as small as in *globulus*. This Eucalypt comes true by seed.

It is very difficult to affirm that this deviation from type is of hybrid origin, but it is well characterised, and remains constant.

This form is referred to by Naudin in the following words:—"Nous ne lui connaissons jusqu'ici qu'une seule variété, celle qui a reçu le nom de *pseudo-globulus*, qui ne se distingue du globulus ordinaire que par le volume de ses fruits, de trois ou quatre fois plus petits que ceux du type commun. Il y a d'ailleurs tous les passages entre les extrêmes de volume."

I have received specimens from Dr. Trabut. I have notes on it in *Proc. Linn. Soc., N.S.W.*, xxviii, p. 899 (1903) and xxx, p. 499 (1905). In the latter reference I was not satisfied of its hybrid nature, but I am now.

CCXCIX. x E. Trabuti Vilmorin.

Reputed parents, *E. rostrata* Schlecht., and *E. botryoides* Sm.

Synonym.—*E. Rameliana* Trabut non F.v.M., in *Revue Horticole de l'Algerie*, No. 8, p. 237 (August, 1901); *Bulletin Agricole de l'Algerie et de la Tunisie*, p. 326 (15th July, 1901); Maiden in *Proc. Linn. Soc. N.S.W.*, xxviii, p. 903 (1903).

During my stay at the Nuestapha Hospital, I have, since 1874, sown there several Eucalypts obtained from the Trottier collections. Two species were planted together in the garden, *E. rostrata* and *E. botryoides*.

In 1886 an *E. botryoides* of this sowing seemed to me worth reproducing, and I had some seeds collected, as also in 1887, 1888, 1889. Of plants obtained from these seeds, a small number were *E. botryoides*, the others were very different, and I was unable to attribute them to a species already introduced.

In 1891, after careful study, I was convinced that these Eucalypts, from a sowing of *E. botryoides*, were hybrids, *botryoides* x *rostrata*, and I gave a description of them at the Marseilles meeting of the French Association for the Advancement of Science. The new Eucalypt was dedicated to Ramel, and described under the name of *E. Rameliana*, hybrid *botryoides* x *rostrata*.

This name, which had for its object the honouring of the apostle of Eucalyptus in Algiers, could not be maintained; von Mueller had already given Ramel's name to a form of *E. pyriformis* Turcz. H. de Vilmorin called my hybrid *E. Trabuti*, and it is under this name that it figures in his catalogue of seeds of trees. Here is the description:—

E. Trabuti H. de Vilmorin in Cat. *E. Rameliana* Trab. (non Mueller) *Ass. Franc. Adv. Science*, 1891. *E. botryoides* x *rostrata*.

A tree of rapid growth, branching very early, and of a regular pyramidal shape; the trunk often with a cracked bark; foliage dense, dull green; leaves coriaceous, oval, lanceolate, slightly falcate, very pointed, finely nerved, the two pages distinct, the upper more shiny and with about 70 stomata to the square mm., the lower paler and 150 stomata to the square mm. (in *E. botryoides* the leaves have only stomata on the lower surface, 200 to the square mm.; in *E. rostrata* these openings are equally spread on the two pages). These leaves are from 15 to 22 cm. long, and 30–45 mm. broad; the angle of divergence of the secondary veins is 55 degrees to 60 degrees. It is a mean between the angle of divergence of *E. botryoides*, from 65 degrees to 70 degrees, and that of *E. rostrata*, which is from 45 degrees to 50 degrees. The inflorescence is in axillary umbels, borne on a slightly flattened peduncle under the flowers, which have short pedicels equal to the calyx-tube; their number varies from seven to twelve. The bud has a conical operculum, generally rostrate. The fruit is of about the size of a pea, and is semi-oval, the calyx-tube sometimes extending beyond the capsule, which opens when mature by means of valves whose extremities are sphacelate and deciduous.

Because of its vigour, the regularity of its shape, and the density of its foliage, this Eucalypt merits attention. The wood of *E. Trabuti* is red; I have had furniture made of it which had all the appearance of mahogany.

In order to verify the rapidity of growth of this hybrid, I have had a row of *E. rostrata* and *E. botryoides* planted, alternating with *E. Trabuti*. After ten years all the hybrids had largely dominated the parents, which were often atrophied between two hybrid trees.

The facts on which I base my opinion that *E. rostrata* is the male in this hybrid are the following:—

The seed-bearing *E. botryoides* was surrounded by *E. rostrata*; on the outside there was only *E. globulus*. The botanical characters are exactly intermediate between the two parents. The mixed character of the leaves is evident. As to the capsule, it could not have a more intermediate character; in *E. botryoides* the valves of the capsule dry up and fall in order to set free the seeds; in *E. rostrata* the valves stand erect and the upper half dries up and falls.

E. Trabuti greatly resembles *E. resinifera* Sm., and if I had not many times seen this hybrid formed from a seed gathered from *E. botryoides* I should not have distinguished it. *E. resinifera* differs in the venation of the leaves, with hypogenous stomata, and by the valves of the capsules, which are entirely persistent and erect.

E. punctata DC. also greatly resembles *E. Trabuti*; it differs in the absence of stomata on the upper surface of the leaves.

In collections there has been named *E. resinifera* from varying forms, and I think that a certain number are *botryoides* x *rostrata*; one recognises them by the very peculiar character of the valves, partly deciduous at the moment of dehiscence of the capsule, a character inherited from *E. botryoides*.

The descendants of this hybrid form, that I have been able to observe, are constant in their characters, always in certain specimens. One can notice a certain tendency towards *E. rostrata* rather than to *E. botryoides*, which in practice will lead to joining *E. Trabuti* to the group of the "Red Gums."

In the plantations of the Forestry Station of Bainen I have seen in an area planted with *E. rostrata* a large number of *E. Trabuti*, with a slightly exsert capsule; it is possible that these specimens come from a *rostrata* hybridised by a *botryoides*. These trees are distinguished by their great vigour.

For what is meant in Algiers by "Red Gum," see under *E. algeriensis*, p. 72.

Professor Trabut has sent me a number of specimens that he states are hybrids between *E. botryoides* and *E. rostrata*. Some of them depart from the type of *E. Trabuti*, and approach the assumed parents more or less closely.

Eucalyptus Stuartiana x *globulus* Trabut.

At the Forestry Station of Bainen, in a plantation of *E. Stuartiana* F.v.M., there is a fairly large number of specimens easy to distinguish from the type by larger fruits and sculpture, or young leaves recalling absolutely those of *E. globulus* by the shape and by the peculiar odour. This hybrid will be described later on.

I have not seen a description, figure, nor specimens of this reputed hybrid.

Following are some notes by Dr. Trabut on experiences with certain Australian species in Algiers:—

E. botryoides Sm.

Although little distributed, this species presents numerous very different forms in collections, and certainly of hybrid origin; it tends to *E. goniocalyx*.

These hybrids of *botryoides* are generally very fine trees, worthy of the attention of cultivators.

The *botryoides* type shows on the contrary a tree of rather slow growth and medium dimensions.

E. goniocalyx and *E. botryoides* are species not very closely related. (J.H.M.)

E. polyanthemos Hort.

This species has given me a very ornamental hybrid with its fine foliage and its abundant inflorescence; but no capsule has developed; it remains sterile. There is a fine specimen in the gardens of the hospital.

The study of the pollen of these hybrids of Eucalyptus may sometimes permit us to establish the hybrid nature of a form observed, but the sterility in this case appears to be exceptional.

E. punctata DC.

To the group of the Red Gums one may attach also *E. punctata* DC., a very fine tree, which recalls *E. Trabuti*. I only know one group of it, which is not absolutely typical, at M. Bertrand's at Sidi-Alé. The seeds were received under the name of *E. resinifera*.

E. resinifera Sm.

E. resinifera Sm. is very rare; it is found in the Cordier collection, but it does not propagate itself.

E. robusta Sm.

In the sowings of *E. robusta* of seeds coming from the Cordier collection I have been able to observe some very interesting hybrid forms. In the plantings of Dr. Bourlier at La Reghaia, one of these forms turned out to be *E. Kirtoniana* F.v.M., which is very probably a hybrid between *E. robusta* and *E. rostrata*, according to Maiden, the Australian Eucalyptologist. *E. Kirtoniana* has not been sown by Cordier, but it is shown in the sowings of *E. robusta*, which tends to show that in Australia there are species of Eucalyptus of hybrid origin.

E. Kirtoniana F.v.M. is doubtless a good species. See p. 200, Part XXIX of the present work.

A SOUTH AFRICAN HYBRID.

We now proceed to South Africa, and I offer a very interesting hybrid from thence, whose abnormality was discovered by the local Forest Officers:—

CCC. x E. Insizwaensis Maiden n.sp.

Reputed parents, *E. robusta* Sm., and (?).

A tree of medium size, with a smooth bark "somewhat resembling that of *E. globulus* at the same stage."

Juvenile leaves broadly lanceolate to almost ovoid (say about 13 cm. long to 6·5 cm. broad), the base slightly lobed and the leaf on a short petiole. The under side dull, the upper side shiny, the rachis glaucous, and perhaps the whole of the foliage glaucous in a young state.

Mature leaves pale green, the upper surface shiny, not coriaceous, lanceolate, with a long tapering apex, the base tapering into a moderately long, flattened, and somewhat twisted petiole, venation distinct, but not very prominent, moderately spreading, the secondary veins making an angle of 30 or 40 degrees with the midrib, the intramarginal vein not far from the margin.

Flowers axillary and in threes, sessile on broad peduncles of about 1 cm. long, the buds glaucous, the calyx-tube tapering, ribbed with two opposite ribs so prominent as to be almost winged, the operculum conical or umbonate, when dry slightly exceeding the calyx-tube in diameter at the commissure, surface glandular, about half the length of the calyx-tube.

Fruits campanulate, ribbed, with two opposite prominent ribs, rather large, exceeding 1·5 cm. in length and less in width, with a sharply sculptured, rather narrow rim, the capsule well sunk, so that the tips of its four valves barely reach the orifice.

Range.

This comes from South Africa, being collected at Insizwa Plantation, Mount Ayliff district, Cape Province. It was received from the Chief Conservator of Forests at Pretoria, who states that the District Forest Officer, Kokstad, collected it.

Affinities.

The history of the specimens is as follows:—

"The trees from which herbarium specimens Nos. 2,735 and 2,736 were taken were raised with plants of *Eucalyptus saligna* ([?] *E. grandis* (Hill) Maiden, " 'Flooded Gum,' J.H.M.) from seeds collected from trees of this species growing in a shelter belt, together with *E. globulus*, at the Kokstad Plantation (Transkei). It has not, however, been possible to trace the origin of the shelter belt of trees." (J. J. Kotze.) Also "Insizwa Plantation, Mount Ayliff district, Cape Province."

1. With *E. robusta* Sm.

It seems to me that its closest affinity is with this species. Compare Part XXIII, Plates 97 and 98. *E. robusta* is, however, only occasionally three-flowered; the juvenile foliage does not closely resemble that of the hybrid, while the mature leaves have a greater resemblance. There is a resemblance, though not a close one, in the buds, but it is in the size and shape of the fruits that the resemblance is closest, but those of *E. robusta* are not ribbed. The smoothness of the bark of the hybrid removes it from *E. robusta*.

2. With *E. longifolia* Link and Otto.

Some of the remarks under *E. robusta* would apply to the present species. *E. longifolia* has flowers in threes, and sometimes there is a tendency to ribbing of the calyx-tube.

3. With *E. grandis* (Hill) Maiden.

In its general glaucousness and smoothness of its bark, the hybrid shows some affinity to the above species. Compare Part XXIII, Plate 100.

4. With *E. globulus* Labill.

E. globulus has been mentioned; it is growing near an *E. globulus* plantation, and in its glaucousness and pale timber, and in the general appearance of its buds and fruits, it presents a distant similarity to that species.

The Bark.

(Continued from Part LI, p. 59.)

3. Classification of Trees in General by means of their Barks.

IT would appear that there are few classifications in other parts of the world, which are based on the bark. That of Kerner and Oliver, which I proceed to quote, is one of them.

> 1. First, the *scale* bark, which is detached annually in the form of shields and plates, to be seen especially well in the stems of planes, almond willows, and many species of Australian Eucalyptus.
> 2. Second, the *membraneous* bark, which separates as dry films and ribbons; this form of bark is shown in the common Birch (*Betula alba*).
> 3. Third, the *ringed* bark, which is detached from the stem in the form of thin, irregularly fissured tubes, and is especially developed in the Mock Orange (*Philadelphus*).

4. Fourth, of which the Vine (*Vitis vinifera*) may serve as an example, is the fibrous bark, which is detached as numerous stiff threads.
5. Fifth, there is the fissured bark, which is produced on the stems of the oak, lime, ash, and numerous other leafy trees. In this form the bark is not detached in large pieces, but is ruptured by the increasing thickness of the stem, causing longitudinal fissures with a sinuous or zig-zag course, by which, in one case only, narrow ridges and grooves, and in other cases, broad angular patches, are outlined. (Kerner and Oliver, i, 719-20.)

Endeavouring to apply the above to Eucalyptus, under No. 1 would be the Bloodwoods (Lepidophloiae), while No. 2 would come nearest to the most lamellar or extreme forms of the Lepidophloiae, such as *E. miniata* and *E. phoenicea*.

I know no representative of No. 3, but in No. 4 we could have Peppermints and Stringybarks, according to the thickness of the fibrous covering, while of No. 5, the Ironbarks would be an extreme case, and certain Gums, *e.g., E. viminalis, stellulata*, which have more or less rough bark on the butts.

Kerner and Oliver (p. 720) go on to say:—

The form of the bark is so characteristic that by it alone the species of the tree can be recognised; it therefore constitutes an important feature in the picture of a tree, nor can it be altered according to fancy. It is inadmissible that artists should combine the studies they have made of various trees as they please, perhaps putting the crown of an oak on the trunk of a plane.

The above remarks are written with European trees in view, but in Australia the barks of trees have not been even so carefully studied. It is painful sometimes to be asked to admire a painting which may possess many merits, but in which the barks of the trees are impossible. The time will come when photographs and other true illustrations of types of barks of Australian trees will find their way into the schools, and lessons on the barks of Australian trees and the shapes of trees, and notes on the situations in which trees with special barks are found, will be available to students. As a rule, I am afraid that some artists, sensitive of their weak spots in Australian tree-drawing, give us vague drawings that are indeterminable. At all events, I have often failed to comprehend the tree which has been in an artist's mind, simply because I could not determine the bark. I am, of course, referring to drawings with some detail, and not to impressionist sketches.

I have often, on a railway or coach journey, heard people deplore the monotony of the Australian forest. There is no necessity to make comparisons of the forests of one country with another, but I say without hesitation that, to me, the Australian Eucalyptus forest is one of the most varied and charming of any country I know. Leaving aside the habit of the tree, its size, canopy, colour of foliage, the study of the barks may become of never-ending interest. I have often been thanked by fellow-travellers, who have said that I had given new interest to a journey by pointing out the marvellous variation in barks alone. Where curiosity is excited, there may be a stimulus to further knowledge, and instead of the parrot cry of the monotony of the bush we shall have the feeling statement that our trees increase in charm as we know more about them. This depreciation of the Australian bush is observed in regard to other phases of it. As a very general rule it is not spiteful, but rather jocular, and springs from ignorance. As knowledge progresses, it will tend to disappear.

In "A Text-book of Botany," Coulter, Barnes, and Cowles (vol. ii, Ecology) these distinguished authors discuss barks more from the physiological aspect, and the (chiefly) American barks they cite by way of illustration have, to some extent, their analogies in Eucalyptus. Following are some extracts, with my brief comments in square brackets:—

1. *Smoothness and roughness—Exfoliation*.—When the epidermis persists, young stems are smooth, except in the neighbourhood of lenticels and leaf-scars.

For a few years most stems remain smooth or smoothish, owing to the development of bark tissues as the stem increases in diameter. In some trees (as in the Beech, *Fagus*) continued lateral growth causes the bark to remain thin and smooth throughout life; the tropical rain-forest in particular is rich in smooth-barked trees. . . . (p. 708). [These remarks also apply to Eucalyptus, many of which, tropical or sub-tropical rain-forest, *e.g., E. saligna, E. Torelliana*, are Gums or Smooth-barks.]

2. In most trees, new phellogen areas develop at deeper levels or lateral growth fails to keep pace with diametric increases, so that the bark splits and becomes variously roughened. Some trees, as Burr Oak (*Quercus macrocarpa*), become furrowed very early, while others, as Bass Wood (*Tilia americana*) presumably remain smooth-barked for a very long time, but ultimately become furrowed. [Such trees as these have much in common with some of our Ironbarks, even if the Oak, &c., barks be not so rough and hard.]

3. *Tesserae*.—"Alligator Bark" is caused by the division of the bark into blocks by somewhat equidistant transverse and longitudinal furrows (as in *Nyssa*) (p. 708). [Amongst the Eucalypts *E. tessellaris*, the Moreton Bay Ash, is an excellent example of this.]

4. In a number of trees, the bark exfoliates in definite layers (Fig. 1034), the separation being in the zone of weakness, known as the *separation layer*, which is composed of loose and weak cells that alternate with the denser and stronger cork layers (p. 709). [The figure above quoted is that of a Ribbony bark, analogous to, *e.g., E. viminalis*, on a very reduced scale.]

5. In trees with scaly bark, the cork layers separate into patches or arcs, as in the Sycamore (*Acer pseudo-platanus*), Cherry (*Prunus Cerasus*), and Pine (*Pinus*). [The bark of some Pines has a close superficial resemblance to that of some of the Bloodwoods, *e.g., E. corymbosa*.]

6. While in plants with ringed bark, the cork layers form concentric cylinders, and the bare shreds or slivers off (as in the Grape, *Vitis*, and Arbor-vitae, *Thuja*). [I can find no useful Eucalyptus analogy here.]

7. In trees with shaggy bark the exfoliating masses are elongated, and in the birches the bark exfoliates in thin papery layers (p. 709). [The Eucalyptus barks which approach nearest to those of the Birches are those of some of the extreme members of the Lepidophloiae, such as *E. miniata* and *E. phoenicea*, but the resemblance is not close.]

4. Variation in Barks of the same Species.

This has been referred to by only a few authors. Following is an illustrative reference:—

There are exceptions (to Mueller's cortical system), for instance to the Leiophloiae; for *E. haemastoma, E. saligna, E. viminalis, E. stellulata*, and *E. punctata* are somewhat half-barked, while instances occur in which *E. tereticornis* has fibrous bark. The different kinds of Box are not always half-barked, and so some of the Hemiphloiae incline to the Leiophloiae in extreme age. I have noticed this peculiarity in *E. largiflorens* (*bicolor*) (he probably means the species afterwards known as *E. Bosistoana* F.v.M., J.H.M.), and in some of the Blackbutts (*E. pilularis*) . . . in the Woollybutt (*E. longifolia*), of which the Baron (von Mueller) regards the bark as wrinkled, somewhat fibrous and persistent, I have seen old trees which might have been mistaken for *E. tereticornis*, their trunks having completely shed their bark, and become similar to Gum trees. . . . (Rev. Dr. Woolls in *Proc. Linn. Soc. N.S.W.*, xvi, 60, 1891.)

While there is undoubted variation of bark in the same species, it is proper to point out that it is also a fact that, some of the instances quoted by the older writers are not to the point, because they were unconsciously including two or more species under one name. I have in my mind's eye such cases as *E. paniculata* and *E. fasciculosa* on the one hand, and *E. sideroxylon* and *E. leucoxylon* on the other. The first member of each pair is an Ironbark, and the other a Gum, but, because of the similarities of herbarium material, each pair was looked upon as identical, until realisation of the fact that their barks are totally distinct led to their final recognition as separate species. Dr. Woolls' reference to *E. tereticornis* occasionally having “fibrous bark” probably refers to *E. exserta*, and so on.

The amount of rough bark at the base of a Gum is well shown in a photograph of *E. Benthami*, to be reproduced later, where it will be seen that a certain specimen could readily be grouped as a half-barked tree. The cause of the unusual amount of rough bark is ringbarking. Such a condition is stimulated by violence in various forms, *e.g.*, cincturing, wounds, insect-action, and also by absence of shelter. Indeed the description of a bark should only be made from a normal healthy tree.

Furthermore, it is a matter of importance to note the size or age of a tree in considering its bark. For example, an Ironbark which may have rough branches may, in the young state, have the upper part of the trunk and the branches smooth. This brings us naturally to consideration of—

Deciduousness of Bark.—Mr. Hill assured me that some of the Gum trees, and perhaps all of them, shed their bark twice in the year. The Stringybark (*E. obliqua*) is one of the most striking instances of this. (Tenison-Woods, speaking of southern Tasmania, in *Journ. Roy. Soc. N.S.W.*, xii, 21.)

The above note on a Stringybark may be supplemented by the case of two Ironbarks, viz., *E. decorticans* in particular, see Part XLVIII, p. 231, and F. M. Bailey (*Queensland Agric. Journ.*, March, 1911, p. 127) quotes Mueller in regard to deciduousness of the bark in two cases of *E. crebra*. (Perhaps, however, *E. decorticans* is really meant.) Of course, the deciduousness of the outer bark of the Gums, of which the Ribbony Gums are extreme cases, is well known.

Here follow a few notes, arranged in alphabetical order of species names, referring to bark-variation. Care should be taken, in reporting anomalous barks, to note if there is any predisposing cause of rough bark, as already briefly referred to:—

E. haemastoma Sm.—Mr. C. T. White, in *Queensland Agric. Journ.*, August, 1920, at p. 70, has a “Note on variation in the bark of two common Eucalypts,” and the paper is illustrated by photographs. He shows the ordinary *E. haemastoma* var. *micrantha*, the “White or Scribbly Gum,” alongside a “Gum-topped Stringbark,” which he calls *E. haemastoma* var. *inophloia*, new variety. (Now see *E. Seeana*.)

E. hemiphloia F.v.M.—This cortical system has its utility; but there are several species which exhibit inconstant characters, as, for example, *E. hemiphloia* in its ordinary state is typical of section 2, but in the high uplands of the Mount Torrens district of South Australia it assumes the characteristics of section 4, and is locally known as “Bastard Stringy-bark.” (Professor Ralph Tate.)

E. maculosa R. T. Baker.—A remarkable case is that of a tree of this species in the Federal Territory, on the Yass-Queanbeyan road, in the vicinity of Gungahleen. Normally this is a smooth-bark, with lenticular blotches, but the specimen in question has a bark not only rough all over the trunk, but also crinkled, probably corresponding to a very interlocked timber. A photograph of this tree by Mr. C. J. Weston, Afforestation Officer of the Territory, will be given in due course.

E. microtheca F.v.M.—I have invited attention to the remarkable variation of the bark in *E. microtheca* in my "Forest Flora of New South Wales," vol. vi, p. 20, and also in Part XI, p. 51, of the present work.

E. Seeana Maiden.—After *E. haemastoma*, Mr. C. T. White also shows *E. Seeana* "Narrow-leaved Blue Gum" in its normal, almost smooth-barked form, and a form of the same species with the note: "This tree carried its flaky bark almost to the topmost branches, and is a remarkable variant from the type." Truly the forms, to which Mr. White has drawn attention, are so aberrant, that they should be further investigated. Without doubting the correctness of Mr. White's determinations for a moment, both rough-barked forms appear to be suffering from pathological conditions, which may account, in part, for the extraordinary roughness of the bark.

E. stellulata Sieb.—"I have seen bark of *E. stellulata* (which Mueller includes in section 5), which cannot be distinguished from what are known as Ironbarks." (Maiden in *Proc. Linn. Soc., N.S.W.*, 1278, 1890, and Part V, p. 129, of the present work.) It really belongs to the smooth-barks or Gums, and this Ironbark character is not strictly typical.

E. viminalis Labill.—Luehmann (*Proc. A.A.A.S.*, vii, 524) quotes the remarkable variation in the bark of *E. viminalis* in Victoria. He says:—

This tree, which grows around the Melbourne herbarium building, shows here, in its sapling state, a smooth, whitish bark, until it attains a diameter of from 4 to 6 inches, then gradually the outer layers remain attached, at first near the base only, becoming rough and brown; as the plant gets older, these layers creep higher and higher up the stem, until, in aged trees, the whole of the trunk and also the larger branches are covered with a thick, rugged, dark brown bark. Within 10 miles inland from Melbourne, already the tree changes its character in this respect, inasmuch as only the lower part of the stem is covered with this rugged bark, while another 10 miles further towards the ranges this species presents a smooth white trunk, except, perhaps, just near the ground. Although the floral characters remain the same, yet anyone seeing only the two extreme forms would certainly consider them two distinct species."

Mr. R. H. Cambage has taken a photograph to illustrate this. The bark of this particular tree is the reverse of the normal White or Ribbony Gum, and it will be found illustrated in due course. So, also, will an excellent photograph of a rough-barked *viminalis* in Studley Park, Melbourne (Hardy).

It has been found, in a number of cases, that trees with barks approximately smooth, in low-lying situations, may become increasingly rougher or more fibrous-barked in more elevated, better drained situations, such as hill-sides or tops of hills. Examples are:—*E. regnans* (the rough-barked variety has been described as *E. fastigata*), *E. saligna* and *E. viminalis*.

5. Bark in Relation to heat and cold.

In connection with Mr. Cambage's observations, recorded at pp. 318-9, Part L, to show how careful one has to be in interpreting the relation of the bark to resistance to heat and cold, we find that those species which are exposed to the greatest extremes in these directions are the smooth-barked (Leiophloiae), those which have a naked look. *A priori*, one would expect the Stringybarks, with their blankety covering, to be most cold or heat-resistant, just as we pack a tree with a coat of straw or other non-conducting material to pass it through an inclement winter. We adopt no corresponding method in dealing with trees in relation to hot winds and high temperatures generally, simply because it is not convenient to do so.

Nature's method, as regards Eucalyptus in these situations, is not to employ dead tissue for non-conducting purposes, but smooth, thick, parenchymatous tissue full of water-containing cells, which offer considerable resistance to extremes and changes in temperature.

The thickness of bark varies considerably with the habitat, being greatest in deserts and other dry situations and in alpine regions, and least in the tropical rain forest. Individuals of a species common to two situations have the thicker bark in the more xerophytic habitat; alpine and light cultures show more bark than lowland and shade cultures. Probably in most cases thick bark is associated with high transpiration, and thin bark with low transpiration. (Coulter, Barkes and Cowles, *op. cit.*, ii, 707.)

6. Adventitious Shoots.

Let us now give consideration to two intensely practical Australian questions, more or less intertwined:—

1. Ringbarking.
2. Control of Coppice or second-growth.

Under certain circumstances we wish to destroy trees, large or small, and the methods (other than those of the forester) are ringbarking for trees of large, medium, or even small size, and the use of the axe or tomahawk and the mattock for saplings. As the work is usually done, there is always more or less risk of suckers, resulting through imperfect ringbarking, or because of imperfect grubbing.

I preface notes on ringbarking and coppicing by offering translations of two interesting articles, by Planchon and Casimir de Candolle, written many years ago. The physiology of Eucalyptus trees, then recently introduced into Europe, presented very great scientific interest to these eminent botanists. The latter quotes earlier papers bearing on the same subject, and these references are important.

Planchon, 1875.—The *Eucalyptus globulus* presents itself under two very striking aspects: the infantile form, in which the leaves are opposed and sessile; that is, a sort of *larval* state, during which the plant is not apt to flower; and the adult state, in which the leaves are alternate and petiolate, and which is the perfect state, characterised by the presence of fruit and flowers.

It is not necessary to resort to analogies, and to compare this dimorphism of the *Eucalyptus* to those metamorphoses that insects undergo; such, for example, as the changes of the same insect through the forms of caterpillar, chrysalis, and butterfly. In the latter case, it is the individual itself that throws off its successive envelopes, and appears with new forms, resulting from internal effort and changes of the same organs. In the case of the *Eucalyptus*, it undergoes no metamorphosis, but only appears with new organs superadded to the old ones; or, more properly speaking, the tree represents, not an individual, but a foliate collection (the phytons of Gaudichaud), each successive element having its own form independent of the form of the elements which precede and follow it. The resemblances or the differences of these elements do not alter its own individuality. In short, it is a successive *polymorphism*, and not a metamorphosis in the primitive sense of the word.

This *polymorphism* is not, however, a general character of the *Eucalyptus*. It is in a certain measure wanting in the species *Eucalyptus cordata*, which flowers upon branches with opposed leaves. (An isoblastic species, J.H.M.) Here the adult and infantile states are confounded; and without attempting to establish a too narrow assimilation between animals with centralised functions and plants with multiplied elements, it is, perhaps, allowable to compare the infantile and adult forms of the dimorphous *Eucalyptus* to the two states of tadpole and adult of common batrachians (toads, salamanders); whilst the *Eucalyptus* fructifies upon its branches an infantile type which may be analogus to batrachians called *Perennibranches*, which reproduce themselves while preserving the character of larvae to the branchial respiration. Whatever may be the character of this general assimilation, the prominent fact is the existence of two states of foliation among certain of the *Eucalypti*, and only one state among (most, J.H.M.) others. Now, from causes the action of which cannot be foreseen, a *Eucalyptus* of this first group fructifies upon its young branches, and the seeds of the fruits may not, in germinating, reproduce the characters of the branches from which they are derived; will not nature have thus formed by a simple variation of fixed foliage nearly the equivalent of that which is always described as the species? In other words, if we find the habitually sterile branches of a *Eucalyptus globulus* normally fructifying, have we not before us a new form of the type, which, encountered by itself and disconnected with its point of departure, would naturally be described as the veritable species? And what assurance have we that the accepted good species are not thus derived from actually living or from anterior types? This is only an hypothesis; but the natural polymorphism that we observe in the similar elements of the same plant may well represent, when fixed upon that plant, the variations which, in other circumstances, would become detached and isolated, and live separately, protected by the generation of a certain fixity.

We do not pretend to resolve this complex problem of the species in this manner; but we find here an argument in favour of the general theory of derivation, opposed to the theory of the absolute fixity of the types of successive creations by a sort of repeated miracle. (These were looked upon as advanced opinions half a century ago, J.H.M.) Let us, however, leave these nebulous regions of philosophic speculation and descend to the facts concerning the *Eucalyptus globulus*. . . . (J. E. Planchon's article on *E. globulus* in "Revue de Deux Mondes," 1875, translation by United States Department of Agriculture, pp. 8, 9.)

Casimir de Candolle, 1903.—*Adventitious buds* are those which arise accidentally in indeterminate points of the body of the plant, or on parts of it which do not normally produce them. Their disposition is therefore irregular; that is to say, without relation to that of the leaves and of the ordinary branches. They must not be confused with certain *axillary buds* whose retarded evolution only takes place a long time after the falling of the leaves in the axil of which they have taken birth, and which are called, for that reason, *dormant buds*.

Adventitious buds are met with very often on the trunks or on the branches of trees, and more rarely on herbaceous stems. Many plants produce them also on their roots or their leaves. They are even formed sometimes in the interior of seeds, where they constitute adventitious embroyos.

I am only here concerned with those which are produced on the trunk and on the branches of trees and shrubs. They are always[1] of endogenous origin, arising in the tissue around the cambium. The cellular layer in which the formation of these buds begins has only yet been determined absolutely in a small number of dicotyledons,[2] in which it is found to be the pericycle, and everything leads to the belief that it is the same with other plants of this class.

The shoots issuing from the adventitious buds always exhibit, at the beginning, vegetative characteristics of the young plant of the same species. Also they are never entirely similar to those of the axillary buds of the adult tree. In certain cases they differ from them even in a striking manner. This pecularity of the adventitious shoots deserves to be closely examined, and it is this that I propose to do in the following pages.

I shall commence by recalling that every plant begins, in its development, by the production of phyllomes belonging to the simplest types, such as the cotyledons and the basilar scales which succeed them on the primary stem of many of the species. Then come the true leaves, of which the dimensions and also the degree of complication increase from one to the other, more or less rapidly, until there is attained the type of the definite leaves characterising the species to which they belong. One may then say that every plant presents, in the course of its individual evolution, a more or less varied heterophylly. There are produced sometimes, at the same time, changes in the form and the structure of the successive axes. Finally, the phyllotaxy even of the leaves may also change, and it is then the lower leaves which present arrangements the most condensed in character.

The different phases of individual evolution succeed each other generally quick enough, because many plants have acquired already on their primary stem their adult leaves. In this case the latter differ from those which come later on the adult plant. They are distinguished, however, almost always by a certain juvenile appearance belonging to characters it is difficult to define, such as the slight differences of form, of consistence, or of colouring. This same juvenile appearance is always found in the adventitious shoots of the adult plant. There are also species in which the young plant has very similar leaves, as to form and dimensions, to those of the adult plant, but having a simpler internal structure. The first leaves of the adventitious shoots always display equally this same simplicity of internal structure.

Finally, there are species whose individual evolution is very slow, and in which the vegetative organs of the young plant, especially its leaves, have a juvenile aspect so pronounced that they entirely differ from those of the adult plant. This may, moreover, manifest itself in two ways. Generally the most developed leaves of the young plant, those that I shall call henceforth the juvenile leaves, are in shape and internal structure simpler than the leaves arising later on the adult plant. But there are also species in which it is, on the contrary, the adult plant which presents the least complicated vegetative organs, as one sees, for example, in the phyllodes of Acacia. Therefore, in either case, the adventitious shoots of the adult plant are always in the beginning leaves of the juvenile form.

This general characteristic of adventitious shoots has been for a long time unrecognised. Schacht seems to me the first who has mentioned it. One finds in his *Traite** a short passage in which he speaks of it *àpropos* of the Canary Island Pine. However, many other trees, and some of the most common in Europe, furnish still more striking examples of this phenomenon. Also it is singular that there is no question either in the *Morphologie* of Hofmeister, nor even in the Memoir of Alexander Braun on the *Individu Vegetal*. This characteristic trait of the adventitious shoots is similarly entirely passed over in silence in modern treatises. Yet, moreover, an eminent Italian botanist, the late G. A. Pasquale, had long ago specially called the attention of morphologists to it. This is how he expresses himself on the subject in his memoir on heterophylly (*Sulla Eterophylla*, p. 22), which appeared at Naples in 1867:—

"In the course of all these generations of buds and shoots which succeed each other indefinitely on the arborescent plant, one would not again see the forms of the youthful stage, if it did not reproduce in indeterminate points of the axis another sort of bud, which strongly resemble the young plant, and which produce its form and even its colour. These are the adventitious buds which in Pines show themselves freely on the trunk and even on the branches. These adventitious buds enclose the new shoot, which repeats the primitive form of the young plant in everything that it has produced above its cotyledons. It is seen, therefore, that every time one finds juvenile branches with their special leaves on an adult tree or a large one, or even an old one, that this is the result of the accidental formation of adventitious buds. And this phenomenon, the cause of which resides in the plant, can also be produced at will by methods which tend to cause the formation of adventitious buds similar in shape and all other characters belonging to the free development of the trunk and branches. So that, if one wishes to see the juvenile forms reproduce themselves on a tree, one has only to cause adventitious buds to shoot. Similar cases to those I have quoted are seen in *Schinus, Eucalyptus, Pinus*, &c."

Further on the author adds this remark, to which I shall have to return:—"In the very small adventitious buds of *aesculus Hippocastanum* are found leaves with three leaflets; that is to say, of simpler form than in the plantlet resulting from germination."

The quotations from the memoir of Pasquale show with what perspicacity and neatness of expression this scholar had recognised and shown the special nature of adventitious buds, and the exact position that they occupied in the ontogenic development of the plant. This memoir is not less remarkable and instructive, because of the rational method with which he treats of what has been improperly called Vegetable Metamorphosis. When, fixing on the study of the internal study of leaves, I myself studied later this supposed metamorphosis as a fact of heterophylly, due to the unequal development of the phyllomes,[1] I was then ignorant that this same idea was already expressed in the memoir of Pasquale. The correctness of this point of view is to-day proved, thanks to the observations and experience of Herr Goebel. Indeed, by an ingenious application of the pruning, not only of the vegetative axes, but also of their appendicular organs, he has succeeded in causing an increase of development in the phyllomes, which, according to their position on the plant, should have maintained the rudimentary state of the bud scales and caused them to assume the forms of true leaves.[2]

To return to the memoir of Pasquale, it is indeed a pity that this masterly work has not received the attention of contemporary botanists. One might almost say that it has been passed almost unnoticed, for the too brief review of it in the *Bull. de la Soc. Botanique de France*[3] does not truly give an idea of its real value.

Since then it does not seem to have been noticed by anybody, except, perhaps, by Herr Goebel, who quotes it *apropos* of a special case of heterophylly.[1]

To my regret this memoir was still unknown to me, when, several years ago, I made my first communication on adventitious buds.[2] The facts that I then put forth I should admit to-day, were only the confirmation of opinions previously set forth by the Italian scholar. It is the same with the analogous observations made by Prof. Bayley Balfour when he was staying on Rodriguez Island. Having been specially struck by the reappearance of juvenile forms on the adventitious shoots of certain shrubs, he devoted the following lines:—

"The most striking note of variation in the vegetation of the Island, and it is worth attention, consists in the difference of shape and aspect which the leaves of certain species have in the different periods of the growth of the plant. This variation is seen almost solely in trees or shrubs, with the exception, however, of a Composite of small size, *Abrotanella*. In species endowed with this heteromorphism, the young plant produces leaves having, as it were, a degree of development less than those of the leaves of the adult plant, and from the time that the latter reaches this period of its growth, it only produces leaves of the adult form. But, if adventitious shoots arise at the base of the trunk, or even higher, below the first branches, the leaves of these shoots always have the juvenile and not the adult form.

"Further, if young shoots arise from the trunks of mutilated or pruned trees, the latter also bear, as if it were foreseen; the leaves of the juvenile form. An interesting point to clear up would be to determine if shoots arising from a branch treated in the same way would have juvenile or adult leaves, and how far it would thus produce variations in the foliage. It seems to me that there is here a field of interesting observations and experiences of a kind to fix the attention of those who will have opportunity to devote themselves to research of this kind."

The author then enumerates up to seventeen species of Rodriguez in which he has indicated a very marked heterophylly.

Moreover, Dr. Balfour has perfectly recognised the distinctive feature of adventitious shoots, and it is a pity that he is content to describe it incidentally in a floristic work in which it had every chance of being lost to morphologists. If Dr. Balfour had himself pursued the study of the question, he would not have been long in finding, quite within his reach, numerous examples of facts similar to those that he had observed so well in Rodriguez Island. That is what has happened to me many times during the last few years, and I am going to review in turn all the species which have been the subject of my observations.

He then proceeds to give illustrative particulars concerning *E. globulus* and *E viminalis*. See pp. 58-9. (C. de Candolle, *Archiv. des Sciences Phys. et Nat.*, xvi (4), p. 50, July, 1903; translation by J.H.M.).

[Much of this valuably supplements my notes on the relations between the vegetative form and the flowering period, as given at p. 273, Part XLIX.]

7. Ringbarking.

There is a vast field for inquiry into the best methods of destroying tree-growth. It is a matter of everyday knowledge that trees are sacrificed unnecessarily, but, when it is decided what trees are to be destroyed, there is frequently serious trouble owing to the suckering of certain species (or the ground being taken possession of by others whose seeds have been lying dormant in the ground). The result, from whatever cause, is that ground is taken possession of by scrubby growths which have frequently become well nigh impenetrable, and instead of ringbarking having resulted in an increased growth of grass, the reverse has been the case. So diverse are local conditions that it is impossible to prescribe with exactness the time for destroying trees in every district.

If it be thoroughly understood that trees of different species do not perform their various functions connected with rest and growth simultaneously, and that our seasons are exceedingly irregular compared with those of Europe, on the recorded experience of which many of us rely, perhaps too much, we shall have learned a good deal. And let it be further noted that we have a good deal of pioneer investigation to do yet—in other words, that when a man asks us the best time to ringbark a certain tree, we have frequently no precedent to offer him. Because Stringybark was successfully ringbarked at one place in September, 1911, it does not follow that Box may be successfully ringbarked at the same or any other place in September, 1921. If we could prepare a column of statistics in this way, just as we record physical constants, what a boon it would be! No, we must approach this subject, the importance of which is still of such magnitude to Australians that outsiders can scarcely understand, in another way. We must consider the tree as a living organism, and give some attention to the physiology of tree-growth.

The first thing is to ascertain when the sap is "up" (to use a rather loose phrase, the meaning of which is, however, well understood in practice), evidence of which is shown by the facility with which the bark strips, and also by the formation of the leaves, to be noted at a distance by their greater greenness or freshness of colour, often of a shade of purple. (In Australia we have, of course, mainly to deal with non-deciduous trees, but, nevertheless, it is usually an easy matter for a careful observer to note the extent to which the flush or formation of a new growth of leaves has extended, or whether the tree is at rest.) For an account of the physiology of the processes connected with sap-movement, I must refer to the text-books. But I may remind my readers that starch is contained in the sap of trees, or a substance from which starch is obtained. This starch is separated from the sap and is stored up, during the period of active growth, in the wood, and especially in the rootwood, ready for the formation of buds (usually leaf buds), which buds usually burst in the spring, but the season of bursting forth is exceedingly variable with various trees, as I have already hinted. Every forester, every man concerned in the procuring of timber, and every pastoralist, should make and preserve records of the periods of "flushes" of leaves on each of the various kinds of trees in his own district. Considerable success has attended the ringbarking of trees as they come into flower. The trees are very vulnerable then.

Now, many trees, if the bark be injured or ringbarked, have the power of developing the latent buds (these buds may develop from mere exuberance of sap, without the tree having been visibly injured) which exist under the bark, which buds are developed by means of the store of starchy matter which we have already referred to as existing in the rootwood (and in the stump). In other words, we have "suckers"— those curses of the forester and pastoralist.

So here, as pointed out by Farrer and others many years ago, we have, I think the key to the problem of ringbarking. If a tree is to be rung, see that the work is done properly—right through the cambium layer all round. Then see that it is cut at a period when the particular kind of tree operated upon has little or no starch or budsustaining material left in its roots. In other words, see that it is cut off from its base of supplies. Consequently, it may be bad practice to set a man to indiscriminatel ringbark an area. Ringbarking is, in fact, an operation requiring scientific direction and no landowner should turn a number of axemen into his property to ringbark without very cautiously directing their operations.

It is a pity that the operation of ringbarking should be more difficult than is usually supposed, but we cannot contravene nature's laws without taking the consequences.

8. Coppice-Growth (Suckering.)

Coppice-shoots are what Australians know as "suckers," and it is obvious that, whereas suckers of worthless trees are a curse to the pastoralist and perhaps to others, suckers of useful trees may be valuable to the forester from the points of view of the production of timber and of leaves for oil.

Hutchins ("Discussion on Australian Forestry," p. 91) has some notes on Western Australian species. He says:—

The coppicing power of the different species of Eucalypts, by which I mean their ability to shoot from the stump when cut, is a subject which will be more studied with the advance of systematic forestry in Australia. Karri (*E. diversicolor*) seems to coppice well, Jarrah (*E. marginata*) fairly, and Red Gum of Western Australia (*E. calophylla*) very well. I have seen stools up to 3 feet in diameter shooting freely and vigorously. Yate (*E. cornuta*) is said to coppice readily, but not so strongly as the Red Gum, with which it is associated. This might account for the patchy distribution of Yate, for a great deal of shooting in the natural forest takes place from more or less badly-burnt trunks. Here, again, it should be noted that a tree will often coppice when cut, but fail to coppice when burnt. Appearances seem to indicate that Yate does not shoot again so easily as many species when the forest has been burnt. Thus, the effect of fire protection may be to bring in more Yate. It is certain that Yate does coppice fairly freely, since I have seen large old stools, or the remains of them, with three or four big trees growing from them.

The coppicing power of all Eucalypts varies with the season. It is best in winter and early spring worst in late summer. Many Eucalypts, if cut in the middle of a dry summer, will die straight away, or shoot badly with the return of better weather. Brushing off the shoots, as by cattle, will often destroy young copse. If the shoots are systematically knocked off, the stool will inevitably die. This has to be remembered in clearing for fire-lines.

The late Sir D. E. Hutchins is quite correct in hinting that but few definite observations have been made in regard to the coppicing proclivities of various species of Eucalypts in Australia. It is a forester's job, and this officer can now systematically record his results far better than he could before the taxonomy of the species was as settled as it is to-day.

Here are a few brief notes on the subject—a mere casual selection from my pocket books:—

E. pilularis has high reproductive power. See Part I, p. 30.

E. gigantea is quoted as "absolutely the best re-afforester in the State." (See my "Forest Flora," Part LXI, p. 6.)

E. populifolia (Bimble Box) becomes a great pest when improperly rung or grubbed, for not only do the stumps sucker freely, but the consequent access of light and availability of plant-food cause abundance of seedlings to spring up, and thus large areas of country may be thrown out of occupation.

The tree suckers freely after having been cut down, both from the stems, but apparently more freely from the roots, when they are damaged by the plough, travelling stock, or vehicles. It emits suckers near the injured part, which may be situated at some distance from the trunk. It also seeds freely, and no doubt what often appear to be suckers are really seedlings.

Oil yielding Mallees, usually found in regions of comparatively low rainfall, are cut over, and the permanence of an area to the oil-distiller depends upon the care with which the coppicing is carried out. I will take some typical Mallees in the Wyalong district, New South Wales, with the view of inviting attention to the research required in this direction from the point of view of the forester. I would like to see inquiries as to the coppicing powers of all Eucalypts carried out by the various forestry administrations of the States and the results carefully co-ordinated.

E. regnans F.v.M.—Mr. D. Ingle, Forester, of Healesville, Victoria, gave the following note many years ago:—

A peculiarity of our Mountain Ash is that if ringbarked, cut off stump high or otherwise, or burnt badly, *i.e.*, the head burnt or scorched off (leaves, I mean), it never throws off suckers or side shoots, but dies right out. I have been observing this fact for two or three years now, and lately have made inquiries from selectors, splitters, and millmen, and I find that no one has known this species to throw shoots under the circumstances mentioned, although they don't seem to have recorded it.

E. fruticetorum F.v.M.—Coppices freely, both from roots and stem. Owing to its suckering proclivities, it is a difficult matter to entirely eradicate it from cultivation paddocks. The New South Wales Forestry Regulations for the cutting of this particular Mallee require that it be cut down close to the ground, the result being that in six months after being cut down it sends forth many young growths, which yield more abundant and richer material for the oil distiller. At 3–4 feet high its growth is rapid. It apparently does not deteriorate, at least rapidly, with coppicing. So favourable has been its development that steps are being taken to plant up certain areas of the district with seedlings.

E. Behriana F.v.M.—The leaves are not used by the oil distiller, although it is very common; its timber is used for rough carpentry and firewood. It coppices freely, either on the stems or from the roots or stools. Owing to its comparatively large size, the removal of the plants from a cultivation paddock appear more complete, no doubt owing to the more thorough measures adopted for eradicating it, either by axe, mattock, or spade. The method adopted in the case of the smaller mallees is more slip-shod, they being usually rolled down and ploughed out, but the larger Mallees cannot be so treated. It was noted in a cleared and deserted paddock that the Mallees were again taking possession, both *E. fruticetorum* and *E. Behriana* seeming to succeed equally well.

E. acacioides A. Cunn.—This is a small tree as a rule, but if cut down it sends forth many new growths from the root, stems, and branches. It is of no value as an oil producer, hence it is not valued. It bears a bad name because of the difficulty of eradicating it from cultivated ground. The usual cutting-down process does no more than increase the number of stems, indicating the real Mallee-like character of the plant. It is even said to be a pest of the district because of its uselessness.

E. oleosa F.v.M.—It has all the characteristics of a Mallee, the stools are usually possessed of 6–8 stems, all very much the same height, 12–30 feet, and about 3–4 inches in diameter. In the district of Yalgogrin there are large areas of this species, most of them less than 10 feet high, and consisting of this species exclusively. It coppices freely after being damaged, both at the roots and stem. It being a large plant as a rule, it has to be rooted out by hand, which, while more laborious, is certainly efficacious— hence but few plants are noted growing in cleared land.

E. radiata, a noted oil yielder of the southern tableland and south coast of New South Wales, suckers freely. So also do *E. dives, macrorrhyncha, piperita, melliodora, polyanthemos, Stuartiana, eloeophora*, to take a few species of the southern tableland. But a proper investigation, as quantitative as possible, requires to be made.

Physiological reserve material in a log (Moreton Bay Ash, *Eucalyptus tesselaris*) is illustrated by a paper by the late Albert Norton in *Proc. Roy. Soc. Queensland*, iii, 1886, p. 38, entitled “Notes on a living tree-stump.”

In June, 1919, Dr. J. B. Cleland exhibited before the Royal Society of New South Wales a shoot several inches long, which had been taken from an excavated log of *E. trachyphloia*, which had been in use for some years as a water-trough in the Pilliga district.

But these are mere notes, intended to stimulate an interest in the effects of coppicing and of bush fires.

BURRS.

Gnaurs and burrs, or knotty excrescences, are very familar to us on the stems of

Gum trees, where they frequently attain an enormous size, having a "nigger-head" appearance. They result from dense clusters of adventitious buds arrested in their growth. A photograph of a large burr on *E. tessellaris* will be shown in due course.

9. Twist in Bark.

Under the heading "Twist in Australian Timber," I have brought together certain evidence in my "Forest Flora of New South Wales," Part XLI, p. 15, and have a brief note in the same work, Part LVIII, p. 213.

The twist is the resultant of forces represented by the effect of the sun on the one hand, and the wind on the other. The matter is of economic importance, because, in the vast majority of cases, non-twisted trunks, yielding straight-grained timber, are desired by the timber merchant.

I have, at this place, given the heading "Twist in Bark" because the appearance of the bark is readily seen, and affords a ready indication to the timber expert as to whether the subjacent timber will be twisted or not. So that study of the bark receives additional economic importance.

In our Australian forests, as a rule, the greater bulk of the head of a tree is to the north, *i.e.*, it faces the sun, which rises in the east and longest influences the north. I have known bushmen use this indication of the north when lost or in difficulties.

There are many references to this twist in European, and some in American literature, but few in Australian. One of them is the following, and I invite attention of country observers to the problem, premising that their observations will have permanent value if they collect twigs of the trees observed, in order that their specific identity may be ascertained. I may refer to this Torsion or Twist in Bark and Timber under Meteorology later.

Dr. (J. B.) Cleland contributed a "Note on Twists in the Bark of the Jarrah (*Eucalyptus marginata* Sm.)." Of one hundred trees observed in the neighbourhood of Perth, Western Australia, four showed a decided left twist, sixteen a slight left twist, forty-four were straight, twenty-four showed a slight right twist, nine a marked right twist, and in three the twist was undecided (*i.e.*, irregular). As there appeared to be no indication of a tendency to tree-growth in a spiral direction, the explanation was offered that, when young, a predominant branch probably extended to one or other side, and, being played on by the prevailing wind, caused the young stem to become twisted to some extent. Later such a branch may have died and disappeared. The explanation offered seems to be favoured by the fact that contiguous trees are often twisted in opposite directions. (*Proc. Linn. Soc. N.S.W.*, xxxiii, 291, 1908.)

The twist of the bark of *E. gigantea* is decidedly to the left. See the photo. in my "Forest Flora of New South Wales," vol. vi.

Speaking of the bark of a Gum, Professor A. J. Ewart writes to me, inculcating caution in observation:—

Re twist in *Eucalyptus globulus*, I have not made any special observations, but doubt whether the appearance is not largely an optical effect, as in a climbing plant. In stems which appear twisted the fibres may cross one another in opposite directions, and their inclination is not that of the apparently twisted stem.

But Gums (*e.g., E. tereticornis*), however, do show twist in a marked manner, and I hope that some observer will systematically take the matter up, as far as Australia is concerned.

Mr. J. F. Campbell, the well-known New South Wales surveyor, writes:—

The Eucalypts, as far as I have observed, do not conform to any fixed mode of development as regards their growth curvatures. Spiral twisting is least noticeable within the dense stands of timber or in the brush areas, but the trees which skirt these areas are usually twisted and frequently gnarled. Thinly scattered timber almost invariably show well-defined growth curvature (owing to the lack of shelter from the wind, J.H.M.). The cross-grained character of the Eucalypt is readily seen when logs are split radially. The split surfaces show both dextrorse and sinistrorse growth curvatures alternating irregularly.

My non-Australian references shall be of the briefest.

1. Schlich, v. 39, says:—" . . . it is found that those (trees) twisting from left to right (against the sun's apparent course) are harder to split than those twisting in the opposite direction." (He is, of course, referring to the northern hemisphere.)

2. It is also, of course, the direction of the apparent movement of the sun in the northern hemisphere. Some writers (*e.g.*, the Belgian geologist, Van den Broeck) say that the twisted trunks of trees are produced by the earth's rotation, and therefore when they exhibit a spiral they should show a right-hand spiral in the northern hemisphere, and a left hand in the southern, like the turn of the cyclonic storms or the twist in water vortices; but this is still open to more exact observation. It has also been suggested that, as the winds due to the earth's motion blow fairly steadily just when the trees are growing fast, the young trees may take a permanent twist from this cause, which it never loses. ("The Curves of Life," by T. A. Cook, p. 31.)

3. That part which looks towards the north is narrower, and has closer and denser rings than the other.

M. Ch. Musset states that the trunks of trees are always flattened in a northerly and southerly direction, and expand in an east and west plane, a fact which he considers quite in accordance with astronomical laws.

4. A singular uniformity has been observed in the twist of tree trunks. In 990 trees out of every 1,000 whose trunks show torsion, the direction of the twist is from right to left. This accords with the direction of the revolution of cyclonic storms in the Northern Hemisphere, and also with that of whirlpools, which the French *savant*, Jean Brunhes, says almost invariably turn from right to left. The question arises whether in the Southern Hemisphere the torsion of tree trunks has an opposite direction, like the cyclonic motions of the atmosphere in that half of the globe. (A reference, the origin of which I have lost.)

Another quotation from my old friend, Mr. J. F. Campbell:—

5. While engaged in architectural pursuits in Britain I had an excellent opportunity of observing some of the structural characteristics in the growth of the pine timber trees then used in building construction. As regards the growth curvatures of the trunks of these trees and the influences that produced them, I found that practically all scantlings cut from the pines of the Northern Hemisphere as seen and handled by me had a dextrorse twist, which I then attributed to heliotropism. Assuming heliotropism as one of the most potent stimuli to twisting, its effect would or should be somewhat irregular within the tropical regions, but becoming more definite and regular towards the Poles. The pine belt of the Northern Hemisphere has practically no counterpart in the Southern Hemisphere owing to the absence of land surfaces of any extent south of lat. 40. But specimens of, say the South Patagonian pines, should aid in elucidating this interesting subject of inquiry.

10. Bark Repair.

The following species possess the power, in a high degree, of bark-repair if a portion be removed from the trunk. The injured bark will also spread, or tend to spread, over any foreign body adjacent:—*E. maculata, E. hoemastoma*, var. *micrantha, E. tesselaris, E. coriacea*. (*Angophora lanceolata* is an even better example, perhaps.)

It will be observed that all these are true Gums, or Smooth-barks, in other words, barks that are full of life, not those which are more or less dead superficially, such as Stringybarks and Ironbarks.

In the case of explorers' and surveyors' marks, a good deal of inconvenience is sometimes caused by the over-growth of the bark, which may completely obliterate the inscriptions.

Callus is the name given to the soft parenchymatous tissue which forms over any wounded or cut surface of a stem. The callus forms a cork cambium on its outer surface. The subject of the growth of the callus over an old wound is dealt with in a lucid manner (with illustrations) by Professor B. E. Fernow in Circular No. 16 of the Division of Forestry, United States Department of Agriculture.

In Mr. R. T. Baker's exhibit of a series of specimens showing traumatic growth in timbers, before the Royal Society of New South Wales, 1st September, 1919, he verbally made the suggestion that Kino flow (in Eucalypts) and the formation of Alumina succinate (in *Orites excelsa*) may have an antiseptic action, thus promoting new growth. This is, of course, an analogy to Listerism in surgery.

11. Microscopic Characters of Bark.

The published references to the microscopic structure of Eucalyptus barks seem scanty in the extreme.

General.—In "Eucalyptographia" (Mueller), under *E. globulus*, we have four sections, labelled as follows:—

1. Tangential section of middle-bark (A), and inner-bark (B).
2. Radial section of a portion of middle-bark (A), and inner-bark (B).
3. Transverse section of a portion of inner-bark.
4. Transverse section of a portion of middle-bark:—

b. Bast-fibre; *c*. cork-cells; *n*. crystal-cells; *m*. medullary-rays; *p*. bast-parenchyma; *s*. stone-cells (214 diameters).

Solederer even has less to say: "Stone cells, according to Möller, occur in the secondary bast of species of Eucalyptus; the stone-cells attain considerable dimensions in *E. corymbosa*, while in other species they are only slightly sclerosed." (i, 355.)

12. Calcium Oxalate.

Calcium oxalate is a very common substance in plants, occurring usually in the form of needle-shaped crystals (raphides) or crystal aggregates.

Calcium oxalate crystals are undoubted excreta, representing by-products of metabolism. Oxalic acid in the free state, existing as a solute in the cell sap, is believed to be poisonous, especially if present in large amount, though in the various Sorrels (*Oxalis*) it is abundant enough to give them their characteristic taste. Even if not poisonous, free oxalic acid certainly is deleterious, since its formation interferes with further cell activity, as does sugar or any other product of metabolism, unless transformed into an insoluble substance or removed to other cells. Thus, the chief advantage of crystals is in removing oxalic acid from solution. Sometimes it is held that crystals are beneficial in removing calcium from solution, especially in calcareous soils, though this view has not met with general acceptance. . . . In most cases it is not necessary or even desirable to seek a subsidiary function for the excreted products of plants; if in certain instances they have such a function, it must be regarded as wholly incidental. (Coulter, Barnes and Cowles, *op. cit.* ii, 626.)

Solederer, i, 352, 355, says that in the Myrtaceae, oxalate of lime occurs only in the form of clustered and ordinary solitary crystals—in the primary cortex and bast.

In figures of some sections of bark ("Eucalyptographia," under *E. globulus*) Mueller depicts "crystal-cells," but he does not state the composition of the crystals. They are calcium oxalate.

H. G. Smith, in a paper "On the occurrence of Calcium Oxalate in the barks of the Eucalypts" (*Proc. Roy. Soc. N.S.W.*, xxxix, 23, 1905) announces the presence, in large quantities, of calcium oxalate in the barks of several species. It is similar in form and appearance in all species, being well defined monoclinic crystals, in stout microscopic prisms, averaging 0·0174 mm. in length and 0·0077 mm. in breadth, and containing one molecule of water. A peculiarity of these is the tendency to form twins geniculate in appearance; twinned forms being pronounced in some species. The theory is advanced that some of the "Mallees" or shrubby Eucalypts have been formed through the poisoning effect of the excess of this substance, acting for a long time upon species which originally grew as large trees. The tannins in those Eucalyptus barks containing a large amount of calcium oxalate are of very good quality, light in colour, astringent, easily soluble, and should make leather of good quality. On evaporating the extract to dryness on the water-bath, but little darkening takes place, and the product is still readily soluble.

He goes on to say that this class of Eucalyptus barks should, therefore, make excellent tanning extracts. From the bark residue the calcium oxalate should be profitably extracted, and the oxalic acid obtained cheaply from this, practically as a by-product. The air-dried bark of *Eucalyptus salubris*, the "Gimlet" of West Australia gives 30·5 per cent. of total extract and 18·6 per cent. of tannin absorbed by hide powder and contains 16 per cent. of calcium oxalate. The bark of *E. gracilis* contains 16·66 per cent. of calcium oxalate; that of *E. Behriana*, 16·5 per cent.; of *E. oleosa*, 10·64 per cent.; of *E. dumosa*, 9·8 per cent.; and of *E. salmonophloia*, 8·34 per cent. The barks of all the Eucalypts tested contained calcium oxalate, although in some species in very small amount.

"The Mallees which contain the crystals in greatest abundance seem to be those species which have a very thin, smooth bark."

"*E. salmonophloia* and *E. oleosa*, being apparently the same tree in different forms of growth, it is probable that the latter is a stage in the slow, and permanent degeneration of the larger tree" (p. 26).

"The form of calcium oxalate peculiar to Eucalyptus barks contains one molecule of water, and has the composition and crystalline form of the mineral Whewellite, with which substance it is perhaps identical." (p. 26.)

Mr. Smith found percentages of calcium oxalate in the following barks:—

E. gracilis, 16·66.	*E. occidentalis*, 6·82.
E. Behriana, 16·50.	*E. viridis* (*acacioides*), 5·01.
E. salubris, 16·00.	*E. redunca*, 4·46.
E. oleosa, 10·64.	*E. fruticetorum* (*polybractea*), 2·14.
E. dumosa, 9·80.	*E. stricta*, 0·69.
E. salmonophloia, 8·34.	*E. Morrisi*, 0·08.

The substance occurs also in *E. pumila*.

13. Tannin.

Tannin is another waste product, and reference has already been made to it in Mr. H. G. Smith's remarks concerning calcium oxalate.

Most tannins doubtless are waste products, and eventually they are removed through the exfoliation of the bark; similarly, exfoliation rids trees of many other waste products that accumulate in the bark, such as alkaloids, gums, resins, and calcium oxalate. Tannins, because of their bitterness, may be useful incidentally in protecting from animal depredations; some tannins, known as plastic tannins, probably are of value in nutrition. Tannin production appears to be especially characteristic of xerophytes, desert plants growing in mesophytic conditions have much less tannin than in their natural habitat. (Coulter, Barnes, and Cowles, *op. cit.* ii, 724.)

See also "An investigation of the Barks of four Western Australian Species of Eucalyptus," by H. G. Smith, *Journ. of Agriculture*, Western Australia, April, 1905, p. 219. This investigation was undertaken to determine the value of these barks for tanning purposes. The species are *salmonophloia, salubris, redunca*, and *occidentalis*.

While some analyses have been made of Eucalyptus barks for tannin, only one variety, perhaps a good species, *Eucalyptus occidentalis* var. *astringens* Maiden, the "Mallet" of Western Australia, has been put to commercial use. In this connection see Part XXXVI, p. 143. See also D. E. Hutchins' "A Discussion of Australian Forestry," p. 239 (1916).

Mr. C. E. Lane-Poole, Conservator of Forests of Western Australia, is giving attention to the potential value of the tan-bark value of *E. platypus* and other species.

The consolidated barks, which include the Gums, and, to a certain extent, the Ironbarks, contain more or less tannin in the form of kino; the fibrous barks contain it least, in proportion, as the differentiation into fibre has proceeded.

14. Oil in Bark.

A correspondent (Mr. E. H. F. Swain) states that the inner bark of *E. acacioeformis* has a distinct odour of turpentine, and hence the tree is sometimes known as Turpentine. The bark of old trees of *E. aggregata* contains essential oil. As regards oil in the bark of *E. cinerea*, see Part XXIV, p. 72. See a paper "On the Essential Oil from the Bark of *Eucalyptus Macarthuri," Journ. Roy. Soc. N.S.W.*, 1, 177, 1916, by H. G. Smith. "The oil from the bark of this species agrees with that distilled from the leaves. It is equally rich in geranyl-acetate, and need not be kept distinct from the leaf oil."

There is no doubt that search will bring to light oil in the barks of other species.

15. Fibre in Bark.

In the Official Record, Intercolonial Exhibition, Melbourne, 1866–67, p. 248, are the results of experiments in paper-making with the barks of *E. obliqua, rostrata. amygdalina (radiata), globulus, goniocalyx, corymbosa, leucoxylon, longifolia, Stuartiana*.

In *Agric. Gazette, N.S.W.*, February, 1902, will be found a paper by me entitled "Some Australian Vegetable Fibres," which gives a short bibliography of the subject, and briefly refers to a few species. *E. amygdalina* (probably *E. numerosa* was chiefly meant, for *E. amygdalina* was very comprehensive in 1902), when I quote: "The inner bark is adapted for the manufacture of coarse paper, and the same may be said of many other species."

Then certain Stringybarks (*capitellata, eugenioides, macrorrhyncha, Muelleriana*) were referred to. The chief use of the bark is, when removed in large sheets, for roofing purposes, and also for the walls of settlers' huts, also of outhouses. The inner layers are used for hay-bands, and for other uses where a coarse tying material is required. *E. capitellata* is quoted for door-mats.

A figure of a basket (Bee-lang), showing good workmanship, and made by Yarra natives out of this fibre is in Brough Smyth's "Aboriginals of Victoria," i, 344. A few more notes will be given later when Aborigines and Eucalyptus are referred to.

In a paper, "Indigenous Fibrous Plants of Victoria," *Vict. Journ. Agric.*, October, 1918, p. 600, J. W. Audas quotes the bark of certain Eucalypts as "suitable for the manufacture of packing and, probably, printing paper . . . coarse paper . . . strong wrapping-paper . . . paste-boards."

In a paper in the same Journal, December, 1918, p. 747, Professor A. J. Ewart corrects some loose ideas on the subject, and following is part of what he said:—

As the term "fibre plant" has been used in a misleading sense, it may be as well to define it more exactly. Fibres are as much an essential part of the structure of a flowering plant as bones are of a vertebrate animal, so that a list of the fibre plants of Victoria would be merely a list of the flowering plants of Victoria, and would include the ferns and their allies also. The term can, however, be restricted so as to include only those plants whose fibres have been proved to have a definite commercial value as sources of fibre. From this point of view no plants native to Victoria have become recognised fibre plants. A number of the more promising were tested by Mr. Guilfoyle and others many years ago and the fibres extracted, but none of them has been able to displace any of the recognised sources of fibres. To be able to do this, a new fibre plant must satisfy various conditions, which may be detailed as follows:—

1. Its fibres must be easily capable of separation and purification.
2. They must be equal or superior in strength, length, and quality to the class of fibre with which they have to compete.
3. They must be present either in unlimited quantity, or must come from plants which are capable of cultivation.

The exploitation of a fibre plant means a factory, and a factory cannot be dependent upon a precarious or quickly exhausted supply of a wild plant. If the fibre of the latter is sufficiently valuable commercially, the plant is worth cultivating to secure a constant supply, and it must then compete with easily cultivable plants, such as flax, &c. Further, in a country where thousands of tons of straw are burnt annually, not out of wastefulness, but because the price obtainable for the whole yield would not cover the cost of collection and transportation, there is no need to search among wild plants for materials for strawboard or coarse paper pulp.

The plant fibres of use commercially fall into three main classes. There are, firstly, the fibres termed "pappus," which are hairs growing usually from seeds enclosed in pods (cotton, kapok, &c.). No native plant shows any likelihood of being able to displace any of the plants recognised as sources of this type of fibre. The combination of strength, length, and purity in the cotton fibre is unique among plants.

In the second class of fibre plants, the fibres belong to what is termed sclerenchyma tissue, and in Dicotyledons they occur just outside the vascular bundles (veins) in a herb, or in the bark outside the wood in a tree. In Monocotyledons, however, the fibres are usually associated with the vascular bundles which are scattered all through the stem or leaf, and do not occur on the outside of the stem only. As a general rule, therefore, in Dicotyledons this class of fibre is more easily obtained in pure form than in Monocotyledons, where it is associated with the wood tissue and soft, weak, easily decomposed phloem tissue of the vascular bundle. The finer fibres of this type are, therefore, obtained from Dicotyledons (flax, hemp, jute), for the most part. Monocotyledons yield coarser, weaker, darker, or more irregular and rougher fibres of less commercial value (coir, raffia). New Zealand flax (*Phormium tenax*) is one of the few exceptions, but is at a disadvantage owing to its slow growth under cultivation.

The third class of fibre is derived from the fibres of wood tissue, and, as a general rule, is employed only for making paper pulp, but has been used in various ways in Germany for weaving to make good the deficiency of proper textile fibres. For wood pulp the fibres should be at least 1 to 4 millimetres long, they must be easily separated by mechanical or chemical treatment, and must, therefore, not be too strongly cemented together, and the less lignified the fibres are, and the more they consist of unaltered cellulose, the better.

Bearing the above facts in mind, it may be worth while to consider how far the native plants which have been put forward as fibre plants comply with the above conditions and requirements as possible commercial sources of fibre.

Eucalyptus Barks as Fibre-yielding Barks for Paper-making.—The first statements to this effect appear to have been made some thirty years ago by Baron von Mueller, and apparently were intended as statements of possibility rather than as statements of fact. Since then, owing to the increased use of wood pulp for paper-making, many once promising materials have lost all value for this purpose. The original statements have, however, been repeated again and again more and more dogmatically without further investigation of the actual economic value of such materials.

In some respects the barks of Eucalypts have precisely those qualities which should not be present in good paper-pulp materials. Thus the presence of insoluble gum, resin, or kino, or of a high percentage of tannin or colouring materials is a serious disqualification for paper-pulp purposes. The pulp must be capable of ready bleaching without treatment so severe as to damage the fibres, lessen their strength, or cause their walls to swell. Finally, the bark must not contain suberinized tissue mixed up with the fibres, as is the case with the stringy barks. The suberinized tissue is more resistant than the fibres to caustic soda and retting, and can only be removed even partially by expensive mechanical methods. Until it is removed a satisfactory pulp cannot be obtained.

Statements as to the value of the barks of Eucalypts for paper-making should, therefore, be received with great caution, unless definite evidence is given of the actual manufacture, cost, and quality of the paper supposed to be yielded by them.

Eucalyptus obliqua.—The bark is stated to be suitable for the manufacture of packing, printing, or even writing paper, as well as for mill and paste boards, and the pulp is stated to bleach readily. As a matter of fact, the fibres are red or brown in colour, are very weak, and cannot be bleached readily by any cheap method without still further weakening them. As the bark contains large amounts of suberinized non-fibrous tissue, it is unsuitable for paper-making. The same applies to *Eucalyptus macrorrhyncha*, the red stringy bark.

The barks of *E. globulus, E. amygdalina, E. radiata, E. goniocalyx, E. corymbosa, E. longifolia, E. Stuartiana*, and *E. rostrata*, are also stated to be useful in or suitable for paper-making. I have not been able to procure any samples of paper made from these barks, nor can I find any data as to the cost and value of paper prepared from them. They all appear to have one or more disqualifications as economically valuable sources of paper-making materials, and hence, until precise information in regard to them can be brought forward, including cost of treatment and value of product, they can be dismissed from the list of materials suitable for paper-making.

In the "Australian Forestry Journal," March, 1921, p. 84, there is a note on "Rope from Jarrah Bark" (*E. marginata* Sm.) In Western Australia there are great accumulations of this at the mills, and experiments are going forward with the object of utilising the inner bark, which has some tenacity, in the direction indicated. If a cheap method can be devised, it will doubtless be applied to the inner fibre of many other species, utilised already as a rough tying material.

The bark of *E. sideroxylon*, grown in South Africa, is being tested as an insulating medium in cold-storage work, see "The South African Journal of Industries," March-April, 1921, p. 271. The fibre of this species has properties in the direction of corkiness or non-conduction of heat, rather than that of tenacity of fibre.

16. Colour of Inner Bark.

The inner bark in Eucalyptus may, when quite fresh, be quite pale-coloured, ("white,") yellow, of various degrees of intensity, to orange, and even brown and red. These colours are probably due to tannins, and, particularly as regards the yellows, it would be desirable to invoke the aid of the chemist.

The bright yellow of the inner bark of *E. melliodora* is so characteristic that the name of the tree is "Yellow Box" because of it, and one chips off a little of the bark with a tomahawk in all cases of doubt. I remember, at a time that *E. Bosistoana* was but little known, and its range far less worked out than it has been since, coming across a tree in the Liverpool district (N.S.W.) called "Yellow Box." A chip showed the inner bark to be non-yellow, and therefore it could not be *E. melliodora*. It turned out that it was known as Yellow Box because of the yellowish colour of the wood, but the colour of the inner bark at once showed the difference between it (*E. Bosistoana*), and the original Yellow Box (*E. melliodora*).

I have a note in regard to the yellow inner bark of *E. Muelleriana*, the stain sometimes penetrating through the wood, at Part VIII, pp. 220 and 236. Other Stringybarks, perhaps all of them, have yellow inner barks, *e.g., E. capitellata, E. macrorrhyncha, E. eugenioides, E. loevopinea. E. cladocalyx* has a thick, sappy bark of a rich orange colour.

E. acacioides has an inner bark of an orange colour, but I do not know whether this colour is practically constant. I feel in this, as in so many other aspects of the big subject of Eucalyptus, I am but offering a pointer to others. We want the accumulation of facts, and then we can group them and, later on, make deductions concerning them.

17. Colour of Outer Bark.

These notes on colours apply only to the Gums, and they vary to some extent with locality and season of year. For further notes on colours see under *E. stellulata, pumila, Boeuerleni, Behriana*. In all these species we have greenish barks at one season or another. Sometimes they are oily green, and sometimes olive green, and sometimes shade off into a lead colour.

E. hoemastoma also sometimes exhibits a brown colour, and so do the Grey Gums (*E. punctata* and *E. propinqua*). The Gums display a variety and intensity of colour during the year, and in different years, and I regret I have not brought my notes on the subject together.

The following passages from a standard American work may be useful:—

Young bark commonly is green, because the cortical chlorophyll is evident through the transparent epidermis. Soon the stem ceases to appear green; the chief cause of the change in colour being the development of the cork layer, whose opacity makes the chlorophyll invisible. The common bark colours are grey, brown, and black; but red occurs, as in some Dogwoods (*Cornus*), and white, as in some Birches (*Betula*). As the tree matures the characteristic bark colour may be seen only on the young branches, if the older limbs are furrowed.

In a few cases, as in the Mistletoe (*Phorodendron flavescens*), Moonseed (*Menispermum*), Sassafras (*Laurus Sassafras*), and Greenbrier (*Smilax rotundifolia*), the relative freedom from cork formation permits the green colour to remain evident longer than usual. Such green-stemmed trees as the Bamboo and the Banana are in reality gigantic herbs, in which ordinary bark does not develop.

Often the exterior and the interior of the bark are differently coloured, as in the Hemlock (*Tsuga*), where it is black without and red within, and as in the Yellow-barked oak (*Quercus tinctoria*), which is named from its inner bark, the outer bark giving rise similarly to the name Black Oak (*Quercus Robur*). Bark colours, especially interior colours, often are due to the presence of various excreted products, such as the Tannins. Advantages in the various colours are not to be looked for. (Coulter, Barnes, and Cowles, *op. cit.* ii, 708.)

GLAUCOUSNESS.

Some Eucalypts have glaucous branches, the rest of the plant being mainly non-glaucous, *e.g.*:—*E. Andrewsi, E. Consideniana, E. gigantea, E. obliqua, E. sepulcralis, E. Sieberiana*. This hint is sometimes useful in the forest.

"Powder-barks," in Western Australia, are tress with smooth barks with more or less glaucous appearance (they are allied to the preceding), but the glaucousness more or less covers the whole of the trunk, and is so abundant that it is easily removed by friction, *e.g.*, by human clothing. Such species include—

E. accedens;

E. Lane-Poolei;

E. microtheca (of Cue), that form of the species which is abnormal in the volume of its glaucousness.

The subject is more or less bound up with that of glaucousness in leaves, and will be referred to when leaves are dealt with.

Explanation of Plates (212–215).

Plate 212.

Plate 212: x EUCALYPTUS ALGERIENSIS Trabut. (1, 2) x E. ANTIPOLITENSIS Trabut. (3) x E. BOURLIERI Trabut. (4, 5) Lithograph by Margaret Flockton.

x *E. algeriensis* Trabut.

1*a*. Flowering twig; 1*b*, buds and flowers; 1*c*, umbel of fruits; 1*d*, fruits viewed from the top. All reproduced from *Bull. de la Station de Recherches Forestières du Nord de l'Afrique*, Vol. 1, Plate 12 (Trabut).
2. Juvenile leaves from No. 221, Herb. d'Algerie, received from Dr. Trabut, in National Herbarium Sydney.

x *E. antipolitensis* Trabut.

3*a*. Juvenile leaves; 3*b*, mature leaf; 3*c*, buds; 3*d*, two views of fruits. Note that the buds and fruits are angled, and in threes. Reproduced from the same bulletin as *E. algeriensis*, but Plate xv *bis*.

PLATE 212—*continued*.
x *E. Bourlieri* Trabut.

4*a*. Juvenile leaf; 4*b*, mature leaf; 4*c*, leaf and buds; 4*d*, leaf and flower; 4*e*, buds; 4*f*, fruits. All from the same bulletin as *E. algeriensis*, but Plate 13.
5*a*. Front and back views of anther; 5*b*, hardly ripe fruits, sessile on a flattened pedicel. Both from a specimen furnished by Dr. Trabut.

Plate 213.

Plate 213: x EUCALYPTUS CORDIERI Trabut. (1-3) x E. TRABUTI H. de Vilmorin. (4-6) Lithograph by Margaret Flockton.

x *E. Cordieri* Trabut.

1*a*. Juvenile leaf; 1*b*, mature leaf, with fruits; 1*c*, buds. All from the same bulletin as *E. algeriensis*, but Plate 15.
2*a*. Buds; 2*b*, fruits. Drawn from No. 243, Herb. d'Algerie, from “Collection Bourlier, Alger” (Dr. Trabut). Apparently identical with No. 16 (one specimen) and No. 241.

3*a*. Buds and flower; 3*b*, fruit. Drawn from No. 237 of the same herbarium, det. Trabut, and bearing a note, “Hybride de *globulus*, dans un semi de *Risdoni*? Echantillon provenant de M. Cordier et determine par lui hybride de *globulus*, 1865.”

x *E. Trabuti* H. de Vilmorin.

4*a*. Large mature leaf; 4*b*, twig with buds; 4*c*, twig with fruits; 4*d*, two views (enlarged) of a fruit. All from same bulletin as *E. algeriensis*, but Plate 11.
5*a*. Buds; 5*b*, fruits; both smaller than the type. Both drawn from No. 192, Herb. d'Algerie (Jardin Botanique de l'Université), det. Dr. Trabut.
6. Fruits, more cylindrical and with longer pedicels than the type. Drawn from No. 193, Herb. de l'Algerie.

Plate 214.

Plate 214: x EUCALYPTUS GOMPHOCORNUTA Trabit. (1-5) x E. PSEUDOGLOBULUS Hort. (6) Lithograph by Margaret Flockton.

x *E. gomphocornuta* Trabut.

1. Reproduced from Révue Horticole, 1903, Fig. 128, p. 326 (“Quelques Eucalyptus hybrides dans la region Mediterranéene”). Type.
2*a*. Buds; 2*b*, fruit, of *E. gomphocornuta*.
3*a*. Buds; 3*b*, fruit, of *E. gomphocephala*.
4. Buds of *E. cornuta*. (4*a* has been admitted in error.) (Nos. 2, 3, 4 reproduced from Fig. 3, p. 148, of *Bull. de la Stat. de Rech. du N. de l'Afr.*)

Nos. 3 and 4 are the parents of the two species in the Algerian plantation which cross-pollinated and produced *E. gomphocornuta*, figured at 2 (and also at 1).

5*a*. Juvenile leaf; 5*b*, mature leaf and fruits of No. 51, Herb. d'Algerie, 1904, labelled by Dr. Trabut *E. gomphocornuta*.

x *E. pseudo-globulus* Hort.

7*a*. Buds and mature leaf; 7*b*, fruits. Reproduced from Fig. 5, p. 152, of Dr. Trabut's paper in *Bull. de la Stat.*, etc., already frequently quoted.

It is an undoubted hybrid, but has apparently not yet been formally described.

Plate 215.

Plate 215: x EUCALYPTUS INSIZWAENSIS Maiden, n.sp. (1-2) x E. JUGALIS Naudin. (3) Lithograph by Margaret Flockton.

x *E. jugalis* Naudin.

1*a*. Juvenile leaves; 1*b*, mature leaf and buds; 1*c*, buds; 1*d*, truncate anther. No. 8, Herb. d'Algerie (Dr. L. Trabut, 1904).
2*a*. Mature leaf; 2*b*, two different views of fruits. No. 22, Herb. d'Algerie (Dr. L. Trabut, 1904).

x *E. Insizwoensis* Maiden, n.sp.

3*a*. Juvenile leaf, the upper face shiny; 3*b*, mature leaf; 3*c*, mature leaf and buds; 3*d*, front and back view of anthers; 3*e*, fruits. From Insizwa Plantation, Mt. Ayliff district, Cape Province, South Africa (from Chief Conservator of Forests).

1 But see Vines' "Students' Text-book of Botany."—"They may be produced endogenously or exogenously (1) from a single epidermal cell, (2) from epidermis and pericycle."

2 Also *Cuscuta* and *Convolvulus*. See Vines' "Students' Text-book of Botany," p. 190—"When the part is very young the adventitious member is developed exogenously; when the part is older the adventitious member is developed endogenously, usually from the pericycle, but sometimes from still deeper tissues."

* *Handbuch* v. 2 p. 11. This is the translation of the passage in question:—"While our fir-trees never produce adventitious buds, many of those in America are remarkable for the facility with which they produce them. And even in the case of the beautiful Canary Island Pine (*Ables Canariensis*), when the branches have been removed, the trunk is covered with young shoots which have, like the young plants of the ordinary firs, long leaves, in the axils of which there grow later three needles in one sheath.

1 *Mem. Soc. Phys. et Hist. nat. Gen.* t. xxvi, 2, 1879, p. 453. *Vol. Cent.* 1890, p. 30.

2 "Beitrage zur Morphologie und Physioldes Blattes." *Botan. Zeit*, 1880, p. 803.

3 Tome xiv, 1867, p. 153.

1 "Organographie der Pflanzen," p. 145

2 *Arch. des. Sc. Phys. et Nat* t. viii, 1899.

Part 53

Natural Hybrids.

WE now come to the main selection of such spontaneous hybrids as have come under my notice in Australia. Now that attention has been prominently drawn to the subject, with concrete instances, I confidently predict that records will be made of very many more.

The instances given include evidence in proof of the fact, to which I have long since drawn attention, of the proneness of some of the Ironbarks and Boxes to hybridise.

Following is a list in those described in the present Part, and cognisance will be taken of a few more in Part 54:—

x *E. Barmedmanensis* Maiden, n.sp.
x *E. Tenandrensis* Maiden, n.sp.
x *E. Peacockeana* Maiden, n.sp.
x *E. Stopfordi* Maiden, n.sp.
x *E. Forsythii* Maiden, n.sp.
x *E. Auburnensis* Maiden, n.sp.
x *E. Yagobiei* Maiden, n.sp.
x *E. Blackburniana* Maiden.
x *E. Studleyensis* Maiden, n.sp.

[Perhaps this will be an appropriate place for the following statement:—

"The consideration of all these facts led me years ago to raise the question whether hybrids could originate species (*Oesterreich. bot. Zeitschr*. xxi, 34, 1871), and to answer it in the affirmative. Looked at from this point of view, the hybrids which have been and are being produced in nature acquire a special significance, and it becomes important to form a correct notion as to their existence, behaviour and distribution in localities where the life of plants is untrammelled and undisturbed. Only the vegetation of Europe has been thoroughly studied in this connection; yet this alone affords a fund of information, and we may take it for granted that what is true for Europe will apply likewise to the other quarters of the globe." (Kerner in Kerner and Oliver, "The Natural History of Plants," ii, 582.)]

CCCI. x E. Barmedmanensis Maiden, n.sp.

Reputed parents, *E. sideroxylon* A. Cunn., and *E. melliodora* A. Cunn.

BEFORE submitting a formal description of this hybrid and of some trees which are close to, and probably identical with it, it will be instructive to quote three passages from Mr. R. H. Cambage's writings and one from my own.

A.—Cobar to the Bogan River, above Nyngan, N.S.W.—

In view of the prominence of the question of hybridisation of Eucalypts . . . (here comes a passage printed in Part LII, p. 65). These are points of circumstantial evidence which suggest hybridisation. There is one feature in which this tree more nearly resembles the Ironbark than the Box, and it is in regard to the colour of the sap (wood), which is a yellowish-green, similar to Ironbark, while that of the Box is white. In general appearance the tree is much like *E. affinis*, but the fruits separate them. It is also like the doubtful tree at Liverpool. The chief flowering time of *E. sideroxylon* in the west is about April and May, but flowers can generally be found before and after those months. I have seen it flowering at Cabramatta in January and July. *E. Woollsiana* flowers about February and March, but flowers of this species have been collected in May in the same locality as that in which *E. sideroxylon* was then flowering. I am not able to state the flowering time of the tree which looks half Box and half Ironbark, for though a very few flowers were collected in June, buds were found in September, which seemed to indicate that the trees would be flowering in October. The scarcity of the tree makes it difficult to arrive at a definite conclusion in the matter. It is no part of my purpose to try and prove that the tree in question is a hybrid, but simply to offer observations which may assist in settling the question. I have handed specimens to Mr. Deane, who will probably investigate this species.

(R. H. Cambage in *Proc. Linn. Soc. N.S.W.*, xxv, 716, 1900.) (I was then in Europe at the time, and Mr. Deane handed me the specimens on my return. J.H.M.)

B.—Mr. Cambage is travelling from Mount Hope to Parkes, and is on the Melrose road, approaching Condobolin:—

Finding *E. sideroxylon* and *E. Woollsiana* growing together between the three and four-mile posts, I searched for the supposed hybrid or Ironbark-Box, and succeeded in finding a few trees on the eastern side of the road. None were growing within sight from the road, and had their presence not been suspected, they would have been passed unnoticed. They were in every respect similar to those found north of Nymagee, and mentioned in a previous paper (Part II). These trees can generally be at once detected by their bark, it being rougher than the Box and smoother than the

Ironbark, and usually is somewhat of a yellowish-brown colour, especially towards the upper part of the trunk." (*Proc. Linn. Soc. N.S.W.*, xxvi, 324, 1901).

C.—Mr. Cambage is now between Barmedman and Temora:—

The Eucalypts were represented by *E. Woollsiana, E. sideroxylon, E. melliodora* (increasing in quantity), *E. tereticornis* and var. *dealbata* (*E. dealbata*), one tree of *E. affinis*, and three of Ironbark Box similar to the reputed hybrid of Nymagee.

E. Woollsiana, which is known locally as Black Box, was being cut for railway sleepers. Finding t on a ridge near Barmedman with *E. sideroxylon*, I searched a considerable area for the questionable hybrid, and eventually found three trees fairly close together, with the bark, timber and fruits about midway between those of the other two, and corresponding with trees previously found in similar company (*vide* vol. xxv, p. 716, and xxvi, p. 324). I am still unable to offer any definite opinion as to what these trees really are. In a general way they seem to more nearly approach *E. sideroxylon* than any other local species, but the fruits are smaller, the bark less rough, and inclined to be like that of the Box, and the wood yellowish, while they seem too scarce to represent a distinct species. In this instance, as previously, they were only found as the result of special search. Although these trees appear to be very rare, it may be mentioned that in nearly every case they have been found in twos or threes. (R. H. Cambage, in *Proc. Linn. Soc. N.S.W.*, xxvii, 195, 1902).

I wrote as follows:—

The Ironbark-Boxes.—These seem to me to be indubitable hybrids. Mr. R. H. Cambage (these Proceedings, 1900, p. 715) has pointed out the probability of an Ironbark-Box of the Lachlan being a hybrid between *E. sideroxylon* and *E. Woollsiana*. He has also suggested the hybrid character of the Ironbark-Box or Bastard Ironbark of Nymagee, and the White Ironbark or Ironbark-Box of Barmedman; and I would add the Cooburn or Black Box of Narrabri. I only mention these forms because they have been referred to at some length in my paper on *E. odorata*, a species they closely resemble in bark, timber, buds, &c. The foliage of the Ironbark-Boxes is duller than that of *E. odorata*, and the venation less marked.

Mr. Cambage's observations as to the evolution of these forms are interesting, and must be borne in mind in considering the relations of the western "Boxes." I confine myself at this moment to emphasising the resemblance of these forms to *E. odorata*.

It is not desirable to name these forms until after further enquiries as to their relationship. Mr. R. H. Cambage writes to me:—"I should say that the Nymagee and Condobolin trees are associated with the narrow-leaved form of *E. Woollsiana*, and even the Barmedman ones are rather more the narrow forms that the broad, but it is getting difficult in the latter place." The "Narrow-leaved form of *E. Woollsiana*" is the form that, I recommend presently, should be known as *E.*

Woollsiana, the broader-leaved forms really belonging, in my opinion, to *E. hemiphloia*. (*Proc. Linn. Soc. N.S.W.* xxix, 763, 1904).

Following is a description of *E. Barmedmanensis*, as complete as the material permits:—

A medium-sized tree.

Bark hard, tough, dark-coloured, flaky furrowed, so hard that portions do not rub off; the classification of it as an Ironbark Box is descriptive; it is hard, but not so furrowed as an Ironbark. The bark contains a good deal of kino.

Timber reddish brown; this is the colour after nearly twenty years' exposure, but it has darkened with age. It is hard and interlocked.

Juvenile leaves not seen.

Mature leaves dull green, and covered with fine dots, pedunculate, straight or rarely slightly falcate, not large, say up to 1 dm. long, and under 1·5 cm. in greatest width, tapering gradually into a fine but soft point, and gradually at the base into a petiole of 2 cm. Venation almost invisible, secondary veins making an angle of 30 deg. and more with the midrib; intramarginal vein fine and well removed from the edge.

Inflorescence in axillary pedunculate umbels up to 5 in the head on rather slender peduncles and pedicels; buds rostrate-ovoid, the rostrate or conical operculum varying in length. Although not seen mature, the anthers are evidently truncate.

Fruits about 5 mm. in diameter, nearly spherical to pear-shaped, tapering moderately sharply into a pedicel of under 5 mm. Rim of moderate thickness, with usually four or five blunt valves whose tips scarcely reach the orifice. Deciduous staminal ring.

The type is "White Ironbark, Barmedman, R. H. Cambage, No. 1 (4834), suggested by Mr. Cambage to be a hybrid between *E. sideroxylon* and *E. Woollsiana*.

I am of opinion that the following trees (to be further described immediately) come under *E. Barmedmanensis*:—

1. Trowel Creek, Nymagee.
2. Condobolin.

1. "Ironbark-Box" or "Bastard Ironbark," Trowel Creek, Nymagee (R. H. Cambage, May, 1900). This was looked upon by Mr. Cambage as a hybrid between *E. sideroxylon* and *E. Woollsiana*.

The tree has already been briefly described by Mr. Cambage. The bark is similar to that of Barmedman, except that it contains less kino. The timber similar to that of

Barmedman. As regards the other characters (so far as the imperfect material is available) the only one calling for notice is the pointed character of both calyx-tube and operculum in the Trowel Creek specimens. It is very likely, however, that there is no important difference between the trees from the two localities in this and other respects.

2. Ironbark-Box, Condobolin (R. H. Cambage, 18th June, 1900). I have quoted Mr. Cambage's remarks (under B), and have referred to it in the following passage. It may be the Cooburn or Black Box of Narrabri, but my specimens are not very satisfactory, being in bud only.

"It appears to be the 'Ironbark-Box or Bastard Ironbark' of Condobolin (R. H. Cambage); the Ironbark-Box or Bastard Ironbark of Nymagee (R. H. Cambage); the Cooburn or Black Box of Narrabri (Forester McGee). It is a tree which requires further investigation, the first work to be undertaken being a list of localities which produce timbers known as 'Ironbark-Box' or 'Bastard Ironbark'. . . .

"The 'Cooburn or Black Box' is a tree that is often placed under *E. bicolor*, but in my opinion its place is with *odorata*. 'Cooburn, Black Box; Ironbark Box, Bastard Ironbark.' This tree is referred to in the following passage:—'Cooburn, Black Box (*Eucalyptus largiflorens*). Timber hard, tough and durable, very lasting underground, of a red colour. Used for fencing, rough buildings and sleepers. Habitat, stony ridges, scrub forests, N. and S. coast districts (*sic.*) 100–120', 2–3'. Not very plentiful. N.S.W. Catal, Col. and Ind. Exh., p. 199. It has a hard, scaly, black bark." Maiden in *Journ. Roy. Soc. S.A.*, xxvii, 246 (1903.)

Affinities.

From what Mr. Cambage wrote in 1900–2, it will be observed that he inclined to the view that the Box which is supposed to have entered into this hybrid is *E. Woollsiana*, though he points out that *E. melliodora* may or may not have a share. In Part XLVII, p. 199, of the present work, I have expressed the opinion that *E. Woollsiana* is a composite species and may include *E. odorata*. In 1903 I placed these hybrids under *E. odorata*, not that I believed them to be typical, but, as I did not wish to create another species, they seemed to come nearest to it, although at that time my views of *E. odorata* were not entirely what they are at present. As regards *E. sideroxylon*, we are both agreed that, if the trees be hybrids, that is probably one of the parents.

1. With *E. odorata* Behr. and Schlecht.

The timber was described as yellowish when freshly cut, but while it gets reddish-brown after the lapse of years, I think it may be fairly stated that when fresh it was never as pale as that of *E. odorata* or *E. melliodora*, nor, when old, as red as that of *E. sideroxylon*.

2. With *E. melliodora* A. Cunn.

The fruits are in shape and size and in the staminal ring a good deal like those of *E. melliodora*. There is some similarity to this species in buds also. The timber is a little darker than that of *E. melliodora*.

3. With *E. sideroxylon* A. Cunn.

The description of the timber after twenty years' exposure is reddish-brown, doubtless distinctly darker in colour than when freshly cut. I have heard of it being paler, but the cuts may not have been deep. The colour, in my view, is not in discord with the assumption that *E. sideroxylon* may be one of the parents. The fruits are smaller than those of *E. sideroxylon*, but show affinity to those of that species.

E. melliodora A. Cunn. var. (See fig. 3; Plate 216.)

Herewith are drawings which should be compared with the figures of *E. melliodora* at Plate 61, Part XIV. Besides the differences from that species already given, I would point out that the foliage is too rigid for normal *E. melliodora*, whose leaves are inclined to be thin, also the buds are more pointed, which may, or may not, show a tendency to *E. sideroxylon*.

Although I still believe it to be a hybrid, I do not propose to give it a name, because of its lack of distinctness, and therefore have named it *E. melliodora* var. for the present.

The specimen came from Murrurundi, New South Wales (J.H.M. and J. L. Boorman, May, 1902), and is referred to in *Proc. Linn. Soc. N.S.W.*, xxx, 495 (1905).

CCCII. x E. Tenandrensis Maiden, n.sp.

Reputed parents, *E. melliodora* A. Cunn., and *E. crebra* F.v.M.

AN Ironbark, with hard timber of a pale brown colour, the foliage of a pale colour, and drying even paler.

Juvenile leaves not seen in the very earliest stage, but, in the early stage depicted in figs. 1*a*, 2*a*, Plate 217, broadly lanceolate, with a blunt apex, and tapering gradually into a long petiole, say 1 dm. long, by nearly 4 cm. in greatest width, and a petiole of 2 cm. Venation spreading, intramarginal vein at some distance from the edge; the venation not prominently but distinctly triplinerved.

Mature leaves narrow lanceolate, tapering gradually to the apex and less so to the petiole, slightly falcate, say 14 cm. long and 1 cm. broad, venation spreading, scarcely visible to the naked eye, the intramarginal vein a little removed from the edge.

Flowers.—Inflorescence in panicles, buds only seen in a young state, but with pointed opercula.

Fruits sub-globular, about 5 mm. in diameter, with a rim, the valves well sunk, pedicellate.

Range.

State Forest No. 166, Tenandra, parish of Baronne, land district of Coonamble, county of Leichhardt, western New South Wales (Forest Guard Withers, of Gilgandra).

Affinities.

1. With *E. melliodora* A. Cunn.

This is another species having an affinity to *E. melliodora*. Its similarities are in the fruits, but to a less degree in the foliage. There is some similarity in the triplinervation, but the juvenile and intermediate leaves are much larger and paler in the new species than in *E. melliodora*. The new species is an indubitable Ironbark, with pale timber suggesting a resemblance to *E. melliodora* in that respect.

2. With *E. crebra* F.v.M.

The general appearance of the trunk of the tree closely resembles *Euc. crebra*, but seed capsules appear larger than those of this variety. The sucker leaves are very large, and the leaves somewhat glaucous in tint, thereby differing considerably from

Euc. crebra. The timber has a high reputation locally. (Forest Guard Withers.)

The timber of *E. crebra* is red, thus sharply separating it from that of our new species, but in the adult foliage and fruits there is resemblance to the new species.

CCCIII. x E. Peacockeana Maiden, n.sp.

A TREE of medium size, an undoubted Ironbark. “Inner bark and trunk, where contact is made with bark, are a brilliant yellow or saffron in hue.” (L. Peacocke.)

Colour of timber yellowish to the palest brown.

Juvenile leaves.—The foliage throughout life is sap-green in colour, entirely glabrous and thinnish. The juvenile leaves are especially thin, narrow lanceolate;* venation for the most part indistinct, but the secondary veins, while spreading, mostly at an angle of 45 degrees with the midrib. The intramarginal vein is distinct, and is clearly removed from the margin.

Mature leaves linear-lanceolate, scarcely falcate, petiolate, with an average length of say 12 cm., with a width of about 1 cm.

Flowers, inflorescence axillary, up to five in the head, on slender peduncles of .5 cm. supporting shorter pedicels, buds with conoid opercula, calyx-tubes of equal length, gradually tapering into the pedicels. The anthers have transition forms, varying from the truncate to those with the parallel cells (an indication of the instability of this form.)

Fruits small, about 5 mm. in diameter, almost pyriform, and with a narrow rim.

Range.

Elsmore, county of Gough, New South Wales. The type came from the base of a trap or porphyry ridge on Mr. H. R. Hughes’ property, Elsmore Station, parish of Elsmore (Lance B. Peacocke, Forest Guard).

Affinities.

1. With *E. melliodora* A. Cunn.

If the drawings be compared with those of *E. melliodora*, Plate 61 (Part XIV), it is impossible to fail to note that the resemblances of the mature leaf, fig. 3*a*, and also the buds and fruits are very great. In two important points the differences are so great, viz., in juvenile leaves, and the bark, that I feel justified in giving the tree a name. There is also some variation in the shape of the anthers that is worthy of note.

2. With *E. crebra* F.v.M.

“No other Ironbark tree of any species for many miles from this one, and no *E. crebra* for a distance of at least 15 miles.” (L. Peacocke.)

Obviously in a distinct narrow-leaved Ironbark like this, we naturally think of *E.*

crebra, but the red timber of that species at once separates the two. There are also differences in the anthers.

* Fig. 4 of Plate 61, Part XIV, under *E. melliodora*, shows a "very narrow 'juvenile' leaf, Lachlan River, N.S.W., J. Duff." This is a misprint for "mature" leaf, and it very strongly resembles in outline that of the juvenile leaf of our new species. Duff's specimen is a flowering branch.

CCCIV. x E. Stopfordi Maiden, n.sp.

Reputed parents, *E. melliodora* A. Cunn., and *E. sideroxylon* A. Cunn.

AN Ironbark with pale-coloured timber, which is curly in texture in the specimens before me.

Juvenile leaves not seen in the earliest state. Intermediate leaves glaucous, thickish, rather broadly lanceolate, venation spreading, intramarginal vein well removed from the edge. A specimen 11·5 cm. long and 2·5 cm. in greatest width, tapering into a petiole of nearly 2 cm.

Mature leaves glaucous, thickish, venation spreading, inconspicuous, except the midrib and intramarginal vein. Lanceolate, usually bluntish at the apex, smallish, usually not much exceeding 8 cm. long, and 1·5 cm. in width.

Flowers.—Inflorescence paniculate, each peduncle bearing up to seven pedicellate flowers, the opercula short, conical, pointed, and commonly each with a second operculum; anthers obliquely truncate.

Fruits not seen.

Range.

This was sent from "near Inverell," New South Wales, by the late District Forester A. E. Stopford, and further particulars were not available through the state of his health, which not long afterwards culminated in his tragic death.

Affinities.

1. and 2. With *E. melliodora* A. Cunn., and *E. sideroxylon* A. Cunn.

This is a puzzling form. In its timber, perhaps in the outline of its intermediate leaves, and certainly in its inflorescence, it resembles the former; in its bark, the colour and texture of its leaves, it resembles the latter. In the present state of our knowledge, therefore, there are grounds for the supposition that it may be a hybrid between the two.

CCCV. x E. Forsythii Maiden, n sp.

Reputed parents, *E. melliodora* A. Cunn., and an Ironbark (? *E. crebra* F.v.M.).

AN Ironbark. Colour of timber not known.

Juvenile leaves not known.

Mature leaves dull green, lanceolate, scarcely falcate, tapering to the apex, and also gradually to the petiole, about 12 cm. in average length, and 2 cm. in greatest width, with a petiole of 1·5 cm., venation spreading, the intramarginal vein much removed from the edge, giving the leaf a triplinerved appearance.

Flowers.—No opercula on the specimens available, anthers obliquely truncate.

Fruits nearly hemispherical in shape, and 7 mm. in diameter, with a dark-coloured broadish rim, best seen on the top of the expanding orifice, and reminding one of the rim (and shape of fruit) of *E. hoemastoma.*

Named in honour of the late Mr. William Forsyth, for many years the respected Superintendent of the Centennial Park, Sydney.

Range.

On the Coonabarabran-Baradine road, Pilliga Scrub, New South Wales (William Forsyth, October, 1899).

Affinities.

1. With *E. melliodora* A. Cunn.

It differs in the dull or glaucous foliage, but resembles *E. melliodora* in the mature leaves. There are, however, important differences in the fruits, and in the bark, for the new species is an Ironbark.

2. With *E. hoemastoma* Sm.

Under the description of the fruit I have a note as to its similarity to this species, but this appears the only similarity.

CCCVI. x E. Auburnensis Maiden, n.sp.

Reputed parents, *E. melliodora* A. Cunn., and *E. melanophloia* F.v.M.

AN Ironbark, with yellowish inner bark, and pale-coloured timber.

Juvenile leaves glaucous, broadly lanceolate or almost lanceolate, say 6 cm. long by 4·5 broad, with a short petiole of 3 mm. Venation spreading or curved, intramarginal vein or secondary intramarginal vein at some distance from the margin, giving the leaf a triplinerved appearance.

Mature leaves glaucous or dull green, lanceolate, rarely falcate, tapering to a not very sharp apex; commonly 8 cm. long and 2·5 cm. broad in its greatest width; venation spreading, inconspicuous, intramarginal vein distinctly removed from the edge.

Flowers not seen.

Fruits only observed on the old wood, in umbels up to five, with slender peduncles and distinct, slender pedicels. Small (about 4 mm. in diameter), globular or slightly pear-shaped, tips of valves sunk beneath, or scarcely protruding beyond, the orifice, rim reddish-brown.

Range.

On Auburn Vale, county of Arawatta, near Inverell (Gordon Burrow, 28th October, 1907).

I have never seen anything like them before; there is only a small clump of about thirty trees. They grow straight and fairly tall, and at a distance look like Stringybark, until one gets near enough to see the bark. Other trees in the vicinity were Apple (*Angophora subvelutina*), Yellow Box (*Eucalyptus melliodora*), Red Gum (*E. dealbata* (?)). There is no Stringybark or Ironbark within at least a mile. On the growing tree the bark looks almost like Wattle Bark. (Gordon Burrow, 28th October, 1907.)

This reference to Wattle Bark is to those species which have hard furrowed barks, almost like an Ironbark.

Affinities.

1. and 2. With *E. melliodora* A. Cunn., and *E. melanophloia* F.v.M.

This is another species which seems to me to be a hybrid between *E. melliodora* on the one hand, and an Ironbark on the other. The assumed Ironbark in this case is

E. melanophloia, which is unusual in this association, so far. The foliage is preponderatingly nearer to *E. melanophloia,* rather than *E. melliodora,* but *E. melanophloia* has a red timber; the colouration of the bark and timber much resembles that of *E. melliodora.*

3. With *E. hoemastoma* Sm., var. *micrantha.*

The only similarity appears in the red rim and shape of the fruits; as regards the red rim there is a note under *E. Forsythii,* but the fruit is larger in that case. We see the character also in *E. Tenandrensis,* but the rims of the proposed new species are thicker, and the fruits only observed (so far) on the old wood.

CCCVII. x E. Yagobiei Maiden, n.sp.

Reputed parents, *E. microtheca* F.v.M., and *E. hemiphloia* F.v.M. var. *albens.*

A Box. A glaucous foliaged tree of medium size, with a whitish, furrowed, fibrous-flaky bark on the trunk, the branches smooth. Timber pale-coloured, drying pale-brown.

Juvenile leaves shortly pedunculate, thickish, broadly-ovate, approximating 4 cm. in length and breadth, secondary veins fine, almost transverse, making an angle of about 60 degrees with the midrib, the intramarginal vein distinct from the edge.

Mature leaves shortly petiolate, coriaceous, narrow-lanceolate, symmetrical, the apex terminating in a blunt point, not much exceeding 1 dm. long, usually more than 1 cm. broad, venation inconspicuous when mature, much more conspicuous in the immature stages, secondary veins almost pennate, and making an angle of about 45 degrees with the midrib, the intramarginal vein distinct from the edge.

Flowers.—The inflorescence paniculate, the slightly flattened peduncles bearing umbels three-flowered or more, on distinct pedicels, the buds small, symmetrical, the opercula and calyx-tubes conoid, the greatest diameter under 4 mm. Anthers opening in parallel slits, small gland at top, usually becoming broader at the base. Filament attached at the base; not versatile.

Fruits hemispherical to pear-shaped, up to 5 mm. in greatest diameter, tapering somewhat abruptly to a pedicel, the valves (usually three) well exserted.

Range.

This is the tree of which I wrote three years ago—

B. Bark white like a White Box (*E. hemiphloia* var. *albens*), but the foliage is like Silver-leaf Ironbark (*E. melanophloia*). All the surrounding trees are Silver-leaf Ironbark. This is the first tree of its kind I have noticed in this division. Parish Yagobie, county Burnett. (W. M. Brennan.) Again reporting on this tree, Mr. Brennan says: "Grows on a red ridge, well away from the river, and the only Coolabah (*E. microtheca*) tree I know of is about 5 miles away; this tree is somewhat similar in foliage to the tree in Mr. Solling's paddock (See A). (A. is *E. melanophloia,* and the tree is described at p. 70), but the bark is very different, being white like the White Box bark. Mr. District Forester Gordon Burrow has visited this tree, and confirms Mr. Brennan's observations. Excellent specimens are before me." (*Journ. Roy. Soc. N.S.W.,* liii, 71 (1919).)

The locality is northern New South Wales, on the banks of the Gwydir River.

Affinities.

It is a question as to the affinity of this tree to *E. melanophloia,* or to *E. microtheca.* Its foliage is like *E. melanophloia.* I think its affinity is with *E. melanophloia,* but the timber is pale. I think we have a *melanophloia* hybrid, and as I am actively collecting data and materials in regard to Eucalyptus hybrids, I draw attention to what appears to be an interesting one. (Maiden, *op. cit.,* p. 71.)

1. and 2. With *E. microtheca* F.v.M., and *E. hemiphloia* F.v.M. var *albens.*

I now think that the affinities of the suggested hybrid lie between these two species, and not with *E. melanophloia* F.v.M. For figures of the former see Plate 52, and of the latter see Plate 50. I think from *E. microtheca* the new form obtains its flowers, fruit (especially the fruit), and to some extent its foliage. From *E. hemiphloia* var. *albens* comes the bark and pale-coloured timber. From both assumed parents we have the glaucous foliage, but the size of its leaves is rather that of *E. melanophloia.*

CCCVIII. x E. Blackburniana Maiden.

Reputed parents, *E. odorata* Behr. and Schlecht, and (?).

THIS has already been described, under No. XLIV (*a*), "An Ironbark Box," in Part XI, p. 38 of this work, February, 1910, and figured figs. *a* to *i,* Plate 52.

As I suspected it to be a hybrid (see Part XI, p. 39) I did not give it a name, except in MS. (intending to name it with other hybrids), and only distributed it to Mr. R. T. Baker and to the Melbourne Herbarium. Mr. Baker inadvertently published the name in *Journ. Roy. Soc. S.A.,* xl, 478 (1916), which I presume is therefore the date of the species.

I named it in honour of John Blackburne, formerly Conservator of Forests of Victoria, who has long taken great interest in the elucidation of Victorian Eucalypts.

Range.

The type comes from Inglewood, Victoria (J. Blackburne, No. 14). I have seen imperfect specimens from the Wimmera, which are closely allied to, if not identical with, the Inglewood tree. I have not seen similar specimens out of Victoria, but it is reasonable to expect it from south-western New South Wales and middle-eastern South Australia.

Affinities.

Those with *E. Bosistoana* F.v.M., and *E. bicolor* A. Cunn., are dealt with in Part XI, p. 39.

Its closest affinity seems to be to E. *odorata* Behr and Schlecht, near which I tentatively placed it (*op. cit.,* p. 38.)

CCCIX. x E. Studleyensis Maiden, n.sp.

Reputed parents, *E. rostrata* Schlecht, and *E. ovata* Labill.

AN entirely glabrous, erect tree of considerable size, with rough, softish, friable bark, extending a considerable distance up the trunk and with smooth or ribbony bark beyond. Timber pinkish.

Juvenile leaves orbicular (say 4 cm. in diameter) to ovoid, thinnish, very shortly petiolate, venation transverse, spreading, the intramarginal vein looped and at a considerable distance from the edge.

Mature leaves moderately coriaceous, lanceolate, say 13 mm. long and 2·5 mm. in greatest width, venation spreading, the secondary veins making an angle of about 45 degrees with the midrib, the intramarginal vein distinct from the edge.

Flowers.—Inflorescence axillary, with umbels bearing up to seven flowers, on rather long slender peduncles and pedicels of half the length; buds smooth, operculum rostrate, of the same length as the calyx-tube, the anthers opening in parallel slits; the gland at the back versatile.

Fruits small (say 7 mm. in diameter), hemispherical or slightly campanulate, rim thin, and with the tips of the capsule slightly protruding from the orifice.

Range.

Studley Park, Kew, Victoria (A. D. Hardy, Forestry Commission, Melbourne). Mr. Hardy, who has studied this hybrid, and who first brought it under my notice, says that the neighbouring flora in the part of the Park containing the supposed hybrid, *i.e.,* near the top, in contradistinction to the river-flats, on a "red-bed capped spur which falls to the river (Yarra) has stunted but smooth-barked *E. viminalis,* close to the type, half-way down, in a valley, and has *E. rostrata* (typical) at the lower end of a little valley, and on a small flat, and at the river bank." There is rough-barked *viminalis* growing on the river flats.

Affinities.

Mr. Hardy has raised seedlings from this reputed hybrid, and says they are reminiscent of *E. viminalis, E. rostrata* and *E. robusta* (?). It seems to me that the species closest to it are *E. rostrata* and *E. ovata. E. viminalis* seems to be less close, but those who desire to follow up this line of thought may refer to Part XXVIII, Plates 117, 118, 119.

1. With *E. rostrata* Schlecht.

See Part XXXIII, Plate 136. The buds of the supposed hybrid undoubtedly suggest *E. rostrata*; there is some, but less, similarity in the juvenile leaves as regards shape, but not in colour, those of *E. rostrata* being usually pale. The departure is increased as regards the fruits and timber.

2. With *E. ovata* Labill.

As regards *E. ovata,* see Part XXVII, Plates 113 and 114, but the buds are as a rule somewhat different, while the fruits of the hybrid lack that conoid appearance so common in *E. ovata.* The peduncles and pedicels are more slender in the hybrid, which seems nearest to *E. ovata* of any species.

3. With *E. leucoxylon* F.v.M.

The resemblance of the local *E. leucoxylon,* the foliage of which seems much less glaucous than is usually observable in the species, is evident. There is considerable similarity in the juvenile leaves, which, in the local *E. leucoxylon* seem to be broader, more reniform and more pointed than in *E. Studleyensis.* The buds of the two species are a good deal similar, but if figs. 3c., 4, 3, 6, Plate 56, Part XII, be turned to, it will be seen that the fruits are somewhat similar, but more urceolate in *E. Studleyensis.*

MISCELLANEOUS NOTES ON HYBRIDS.

I NOW give some notes on hybrids or reputed hybrids, which may be useful for reference. Very little attention has been given to the subject even yet, and I confidently predict that the botanist of the early future will repair this omission. Reference may be made to the hybrids to which names have been given for the species mentioned as reputed parents.

At a meeting of the Royal Society of New South Wales held on 5th November, 1919, I exhibited coloured drawings of the first hybrid Eucalypts that have been raised in Australia by the direct action of the plant-breeder. The Algérian and other hybrids hitherto described are the results of accidents, plants having been selected in the plantation that could only have arisen as the result of the proximity of certain pairs of species. Some of the reputed natural hybrids referred to in Australian literature may or may not be true; to say that they are so seems justified by the facts in regard to a number of them. These artificial hybrids are the work of Mr. C. J. Weston, Afforestation Officer, Federal Territory, Canberra. They are—

A.—*E. macrorrhyncha* x *Maideni,*
B.—*E. rubida* x *melliodora,* the former being the pollen parent in each case.

They were pollinated on 8th February, 1918, and 9th December, 1917, respectively. My specimen of "A." died in May last, when the seedling was 2 inches high. Of "B." I have two plants, 111/2 and 12 inches high on 1st November, 1919. They will be described in detail on a future occasion.

1. E. AFFINIS Deane and Maiden.

The parents are assumed to be *E. sideroxylon* and *E. hemiphloia,* var. *albens.* See Part XIII, 101–3.

Fruits of this species may vary in size from 7 to 15 mm. in length. The average is about 10 mm. There are in the National Herbarium, Sydney, specimens which depart from the type. Amongst these may be enumerated—

(*a*) Murrurundi, N.S.W. (J. H. Maiden and J. L. Boorman, May, 1902), with leaves as small as those of the type and also much longer and broader. In these specimens the pedicellate character is emphasised. These trees grow in the vicinity of *E. melliodora.*

(*b*) Grattai, Mudgee district, New South Wales (J. L. Boorman and A. Murphy). In this district there are two forms, with small fruits as depicted in figures 4*a* and 4*b,* Plate 57, and one with leaves coarser than those of the type, and with fruits as large as those of the type, but globular, rather than pear-shaped.

2. E. BOORMANI Deane and Maiden.

See Part X, p. 330. This is assumed to be a hybrid between *E. siderophloia* Benth., and *E. hemiphloia* F.v.M.

3. E. CALOPHYLLA R.Br., x E. FICIFOLIA F.v.M.

PEREZ, Dr. G. V., 1919.—I had frequent communications with the late Dr. G. V. Perez, of Teneriffe, and have been long a believer that the puzzling colour-forms attributed to *E. ficifolia* were, at least, as regards some of them, to be attributed to hybridism with *E. calophylla.* I sent him seeds of several forms for experiment, and following are extracts from recent letters from him:—

In order to preserve a very beautiful Eucalyptus hybrid which I am growing from seeds sent from Sydney as *E. ficifolia* (cherry coloured) (this is really *E. calophylla* var. *rosea,* J.H.M.), I am grafting by approximation, placing the stock in a large and long bamboo tube; the method succeeds very well, and I should say that to preserve any pretty shade of colour it will be valuable. I am going to employ as stock the hybrid *calophylla* x *ficifolia,* as *E. ficifolia* is much more delicate in the bad soil I have here, and besides the "cherry" I wish to preserve is a hybrid, which does not breed true from seeds. I have thought that what I have written may possibly be of some interest. (31st March, 1919.)

I shall now endeavour to obtain several plants of one which you sent as *E. ficifolia,* and which is certainly a hybrid, often referred to in my correspondence with you as "cherry" colour, and most beautiful and floriferous, which began to flower when only four years old, and the progeny of which began to flower as early as two years old, some of them being white, some resembling the parent plant, and some rosy pink. The colour is so beautiful that it is worth while preserving by grafting by approximation, by the method above named, and grafting on its own stock; I have already two successfully grafted and planted out, but on (?) true *ficifolia,* which is not such a good stock.

One of these days I am going to send you by sample post or perhaps by a postal packet, the capsules of the progeny of this tree, which are most variable and which, like the flowers, tell the story of its hybrid nature. (18th June, 1919.)

The untimely death (on 29th February, 1920) of this accomplished investigator put a stop to experiments which would doubtless have been very interesting. He was a confirmed believer in hybridism in the genus.

Some notes on *E. ficifolia* and *E. calophylla* will be found in this work, Part XLIII, pp. 78–81. See also a paper by myself "On a Eucalypt Hybrid (*E. calophylla* x *E. ficifolia*)," in *Proc. Linn. Soc. N.S.W.,* xli, 185 (1916).

Interesting results as regards the segregation of commercially valuable colour-forms would follow experiments on Mendelian lines.

4. E. CONSIDENIANA Maiden.

See Part X, p. 315. It is suggested to be a hybrid between *E. piperita* Sm. and *E. Sieberiana* F.v.M.

5. E. CORNUTA x LEHMANNI Bourlier.

In Trabut, *Rev. Hort. de l'Algérie,* August, 1901, p. 239. A preliminary note only.

I have seen no details of this reputed hybrid.

6. E. FOELSCHIANA F.v.M.

I have already quoted Mueller's opinion that hybridisation may account for some of the forms to which *E. Foelschiana* belongs. (Maiden, *Trans. Aust. Ass. Adv. Science,* 1904, p. 303.)

7. E. GOMPHO-OCCIDENTALIS Hort.

8. E. GUNNII-GLOBULUS Hort.

They have both been distributed by MM. Vilmorin, Andrieux and Cie, are near *E. gomphocephala* DC. as far as fruits are concerned, but I have not seen complete specimens, and am therefore unable to criticise the nomenclature as indicative of the supposed parents.

9. E. HEMIPHLOIA F.v.M. x E. MELLIODORA A. Cunn.

Mr. A. D. Hardy refers to a reputed hybrid of *E. hemiphloia* x *melliodora,* between Stawell and the Grampians, in *Proc. Roy. Soc. Vict.,* xxix (new series), p. 169:—

On the way from Stawell to the Grampians, and near Brigg's Creek, on Rose's Gap road, there is, in a paddock lately occupied by Mr. Wills as a bee-farm and range, a tree which seemed to be a hybrid (*E. hemiphloia* x *E. melliodora*), with foliage, fruit and bark satisfying the requirements of the former, and with buds distinctly nearer the latter species. Both species grew in the district, but with no *E. melliodora* lately in the immediate neighbourhood. *E. melliodora* (Yellow Box) sometimes—frequently in the silurian country near Alexandra, &c.—assumes a drooping habit like *Salix babylonica,* or the Weeping Elm; many trees may be found aggregated in a locality, or scattered amongst those of more or less erect habit, but *E. hemiphloia* avoids this weeping habit entirely, so far as my experience goes.

Mr. Hardy proceeds to describe heterotropy (reversed direction of growth of a branch and branchlets) in this tree.

10. E. HYBRIDA Maiden.

See this work, Part XLII, p. 48. It is assumed to be a hybrid between *E. paniculata* Sm. and *E. hemiphloia* F.v.M.

11. E. INTERMEDIA R. T. Baker.

It was originally suggested as a hybrid between *E. corymbosa* Sm. and *E.*

maculata Hook. See this work, Part XXXIX, p. 256, for Mr. Baeuerlen's original statement. Such a surmise explains some of the facts.

12. E. KIRTONIANA F.v.M.

Suggested parents, *E. robusta* Sm. and *E. resinifera* Sm.

Mueller in "Eucalyptographia," under both "*E. resinifera*" and "*E. robusta,*" refers to a tree which partakes of the characters of both, and for which he proposes the provisional name of *E. Kirtoniana.* There are reasons for supposing that this tree is a hybrid, one of whose parents being probably *E. rostrata* (*robusta* in original; *rostrata* a misprint). (Maiden in *Trans. Aust. Ass. Adv. Science,* 1904, p. 302.) See Part XXIX of the present work, p. 203.

13. E. KITSONIANA (Luehmann) Maiden.

See Part XXVIII, p. 164.

I am of opinion that this may be a hybrid in which *E. ovata* Labill. plays a part.

14. E. LASERONI R. T. Baker,

which is assumed by me to be a hybrid between *E. eugenioides* Sieb., and *E. stellulata* Sieb. See Part XLVII, p. 188.

15. E. LEUCOXYLON F.v.M. and (?) E. FASCICULOSA F.v.M.

Mr. Walter Gill, Conservator of Forests, Adelaide, sent me herbarium specimens, timber and bark, of an aberrant tree from Kuitpo, South Australia, with the following note:—"I send you a specimen of *E. leucoxylon* timber showing a very red heartwood, which I have only seen in this district, the northern Blue Gum (*E. leucoxylon*) being all one colour."

The herbarium specimens are obviously strongly akin to those of *E. leucoxylon* F.v.M. (They also resemble those of *E. sideroxylon* A. Cunn., but I do not know an individual of that species nearer than some hundreds of miles.) The timber is deep red, and the bark is somewhat fibrous (Box-like), characters rarely present in *E. leucoxylon.* It seems reasonable to look upon this rare plant as a hybrid, and as to the other parent, Mr. Gill suggests *E. fasciculosa* as likely. The points in which these specimens differ from *E. leucoxylon* could be supplied by *E. fasciculosa,* a red-timbered species abundant locally. (Maiden in *Proc. Linn. Soc. N.S.W.,* xxx, p. 497 (1905)).

16. E. LONGICORNIS F.v.M. x E. FOECUNDA Schauer.

The late Mr. Henry Johnston, Surveyor-General of Western Australia, told me that he had given the descriptive name of "Yorrel" to a supposed hybrid between York Gum (*E. foecunda* Schauer) and the Morrel; it seemed to him to have the timber of the York Gum and the twigs of the Morrel.

I have not been able to obtain twigs of any of Mr. Brockman's or of Mr. Johnston's supposed hybrids, so I cannot express an opinion as to their botanical relationships, but I think it highly probable that hybridism does explain the puzzling variations to be referred to in regard to the Morrels. (Maiden in *Journ. Roy. Soc. N.S.W.,* xlix, p. 325, 1915.)

17. E. LONGICORNIS F.v.M. x E. OCCIDENTALIS Endl.

The use of the name "Morrel," which is one of the most used names in Western Australia, is referred to in the present work, Part XV, pp. 166–7. It is usually applied to *E. oleosa* F.v.M. var. *longicornis* F.v.M.

Mr. Fred. Brockman, then Chief Surveyor of Western Australia, and whose knowledge of the trees of that State was very extensive, in an interesting interview, suggested hybridism in regard to the "Morrel." He suggests that the Yate (*E. occidentalis* Endl.) from the south coast of Western Australia and the Morrel from the eastern district of Western Australia (*E. oleosa* F.v.M., var. *longicornis* F.v.M.) probably have met say in the latitude of Katanning, and "from the common point of process of hybridising has proceeded spreading northward until Yate is lost in Morrel, and southward until Morrel is lost in Yate." (Maiden in *Journ. Roy. Soc. N.S.W.,* xlix, 325, 1915.)

18. E. MOOREI Maiden and Cambage, and E. STRICTA Sieb.

In *Proc. Linn. Soc. N.S.W.* xxx, 200 (1905), Maiden and Cambage fully describe, under the letter B, a form that they assume to be a hybrid of the above two species.

19. E. MUNDIJONGENSIS Maiden.

In describing the above species in *Journ. Roy. Soc. N.S.W.,* xlvii (1913), I made the following observation at p. 225:—

When a tree is isolated, or very rare, there is a temptation to look upon it as a hybrid, and I have considered that view in the present case. It may be a correct one, but I do not know enough about its parents to emphasise the point. I believe it should have a name, and although I have a fair knowledge of Western Australian Eucalypts, it seems quite distinct from any, imperfect as my material is. Locally it is looked upon as allied to the Tuart, *E. gomphocephala* DC.

20. E. NEGLECTA Maiden.

See Part XXVII, p. 151. I am of opinion that this may be a hybrid in which *E. ovata* Labill. takes a part.

21. E. PENRITHENSIS Maiden.

It is assumed that this may be a hybrid between *E. eugenioides* Sieb. and *E. hoemastoma* Sm. var. *micrantha.* See Part XLVII, p. 215.

22. E. SALIGNA Sm. and E. ACACIaeFORMIS Deane and Maiden (?).

Mr. A. R. Crawford, Moona Plains, Walcha, sends me specimens with the following note:—"No. 5. Supposed hybrid between *E. saligna* and *E. acacioeformis* (Black Peppermint). The tree is from 60–70 feet in height, rough-barked from the ground to within 5 or 6 feet or less of the smallest twig; in appearance the tree reminds me of the true *saligna,* although the bark resembles that of the "Black Peppermint."'

The fruits of this tree are intermediate in size and shape, and the buds intermediate in size and shape between those of *E. saligna* and *E. acacioeformis.* The suggestion as to the hybrid origin appears reasonable enough. (Maiden in *Proc. Linn. Soc. N.S.W.,* xxx, 498, 1905).

On further consideration, I am less confident about this supposed hybrid.

23. E. STUARTIANA F.v.M. and E. NOVA-ANGLICA Deane and Maiden (?).

Seven miles east of Walcha (J.H.M.) we have a tree with Peppermint bark all up the trunk (bark of *E. nova-anglica*). Suckers narrower than those of *E. Stuartiana.* Fruits smaller than, but near to those of *E. Stuartiana.* Foliage intermediate in character between that of *Stuartiana* and *nova-anglica.* I am inclined to think this is a case of hybridism. (Maiden in *Proc. Linn. Soc. N.S.W.,* xxx, 499, 1905).

I have mislaid these specimens, and therefore cannot follow up this case of supposed hybridism.

24. E. TaeNIOLA R. T. Baker.

L. Rodway in *Proc. Roy. Soc. Tas.,* 12 (1917), says it seems probable that it is a hybrid between the Black Peppermint (*E. amygdalina*) and Mountain Ash (*E. Sieberiana*).

25. E. VITELLINA Naudin.

26. E. VITREA R. T. Baker.

I am of opinion that these are hybrids between *E. amygdalina* Labill. and *E. coriacea* A. Cunn. The matter has been discussed at some length in Part VI, pp. 164–166, 167 of the present work. See also observations by me in *Journ. Roy. Soc. N.S.W.* lii, pp. 516–518 (1918).

TIMBER.

Historical.—Early Attempts at Classification.

GOVERNOR PHILLIP was not enraptured with Eucalyptus timber. Four months after the foundation of the colony (of New South Wales, which took place January, 1788) he thus wrote (*vide* G. B. Barton):—

The timber is well described in Captain Cook's Voyage, but unfortunately it has one very bad quality, which puts us to great inconvenience; I mean the large gum-tree, which splits and warps in such a manner when used green, and to which necessity obliged us, that a storehouse boarded up with this wood is rendered useless.

The expedition landed in the middle of summer, the worst time, of course, for converting timber, while no one, a century and a quarter later, is likely to select timber for economic purposes which naturally grows on the shores of Port Jackson. Phillip, however, felt he had not been able to give the timber a fair chance, for he wrote a few months later—

. . . Gum trees of a very large size, and which are only useful as firewood, though I think that when we can cut them down in the winter and give them time to season, they may be made useful in building. (Barton's *History of New South Wales,* i, 337.)

It cannot be said that early writers exaggerated the utility of Australian timbers. During the very month that Phillip wrote the first quoted statement, Major Ross wrote—

. . . and I have no doubt but will, like the wood of this vile country when burned or rotten, turn to sand. This latter is a fact that has been proved . . . It is very certain that the whole face of it is covered with trees, but not one bit of timber have we yet found that is fit for any other purpose than to make the pot boil (*op. cit.,* i, 501.)

An officer of marines wrote to Sir Joseph Banks, and summed up the matter thus: “These Gum-trees grow to an amazing size, but are scarce worth cutting down.” (i, 504.)

The early colonists met with timber of a hardness and intractability to which they had been quite unaccustomed, and possessed very little food to supply the necessary muscular energy. The references to Australian Eucalyptus timbers in works published in the very early days were scant and indefinite, and are hard to interpret because of the imperfection of the nomenclature. It was long before even botanists tackled them because of the difficulties surrounding their classification.

The collection of New South Wales timbers by Caley (1800-1810) has been referred to at Part L, p. 308 (under Barks).

The vast majority of Australian timbers at present put to use are Eucalypts, and the discrimination of species precedes and dominates the state of our knowledge of these timbers. The botany of Eucalyptus has for long been obviously unsatisfactory, as can be gathered from the taxonomic portion of this work, but the co-ordination of knowledge in regard to the timbers was in far greater confusion. The use of vernaculars was rampant. Timbers were either exhibited under vernaculars (an honest method) or under vernaculars with botanical names "fitted on" to them, which sometimes was not honest, although there was no intention to deceive. The managers of our courts at International Exhibitions demanded botanical names, and the officer in charge of an exhibit did his best to oblige. And when it is pointed out that some timbers have a dozen vernaculars, and that the same vernacular may perhaps be applied to a dozen timbers, some idea of the position can be formed, or perhaps not. Many years ago I set out to do something to rectify a state of things which reflected no credit on any Australian State.

The scientific method (always the true method) was adopted, and one thing led to another. Firstly, in 1881, I set myself to gather together the scattered literature of Australian timbers, and this led to the compilation of my "Useful Native Plants of Australia" (1889), a pioneer work, followed by a "Bibliography of Australian Economic Botany" in 1892. Meantime this research led to my forming the timber collection of the Technological Museum, Sydney. For a reference to the earliest collections see my Annual Report of the Technological Museum, presented to Parliament for 1886, p. 16, and especially 1887, p. 24. The collections were based on material of ascertained botanical origin, with the view of reducing empiricism to a minimum. In my capacity as one of the New South Wales Commissioners for various International Exhibitions, I saw the old empirical methods in full swing, and because I could not convince my colleagues (worthy citizens, but few with scientific proclivities), that the way they were exhibiting our timbers was of very little practical value, and, because my desire to substitute authentic information for empiricism met with little response, I determined to throw my energy into the formation of the permanent referential timber collection already referred to.

The following preface to a paper read by me, by invitation, before the Engineering Association of New South Wales, and published in the "Building and Engineering Journal," Sydney, and also in the "Builders' and Contractors' News," of 25th May, 1889, shows that the serious investigation of the properties of New South Wales and Australian timbers is comparatively recent, although the period is a big slice in the working life of a man:—

Systematic attempts to describe and classify our timbers date from the year 1855, the date of the Paris Exhibition, as it was only Tasmania (Van Diemen's Land, as it was then called) which used the Great Exhibition of 1851 to make known her native timbers. In the year 1854, for the display at Paris in the year following, the first serious attempt was made to gather our native timbers together, name, and give particulars concerning them. This work was delegated to Mr. (afterwards Sir) William Macarthur, who undertook the collection of timbers from what was called the “southern districts” of New South Wales, but which mainly comprised the counties of Cumberland and Camden, while Mr. Charles Moore, then, as now (I succeeded him in 1896—J.H.M.), Director of the Botanic Gardens, took charge of the “northern district,” but his specimens came from what is now a portion of southern Queensland. These two gentlemen again co-operated for the London Exhibition of 1862, their collections in that exhibition being of enhanced value, partly by reason of their greater number, and partly because they were better named, owing to the advance of Australian botanical science in the interim. Queensland having become a separate colony since the previous exhibition, Mr. Moore substituted for his previous collection a large number of timbers chiefly from the Clarence River district of our colony. Since then, advantage has been taken to exhibit New South Wales timbers at most of the principal International Exhibitions, but I regret to express the opinion that strangers to New South Wales have learnt but little of our timbers, for the reason that we have imparted so little information concerning them. There is no doubt that the conventional method of showing timbers at exhibitions is almost a useless one; if the object be simply to show the appearance of polished blocks, that might easily be attained by carefully colouring and graining pieces of some light and inexpensive wood which would lend itself to the process.

The fact of the matter is that exhibition collections are, as a general rule, required at too short a notice for justice to be done to timbers in regard either to variety or quality. Again, recommendations of this and that timber for this and that purpose have been freely made; many of them appear to be merely guesses, more or less judicious, and should be prefaced with the words “I think.” But to rectify such statements, and to assess a timber at its true value takes a long time, perhaps longer than any other vegetable product. Under the direction of the Committee of Management of the Technological Museum, I have for the past three years been collecting logs of New South Wales timbers, with complete sets of herbarium material, in case any doubts should crop up. We have, up to date, nearly 130 logs 4 feet long, most of them of fairly large diameter. They have been cut at the proper season, are now undergoing seasoning, and at the proper time each will be sawn longitudinally into halves, one half displayed to show the nature of the wood, while the other will be, as far as possible, worked into various articles for which it has been pronounced by various writers to be suited. Pieces will also be available for the testing-machine. Now all this requires much time, and is a serious expense, but there appears to be no golden road to a knowledge of timbers any more than to any other branch of human knowledge. One of my reasons for coming here to-night is to ask members of this important Association to help in this national work of learning the truth about our native timbers. I would say to an individual member, “Keep the timber of a particular species under observation, making notes in regard to the experience of yourself, and trustworthy informants, as to its use and capabilities. Try to prove the truth or falsity of reports. But if the botanical name is not known to you already, it is in the highest degree important to collect flowering and fruiting specimens (usually most conveniently obtained by a gun), from a tree of the same kind. The reason of this is, of course, to give precision to your remarks, for if a tree is ever so valuable, it is obvious that it is of no use unless it can be identified.” To the difficulty of identifying Australian trees unless botanical precautions have been taken, I have already alluded. I state a truism when I observe that our knowledge of Australian timbers is in its puling infancy, and I need not further apologise for these prefatory remarks, which are intended to show the state of the case, and thus engineers may see that the slightest observation, on authenticated timber, is worthy of record and will pave the way for a literature of the subject.

Modern Systems of Classification.

1892.—In a lecture delivered by me on 5th September, 1892, before the Sydney Architectural Association of New South Wales, entitled “Some of the Pale Hardwood Timbers of New South Wales” (“Building and Engineering Journal,” Sydney, 10th September, 1892) I divided many of the Eucalyptus timbers (of New South Wales) into pale hardwoods, subdividing them into three groups—(*a*) hard, interlocked; (*b*) fissile; (*c*) inferior, such as Gums; which is a useful practical classification.

In (*a*) I included Grey or White Box (*E. hemiphloia*), Spotted Gum (*E. maculata*), Tallow-wood (*E. microcorys*), Blackbutt (*E. pilularis*), Mountain Gum (*E. goniocalyx*), Blue Gum of the southern ranges (*E. Maideni*).

In (*b*) the Stringybarks, *E. capitellata, macrorrhyncha, eugenioides, obliqua,* Mountain Ash (*E. Sieberiana*), White Ash (a tree we now know as *E. gigantea*), White Ash (later described as *E. fraxinoides*), Cut-tail (a tree we now know as *E. regnans* var. *fastigata*), Silver-top (a tree that probably is now known as *E. nitens*).

In (*c*) were grouped Peppermint No. 1 (*E. piperita*), Peppermint No. 2 (a tree now known as *E. radiata*), Messmate (*E. dives*), Manna Gum (*E. viminalis*), Apple Gum (*E. Stuartiana*).

1895.—In my "Notes on the Commercial Timbers of New South Wales" (first edition, 1895), at page 6, was submitted a classification (I give only the Eucalypts) of—

1. Ironbarks.
2. Pale Hardwoods.
3. Red Hardwoods.

1. *Ironbarks* of various kinds.

A table was given comparing—
E. paniculata (White or She Ironbark).
E. crebra (Narrow-leaved Ironbark).
E. siderophloia (Broad-leaved Ironbark).
E. sideroxylon (Red Ironbark).

2. *Pale Hardwoods*—

(*a*) Blackbutt (*E. pilularis*).
(*b*) White Mahogany (*E. acmenioides*).
(*c*) Tallow-wood (*E. microcorys*).
(*d*) Spotted Gum (*E. maculata*).
(*e*) Grey Box (*E hemiphloia*).

3. *Red Hardwoods*—

(*a*) Red Mahogany (*E. resinifera*).
(*b*) Grey Gum (*E. propinqua*).
(*c*) Murray Red Gum (*E. rostrata*).
(*d*) Forest Red Gum (*E. tereticornis*).
(*e*) Sydney Blue Gum (*E. saligna*).
(*f*) Woollybutt (*E. longifolia*).
(*g*) Bloodwood (*E. corymbosa*).

1896.—"New South Wales, the Mother Colony of the Australias," see p. 186. In my article on the Timbers of New South Wales in the same work, at p. 171, I divide the Eucalypts into "Ironbarks"; after these a convenient practical classification of our hardwoods is into "Pale Hardwoods," "Red Hardwoods" (both these comprising the commercial or best hardwoods of the colony) and the inferior or doubtful hardwoods (for lists consult paper).

1901.—In "The Forests of New South Wales," a lecture delivered before the Royal Society of New South Wales, and reported in the *Agricultural Gazette* of New South Wales for July, 1901, I propose the classification—Ironbarks, Boxes, Stringybarks, Pale Hardwoods, Red Hardwoods.

1902.—In *Journ. Roy. Soc. N.S.W.,* xxxvi, p. 319 (1902) I submitted the following notes on classification:—

1. *Gums.*—These timbers are short in the grain, dry to a brown or reddish colour, crack radially in drying, have many gum-veins, and, as a rule, lack durability. Their barks are smooth, and more or less ribbony. Examples: *stellulata, coriacea, hoemasloma, viminalis, Gunnii.* They connect with the "Boxes" (Bastard), and also with the smooth-barked members of the Jarrah Group.

2. *Mallees.*—Examples: *oleosa, Behriana, incrassata.* This is a group based on geographical considerations. They are arid country species, and connect the "Gums" and "Red Boxes."

3. *Ironbarks.*—These are fully described in my "Notes on the Commercial Timbers of New South Wales." They consist of (*a*) True Ironbarks, viz., *paniculata, siderophloia, crebra, sideroxylon*; (*b*) Bastard Ironbarks, timbers very similar to Ironbarks, but the barks belonging to the "Box" group. They consist of *Boormani* and *affinis; melanophloia* (and perhaps *microtheca*) connect the two groups.

4. *Boxes.*—These are tough, interlocked timbers, usually with fibrous bark on the trunk, and may be subdivided into:—

(*a*) Pale.—Examples: *hemiphloia, melliodora, Bosistoana, Baueriana, populifolia, quadrangulata, Cambagei* (*eloeophora*), *goniocalyx, tesselaris, leucoxylon, corynocalyx* (*cladocalyx*), *globulus.*

(*b*) Red.—Examples: *bicolor, microtheca, polyanthema, odorata* (should be brown), *fasciculosa.* These two groups include some smooth barks or "gums," but their timbers are provisionally classified with the "Boxes."

(*c*) Bastard.—Examples: *Stuartiana, pulverulenta, Macarthuri, aggregata.* The timber of (*c*) is inferior and closely resembles that of the Gums.

5. *Stringybark Group.*—This includes a number of fissile timbers that pass into each other and may be subdivided as follows:—

(*a*) True Stringybarks.—Examples: *eugenioides, macrorrhyncha, capitellata, obliqua, Baileyana.*

(*b*) Blackbutts.—Examples: *pilularis* (which absolutely connects with the Stringybarks through its variety, *Muelleriana*), *acmenioides.* The most valuable timbers of the group.

(*c*) Peppermints.—Examples: *amygdalina, regnans, dives, piperita*; these timbers have gum-veins and are altogether inferior in quality.

Allied to these are:—

6. *Mountain Ash Group.*—Fissile timbers usually pale in colour, and with bark not so fibrous as the preceding. Example: *Sieberiana.*

7. *Tallow-wood and Spotted Gum.—E. microcorys* and *E. maculata,* two valuable pale-coloured timbers, *sui-generis.*

8. *Bloodwoods.*—These have gum-veins and are coarse grained; *corymbosa* is red, and *eximia* and *trachyphloia,* which are pale, connect with *maculata.*

9. *Jarrah Group.*—Containing a number of heterogeneous species, and which I name after the best known member. Some have fibrous barks, others are smooth, but they are all deep red, durable timbers. Examples: *marginata, resinifera, diversicolor, propinqua, punctata, saligna, botryoides, robusta, tereticornis, rostrata, longifolia,* This group connects with the Red Boxes.

1904.—“Notes on the Commercial Timbers of New South Wales,” (2nd edition 1904). In this edition I submitted a classification—

1. *Ironbarks.*
2. *Stringybarks,* including—

White Stringybark (*E. eugenioides*).
Red or Coast Stringybark (*E. capitellata*).
Red or Mountain Stringybark (*E. macrorrhyncha*).
Messmate or Stringybark (*E. obliqua*).

3. *Pale Hardwoods*—

(*a*) Mountain Ash (Mountain form of *E. obliqua,* subsequently ascertained to be *E. gigantea.* Also *E. Sieberiana* and *virgata* var. *altior* (*E. altior* or *E. oreades*)).
(*b*) Blackbutt (*E. pilularis*).
(*c*) White Mahogany (*E. acmenioides*).
(*d*) Tallow-wood (*E. microcorys*).
(*e*) Spotted Gum (*E. maculata*).
(*f*) Grey Box (*E. hemiphloia*).
(*g*) Some other pale-coloured Boxes of secondary importance—

A. Yellow Box (*E. melliodora*).
B. A Yellow or Bastard Box (*E. Bosistoana*).

C. A Box (*E. quadrangulata*).

(*h*) Some miscellaneous pale timbers—

A. Mountain Gum (*E. goniocalyx*).
B. Bundy or Mountain Apple (*E. Cambagei,* since ascertained to be *E. eloeophora*).
C. A Blue Gum (*E. Maideni*).

(*i*) Boxes of intermediate colour—

A. Round-leaf Box or Fuzzy Box (*E. Baueriana*).
B. Bimble Box (*E. populifolia*).
C. Ironbark Box, Mallee Box (*E. odorata*).

4. *Red Hardwoods*—

(*a*) Red Mahogany (*E. resinifera*).
(*b*) Grey Gums (*E. punctata* and *E. propinqua*).
(*c*) Murray Red Gum (*E. rostrata*).
(*d*) Forest Red Gum (*E. tereticornis*).
(*e*) Sydney Blue Gum (*E. saligna*).
(*f*) Woollybutt (*E. longifolia*).
(*g*) Bloodwood (*E. corymbosa*).
(*h*) Red Boxes—

A. Red Box or Slaty Gum (*E. polyanthemos*).
B. River Box, Drooping Box (*E. bicolor*).
C. Coolibah (*E. microtheca*).

1905.—“Forestry in New South Wales.” University of Sydney Extension Lecture. Reported in the *Agricultural Gazette, N.S.W.,* for December, 1905, p. 1185.

In this lecture, at page 1193, I made new suggestions for classification. I suggested a new grouping of Blackbutt, Pale Box, and (amplifying my 1902 suggestion), I suggested that the name Jarrah should include a number of red timbers, including Grey Gums, Forest Mahogany, Woollybutt, Blue Gums, the Red Boxes and the Red Gums. Such a suggestion as this is worthy of consideration if the question of the reduction of the number of names for somewhat similar timbers on this continent is to be gone into.

Blackbutt. I made this term include:—

E. pilularis (the true Blackbutt).

E. acmenioides and *E. umbra* (two kinds of White Mahogany).

E. goniocalyx (Mountain Gum).

Pale Box. I made this term include:—

E. hemiphloia (White or Grey Box).

E. Baueriana (Fuzzy Box.)

E. Bosistoana (South Coast Box).

E. quadrangulata (A Box).

E. melliodora (A Yellow Box).

Fissile specimens of the Pale Boxes may approximate in texture to the Blackbutts.

Jarrah. I would make this term include:—

A. *E. punctata* and *E. propinqua* (Grey Gums).

E. resinifera (Forest Mahogany).

E. longifolia (Woollybutt).

E. saligna (Blue Gum).

B. The Red Boxes—

E. polyanthemos (Red Box or Slaty Gum).

E. Rudderi (Coast Red Box).

E. bicolor (Black or Flooded Box).

E. fasciculosa (really *intertexta*) (Western Red Box).

C. The Red Gums—

E. rostrata (River Red Gum).

E. tereticornis (Forest Red Gum).

1914.—In the New South Wales Handbook (prepared for the visit of the British Association, 1914), p. 440, I briefly classified the species of that State as follows:—

Ironbarks.

Stringybarks.

Woollybarks.

(By this term I referred to barks which are matted and comparatively smoothish externally, not with the fibres longitudinally disposed and coarse, as in the preceding section. This is a large group, which includes Blackbutts, Ashes, Peppermints, Boxes.)

Bloodwoods.

Gums.

Mallees.

Other dwarf species.

In the Federal Handbook (prepared for the visit of the British Association, 1914), p. 187, I stated that the timbers of Eucalyptus may, as regards colour, be roughly divided into red, brown, and pale.

I shall have something more to say on this very important matter of classification when I come to the question of nomenclature, which will be separately considered in the present Part, p. 136.

1917.—"Australian Eucalyptus Timber," R. T. Baker, *Official Year-book,* x, 85 (1917).

Mr. Baker's classification is as follows:—

1. Ironbarks.
2. Gums.

(*a*) Pale-coloured woods.
(*b*) Red coloured timbers.

(*E. leucoxylon* has been admitted into this group in error, and *E. redunca* is not a true red wood. J.H.M.)

3. Tallow-wood.
4. Stringybarks.
5. Ashes. These include *E. gigantea* (*E. delegatensis*). *E. fraxinoides, E. Sieberiana, E. oreades.*
6. Blackbutts. *E. patens,* the W.A. Blackbutt, is added to the eastern *E. pilularis.*
7. Mahoganies—

(*a*) Pale (*E. acmenioides* and *E. umbra.*)
(*b*) Red (*E. resinifera, E. marginata* (Jarrah)).

8. Boxes—

(*a*) Pale. This is made to include *E. Boormani, E. microtheca, E. bicolor* (which are certainly not pale. J.H.M.).
(*b*) Red. This is made to include *E. Bosistoana* and *E. populifolia* (which are certainly not red. J.H.M.).

9. Bloodwoods.
10. Peppermints.

1919.—"The Hardwoods of Australia and their Economics," by R. T. Baker.

In this work the classification of 1917 does not appear to have been disturbed, but at p. 5, a classification, based on colours, is introduced (see Colours below), and at

p. 383 one of grades of hardness.

Colours.

Although colours have already been casually referred to, there is a practical convenience in giving the literature of the subject as regards colours, so far as I know it.

The comparison of the colours of timbers is not easy, since sometimes they are noted when newly cut, and sometimes when seasoned. As a rule, the timber is judged as regards colour when seasoned, but, if the colours when fresh could be ascertained in addition, the records would be more useful. Some of the colours of timbers are apparently discrepant because the freshly cut timbers of some are compared with the colours of seasoned timbers of others. At the same time, I have quoted colours of freshly cut timbers whenever I could ascertain them.

The colour of timber usually darkens and gets duller with age. As a rule, the timber of a young tree is paler in colour than that of an older one.

A chemical investigation of Eucalyptus timbers from the point of view of presence or absence of colouring matter has not, so far as I am aware, been undertaken.

I have briefly referred to colouration under Barks in Part LII, p. 104, and the colour of the inner bark is frequently transmitted more or less to the timber.

What is known as Heartwood consists of dead cells, the cavities of which as a rule are blocked up by gums or other substances which, being more or less saturated with tannins, are usually of a dark colour.

The following passage is suggestive:—

The Accumulation of Waste in Wood.—In many trees the heartwood serves as a reservoir of various excreta which may give it a colour different from that of the sapwood, as in the Red Cedar (*Juniperus Virginiana*), and in the Black Walnut. The coloured heartwood is usually much harder than the white sapwood (as in Mahogany and Ebony), whence the significance of the name *duramen.* Occasionally the medulla is a reservoir of excreta, as in the sumac, which is coloured yellow. Doubtless the chief advantage of the accumulation of such substances in the duramen is that thus they are removed from the active tissues, though it is an important subsidiary advantage that they increase the durability of the heartwood and thus promote longevity. ("Text-book of Botany," Coulter, Barnes and Cowles, ii, 725.)

The literature on the subject of colour in timber is not abundant, and attention may be invited to "Réchèrches sur la determination des bois exotiques colorés d'apres les caractères chimiques et spectroscopiques," par M. A. Jauffret (*Ann. du Musée*

Colonial de Marseille, 1920, pp. 163). It is a valuable paper, but chiefly refers to the timbers of the French colonies, a number of which are not cited by botanical names. There is a useful bibliography of the subject. No Eucalyptus timbers are mentioned.

Following is the first attempt to classify Australian timbers by colours:—

Maiden, 1892.—"Some of the Pale Hardwoods of New South Wales." Read, by invitation, before the Sydney Architectural Association, and published in the *Building and Engineering Journal,* 10th September, 1892.

Following is an extract:—

I have not, however, seen our hardwoods grouped according to colours, but I think that such a classification will be found useful, and, as our knowledge extends, degrees of difference in colour between our various hardwoods will be found which are scarcely appreciated at present. I propose this evening to deal with such of our hardwoods as are free, or almost free, from a reddish tinge, and which vary in colour when quite fresh, from white to a very pale brown. For precision I shall confine my remarks to the products of the genus Eucalyptus, which, of course, includes the vast majority of our hardwoods. Treat it as one will, the subject remains a difficult one if it be done with any approach to thoroughness. . . . (Here follow some notes in regard to the use of vernaculars and botanical names for the timbers of commerce, see p. 141). . . . I would like to remind architects, in passing, that there is some kudos to be obtained in designing furniture to be constructed out of our hardwoods. I particularly allude to such massive furniture as tables, settces, &c. In large houses in Europe, such furniture is often made of oak, where weight is not considered an object, and I think that some of our hardwoods may well be utilised as oak-substitutes. I may remind you that one of our pale hardwoods, White Ash, is pretty extensively used in Sydney already as a substitute for English and American Ash, and it is particularly suitable for bedroom furniture, presenting an excellent appearance. In classifying the pale hardwoods of this colony, it is not possible to draw a hard-and-fast line between the pale ones and those which are not pale, but I hope eventually to be able to give a scale of timber-colours. I have divided our New South Wales pale hardwoods into three groups, viz:—

1. Hard, interlocked timbers;
2. Fissile timbers;
3. Inferior timbers;

which I submit as a practically useful classification.

The classification will be found in brief detail at p. 130.

Maiden, 1895.—In my "Notes on the Commercial Timbers of New South

Wales," (First edition, 1895), I reiterated the classification of Pale Hardwoods, and added that of Red Hardwoods for the first time (see p. 131). Although, so far as I know, I may have used the terms Pale and Red for the first time in a scientific classification, I have known timber-men to use these terms as a general classification as long as I can remember. Governor Phillip's woodcutters must have noticed these extremes of colours.

Cambage, 1913.—Mr. R. H. Cambage, in his presidential address (*Proc. Roy. Soc. N.S.W.,* xlvii, 34, 1913), refers to the colour of timbers in the following words:—

In studying the dark and pale-coloured timbers, it is noted that in the warmer parts both colours occur, while in the Mountain Region, above an altitude of 3,500 feet in latitude 32 degrees, and at diminishing elevations to the southward, the prevailing colour of Eucalyptus timbers is pale, no red-timbered Eucalypt occurring in Tasmania (R. T. Baker and H. G. Smith make some reference to this subject in *Proc. Roy. Soc. Tas.,* p. 139, 1912). The colouring of dark timbers is evidently due to the presence of some constituent, perhaps developed in response to a plant food, and it seems not improbable that the development of the substance in question is retarded by the cold. The wood of mountain Eucalypts is also regarded as the least valuable for firewood among the genus, which fact implies some difference in the composition of many lowland and highland Eucalyptus timbers.

Baker, 1913.—In "The Cabinet Timbers of Australia," by R. T. Baker (1913), a few Eucalyptus timbers are shown in colour. They are admirable, and it is to be regretted that more species are not figured, and more specimens of each to show variation. Those figured are—

Plate XXX.—Mountain Ash or Tasmanian Oak (the latter a misleading trade name, but in use) (*E. gigantea,* given as *E. delegatensis*); a Stringybark (*E. obliqua*); Red Mahogany (*E. resinifera*); Jarrah (*E. marginata*); a Red Box (*E. Rudderi*); Spotted Gum (*E. maculata*); Sydney Blue Gum (*E. saligna*); Slaty Gum (*E. Dawsoni*).

In the same year, in dealing with Victorian Timber Trees at p. 307 of *Report Aust. Assoc. Adv. Science,* Mr. Baker says, "No less than seven-eighths of the sixty trees described in this paper are pale-coloured. The red timbers are, therefore, comparatively few, and number less than a dozen." He offers the classification:—

Heavy—

(*a*) Red-coloured timbers—*E. croymbosa, E. botryoides, E. polyanthemos, E. rostrata, E. tereticornis, E. longifolia, E. sideroxylon.*

(*b*) Pale-coloured timbers—*E. goniocalyx, E. hemiphloia, E. melliodora, E. Bosistoana, E. albens* (*hemiphloia* var. *albens*), *E. Fletcheri* (*Baueriana*), *E. Behriana.*

Medium—

Pale-coloured—*E. paludosa* (*ovata*), *E. globulus, E. pilularis, E. amygdalina* (*radiata*), *E. Muelleriana, E. eugenioides, E. capitellata, E. macrorrhyncha.*

Light—

Pale-coloured—*E. delegatensis* (*gigantea*), *E. regnans, E. obliqua, E. piperita*

Maiden, 1914.—The use of the designation "Brown" seems to have been omitted from classification until 1914, when (Federal Handbook for the British Association Meeting, p. 187) I suggested their grouping into red, brown, and pale, and added the following brief note:—

Red timbers may be found both in the interior (*e.g., E. rostrata* Schlecht, *E. microthcca* F.v.M., *E. salmonophloia* F.v.M.), or in the comparatively well-watered coastal districts (*E. marginata* Sm., *E. resinifera* Sm., *E. saligna* Sm.); but in the dry districts of eastern Western Australia, the timber is nearly always cigar-brown in colour. The pale timber (*e.g., E. pilularis* Sm., *E. microcorys* F.v.M., *E. gomphocephala* DC.) is mainly found in well-watered districts.

In the New South Wales Handbook for the British Association, p. 440, I emphasised the reference to brown timbers a little more—

Others may be brownish of shades, such as Blue Box, *Baueriana*; Grey Box. *hcmiphloia*; Shiny-leaved Box, *populifolia.* Some are very pale, almost white, such as Blackbutt, *pilularis*; New England Blackbutt, *Andrewsi*; Mountain Ash, *Sieberiana, gigantea*; but a hard-and-fast' line cannot be drawn between the pale and the brown ones.

Baker, 1917.—In *Proc. Roy. Soc. N.S.W.,* li, p. 410, with Plate XX, Mr. R. T. Baker uses colour in the discrimination of some of the Ironbarks, but in my view the colour-photographs are not quite satisfactory. My observations as to the unsatisfactoriness of using colour for diagnostic purposes in these Ironbarks, are given in Part XLVIII, p. 225, of the present work.

To the notes on variation in timber there given, may be added the following reference to *E. Andrewsi*—

Varies very much in quality according to soil and altitude. Timber growing on granite formation, and at a high altitude, is pale in colour and harder than the same timber at a lower altitude on soil of a basaltic formation. Where growing on the latter, the timber generally is a pale brown colour, denser and heavier than the former. (Forest Guard N. Stewart, Glen Innes district.)

Baker, 1919.—In Mr. Baker's "Hardwoods of Australia," at p. 3, we have some preliminary remarks on colour, and the following are extracted from his list of timbers under the various headings. I have collected the nomenclature adopted by Mr. Baker.

1. Dark Red.

E. affinis.
E. Cambageana.
E. Dawsoni.
E. Fergusoni (paniculata).
E. longicornis.
E. marginata.
E. microtheca.
E. polyanthemos.
E. punctata.
E. redunca.
E. resinifera.
E. rostrata.
E. salmonophloia.
E. siderophloia.
E. squamosa.

2. Red.

E. botryoides.
E. cornuta.
E. crebra.
E. Deanei.
E. diversicolor.
E. Griffithii.
E. hemilampra (*resinifera*.)
E. intermedia.
E. Longifolia
E. melanophloia.
E. N anglei (*paniculata*).
E. patentinervis (*Kirtoniana*).
E. propinqua.
E. populifolia.
E. robusta.
E. saligna.
E. tereticornis.

3. Pink.

E. Benthami.
E. bicolor.
E. Jacksoni.
E. Laseroni.
E. macrorrhyncha.
E. Macarthuri.
E. rubida.
E. viminalis.

4. Grey.

E. calophylla.
E. maculata.
E. paniculata.

5. Chocolate.

E. Beyeri.
E. Clelandi.
E. Le Souefii.
E. loxophleba (*foecunda*).
E. tesselaris.

6. Yellow.

E. Fletcheri (*Baueriana*).
E. globulus.
E. gomphocephala.
E. hemiphloia.
E. microcorys.
E. Muelleriana.

E. goniocalyx.	*E. patens.*

7. Pale.

E. acervula (*ovata*).	*E. Jacksoni* (also under Pink).
E. acmenioides.	*E. loevopinea.*
E. albens (*hemiphloia* var. *albens*).	*E. leucoxylon.*
E. amygdalina.	*E. Muelleri.*
E. angophoroides.	*E. Maideni.*
E. australiana (*radiata*).	*E. melliodora.*
E. Banksii.	*E. Mundijongensis.*
E. Bosistoana.	*E. oreades.*
E. Brownii.	*pilularis.*
E. campanulata (*Andrewsi*).	*E. piperita.*
E. Cannoni.	*E. Planchoniana.*
E. capitellata.	*E. quadrangulata.*
E. carnea (*acmenioides*).	*E. Rodwayi* (*aggregata*).
E. delegatensis (*gigantea*).	*E. scoparia.*
E. dextropinea (*Muelleriana*).	*E. Sieberiana.*
E. eugenioides.	*E. umbra.*
E. fastigata (*regnans*).	*E. virgata* (*Sieberiana*).
E. Guilfoylei.	*E. Wilkinsoniana* (*eugenioides*).

8. White.

E. Dunnii.	*E. nitens.*
E. fraxinoides.	*E. regnans.*

Maiden, 1921.—Here follows the classification I submit as a practicaly useful one.

It will be seen that my scheme is mainly based on colour. Other characters of ready application are fissility and its opposite (interlockedness), weight and hardness. It does not seem safe in the present state of our knowledge, and in the absence of detailed information, to bring in other factors.

No doubt some of the descriptions are similar to others in somewhat different verbiage, but, where possible, I have quoted the actual words of different authorities, or made by me at the time.

There is a certain amount of parallelism with the bark classification, but, in the present state of our knowledge, perhaps not much, and it has to be applied with care.

The normal colour of Eucalyptus timber is pale (“white”). The browns and the reds are due to tannins. The dull cigar-brown timbers of the interior I look upon as a later oxidation stage of the reds.

The Timbers may be provisionally arranged as follows:—

0. Mallees.

1. Pale Hardwoods—

A. Peppermint.
B. Mountain Ash.
C. White Mahogany.
D. Blackbutt.
E. Stringybarks.
F. Coriaceae.
G. Brittle Gums, pinkish when newly cut:—

(*a*) Gums.
(*b*) Half-barks.
(*c*) Rough barks.

H. Pale inlocked timbers.

2. Brown Hardwoods.
3. Red Hardwoods—

A. Red Gums.
B. Blue Gums.
C. Grey Gums.
D. Red Box.
E. Mahogany.
F. Woolly Butt.

4. Ironbarks.

A. Ironbark-Boxes.

5. Bloodwoods.

A. Red.
B. Pale.

(*a*) *E. setosa* group.
(*b*) Moreton Bay Ashes.

(*c*) *Eudesmiae.*

6. Western Australian Hardwoods.

A. Pale brown.
B. Dull cigar-brown.
C. Red.

0. MALLEES.

These are listed at p. 321, Part 50, and, as a rule, are too small to be enumerated as timber. I have, therefore, not repeated the lists.

1. PALE HARDWOODS.

Nos. A. to F. belong to the Renantherae, and are more or less fissile.

Amongst the Renantherae, *E. hoemastoma* (a White Gum) has been transferred to the Pink timbers.

E. microcorys (Tallow Wood) and *E. Planchoniana* have been transferred to the Pale inlocked timbers.

This section includes—

A. Peppermint (9 species).
B. Mountain Ash (6 species).
C. White Mahogany (2 species).
D. Blackbutt (1 species).

A. PEPPERMINT—

E. amygdalina Labill.	*E. numerosa* Maiden.
E. Andrewsi Maiden.	*E. piperita* Sm.
E. Consideniana Maiden.	*E. radiata* Sieber.
E. dives Schauer.	*E. taeniola* Baker and Smith.
E. linearis Dehnh. (Very little rough bark.)	

These are trees with what is known as the "Peppermint" bark, and characteristics of the timber are paleness (not always as pale as Mountain Ash), liability to gumveins, and a medium fissility, with low durability in the ground. Some of them have satisfactory durability for situations which do not involve contact with the earth.

E. AMYGDALINA Labill.

Pale, durable, with the limitations referred to.

E. ANDREWSI Maiden.

Pale to pale-brown, has gum-veins; durable.

Mr. Forest Guard N. Stewart, of Glen Innes, New South Wales, reports :—

This Blackbutt varies very much in quality according to soil and altitude, as I find that this timber growing on granite formation and at a high altitude is pale in colour and harder than the same timber at a lower altitude on soil of a basaltic formation. Where growing on the latter, the timber is generally of a pale brown colour, denser and heavier than the former, and the bark is of a more fibrous nature. It appears to be very subject to gum-veins, although not to such an extent as to injure the timber.

E. CONSIDENIANA Maiden.

Pale-coloured, liable to gum-veins, inferior in durability; resembles *E. piperita* a good deal.

E. DIVES Schauer.

Pale, full of concentric kino veins.

E. LINEARIS Dehnh.

Pale and moderately fissile. This is a true Gum (Leiophloiae), and not a Half-bark (Hemiphloiae).

E. NUMEROSA Maiden.

Pale-coloured, very fissile. Tough when freshly cut, but afterwards of inferior strength.

E. PIPERITA Sm.

Pale-coloured, with gum-veins, deficient in strength and durability, and only used in default of better timber.

E. RADIATA Sieber.

Pale-coloured, moderately fissile and durable.

E. TaeNIOLA (Black Peppermint of Rodway) Baker and Smith. Moderately fissile.

B. MOUNTAIN ASH—

E. fraxinoides Deane and Maiden.	*E. regnans* F.v.M.
E. gigantea Hook. f.	*E. Sieberiana* F.v.M.
E. oreades R. T. Baker.	*E. Smithii* R. T. Baker.

As compared with the Peppermints, this section flourishes in colder climates. The timbers are paler, often almost white, and some are remarkably fissile. They are comparatively light in weight, and include some useful furniture woods, particularly for bedrooms.

To show how puzzling the use of vernacular names is, we have the name

Peppermint in use also for Brittle-Gums (sub-sections Half-barks and Rough-barks), to mention no others.

E. FRAXINOIDES Deane and Maiden.

Pale-coloured, light in weight, fissile, tough.

E. GIGANTEA Hook. f.

Very pale, very fissile, of especial merit.

E. OREADES R. T. Baker.

Pale-coloured, rather soft, fissile.

E. REGNANS F.v.M.

Sometimes also known as Blackbutt. Pale, very fissile.

E. SIEBERIANA F.v.M.

Pale-coloured, moderately fissile.

E. SMITHII R. T. Baker.

Pale, moderately fissile.

C. WHITE MAHOGANY—

E. acmenioides Schauer.

E. umbra R. T. Baker.

These are intermediate in character between the two preceding groups, and Blackbutt (*E. pilularis*). *E. umbra* may be looked upon as an inferior quality of *E. acmenioides*. The best White Mahogany sometimes resembles Tallow-wood (*E. microcorys*).

E. ACMENIOIDES Schauer.

Pale-coloured, dense, somewhat fissile and durable. Often resembles *E. microcorys* somewhat.

E. UMBRA R. T. Baker.

Pale and somewhat resembling the preceding.

D. BLACKBUTT—

E. PILULARIS Sm.

Pale-coloured, more or less fissile, durable. It is usually readily diagnosed by the presence of narrow, concentric gum-veins, but sometimes these gum-veins are nearly or wholly absent. As a rule, they are too narrow to cause deterioration.

E. STRINGYBARK—

E. Blaxlandi Maiden and Cambage.	*E. macrorrhyncha* F.v.M.
E. capitellata Sm.	*E. Muelleriana* Howitt.
E. eugenioides Sieb.	*E. obliqua* L'Herit.
E. loevopinea R. T. Baker.	*E. Penrithensis* Maiden.

All distinctly fissile, although not so much as the most fissile of the

Renantherae. All well-grown trees yield valuable timber. Colour of timbers varying from "not white" to brownish and reddish brown, *i.e.,* becoming darker coloured than most of the Renantherae. It is not easy to make distinctive remarks in regard to the various Stringybarks. The names are not always distinctive.

E. BLAXLANDI Maiden and Cambage.

Closely allied to the next.

E. CAPITELLATA Sm.

Brown Stringybark.

E. EUGENIOIDES Sieb.

White Stringybark.

E. LaeVOPINEA R. T. Baker.

A silver-leaved Stringybark.

E. MACRORRHYNCHA F.v.M.

Red Stringybark.

E. MUELLERIANA Howitt.

Yellow Stringybark.

E. OBLIQUA L'Herit.

Sometimes called Messmate.

E. PENRITHENSIS Maiden.

Bastard Stringybark. Light to reddish-brown, concentric though not abundant gum-veins. Not a typical Stringybark—a reputed hybrid.

F. CORIACEae—

E. de Beuzevillei Maiden.	*E. Risdoni* Hook. f.
E. coriacea A. Cunn.	*E. stellulata* Sieb.
E. Laseroni R. T. Baker.	*E. vitrea* R. T. Baker.
E. Mitchelliana Cambage.	

Mostly Gums, more brittle, and perhaps more liable to gum-veins than the generality of the section of Renantherae to which they belong.

E. Laseroni is anomalous, for it is a reputed hybrid with a Stringybark, and its timber seems to bear out that assumption. It is sometimes known as "Stringybark," but it has more or less of a clean top. Indeed, several of the species have bark more or less rough at the butt.

The placing of *E. Risdoni* with the Coriaceae rather than with the Peppermints (of which *E. amygdalina* is a representative) is a departure which will be emphasised in due course.

E. DE BEUZEVILLEI Maiden.

Pale-coloured, almost white, with kino veins. General resemblance to *E. coriacea* timber.

E. CORIACEA A. Cunn.

White Gum. Pale-coloured, liable to gum-veins, warps seriously.

E. LASERONI R. T. Baker. “Stringybark.”

Yellowish-brown, tough to cut, brittle; pale, with gum-veins. A poor, upland timber.

E. MITCHELLIANA Cambage.

Drooping Gum. Pale coloured, with gum-veins.

E. RISDONI Hook. f.

Risdoni var. *elata* (Drooping Gum).

Pale coloured. This species appears to have a greater affinity with the Coriaceae than with *amygdalina,* alongside which it has been usually placed.

E. STELLULATA Sieb.

Green or Lead Gum. Pale-coloured, rarely free from gum-veins, warps seriously.

Timber that shrinks much in drying may do so regularly or irregularly. Those of the first-class have, when dry, practically the same shape as the original piece, but those of the second-class take on irregular shapes. The timbers of *E. stellulata* and *E. coriacea* belong to the latter class.

E. VITREA R. T. Baker.

White-topped Messmate. Liable to gum-veins.

G. BRITTLE GUMS.

I name these timbers (enumerated below) collectively Brittle Gums, as their timbers are brittle rather than fissile. Colour pinkish (particularly when newly cut) to pale red. (They connect with both the Whites and the Reds).

Most of them are indeed Gums (18), with Half-barks (5), and Rough-barks (6).

(*a*) Gums (Leiophloiae).

It will be observed that most of the timbers of this section are Gums. Most of them go under the name of White Gum, but some have different qualifying adjectives.

E. alba Reinw.	*E. leucoxylon* F.v.M.
E. Benthami Maiden and Cambage.	*E. maculosa* R. T. Baker.
E. cladocalyx F.v.M.	*E. Muelleri* T. B. Moore.
E. cordata Labill.	*E. Naudiniana* F.v.M.
E. Dalrympleana Maiden.	*E. Perriniana* F.v.M.
E. Dunnii Maiden.	*E. proecox* Maiden.
E. Gunnii Hook. f.	*E. rubida* Deane and Maiden.
E. hoemastoma Sm.	*E. scoparia* Maiden.
E. Irbyi Baker and Smith.	*E. viminalis* Labill.

(It will be observed that *E. hoemastoma* has been removed from the Renantherae section as regards the timbers.)

E. ALBA Reinw.

White or Cabbage Gum. Red when newly cut, drying reddish-brown, coarse-fibred, not fissile, brittle, not durable.

E. BENTHAMI Maiden and Cambage.

White Gum. Timber pale pink when fresh, and of moderate hardness and fissility.

E. CLADOCALYX F.v.M.

Sugar Gum. Pale, but slightly brown in the centre, tends to be brittle. White ants are fond of it.

E. CORDATA Labill.

A White Gum. Pale pink.

E. DALRYMPLEANA Maiden.

White Gum. A pinkish timber, reputed to be of promise for paper-pulp.

E. DUNNII Maiden.

White Gum. White throughout, from the sap to the heart, somewhat coarse-grained and fissile, apparently tough.

E. GUNNII Hook. f.

Cider Gum. Pale-coloured, pink when fresh; brittle.

E. HaeMASTOMA Sm.

White Gum. Reddish; soft, brittle and usually considered inferior.

E. IRBYI Baker and Smith.

White Gum. Pale-coloured.

E. LEUCOXYLON F.v.M.

White Gum. Pale, inferior.

E. MACULOSA R. T. Baker.

White or Spotted Gum. Pink when fresh—dries paler; brittle, not durable.

E. MUELLERI T. B. Moore.

Wood of a light red colour, extremely hard and surprisingly heavy, and of a stringy and close-grained character.

E. NAUDINIANA F.v.M.

Reddish when fresh.

E. PERRINIANA F.v.M.

A White Gum. Pale, brittle.

E. PRaeCOX Maiden.

White Gum. Pale-coloured, with kino veins; brittle.

E. RUBIDA Deane and Maiden.

Candle-bark. Pink when fresh, dries paler. Brittle, not durable.

E. SCOPARIA Maiden.

White Gum. Pale-coloured.

E. VIMINALIS Labill.

Ribbony or White Gum. Pale pink when fresh.

(*b*) Half-barks (Hemiphloiae).

I would emphasise the point that there is not a line of absolute demarcation between this section and the next (Rough-barks) so far as the timbers go.

The members go under the name of Woolly Butt (*Banksii* and *Macarthuri*), Peppermint (*cinerea*), while two (*ovata* and *Yarraensis*) are most commonly known as Swamp Gum, eloquent testimony to their affinity with the Gums.

E. Banksii Maiden.	*E. ovata* Labill.
E. cinerea F.v.M.	*E. Yarraensis* Maiden and Cambage.
E. Macarthuri Deane and Maiden.	

E. BANKSII Maiden.

Woolly Butt. A good hard timber, pale-coloured, said to resemble that of *E. Stuartiana* somewhat.

E. CINEREA F.v.M.

Peppermint. Reddish, inferior, not durable.

E. MACARTHURI Deane and Maiden.

Woolly Butt. Pale-coloured, nearly white. Does not split well, not durable.

E. OVATA Labill.

Swamp Gum. Pale, not durable.

E. YARRAENSIS Maiden and Cambage.

Swamp Gum. Pale-coloured, resembling that of *E. ovata.*

(*c*) Rough-barks (Rhytophloiae).

E. acacioeformis Deane and Maiden.	*E. eloeophora* F.v.M.
E. aggregata Deane and Maiden.	*E. nova-anglica* Deane and Maiden.
E. angophoroides R. T. Baker.	*E. Stuartiana* F.v.M.

Most of these trees go under the name of Peppermint (*acacioeformis, aggregata, nova-anglica, Stuartiana*). Three are called Apple of one kind of another, viz., *angophoroides* (Apple-top Box), *eloeophora* (Apple or Bastard Box), *Stuartiana* (Apple or Peppermint).

These names show a relation with the Peppermints enumerated at p. 142.

The Australian bushman uses the words Apple and Peppermint somewhat similarly. In the colder regions where the Apple-barked trees are found, he usually means that the Apple has a woollier bark than the Peppermint.

E. ACACIaeFORMIS Deane and Maiden.

Peppermint. Pale reddish.

E. AGGREGATA Deane and Maiden.

Black Gum. White, tough, not durable.

E. ANGOPHOROIDES R. T. Baker.

Apple-top Box. Pale-coloured, soft, specifically light timber, open in the grain and perhaps to be regarded as porous.

E. ELaeOPHORA F.v.M.

Bastard Box. Pale-coloured, not durable.

E. NOVA-ANGLICA Deane and Maiden.

Peppermint. Pinkish or pale red when fresh, drying to a pale colour. Not durable.

E. STUARTIANA F.v.M.

Apple Box. Pale (sometimes flesh-coloured when fresh), soft, brittle, not durable.

H. PALE, INLOCKED TIMBERS.

Economically this Group includes valuable timbers, indeed some of the best of the genus; there is not an inferior timber in the group.

E. canaliculata Maiden.	*E. microcorys* F.v.M.
E. globulus Labill.	*E. nitens* Maiden.
E. goniocalyx F.v.M.	*E. notabilis* Maiden.
E. hemiphloia F.v.M.	*E. Planchoniana* F.v.M.
E. Maideni F.v.M.	*E. quadrangulata* Deane and Maiden.
E. melliodora A. Cunn.	*E. unialata* R. T. Baker.

Of the above, the Gums (Leiophloieae, 5) are *canaliculata, globulus, goniocalyx, Maideni, unialata*; the Half-barks (Hemiphloiae, 4) are *hemiphloia, melliodora, nitens, quadrangulata*; the Rough-barks (Rhytiphloiae, 3) are *microcorys, notabilis,* and *Planchoniana.*

E. CANALICULATA Maiden.

A Grey Gum. Pale-coloured, pale snuff-brown (Dauthenay Plate 2, shade 303). Somewhat coarse-fibred, tough, resembling that of *E. maculata* (Spotted Gum) and *E. microcorys* (Tallow-wood) a good deal.

E. GLOBULUS Labill.

Tasmanian Blue Gum. Timber pale.

E. GONIOCALYX F.v.M.

Mountain Gum. Pale-coloured, sometimes inclined to be fissile.

E. HEMIPHLOIA F.v.M.

Grey Box. Pale-coloured or light brown.

E. MAIDENI F.v.M.

A Blue Gum. Timber pale.

E. MELLIODORA A. Cunn.

Yellow Box. Pale, almost yellowish, drying to a pale brown.

E. MICROCORYS F.v.M.

Tallow-wood. Pale-coloured. Pale yellowish brown, tough, interlocked, of a greasy nature.

E. NITENS Maiden.

Grey Box. Almost flesh-coloured when fresh, dries white. Straight in grain, but not very easy to work.

E. NOTABILIS Maiden.

Pale-coloured (of the palest brown when freshly cut). Fair tensile strength.

E. PLANCHONIANA F.v.M.

Bastard Tallow-wood. That it is sometimes substituted by Tallow-wood (*E. microcorys*) will give some idea of its properties.

E. QUADRANGULATA Deane and Maiden.

Grey Box. Pale, tough.

E. UNIALATA R. T. Baker.

Blue Gum. Pale-coloured, closely resembling *globulus.*

2. BROWN.

Most of these timbers are known as “Box” of one kind or another. The colour of the timber is brown, usually pale-brown, and of medium hardness and coarseness of fibre, but those of *E. ochrophloia* and *E. Thozetiana* are very hard and very dense, and also very brown. They are looked upon as durable, and generally valuable.

It is certainly sometimes not easy to make a sharp line of demarcation between some members of those in Group 1 (Pale Hardwoods) and some of the present group.

The trees producing the present group are divided between the Half-barks (Hemiphloiae) and the Rough-barks (Rhytiphloiae), two groups, it has already been explained, which run into each other. The vast preponderance of them belong to the Rough-barks.

E. Baueriana Schauer.	*E. odorata* Behr.
E. Blackburniana Maiden.	*E. Pilligaensis* Maiden.
E. Bosistoana F.v.M.	*E. populifolia* Hook.
E. Cloeziana F.v.M.	*E. rarifolia* F. M. Bailey
E. conica Deane and Maiden.	*E. Raveretiana* F.v.M.
E. exserta F.v.M.	*E. Thozetiana* F.v.M.
E. ochrophloia F.v.M.	

E. BAUERIANA Schauer.

Blue Box. Timber brown, heartwood very hard, hence one of the local names, Lignum vitae.

E. BLACKBURNIANA Maiden.

A Box. Pale brown. Interlocked.

E. BOSISTOANA F.v.M.

A Yellow Box. Its timber is often of a yellowish colour, a tint which it preserves for some time. Sometimes it is pinker, and hence obtains the name of Red Box. It is tough and inlocked.

E. CLOEZIANA F.v.M.

Pale-coloured, drying yellowish brown. Fissile, rather coarse and wavy in grain.

E. CONICA Deane and Maiden.

Fuzzy Box. Pale-brown, with a shade of pink.

E. EXSERTA F.v.M.

Brown, not red. Softish, easily split.

E. OCHROPHLOIA F.v.M.

Yapunyah. Brown, hard, heavy, close-grained.

E. ODORATA Behr.

South Australian Box or Peppermint. Pale coloured to brown, hard, interlocked.

E. PILLIGAENSIS Maiden.

Narrow-leaved Box. Brown, interlocked.

E. POPULIFOLIA Hook.

Bimble Box. Pale brown, wavy in grain, interlocked.

E. RARIFLORA Bailey.

A Box. Brown, very much like the preceding.

E. RAVERETIANA F.v.M.

A Box. Brown, very hard.

E. THOZETIANA F.v.M.

Brown, or blackish brown, not red. Tough.

Perhaps the following three timbers come in here, but I have not seen satisfactory specimens of them :—

E. Howittiana F.v.M.

E. Normantonensis Maiden and Cambage.

E. pruinosa Schau.

E. HOWITTIANA F.v.M.

“Wood, however, much like that of the former (*i.e.,* the Boxes), but its fibres not quite so interwoven, hence easier to split.” (Inspector Stafford.)

E. NORMANTONENSIS Maiden and Cambage.

Box. Colour unknown.

E. PRUINOSA Schau.

Believed to be hard.

3. Red Hardwoods.

All the timbers in this group are red, sometimes deep red, and, probably when over-mature, more or less brown. They are all durable. It is very difficult to subdivide them, but I have submitted a classification.

A. RED GUMS—

E. amplifolia Naudin.	*E. rostrata* Schlecht.
E. Bancrofti Maiden.	*E. Seeana* Maiden.
E. Blakelyi Maiden.	*E. squamosa* Deane and Maiden.
E. dealbata A. Cunn.	*E. tereticornis* Sm.
E. Parramattensis C. Hall.	

Most of these, viz., *amplifolia, Bancrofti, Blakelyi, dealbata, Parramattensis, rostrata, Seeana, tereticornis,* cluster round *E. rostrata,* the Murray Red Gum, as a type. They are deep red in colour, inclined to shell from presence of gum-veins when growing in uncongenial surroundings, but at their best, hard, interlocked, and durable.

E. AMPLIFOLIA Naudin.

Red, interlocked; inferior.

E. BANCROFTI Maiden.

Dark reddish brown, an inferior timber, so far as I have seen it.

E. BLAKELYI Maiden.

Red, interlocked.

E. DEALBATA Maiden.

Timber red and tough, often faulty; the trees usually gnarled.

E. PARRAMATTENSIS C. Hall.

Red of varying depth of tint, "soft, seasons badly"; "soft and ringy," "Centre wood red." This is either a disappearing species, or perhaps a form of *E. Seeana.*

E. ROSTRATA Schlecht.

River Red Gum. Deep red, interlocked.

E. SEEANA Maiden.

Deep red, tough, durable.

E. SQUAMOSA Deane and Maiden.

This seems to be a disappearing species; at all events, it is only known as a small, somewhat gnarled tree.

E. TERETICORNIS Sm.

Forest Red Gum. Red, interlocked.

Following are three species not closely related to those Red Gums which have just been enumerated :—

E. cosmophylla F.v.M.

E. fasciculosa F.v.M.

E. pallidifolia F.v.M.

E. COSMOPHYLLA F.v.M.

A Red Gum. Red, easy working timber. Durable. Splits readily on the quarter, but backs badly with irregular fracture along the annual rings of growth. Confined to South Australia.

E. FASCICULOSA F.v.M.

Pink Gum. Deep reddish brown, not considered valuable. This is a second of a few species confined to South Australia.

E. PALLIDIFOLIA F.v.M.

A Red or White Gum. Red, hard, close-grained. This is a tropical species of whose timber we know but little.

B. BLUE GUM—

This is a term used in the old Australian sense, for the name Blue Gum originated, in the earliest days of settlement at Port Jackson, owing to the glaucous or bluish appearance of *Eucalyptus saligna.*

E. Deanei Maiden.

E. grandis (Hill) Maiden.

E. saligna Sm.

E. DEANEI Maiden.

Red or reddish brown.

E. GRANDIS (Hill) Maiden.

Strong, durable, will float in water when dry, which is an unusual circumstance in Eucalyptus timber.

E. SALIGNA Sm.

Red, fissile.

C. GREY GUM—

The original Grey Gum is *E. punctata,* and *E. propinqua* is closely related to it. The origin of the name Grey Gum was described at Part LI, p. 32.

E. adjuncta Maiden.

E. propinqua Deane and Maiden.

E. punctata DC.

E. ADJUNCTA Maiden.

Timber deep red.

E. PROPINQUA Deane and Maiden.

Red. The timber so resembles that of Red Ironbark as to be often substituted for it.

E. PUNCTATA DC.

Hardly to be distinguished from the preceding.

D. RED BOX—

The term "Red Box" was first given to *E. polyanthemos,* to indicate a tree with "box" bark (a term of rather wide application, as has already been seen, under Barks, Part LI, p. 36), and with red interlocked timber. Every tree is known as Box of some kind or another. Most of them come from New South Wales, but three are peculiar to tropical Queensland. There is sometimes a very undefined line between a Box and a Gum, while the name Blackbutt is often applied locally (see Part L, p. 310) to a Gum with not very much dark, flaky bark at the butt.

E. bicolor A. Cunn.	*E. leptophleba* F.v.M.
E. Brownii Maiden and Cambage.	*E. microtheca* F.v.M.
E. Cambageana Maiden.	*E. polyanthemos* Schauer.
E. Dawsoni R. T. Baker.	*E. Rudderi* Maiden.
E. intertexta R. T. Baker.	

E. BICOLOR A. Cunn.

Box of one kind or another. Timber red, or rarely reddish-brown. Interlocked.

E. BROWNII Maiden and Cambage.

Box. Dark red.

E. CAMBAGEANA Maiden.

Blackbutt or Gum. Deep red or chocolate; used for milling.

E. DAWSONI R. T. Baker.

Deep red, interlocked.

E. INTERTEXTA R. T. Baker.

Red, interlocked.

E. LEPTOPHLEBA F.v.M.

Box or Blackbutt. Red, hard, durable.

E. MICROTHECA F.v.M.

Coolabah or Flooded Box. See Part LI, p. 39.

E. POLYANTHEMOS Schauer.

The original Red Box. Deep red, interlocked.

E. RUDDERI Maiden.

Red. (A dubious brown specimen noted at Part XIII, p. 118.)

E. MAHOGANY—

This name is a very old one as applied to Australian hardwoods, and was first applied to *E. resinifera,* the Red or Forest Mahogany. It reminded the first settlers of the West Indian Mahogany, to which is is not botanically closely related.

E. Kirtoniana F.v.M.

E. pellita F.v.M.

E. resinifera Sm..

E. KIRTONIANA F.v.M.

Red.

E. PELLITA F.v.M.

A Mahogany. Red.

E. RESINIFERA Sm.

Red or Forest Mahogany. Red, durable.

F. WOOLLY-BUTT—

The term Woolly-butt is self-explanatory, being applied to trees whose butts are more or less covered with a soft bark. All vernaculars tend to laxity of application, and this particular name has been applied to trees which have harsh rather than soft barks.

E. botryoides and *E. robusta* are often known as Mahogany, but their barks are softer than those of *E. resinifera* and its allies.

E. botryoides Sm.

E. longifolia Link and Otto.

E. robusta. Sm.

E. BOTRYOIDES Sm.

Bastard Mahogany. Deep red.

E. LONGIFOLIA Link and Otto.

Woolly-butt or Peppermint. Red.

E. ROBUSTA Sm.

Swamp Mahogany. Deep red.

4. IRONBARKS (Schizophloiae).

Ironbark timbers ’form (as a group) the heaviest, toughest, and strongest of Eucalyptus timbers. The prevailing colour is red, but in *E. Beyeri* we have brown as the prevailing colour, and *E. paniculata* (usually looked upon as the most valuable of all Ironbark timbers) has the palest-coloured of all the Ironbarks, with, however, shades of red.

E. Beyeri R. T. Baker. *E. melanophloia* F.v.M.

E. Caleyi Maiden.	*E. paniculata* Sm.
E. crebra F.v.M.	*E. siderophloia* Benth.
E. Culleni R. H. Cambage.	*E. sideroxylon* A. Cunn.
E. decorticans (Bailey) Maiden.	*E. Staigeriana* F.v.M.
E. drepanophylla F.v.M.	

E. BEYERI R. T. Baker.

Beyer's Ironbark. "Dark chocolate." It is the brownest of the Ironbark timbers, which are, however, all more or less brownish.

E. CALEYI Maiden.

Caley's Ironbark. Deep red, durable.

E. CREBRA F.v.M.

Narrow-leaved Red Ironbark. Red, hard, durable.

E. CULLENI R. H. Cambage.

Cullen's Ironbark. Red.

E. DECORTICANS (Bailey) Maiden.

Deciduous barked Ironbark. Red.

E. DREPANOPHYLLA F.v.M.

Red. Imperfectly known.

E. MELANOPHLOIA F.v.M.

Silver-leaved Ironbark. Red; inferior.

E. PANICULATA Sm.

Grey or White Ironbark. In colour it varies from grey to shades of a yellowish colour, or light red and very brown dark, but these colours change in drying, sometimes becoming, where dark, much paler, and in the case of pale red and grey, becoming of darker colour.

E. SIDEROPHLOIA Benth.

Broad-leaved Red Ironbark. Red.

E. SIDEROXYLON A. Cunn.

Fat-cake Ironbark. Mugga. Dark red.

E. STAIGERIANA F.v.M.

Lemon-scented Ironbark. Red.

A. IRONBARK-BOXES—

Hard pale-coloured, tough, timbers. The trees are assumed to be natural hybrids between the Ironbarks and the Boxes, and the timbers have characters which seem to be intermediate between those of the reputed parents. Some of the Ironbarks and Boxes are deemed to be especially susceptible to hybridisation. The subject is dealt with at some length at p. 109 of the present Part.

E. affinis Deane and Maiden.

E. Boormani Deane and Maiden.
E. hybrida Maiden.

E. AFFINIS Deane and Maiden.

Medium brown, hard, heavy, tough.

E. BOORMANI Deane and Maiden.

Pale reddish brown. Hard, tough, very durable.

E. HYBRIDA Maiden.

Pale-coloured, hard, interlocked.

5. BLOODWOODS.

They are liable to shell and to contain much kino. Geologically they are reputed to be the oldest of the Eucalypts, and hence to include some of the least vigorous species and, therefore, timbers.

A. RED BLOODWOODS—

E. Abergiana F.v.M.
E. Cliftoniana W. V. Fitzgerald.
E. corymbosa Sm.
E. dichromophloia F.v.M.
E. Foelscheana F.v.M.
E. grandifolia R.Br.
E. hoematoxylon Maiden.
E. Hillii Maiden.
E. latifolia F.v.M.
E. miniata A. Cunn.
E. perfoliata R.Br.
E. phoenicea F.v.M.
E. ptychocarpa F.v.M.
E. pyrophora Benth.
E. terminalis F.v.M.

Some of the timbers in this section are described as reddish-brown. They are, however, deep coloured and more or less red. It may be that we have a group of intermediates, reddish-brown; on the other hand, I have seen so few timbers of this class, that I am inclined to think that they are a faded or oxidised form of the definitely red timbers, and, until further evidence is available, I think they should be looked upon as Red Bloodwoods. At the same time, I have followed my usual practice of not altering original notes as to colour, &c.

The red timbers are especially durable. It is very interesting to find that the timber of *E. hoematoxylon* is red, while the colour of that of *E. calophylla* and *E. ficifolia,* the only other sub-tropical Western Australian species, is pale.

E. ABERGIANA F.v.M.

"Reddish." I have not seen a specimen.

E. CLIFTONIANA W. V. Fitzgerald.

"Red, tough and hard."

E. CORYMBOSA Sm.

Deep red.

E. DICHROMOPHLOIA F.v.M.

Reddish brown.

E. FOELSCHEANA F.v.M.

Red, apparently not a large tree.

E. GRANDIFOLIA R.Br.

Reddish brown.

E. HaeMATOXYLON Maiden.

Red, with gum-veins. "Very soft." Our specimen is red, like *E. corymbosa,* and thus sharply different from *E. ficifolia* and *E. calophylla.*

E. HILLII Maiden.

Rich reddish brown. Hard.

E. LATIFOLIA F.v.M.

Pale red. (I have reason to believe that this refers to the timber of a small tree which is paler than that of a mature one.)

E. MINIATA A. Cunn.

Red, hard, but "reddish brown," according to Mr. Cambage.

E. PERFOLIATA R. Brown.

Dark red, tough and hard.

E. PHOENICEA F.v.M.

Reddish brown.

E. PTYCHOCARPA F.v.M.

Red, soft and very porous.

E. PYROPHORA Benth.

The colour of the variety *polycarpa* is red. I have not seen timber of the normal species.

E. TERMINALIS F.v.M.

Deep red.

B. PALE BLOODWOODS—

E. calophylla R.Br.	*E. maculata* Hook.
E. eximia Schauer.	*E. peltata* Benth.
E. ficifolia F.v.M.	*E. trachyphloia* F.v.M.
E. intermedia R. T. Baker.	*E. Watsoniana* F.v.M.

These correspond, in the main, to the Pale Bloodwood barks enumerated at p. 56, Part LI. While *E. calophylla* and *E. ficifolia* have pale timbers, their barks are not so pale as most of those of the Pale Bloodwoods.

E. maculata (Spotted Gum) is an extreme form, with pale bark, it is true, but with the smoothness of a Gum, while the timber is paler than all the others of this section.

E. CALOPHYLLA R.Br.

Red Gum. Pale-coloured, with numerous gum-veins.

E. EXIMIA Schauer.

Yellow Bloodwood.

E. FICIFOLIA F.v.M.

Resembles *E. calophylla* a good deal, but a smaller tree.

E. INTERMEDIA R. T. Baker.

White Bloodwood. Pale coloured. “Hard, straight-grained.” Sometimes pinkish, but paler than *E. corymbosa,* and somewhat variable.

E. MACULATA Hook.

Spotted Gum. Tough, interlocked, durable.

E. PELTATA Benth.

Yellow Jacket. Pale towards the outside, dark brown near the centre.

E. TRACHYPHLOIA F.v.M.

White Bloodwood. Brown, brittle of some writers. Pale coloured, somewhat like *E. maculata.*

E. WATSONIANA F.v.M.

Pale brown.

(*a*) *E. setosa* Group.

This Group has the Bloodwood-like fruits, combined with scabrous Angophora-like foliage, and thus we have a connecting link between the Bloodwoods and the Moreton Bay Ashes. The only important member, *E. Torelliana,* has timber which resembles that of *E. maculata,* the Spotted Gum.

E. aspera F.v.M.	*E. setosa* Schau.
E. ferruginea Schau.	*E. Torelliana* F.v.M.

E. ASPERA F.v.M.

A small tree; I know little of its timber.

E. FERRUGINEA Schau.

This is closely allied to *E. setosa,* and is apparently small. I have not been able to obtain a specimen of the timber.

E. SETOSA Schau.

Reddish, moderately hard and tough, according to one writer. Dark brown (R. H. Cambage), hard, strong, and durable.

E. TORELLIANA F.v.M.

Very pale, whitish to pale brown. Reminiscent of *E. maculata,* only freer. Very fissile. An important timber.

(*b*) Moreton Bay Ash Group.

This is a naturally defined Group, with thin, papery fruits, which are very deciduous. The bushman is quite aware of the peculiar nature of these fruits, which remind one of those of the common Apple-trees (*Angophora*).

The colours of the timbers vary from dark brown to brownish-red and red. It must be borne in mind that we know but little of most of these timbers, except *E. tessellaris,* and it will probably prove to be a fact that the prevailing colour is dark brown, and that they present a good deal of similarity to that timber.

E. brachyandra F.v.M. *E. Spenceriana* Maiden.
E. clavigera A. Cunn. *E. tessellaris* F.v.M.
E. papuana F.v.M.

E. BRACHYANDRA F.v.M.

Red, hard, and tough.

E. CLAVIGERA A. Cunn.

Brownish red, and fairly hard and tough, according to Mr. Froggatt. Described by others as “dark brown” and “rich deep brown.” Close in the grain and durable. White-ants will not touch it in the Northern Territory.

E. PAPUANA F.v.M.

Very dark brown.

E. SPENCERIANA Maiden.

Dark reddish brown. Interlocked, “excellent, durable.”

E. TESSELLARIS F.v.M.

Dark brown, heavy, interlocked in fibre.

(*c*) Eudesmieae.

The relations of this very small group of trees is purely botanical, and remain of scientific interest at present. Some members of the Group are imperfectly known (*e.g., eudesmioides*) and may prove to attain a size and an abundance in certain districts which will render them of economic importance.

E. Baileyana F.v.M.
E. lirata (W. V. Fitzgerald) Maiden.
E. tetrodonta F.v.M.

E. BAILEYANA F.v.M.

Light grey when fresh, very tough, inferior in quality.

E. LIRATA (W. V. Fitzgerald) Maiden.

Brownish, fairly hard and rather free in the grain.

E. TETRODONTA F.v.M.

Messmate or Stringybark. Reddish brown and hard. Of considerable importance locally.

6. Western Australian Hardwoods.

I offer this as an empirical classification—

1. Because they are largely endemic to the Western State, and
2. For geographical reasons it will be convenient, from all points of view, to keep most of the Western Australian timbers separate.

A. PALE BROWN—

E. cornuta Labill.	*E. occidentalis* Endl.
E. decipiens Endl.	*E. patens* Benth.
E. foecunda Schau.	*E. redunca* Schau.
E. gomphocephala DC.	*E. rudis* Endl.
E. Guilfoylei Maiden.	*E. salubris* F.v.M.
E. megacarpa F.v.M.	*E. Todtiana* F.v.M.
E. Mundijongensis Maiden.	

Practically all these timbers come from the comparatively well-watered southwest. They vary a good deal in colour from the palest to a moderately dark brown, and in quality from exceptionally hard, tough, and durable, such as *E. cornuta* (Yate) and *E. occidentalis* (Flat-topped or Swamp Yate), to such inferior timbers as *decipiens, megacarpa* and *rudis,* with a number of useful intermediate ones.

E. CORNUTA Labill.

Yate. Pale brown; toughest of Western Australian woods, and said to be the strongest in Australia.

E. DECIPIENS Endl.

Dull pale brown, liable to gum-veins, cracks radially, is brittle and perishable, and of no ascertained economic value.

E. FOECUNDA Schau.

York Gum. Timber dark brown, hard.

E. GOMPHOCEPHALA DC.

Tuart. Pale-coloured and of a yellowish cast. Reminds one of *cladocalyx* and *leucoxylon,* but is superior in quality to both.

E. GUILFOYLEI Maiden.

Yellow Tingle Tingle. Pale-coloured, fissile.

E. MEGACARPA F.v.M.

Brownish towards heart, liable to gum-veins; not durable, apparently a disappearing species.

E. MUNDIJONGENSIS Maiden.

A Tuart. Pale-coloured, reminiscent of *E. gomphocephala,* but not seen by me.

E. OCCIDENTALIS Endl.

Flat-topped Yate. Brown, tough.

E. PATENS Benth.

Blackbutt of the south-west. Pale brown.

E. REDUNCA Schau.

Wandoo or White Gum. *E. redunca* var. *elata.* Pale brown, drying dark brown, hard, particularly tough, interlocked, heavy and durable.

E. RUDIS Endl.

Swamp Gum. Yellowish to pale brown when fresh, to brown later, brittle and readily attacked by insects.

E. SALUBRIS F.v.M.

Gimlet. Pale brown.

E. TODTIANA F.v.M.

A Blackbutt. Pale brown, brittle, not durable.

B. DULL CIGAR-BROWN—

E. celastroides Turcz.	*E. Griffithsii* Maiden.
E. Clelandi Maiden.	*E. Le Souefi* Maiden.
E. corrugata Luehmann.	*E. Stricklandi* Maiden.
E. gracilis F.v.M.	

These are Gold-fields (Kalgoorlie district) timbers, and I followed the wood-choppers on the wood-lines for some days. I formed the opinion that most of the timbers were of that bright brown colour known as cigar-brown. It may be, however, that this colour represents a stage of oxidation or over-ripeness.

E. CELASTROIDES Turcz.

Cigar-brown, “very hard, dense, splitting very straight”; a spear wood.

E. CLELANDI Maiden.

Cigar-brown.

E. CORRUGATA Luehmann.

Cigar-brown.

E. GRACILIS F.v.M.

Deep cigar-brown, tough. (I am referring to the Western Australian form of this tree).

E. GRIFFITHSII Maiden.

Reddish brown.

E. LE SOUEFI Maiden.

Cigar-brown.

E. STRICKLANDI Maiden.

A Blackbutt. Colour of timber, rich deep brown.

C. RED TIMBERS—

E. accedens W. V. Fitzgerald.	*E. Jacksoni* Maiden.
E. argillacea W. V. Fitzgerald.	*E. Lane-Poolei* Maiden.
E. confluens W. V. Fitzgerald.	*E. longicornis* F.v.M.
E. diversicolor F.v.M.	*E. marginata* Sm.
E. Drummondii Bentham.	*E. Mooreana* (W.V.F.) Maiden.
E. Flocktonioe Maiden.	*E. salmonophloia* F.v.M.
E. Houseana W. V. Fitzgerald.	*E. transcontinentalis* Maiden.

Here, again, the colour varies from red to reddish-brown, and we require more information as to colours. The majority of these trees come from coastal localities, but some are from the drier country.

E. ACCEDENS W. V. Fitzgerald.

Powder-bark. Pale reddish when fresh, darkening somewhat with age. Hard, interlocked.

E. ARGILLACEA W. V. Fitzgerald.

Reddish to brownish, very hard and tough. (From the tropics.)

E. CONFLUENS W. V. Fitzgerald.

Brownish red to red, very hard and extremely tough. (A tropical species.)

E. DIVERSICOLOR F.v.M.

Karri. Red. Resembles *E. marginata,* but not durable underground. (A south-western species.)

E. DRUMMONDII Bentham.

Red, but apparently only a small tree.

E. FLOCKTONIae Maiden.

The timber-cutters see no difference between this timber and *E. transcontinentalis* (see below, this page).

E. HOUSEANA W. V. Fitzgerald.

Reddish, not very hard or tough. (A tropical species.)

E. JACKSONI Maiden.

Red Tingle Tingle. Timber bright red, reminding one, in this respect, of *E. resinifera.* It is fissile and tough. (A south-western species.)

E. LANE-POOLEI Maiden.

A White Gum. Rich reddish brown, drying, in course of years, to deep purplish brown; interlocked. (A south-western species.)

E. LONGICORNIS F.v.M.

Morrel. Red, very tough.

E. MARGINATA Sm.

Jarrah. Deep red, durable; Perth and south-western districts; the best known of the Western timbers.

E. MOOREANA (W.V.F.) Maiden.

Reddish, tough and moderately hard. (A tropical species.)

E. SALMONOPHLOIA F.v.M.

Salmon Gum. Reddish brown, red with crimson in it when fresh; very durable.

The largest tree on the Gold-fields, and often associated with Gimlet (*E. salubris*).

E. TRANSCONTINENTALIS Maiden.

Rich reddish brown, very tough.

Explanation of Plates (216–219.)

Plate 216.

Plate 216: x EUCALYPTUS BARMEDMANENSIS Maiden, n.sp. (1, 2). E. MELLIODORA A. Cunn.; var. (3). [See Plate 61.] Lithograph by Margaret Flockton.

E. Barmedmanensis Maiden, n.sp.

1*a.* Twig with mature leaves and buds; 1*b,* leaf, somewhat enlarged, to show venation; 1*c,* immature fruits, showing rims; 1*d,* mature fruits. "White Ironbark" or "Ironbark Box," Barmedman, New South Wales, 16th September, 1900 (R. H. Cambage). The type.
2*a.* Twig with mature leaves and buds; 2*b,* fruits. "Ironbark" or "Bastard Ironbark," Trowell Creek, Nymagee, New South Wales, May, 1900 (R. H. Cambage). This differs from the type in longer peduncles and pedicels, and in more attenuated opercula.

E. melliodora A. Cunn. var.

3*a.* Intermediate leaf; 3*b,* mature leaf; 3*c,* buds; 3*d,* anther; 3*e,* immature fruit; 3*f,* mature fruits. Murrurundi, New South Wales, May, 1902 (J.H.M. and J. L. Boorman). A form of the species referred to at p. 111.

Plate 217.

Plate 217: x EUCALYPTUS TENANDRENSIS Maiden, n.sp. (1, 2). x E. PEACOCKEANA Maiden, n.sp. (3). Lithograph by Margaret Flockton.

E. Tenandrensis Maiden, n.sp.

1*a,* 1*b,* 1*c.* Intermediate leaves in various stages; 1*d,* mature leaf and fruits. February, 1921.
2*a.* Juvenile leaf, or the youngest leaf I have seen; 2*b,* immature buds. April, 1921. The whole from an Ironbark tree in Tenandra State Forest, No. 166, Parish Baronne, county Leichhardt, New South Wales (Forest Guard Withers). The type.

E. Peacockeana Maiden, n.sp.

3*a.* Juvenile leaves; 3*b,* mature leaf with buds; 3*c,* two types of anthers produced by this hybrid; 3*d,* fruits. Elsmore Station, parish Elsmore, Inverell district, county Gough, New South Wales, November, 1920 (Lance Beresford Peacocke). The type.

Plate 218.

Plate 218: x EUCALYPTUS STOPFORDI Maiden, n.sp. (1). x E. FORSYTHII Maiden, n.sp. (2). Lithograph by Margaret Flockton.

E. Stopfordi Maiden, n.sp.

1*a.* Intermediate leaf (in as early a stage as I have seen); 1*b,* twig with mature leaves and buds (double opercula are common); 1*c,* three views of anthers. Near Inverell, New South Wales, May, 1910, (the late A. E. Stopford, District Forester.) The type.

E. Forsythii Maiden, n.sp.

2*a.* Twig with flowers; 2*b,* anther; 2*c,* twig with fruits. Coonabarabran-Baradine road, October, 1899 (the late William Forsyth). The type.

Plate 219.

Plate 219: x EUCALYPTUS AUBURNENSIS Maiden, n.sp. (1). x E. YAGOBEI Maiden, n.sp. (2). x E. STUDLEYENSIS Maiden, n.sp. (3). Lithograph by Margaret Flockton.

E. Auburnensis Maiden, n.sp.

1*a.* Juvenile leaf; 1*b,* juvenile leaf, a stage further, in the acuminate stage; 1*c,* mature leaf; 1*d,* fruits. Auburn Vale, near Inverell, New South Wales, 1907 (District Forester Gordon Burrow). The type.

E. Yagobiei Maiden, n.sp. (erroneously spelled on the Plate).

2*a.* Juvenile leaf; 2*b,* 2*c,* 2*d,* various stages of intermediate leaf; 2*e,* mature leaf; 2*f,* bud; 2*g,* two views of anther; 2*h,* panicle of fruits; 2*i,* top view of fruit. Parish of Yagobie, on banks of Gwydyr River, county of Burnett, New South Wales, 1916 (District Forester Gordon Burrow). The type.

E. Studleyensis Maiden, n.sp.

3*a.* Juvenile leaf; 3*b,* intermediate leaf; 3*c,* twig with mature leaf and buds; 3*d,* front and back view of anther; 3*e,* fruits. Studley Park, Kew, Melbourne, Victoria (Alfred Douglas Hardy). The type.

Part 54

Australian Hybrids.

E. sideroxylon A. Cunn., and *E. leucoxylon* F.v.M.

(*a*) As I had seen specimens which, in my view, showed hybridism between *E. sideroxylon* A. Cunn. and *E. leucoxylon* F.v.M., I some years ago wrote to Mr. J. Blackburne, then Secretary of the National Forest League of Maryborough, Victoria, drawing his attention to the subject. In a few weeks he sent me four specimens from the Maryborough district.

No. 1 is typical *E. sideroxylon* A. Cunn., "Red Ironbark." Timber red, bark furrowed.

No. 4 is typical *E. leucoxylon* F.v.M., called by Mr. Blackburne "Smooth-barked Ironbark." Timber pale, bark smooth. I wrote to Mr. Blackburne in regard to his use of the term "Ironbark" for this species, it being often termed "White Ironbark" in Victoria, although there is often little or no "iron" bark. To this he replied : "I think Victorian writers in speaking of 'White Ironbark' undoubtedly referred to *E. leucoxylon*. I know that Howitt did so. Another tree, *E. Sieberiana*, is sometimes alluded to as White or White-topped Ironbark, but I think you can rest assured that *E. leucoxylon* is the tree generally meant. *E. leucoxylon* is not altogether a white wood, although the heart wood is much paler in colour than *sideroxylon*."

His Nos. 2 and 3 he described in the following words:—

"No. 2 has a thin, brown bark, lighter in colour than No. 1, and not so deeply furrowed; the upper portion of the trunk and branches are smooth, like No. 4."

"No. 3 has at the lower part of the stem or trunk the deeply furrowed, dark-coloured bark of No. 1, changing then for some feet into the type of No. 2 (thin and brown). Higher up it becomes thinner and flaky in texture. Upper portion of stem and branches like No. 4 (Gum top)."

He then adds—"You will, of course, understand that Ironbark trees showing hybrid forms are not common in our young forest, being only occasionally met with."

I have received from Mr. Blackburne a complete suite of herbarium specimens, bark and timbers of these trees. They bear out his descriptions. Nos. 2 and 3 are intermediate between Nos. 1 and 4, and on these specimens alone I fail to see how the fact that *E. sideroxylon* and *E. leucoxylon* hybridise can be resisted.

(*b*) The following two specimens, both collected by Mr. W. S. Brownscombe, of Messrs. J. Bosisto <&> Co., of Melbourne, from Black Waterholes, near Redcastle, Victoria, are, in my opinion, hybrids of the above species.

11A. Bark rough, black, rugged, but not grooved like *E. sideroxylon*. Upright habit, bark on branches of a bluish-grey hue, and deciduous, like the upper branches of *E. hemiphloia*.

12A. Tree upright in habit, 2 feet in diameter at butt. Bark having resin-deposits in layers, characteristic of *E. sideroxylon*; bark at butt black, inclined to be grooved, but rugged, gradually getting less rugged, but persistent and black to the smaller branches, thence smooth.

CCCX. E. McIntyrensis n.sp.

Assumed parents—*E. rostrata* Schlecht., and *E. ovata* Labill.

A medium-sized, scrambling gum-tree, with more or less flaky bark on the butt. Timber red.

Juvenile leaves glabrous, equally bright green on both sides, pointed-ovate, petiolate, rather coriaceous, puckered, venation distinct, curved-spreading, the intramarginal vein distinctly removed from the edge. A common measurement of the blade is 13 x 7 cm.

Mature leaves lanceolate, up to 16 cm. long and 3 cm. broad, somewhat spreading, the secondary veins distinct, making an angle of about 45 degrees with the midrib, the intramarginal vein distinct from to rather distant from the margin.

Inflorescence.—An axillary umbel up to five in the head on a rounded peduncle of at least 1 cm., and pedicels of about half that length, buds rostrate, anthers (not perfectly ripe) opening in parallel slits, with a gland at the back; versatile.

Fruits hemispherical, under 1 cm. in diameter, with a distinctly domed rim, and four exsert valves.

Type from Mount McIntyre, South Australia (Walter Gill, Conservator of Forests, South Australia, April, 1921).

Range.

It is confined to south-eastern South Australia so far as we know at present. Mount McIntyre is about 10 miles west from Kalangandoo Station, and Mount Burr (where an allied form occurs) is about the same distance south-west from Kalangandoo. Both mountains are about north-west from Mount Gambier, the first, say, 30 miles, and the second 22 miles distant.

Affinities.

This seems a hybrid in which *E. rostrata* appears to be concerned. What the other parent is, if it be a hybrid, is less clear. It appears to be *E. ovata*, which is common in the district.

1. With *E. rostrata* Schlecht.

The timber of the assumed hybrid may be described as resembling quickly-grown *rostrata*, that is to say it is a little paler and a little more fissile than that of normal *rostrata*. Comparison of the figures of *E. rostrata* as shown in Plates 136 and 137 of

Part XXXIII, shows that there is considerable similarity in the mature leaves and buds, and occasionally in the fruits, which are, however, larger in the hybrid. A wider divergence is, however, seen in the juvenile foliage, which in *E. rostrata* is always thin and glaucous, never puckered, rarely broad, and never, unless malformed, nearly ovate.

2. With *E. ovata* Labill.

See Plates 113 and 114, Part XXVII, but particularly 2*d* of the latter plate, which depicts the fruits of var. *grandiflora*, obtained from the Mount Gambier district of South Australia. The timber of *E. ovata* is paler, and the resemblances in other characters less close to the hybrid than is *E. rostrata*.

3. With *E. rudis* Endl.

For this species see Plates 138, 139, Part XXXIII. This is a Western Australian species, with inferior, pale timber. The fruits of this species and of the hybrid are sometimes not unlike; the resemblance in the case of the buds is less close. The affinity with *E. rostrata* is far closer.

Fossil Plants Attributed to Eucalyptus.

ENDLICHER, 1840.—Endlicher (*Genera Plantarum*, 1836–1840) was a pioneer in recording fossil plants in their proper systematic position in comparison with existing plants. Thus he records fossils in *Marsiliaceis affinis* (*Sphenophyllum*), Isoetaceae, Lycopodiaceae, Lepidodendrae, Cycadaceae, and perhaps others. He does not take cognisance of Eucalyptus; indeed, I do not think a fossil Eucalypt had been described up to 1840.

HOOKER, 1853.—Hooker (in Hooker's *Journ. Bot.*, vol. v, p. 415, 1853) made an early protest in regard to deductions from inadequate data, although he did not, at this date, make any reference to Eucalyptus in this connection.

We regret also to observe a tendency on the part of the author of the pamphlet before us ("Pflanzenverbreitung und Pflanzenwanderung," by Dr. Herman Hoffmann, Darmstadt, 1853) to place a degree of reliance on the identification of fossil species of plants with those now existing, which we do not by any means think the materials usually at the disposal of fossil botanists can warrant. Everyone who is accustomed to the handling of large masses of plants must have felt the great difficulty of referring specimens without flowers or fruit to the Natural Orders. How much more difficult, then, must it be to identify fossil specimens, chiefly single leaves, with living species! a thing now often done, with the utmost confidence, on exceedingly slender grounds. We should not like to be obliged to distinguish fragments of dried specimens of *Pinus Pumilo* from *Pinus sylvestris*, or from a great many other Pines; and yet our author tells us, on the authority of Goppert, that the former of these so-called species is found in Miocene strata in Germany. Such hasty references are, in our opinion, particularly dangerous, and likely to lead to a great deal of mischief.

A few years later he remarked:—

“Wesel and Weber describe from the brown coal of the Rhine a rich and varied flora, representing numerous families never now seen associated, and including some of the peculiar and characteristic genera of the Australian, South African, American, Indian and European Floras.” (Hooker, “Introd. Essay,” *Fl. Tas.*, p. xxi., 1861.)

In a footnote Hooker says—

“See *Quart. Journ. Geol. Soc. XV*, Misc. 3, where an abstract is given, with some excellent cautions, by C. J. F. Bunbury. The Australian genera include *Eucalypius, Casuarina, Leptomeria, Templetonia, Banksia, Dryandra* and *Hakea.* I am not prepared to assert that these identifications, or the Australian ones of the Mollasse, are also so unsatisfactory that the evidence of Australian types in the brown coal and Mollasse should be altogether set aside; but I do consider that not one of the above-named genera is identified at all satisfactorily, and that many of them are not even problematically decided.”

UNGER, 1861.—Prof. Franz Unger, of the University of Vienna, delivered in 1861 a lecture (“Neu Holland in Europa,” Braunmüller), which, under the title “New Holland in Europe,” was translated and published in *Journ. Bot.* iii, 39 (1865). It is well illustrated (though not with Eucalyptus), is charmingly written, and gives an interesting account of the views then held in regard to the relations of the European and Australian floras in the Eocene period.

Following are some extracts from the paper:—

“ . . . I proceed to prove that New Holland exercised a decisive influence on the formation of our much favoured continent (Europe) and, paradoxical as it may sound, contributed to make it what it is . . . When New Holland stood in the connection I allude to with Europe . . . and the soil covered with plants . . . the continent (New Holland) was youthful and vigorous, full of precious germs destined for distribution over the globe” (p. 40).

He alleges that the European Eocene contains Eucalyptus. “Of several species the peculiar leaves, as well as the fruit, have been found” (p. 42). Prof. Unger was sometimes content with very little, for he goes on to say—“The same is the case with the Epacrids, although as yet *only a single leaf* furnishes evidence of the former existence of this now widely-diffused natural order.” [The italics are mine.]

Then follows a list of all those plants hitherto (1861) discovered in the Eocene formation (of Europe) having analogous species in New Holland or any other part of the southern hemisphere. There is a remarkably long list of genera and species. It is not surprising that when one gets to the Proteaceae we find large numbers of species attributed to individual genera. When one has had experience with the marvellous protean character of the leaves of this Family, the list almost takes one's breath away.

"After this review, showing what a considerable portion of the Australian and Polynesian flora was already represented by characteristic types in the Eocene vegetation, there can no longer be any doubt that *Europe stood in some kind of connection with that distant continent* (Australia)."

He then discusses the European forests formed of *Araucarias* instead of Pines (*Pinus,* &c.) and the underwood of Proteaceae, Santaleae, &c., instead of Rhamni, Privets, and Hazels, and concludes that *at the Eocene period Europe must have had a climate like that of New Holland at the present day* (p. 44).

"Nothing remains but to assume that either the New Holland plants emigrated to Europe, or (what is less probable) the former European plants, which had an Australian character, passed from Europe to New Holland" (p. 46). He then goes on to discuss theories and possibilities of migration of plants between the two continents. "The continental connection of Australia and Europe during the Eocene period is consequently a necessary assumption . . . incontrovertibly . . . that the highway by which the New Holland plants passed to Europe led through Asia . . . " (p. 48).

The European fossils attributed to Eucalyptus enumerated in his paper are—

E. Radobojana Ett. (Radoboj); *E. aegea* Ung. (Kumi); *E. Hoeringiana* Ett. (Haring); *E. oceanica* Ung. (widely distributed, for Unger records it from Sotzka, Haring, Sagor, Monod, Thalheim, Sinigagtia, Salcedo, Chiavon, Nocale, Pastelio (Verona).

There is a brief account of Franz Joseph Andreas Nicholaus Unger by Bentham in *Proc. Linn. Soc.,* 1870, p. cxii. He was born 30th November, 1800, at Leitschach, in Styria. He died mysteriously at Graz on 13th February, 1870. He published "Genera et Species Plantarum Fossilium" in 1850, and Bentham says that a bibliography of his works will be found in the *Botanische Zeitung* of 22nd April, 1870.

BENTHAM, 1870.—For some criticisms on Unger's work and consideration as to "what place a leaf really holds in systematic botany," we have some remarks by Bentham in a Presidential address. He says:—

"Would any experienced systematic botanist, however acute, on the sole examination of an unknown leaf, presume to determine, not only its Natural Order and genus, but its precise characters as an unpublished species? . . . "

"Palaeontologists have . . . in the majority of these Tertiary deposits, had nothing to work upon but detached leaves or fragments of leaves, exhibiting only outward form, venation, and to a certain degree, epidermal structure, all of which characters may be referred to that class which Prof. Flower, in his introductory lecture at the Royal College of Surgeons (February, 1870), has so aptly designated as *adaptive,* in contradistinction to essential and fundamental characters." (*Proc. Linn. Soc.* lxxxiii, 1870.)

While willingly conceding the value of such determinations as that of *Podogonium* by Heer, he proceeds to say—

But the case appears to me to be far different with the theory so vividly expounded by Prof. Unger in 1861, in his address entitled "Neu Holland in Europa." This theory, now generally admitted, seems to be established on some such reasoning as this:—There are in the Tertiary deposits in Europe, and especially in the earlier ones, a number of leaves that look like Proteaceae; Proteaceae are a distinguishing feature in Australian vegetation; *ergo,* European vegetation had in those times much of the Australian type derived from a direct land communication with that distant region.

After saying that contemporary palaeontologists enumerated nearly one hundred Tertiary species as above, he says—

And yet, although the remains of the Tertiary vegetation are far too scanty to assert that Proteaceae did not form part of it, I have no hesitation in stating that I do not believe that a single specimen has been found that a modern systematic botanist would admit to be Proteaceous unless it had been received from a country where Proteaceae were otherwise known to exist.

He then refers to the fact that he has recently had to make analyses and detailed descriptions of between five and six hundred Proteaceae [for vol. v of the *Flora Australiensis.*—J.H.M.]. He discusses the Proteaceae at some length, and finally does not concur in some of Ettingshausen's determinations in his "Die Proteaceen der Vorwelt."

Bentham, always judicial, points out that he is only a "recent botanist," and not a palaeontologist, and offers his criticisms in " . . . the hope that they may in some measure distinguish proved facts from vague guesses, in order that we may know how far reliance is to be placed on their conclusions."

E. W. Berry, a distinguished American palaeobotanist ("Science," xlix, p. 91, 24th January, 1919), makes the following remarks:—

The identification of the antipodean genus *Eucalyptus* in the fossil floras of Europe was the subject for a sweeping condemnation by the veteran systematist Bentham in one of his addresses. Without subscribing to the viewpoint of one who was at best a narrow specialist and could see nothing useful in the study of fossil plants, it remains true that the identification of *Eucalyptus* in many fossil floras has led to what I believe to be erroneous conclusions in the minds of many geologists and botanists who lack both time and the special knowledge for passing on the returns.

If what I have already quoted fairly represents Bentham's views that Professor Berry has in his mind, then, as a life-long student of Bentham's work, I express the opinion that the description of him as a “narrow specialist” is ludicrously incorrect. I am not aware that Bentham could “see nothing useful in the study of fossil plants”; I think he has done good service in drawing attention to the fact that certain risks have been run in attributing some fossil leaves to Protean genera. It would appear that Bentham's judgment has, in the opinion of present-day palaeobotanists, come true as regards reputed Eucalypti in the northern hemisphere, and he was the greatest authority on the genus at the time he wrote the *Flora Australiensis,* and paved the way for Mueller's work.

ETTINGSHAUSEN, 1883.—Ettingshausen's papers dealing with plants of the Tertiary of Australia (1883, 1886), and his paper on the Cretaceous plants of Australia (1895) will be dealt with at pp. 177 and 182 of the present Part.

MUELLER, 1884.—In *Papers and Proc. Roy. Soc. Tas.,* p. 203 (1884), there is a paper “References to Baron Constantin von Ettingshausen's recent Observations on the Tertiary Flora of Australia” by Baron von Mueller. He quotes the 1883 paper already referred to. He chiefly refers to a well-known Derwent River (Tasmania) locality for palaeobotanical specimens, and cites R. M. Johnston's labours. The following involved sentence contains a protest:—

Were I to be allowed to offer a suggestion on the subject, which from its very nature must be perplexing, it would be to recommend a preference of new generic names for all such organic remnants as cannot be put with any degree of certainty along with generic forms now living, nor can safely be placed into clearly-defined fossil genera, as this would not commit us to fix the exact systematic position of any organism, known only from fragments quite insufficient for that strict generic recognition which, for instance, would be expected from dealing with Laurineae, in the sense of living genera of that order, the corresponding exact circumscription of which for fossils, even if flowers and fruits were always or finally obtained, would ever remain an impossibility.

The paper does not criticise Ettingshausen in detail, and puts forth another plea for the necessity of obtaining flowers and fruits (in addition to leaves) before one can be certain of one's ground in naming them.

DEANE, 1896.—Mr. Henry Deane, in his Presidential address (*Proc. Linn. Soc. N.S.W.,* xx, 639, 1896), combats the views of Unger, Ettingshausen, &c., “that in Tertiary times, or earlier, there was a universal flora of mixed types, which later on, through the influence of floral climates, became sorted out, so that at the present day distinct regions present distinct peculiarities which at first did not exist."

At p. 651 he refers to Schimper, Schenk, and Zittel's "Handbuch der Palaeontologie," Part II (Palaeophytologie), (1890), and shows that Zittel (the editor) abandons a number of the Australian genera alleged to have been found in European deposits.

Speaking of the remains attributed to the capsular Myrtaceae (which, of course, includes Eucalyptus), Zittel says there is no necessity to fly to that explanation. . . I have looked carefully through Zittel's work, and I cannot find that the correctness of the identification of any Australian forms is acknowledged except some fossils of the Upper Cretaceous, which have been classed and named *Eucalyptus Geinitzi.*

It is to be observed that all resemblances to Australian existing vegetation in the Tertiary flora is looked upon by Hooker, Bentham, Zittel, and many others as fanciful and unproved. As regards the supposed *Eucalyptus Geinitzi,* it will be noticed that the figure in Zittel's book reminds one of the style of growth of a Eucalypt, but the fruits are by no mean; like what exist at the present day. It is, however, just possible that here we have something like an ancestral example of the capsular Myrtaceae, or indeed of the whole group of the Myrtaceae, for it may be a sumed that the fleshy-fruited section of the Order, developed by natural selection out of the hard-fruited one-community of type no doubt implies community of origin. There is, however, an element of doubt about the whole matter, as it is strongly to be suspected that the immediate ancestors of Eucalyptus in Australia had opposite leaves.

Be that as it may, however, there is nothing to prove that in Tertiary times any of the Australian groups existed outside Australia.

See a note on these fruits, *infra,* p. 172. They will be discussed at length, with figures, in the next Part (LV) of the present work.

At p. 653 Mr. Deane goes on to say—

Ettingshausen examined some fossil plant remains found when excavating some railway cuttings, near Brisbane [Oxley.—J.H.M.], and submitted a preliminary report of them to the Imperial Academy of Sciences at Vienna on 13th April, 1893 [see his 1895 paper referred to at p. 182—J.H.M.]. The presence of many Tertiary forms is apparent, and among them *Myrica, Quercus, Fagus, Cinnamomum, Banksia* and *Eucalyptus* are found to be well represented.

In his address of the following year (xxi, p. 833) Mr. Deane says that he had received a number of specimens from these Oxley beds. "They seem to me as a whole to be rather conspicuous for the scarcity of Eucalypts and Proteads as we know them, a circumstance which, as I have already indicated, we need not be at all surprised at."

DEANE, 1900.—Subsequently Mr. Deane published two papers (*Proc. Linn. Soc. N.S.W.,* xxv, 1900) entitled "Observations on the Tertiary Flora of Australia, with special reference to Ettingshausen's Theory of the Tertiary Cosmopolitan Flora" (xx, p. 463; xxi, p. 581).

He continues his former criticisms, and traverses the conclusions made by Unger, Ettingshausen and others, discounted as they may be by Zittel in his "Palaeophytologie." He deprecates the statements of those who take the determinations of Ettingshausen and others for granted and speak of—

" . . . in Eocene times forests of Eucalypts waved in England and that the vegetation was largely of an Australian character, while on the other hand in Australia during the Tertiary period forests of oak and beech flourished. It will be my endeavour to show that it is unnecessary to seek outside Australia for the types of our fossil flora." (p. 464.)

He quotes (p. 470) Zittel's work as throwing doubt on a great many of the determinations of Ettingshausen and his school.

It seems to be conceded, indeed, that the existence of *Eucalyptus,* which most of the specimens do not absolutely prove, receives strong support from the case of *E. Geinitzi* in the Cretaceous, as leaves, flowers and fruit approximating to those of Eucalyptus have been produced, the fruits indeed separate, but the leaves and flowers on the same stalk. Now, however, we have in Dr. Newberry's posthumous work on the Amboy Clays (*Monographs U.S. Geol. Survey,* vol. xxvi), a statement that the author has discovered Heer's fruits of *E. Geinitzi* in great abundance, that he has no doubt whatever of their being identical with Heer's specimens, and that he has proved them not to be those of any species of Eucalyptus at all, inasmuch as they are flattened, not round as they ought to be if of that genus, and that he has obtained them attached to a core of a cone, evidently that of a conifer (see p. 46 of the work referred to). Clearly the so-called fruits have been improperly assumed to be associated with the leaves and flowers, and without them the value of the evidence is almost nil, for the leaves and flowers might easily belong to something else quite different.

The matter of these alleged *E. Geinitzi* fruits will be discussed when I quote Newberry's remarks at p. 111 of his "Flora of the Amboy Clays" in the next Part (LV) of the present work. I will then give a few notes on Zittel's observations.

At p. 471 Mr. Deane asks the question—

"If *Eucalyptus* flourished in England and Europe in the Cretaceous and Tertiary, and if the Cosmopolitan theory is trustworthy, throughout the world in the latter age, what possible conditions could have caused its extinction everywhere else but in the Australian region?”

Part II of Mr. Deane's paper (*op. cit.,* 581, 1900) is entitled “On the Venation of Leaves and its value in the determination of botanical affinities.”

His remarks are very trenchant in regard to nomenclature based on leaves, and the deductions which have been made on such scientifically incomplete material. I sympathise with him, and while I think that most of the conclusions to which he refers were wrong, knowledge has been advanced by stating the case as Ettingshausen and others have stated it, particularly when good, if scanty, figures have been employed. We have thus been favoured with the other side of the case, and can conveniently refer to statements in discussions since they have been admirably presented.

This imposition on the impression of the leaf of a bigger burden than we believe it can bear, is a passing phase, or “cult,” and has been by no means a useless one.

CAMBAGE, 1913.—Mr. R. H. Cambage, in his presidential address (*Proc. Roy. Soc. N.S.W.,* xlvii, 48, 1913), has some observations on “Fossil (Eucalyptus) Leaves.” He, for the first time, groups these fossils according to their venation, as had been already done with living forms, viz., oblique, transverse, &c., with all the disadvantages of the imperfect venation we see in the fossils themselves, and the somewhat diagrammatic venation as indicated in some of the drawings of them. This phase of the subject will be better understood when I arrive at the general question of Eucalyptus leaves and their venation in a subsequent Part of the present work. He says:—

Of the fossil leaves which have been identified as Eucalypts in Miocene deposits in South-eastern Australia, some are considered to possibly belong to other genera, but those recorded as Eucalypts are distributed aomewhat as follows:—Those showing the transverse venation have been recorded from Oxley, near Brisbane,* in latitude 271/2 deg. to Tasmania, and those with the oblique venation, from northern New South Wales to southern Victoria, though one or two of the Brisbane specimens show the beginning of the latter venation. A typical form of the oblique venation, *E. Pluti* McCoy, has been found near Daylesford, in Victoria, in Miocene beds.

Mr. H. Deane has described what he regards as probably a Eucalyptus fossil, from a specimen discovered at Mornington, towards the extreme south of Victoria, under the name of *E. proecoriacea* (below, see p. 187). It has the parallel venation of the living *E. coriacea,* but also much resembles a phyllodineous *Acacia* or a *Hakea,* as suggested by Mr. Deane. The same author has also described several species from the fossil flora of Berwick in about latitude 38 deg., but these belong chiefly to the section which has leaves with the early oblique venation, the lateral veins being usually arranged in these specimens at angles of from 40 to 65 deg., or rarely 70 deg. with the midrib. The Mornington and Berwick beds are doubtfully referred to the Eocene period.[†]

Mr. F. Chapman, in writing of some fossils of probably Janjukian or Miocene age, from Wannon Falls, Redruth, Western Victoria, says, "Several fragments of long, ovate, pointed leaves, can without doubt be referred to the genus Eucalyptus. Their venation differs from those of the fossil species described by McCoy and Ettingshausen in having remarkably long and subparallel veins; and very closely agree with the leaves of *E. amygdalina.*"[‡]

If the extreme or parallel type of venation had been evolved in Eocene or early Miocene time, then it would seem not unlikely that the genus originated as far back as towards the close of the Cretaceous, though its occurrence in Europe in Cretaceous or Tertiary time seems most improbable, as already pointed out by Mr. Deane (*op. cit.,* p. 463, *ante,* p. 172).

Mr. R. M. Johnston has described two species of Eucalyptus from fossil leaves found in Tasmania, one, *E. Kayseri* from Mount Bischoff, and the other, *E. Milligani,* probably from Macquarie Harbour (*infra,* see pp. 176 and 177). From the drawings, these both belong to the transverse venation type, and this implies that Eucalypts, having leaves with this class of venation, had extended south to latitude 42 deg. in Eocene or Miocene time, or about 4 degrees beyond where living examples of this type are found to-day.

In his Presidential address to the Linnean Society, Mr. Deane referred to this phase of distribution, owing to the warmer early Tertiary climate, and said:—"Taking into consideration the difference between the Eocene and Miocene climate and that of the present period, we might expect to find existing types a few degrees further south in the fossil state" (*op. cit.,* p. 832, *ante,* p. 172).

Mr. Chapman has also kindly shown me a Tertiary fossil leaf with the oblique venation, probably a Eucalypt, from near Burnie, in Tasmania.

The leaves described by Ettingshausen as Eucalypts, from Miocene beds at Emmaville (Vegetable Creek) in latitude 291/2 deg., include those with both the transverse and oblique venations, the former predominating (*infra,* see pp. 180, 181, and 182).

The somewhat meagre fossil evidence available rather supports the idea that the transverse venation belongs to the earliest form of Eucalyptus leaf, while it also goes to show that even the extreme or parallel type of venation flourished in the south as far back at least as the Miocene period. After the Kosciusko uplift, and perhaps assisted by the glacial period in Pleistocene time, this latter type was enabled to invade New South Wales from south to north by travelling along the

Main Divide.

BERRY, 1916.—Professor E. W. Berry, in “Maryland Geological Survey, Upper Cretaceous” (1916), p. 249, makes the following sweeping statement. I think it is so vague and so unfair that it will probably be detrimental to his own honourable reputation:—

There have been more worthless articles written about the Cretaceous and Tertiary floras of Australia than of any other equal area of the earth's surface. With the exception of Ettingshausen and Ferd. von Mueller, none of the contributors appears to have had any knowledge of botany or any acquaintance with paleobotany. The latter student did a small amount of admirable work on the fossil fruits of the late Tertiary gold drifts. The former did pioneer work on the floras of what he called Cretaceous and Eocene. Since his day the age determinations have been shifted back and forth. The Eocene floras are now considered Oligocene and Miocene. The Cretaceous flora he described may or may not be Cretaceous. Ettingshausen deducted certain broad conclusions from his studies, the most notable being that as late as the Tertiary, the Australian flora was not a provincial flora, but a part of the cosmopolitan flora. Doubtless many of Ettingshausen's determinations are over-sanguine, and his comparisons in general were with European fossil floras rather than with existing Australian floras; at the same time it should be pointed out that such a statement has a much greater theoretic probability when applied to the Cretaceous or Eocene than when applied to the later Tertiary.

The following were included by Ettingshausen (Ettingshausen, C. von, “Beitrage zur Kenntniss der Kreideflora Australiens.” Denks. k. Akad. Wiss. Wien, Bd. lxii, 1895, pp. 1–56, p. i-iv).

* *Eucalyptus cretacea, Eucalyptus Davidsoni, Eucalyptus Oxleyana, Eucalyptus scoliophylla, Eucalyptus Warraghiana* (all Ettingshausen).

PATTON, 1919.—In his “Notes on Eucalypt leaves occurring in the Tertiary Beds at Bulla” (Victoria), by R. T. Patton, *Proc. Roy. Soc. Vict.,* xxxi (New ser.), 362 (1919), with one text-plate, it is remarked that they “appear to belong to the same general type. . . . I do not think we are justified in making species out of material which all conforms to a general type.”

I take it that the object in giving fossil Eucalyptus leaves full botanical names is to label them for convenience of reference, a clumsy arrangement, but perhaps the best that can be done. These fossil leaves reputed to be Eucalyptus can be said not to belong to the same “general type” in the sense that they vary in venation, but no fossil species yet discovered can be defined with any degree of precision comparable to that possible in a living one.

During a long official career, with special experience arising out of much travel, and the care of a rich botanic garden and herbarium, I have had frequent experience of the way in which the average citizen firmly believes that the botanist can name a plant from a leaf. One has to tell him that unless the leaf is characteristic and well known, naming becomes a guess. With fresh leaves (and to a less extent with dry ones) we have an upper and lower surface, and can examine colour, texture, thickness, smell, taste, &c., but what shall we say of the disabilities of those botanists who determine plants from impressions, frequently of one surface, and frequently poor impressions and broken. In a fossil species we can measure the approximate angle the secondary veins make with the midrib, and we can note the shape of the leaf, a very variable thing. When I arrive at consideration of the Mature Leaf, I shall offer details of the angles of the leaves of Fossil species and make comparisons and deductions.

I follow the great Bentham in his remarks already quoted. I have often been requested to express an opinion as to supposed fossil Eucalyptus remains, but, as a very general rule, an affirmative expression of opinion would, as regards the specimens submitted to me, require such an exercise of the imagination as seemed to me not justified. I attach importance to the opinions of men such as Bentham (although he protests his ignorance of palaeontology), Johnston and Deane, who knew and know the living genus.

The variation in leaves in Australian and other plants has been emphasised in my mind through the researches of one of my late assistants (Mr. A. A. Hamilton), who has specialised in making collections of leaves from individual species of various genera and families, showing the startling variation which can only be ascertained by actually making and viewing such collections. I am quite certain that one cannot realise the amount of foliar variation without examination of such special collections as those to which I have referred. It is quite impossible to bear them in mind in a general way unless they are specially brought together.

A.—AUSTRALASIAN.

I give serial numbers, together with descriptions and figures, of the following fossil plants, all of them found in Australia and Tasmania, because I look upon them as Eucalypts (with a possible reservation in regard to some of those referred to the Cretaceous).

* Baron von Ettingshausen, Denks. K. Akad, Wissen, Wien., Math.-Naturw. Cl. lxii, p. 48 (1895).

† A. E. Kitson, *Rec. Geol. Surv. Victoria,* 1902, p. 52.

‡ *Proc. Roy. Soc., Victoria,* 1910, p. 25.

* The identity of this and the following forms with *Eucalyptus* is questionable.

CCCXI. E. Pluti McCoy.

In *Prod. Palaeontol. Vict.,* Dec., iv, p. 29, Plate xxxix (1876), also Couchman's Progress Report, 1877, iv, p. 17.

From Daylesford, Victoria, in the Deep Leads.

FOLLOWING is the original description:—

Leaves usually about 5 or 6 inches long and 10 lines wide, falcate, acuminate, rapidly tapering near the petiolate base; substance thick; veins delicate, numerous, oblique, subparallel, with rather few branches, or anastomosis; intramarginal one moderately close to the edge.

The foliage of this species is almost identical in size and shape with that of the living *Eucalyptus globulus,* but the veins are much more numerous, straighter, or less flexuous, and more nearly parallel in the fossil than in the living analogue.

CCCXII. E. Kayseri R. M. Johnston.

In *Pap. and Proc. Roy. Soc. Tas.,* 1885, p. 322 (also *ante,* p. cxii), with Plate ii, fig. 4.

THIS will be found in a paper “Descriptions of New Species of Fossil Leaves from the Tertiary Deposits of Mount Bischoff (Tasmania) belonging to the genera *Eucalyptus, Laurus, Quercus, Cycadites,* etc.”

Following is the original description:—

Leaf lanceolate, acuminate, slightly bent, and very attenuate towards the acute apex; base rounded and tapering, about 43/4 inches long and 21 millimetres wide; substance evidently thin, midrib well marked; lateral veins numerous and very delicate, subparallel, almost horizontal near midrib, the most prominent being very indistinct and curving upwards at junction with intramarginal vein, the least prominent usually anastomosing before reaching the same vein; intramarginal vein delicate, wavy, following moderately close to the edge. This form is easily distinguished by its most delicate, close, and almost horizontal veins, and by its extremely acuminate apex.

See also the same author's “Geology of Tasmania,” p. 290, and Plate xxxix, fig. 8 (1888).

CCCXIII. E. Milligani R. M. Johnston.

In *Papers and Proc. Roy. Soc. Tasmania,* p. 336, Plate ii, fig. 4 (1885).

FOLLOWING is the original description:—

Leaves ovate-lanceolate or lanceolate, mucronate acute, with very numerous fine transverse parallel veins, the intramarginal one scarcely distant from the edge. The lateral parallel veins emerge and radiate gently outwards and upwards. This species more closely approaches the existing *Eucalyptus ficifolia* of Western Australia than to existing species in Tasmania, or to the described fossil species, *E. Kayseri* mihi, and *E. Pluti* McCoy. Large specimens, 9 inches long when perfect, and 2⅝ inches broad at greatest diameter.

Supposed locality: Tertiary leaf beds, Macquarie Harbour (Tasmania).

See also the same author's “Geology of Tasmania,” p. 293 and fig. 11, Plate xxxix (1888).

“The only Eucalypts (fossil) described by me up to the present time are *E. Kayseri* and *E. Milligani.* The genus Eucalyptus, in our old Tertiary (Eocene) is the most rare of all genera associated therewith. I have only come across two or three casts among many thousands of representatives of other genera. The period in Tasmania indicates the dawn of our Eucalypts of Australia.” R. M. Johnston in letter to me of 21st January, 1918 (he died in March).

Now we come to—

“Beitrage zur Kenntniss der Tertiärflora Australiens,” by Dr. Constantin v. Ettingshausen. The original (Part I) appeared in *Denkschriften der Math. Naturwiss. K. Akad. Wiss.,* Wien., xlvii Bde. (1883), and Part II, *op. cit.,* liii Bde (1886).

At p. 142, with Taf. vi, fig. 15 of Part I, we have *Eucalyptus Delftii,* sp. n. (1883).

In Part II (Zweite Folge) we have *Eucalyptus Mitchelli, Diemenii* (p. 51), *Houtmani, Hayi* (p. 52), spp. n. (1886).

The whole of the two Parts appeared in Sydney as—

“Contributions to the Tertiary Flora of Australia,” by Dr. Constantin, Baron von Ettingshausen. Translated to form *Mem. Geol. Survey, N.S.W.* Edited by R. Etheridge, Jnr., as No. 2 of the Palaeontology Series (1888).

I take the following notes from this translation:—

“Although the Tertiary Flora of Australia deviates very much from the living one, we find numerous points of connection between them. . . . *Eucalyptus* (is) represented by species more or less closely related to living Australian forms” (p. 81). See also p. 4 and the late Mr. C. S. Wilkinson's preface summarising Ettingshausen's conclusions. . . . . the Tertiary Flora in general contains the elements of all the living floras of the globe. This conclusion he based, first on the occurrence in the European Tertiary Flora of *Alnus,* &c., and other genera peculiar to the Northern Hemisphere, together with . . . . *Eucalyptus* and other genera particular to the Southern Hemisphere."

At p. 78 Ettingshausen quotes his previous conclusions that "the elements of floras are united, not only in the Tertiary Flora of Europe, the Arctic Regions, North America, and of Australia, but also in the Tertiary Floras of other portions of the globe. The facts just mentioned confirm this even more strongly. Besides, I am able to state the same result from facts obtained by examining the Tertiary Flora of New Zealand. . . . There is now scarcely any doubt that the general character of all Tertiary Floras of the globe is one and the same in regard to the mixture [including Eucalyptus in both hemispheres.—J.H.M.] which they exhibit, and carried, until the separation of the elements of floras into the special floras towards the present period."

See also the general conclusions at p. 81.

See also some stratigraphical notes, concerning Dalton, near Gunning, New South Wales:—

The fossil plants of this locality are found in layers of clay, sand, and marl, which are ferruginous. Similar strata occur also in New England. Mr. C. S. Wilkinson regards these strata as at least Lower Miocene.

The author then enumerates the plants of peculiar interest, and proceeds—

"Among these, however, there are no forms of specifically Australian character, which would appear to have retreated into the background altogether. A *Pittosporum* and a *Eucalyptus* are the only plants of this kind. . . . I regard the Fossil Flora of Dalton as Eocene." (p. 9.)

For further stratigraphical notes of certain localities containing Eucalyptus deposits, see Etheridge in the same work, p. 185, in regard to the Emmaville deposit containing *E. Diemenii, E. Houtmanni, E. Hayi,* and p. 187 in regard to a second Emmaville locality containing *E. Mitchelli.*

"I believe that Ettingshausen's conclusions as to the character of the flora and its resemblance to the flora of other parts of the world, as based on the determinations of the Dalton and Vegetable Creek fossils are utterly wrong." (Deane, *Proc. Linn. Soc. N.S.W.,* xx, 654, 1896.)

"Messrs. Hall and Pritchard suggest that the beds at Dalton and Vegetable Creek, which have the same lithological character, and which Ettingshausen considered Eocene, may have to be referred back to the Cretaceous." (Deane, *ib.,* xxi, 857, 1897.)

At p. 16 Ettingshausen gives *E. oceanica* Unger, of the Tertiary of Europe; *E.*

sibirica Heer, of the Tertiary of the Arctic Zone; *E. americana* Lesq., of the Tertiary of North America, as the nearest relations to the New South Wales and Victorian fossils *E. Delftii* Ett., *E. obliqua* L'Herit., *E. Pluti* McCoy.

FOLLOWING is the 1883 species:—

CCCXIV. E. Delftii Ettingshausen (1883).

(*Ante,* p. 177.)

Dalton, near Gunning, New South Wales, in hard siliceous grit, reposing on Silurian rocks.

He compares it with his own *E. teretiuscula* “and others” (Ettingshausen, Blattskelete der Dicotyledonen, Pl. lxxxv., fig. 17).

Here is the original description:—

Sp. Char.—E. foliis rigide coriaceis lanceolato-oblongis obtusiusculis, integerrimis; nervatione camptodroma; nervo primario apicem versus subflexuoso; nervis secundariis subangulis 30–40° orientibus, tenuibus marginem adscendentibus, cum nervo marginali anastomosantibus (?); nervis tertiariis obsoletis.

Obs.—A leaf whose strong, somewhat recurved margin indicates a remarkably rigid texture. At the base it can be restored into an oblong, almost lanceolate leaf, which is narrowed towards both ends and obtuse at the apex. The midrib is somewhat flexuous towards the apex, and not prominent on the upper surface of the fossil, whilst the under side is covered by the rock material.

Owing to this unfavourable circumstance, even the course of the fine and remarkably acute-angled secondary veins, but more especially their behaviour at the margin, cannot be observed with sufficient accuracy. In one place near the margin I thought I could perceive an indication of the marginal vein, with which the secondary veins are connected. Tertiary veins and reticulation have not been preserved. The form of leaf, texture, and venation just described are found in *Eucalyptus,* viz., in *E. teretiuscula,* and others. As the assumption that *Eucalyptus* was not wanting in the Tertiary of Australia is, at all events, more probable than the contrary, so much the more as this genus occurs even in the Tertiary Flora of Europe, I believe the Eucalyptus-like leaf remains found amongst the plant fossils from Dalton may for the present be set down as in all probability a representative of Eucalyptus. A more detailed comparison of the species with hitherto described fossil species of Eucalyptus can only be undertaken when more perfect material has been obtained.

I named this species after the Dutchman, Van Delft, who in the eighteenth [seventeenth.—J.H.M.] century made important exploring journeys in Australia.

FOLLOWING are the 1886 species (*ante,* p. 177):—

CCCXV. E. Diemenii Ettingshausen.

(*Ante,* p. 177.)

See also Tate, *Rept. Horn. Exped.,* 1896, Part 3, p. 69. Desert Sandstone of South Australia.

Ettingshausen compares it to *E. marginata* Sm. and *E. corymbosa* Sm., a remarkable comparison. It comes from near Emmaville, New South Wales, under basalt. Tate and Watt record it from Arcoona, Central Australia.

Following is the original description:—

Sp. Char.—E. foliis coriaceis, petiolatis, lanceolatis, basi acutis, apice acuminatis, integerrimis; ne. vatione brachidodroma; nervo primario, prominente; nervis secundariis subangulis 65–75° orientibus, valde approximatis fere congestis, tenuibus, subrectis, ne vo marginali inter se conjunctis; nervis tertiariis e secundariis extus angulis acutis egredientibus, abbrevatis.

Obs.—The leaf is smaller and broader than that of the preceding species (*E. Mitchelli*), not falciform and less narrowed at apex. Its most distinguishing character is that the secondary nerves are very close to one another, and that they quit the primary one at rather acute angles of divergence. From the close secondary nerves the tertiary ones are very much abbreviated, and the reticulation less developed (see Fig. 9A, magnified). Of the living species, *Eucalyptus marginata* Sieb., and *E. corymbosa* Smith, correspond to our fossil, the first relating to form and texture, but the second to all the leaf characters.

CCCXVI. E. Hayi Ettingshausen.

(*Ante*, p. 177.)

E. resinifera Sm. and *E. pilularis* Sm. "show a striking similarity in leaf-formation." Emmaville, New South Wales, in brown carbonaceous clay, below basalt.

Following is the original description:—

Sp. Char.—E. foliis coriaceis, petiolatis, lanceolatis, utrinque attenuatis, integerrimis; nervatione brachidodroma; nervis secundariis subangulis 30–40° orientibus, approximatis, tenuibus, flexuosis nervo marginali inter se conjunctis; nervis tertiariis e secundariis extus angulis variis acutis obtusisque egredientibus, inter se conjunctis.

Obs.—This species is different from the others here described in its secondary and tertiary nerves. The former are more flexuous, and diverge from the primary at more acute angles, the latter, varying in their angles of divergence, are unequal in their course, longitudinal and transversal intermixed, especially on the forepart of the leaf. The network partly preserved on the specimen, Fig. 5, is represented in Fig. 5A, slightly enlarged, and consists of irregularly-edged meshes.

CCCXVII. E. Houtmanni Ettingshausen.

(*Ante*, p. 177.)

THE author compares it with *E. Mitchelli* and *E. Diemenii.* It "corresponds to *E. Haidingeri* Ett., of the European Tertiary flora, and to *E. robusta* Sm., of the living flora."

Found in the Emmaville district, New South Wales, in brown carbonaceous clay, below basalt.

Deane (*Rec. Geol. Surv. Vict.*, vol. i, Part I, p. 24, Plate iv, fig. 1) doubtfully refers a leaf from the deposits at Berwick, Victoria, to this species. He points out the differences from Ettingshausen's type.

Following is the original description:—

Sp. Char.—E. foliis coriaceis, late lanceolatïs, utrinque angustatis, integerrimis; nervatione brachidodroma; nervo primario firmo, prominente; nervis secundariis subangulis 65–75° orientibus, approximatis, tenuibus, subflexuosis, nervo marginali inter se conjunctis; nervis tertiariis vix conspicuis.

Obs.—Differs from the other *Eucalypti* described here by its larger and broader leaf. Besides, this species deviates from *Eucalyptus Mitchelli* by the secondary nerves diverging at more obtuse angles, and from *E. Diemenii* by the more distant secondary nerves. The nervation is represented in Fig. 3A, enlarged.

CCCXVIII. E. Mitchelli Ettingshausen.

(*Ante*, p. 177.)

Also Tate, *Rept. Horn. Exped.*, 1896, Part 3, p. 69. Desert Sandstone of South Australia.

HE compares it as similar to the living *E. rudis* Endl., and *E. scabra* Dum. (*E. eugenioides* Sieb.), and says it "corresponds" to *E. oceanica* Ung. of the European Tertiary flora.

The type comes from near Emmaville, New South Wales, in ironstone shale, under basalt. "Certain fragments of leaves appear to have the characters on which Ettingshausen described this species." So Mr. Deane writes on specimens from Mornington, Victoria, figured by him, Plate iii, figs. 5, 6, 7, 8 (*Rec. Geol. Surv. Vict.*, vol. i, Part I, p. 24, 1902). Tate and Watt record it from the Elizabeth River, Central (South) Australia.

Following is the original description:—

Sp. Char.—E. foliis coriaceis, petiolatis, lanceolatis vel lineari-lanceolatis, subfalcatis, basi attenuatis, apice acuminatis, integerrimis; nervatione brachidodroma; nervo primario prominente; nervis secundariis subangulis 50–60° orientibus, approximatis tenuibus subflexuosis, arcubus laqueorum in nervum marginalem confluentibus inter se conjunctis; nervis tertiariis e secundariis extus subangulis acutis egredientibus; reticulo microsynammato.

Obs.—The fossil leaves represented in figs. 6, 7, 8 doubtless belong to one and the same species. They are equal in texture, shape and nervation, and only show fragments of different parts of leaf. The specimen, fig. 7, exhibits the petiole and the rather narrowed base of leaf, and the specimen, fig. 6, shows the lamina of the leaf to be lanceolate and falciform. The texture is coriaceous as the above-mentioned specimens, and that of fig. 8, indicate. Borders are untoothed. The nervation represented in fig. 7*a* (enlarged) is well preserved on all specimens, and exactly shows the type of the Myrtaceae. The primary nerve is prominent. The secondary nerves are thin, approximate, somewhat flexuous, and joined together by a marginal nerve. The tertiary nerves join the secondary ones in a direction which is oblique to the axis of the leaf. The network consists of minute meshes. The well-preserved specimens, figs. 6 and 7, exhibit fine dots, equally spread over the lamina. When examined through a strong glass they show themselves to be the receptacles corresponding to the oil glandules due to the leaves of Myrtaceae.

A comparison of these fossils to the leaves of the recent Myrtaceae led me directly to the large genus *Eucalyptus*. *E. rudis* Endl., and *E. scabra* Dum., both living in

Australia, possess leaves very similar to our fossils. Among the fossil species hitherto described, ours corresponds to *Eucalyptus oceanica* Ung. of the European Tertiary flora. I will reserve the decision as to whether both species are to be united or not for future investigation.

Now we come to “Beiträge zur Kenntniss der Kreideflora Australiens,” by Dr. Constantin von Ettingshausen, in *Denkschriften K. Akad. Wissen.*, Vienna (1895), which contains descriptions of the following new species, viz., *E. cretacea* (p. 48), *E. Davidsoni, Oxleyana, scoliophylla* (p. 49), *E. Warraghiana* (p. 50). They are all attributed by the author to the Cretaceous of New South Wales.

Mem. Geol. Surv. N.S.W., Palaeontology, No. II, consists of “A Monograph of the Cretaceous Invertebrate Fauna of New South Wales,” by R. Etheridge. There is a supplement “Plantae.” At p. 54 there is a list of Eucalypts recorded from the Cretaceous, as already quoted.

Mr. Henry Deane (*Proc. Linn. Soc. N.S.W.*, XXV, 471, 1900) properly uses the argument of a genus so highly specialised as Eucalyptus is to resist drought, for example, as not likely to have lived in Europe so far back as the Cretaceous.

Chapman, p. 128, in the same strain, remarks:—

“Ettingshausen places the horizon in the Cretaceous series, but the presence of well-advanced types of Eucalypts and many of the genera and species found in Mid-Tertiary beds elsewhere in Australia, exclude it from so old a formation as the Cretaceous.”

See “A Sketch of the Geological History of Australian Plants: the Cainozoic Flora,” by Frederick Chapman, *Vict. Nat.*, xxxvii, 115, 127 (with three plates), February-March, 1921.

Following are the descriptions of von Ettingshausen's five species.

CCCXIX. E. cretacea Ettingshausen.

(*Ante*, p. 182.)

FOLLOWING is the original description:—

E. foliis coriaceis petiolatis, lineari-lanceolatis, basi attenuatis, margine integerrimis; nervatione brachidodroma, nervo primario valido, prominente, recto; nervis secundariis tenuissimis, subangulis 70–80° orientibus, approximatis, subrectis, arcubus laqueorum in nervum marginalem tenuissimum confluentibus; nervis tertiariis obsoletis.

Fundorte: Ipswich Road, gegenüber der Bahnstation Warragh (Loc. IV); Bahneinschnitt zwischen den Stationen Warragh und Oxley (Loc. VII).

Die hieher gehörigen Blattfossilien verrathen eine steife, lederartige Textur sehr deutlich. Der Stiel erreight mindestens die Länge von 11 *mm*, da er an dem Blatte fig. 8, an dem er am meisten sich erhalten hat abgebrochen zu sein scheint. Die ganzrandinge Lamina erreicht die Breite von 22 *mm*, ist aber lineal-lanzettformig und etwas in den Stiel verschmälert. Der Primärnerv tritt sehr stark hervor, verschmälert sich nur sehr allmälig und entsendet zahlreiche, sehr feine, genäherte, fast geradlinig und einfach bis zum Saumnerv verlaufende Secundärnerven. Letzterer liegt fast ganz am Rande und ist wegen seiner ausser-ordentlichen Zartheit nur an einer einzigen Stelle deutlich sichtbar. Tertärnerven haben sich keine erhalten; dagegen gewahrt man stellenweise mittels der Loupe zahlreiche, sehr feine, gleichmässig ver theilte Punkte, welche als die Überbleibsel der Öldrüsen zu deuten sind und in derselben Weise auch an anderen fossilen *Eucalyptus*-Blättern beobachtet wurden (S. die Vergrösserung fig. 7*a*).

Diese Art entspricht einerseits der in den Kreidefloren von Atane, Moletein und Bohmen vorkommenden *E. Geinilzi* Heer, anderseits der *E. Hayi* m. aus der Eocanflora Australiens, unterscheidet sich aber von beiden durch die unter stumpferen Winkeln entspringenden, ungetheilt und fast gerade gegen den Rand zu laufender Secundärnerven.

CCCXX. E. Davidsoni Ettingshausen.

(*Ante*, p. 182.)

FOLLOWING is the original description:—

E. foliis coriaceis, late lanceolatis, basi angustatis, margine integerrimis; nervatione brachidodroma, nervo primario valido, prominente recto; nervis secundariis tenuissimis, subangulis 40–50° orientibus, approximatis, nervo marginali inter se conjunctis; nervis tertiariis inconspicuis.

Fundort: Strasseneinschnitt bei Oxley, nahe dem Flusse (Loc. II).

Die Eucalyptus-Natur dieses Fossils unterliegt keinem Zweifel; ob dasselbe aber mit obiger Art zu vereiniger sei oder einer besonderen Art angehört, kann erst bei einem reichlicher vorliegenden Material endgiltig entschieden werden, wo es sich herausstellen muss, ob die unterscheidenden Merkmale durch Übergänge verbunden sind oder nicht. Bis jetzt unterscheidet sich das beschriebene Fossil von den Blatt-fossilien der vonhergehenden Art durch eine breitere Lamina und die mehr genäherten, unter spitzeren Wilkeln abgehenden Secundärnerven Durch das letztere Markmal ist dasselbe auch von den Blattern der *Eucalyptus Houtmanni* m. aus der Eocänflora Australiens, mit welcher es die ü brigen Merkmale theilt, verschieden. Die Art zeigt eine auffalldende Annäherung zur *E. haldemiana* Hos. et v.d. Marck aus der westfalischen Kreideflora.

CCCXXI. E. Oxleyana Ettingshausen.

(*Ante*, p. 182.)

FOLLOWING is the original description:—

E. foliis coriaceis, lanceolatis, falcatis, inaequilateris, basi attenuatis, apice acuminatis, margine integerrimis, nervatione brachidodroma, nervo primario firmo, prominente, apicem versus valde attenuato; nervis secundariis subangulis 50–60° orientibus, approximatis tenuissimis, rectis, nervo marginali inter se conjunctis; nervis tertiariis inconspicuis.

Fundort: Oxley Road, nachst der Eisenbahnstation Oxley (Loc. I).

Ist von beiden vorhergehenden Arten durch die ungleichseitig lanzettförmigen, etwas sichelförmig gekrümmten Blätter und von *E. cretacea* durch die unter spitzeren Winkeln entspringenden Secundarnerven verschieden. Das Blatt zeichnet sich überdies durch seine verschmälerte und lang vorgezogene Spitze aus, und der Primärnerv, welcher noch bis zur Mitte der Lamina mächtig ist und stark hervortritt, verfeinert sich gegen die Spitze zu sehr rasch. Eine sehr grosse Ähnlichkeit zeigt das Blatt der *E. Mitchelli* m. aus der Eocanflora Australiens, welches jedoch mehr geschlängelte Secundärnerven besitzt, und obwohl etwas sichelförmig gebogen, doch nicht so auffallend ungleichseitig ist wie das hier beschriebene.

CCCXXII. E. scoliophylla Ettingshausen.

(*Ante,* p. 182.)

FOLLOWING is the original description :—

E. foliis coriaceis petiolatis lanceolato-linearibus inaequilateris, subfalcatis utrinque attenuatis, integerrimis; nervatione brachidodroma, nervo primario firmo, prominente, apicem versus valde attenuato; nervis secundariis sub angulis acutis variis egredientibus tenuissimis, arcuatis, nervo marginali obsoleto.

Fundorte: Oxley Road, nächst der Bahnstation Oxley (Loc. I), Ipswich Road, gegenüber der Bahnstation Warragh (Loc. IV).

Obgleich der charakteristiche Saumnerv an den hieher gestellten Blattfossilien vermisst wird, so können dieselben wegen der übrigen Merkmale under der Tracht des Blattes der Analogie nach doch nur als *Eucalyptus*-Blätter betrachtet und es muss demnach angenommen werden, dass der feine Saumnerv vorhanden war, jedoch sich nicht erhalten hat, wie dies an fossilen *Eucalyptus* Blattern oft vorkommt. Die Art schliesst sich wegen der ungleichseitigen, etwas gekrummten Blätter an die vorige an, unterscheidet sich aber von derselben durch viel kleinere Blätter und bogenförmig gekrümmte Secundärnerven. Auf der Lamina sind hin und wieder Spuren der Öldrüsen bemerkbar. (S. die Vergrösserung Fig. 12a.) Auch zu dieser Art finden wir eine Analogie in der Eocänflora Australiens, nämlich *E. Diemenii* m., bei welcher ebenfalls kleinere, ungleichseitige Blätter vorkommen, welche jedoch durch die fast geradlinigen, einander sehr genäherten Secundarnerven abweichen.

CCCXXIII. E. Warraghiana Ettingshausen.

(*Ante,* p. 182.)

FOLLOWING is the original description:—

E. foliis coriaceis sublinearibus, acuminatis, integerrimis; nervatione brachidodroma, nervo primario basi firmo, apicem versus valde attenuato, recto; nervis secundariis tenuissimis rectis, approximatis, vix conspicuis, nervo marginali obsoleto.

Fundort: Ipswich Road, gegenüber der Bahnstation Warragh (Loc. IV).

Auch bei diesem Blattfossil lässt sich der charakteristische Saumnerv nicht wahrnehmen und die seh feinen Secundarnerven sind kaum sichtbar; dennoch glaube ich den übrigen Eigenschaften und der Analogie nach dasselbe zu *Eucalyptus* stellen zu du fen. Das Blatt ist lederartig, fast lineal und nur 9 *mm.* breit, lang zugespitzt, am Rande ungezahnt, jedoch etwas wellig aufgebogen. Von der Nervation bemerkt man nur den an der Basis stark hervortretenden, gegen die Spitze zu aber sehr verfeinerten. Primärnerven und Spuren der sehr feinen geradlinigen und genäherten Secundarnerven. Ferner sind deutliche Spuren der Oldrüsen an der Lamina wahrzunehmen. Ist von den vorhergehenden Arten durch die Form der Lamina wohl verschieden. Sehr ähnliche, schmale und lang zugespitzte Blatter kommen bei *E. angustata* Vel. aus der böhmischen Kreideflora vor, welche aber durch die unter auffallend spitzen Winkeln entspringenden Secundarnerven von der Australischen Art abzuweichen scheint.

("In this memoir Ettingshausen refers to Darra as Warragh, a misnomer which also enters into his specific references." Chapman, p. 128.)

Now we come to "Records of the Geological Survey of Victoria," published by the Department of Mines of that State in 1902. At vol. i, Part I, p. 15, we have "Notes on the Fossil Flora of Pitfield and Mornington," by Henry Deane, and this includes a description of *E. proecoriacea.* At p. 21 we have "Notes on the Fossil Flora of Berwick," by the same author. He says—"The naming of fossil Eucalypt leaves is a difficult task, and in the end the names can only be conventional." He refers to *E. Mitchelli* Ett., and doubtfully to *E. Houtmanni* Ett. He makes five new species.

CCCXXIV. E. proecoriacea Deane.

In *Rec. Geol. Surv. Vict.,* vol. i, Part I, p. 20, with Plate ii (1902).

FOLLOWING is the original description:—

The figure shows portions of branchlets with leaves attached. Branchlets evidently angular. Leaves almost sessile, lanceolate, falcate, probably 6 inches in length and 1 inch wide, tapered at the base into a short petiole. The venation consists of several veins disposed longitudinally, no one of which can be said to form a midrib. Some of these veins are more conspicuous than the others.

The author adds:—"There are three types which naturally suggest themselves as possessing leaves with parallel veins, as shown in the figure, namely the phyllodineous *Acacioe,* some of the *Hakeoe,* like *H. dactyloides* Cav., and *Eucalyptus coriacea* A. Cunn." He decides that it is a Eucalypt and places it near *coriacea.* "The fossil leaves are very oblique at the base, they have numerous parallel veins, without any, or much sign of any, anastomosing veins between them. The *Hakea* and *Acacia* leaves nearest in character are not oblique at the base, and the anastomosing veins are rather a feature. I am, therefore, of opinion that we have a branchlet here of a species of *Eucalyptus* of the group Renanthereae, and allied to *E. coriacea.*"

See also some remarks at p. 21, *op. cit.*

CCCXXV. E. Hermani Deane.

In *Rec. Geol. Surv. Vict.,* vol. i, Part I, p. 25, Plate iv, figs. 3 and 4.

FOLLOWING is the original description:—

Leaves evidently long and linear, scarcely falcate. Lateral veins very fine, close and parallel, and meeting the midrib at an angle of from 60 to 65 deg. Intramarginal vein close to the margin.

CCCXXVI. E. Howitti Deane.

In *Rec. Geol. Surv. Vict.,* vol. i, Part I, p. 24, Plate iii, fig. 10, Plate iv, fig. 2.

FROM Berwick, Victoria.

Following is the original description:—

Leaves oblique, almost cordate at base, lateral veins transverse, intramarginal vein conspicuous. . . . . They seem to belong to species with opposite leaves, or to be leaves of seedlings or suckers, these being often cordate or rounded at the base.

“One of the most important assemblages of fossil leaves of the Older Tertiary series is that found under the floor of Wilson's bluestone quarry at Berwick, Gippsland. These leaf-bearing beds are described by A. E. Kitson as ‘yellow, white, black and brown soft clays and sandy clays, some of them containing leaves of dicotyledonous plants in great abundance.’ . . . By the almost equal proportion of Eucalyptus leaves of the wide-angled, parallel-veined (archaic) type, and those in which the veins are acutely disposed to the midrib, one cannot help concluding that the flora is somewhere in the mid-stage of development, and precludes the idea of one so old even as the Eocene.” (Chapman, p. 117.)

CCCXXVII. E. Kitsoni Deane.

In *Rec. Geol. Surv. Vict.,* vol. i, Part I, p. 25, Plate iv, figs. 5, 6, 7.

FOLLOWING is the original description:—

Leaves long and linear, probably 5 inches in length and 5/8 inch in width, nearly straight. Lateral veins proceeding from the midrib at an angle of about 40 deg., close together, straight and parallel. Intramarginal vein close to the edge.

These leaves are considered to resemble *E. Hermani* Deane and *E. Hayi* Ett.

(See Part XXVIII, p. 164, of the present work, where I correct the nomenclature of a living species to which I had given the name *E. Kitsoni.*) CCCXXVIII. E. Suttoni* formerly E. Muelleri Deane.

In *Rec. Geol. Surv. Vict.,* vol. i, Part I, p. 24, Plate iii, fig. 3.

FOLLOWING is the original description:—

Leaf broadly lanceolate, falcate, much attenuate at base; lateral veins rather close, parallel and inclined to the midrib at an angle of about 45 deg. Intramarginal vein close to the margin. . . . .It is not unlike *E. Woollsii* in venation, but differs from that species in being strongly falcate, and in its more attenuate base. CCCXXIX. E. Chapmani† formerly E. Woollsii Deane.

Rec. Geol. Surv. Vict., vol. i, Part I, p. 24, Plate iii, figs. 4 and 9.

FOLLOWING is the original description:—

Leaf lanceolate, attenuate at base, almost straight and symmetrical, only slightly oblique at base. Midrib strongly marked, lateral veins close together, making an angle of about 40 deg. with the midrib. Intramarginal vein rather close to the margin.

Mr. Deane compares it with *E. Hayi* Ett.

Miscellaneous Notes.

FOLLOWING are some notes on sub-fossil species:—

(*a*) *E. obliqua* L'Herit.

See McCoy in R. B. Smyth "Report of Progress of the Geol. Survey Vict." (Melb. imp., 8vo., vol. i, pp. 30 and 36, 1874; iii, 48, 1876.)

"At Haddon, in what appear to be older drifts, we find a different flora; and at Malmesbury and Daylesford, intercalated between the flows of lava, or resting on Silurian rocks, but covered with newer volcanic rocks, there are mudstones and mud-shales full of the leaves of a species of Eucalyptus."

"In the mud forming the beds of old lakes and covered with newer volcanic rock, there are in Victoria numerous impressions of leaves of myrtaceous plants resembling those of the *Eucalyptus obliqua. . . .* ”

(*b*) *E. amygdalina* Labill. (?).

Redruth Ironstone, near Casterton, Victoria. Probably Miocene.

“ . . . good imprints of Eucalyptus leaves of the *E. amygdalina* type. . . . ” (Chapman, p. 130.)

(*c*) *E. melliodora* A. Cunn. (?), and *E. piperita* Sm. (?).

Fossil wood from the Miocene and Pliocene forests of Victoria.

“*Eucalyptus* cf. *melliodora* A. Cunn., from Bruthen, and *E.* aff. *piperita* Sm., from Mallacoota Inlet. Their microscopic structure is wonderfully preserved, although occasionally broken down by chalcedonic crystallisation, probably where the tissue was already partially decayed when petrification took place.” (Chapman, p. 131.)

(*d*) *Eucalyptus* spp.

Newer Volcanic tuffs. “At Warrnambool Volcanic tuff occurs, containing impressions of Eucalyptus leaves.” (Chapman, p. 131.)

III. Timber.

(*Continued from Part LIII, p.* 163.)

MICROSCOPIC STRUCTURE.

Timbers in transverse, radial and tangential sections are dealt with by the microscopist.

The work of preparing and microscopically examining sections is one specially adapted to the laboratory, and it is to be hoped that many thousands will be examined, giving the particulars, omitted so far in many cases, of place of origin, size, &c., and reference to corresponding herbarium specimens, in order that the section may be standardised. The day is past when we should be expected (in any set record of results) to receive the bare statement from any man, however eminent, that a certain timber belongs to a certain species, without details as indicated above. To be baldly told that a certain timber belongs to *E. corymbosa,* for example, simply indicates generalities, whereas the provision of details would convey a more definite idea than it does at present. We are in the early research stage yet, and shall be for many years. In Europe this preliminary stage has passed, as regards some timbers, but the structure of the vast majority (even including many which are often referred to in books) is unknown, so that we in Australia are in good company.

Following are some references to work on the microscopy of Eucalyptus timbers; in research of this kind I do not doubt that many private workers have done work that has not been made public.

1859.—At the meetings of the Microscopic Section of the Philosophical Society of New South Wales, at least as early as 1859, microphotos and sections of Eucalyptus timbers were exhibited by various members. I take this note from the minutes, and hope that the exhibitors worked at determined material. Their photographs must have been amongst the earliest of the kind. I have vainly endeavoured to trace these specimens or further particulars.

1861.—H. Nordlinger, a professor of Forestry, first at Hohenheim, Germany, and subsequently at Tubingen, published between 1856 and 1888, eleven small boxes (4 x 51/2 inches, inside measurement), each containing 100 timber sections ready for the microscope, with explanatory notes. The Australian material was supplied by Mueller, but out of the 1,100 specimens, there were only nine of Eucalyptus, viz.:—

E. corymbosa and *E. paniculata* in box or vol. iii (1861).

E. globulus and *E. rostrata* in box vi (1874); and

E. macrorrhyncha, E. coriacea, E. rudis, E. robusta, and *E. Stuartiana* in box xi (1888).

1879.—Mueller, F. von. “Report on the Forest Resources of Western Australia” (L. Reeve <&> Co., London, 1879), 4to, pp. 30, with twenty plates. This work, chiefly useful for its plates, figures seventeen Eucalypts, which were precursors of those depicted a little later in the “Eucalyptographia.” It contains a chapter on Chemical and Microscopical Examination of Eucalyptus wood.

1879–1884.—In “Eucalyptographia” Mueller devotes several illustrations to microscopic sections of timber, viz.:—

1. *E. Behriana.* A separate plate with sixteen transverse sections of the following species:—

E. amygdalina.	*E. melliodora.*
E. Behriana.	*E. obliqua.*
E. botryoides.	*E. punctata.*
E. globulus.	*E. polyanthema.*
E. Gunnii.	*E. rostrata.*
E. goniocalyx.	*E. Stuartiana.*
E. hemiphloia.	*E. Sieberiana.*
E. macrorrhyncha.	*E. viminalis.*

2. *E. goniocalyx.* On the ordinary plate there are transverse sections of wood, magnified 60 and 220 times.

3. *E. leucoxylon.* On the ordinary plate there is the following legend:—

14. Transverse section of wood.
15. A separate vascular tube, and next to it an isolated woody fibre.
16, 17. Parenchymatous particles (220 diameters).

4. *E. macrorrhyncha.* Three sections on a Supplementary Plate, with the following legend, which I quote literally:—

2. Transverse section of aged wood, the large openings representing the vascular tubes; the rows of elongated cells constitute the medullary rays; the scattered cells and those near the vascular tubes are parenchyme (*sic*); the rest show the transverse form of the numerous woody fibres, all closely set and in diameter smaller than the parenchyme-cells.
3. Tangential section of aged wood; wide and dotted vascular tubes, rows of cells of the medullary rays cut transversely, sparingly dotted woody fibres, parenchymatous ampler interstices.

4. Radial section of aged wood, wide dotted vascular tubes, rows of cells of the medullary rays cut vertically, sparingly dotted woody fibres, parenchymatous ampler interstices. All x 214.
5. *E. rostrata.*

10, 11. Transverse section of wood.

12, 13. Longitudinal section of wood. (x 200–220.)

6. *E. viminalis.*

12. Transverse section of wood. (x 220.)

1902.—Gamble (Manual of Indian Timbers, 1902 edition) has some notes on six timbers of Indian-grown Eucalypts, as follows:—

1. *E. globulus.* (With a photo-micrograph of a transverse section, magnified three and a half times.)

Pores small to moderate-sized, round, in groups or in radial or oblique lines; closely packed in concentric belts in the annual rings. *Medullary rays* fine, very numerous, the intervals between the rays smaller than in the diameter of the pores. Pores marked on a longitudinal section, and medullary rays visible as a silver-grain or a radial section.

2. *E. marginata* Sm.

Pores small, scanty, scattered unevenly, but chiefly in pale concentric bands. *Medullary rays* very fine, very numerous.

3. *E. obliqua* L'Her.

Pores moderate-sized, scantly enclosed in pale tissue and arranged in short radial or oblique strings. *Medullary rays* very fine, very numerous. Occasionally numerous white wavy lines across the rays (p. 354).

4. *E. amygdalina* Labill. (probably *E. radiata* Sieb. is meant).

Pores small, moderately numerous, in long radial lines or oblique lines first one way, then the other. *Medullary rays* extremely fine, very numerous (p. 354).

5. *E. calophylla* R.Br.

Pores moderate-sized, usually in radial lines of 3 to 6, joined by concentric white bars. *Medullary rays* fine, numerous (p. 354).

6. *E. tereticornis* Sm.

Pores few, moderate-sized, the rest small, in patches of pale tissue arranged in concentric bands. *Medullary rays* very fine, very numerous, indistinct (p. 354).

1904.—“The Timbers of Commerce and their Identification,” by Herbert Stone (photo-micrographs by Arthur Deane) (London, 1904) is a useful attempt to tackle a very difficult subject.

He classified the information he gives under Vernacular and Botanical Names, Natural Order (now called Family), Alternative Names (*i.e.,* of Vernaculars), Source of Supply, Physical Characters, &c., Grain, Bark, Uses, &c.; Colour, Anatomical

Characters—Pores, Rays, Rings, Pith, Radial Section, Tangential Section, Type Specimen (which in the book means the specimen, deemed to be authentic, he has described).

As regards Eucalyptus timbers, it is a pity that he did not get into touch with at least one botanist who has specialised in timbers of the genus. If non-Australian writers and, indeed, many Australian ones could only realise the limitations of many of the older botanical names, their work would be very much more valuable than it is. I am led to make these remarks because I look upon Mr. Stone's book as the most useful of its kind that had appeared up to the date of its publication.

He deals in detail with the following species:—

E. marginata (Jarrah).

E. resinifera (Red Mahogany).

E. diversicolor, versicolor by a slip (Karri).

E. calophylla (Western Australian Red Gum).

E. loxophleba (*foecunda*) (York Gum).

E. salubris (Gimlet Wood).

E. gomphocephala (Tuart).

E. hemiphloia (Box).

E. pilularis (Blackbutt).

E. globulus (Tasmanian Blue Gum).

E. patens (Western Australian Blackbutt).

E. salmonophloia (Salmon Gum).

E. longicornis (Morrell).

Thirteen species in all, and nine of them confined to Western Australia. This probably arises from the fact that Western Australian timbers are, as a rule, more gregarious than those of the eastern States, and also because the Western Australian Government is very keen on propagandist work in regard to its timbers.

One example will show Mr. Stone's method of treatment of a timber. I take *E. marginata*:—

Grain.—Coarse, open-sinuous, surface rather dull. The ground tissue the brightest portion, the pores and rays very dull.

Anatomical Characters.—Transverse section.

Colour.—Very dark chocolate, or the colour of dried blood with black zones here and there; runs lighter in colour at times. Sapwood brownish, écru; ⅝ to 3/4 inch wide, well-defined from the heart.

Pores.—Clear in certain lights in dark pieces, clearer in light wood, not prominent on account of the lack of contrast of colour. Size, 1 or 1–2, with considerable variation in each ring in no particular order; irregularly distributed, often running in oblique, straggling lines which occasionally reverse their direction; mostly single, but joining up into compact strings of about 15 pores: numerous, 0–15 per sq. mm.: round or oval: often contain resin or gum. Radial sec., prominent, coarse, open grooves usually filled with dark contents: often reversed in adjoining bands. In tang. sec. usually sinuous.

Rays.—Require the lens: size 5: uniform and equidistant, much less than the width of the large pores apart: avoiding or interrupted by the pores: very much waved: very numerous, 10–12 per mm.; denser than the ground tissue. In radial sec. scarcely perceptible: appear as fine, black (or lighter) shining flakes under the lens. In tang. sec., extremely fine blackish lines: scarcely visible with lens, less than 0·1 mm. high.

Rings.—Bands or zones of few or crowded pores, often in regular rows of oblique straggling lines: often zones of black colour having no relation to the structure: also denser and softer zones of the ground tissue causing contrast in the solid wood: contour waved.

Soft-tissue.—Encircling the pores and compacting the oblique lines.

1905.—MacMahon's "Merchantable Timbers of Queensland," Plates XLII and XLIII (1905), shows "Sections of Queensland Woods," which are but of little value, partly at least because of the imperfections of reproduction.

1906.—In *Journ. Roy. Soc. N.S.W.,* xl, civ (1906), Mr. James Nangle, of the Technical College, Sydney, exhibited transverse sections of timbers of various Eucalypts, together with photo-micrographs of the sections, and gave some account of his observations. These include—*E. sideroxylon, E. polyanthemos, E. hemiphloia, E. crebra, E. bicolor.*

1917.—In *Journ. Roy. Soc. N.S.W.,* li, 410, Mr. R. T. Baker has a paper "Some Ironbarks of New South Wales," in which he gives anatomical notes in regard to the timbers of the following:—

E. paniculata Sm., *E. Fergusoni* n.sp. (with microphotos of transverse, radial and tangential sections), *E. Nanglei* n.sp., *E. Beyeri* n.sp. I have shown in Part 48 that, in my view, *E. Fergusoni* and *E. Nanglei* are not specifically different from *E. paniculata.*

1919.—Under the heading of "Structure," and chiefly referring to the timber of *E. regnans,* see a brief account in the paper by R. T. Patton in *Proc. Roy. Soc. Vict.,* xxxi, 410 (1919). He speaks of its outstanding feature in the simplicity of its structure as compared with Pine (*Pinus*).

1919.—R. T. Baker, in his "Hardwoods of Australia," has a chapter at p. 18 on "Fibrous Bodies." They are divided into two kinds, wood-fibres and septate wood-fibres. He refers to their arrangement in *E. crebra, E. paniculata, E. oreades* and *E.*

rubida, and gives highly magnified figures of them in *E. microcorys, oreades, gigantea* (*delegatensis*), *siderophloia.*

Dealing with Vertical or Wood parenchyma, at p. 19, he says—"The disposition of wood parenchyma cells is of some taxonomic value, for they are found arranged in various forms in different genera or species, as, for instance, in Eucalypts they occur clustered around the large vessels or pores, or scattered amongst the wood fibres. This is well seen in the various transverse micro-sections of Eucalyptus species."

Crystals (Calcium Oxalate).

The presence of crystals in Eucalypts has been referred to under Barks, see Part LII, p. 99.

In my "Forest Flora of New South Wales," v, 175, I have some notes on timbers which are reputed to cause irritation, including *E. maculata, E. hemiphloia,* and *E. marginata.* As regards the last, Mr. C. E. Lane-Poole, late Conservator of Forests of Western Australia, informs me that the reputed Jarrah (*E. marginata*) unloaded at Port Hedland, was really Karri (*E. diversicolor*), and that the timber was Powellised and therefore arsenical. As regards the other two species, the question of arsenic does not appear to come in, and I throw out the suggestion that Calcium Oxalate may be inquired into as the cause.

In a paper "On the occurrence of Crystals in some Australian timbers," by R. T. Baker (*Journ. Roy. Soc. N.S.W.,* li, 435, 1917), the author goes into the general question. The only Eucalypts referred to are *E. hemiphloia* F.v.M. var. *albens* (*E. albens* Miq.), *E. Dawsoni* R. T. Baker, *E. pilularis* Sm., *E. polyanthemos* Schauer, *E. melliodora* A. Cunn., and *E. paniculata* Sm., but calcium oxalate was not found in all cases. There are no figures referring to Eucalyptus timbers.

The following general remarks referring to Oxalates amongst other waste products will be found useful for reference:—

Wastes not Useless.—In the course of the many and varied chemical changes which take place in plants, there arise, especially in consequence of the destructive metabolism, a great number of compounds which are not usable for the building of new parts, and are not again drawn into the metabolism. Some of these are nevertheless of considerable service to the plant, and in varied ways; as for example, in protecting it from predatory animals by disagreeable tastes, or odours, in covering wounds by gummy or resinous exudations, in attracting by colour or odour insects which effect pollination, &c. In spite of the usefulness of some of them, these substances are often called *waste* products, and this word may well be retained instead of the more technical term, *aplastic* products, which has been applied to them. For in every household there are like products, properly "waste," as far as the direct economy is concerned, some of which may nevertheless be collaterally serviceable. (Coulter, Barnes and Cowles, 1, 412.)

A Warning Note in regard to Undue Reliance on Microscopic Structure for Diagnostic Purposes.

"The role of the microscope in the identification and classification of the timbers of commerce," by Irving W. Bailey (*Journn. of Forestry,* xv, 176, February, 1917), is a valuable paper, and the following Summary and Conclusions at the end are supported by evidence (Eucalyptus timbers are not used illustratively).

1. There has been a marked tendency amongst those who have advocated the use of minute anatomical characters in the classification and identification of wood, on the one hand, to over-estimate the possible economic applications of such diagnostic criteria, and, on the other hand, to greatly under-estimate the variability of anatomical structures.

2. The fact that the average lumberman (timber getter) and tradesman has to handle a large amount of material in a comparatively limited space of time, eliminates the use of any except the most obvious anatomical characters.

3. There are, however, certain important, although somewhat restricted, economic fields of usefulness for very accurate and reliable keys in the hands of technically-trained experts.

4. The inaccuracies in existing systems of classifying woods are largely due to the fact that investigators have not studied the limits of variability of anatomical characters, but have assumed that their diagnostic criteria are constant and comparatively invariable.

5. A careful study of some of the supposedly more reliable diagnostic criteria, such as the distribution of wood-parenchyma, form and structure of the rays, type of pitting, &c., indicates very clearly that these characters may fluctuate considerably, not only in certain families, genera and species, but also in different parts of a single tree.

6. There seems to be little doubt that anatomical characters must be largely dependent (depended) upon in the construction of a thoroughly accurate and reliable key, such as is needed for general scientific purposes and the use of technical experts in certain phases of commercial work.

7. There are two methods of constructing such a key. The first is the "trial and error" method of examining more and more material until a key is secured which

proves to be accurate and reliable. The second method is logically more direct and scientific. This method of attacking the problem is to study the limits of the variability of anatomical characters in different plants, to endeavour to isolate and analyse the factors which control or regulate this variability, and to attempt to formulate laws for forecasting the variability of selected characters in a given species or environment.

8. There are undoubtedly important economic fields of usefulness for the student of plant anatomy in the study of problems connected with the decay, seasoning, preservative treatment, pulping, chemical utilisation and classification, and identification of wood; but the business man should realise the fact that the problems to be solved are complex and difficult, and that results of economic value are not likely to be secured without prolonged and painstaking work.

The discussion which followed the paper is also well worth reading.

Paper Pulp.

The first important Australasian report on this subject is "Feasibility of Manufacturing Paper Pulp from Tasmanian Timbers" (Tasmanian Parliamentary Paper No. 8, 1915), by Henry E. Surface, Consulting Engineer in Forest Products, Madison, Wis., U.S.A.

The Eucalypts reported on were—

"Swamp Gum" (*E. regnans* F.v.M.).

"Blue Gum" (*E. globulus* Labill.).

"Stringybark" (*E. obliqua* L'Her.).

He also reported on Myrtle or Beech (*Fagus Cunninghamii* Hook.).

His conclusions, although unfavourable, are valuable, and are set out at p. 10 as follows:—

(1) That Myrtle (or Beech), Swamp Gum, Blue Gum, and Stringybark are very much the same so far as their wood-structure and pulp-making characters are concerned.

(2) That these woods are all very short-fibred.

(3) That these woods contain relatively large amounts of water-soluble materials, of materials easily soluble or destroyed by paper pulp digestion processes, and of non-fibrous cellular materials.

(4) That they are not suitable for the manufacture of paper pulp by either the sulphite or the mechanical (grinding) process.

(5) That they are suitable for the manufacture of bleached paper pulp by the soda process; that the soda pulp is of excellent quality, and suitable for use as the main constituent in the manufacture of book, magazine, coated, lithograph, map, cord, cover and common envelope

and writing paper.

(6) That the yields of pulp from these woods are comparatively very small, and the wood requirements high; that Stringybark affords the most favourable results from the yield standpoint, but Blue Gum is the more favourable when volume and weight of pulp wood are considered. Swamp Gum is the least desirable.

(7) That more than ordinary amounts of chemicals and coal are required for the manufacture of soda pulp from the woods in question.

(8) That the cheapest and most reliable source of pulp wood in Tasmania would be to conduct bush operations similar to the existing sawmills, but bringing in more or less desirable logs; that the sawdust is not a suitable material for pulp-making by present-day commercial methods; that most of the sawmill waste is not suitable or not sufficiently available for pulp-mill purposes.

(9) That under existing circumstances the manufacture of bleached soda pulp from the Tasmanian timbers would be too costly to afford a profit if the pulp were to be marketed as such. Stringybark affords the lowest cost of production; Swamp Gum the highest of the four woods.

(10) That the manufacture in Tasmania of the papers for which bleached soda pulp from Stringybark is most suitable might be a profitable undertaking only under the most favourable circumstances.

(11) That under conditions to be expected the manufacture of paper in Tasmania, utilising pulp from the woods in question, would not be a profitable undertaking at the present time.

(12) That the utilisation of Myrtle (or Beech), Swamp Gum, Blue Gum, and Stringybark for the manufacture of wood pulp and paper products in Tasmania is not a feasible business proposition under existing circumstances.

Bulletin No. 1 of the Department of Chemistry of South Australia is “An Investigation into the Prospects of Establishing a Paper-making Industry in South Australia,” by W. A. Hargreaves (Appendices by J. C. Earl and D. C. Winterbottom), Royal 8vo., pp. 56 (1916). A useful Bulletin, which scarcely touches upon Eucalyptus, but useful for reference in this connection.

Bulletin No. 11 of the Advisory Council of Science and Industry is entitled “Paper Pulp: Possibilities of its Manufacture in Australia,” compiled by Gerald Lightfoot (1919).

At p. 24 we have “Utilisation of Young Eucalypts,” based on information supplied by Mr. C. E. Lane-Poole, from experiments by M. Mathey, Conservator of Forests at Dijon, France, on the wood of *E. globulus* grown in Spain. The wood experimented on is comparatively young second growth, not mature timber as experimented on by Mr. Surface in Tasmania.

Then follow notes on “Investigations on Pulping Qualities of young Karri Timber” (*E. diversicolor*), by Mr. J. H. Boas, of the Perth Technical School. His experiments give comparative results of tests on trees 8, 15, or 20 years old, and on mature trees. His experiments indicate that the best results, both in respect to yield of pulp and consumption of soda and bleach, are obtained from trees about 8 years old.

Mr. Boas' experiments are of a preliminary nature, but they hold out hope that even if Mr. Surface's report on the timber of certain mature Eucalypts is of general application, the results with second-growth or other young trees may be more favourable.

Bulletin No. 19 (of the same series) by Mr. Boas is entitled "Wood Waste" (1921), and it contains valuable information on the subject of Wood Pulp.

For some information on Pulping Material, see the Report of the New South Wales Forestry Commission for the year ending 30th June, 1919, p. 21.

Heart-wood and Sap-wood.

The living portion of the wood is known as *Sap-wood* or *Alburnum,* while the dead portion is known as *heart-wood* or Duramen. Usually the heartwood and sapwood differ in colour and otherwise, owing to the accumulation of excreta in the former

Speaking more particularly of Gum trees, Sir William Macarthur wrote in 1854, with knowledge chiefly obtained from the counties of Cumberland and Camden, New South Wales—

When at full maturity they are rarely sound at heart, and even when they are so, the immediate heartwood is of no value on account of its extreme brittleness. In sawing up log into scantlings or boards, the heart is always rejected. The direction in which the larger species split most freely is never from the bark to the heart (technically speaking, the "bursting" way), but in concentric circles round the latter.

G. A. Julius remarks that—

"Contrary to general practice in the case of other chief timbers of the world, the heartwood core of the Eucalypts is to be avoided. In Western Australian woods this applies specially to Jarrah, Karri, Blackbutt, and Wandoo, and generally to others. Specifications for cut timbers should therefore require freedom from heartwood, except in the case of piles, which are better round than squared. Sapwood, on the other hand, rarely measures above an inch in thickness, and being often almost as hard as the inner wood, hardly needs to be particularly excluded, except in cases of special importance." ("W. A. Timber Tests," 1908 Edition (c), p. 11.)

Speaking generally, trees with thin sapwoods are found in regions of low rainfall, or in well-drained situations. For example, *E. rostrata,* which grows on the banks of streams (or depressions which become streams when the rain comes), has a comparatively thick sapwood, while *E. bicolor, E. intertexta, E. salmonophloia,* which may be found in the same district, but which frequent drier situations, have a thinner sapwood.

Making allowance for the small diameters of the trunks, the sapwoods of Mallees are very thin.

Trees with thick sapwood (which, by the way, is readily attacked by insects) include *E. maculata* and the Corymbosae generally, *E. papuana* (and some other Angophoroideae), *E. obliqua,* a Stringybark of Tasmania and Victoria, and a Messmate in New South Wales, is another.

Prehaps the list of pests which attack the Eucalyptus timbers, and which are enumerated in Part LXX of my "Forest Flora of New South Wales," may be referred to in this connection.

Seasoning.

Under this heading Schlich (Fisher), iv, 53, has some notes as follows:—

(*a*) Shrinkage of dried wood.
(*b*) Cracks in dried wood.
(*c*) The swelling of dried wood exposed to moisture.
(*d*) Warping of timber.

The timbers selected for illustrative purposes are those commonly in evidence in European forestry, and therefore do not include Eucalypts, but the notes are well worthy of reference in connection with a subject which has received but little scientific attention in regard to this genus.

Closely connected with the above is the section (p. 61) on defects and unsoundness in timber when warping, and various blemishes may result as the result of ill-usage of the tree. Much of the "shake" noticed in the large logs, and to which all timber of this kind seems liable, appears to be preventable wholly, or in part, by proper seasoning, careful felling, so that the trees do not come down with a crash, and rejection of trees of the largest size.

As important deductions are sometimes drawn in regard to the presence or absence of gum-veins as affecting Eucalyptus timbers, the section on "Kinos" should be referred to.

Some timbers have a special tendency to shell, and amongst them the Bloodwoods (including *E. corymbosa* and the Western Australian *E. calophylla*) can be specially enumerated. *E. rostrata* and its ally *E. tereticornis* have a similar tendency, and so has the Western Australian *E. redunca.*

The paper on "The Timbers of New South Wales," by J. V. de Coque in *Journn. Roy. Soc. N.S.W.,* xxviii, 189, 1894, has a useful section, "Effect of Natural Drying or Seasoning," which is illustrated.

The artificial drying of timber is a technical operation, and must be left to the engineer, working in co-operation with the forester. I must dismiss the subject with a few, mainly Australian, references.

The question of seasoning of timber is a technical matter now being dealt with by industrial specialists, and greater progress will be made now that our taxonomic knowledge of species is much better than it was a few years ago.

A valuable contribution to the scientific aspects of the problem will be found in R. T. Patton's paper in *Proc. Roy. Soc. Vict.,* xxi, 403 (1919).

In a paper published shortly afterwards, the same author, "On the Seasoning of Hardwoods," *ib.,* xxxii, 350 (1920), remarks:—"The results given in this paper do not claim to settle, in any way, the question of seasoning, but are rather a record of accurate observations made on our timber when treated in various ways."

In the first paper Mountain Ash (*E. regnans*) was chiefly used; in the present one Messmate (*E. obliqua*). Both papers should be referred to.

At p. 230 of D. E. Hutchins' "A Discussion on Australian Forestry" (Perth, 1916), we have sections, "Natural and Artificial Seasoning of Timber," and "Deformation during Seasoning," which should be turned to, as they contain a useful précis of Australian experience up to date.

Bulletin No. 1 of the Forests Department of Western Australia is entitled— "The Kiln-drying of Jarrah" (*E. marginata*), by C. E. Lane-Poole, late Conservator of Forests, who acknowledges the collaboration of Acting Professor A. Tomlinson, of the Engineering School of the local University. Royal 8vo, 22 pp., and profusely illustrated (1919). There are chapters on Seasoning, Kiln-drying, the well-known Tiemann Kiln, its Construction, Operation of the Kiln, Case-hardening, Temperature, Shrinkage, with notes on After-treatment, Improvements and Grading of Timber.

The case for natural seasoning is given by V. B. Trapp in "The Gum Tree," quoted in "The Australian Forestry Journal," March, 1920, p. 84. But already a small library has been written on the subject.

Specific Gravity.

There is much room for research in this direction, the published results being alike few as regards both individuals and species, many being not represented at all. And of very few results can we say that we know the biological history of the timber whose specific gravity is recorded. Here is a useful line of research for a student, or rather, many of them, who will first have to decide as to a uniform method of presenting their results.

Speaking generally, we have to refer to the specific gravity of Eucalyptus timbers in vague terms, *e.g.,* amongst the heaviest timbers we include Ironbarks (various species), Tallow-wood (*E. microcorys* F.v.M.), Yate (*E. occidentalis* Endl.).

Warren, in his "Australian Timbers" (1887), p. 13, and 1892 (Chicago Exhibition), p. 20, gives the weights per cubic foot of five New South Wales timbers by two methods—the ordinary specific gravity method and by direct weighing and measuring. These are—

	lb. per cub. ft.
Grey Ironbark (*E. paniculata*)	73·854
Red Ironbark (*E. siderophloia*)	76·522
Spotted Gum (*E. maculata*)	62·195
Blackbutt (*E. pilularis*)	65·539
Woollybutt (*E. longifolia*)	63·895

The weights by the specific gravity method are also given.

1889.—A number of weights of Eucalyptus timbers will be found in my "Useful Native Plants of Australia" (1889), but while I worked on authenticated material, the pieces weighted were too small to be satisfactory, as a rule.

1900.—The following timbers tested at the Melbourne University by Mr. James Mann had been stored away in a rack in a dry room for upwards of eight years; they were 2 feet long, and approximately 3 inches square:—

	lb. per cub. ft.
Ironbark (*E. sideroxylon*)	69·7
Grey Box (*E. hemiphloia*)	61
Yellow Stringybark (*E. Muelleriana*)	56
Tuart (*E. gomphocephala*)	72
Blue Gum (*E. globulus*)	57
Tallow-wood (*E. microcorys*)	59
Yellow Box (*E. melliodora*)	63
Karri (*E. diversicolor*)	58

A further table at p. 36 gives—

Jarrah (*E. marginata*)	65
Karri (*E. diversicolor*)	63
Tuart (*E. gomphocephala*)	67
Wandoo (*E. redunca*)	72

White Gum (*E. viminalis*)	69
Flooded Gum (*E. rostrata*)	76
Blue Gum (*E. globulus*)	63
Grey Box (*E. hemiphloia*)	73

(J. Mann, "Australian Timber—Its Strength, Durability and Identification," 1900, p. 25.)

1902.—A. O. Green ("Tasmanian Timbers, their Qualities and Uses") gives the weights of certain Tasmanian timbers:—

	lb. per cub. ft.
Blue Gum (*E. globulus*), fresh cut	73
Blue Gum (*E. globulus*), dry	60
Stringybark (*E. obliqua*), fresh cut	69
Stringybark (*E. obliqua*), dry	57
Gum-top Stringybark (*E. gigantea*)	50
Swamp Gum (*E. regnans*)	54
Peppermint (*E. amygdalina*)	59
White Gum (*E. viminalis*)	46

In G. A. Julius' "Western Australian Timber Tests, 1906," which embodies the physical characters of the timbers of that State (and some others), in Schedule I we have—

Name of Timber.			Specific Gravity, &c.				
			Weight in lb. per cubic foot.			Moisture when Green.	
Local Name.	Botanical Name.	Where grown.	Average when First Cut.	Average of 12 percent Moisture Per cent. of Dry Weight.	Average Dry Weight.	Per cent. of Total Weight.	Per cent. of Dry Weight.
Jarrah	*E. marginata*	W.A. . . .	68	55	48	33	50
Karri	*E. diversicolor* . . .	W.A. . . .	72	58	50	35	54
Tuart	*E. gomphocephala* . . .	W.A. . . .	78	68	60	30	43
Wandoo	*E. redunca* . . .	W.A. . . .	79	71	63	22	28
Blackbutt . . .	*E. patens* . . .	W.A. . . .	69	54	46	38	61
Red Gum . . .	*E. calophylla* . . .	W.A. . . .	72	56	47	43	75
Yate	*E. cornuta* . . .	W.A. . . .	79	71	64	24	32
York Gum . . .	*E. loxophleba* (*foecunda*)	W.A. . . .	77	67	59	23	30
Salmon Gum . . .	*E. salmonophloia* . . .	W.A. . . .	70	66	60	20	25
Morrell	*E. longicornis* . . .	W.A. . . .	73	64	56	23	30

Ironbark . . .	*E. paniculata, crebra*, &c	N.S.W. . . .	76	71	. . .	. . .	. . .
Tallow-wood . . .	*E. microcorys*	N.S.W. . . .	74	63	. . .	. . .	. . .
Blackbutt . . .	*E. pilularis*	N.S.W. . . .	66	57	. . .	. . .	. . .
Spotted Gum . . .	*E. maculata*	N.S.W. . . .	67	60	. . .	. . .	. . .
Flooded Gum . . .	*E. saligna*	N.S.W. . . .	74	63	. . .	. . .	. . .
Grey Gum . . .	*E. propinqua*, &c. . . .	N.S.W. . . .	71	65	. . .	. . .	. . .
Grey or White Box.	*E. hemiphloia*	N.S.W. . . .	74	68	. . .	. . .	. . .
Red Gum	*E. rostrata*	Vic. . . .	65	59	. . .	. . .	. . .
Blue Gum . . .	*E. globulus*	Vic and Tas. . . .	67	57	. . .	. . .	. . .
Stringybark . . .	*E. obliqua*	Vic and Tas. . . .	64	56	. . .	. . .	. . .

From the figures given in Schedule No. I the following deductions have been made:—

A. Specific gravity, and its relation to strength.

The heaviest of the Western Australian timbers, and of all the Australian timbers of note, are Yate and Wandoo, which when first cut both average 79 lb. per cubic foot, Tuart and York Gum following closely with weights of 78 and 77 lb. respectively.

When seasoned, *i.e.*, at 12 per cent. moisture, Yate and Wandoo are still the heaviest, with Tuart, York Gum, Salmon Gum, and Morrell following in that order.

It has been stated that the weight and density of a seasoned timber is to a certain extent a measure of its strength, and this is borne out in the case of Yate, which is the heaviest and very much the strongest of the Australian hardwoods; and although Wandoo and Tuart do not come next in order of strength, yet both are well to the front.

It is more nearly correct, however, to state that, the greater the density, and therefore the weight, the greater is the strength to resist compressive strain, whether applied edgewise or crosswise; and this is fully borne out by the results of the tests in which the relative positions are, Yate, Wandoo, Morrell, Tuart, Salmon Gum, and York Gum.

It has been found that the "density" is no criterion as to the "Tenacity" or Tensile strength of the material, and hence, therefore, affords no guide as to the relative strength of beams, which largely involves the tensile strength of the timbers. Thus, Karri, which when seasoned is lighter and less dense than any of the above-mentioned timbers, is very much stronger in tension and as a “beam” than all others, excepting Yate and Salmon Gum.

Red Gum also, which is comparatively light when seasoned, is very strong in tension, although not so high when used in beams, due to its lower compressive strength. (pp. 14–15.)

Hardness.

The hardness of a body is its power of resisting the insertion of another body into its mass. Woods which offer considerable resistance to being worked by instruments are termed *hardwoods*, and those which may be easily worked are termed *softwoods.* Eucalyptus timbers pass under the name of hardwoods, but reference to any work which deals with their physical properties shows that the variation amongst them, in this respect, is very great indeed.

Schlich (Fisher), v, 34, states that the factors on which the hardness of a wood depends are—its anatomical structure, the coherence of its fibres, the amount of resin it contains, its degree of moisture, and the kind of instrument used. The chapter is interesting, but Eucalyptus timbers are not used as illustrations.

The determination of degrees of hardness is one for the engineer, and I content myself with quoting the observations and results of Stone, Julius, and Warren, who are distinguished members of the engineering profession, and they have given special attention to the subject.

The hardness of timber is unfortunately just as much dependent upon our impressions as are taste and smell, but its commercial importance is much greater, hence many attempts have been made to express a scale of hardness in words.

Nordlinger expressed it in figures corresponding with the weight of sawdust removed by a given number of strokes of a saw; another observer employed a rasp; a third turned balls of the wood to be tested, and measured the distance they rebounded when dropped from a given height; another (Hough, I believe) dropped a pointed weight upon the wood and measured the depth of indentation. The methods are all useless because Nordlinger's saw (to say nothing of his biceps) is needed to produce the same result, and the saw must always be equally keen; and the like with the rasp. Again, the turned ball could never be reproduced exactly, even in the same wood, and in most woods a ball would soon become distorted by warping. By Hough's method the bottom of the depression made by the impact of the point would rise up in some woods from their elasticity, while in others it would remain deeply impressed. My own method, though more complicated, presupposes nothing that cannot be reproduced by others, but unfortunately it requires a machine of considerable complexity, which, as I have had no leisure so far to make exhaustive researches in this direction, is merely described in the Appendix. After all, it is not hardness alone that is measured, but more accurately the resistance to impact, spoken of by Hough, or, in other words, the amount of force which wood will absorb when struck. We are, therefore, thrown back upon vague terms, such as "hard," "very hard," "moderately hard," &c., &c., coupled with the names of a few well-known woods for comparison, so that they are not quite empty words. Gamble's scale of hardness, expressed in this fashion, is good, but cannot be used by English readers, as his standard woods are all Indian. I have, therefore, used Nordlinger's scale, in which the type species are chiefly familiar European woods, and as it embraces a longer and rather more convenient series. I cannot say that it is at all uniform when tested by accurate means, but I am loath to pile another empirical scheme upon those already in existence, without more substantial gain than appears in sight at present. A rough method, not to be despised, as a test for hardness (?), is to try the wood upon the transverse section (across-grain) with the finger-nail. The amount of resistance felt, and the depth of the mark made, give a ready and not at all inaccurate means of comparison.

("The Timbers of Commerce and their Identification," by Herbert Stone, pp. xxxv–xxxvi, 1904.)

Tests for Hardness.—A "hard" wood has been defined as one requiring a load in excess of 1,000 lb. per square inch to produce an indentation of one-twentieth of an inch.

Tests were made to determine this factor, which is of considerable importance in sleepers, upon specimens 12 in. x 3 in. x 2 in. The load was applied through a circular steel die nominally 1 square inch sectional area, and the "instant" of obtaining a penetration of one-twentieth of an inch was automatically recorded by the apparatus shown on Plates Nos. 17 and 18.

The relative hardness was also derived by measurement of the penetration produced by a weight of 40 lb. falling from a height of 5 feet on to the specimen, which was held firmly upon a machined surface that formed portion of an anvil of 1 ton weight.

The requisite height of drop was previously determined by experiment, and was sufficient to produce well-defined differences in penetration, but not so great in the majority of cases as to split the timber.

To afford means for comparison, a number of samples of "American Oak" and "Selected Indian" teak were tested for hardness by both methods, and the results are given hereafter.

SPALLING TESTS were made upon turned specimens, 3 inches in length and 4 square inches in sectional area, by allowing a 40 lb. weight to fall upon them from a height of 5 feet, the specimens being placed on “end” on the 1-ton anvil.

The number of blows required to produce certain “deformations” upon the specimens, as recorded automatically, were taken as a measure of the resistance to “breaking up under shock” by comparison with the results obtained on similar tests of American Oak and Teak.

(Western Australian Timber Tests, 1906. “The Physical Characteristics of the Hardwoods of Western Australia,” by G. A. Julius, pp. 10–11.)

Hardness.—This was experimented upon by the measurement of both “static” and suddenly applied loads, and the former was found to more accurately represent the hardness of the material.

Where the load was suddenly applied, the “very moist” timbers generally gave higher results when they were partially seasoned than when dry, due probably to the elasticity of the specimens, the “cells” closing upon receiving the blow, and reopening immediately and before the depth of indentation could be measured—this being particularly noticeable with Karri and Red Gum.

For this reason, therefore, the static pressure required to produce a given penetration is the more accurate of the two methods, and as was to be expected, the “dry,” “dense” “curly” grained timbers gave considerably higher results than those that are straight grained. (*Ibid.*, p. 18.)

See the following two tables concerning Western Australian timbers, furnished by Julius:—

Name of Timber.		Hardness.					
		As determined by the Indentations produced by a suddenly applied load.				As determined by static load required to produce given Indentation.	
Local Name.	Botanical Name.		Average Indentation in Mills.				
		Number of Tests.	Minimum.		At 12 per cent. Moisture.	Number of Tests.	Load in lb. per sq. inch required to produce an Indentation of 1/20 inch.
			Per cent. Moisture.	Depth in Mills.			
Jarrah . . .	*E. marginata*	47	24	90	128	51	4,500

Karri	*E. diversicolor*	37	45	50	102	43	4,400
Tuart	*E. gomphocephala* . . .	52	25	50	87	59	7,050
Wandoo . . .	*E. redunca*	44	12	55	55	54	8,000
Blackbutt . . .	*E. patens*	38	12	105	105	40	4,300
Red Gum . . .	*E. calophylla*	45	27	85	105	49	4,500
Yate	*E. cornuta*	19	12	25	25	19	7,400
York Gum . . .	*E. loxophleba* (*foecunda*)	17	24	32	40	17	7,600
Salmon Gum . . .	*E. salmonophloia* . . .	16	12	60	60	18	6,800
Morrell . . .	*E. longicornis*	19	12	50	50	20	6,900

Name of Timber.		Spalling Test.		
		40 lb. dropped 5 feet on to cylindrical specimen 3 inches in length by 4 square inches sectional area carried on an anvil 1 ton in weight.		
Local Name.	Botanical Name.	Number of Tests.	Number of blows sustained.	
			Before failure commenced.	Before complete failure.
Jarrah	*E. marginata*	51	5	6
Karri	*E. diversicolor*	40	5	6
Tuart	*E. gomphocephala*	41	8	10
Wandoo	*E. redunca*	31	16	16
Blackbutt	*E. patens*	39	3	5
Red Gum	*E. calophylla*	63	4	6
Yate	*E. cornuta*	11	9	12
York Gum	*E. loxophleba* (*foecunda*)	37	12	15

Salmon Gum	*E. salmonophloia*	4	20	24
Morrell	*E. longicornis*	19	17	22

Warren, W. H. "Sand Blast Tests of New South Wales Timbers," *Journn. Roy. Soc. N.S.W.,* xliv, 620, 1910.

Twelve of the timbers chosen for comparison were Eucalypts, viz.:—

Blackbutt (*E. pilularis*).	Red Mahogany (*E. resinifera*).
Tallow-wood (*E. microcorys*).	Grey Box (*E. hemiphloia*).
Grey Gum (*E. propinqua*).	Woollybutt (*E. longifolia*).
Grey Ironback (*E. paniculata*).	Spotted Gum (*E. maculata*).
Blue Gum (*E. saligna*).	Jarrah (*E. marginata*).

The first nine were from New South Wales, all coastal, mostly North Coast, the remainder South Coast. The tenth was the well-known Western Australian timber.

The apparatus is described and the method of conducting the experiments. In addition to the tables of results, there are plates showing—

(*a*) Specimens of the various timbers after testing in direction A, *i.e.,* parallel to the direction of the fibre.

(*b*) Specimens of the various timbers after being tested in direction B, *i.e.,* perpendicular to direction of fibre and also perpendicular to annual rings.

(*c*) Specimens of the various timbers after testing in direction C, *i.e.,* perpendicular to direction of the fibre, and tangential to the annual rings.

Mr. R. H. Cambage, *Journ. Roy. Soc. N.S.W.,* xlvii, 34 (1913), has the following general notes in regard to the hardness of Eucalyptus timbers from a geographical point of view, mainly as regards New South Wales:—

Timbers may broadly be grouped under two heads, viz:—Texture and colour, the former of which may be subdivided into hard and soft, and the latter into dark and pale. In arranging Eucalyptus timbers into hard and soft groups it is found tha the hardest occur in the Interior where the conditions are the most arid and the trees of slowest growth, though the hardest are not necessarily the strongest. The second in degree of hardness are found on the Western Slopes, the third on the Coastal Area, and the fourth or softest in the Mountain Region. The Coastal Area contains both hard and soft Eucalyptus timbers, members of the Ironbark group, such as *E. paniculata, siderophloia,* and *crebra,* also *E. hemiphloia* of the Box group being among the hardest. It might perhaps be expected that the decrease in hardness would accord with the increase in rainfall, but although this progression applies so far as the Interior and Western Slopes are concerned, it is in the division with the third highest rainfall and not the fourth, viz., in the cold Mountain Region, where there are the least hardwoods.

Now, under the peneplain conditions, long prior to the Kosciusko period, a greater similarity in the texture of Eucalyptus timbers in South-Eastern Australia would undoubtedly have existed over at least the Coastal, Mountain, and Western Slopes divisions, and it seems a fair inference that the great uplift in that period is responsible for accentuating, even though an earlier and slighter uplift may have helped to originate, some of the various differences in the textures of these timbers.

Mr. R. T. Baker, in his "Hardwoods of Australia," at p. 2, has a qualitative scale of hardness, viz.:—Very hard (*E. crebra*), hard (*E. rostrata*), moderately hard (*E. gigantea* or *delegatensis*) (and *E. marginata*), which, however, does but show the unsatisfactoriness of all such scales in the present state of our knowledge.

Fissility and Interlockedness.

Schlich (Fisher), v, 39, has a special section devoted to "Fissility," or "Fissibility," as he calls it.

By the fissibility of wood is meant the property it possesses of being split by a wedge driven into it in the direction of the fibres. Fissibility is clearly a form of hardness. . . . Branch and rootwood, owing to twisted knotty structure, is harder to split than stem wood, and no part of a tree is harder to split than the stump, where the tap and side-roots unite to form the bole. Trees with twisted fibre are specially hard to split, and it is found that those twisting from left to right (against the sun's apparent course) are harder to split than those twisting in the opposite direction. The structure of the medullary rays has very great influence on the fissibility of a wood, for they are in the plane in which the principal splitting action lies, so that (trees) with large rays are easily split.

In addition to this factor of structure, he deals with Elasticity and Flexibility of Fibre, Moisture, &c., Locality and Mode of Growth, all in relation to Fissibility.

Those timbers which are converted by splitters into rails, shingles, and palings may be fairly enumerated as fissile. As a rule, species producing such timbers grow in sheltered valleys with good soil and drainage, and good cultural conditions generally, so as to encourage straight, rapid growth. The timber-getter, as a rule, knows his species by experience, and he selects individuals by reason of their absence of twist, usually obvious in the bark to the trained eye. A simple guide will be the list of uses to which timbers are put and which presuppose fissility, in my "Notes on the Commercial Timbers of New South Wales" (Third Edition).

Amongst Eucalypts, the Stringybarks have a fair degree of fissility, to which may be added the Mountain Ashes (*E. regnans* and *E. gigantea*), which are more fissile still. But very many species are worked up by splitters for one use and another. Fissility enters somewhat into the classification submitted at p. 142, Part LIII.

Notice the admirably depicted shearing tests in Plates 60–64 of Julius, 1906 (*a*). The following also is a measure of fissility:—

Tests to determine the holding power of dog spikes in sleepers were made with both old and new sleepers, the old sleepers being drawn from the "road" by withdrawing two out of the four spikes, thus allowing the sleeper to be removed without disturbing the remaining two spikes.

These were then "pulled out" by means of the apparatus shown in Plate 26, the "pull" required to "start" the spike being recorded, as also the size and type of spike. New holes were bored in the "old" sleepers and the spikes redriven, to be again pulled out in order to determine the holding power of the "used" sleepers upon the freshly-driven spikes. Similar tests were also made upon new sleepers.

All of the spikes were 5/8 inch square, and, with the exception of several of the oldest sleepers, were of the standard pattern marked B. on Plate 26, and had been driven into holes bored with a 5/8-inch auger. ("W.A. Timber Tests, 1906," by G. A. Julius, p. 11.)

Photographs illustrating fractures, which are a measure of fissility, can be seen, not only in the works of Julius, but also in those of Professor Warren, A. O. Green, Nangle, and many others.

Interlocked Timbers.—Interlockedness is the converse of fissility, and, like it, is not capable of other than broad generalisations at the present time. Interlocked timbers which specially stand out are the Yate of Western Australia and the Ironbarks and Boxes of the Eastern part. Engineers are working at the problems involved, for economic reasons, and, in a few years, our interlocked timbers will be classified more quantitatively than is the case at present.

Reference may also be made to Mr. Baker's "Hardwoods of Australia," p. 13, under the heading "Texture," and also at p. 9, he remarks under "Grain," which he subdivides into Straight Grain, Open Grain, Close Grain, Interlocked, Short-grained, Wavy, &c.

Inflammability.

G. Rodney Cherry, "Comparative Combustibility of Timbers," is a paper read before the Insurance Institute of New South Wales, 18th August, 1903, and published in its Journal, "The Sydney Record," for September, 1903.

It takes cognisance of a number of Eucalyptus timbers, amongst others. The subject has been very little dealt with, and it is hoped that additional research will be made. Mr. Cherry devised a special apparatus, and the tests (which seem somewhat perplexing) were made with this apparatus.

Stone, *op. cit.*, p. xxxv (1904), has a few brief notes, of a general character, in regard to simple qualitative tests of inflammability.

A book "Firewoods: their Production and Fuel Values," by A. D. Webster, is interesting because of the paucity of literature on the subject. It does not refer in any way to Australian timbers or Australian conditions; it is written chiefly for British readers.

Non-inflammability.—

"The British Fire-Prevention Committee made some careful inflammability trials with Jarrah and Karri timbers a few years ago, with a view of obtaining reliable data as to their fire resistance capabilities, when severe tests were applied. The results were regarded as generally satisfactory, and as indicating that a building constructed of Jarrah or Karri would be unusually resistant to fire, especially in the case of floors and floor-beams. Tuart is about equally resistant, while Blackbutt (*E. patens*) is especially mentioned by the State Royal Commission as being notably non-inflammable." (G. A. Julius, "W.A. Timbers," p. 12, 1906.)

A paper on the "Fire-resisting Qualities of Eucalyptus Timbers" ("Australian Forestry Journal," August, 1920, p. 248) quotes the tests of the British Fire Prevention Committee, referred to by Mr. Julius, on Jarrah and Karri door and Jarrah floors, made in 1902 and 1903.

Endeavour must be made to gather together the scattered facts in regard to the inflammability (and the reverse) of our living Eucalyptus timbers. Mr. W. A. W. de Beuzeville speaks of the low fire-resisting power of *E. fraxinoides* in the Queanbeyan district, New South Wales, which is important to foresters, as such a tree does not stop a forest fire. Indeed, the time will come when foresters will have compiled a list of trees in respect to their capacity to burn. Of course, this list may not be identical with a list of fire-resistant seasoned timbers of the same species.

The Ironbarks and Box-trees of Eastern Australia supply excellent firewoods, and are hence much sought after for the purpose, and I regret to say that I have often seen fine trees of this class converted into firewood by a man who has purchased the "firewood rights," when they ought to have been reserved for further development or for immediate constructive purposes.

E. Seeana is a bad burner. See this work, Part XXXII, p. 30.

In the eastern gold-mining areas of Western Australia (Kalgoorlie, &c.), the Eucalyptus firewood industry assumes an importance it has in no other Australian gold-field, because of the absence of coal. There are "Wood-lines," owned by wood companies which traverse timber areas, cut it out (under regulations approved by the Forest Department), and the lines (rails) are pulled up and re-erected in another area. The lines have all the essential equipment of a railway, and along its course temporary villages spring up.

The photograph, 8 B, to be reproduced later, taken and presented by Mr. C. E. Lane-Poole, later Conservator of Forests for Western Australia, shows mining fuel at the end of the Kurrawang line, 82 miles from Kurrawang, about 10 miles west of Kalgoorlie. A trip of three days on this line as a guest of the Company, is a very pleasant memory, as, apart from seeing the operations of the line, I was enabled to visit an area containing interesting trees I could reach in no other way.

Mr. Lane-Poole's notes are as follows:—

The photograph shows the firewood stacked on each side of the line ready to be trucked. The bush is divided out on each side into strips and each cutter or pair of cutters is allotted his strip. The wood is then carted in and dumped upright alongside the line. The trucks pass over a weighbridge, and so the quantity of wood cut by each man is known and paid for at a rate which was fixed by agreement between the workers and the Kurrawang Wood Company. All work is piece-work, and the majority of the men working are Italians. The average earnings would seem to work out at 17s. 6d. per day (1919).

Destructive Distillation.

See an article "Products of the Dry Distillation of Victorian Woods," in Official Record, Intercolonial Exhibition (Melbourne), 1866–67, p. 238.

Proximate analyses, including those of four Eucalyptus timbers (*E. leucoxylon, rostrata, obliqua*, and *globulus*) showing the yield of charcoal, crude wood, vinegar, and incondensable gases, are given at pages 241, 242. See also p. 315 (Pyroligneous acid).

In a laboratory under the direction of the Forestry Commission, New South Wales (Report for year ending 30th June, 1917, p. 15), the following results were obtained:—

Samples of Wood treated in one-ton Lots.

		Yields.		
Timber.	Species.	Pyroligneous Acid in gallons.	Wood tar in gallons.	Charcoal in cwt.
Red Stringybark	*E. capitellata*	70	3	6·5
Bloodwood	*E. corymbosa*	74	3·5	7
White Gum	*E. hoemastoma*	64	4	6
Blackbutt	*E. pilularis*	80	3·5	6·25

White Stringybark	*E. eugenioides*	71	4·5	6·5
Swamp Mahogany	*E. robusta*	76	3	6·25
White Mahogany	*E. acmenioides*	68	3·5	6·5
Tallow-wood	*E. microcorys*	80	4·5	6·25

In the Report for the following year, at p. 20, we have—

Wood Distillation.—The distillation of wood tests commenced last year are now nearing completion, and some very interesting data has been derived from them. A wide range of timbers was employed, and the results, with one or two exceptions, show a remarkable uniformity.

The following table shows the results for timbers on which a complete test has been made:—

Products of the Dry Distillation of New South Wales Timbers.

Name of Timber.					Composition of Pyroligneous Acid.		
Local Name.	Botanical Name.	Tar in gallons from 1 ton.	Charcoal in cwt. from 1 ton.	Pyroligneous Acid in gallons from 1 ton.	Acetic Acid, per cent.	Methyl. Alcohol, per cent. by volume.	Acetone, calculated from Acetic Acid, per cent.
Red Stringybark	*E. capitellata* .	3	61/2	70	5·49	·97	2·65
Bloodwood . . .	*E. corymbosa* . . .	31/2	7	74	5·28	1·34	2·55
White Gum . . .	*E. hoemastoma* . . .	4	6	64	5·55	1·66	2·68
Blackbutt	*E. pilularis* . . .	31/2	61/4	80	3·03	1·16	1·46
White Stringybark	*E. eugenioides* . . .	41/2	61/2	71	5·49	1·3	2·65
Swamp Mahogany . . .	*E. robusta* . . .	3	61/4	76	4·26	1·68	2·06
White Mahogany . . .	*E. acmenioides* . . .	31/2	61/2	68	4·68	1·45	2·26
Tallow-wood . . .	*E. microcorys* . . .	41/2	61/4	80	6·33	1·34	3·06
Flooded Gum . . .	*E. grandis*	51/2	61/4	69	4·20	1·58	2·03
Woollybutt	*E. longifolia* . . .	3	6	71	2·16	·27	1·04
Blue Gum	*E. saligna* . . .	21/2	53/4	62	4·14	·39	2·00

Grey Gum	*E. punctata*	21/2	51/2	62	3·78	·83	1·83
Ironbark, Red . . .	*E. siderophloia* . . .	3	61/2	70	5·55	1·00	2·68
Spotted Gum . . .	*E. maculata* . . .	21/4	5	61	6·	1·1	2·9
Grey Box	*E. hemiphloia*	2	51/4	64	6·72	1·23	3·24
Red Mahogany	*E. resinifera* . . .	21/2	61/4	68	5·97	·7	2·88
Ironbark, Grey . . .	*E. paniculata* . . .	31/4	6	70	6·27	·5	3·09
Ironbark, Grey . . .	*E. paniculata* . . .	3	61/4	74	5·79	·3	2·80

In the Report for 1919, pages 22 and 23, we have continued reports under the headings “Wood Distillation and Wood Tars.”

In the Report for 1920, p. 23, we have, under the heading of “Wood Distillation,” Black Peppermint, *Eucalyptus amygdalina* (really *E. radiata*)—

Per ton of wood-tar in gallons	21/4
Pyroligneous acid in gallons	78
Charcoal in cwt.	51/4

In “Jarrah,” the organ of the Australian Forest League at Perth, we have, in the issue for August, 1920, an excellent article on “Alcohol from Waste Wood or Sawdust,” by J. H. Boas, the value of which is enhanced by the table of Principal Products of Wood Distillation.

The same author's pamphlet on “Wood Waste,” published as Bulletin No. 19 of the “Institute of Science and Industry” (Melbourne, 1921), should also be referred to, for it is most suggestive. The subject of destructive distillation is dealt with in much greater detail than was possible in the “Jarrah” article, and figures of stills are shown.

The destructive distillation of Australian timber has formed the basis of Australian enterprise for many years, notably by the firm of William Cuming <&> Co., which works with (largely) *Eucalyptus regnans* at Warburton, Victoria.

Ash.

1867.—For some brief notes on the ash of a Eucalyptus wood and a bark, see “Official Record, Intercolonial Exhibition” (Melbourne), 1866–67, p. 317.

In *Rept. Aust. Assoc. Adv. Sci.*, xiv, 576 (1913), is an abstract by James Mann of his work on “The Calorific Value of some Australian Woods, with notes on the

Production of Charcoal and Ash,” from which the following is taken. Indeed, it is the first important Australian research on the subject.

The objects of investigation were to determine, for different Australian woods, and the charcoal produced from them, their calorific values as fuel, the quantity of charcoal and the amount and colour of the ash.

The specimens of wood used in the tests were in the form of 3/4-inch cubes, and for each species, at least four cubes were tested both as wood and charcoal. The cubes were dried for twenty-four hours at a temperature of 103 deg. C., and placed in a desiccator, to prevent absorption of moisture before weighing.

Charcoal Tests.

The cubes were carbonised in a closed muffle packed with powdered charcoal, which was heated in a gas furnace. When nearly cool the carbonised cubes were placed in the desiccator, as above.

Ash Tests.

Cubes, similar to those used in the charcoal tests, were burnt in platinum crucibles.

The following table (Table 1) gives the weights of charcoal and ash produced from one ton of wood. The third column is the weight of ash produced from one ton of charcoal.

Botanical Name.	Local Name.	Weight of Charcoal in pounds.	Weight of Ash from Wood in pounds.	Weight of Ash from Charcoal in pounds.
E. bicolor	Black Box	805	1·340	3·98
E. rostrata	Red Gum	696	0·636	2·05
E. Stuartiana	Apple Gum	681	7·280	23·89
E. sideroxylon	Red Ironbark	656	0·957	3·26
E. hemiphloia	Grey Box	656	17·270	60·03
E. polyanthema	Red Box	647	4·150	13·86
E. macrorrhyncha	Stringybark	637	0·668	2·40
E. melliodora	Yellow Box	631	6·380	22·70
E. obliqua	Messmate	600	0·718	2·68
E. globulus	Blue Gum	599	5·216	19·63
E. amygdalina	Peppermint	593	1·079	4·23
E. botryoides	Gippsland Mahogany	584	2·300	8·84
E. eugenioides	White Stringybark	583	0·291	1·11
E. Bosistoana	White Box	574	17·158	67·00
E. Consideniana	Yert Chuck	557	0·980	3·93

E. viminalis	White Gum	539	4·062	17·63
E. pulverulenta	Woollybutt or mealy Stringybark.	463	0·792	3·96

Calorimetric Tests.

Cubes, similar to those used above, were also adopted in these tests. A Berthelot-Mahler bomb calorimeter was employed to determine the calorific values, which are here (Table 2) expressed in calories, per gramme:—

Botanical Name.	Local Name.	Calorific Value of Charcoal.	Calorific Value of Wood.
E. eugenioides	White Stringybark	7,912	4,680
E. obliqua	Messmate	7,901	4,594
E. melliodora	Yellow Box	7,895	4,693
E. pulverulenta	Woollybutt or mealy Stringybark	7,853	4,604
E. rostrata	Red Gum	7,842	4,811
E. rostrata	Red Gum	*7,018*	*4,250*
E. macrorrhyncha . . .	Stringybark	7,839	4,674
E. Stuartiana	Apple Gum	7,819	4,703
E. Consideniana	Yert Chuck	7,802	4,576
E. viminalis	White Gum	7,749	4,670
E. botryoides	Gippsland Mahogany	7,758	4,756
E. globulus	Blue Gum	7,736	4,560
E. amygdalina	Peppermint	7,731	5,099
E. bicolor	Black Box	*7,610*	*4,595*
E. hemiphloia	Grey Box	*7,052*	*4,422*
E. polyanthema	Red Box	*7,044*	*4,828*
E. sideroxylon	Red Ironbark	*6,995*	*4,528*
E. Bosistoana	White Box	6,715	4,431

The numbers in italics represent the results of experiments on undried specimens, which contained at least 12 per cent. of moisture, showing a reduction of the calorific value of charcoal by 10 per cent., and that of wood by 11·5 per cent.

Table 3 shows the percentage of ash and charcoal from wood, the calorific values of both dry wood and dry charcoal, and remarks on the colour and *texture* (?) of the ash. They are arranged in the descending order of the percentage of ash. In this table the botanical names only are given:—

Botanical Name.	Ash.	Charcoal.	Calorific Value of Wood.	Calorific Value of Charcoal.	Remarks on the Ashes.
	per cent.	per cent.			
E. hemiphloia . . .	0·7726	29·34	4,934	7,792	Light stone, pink shade. Amorphous.
E. Bosistoana . . .	0·7660	19·22	4,431	6,715	Decided pink. Amorphous.
E. Stuartiana . . .	0·3230	30·74	4,703	7,819	Bluish grey. Slightly granular. Like

					powdered pumice.
E. melliodora . . .	0·2850	28·20	4,693	7,895	White, pinkish tinge. Amorphous.
E. globulus	0·2330	26·80	4,560	7,736	Light yellow, like brickdust. Granular.
E. viminalis	0·1810	24·02	4,670	7,749	Stone colour, *yellow*. Granular.
E. botryoides . . .	0·1026	26·04	4,576	7,758	Shades of dark grey and yellow.
E. amygdalina . . .	0·0790	26·50	5,099	7,731	Light brown, like fine sand.
E. bicolor	0·0640	35·93	5,142	8,409	Light yellow, like brickdust. Amorphous.
E. polyanthema . . .	0·0485	28·92	4,827	7,783	Very light stone colour, like fine sand.
E. Consideniana . . .	0·0438	24·90	4,576	7,802	Cream. Granular.
E. sideroxylon . . .	0·0427	29·36	5,053	7,729	Stone colour, pinkish. Slightly granular.
E. pulverulenta . . .	0·0354	20·21	4,604	7,853	Dark brown, like ground coffee.
E. obliqua	0·0321	26·79	4,594	7,901	Cream. Finely granular.
E. rostrata	0·0284	31·09	4,811	7,842	Dark cream. Medium granular.
E. macrorrhyncha . . .	0·0272	29·23	4,674	7,839	Dark brown, shading from pink. Sandlike.
E. eugenioides . . .	0·0130	26·31	4,680	7,912	Yellowish brown. Woolly.

It will be observed that there is no relation between the percentage of ash and charcoal produced, but the tendency, in regard to the calorific value is, that the timber giving the lowest percentage of ash also gives the highest calorific value, and, conversely, the timber giving the greater percentage of ash, is lower in calorific value.

Summary.

1. The calorific value of dry charcoal produced from the Eucalypts averages 7,800 C.
2. The calorific value of dry wood produced from the Eucalypts averages 4,650 C.
3. That moisture decreases the calorific value about equal to the percentage of moisture it contains.
4. The calorific value does not depend upon the density of the wood, but rather on the amount of ash it contains.
5. It would appear that the lighter woods give the purest charcoal.

In a paper by Messrs. Baker and Smith in British Association Report, 1915, we have a paragraph headed— "Directing Influences of Inorganic Chemical Constituents," and which contains the following statements:—

. . . . The large trees mostly grow in soil comparatively poor in mineral constituents, the soil being of a siliceous nature. The apparent difficulty of trees so placed is overcome, as they have the peculiarity of only storing minute quantities of mineral constituents in their timber (3); this appears to be one of the chief reasons why such trees are able to continue growing until they reach very great dimensions: *E. regnans,* for instance, sometimes exceeds 70 feet in circumference, and reaches a height of over 300 feet. If species growing in highly siliceous country stored mineral matter in the woody portions as freely as do the Eucalypts which grow on less siliceous or on basic soils, this available mineral material would soon be exhausted and the growth of the tree would cease; but some of the largest trees of these species must be many hundreds of years old. (But see Tenison Woods, de Beuzeville, and Patton in Part XLVIII, pp. 244–259.—J.H.M.)

The mineral matter stored in the timber of the four above-named species, calculated on the anhydrous timber, is as follows (3):—

E. regnans	0·054 per cent.
E. Delegatensis (gigantea)	0·038 per cent.
E. obliqua	0·025 per cent.
E. pilularis	0·052 per cent.

These values are obtained from timbers collected from five widely-distributed (separated) localities.

Although the amount of ash constituents in the woody portions of the species referred to is so small, a much larger quantity is found in their leaves, those of *E. regnans* giving 2·85 per cent. of ash, those of *E. pilularis* 2·91 per cent.

The buds, petioles, seed-cases and seeds also contain a considerable amount of mineral matter: thus in the case of *E. pilularis*—

Buds, with petioles	3·79 per cent.
Seed-cases (fruits)	2·89 per cent.
Seeds	1·04 per cent.

The mineral matter in these portions of the tree, like that of the leaves, would obviously be available for repeated use.

A striking peculiarity of several groups of Eucalypts is the comparative constancy of the amount of manganese in the ash of the timber of a given species from trees grown over the whole range covered by the species; thus the amount found in *E. pilularis* from five widely-distributed localities ranged between 0·2 and 0·26 per cent.; *E. regnans* gave 0·27 per cent.; *E. Delegatensis (gigantea),* 0·3 per cent.; *E. obliqua,* 0·22 per cent.

The mean results obtained in the case of these four species show that the manganese present in their timber represents only one part in about one million parts of anhydrous wood; in five species of “Ironbarks” it is one part in 60,000 parts (3). Again, in the case of this group, whatever the variation in the percentage amount of ash in the timber of the several species of the group, the ratio of Mn to the other inorganic constituents is remarkably uniform; the following are results obtained with the five principal “Ironbarks”:—

	Per cent. of Ash.	Per cent. of Mn. in ash.
E. paniculata	0·47	1·40
E. siderophloia	0·17	1·25
E. melanophloia	0·172	1·50
E. sideroxylon	0·072	1·15
E. crebra	0·06	1·50

The indications these ash results afford is that *E. crebra,* and to a lesser extent, *E. sideroxylon,* would be found growing naturally on soils more siliceous than that consonant with the other species of "Ironbarks": this is fairly borne out by results.

There are considerable differences in the general character of other mineral constituents of the several groups of Eucalypts as well as in the amount of mineral matter stored, but there is an approximate relative constancy in the amounts of certain elements required by the members of the several groups. Magnesium is a pronounced constituent in the ashes of species belonging to some groups, whilst calcium predominates in those of others. Representative species of the three large groups, the "Boxes," the "Ironbarks," and the "Ashes," show this fact somewhat clearly; the results in each case with members of the same groups agree closely.

"Boxes" (*E. hemiphloia* and *E. albens*):—

	Mean percentage in ash.
CaO	51·31
MgO	2·13

"Ironbarks" (*E. siderophloia* and *E. paniculata*):—

	Mean percentage in ash.
CaO	29·63
MgO	6·92

"Ashes" (*E. Delegatensis (gigantea)* and *E. regnans*):—

	Mean percentage in ash.
CaO	16·11
MgO	21·76

Wood-ash Tests.—Interesting information was obtained from an analysis of the ashes of several species of timber. Two pounds of ashes of each timber were obtained in the following way:—Pieces of the timber were burnt in an ordinary oil drum, which had been perforated with 1/2-inch holes about 3 inches from the bottom to admit of sufficient draught.

The tests are as yet incomplete, but the percentage of unburnt carbon in each sample and the percentage of potash in the true ash has been determined for the following species:—

Timber.	Botanical Name.	District.	Percentage of Unburnt Carbon in sample.	Percentage of Potash in true ash.
Mountain Gum	*E. goniocalyx* . . .	Bermagui (Moruya)	30·60	6·85
Mountain Ash	*E. Sieberiana*	Bermagui (Moruya) . . .	30·57	5·57
Woollybutt	*E. longifolia* . . .	Bermagui (Moruya) . . .	17·60	6·36
Yellow Stringybark	*E. Muelleriana* . . .	Bermagui (Moruya) . . .	9·70	5·59
Yellow Box	*E. melliodora* . . .	Dubbo	16·74	·28
Spotted Gum	*E. maculata*	Wyong	20·02	4·70
Blue Gum	*E. saligna*	Wyong	26·14	5·17
Grey Box	*E. hemiphloia* . . .	Wyong	24·81	2·95
Mountain Ash	*E. gigantea*	Tumbarumba . . .	20·02	9·23
Grey Ironbark	*E. paniculata* . . .	Casino . . .	22·89	·13
Red Ironbark	*E. siderophloia* . . .	Casino	21·32	1·02
Forest Red Gum	*E. tereticornis* . . .	Casino	47·03	1·58
Grey Gum	*E. punctata*	Casino	24·66	·26
Blackbutt	*E. pilularis*	Taree	40·31	2·04

(Report of Forestry Commission, New South Wales, for year ended 20th June, 1918, p. 22.)

Some determinations of Ashes of Eucalypts by J. C. Brunnich, Agricultural Chemist, will be found in the report of the Director of Forests for 1918 in Annual Report of Department of Public Lands, Queensland, p. 60.

Explanation of Plates (220–223).

AUSTRALIAN HYBRIDS.

Plate 220.

Plate 220: EUCALYPTUS SIDEROXYLON A. Cunn. (1). E. LEUCOXYLON F.v.M. (4). (2) and (3) are hybrids between E. sideroxylon and E. leucoxylon. [See also Plate 221.] Lithograph by Margaret Flockton.

Eucalyptus sideroxylon A. Cunn.

1*a.* Juvenile leaf; 1*b,* mature leaf; 1*c,* flowers; 1*d,* anther; 1*e,* fruits not quite ripe, and showing remains of filaments. Maryborough, Victoria. (J. Blackburne.)

Eucalyptus sideroxylon-leucoxylon hybrids (2 and 3).

2*a.* Juvenile leaf; 2*b,* mature leaf; 2*c,* buds and a flower; 2*d,* anthers; 2*e,* fruits. Black Waterholes, near Redcastle, Victoria. (W. S. Brownscombe, No. 12a, through J. Blackburne.)
3*a.* Twig, bearing an intermediate leaf, buds and a flower; 3*b,* mature leaf; 3*c,* anther; 3*d,* immature fruit, showing style and stigma, and deciduous ring; 3*e,* fruits, showing one end on. Black Waterholes, near Redcastle, Victoria. (W. S. Brownscombe, No. 11a, through J. Blackburne.)

Eucalyptus leucoxylon F.v.M.

4*a,* 4*b.* Glaucous juvenile leaves; 4*c,* mature leaf; 4*d,* anther; 4*e,* immature fruits, showing stamens and ring; 4*f,* fruits. Maryborough, Victoria. (J. Blackburne.)

Plate 221.

Plate 221: x E. McINTYRENSIS Maiden, n.sp. (1). (2) and (3) are hybrids between E. sideroxylon and E. leucoxylon. [See also Plate 220.] Lithograph by Margaret Flockton.

X *Eucalyptus McIntyrensis* Maiden, n.sp.
(A reputed hybrid between *E. rostrata* Schlecht. and *E. ovata* Labill)

1*a.* Juvenile leaves; 1*b,* intermediate leaf and buds; 1*c,* mature leaf and fruits. Mount McIntyre, South Australia. (Walter Gill.)

Eucalyptus sideroxylon-leucoxylon hybrids (2 and 3).

2*a,* 2*b.* Juvenile leaves in various stages; 2*c,* intermediate leaf; 2*d,* mature leaf; 2*e,* anther; 2*f,* two flowers, rather far advanced; 2*g,* fruits, immature, the fruit also shown end on. Maryborough, Victoria. (J. Blackburne.)
3*a.* Twig, with mature leaf and immature fruits, showing remains of stamens; 3*b,* anthers; 3*c,* fruits, one shown end on. Maryborough, Victoria. (J. Blackburne.)

Specimens (2) and (3) form a perfect series between *E. sideroxylon* and *E. leucoxylon.* The corresponding specimens are Nos. (1) and (4) of Plate 220.

Mr. Blackburne sent, at my request, complete material of all four trees, including bark and timber, and these four specimens were fully described by me in *Proc. Linn. Soc. N.S.W.,* xxx; 496 (1905). See also p. 165 of the present Part.

Fossil Species.

Plate 222.

Plate 222: FOSSIL SPECIES. EUCALYPTUS PLUTI McCoy (1). E. MILLIGANI Johnston (2). E. KAYSERI Johnston (3). E. DELFTII Ett. (4). E. DIEMENII Ett. (5). E. HAYI Ett. (6). E. HOUTMANNI Ett. (7). Lithograph by Margaret Flockton.

Eucalyptus Pluti McCoy.

1*a,* 1*b.* Average leaves; 1*c,* "broad sapling form of leaf"; 1*d,* "magnified, showing leaves and average oil-dots"; 1*e,* "magnified portion of leaf of *E. globulus*" (for comparison with 1*d.* Adapted from Plate XXXIX, Decade IV, "Palaeontology of Victoria," McCoy. From Daylesford, Victoria, in the Deep Leads.

Eucalyptus Milligani R. M. Johnston.

2. Mature leaf. From fig. 11, Plate XXXII, Johnston's "Geology of Tasmania." From Tertiary Deposits, Mt. Bischoff, Tasmania.

Eucalyptus Kayseri R. M. Johnston.

3. Mature leaf. From fig. 8, Plate XXXIX, Johnston's "Geology of Tasmania." The fossil was evidently in a poor state of preservation, as the venation is so imperfectly shown. Supposed locality, Tertiary Leaf Beds, Macquarie Harbour, Tasmania.

Eucalyptus Delftii Ettingshausen.

4. Upper portion of mature leaf, from fig. 15, Taf. vi, of Ettingshausen's "Beitrage zur Kenntniss der Tertiarflora Australiens" in "Contributions to the Tertiary Flora of Australia,"

being a translation in No. 2 of the Palaeontology Series of the New South Wales Department of Mines (1888).

Eucalyptus Diemenii Ettingshausen.

5 and 5*b.* Mature leaves, from figs. 9, 9*a,* and 10 of Plate XV of the same work as quoted under No. 4.

Eucalyptus Hayi Ettingshausen.

6*a* and 6*b.* Portions of mature leaves; 6*c,* venation, from figs. 4, 5 and 5*a* respectively of Plate XV, same work as quoted under No. 4.

Eucalyptus Houtmanni Ettingshausen.

7*a.* Fragment of mature leaf; 7*b,* venation, from figs. 3 and 3*a* of Plate XV, same work as quoted under No. 4.

Plate 223.

Plate 223: FOSSIL SPECIES. EUCALYPTUS MITCHELLI Ett. (1). E. CRETACEA ETT. (2). E. DAVIDSONI Ett. (3). E. OXYLEYANA Ett. (4). E. SCOLIOPHYLLA Ett. (5). E. WARRAGHIANA Ett. (6). E. PRAECORIACEA Deane (7). E. HERMANNI Deane (8). E. HOWITTI Deane (9). E. KITSONI Deane (10). E. SUTTONI Deane (11). E. CHAPMANI Deane (12). Lithograph by Margaret Flockton.

Eucalyptus Mitchelli Ettingshausen.

1*a,* 1*b.* Portions of mature leaves; 1*c,* 1*d,* venation; 1*e,* mature leaf, lettered from figures 6, 7, 8, 7*a,* 7*b,* of Plate XV, same work as quoted under No. 4, Plate 222.

Eucalyptus cretacea Ettingshausen.

2*a.* Mature leaf; 2*b,* venation, enlarged; 2*c,* fragment of mature leaf, being figs. 7, 7*a,* and 8 respectively of Taf. iv of Ettingshausen's “Beitrage zur Kenntniss der Kreideflora Australiens,” Vienna, 1895. Warragh (Darra) Railway Station and between that and Oxley, Queensland.

Eucalyptus Davidsoni Ettingshausen.

3. Portion of mature leaf, being fig. 10 of Taf. iv of the same work as quoted under No. 2.

Eucalyptus Oxleyana Ettingshausen.

4. Mature leaf, being fig. 9 of Taf. iv of the same work as quoted under No. 2.

Eucalyptus scoliophylla Ettingshausen.

5*a*. Portion of mature leaf; 5*b,* mature leaf. Forming figures 12 and 13 of Taf. iv of the same work as quoted under No. 2.

Eucalyptus Warraghiana Ettingshausen.

6. Portion of mature leaf, being fig. 11 of Taf. iv of the same work as quoted under No. 2.

Eucalyptus proecoriacea Deane.

7. Portions of two leaves, and axis, from Plate II of "Records of Geological Survey of Victoria," vol. i, Part I (1902).

Eucalyptus Hermanni Deane.

8*a* and 8*b*. Fragments of mature leaves, being figures 3 and 4 respectively of Plate IV of the same work as quoted under No. 7.

Eucalyptus Howitti Deane.

9*a,* 9*b*. Portions of mature leaves, being fig. 10, Plate III, and fig. 2, Plate IV, of the same work as quoted under No. 7.

Eucalyptus Kitsoni Deane.

10*a,* 10*b,* 10*c*. Portions of mature leaves, being figs. 5, 6, 7 of Plate IV of the same work as quoted under No. 7.

Eucalyptus Suttoni Deane.

11. Portion of mature leaf, being fig. 3, Plate III (as *E. Muelleri*) of the same work as quoted under No. 7.

Eucalyptus Chapmani Deane.

12*a,* 12*b*. Portions of mature leaves, being figs. 4 and 9 of Plate III (as *E. Woollsii*) of the same work as quoted under No. 7.

* This name, originally proposed, gives way to *E. Muelleri* T. B. Moore. See the present work, Part XXVIII, p. 160. Mr. Deane writes to me changing the name of his fossil to *E. Suttoni,* in honour of Dr. Charles Stanford Sutton, a well-known Victorian botanist.

† The name *E. Woollsii* is preoccupied. See Part XLVII, p. 199 of the present work. Mr. Deane writes to me changing the name of this fossil to *E. Chapmani,* in honour of Frederick Chapman, the well-known Victorian palaeontologist, whose writings I have already quoted in this Part.—J.H.M.

Part 55

Fossil Plants Attributed to Eucalyptus.

B.—NON-AUSTRALASIAN.

FOLLOWING are descriptions of fossil plants found in New Zealand, Europe, North America (indeed, various countries out of Australasia). Although I have not seen the fossils themselves, with such figures and other evidence as I have been able to obtain I have satisfied myself that the majority of them are not Eucalypts. I have, therefore, not given the reputed species serial numbers in the present work.

We may begin with “Die Tertiäre Flora von Häring in Tirol,” von Constantin v. Ettingshausen (*Abhandl. der K. K. Geologischen Reichsanstalt,* ii Band, 3 Abtheilung, Nr. 2; Wien, 1853).

This work deals with two species, *E. oceanica* and *E. hoeringiana,* which are contrasted as follows:—

Mediannerven lanzettlich oder lineal-lanzettlich, fast sichelförmig, am Rande oft wellig, in einen Stiel verschmälert; Secundärnerven sehr fein, unter spitzen Winkeln entspringend. *Eucalyptus oceanica* Ung. (Taf. 28, fig. 1).

Mediannerven lanzettlich oder lineal-lanzettlich, oft fast sichelförmig, gestielt, an der Basis meist spitz; Secundärnerven fein, ziemlich genähert, unter spitzen Winkeln entspringend. *Eucalyptus hoeringiana* Ettingsh. (Taf. 28, fig. 2–13, 25.)

A.—E. oceanica Unger.

FOLLOWING is the description, as given by Ettingshausen, *op. cit.* p. 84, Taf. xxviii, fig. 1.

"Unger, *Fossile Flora v. Sotzka, Denkschriften der kais. Akademie der Wissenchaften,* II Band, p. 182, Taf. 57, fig. 1–13 (Vienna)." (See also Heer's *Fl. Tert. Helvet.* iii, Taf. cliv, 14, which is not available to me.)

E. foliis 2–5 pollicaribus, lanceolatis, vel lineari-lanceolatis acuminatis, subfalcatis, in petiolum attenuatis, coriaceis, integerrimis, petiolis semipollicaribus, saepius basi contortis; nervatione dictyodroma, nervo primario distincto, nervis secundariis tenuissimis, sub angula acuto orientibus.

In schisto margaceo formationis eocenicae ad Sotzka inferioris, ad Sagor Carnioliae, ad montem Promina Dalmatiae, nec non in calcareo bituminoso ad Haering. Diese in den Eocen-Schichten von Sotzka, Sagor und Monte Promina besonders häufige Art fand sich hier nur in wenigen Blatt-Exemplaren.

B.—E. Hoeringiana Ettingshausen.

THIS is described by Ettingshausen *op. cit.* p. 84, with Taf. xxviii, fig. 2-25.

E. capsula calycis tubo cupulaeformi inclusa, obconica vel pyriformi; capsulae limbo deciduo; foliis lanceolatis vel lineari-lanceolatis, subfalcatis, petiolatis basi acutis, versus apicem acuminatis, integerrimis, coriaceis; nervatione dictyodroma, nervo primario excurrente, nervis sccundariis tenuibus, approximatis, sub angulo acuto orientibus. Longt. fol. 5–10 centm., lat. 8–20 millm.

In schisto calcareo bituminoso ad Haering.

Die Fig. 14–24 dargestellten Fossilien scheinen mir kapselartige Früchte zu sein, welche sich mit den verkehrt-kegelförmigen, am oberen Saume oft wulstig verdickten oder daselbst eingeschnürten und dann gleichsam mit einen Deckel versehen Kapseln einiger *Eucalyptus*—Arten sehr wohl vergleichen lassen. Unter diesen sind *Eucalyptus globulus,* Fig. c und d, und *E. ampullacea,* Fig. 4 [not reproduced.—J.H.M.], hervorzuheben, zwischen welchen beiden Arten unsere Fossilien der Fruchtbildung nach zu stehen kommen. In der Tracht gleichen sie mehr der ersteren, nach der Eigenthüm-lichkeit des öfteren Verwachsens der Kapseln untereinander (wie diess bei den in Fig. 17 und 18 abgebildeten Exemplaren ersichtlichist) aber der letzteren Art.

Die Blätter, welche ich mit diesen Früchten unter Eine Species bringe, stimmen im Allgemeinen mit *Eucalyptus*-Phyllodien in allen Puncten überein. Sie kommen mit den Früchten entsprechend häufig vor. Zur Vergleichung fügte ich Blätter von *Eucalyptus pilularis* Sm., Fig. a und b, hier bei, denen unsere Fossilien in Form und Nervation, Fig. α (Fig. β Stellt die Nervation der genannten lebenden Art in schwacher Vergrösserung dar), vollkommen analog sind. [*E. pilularis* not reproduced.—J.H.M.]

See also Lesquereux, *infra,* p. 222.

C.—E. Aegea Unger.

Schimper, W.Ph., in his “Traité de Paléontologie Vegetale” . . . Tome III, p. 303, Paris, 1874, gives the following description and reference to an illustration of this species:—

“2. *Eucalyptus aegea* Ung., foliis lanceolatis, acuminatis, rectis, vel subfalcatis, longe petiolatis subcoriaceis; nervis marginalibus tenuissimis. *Foss. Fl. v. Kumi,* p. 57, tab. XV, f. 1. Kumi.

M. Unger compare ces feuilles à celles de l'*E. melliodora* A. Cunn.”

I have not been able to see the figure.

Then we come to *E. Geinitzi* Heer, perhaps the most frequently referred to of all fossil Eucalypts, and originally described as a doubtful species. The name is often, but erroneously, spelt *Geinitzii.*

D.—Myrtophyllum (Eucalyptus?) Geinitzi Heer.

In “Beitrage zur Kreide-Flora von Dr. Oswald Heer.” 1. Flora von Moletein in Mahren, p. 22, Taf. xi, figs, 3, 4 (1874).

M. foliis petiolatis, coriaceis, anguste, lanceolatis, nervis secundariis sub-angulo acuto egredientibus. Alt. Moletein (Tubingen).

Die zwei Tafel XI, Fig. 3 und 4 abgebildeten Blätter gehoren ohne Zweifel zu einer Art. Der Blattstiel ist dick und ziemlich lang; die Blattflache lang und schmal, gegen den Grund, wie die Spitze verschmälert, ganzrandig, der Mittelnerv ist stark, von ihm gehen in spitzen Winkeln zahlreiche sehr zarte Secundarnerven aus. Diese munden alle in einen Saumnerv. welcher nahe dem Rand und mit diesem parallel verlauft.

Stimmt in diesen schief aufsteigenden Secundarnerven und dem sie aufnehmenden Saumnerv ganz zu den Myrtaceen, unter welchen wir nämentlich bei dem australischen Eucalyptus Blätter von sehr ahnlicher Nervation und Form finden. Unter den fossilen Blättern ist es der *Eucalyptus rhododendroides* Massalongn vom M. Bolka, welcher der Art von Moletein am nächsten steht. Die Blat form ist dieselbe, aber die zarten Secundarnerven stehen hier dichter beisammen und steigen weniger steil an vereinigen sich aber auch in einem Saumnerv.

E. — Myrtophyllum (Eucalyptus?) Schubleri Heer.

Op. cit., p. 23, Taf. xi, fig. 2.

M. foliis coriaceis, lanceolatis, nervis secundariis sub-angulo acuto egredientibus, areis reticulatis. Alt Moletein (Tubingen).

Gehört beilleicht zu voriger Art; es ist aber nur die mittlere Parthie des Blattes arhalten und seine Form daher nicht sicher zu bestimmen. War viel grösser als vorige Art und die Nervillen treten hier in den Feldern als ein polygones Netzwerk deutlich hervor. Es gehen auch vom starken Mittelnerv zahlreiche Secundarnerven in spitzen Winkel, welche vorn in flachen, dem Rande parallelen Bogen sich verbinden und dort einen Saumnerv bilden. Es zeigt diese Nervatur eine grosse Uebereinstimmung mit derjenigen von Eucalyptus.

A note on the Moravian 'Cretaceous flora from the pen of E. W. Berry ("Maryland Geological Survey, Upper Cretaceous," 1916, p. 301) may be usefully inserted here:—

With the exception of the indefinite remains from the younger beds around Kwassitz and Kremsier described by Glocker (Glocker, E. F., "Ueber die Kalkfuhrende Sandstein formation auf beiden seiten der mittleren March, in der Gegend zwischen Kwassitz und Kremsier," *Nova. Acta. Acad. Leop. Carol.,* Bd. xix, Suppl. ii. 1841, pp. 309–334, pl. iv), no other contributions have been made to the Upper Cretaceous paleobotany of Moravia. Combining the work of the above-mentioned author's results in the following list of Cenomanian plants from Moravia:—

Eucalyptus angusta Velenovsky, *Eucalyptus borealis* Heer, *Eucalyptus Geinitzi* Heer, *Eucalyptus Schubleri* (Heer) Hollick.

F.—E. sibirica Heer.

In “Beitrage zur fossilen Flora Sibiriens und des Amurlandes” by Prof. Dr. Oswald Heer, Taf. xiii, fig. 2, xiv, 1—*Mem. de l'Acad. Imp. des Sciences de St. Petersbourg,* VII serie, Tome xxv, No. 6.

FOLLOWING is the original description:—

E. foliis lanceolatis, subfalcatis, basi in petiolum angustatis, 16–20 mm. latis, integerrimis, nervis secundariis subtilibus, approximatis, angulo acuto egredientibus, cum nervo marginali confluentibus.

Steht dem *E. oceanica* Ung. sehr nahe, hat aber in spitzeren Winkeln auslaufende Seitennerven (cf. *Fl. Tert. Helvet.* iii, Taf. cliv, 14).

Taf. XIV, Fig. 1, zeigt nur die Basis des Blattes; sie ist gegen den Stiel zu verschmälert; die Mitte des Blattes würde 16 Mn. Breite haben, wenn sie ganz erhalten wäre. Der Saumnerv, welcher dem Rand genähert ist und demselben parallel läuft, ist deutlich, in denselbenmünden die zahlreichen, in spitzen Winkel auslaufenden Seitennerven. (Fig. 1.b. vergrössert.) Noch deutlicher ist diese Nervatur bei den auf Taf. XIII, Fig. 2 a.u.6.a dargestellten Blättern. Es hatten diese eine Breite von 2 Cm. und Fig. 2.a. ist vorn allmälig verschmälert. Die dicht stehenden Seitennerven sind durch zahlreiche Schlingen verbunden und bilden längliche Zellen, von welchen die äussersten an den Saumnerv sich anschliessen.

Die Nervation stimmt sehr wohl zu Eucalyptus, ob aber das Blatt lederartig gewesen, lässt sich nicht ermitteln. Grösse und Form des Blattes, wie Nervation, ist sehr ähnlich bei *E. floribunda* [*E. marginata* Sm.—J.H.M.].

Now we come to Report of the United States Geological Survey of the Territories, Vol. VII—“Contributions to the Fossil Flora of the Western Territories, Part II. The Tertiary Flora,” by Leo Lesquereux, p. 296 (1878).

The following extracts are taken from this Report, and it will be seen that Mr. Lesquereux begins with a note of doubt. He may well do so. See fig. 3, Plate 225, of the present Part, which is certainly not *Eucalyptus.* See also *ante,* p. 220.

Of this family (Myrtaceae), of which a large part of the present flora of New Holland is composed, we have only two species whose characters seem related to those of the genus *Eucalyptus,* as represented by fossil remains. They do not appear, however, satisfactorily identified.

B. *Eucalyptus Hoeringiana* ? Ett. Plate lix, Fig. 10.

E. Hoeringiana Ett., *Här. Foss. Fl.,* p. 84, pl. xxviii, figs. 2–25. Heer, *Flor. v. Börnst.,* p. 19, pl. iv, fig. 14.

E. Hoeringiana ? Lesqx., Annual Report, 1872, p. 400.

Leaves linear-lanceolate to the point and to the slightly inequilateral base; secondary nerves alternate, mostly simple, ascending to the point, parallel to the midrib.

If some of the leaves figured by the author of the “Flora of Bilin” have the same form and size as these, that one represented by Heer in the “Börnstaedt Flora” differs by its characters, form and nervation. I am, therefore, now more uncertain in regard to the relation of this species than when I described it *loc. cit.,* when this “Börnstaedt Flora” was still unknown to me. The nervation is somewhat like that of Grevillea species; for example, *G. provincialis* Sap. (&EACUTE;t., i, p. 99, pl. viii, fig. 3), and still more like that of some *Mimosoe, Prosopis,* &c.

Habitat.—Black Buttes, Wyoming, in red baked shale.

G.—E. (?) americana Lesqx. Op. cit., Plate lix, figs. 11, 12.

FOLLOWING is the description:—

Eucalyptus americana Lesqx., “Supplement to Annual Report,” 1871, p. 7.

Leaves subcoriaceous, very entire, narrowly lanceolate, gradually tapering upward from below the middle into a long, narrow acumen, narrowed in the same degree to the base, sessile; middle nerve thick, enlarged at the point of attachment; lateral nerves oblique, straight to near the borders, where they join a continuous marginal vein.

These fine leaves have the nervation and shape of species of this genus. They are comparable, for the nervation at least, to *E. oceanica* Ung., as figured by Heer (*Flor. Tert. Helv.,* pl. cliv, fig. 14.) In this figure the lateral nerves are more open; but, in the species represented by the leaves of the “Baltic Flora” of the same author, they are more oblique than in those described here. Since 1871, the time when they were first considered, I have obtained a number of living species from Cuba. Some of these, especially of the family of the *Euphorbiaceoe, Tricera retusa* Gray, *T. fasciculosa* Gris., have a nervation and a texture of leaves exactly corresponding with those of the specimens of Green River, and I now should be disposed to rather refer them to this genus, or at least to the Euphorbiaceae, abundant in the subtropical North American flora, than to Australian types; for this *Eucalyptus* would be, like the former, an anomaly in the Upper Tertiary flora of the Lignitic. As in species of *Tricera,* the leaves are very short-petioled, attached to the stems merely, as far as can be seen from the specimen, by the enlarged base of the flat, broad midrib; the lateral veins, at an angle of divergence of 40°, pass straight to the borders, where they join, with scarcely any curve, a distinct marginal nerve, somewhat thinner than the veins. This apparent marginal nerve is of course formed by the abrupt curve of the lateral nerves which follow the borders, as more distinctly marked in fig. 11. In *Tricera retusa,* we see exactly the same character, which is observable also in the distribution of the numerous parallel secondary nerves, separated by thinner and shorter tertiary veins, joined either in right angle by nervilles or in very acute angle by branchlets coming out from the midrib or from the lateral nerves. From the fragments figured here, the leaves seem to be comparatively very long, for fig. 11 is twelve centimeters long and fifteen millimeters broad; and by comparison, the fragment represented in fig. 12, which is more than one-third broader, should be part of a leaf about eighteen centimeters long.

Habitat.—Green River group, Wyoming, above fishbeds. (Dr. F. V. Hayden.)

(*Op. cit.,* pp. 296–7, 1878.)

H.—E. borealis Heer.

From "Flora fossilis arctica. Die Fossile Flora der Polarlander," von Dr. Oswald Heer. Band vi, Zweite Abtheilung, pp. 94, 111, 112, Taf. xl, fig. 3, 4; xlvi, 14. Zurich, 1882.

FOLLOWING is the original description:—

E. foliis coriaceis, elongato-oblongis, apice obtusis, subapiculatis, nervo medio valido, secundariis subtilibus, angulo acuto egredientibus, cum nervo marginali confluentibus.

Ivnanguit. Igdlokunguak.

Dem *Eucalyptus Geinitzi* zwar sehr ähnlich, doch ist das Blatt am Grund nicht in den Stiel verschmälert, sondern ziemlich stumpf; ebenso ist es nach vorn nicht verschmälert und stumpf zugerundet. Das Blatt von Ivnanguit (Taf. XLVI, Fig. 14) hat eine Breite von 18 mm. einen zwar flachen, aber ziemlich breiten Mittlenerv und sehr zarte Secundarnerven, welche in derselben Weise, wie bei Eucalyptus, in spitzen Winkeln entspringen und in einen Saumnerv ausmünden, der nahe dem Rande und mit diesem parallel läuft; nach vorn ist es nicht verschmälert und hat am stumpf zugerundeten Ende ein kleines Spitzchen. Von Igdlokunguak erhielt ich zwei Blätter, bei welchen die Blattbasis erhalten ist (Taf. XL, Fig. 3, 4); wir sehen daraus, dass das Blatt dort nicht allmälig verschmälert ist, sondern am Grund sich zurundet. Diese Blätter sind etwa 10 cm. lang bei 25 mm. Breite, lanzettlich, mit deutlichem Mittelnerv; der Saumnerv ist vom Rand ziemlich weit entfernt; das feinere Geäder ist verwischt.

D. *Eucalyptus Geinitzi* Heer. Taf. xix, fig. 1c, xlv, 4–9, xlvi, 12c, d, 13 (*ante,* p. 221).

E. foliis petiolatis, coriaceis, anguste lanceolatis, apicem versus basique angustatis; nervo medio valido, secundariis sub angulo acuto egredientibus, vervo marginali confluentibus.

Myrtophyllum Geinitzi Heer, *Flora Foss. Arct.* iii, p. 116, Taf. xxxii, 14–17.

Unter-Atanekerdluk im Liriodendronbett. Ivnanguit.

Die zwei auf Taf. XLVI Fig. 12c. 13 abgebildeten Blätter von Ivnanguit stimmen ganz mit dem auf Taf. XI, Fig. 4 meiner Flora von Moletein dargestellten Blatt überein. Aus Fig. 13 sehen wir, dass das Blatt allmälig gegen die Basis verschmälert ist. Der Saumnerv ist sehr deutlich und nimmt die steil ansteigenden, zarten Secundarnerven auf, die aus dem starken Mittelnerv in spitzen Winkeln entspringen. Dieselbe Nervation zeigt uns das Fig. 12c abgebildete Blatt, das auswärts sich allmälig verschmälert. Es ist dies die für Eucalyptus bezeichnende Nervation.

Unmittelbar neben Diesem Blatte liegt ein becherförmiges Körperchen, das lebhaft an die Blüthenknospen von Eucalyptus erinnert (Fig. 12d) und das wir wohl als eine solche Stücke erhalten und diese auf Taf. XLV, Fig. 4–9 abgebildet. Sie kommen mit den Blüthenknospen von Eucalyptus in dem dicken, kurzen Stiel und dem Deckel überein, der bei allen Stücken durch eine deutlich vortretende Querlinie von der untern Partie sich abgrenzt. Bei Fig. 4 ist dieser Deckel weggefallen und wir haben einen Becher vor uns, welcher der Eucalyptus-Blüthe entspricht, wenn der Deckel abgesprungen ist.

Der Stiel hat eine Länge von 1 cm. bei 3–4 mm. Dicke. Er ist von mehreren feinen Langsstreifen durchzogen und etwas runzelig. Der Becher hat eine Breite von 13–18 mm. und ist runzelig grestreift (Fig. 6 vergrössert). Der Deckel ist ziemlich flach, 5 mm. hoch, oben zwar zugespitzt, doch nicht in einen Zipfel verlängert. Er ist am Grunde auch gestreift, weiter oben aber fast ganz glatt.

Die Knospe ist viel grösser als bei *Eucalyptus robusta* (Taf. XLV, Fig. 10, 11) [not reproduced.—J.H.M.], die auch durch den lang geschnabelten Deckel sich auszeichnet. Von ähnlicher Grösse ist sie aber bei *Eucalyptus globulus.*

So auffallend auch das Vorkommen der neuholländischen Gattung Eucalyptus in Grönland ist, macht doch das Zusammenvorkommen von Blättern und Blüthen, die denen der lebenden Gattung so ähnlich sehen, in den schwarzen Schiefern von Grönland, es in hohem Grade wahrscheinlich, dass dieser Pflanzentypus schon zur Kreidezeit im hohen Norden Gelebthat. (*Op. cit.,* pp. 93, 109, 112.)

There is a useful bibliography of this species by E. W. Berry under “Maryland Geological Survey” (p. 236 below).

I.—E. angusta Velenovsky.

In “Die Flora der Böhmischer Kreideformation” von J. Velenovsky, ii, Theil, p. 3 (64), Taf. iii (xxvi), fig. 2–12 (1885).

FOLLOWING is the original description:—

Blätter lineal, schmal lineallanzettlich, in der Mitte oder in der unteren Hälfte am breitesten, ganzrandig, vorne in eine sehr lange Spitze vorgezogen und mit einen harten Dorn beendet. Der Primärnerv gerade, ziemlich stark, zur Spitze him verdünnt. Die Secundärnerven zahlreich, unter spitzen Winkeln entspringend, am Rande durch einen Saumnerv untereinander verbunden. Der Blattstiel gerade, etwa 1 cm. lang, stark.

Ebenso wie die vorige Art in den Perucer Schichten allgemein verbreitet, manchmal auch massenhaft beisammen. Ich fand sie bei Vyšerovic und Kaunic, bei Melnik an der Sázava, bei Liebenau, Lipenec, Kuchelbad, Jinonic and Počernic bei Prag.

Diese Blätter sind durch ihre schmale, lange Form und durch fein vorgezogene Spitze leicht kenntlich. Erreichen sie aber eine bedeutende Breite, so ähneln sie nicht wenig den Blättern der vorigen Art.

Die ganze Ercheinung der Abdrücke weist auf ehemals derbe Beschaffenheit der Blattspreite, Bemerkenswerth ist die hornig endigende Blattspitze, wie sie z.B. in Fig. 2, 10, 12 abgebildet ist. Diese Eigenschaft findet man bei den Blättern der jetzigen Gattungen *Eucalyptus* und *Callistemon* sehr haüfig. Die Nervation ist von derselben Zusammensetzung wie bei der vorhergehenden Art, und kommt nicht selten schön erhalten vor; der Saumnerv ist ganz deutlich (Fig. 8, 10).

Alle diese Umstände sprechen deutlich für die Verwandtschaft mit den Arten der Gattung *Eucalyptus.* Es bleibt aber eine andere Frage zu beantworten, nämlich, ob man diese Blätter zu der vorigen Art stellen soll, ob sie als blosse Varietät derselben an anzusehen sind, oder ob sie eine selbstständige Art repräsentiren. Die schmale Form der Blätter, welche die Blattränder parallel erscheinen lässt, kommt bei der *E. Geinitzi* nie vor. Auch die dornig endigende Blattspitze fand ich nie bei dieser Art, auch ist der Primärnerv viel feiner, am Grunde niemals so stark verdickt wie bei *E. Geinitzi.* Ferner kommen veide zwar haüfig zusammen vor, doch habe ich *E. angusta* auch in Schichten gefunden, welche keine Spur von *E. Genitzi* enthalten. Eine Menge sehr schöner Exemplare (Fig. 6, 7, 9) fand ich z. b. in den hellgrauen, mit Unionen gefüllten Thonen bei Vyšerovic, wo überhaupt kein anderer Pflanzenabdruck vorkommt. In den Schieferthonen bei Melnik und Kuchelbad ist diese Art auch viel haüfiger als *E. Geinitzi.*

I quote the following from E. W. Berry, “Maryland Geological Survey, Upper Cretaceous” (1916):—

Bohemia . . . The plants come from over 40 localities, of which the best known and most prolific are Hloubtein, Vyserovic, Kounic, Melnik, Landsberg, Bohdankov, Lipenec, Peruc, Mseno, Lidic, Otruby, Vydovle and Kuchelbad. They include the following species:—

Eucalyptus angusta Velenovsky and *Eucalyptus Geinitzi* Heer.

. . . Nearly all the plants named come from the upper or Wehlowitzer unit, which also contains the most extensive fauna. The plants embrace the following species:—

Eucalyptus Geinitzi Heer and *Eucalyptus Schubleri* (Heer) Hollick (p. 292).

Bohemia. Emscherian. The Senonian is represented in the Bohemian area by only the Emscherian or lower Senonian. The beds are generally known as the Chlomeker Schichten, although some authors segregate the lower Chlomeker under the name of the Kreibitzer Schichten. The extensive marine fauna includes . . . . The flora includes . . . . *Eucalyptus angusta* Velenovsky (p. 299).

J.—E. dubia Ettingshausen.

In *Trans. and Proc. N.Z. Inst.,* xxiii, 283, with Plate xxix, figs. 5 and 5a (1890).

FOLLOWING is the original description:—

E. foliis coriaceis, lineari-lanceolatis, acutis, subfalcatis, integerrimis; nervatione brochidodroma, nervo primario prominente; nervis secundariis tenuibus, angulis subacutis exeuntibus, nervo marginali inter se conjunctis; nervis tertiariis obsoletis

Locality.—Shag Point (Canterbury Museum). (Ex Coll. *Geol. Surv., N.Z. Rep.,* 1872; v. Haast. l.c.)

The fragment (Fig. 5) from Shag Point belongs undoubtedly to *Eucalyptus.* It is possible to complete it so as to form a linear lanceolate leaf, which is curved almost like a sickle. The top is partly preserved, and does not become much narrower. As regards the nervation, the primary nerve is strongly pronounced, and bent in accordance with the shape of the leaf. A few of the delicate secondary nerves are preserved, which start from the primary nerve at scarcely acute angles. The characteristic seam or edge-nerve, which connects the secondary nerves with each other, is also preserved. The last-named nerves can, however, be only observed under the lens with a favourable light (see enlargement, Fig. 5a).

The species described is most nearly related to *Eucalyptus Mitchelli* Ett., of the Australian Tertiary Flora, from which it is distinguished by the fact that the top of the leaf narrows only a little, but, as in Eucalyptus, leaves occur in the same species, and even off the same tree and on the same branch, which are pointed and little narrowed at the top, this distinguishing mark carries no weight, and I should have no hesitation in uniting the New Zealand Eucalyptus species of former ages with the Australian species named if more points had been offered for comparison of the nervation, especially of the reticulation, which only in the latter is eminently well preserved; consequently I must leave the decision if there is a difference in the nervation, to further researches.

Ettinghausen (Contrib. Tert. Fl. Austral., N.S.W. Pal. 2, 1888, p. 91.) says its nearest relations are *E. oceaniica* Ung. of the Tertiary of Europe; *E. americana* Lesq., of the Tertiary of North America; and *E. Mitchelli* of the Tertiary of Australia.

K.—E. dakotensis Lesquereux.

In U.S. Geological Survey Monographs, Vol. xvii, “The Flora of the Dakota Group,” p. 137, with Plate xxxvii, figs. 14–19, a posthumous work by Leo Lesquereux, edited by F. H. Knowlton (1891).

FOLLOWING is the original description:—

Leaves coriaceous, linear, or gradually narrowed from an obtuse apex to the base, decurring into a short, alate petiole; borders recurved, median nerve strong; secondaries thin, oblique, proximate, parallel, camptodrome.

The species is represented by numerous fragments of very thick leaves, about 1 cm. broad and at least 8 cm. long; the borders are sometimes strongly recurved as in Fig. 15; sometimes flat as in Fig. 19, and judging from the fragment (Fig. 14) the leaves are obtuse at apex. The median nerve is thick, especially so on the lower surface, as in Fig. 19, where the flattened borders are seen decurring along the median nerve at base and thus bordering the short, margined petiole. The secondaries, which are 3 mm. to 4 mm. distant at the base, traverse the blade at an angle of divergence of 30° to 40°, and, curving close to the borders, form by their crossing simple, incumbent bows, like a marginal nerve, distinctly seen only on the lower side of the leaves of the fragments.

The species is intimately related to *E. Geinitzi* Heer, described below, the leaves of which are generally much larger. Heer considers his species as the equivalent of *Myrtophyllum* (*Eucalyptus*) *Geinitzi* of the Kreidefl., v. Moletein, p. 22, Pl. xi, Figs. 3, 4, represented by two leaves not any larger, 2·5 cm. long, and tapering to an acumen, with the base not decurrent, but narrowed to a short, naked petiole. These material differences prevent the identification of the Kansas leaves with those of Moletein and Greenland, though the relation is very close.

E. dakotensis is also comparable to *E. angusta* Velenovsky (*Flora der böhmischen Kreideformation,* pt. 4, p. 3, Pl. iii, figs. 2–12) but differs by the base of the leaves decurring and apparently obtuse.

Habitat.—Ellsworth County, Kansas. Nos. 53, 108, 674, 685, 710 of the Museum of the University of Kansas; A. Wellington and E. P. West, collectors.

L.—E. Gouldii Ward.

In *Bull. Torrey Bot. Club,* xxiv, p. 576, text fig. 1, 2 (1897), Kansas.

(Through the kindness of Dr. W. A. Taylor, Chief of the Bureau of Plant Industry of the United States Department of Agriculture, I received a photostat of these text figures, but, through my fault, too late for the present plates. J.H.M.)

FOLLOWING is the original description:—

Leaves slightly falcate, about 7 cm. long and 12 mm. wide, 2 cm. above the base, from which point they diminish in both directions, being drawn out into a long point above (tip and base wanting in the only specimen found). Substance of the leaf firm and thick; nervation very distinct, midrib strong, secondaries about 10 on a side, rising at a very acute angle, proceeding in a zig-zag course so as to meet one another and anastomose, forming elongated angular areas in two rows, the outer row smaller and bounded on the outer side by a connected series of gentle arches forming a continuous nerve generally parallel to the margin and less than 1 mm. distant from it.

Of all living species of *Eucalyptus,* this approaches most closely in its nervation to that of *E. largiflorens,* first described by Baron von Mueller in the Transactions of the Victoria Institute, i, 24, 1854, and figured in the "Eucalyptographia," Decade V, 1880.

In the accompanying cut, Fig. 1 represents the fossil leaf, and Fig. 2 [figs. not reproduced.—J.H.M.] is a copy of one of the leaves of approximately the same size of *E. largiflorens* Muell., from the plate accompanying the description given in the work already referred to. The substantial identity of the nervation is apparent at a glance. In describing that species in the same work, Baron von Mueller devoted only two lines to the nervation as follows:—"Lateral veins extremely fine, diverging at a very acute angle or not very spreading nor quite close, the circumferential vein somewhat removed from the edge." This description is, of course, very inadequate, but it is well known that botanists pay scarcely any attention to nervation and do not take the trouble to acquaint themselves with the proper terminology of the subject.

We thus have another link in an already long chain of evidence which goes to prove that the Australian Fever Tree has had a long history, and was widely distributed over the globe in Cretaceous and Tertiary time, millions of years before man made his appearance.

Prof. E. W. Berry, in "Maryland Geological Survey, Upper Cretaceous" (1916), p. 226, speaking of the Dakota Sandstone, says:—

. . . Combining all of the published work dealing with areas within the United

States, that for the Dominion of Canada being given in another place, results in the following lists of species:— *Eucalyptus dakotensis* Lesquereux, *Eucalyptus Geinitzi* Heer, *Eucalyptus Gouldii* Ward.

Then we have—

D. *Eucalyptus Geinitzi* Heer, Pl. xxxvii, fig. 20, p. 138 of Lesquereux' "Flora of the Dakota Group." His observations are :—

Fl. Foss Arct., Vol. 6, 2 Abth., p. 93, Pl. xix, fig. 1c; Pl. xlv, figs. 4–9, fruits; Pl. xlvi, figs. 12 c, d, 13.

Leaves coriaceous, lanceolate or linear-lanceolate; narrowed to the apex and to the base, median nerve stout; secondaries at an acute angle of divergence, confluent with the marginal nerve.

There is only a fragment of a leaf, which, however, distinctly represents Heer's species, especially as figured on Pl. xix, fig. 1c, for the size of the leaves, the direction of the secondaries and their confluence with a marginal nerve, and on Pl. xlvi, fig. 12c, for the areolation in large meshes formed by undulate nervilles cut at right angles by thin, intermediate tertiaries.

Habitat.—Ellsworth County, Kansas. No. 775 of the Museum of the University of Kansas: E. P. West, collector.

Then we have a fossil which, according to E. W. Berry in "Maryland Geological Survey, Upper Cretaceous" (1916), p. 870, is *E. Geinitzi* Heer, confirming Saporta's suggestion.

Now we come to "Flore Fossile du Portugal. Nouvelles Contributions à la Flore Mésozoique par le Marquis de Saporta, accompagnées d'une Notice Stratigraphique par Paul Choffat. Lisbonne, Imprimerie de l'Académie Royale des Sciences, 1894."

Eucalyptus Herit. Heer, dans sa "Flore crétacique du Groënland" (*Foss. Fl. Grönlands,* I, Fl. d Ataneschicht, p. 93, tab. XLV, fig. 4–9) a figuré des organes considérés par lui comme représentant des calices floraux d'Eucalyptus, soutenus par un épais et court pédoncule et surmontes d'un opercule destiné à se détacher an moment de l'anthèse. Une pareille attribution ne laisse pas que d'inspirer des doutes fondés, les figures de Heer ayant quelque chose de schématique et pouvant tout aussi bien se rapporter à des écailles strobilaires isolées, pareilles à celles des Doliostrobus de M. Marion. Une incertitude aussi forte ne s'attache pas, à ce qu'il semble, aux glomérules ou appareils fructifiés globuleux, recuellis dans le cénomanien de Boheme par M. Velenovsky (*Fl. de Bohm. Kreideform,* iv, p. 1–2, tab. I et II) et dont quelques uns sont encore attenant a des rameaux pourvus de feuilles "Eucalyptoïdes." Neanmoins, la signification donnée par l'auteur à ces glomerules, dont les diverses parties, de son aveu, n'offrent rien de distinct,* surtout en tenant compte d l'évident ressemblance de ceux de ces sortes d'organes qui se presentent isolément avec les appareils fructices des *Platanus,* cette signification demeure entachée d'obscurité et nous sommes loin de pouvoir affirmer qu'il agisse reellement d'une inflorescence ayant quelque affinite directe avec les parties correspondantes de Eucalyptus d'Australie. Ce qui parait incontestable, c'est la présence, soit dans la craie du Grönland, soit dans le cenomanien de Boheme de feuilles conformes, par leurs caracteres apparents et les détails même de leur nervation, avec celles des *Eucalyptus* actuels. Ces mêmes feuilles se montrent dans le crétacique inferieur du Portugal, et leur intime resemblance avec les precedentes nous engage a les considerer comme ayant appartenu, sinon a le même espece, du moins au même type, et à suivre l'example de Heer et de Velanovsky, sans rien affirmer de plus au sujet de leur parente absolue ou relative avec le groupe actuellement australien des *Eucalyptus. (Op. cit.,* p. 206.)

* Voici les propres paroles de M. Velenovsky: “Dans les schistes argileux, à Vgerovic et à Kaunic, on trouve fréquemment des empreintes en forme de calices, tronqués au sommet et marqués à la superficie de stries longitudinales. Ces empreintes répondent très exactement a des calices fructifiés d'*Eucalyptus.* Cependant l'opercule n'a pu ètre rencontre. Heer decrit et figure des objets absolument analogues dans sa flore crétacée du Groënland; mais ses calices se rapportont à un stade moins avancé de fructification.”

M.—E. proto-Geinitzi Saporta.

Op. cit., p. 206, with Pl. xxxvi, fig. 16, and xxxvii, fig. 11.

FOLLOWING is the original description:—

E. foliis sat longe petiolatis, ovato-oblongis vel latolineari-oblongis, basi breviter obtuse attenuatis, sursum, ut videtur, longe sensim attenuatis, integris, penninerviis; nervo primario distincto a basi ad summum sensim imminuente; secundariis plurimis, subobliquis, secus marginem nervulo inframarginali continuo inter se conjunctis; tertiariis flexuosis, in reticulum solutis.

Nous avons d'abord une première feuille (pl. xxxvii, fig. 11), à laquelle la terminaison superieure fait défaut; elle est munie d'un assez long et mince pétiole, entière avec un contour ovale-allongé, tendant à la forme linéaire dans le haut et obtusement atténuée a la base. La nervure médiane, assez nettement prononcée, s'amincit graduellement en approchant du sommet que dérobe une dechirure. Les nervures secondaires sont relativement nombreuses, plus ou moins obliques et legerement flexueuses; elles courent à la marge et donnent lieu par leur reunion a une nervure inframarginale continue, disposée comme dans les *Eucalyptus.* L'espece pourrait ètre rapprochée de plusieurs formes actuelles; elle est evidement alliée de fort pres a l'*Eucalyptus Geinitzi* Hr., dont M. Velenovsky a figure un grand nombre de feuilles. Mais la nôtre se distingue assez nettement de celles-ci par sa base obtuse et un plus mince petiole. Nous réunissons a cette feuille la terminaison superieure d'une autre (pl. xxvi, fig. 16) dont la base manque et qui par cela meme sert a completer la premiere. Cette sommite longuement attenuee an pointe est parfaitement conforme à celle qui distingue les feuilles d'*Eucalyptus Geinitzii* et de la plupart des formes actuelles du genre. (*Op. cit.*, p. 206.)

N.—E. Choffati Saporta.

Op. cit., p. 207, with Plate xxxvii, fig. 1

FOLLOWING is the original description:—

E. foliis valide petiolatis, lanceolato-linearibus, elongatis, basi obtuse attenuatis, integerrimis, penninerviis; nervo primario expresso; secundariis numerosis, inflexis, ante marginem nervulo inframarginali continuo inter se conjunctis.

Cette seconde espèce ets représentée par une feuille assez peu differente des précédentes et mutilée superieurement. Elle présente un petiole plus épais et une nervure médiane plus forte; le limbe, plus étroit, affecte un contour plus linéaire. Les nervures secondaires reliées entre elles par des venules obliquement flexueuses, se replient de long de la marge, réunies entre elles par une nervule continue et parallele a cette marge. Cette espece, dédiée a M. Choffat, s'écarte peu d l'*Eucalyptus Geinitzii* Hr.; mais elle nous paraît surtout alliee a l'*Eucalyptus borealis* Hr., du gisement d'Atane, dans le Groenland. Elle se rapproche particulierement de là fig. 14, pl. xlvi, de la Flore de Heer (*Foss. Fl. Gronlands*, I, Fl. v. Ataneschicht, p. 94). Ce sont là des formes d'un type sans doute sujet à de faibles variations individuelles et locales. (*Op. cit.*, p. 207.)

I. *Eucalyptus angusta* Velenovsky, in Saporta, with Pl. xxxvi, fig. 12, en a, et pl. xxxvi, fig. 10.

Following is a description. See also *ante*, p. 226.

E. foliis linearibus, angusteque lanceolato-linearibus, integris, basi attenuatis, sursum longe sensim in apiculum abeuntibus, penninerviis; nervo primario expresso; secondariis numerosis, subobliquis, secus, marginem nervulo inframarginali continuo conjunctis.

Les feuilles ou fragments de feuilles, quelques-unes indiquant une terminaison linéaire três longuement prolongée, que nous figurons sous ce nom, ne paraissent différer par aucum caractère essential de celles du cenomanien de Boheme, décrites par M. Velenovsky, et qui proviennent des schistes argileus de Peruc. Le savant de Pragues remarque que ces feuilles, non seulement s'écartent de celles d l'*Eucalyptus Geinitzii* par leur forme etroitement a longée et la presence d'une nervure mediane plus fine, mais encore qu'elles se rencontrent dans des lits d'ou cet *Eucalyptus* est absent; tandisque dans les schistes de Melnik et de Kuchelbad l'*Eucalyptus angusta* abonde, là même ou l'*Eucalyptus Geinitzii* est au contraire plus rare. (*Op. cit.*, p. 207.)

E. pseudo-Geinitzii Sap., is figured by Saporta, see fig. 11, Plate 226 of the present work, but no description is given in the work.

Following is a work especially important as regards *Eucalyptus*:—

Monographs of the U.S. Geological Survey, Vol. xxvi, “The Flora of the Amboy Clays,” by John Strong Newberry. A posthumous work, edited by Arthur Hollick (1895).

O.—E. (?) attenuata Newberry.

In "The Flora of the Amboy Clays," p. 111, with Pl. xvi, figs. 2, 3, 5. (1895.)

FOLLOWING is the original description:—

Leaf 10 cm. to 15 cm. in length, narrowed or rounded at the base, pointed or attenuated at the summit, margin entire; nervation strongly reticulate.

Numerous leaves of this species occur, generally in an imperfect state of preservation. The nervation, however, is nearest that of Eucalyptus, or at least of the leaves so designated by Heer from the Atane beds of Greenland. More material will be required before the generic affinities can be positively asserted.

Locality.—South Amboy.

We come to another important Monograph, by Prof. E. W. Berry, viz., "Maryland Geological Survey, Upper Cretaceous" (1916), for ampler particulars of this reputed species.

Following is a description:—

O. *Eucalyptus* (*?*) *attenuata* Newberry.

Eucalyptus (*?*) *attenuata* Smith, 1894, Geol. Coastal Plain Ala., p. 348 (nomen nudum).

Eucalyptus (*?*) *attenuata* Ward, 1895, 15th Ann. Rept., U.S. Geol. Survey, p. 371 (nomen nudum).

Eucalyptus (*?*) *attenuata* Newberry, 1896, Mon. U.S. Geol. Survey, vol. xxvi, p. 111, pl. xvi, figs. 2, 3 (non fig. 5).

Eucalyptus (*?*) *attenuata* Berry, 1906, Ann. Rept. State Geol. Survey of New Jersey for 1905, p. 138.

Berry, 1906, Bull. Torrey Bot. Club, vol. xxxiii, p. 180.

Berry, 1907, *ibidem*, p. 203.

Berry, 1911, Bull. 3, Geol. Survey of New Jersey, p. 195, pl. xxviii, fig. 6.

Description.—Leaves lanceolate in outline, 9 cm. to 12 cm. in length by 1·5 cm. to 2 cm. in greatest width, which is in the basal half of the leaf. Margin entire, somewhat undulate in some specimens. Apex narrow and produced, acutely pointed. Base cuneate. Petiole stout, 1 cm. to 2 cm. in length. Midrib stout, especially in its lower part. Secondaries numerous, branching from the midrib at an acute angle, reticulate-camptodrome.

This species has little in common with the leaves usually referred to this genus, except its outline, which is also that of a great many unallied genera. It is somewhat suggestive of some of the leaves referred to *Laurophyllum*, in fact, many possible relationships could be suggested, all of which possess equal elements of uncertainty.

This species is common in the upper Raritan, and has a recorded range of considerable extent in somewhat later formation. It is recorded from the Magothy formation of New Jersey and Maryland, the Black Creek formation of North Carolina, and the Tuscaloosa formation of Alabama.

Occurrence.—Magothy formation. Grose Point, Cecil County; Round Bay, Anne Arundel County.

Collection.—U.S. National Museum. (*Op. cit.*, p. 869.)

In the following paper Prof. Berry removes this reputed Eucalypt to *Ficus*:—

"U.S. Geological Survey, Professional Paper 112 (1919), Upper Cretaceous Floras of the Eastern Gulf Region in Tennessee, Mississippi, Alabama and Georgia. E. W. Berry."

Ficus daphnogenoides (Heer) Berry, pl. xiii, figs. 6, 7.

Proteoides daphnogenoides Heer. Phyllites cretacées du Nebraska, p. 17, pl. 4, figs. 9, 10, 1866.

Eucalyptus (*?*) *attenuata* Newberry. The Flora of the Amboy Clays: New Jersey Geol. Survey Bull. 3, p. 122, pl. 12, fig. 4, 1911; pl. 16, fig. 5 (not figs. 2, 3), 1896. (p. 80.)

P.—E. (?) angustifolia Newberry.

Op. cit., p. 111, with Pl. xxxii, figs, 1, 6, 7. (1895.)

FOLLOWING is the original description:—

Leaves long linear, pointed above, attenuated or rounded below, from 10 cm. to 15 cm. long, 8 mm. to 12 mm. wide, margins entire; nervation rather crowded, midrib slender, side branches numerous, leaving the midrib at an acute angle and forming a festoon close along the margin.

These leaves apparently belong to the same genus as those that have been called Eucalyptus by Heer in his "Flora Fossilis Arctica," vol. vi, Abth. ii, pp. 93, 94, plate xlvi, figs. 12–14. The general form of the leaf is similar, and the peculiar nervation—that is, numerous lateral nerves uniting to form a continuous festoon closely parallel with the margin—is essentially that of Eucalyptus. Professor Heer feels strengthened in his reference of leaves having this nervation to Eucalyptus by finding in company with them what he regards as the fruit of Eucalyptus; but in my judgment the examples he gives of this fruit (*op. cit., loc. cit.*, and pl. xlv) are rather detached scales of the cone of some conifer, and probably generically identical with the cone scales which he has called *Dammara borealis* (*op. cit.*, pp. 54, 55, pl. xxxvii, fig. 5). The fruit of Eucalyptus is a pyxis or urn, circular in section, and with a lid; but in the large number of specimens of organisms which I have found in the Amboy Clays, and have considered identical with Heer's so-called *Dammara*, I have looked in vain for any evidence of a separation between the summit and base, and have regarded them as the exposed and buried portions of cone scales. (See *supra*, pp. 54, 55.)

The leaves now under consideration differ from those I have considered as identical with Heer's *Eucalyptus Geinitzi* in this, that they are much longer and narrower and more attenuated at base and summit.

Locality.—South Amboy.

NOTE.—For representatives of fruit of *Dammara microlepis* Heer, and *Eucalyptus Geinitzi* Heer, from *Fl. Foss. Arct.*, see pl. x, figs. 9, 10, of this monograph. A.H. (Hollick). (*Op. cit.*, p. 111.)

D. *Eucalyptus Geinitzi* Heer, *Fl. Foss. Arct.*, Vol. vi, abth. i, p. 93, Pl. xlvi, figs. 12c, 13.

Following is a description, with Pl. xxxii, figs. 2, 12, 15, 16* :—

Leaves lanceolate, pointed above and below, 10 cm. to 15 cm. long by 15 mm. to 25 mm. wide, margins entire; nervation open and flexuous, lateral nerves numerous, arched upward, connecting above to form a festoon parallel with the margin, united by tertiary branches which divide the spaces between them into square or oblong areoles.

A considerable number of leaves answering to the description given above occur in the Amboy Clays, and so nearly coincide with those figured by Heer under the name of *Eucalyptus Geinitzi* that I have been compelled to consider them the same. The plan of nervation is essentially the same as that of the other leaves I have grouped in the same genus, but the nervation is more open and the leaves are broader and larger.

One of the supposed fruits of this species as figured by Heer is represented on Plate x, fig. 10, of this monograph. (See *supra*, p. 46.)

Localities.—Woodbridge, Sayreville, &c.

* I doubt very much that fig 16 represents a specimen of this species, or even genus. It is unquestionably so included, however, in Dr. Newberry's manuscript. A.H. (Hollick). (*Op. cit.*, p. 110.)

Q.—E. (?) nervosa Newberry.

Op. cit., p. 112, with Plate xxxii, figs. 3, 4, 5, 8.

FOLLOWING is the original description:—

Leaves long-linear, rounded or subacute at summit, narrowed and wedge-shaped at base, 15 cm. in length by 1 cm. in width, margins entire; nervation strong, crowded, midrib, continuous from base to summit, lateral nerves very numerous, generally parallel and uniting to form a continuous nerve-thread near to and parallel with the margin.

The general aspect of these leaves is peculiar. The style of nervation is similar to that of all the elongated, lanceolate, or linear leaves which I have grouped provisionally in the genus *Eucalyptus,* but in this species the nervation is much more crowded, and the union of the summits of the lateral nerves forms a more straight and continuous nerve-thread.

Locality.—South Amboy. (*Op. cit.,* p. 112.)

R.—E. (?) parvifolia Newberry.

With Pl. xxxii, figs. 9, 10.

FOLLOWING is the original description:—

Leaves small, about 5 cm. to 6 cm. in length by 12 mm. to 15 mm. wide in the middle, strictly lanceolate in form, pointed above and below, margins entire; nervation rather delicate and open, lateral nerves more or less numerous united in a festoon somewhat removed from the margin.

The leaves described above may be but one of the varieties of *E. Geinitzi,* but they are so decidedly lanceolate in outline, so much broader in proportion to their length, and so much smaller, that I have felt constrained to consider them distinct. The characters of the form and nervation exhibited by these leaves are well shown in the figures now given.

Locality.—South Amboy. (*Op. cit.,* p. 112.)

(There is an *E. parvifolia* Cambage, see Part XXV, p. 88, of the present work, which, in my opinion, must stand, as the *E. (?) parvifolia* Newberry is, in my view, not a Eucalypt at all.—J.H.M.)

In "Maryland Geological Survey, Upper Cretaceous" (1916), p. 870; E. W. Berry gives a valuable synonomy of a well-known species:—

D. *Eucalyptus Geinitzi* (Heer) Heer. (Plate lxxxi, Figs. 1–5.)

Following is a description also:—

(Some synonyms already given are omitted here.)

Myrtophyllum Geinitzi Fric, 1878, Archiv. Naturw. Landes, Bohm., Bd. iv, Nr. i, pp. 18, 94.

Eucalyptus Geinitzi Heer, 1885, Fl. Foss. Arct., Bd. vi, Ab. ii, p. 93, pl. iv, figs. 1–3, pl. xix, fig. 1c.

Eucalyptus Geinitzi Englehardt, 1891, Isis, Ab. vii, p. 102.

Eucalyptus Geinitzi Lesquereux, 1892, Mon. U.S. Geol. Survey, vol. xvii, p. 138, pl. xxxvii, fig. 20.

Myrtophyllum Warderi Lesquereux, 1892, Mon. U.S. Geol. Survey, vol. xvii, p. 136, pl. liii, fig. 10.

Eucalyptus (?) angustifolia Newberry, 1896, Mon. U.S. Geol. Survey, vol. xxvi (non Desv., 1822), p. 111, pl. xxxii, figs. 1, 6, 7.

Eucalyptus Geinitzi Newberry, 1896, Mon. U.S. Geol. Survey, vol. xxvi, p. 110, pl. xxxii, figs. 2, 12 (non figs. 15, 16).

Eucalyptus Geinitzi Krasser, 1896, Beitr. z Kennt. Kreidef. Kunstadt in Mahren, p. 22.

Eucalyptus Geinitzi Hollick, 1898, Ann. N.Y. Acad. Sci., vol. xi, p. 60, pl. iv, figs. 1–3.

Eucalyptus Geinitzi Fric and Bayer, 1901, Archiv. Naturw. Landes, Bohm., Bd. xi, Nr. ii, p. 142, tf. 110.

Eucalyptus Geinitzi Berry, 1903, Bull. N.Y. Bot. Garden, vol. iii, p. 87, pl. liii, fig. 3.

Eucalyptus (?) angustifolia Hollick, 1904, Bull. N.Y. Bot. Garden, vol. iii, p. 408, pl. lxx, figs. 8, 9.

Eucalyptus Geinitzi Berry, 1904, Bull. Torrey Bot. Club, vol. xxxi, p. 78, pl. iv, fig. 5.

Eucalyptus Geinitzi Berry, 1906, *ibidem,* vol. xxxiii, p. 180.

Eucalyptus Geinitzi Berry, 1907, *ibidem,* vol. xxxiv, p. 201, pl. xv, fig. 4.

Eucalyptus (?) angustifolia Hollick, 1907, Mon. U.S. Geol. Survey, vol. i, p. 95, pl. xxxv, figs. 9, 14, 15.

Eucalyptus Geinitzi Hollick, 1907, Mon. U.S. Geol. Survey, vol. i, p. 96, pl. xxxv, figs, 1–8, 10–12.

Eucalyptus Geinitzi Berry, 1907, Johns Hopkins Univ. Circ. n.s., No. 7, p. 81.

Myrtophyllum Warderi Hollick, 1907, Mon. U.S. Geol. Survey, vol. i, p. 97, pl. xxxv, fig. 13.

Eucalyptus Geinitzi Berry, 1910, Bull. Torrey Bot. Club, vol. xxxvii, p. 26.

Eucalyptus Geinitzi Berry, 1911, Bull. 3, Geol. Survey of New Jersey, p. 189, pl. xxviii, fig. 7.

Eucalyptus Geinitzi Berry, 1912, Bull. Torrey Bot. Club, vol. xxxix, p. 402.

Eucalyptus Geinitzi Berry, 1914, Prof. Paper, U.S. Geol. Survey, No. 84, p. 56, pl. xiii, figs. 8–12; pl. xiv, fig. 1.

Description.—Leaves lanceolate in outline, broadest near the middle and tapering almost equally in both directions to the acute apex and base. There is considerable variation in size, averaging about 15 cm. in length by 2·2 cm. in greatest width. The petiole is very stout, as is the prominent midrib, which leaves a sharp groove in impressions showing the lower surface. Secondaries numerous, thin, branching from the midrib at acute angles, about 45°, and running with but a slight curvature to the marginal vein, which is either almost straight when the secondaries are close set, or more or less bowed when the secondaries are some little distance apart, as is often the case.

This species is especially wide ranging. It was described originally from the Cenomanian of Moravia, and has since been recorded from the Cenomanian of Saxony and the Cenomanian and Turonian of Bohemia, from the Atane beds of Greenland, the Dakota sandstone of the West, and from Martha's Vineyard to Texas along the Atlantic coast. It ranges upward into the Black Creek formation of North Carolina, and is not rare in the Middendorf beds of South Carolina. In the Tuscaloosa formation of Alabama the species has not been commonly met with, but this may simply be due to accidents of preservation.

Occurrence.—Magothy formation. Deep Cut, Delaware; Grove Point, Cecil County; Round Bay and Little Round Bay, Anne Arundel County, Maryland.

Collection.—Maryland Geological Survey. (*Op. cit.,* p. 870.)

S.—E. latifolia Hollick.

With Plate lxxxi, figs, 6, 7.

FOLLOWING is the original description:—

Eucalyptus latifolia Hollick, 1907, Mon. U.S. Geol. Survey, vol. 1, p. 97, pl. xxxv, figs. 1–5 (1906). Berry, 1910, Bull. Torrey Bot. Club, vol. xxxvii, p. 26 (1910).

Description.—Leaves elongate-ovate in outline, tapering to a somewhat abruptly attenuated and more or less curved or flexuous tip. Base cuneate. Length about 15 cm. Maximum width, about half-way between the apex and the base, about 5 cm. Midrib stout, flexuous. Secondaries thin, numerous, diverging from the midrib at angles of from 45° to 50°, nearly straight or flexuous, their tops joined by a marginal vein. Margins entire. Texture subcoriaceous.

These large leaves occur in the Magothy formation of Martha's Vineyard, Long Island, and Maryland. They are not uncommon at one locality in the lower Tuscaloosa of Alabama. Their relation to *Eucalyptus* is extremely doubtful, but a change of generic reference is not considered advisable at the present time.

Occurrence.—Magothy formation. Round Bay, Anne Arundel County.

Collection.—Maryland Geological Survey. (*Op. cit.,* p. 870.)

(For a description, p. 1, and figure, Plate 168, of *E. latifolia* F.v.M. (1859), see Part XLI of the present work.)

T.—E. Wardiana Berry.

FOLLOWING is the original description:—

Eucalyptus (?) dubia Berry, 1903, Bull. N.Y. Bot. Garden, vol. iii, p. 87, pl. lii, fig. 1 (non Ettings-hausen, 1887).

Eucalyptus Wardiana Berry, 1905, Bull. Torrey Bot. Club, vol. xxxii, p. 47.

Berry, 1906, *ibidem,* vol. xxxiii, p. 180.

Berry, 1906, Rept. State Geol. of New Jersey for 1905, pp. 138, 139, 141.

Berry, 1914, Prof. Paper U.S. Geol. Survey, No. 84, p. 57, pl. xiv, figs. 3, 4.

Description.—Leaves linear-lanceolate in outline with a pointed base and a gradually narrowed, acuminate tip. Length about 8 cm. to 10 cm. Maximum width about 1·3 cm. Margins entire. Texture subcoriaceous. Midrib of medium size. Secondaries very numerous, equally spaced, at intervals of about 1 mm.; they diverge from the midrib at angles of about 60°, and pursue relatively straight courses to the immediate vicinity of the margins, where their ends are united by a straight acrodrome marginal vein running close to and parallel with the margins. Tertiaries forming a double series of nearly isodiametric four-sided or five-sided meshes in each interval between adjacent secondaries.

This species greatly resembles some of the smaller forms that have been referred to *Eucalyptus Geinitzi,* especially those with closely spaced secondaries. It is, however, quite different from the type of that species, and may be distinguished by its thinner midrib, more numerous secondaries, straighter marginal veins and more prominent tertiaries. It also greatly resembles *Eucalyptus angusta* Velenovsky (Velenovsky, *Fl. Bohm. Kreidef.* Theil iv, p. 3, pl. iii, figs. 2–12, 1885) of the Cenomanian of Bohemia, which species has been recorded by the writer from the upper Raritan of New Jersey and the late Upper Cretaceous in North Carolina and Georgia. It is possible that the two species may be confused, since much of the material is fragmentary. *Eucalyptus Wardiana* is, however, more elongated, straighter, with more prominent tertiary areolation, and with the secondaries diverging at a wider angle. It characterises the Magothy formation from Raritan Bay in New Jersey to the Severn River in Maryland, and also occurs in the Middendorf beds of South Carolina.

Occurrence.—Magothy formation. Deep Cut, Delaware; Grove Point, Cecil County; Round Bay, Anne Arundel County, Maryland.

Collection.—Maryland Geological Survey. (*Op. cit.,* p. 872.)

This work ("Maryland Geological Survey, Upper Cretaceous," 1916) contains a valuable resumé, "The Upper Cretaceous Floras of the World," by Edward Wilber

Berry, pp. 183–313, which I have already quoted several times. The following notes referring to reputed Eucalypts may be added.

" . . . Among the characteristic species found in the Magothy of Maryland are *Eucalyptus Wardiana* Berry." (p. 64.)

"*North Carolina* . . . In this and subesquent years fossil plants were discovered at numerous localities, and were the basis of publication of several minor papers, which contain all that has been printed regarding the Upper Cretaceous flora. This flora comes from the Black Creek formation, which is fully described in the recent work on the Coastal Plain of North Carolina. The following species have been determined:—

E. attenuata Newberry, *E. Geinitzi* (Heer) Heer, [*] *E. linearifolia* Berry." (p. 211.)

"*South Carolina.* . . . The geology and floras have recently been described in detail by the writer (Berry, E. W., 'U.S. Geol. Survey,' Prof. Paper 84, 1914, pp. 5–98, pls. i–xiv). The floras clearly constitute a single floral unit, which is made up of the following species:—

E. angusta Velenovsky, *E. Geinitzi* (Heer) Heer, *E. Wardiana* Berry." (p. 213.)

"*Georgia.* . . . A considerable flora has been described from different localities in the Eutaw formation, considered by the writer to correspond with a part of the Black Creek formation of the Carolinas, and to be of Turonian age. The following species have been recorded:—

E. angusta Velenovsky.

The Ripley formation, a series of littoral and marine shallow-water deposits with abundant faunas, contains a meagre flora, probably of Emscherian age. The following species have been recorded:—

E. angusta Velenovsky." (pp. 215, 216.)

"*Alabama* (including scattered floras from Mississippi and Tennessee). The presence of fossil plants in the Tuscaloosa formation of western Alabama was announced by Winchell (Winchell, Alex., *Proc. Amer. Assoc. Adv. Sci.,* vol. x, 1856, p. 92) in 1856. The formation was described in detail by Smith and Johnson (Smith, E. A., and Johnson, L. C., *Bull. U.S. Geol. Survey,* No. 43, 1887) in 1887. During the course of their work large collections were made and forwarded to Washington, and a brief list of species was drawn up in 1894 by Ward (in Smith, E. A., 'Geology of the Coastal Plain in Alabama,' 1894, p. 348). These collections did not, however, receive critical study until the writer took up the work in 1907. Large additional collections were made, resulting in a complete account of this important flora. (This is in course of publication by the U.S. Geol. Survey as a Professional Paper entitled 'Upper Cretaceous Floras of the Eastern Gulf Area.') A brief abstract was published (Berry, E. W., *Bull. Torrey Bot. Club,* vol. xl, 1913, pp. 567–574) in

1913. The following species are enumerated (a considerable number of these will remain *nomina nuda* until after the publication of the Professional Paper referred to):—

E. Geinitzi (Heer) Heer, *E. latifolia* Hollick." (p. 218.)

"*Texas.* The presence of fossil plants in the Woodbine sands along the Red River in north-eastern Texas was announced by Shumard in 1868 (Shumard, B. F., *Trans. Acad. Sci. St. Louis,* vol. ii, 1868, p. 140). The first account of plants from these beds was published in Knowlton (Knowlton, F. H., in Hill (*op. cit.*), (pp. 314–318, pl. xxxix) in 1901 in Hill's great work on Texas (Hill, R. T., 'Geography and Geology of the Black and Grand Prairies,' 21st *Ann. Rept. U.S. Geol. Survey,* pt. vii, 1901), and was based on collections made by Hill and Vaughan. A small collection made by Stanton and Stephenson was described by the writer (Berry, E. W., *Bull. Torrey Bot. Club,* vol. xxxix, 1912, pp. 387–406, pls. xxx-xxxii) in 1912. The flora, while limited, indicates synchroneity with a part of the Dakota sandstone of the West, the lower Tuscaloosa of the eastern Gulf area, and the upper Raritan and Magothy of the northern Atlantic Coastal Plain. It includes the following species:—

E. Geinitzi (Heer) Heer." (p. 221.)

" . . . . In Alabama the following have been recorded from the Lower Eutaw:—

E. havanensis Berry. (Also recorded from deposits of this age in Western Tennessee)." (p. 220.)

The following refer to European deposits:—

"*Saxony—Niederschoena.* One of the most celebrated localities for Upper Cretaceous plants is at Niederschoena (Nieder Schona) between Dresden and Freiburg, and about 7 kilometres north-east of the latter place. . . . Combining the identifications of the above-mentioned authors furnishes the following list of species:—

E. angusta Velenovsky, *E. Geinitzi* Heer. . . . ." (p. 279.)

"The Maestrichtian flora (Caeloptychien Kreide) is recorded from a large number of localities in the Munster basin, some of which may have already been mentioned. These are not all of the same age, the schichten, mergel and sandsteine der Baumberge and the Hugelgruppe von Haldem-Lemforde being younger than the plattenkalk von Sendenhorst, the latter being said to be the youngest Cretaceous in the basin. By combining the fossil plants that have been recorded from all these localities, the following list is obtained:—

E. Haldemiana Debey, *E. inoequilatera* von der Marck." (p. 283.)

We now turn to an important paper—"U.S. Geological Survey, Professional Paper 112 (1919), Upper Cretaceous Floras of the Eastern Gulf Region in Tennessee, Mississippi, Alabama and Georgia," by E. W. Berry, for three descriptions.

Presumably the first is identical with *E. havanensis* Berry, referred to under "Maryland Geological Survey, Upper Cretaceous" (1916), p. 220.

* Unknown to me. (Prof. Berry.)

Myrcia havanensis Berry.

Plate XI, figure 4; Plate XXVIII, figure 7.

Myrcia havanensis Berry, “Torrey Bot. Club Bull.,” vol. 43, p. 300, 1916.

Eucalyptus attenuata Ward (not Newberry), “U.S. Geol. Survey, Fifteenth Annual Report,” p. 371, 1895.

Leaves linear-lanceolate in outline, falcate, about 9 centimeters in length by 1 centimeter in maximum width, which is in the lower half of the leaf. Margins entire. Apex gradually narrowed, acuminate. Base narrowly pointed, decurrent. Petiole very stout, tapering upward, 1·75 centimeters in length. Midrib stout, curved. Secondaries numerous, thin, somewhat irregularly spaced, 2 to 6 millimeters apart, branching from the midrib at angles of about 40°, running with but slight curvature to the well-marked and nearly straight longitudinal vein which forms a marginal hem less than 0·5 millimeter from the margin. Texture coriaceous.

The present species is very close to some of the numerous forms which from time to time have been referred to *Eucalyptus Geinitzi* (Heer) Heer. It is, however, distinct from that species, especially when compared with Heer's type or with the more typical Americal material. In general it is a smaller leaf, has a larger and longer petiole and an outline less inclined toward ovate, and is relatively much more produced apically. It is typically *Myrcia*-like in all of its characters and is readily distinguishable from the forms from the Tuscaloosa formation which have been referred to *Eucalyptus Geinitzi* in this work. It is confined to the basal beds of the Eutaw formation in Hale County, Ala., and the Ripley formation in western Tennessee, and takes its name from the town of Havana, near which the leaf-bearing laminated clays of this formation outcrop. A single specimen collected by R. T. Hill in 1891 at the big cut on the Southern Railway east of Pocahontas, Tenn., and identified by Ward as *Eucalyptus attenuata* Newberry, proves to belong to this species (pp. 125-6).

D. EUCALYPTUS GEINITZI (Heer) Heer.

Plate XXVIII, figure 8.

(See the bibliography at p. 236.)

Eucalyptus Geinitzi Hollick, *New York Acad. Sci. Ann.,* vol. 11, p. 60, pl. 4, figs. 1–3, 1898. The Cretaceous Flora of Southern New York and New England, p. 96, pl. 35, figs, 1–8, 10–12, 1906.

This species has a wide range. It was described originally from the Cenomanian of Moravia, and has since been recorded from a number of other European Cenomanian localities, from the Atane beds of Greenland, the Dakota sandstone of the West, and from Martha's Vineyard to Alabama along the Atlantic coast. It ranges upward into the Black Creek formation of North Carolina, and is not rare in the Middendorf arkose member of the Black Creek formation of South Carolina. In Alabama the species is not common, but this may simply be due to accidents of preservation. (pp. 126-7.)

S. EUCALYPTUS LATIFOLIA Hollick.

The Cretaceous Flora of Southern New York and New England, p. 97, pl. 36, figs. 1–5, 1906. (See p. 237.)

. . . According to long-established usage, therefore, this species and *Eucalyptus Geinitzi* and *E. angusta* are referred to the genus *Eucalyptus,* although it seems more probable that they represent the genus *Myrcia* of this same family, or its ancestral stock. (p. 126.)

Supposed Cretaceous Fruits of Eucalyptus.

Let me reproduce the following important extract from U.S. Geological Survey, xxvi, Newberry, "The Flora of the Amboy Clays," p. 46:—

"*Dammara borealis* Heer, Pl. X, fig. 8.

Dammara borealis Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 54, Pl. XXXVII, fig. 5.

In his Flora Fossilis Arctica (*loc. cit.*) Professor Heer describes and figures the scales of a cone of a conifer which very much resemble those of *Damara australis,* and yet there are some reasons for doubting the accuracy of his reference. It may also be said that the fruit scales which he calls *Eucalyptus Geinitzi* (*ibid.,* p. 93, Pl. xlv, figs. 4–9; Pl. xlvi, fig. 12d) are without doubt generically the same. They have very little resemblance to any of the fruits of Eucalyptus, however, which are urn-like, with a conical cover. On the contrary, the fruits figured by Heer under the name of Eucalyptus are plainly scales, and are parts of an imbricated cone. I say this with confidence, because it has happened that in the Amboy Clays we have found numbers of them, sometimes associated together, often scattered and showing both faces. A peculiarity of these scales is that they are striped longitudinally by clefts which are filled with an amber-like substance. This structure is plainly seen in those figured by Professor Heer on Pl. XLV. Similar scales are described in an article by Mr. David White on the fossil plants from Gay Head. (*American Journal of Science,* 3d series, Vol. xxxix, p. 98, Pl. ii, figs. 9, 10.)

The considerations which have led me to doubt whether these cone scales are those of Dammara are that we have found no Dammara-like leaves associated with them, whereas in one locality in New Jersey they occur in great numbers mingled with and sometimes apparently attached to the branchlets of an extremely delicate conifer much like Heer's *Juniperus macilenta* (Fl. Foss. Arct., Vol. vi, Abth. ii, p. 47, Pl. xxxv, figs. 10, 11), but the leaves are more appressed. Almost no other plant except this conifer is found with the cone scales, and it is difficult to avoid the conclusion that they belong together. Another reason for doubting whether these are the scales of a species of Dammara is that in some of them traces of two seeds are apparently visible, while in Dammara there is but one seed, under each scale.

On our plate (fig. 9) is a representation of *Dammara microlepis* Heer, taken from his work, Pl. XL, fig. 5, and also (fig. 10) one of *Eucalyptus Geinitzi* Heer, from the same volume, Pl. XLV, fig. 5, for purposes of comparison.

PLATE X.

Fig. 8. *Dammara borealis* Heer . . . . -Page 46

Fig. 9. *Dammara microlepis* Heer (introduced for comparison) Page 47

Fig. 10. *Eucalyptus Geinitzi* Heer (introduced for comparison) . . . Page 110

Zittel's Fig. 348, at p. 638, shows “flowers” of *E. Geinitzi* Heer. The flowers are shown in Plate 227, figs. 11 and 13, of the present Part.

Saporta (1894) (p. 230) and shortly afterwards Dr. J. S. Newberry, “The Flora of the Amboy Clays” (1895) (under *E.* (?) *angustifolia, ante,* p. 234) were the first to throw doubt on the supposed Eucalyptus fruits of Heer.

Newberry surmised them to be “the detached scales of the cone of some conifer, and probably generically identical with the cone-scales he (Heer) had labelled *Dammara borealis.*” He then goes on to show an essential difference between a Eucalyptus fruit and the fruits which are aggregates of these scales.

Dr. A. Hollick (the editor of Dr. Newberry's posthumous work) suggests reference to fruits of *D. microlepis* Heer and *E. Geinitzi* Heer, as depicted by Heer himself. Dr. Hollick (*ante,* p. 234) under *E. Geinitzi,* doubts whether a specimen from the Amboy Clays referred to that species “represents a specimen of this species or even genus.” This early had there been doubts about the American fossil reputed Eucalypts.

In the following observations Professor E. W. Berry is feeling his way towards referring certain alleged American fossil Eucalypts to the very American genus *Myrcia.* He is naturally diffident about extensively disturbing nomenclature.

“The Origin and Distribution of the Family Myrtaceae.”

“ . . . The *Eucalyptus* forms, according to the view of this student (E. C. Andrews, *Proc. Linn. Soc. N.S.W.,* xxxviii, 529, 1913), were derived from *Metrosideros* after the separation of New Caledonia from Australia and the latter continent from Asia.

To support this latter point Andrews is obliged to consider all of the cretaceous identifications of *Eucalyptus* and all of the Tertiary identifications outside of Australia as equally misleading. With regard to the presence of *Eucalyptus* in North America, I think this contention to be not unlikely, for although in accordance with paleobotanical usage I have identified numerous forms of *Eucalyptus* in the North American Upper Cretaceous, I have long thought that these leaves represented ancestral forms of *Eugenia* or *Myrcia,* but have hesitated suggesting any change based merely on personal opinion, and also from a consideration that such change in nomenclature is undesirable at the present time from the standpoint of stratigraphic paleobotany, which, in this country, at least, is a most useful handmaid of geology.

"The supposed cretaceous fruits of *Eucalyptus* have long since been shown to represent *Dammara*-like forms, and, in my studies of the tertiary floras, I have refrained from referring any of the numerous and unquestionable myrtaceous leaves to the genus *Eucalyptus.* Regarding the possible occurrence of *Eucalyptus* in the Tertiary of Europe, I am not sure that all of the identifications of Heer, Unger, Ettingshausen, and others, are erroneous. Certain remains considered as *Eucalyptus* fruits by these authors seem very convincing* from the published figures [he repeats these sentiments the following year in 'U.S. Geological Survey, Professional Paper 91,' p. 119.—J.H.M.], and furthermore there is not the slightest doubt that the other great Australian alliance of the existing flora, the Proteaceae, was represented in both Europe and America during the Cretaceous and the Tertiary. There is an additional argument against the cretaceous radiation and the paleobotanical determination of *Eucalyptus,* which is furnished by the great persistence in the modern forms of the peculiar juvenile, opposite, cordate, sessile, and horizontal leaves, a feature which must represent an ancestral character of long standing before the evolution of the falcate leaves of the genus with twisted leaf-stalks and other xerophytic features. (See Deane, H., 'Observations on the Tertiary Flora of Australia,' *Proc. Linn. Soc. N.S.W.,* 15, 463–475, 1900; and Cambage, R. H., 'Development and Distribution of the Genus *Eucalyptus,*' *Journ. Roy. Soc. N.S.W.,* 1913.)

"Among the numerous cretaceous fossils from North America now referred to *Eucalyptus,* there is not a single one that does not exhibit characteristic features of *Eugenia* or *Myrcia,* especially of the latter, a fact greatly impressed on me in handling a large amount of recent material during my study of the American tertiary forms. . . .

" . . . The types peculiar to the Australian region represent the relics of the cretaceous radiation with numerous new types evolved on that continent in the manner that Andrews has suggested, and at a comparatively recent date geologically. This is exactly the reverse of the hypothesis proposed by Deane (*op. cit.*), but one that accords far better not only with the facts of geologic history, but also with those of existing distribution. (p. 488.)

" . . . About 150 fossil forms have been referred to the family Myrtaceae, one-third at least having been described as species of *Eucalyptus.* At least half of these occur in the Cretaceous of all parts of the world, but particularly throughout the Northern Hemisphere. They are especially well represented in North America, and the possibility that they are ancestral forms of *Myrcia* or *Eugenia* has already been pointed out. A similar wide-spread distribution, but less specific variation, characterises the Eocene forms that have been referred to *Eucalyptus.* The Oligocene records are all European, and the Miocene records include both Europe and Asia." (p. 488.) (E. W. Berry in *Bot. Gazette,* vol. 59, pp. 486–488, 1915.)

In U.S. Geological Survey, Professional Paper 91 (1916), "The Lower Eocene Floras of South-eastern North America," E. W. Berry, we have the following notes:—

Myrcia Vera Berry, n.sp., Pl. xc, fig. 3.

" . . . This species is of a type usually referred by paleobotanists to the allied genus *Eucalyptus* or *Myrtus,* to which so many fossil species from the Upper Cretaceous to the present have been placed, and it is not very different from the widespread *Eucalyptus oceanica* Unger of the European Tertiary." (p. 315.)

Myrcia Bentonensis Berry, Pl. xc, figs. 7–9.

" . . . It suggests fossil forms that have been referred to the genera *Eucalyptus, Nerium, Ficus,* and *Apocynophyllum,* but it appears to be most like the genus *Myrcia,* which has so many existing species in the American tropics. It may be compared with certain existing species of Myrcia." (p. 317.)

In U.S. Geological Survey, Professional Paper 112 (1919), by E. W. Berry, we have—

I. *Eucalyptus angusta* Velenovsky (*ante,* p. 226).

Berry, "U.S. Geol. Survey, Prof. Paper 84," p. 119, Pl. 20, figs. 2–4, 1914.

"This species was recently discussed by me for the eastern Gulf area in the paper cited.

"It may well be doubted whether this and the preceding species (*Geinitzi*) are correctly referred to the genus *Eucalyptus.* Were it not for the havoc which would be wrought with the synonomy and the obscuring of their bearing on geographic distribution, I would refer these forms to the myrtaceous genus *Myrcia,* which is so abundant in the existing flora of tropical America and whose foliage is not distinguishable from the adult leaves of *Eucalyptus*. *Myrcia* is represented in the Eocene floras of the Mississippi embayment by several species, some of which are undoubtedly descended from these Upper Cretaceous species of so-called *Eucalyptus.*” (p. 127.)

Finally he makes the plunge, and in “Science,” N.S., Vol. lxix, January, 1919, p. 91, publishes a letter headed—

“Eucalyptus Never Present in North America.”

(This begins with an attack on Bentham, quoted in Part LIV, p. 170), and proceeds:—

“ . . . A few years ago I advanced a theory of origin and distribution for the family Myrtaceae which was based largely upon the recent and fossil distribution of the different tribes (Berry, E. W., ‘The Origin and Distribution of the Family Myrtaceae,’ *Bot. Gaz.,* vol. 59, pp. 484–490, 1915). This theory in its broader outlines considered America as the centre of radiation for the family, and regarded the sub-family Myrtoideae as the most ancient. The sub-family Leptospermoideae was regarded as derived from the former; and the Australian types, which are the peculiar ones of the family, were regarded as having originated in that region in response to local environmental conditions subsequent to the Cretaceous radiation of the family stock. Genera such as *Eugenia* and *Myrcia* were regarded as representing this ancestral stock more nearly than any other of the existing genera.

“This theory considered *Eucalyptus* as one of the more specialised genera, and in this conclusion I agreed entirely with Andrews and other Australian friends, who have repeatedly expressed doubts regarding the presence of *Eucalyptus* in the fossil floras of the northern hemisphere. Without wishing to be dogmatic about European fossil forms referred to *Eucalyptus,* and known to me only from figures, I may say that I do not regard the genus as ever having been present in North America, although in conformity with long-established custom and with due consideration for the stratigraphical applications, I have frequently referred fossil forms to this genus.

“A question of considerable importance is the real botanical affinity of the numerous North American Cretaceous forms which have been referred to *Eucalyptus.* These are undoubtedly ancestral to the American Eocene forms referred to *Eugenia* and *Myrcia,* and it would probably be not far from the truth if they were referred to the genus *Myrcia.* I have collected and studied a great many of these Cretaceous types, and some of them are certainly closely allied to, if not identical with, that genus. Others are somewhat remote, and, pending a solution of their botanical affinity, which may never be satisfactorily attained, I would advocate the dropping altogether of the use of *Eucalyptus* for those North American fossil forms. This usage is seriously misleading from the standpoint of evolution and distribution, and, moreover, is not supported by any valid botanical arguments, as I pointed out in the paper already alluded to at the beginning of this note. The alternative that I suggest is the taking up of the genus *Myrtophyllum* proposed by Heer in 1869 (Heer, O., *Neue Denks. Schw. Gesell. Naturw.* Bd. 23, nem. 2, p. 22, 1869. Type being the widespread mid-Cretaceous species *Eucalyptus Geinitzi*), and using it for leaves of Myrtaceae whose generic relations cannot be determined with certainty, and more especially for the leaves commonly referred to the genus Eucalyptus."

Ackowledgments.—Mr. W. S. Dun, the well-known Palaeontologist and Librarian, has been most kind in procuring me books from the library of the N.S.W. Geological Survey, and in verifying my references. He could not have been kinder in answering my many letters, but that will not surprise anyone who knows him. I am also grateful for a couple of references from Dr. A. B. Walkom, Secretary of the Linnean Society of N.S.W. I am not a palaeobotanist, and I should have been glad if I could have obtained the help of a geological or palaeobotanical friend to read Parts LIV and LV before publication, but that was out of the question, as they grew to be so voluminous.—J.H.M.

IV. The Root.

Adventitious Roots.

An illustrated article will be found in my "Forest Flora of New South Wales," Part LXII, p. 64 (1918).

Adventitious roots in *E. rostrata, E. resinifera, E. rudis, E. robusta, E. tereticornis* and *E. paniculata* are dealt with at pages 64–67 of this article, and I beg to refer my readers to the interesting information there recorded.

(Particulars of the roots being employed as water-supply by the aborigines will be referred to under "Aborigines" in a subsequent Part of this work.)

V. Exudates.

a. Kinos.

The earliest references to the astringent exudations of our Eucalypts appear to be as follows:—

The following is the earliest I can find:—

Dampier, W.— "A new voyage round the world, describing particularly the Isthmus of America, ec., ec., New Holland, ec., their soil, rivers, harbours, plants, fruits, animals and inhabitants." Third edition, 3 vols. (London, 1698–1709).

Vol. I, p. 463, Notes on "Dragon Trees" (Eucalypts), exuding kino; Vol. III contains some plates of Australian plants.

The name Gum Tree arose because of the kino which exuded from the trunks of Eucalypts. Banks noticed this exudate at Botany Bay in 1770—

"The soil, wherever we saw it, consisted of either swamps or light sandy soil, on which grew very few species of trees, one, which was large, yielding a gum much like *Sanguis draconis. . . .* "

(Banks' Journal, edited by Hooker, p. 267.) See also p. 271.

At p. 271 the "Endeavour" is in Bustard Bay, Queensland, where they landed, and Banks says:—

"Upon the sides of the hills were many of the trees yielding a gum like *Sanguis draconis.* They differed, however, from those seen on the 1st of May, in having their leaves longer and hanging down like those of the weeping willow. Notwithstanding that, I believe that they were of the same species. There was, however, much less gum upon them. Only one tree that I saw had any, contrary to all theory, which teaches that the hotter a climate is the more gums exude." (p. 271.)

At p. 300 he points out (quite correctly) that this may be the gum found on trees both by Dampier in North-western Australia (statement published in 1694), and by Tasman in the modern Tasmania earlier in the same century.

Then we have—

Phillip, A.—"The voyage of Governor Phillip to Botany Bay, etc." (4° London, 1789.) Account of the "red and yellow gum-trees" (*Eucalyptus* and *Xanthorrhoea hastilis*), pages 59 and 60, as follows:—

"In the dysentry, the red gum of the tree which principally abounds on this coast, we found a very powerful remedy. . . . The tree . . . is very considerable in size, and grows to a great height before it puts out any branches. The red gum is usually compared to that called *Sanguis draconis,* but differs from it in being perfectly soluble in water, whereas the other, being more properly a resin, will not dissolve except in spirits of wine. It may be drawn from the tree by tapping, or taken out of the veins of the wood when dry, in which it is copiously distributed. The leaves are long and narrow, not unlike those of a willow. The wood is heavy and fine-grained, but being much intersected by the channels containing the gum, splits and warps in such a manner as soon to become entirely useless, especially when worked up, as necessity at first occasioned it to be, without having been properly seasoned."

In the same year we have Tench's "Narrative, etc.," p. 119, "These trees yield a profusion of thick red gum (not unlike the Sanguis draconis)."

White, J.—"Journal of a Voyage to New South Wales, with sixty-five plates of nondescript animals, e'c., curious cones of trees and other natural productions." 4to., London, 1790. Kino for medicinal use, p. 178; Peppermint tree (*Eucalyptus piperita*), with figure, p. 226; the "Red Gum" tree (*Eucalyptus resinifera*), with figure, and notes on its medicinal value, p. 231.

We now leave ancient history, and come to a few modern papers, of which the following may be taken as typical:—

Redwood, T.—"On the gelatinization of tincture of Kino," *Pharm. Journ.* I, 399. Eucalyptus kino is referred to in general terms, and it is the first reference to the subject of gelatinisation that I know.

Sutherland, J.—"On the medicinal properties of the Red Gum of Australia." *The Technologist,* III, p. 69. A brief essay on the chemical behaviour and therapeutic effects of the kino of *Eucalyptus rostrata.*

Wiesner, T.—"Eucalyptus Gum." *Pharm. Journ.* (3), ii, p. 102, from *Zeitschr. d. Allg. Oest. Apotheker. Vereines.* Contains notes on a number of kinos.

E. corymbosa Sm., *E. globulus* Labill., *E. rostrata* Schlecht., *E. leucoxylon* F.v.M., *E. corynocalyx* F.v.M., *E. citriodora* Hook., *E. maculata* Hook., *E. calophylla* R.Br., *E. amygdalina* Labill., *E. piperita* Sm., *E. pilularis* Sm., *E. fabrorum* Schlecht., *E. fissilis* F.v.M., *E. gigantea* Hook., *E. viminalis* Labill., *E. obliqua* L'Her.

Kremel, A.—Eucalyptus kino is dealt with amongst others. He fails to find the Kinoin of Etti (*Amer. Journ. Pharm.,* 1872, 6,000). *Pharm. Post,* 1883, No. 11.

Hudson, F.J.—Kino of *E. rostrata* as a remedy in diarrhoea. *Zeitschr. des oesterr. Apoth.* Ver., 1883, 220.

Heckel, E. et Schlagdenhauffen, Fr.—Sur quelques gommes d'*Acacia (dealbata)* et d'*Eucalyptus* (*leucoxylon* and *viminalis*). *Le Naturaliste,* 2nd Serie, No. 80, p. 151 (1st July, 1890). Contains analyses of a gum and two kinos, obtained from trees growing in the south of France.

Eucalyptus products. *Pharm. Journ.* (3), xvi, 898. Kinos are here referred to.

Grimwade, E. N.—“A Kino from *Eucalyptus maculata.*” *Pharm. Journ.* (3), xvi, 1102. A chemical examination.

The only references to Kinos I can find in Bentham's “Flora Australiensis” are—

“Shrubs or trees, attaining sometimes a gigantic size, secreting more or less of resinous gums, whence their common appellation of ‘Gum-trees’ ” (B.Fl. iii, 185, 1866), while *E. alpina* is described with the young shoots viscid, the only species so described, as far as I know.

Maiden, J. H.—“The examination of Kinos as an aid in the diagnosis of Eucalypts.” Part I: The Ruby Group, *Proc. Linn. Soc. N.S.W.* (2), iv, p. 605 (1889); Part II: The Gummy Group (2) iv, p. 1277; Part III: The Turbid Group (2), vi, p. 389 (1891). The groups are primarily divided according to the behaviour of the kinos in water and alcohol.

(In *Journ. Roy. Soc. N.S.W.,* xxxviii, 23, 1904, Mr. H. G. Smith shows that the substance thought to be gum is not gum, and therefore the name “Gummy Group” is misleading.)

The same, “Botany Bay or Eucalyptus Kino.” *Pharm. Journ.* (3), xx, pp. 221–321. Comprises the following papers:—

1. Commerce and uses of Eucalyptus Kinos; 2. Collection of Eucalyptus Kinos;—3. Use of the word “gum” or “gum-tree” in Australia; 4. Classification of Eucalyptus Kinos; 5. Definition of the terms “Botany Bay Kino” or “Australian Kino”; 6. Gelatinisation of tincture of kino.

The same, “Report on the Vegetable Exudations collected by the Elder Exploring Expedition.” *Proc. Roy. Soc. S.A.,* xvi, 1.

The same, “Notes on some Vegetable Exudations.” Appendix to the *Report of the Horn Expedition to Central Australia,* Part 3, Geology and Botany, March, 1896.

The same, “The Gums, Resins and other Vegetable Exudations of Australia.” *Journ. Roy. Soc. N.S.W.,* xxxv, 161 (1901).

Maiden, J. H., and Smith, H. G.—“A contribution to the chemistry of Australian Myrtaceous Kinos.” *Proc. Roy. Soc. N.S.W.,* xxix, p. 30.

The same, “Contributions to a knowledge of Australian Vegetable Exudations, Part I.” *Proc. Roy. Soc. N.S.W.,* xxix.

“*Astringent Gums or Kinos.*—These are natural astringent extracts which some of our gum-trees in certain seasons and certain districts exude very freely. They vary somewhat in composition, and therefore it is necessary that the products of different kinds of trees should be kept separate, to be afterwards classified by experts. I believe that if tanners could obtain these gums (kinos) in quantity at a cheap rate, they would replace some of the extracts at present in use. Although the demand for the official kino as an astringent medicine is far less than what it used to be, I am of opinion that some of our kinos can replace the kino of the Pharmacopoeia, and the introduction of kinos of known composition, and comparatively low in price, might result in an increased demand for astringent medicines of this class. The only kino in regular Australian demand at present is that of the Murray Red Gum (*Eucalyptus rostrata*), and we have several species of Eucalyptus yielding exudations of similar composition, but our local market might be readily over-supplied."

The above note was published by me in "New South Wales, the Mother Colony of the Australias," p. 186 (1896). The paper contains other Eucalyptus references.

I was writing chiefly of the products of New South Wales at the time, but it must be remembered that Red Gum (*E. calophylla*) yields an abundant supply of kino to Western Australia. There is a useful article entitled "Red Gum Tapping" by W.F.H. (with 2 figs.), in "Jarrah," Vol. I, No. 3, p. 6, November, 1918.

We should also remember that the Bloodwoods (close relations of *E. calophylla*) produce kino copiously in the eastern States.

Lauterer, M.D., Joseph.—"Gums of Eucalypts and Angophoras," *Proc. Roy. Soc. Qld.,* 1891, p. 37; *Pharm. Journ. N.S.W.,* Feb., 1891, p. 45.

The same, "Queensland native astringent medicines, illustrated by the chemistry of the gums of Eucalypts and Angophoras." *Proc. Aust. Assoc. Adv. Sci.,* vi, 293 (1895); *Chemist and Druggist of Australia,* May, 1895, p. 108.

"Gums and Resins exuded by Queensland Plants chemically and technologically described" in Bailey's *Botany Bulletin,* xiii, pp. 35–80, Brisbane (1896).

At pages 58–62 he deals with Eucalyptus Kinos. He makes the grouping "Eucalypt Gums entirely soluble in water," "A. Gums of the Gummy Group," "B. Gums of the Ruby Group," supplementing my work to some extent. The work of Dr. Lauterer and myself was pioneer work, mainly from the botanical side, which cleared the way for the chemical work (as Mr. H. G. Smith is entitled to point out) of himself and other workers.

Mr. H. G. Smith has done the most important work in the investigation of our Kinos, and the originals may be referred to in the following papers:—

"A Contribution to the Chemistry of Australian Myrtaceous Kinos," *Journ. Roy. Soc. N.S.W.,* xxix, 30, 1895. This investigation describes the characteristics of a new constituent of Eucalyptus kinos (Eudesmin). It is one of the substances causing turbidity in the Turbid Group. *E. hemiphloia* supplied the material for this investigation. (With J. H. Maiden.)

"Contributions to a knowledge of Australian Exudations," *Journ. Roy. Soc. N.S.W.,* xxix, 393, 1895. Amongst other exudations, those of *E. hoemastoma* var. *micrantha* and of *E. Planchoniana* were briefly described. (With J. H. Maiden.)

"On Aromadendrin from the turbid group of Eucalyptus Kinos," *Journ. Roy. Soc.*

N.S.W., xxx, 135, 1896. An investigation of the chemistry of this new constituent which occurs in the exudations of certain of the Eucalypts. This substance, with Eudesmin, is responsible for the "turbidity" of certain Eucalypts. Both substances occur in *E. hemiphloia,* and only Aromadendrin in *E. calophylla,* which is, indeed, a convenient Kino to use as a source of this substance.

"The Dyeing Properties of Aromadendrin and of the Tannins of Eucalyptus Kinos," *Journ. Soc. Chem. Industry,* Nov., 1896. An investigation of the value and peculiarities of these substances for dyeing purposes with various mordants.

"On the Saccharine and Astringent Exudations of the 'Grey Gum,' *Eucalyptus punctata* DC., and on a product allied to Aromadendrin," *Journ. Roy. Soc. N.S.W.,* xxxi, 171, 1897. The saccharine exudation is referred to at p. 182. The astringent exudation is shown to contain a product allied to Aromadendrin.

"On the absence of Gum and the presence of a new Diglucoside in the Kinos of the Eucalypts," *Journ. Roy. Soc. N.S.W.,* xxxviii, 21, 1904. The supposed "Gum" of Eucalyptus kinos is here shown to be a new tannin glucoside, which is practically insoluble in alcohol. On hydrolysis it breaks down into a "Kino Red," and a sugar, probably isomeric with melibiose. The name *Emphloin* has been suggested for this glucoside.

"On Eucalyptus Kinos, their value for Tinctures and the Non-Gelatinisation of the Product of certain Species," *Journ. Roy. Soc. N.S.W.,* xxxviii, 91, 1904. In this paper it is shown that the tannins in the exudations from the various Eucalypts vary considerably in character, and that while some of the kinos gelatinise in tinctures, others do not do so. The results indicate that the exudations of *E. microcorys* and *E. calophylla* might be used with advantage for the manufacture of tincture of kino, which would not form a jelly on keeping many years.

"Some Recent Chemical Discoveries in the Eucalypts," *Pharm. Journ.,* London, July, 1906. A paper read before the Pharmaceutical Conference at Birmingham in 1906. The various constituents recently discovered in these trees is here brought down to date, and the possible economics of certain of the kinos, oxalic acid, &c., considered.

"On the Kinos or Astringent Exudations of 100 Species of Eucalyptus," *Proc. Aust. Ass. Adv. Science,* xiv, 83, 1913. In this paper the chemical differences in the kinos of the several groups are shown, together with their characteristic peculiarities. The close affinity existing between the Angophoras and certain Eucalypts is demonstrated through the crystalline bodies Aromadendrin and Eudesmin, thus supporting previous conclusions obtained from studies in other directions. Although some of the kinos gelatinise rapidly, yet, the exudations of some Eucalypts are the only ones which do not gelatinise in tinctures.

This is the best summary to date, and the author divides them into four classes. Class I are all members of the Renantherae; Class II contains a number of the Boxes, with some others; Class III form tinctures which do not gelatinise. They mainly belong to the Corymbosae, but some of the intermediate forms present classificatory difficulties. Class IV consists of kinos distinguished by their ready solubility in water and slight solubility in alcohol. Some of the members are Ironbarks and Mahoganies.

"Eudesmin and its Derivatives, Part I," *Journ. Roy. Soc. N.S.W.,* December, 1914. The object of this research was to determine the constitution of Eudesmin, one of the crystalline bodies occurring in the kinos or exudations of some Eucalyptus species. Descriptions are given of the formation and analyses of dinitroeudesmin, dinitroveratrol, dichlor, dibrom and diiodo eudesmins. The molecule was shown to contain two veratrol nuclei.

A further, but a briefer, summary on Kinos or Astringent Exudations will be found, by Messrs. Baker and Smith, in *Rep. Brit. Ass.,* 1915.

Analyses of Kinos for tannins by J. C. Brunnich will be found in the Report of the Director of Forests for 1918 in Annual Report of the Department of Public Lands, Queensland, p. 60.

See also "A gum (Levan) Bacterium from a Saccharine Exudate of *Eucalyptus Stuartiana*" (*Bacterium Eucalyptii,* n.sp.), by R. Greig Smith, in *Proc. Linn. Soc. N.S.W.,* xxvii, p. 230 (1902).

It is worthy of note that some timbers (*e.g.,* Blackbutt, *E. pilularis*) are, in experienced hands, diagnosed by the (usual) presence of narrow concentric gum (kino) veins. When these gum-veins are absent, the timber displays considerable resemblance to that of *E. microcorys* (Tallow-wood), for which it is sometimes substituted.

b. Mannas.

I have dealt with this subject at considerable length in Part LXIII of my "Forest Flora of New South Wales," pages 101 to 119, to which I refer my readers. There is an excellent article on "The Manna of Scripture" by E. M. Holmes in the "Chemist and Druggist" for 3rd January, 1920, which I received some months after my article referred to above had been written.

With reference to the list of Eucalyptus species at p. 103 of my own paper, I collected manna on the edges of the leaves and young shoots of *E. radiata* at Blackheath, N.S.W., in March, 1920.

The following is an early record (1815) of Manna in Australia. For one dated

1808, see my “Forest Flora of New South Wales,” Part LXIII. p. 107.

In a paper entitled “Exploration between the Wingecaribee, Shoalhaven, Macquarie and Murrumbidgee Rivers (N.S.W.),” Mr. R. H. Cambage has an interesting note.

Surveyor Meehan arrived in the Orange district on 4th May, 1820, passing a mile or two to the eastward of Cadia. Mr. Cambage says, “He afterwards mentioned ‘Blackbutted Gums.’ The Gums were probably *Eucalyptus viminalis* (Manna Gum), many of which, in that district, have dark, thick, flaky bark at the base. . . . Met some white congealed gum distilled from the Blackbutted Gum. Is the same that Mr. Evans found when first going to the Lachlan. Evans found the ‘manna’ on May 20th, 1815, to the eastward of Mandurama, and it occurs also on *Eucalyptus rubida,* another White Gum.” (R. H. Cambage, in *Journ. Roy. Aust. Hist. Soc.,* vii, 253, 1921.)

The passage is also of interest as giving an early use of the term “Blackbutted Gum.” In Part L, p. 310, I have quoted a later use (1833) from Sturt's “Southern Australia,” II, 236, and these two references indicate that use of the term “Blackbutt” which refers to a member of the Leiophloiae with more or less dark flaky bark at the butt (see Part LI, p. 19). But a reference I have recently found (Oxley's “Journal of Two Expeditions,” 331), published in 1820, but recording observations made in 1818, attaches the name “Blackbutted Gum” to the tree at Port Macquarie which is *E. pilularis* Sm., and which is the well-known eastern coastal member of the Hemiphloiae (see Part LI, p. 33).

Explanation of Plates 224–227.

Plate 224.

Plate 224: EUCALYPTUS OCEANICA Unger (1). E. HAERINGIANA Ettingshausen (2-18). E. SCHÜBLERI Heer (19). E. GEINITZI Heer (20, 21). Lithograph by Margaret Flockton.

The figures on this Plate, and to which I have given the numbers 1–18, are all taken from Taf. XXVIII, "Die Tertiare Flora von Häring in Tirol" von Constantin v. Ettingshausen—Abhandlungen der k. k. geologischen Reichsanstalt, II Band, 3 Abtg., Nr. 2, p. 117, 1853, Ettingshausen's figure numbers being quoted by me in brackets.

E. oceanica Unger.

1. (Fig. 1). Leaf. (I have not Unger's original figure, as quoted by Ettingshausen, and it will be observed that the figure given by Ettingshausen and now reproduced, though probably well authenticated, has no venation. Nor have I seen the species figured by Heer (*Flor. Tert. Helv.,* pl. cliv, fig. 14) as quoted by Lesquereux.)

E. Haeringiana Ettingshausen.

2 (fig. 2), 3 (fig. 3), 4 (fig. 5), 5 (fig. 7), 6 (fig. 13), 7 (fig. 25). Leaves.

8 (fig. 14), 9 (fig. 15), 10 (fig. 16). Fruits.

11 (fig. 17), 12 (fig. 18). Fruits.

13 (fig. 19), 14 (fig. 20), 15 (fig. 21), 16 (fig. 22), 17 (fig. 23), 18 (fig. 24). Fru s.

(Lesquereux at Fig. 3, Plate 225, has some leaves which he labels *E. Haeringiana* (?). They are certainly more doubtful than most fossils attributed to Eucalyptus.)

The figures, to which I have given the numbers 19–21, are taken from "Beitrage zur Kreide Flora," by Dr. Oswald Heer, Heer's numbers being quoted by me in brackets. All the leaves are referred to *Myrtophyllum.*

Eucalyptus (*Myrtophyllum*) *Schubleri* Heer.

19 (fig. 2). Leaf.

Eucalyptus (*Myrtophyllum*) *Geinitzi* Heer.

20 (fig. 3), 21 (fig. 4). Leaves.

Plate 225

Plate 225: EUCALYPTUS SIBRICA Heer (1, 2). E. HAERINGIANA (?) eTT. (3). E. AMERICANA Lesqx (4, 5). E. BOREALIS Heer (6-17). E. GEINITZI Heer (18). E. ANGUSTA Vel. (19-23). Lithograph by Margaret Flockton.

E. sibirica Heer.

(Drawings taken from “Beitrage zur Fossilien Flora Sibiriens und des Amurlandes.” Taf. XIII, fig. 2, xiv, 1. For further details of these figures, *ante,* p. 222.)

1 (Taf. XIII, fig. 2). Leaf.
2 (Taf. XIV, fig. 1). Leaf.

E. Haeringiana (?) Ett.

(*E. Haeringiana* (?) Ett., Plate lix, fig. 10.

E. americana Lesqx., Plate lix, figs. 11, 12.

“Report of the U.S. Geological Survey of the Territories,” vol. vii, pp. 296–7, by Leo Lesquereux.)

3 (fig. 10). Three leaves. See above. It is not easy to understand how these leaves could have been attributed to Eucalyptus.

E. americana Lesqx.

4 (fig. 11), 5 (fig. 12). Leaves (see above).

E. borealis Heer.

(Drawings taken from “Flora fossilis arctica.”)

6, 7 (figs. 3, 4, Taf. XL. Igdlokunguak). No venation given.

8 (fig. 14, Taf. XLVI. Von Ivnanguit).

E. Geinitzi Heer.

(From “Flora fossilis arctica. Die Fossile Flora der Polarlander,” von Dr. Oswald Heer. Band VI, Zweite Abtheilung, Zurich, 1882. Taf. XLV, figs. 4–9, Taf. XLVI, fig. *d,* are certainly not representations of Eucalyptus fruits. The matter is discussed at p. 234, &c.)

9 (fig. 1*c,* Taf. XIX). Leaf.

10–15 (figs. 4–9, Taf. XLV). Von Kitdlusat.

10 (fig. 4). Two calyces, one with an operculum broken off.

11, 13, 14, 15 (figs. 5, 7, 8, 9). Natural size.

12 (fig. 6). Enlarged.

16*a* (fig. 12*c*), 16*b* (fig. 12*d,* Taf. XLVI, Von Ivnanguit). Leaf.

17 (fig. 13). Leaf.

(The following is taken from “Die Flora der Bohmischen Kreideformation,” von J. Velenovsky II Theil, p. 3 (64), Tafel III (XXVI).

Fig. 1. *Eucalyptus Geinitzi* Heer. Ein Blatt von gewohnlicher Grosse mit allmalig verschmalerte. Spitze, von Vyserovic, pag. 1 (62).

Fig. 2–12. *Eucalyptus angusta* Vel. Fig. 2, 4, von Melnik an der Sazava; fig. 3, 5, von Liebenau; fig. 8, 10, 12, von Kuchelbad; fig. 6, 7, 9, 11, aus den Unionschichten von Vyserovic; fig. 8, 10, die Nervation ausgefuhrt; fig. 12, Blattspitze mit hornartiger Endigung. Pag. 3 (64).)

E. Geinitzi Heer.

18 (fig. 1 of the above). Leaf, without venation.

For other fossils attributed to *E. Geinitzi,* see below, fig. 9, &c., Plate 225 (from *Flora fossilis Arctica,* Heer); fig. 9, Plate 226 (from *Flora of the Dakota Group*); fig. 1, &c., Plate 227 (from *Flora of the Amboy Clays*).

E. angusta Velenovsky.

19, 20, 21, 22, 23 (figures respectively 2, 3, 7, 8, 10) of the above work.

For other fossils attributed to *E. angusta,* see below, fig. 10, Plate 226 (from Saporta *Fossile du Portugal*).

Plate 226.

Plate 226: EUCALYPTUS HAIDINGERI Ett. (1). E. DAKOTENSIS Lesqx (3-8). E. ANGUSTA Vel. (10). E. CHOFFATI Sap. (12). E. ATTENUATA Newb. (14-16). E. DUBIA Ett. (2). E. GEINITZI Heer (9). E. PROTO GEINITZII Sap. (11). E. PSEUDO-GEINITZII (13). E. ANGUSTIFOLIA Newb. (17-19). Lithograph by Margaret Flockton.

E. Haidingeri Ettingshausen.

1. Leaf, showing venation and oil-glands. Being fig. 22 of Ettingshausen's “Das Australische Florenelement in Europa” (Graz (Gratz, Austria), 1890).

E. dubia Ett.

2. Portion of leaf; 2*a,* fragment of leaf, showing venation, taken from *Trans. N.Z. Inst.,* vol. xxiii, Plate xxix, figs. 5, 5*a* (1890).

(See Leo. Lesquereux, “The Flora of the Dakota Group,” U.S. Geological Survey, xvii, edited by F. H. Knowlton (1891)—

Figs 14–19 (Plate xxxvii) *Eucalyptus dakotensis* sp. nov.;

Fig. 20 (Plate xxxvii), *Eucalyptus Geinitzi* Heer).

E. dakotensis Lesqx.

3, 4, 5, 6, 7, 8. (Reproduced from figs. 14, 15, 16, 17, 18, 19, above.)

E. Geinitzi Heer.

9. (Reproduced from fig. 20 above.)

(*Flore Fossile du Portugal* (Saporta). Mesozique Plates xxxvi and xxxvii, Nazareth.)

E. angusta Vel.

10. Reproduction of fig. 12, Plate xxxvi, of the above work.

E. proto-Geinitzi Sap.

11. Reproduction of fig. 16, Plate xxxvi, of the above work.

E. Choffati Sap.

12. Reproduction of fig. 1, Plate xxxvii, of the above work.

E. pseudo-Geinitzi Sap.

13. Reproduction of fig. 8, Plate xxxvii, of the above work.

(This last species is not described in the body of Saporta's work.)

(Newberry. “The Flora of the Amboy Clays,” U.S. Geological Survey, xxvi.)

E. (?) attenuata Newb.

14, 15, 16. Leaves, being figs. 2, 3, 5, Plate xvi, of the above work.

E. (?) angustifolia Newb.

17, 18, 19. Leaves, being figs. 1, 6, 7, Plate xxxii, of the above work.

Plate 227.

Plate 227: EUCALYPTUS GEINITZI Heer (1-4). E. PARVIFOLIA Newb. (9, 10). E. GEINITZI Heer (18-22). E. NERVOSA Newb. (5-8). E. GEINITZI Heer (11-17). E. LATIFOLIA Hollick (23, 24). Lithograph by Margaret Flockton.

E. Geinitzi Heer.

1, 2, 3, 4, being reproductions of figs. 2, 12, 15, 16 of Plate xxxii, of “Flora of the Amboy Clays.”

E. nervosa Newb.

5, 6, 7, 8, being reproductions of figs. 3, 4, 5, 8 of Plate xxxii of “Flora of the Amboy Clays.”

E. parvifolia Newb.

9, 10, being reproductions of figs. 9, 10 of Plate xxxii of “Flora of the Amboy Clays.”

E. Geinitzi Heer.

The following are reproduced from Zittel's “Handbuch der Palaeontologie.”

11, 13 (figs. 1, 6, Bluthenstande). Heads of flowers.

12 (fig. 3). Leaf, showing venation.

14, 15, 16, 17 (figs. 8, 9, 10, 11, Bluthen). Flowers.

Zittel's Plate also contains other figures by Heer, including figs. 10 and 11, reproduced in Plate 225 of the present work.

E. Geinitzi Heer.

See “Maryland Geological Survey, Upper Cretaceous” (1916), Plate lxxxi.

18, 19, 20, 21, 22, see figs. 1–5 of the above Plate.

18 (fig. 1). *Eucalyptus Geinitzi* (Heer) Heer, Grove Point, Cecil County.
19, 21 (figs. 2, 4). Round Bay, Anne Arundel County.
22 (fig. 5). Deep Cut, Delaware. All Magothy formation.
20 (fig. 3). Showing *Sphoerites Raritanensis* Berry, Magothy formation.
E. latifolia Hollick.
23, 24. See figs. 6, 7 of above Plate. Magothy formation, Round Bay.

* If Prof Berry refers to Heer's figures of those of *E. Haeringiana* shown in his Plate 28 (1853) and reproduced in figs. 10, 11, &c., Plate 225, of the present Part, then I regret I cannot agree with him. I have not seen a fruit referred to Eucalyptus of either Cretaceous or Tertiary that I agree in referring to that genus, but it may readily happen that Prof. Berry has seen figures unknown to me.

Part 56

CCCXXX. E. Jenseni n.sp.

FOLLOWING is the description:—

"Ironbark" altitudinem 30-40' attinens, trunco 2' diametro; ligno rubro; ramis patentibus, foliis inflorescentiaque glaucis; foliis juvenilibus tenuibus petiolatis, ovatis, circiter 8 cm. longis, minus 5 cm. latis: foliis maturis subtenuibus, plerumque ovoideis ad ovoideo-lanceolatis, apicibus obtusis, circa 5-8 cm. longis et 2-3 c.m. latis, venis secondariis angulos circa 40° cum costa formantibus; inflorescentia in axillaribus umbellis ad 7 in capitulo, pedunculis ad 5 mm., pedicellis brevissimis; alabastris parvis, fere ovoideis, calycis tubo fere hemispherico, operculo hemispherico ad conoideo; fructibus parvis, circa 3 mm, diametro fere hemisphericis, valvarum capsularum apicibus conspicue exsertis.

An Ironbark, "The Wandi Ironbark" (H. I. Jensen). A spreading, more or less glaucous tree, giving good shade, attaining a height of 30-40 feet, and with a trunk up to 2 feet in diameter. Rough bark both on trunk and branches. Colour of timber red.

Juvenile leaves moderately thin, petiolate, slightly oblique, ovate (about 8 cm. long by under 5 cm. broad), the secondary veins spreading and making an angle of about 30–40 degrees with the midrib, the intramarginal vein well removed, though not distant, from the edge. (The juvenile leaves seen by me are in the opposite, but perhaps not in the earliest stage).

Mature leaves thin, mostly ovoid to ovoid-lanceolate, apices blunt; short. Common dimensions are 5–8 cm. long, with widths of 2–3 cm. Secondary veins making an angle of about 40 degrees with the midrib.

Inflorescence in axillary umbels up to 7 in the head, with peduncles up to 5 mm. and pedicels very short or absent. The markedly glaucous buds small, nearly ovoid, the calyx-tube nearly hemispherical, and sometimes marked with one or more ribs, the operculum hemispherical to conoid. The anthers very small, opening in parallel slits with gland at the top or near it. Filament at base. Pores round when dried.

Fruits glaucous, pedunculate, but pedicels very short or absent; small, about 3 mm. in diameter, nearly hemispherical, not tapering at the base; the capsule markedly distinct from the thin rim; the tips of capsule-valves distinctly exsert.

The type is Wandi, Northern Territory (Dr. Harald Ingemann Jensen, No. 372, April, 1916). Photograph available.—"Cabbage Gum or Bastard Bloodwood," near Wandi (Dr. H. I. Jensen, No. 378, April, 1916), is very near *E. Jenseni,* and from the small amount of imperfect material available I cannot detect the difference. I have only quite young fruits, with a sunken capsule, but this may be changed as ripening proceeds. Named in honour of Dr. Harald Ingemann Jensen, the geologist, who, as regards Eucalyptus, has done admirable collecting in the Northern Territory, and in other States, has correlated the species and the soils on which they grow.

Range.

This is confined to the Northern Territory so far as we know at present. Dr. Jensen writes: “Belt about I mile wide, between 3 and 4 miles west of Wandi. As far as known, this tree occurs nowhere else in this part of the Territory.” Wandi is an old gold-mining camp about 22 miles due east of Pine Creek.

Settlement is sparse in the Territory, and the species may be picked up again. It is quite possible that this species may not occur except in localities at considerable distances apart.

Affinities.

1. With *E. melanophloia* F.v.M.

I looked upon *E. Jenseni* as the Northern Territory form of this species in *Journ. Roy. Soc., N.S.W.,* liii, 71, 1919. Particulars of *E. melanophloia* may be found at Part XII of the present work, with Plates 53 and 54.

E. Jenseni differs from *E. melanophloia* in the much smaller and sessile fruits, which are also more hemispherical. The foliage also shows slight variation from that of *E. melanophloia.* It is petiolate in all the specimens available, and not quite as glaucous as *E. melanophloia.* In colour it is more of an olive green. The timbers of both species are about the same colour, but the bark appears to be free from gum veins in *E. Jenseni.* The young branches also shed the bark, which has not been noticed in *E. melanophloia.*

The specimen referred to as “probably *E. grandifolia,* No. 378, Cabbage or Bastard Bloodwood,” by Dr. Jensen, is also this species. It would appear from the reference to *E. grandifolia* that the trees have a bloodwood appearance. It is noticed that after the old bark peels off the small branches they are creamy white and smooth.

CCCXXXI. E. Umbrawarrensis n.sp.

"Mountain Blue Gum."

FOLLOWING is the description:—

Arbor "Mountain Blue Gum" vocata, subcontorta, ad 40' altitudine, trunco 2' diametro, ligno flavo, duro non durabili, cortice laevi, decidua; foliis maturis obscure viridibus, sub-tenuibus, petiolatis, lineari-lanceolatis ad lanceolatis, parviusculis, non 9 cm. excedentibus, 15 mm. latis, venis inconspicuis, venis lateralibus angulum 35–40° costa media formantibus; inflorescentia paniculata, petiolis longuisculis applanatisque, umbellis sessilibus ad 7 in capitulo; operculo fere hemispherico calycis tubi dimidium aequanti; fructibus fere hemisphercis ad cylindroideis vel fere piriformibus, pedicellatis minus 3 mm. diametro; margine tenui valvarum capsularum apicibus distincte orificio exsertis.

"A large rather crooked tree 40 feet high, with a stem up to 2 feet in diameter, wood tough and yellowish and consumed internally by borers. Bark smooth, bluish or white, deciduous" (Jensen). The whole tree more or less glaucous, or hoary-looking.

Juvenile leaves not seen.

Mature leaves dull green, the same colour on both sides, rather thin, petiolate, linear-lanceolate to lanceolate, rather small, not exceeding 9 cm. long and 15 mm. broad as seen. Venation not prominent, the lateral veins making an angle of 35–40 degrees with the midrib, the intramarginal vein not far removed from the edge.

Inflorescence. (Although Dr. Jensen, 5th July, 1916, wrote "Tree now in flower," the flowering specimens miscarried, and unripe buds, and a few authers clinging to an unripe fruit were alone available.)

Paniculate, with rather long, flattened petioles, expanded at the top, and carrying sessile umbels up to seven in the head. The opercula nearly hemispherical and about half the length of the calyx-tube. Anther broad, opening in parallel slits (round pores when dried). Gland on top, filament at base.

Fruits nearly hemispherical to cylindroid or almost pear-shaped, pedicellate, small, under 3 mm. in diameter, rim thin, the tips of the valves of the capsules distinctly protruding from the orifice.

The type is H. I. Jensen, No. 412, 5th July, 1916.

Range.

Only known from the Northern Territory, and from one locality at present. On top of sandstone residuals near Umbrawarra—dry, barren, flat-topped hills. Umbrawarra is a tin-field situated about 12 miles, as the crow flies, south-west of Pine Creek.

Affinities.

1. With *E. Jenseni* Maiden.

The closest resemblance is in the shape of the fruits, which are, however, pedicellate in *E. Umbrawarrensis;* the anthers are not very dissimilar. But in foliage and timber (*E. Jenseni* is an Ironbark with red timber) the two species are far removed from each other.

2. With *E. pallidifolia* F.v.M.

See Part XXII, p. 29, Plate 93. The timber of *E. pallidifolia* is yellowish near the bark, but it is a red timber nevertheless. Both are White Gums, and they somewhat resemble each other in the narrow foliage, but the branches are glaucous or pruinose, and the leaves are olive-green in a dry state, while those of *E. pallidifolia* dry whitish with a yellow cast. They are also broader in some specimens, while those of the type of *E. Umbrawarrensis* are narrow.

The buds of both species are small, but, in *E. Umbrawarrensis* they are slightly cylindrical to pear-shaped, as opposed to the very short globose clavate and thicker or larger buds of *E. pallidifolia.* We have the same difference in the shape of the fruits. The fruits of *E. Umbrawarrensis* are smaller, more cylindrical, thinner, with scarcely conspicuous valves, while those of *E. pallidifolia* are much larger, hemispherical to globose, with a thick rim and very strong prominent valves.

CCCXXXII. E. leptophylla F.v.M.

In Miquel in Ned. Kruidk. Archief. IV, 153 (1859).

THE original description (in Latin) will be found in Part XIV, pp. 144, 145, of the present work.

This may be translated in the following words:—

E. leptophylla Ferd. Müll. MSS. (*E. perforata* Behr. Herb. partim. *E. xanthonema* Turczaninow.)

A slender, graceful shrub, branchlets somewhat red or becoming yellow, leaves broad-linear, extending into a thin point, coriaceous, frequently covered with transparent dots, umbels axillary, 3–7 flowered, calyx-tube obconical, campanulate, the same length as the yellowish, broadly conical, non-umbonate, somewhat smooth operculum; fruits small and cup-shaped.

New Holland, Australia, Murray Scrub, flowering in the summer (Dr. Behr.).

A shrub the height of a man, leaves 2–3 inches long, 11/2–2 or rarely 3 lines broad, a distinct mid-rib on both sides, which, however, is not prominent; secondary veins not prominent. Peduncles 1–11/2 lines long; flowers subsessile. Calyx-tube 1 line long. Nearest to *E. riminalis,* from which it differs in having leaves narrower and the operculum more pointed and longer.

The following supplementary notes seem all that are necessary:—

Juvenile leaves cordate to elliptical, smaller and thinner than in *E. uncinata,* paler on the underside. They have been figured at figs. 6a and 6b of Plate 62, and others, from practically the type locality, in fig. 2, Plate 229 (herewith).

Mature leaves. They are distinctly petiolate, but this is not referred to in the original description.

Buds slightly pedicellate, the common peduncle much longer and terete. Operculum occasionally rostrate.

Fruits invariably clavate or club-like.

ILLUSTRATIONS.—Figures 5, 6, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21 of Plate 62, Part XIV. See the legends at pp. 162, 163, which are all *E. leptophylla.* No. 11 illustrates the type of *E. leptophylla.* No. 21 has very pointed opercula, and is not typical. It shows transition to *E. uncinata.*

The type specimen has been drawn from ampler material in Plate 229 of the present Part.

The oil purporting to be from *E. uncinata,* and which was obtained from Parilla, South Australia, in Baker and Smith's "Research on the Eucalypts," p. 234 (2nd Ed.), was obtained from *E. leptophylla.*

Synonyms.

1. *E. oleosa* F.v.M., var. *leptophylla* F.v.M.
2. *E. desertorum* Naudin.

1. *E. leptophylla* is included under *E. uncinata Turcz.* in B.Fl. iii, 216, also by Mueller in his "Census" and elsewhere. Also by Mueller as a variety (*leptophylla*) of *E. oleosa* F.v.M., see Part XIV, p. 143.

Mueller's original specimen of *E. leptophylla* is labelled in his own handwriting, "*Eucalyptus oleosa* ferd Mll. β. *leptophylla.* In deserto ad fl. Murray, Dr. M.," which was altered in Bentham's handwriting to "*uncinata.*"

The reference to *E. oleosa* is erroneous; it has the terminal anther found in *E. uncinata* and other species; the *E. oleosa* anther is quite different.

2. In Part XIV, p. 145 of the present work, *E. desertorum* is placed under *E. uncinata.* It should be transferred to *E. leptophylla.*

Range.

Speaking generally, it is a dry country species, in contradistinction to *E. uncinata,* which is mainly a coastal one. Exceptions are Fremantle, Western Australia, and some of the South Australian localities.

Let us turn to the localities given for *E. uncinata* in pages 145 and 146, Part XIV. I announce that the whole of them in South Australia, Victoria, and New South Wales should be transferred to *E. leptophylla,* and the following, recorded under Western Australia, belong to *E. leptophylla,* also, viz., Tambellup, Cut Hill, and all those given in the top paragraph of page 146. It will be seen how extensive is its range compared with that of *E. uncinata.*

In addition, I give the following localities since ascertained:—

Western Australia.—(*a*) A specimen labelled "No. 10, *Eucalyptus foecunda* Schauer, *Pl. Preiss,* i, p. 130, Fremantle, by L. Preiss, No. 231."

Preiss speaks of it as a shrub of 5 feet, and Schauer, who wrote the Myrtaceae for Preiss's work, wrongly attributed the Fremantle specimen (which is only in fruit, as he himself states), to his own *E. foecunda.* I see no difference between Preiss's No. 231 and *E. leptophylla* F.v.M.

(*b*) Erect bushy shrub, 5–8 feet high, limestone hills, 3 miles south of Fremantle (W. V. Fitzgerald).

(*c*) Mallee, up to 18 feet and diameter up to 5 inches. In limestone country, south of Fremantle, near the Newmarket Hotel (T. W. C. Schock, No. 405).

(*d*) Cut Hill, York (O. H. Sargent). This specimen is comparatively broad-leaved (see fig. 8a, Plate 62), and is an illustration of flowering maturity while in the juvenile leaf stage.
(*e*) Avon District (E. Pritzel, No. 999, through the British Museum).
(*f*) Dowerin (C. A. Fauntleroy, through W. C. Grasby).
(*g*) Totadjin (Dr. F. Stoward, No. 44).
(*h*) Comet Vale, 63 miles north of Kalgoorlie (J. T. Jutson, No. 238).
(*i*) "Victoria Desert, Camp. 56 (lat. 29° 54' 35", long. 124° 20'). R. Helms, Elder Exploring Expedition, 19th September, 1891," labelled *E. doratoxylon.* (Quoted 20th September in the Journal, the dates being usually a day later than those quoted on the herbarium labels). Five kinds of Mallees and limestone outcrops are referred to at this date. In *Journ. Roy. Soc. S.A.,* xvi, 357, the specimen is recorded by Mueller and Tate as *E. uncinata,* as a shrub of 12 feet.
(*k*) *E. uncinata* Turcz., Mt. Churchman, 50 miles to the south-east. R. Helms, Elder Exploring Expedition, 10th December, 1891. Mallee and granite outcrops are spoken of in the Journal at Camp 92 on that date. It is presumed that this specimen is referred to by Mueller and Tate in *Proc. Roy. Soc. S.A.,* xvi, 357 (under *E. uncinata*), as from "about 50 miles north-west from Knutsford" and 20 feet high.

South Australia.—Yeelanna, Eyre's Peninsula (W. J. Spafford). Parilla Forest (W. Gill). "Mallee," Monarto (Dr. J. B. Cleland, No. 38); "Mallee," River Murray, chiefly 15 miles east of Morgan; also Alawoona (Dr. J. B. Cleland, Nos. 3, 24, 25). (These last two are practically type localities). "Mallee scrub near bluff," Encounter Bay (Prof. J. B. Cleland, Nos. 14 and 21).

New South Wales.—Wyalong (Miss E. Clark, per D. W. C. Shiress). "Narrow-leaved Red Mallee. Grows to a height of from 5 to 10 feet. Bark maroon, with grey patches." Near Wyalong (J. W. House, Forest Guard, No. 4, December, 1913).

"Small Mallee up to 8 or 9 feet." Griffith, also Line 9900, Griffith; also north and north-west of Lake View and Ballandry, both near Griffith (W. D. Campbell, L.S., 1917, 1918).

Affinities.

With *E. uncinata* Turcz. See p. 264.

LXVIII. E. uncinata Turcz.

In *Bull. Soc. Nat. Mosc.,* XXII, Part II, p. 23 (1849).

THE original Latin description will be found at Part XIV, p. 143, of the present work. It may be translated into English as follows:—

Stem, branches and branchlets terete; bark brown; leaves alternate, petiolate, linear-lanceolate, glaucescent, covered with sub-pellucid dots, marginate, narrowed at the base, produced into an uncinate point at the apex; heads many-flowered, pedunculate, the lower ones somewhat remote, the upper ones collected into a dense raceme; peduncles about the same length as the petioles; pedicels almost absent; calyx-tube turbinate, terete or scarcely angled; operculum conical, rather obtuse, about the same length as the calyx-tube, stamens exsert (white). Buds small, the size of those of *E. robusta,* leaves 2–3 inches long, not exceeding 21/2 lines in greatest breadth.

Then Bentham described it:—

A tall shrub, with a smooth red or ash-grey bark, coming off in coriaceous plates (Oldfield).

Leaves narrow-lanceolate or linear, usually under 3 inches, thick, the very fine veins scarcely visible, distant and rather oblique, but not so much so as in *E. gracilis,* always conspicuously black-dotted, especially underneath.

Peduncles axillary, rather short, terete or scarcely flattened, bearing each an umbel or head of about 6 to 8 small flowers. *Buds* ovoid or oblong. *Calyx-tube* about 11/2 lines long, sessile or tapering into a short pedicel. *Operculum* obtusely conical or acuminate, as long as or rather longer than the calyx-tube. *Stamens* about 2 lines long, all perfect, the filaments slender and inflected, with an acute angle, as in *E. corynocalyx* and *E. decurva* anthers very small, nearly globular, with contiguous cells opening in terminal pores.

Ovary flat-topped. *Capsule* globular-truncate or pyriform, 2 to nearly 3 lines diameter, contracted at the orifice, the rim concave or at length nearly flat, the capsule sunk, but the valves often acuminate by the split base of the style, and then the subulate tips protruding. (B. Fl. III, 216).

The buds are sessile on a compressed common peduncle; operculum sometimes very short, sometimes rostrate. Calyx-tube somewhat angular. Fruits barrel-shaped, sessile.

1. The var. *latifolia* Benth., based on Drummond's No. 76.

At Part XIV, p. 144, I have already thrown doubt on the validity of this variety, and I now emphasise the doubt, and am of opinion that it should be dropped.

It affords a case of “The flowering of Eucalyptus when in the juvenile stage,” referred to in Part XLIX, p. 217. It belongs to that branch of the subject (see p. 274) in which in a mature plant there is juvenile (reversionary) foliage which flowers, and which I have called Diels's Law. In other words, the supposed var. *latifolia* arises from such a case of juvenile foliage. It is figured at 2a, Plate 62 (incidentally I may point out that a similar condition is shown at 9a, Plate 62, in the case of *E. leptophylla,* attributed in the Plate to *E. uncinata,* and also at p. 144). Bentham (B.Fl. III, 216) probably referred to this when (under *E. uncinata*) he says, “The young plant has sometimes ovate opposite leaves.”

Other cases of this form of “juvenile precocity” include Kalgan Plains, (J.H.M.). In the legend of fig. 3, Plate 62 (Part XIV, p. 162) I have the words “These leaves show that in *E. uncinata* the juvenile leaves sometimes persist to maturity—in other words, that we have dimorphism.” Kalgan Plains, north of the Kalgan River, W.A. (J.H.M.). See also fig. 4.

A similar case is Cranbrook (F. Stoward, No. 176), unfigured. In such cases we have broad juvenile leaves on the same twig as flowering, narrowish mature ones. At the same time, it is proper to point out that, as a rule, there is evidence of a trauma—an injury to the branch, which induces the growth of these broadish, juvenile leaves.

Note that the young leaves are ovate-cordate and therefore stem-clasping. For example, 3a, Plate 62. See also No. 5 of Plate 63, where a juvenile leaf from Desmond, near Ravensthorpe (J.H.M.) although attributed to *E. decipiens,* is really *E. uncinata.*

2. var. *rostrata* Benth.

Drummond's No. 186 is, as I have stated in Part XIV, p. 144, figured at fig. 15 Plate 66, Part XV. It is referred to at pp. 172, 173 as *E. oleosa* var. *glauca,* and at p. 269, Part XXXIV, var. *glauca* is raised to specific rank as *E. transcontinentalis* Maiden. In other words, var. *rostrata* has no existence as such.

What I have said about var. (?) *major* Benth., in Part XIV, p. 144, may be referred to. I think it is *E. uncinata,* but hardly a variety. The species grows coarse (“major”) near the sea.

ILLUSTRATIONS.—Part XIV, Plate 62, figures 1 (the type), 2 (including inflorescence when in the juvenile-leaved stage), 3 (including typical juvenile leaves), 4 (ditto), 7, 14, 15. *E. uncinata* seems to me to be adequately figured.

Range.

For many years we have looked upon this species as extending from Western

Australia, through South Australia, Victoria and New South Wales (see Part XIV, p. 145). This investigation shows that it is confined to Western Australia and to the coastal districts of the south-west of that State.

Western Australia.—The only localities quoted in Part XIV, p. 145, which belong to *E. uncinata* are Kalgan Plains, Cape Riche, Deeside, and Israelite Bay. (The Subiaco Beach specimen is *E. decipiens,* as has been stated in Part XLII, p. 67, but I have an incomplete specimen, in mixed material, from Dr. J. B. Cleland from the same locality, which probably belongs to *E. uncinata.*) None of the localities (W.A.) quoted on p. 146 belong to *E. uncinata.*

The following are additional localities for *E. uncinata*:—

Mallee, 6 ft. A dense thicket-like growth on top of ironstone ridge, Cranbrook (Dr. F. Stoward, No. 176).

"Stirling's Range, W.A., October, 1861." Labelled *E. uncinata* by Mueller. From Melbourne Harbarium. (?) Collected by Oldfield.

Bremer Bay (J. Wellstead.) Lynburn, Alexander River (H. P. Turnbull).

Affinities.

With *E. leptophylla* F.v.M.

It is doubtless closely allied to this species. Speaking generally, it is a coarser plant (particularly when growing near the sea) than *E. leptophylla,* and often dries blue-green or yellow-green.

The seedlings of the two species are very different, those of *E. uncinata* being broad and those of *E. leptophylla* narrow. The leaves of *E. uncinata* are more sessile than those of *E. leptophylla.* There is a kink in the filament in both species.

CCCXXXIII. E. angusta n.sp.

FOLLOWING is the description:—

Frutex altus vel arbor parva; foliis maturis nitentibus, crassissimis, rigidis, flavo-viridibus, petiolatis, anceolatis, venis inconspicuis, venis secondariis angulum 30–45° costa media facientibus; inflorescentia axillari, pedunculo longo subplanato capitulum 9 florum sustinenti; calycis-tubo cylindro conoideo oper-culum conoideum aequanti; antheris terminalibus; fructibus piriformibus ad hemisphericis, circa 8 mm. diametro, truncatis et leniter rotundata; pedicellis marginibusque crassis; valvarum capsularum apicibus subulatis exsertis.

A tall shrub, or spindly, small tree, foliage, buds and fruits shining all over.

Juvenile leaves.—Strictly juvenile leaves not seen, but, the result of a trauma, the type specimen has a branchlet which contains a pair of leaves in the opposite, though not in quite the carliest stage, which are petiolate (6 mm.) symmetrical, bluntly lanceolate, 4 cm. long and 12 mm. wide; texture, lustre, &c., same as mature leaves.

Mature leaves very thick, rigid, yellowish-green, the same colour and lustre on both sides, petiolate, lanceolate to narrow-lanceolate, apex rigid or hooked, venation indistinct, the secondary veins making an angle of 30–45 degrees with the midrib.

Inflorescence axillary, a fairly long, flattish peduncle supporting a head of up to nine flowers on short pedicels. The buds with cylindro-conoid calyx-tubes and conical opercula of equal length, and each exhibiting a double operculum. Anthers only seen in an immature state, but evidently terminal.

Fruits pyriform to hemispherical, about 8 mm. in diameter, truncate or slightly domed, with short, thick pedicels. Rim thick and probably reddish-brown (of a different colour to the calyx-tube), with awl-like protruding tips to the capsule-valves, as in *E. oleosa* (not shown in Plate 229).

Illustration.—E. angusta has been already figured at fig. 13, Plate 65, Part XV, which shows the exsert awl-like tips of the capsule-valves, which have been inadvertently omitted in fig. 3b, Plate 229.

Range.

It is only known from Western Australia, viz., Comet Vale, 63 miles north of Kalgoorlie. J. H. Maiden (buds and fruits), September, 1909, is the type, and J. T. Jutson, No. 156 (buds only), from the same locality, December, 1916, is a co-type.

Affinities.

1. *E. uncinata* Turcz.

In the absence of complete material, it was at one time looked upon by me as a pedicellate form of *E. uncinata,* to which it is related by its terminal anthers. The foliage of *E. angusta* is narrower, and of a different colour.

E. uncinata has no awl-like tips to the valves of the capsule.

The seedlings of *E. angusta* are different from those of *E. uncinata* and *E. oleosa,* but I propose to go into the question of the seedlings of the genus in a later Part.

2. *E. oleosa* F.v.M.

"At Comet Vale (*via* Kalgoorlie) I noticed a small, erect, rigid gum, leaves very thick, fruits a little more pear-shaped than usual, in bud and ripe fruit. It is a coarse form of *E. oleosa,* and I did not find this particular form anywhere else." (Maiden in *Journ. W. A. Nat. Hist. Soc. iii,* 170, 1911.) See fig. 13, Plate 65. Quoted in Part XV, p. 169 of the present work.

E. angusta and *E. oleosa* are sharply separated by their anthers, and by their juvenile leaves, and, to a less extent, by their mature leaves and buds. They approach each other in their fruits, and particularly in the awl-like processes of the capsule-valves.

XXI. E. marginata Sm.

THE brief, insufficient original description will be found at Part VIII, p. 241, so my readers will welcome that of Bentham in the *Flora Australiensis:*—

E. marginata Sm. in *Trans. Linn. Soc.* vi, 302.

Usually a large shrub or small tree with a smooth or roughish bark, but sometimes a tree of 12 to 50 feet, with a persistent rough bark (Oldfield), or a large forest-tree (Fraser).

Leaves ovate-lanceolate or lanceolate, acuminate, often falcate, mostly 3 to 5 inches long, with rather numerous, very diverging veins, conspicuous, especially underneath, when the leaf is not very thick, much less so when it is thickly coriaceous, the intramarginal vein at some distance from the edge, the upper surface said to be dark-green, and the under one whitish, but the difference scarcely perceptible in dried specimens.

Peduncles axillary, or the upper ones without floral leaves, terete or flattened, especially in coarser specimens, each with about 4 to 8, or sometimes more, rarely only 3 flowers, on pedicels of about 2 or 3 lines.

Calyx-tube short and very open, 2 to 3 lines diameter. *Operculum* oblong-conical, from a little longer than to more than twice as long as the calyx-tube, obtuse or acuminate. *Stamens* 3 to 4 lines long, the filaments very flexuose but not inflected in the bud; anthers reniform, the cells diverging, confluent at the apex.

Ovary flat or convex in the centre. *Fruit* obovoid or subglobose, 1/2 in. diameter or larger, thick, hard and smooth, contracted at the orifice, the rim usually flat and not very broad, with the capsule scarcely depressed, but sometimes the rim is still thinner with a sunk capsule; valves small, not protruding. (B.Fl. iii, 209.)

Figure 2*b* shows the thickened margin, to which the species owes its specific name.

The species is depicted in Plate 230 by request, as it has not hitherto been figured in the present work, and it has been represented to me that the plate in Mueller's “Eucalyptographia” is only available to a limited number of students.

There are some notes on the timber of *E. marginata* in Part LI, p. 46.

XXII. E. buprestium F.v.M.

THIS is briefly referred to at Part VIII, p. 243, without description. It will be convenient to have the *Flora Australiensis* description :—

E. buprestium F. Muell. *Fragm.* iii, 57.

A shrub of 8 to 10 feet (Maxwell)

Leaves lanceolate or rarely oblong, usually narrow, acute or mucronate, mostly under 3 inches, rigid, but not very thick, with the oblique reticulate veins usually prominent, the intramarginal one at a distance from the edge.

Peduncles terete or slightly flattened, mostly lateral below the leaves, each usually with about 6 to 10 flowers, on short but not thick pedicels.

Buds obovoid. *Calyx-tube* about 2 lines long, dilated above the ovary. *Operculum* hemispherical, obtuse, shorter than the calyx-tube. *Stamens* inflected in the bud, 2 or 3 lines long; anthers broad and flat, opening in short divergent slits confluent at the apex.

Fruit nearly globular, about 1 inch in diameter when full grown, but sometimes apparently ripe when much smaller, thick and hard, the orifice much contracted, the rim narrow, the capsule sunk. Perfect seeds very few, large, very irregularly shaped, the acute edge sometimes expanded into a narrow wing. (B.Fl. iii, 205).

The figure on Plate 230 will doubtless be found useful, as also the following notes:—

It is a tall shrub, sometimes up to 15 or 20 feet, with a Mallee habit; smooth stems.

Juvenile leaves (not previously described.) Ovoid to oblong mucronate, petiolate, say 2–3 inches long by 1–11/4 broad, glaucous, equally green on both sides, margin slightly thickened. Venation distinct, intramarginal vein at a considerable distance from the edge, sub-pinnately veined, with the lateral veins approximately forming an angle of 45 deg. with the midrib.

The anthers are not typically renantherous; they are a little top-heavy, if I may use such a homely expression; they seem to form a connecting link between the typical Renantherae and anthers such as those of *E. decipiens* Endl., of the Porantherae.

Very young fruits simulate those of *E. trachyphloia* in shape and size. They are slightly urceolate and have a distinct rim. As growth proceeds, they are borne in the greatest profusion, being as close as they can pack on the previous season's wood.[*] Individual fruits are even larger than depicted in the Eucalyptographia. Mueller depicts them 1⅛ inch in diameter; I measured them when green 11/2 inches in diameter.[†] Often old large fruits and small fruits are found in the same cluster.

(Maiden in *Journ. W.A. Nat. Hist Soc.,* vol. iii, Jan., 1911.)

Range.

(See also Part VIII, p. 243.)

Confined to Western Australia. I found this species abundantly between the Kalgan River and Stirling Range.

Dr. Diels (Engler's *Bot. Jahrb.* XXXV, 437) doubts the correctness of Mueller's locality, "near Arrowsmith River," for this species. If specimens are not in existence it should certainly be considered doubtful. I have an intermediate locality, viz., Geographe Bay (Mrs. Irvine), backed by fruits given me by the late Mr. J. G. Luehmann, of the National Herbarium, Melbourne (Maiden, *op. cit.*).

* The figure in "Eucalyptographia" is true as far as it goes, but it is of a branch in which the fruits have largely fallen off in transit to the herbarium.

† Along with the full-grown fruits are usually a few hypertrophied fruits; these display considerable resemblance to those of *E. Todtiana,* or even *E. marginata.*

* G. A. Briosi. "Intorno all anatomia delle fogilie dell *Eucalyptus globulus* Labill. Milano, 1891, p. 3.

XLI. E. Bosistoana F.v.M.

(See Part XI, and Plate 49.)

IN "Research on the Eucalypts," 2nd ed., p. 167, 1920, Messrs. Baker and Smith constitute a new species, *E. Nepeanensis.* This is, however, *E. Bosistoana* F.v.M., and what has quite excusably misled the authors is the broad juvenile or intermediate leaf with fruit, but we now know many species which flower in the juvenile stage. (The large intermediate leaf of *E. Nepeanensis,* fig. 1*c,* Plate 234, corresponds to fig. 4*a* of Plate 49 quoted above).

We have precisely the same thing in a specimen of *E. Bosistoana* from Metung, Victoria (J. H. Maiden, July, 1908), with broad leaves and fruit *in situ.*

This is an example of Diels's Law, and not merely of precocious flowering. I have cited some similar instances to that of *E. Nepeanensis* in Part XLIX, p. 275, *i.e.,* where, after an injury, a new branchlet may develop, with juvenile leaves, inflorescence, and even fruit, often in the head of the tree, surrounded by normal mature leaves. At this place some of the instances quoted are examples of Nanism, but at this Part, p. 303, under the special heading of "Diels's Law," I will clearly state the situation, which I have imperfectly done at Part XLIX, pp. 273, 274. I will also point out that illustrations of Diels's Law give us the opportunity of examining juvenile leaves (for purposes of classification or otherwise), when juvenile leaves in the ordinary place are unavailable.

I have referred to *E. Nepeanensis* as a synonym of *E. Bosistoana* at Part XLIX, p. 275, and at p. 277 I raised the question that *E. proecox* might be a similar case of representing a juvenile form of some existing species. I find this is not the case, as there are in the National Herbarium abundant specimens to show that the juvenile leaves are normal in that species.

Following is the original description of *E. Nepeanensis,* Baker and Smith, "Research on the Eucalypts," 2nd ed., p. 167 (1920):—

"A medium-sized tree, with 'Box' bark on the lower portions of the stem. Leaves lanceolate, but very variable in size, from broad lanceolate (2 inches broad and over 6 inches in length) to narrow lanceolate (2 lines broad and over 6 inches long), ovate, acuminate, under 4 inches long, dull or slightly shining, uniform green on both sides; venation distinct, lateral veins oblique, intramarginal vein removed from the edge, and especially so in the case of the broad lanceolate and ovate forms of the leaves. Peduncles axillary, 4 to 5 lines long, with six or more flowers in the umbel. Buds about 6 lines long, angular in the early stages. Calyx 11/2 lines in diameter at the time of flowering, hemispherical; operculum hemispherical, acuminate, 11/2 lines long. Fruit hemispherical to pyriform, rim flat or slightly countersunk; valves not exserted; under 3 lines in diameter."

Range.

This is stated at Part XI, p. 2, and the following New South Wales localities may be added:—

Wyndham. "Known as Yellow Box. It grows into massive trees, 40–60 feet high, having a thick, corky bark, with the cambium pale yellow, but less so than the pale Yellow Box *E. melliodora.* Owing to being much interwoven in grain it is difficult to split, and is little used except in the unsplit form." (J. L. Boorman.)

It is worthy of note that the name "Yellow Box" in use at Wyndham in the south-east, near the Victorian border, is also in use in the Sydney district (Cabramatta, &c.).

St. Mary's. (A. J. Holloway.) This is a co-type of *E. Nepeanensis.*

Messrs. Baker and Smith also quote specimens from Cabramatta as forming, with St. Mary's, co-types of their species. At Part XI, p. 3 of the present work, the Cabramatta locality (which is really that of the Rev. Dr. Woolls, although not stated by Messrs. Baker and Smith), also a second locality (Bringelly), by Dr. Woolls, nearer to St. Mary's, are quoted.

Affinities.

Messrs. Baker and Smith (*loc. cit.*) have the following, under "Remarks":—

"Since the publication of the 'Flora Australiensis' it has been usual to place this species and *E. pendula* (both of Cunningham) under Mueller's *E. largiflorens.* With such a classification we do not agree, as Cunningham's specific names apply to interior species, whilst this is a coastal tree, with a pale-coloured whitish timber, 'Box' barked only on the lower portion of the stem, and with erect branches and branchlets. In our first edition it was placed and fully described under *E. bicolor.*"

As well as I could, I have explained the errors in the above passage (into which I consider Messrs. Baker and Smith have fallen) in Part XI of the present work, p. 2, under *E. bicolor* Woolls, and also at pp. 7 and 8. I will leave it at that.

CCXIII. E. altior (Deane and Maiden) Maiden.

(See also Part XXXIX, p. 290, of the present work.)

Synonyms.

1. *E. Luehmanniana* F.v.M., var. *altior* Deane and Maiden (*Proc. Linn. Soc., N.S.W.,* XXII, 713, 1897).
2. *E. oreades* R. T. Baker (*Proc. Linn. Soc., N.S.W.,* XXIV, 596, 1899).
3. *E. virgata* Sieb., var. *altior* Deane and Maiden (*Crit. Rev. Gen. Eucalyptus,* Part IX, p. 288, 1907).

ILLUSTRATIONS.—A bibliography of illustrations of this species is given at Part XXXIX, p. 290, but they do not appear to me to be sufficient, particularly in regard to the juvenile leaves. Consequently, in Plate 231, some supplementary figures are offered, which should make the species perfectly clear.

Shortly after Part XXIX of the present work appeared a friend wrote to me as follows:—

"With reference to *Eucalyptus Luehmanniana,* var. *altior* Deane and Maiden, it would appear that Mr. Baker, when publishing his *Eucalyptus oreades* as a new species in the same journal two years later, was unaware that his supposed new species was identical with the var. *altior* Deane and Maiden of *E. Luehmanniana.*

"It seems clear to me that the oldest name of any plant should stand, and as the varietal name *altior* was not preoccupied, it was Mr. Baker's duty to take up that name, if in his opinion the plant referred to was worthy of specific rank.

"The International Rules of Botanical Nomenclature (Vienna Congress), 1906, p. 450, give an example under Art. 43 as to the requirements under such circumstances."

The example quoted in the Article is:—

"*Medicago polymorpha* L., var. *orbicularis* L., when raised to the rank of a species, becomes *Medicago orbicularis* All. or *Medicago orbicularis* (L.) All."

I have made a slip in the matter, and my friend's contention is obviously right; therefore the species will stand as *E. altior* (Deane and Maiden) Maiden.

CCCXXXIV. E. conglobata (R.Br.), Maiden.

(FOR a history of this species see under "Synonyms." The following description is now offered.)

A dwarf, spreading Mallee, or a medium-sized tree up to 50 feet high, with a stem-diameter up to 2 feet. Bark smooth or ribbony, timber pale-coloured. (See p. 276.)

Juvenile leaves probably broad, but not seen in the youngest state.

Intermediate leaves broad lanceolate, 5–10 cm. long, 4 cm. broad, thick, a palè olive green on both sides, obscurely veined, the median nerve alone conspicuous; intramarginal nerve close to thé edge.

Mature leaves thick, rigid, often spreading at right angles from the stem, narrow to broad lanceolate, acuminate, the apex sometimes uncinate, 6–14 cm. long, 11/2–2 cm. broad; petioles slightly flexuose, compressed 11/2–2 cm. long, pale olive green on both surfaces, usually obscurely veined, the median nerve yellowish brown, conspicuous on both sides, channelled above, scarcely raised beneath, passing gradually into the well defined petiole, the secondary veins making angles of about 30–40 degrees with the mid-rib, the intramarginal nerve very close to the edge.

Branchlets angular, compressed, marked by the decurrent lines of the petioles.

Flowers closely capitate, 5–8 in the head, the peduncle very short, thick, somewhat quadrangular. *Buds* robust, closely sessile, ovate, acute, about 10 mm. long. *Operculum* conical, thick, somewhat striate, usually slightly longer than the broad calyx-tube. Filaments numerous, all antheriferous; anthers rather large, with a large prominent gland on the back.

Fruits closely sessile, broadly hemispherical, truncate, thick, slightly dipterous, 6 x 10 mm., valves broad, included or slightly exsert, the rim more or less prominent.

I have made Port Lincoln, South Australia (J.H.M., January, 1907, the type. See p. 275.) Robert Brown undoubtedly, and probably Allan Cunningham, collected it there. Wilhelmi collected it there many years later.

Synonyms.

Reference to B.Fl. iii, 231, will show that Bentham included in *E. incrassata* Labill., a somewhat large number of synonyms. Mueller followed him, and I followed both.

In Part IV, p. 96, of the present work, I added additional synonyms, of which I abandoned *E. goniantha* Turcz., and *E. grossa* F.v.M., in Part XVI, and *E. dumosa*

A. Cunn. in Part XXXVIII. The matter of dealing with the synonyms of *E. incrassata* has been complicated by the unavailability of the type of *E. incrassata.* This is dealt with, to some extent, at Part XXXVIII, p. 223. I have for some time had the matter of other supposed synonyms of *E. incrassata* and *E. dumosa* under consideration, and propose, in the present Part, to deal with forms of these two species passing under the names of var. *conglobata* and var. *angulosa* respectively.

E. conglobata R.Br., is in B.Fl. iii, 230, placed as a variety of *E. dumosa* A. Cunn. The matter of *E. dumosa* and its varieties is, in addition to Part IV, p. 97, dealt with at Part XXXVIII, p. 220.

To enumerate the Synonyms we have:—

1. *E. dumosa* A. Cunn., var. *conglobata* (R.Br.) Benth. in B.Fl. iii, 230.
2. *E. incrassata* Labill., var. *conglobata* (R.Br.) Maiden, in the present work, Part IV, p. 100.
3. *E. anceps* R.Br.
4. *E. pachyphylla* F.v.M., non. A. Cunn.

For further particulars as to synonyms see Part IV, pp. 100, 101, and XXXVIII, p. 220.

No. 3. *E. anceps* R.Br.

This is represented in figs. 3*a,* 3*b,* and 4, Plate 17, and the following additional observations may be made:—

E. anceps is closely allied to *E. conglobata;* the chief points of difference are mainly in the buds and fruits. In *E. anceps* the calyx-tube is cylindrical and usually longer than the operculum. In the type (which comes from Kangaroo Island) the buds are not fully developed, and show the outer operculum adhering to the second operculum, which was only noticed in one specimen of *E. conglobata.* In *E. conglobata* the calyx-tube is nearly hemispherical, about the same length as the calyx-tube or even longer, while it is always striate; only the mature operculum is striate in *E. anceps.*

The fruits of *E. anceps* are barrel-shaped, almost smooth or without the conspicuous wings of *E. conglobata,* while the valves are smaller and enclosed. The fruits of *E. conglobata* are hemispherical, with a broad top and rather prominent valves, and not contracted at the base, as in the case of *E. anceps.*

In one specimen of *E. anceps* (Encounter Bay, South Australia, Dr. J. B. Cleland, No. 19), the buds and fruits are sessile in the axes of the leaves, without the usual common peduncle. In another specimen (same sheet) the style is considerably enlarged at the top, giving it a clavate appearance. I examined the style of some specimens of *E. conglobata,* but found them ali normal.

E. anceps differs from *E. dumosa* in the sessile buds and fruits. The calyx in *E.*

dumosa is longer than that of *E. anceps* and is always pedicellate. The fruits are also more uniformly shortly cylindrical and not barrel-shaped as in *E. anceps.*

So far, *E. anceps* has been found almost exclusively in South Australia (besides Kangaroo Island), viz., Encounter Bay (Dr. J. B. Cleland, Nos. 18 and 19); Port Lincoln to Coffin's Bay (J.H.M., January, 1907). These are coastal; more inland localities are Murray Bridge (Walter Gill, June, 1903; J. H. Maiden, January, 1907); Monarto South (Dr. J. B. Cleland, No. 37, September, 1920).

Such of the above as have been noted in this work, have been recorded as *E. dumosa.* Mueller also entered as *E. dumosa* "Sand Plains N. from the Stirling Range, (W.A.). See Plate 16." (Part IV of this work, p. 105.)

E. anceps is too near to *E. conglobata* and *E. dumosa* to be retained as a species, but it is worthy of discrimination, and I propose the name *E. conglobata* var. *anceps* for it.

Illustrations.—E. conglobata is profusely illustrated at Plate 17, Part IV of the present work. I make this the type, it is a specimen collected by Mr. Walter Gill at Port Lincoln, S.A., figures 1*a* and 1*b.*

Range.

It is confined to coastal Western and South Australia, so far as we know at present, and certain particulars concerning these localities will be found at Part XXXVIII, p. 220. In the "Flora Australiensis," it is recorded from Port Lincoln, South Australia, while "South Coast" (R. Brown) also includes Western Australia.

Western Australia.—In addition to the localities already referred to "This variety (*conglobata*) occurs not unplentifully at Kalgan Plains, Hopetoun and Esperance. Specimens from the two latter places have the fruits unusually large, and with the rim well defined" (Maiden in *Journ. W.A. Nat. Hist. Soc.* iii, 174, Jan., 1911).

Gnowangerup, 30 miles east of Broome Hill (W. C. Grasby). This and the following specimens have the fruits rather smaller than the type.

"A shrubby tree of 10–15 feet, branching from near the base, but not a Mallee. Bark persistent and flaky in the lower parts, but decorticating on the upper stem and branches, leaving them smooth, of a greenish-brown colour Flowers yellowish-white. Near Wagin, in gravelly soil. Fl. February-March." 9th February, 1922 (C. A. Gardner, No. 1,236, Forests Department of Western Australia). Wagin is approximately 100 miles from the coast, and a comparatively inland locality is new to me. Mr. Gardner says it is rather common further south in the Gnowangerup district.

South Australia.—See the localities already referred to. Following is an additional note :—

"Port Lincoln is the home of this variety (*conglobata*), and I hitherto understood it to be always a shrubby form, but it attains the dignity of a medium-sized tree. At Boston Island the largest tree I saw is 2 feet diameter for a stem of 6 feet; a spreading, straggly tree. It attains a height of 30–35 feet, with smooth or ribbony stems, many of which are 9 inches to 1 foot in diameter. Mr. Dabovich, of Port Lincoln, says there are some on the island 50 feet high. I saw some trees of this height on the island, but not close enough to distinguish the species. At Kirton Point, it is a strong, coarse-growing, tall shrub near the sea, but larger away from it. It occurs halfway down Stamford Hill. On the western road from Port Lincoln it seems to first appear at 21/2 miles (old road). Timber pale throughout (small saplings.)" (Maiden in *Trans. Roy. Soc. S.A.,* xxxii, 30, 1908). Also Memory Cove (J.H.M.).

Also Taylor's Island, named by Flinders after a midshipman lost in the disaster at Cape Catastrophe, near Port Lincoln (Dr. R. S. Rogers, September, 1907).

Affinity.

1. With *E. dumosa* A. Cunn.

In making it a variety of *E. dumosa* (B.Fl. iii, 230), Bentham says "Peduncles shorter than broad. Flowers closely sessile, the calyx-tube shorter than broad, angular, and operculum conical as in *E. goniocalyx,* but leaves of *E. dumosa.*"

Compare Plates 16 and 19 (*E. dumosa*) and Plate 17 (*E. conglobata*), Part IV of this work. Speaking generally, the former is inland and the latter coastal. The former has smaller and less coarse foliage, more sessile inflorescence, with a thinner peduncle; the fruits are cylindroid, while those of *E. conglobata* are always hemispherical. At the same time, the two species are very close to each other.

Range.

It was originally simply described from "New Holland," but there is little doubt that the type came from coastal South or Western Australia, and was collected by Robert Brown or Allan Cunningham. It also occurs in north-western Victoria.

A number of localities are quoted by Bentham in B.Fl., iii, 231. As *E. Muelleri* is included in his synonyms of *E.* (variety) *angulosa,* it may be well to say that the type of *E. Muelleri* came from "near the River Murray" (South Australia).

Western Australia.—I have collected the species at most of the localities quoted by Bentham, and agree with them. They are all coastal.

Inasmuch as Messrs. Baker and Smith (*loc. cit.*) say that *E. torquata* Luehmann, is a synonym of *E. costata* (a regrettable error, which will be taken up under *E. torquata* in Part LVII), they are led to quote the inland locality, Coolgardie (the only locality known for *E. torquata* for very many years) and which I am satisfied is erroneous as to *E. angulosa* (*costata*), although there are smaller fruited forms which approach *E. angulosa,* which have been collected by R. Helms and E. Lidgey in the district (this work, Part IV, p. 105).

The coastal specimens recorded by me from Western Australia will be found at Part IV, p. 106. In *Journ. W.A. Nat. Hist. Soc.,* iii, 173 (1911) the following note on "var. *angulosa*" is from my pen :—

"This is by far the most abundant form of *incrassata* in the south coastal districts visited by me. In sheltered places near the sea it forms large shrubs or small trees, shapely, with dense foliage forming an agreeable shade, and a graceful ornament to the beach. It is common between Albany and Esperance. I have since received it from Point Malcolm and Middle Island (Cape Arid) from Mr. G. Simmonds.

On the Kalgan Plains also it is the tallest of the Mallees (say, 15 feet) with fleshy, large leaves. In such situations, which are more exposed, it has smooth, clean stems (say, 3 inches) with the leafy branches coming less close to the ground."

South Australia.—I have collected the species at most of the localities quoted by Bentham, and agree with them. They are all coastal. Some localities are referred to at Part IV, p. 107. The coastal ones are normal, but the more interior ones (Ninety Mile Desert) are abnormal, as stated. Speaking of my 1907 trip, I published the following note :—

"This variety (*angulosa*) was the scarcest on my trip. It occurs at Kirton Point; it is common around the Flinders Monument (Stamford Hill). It was noticed at 18 miles from Port Lincoln, along the western road, with unusually elongated cylindrical fruits." (Maiden in *Journ. Roy. Soc. S.A.,* xxxii, 30, 1908).

Victoria.—This State is not mentioned by Bentham, but I give a number of Victorian localities in the present work, Part IV, p. 108.

In B. Fl. iii, 231, we have it stated under New South Wales, "Mallee scrub of the Murray desert to the Barrier Range, Victorian Expedition." (Howitt's.)

Messrs. Baker and Smith (*loc. cit.*) record "South-west of New South Wales," without quotation of specimens. Perhaps they follow Bentham. In the present work, IV, 108, I definitely state that I have not seen *E. angulosa* (var. *angulosa*) in New South Wales, and it should be searched for.

Affinities.

1. With *E. torquata* Luehmann.

I mention this here because Messrs. Baker and Smith reduce it to a synonym of *E. costata* (*angulosa*), which is quite untenable. There are figures of flowers and fruits at fig. 6, Plate 13, and these may be compared with the figures on Plate 14 (Part IV), but as I am giving additional figures in Part LVII, I shall refer to the matter then. At the present time, it may be sufficient to say that *E. torquata* is a fairly large, rough-barked tree, only found in the interior, while *E. angulosa* is a usually coastal, tall, umbrageous shrub, and rarely a small, smooth-barked tree with ribbons. *E. angulosa* is usually sessile or nearly so, but the pedicels (where they exist) and the peduncles are totally different. The opercula and shapes of the buds in the two species are very different, and the same may be said of the fruits. *E. angulosa* has white or cream-coloured flowers, while those of *E. torquata* are pink of various shades.

2. With *E. conglobata* R.Br.

Compare Plate 17 (*E. conglobata*) with that of *E. angulosa.* The flowers and fruits of the latter are much coarser, the buds smaller, less ribbed, only exceptionally quite sessile, the fruits much larger, of a different shape, and very much more ribbed than those of *E. conglobata.*

CXLVI. E. Johnstoni n.sp.

Synonym.

E. Muelleri T. B. Moore, *Proc. Roy. Soc. Tas.,* 1886, p. 207. (This work, Part XXVIII, p. 160.)

E. Muelleri is preoccupied by—

1. *E. Muelleri* Miq., *Ned. Kruidk. Archief,* iv, 130 (1856), which is a synonym of *E. dumosa* A. Cunn., see Part IV, p. 100 of the present work, and also by
2. *E. Muelleri* Naudin, which is probably a synonym of *E. ovata* Labill.

(By the way, the name of Mueller is commemorated by *E. Muelleriana* Howitt. See p. 219, Part VIII, of the present work.)

The name *E. Muelleri* must, therefore fall. I propose, therefore, for *E. Muelleri* T. B. Moore, the name *E. Johnstoni,* in honour of Robert Mackenzie Johnston (1845 to 1918), a competent botanist and palaeo-botanist, who, particularly in the early part of his career, did much to popularise the study of Tasmanian plants. A few notes on this excellent man will be found in my "Records of Australian Botanists" (2nd Supplement), *Journ. Roy. Soc. N.S.W.,* lv, 163 (1921).

Illustrations.—This species (as *E. Muelleri*) is adequately illustrated at Plate 116 of Part XXVIII of the present work.

VI. The Leaf.

A.—Juvenile Leaf.

Historical.

1. Link, 1822.
2. A. P. de Candolle, 1828.
3 and 4. Bentham, 1866, and Mueller, 1869. (Both made passing references to juvenile Eucalyptus leaves.)
5. Mueller, 1879–1884.
6. Naudin, 1883 and 1891.
7. Howitt, 1891.
8. Woolls, 1892.
9. Deane and Maiden, 1895.
10. Deane, 1897.
11. Goebel, 1900.
12. C. de Candolle, 1903.
13. Musson, 1905.
14. Diels and Pritzel, 1905.
15. Cambage, 1913.

1. *Link,* 1822.—In Link's "Enumeratio Plantarum," Part II, p. 29 (1822), we have the species classified into two sections, more or less according to their juvenile leaves, viz.:—

A. Leaves alternate. Fourteen species are included in this section, as follows. Most of them are Link's then new species, which, with the exception of *E. longifolia,* were described from seedlings, or from such imperfect material that they have not been taken up by subsequent authors, viz.:—

E. robusta Sm.	*E. piperita* Sm.
E. reticulata.	*E. triantha.*
E. marginata Sm.	*E. elongata.*
E. longifolia.	*E. myrtifolia.*
E. obliqua. Sm.	*E. microphylla* Willd.
E. media.	*E. stenophylla.*
E. mucronata.	*E. angustifolia* Desf.

B. The younger leaves opposite, the adult ones alternate. This sections consists of five species, as follows:—

E. hypericifolia Dumont.	*E. hirsuta* Link
E. purpurascens Link	*E. pulverulenta* Link.
(*amygdalina* Labill.)	*E. cordata* Loddiges.

2. *A. P. de Candolle,* 1828.—De Candolle, in his *Prodromus,* Part III, p. 216, combines the use of the operculum and calyx-tube with the position of the leaf for purposes of classification. His sections are:—

(1) *Alternifolioe.*—Alternate leaved, with leaves undoubtedly all alternate.
(2) *Oppositifolioe.*—Opposite leaved, the leaves in some opposite and sessile (these are juvenile leaves, J.H.M.), the others alternate and petiolate.

Section (1) he subdivides according to the relative length and size of the operculum and calyx-tube (cupula.) Although he gets his idea from Link, his illustrations of species are, on the whole, different.

An English translation of de Candolle, in detail, will be found in George Don's "Gen. Hist. Dichlamydeous Plants," ii, 818 (1832).

3. *Bentham,* 1866.—Bentham (B.Fl. iii) in 1866, gave but few references, as he realised it was a subject that could only be adequately dealt with in Australia; at all events the material available to him at that time was insufficient. He says:—

Leaves in the young saplings of many species, and perhaps all in some species, horizontal, opposite, sessile and cordate. (B.Fl. iii, p. 185).

Then he goes on to say:—

The extraordinary differences in the foliage of many species at different periods of their growth add much to the ordinary difficulties arising from the gradual transition of varieties, races, or species one into the other; moreover, a considerable portion of our herbarium specimens have been gathered to illustrate collections of woods by persons little acquainted with botany, and are but too frequently not in a state to supply the most essential characters. The old division of the genus according to the opposite or alternate leaves is now found to be quite fallacious, so many species having them opposite at an early stage, and alternate when full grown, (p. 186). . . . .

A great majority of the species are now known to have on the young sapling, or even on adventitious barren branches of older trees, opposite sessile broad or cordate leaves, passing gradually into the ordinary alternate petiolate narrower ones. It appeared quite useless in any manner to describe these sapling leaves in the several species where they have been observed, for they present at once similarity in the corresponding leaves of different species, and the greatest dissimilarity in the different leaves of the same species or specimen. Where in the following pages the leaves are described as opposite or sessile, it is meant that they retain that form on the flowering branches . . . Diagnostic characters are sometimes taken from the position of the leaves, horizontal or vertical (p. 187).

4. *Mueller,* 1869.—In *Fragm.* vii, 44 (1869), at the end of the descriptions of a large number of Eucalyptus seedlings, Mueller adds:—

The descriptions of Eucalyptus seedlings raised in a garden are easily confused with those of shoots of the parent tree, concerning which there may be difficulty in attributing them to their botanical origin.

This is the first published statement, to my knowledge, of the similarity of seedling to the corresponding sucker leaves (usually termed by me "juvenile leaves").

5. *Mueller,* 1879–84.—Mueller "Eucalyptographia," 1879–84, in defining the genus, speaks of the leaves "of very young states of the plant frequently different in texture, position and shape to those of the more aged plants . . . "

He seemed to avoid a term for the description of young leaves. In the generic description he speaks of those "of very young states."

At the same time he figured the young foliage of the following twenty species, although he did not name the young state in the description of each plate. He did not use this state for diagnostic purposes:—

E. amygdalina.	*E. obliqua.*
E. calophylla.	*E. pauciflora (coriacea).*
E. diversicolor.	*E. pilularis.*
E. eugenioides.	*E. piperita.*
E. Foelschiana.	*P. ptychocarpa.*
E. globulus.	*E. redunca* (? *accedens*).
E. goniocalyx (?).	*E. rudis.*
E. leucoxylon.	*E. salmonophloia.*
E. macrorrhyncha.	*E. Stuartiana.*
E. melliodora.	*E. viminalis.*

6. *Naudin,* 1883.—Naudin, both in his 1*st Mem.* (1883) and 2*nd Mem.* (1891) drew attention to the young foliage in a manner clearer than had previously been done. Although his classification is mainly based on the fruit, it will be observed that he calls in the aid of leaf-contrast (uniform and biform).

He employs the amount of variation in Eucalypts as regards the juvenile and mature foliage to constitute two series—

(1) Biform (Espèces biformes).
(2) Uniform (Espèces uniformes) (ii, 9).

He has been speaking of the Cotyledons, and he goes on to say (*Mem.* i, 347) of which the following is a translation:—

The variations are much greater in the following period, and it is there, indeed, that the difficulties of specific diagnosis begin. The first leaves which follow the cotyledons are seldom the shape of those which appear at a later period. They are sometimes alternate and petiolate from the start; more often they are opposite and sessile, or almost sessile; but while in most species this last characteristic only affects the 6 or 8 first leaves, in other species also in great number, they remain sessile and opposite during a long period of the youth of the tree, and sometimes during its whole life. (A note follows which will be found at p. 314 under Connate Leaves.)

There are, as we have seen, some Eucalypts which are really *biform*; that is to say, in which the juvenile stage so little resembles the adult, that it would be impossible to connect the two stages to the same species, if one had not been present at the passage of the one to the other. Habitually in the case of Eucalypts with opposed and sessile leaves at an early stage, the adult phase is characterised by leaves alternate, petiolate, more or less long-lanceolate, nearly always arranged on an oblique plan and vertical relatively to the horizon, caused by semi-torsion of the petiole. In this state many species resemble one another, and if we had no other resource than the leaves, it would be often impossible to distinguish one species from the other. An interesting fact to note, is that if the stems of these adult trees are cut down to the ground, or to a low height; one can readily obtain shoots which entirely take the form of the young foliage. (See also Planchon's and C. de Candolle's remarks at Part LII, p, 89. J.H.M.). It sometimes happens that without any appreciable injury one sees branches appear on a tree which take on the appearance of the juvenile stage, and form by this means a curious contrast to those which surround them. This retrogression towards anterior forms, and which is like a partial rejuvenation of the trec, is not an obstacle to the flowering; these branches of juvenile aspect sometimes flower and ripen the fruits as well as those of the adult form."

(See also Part XLIX, p. 273, J.H.M.). He goes on to say:—

It would be desirable for the describer of Eucalyptus if the two groups of *Biforms* and *Uniforms* were clearly determined; unfortunately it is not the case. Between the extremes of each group, between the most *Uniform* and the most *Biform* Eucalypts, one finds a numerous series of species, where these differences taper off in a very gradual manner, so that one does not know where to place the limit of separation. On the other side, when we see *how unstable almost all the characters are, on which we try to found a species* (my italics, J.H.M.), we ask ourselves if there are not some common to the two groups, distributing indifferently their individuals amongst the Uniforms and the Biforms. It is a question which presents itself to our mind when one has before one seed-plots where certain species are represented by very numerous specimens. One is struck then by the slight uniformity that they present, without being able to attribute it with certainty to a mixture of different seeds, or to bad labelling. It is not impossible that seeds of the same species collected from different individuals give more or less dissimilar results. Finally, though one has no proof of it, it happens that the crossing of neighbouring species or of simple varieties of the same species are the first and principal cause of these variations. (Naudin, *Mem.* i, 349).

He subsequently writes, reviewing the general subject:—

First Foliage.—It is very variable in a single species, changing in shape with age and tending to take the same form and exhibiting the same appearance in a very different species according as the trees approach their adult age, which causes me to repeat that the foliage must be observed in its successive phases. What is called the *juvenile state* of Eucalypts often furnishes useful characteristics for distinguishing species.

In Eucalypts the leaves are sometimes opposite, sometimes alternate. There are some in which they remain opposite during the whole life of the tree; in most cases, however, they are only opposite in the first period of their development, then they give place to alternate leaves. This first period, or juvenile stage, lasts for a greater or lesser length of time, according to the species, which justifies in a certain measure the qualification of *biform species.* Finally there are many others in which the leaves are always alternate, except the six or eight which immediately follow germination. These species may then be called *uniform,* and they are so at least relatively. However, even in their case, the leaves of the first stage often differ more or less from those which characterise the adult stage. Based on these diversities we may divide the Eucalypts into three groups or sections:—

1. The uniform opposite-leaved,
2. The uniform alternate-leaved, and
3. The biform,

but I hasten to observe that these three groups are not always clearly defined, and there are some cases in which one has difficulty in deciding if such species should be ranged with the *uniforms* or *biforms.* (2nd *Mem.,* p. 9.)

Naudin then makes the following *apologia* for that classification of species which he submits. His *Biforms* and *Uniforms* (with other characters) take part in it, and he points out that only few species are concerned, namely, those he has under cultivation in France. I have translated some additional remarks in his admirable pamphlet:—

Classification of Species.—Descriptive botanists have often employed the dichotomous method for facilitating the recognition of species, especially in genera where they are numerous. This method is excellent, but it presupposes that the student has before him specimens on which he can find all the characters indicated in the tables presented to him. It is not the same for the cultivators of Eucalyptus, whose always incomplete collections only furnish them partly, and at great intervals, with what they need to arrive at a certain determination. In order to supplement, and to aid as much as possible the reader in making at least a first selection, I have thought of giving here a series of synoptical tables, each one founded on a dominant character easy to understand. It will not surprise my readers to see the same species figuring in several of these tables, which would not otherwise include the species we actually possess (in France, J.H.M.) or at least those which are best known to me.

A. Classification of species according to the disposition and diverse modifications of the leaves. (Naudin, *Mem.* ii, 15.)

1st. *Species more or less biform.* I class in this section the Eucalypts which in the first period of their development, which we call their *juvenile stage* (état juvenile) more or less lasting, have the leaves opposite, more often decussate and sessile, those of the adult stage being always alternate, lanceolate and petiolate. This section may be subdivided:—

(*a*) Biform species with axillary umbels or 3-flowered cymes, *e.g., E. globulus, viminalis, urnigera.*

(*b*) Biform species having axillary umbels, with more than three flowers, except in cases of suppression or premature falling (they are frequent in *E. jugalis), e.g., E. coccifera, goniocalyx, myrtiformis, Huberiana, Mazeliana, jugalis, gracilipes, Risdoni.*

2nd. *Uniform species,* that is to say, those in which the first stage only slightly differs from the adult. Here also we have two groups, according as the leaves are alternate, or remain opposite during the whole life of the tree.

(*a*) Uniform, *opposite-leaved species,* (He is in this respect following Link, 1822, J.H.M.), *E. cordata, cinerea, doratoxylon.*

(*b*) Uniform *alternate-leaved species,* that is to say, those having the leaves always alternate and petiolate, with some exceptions, in which the 4, 6 or 8 first leaves (premières feuilles) above the cotyledons may be opposite and more or less sessile, but this state soon gives place to the adult form, characterised by the petiolate and alternate leaves. Nevertheless, it often happens that these first leaves differ considerably in shape and size from those of a more advanced age, *e.g.*—

E. resinifera.	*E. melliodora.*
E. leucoxylon.	*E. crebra.*
E. occidentalis.	*E. diversicolor.*
E. rudis.	*E. cosmophylla.*
E. tereticornis.	*E. cornuta.*
E. citriodora.	*E. botryoides.*
E. maculata.	*E. Lehmanni.*
E. corynocalyx.	*E. robusta.*
E. polyanthema.	

A small number of species of this section are distinguished from others in the juvenile stage, in that their first leaves are peltate, by reason of the insertion of the petiole a little above the base of the lamina. One sees this in—

E. citriodora. E. maculata. E. calophylla.

In this same section we find species whose secondary venation is sufficiently characteristic. Sometimes the veins are longitudinal and are directed towards the apex of the leaf. (Longitudinal venation, see next Part, J.H.M.), *E. pauciflora (coriacea).*

Sometimes they are fine, approaching one another, parallel to one another, and spreading out at a very wide angle from the median vein, to lose themselves in a marginal nerve which almost becomes identical with the margin of the leaf. (Transverse venation, see next Part, J.H.M.).

E. maculata.	*E. calophylla.*
E. citriodora.	*E. botryoides.*
E. robusta.	*E. resinifera.*

Uniform species, that is to say, those in which the first stage differs only slightly from the adult. Here also we have two groups, according as the leaves are alternate or remain opposite during the whole life of the tree. (Additional information has shown that some examples are no longer true, J.H.M.).

(*a*) Uniform opposite-leaved species, *cordata, cinerea, doratoxylon.*
(*b*) Uniform alternate-leaved species, *resinifera, leucoxylon,* and many others. (Naudin, 2nd *Mem.,* 16.)

7. *Howitt,* 1891.—Howitt, A. W., in his "Eucalypts of Gippsland," *Trans. Roy. Soc. Vict.,* ii, Part I, 81, with plates (1891), read 10th July, 1890, may fairly be said

to be the first Australian botanist who in print insisted on the importance of the juvenile leaves, as aids to diagnosis. He employed the "seedlings and young saplings" chiefly, and they are referred to all through his paper, *e.g.,* pp. 92 and 93, where he is discriminating between the various Stringybarks. See also the figures of seedlings in Plates 8, 9, 10, 11, 14, 15, 16. His nomenclature of species is not always now accepted; indeed his work on juvenile leaves sometimes led to modification of nomenclature.

8. *Woolls,* 1892.—Dr. Woolls stated: "The trees which have opposite leaves are chiefly:—

E. pulverulenta (including *E. cinerea*).	*E. odontocarpa* opposite or alternate.
E. melanophloia.	*E. tetrodonta*
E. cordata.	*E. gamophylla.*
E. macrocarpa.	*E. setosa.*
E. perfoliata.	*E. pruinosa* (nearly).
E. erythrocorys (nearly so).	*E. doratoxylon* (nearly).
E. tetragona (nearly so).	

Those which have the leaves opposite when young are:—

E. viminalis.	*E. Stuartiana.*
E. pilularis.	*E. goniocalyx.*
E. globulus.	*E. amygdalina.*

(*Proc. Linn. Soc. N.S.W.,* xvi, 64, 1892).

Dr. Woolls remarked:—

To these may be added a few species which appear with opposite leaves simply as seedings; but it does not seem probable that, even with a more extensive knowledge of the foliage (desirable as such information is) much advantage would be gained in the way of classification.

It would appear that the above remarks are based on the figures and specific descriptions in Mueller's "Eucalyptographia," and add little to existing knowledge.

9. *Deane and Maiden,* 1895.—After Howitt, Deane and Maiden were the first Australian botanists to systematically employ the juvenile leaves in botanical descriptions; they were certainly the first to insist on them in descriptions of new species. They regularly employed this foliage for diagnostic purposes in their botanical trips as early as 1886, and their series of papers on the genus in *Proc. Linn. Soc. N.S.W.,* beginning xx, 596 (1895) where they prominently used the term "seedling or sucker leaves" was but the printed expression of their regular practice of a number of previous years in the bush and in the herbarium. The terms were used more or less interchangeably by them.

Later on I used the term "Juvenile leaves" for sucker leaves (and also sometimes for seedling leaves when the context made it plain), but usually to indicate sucker leaves.

10. *Deane,* 1897.— "Eucalyptus belongs to a natural order in which the leaves are normally opposite. That the ancestral forms of that genus possessed opposite leaves is inferred from the fact of the leaves being so arranged in seedlings; in many species the change to long and alternate leaves only takes place after several years' growth; in some species, such as *E. melanophloia,* the opposite character persists throughout life. (This is not the case as regards this particular species, according to subsequent investigations; see pp. 71, 72, Part XII, and later the subject will be dealt with more fully, J.H.M.)

These facts seem to point to the probability of the pendent, leathery leaves alternately placed being an adaptation to conditions of drought, and in support of this supposition it has been pointed out that where species have failed to produce the vertically hanging leaves, another expedient has made itself apparent, namely, that they have not only become thick and leathery, but protected with a coating of an oily secretion giving them a glaucous appearance." (Henry Deane, *Proc. Linn. Soc. N.S.W.,* xxii, 471, 1897.)

11. *Goebel,* 1900.—

The difference in the configuration of the juvenile leaves, compared with that of the adult ones is frequently due to the fact that they are *arrested formations;* in other words, the development of the leaves is the same in both juvenile and adult, but in the juvenile the primordium of the leaf is arrested in its development at a certain stage, and therefore the leaf exhibits an evident, often extremely different configuration. This point in the history of development must also be applied to the explanation of the differences between the configuration of those juvenile forms which have already been referred to as phytogenetically primitive and the adult forms, inasmuch as the latter have acquired their different character by passing through a further transformation.

In many plants *reversion* of the adult to the juvenile form frequently occurs. . . . The duration of the juvenile form is scarcely less variable than its external configuration, and is frequently dependent upon external factors, especially in lower plants. ("Organography," Part I, p. 145.)

12. *De Candolle,* 1903.—Casimir de Candolle, 1903, *loc. cit.,* p. 9. I offer this in translation; the rest of the paper will be found at Part LII, p. 90.

Eucalyptus globulus.—It is known that the trunk of this tree frequently produces adventitious shoots, with the branches and the leaves having the juvenile form so characteristic of this species. The fact has been known for a long while. We have seen above (p. 91, Part LII) that it did not escape Pasquale. M. Briosi* has recently quoted an example remarkable for the great height at which an adventitious shoot, with juvenile leaves, was produced on one of these trees.

I had myself the opportunity of observing many similar cases during a stay at Cannes in 1899. It is not rare to encounter Eucalypts which have had the branches suppressed or have lost them by means of accidents, and on which the adventitious shoots are produced round the scars. *I have invariably maintained that the first branches of these shoots, as well as their leaves, have always the juvenile form and structure* (my italics, J.H.M.), whatever may be the part of the tree from which they have arisen. I saw also at Cannes many old Eucalypts that had been entirely robbed of all their branches, and whose trunks thus mutilated bore, on their tops, an abundant head of adventitious shoots presenting all the juvenile characters. Having written on this subject to the late M. Naudin, then Director of the Villa Thuret, and who had made, as is known, a special study of Eucalypts, I received the following reply from him, which will not be read, I think, without interest: "I am pleased to be able to confirm your observation on *Eucalyptus globulus.* Every time that this tree has its trunk cut, it produces an abundant tuft of shoots, which has completely returned to the juvenile state; large leaves, opposite, sessile, or almost so, whitish grey, and with a balsamic and penetrating odour; quite different, in a word, from those of the adult tree, which are alternate, falcate, petiolate, with whitish powder, and little or not at all odorous, at least on being crushed between the fingers. And note that it is not only at the base of the tree, but at all heights of the trunk, wherever one cuts it that this transformation takes place. Even the simple removal of a slightly heavy branch is the starting of a number of branches returned to the juvenile stage. I have observed the same thing on *Eucalyptus viminalis,* which is very 'biform.' See p. 285). Loppings cause the appearance of bunches of branches in the juvenile stage. It seems probable to me that the same modifications would be observed on all the thoroughly 'biform' Eucalypts. It would be less evident on the 'uniform' ones. I think I have also seen similar changes in appearance or something the same on other trees."

13. *Musson,* 1905.

The large size of many of the sucker and seedling leaves, as in our Cabbage Gum (*E. haemastoma*), with their frequent horizontal position, doubtless points to necessary "protection" afforded to the young growing tree, possibly a "throw-back" to leaf character at a time when the Gum Trees lived under more favourable conditions here as to rain and sun—to a great rainfall period, when huge marsupials roamed our forests, and much of Central Australia was occupied by sea; when sun heat was less, sand evaporation much less than at present takes place. With such surroundings leaf growth would be larger, leaves would hang horizontally, and there would be no necessity for narrow, drooping leaves. Present variations therefore lead to interesting speculations in this direction ("Hawkesbury Agricultural College Journal," N.S.W., 25th March, 1905, p. 68).

14. *Diels and Pritzel,* 1905.—These authors, *e.g.,* Engler's *Bot. Jahrb.* xxxv, 438 (1905), use the words "folius primariis." Diels, in his "Jugendformen und Blutenreife" of the following year, usually speaks of "Jugendform" as applied to Eucalyptus foliage.

15. *Cambage,* 1913.

"JUVENILE LEAVES. Under the designation of juvenile leaves may be included *not only seedling leaves, but also most of those of certain adventitious growths* (my italics, J.H.M.) abundantly produced by cutting or wounding parts of the barrel or branches, and which in Australia are popularly known as suckers, and the difference between these leaves and the mature or adult foliage of the same tree is often so great as to convey the impression to one who has not studied the genus that they belong to distinct species. It is remarkable that Eucalypts rarely, if ever, produce true botanical suckers or shoots from the roots, and a careful examination of the young growths which appear around and at some little distance from a standing tree and look like true suckers, results in the discovery that the plants are seedlings.

Between these stem-shoot and seedling leaves there is a great similarity, and as according to the general biological belief it is in the young forms of both flora and fauna that we may expect to find the greatest resemblance to ancestral types, so we may regard these reversion shoots as of almost equal value with the seedlings for the purpose of studying the ancestral forms of Eucalypts. Although the leaves of these "suckers" when available are of considerable assistance in the identification of many species, they vary within certain limits both in size and shape, possibly in response to differences of climate, and to extremes of nourishment and poverty. An interesting feature of their form is the degree of dissimilarity between them and the mature leaves. *In some instances the difference is slight and in others exceedingly great.* Mr. Andrews has already pointed out that the difference is greatest in the highland and coastal region (*Journ. Roy. Soc. N.S.W.,* xliv, 467, 1910). (R. H. Cambage in same *Journ.* xlvii, 1913.)

Size.

In making an attempt to classify juvenile leaves according to size, the only terms that appear to be convenient are very small, small, medium, large, very large. Juvenile leaves are, in their earliest and opposite-leaved stage (those of every species have not been collected or recorded), usually as broad as long, *i.e.,* tending to the orbicular. Many of them have already been figured, and, in examining the plates, it is to be noted that they have usually been drawn from dried and therefore shrunken specimens. This secures uniformity; at the same time, and also from further information, I have ascertained that frequently the juvenile leaves are, when fresh, sometimes rather larger than drawn. I repeat that the sizes given are approximations.

As a suggestion, I give the average diameters in cm. as follows:—

Very small, under 4.	Large, 11–20.
Small, 5–6.	Very large, 21 and over.
Medium, 7–10.	

It is obvious that, giving only one dimension can only, in strictness, apply to such leaves as approach the orbicular. With all their defects, my suggestions as to relative sizes may have some use.

Very small, under 4 cm.

E. Kruseana. *E. vernicosa.*

Small, 5–6 cm.

E. aspera. *E. Camfieldi.*

Medium, 7–10 cm.

About 7 cm.—

E. eximia.	*E. melanophloia.*
E. goniocalyx.	*E. odorata.*
E. haemastoma.	*E. peltata.*
E. haematoxylon.	*E. Perriniana.*
E. Irbyi.	*E. regnans.*
E. Jacksoni.	*E. rostrata.*
E. laevopinea.	*E. tereticornis.*
E. leucoxylon.	*E. trachyphloia.*

About 8 cm.—

E. acmenioides.	*E. Guilfoylei.*
E. alpina.	*E. Houseana.*
E. Bancrofti.	*E. Naudiniana.*
E. Banksii.	*E. piperita.*
E. Behriana.	*E. punctata.*
E. botryoides.	*E. robusta.*

E. corymbosa.	*E. Le Souefii.*
E. Ewartiana.	*E. tetragona.*
E. ficifolia.	*E. urnigera.*
E. gamophylla.	

About 9 cm.— Medium, 7–10 cm.—*continued.*

E. Blakelyi.	*E. paniculata.*
E. Caleyi.	*E. papuana.*
E. cordata.	*E. Preissiana.*
E. cornuta.	*E. rubida.*
E. fasciculosa.	*E. rudis.*
E. ferruginea.	*E. Sieberiana.*
E. Mooreana.	

About 10 cm.—

E. angophoroides.	*E. Maideni.*
E. capitellata.	*E. ovata.*
E. miniata.	*E. pellita.*
E. nitens.	*E. siderophloia.*
E. occidentalis.	*E. Torelliana.*
E. globulus.	

About 11 cm.— Large, 11–20 cm.

E. Andrewsi.	*E. hemiphloia.*
E. Deanei.	*E. umbra.*
E. elaeophora.	*E. virgata.*

About 12 cm.—

E. Baueriana.	*E. populifolia.*
E. Dawsoni.	*E. ptychocarpa.*
E. oligantha.	*E. pyrophora.*
E. patens.	*E. rariflora.*
E. perfoliata.	*E. Spenceriana.*
E. polyanthemos.	*E. Stuartiana.*

About 13 cm.—

E. accedens.	*E. latifolia.*
E. calophylla.	*E. Spenceriana.*
E. Kitsoniana.	

About 14 cm.—

E. amplifolia. *E. tetradonta.*
E. leptophleba.

About 15 cm.—

E. Hillii. *E. obliqua.*

About 21— Very large, 21 cm. and over.
E. grandifolia.
About 22 cm.—
E. gigantea.
About 24 cm.—

E. clavigera. *E. Foelscheana.*

About 30 cm.—
E. alba (platyphylla).

Shape.

Juvenile leaves shapes cluster about (*a*) the line and (*b*) the circle.

The following are the terms I propose to employ in dealing with these shapes, although very many more will be found in descriptions, and in some species the amount of variation is surprising. In a few cases the same species will be found in more than one list.

(*a*) 1. Linear.
2. Linear-lanceolate to narrow-lanceolate.
3. Lanceolate.
4. Lanceolate, with cordate base.
(*b*) 5. Broadly lanceolate to nearly orbicular.
6. Orbicular.
7. Orbicular (or nearly so), with cordate base.

What follow are not complete lists, but they may be useful as a guide. With reference to *a* (4) and *b* (7), the leaves with cordate bases will be found referred to with respect to the classification by petiole, or absence of it, p. 308. It will be found that the preponderating shape in juvenile leaves tends to the broad, or orbicular.

(*a*) 1. Linear.

E. acaciaeformis var. *linearis.* *E. exserta.*
E. acacioides. *E. linearis.*
E. angustissima. *E. Seeana.*

E. apiculata. *E. Thozetiana.*

(*a*) 2. Linear-lanceolate to narrow-lanceolate.

E. amygdalina. *E. Moorei.*
E. approximans. *E. Morrisii.*
E. Bakeri. *E. ochrophloia.*
E. Baeuerleni. *E. pachyloma.*
E. bicolor. *E. Penrithensis.*
E. buprestium. *E. Pilligaensis.*
E. cneorifolia. *E. radiata.*
E. crebra. *E. scoparia.*
E. decorticans. *E. Seeana.*
E. doratoxylon. *E. sideroxylon.*
E. eugeniodes. *E. Smithii.*
E. exserta. *E. spathulata.*
E. fruticetorum. *E. stricta.*
E. gracilis. *E. taeniola.*
E. leptopoda. *E. tessellaris.*

(*a*) 3. Lanceolate.

E. acaciaeformis. *E. longicornis.*
E. annulata. *E. macrorrhyncha.*
E. Beyeri. *E. maculosa.*
E. Brownii. *E. marginata.*
E. calycogona. *E. microtheca.*
E. Campaspe. *E. Muelleriana.*
E. canaliculata. *E. Normantonensis.*
E. drepanophylla. *E. notabilis.*
E. erythrocorys. *E. odontocarpa.*
E. eugenioides. *E. odorata.*
E. eudesmioides. *E. papuana.*
E. ferruginea. *E. Parramattensis.*
E. fraxinoides. *E. pilularis.*
E. fruticetorum. *E. Planchoniana.*
E. goniocalyx. *E. pyriformis* var. *Kingsmillii.*
E. Griffithsii. *E. resinifera.*
E. Kybeanensis. *E. Rudderi.*
E. laevopinea. *E. salmonophloia.*
E. Laseroni. *E. salubris.*

(*a*) 4. Lanceolate, with cordate base.

E. Benthami. *E. pilularis.*

E. ferruginea.	*E. pilularis* var. *pyriformis.*
E. globulus.	*E. quadrangulata.*
E. Macarthuri.	*E. Smithii.*
E. Maideni.	*E. unialata.*
E. nitens.	*E. viminalis.*

(*b*) 5. Broadly lanceolate to nearly orbicular.

E. acmenioides.	*E. corymbosa.*
E. aggregata.	*E. Culleni.*
E. alba.	*E. dealbata.*
E. Bancrofti.	*E. Deanei.*
E. Baueriana.	*E. decurva.*
E. calophylla.	*E. diversicolor.*
E. Cambageana.	*E. dumosa.*
E. celastroides.	*E. Ewartiana.*
E. cinerea.	*E. fasciculosa.*
E. Clelandi.	*E. ficifolia.*
E. Cloeziana.	*E. Guilfoylei.*
E. conica.	*E. haematoxylon.*
E. Consideniana.	*E. Houseana.*

(*b*) 5. Broadly lanceolate to nearly orbicular—*continued.*

E. intertexta.	*E. pumila.*
E. Jacksoni.	*E. punctata.*
E. Lane-Poolei.	*E. Raveretiana.*
E. latifolia.	*E. regnans.*
E. leptophleba.	*E. robusta.*
E. macrandra.	*E. rostrata.*
E. maculata.	*E. saligna.*
E. megacarpa.	*E. Sieberiana.*
E. melliodora.	*E. similis.*
E. microcorys.	*E. Le Souefii.*
E. miniata.	*E. Spenceriana.*
E. Mooreana.	*E. squamosa.*
E. Naudiniana.	*E. Stowardi.*
E. obtusiflora.	*E. Stricklandi.*
E. oleosa.	*E. terminalis.*
E. pallidifolia.	*E. tereticornis.*
E. paniculata.	*E. torquata.*
E. pellita.	*E. trachyphloia.*
E. piperita.	*E. transcontinentalis.*
E. platypus.	*E. uncinata.*
E. propinqua.	*E. Watsoniana.*

(*b*) 6. Orbicular.

E. affinis.	*E. cornuta.*
E. agglomerata.	*E. cosmophylla.*
E. altior.	*E. Dalrympleana.*
E. amplifolia.	*E. Dawsoni.*
E. Andrewsi.	*E. Deanei.*
E. angophoroides.	*E. decipiens.*
E. aspera.	*E. Drummondii.*
E. Baileyana.	*E. elaeophora.*
E. Banksii.	*E. eximia.*
E. Baueriana.	*E. foecunda.*
E. Behriana.	*E. gigantea.*
E. Blakelyi.	*E. gomphocephala.*
E. Boormani.	*E. Gunnii.*
E. Bosistoana.	*E. hemiphloia.*
E. botryoides.	*E. Hillii.*
E. Caleyi.	*E. Irbyi.*
E. capitellata.	*E. Kirtoniana.*
E. cladocalyx.	*E. Kitsoni.*
E. coriacea.	*E. Lehmanni.*
E. leucoxylon.	*E. pruinosa.*
E. ligustrina.	*E. pulverulenta.*
E. longifolia.	*E. rariflora.*
E. melanophloia.	*E. Risdoni.*
E. Muelleri.	*E. rubida.*
E. Mundijongensis.	*E. rudis.*
E. nitida.	*E. siderophloia.*
E. obliqua.	*E. Staigeriana.*
E. occidentalis.	*E. striaticalyx.*
E. odorata.	*E. Stuartiana.*
E. Oldfieldi.	*E. tereticornis.*
E. oligantha.	*E. tetragona.*
E. ovata.	*E. tetraptera.*
E. parvifolia.	*E. urnigera.*
E. peltata.	*E. vernicosa.*
E. polyanthemos.	*E. virgata.*
E. populifolia.	*E. Websteriana.*
E. praecox.	*E. Woodwardi.*
E. Preissiana.	

(*b*) 7. Orbicular (or nearly so) with cordate base.

E. accedens.	*E. Gillii.*

E. de Beuzevillei.	*E. neglecta.*
E. Camfieldi.	*E. nova-anglica.*
E. coccifera.	*E. patens.*
E. cordata.	*E. pyrophora.*
E. Dalrympleana.	*E. setosa.*
E. diversifolia.	*E. umbra.*
E. dives.	

The angles the secondary veins make with the midrib.

(We shall have much to say on the subject when we come to Mature Leaves in the next Part.)

a. *Normal Species.*—In an orbicular leaf, of which most juvenile leaves consist, it is obvious that the venation, from the base to the apex, varies most widely. At the apex the secondary veins may vary from about 75 deg. at the base, to about 30 deg. towards the apex. In dealing under "Mature Leaves," in recording the angles I have dealt with the middle third of the leaf; there is less necessity for this in dealing with "Juvenile Leaves," as I am at present.

In many cases we do not know whether we have the earliest juvenile leaves or not, although we have in juvenile leaves frequently the assistance of the seedling series, assistance we do not receive in regard to mature leaves.

There is much difficulty in standardising juvenile leaves, by reason of the incompleteness already referred to. Our object should be to have them as young as possible, thus showing as many of the characters as we can get.

When dealing with an orbicular leaf, we may note the curving of the secondary veins in the early stages; afterwards they become less curved, often almost straight.

Most of the juvenile leaves being broad, there is a tendency in the secondary veins to be more spreading than in the case of the mature leaves. There is greater uniformity in the venation, that is to say, a greater range of angle in the same species than in mature leaves. So far as one can see, the measurements of the angles do not indicate recognised groups as definitely in the juvenile as in mature leaves. I have referred to a few groups only, such as the Renantherae.

I shall go more into the subject when mature leaves are dealt with, and in the meantime advocate that closer attention be given in the field to the measurements of these angles.

15–20°.

E. gracilis.

25–35°.

E. amygdalina (Renantherae). *E. ligustrina* (Renantherae).
E. capitellata (Renantherae). *E. numerosa* (Renantherae).

25–40°.

E. eugenioides (Renantherae).

25–50°.

E. dives (Renantherae). *E. virgata* (Renantherae).

30°.

E. odorata.

30–35°.

E. Benthami. *E. Brownii.*
E. macrorrhynca (Renantherae).

30–40°.

E. amygdalina (Renantherae). *E. haemastoma* (Renantherae).
E. capitellata (Renantherae). *E. numerosa* (Renantherae).
E. Consideniana (Renantherae).
E. elaeophora. *E. polyanthemos.*
E. odorata var. *calcicultrix.* *E. Simmondsii.*
E. Jenseni. *E. viminalis.*

30–45°.

E. de Beuzevillei (Renantherae). *E. eugenioides* (Renantherae).
E. affinis. *E. ovata.*
E. Behriana. *E. Simmondsii.*
E. Beyeri. *E. viminalis.*

30–50°.

E. altior (Renantherae). *E. Simmondsii.*
E. redunca var. *melanophloia.* *E. viminalis.*

35–40°.

E. capitellata (Renantherae). *E. pachyloma* (Renantherae).
E. coriacea (Renantherae). *E. regnans* (Renantherae).
E. haemastoma (Renantherae). *E. stricta* (Renantherae).
E. nitida (Renantherae).
E. acaciaeformis var. *linearis* *E. cinerea.*
E. affinis. *E. dealbata.*
E. Boormani.

35–45°.

E. buprestium (Renantherae).	*E. Muelleriana* (Renantherae).
E. Camfieldi (Renantherae).	*E. radiata* (Renantherae).
E. laevopinea (Renantherae).	*E. Sieberiana* (Renantherae).
E. macrorrhyncha (Renantherae).	
E. bicolor.	*E. paniculata.*
E. Bosistoana.	*E. parvifolia.*
E. Ewartiana.	*E. Staigeriana.*
E. incrassata var. *angulosa.*	*E. tereticornis* var. *latifolia.*
E. tessellaris (Angophoroideae).	
E. cornuta (Cornutae).	*E. tetragona* (Cornutae).

35–50°.

E. coriacea (Renantherae).	*E. pilularis* var. *pyriformis* (Renantherae).
E. Consideniana (Renantherae).	*E. radiata* (Renantherae).
E. Blakelyi.	*E. oleosa.*
E. Caleyi.	*E. populifolia.*
E. Irbyi.	*E. pyriformis.*
E. Kirtoniana.	*E. rubida.*
E. cornuta (Cornutae).	

35–60°.

E. Le Souefii.

40°.

E. Campaspe. *E. Clelandi.*

E. hemiphloia var. *albens.*

40–45°.

E. eugenioides (Renantherae).	*E. Sieberiana* (Renantherae).
E. pilularis (Renantherae).	*E. odorata.*
E. Bancrofti.	*E. paniculata.*
E. Blakelyi.	*E. pumila.*
E. Bosistoana.	*E. resinifera.*
E. Cambageana.	*E. rubida.*
E. cladocalyx.	*E. sideroxylon.*
E. leptophleba.	*E. striaticalyx.*
E. melanoxylon.	*E. occidentalis* (Cornutae).
E. Normantonensis.	*E. Baileyana* (Eudesmieae).

40–50°.

E. diversifolia (Renantherae). *E. pilularis* (Renantherae).
E. dives (Renantherae). *E. piperita* (Renantherae).
E. alba. *E. platypus* (Cornutae).
E. agglomerata. *E. intertexta.*
E. angophoroides. *E. leucoxylon.*
E. Bancrofti. *E. maculosa.*
E. conica. *E. Perriniana.*
E. Dawsoni. *E. polyanthemos.*
E. dealbata. *E. robusta.*
E. elaeophora. *E. rubida.*
E. Ewartiana. *E. squamosa.*
E. faecunda. *E. Todtiana.*
E. hemiphloia.
E. clavigera (Angophoroideae). *E. Torelliana* (Corymbosae).

40–55°.

E. Banksii. *E. Lane-Poolei.*
E. falcata var. *ecostata.* *E. longicornis.*
E. elaeophora. *E. microtheca.*
E. Kitsoniana. *E. Stuartiana.*

40–60°.

E. falcata var. *ecostata.* *E. melanophloia.*
E. goniocalyx. *E. Perriniana.*
E. peltata (Corymbosae).

40–65°.

E. clavigera (Angophoroideae).

40–70°.

E. capitellata (Renantherae).
E. nova-anglica. *E. ovata* var. *camphora.*
E. haematoxylon (Corymbosae).

45–50°.

E. accedens. *E. quadrangulata.*
E. Bancrofti. *E. Raveretiana.*
E. Macarthuri. *E. resinifera.*
E. nitens. *E. Stricklandi.*
E. Oldfieldi. *E. transcontinentalis.*
E. praecox.
E. stellulata (Coriaceae).

45–55°.

E. capitellata (Renantherae).

E. angophoroides. *E. elaeophora.*
E. decipiens. *E. rariflora.*
E. Dunnii. *E. redunca* var. *elata.*
E. terminalis (Corymbosae). *E. unialata.*

45–60°.

E. acmenioides (Renantherae).

E. Cloeziana. *E. paniculata.*
E. Drummondii. *E. punctata.*
E. globulus. *E. Stuartiana.*
E. gomphocephala. *E. Stuartiana* var. *grossa.*
E. ovata. *E. tereticornis.*
E. grandifolia (Angophoroideae). *E. miniata* (Corymbosae).

45–65°.

E. pilularis (Renantherae).

E. Muelleri. *E. rubida.*
E. paniculata. *E. rudis.*
E. trachyphloia (Corymbosae). *E. tetrodonta* (Eudesmieae).

45–70°.

E. trachyphloia (Corymbosae).

45–75°.

E. pellita.

50°.

E. agglomerata. *E. torquata.*

50–55°.

E. decurva. *E. rostrata.*
E. Houseana.
E. similis (Eudesmieae).

50–60°.

E. accedens. *E. cosmophylla.*
E. aggregata. *E. Dalrympleana.*
E. Bosistoana. *E. Guilfoylei.*
E. Gunnii. *E. resinifera.*

E. Houseana. *E. quadrangulata.*
E. propinqua.
E. Torelliana (Corymbosae). *E. tetragona* (Eudesmieae).

50–65°.

E. botryoides. *E. Hillii.*

E. Jacksoni.

50–75°.

E. capitellata (Renantherae).

50–90°.

E. marginata (Renantherae). *E. patens.*

55–65°.

E. peltata (Corymbosae). *E. pyrophora* (Corymbosae).

55–70°.

E. diversicolor. *E. megacarpa.*

55–75°.

E. maculata var. *citriodora* (Corymbosae).

55–90°.

E. leptophleba.

55–85°.

E. Stuartiana var. *grossa.*

60°.

E. maculata (Corymbosae).

60–70°.

E. amplifolia. *E. Deanei.*

b. *Hybrids.*—In these species I have not always been able to secure juvenile leaves. In some cases, Intermediate leaves were the nearest I could get, and these are indicated by the letter (I). It will be seen that they practically all belong to the Obliquae (to be understood when venation and Mature Leaves is reached in the next Part).

25–40°.—*E. Studleyensis* (I).

30°.—*E. Tenandrensis.*

30–40°.—*E. antipolitensis, E. Insizwaensis.*

35–45°.—*E. Auburnensis.*

35–55°.—*E. Auburnensis.*
40–50°.—*E. Tenandrensis* (I), *E. Yagobiei, E. Bourlieri.*
40–55°.—*E. Algeriensis.*
45°.—*E. Studleyensis.*
45–50°.—*E. antipolitensis, E. Cordieri, E. gomphocornuta* (I).
45–55°.—*E. jugalis.*
45–60°.—*E. McIntyrensis.*

Isoblasticity; Heteroblasticity.

(These characters can obviously be dealt with under both Juvenile and Mature leaves. They will be more fully dealt with under the latter in the next Part.)

The apparent uniformity of the leaves of certain species of Eucalyptus throughout life, or, what is much more commonly observed, the changes in shape, size, vestiture, texture, venation, which occur, have long attracted the attention of botanists, usually in a general way.

In the present work I have figured and given information concerning this variation to an extent not previously recorded. The changes are shown in practically every plate; some special references are in Parts XLII, p. 54, XLIX, p. 273.

The opposite leaves are the primitive leaves, and only a few years ago it was believed that, in the case of a few species, the opposite leaves persisted through life. Gradually this number has been dwindling, till at length only one or two remain, of which we have not found the true adult form, and careful search may find those yet. At the same time, we must not lose sight of the fact that, as regards several species, they seem loth to part from the primitive or juvenile form, the condition being one of retarded heteroblasticity. Indeed, in these cases, the leaves of some species, to all intents and purposes, preserve their opposite or juvenile character throughout life.

One of the earliest observers who gave attention to the subject was the late Augustus Oldfield, and from his MSS. (circa. 1864), I extract the following passage:—

On the other hand, there are forms which at certain periods of their growth are so unlike their adult states, and others that in their young states are so like to the young forms of other species which attain their adult condition without any violent transition, that it is equally impossible to assign any reason for the change in the direction of the vital forces, whereby forms (in the former instance) are made to approach, and others (in the latter) to recede from a certain type.

As an example of the first kind of variations may be cited the genus *Eucalyptus,* many of whose members in the young state are very different from the adult forms, and as they frequently retain this habit for several years, and even produce blossoms ere they have attained the adult forms, it has happened that they have been regarded as specifically distinct from their parents, a striking proof of the inadequacy of the methods now employed to discriminate species. As far as my experience goes—and I have carefully studied seventy-five species in their native localities—there is no species of Eucalyptus which is normally fruticose, or that has opposite leaves in the adult stage, so that all those in the latter category which have been recorded by botanists, must be the young states of species, known or unknown. There are but two of the so-called opposite-leaved species known to me that I have failed to connect with their parent forms. In the one, *E. Preissii,* this character is by no means constant, for towards the summits of the taller plants, the leaves are decidedly alternate. Of the other species, *E. pleurocarpa (tetragona),* this much can be said, that the squalid habit of the plant conveys the idea that it is not in a stable condition, and of both forms it may be stated that, inhabiting localities subject to periodical conflagrations, caused by the aborigines in their search after food, they suffer more from such conditions than do most of the plants with which they are associated, owing to the great amount of essential oil that pervades every part of them. In fact, out of the vast number of places in which I have found these plants (which are never associated, *E. Preissii* growing on rocky hills only, while *E. pleurocarpa* invariably inhabits localities where the soil is composed of sand and clay), I never discovered one in which, among the living plants, there were not the charred stems of dead ones, and these generally taller than the living plants (pp. 399–403).

I offer some notes on species which at one time were deemed to be isoblastic, but which subsequent observation has shown to be more or less heteroblastic. All are broad-leaved, except *E. doratoxylon,* referred to at p. 302.

E. ASPERA F.v.M.

I am not satisfied that alternate leaves have been found in this species. See Part XXXVII, p. 185, Plate 152.

E. CINEREA F.v.M.

This species was, when first described, and for many years afterwards, looked upon as an isoblastic species, but I found lanceolate leaves on the species in the Goulburn district, N.S.W. (*Proc. Linn. Soc. N.S.W.,* xxvi, 551, 1901); see also this work, Part XXI, Plate 89.

E. CORDATA Labill.

I have a note in *Pap. and Proc. R. S. Tas.,* 1918, p. 83, in regard to this species, still specially looked upon as isoblastic, but Mr. L. Rodway tells me that *E. cordata* at Brown Mountain, Port Arthur, where it is only 3–5 feet high, has upper leaves which are pedunculate and slightly alternate.

E. ERYTHROCORYS F.v.M.

With a strong tendency to maintain an opposite character, it proceeds to the alternate character in fully mature leaves as growth proceeds.

E. FERRUGINEA Schauer.

With usually sessile, cordate, rusty pubescent leaves. It has been found with very short petioles (fig. 2*a,* Plate 159, Part XXXVIII), but not yet alternate. See *E. setosa.*

E. GAMOPHYLLA F.v.M.

Mueller in "Eucalyptographia," speaks of the "concrescence of leaves by pairs in all stages of growth" in this species, and figures it so, but in Plate 147 and p. 128, Part XXXV, I have shown that it becomes eventually lanceolate and very shortly stalked. In the same Part, XXXV, p. 133, I have suggested that *E. argillacea* W. V. Fitzgerald may be the petiolate form of *E. gamophylla.*

E. GILLII Maiden.

In Plate 67, Part XV, I have depicted petiolate forms as "transit forms *E. oleosa* to *E. Gillii,*" but I now look upon them as belonging to the latter species.

E. KRUSEANA F.v.M.

See Part XLII, p. 51, Plate 175. So far as we know at present, petiolate leaves have not been found in this species.

E. MACROCARPA Hook.

Is no longer isoblastic. The lower leaves are alternate as in *E. cordata.* Further observations are desired by local botanists. See *Journ. Roy. Soc. N.S.W.,* liii, 70, and lii, 506.

E. MELANOPHLOIA F.v.M.

See Part XII, p. 71.

E. PARVIFOLIA Cambage.

The leaves later become all lanceolate or linear-lanceolate, mostly opposite, or begin to be alternate. See Part XXV.

E. PREISSIANA Schauer.

See Oldfield's remarks just quoted.

E. PRUINOSA Schauer.

See Part XII with Plate 54. See also Part XLII, p. 54, where I speak of seedlings with petiolate (pedicellate by misprint) young leaves. The subject is one for inquiry.

E. PULVERULENTA Sims.

See Part XXI, with Plates 90 and 91. This has not been collected in the bush other than as isoblastic, but petiolate leaves have appeared in seedlings.

E. RISDONI Hook. f.

Cordate and lanceolate leaves are common on the same branch. See Part VI, p.

175. This is similar to *E. cinerea.*

E. SETOSA Schauer.

A usually sessile, cordate, Angophoroid species with bristly branchlets. It may, towards the end of a branchlet, become pedunculate; see fig. 5, Plate 157, Part XXXVIII. The leaves may become decidedly narrower, tending to lanceolate, *e.g.,* fig. 8*c,* Plate 158, but I have not come across petiolate lanceolate leaves in this species yet.

E. TETRAGONA F.v.M.

In Plate 188, Part XLVI, it will be seen that we have petiolate leaves in this species. See also Oldfield's notes just quoted.

E. TORELLIANA F.v.M.

Mueller only described the juvenile leaves, but petiolate alternate leaves are now known. See Part XXXIX, p. 239, and Plate 160.

E. VERNICOSA Hook. f.

Later on the leaves become elliptical to broad-lanceolate, petiolate, and alternate, in plants growing in the Botanic Gardens, Sydney (1919). See also Plate 116, Part XXVIII.

All the above are broad-leaved.

E. DORATOXYLON F.v.M.

This is the only narrow-leaved species of which this may be truly said, so far as I know (see fig. 3, Plate 70). Even in this species there is a trace of alternation, but as the species is so little known, it is very desirable that careful search be made to see whether the foliage becomes markedly alternate, and whether there is any marked difference between the juvenile and mature leaves.

At the present time it seems as if this persistence in the opposite character of the foliage points to close affinity to *Angophora.*

Diels's Law.

In the year 1906, Dr. L. Diels published a small book (royal 8vo, pp. 130) entitled "Jugendformen und Blutenreife im Pflanzenreich" (Juvenility and flowering ripeness). I have already drawn attention to this work in Part XLIX, p. 273, but think the thesis mainly referred to in it should be dealt with under the name of Diels's Law. I will presently restate the thesis or law.

It may be convenient, at the present place, to offer a translation of certain passages in Diels's work:—

(p. 89 of the work.) *Eucalyptus Risdoni.* J. D. Hooker described *E. Risdoni* (Hooker's *London Journal of Botany,* v, 477) in 1847 from Gunn's Southern

Tasmanian collections. He characterised the species specially by its foliage "foliis oppositis ovato-cordatis acuminatis, sessilibus, vel basi lata connatis, junioribus ramulis alabastrique pulverio-glaucentibus." The collector's notes give 6 to 7 metres as the height of the tree. From Hooker's description of the generative parts of the tree (see fig. 25 *b, c, d, e* of the work) one can draw the conclusion that these organs are nearly related to those of *E. amygdalina.*

(p. 90.) Though the foliage of the full-grown *E. amygdalina* is lanceolate and pointed, it resembles closely those of *E. Risdoni* in their juvenile state. (Fig. 25 *a.*) (N.B.—No form of *E. amygdalina* resembles 25 *a.*—J.H.M.) *E. amygdalina* is widely spread in south-eastern Australia and Tasmania, is that polymorphous species which attains gigantic dimensions, and is found occasionally over 100 metres high, but generally its height is more moderate, and Bentham describes it from travellers' notes as "A tree usually small or moderate-sized." The number of forms of *E. amygdalina* are first thoroughly described by Mueller in *Fragm.* xii (1860). At page 54 we have the following sentence: "Transitus autem claros ab *E. Risdoni,* qualem J. Hooker depixit, ad illam *E. amygdalinae* formam, quam Sieber sub nomine *E. radiatae* distribuit, a cl Oldfield accepi." F. v. Mueller repeats this opinion more in detail in his "Eucalyptographia," 1880. He regards *E. Risdoni* Hook. f., "only as an aberrant form of *E. amygdalina. E. Risdoni* is to the present day only known from southern Tasmania. It is a small tree. The leaves of the upper branches are mostly thick and stiff, proportionally short and nearly equal-sided, while the leaves of the lower branches are, like those of the seedling plants and adventive shoots, opposite, sessile, broad, often connate, and covered with a whitish powder, also the branchlets and umbels, besides the fruits are generally larger. But these characters are only gradual, and not really specific. Further, Bentham, who saw only dried material, admitted (*B. Fl.* iii, 203) that the characters of *E. Risdoni* were only gradual distinctions, and that "Our dried specimens do not admit of our fixing any precise limits, and in that state it is sometimes scarcely possible to decide to which species they should be referred." These opinions of the most eminent experts make the facts perfectly clear. In the generative characters there is no distinction between *E. amygdalina* and *E. Risdoni,* and in the vegetative characters, *E. Risdoni* appears as the juvenile form of *E. amygdalina.* Our figure No. 25 gives everyone an opportunity of forming his own opinion. The useless trouble some former botanists took to find out some minute distinctions between the two species should be ignored at the present day !!! These minute distinctions disappear if compared with the mass of characters they have in common." (If by this Dr. Diels considers the differences between *E. Risdoni* and *E. amygdalina* to be minute he will get no modern botanist to agree with him. Many of the demarcations of species as laid down by Mueller have been abandoned as field knowledge has become more accurate. See below, p. 305.—J.H.M.)

(p. 91). The relationship between *E. Risdoni* and *E. amygdalina* caused Mueller to point out similar relationships between other species in the genus Eucalyptus. *E. pulverulenta* and *E. melanophloia* seem to be in the same position to *E. Stuartiana* and *E. crebra,* as *E. Risdoni* is to *E. amygdalina.* (Mueller, "Eucalyptographia," under *E. amygdalina*).. . . .

(p. 92). With these statements Mueller has proved undisputably that a *vegetative juvenile form and a vegetative full-grown form can exist in a single species, and each form flowers and fruits and forms a perfectly closed cycle of life.* (The words in italics are what I propose to call Diels's Law. See below, p. 305.—J.H.M.) It is quite unlikely that these relations will be found to be confined to our present-day species. They will have been equally in force in the past, and must have had an influence on the phytogeny, and find expression in at the present day less nearly allied species. Indeed, there is much reason for the conclusion that the juvenile forms of the vegetative organs often point to relation of species apparently now very distant.

(p. 93). *E. peltata* Benth., is the first example. This species of an inland north-eastern district, which occurs in the neighbourhood of the Burdekin, Lynd, and Gilbert Rivers, is the only species of the genus which has peltate leaves in the full-grown state (Mueller's error again repeated, see Part XLII, p. 33.—J.H.M.). Otherwise it shows in many characters, especially in the very important shape of the fruit, a great approach to *E. latifolia.* It is more than probable that the two species are closely connected; indeed, in their geographical distribution they belong to the same region, *i.e.,* north-east Australia. Unfortunately the ontogeny of *E. latifolia* is not perfectly known. I could nowhere find a description of the juvenile leaves. Generally speaking, the peltate leaf in Eucalyptus is a character of juvenile form, which I saw in surprising perfection in *E. calophylla* and in *E. erythrocorys.*

(p. 93). *Eucalyptus cordata.* Another case is given by Mueller under *E. cordata.* This Tasmanian species remains mostly shrubby. It belongs to the species with sessile, opposite, cordate, and orbicular leaves with crenate margins, possessing therefore prominently the characters of juvenile leaves. Crenate leaves, says Mueller in "Eucalyptographia," occur also in *E. urnigera,* and, strange as it may appear, *E. cordata* is nearest allied to this species. In its full-grown state *E. urnigera* has alternate, dark green, lanceolate-falcate leaves on long petioles, the calyces are elongate and narrowed at the base into distinct pedicels, the operculum is larger and the fruits are urn-shaped with sunk valves, but Mr. Stephens found on "Old Man's Head," a sub-alpine mountain near Lake Crescent, trees which formed, to all appearance, a perfect transition between *E. urnigera* and *E. cordata.*

(p. 94). Further, Augustus Oldfield sent many years ago from Mount Wellington, near Hobart, sterile specimens of the juvenile state of *E. urnigera,* whose lower sucker-shoots could not be distinguished in foliage in any way from *E. cordata,* and which had to some extent also the same whitish bloom. On Mount Wellington I collected a state of *E. urnigera* whose leaves were nearly oval and whose fruits were "truncate-ovate." (The mature leaves of *E. urnigera* are alternate, petiolate, and lanceolate. See fig. 15, Plate 80.—J.H.M.).

Then follow some notes on *E. tetragona* and its affinity to *E. eudesmioides,* which I have translated and quoted in Part XLVI, pp. 162 and 168. The affinity is explained at the bottom of p. 168.

We then pass on to Dr. Diels's "General Remarks concerning Eucalyptus," (p. 95).

The cases described on page 89 (*E. Risdoni* and *E. amygdalina*) enlarge the validity of the previously explained connection between juvenile forms and flowering maturity, but its limits are not yet reached. We clear a way for it if we try again to lay down *the characters of the primary state* of the heteroblastic Eucalypts. The following forms appear to be essential, or, at least, specially common in the juvenile state.

(p. 96). 1. *Shape.* Leaves opposite, connate in pairs or sessile or shortly petiolate, the blade often cordate at the base, occasionally even the petiole is superbasal (peltate).

2. *Bloom.* Frequently all parts have a whitish or glaucous waxy bloom.

3. *Hairs.* Frequently the axis and leaves are covered with bristly hairs.

We find that a series of species of Eucalyptus produce flowers in the vegetative juvenile state as well as in the matured vegetative state, and therefore develop two generative identical parallel forms, as shown on pages 90 and 91. In other cases, the existence of such pairs of identical species has been at least shown as probable (pp. 93, 94). But there are still other states in Eucalyptus. There are normally flowering species with juvenile leaves, of which we have not yet found their doubles with mature foliage. I mention three of the most prominent species of this kind.

1. *E. gamophylla* F.v.M. Leaves all opposite and broadly connate, often cordate, equal-sided, of whitish-grey colour. An always shrubby species inhabiting the dry north-west quarter of Australia, and extending from the Hammersley Ranges south-east to the upper Finke River. The relationship of this species is doubtful.

2. *E. setosa* Schau., and *E. ferruginea* Schau. Leaves all opposite, sessile, cordate, rather obtuse or acute. The branches and axis of the inflorescence provided with rusty-brown felt or bristly hairs. Small trees in tropical north-east Australia, reaching southward as far as 20°. Both species remind one somewhat of *Angophora,*

and are related to the next species:—

3. *E. perfoliata* R.Br. Leaves all opposite, connate in pairs, glaucous. A large shrub of the dry tropical north-west of Australia.

(p. 97). 4. *E. macrocarpa* Hook. All over with a glaucous bloom. Leaves all opposite, sessile, with a cordate base. Flowers solitary, sessile, very large. Shrubs of considerable size in the interior of south-west Australia, where it occurs in gravelly-sandy soil, with a rainfall of about 40 cm. (153/4 inches). The only near relation of this species is *E. pyriformis* Turcz., with mature leaves, which occurs in still drier regions. There are forms of this which deviate from the typical *E. pyriformis* in the direction of *E. macrocarpa.* Some have some opposite leaves, others have a white bloom, at least on the inflorescence, and the pedicels, normally very distinct, are occasionally wanting. To be brief, one sees that *E. pyriformis* and *E. macrocarpa* are sisters with helicomorphic distinctions in the vegetative organs.

It must be noted that not all Eucalypts are so heteroblastic as these mentioned here. There are many whose juvenile leaves differ only in size and in a broader, less, falcate blade. Such juvenile forms will behave in a similar way as the extreme heteroblastic forms. Therefore it cannot surprise us to find amongst the normal flowering species some which make an impression of juvenility by their broader and larger leaves. Amongst the species I have observed myself I have specially in mind *E. Preissiana* Schau., and *E. grossa* F.v.M. Both inhabit edaphic dry localities in south-western Australia in the dry inland region. Their juvenile leaves are strongly built and xeromorphic.

It is unfortunate that Diels has chosen the comparative examples of *E. Risdoni* ans *E. amygdalina,* the relations of which have been misunderstood by both Bentham and Mueller. When I deal with affinities, I shall show that *E. Risdoni* is nearer to other species.

At the same time these pairs, illustratively cited, do not fundamentally affect Diels's arguments. *E. amygdalina* and *E. Risdoni* cannot be accepted as belonging to the same species according to any modern criterion. Diels further quotes Mueller as comparing *E. pulverulenta* and *E. melanophloia* and also *E. Stuartiana* and *E. crebra,* two so-called Apples, with two Ironbarks. These two pairs are so distant from each other in phytogenetic relations that Mueller has misled Diels, and while I think Diels's generalisation is so useful that I propose it as a law, I think these particular examples unfortunate. I will state the law.

Definition of Diels's Law.

At p. 92 Dr. Diels says, "A vegetative juvenile form and a vegetative full-grown form can exist in a single species, and each from flowers and fruits, and forms a perfectly closed cycle of life." I call this Diels's Law.

C. R. Barnes (the present work, Part XLIX, p. 274) puts it this way: "The thesis of the book is that *the generative maturity of plants is not connected immutably with a definite stage of their development,* as has been so widely held."

The italics are mine, and Diels's law may be conveniently expressed in that way.

The function of bearing flowers and fruits is not restricted to branches bearing mature leaves solely. It is by no means rare on branches which have juvenile leaves, and which causes a strange appearance on branches which have both juvenile and mature leaves. Such an anomaly, I believe to be the result of an injury; in other words the branch is beginning its physiological life again, and so we may have, on a tree, a kind of botanical *imperium in imperio.* This trauma may be caused by animals or by wind or other meteorological phenomena.

Indeed, when we see what appear to be abnormal leaves on a branch, *i.e.,* usually broader leaves, we should consider the possibility that we may have an illustration of Diels's law. An incidental result of such apparent abnormality may give us illustrations of the equivalents of juvenile leaves, which may serve our purpose when we cannot get them from early leaf growth in the ordinary way.

Diels's Law will be found to have a really practical value to the taxonomist, in a genus in which the juvenile leaf plays such a prominent part in classification. It enables us to have a second chance of getting a juvenile leaf, *i.e.,* as the result of a trauma or other stimulus, where the leaf may be flowering or fruiting or not, or otherwise concealed amongst the mature foliage.

If the figures and Plates (as indicated) of the following species be referred to, it will be found that they indicate examples illustrative of Diels's Law. The names should be compared with the list given at Part XLIX, pp. 275–278, which includes some species which appear to illustrate Nanism, in absence of the specimens or notes on them, and some which certainly do. I believe, however, that a number of the species referred to in Part XLIX illustrate Diels's Law as well, other than those I have selected.

I have observed Diels's Law in so many species now that I think it will probably be observed eventually in all species.

In the following references, the species is given first, in alphabetical order, and the figures and Plates of the present work in brackets:—

E. alba (Plates 105–107), Part XXV.

E. altior (figs. 7*a*–7*g,* Plate 44, Part IX), Blackheath, J.H.M., January, 1905.

E. Beyeri (figs. 1–2, Plate 199, Part XLVIII). We may have a case of flowering in the juvenile leaved stage in *E. Beyeri.*

E. Blakelyi (figs. 1–2, Plate 134, Part XXXII).

E. Bosistoana. See Part XLIX, p. 275, and also present Part, p. 270.

E. calophylla. Often flowers in the peltate (young) stage.

E. calycogona (fig. D, Plate 9, Part III). Intermediate. Not quite juvenile leaves are shown in this figure.

E. celastroides (fig. B, Plate 10, Part III).

E. cinerea (Plates 89 and 90, Part XXI).

E. Cooperiana (fig. 5, Plate 151, Part XXXVI).

E. coriacea (fig. 1*a,* Plate 27, Part V).

E. dealbata (Plate 134, Part XXXII). The very type specimen illustrates Diels's Law. It is in the opposite-leaved stage (fig. 3*a,* Plate 134). The leaves are broadly lanceolate to almost ovate, but not many years elapsed before it was seen that the normal leaves were lanceolate.

E. decipiens (figs. 1–12, Plate 63, Part XIV). Eudesmieae. See Part XLIX, p. 276.

E. fasciculosa (fig. 16, Plate 61, Part XIV).

E. Foelscheana (fig. 4*a,* Plate 169, Part XLI).

E. Forrestiana (fig. 2*a,* Plate 95, Part XXII).

E. gamophylla (figs. 3, 6, Plate 147, Part XXXV).

E. gigantea (fig. 2, Plate 85, Part XX). See Part XLIX, p. 276.

E. Gillii (figs. 6–9, Plate 67, Part XV).

E. globulus. See Part XLIX, p. 276.

E. gracilis (fig. L, Plate 12, Part III).

E. Houseana. See Part XLIX, p. 276, and Part L, p. 294, for remarks which should be referred to Diels's Law.

E. Kitsoniana (fig. 1*b,* Plate 117, Part XXVIII).

E. Kybeanensis. See Part XLIX, p. 276.

E. leucoxylon. See Part XLIX, p. 276.

E. macrocarpa. See Part XLIX, p. 276.

E. melliodora. See Part XLIX, p. 277.

E. miniata (fig. 3, Plate 193, Part XLVII). Flowers at height of 2 feet. (W. V. Fitzgerald).

E. marginata (fig. 4*b,* Plate 230).

E. Moorei. See Part XLIX, p. 277.

E. Muelleri (fig. 8*a,* Plate 116, Part XXVIII).

E. neglecta. A specimen, Spring Creek, Cobungra, 18 miles from Omeo, Victoria (H. B. Williamson, 10th January, 1922), shows the juvenile foliage precisely as depicted at fig. 5*a,* Plate 115, Part XXVII, but with inflorescence in the axils of the juvenile foliage.

E. occidentalis (figs. 4*a,* 4*b,* Plate 148, Part XXXVI).

E. orbifolia (fig. 12, Plate 74, Part XVII). May be a case of “flowering in juvenile stage” of *E. pyriformis*.

E. papuana (figs. 1*a,* 3*b,* Plate 155, Part XXXVII).

E. peltata (fig. 2, Plate 173, Part XLII).

E. platypus (fig. 5*b,* Plate 145, Part XXXV).

E. pruinosa (figs. 5–8, Plate 54, Part XII).

E. rubida (fig. 7*a,* Plate 110, Part XXVI).

E. Stuartiana var. *grossa* (fig. 1*c,* Plate 102, Part XXIV).

E. tereticornis (fig. 1, Plate 129, Part XXXI).

E. tetragona (fig. 7, Plate 188, and fig. 1*a,* Plate 189, Part XLVI).

E. Torelliana (figs. 4*a,* 4*b,* Plate 160, Part XXXIX).

E. uncinata (Plate 62, Part XIV). See also the present Part, pp. 262, 263.

Non-recognition of Diels's Law has occasionally caused botanists to think that these juvenile leaves, often far away from the root of the tree, indicate new species, or has caused uncertainty as to the taxonomic value of this abnormally placed foliage.

The Petiole.

a. Its presence.

Once more we have to deal with variables. For example, it is probable that in some cases quoted the record “Slightly petiolate” will, with further experience, turn out to be “Sessile.” The tendency is for the records of petioles to indicate diminished length in juvenile leaves as we get to know more about them, and, as regards the truly petiolate ones, for us to find that the petioles become increased in length. In some cases, the same species may appear in more than one list.

We, therefore, in this particular enumeration, can only take cognisance of those juvenile leaves which are—

1. Slightly petiolate.
2. Petiolate.
3. Petiolate very long, and, as an exceptional case,
4. Peltate.

1. SLIGHTLY PETIOLATE.

E. acmenioides.	*E. corymbosa.*
E. affinis.	*E. crebra.*
E. agglomerata.	*E. Culleni.*
E. alba.	*E. dealbata.*

E. alpina.
E. altior.
E. amplifolia.
E. apiculata.
E. approximans.
E. Baileyana.
E. de Beuzevillei.
E. Beyeri.
E. bicolor.
E. Blaxlandi.
E. Boormani.
E. Bosistoana.
E. botryoides.
E. calophylla.
E. calycogona.
E. calycogona var. *gracilis.*
E. celastroides.
E. cinerea.
E. Cloeziana.
E. cneorifolia.
E. Consideniana.
E. cornuta.
E. Lehmanni.
E. leptopoda.
E. macrandra.
E. maculata.
E. maculosa.
E. Maideni.
E. megacarpa.
E. melliodora.
E. microcorys.
E. microtheca.
E. miniata.
E. Morrisii.
E. Mundijongensis.
E. Naudiniana.
E. Normantonensis.
E. obliqua.
E. occidentalis.
E. oleosa.
E. pachyloma.
E. papuana.
E. paniculata.
E. Deanei.
E. decipiens.
E. decorticans.
E. diversicolor.
E. dumosa.
E. erythrocorys.
E. erythronema.
E. Ewartiana.
E. exserta.
E. falcata.
E. fasciculosa.
E. ficifolia.
E. foecunda.
E. fruticetorum.
E. gigantea.
E. Guilfoylei.
E. hoemastoma.
E. haematoxylon.
E. intertexta.
E. Kitsoniana.
E. Laseroni.
E. Lane-Poolei.
E. pyrophora.
E. Raveretiana.
E. redunca.
E. regnans.
E. resinifera.
E. robusta.
E. Rudderi.
E. saligna.
E. salmonophloia.
E. salubris.
E. scoparia.
E. siderophloia.
E. sideroxylon.
E. Sieberiana.
E. Le Souefi.
E. squamosa.
E. Staigeriana.
E. striaticalyx.
E. stricta.
E. terminalis.
E. tessellaris.

E. Parramattensis.
E. pellita.
E. Pilligaensis.
E. piperita.
E. platypus.
E. Preissiana.
E. propinqua.
E. pumila.
E. pyriformis.
E. tetragona.
E. tetrodonta.
E. Thozetiana.
E. Todtiana.
E. Torelliana.
E. torquata.
E. trachyphloia.
E. virgata.
E. Websteriana.

2. PETIOLATE.

E. accedens.
E. affinis.
E. alba.
E. amplifolia.
E. Andrewsi.
E. Bancrofti.
E. Banksii.
E. Baueriana.
E. Behriana.
E. de Beuzevillei.
E. Cambageana.
E. Campaspe.
E. canaliculata.
E. cladocalyx.
E. Clelandi.
E. conica.
E. cornuta.
E. corymbosa.
E. cosmophylla.
E. Dawsoni.
E. dealbata.
E. diversicolor.
E. drepanophylla.
E. Drummondi.
E. dumosa.
E. Dunnii.
E. erythrocorys.
E. eximia.
E. falcata.
E. foecunda.
E. Foelscheana.
E. Forrestiana.
E. Beyeri.
E. bicolor.
E. Blakelyi.
E. Boormani.
E. Bosistoana.
E. botryoides.
E. Brownii.
E. buprestium.
E. Caleyi.
E. calycogona.
E. miniata.
E. Morrisii.
E. Mundijongensis.
E. notabilis.
E. obliqua.
E. odorata.
E. Oldfieldii.
E. oligantha.
E. pachyphylla.
E. pallidifolia.
E. peltata.
E. Penrithensis.
E. Planchoniana.
E. polyanthemos.
E. populifolia.
E. ptychocarpa.
E. punctata.
E. pyriformis var. *Kingsmilli.*
E. rariflora.
E. robusta.
E. rostrata.
E. Rudderi.

E. gigantea.	*E. rudis.*
E. gomphocephala.	*E. saligna.*
E. gracilis.	*E. salmonophloia.*
E. grandifolia.	*E. Seeana.*
E. Griffithsii.	*E. similis.*
E. Guilfoylei.	*E. Le Souefii.*
E. hoematoxylon.	*E. Spenceriana.*
E. hemiphloia.	*E. squamosa.*
E. Hillii (very).	*E. Stowardi.*
E. Jacksoni.	*E. striaticalyx.*
E. Kirtoniana.	*E. Stricklandi.*
E. loevopinea.	*E. Tenandrensis.*
E. latifolia.	*E. tereticornis.*
E. Lehmanni.	*E. terminalis.*
E. longifolia.	*E. tetraptera.*
E. macrandra.	*E. tetrodonta.*
E. marginata.	*E. virgata.*
E. melliodora.	*E. Watsoniana.*
E. microcorys.	*E. Woodwardi.*

3. PETIOLE VERY LONG.

E. Foelscheana.	*E. populifolia.*
E. Hillii.	*E. rariflora.*

4. PELTATE LEAF.

A very few at that age (what Bentham calls “sapling leaves”) especially in the Corymbosae series, appear to be already alternate, but have the lamina peltately inserted on the petiole above the base, but our data on that point are but very scanty. (B.Fl. iii, 187.)

The petiole is a continuation of the midrib, and in peltate leaves the base of the leaf is extended below the point of insertion of the petiole into the leaf.

The remarks of Mueller in “Eucalyptographia” on the peltate leaf are chiefly based on *E. peltata,* a species which, at Part XLII, p. 33, I have shown to have been erroneously understood by him as regards its mature leaves. Bentham followed Mueller's earlier description of *E. peltata* as regards the supposed peltateness of the mature foliage.

Then Naudin has some remarks on the subject, translated herewith:—

. . . These are not the only modifications of the foliage in Eucalyptus. There are some species in the group, which in opposition to the preceding can be called *Uniform,* in which the primordial leaves, alternate and petiolate, are really peltate by reason of the insertion of the petiole at a certain distance from the base of the leaf.

This character is not very constant, for in the same species one finds species which have it and other which have not. Besides, it does not generally affect more than the first five or six first leaves, sometimes also a large number. But if it is transitory in these species, it becomes permanent in others; it is at least the case of *E. peltata,* whose leaves remain peltate during the whole life of the tree. (Naudin, 1st *Mem.,* 347.)

A few years later, Naudin wrote:—

There is finally a last peculiarity, the way in which the petiole is inserted on the blade. In the great majority of species this insertion takes place at the very base of the blade, as in our native (French) trees, but there is a small number of them in which it occurs a little below the insertion of the petiole. The result is what is called peltate leaves. This modification is always limited to the juvenile stage, except in one species, *E. peltata,* in which this character becomes permanent. (Naudin, ii, 1'0.)

In ii, 16, Naudin adds *citriodora, maculata,* and *calophylla* as having peltate leaves. He is referring to very young leaves. No species has peltate leaves throughout the whole life of the species; the mistake, as regards *E. peltata,* originated with Mueller, and has already been dealt with.

So far as I have seen, the peltate leaves preponderatingly belong to the Corymbosae. Those that I have seen are, and no doubt peltateness will be found in others:—

E. calophylla.	*E. peltata.*
E. eximia.	*E. Torelliana.*
E. ficifolia.	*E. trachyphloia.*
E. maculata.	

In addition, we have *E. erythrocorys* (belonging to the allied Eudesmieae), and others should be searched for.

b. **Its absence.**

1. Sessile.
2. Stem-clasping, *i.e.,* with expansions of the lobes of the leaf.
2*a.* Stem-clasping and crowded.

1. SESSILE.

It will be seen at once, on examination of a sessile leaf, say *E. Gunnii,* fig. 6*a,* Plate 108, Part XXVI, that the bases of the two leaves touch the stem.

It must be understood that, in dealing with juvenile leaves, their insertion on the plant involves—

(*a*) Petiole (or absence of it).
(*b*) The common axis or stem, not the petiole.

The following leaves are sessile, or practically so:—

E. acacioeformis.
E. acacioides.
E. aggregata.
E. amygdalina.
E. angophoroides.
E. apiculata.
E. approximans.
E. Baeuerleni.
E. Bakeri.
E. capitellata.
E. dichromophloia.
E. doratoxylon.
E. eugenioides.
E. fruticetorum.
E. Kybeanensis.
E. loevopinea.
E. ligustrina.
E. lineans.
E. longicornis.
E. macrorrhyncha.
E. megacarpa.
E. Moorei.
E. Muelleriana.
E. obtusiflora.
E. ochrophloia.
E. odontocarpa.
E. odorata.
E. oleosa.
E. pachyloma.
E. proecox.
E. pyrophora.
E. regnans.
E. resinifera.
E. scoparia.
E. Smithii.
E. spathulata.
E. tetragona.
E. transcontinentalis.
E. umbra.
E. uncinata.
E. vernicosa.
E. vitrea.
E. Websteriana.

2. STEM-CLASPING.

In other words, we have basal expansions of the lobes of the leaves. The bases, in connection with an appropriate shape of the leaf, gives us a cordate leaf, and the stem-clasping leaf itself is often termed amplexicaul. At p. 291, under "Shape," they are separately classified under broad and narrow. In the list which follows, those inclined to be narrow are indicated by (N).

E. accedens.
E. acmenioides.
E. angophoroides.
E. Benthami (N).
E. de Beuzevillei.
E. Camfieldi.
E. capitellata.
E. melanophloia.
E. Mooreana.
E. Muelleri.
E. neglecta.
E. nitens (N).
E. nitida.
E. nova-anglica.

E. cinerea.	*E. numerosa* (N)
E. clavigera.	*E. ovata.*
E. coccifera.	*E. parvifolia.*
E. cordata.	*E. patens.*
E. coriacea.	*E. Perriniana.*
E. Dalrympleana.	*E. pilularis.*
E. decurva.	*E. pilularis* var. *pyriformis* (N).
E. dichromophloia.	*E. piperita.*
E. diversifolia.	*E. Preissiana.*
E. dives.	*E. pruinosa.*
E. Dunnii.	*E. pulverulenta.*
E. eloeophora.	*E. pyrophora.*
E. eudesmioides.	*E. quadrangulata* (N).
E. eximia.	*E. radiata* (N).
E. ferruginea (N).	*E. Risdoni.*
E. Gillii.	*E. rubida.*
E. globulus (N).	*E. setosa.*
E. goniocalyx (N).	*E. Sieberiana.*
E. Gunnii.	*E. Smithii* (N).
E. Houseana.	*E. stellulata.*
E. Irbyi.	*E. Stuartiana.*
E. Kruseana.	*E. unialata* (N).
E. leucoxylon.	*E. umbra.*
E. Macarthuri (N).	*E. urnigera.*
E. macrocarpa.	*E. vernicosa.*
E. Maideni (N).	*E. viminalis* (N).

2*a.* STEM-CLASPING AND CROWDED.

This sub-head may prove convenient for purposes of rough classification.

E. aspera.	*E. pruinosa.*
E. macrocarpa.	*E. vernicosa.*
E. Muelleri.	

Connate or Perfoliate.

This is a question of fusion of two leaves by their bases, around a common axis or stem, not petiole.

It even happens in a small number of Eucalypts, that these opposite (*i.e.,* sessile and opposite during a long period of the youth of the tree) leaves unite by their base and become what is called *connate,* forming then a single piece, which is traversed through its centre by the stem or the branch. This new disposition of the foliage is sometimes transitory, as in *E. Risdoni,* sometimes permanent as in *E. gamophylla, E. perfoliata,* and perhaps some others. (Naudin, 1st *Mem.,* 347.)

Mueller in "Eucalyptographia" under *E. gamophylla* has a note on *E. perfoliata.*

The concrescence of the leaves by pairs in all stages of growth occurs, so far as known, only in *E. perfoliata,* if even in that rare and little known congener this coalescence should prove also exceptional.

If Plate 180, Part XLIV of the present work be referred to, it will be seen that this species is not perfoliate throughout life.

Besides those species mentioned by Naudin as showing perfoliation, we may include *E. pulverulenta, E. Perriniana.* A figure of a perfoliate leaf (*E. Perriniana*) may be seen at fig. 11, Plate 83, Part XIX (erroneously as *E. cordata*).

See fig. 1*a,* Plate 32, Part VI, for the connate leaves of *E. Risdoni* encircling the stem. This particular twig shows flowers and fruits, the leaves still exhibiting juvenility. Perfoliate leaves of *E. gamophylla* will be found figured on Plate 147, Part XXXV.

Scars on branches and trunks.—As growth proceeds, the rachises increase in diameter, and stretch the bases of the perfoliate leaves. The leaves are persistent for a long time, and leave circular ragged scars or fragments on the branches and on the main trunk, even when the latter attain several inches in diameter. This character seems rare in Eucalyptus. I have seen it in *E. pulverulenta* (see Part XXI, p. 15), but only in a very marked manner in *E. Perriniana.* It, however, probably occurs in all perfoliate species.

Fusion of leaves by margins.

We have already spoken of fusion of leaves by their bases, but we may have fusion taking place at other parts of their margins.

This is an unusual occurrence in Eucalypts; the following are the only cases known to me. Additional instances should be searched for:—

1. *E. numerosa,* Bega district (James Taylor, May, 1918).
2. *E. maculosa,* Blackheath (R. H. Cambage).
3. *E. cordata.* In specimens growing in the Botanic Gardens, Sydney, the laminae are sometimes fused both basally and laterally.

At Part XLIX, p. 279, we have already spoken of Cohesion of Branches. This fusion may be referred to as "Cohesion of Leaves."

Decurrence of Leaf.

When the green tissues of sessile leaf blades is continued down the stem, by adhesion, in the form of two green bands or wings, the leaf is said to be decurrent.

A marked case is rare in Eucalyptus. We have it in *E. Flocktonioe,* figs. 3*a* to 3*c,* Plate 236, Part LVIII, which is the best example known to me. It occurs also in *E. macrocarpa,* fig. 1*a.* Plate 77, Part XVIII.

The typical form is morphologically close to "stem-clasping," and less close to that extreme form of quadrangularity which exhibits that type of winged stem which is familiar to us in *E. quadrangulata* and *E. tetragona.* In the latter species it is not the lobes of the leaf (or of two opposite leaves) which are concerned, but one (or two) flattened or expanded petioles, with no lamina.

Angularity of Branchlets.

A few notes may be required on some of the minor characters which I have made use of or neglected in the specific diagnosis and descriptions. I have thought it generally useless to describe the branchlets terete or angular, for in those species such as *E. pruinosa, E. tetragona, E. tetraptera,* &c., where the angles are often so prominent as to be almost transformed into wings, there occur branches, often on the same specimen, quite terete. (B.Fl. iii, 186.)

For sketches of angular stems of these species, see *E. pruinosa* (Part XII, Plate 54); *E. tetragona* (Part XLVI, Plate 188); *E. tetraptera* (Part XXII, Plate 94). An exaggerated case is that of *E. quadrangulata,* of which a section of the young stem is figured at fig. 4e, Plate 103, Part XXIV.

It is probably the case that some branchlets will be found to be angular in all species. The following are some in which I have personally observed to be marked, in addition to those mentioned by Bentham, and I could mention others.

E. globulus and its allies.—*E. Maideni, E. unialata,* and *E. goniocalyx.*

E. tereticornis and its allies.—*E. rostrata* and *E. amplifolia.*

E. cosmophylla.	*E. Planchoniana.*
E. dumosa.	*E. Preissiana.*
E. Kybeanensis.	*E. propinqua.*
E. macrocarpa.	*E. punctata.*
E. neglecta.	*E. Shirleyi.*
E. nitens.	*E. Woodwardi.*

In a note "On the forms of Stems of Plants" (British Association Meeting, 22nd August, 1904), Lord Avebury remarks: "Plants with quadrangular stems always have opposite leaves." He was referring to such families as the Labiatae, but it is true of many Eucalypts, so far as the juvenile foliage is concerned.

Texture.

Their texture is very variable. In all the species there is a certain firmness, but with some, this firmness makes them exceptionally coriaceous. (Naudin, 2nd *Mem.,* 10.)

Mr. R. H. Cambage is one of the few botanists who has written on the subject:—

The *thickening of the epidermis* for the purpose of sheltering the stomata, is one of the expedients resorted to by the Eucalypts to resist evaporation, and consequently it is compatible with such an endeavour, that those species having the thickest epidermis and of which such as *E. dumosa* may be taken as a type, are commonest in the interior. But this particular character is to be met with intermittently in all the four climatic divisions of New South Wales, so that it would appear that various species have adopted this precaution for preservative objects but from different causes. A dwarfed Port Jackson form of *E. capitellata* has remarkably thick almost orbicular leaves, while large normal type specimens within a few miles have lanceolate foliage of ordinary thickness. The thick-leaved form, however, grows in the more exposed positions, and in the more rocky situations with probably less plant-food available. It seems therefore not improbable that in order to counteract the effect of strong winds, to which its exposure renders it liable, and also to compensate in some way for the limited nourishment it obtains, that the thick-leaved adaptation has been evolved in this case, to preserve the starch which forms in the leaf and which is regarded as an auxiliary food supply. It is of interest to note that the thickest leaved types usually correspond with the more dwarfed forms, and when the same species at maturity occurs both as large and as stunted trees, it is on the latter that the thickest leaves are found.

Turning next to the Eucalypts in the cold climate, we find a similar variation in leaf characters. The foliage of *E. Gunnii* as dwarfed trees on Mount Roland in Tasmania at nearly 4,000 feet above sea-level, is distinctly thicker in texture than that of the same species around Guildford Junction at an altitude of 2,000 feet, and where the trees are upwards of 80 feet high.

The leaves of *E. coriacea* are always somewhat leathery, as the specific name would imply, but in observing trees of this species from just above the 2,000-feet level around Goulburn upwards to the 6,000 feet level towards Kosciusko, it is found that with the ascent the leaves get gradually smaller and thicker, and the trees become dwarfed from the rigid conditions and weight of winter snow, until at last they appear as gnarled shrubs with interlacing branches and the now thickened leaves have been reduced in length from about 6 to 3 inches.

It therefore appears that the sub-arid conditions of the inland country, and the coldest effects of the mountains, though extreme in their climatic influence, have so operated in regard to this particular phase of leaf character as to bring about the same result. It is suggested, however, that the modifications of the internal structure of the leaves of two Eucalypts which originated before the Kosciusko uplift, and developed until the present time under those two extremes of climatic influence, would not be the same, and, although the leaves of *E. coriacea* at 6,000 feet have their counterpart in the interior at 500 feet, so far as the thickening character is concerned, yet in their venation they are distinct from those of all species found in that dry region. (*Proc. Roy. Soc. N.S.W.,* xlvii, 36, 1913.)

I quite agree with Mr. Cambage that thickness in leaves is sometimes evidence of lack of transpiration. The thickest leaf in Eucalyptus known to me is *E. tetraptera* (and to a less extent *E. Preissiana*). Both of these are denizens of a coastal region in south-western Australia, east of a well-watered belt. The saline winds (tending to xerophytic conditions) and a moderate rainfall, combine to induce this thickness of tissue. *E. incrassata* var. *angulosa,* very common near the sea in Western and South Australia, may be even succulent in texture. To mention other species which love the saline breezes would be to enumerate those with abnormally thick leaves. Thus we have *E. capitellata, E. obtusiflora,* and many others.

Cold localities (*e.g.,* mountain-tops) also check transpiration and induce thickness; thus we have *E. coriacea, E. alpina, E. coccifera, E. Gunnii.* (These are the species that are included in a list of those that cattle eat in droughty times, but it must be borne in mind that they frequent localities not subject to great droughts. See my "Forest Flora of New South Wales," Part LXX, p. 445.)

Conversely, we have thin leaves to facilitate transpiration, such leaves being always denizens of brushes, most commonly on the east coast, where the dense growth of the rain forests induces shelter. Very thin leaves, usually with pale undersides, can be found in such species as *E. microcorys, E. acmenioides, E. umbra, E. paniculata, E. botryoides, E. saligna,* and many others, the thinness being accentuated in the juvenile foliage. These thin leaves tend to be horizontal. See pp. 288 and 324.

It is obvious that, since the texture of a leaf varies according to the ecological conditions of the plant, there is much variation in the records of this character.

The following grouping of leaves under varying degrees of thickness has a basis of truth in it, but must be studied in a truly philosophic spirit. These lists (as indeed all under Juvenile leaves) are based on examination of actual specimens).

Very thin.

E. Benthami.	*E. latifolia.*
E. Beyeri.	*E. notabilis.*
E. Blaxlandi.	*E. rudis.*
E. ficifolia.	*E. tereticornis.*
E. gigantea.	*E. Watsoniana.*
E. haematoxylon.	

Thin.

E. acacioides.	*E. decorticans.*
E. acmenioides.	*E. diversicolor.*

E. alba.
E. altior.
E. Andrewsi.
E. Baueriana.
E. de Beuzevillei.
E. bicolor.
E. Bosistoana.
E. Cloeziana.
E. coccifera.
E. Considenianа.
E. crebra.
E. Dalrympleana.
E. Dawsoni.
E. Deanei.
E. maculata.
E. maculosa.
E. Maideni.
E. marginata.
E. microcorys.
E. Muelleri.
E. Muelleriana.
E. Naudiniana.
E. occidentalis.
E. odorata.
E. paniculata.
E. papuana.
E. Parramattensis.
E. patens.
E. pellita.
E. peltata.
E. Pilligaensis.
E. pilularis.

E. diversifolia.
E. Dunnii.
E. elaeophora (sometimes).
E. foecunda.
E. gigantea.
E. goniocalyx.
E. gracilis.
E. Guilfoylei.
E. Irbyi.
E. Kirtoniana.
E. Lehmanni.
E. linearis.
E. longifolia.
E. Macarthuri.
E. piperita.
E. propinqua.
E. quadrangulata.
E. radiata.
E. regnans.
E. resinifera.
E. robusta.
E. Rudderi.
E. saligna.
E. Seeana.
E. Sieberiana.
E. similis.
E. Smithii.
E. terminalis.
E. Torelliana.
E. umbra.
E. viminalis.

Moderately Thin.

E. amygdalina.
E. angophoroides.
E. Baeuerlenii.
E. Bancrofti.
E. botryoides.
E. canaliculata.
E. cladocalyx.
E. cneorfolia.
E. conica.

E. Morrisii.
E. neglecta.
E. nitens.
E. nitida.
E. oleosa.
E. ovata.
E. proecox.
E. punctata.
E. Raveretiana.

E. cornuta.
E. Culleni.
E. dives.
E. elaeophora.
E. fraxinoides.
E. globulus.
E. gomphocephala.
E. grandifolia.
E. Jacksoni.
E. laevopinea.
E. megacarpa.
E. melliodora.
E. miniata.
E. rostrata.
E. rubida.
E. salmonophloia.
E. setosa.
E. sideroxylon.
E. Spenceriana.
E. Staigeriana.
E. Stuartiana.
E. tessellaris.
E. tetrodonta.
E. Thozetiana.
E. unialata.

Somewhat Thick or Thickish.

E. affinis.
E. amplifolia.
E. angustissima.
E. annulata.
E. apiculata.
E. approximans.
E. Banksii.
E. Behriana.
E. Blakelyi.
E. Boormani.
E. calophylla.
E. Campaspe.
E. celastroides.
E. Cooperiana.
E. cordata.
E. cosmophylla.
E. crebra.
E. dealbata.
E. drepanophylla.
E. Drummondii.
E. elaeophora.
E. erythrocorys.
E. falcata.
E. fasciculosa.
E. fruticetorum.
E. gamophylla.
E. gigantea.
E. Gillii.
E. leptophleba.
E. leucoxylon.
E. longicornis.
E. melanophloia.
E. Moorei.
E. Normantonensis.
E. odontocarpa.
E. pachyloma.
E. parvifolia.
E. Perriniana.
E. Planchoniana.
E. polyanthemos.
E. populifolia.
E. pulverulenta.
E. pumila.
E. pyrophora.
E. Risdoni.
E. salubris.
E. spathulata.
E. squamosa.
E. Stowardi.
E. Stricklandi.
E. stricta.
E. tetragona.
E. Todtiana.
E. torquata.
E. transcontinentalis.
E. uncinata.

E. intertexta. *E. urnigera*.
E. Kitsoniana. *E. vernicosa*.
E. Kybeanensis. *E. virgata*.
E. Lane-Poolei. *E. vitrea*.
E. Laseroni.

Thick.

E. accedens. *E. obtusiflora*.
E. Caleyi. *E. Oldfieldi*.
E. capitellata. *E. pachyphylla*.
E. coriacea. *E. platypus*.
E. decipiens. *E. Preissiana*.
E. dumosa. *E. pruinosa*.
E. Forrestiana. *E. redunca*.
E. Griffithsii. *E. siderophloia*.
E. Hillii. *E. Le Souefii*.
E. leptopoda. *E. striaticalyx*.
E. Mooreana. *E. Woodwardi*.
E. Mundijongensis.

Very Thick.

E. Ewartiana. *E. Preissiana* (almost the thickest known to me).
E. Foelschiana.
E. perfoliata. *E. tetraptera* (the thickest known to me).

Vestiture (Glands and Hairs).

Bentham ("Flora Australiensis") seems to have almost ignored hairiness in the leaves. He does not mention it in the introduction to the genus, at p. 185, B.Fl., iii, and apparently he only mentions it in the case of *E. peltata* at p. 254. He apparently looked upon hairs as being so early deciduous as not to be worth while mentioning in descriptions.

Mueller ("Eucalyptographia"), in defining the genus, says, "Branchlets . . . quite glabrous or sometimes those of juvenile plants rough-hairy or rarely so those of advanced plants; leaves of aged plants nearly always glabrous . . . and never soft-hairy . . . "

It is my intention to revert to the matter when I deal with the question of Seedlings, one of the most important phases of the whole subject.

In the juvenile state, many of the species have the stem and the leaves covered with little glandular hairs, which make them rough to the touch and give them a dull appearance (*E. cornuta, Lehmanni, Planchoniana*, &c.), but this hairiness is mostly very transitory. Sometimes it is replaced by simple asperities, for example, in *E. coccifera*, which even to its second or third year is covered with projecting glandules, which may be regarded as the foundation of aborted hairs. On passing to the adult stage it rids itself of this vestiture, and becomes entirely glabrous. (Naudin, 1st *Mem.*, 348.)

As to their vestiture, the leaves of Eucalyptus are almost always very glabrous; however, in some, those which succeed the cotyledons are covered with very short hair, like the young stem, which is then covered with little asperities. We know, however, one species, *E. setosa*, in which the upper branches, the flowers and the fruit are hairy, but it is perhaps the only exception in the genus. (Naudin, 2nd *Mem.*, 10.)

Solederer, i, 353, at fig. 77, shows secretory cavity in an emergence of the leaf of *E. citriodora*. (After Lignier.)

Eucalyptus leaves are unarmed, so far as any mechanical means are concerned, such as spines, thorns, or stinging hairs. At the same time, most of them are effectively protected by their essential oils and fibre from attacks by the grazing animals which have been brought to Australia by the white man. Some exceptions are enumerated in the paper referred to below, and there is no doubt that, in time, such animals will develop increased toleration for these leaves.

On the other hand, some of the indigenous animals have developed a fondness for leaves rich in oil; indeed, the Native Bear, which is often kept as a pet, has a very decided taste for highly aromatic species. (The subject of the attractiveness, as fodders, of Eucalyptus leaves to native and introduced animals, is referred to in my "Forest Flora of New South Wales," Part LXX, p. 452.)

Coats of hairs are of great use as protections or screens to the young foliage leaves when they first emerge from the buds. The leaves of a great number of plants are only hairy during the earliest stages of development. (See notes on Anthocyanin, p. 331.)

On the foliage leaves of quite a number of species there appear felted stellate hairs which fall off as soon as the epidermis is sufficiently thickened.

The Stringybarks (*E. capitellata* and allies) have the double protection of somewhat harsh leaves, and of stellate hairs in the young state.

Glands are probably incipient hairs as Naudin suggests, and sometimes they may be called stellate glands. It is not always possible to make a line of demarcation between glands and hairs. No doubt the subject of hairs and incipient hairs in Eucalyptus will engage the attention of a special investigator.

The parts of the leaf on which hairs (when present) are usually found, are the rachis, petiole, midrib, secondary and marginal veins. In the case of those species which are copiously hairy, the minute, reticulate veins are more or less covered.

A. Stellate Hairs.

(*a*) Leaves more or less crinkled and hairs all over. These are Stringybarks:—

E. agglomerata.	*E. capitellata*.
E. alpina.	*E. eugenioides*.
E. Blaxlandi.	*E. ligustrina*.
E. Camfieldi.	*E. macrorrhyncha*.

(*b*) Hairs chiefly on edges of leaves, but variable. These (except *E. leptophleba* and *regnans*) are Stringybarks:—

E. laevopinea.	*E. Muelleriana*.
E. Laseroni.	*E. regnans*.
E. leptophleba.	

(*c*) Other Renantherae:—

E. apiculata.	*E. obtusiflora*.
E. haemastoma.	*E. virgata*.

(*d*) Corymbosae, or Bloodwoods:—

E. calophylla. Capitate hairs.
E. Cliftoniana. White glandular hairs.
E. corymbosa. Long glandular hairs.
E. dichromophloia. Stellate hairs.
E. eximia. Transparent glands and glandular hairs.
E. ficifolia. Scattered glandular processes.
E. Foelscheana. Glandular processes.
E. haematoxylon Glandular hairs.
E. latifolia. Small glands.
E. maculata. Glandular protuberances.
E. maculata var. *citriodora*. Glandular hairs.
E. miniata. Stellate hairs.
E. peltata. Flaccid glandular hairs.
E. ptychocarpa. Glandular hairs.
E. pyrophora. Prominent warty glands.
E. setosa. Glandular protuberances.
E. terminalis. Transparent glands and stellate hairs.

E. Torelliana. Stellate hairs, abundant.

E. trachyphloia. Reddish glandular hairs.

E. Watsoniana. Prominent glands.

The above will probably be found to have stellate hairs in all species, but I prefer to leave my notes as made at the time of the examination of each.

(*e*) Eudesmieae:—

E. Baileyana.	*E. tetrodonta*.
E. erythrocorys.	*E. tetragona*.
E. eudesmioides.	

It will be seen from the above that the Renantherae (chiefly as regards the Stringybarks) in the matter of stellate hairs, closely resemble the Corymbosae, an affinity shown also in regard to the cotyledons.

(*f*) Other species:—

E. Lehmanni. *E. Preissiana*.

B. Warty glands or glandular processes.

(*a*) Renantherae:—

E. altior.	*E. linearis*.
E. amygdalina.	*E. Moorei*.
E. Andrewsi.	*E. numerosa*.
E. approximans.	*E. obliqua*.
E. coccifera.	*E. Penrithensis*.
E. Consideniana.	*E. pilularis*.
E. coriacea.	*E. radiata*.
E. diversifolia.	*E. Sieberiana*.
E. dives.	*E. stellulata*.
E. fraxinoides.	*E. umbra*.
E. Kybeanensis.	*E. vitrea*.

(*b*) Bilobae (this and Bisectae are Cotyledon terms which will be explained later):—

E. acaciaeformis.	*E. leucoxylon*.
E. acacioides.	*E. Maideni*.
E. aggregata.	*E. Morrisi*.
E. angophoroides.	*E. Muelleri*.
E. Behriana.	*E. oligantha*.

E. botryoides.	*E. Parramattensis.*
E. cinerea.	*E. patens.*
E. Clelandi.	*E. populifolia.*
E. cordata.	*E. pulverulenta.*
E. Dunnii.	*E. punctata.*
E. elaeophora.	*E. rudis.*
E. globulus.	*E. sideroxylon.*
E. goniocalyx.	*E. Stuartiana.*
E. grandifolia.	*E. unialata.*
E. Gunnii.	*E. urnigera.*
E. hemiphloia.	*vernicosa.*
E. Kitsoni.	*E. Woodwardii.*

(*c*) Bisectae:—

E. leptophylla.	*E. uncinata.*
E. redunca.	

Lustre.

Very few writers refer to the subject of the lustre of juvenile leaves. This is readily understood, as very little has been written on juvenile leaves as such. Bentham says:—

. . . and the comparative *colour* of their surfaces, dark above and pale underneath or similar on both sides, but this can rarely be ascertained from dried specimens. In general, it would appear that the horizontal leaves have the two surfaces different, and the veins very divergent or transverse, and the vertical leaves have the surfaces similar and the veins oblique; so that where the leaves of the adult tree are alternate lanceolate and foliate with *oblique* veins, they are usually vertical, whilst the opposite ones of the sapling of the same species are horizontal. (B.Fl. iii, 187.)

This deals with the difference in colour (see also a separate note on "Colour," at p. 324), of the lower and upper pages or surfaces. I will presently give some species in which it has actually been observed, and it will be noted that many are from regions of comparatively high rainfall. We require further observations to ascertain our facts.

It will be observed that Bentham employs the term "horizontal" for juvenile leaves, and "vertical" for mature ones. It will be seen from the drawings already given in this work, that these terms are not quite satisfactory. They are technical terms merely. We have other examples, in descriptive botany, of absence of strict adherence to mathematical precision. Thus, in B.Fl. i, vi (definitions), speaking of venation, we have "When several (veins) start from the stalk, diverge slightly without branching, and converge again towards the summit, they are said to be *parallel*, although not mathematically so."

Mr. R. H. Cambage refers to the subject in the following passage:—

. . . *Horizontal and vertical leaves*.—The mature foliage of almost all Eucalypts is arranged vertically, and this fact furnishes strong evidence that there must have been considerable development in the genus, for in the great majority of cases the juvenile foliage is arranged horizontally. The same remark in regard to the juvenile foliage applies equally to its nearest allied genus, *Angophora*. There seems little reason to doubt that the mature foliage also was originally sessile and arranged horizontally, and that the pendant, vertical form is the most recent adaptation. Throughout the genus Eucalyptus there are various species which show a connecting link amongst their mature foliage, between the horizontal and vertical forms, and in a collection of leaves, some of the foliage may be noticed with the underside pale, which proves the horizontal disposition of the leaf.

Judging by results, it would seem to have been almost a necessity at some particular stage of Eucalyptus development that some adjustment of leaf arrangement should have been made to conform to some altered climatic condition, and ensure the further progress of the genus. The simplest method for those species to adopt which had already developed petiolate leaves, was to gradually twist the leaf-stalk and so change the position of the blade from horizontal to vertical. It is instructive to inquire into the condition of one or two species which appear to have been unable to do this. (*Journ. Roy. Soc. N.S.W.*, xlvii, 38, 1913.)

The difference in colour in the juvenile leaves is often associated with thinness, and the leaves contain a high percentage of moisture; they readily curl and dry up, showing their moist environment, and consequent free growth, creating abundance of shade. The question of the pale underside of a juvenile leaf is not entirely a matter of a coastal district, in comparatively rich soil and plenty of moisture, which conditions induce shade by exuberance of foliage. It is frequently seen, irrespective of obviously favourable conditions of soil and moisture, where there is a profusion of seedlings or other juvenile foliage, when the leaves shelter each other, obscuring the light from one side of a leaf. In some cases, *e.g., E. microcorys*, the paleness disappears as growth proceeds, but the mature foliage does not markedly differ from the juvenile.

Shiny.

Not many leaves can be said to be shiny when they are in the juvenile stage. *E. populifolia* is the most noticeable.

Pale Underside.

E. globulus and *E. Maideni* are conspicuous examples of leaves in which the glaucous underside is sharply differentiated from the glabrous upper surface. The letter (S) in brackets indicates "Slightly," so far as actually observed.

E. acmenioides.
E. angophoroides.
E. Baileyana.
E. Banksii (S).
E. Benthami.
E. botryoides.
E. cladocalyx.
E. Cloeziana.
E. Consideniana (S).
E. longifolia (S).
E. maculata.
E. Maideni.
E. marginata.
E. megacarpa.
E. microcorys.
E. Muelleriana.
E. Naudiniana.
E. notabilis.
E. obliqua.
E. paniculata.
E. parvifolia.
E. patens.
E. Deanei.
E. diversicolor.
E. Dunnii.
E. eximia.
E. ficifolia.
E. globulus.
E. goniocalyx.
E. Guilfoylei.
E. Jacksoni.
E. pellita.
E. pilularis.
E. piperita.
E. propinqua.
E. punctata (S).
E. quadrangulata.
E. Raveretiana.
E. resinifera.
E. saligna.
E. terminalis.
E. Torelliana.
E. trachyphloia.
E. umbra.

Equally Green on Both Sides.

E. acaciaeformis (pale coloured?).
E. amplifolia.
E. apiculata.
E. approximans.
E. Baeuerleni.
E. Bakeri (dull green).
E. Bancrofti (dull).
E. Baeueriana (dark green).
E. Behriana (bright green).
E. Beyeri.
E. bicolor.
E. Boormani.
E. Bosistoana.
E. Brownii.
E. calophylla (dull).
E. cornuta.
E. cosmophylla.
E. Culleni.
E. decipiens.
E. decorticans (pale green).
E. diversicolor.
E. dives.
E. drepanophylla.
E. Drummondii.
E. elaeophora.
E. erythrocorys (bright green).
E. Ewartiana.
E. exserta.
E. falcata (pale, also glaucous).
E. fasciculosa.

E. Cambageana.
E. canaliculata.
E. coccifera.
E. coriacea (pale green).
E. Griffithsii (dull green).
E. intertexta (pale green).
E. Kirtoniana.
E. Kitsoni.
E. laevopinea.
E. Lane-Poolei.
E. Laseroni.
E. latifolia (dull green).
E. Lehmanni.
E. leptophleba.
E. leptopoda.
E. linearis.
E. longifolia.
E. Macarthuri.
E. macrandra (bright green).
E. maculosa.
E. microtheca.
E. miniata (dull green).
E. Mooreana (glaucous).
E. Morrisii (dull green).
E. Muelleri (bright green).
E. Mundijongensis.
E. neglecta (pale green).
E. nitens.
E. nitida.
E. Normantonensis (sub-glaucous).
E. obtusiflora (bright green).
E. occidentalis (pale).
E. odorata.
E. Oldfieldi.
E. ovata.
E. pachyloma (dull green).
E. pachyphylla (pale green).
E. pallidifolia (pale green).
E. papuana (dull).
E. fraxinoides.
E. gomphocephala.
E. goniocalyx.
E. grandifolia.
E. Parramattensis.
E. peltata.
E. Penrithensis.
E. perfoliata (pale green).
E. Pilligaensis.
E. Planchoniana (pale green).
E. populifolia (dull).
E. Preissiana.
E. punctata.
E. pyriformis var. *Kingsmilli* (pale green).
E. pyrophora.
E. redunca (pale green).
E. robusta.
E. rudis.
E. salmonophloia (dull).
E. scoparia.
E. Seeana.
E. Smithii (slightly glaucous).
E. spathulata.
E. Spenceriana.
E. squamosa (dull green).
E. Staigeriana.
E. Stowardi.
E. Stricklandi (bluish green).
E. stricta (bright green).
E. tereticornis.
E. tessellaris.
E. tetraptera (bright green).
E. tetrodonta.
E. Thozetiana (dark green).
E. uncinata (pale).
E. unialata.
E. vernicosa (shiny).
E. viminalis.
E. Watsoniana.

In the following cases the juvenile leaves have been ascertained to be—

Glaucous.

E. acacioides.
E. melanophloia.

E. accedens.
E. affinis (S).
E. alba (S).
E. altior.
E. amygdalina.
E. Andrewsi.
E. aspera.
E. Benthami.
E. Blakelyi.
E. buprestium (S).
E. Caleyi (S).
E. calycogona.
E. Campaspe (S).
E. celastroides.
E. cinerea.
E. Clelandi (glaucous green).
E. cneorifolia.
E. conica (S).
E. cordata.
E. crebra (S).
E. Dawsoni.
E. dealbata.
E. decurva (S).
E. dumosa.
E. eudesmioides (S).
E. falcata (S).
E. foecunda.
E. Forrestiana.
E. fruticetorum.
E. gamophylla.
E. gigantea.
E. Gillii.
E. gracilis.
E. Gunnii.
E. Houseana (S).
E. Irbyi.
E. leucoxylon.
E. longicornis (S).
E. melliodora (S).
E. Mooreana.
E. Morrisii (S).
E. Normantonensis (S).
E. nova-anglica.
E. odorata (S).
E. oleosa.
E. peltata (S).
E. perfoliata (trace).
E. Perriniana.
E. polyanthemos.
E. praecox (S).
E. pruinosa.
E. pulverulenta.
E. pumila (S).
E. Risdoni.
E. rostrata.
E. rubida.
E. salmonophloia (trace).
E. salubris.
E. siderophloia.
E. sideroxylon.
E. Sieberiana (S).
E. Smithii (S).
E. Le Souefii.
E. striaticalyx.
E. Stuartiana.
E. tetragona.
E. tetradonta (trace).
E. torquata.
E. transcontinentalis.
E. unialata (S).
E. urnigera.
E. virgata
E. vitrea (S).
E. Websteriana.
E. Woodwardi.

Glaucousness.

The only reference to Eucalyptus I can find in the “Life and Letters of Charles Darwin” is in the following passage, iii, 341, in a letter to Asa Gray (the celebrated

American botanist):—

. . . I am now trying to make out the use or function of "bloom" or the waxy secretion on the leaves and fruit of plants . . . Are such plants commoner in warm than in cold climates? I ask because I often walk out in heavy rain, and the leaves of very few wild dicotyledons can be here seen with drops of water rolling off them like quicksilver. Whereas, in my flower garden, greenhouses and hothouses there are several. Again, are bloom-protected plants common in your *dry* western plains? Hooker *thinks* that they are common at the Cape of Good Hope. It is a puzzle to me if they are common under very dry climates, and I find bloom very common on the Acacias and Eucalypti of Australia. Some of the Eucalypti which do not appear to be covered with bloom, have the epidermis protected by a layer of some substance which is dissolved in boiling alcohol. Are there any bloom-protected leaves or fruit in the Arctic regions?

Darwin's experiments and observations on bloom remained unfinished at the time of his death.

The colour of the leaves in Eucalypts is subject to many variations. The fundamental colour is without doubt green, but it is often concealed by the secretion of essential oils in the glands, not very visible, with which the foliage and all the young parts of the tree are enveloped. The result is glaucous tints of different degrees, which sometimes give a bluish cast to the trees, whence the name Blue Gums given by the Australian colonists to some species, among others to *E. globulus,* which in its juvenile stage shows this character very markedly. Sometimes the oily resinous secretion exudes and becomes solidified in the form of a whitish pulverulence, and there are indeed some Eucalypts having this last colour in a very pronounced manner. These are the White Gums of the Australians. (In a preponderating number of cases, when an Australian speaks of a White Gum, he means one with a white, smooth *bark,* J.H.M.). Other variations of leaves should be noticed. If these organs appear glaucous, glaucescent, greyish, or, almost white in certain species, it is because of an oily resinous secretion which does not sensibly alter the fundamental green colour. These have green foliage, often shiny, and even varnished, particularly on the upper surface; in the case of many of the others, the colour remains dull, and it is almost the same colour on both sides of the leaf, especially when the blade, being in an oblique or vertical plane, receives almost as much light from one side as the other. In the species in which the blade is horizontal, the lower side is always duller than that which faces the sun. (Naudin, 2nd *Mem.,* 10.)

In certain species of Eucalyptus (*E. globulus* and *E. pulverulenta*) the outer wall of the epidermis is provided with a coating of wax; the latter consists of an aggregate of small rod-like particles. (Solederer, i, 352.)

Many leaves, especially those that appear “glaucous” have a bluish-grey surface film of wax, sometimes known as *bloom,* which is readily removed by rubbing. Wax coats are best developed by xerophytes, and appear to be increased by excessive transpiration. Thin as they are, wax coats effectually impede transpiration, the mere rubbing of a glaucous leaf sometimes inducing an increase of a third in the transpired water. Wax coats also retard the heating of leaves. As with hairs, but not with cutin, wax coats are best developed on the under leaf surface, where the stomata are the more abundant. (Coulter, Barnes and Cowles, ii, 570.)

One of the most interesting Eucalypts in this (the author is speaking about Horizontal and Vertical Leaves) connection is *E. pulverulenta* (*E. pulvigera*) which is growing in the Mountain Region at Cox's River, at Bathurst and near Cooma. This tree appears to have been unable to develop any lanceolate leaves at all, or to substitute the alternate for the juvenile opposite arrangement, the whole of its foliage being either orbicular or broadly ovate, and being sessile, the cordate leaves remain clasping the stem at right angles, and therefore present their full surface to the sun. It is now that we see the potentialities of the Eucalypt to adapt itself to its surroundings, and the method selected in this instance has been to cover the leaves with a glaucous powder or vegetable wax which reduces the effect of the sun's rays and therefore lessens the evaporation, while it also serves to keep out the cold in winter. It would seem, however, that this provision has not been so successful as the twisting of the leaf-stalk, for this species is a weakling and rarely seems able to grow more than 20 feet high, and although in the past it appears to have had an extensive range at least from Bathurst to Cooma, a distance of about 200 miles, it is not known in the intervening area, and is looked upon as rare in both localities. The available evidence regarding this tree points to the conclusion that it is probably a vanishing species.

E. cordata of Tasmania is a very similar little tree and has adopted the vegetable wax instead of the vertical leaf. The species is confined to Tasmania, and even there is not regarded as plentiful. It seems not unlikely that in the near geological future both these species will have disappeared.

E. cinerea of the Goulburn district is somewhat similar to the two former, but appears to be past the critical stage. It has covered its leaves with glaucous powder, and although some trees are furnished with opposite orbicular and broadly ovate leaves only, others have developed many lanceolate leaves which hang vertically. It grown to a height of 40 or 50 feet, has a fairly considerable range, and its stems are covered with thick, shortly-fibrous bark, while the two former have smooth bark.

The remarks in regard to *E. cinerea* apply generally to an interesting species known as Silver-leaved Ironbark, *E. melanophloia,* except that the latter has a hard furrowed bark. (R. H. Cambage, *Proc. Roy. Soc. N.S.W.,* xlvii, 39, 1913.)

Glaucescence.—The clothing of the leaves with a glaucous powdery wax is often resorted by to the Eucalypts, and especially by the juvenile foliage, but in many instances this method of protection is adopted by the mature foliage as well, and under different conditions of climate, from that of the hot and dry interior to that of the cool mountain region, and also with varying degrees of intensity according to the age of the leaves. This covering is largely met with in the cool climate, where it may be seen not only on the leaves and buds, but also on the branchlets, and in some cases on the smooth-barked boles, as on *E. maculosa, Sieberiana,* and *rubida.* As already pointed out (see Horizontal and Vertical leaves) it is the method commonly availed of by those species whose leaves are sessile and orbicular to ovate (H. Deane *Proc. Linn. Soc. N.S.W.,* xxv, 471, 1900), and it appears to be a device adopted as a protection against evaporation which may be caused either by the heat of the dry lowlands, or by the winds and intensity of light in a clear atmosphere on the highlands.

Thick Epidermis.—The thickening of the epidermis has already been referred to under "Thick and Thin leaves." (*ib.,* p. 44.)

There are factors which induce variation in glaucousness, and it will require many years of research before the facts are ascertained. The seasons and the climatic conditions affect the amount. As has already been well ascertained, glaucousness hinders transpiration, and therefore approach to the interior, and xerophytic conditions generally regulate its amount. Conversely, hardly any members of the Renantherae are glaucous; they are coastal.

I make a beginning in offering a provisional list of species as regards glaucousness; it will be a framework for observers to begin on.

Glaucous only on the underside.

The most marked species are:—

E. globulus, E. Maideni,

and they seem unique.

Those which are simply paler on the underside are very much more numerous; the pale undersides can be best studied from seedlings, and I will draw attention to the subject when I deal with those.

Glaucous all over.

We have various degrees of glaucousness, from such species as *Campaspe* and *tetragona,* where it is so abundant as to seem to require the name of mealy, for one fancies one could collect the wax with a knife.

Following is a general list of glaucous species:—

E. accedens.	*E. Kruseana.*
E. amygdalina.	*E. leucoxylon.*
E. Benthami.	*E. macrocarpa.*
E. calycogona.	*E. nitens.*
E. calycogona var. *gracilis.*	*E. nova-anglica.*
E. Campaspe.	*E. oligantha.*
E. cinerea.	*E. Perriniana.*
E. Clelandi.	*E. pruinosa.*
E. cordata.	*E. pulverulenta.*
E. Dalrympleana.	*E. quadrangulata.*
E. dealbata.	*E. Risdoni.*
E. decurva.	*E. rubida.*
E. Gillii.	*E. Stuartiana.*
E. Gunnii.	*E. urnigera.*
E. hemiphloia var. *albens.*	*E. Woodwardii.*

Then we have a list of species which, as a general rule, appear to be less glaucous than the preceding. To define them, I have called them—

Slightly Glaucous.

(At the same time, some of the above species are sometimes so slightly glaucous as to be better defined "pale on the underside.")

E. affinis.	*E. leptophylla.*
E. amplifolia.	*E. maculosa.*
E. Andrewsi.	*E. melliodora.*
E. Caleyi.	*E. polyanthemos.*
E. cordata.	*E. pyriformis.*
E. cosmophylla.	*E. redunca.*
E. Dawsoni.	*E. rostrata.*
E. decipiens.	*E. Smithii.*
E. elaeophora.	*E. transcontinentalis.*
E. erythronema.	*E. uncinata.*
E. foecunda.	*E. unialata.*
E. goniocalyx.	*E. viminalis.*
E. Lane-Poolei.	

Then we have a phenomenon not yet worked out—a steel-grey appearance, such as is seen in the Blue-leaf Stringybarks (*E. loevopinea* and *agglomerata*), *E. cneorifolia.* We note it in the young leaves at the tips of the trees. It is akin to the slight glaucousness of some of the preceding species, but may be in succession to the anthocyanin colours of the young foliage referred to below. In this connection we have the silky sheen of the leaves of *E. drepanophylla* (see Part X, p. 332). Some day the subject of lustre and colour in Eucalyptus will be taken up by someone with a competent knowledge of physics.

Speaking of the tropical Western Australia *E. collina,* Mr. W. V. Fitzgerald writes that the branchlets and often the leaves appear as if covered with frost, becoming so conspicuous that the trees can be seen from a long distance.

Colour (Anthocyanin.)

This pigment has been known for many years, but even yet its chemistry has been imperfectly worked out (*e.g.,* see Dr. M. A. Forster, F.R.S., "British Association Report," 1921). It forms the pigment in the reddish or purple colour seen in the spring foliage of the cherry, &c. It keeps back rays injurious to the plant, indeed, protects the chlorophyll (see Kerner and Oliver). Support in favour of this view is found because it is more abundantly deposited in parts exposed to light than those which are shaded. Organs which are very thickly covered with hairs scarcely ever develop anthocyanin. It is abundantly deposited in the young topmost branchlets of Eucalyptus trees, shining in the bright Australian sun. It is a very common practice for ladies to decorate their houses with Eucalyptus-tree tops, especially when flowers are scarce, for they are charmingly decorative. I give, with a few unimportant additions, a paper of mine on the subject taken from *Proc. Linn. Soc., N.S.W.,* xliv, 761 (1919).

Most people have noticed, particularly during the winter and early spring, that on the young branchlets, the foliage of Eucalypts is, in some species, of a brilliant colour, shades of crimson and purple being the commonest. There are few allusions to the character in botanical literature, one of the few being the following:—

Then again, the red colour of new foliage, so commonly seen here, is an outward sign of adaptation, in that the colour apparently acts as a screen to prevent the chemical rays of light (blue end of the spectrum) from penetrating the living workshops. Their admission to the young leaf cells would be detrimental, whilst the heat rays (red end) are collected and thus secured as likely to help along the life processes more rapidly to remove the new growth from babyhood to maturity.[1]*

Some years ago it entered into my mind to collect data as to the colours in question, but I found practical difficulties arising from the fact that the colours that we see on the living plant alter in tint within a few hours after removal. I then tried taking the register of colours to the trees themselves, but found the standard work I have adopted (Dauthenay's "Repertoire de Couleurs") so heavy that it was out of the question to carry it far in the bush. Accordingly, I submit some notes only on plants growing wild or cultivated in the Sydney district, but I feel that observers who desire to continue the work may get over the difficulty in many cases by packing the leaves in closely shut tins, and posting them, provided that they are not longer than a day or two in the receptacle.

I tried, while in the bush, to imitate the records by blotches of water colour, but failed; oil colours would be better, but I had neither the ability nor the time to adopt this method.

It is understood, of course, that my observations are so few that there is but little opportunity for generalisation. Without going so far as to say that in all cases the botanist of the future will be able to determine every species by the colour of its flush, I believe that my observations in regard to the matter (most of them not standardised) justify the belief that a number of species, and some groups, can be diagnosed by this means. I quote the dates and localities, because we have yet to learn whether the colour varies to any extent with these variables.

Each species (or rather each plant, for each plant varies somewhat within the species) has an *optimum* for colour, which requires to be ascertained. It will, therefore, be necessary to make a number of observations (as many as possible should be made on the same tree) before we ascertain the colour which we record as most characteristic of the species.

In some cases (not reproduced) I have marked the colours "secondary," as I am of opinion that they are not characteristic of the species, but represent one or more outside colours. In a few I have noted the colours of the young twigs, for whatever they may be worth. In most cases the colour-references have been made by Miss Margaret Flockton or Mr. W. F. Blakely. Most of the leaves have been collected by Mr. Blakely and Mr. J. L. Boorman.

A.—The Renantherae preponderatingly cluster around vinous purple (Plate 171).

E. microcorys, placed by Bentham and Mueller in this section, has dull carmine lake (Plate 106), and in this respect and in a number of other characters (*e.g.,* kino, anthers, and seedlings), as I shall show in the present work it is so aberrant that it should be removed from the Renantherae.

E. capitellata Sm. Port Jackson. Young foliage: "Vinous purple," see Plate 171. Very young foliage: "Garnet dull," Plate 163, shades 1–3.

E. eugenioides Sieb.—

1. Cabramatta, 10th July, 1917. Young foliage: "Vinous purple," Plate 171, shade 4.
2. Bankstown, 23rd July, 1919, Plate 171, shades 1–3.
3. Glenfield, 9th October, 1918: "Slate violet," Plate 173, shades 1–4.

E. pilularis Sm. Como, George's River, 9th September, 1916. Young foliage: "Vinous purple," Plate 171, shades 1–4. Young twigs angular and red.

E. piperita Sm.—

1. Corso, Manly, 14th September, 1916. "Vinous purple," Plate 171, shade 3. (Young twigs pale yellow-green, tinted with red.)
2. Sutherland, Como, 16th October, 1916. "Slate violet," Plate 173, shades 1–4.
3. Blackheath, December, 1917. Young foliage: "Dark violet," Plate 193, shades 1–4. (These were two days old.)
4. Emu Plains to Blaxland, 17th April, 1919. "Garnet brown," Plate 164, shades 1–4.

E. radiata Sieb. Blackheath, December, 1917. Young foliage: "Plum violet," Plate 172, shades 3–4. (These were two days old when registered.)

E. Sieberiana F.v.M.—

1. Spit-road, Manly, 14th September, 1916. Young foliage: "Plum violet," Plate 172, shades 3–4. Young twigs a rich deep red.
2. Same locality, 28th July, 1917. Young foliage: "Plum violet," Plate 172. Young twigs scarlet to purple-brown.
3. Near Mt. Colah Station, near Hornsby, July, 1917. Young twigs: "Dull purple-lake," Plate 170, shades 3–4. Very young leaves: "Deep carmine-violet," Plate 174, shades 3–4; the older leaves shading to violet-lilac, Plate 175, shades 2–4.
4. Blackheath, December, 1917. Young foliage: "Plum violet," Plate 172, shades 1–4. (Two days old when registered.)

E. umbra R. T. Baker.—Hawkesbury to Cowan by the old road, 26th January, 1918. Young foliage: "Dull purple-lake," Plate 170, shades 1–4.

E. microcorys F.v.M.—Cultivated, Botanic Gardens, Sydney, August, 1917. Juvenile foliage: "Dull carmine-lake," Plate 106, shades 1–4.

B:—The Corymbosae have mostly shades of purple. All belong to the same general group, the garnet-brown of *E. hoematoxylon* being most aberrant, but we must learn more of this species.

E. corymbosa Sm.—

1. Como, George's River, September, 1916. Young foliage: "Purple-brown," Plate 166, shade 2.
2. Old Berowra-road, Hornsby, 17th June, 1917. "Purple-brown," Plate 166, shades 3–4.
3. Sutherland, Como, 16th October, 1918. "Vinous purple," Plate 171, shades 1–4.

E. eximia Schauer.—Emu Plains to Blaxland, 17th April, 1919. "Plum violet," Plate 172, shades 1–4.

E. hoematoxylon Maiden.—(A W.A. species, cultivated Botanic Gardens, Sydney), 7th January, 1918. Young foliage: "Garnet-brown," Plate 164, shades 1–4.

E. maculata Hook.—Mt. Misery, Liverpool, 17th July, 1917. Young twigs "purple-brown," Plate 166, shades 2–3. Highly glazed. Young twigs: "purple-brown," Plate 166, shades 2–3.

C.—E. amplifolia, E. botryoides, E. hemiphloia, E. siderophloia..

These are four miscellaneous species. The slender evidence shows an affinity between the first, third, and fourth species that will be kept in mind, and between the second and the fourth.

E. amplifolia Naudin.—Liverpool, 17th July, 1917. Young foliage: "Plum violet," Plate 172, shades 1–3. Young twigs: "Plum violet," Plate 172, shades 3–4.

E. botryoides Sm.—

1. Corso, Manly, 14th September, 1916. Young foliage: "Garnet," Plate 162. (This is a difficult plate to use, because of its lustre, its appearance becoming nearer to or more removed from Plate 193, according to the incidence of the light.)
2. Glenfield, George's River, 9th October, 1918. "Dark violet," Plate 193, shades 1–4.

E. hemiphloia F.v.M.—

1. Cabramatta, 10th July, 1917. Young foliage: "Vinous purple," Plate 171, shades 2–3. Young twigs: Plate 171.
2. Bankstown, 22nd July, 1919. Young foliage: Plate 171, shades 1–4.

E. siderophloia Benth.—Cabramatta, 10th July, 1917. Young foliage: "Garnet-brown," Plate 164, shade 3; also "vinous purple," Plate 171, shade 3. Young twigs: "Garnet-brown" (Plate 164), "purple-brown" (Plate 166).

D.—E. hoemastoma, E. punctata, E. squamosa, E. virgata.

In these species I have only noted greens in the young foliage so far, but we have only touched the fringe of the subject.

E. hoemastoma Sm. var. *micrantha.*—Como, George's River, September, 1916. "Dark drab-green," Plate 237, shade 2. Midrib yellow or reddish. Stems angular, red or yellow.

E. punctata DC.—Como, George's River, September, 1916. Young foliage: "Laurel-green," Plate 269, shade 2. Back of leaves a pale glaucous-green, shiny on the upper side, midrib yellow or red. Young twigs red and yellow, angular.

(Note made from Glenbrook specimens, J. L. Boorman, 8th October, 1920. Young leaves vinous purple, Plate 171, shades 2–4.)

E. squamosa Deane and Maiden.—Como, George's River, September, 1916.

Young foliage: “Dull sage-green,” Plate 278, shade 2. Leaves the same colour on both sides. Red midribs and edges. Surface dull. Young twigs bright red, terete or slightly angled.

E. virgata Sieb. (*Luehmanniana* F.v.M.).—

1. National Park, 4th July, 1917. Young foliage: “Quaker green,” Plate 271, shade 1; also “pale green oxide of chromium,” Plate 243, shades 1–4; “old moss-green,” Plate 290, shade 1. Young twigs and petioles: “Yellow-green,” or “primrose-yellow,” Plate 16.
2. Same place and date. Young foliage: Plates 271 and 245. Petioles: “Lemon-yellow,” Plate 20, shade 4. Young stems: “Ox's blood-red,” Plate 94, shade 2.
3. Spit-road, Manly, 14th September, 1916. Young foliage: “Spinach-green,” Plate 270, shade 2. Leaves the same on both sides, surface dull, bright yellow midrib and edges. Branchlets coarse, angular, flattened, lemon-yellow.

The following notes on colours have not been standardised by reference to Dauthenay, or any similar work.

(*a*) *E. affinis.* Stuart Town (J.L.B.). “Leaves atropurpureus.”
(*b*) Red (bleeding heart) leaves in *E. obliqua* (Tasmania). (I have often seen young trees of this species with more or less bleeding-heart leaves, which, in transmitted light, look very beautiful, and, in comparison with other trees associated with it, very characteristic.)
(*c*) “As a young tree, the marked purplish cast of its foliage gives it an ornamental appearance.” *E. Planchoniana,* in Part IX, p. 291, of this work.
(*d*) “A specimen of *E. purpurascens* Link., in Herb. Vindob., is in the opposite-leaved stage, and is probably *E. amygdalina* Labill. The underside of the young foliage of this species is often purple. *E. amygdalina,* this work. Part VI, p. 153.

Caoutchouc.

Young Australia has amused himself from early in the settlement of the continent by pulling the young Anthocyanin-coloured shoots of Eucalyptus apart to note the Cauotchouc they contain. See a popular note, “Elastic Threads in Eucalyptus” in my “Forest Flora of New South Wales,” i, 154. It seems to occur in all members of the Corymbosae, and *Angophora.* As I have observed it in *E. stricta,* it may be found in other species.

Mr. H. G. Smith has made a chemical research in the matter “On the elastic substance occurring on the shoots and young leaves of *Eucalyptus corymbosa* and some species of Angophora.” (*Proc. Roy. Soc. N.S.W.,* xlii, 133, 1908.) The result of this investigation showed this elastic substance to be identical in composition with ordinary india-rubber, and that it is eventually oxidised to a white powder. A vegetable wax was also isolated at the same time.

If Eucalyptus caoutchouc could be obtained in quantity it seems reasonable to suppose that it would have considerable commercial value. The small percentage amount, however, makes it at present of scientific value only, without taking into consideration the difficulty of collection, its rapid change, and that it only occurs at certain times of the year.

Anatomy.

This has been referred to to a very brief extent at Part I, pp. 7, 8. There will be a reference to Mr. W. B. Welch's papers on leaf-anatomy in Part LVII.

Following is a very old anatomical reference:—

These two genera (Eucalyptus and Acacia) still more uniformly agree in the similarity of the opposite surfaces of their leaves. But this similarity is the indication of a more important fact—namely, the existence equally on both surfaces of the leaf of those organs, for which, as I believe them to be in general imperforated, I have adopted the name of *cutaneous* glands, but which by most authors are denominated pores, or *stomata of the epidermis.* (R. Brown in *Journ. Roy. Geog. Soc.,* i, 21, 1832; in this Coll. Works, i, 311.)

The stomata in leaves as a rule are chiefly, or wholly, to be found on the concave side, beneath which lies the soft green tissue with its ramifying air-passages.

With reference to Mueller's notes in "Eucalyptographia," already referred to at Part I, p. 8, of the present work, he has the following references to stomata in the same work:—

1. Lists of measurements of numbers on leaves of various species, under—

(*a*) *E. pachyphylla.*
(*b*) *E. phoenicea.*
(*c*) *E. macrorrhyncha,* 214 times mag. (Figure 1 of the Supplementary Plate).
(*d*) *E. rostrata* (Figure 1 of the Supplementary Plate).
(*e*) Figure on *E. Sieberiana* plate.

2. Drawings of cuticle (x 450) of 20 species, under *E. microtheca* (Supplementary Plate).

E. Abergiana.	*E. marginata.*
E. alpina.	*E. microcorys.*
E. botryoides.	*E. microtheca.*
E. buprestium.	*E. peltata.*
E. clavigera.	*E. Raveretiana.*

E. Cloeziana.	*E. resinifera.*
E. globulus.	*E. setosa.*
E. gomphocephala.	*E. siderophloia.*
E. incrassata.	*E. tetrodonta.*
E. largiflorens (bicolor).	*E. Torelliana.*

3. Leaves. Transverse (vertical) sections, under *E. ptychocarpa* (Supplementary Plate).

1. *E. ptychocarpa.*
2. *E. calophylla.*
3. *E. globulus.*
4. *E. viminalis.* (Each with references to—

(*a*) Cuticle.
(*b*) Epidermal cells.
(*c*) Parenchyma cells in rows.
(*d*) Grit cells (sclerenchyma).
(*e*) Breathing pores (stomata).
(*f*) Oil gland.
(*g*) Oleo-resin. All x 214).

Solederer says that *Cork Warts,* resembling lenticels, have been observed on the leaves of *E. calophylla, E. globulus, E. Gunnii, E. megacarpa, E. obliqua, E. siderophloia.* (Oxford Press Trans., i, 352).

Anatomy as an aid in diagnosis and classification.

The following passages are taken from a paper read by me before the British Association for the Advancement of Science, Sydney, August, 1914:—

The Aid of Anatomy.—The anatomical method consists in the methodical employment of the micro-anatomical and micro-chemical characters of the vegetative and reproductive organs in systematic researches.

The actual idea of employing the internal structure for systematic purposes originated in very early times, and has repeatedly been put forward. Early botanists employed it; then we come to the researches of Regnault, Weddell, Bureau, Engler, and others. The classical researches of Radlkofer on the Sapindaceous genus *Serjania* are next in order; "owing to his systematic and unprejudiced mode of procedure, he is to be regarded as the actual founder of the anatomical method."

Consideration of the chemical substances in the plant for systematic purposes commences at an early period, and dates back as far as the times of the doctrine of signatures.

The anatomical method is only a detailed and elaborated morphological method—to use Radlkofer's expression, only an endomorphic as contrasted with an exomorphic one.

Both endomorphic and exomorphic characters have been shown to possess great systematic value in one group of affinity, though of small importance in another. Their systematic value simply depends on the length of time the characters in question have remained unaltered or uninfluenced by adaptation during the development of the plant phylum. Hence the importance of examining the constancy of anatomical characters from species to species, from genus to genus, from family to family, without preconceived ideas.

It is pointed out that Vesque, a distinguished worker at the anatomical method, ascribed a definite degree of value to the different characters.

Emphatic warning is given against any over-rating of anatomical characters, and examples of errors in this respect have already found their way into literature.

Radlkofer points out that besides comparative morphology, the systematist has the assistance of the following methods—the diagrammatic, the developmental, the teratological, the geographical, the palaeontological, the physiological, the chemical, and the experimental, as well as the anatomical.[*]

Macalpine and Remfrey[†] argue that certain transverse sections, which they present, of the petioles of Eucalypts "may be used as valuable aids in the determination of species," and submit that such sections have importance because the petiole is in organic connection with the vital machinery of the plant. They justly advance a plea for the co-operation of the anatomist and systematist. The paper is a meritorious one, but I hesitate to agree that the method has special classificatory value. Losing sight of the mechanical difficulties of obtaining the sections, interpretation of the results is open to the temptation of empiricism, for there are so many minute characters to appraise in each case.

Sarton[‡] also set out to discover whether real species could be detected by their anatomical characters, and after laborious research he pronounced some Jordanian species good and others not, and some Linnean species shared the same fate.

J. M. Coulter says the anatomical method seems to result in readjusting specific lines without settling anything, and in reviewing the paper, adds[¶] —

"The fundamental weakness in this whole point of view is the idea that there can be any rigid test for that elusive conception known as a 'species' which will carry it beyond the reach of fallible and hence diverse human judgment. It is of great interest to know that anatomical characters will vary under given conditions, and herein lies the chief value of this investigation; but even here the conditions are not analysed so as to be convincing. To regard these characters as outweighing all others is to stir afresh the seething mass of taxonomy."

Here I may add a reference from Irving Bailey, which I have quoted at Part LIV, p. 196.

"The 'diagnostic criteria' available in anatomical characters have been assumed to be constant and comparatively invariable. As a matter of fact, some of the supposedly more reliable diagnostic criteria may fluctuate considerably not only in certain families, genera and species, but also in different parts of a single tree." Irving W. Bailey in *Journ. Forestry,* XV, 176 (February, 1917), quoted under "Timber Sections."

Species of which the Juvenile leaves are not available.

The following is a list of species of which no descriptions, or specimens, are available to me. In a few cases I have specimens, but they are unsatisfactory, and, as on former occasions, I confidently appeal to my readers:—

E. Abergiana.	*E. Howittiana.*
E. adjuncta.	*E. hybrida.*
E. annulata.	*E. Jutsoni.*
E. argillacea.	*E. leptopoda.*
E. brachyandra.	*E. lirata.*
E. caesia.	*E. micranthera.*
E. Campaspe.	*E. Mitchelliana.*
E. canaliculata.	*E. Normantonensis.*
E. Cliftoniana.	*E. notabilis.*
E. confluens.	*E. ochrophloia.*
E. Cooperiana.	*E. oligantha.*
E. corrugata.	*E. orbifolia.*
E. diptera.	*E. pachyphylla.*
E. doratoxylon.	*E. Parramattensis.*
E. Dundasi.	*E. patellaris.*
E. Ebbanoensis.	*E. Penrithensis.*
E. eremophila.	*E. phoenicea.*
E. erythronema.	*E. Pimpiniana.*
E. Forrestiana.	*E. ptychocarpa.*
E. goniantha.	*E. sepulcralis.*
E. grandis.	*E. Sheathiana.*
E. Griffithsii.	*E. Stowardi.*
E. grossa.	*E. Watsoniana.*

Explanation of Plates (228–231).

Plate 228.

Plate 228: EUCALYPTUS JENSENI, n.sp. (1). E. UMBRAWARRENSIS, n.sp. (2). Lithograph by Margaret Flockton.

E. Jenseni n.sp.

1*a.* Juvenile leaf. 1*b,* 1*c.* Intermediate leaves. 1*d.* Flowering twig. 1*e.* Three views of anthers. 1*f.* Fruiting twig. "Ironbark," Wandi, Northern Territory (H. I. Jensen, No. 372).

E. Umbrawarrensis n.sp.

2*a.* Twig, with mature leaves and immature buds. 2*b.* Umbel of buds with swollen top to peduncle (enlarged.) 2*c.* Front view of anther. 2*d.* Fruits. "Mountain Blue Gum" (Dr. H. I. Jensen, No. 412).

Plate 229.

Plate 229: EUCALYPTUS LEPTOPHYLLA F.v.M. (1, 2). E. ANGUSTA, n.sp. (3). Lithograph by Margaret Flockton.

E. leptophylla F.v.M.

1*a.* Flowering and fruiting twig. 1*b.* Views of anthers. 1*c.* Umbel of fruits. Murray Scrub (South Australia.) (Dr. Hermann Behr.) The type.
2. Twig of juvenile leaves, Murray Bridge, South Australia (R. H. Cambage and J.H.M., January, 1907).

E. angusta n.sp.

3*a.* Twig with buds. 3*b.* Fruits (see below.) Comet Vale, 65 miles north of Kalgoorlie, W.A. (J. H. Maiden, September, 1909.) The type.

(N.B.—The exsert filiform or awl-like type of the capsule-valves have been inadvertently omitted from fig. 3*b,* but they are shown in fig. 13*b* of Plate 65, where *E. angusta* is figured as a form of *E. oleosa*).

Plate 230.

Plate 230: EUCALYPTUS MARGINATA Sm. (1-4). E. BUPRESTIUM F.v.M. (5). Lithograph by Margaret Flockton.

E. marginata Sm.

1. Juvenile leaf, Pickering Brook, W.A. (T. W. Schock.) 2*a.* Mature leaf. 2*b.* A portion of a mature leaf enlarged showing the thickened margin. 2*c.* Fruits. 2*d.* View of fruit, end on. 3. Buds. Near Perth, Swan River (W. E. Lankester.) 4*a.* Mature leaf. 4*b.* Broad, almost juvenile leaf, with flowers springing from the axil. (This is an illustration of Diels's Law, this Part, p. 303.) 4*c.* Front and back views of anthers. Balingup, W.A. (Dr. R. H. Pulleine).

E. buprestium F.v.M.

5*a,* 5*b.* Juvenile leaves. 5*c,* Twig with mature leaves and buds. 5*d.* Front and back views of anthers. 5*e.* Fruits. Kalgan Plains, north of Kalgan River, W.A. (J.H.M.).

Plate 231.

Plate 231: EUCALYPTUS BOSISTOANA F.v.M. (1). (Syn. E. nepeanensis Baker and Smith). [See also figs. 1-4, Plate 49]. E. ALTIOR (Deane and Maiden), Maiden (2). (Syn. E. oreades R. T. Baker. [See also Part XXXIX, p. 290]. Lithograph by Margaret Flockton.

E. Bosistoana F.v.M.
(Syn. *E. Nepeanensis* Baker and Smith.

1*a.* Mature leaf. 1*b.* Twig with mature leaves and buds. 1*c.* Fruiting twig with intermediate leaf, giving an illustration of Diels's Law. See p. 270, this Part. The figures are drawn from a type of *E. Nepeanensis,* and were collected at St. Mary's, N.S.W. (A. J. Holloway).

E. altior (Deane and Maiden) Maiden.
(Syn. *E. oreades* R. T. Baker. See p. 290, Part XXXIX of the present work.

2*a,* 2*b.* Juvenile leaves. 2*c.* Mature leaf. 2*d.* Intermediate leaf, with buds and flowers in the axil. Blackheath, N.S.W. (J.H.M.) (For references to additional illustrations, see Part XXXIX, p. 290.)

* The above notes have been abstracted from the introduction to Boodle and Fritsch's translation and Solederer's “Systematic Anatomy of the Dicotyledons.”

† “The transverse sections of petioles of Eucalypts as aids in the determination of species.” (*Trans. Roy. Soc. Vict.,* ii, 1–64, with six plates.

‡ Alfred Sarton, “Recherches experimentales sur l'anatomie des plantes affines.” (*Ann. Sci. Nat. Bot.,* ix, 2, 1–115, pls. 1–4, 1905.)

¶ *Bot. Gaz.,* 41, 362 (1906).

Part 57

CCCXXXVI. E. agglomerata Maiden.

In *Journn. Roy. Soc. N.S.W.,* lv, 266 (1921).

FOLLOWING is the original description:—

Arbor mediocris "Stringybark" vocata, ligno pallido durabili; foliis junioribus primum leniter tomentosis deinde hispidis pilis stellatis, sessilibus vel breviter petiolatis, ovatis, marginibus undulatis, venis secundariis tenuibus, venis periphericis margine leniter remotis. Foliis maturis lanceolatis, falcatis, sub-obliquis, petiolatis, crassiusculis, foliis novellis argenteis vel caesiis; venis patentibus, venis secundariis angulum circiter 30° costa formantibus alabastris angustis, rotundatis, stellatis, in pedunculo applanato; operculo calycis tub m plus dimidio aequante; fructibus parvis compresso-spheroidibus, ad 9 in capitulo, orificio parvo margine nitente, valvis depressis vel interdum leniter exsertis.

The name *agglomerata* refers to the crowded heads of fruits, and was first used by me in connection with this plant (as a variety of *E. eugenioides*) in *Agric. Gaz. N.S.W.,* vii, 268 (1896), subsequently in *Proc. Linn. Soc. N.S.W.,* xxi, 806 (1896). I then dealt with it under *E. capitellata* in the present work, Part VIII, p. 215, and in the same work, Part XLV, p. 151, under *E. Blaxlandi,* and the tree has now reached its true position.

Illustrations.—It has been figured as regards juvenile leaves and fruits, at 6a and 6b of Plate 38, Part VIII of the present work, and it is additionally illustrated in Plate 232 of the present part.

A well-shaped tree of 50–80 feet, and 4–6 feet in diameter at 3 feet from the ground. A Stringybark. The timber pale brown, reddish towards the centre, of high repute for durability. The whole plant has a somewhat strong peppermint-like odour.

Juvenile leaves.—Only the first two or three pairs opposite, at first softly tomentose with stellate hairs, eventually becoming markedly hispid on both surfaces; sessile to shortly petiolate, ovate, acute, paler on the lower surface, the margins undulate; secondary veins fine, looping and forming a moderately distant intramarginal vein; 4–7 cm. long, 2–4 cm. broad.

Intermediate leaves alternate, smooth, from paler beneath to dark green on both surfaces, narrow-lanceolate to broadly, and obliquely lanceolate, the apex mucronate to shortly acuminate, 5–8 cm. long, 2–4 cm. broad.

Mature leaves lanceolate, falcate, attenuate, somewhat oblique, occasionally oblong lanceolate, from 10–15 cm. long and 2 to 31/2 cm. broad; petiolate, thickish, equally green on both sides, but particularly in the upper part of the tree, having a steel-grey or "silver-leaf" cast, hence the vernacular name. Venation spreading, the secondary veins making an angle of about 30° with the midrib, the intramarginal vein not close to the edge.

Flowers.—Buds narrow, rounded, or only very slightly angled, stellately arranged, pinkish or brownish at the base when fresh, up to fourteen in the head, sessile or nearly so, on an elongated flattened peduncle. Operculum pointed, more than half the length of the calyx-tube.

Fruits small, under 8 mm. in greatest diameter, compressed spheroid, with a comparatively small orifice, the rim shining, reddish-brown, the valves well sunk, or sometimes very slightly exsert; up to 9 in a dense head.

Range.

Type from Hill Top, New South Wales (J.H.M., January, 1896).

In Part XLV, p. 151 (under *E. Blaxlandi*) the following specimens should be referred to *E. agglomerata:*—

Waterfall (with *E. capitellata*), Woronora, Hill Top, Berrima, Berrima on Mittagong-road, Wombeyan Caves, Taralga-road (with slightly exsert valves); (*ibid.,* p. 152), Goulburn, near Goulburn, Eden, Popran, Yarramalong, near Booral.

In addition to the above, the following are new records:—

Tree of 60 feet, Warrimoo, near Springwood (Dr. E. C. Chisholm and W. F. Blakely).

"Blue-leaved Stringybark," Cut Hill, Mittagong (D. W. C. Shiress). "Blue-leaved Stringybark, sometimes up to 5 feet in diameter. About 12 miles west of Sutton Forest, towards Arthursleigh." (R. H. Cambage, No. 4349). "White Stringybark—Tall trees, white bark, good timber, leaves bluish tint, easily determined from 'red' (Stringybark) in the bush by the more robust growth." Nye's Hill, Wingello (J. L. Boorman, August, 1899). Same locality (J.H.M. and J. L. Boorman, September, 1899), when I determined it "*E. capitellata,* small fruited form."

Nelligen (J. L. Boorman, June, 1906). "The most useful of all the Stringybarks, being cut for all purposes, especially for weatherboards and fencing. Attains large size and height." Clyde, near Nelligen (J. L. Boorman, March, 1909). "On a sedimentary deposit at about 900 feet, a few miles east from between Nelligen and Reidsdale. Locally known as Stringybark." (F. W. Wakefield, No. 27, 1918).

Summing up these records, the species is at present known only from the coastal districts and coastal tablelands of New South Wales, from Booral (Port Stephens district) southward to the Victorian border. It can be confidently predicted to occur in Gippsland, Victoria, and much further north in New South Wales.

Affinities.

It may be compared with certain other Stringybarks as follows:—

1. With *E. Blaxlandi* Maiden and Cambage.

In the early juvenile leaves, which are rather larger in *E. agglomerata,* and in the stellate buds and smaller closely capitate fruits. The buds of *E. Blaxlandi* are clavate. In outward appearance both species have much in common.

2. With *E. capitellata* Sm.

E. agglomerata appears to differ in the following characters:—

(*a*) Smaller and more stellate juvenile leaves, the margins of which are undulate or crenulate. They are also less cordate. They appear to be intermediate between those of *E. Blaxlandi* and *E. capitellata, i.e.,* larger than the former, smaller than the latter.

(*b*) In the *E. eugenioides*-like buds, with its longer operculum.

(*c*) In the smaller and more contracted fruits.

3. With *E. eugenioides* Sieb.

The juvenile leaves are intermediate between *E. eugenioides* (which have the narrowest of the Stringybarks) and *E. Blaxlandi,* but nearer the latter, and considerably smaller than those of *E. capitellata.* The buds more closely resemble those of *E. eugenioides* than those of *E. capitellata.* They are stellate like the former.

In the type locality, *E. eugenioides* grows in flatter country.

4. With *E. laevopinea* R. T. Baker.

They are both Blue-leaf Stringybarks. With *E. loevopinea* the affinity is not quite so close as in the three preceding species, nevertheless, the general facies of *E. loevopinea* is reflected in the essential morphological characters of the new species, with varying degrees of similarity. For example, at one stage, the buds of *E. loevopinea* are between stellate and clavate, while the fruits, though invariably rounded, vary from truncate to domed with slightly exsert valves, but at the same time showing a tendency towards abbreviated and elongated pedicels. The juvenile leaves, too, though not conspicuously stellate, as in *E. agglomerata,* are inclined to broadness.

CCCXXXVII. E. Simmondsii n.sp.

FOLLOWING is the description:—

Arbor mediocris, ligno pallido et durabili existimato; cortice non distincte Peppermint typi; foliis nitentibus vel leniter glaucis foliis primariis lanceolatis vel lato-lanceolatis et fere ovoideis, sessilibus vel leniter amplexicaulibus, venis prominentibus, foliis maturis nitentibus, coriaceis, lanceolatis petiolatis, 10–15 cm. longis et circiter 2 cm. latis, venis lateralibus angulum circiter 30° costa media facientibus; umbellis axillaribus, circiter 15 floris, cupula conoidea, operculo hemispherico cupulam minus dimidio aequante, antheris Renantherae; fructibus conoideis vel turbinatis, margine distincta colorata.

A moderately large tree (50 or 60 feet), timber pale and reputed durable. “Dead bark persists on the stems of most trees, but not distinctly of the Peppermint type.” The foliage more or less glaucous, and dries pale-coloured or yellowish-green.

Juvenile leaves slightly glaucous (in some cases of a warm brown colour, with slight glaucousness along the midrib), coriaceous, from lanceolate to broadly lanceolate and almost ovate, sessile or slightly stem-clasping, moderately acuminate, about 1 dm. long and varying from 3 to 5 cm. in greatest width; stem slightly glandular, venation prominent and spreading, the secondary veins making an angle of 60° and more with the midrib.

Mature leaves shiny, not glaucous, coriaceous, lanceolate, petiolate, mostly varying from 10 to 15 cm. long and about 2 cm. wide, acuminate, the tips slightly hooked, venation not prominent, but longitudinal, that is to say, the lateral veins making an angle of 30° and less with the midrib.

Peduncles axillary or lateral, terete or nearly so, supporting umbels of with about 15 rather small flowers. The pedicels absent, or very short, gradually tapering to the very short calyx-tubes. *Buds* clavate; not seen fully ripe; *calyx-tube* conoid, tapering into a comparatively long pedicel. *Operculum* hemispherical, less than half as long as the calyx-tube, very obtuse or slightly umbonate. *Stamens* inflected in the bud, all perfect, the anthers small, kidney-shaped.

Ovary flat-topped. *Fruit* conoid to turbinate, and, although not seen fully ripe, with a well-defined coloured rim.

Range.

The type comes from Smithton, Tasmania, where it was collected on 27th May, 1921, by the Rev. Joseph Henry Simmonds, of Auckland, New Zealand, well known for his writings on those Eucalypts which have become acclimatised in New Zealand. I have great pleasure in connecting his name with this interesting species. I know no further localities at present.

Affinities.

It belongs to that section or sub-section of the Renantherae to which I have given the name Coriaceae, because it has longitudinal venation, like *E. coriacea.* This sub-section also includes *stellulata, Moorei, vitrea, Mitchelliana.*

1. With *E. vitrea* R. T. Baker.

It differs from *E. vitrea* in the venation, which is not as straight as in that species; in the different shaped fruits, which I cannot match with any of *E. vitrea*; in the different juvenile leaves, and in the seedlings, which have broader leaves than those of *E. vitrea.* The cotyledons are also more emarginate, those of *E. vitrea* are nearly entire. The juvenile leaves (suckers) are sessile, lanceolate, in contradistinction to the broad, somewhat falcate-lanceolate, petiolate suckers of *E. vitrea.* The fruits are also more turbinate than those of *E. vitrea,* and considerably broader at the top.

For a resumé of the history of *E. vitrea,* see *Journ. Roy. Soc. N.S.W.,* lii, 516 (1918–19). *E. Simmondsii* has a position between *E. vitrea* and *E. regnans* F.v.M.

2. E. pilularis Sm. var. *pyriformis* Maiden.

See Part L, fig. 1*a,* Plate 206, and compare the stem-clasping, lanceolate juvenile leaves of *E. Simmondsii,* as shown in fig. 3*a,* Plate 232. The resemblance is remarkable and it is hoped that other juvenile leaves of the Renantherae may be collected at the same stage. They would be most valuable for comparison.

XXIII. E. sepulcralis F v.M.

In "Eucalyptographia."

I have a note on this species in Part VIII, p. 244, of the present work.

The description of the species is as follows (and an original figure is given in Plate 233 herewith) :—

"Arborescent; leaves rather small, scattered, on slender stalks, narrow-lanceolar, slightly curved, of equal colour and somewhat shining on both sides; their lateral veins very subtle, moderately spreading, almost concealed, the circumferential vein but slightly removed from the edge of the leaf; oil-pores angular, much obliterated, umbels 3–5 flowered, solitary, axillary, soon lateral; umbel-stalks long and slender, but much compressed; tube of the flowering calyx slightly bulging towards the base, thence much widening upwards, about as long as its stalklet, of about twice the length of the pyramidal-hemispherical lid, not prominently angular, but as well as the lid wrinkled; stamens all fertile, and all inflexed before expansion; filaments yellow; anthers ovate—or roundish—cordate, bursting in front with upward confluent slits; style elongated; stigma not dilated; fruit large, urceolar-ovate, wrinkled and streaked, somewhat contracted at the margin; orifice cylindrical; edge of the summit narrow; valves four, rarely five, very short, deeply enclosed; fertile and sterile seeds of nearly the same size, very angular, without any membraneous appendage."

"Strange-looking trees, with their branches hanging down all round to the ground, like those of a weeping willow," according to Mr. Taylor, through whose circumspectness and exertions branchlets of this new Eucalypt became accessible to me from a desolate place far inland. Bark of the stem smooth and whitish. Branchlets slender, angular toward their summit and tinged with a bluish-white bloom, soon becoming cylindrical and assuming a dark-bluish, somewhat black, hue. Leaves vividly green; the majority from 2 to 31/2 inches long, and from ⅓ to 2/3 of an inch broad, almost equilateral, terminating into a narrow apex, narrowed into a stalk of from 1/2 to 3/4 inch length. Umbel-stalks 1–11/2 inches long, two-edged, gradually somewhat dilated upwards; two narrow deciduous at first connate bracts enclosing the umbel in its earliest stage. Stalklets wrinkled and angular, but not much compressed or dilated. Tube of the flowering calyx from ⅓ to nearly 1/2 inch long, conspicuously corrugated, as well as the lid; between the latter and former a conspicuous transverse sutural furrow. Longest stamens hardly above ⅓ inch long, filaments not angular, dotted with a few oil-glands, their lower portion not flexuous in bud; anthers whitish, inserted below the middle; dorsal gland small, seated near the summit; in dry anthers the slits wide and separated downward only by an exceedingly narrow intervening membrane; in fresh or macerated anthers the slits very narrow, conspicuously distant downward, though not marginal, confluent in an arched curvature on the summit. Style yellowish, somewhat twisted. Ovary only occupying the basal portion of the calyx-tube, very much over-reached by the comparatively narrow walls of the latter. Fruits about 1 inch long, seated on stalklets of about half that length, greyish and not shining outside, longitudinally traversed by raised and somewhat undulated streaks, the upper fourth rather suddenly ennarrowed and straight, except at the incurved summit, but this infraterminal constriction sometimes so faint as to render the fruit simply truncate-ovate. Placental column comparatively short. Valves deltoid. Seeds not numerous in each cell, mostly from 1 ⅓ to 2 lines in length, a few scarcely 1 line long; the fertile seeds outside black, shining and marked with exceedingly subtle reticulation, the prominent angles ascending and diverging from the hilum, the summit convex and broad; sterile seeds brown, narrower, but never very slender."

Range.

It is confined to Western Australia so far as we know. Mueller's type, and only locality is "Thomas River in south Western Australia." (Mr. Campbell Taylor).

Affinities.

In Part VIII, p. 244, I point out that Mueller places it near *E. buprestium* F.v.M., while drawing attention to its anomalous anthers. I then propose some affinity with *E. erythronema* Turcz.

1. With *E. buprestium* F.v.M.

"It finds its systematic place in the series of Parallelantherae, rather than Renantherae, though it bears great affinity to *E. buprestium,* from which species it differs in the following particulars:—The leafstalks are longer, the veins of the leaves fainter, the flowers larger but fewer in number, the flower-stalks elongated and flattened, the stalklets much longer, the anthers somewhat longer than broad with more extended but less divergent slits, the fruits almost suddenly contracted below the summit and thus rather urceolar than globular, their orifice stretching much deeper downward, by which means the valves are much farther removed from the summit of the fruit." (Original description).

The huge cotyledons place both *E. sepulcralis* and *E. buprestium* (less the shape of the fruits) near the Corymbosae (Bloodwoods), but I prefer to discuss the matter in full detail when dealing with affinities at large.

2. With *E. setosa* Schauer.

"Size and shape of fruit afford an approach to *E. setosa.*" (Original description).

3. With *E. coesia* Benth.

" . . . their position (of fruits), long stalklets and streaky exterior remind of *E. caesia.*" (Original description).

The two species are not closely related, for *E. coesia* belongs to the series of cotyledons with the small divided lobes, known as the Bisectae, while *E. sepulcralis* has very large cotyledons, and hence comes near the Corymbosae.

4. With *E. diversifolia* Bonpl. (*E. santalifolia* F.v.M.)

" . . . The anthers resemble those of *E. santalifolia,* with which it also accords in the near conformity of fertile and sterile seeds." (Original description).

E. sepulcralis is a drooping tree, *E. diversifolia* erect; the fruits of both species are totally dissimilar; for those of the latter, see Part VII, Plate 36.

CC. E. torquata Luehmann.

Some notes on this species have been already given in Part IV, p. 109, together with detail figures at figs. *a-c,* Plate 13, and a photo. showing the appearance of the tree in the same Part.

In Part XXXVIII, p. 225, will be found the original description in full, with some additional notes.

Affinities.

The figs. 2, 3, on Plate 233 usefully supplement those on Plate 13, and enable us to understand its relations to other species better.

1. With *E. Flocktonioe* Maiden.

Some notes on Affinities will be found at Part XXXVIII, p. 226, but no reference is made to *E. Flocktonioe;* with flowers and unripe fruits alone available there is a good deal of external resemblance between the two species.

I will give supplementary figures of this species in Part LVIII (which will be helpful) and will then make some further remarks on the relations of the two species; in the meantime, the following important differences may be pointed out:—The seedlings are very different, those of *E. torquata* being pedicellate and glaucous, and belong to the Bilobae, those of *E. Folcktonioe* afford the most striking case of decurrence of the leaves in the genus, while the cotyledons belong to the Bisectae, being finely divided, very different to the Bilobae.

2. With *E. angulosa* Schauer.

In "Research on the Eucalypts," 2nd Edition, p. 159, Messrs. Baker and Smith, under *E. costata* R.Br. say "Desc. by Schau . . . under *E. angulosa* . . . and recently (*sic.*) by Luehmann, *Vict. Nat.* vol. 13, p. 147, 1897, under the name of *E. torquata.*"

Under the heading of "Remarks," *loc. cit.,* they say, "The smaller fruited variety (of *costata*) was described by Luehmann under the name of *E. torquata, Vict. Nat.* vol. 13, p. 147, 1897. To add to the confuson, &c."

Luehmann, in the description of *E. torquata* says, "It seems to have the greatest affinity to *E. incrassata,* especially as regards the anthers."

In this work, Part XXXVIII, p. 226, in referring to the affinity with *E. incrassata,* I say, "This refers more particularly to the var. *angulosa* of that species, *E. torquata* and the variety displaying affinity in anthers and ribbing of buds and fruits."

But Messrs. Baker and Smith's proposed suppression of *E. torquata* under *E.*

costata (*angulosa*) is very unfortunate, for the two species are very different. *E. torquata* is a rather large tree, with dark rough bark up to the smallest branches; *E. angulosa* is a spreading tall shrub, only exceptionally growing into a tree; it has a smooth bark, with some ribbons. The former is an interior species; the latter a coastal denizen, only exceptionally non-coastal. The seedlings and the juvenile foliage of the two species are different.

CCCXXXVIII. E. Kalganensis n.sp.

FOLLOWING is the description:—

Mallee altitudinem 10' attinens; foliis primariis non visis; maturis flavo-viridibus, crassis, petiolatis lato-vel ovato-lanceolatis, venis leniter distinctis, vena peripherica a margine longe remota, venis lateralibus angulum circiter 30–40 costa media facientibus, inflorescentia axillari; pedunculi longis planisque umbellas ad 7 in capitulo gerentibus; pedicellis brevibus, crassis; operculo conico cupulam aequante; antheris Renantherae affinibus; fructibus fere hemisphericis, magnis (fere 18 mm. diametro), margine crassa, valvarum verticibus orificium vix attingentibus.

A Mallee, which grows to a height of 10 feet, and up to 2 feet in diameter (Stoward). (It must therefore be a very slender Mallee, J.H.M.). Branchlets markedly quadrangular.

Juvenile leaves not seen.

Mature leaves pale (yellowish) green, slightly paler on the under side, thick, alternate, petiolate, slightly curved, broadly- or ovate-lanceolate, under 8 cm. long and between 3 and 4 cm. broad (as seen). Venation moderately distinct, the intramarginal vein well removed from the edge, lateral veins spreading making an angle of about 30–40 degrees with the midrib.

Inflorescence axillary, with long flat peduncles supporting umbels up to seven in the head, each flower on a short thick pedicel; buds brown in colour, the operculum conical and of the same length as the calyx-tube, which tapers gradually into the pedicel. The anthers are close to the Renentherae (and may be that), but are too undeveloped to speak more definitely.

Fruits nearly hemispherical, large (nearly 18 mm. in diameter), very shortly pedicellate, rim thick, slightly sloping inwards, the tips of the valves barely flush with the orifice.

(The fruits are detached, and, so far as my specimens are concerned, they are in threes, but the peduncles and pedicels correspond to those of the inflorescence, while there are distinct scars of additional fruits on the flattened peduncles.)

Type, Dr. F. Stoward, Kalgan Plains, April-May, 1917 (No. 117).

Range.

Confined to south-western Western Australia, so far as we know. "On the Kalgan Plains, south of the Stirling Range. Specimens collected 2 miles from the Kalgan River, between Messrs. Dunn and Phillips's farms, Kalgan Plains."

Affinities.

1. With *E. Preissiana* Schauer.

The closest affinity of this species appears to be *E. Preissiana.* The locality is *E. Preissiana* country, and the foliage of the two species is pale (yellowish) green. I have only one specimen, with fruits detached. I desired to get additional information, but Dr. Stoward never again visited the precise locality.

For *E. Preissiana,* see Part XVIII, p. 243, with Plates 77 and 78. From that species there are the following differences, less oblong shape in the leaves, buds with hemispherical opercula, different anthers, and smaller and different shaped fruits, with more numerous valves.

CCCXXXIX. E. melanoxylon n.sp.

FOLLOWING is the description:—

Arbor mediocris erecta, cortice aspero 10 vel 15', ramis laevibus, ligno aterrimo, aliquando tam nigro quam gagate; foliis primariis glaucis crassiusculis, petiolatis, ovatis, venis leniter distinctis; foliis maturis saturate-viridibus utrinque nitentibus, circiter 7 cm. longis et 1 cm. latis, venis obscuris, venis lateralibus angulum circiter 30–40° costa media facientibus; inflorescentia axillari, umbellis in pedunculis longis applanatis ad 11 longiusculos pedicellos gerentibus alabastris ovoideis, operculis et calycix tubo hemi-ovoideis; filamentis flaviusculis, stigma capitata; fructibus parvis, circiter 7 mm. diametro, conoideo-hemisphericis, valvarum verticibus distincte exsertis.

A tree attaining a height of 60 feet and 3 feet in diameter at 4 ft. 3 in. from the ground. It has a rough bark for 10–15 feet up the bole, furrowed, almost like an Ironbark. The limbs are clean and whitish. The inner bark is of a light yellow colour. The wood is very dark to the heart and in some cases jet black. Branchlets angular.

(The above notes are mainly furnished by Mr. Forester W. M. Cusack to the Acting Conservator of Forests, Mr. S. L. Kessell. Tested by Dauthenay's “Rep. de Couleurs,” the bark is reddish-black (tints, Plate 344, figs. 1 and 2). The wood is warm sepia (Plate 305, fig. 1).)

Juvenile leaves.—Glaucous, rather thick, petiolate, ovate, acuminate (but perhaps not seen in the earliest stage), (about 4 cm. broad by 7 cm. long), venation moderately conspicuous, intramarginal vein distantly removed from the edge, secondary veins somewhat spreading, and making an angle of 30–40° with the midrib.

Mature leaves sap green, shining on both sides, moderately thick, petiolate, narrow-lanceolate (about 7 cm. long and 1 cm. broad), venation indistinct, intramarginal vein not far removed from the edge, lateral veins somewhat spreading, and making an angle of about 30–40° with the midrib.

Inflorescence axillary, the umbels on long narrow, flattened peduncles, which support up to eleven rather long pedicels. The buds are shining, ovoid to clavate, with the opercula sometimes conoid and hemispherical, but usually semi-ovoid, of about the same size and shape as the calyx-tube, which is markedly separated from the pedicel. The anthers are large, white, opening in parallel slits. Large gland at the back. The pale yellow filaments attached half-way down or lower, according to the size of the gland. Stigma capitate.

Fruits small, about 7 mm. in greatest diameter, conoid-hemispherical, the tips of the capsular valves markedly exsert.

Type, Westonia, J. M. Cusack.

Range.

It is confined to Western Australia, so far as we know at present.

Westonia, 6 miles north of Carrabin, a railway station 195 miles east of Perth.

What appears to be this species, but with larger fruits (and fruits only) was collected at Bullabulling, 44 miles west of Kalgoorlie, by W. V. Fitzgerald in November, 1903, and by Dr. F. Stoward in March, 1917.

Affinities.

1. With *E. longicornis* F.v.M. (Red Morrel).

The fact that Western Australians call two trees by the same name of Morrel shows that there must be important points of similarity between them. Speaking of the two trees as they grow in the Kalgoorlie district, Mr. Forester J. M. Cusack compares them as follows:—

"*Red Morrel.*—This tree grows to a height of 60 feet and is 3 feet in diameter at 4 ft. 3 in. from the ground. It has a rough bark for 10–15 feet up the bole. The limbs are clean, or 'gum bark,' which is a reddish tint. The limbs form an open or spreading top, and the leaves hang down. The bark when cut with an axe is red between the rough and the inner bark. The wood is of a reddish colour to the heart.

"*Black Morrel.*—The same particulars apply as to Red Morrel, except that the bark is coarser at the butt, and the limbs are whiter in the bark than the Red Morrel. When the bark is cut with an axe, it is more gummy and the inner bark is of a light yellow colour. The wood is very dark to the heart, and in some cases jet black."

I have two (only two) specimens of bark, but they are excellent; that of *E. longicornis* has flatter flakes or ridges, while that of *E. melanoxylon* is ribbed like an Ironbark. The new species is allied in the general appearance of the tree, including the mature foliage, and also in the glaucous suckers, but the anthers place it in a different section. The operculum of *E. longicornis* is longer, and the fruit more pear-shaped, with the tips of the valves more awl-like, but as I hope to figure some additional material of this species, which has lately come into my possession, in an early Part, it will be convenient to resume the comparison then.

2. With *E. salubris* F.v.M.

For the "Gimlet," see Part XXXVI, p. 156, with Plate 150. *E. salubris* is a Gum, with a twisted trunk which differentiates it from all other Eucalypts; the timber is pale brown, while the foliage is rich in oil. The two species, however, come very close to each other because of the similarity of their anthers.

It also differs in the slightly longer calyx, which does not show the demarcation of the calyx with the operculum as distinctly as *E. salubris* does. The common peduncle is also more slender, and so are the pedicels. The style of *E. melanoxylon* is broad and distinctly triangular at the base, and gradually diminishing upwards, while the stigma is obliquely elongated, which appears to be unique, as it does not appear to have been noticed in any other species. The fruits are about the same size as those of *E. salubris,* but they are more turbinate with or without a small band at the top, truncate throughout, with more or less exsert, spreading valves.

CCXL. E. Isingiana n.sp.

FOLLOWING is the description:—

Mallee patens circiter 6' alta; primariis foliis non visis, maturis foliis pallido-(glauco-) viridibus, crassissimis, petiolatis, late lanceolatis ad fere ovatis circiter 5 cm. maxima latitudine, in acumen obtusum attenuatis, venis obscuriusculis, vena peripherica a margine longe remota, venis lateralibus angulum circiter 30–45° costa media formantibus; inflorescentia axillari, alabastris non visis: floribus in pedunculis longis fere teretibus, umbellis ad 7 floris in pedicellis brevioribus, stylo longissimo; fructibus in pedicellis brevibus distinctis teretibus, junioribus campanulatis, maturis piriformibus, magnis, circiter 2 cm. longis, prominenter costatis valvarum verticibus distincte depressis.

A small, shrubby Mallee, about 6 feet high, and spreading 6-8 feet, branchlets terete or nearly so.

Juvenile leaves not seen.

Mature leaves pale -(glaucous-) green, apparently the same colour on both sides, very thick, alternate, petiolate, broadly lanceolate to nearly ovate, with greatest width of about 5 cm. and length of 12 cm. and more, tapering into a blunt point, venation not very distinct, intramarginal veins well removed from the edge, the lateral veins spreading and at an angle of about 30–45 degrees with the midrib. The petioles, midribs and marginal vein yellowish.

Inflorescence axillary, buds not seen, flowers on long, nearly terete peduncles, bearing umbels with up to seven in the head on shorter, but distinct, nearly terete pedicels, a style remarkably protruding beyond the stamens (pointing to rather a long operculum) for about the length of the calyx-tube, not capitate; anthers large, broad, opening in parallel slits, gland at back.

Fruits on short but distinct, terete pedicels, when young distinctly urceolate or campanulate, when ripe, somewhat decumbent, pear-shaped, large, about 2 cm. long at 1·5 cm. in greatest diameter, distinctly yet not prominently and branchingly ribbed, narrower at the orifice, the narrow rim darker in colour, and the tips of the valves distinctly sunk.

Type, Ernest H. Ising, 407 miles, near Ooldea, South Australia, No. 1480, 5th September, 1920.

Range.

At 407 miles (from Port Augusta), near Ooldea, on the Transcontinental Railway.

“In whitish, sandy soil, between sandhills.” This locality is in South Australia (not far from the Great Australian Bight), and it may be confidently predicted that the species will be found, later on, in Western Australia.

Affinities.

E. Isingiana is allied to certain thick-leaved species, found particularly round the Australian Bight in South and Western Australia. I would particularly mention—

1. *E. Pimpiniana* Maiden. Part XVI, p. 211, Plate 72.
2. *E. Woodwardi* Maiden. Part XVI, p. 213, Plate 72.

Both of them have a tendency, like *E. Isingiana,* to fruits of an urceolate shape, but their complete similarities and dissimilarities cannot be fully set down until full botanical material of all three species is available, together with ecological notes, and particulars of bark and timber.

CXXXIV. E. aggregata Deane and Maiden.

(Syn. *E. Rodwayi* Baker and Smith.)

See Part XXV, p. 85, of the present work, with Plate 104. While in the text I gave the original description (including a description of the mature leaves), the plate only showed leaves which were supplementary to those in the plate with the original description in *Proc. Linn. Soc. N.S.W.*, xxiv, 614 (1899), and did not show fully mature leaves. I have more than once stated that the plates in the present work (at least as regards a number of the earlier ones) are supplementary to those in the "Eucalyptographia" and a few other works, it being desired to avoid repetitions for the sake of economy. I find that Messrs. Baker and Smith have overlooked these statements *re* supplementary figures. I find it desirable, in Plate 235, to supplement the drawings on Plate 104.

E. aggregata, as figured by the authors in Plate 79, and p. 318 ("Research," 2nd ed.), is not the plant, *E. aggregata* Deane and Maiden, as figured on Plate 104 of Part XXV of the present work. *E. aggregata,* as figured by the above gentlemen, is a plant with very narrow juvenile leaves, whereas *E. aggregata* Deane and Maiden has very broad ones. The fruits also should have the valves well exsert. It is not stated whence the plant figured by Messrs. Baker and Smith was obtained.

Non-recognition of the fact that in *E. aggregata* the juvenile leaves are broad, has led them to describe a new species with broad juvenile leaves in *E. Rodwayi* Baker and Smith. See p. 86, Part XXV, of the present work, and also p. 115 and Plate 25 of "Research on the Eucalypts," 2nd ed.

At one time I thought I could keep *E. aggregata* and *E. Rodwayi* apart, (*a*) by the intramarginal vein being nearer the margin in the latter, and (*b*) the fruit being larger in the latter. But examination of a fairly large series of specimens shows that these differences do not really exist.

The following notes on *E. aggregata* and *E. Rodwayi,* hitherto unpublished in this work, will be useful.

1. "Black Gum, also known as Swamp Gum and Apple-scented Gum (*Eucalyptus Stuartiana* F.v.M.). A medium-sized, widely-spreading tree. Bark sub-fibrous, dark, persistent to the branches. Leaves narrow, lanceolate, often slightly unequal-sided, thick and often shining; juvenile foliage opposite, sessile, orbicular, to oblong. Flowers small, many in the umbel; operculum conic. Fruit obconic, usually under 3 millimetres diameter, valves protruding.

The form described above corresponds with specimens sent out by Mueller as typical of the tree described as *E. Stuartiana* in his "Eucalyptographia."

Unfortunately, Mueller tried to bring in many other forms under the same name, which led to some obscurity. Deane and Maiden consider the tree, common in Northern Tasmania, and described above, to be distinct from Mueller's tree, and named it *E. aggregata.* R. T. Baker considers it to differ further, and calls it *E. Rodwayi.*

It may be readily distinguished from Ovate Gum (*E. ovala*) by the fibrous bark, narrower leaves, and smaller fruits." (Rodway, *Proc. Roy. Soc. Tas.*, 1917, p. 20.)

2. "Rodway, this Journal, 1917, p. 20, refers to the Tasmanian tree as Black Gum (a name it shares with the typical New South Wales form). His reference to *E. Stuartiana* is to one of the three trees successively named *E. Stuartiana,* and the Tasmanian tree is the one that I have distinguished under the name *Stuartiana prima* (see C. R. XXI, p. 4). Seedlings from seeds sent to me by Mr. Rodway from Tasmania, in December, 1917, precisely match those of typical *aggregata.*

I gave some attention to this species on my recent visit to Tasmania. Juvenile leaves vary from narrowish to broadish. There are minor differences in the Tasmanian as compared with the New South Wales specimens, but nothing that seems important to me, nor not easily explained by an environment a thousand miles away from the type.

I collected it 15 miles from the Ouse (Victoria Valley P.O.), on the Dee Road. Here I got buds, flowers, and fruits of a flaky barked gum, the tree being of small size. At the Dee this grows into shapely trees of good size. They have a fibrous bark on the butt, with smooth branches; small fruits. A local resident called it Black Peppermint, but I think this name should be reserved for *E. amygdalina.* My informant had probably heard it called Black Gum and corrupted the name." (Maiden, *op. cit.*, 1918, p. 82.)

Following is an additional Tasmanian locality:—

"Trees 50 up to 120 feet high, 2–3 feet in diameter, one 4 feet. Bark flaky on base and trunk, grey, not so fibrous as in *E. amygdalina.* Branches dirty white, with flaky bark. Leaves free and somewhat shining, and have *not* the scent of *E. amygdalina.* Opossums feed on the young leaves. I could find no seedlings which were not nibbled. In basaltic soil at about 2,000 feet level. Guildford Junction, Tasmania." (R. H. Cambage, No. 4101, January, 1911.)

The allusion to *E. amygdalina* is explained by the references to Mr. Archer's Cheshunt specimen, (*a*), Part VI, of the present work, p. 158 (*E. radiata* Hook. f. var. 5), referred by me to *E. amygdalina* var. *nitida,* and figured at fig. 2, Plate 31, also (*b*), p. 86, Part XXV, placed under *E. aggregata.* In other words, *E. amygdalina* var. *nitida* Maiden, or *E. radiata* Hook. f., non Sieb., are synonyms of *E. aggregata.*

It is also to be observed that opossums readily eat the leaves of the Guildford

(Tasmanian) tree, while cattle are very partial to the leaves of *E. aggregata* on the mainland. I have given some notes in Part LXX of my "Forest Flora of New South Wales," but the subject of the partiality (or otherwise) of native and introduced animals for our native trees has been singularly neglected by our stockowners.

E. aggregata leaves have a faint, dainty smell, not easily described. We notice the same thing in *E. viminalis, E. gigantea,* and in some other species.

Variation in Juvenile Leaves.

To recapitulate somewhat, Messrs. Baker and Smith have confused the juvenile leaves that they attribute to *E. aggregata.*

Those particular juvenile leaves they figure never came from *E. aggregata,* and even if they did, they grossly misrepresent the characteristic juvenile leaves of the species, which are broad, very broad. At the same time, in Eucalyptus, the question of broad or narrow juvenile leaves (suckers) so very valuable as a character, must be studied philosophically. I will presently show that, within limits, there may be narrow juvenile leaves in *E. aggregata,* but this remark is true (as already ascertained) of a number of species, and this must not vitiate the fact that it can be stated (perhaps invariably) whether in a particular species, they are broad or narrow.

I have gathered together an enormous amount of evidence to show that, in a given species, there is a surprising amount of variation in the juvenile leaves, (*a*) seedlings from cotyledon-leaves onwards; (*b*) adventitious leaves or suckers from the earliest onwards, until the "mature leaves" become fully developed. As a rule, for classification purposes, we take cognisance of three kinds of leaves only, (*a*) cotyledons, (*b*) juvenile, (*c*) mature. The study of the protean forms which the leaves assume outside these three groups is an important branch of the subject, which will be dealt with in a subsequent Part. So much is preliminary to the figure 5*a,* Plate 235, of short, rather narrow, juvenile leaves, which may exceptionally belong to *E. aggregata,* usually the result of cropping by stock.

The term "Abnormal leaves," which Messrs. Baker and Smith often use, usually in a wrong sense, is true in the way they employ it for *E. Rodwayi,* under "Research, &c.," p. 115, for they have described "abnormal" leaves for "juvenile" leaves (normal "suckers"). There is no doubt' that they belong to *E. aggregata.*

The small juvenile leaves, fig. 5*a,* Plate 235 (and which must be considered in connection with fig. 5*b*), have their counterparts in fig. 2, Plate 49 (plate of the type), and fig. 7*a,* Plate 104.

VI. The Leaf.

B.—THE MATURE LEAF.

Historical.—Venation (Chiefly).

A. Sir James Smith (*Trans. Linn. Soc.,* iii, 288, 1797) was the first author to describe Eucalypts in any number (he described twelve), but he makes no allusion to the venation.

B. G. Don in "Dichlamydeous Plants," vol. 2, p. 818 (1832) under Eucalyptus (which is mainly a translation of De Candolle's "Prodromus," iii, p. 216–220, 1828).

In most descriptions he refers only to the intramarginal vein (see below p. 392). A number of the species referred to by him are not recognised now, but their modern equivalents may be ascertained if desired, by reference to the indexes of the various volumes of the present work.

1. The following refer to the intramarginal vein:—

E. resinifera—marginate by a nerve.

longifolia—marginated by a nerve.

robusta var. *rostrata*—girded by a marginal parallel nerve.

incrassata—girded by a thin nerve, which is parallel with the margin.

persicifolia—with a nearly parallel, very thin, nerve on the margin.

punctata—girded by a nerve, which is parallel to the margin.

purpurascens var. *petiolaris*—girded by a nerve at the margin.

pilularis—veins confluent at the tops, forming a nerve, which is parallel with the margin.

radiata—veins very fine, confluent at the apex, and forming a nerve, which is parallel with the margin.

stenophylla—lateral nerves connected before the margin.

myrtifolia—same as *stenophylla.*

2. The following is a distant reference to longitudinal venation. See p. 394.

E. hypericifolia—lateral nerves of leaves parallel, connected in front of the margin.

3. The following are references to transverse venation:—

E. corymbosa—veins feathered, hardly evident.

micrantha—nerves confluent in front of the margin; veins feathered.

pallens—feather-nerved, veins confluent in front of the margins.

obliqua—feather-nerved.

4. The following refer to reticulate venation:—

E. elongata—reticulately veined.

reticulata—reticulately veined beneath.

5. The following are veinless, or nearly so:—

E. gomphocephala—veinless.

oblonga—veinless.

virgata—nearly veinless.

stricta—having the middle nerve hardly prominent, and the rest veinless.

cneorifolia—the middle nerve is only prominent, or even evident (*sic*).

ambigua—lateral veins hardly evident.

C. Endlicher (1836–1840) "Genera Plantarum," speaks of Eucalyptus as "often parallel-veined," whatever that may be.

D. 1866. *Bentham* (B. Fl. iii, p. 185). " . . . the primary veins often scarcely perceptible when the leaves are thick; in some species few, irregular, oblique, and anastomosing and passing *through every gradation* (the italics are mine, J.H.M.) from that to numerous parallel diverging or transverse veins, always converging into the intramarginal vein, either close to or more or less distant from the edge, the intermediate reticulate veinlets rarely very prominent, and scarcely any when the primary veins are closely parallel." (p. 185).

" . . . So also in the *venation,* characteristic as it often is in the lanceolate leaves, the specific modifications disappear in a great measure as the leaf gets broader, and it is only very rarely that there are any appreciable specific differences in the venation of the sapling leaves" (p. 187).

Then, coming to details, the descriptions of Bentham, one of the few monographers of the genus, one of the most distinguished descriptive botanists of any age, who had the collections of Mueller and of many other collectors and botanists before him, demand especial respect. He described the leaves of over 130 species, and found them to vary a good deal, as he has already indicated.

It will be seen that Bentham's favourite description of the primary or lateral veins is "oblique." In the 135 species he passes under review, he does not describe the lateral veins in eighteen cases, those he omits having usually linear, or broadly glaucous leaves. Of the remaining 117 he uses the term "oblique," in the case of sixty-four species modifying it with "very" or "rather" in many instances. He even uses the word "oblique" for *stellulata* and *coriacea,* though, in those cases supplementing it with a statement that the veins are almost parallel with the midrib. In the case of *E. obtusiflora* he adds the words "and parallel."

Although the transverse venation is the oldest, and there is, therefore, reason for taking it first, it is convenient to take longitudinal venation first, because the species are arranged by both Bentham and Mueller in that way.

1. LONGITUDINAL.

E. stellulata and *E. coriacea,* in the following passages, have venation "almost parallel to the midrib," but defined as "very oblique," while *E. virgata* is given as an intermediate form.

E. stellulata.—Very oblique, starting from near the base, and almost parallel to the midrib, as in *E. coriacea.*

coriacea.—Very oblique, almost parallel to the midrib.

virgata (includes *Sieberiana*).—More oblique than in *E. obliqua,* less so than in *E. coriacea.*

The word "parallel" is commonly used by Bentham, not in the exclusive sense of longitudinal as in *stellulata* and *coriacea,* but without any reference to the direction of the venation, be it longitudinal, transverse or intermediate (oblique or divergent).

2. OBLIQUE.

Following are Bentham's terms in detail:—

Apparently oblique.

E. stricta.

Oblique.

E. albens (*hemiphloia* var. *albens.*)	*E. globulus.*
E. alpina.	*E. gomphocephala.*
E. amygdalina (includes *radiata*).	*E. goniocalyx.*
E. annulata.	*E. grossa.*
E. bicolor.	*E. incrassata.*
E. Bowmani.	*E. melliodora.*
E. buprestium.	*E. obtusiflora.*
E. coccifera.	*E. occidentalis.*
E. corynocalyx (cladocalyx).	*E. odontocarpa.*
E. diversifolia (as *santalifolia*).	*E. oleosa.*
E. doratoxylon.	*E. paniculata.*
E. eudesmioides.	*E. platypus.*
E. exserta.	*E. redunca.*
E. falcata.	*E. Risdoni.*

Rather Oblique.

E. Oldfieldi. *E. vernicosa.*

E. pilularis, but much less so than in *obliqua* and *piperita.*

E. uncinata, but not so much so as in *E. gracilis.*

Somewhat oblique.

E. tetrodonta.

E. capitellata. Oblique venation of *obliqua.*

E. piperita. Very oblique, almost as in *obliqua.*

E. odorata. Oblique and sometimes very much so.

E. foecunda. Less oblique than in *loxophleba.*

Very oblique.

E. Behriana.	*E. Lehmanni.*
E. caesia.	*E. leucoxylon* (includes *sideroxylon*).
E. conoidea (erythronema).	*E. loxophleba.*
E. gracilis.	*E. macrorrhyncha.*
E. haemastoma.	*E. obliqua.*
E. hemiphloia.	*E. pachyloma.*

Irregular, oblique.

E. cornuta. Irregularly oblique.

E. dealbata. Oblique and irregular.

E. erythrocorys. Oblique, rather irregular.

E. megacarpa. Irregular, oblique.

Rather regular, oblique.

E. rostrata.	*E. tereticornis.*
E. urnigera.	

Regular, oblique.

E. patellaris.

Parallel, oblique.

E. dumosa.	*E. pyriformis.*

Parallel, rather oblique.

E. goniantha.

2a. DIVERGENT.

The next most favourite word is “diverging” or “divergent,” which is used thirty-two times; also sometimes modified by adverbs. Perusal of the list shows how great is the variation amongst species with “diverging” veins, and also how impossible it is to separate “oblique” from “divergent.”

Diverging or divergent.

E. alba.	*E. patens.*
E. cneorifolia.	*E. peltata.*
E. cosmophylla.	*E. phoenicea.*

E. decipiens. *E. platyphylla.*
E. decurva. *E. polyanthemos.*
E. longifolia. *E. rudis.*
E. oligantha. *E. siderophloia.*
E. pachyphylla.

Very diverging or divergent.

E. marginata.—Very diverging, conspicuous, especially underneath.
E. diversicolor. *E. microcorys.*
E. pallidifolia.

Rather diverging.

E. grandifolia.

E. macrandra.—More diverging than in *cornuta* (see above).

Rather regular, diverging.

E. Stuartiana (*ovata*). *E. viminalis.*

Diverging, rather distant.

E. tetragona.

Irregular and distant.

E. orbifolia.

3. TRANSVERSE.

The word "transverse" is used not only for the Corymbosae, but is also employed to describe *brachypoda, robusta, saligna,* and *resinifera.* Sometimes, *e.g., clavigera* and *tesselaris,* by the use of such an expression as "diverging or almost transverse," he conveys the sense of variation in the application of the term "transverse."

Diverging or almost transverse.

E. clavigera. *E. tesselaris.*

Very diverging or almost transverse.

E. Drummondii.

Divergent and parallel.

E. concolor. *E. miniata.*
E. Preissiana. *E. tetraptera.*

Very diverging, parallel.

E. botryoides.

Very diverging, fine, parallel.

E. crebra.

Parallel.

E. dichromophloia. *E. eximia.*

Parallel, rather oblique.

E. maculata.

Parallel, very diverging.

E. brachyandra. *E. drepanophylla.*

Transverse parallel.

E. calophylla.	*E. latifolia.*
E. corymbosa	*E. perfoliata.*
E. ficifolia	*E. saligna.*

Parallel, almost transverse.

E. brachypoda (*microtheca*).	*E. resinifera.*
E. pellita.	*E. robusta.*
E. ptychocarpa.	*E. trachyphloia.*

Bentham does not state the venation in the following cases:—

E. angustissima.	*E. macrocarpa.*
E. aspera.	*E. melanophloia.*
E. cinerea.	*E. micranthera.*—Concealed.
E. citriodora.	*E. pruinosa.*
E. cordata.	*E. pulverulenta* (*cinerea*).
E. dives.	*E. pyrophora.*
E. ferruginea.	*E. setosa.*
E. Gunnii.	*E. spathulata.*
E. leptophleba.	*E. terminalis.*
E. leptopoda.	

E. *Mueller,* 1879–84.—Following are the statements of Mueller ("Eucalyptographia"), who deals with only a hundred species.

1. LONGITUDINAL.

Mueller used the word "longitudinal" in two meanings, viz., as applied to *pauciflora* (*coriacea*) and *stellulata* (1) in the Bentham sense, and (2) his use of the term "longitudinal vein" in *E. resinifera,* "the two longitudinal veins removed from the edge"; *E. saligna,* "the two longitudinal veins only slightly or hardly removed from the edge." Here he means what he calls elsewhere the "circumferential" or "peripheric" vein, and in others the "intramarginal" vein, the second vein being that vein which forms the thickened margin.

E. pauciflora (*coriacea*).—Almost longitudinal, several arising nearly together from the acute base of the leaf.

E. stellulata.—Almost longitudinal, three of them arising almost jointly from near the acute base of the leaf.

More longitudinal than transverse.

E. haemastoma. *E. Sieberiana.*

Usually more erect than transverse (which is really the same as the two preceding).

E. piperita.

E. hemiphloia.—Diverging at a very acute angle.

E. incrassata.—Spreading at a rather acute angle.

E. largiflorens (*bicolor*).—Diverging at a very acute angle, or not very spreading.

E. odorata.—Mostly spreading at a very acute angle.

E. salmonophloia.—Spreading at an acute angle.

E. salubris.—Ascending in an acute angle.

2. OBLIQUE.

He is very fond of the word "spreading," which he uses in the sense of Bentham's "oblique" as a rule, but somewhat vaguely with the aid of adverbs. This will be referred to later.

Very or much or considerably spreading.

E. Abergiana.	*E. populifolia.*
E. alba.	*E. Preissiana.*
E. clavigera.	*E. pruinosa.*
E. cordata.	*E. pulverulenta* (*cinerea*).
E. gamophylla.	*E. punctata.*
E. longifolia.	*E. redunca.*
E. macrocarpa.	*E. robusta.*
E. microcorys.	*E. rudis.*
E. oleosa.	*E. setosa.*
E. paniculata.	*E. siderophloia.*
E. Planchoniana.	*E. uncinata.*
E. polyanthema.	*E. Watsoniana.*

Moderately spreading.

E. acmenioides.	*E. goniocalyx.*
E. alpina.	*E. Gunnii* (mixed).
E. Baileyana.	*E. macrorrhyncha.*
E. buprestium.	*E. megacarpa.*
E. capitellata.	*E. obcordata* (*platypus*).

E. cornuta.	*E. occidentalis.*
E. corynocalyx.	*E. Oldfieldii.*
E. cosmophylla.	*E. patens.*
E. doratoxylon.	*E. phoenicea.*
E. erythrocorys.	*E. pilularis.*
E. eugenioides.	*E. pyriformis.*
E. foecunda.	*E. sepulcralis.*
E. globulus.	*E. tetro donta.*
E. gomphocephala.	

Very moderately spreading.

E. stricta.

Not much, or very, spreading.

E. amygdalina (includes *radiata*).	*E. gracilis.*
E. Behriana.	*E. obliqua.*

Some, not much, spreading.

E. erythronema.

Considerably divergent.

E. decipiens.

Neither very spreading nor very numerous.

E. leucoxylon (including *sideroxylon*).

E. melliodora.

Neither crowded nor very spreading.

E. santalifolia (*pachyloma*).

3. TRANSVERSE.

In the use of the term “spreading” associated with “transverse” or “pinnate,” he means “transverse” as now understood.

We have his use of the word in *botryoides, corymbosa, ficifolia* almost transversely spreading, *ptychocarpa, resinifera, saligna,* showing that he partly applies it to the Corymbosae, and partly to species allied to *resinifera* which approach the transverse.

In such descriptions as—

E. calophylla, closely parallel, very spreading;

E. eximia, closely pinnate;

E. ficifolia, almost transversely spreading, closely parallel;

E. Foelscheana, very divergent or almost horizontally spreading;

E. Howittiana, pinnately or pennately spreading;

E. maculata, marginata, microtheca, miniata, peltata, rostrata, tereticornis, tetragona, Todtiana, viminalis, resinifera, saligna, ptychocarpa, almost transversely spreading;

E. tesselaris, pennate-veined;

E. trachyphloia, feathery spreading;

it is quite evident, from his figures, that Mueller is using his words somewhat loosely, because he has not reviewed them as a whole, but he is struggling after the Corymbosae, and the species allied to *tesselaris,* which he means to include in the term "transverse," although he uses the words "parallel" and "pinnate," or "pennate" or "horizontal spreading" and such expressions in lieu. He also includes as illustrations such species as *Howittiana, rostrata,* &c., which really belong to the group between the longitudinal and the transverse.

Almost transversely spreading.

E. botryoides. *E. resinifera.*
E. corymbosa. *E. saligna.*
E. ptychocarpa.

Almost transversely spreading and closely parallel.

E. ficifolia.

Pennately or pinnately, or feathery, spreading.

E. diversicolor. *E. rostrata.*
E. Howittiana. *E. Todtiana.*
E. maculata. *E. trachyphloia.*
E. marginata. *E. tereticornis.*
E. microtheca. *E. tetragona.*
E. miniata. *E. viminalis.*
E. peltata.

Closely pennate.

E. eximia.

Pennate veined.

E. tesselaris.

Closely parallel, very spreading.

E. calophylla.

Almost parallel and moderately spreading.

E. crebra.

Considerably spreading, but neither crowded nor almost transverse.

E. Stuartiana.

Very divergent or almost horizontally spreading.

E. Foelscheana.

Venation not stated.

E. pachyphylla.
E. Raveretiana.
E. tetraptera.

The exceptions, out of a hundred, to the use of "spreading" are the use of the terms "divergent" (which is really the same as "spreading") for *decipiens;* "closely pennate" for *eximia;* "more longitudinal than transverse" for *haemastoma;* "diverging at a very acute angle" for *hemiphloia;* "almost longitudinal" for *pauciflora* (*coriacea*) and *stellulata;* "usually more erect than transverse" for *piperita, Sieberiana;* "ascending in an acute angle" for *salubris;* "pennate veined" for *tesselaris,* amount to say 10 per cent. in all. As regards the 10 per cent. one must not bind Bentham or Mueller to absolute uniformity of treatment in such a protean genus, and doubtless the descriptions were written at different times. Mueller practically uses the term "spreading" as generic.

But while he, in describing the secondary or lateral veins, almost invariably uses the word "spreading," it apparently was an English word with which he was not familiar. For example, consider its use in connection with *E. corymbosa,* "almost transversely spreading"; the word is redundant; compare his plate.

As a rule, I have left out Mueller's terms referring to the closeness of the lateral veins relating to distance between them, such as "not of very close approach" or "not closely approximated"; "not crowded" or "rather remote," "distant," or "close" or "rather close." Mueller frequently uses the word "subtle" to describe the inconspicuous veins in contradistinction to prominent.

In my "Forest Flora of New South Wales," Part LXVII, is an Appendix entitled "A Tentative Bibliography of Eucalyptus Oil." As the title implies, the chemistry rather than the botany, is touched upon, but the paper may be referred to by my present readers.

The papers of Messrs. Schimmel & Co., of Leipzig, Germany, from 1887 onwards, may be picked out for especial reference, as the firm was much interested in Eucalyptus oil, and took pains to test oils belonging to a fairly large number of species.

So also should the following:—Wilkinson, W. Percy, "Preliminary Survey of Eucalyptus Oils of Victoria." *Proc. Roy. Soc. Vict.,* vi (New Ser.), 195 (1894). Gives the values of the physical constants of eighty-seven botanically named Eucalyptus oils. The paper has a useful bibliography, and it is the first scientific investigation of Eucalyptus oils in Australia.

See also Maiden, J. H., "The Chemistry of the Australian Indigenous Vegetation," being the Presidential Address in Section B. (Chemistry), Aust. Assoc. for Adv. of Science. See vol. vi, p. 25 (1895). It contains a brief account of my early endeavours to put the investigation of Eucalyptus oils at the Technological Museum on a scientific basis. “The still is under construction at the Technical College” . . . . (as an exercise in the engineering department of the College, which I was able to effect by virtue of my authority as Superintendent).

F. *Naudin,* 1891. “From each side of the midrib (Naudin, 2nd *Mem.* 10) secondary veins start, which is often sufficiently characteristic of certain species. These veins rejoin a marginal vein which makes the circuit of the leaf, whose margin it more or less approaches, and sometimes merge themselves in it.”

G. *Deane,* 1900.—“Observations on the Tertiary Flora of Australia, &c.,” Part II, “On the venation of leaves and its value in the determination of botanical affinities” (*Proc. Linn. Soc. N.S.W.,* xxv, 581, with Plate 36 (Eucalyptus).

In Plate 36 Mr. Deane gives some illustrations of the leaves of Eucalyptus showing the variable venation. “It may be a surprise to many to find on what different plans the vein system of the leaves of different species is arranged. . . . The secondary veins afford a great many different varieties. Observe for instance:—

E. coriacea and *E. stellulata* with their longitudinal veins, *E. Sieberiana* and others with secondary veins placed at an acute angle with the midrib. Follow the series down until the secondary veins become almost transverse.” (P. 585).

Mr. Deane and I (*Proc. Linn. Soc. N.S.W.,* xxii, 561, 1897) first began to record the angle which the lateral veins make with the midrib, but in many leaves this can only be stated with more or less approximation. The matter is of great importance, and will be dealt with later.

The following papers chiefly refer to Venation and Oil.

H. Gildemeister, E. and Hoffman, Fr. (1899, 1900) “Die aetherischen Oele.” 8vo., p. 919, Berlin, 1899. Also “The Volatile Oils,” by E. Gildemeister and Fr. Hoffman, under the auspices of Schimmel & Co. Translation by Edward Kremers (Milwaukee, U.S.A., 1900, of above.) Pages 524–541 are taken up with Eucalyptus oils. They are divided into five groups, according to their constituents or odour:—

First Group. Cineol (Eucalyptol)—containing oils—*E. globulus* (a valuable article on the quantitative determination of Cineol in Eucalyptus oils). *E. odorata, E. cneorifolia, E. oleosa, E. dumosa, E. amygdalina, E. rostrata, E. populifolia, E. corymbosa, E. resinifera, E. Baileyana, E. microcorys, E. Risdoni, E. leucoxylon, E. hemiphloia, E. crebra, E. macrorrhyncha, E. capitellata, E. eugenioides, E. obliqua, E. punctata, E. loxophleba* (*foecunda*), *E. dextropinea, E. laevopinea, E. Smithii.*

Second Group. Citronellal—containing oils—*E. Maculate, E. citriodora, E. dealbata, E. Planchoniana.*

Third Group. Citral-containing oils—*E. Staigeriana.*

Fourth Group. Oils with a peppermint-like odour—*E. haemastoma, E. piperita.*

Fifth Group. Oils less known and of indefinite odour—*E. diversicolor, E. fissilis, E. goniocalyx, E. gracilis, E. Lehmanni, E. longifolia, E. occidentalis, E. pauciflora (coriacea), E. Stuartiana, E. tereticornis, E. tessellaris, E. Dawsoni, E. camphora.*

I. *R. T. Baker and H. G. Smith,* 1901. "On the relation between leaf venation and the presence of certain chemical constituents in the oils of the Eucalypts." (*Proc. Roy. Soc. N.S.W.,* xxxv, 116, 1901).

1. "The venation of Eucalyptus leaves that *has perhaps the most scientific importance* (my italics, J.H.M.) is that which is characteristic of the

Bloodwoods (*corymbosa, intermedia, eximia, trachyphloia, terminalis*);

Swamp Mahoganies (*botryoides* and *robusta*);

Blue Gum (*saligna*), *tesselaris,* and a few others (not named).

"This particular venation is of importance because it is also generally characteristic of the Angophoras. This venation. . . . appears to be indicative of a preponderance of pinene in the oil."

2. "The venation of the leaves belonging to those species next in order is that which characterises the Eucalypts yielding Eucalyptol oils. Although tending somewhat towards the venation of that group which give oils containing a predominance of pinene, yet the *parallel transverse venation, like that of a feather,* which is characteristic of the pinene group, is not marked, and the venation and reticulation are exceedingly delicate, the spaces between the principal veins are larger, and a picture of the leaf has a much more graceful and delicate appearance."

Then they cite *Smithii, globulus, longifolia, goniocalyx,* "or of any other allied species which gives a first-class Eucalyptol oil." Some other species (Mallees and Boxes) are incidentally mentioned.

3. "The next group . . . is that which includes all those species whose oils contain phellandrene and the ketone of peppermint taste and colour . . . "

The species cited are *coriacea, Sieberiana, vitrea, dives, radiata, amygdalina, delegatensis, oreades,* and many others (not stated).

The classification is not stated very clearly in the text, but the explanation of Plate makes it clearer, the figures 1, 2, 3, below corresponding to Nos. 1, 2, 3, above.

Fig. 1 (*E. corymbosa.*) We have here "close parallel lateral veins and a thick midrib," indicating the presence of pinene in the oil.

Fig. 2. (*E. Smithii.*) "More acute lateral veins which are wider apart . . . The marginal vein is further removed from the edge, and is slightly bending to meet the lateral veins." The authors state these oils consist principally of *Eucalyptol* and *Pinene.*

Fig. 3 (*E. radiata.*) "Note the still more acute and fewer lateral veins." The marginal vein is far removed from the edge. Oils consist largely of *Phellandrene* and *Peppermint ketone.*

K. *R. T. Baker and H. G. Smith,* 1902. "A Research on the Eucalypts," especially in regard to their essential oils." (Sydney, 1902).

This work contains a diagram headed "This diagram showing the probable evolution of the Eucalypts as evidenced by their botanical and chemical characters indicated by this research." It is the first diagram of the kind published in regard to a large number of species, and an attempt is made to show genealogies or affinities in two dimensions, and any criticisms I may have on this most meritorious attempt will be given, in detail, in stating my own results or suggestions. Then follows an amplification of the three Groups of the 1901 paper.

As the second edition of this work was published in 1920, I shall reserve my comments until that work, which embodies the opinions up to date of the authors is dealt with. See p. 371.

The illustrations cited by Messrs. Baker and Smith for the most part appeal to New South Welshmen, and the statement is made that pinene was found in Corymbosae oils in Western Australia. This means, as we would expect, *a priori,* that in oils, as in most other characters, the Corymbosae form one of the most stable and best defined groups of the Eucalypts.

L. *E. C. Andrews,* 1913. "The development of the Natural Order Myrtaceae," (*Proc. Linn. Soc. N.S.W.* xxxviii, 529, 1913).

In working out his thesis the author makes numerous references to the mature leaves of Eucalyptus, and to their venation. The headings of the paper are—Geography; Earlier forms of Myrtaceae; Home of the earlier forms; Differentiation of Myrtaceae. This valuable paper does not readily lend itself to brief abstract as regards Eucalyptus.

M. *R. H. Cambage,* 1913. In *Proc. Roy. Soc. N.S.W.* xlvii, 45 (1913), the author adopts names for three venation groups, viz., Transverse (or right-angled) oblique (or diagonal) and parallel, and defines them as follows:—

1. "In the *transverse* venation the lateral veins are straight, nearly parallel to each other, and close together, while the intramarginal vein is close to the edge, and the midrib is thick."

2. "In the *oblique* venation the lateral veins are further apart than in the last form, while the intramarginal vein is at some distance from the edge."

3. "In the parallel venation the lateral veins are well apart, and sometimes show a system of looping, the intramarginal vein being well removed from the edge, and the midrib is thin."

Mr. Cambage (*loc. cit.*) applies the term "parallel" to the venation, which includes *E. coriacea* and *E. stellulata.* This is following Bentham to some extent, but I think the use of the term “longitudinal” as adopted by Mueller and Naudin is better, especially as the term “transverse” usually applies to the position of the lateral veins to one another, and not with respect to the midrib.

“*Leaf Venation.*—A study of the venation of a series of Eucalyptus leaves discloses the fact that the lateral veins are arranged *at all possible angles* (my italics, J.H.M.) with the midrib between the limits of about 10 to 80 degrees. Attention was first drawn to the botanical and chemical agreement of these venations in a paper read before this Society by Messrs. Baker and Smith, in 1901. For convenience of reference, the venation in its relation to the midrib may be divided into three classes, viz., transverse or right-angled, oblique or diagonal, and parallel, although none of the veins form quite so much as a right-angle with the midrib, nor are any strictly parallel therewith, and the oblique venation may be regarded as that where the lateral veins have a range of about 25 to 65 degrees with the midrib . . . (already quoted).

Seeing the very great divergence which often exists between the seedling and adult leaves of the same tree, and also in the venation of the adult foliage of many species, it seems reasonable to suppose that the various ultimate types of venation have been developed in response to some influence or dominating condition, and if the distribution of these various types can be shown, some data should thereby be furnished that would assist in deciding what that particular regulating influence may have been.

Transverse Venation.—Upon investigating the distribution of those Eucalypts which have the transverse venation, it is found that they form a very small proportion of the Eucalypts of South-eastern Australia, and are commonest in the coastal area, next in the interior and on the Western Slopes, and last in the mountain region. In the last-named division, Eucalypts having this class of venation appear to be quite absent above an altitude of 3,000 feet, while one species, *E. trachyphloia,* occurs on the northern part of the Western Slopes, and another, *E. terminalis,* in the northern portion of the Interior. The venation of *E. tesselaris,* which occurs in the north-eastern portion of the Interior, is rather more oblique than transverse, and shows a sort of transit stage. It will be seen, therefore, that the Eucalypts with the transverse venation avoid the cold parts, and it is significant that they are absent from Tasmania, and almost so from Victoria, three species, *E. corymbosa, botryoides,* and *maculata,* occurring sparsely near the coast in the extreme north-east corner of that State. Further, there are only about a dozen species of this class which occur in South-eastern Australia, though several are found connecting round through north to west Australia.

Judging by its wide distribution, and considering that this type of venation is practically identical with that of the genus *Angophora,* and avoids the cold, the assumption seems warranted that it belongs to the earliest form of Eucalyptus leaf, and also was developed in a warm climate in Northern Australia.*

Oblique Venation.—A study of the oblique venation, or that which is intermediate between the approximately right-angled and parallel venations, and of which *E. globulus* may be regarded as a type, reveals the fact that the bulk of the Eucalypts fall within this class. It is found that they occur in the dry interior and also well up on the mountain region to elevations in a few cases of 5,000 feet. This form is most strongly represented in the coastal area, but that is largely because species and individuals are more numerous in that division. It is also the dominant form on the Western Slopes and in the interior, in fact, except for the two species with transverse venation mentioned as occurring in those divisions, practically all other species there belong to the oblique venation series. It is fairly common in the mountain region between the altitudes of 2,000 and 4,000 feet, but becomes less plentiful above that elevation, and practically ceases just above 5,000 feet.

Considering the prevalence of this type of leaf all over Australia, it seems a correct assumption that it is fairly ancient, and was evolved from the transverse venation as a form better suited to make progress amidst the surroundings in which it was placed.

Parallel Venation.—The type of leaf referred to as having parallel venation, or having the lateral veins arranged at an angle of less than about 25 degrees with the midrib, belongs chiefly to the mountain region, and secondly to the coastal area; and so far as New South Wales is concerned, is practically confined to those two divisions, the form being absent from the Western Slopes and the interior. *E. coriacea* and *stellulata* are very pronounced examples of this class of venation.

A study of the distribution of this type of leaf in New South Wales, Victoria, and Tasmania, leads to the conclusion that it has been evolved largely, if not wholly, in response to cool and moist conditions, and it is of interest to note that the Eucalypt which ascends higher than any other in Australia, viz., *E. coriacea,* and which reaches an altitude of 6,500 feet, is one of the most typical of the parallel-veined forms in the genus. Everything seems to point to the conclusion that the parallel-veined leaf is the newest type of Eucalyptus leaf in existence, that it was developed in the south as an offshoot from the oblique venation, and after the Kosciusko uplift, migrated north along the resultant Main Divide throughout the entire length of New South Wales."

N. *R. T. Baker,* 1913. In *Rept. Aust. Assoc. Adv. Sci.,* xiv, 309, gives lists of species which yield over 75, 50, 25, 10 per cent. of Cineol and also under 10 per cent. of Cineol respectively. These Groups follow no known affinities of species in other directions. I will reserve my criticisms in this direction until the work of Messrs. Baker and Smith (1920) is brought under review.

O. *Baker and Smith,* 1915. “The Botanical and Chemical Characters of the Eucalypts and their Correlation.” (This is part of a paper contained in the First Report of a Committee, British Association Report, 1915, and deals with essential oils).

“The essential oils . . . vary in composition in a striking degree, but the variation is of a remarkably uniform character, and apparently has been contemporaneous with distinctive botanical changes; this is strongly brought out by the progressive alteration in the veins of the mature lanceolate leaves, starting from the featherlike venation of the members of the Corymbosae group, through the intermediate form representative of the members of the cineol-pinene group, to the looping or butterfly-wing venation of the leaves of the ‘Peppermints’ and the ‘Ashes,’ a form indicative of the presence of the terpene phellandrene. The varying thicknesses of the midribs; the disposition of the marginal veins; the second vein in No. 3, and the varying amount of oil-glands in these pictures should all be noted.

The first type is represented by the Angophoras and by certain Eucalypts, between which there is general chemical agreement. The terpene in the oils of the species of Eucalyptus characterised by this venation, and also in the Angophoras, is pinene; phellandrene does not occur in them, and cineol is either absent or only present in small amount whilst the yield of oil is always small.

The second type of venation is characteristic of the species which yield oils consisting of pinene and cineol; the oils richest in cineol are obtained from leaves having this venation. It is well shown in such species as *E. globulus, E. Bridgesiana, E. goniocalyx, E. Smithii,* &c. Oils derived from species with this venation do not contain phellandrene. As the lateral veins are farther apart than are those of the first group, more room for oil-glands is available, so that, as a rule, a greater yield of oil is obtained from the members of the second group than from those of the first.

The third group contains the species which yield oils in which the terpene phellandrene is an important constituent.”

P. *R. T. Baker and H. G. Smith,* 1920. “Research on the Eucalypts.” Second Edition of the 1902 work.

I will confine my essential comments to this edition, as it contains the latest and most comprehensive pronouncements of the authors. The notes in square brackets are mine.

[Of the species figured, (Plates 5–11) *E. corymbosa* and *E. botryoides* fall in Group I; *E. globulus, E. Smithii, E. Australiana* (*radiata*) fall in Group III, Class (*b*); *E. Sieberiana* and *E. dives* fall in Group VII, Class (*b.*) The other Groups and Classes are not represented by similar figures. See below, p. 376].

GROUP I.—In this Group are placed the following Eucalypts yielding an oil consisting largely of Pinene, without phellandrene. Cineol is almost or quite absent:—

1. *E. calophylla.*
2. *E. diversicolor.*
3. *E. tesselaris.*
4. *E. trachyphloia.*
5. *E. terminalis.*
6. *E. corymbosa.*
7. *E. intermedia.*
8. *E. eximia.*
9. *E. botryoides.*
10. *E. robusta.**
11. *E. saligna.*
12. *E. saligna* var. *pallidivalvis* (*grandis*).
13. *E. nova-anglica.*
14. *E. acaciaeformis.**
15. *E. Rydalensis.*
16. *E. carnea.*
17. *E. dextropinea.*
18. *E. nigra* (In Group V, 1st Edn.)
19. *E. laevopinea.*
20. *E. phlebophylla.*
21. *E. alpina.*

[Nos. 1, 2, 12, 14, 15, 16, 18, 20 and 21 are not in this Group in 1st Edition].

Group I.—[Nos. 1, (4–8) belong to the Corymbosae (Bloodwoods.) Nos. 17–21 belong to the Renantherae. The remainder include Swamp Mahoganies, Blue and Flooded Gums (of eastern Australia].

GROUP II.—In this Group are placed the following Eucalypts yielding an oil consisting principally of pinene and cineol; the latter constituent not exceeding 40 per cent., determined by the phosphoric acid method at time of distillation. Phellandrene and aromadendral* are absent.

22. *E. Wilkinsoniana* (In Group I, 1st Edn.)
23. *E. eugenoides.*
24. *E. umbra* (In Group I, 1st Edn.)
25. *E. santalifolia.*

26. *E. Blaxlandi.*
27. *E. microcorys.*
28. *E. hemilampra.*
29. *E. corynocalyx.*
30. *E. fasciculosa.*
31. *E. megacarpa.*
32. *E. redunca.*
33. *E. Lehmanni.*
34. *E. leucoxylon.*
35. *E. rudis.*
36. *E. maculata.*
37. *E. intertexta.*
38. *E. lactea.*
39. *E. paludosa.*
40. *E. Baeuerleni.*
41. *E. viminalis* var. (*a*) (In Group III, Class (*a*), 1st Edn.)
42. *E. paniculata.*
43. *E. cornuta.*
44. *E. quadrangulata.*
45. *E. conica.*
46. *E. Bosistoana.*

[Nos. 24, 25, 26, 29, 30, 31, 32, 33, 34, 35 and 43 are not in this Group in 1st Edition].

[This is an artificial chemical group, inasmuch as its oils are mainly mixtures of pinene and cineol, the quantity of the latter constituent present being fixed at the arbitrary percentage of forty. Accordingly it is not a matter of surprise that, botanically, it consists of heterogeneous species. For example, we have included in this group—Stringybarks, Tallow-wood, Boxes, a Mahogany, Sugar Gum and other White Gums, Yates, and Ironbark and Ribbony Gum.]

GROUP III.—Class (*a*). In this Group are placed the following Eucalypts yielding an oil consisting principally of cineol and pinene, in which the cineol exceeds 40 per cent., at the time of distillation, but under 55 per cent. Phellandrene is absent and aromadendral very rarely occurs.

47. *E. polyanthemos.*
48. *E. Stuartiana.*
49. *E. Stuartiana.* var. *cordata.*
50. *E. bicolor.*
51. *E. longifolia.*
52. *E. Behriana.*
53. *E. Rossii.*

54. *E. salmonophloia.*
55. *E. tereticornis* var. *linearis* (*Seeana*).
56. *E. rostrata* var. *borealis.*
57. *E. camphora.*
58. *E. Maideni.*
59. *E. Rodwayi.*
60. *E. cinerea.*
61. *E. dealbata.*
62. *E. resinifera.*
63. *E. accedens.*
64. *E. vernicosa.*
65. *E. urnigera.*
66. *E. unialata.*
67. *E. Gullicki.*
68. *E. platypus.*
69. *E. calycogona.*
70. *E. Dalrympleana.*

[Nos. 54 and 63–70 are not included in this Group in 1st edition.]

[Group III is divided into two sub-groups, Classes (*a*) and (*b*). These, from the chemical point of view, are classified on the basis of the cineol present exceeding 40 per cent. (see Group II), but under 55 per cent., or over 55 per cent. The figure 55 is chosen because that is the standard fixed by the British Pharmacopoeia. (Incidentally it may be remarked that the U.S. Pharmacopoeia demands 70 per cent. of cineol.)

So that the classification of the species enumerated in Group III (*a*) and (*b*) is limited by the requirements of certain Pharmacopoeias. This is utilitarian, but it is not scientific.

Group III (Class (*a*).—This Class includes species that I am unable to place under any natural groups known to me; for example, we have Red Box, Woolly Butt, a large Mallee, a Blue Gum, a Forest Mahogany, a White Gum, together with miscellaneous other eastern species. From Western Australia we have the Salmon Gum, and two other species belonging to the Mallee type. They embrace trees from various climatic regions, of different sizes, habits, barks, and timbers.]

Group III.—Class (*b*). In this Group are placed the following Eucalypts, yielding an oil consisting principally of cineol and pinene, in which the cineol exceeds 55 per cent. Phellandrene and aromadendral are absent.

[NOTE.—55 per cent. of cineol is the standard fixed by the British Pharmacopoeia. The American Pharmacopoeia demands 70 per cent. cineol. See also Group IV, Class (*a*).]

71. *E. sideroxylon.**
72. *E. squamosa.**
73. *E. Smithii.**
74. *E. Bridgesiana.**
75. *E. populifolia.**
76. *E. Parramattensis.*
77. *E. parvifolia.*
78. *E. pumila.*
79. *E. pulverulenta.**
80. *E. Morrisii.**
81. *E. Moorei.*
82. *E. Muelleri.*
83. *E. longicornis.*
84. *E. Perriniana.*
85. *E. costata.*
86. *E. maculosa.**
87. *E. goniocalyx.**
88. *E. globulus.**
89. *E. Nepeanensis (Bosistoana).*
90. *E. cordata.*
91. *E. Australiana (radiata).*

[Group III, Class (*b*).—A very incongruous group of species according to any test I am able to apply.]

[Groups IV–VII are based on a 40 per cent. standard of cineol, with or without phellandrene and pinene.]

GROUP IV, CLASS (*a*).—In this Group are placed the following Eucalypts yielding an oil containing over 40 per cent. of cineol, but in which pinene is diminishing and aromadendral making its appearance, thus approaching the typical "Boxes." Phellandrene is absent.

92. *E. eloeophora.**
93. *E. punctata.*†
94. *E. tereticornis* var. *cineolifera.*
95. *E. cosmophylla.*
96. *E. stricta.**
97. *E. oleosa.**
98. *E. dumosa.**
99. *E. polybractea** (*fruticetorum*).
100. *E. cneorifolia.**
101. *E. odorata.*

[Group IV, Class (*a*), consists of about half Mallees, the remainder being composed of miscellaneous and dissimilar species, *e.g.,* the Bundy, the Grey Gum, a form of Forest Red Gum, a South Australian White Gum, and a Box from the same State.]

Group IV, CLASS (*b*).—In this Group are placed the following Eucalypts yielding an oil containing over 40 per cent. of cineol, but in which phellandrene is making its appearance, thus approaching the more pronounced phellandrene-bearing oils.

102. *E. melliodora.*[‡]
103. *E. ovalifolia* var. *lanceolata.*[‡]
104. *E. Consideniana.*
105. *E. Risdoni.*
106. *E. linearis.*

[Group IV, Class (*b*), begins with two Boxes, a Yellow one and a Red one; then we have a bastard Peppermint, followed by two White Gums, not closely related to each other, endemic to Tasmania.]

GROUP V.—In this Group are placed the following Eucalypts yielding an oil consisting largely of cineol, pinene, and aromadendral, but in which the cineol does not exceed 40 per cent. Phellandrene is usually absent.

107. *E. tereticornis.*¶
108. *E. punctata* (var. *didyma*).¶
109. *E. rostrata.*
110. *E. propinqua.*‖
111. *E. Deanei.*
112. *E. Rudderi.*
113. *E. salubris.*
114. *E. occidentalis.*
115. *E. exserta.*
116. *E. marginata.*
117. *E. affinis.*‖
118. *E. Fletcheri (Baueriana).*
119. *E. Woollsiana*¶ (a mixed species).
120. *E. albens.*¶
121. *E. hemiphloia.*¶
122. *E. gracilis.*¶
123. *E. viridis (acacioides).*¶
124. *E. uncinata (leptophylla).*

[This Group includes the Forest Red Gum and Murray Red Gum, two Grey Gums, Boxes (Red, Brown, and Grey), Deane's Gum, Gimlet, Yate, Jarrah, Ironbark Box, and three Mallees, and one or two others.]

GROUP VI.—In this Group are placed the following Eucalypts, yielding an oil consisting principally of pinene, cineol, and phellandrene, but in which the cineol does not exceed 40 per cent.

125. *E. viminalis.*[*]
126. *E. Gunnii.*
127. *E. rubida.*[†]
128. *E. Irbyi.*
129. *E. Bancrofti.*
130. *E. acervula.*
131. *E. hoemastona.*[*]
132. *E. Laseroni.*
133. *E. ovalifolia (polyanthemosa).*[*]
134. *E. Dawsoni.*[*]
135. *E. angophoroides.*[*]
136. *E. microtheca.*[*]
137. *E. fastigata (regnans).*[*]
138. *E. fraxinoides.*[*]
139. *E. macrorrhyncha.*[*]
140. *E. capitellata.*[*]
141. *E. acmenioides.*[*]
142. *E. Planchoniana.*[*]
143. *E. pilularis.*[*]
144. *E. obliqua.*
145. *E. crebra.*[*]
146. *E. siderophloia.*[*]
147. *E. melanophloia.*[*]
148. *E. coeruléa* (*sideroxylon* var. *pallens*).[*]

[This includes several White Gums, a Red Gum, two Red Boxes, a Peppermint, a Mountain Ash, three Stringybarks, a White Mahogany, Blackbutt, and four Ironbarks.]

GROUP VII, CLASS (*a*).—In this Group are placed the following Eucalypts yielding an oil consisting largely of phellandrene, cineol, and piperitone, but in which cineol does not exceed 40 per cent:—

149. *E. piperita.*[‡]
150. *E. amygdalina.*[‡]
151. *E. amygdalina* var. *nitida (nitida).*

152. *E. phellandra.*
153. *E. vitrea.*‡
154. *E. Luehmanniana (virgata).*‡
155. *E. coçcifera.*
[Includes four Peppermints and two small White Gums.]

GROUP VII, CLASS (*b*).—In this Group are placed the following Eucalypts yielding an oil consisting largely of phellandrene and piperitone, but in which cineol is almost, if not quite, absent:—

156. *E. coriacea.*¶
157. *E. Sieberiana.*¶
158. *E. campanulata (Andrewsi).*
159. *E. oreades.*¶
160. *E. delegatensis (gigantea).*¶
161. *E. regnans.*
162. *E. gomphocephala.*
163. *E. taeniola.*
164. *E. Andrewsi* (same as 158).
165. *E. dives.*¶
166. *E. radiata.*¶

[It includes two White Gums, three Mountain Ashes, five Peppermints, and Tuart.]

GROUP VIII.—In this Group are placed the following Eucalypts yielding an oil not readily placed in the other groups. Cineol is almost or quite absent:—

167. *E. virgata** (not the *virgata* Sieb).
168. *E. stellulata.**
169. *E. Macarthuri.**
170. *E. aggregata.**
171. *E. Staigeriana.*
172. *E. patentinervis (Kirtoniana).**
173. *E. citriodora.**
174. *E. Marsdeni (Penrithensis).*
175. *E. ligustrina.*
176. *E. apiculata.**

[Includes two Black Gums or Black Sallies, a Lemon-scented Gum, Woollybutt, an Ironbark, a Mahogany, a Bastard Stringbark, a Stringybark, and a false Mallee.]

[There have been certain charges in the grouping in the 2nd Edition, and I hope I have made such clear. They arise in part from:—

1. Examination of some oils which were unavailable when the 1st Edition was written.

2. Transposition into different Groups and Classes.

This is an indication that the chemist, like the botanist, in struggling after the light, is endeavouring to substitute quantitativeness for qualitativeness.]

Following are notes on certain illustrations of leaves contained in Messrs. Baker and Smith's work (both editions):—

First Edition, Plate 2. Second Edition, Plate 5.

Leaf of *Eucalyptus corymbosa* Sm.

The arrangement of the lateral veins indicates the presence of pinene as a principal constituent in the oil, and the absence of phellandrene.

[The secondary veins of the middle-third of the leaf make an angle of 75 degrees with the midrib (according to the photo.).]

First Edition, Plate 3. Second Edition, Plate 6.

Leaf of *Eucalyptus botryoides* Sm.

The venation indicates the presence of pinene in the oil, but shows the commencement of the definition of certain lateral veins, which feature becomes more characteristic in the venation of those leaves belonging to the Eucalyptol-pinene Group, as *E. globulus,* &c. (In the 2nd Edition, cineol is substituted for eucalyptol.)

[The secondary veins, according to the photo., make an angle of 45 degrees to 60 degrees with the midrib.]

First Edition, Plate 4. Second Edition, Plate 7.

Leaf of *Eucalyptus globulus* Labill.

The venation indicates that the oil contains eucalyptol (cineol in the 2nd Edition), together with pinene, and that phellandrene is absent.

[The secondary veins (according to the photo.) make an angle of 45 degrees with the midrib.]

First Edition, Plate 5.

Leaf of *Eucalyptus Smithii* R.T.B.

The venation indicates that the oil contains eucalyptol, together with pinene, and that phellandrene is absent.

[In the 2nd Edition, Plate 8, we have the same species, but the text is: “The venation indicates that the oil contains cineol together with pinene, and that phellandrene is absent. Oils from Eucalyptus species having this leaf venation are extensively used for pharmaceutical purposes.”

The secondary veins, according to the photo., make angles of 30 degrees to 45 degrees with the midrib.]

First Edition, Plate 6. Not in 2nd Edition.

Leaf of *Eucalyptus longifolia* Link.

The venation indicates that the oil contains eucalyptol, together with pinene, and that phellandrene is absent.

[The secondary veins, according to the photo., make an angle of 60 degrees with the midrib.]

First Edition, Plate 7. Second Edition, Plate 9.

Leaf of *Eucalyptus Sieberiana* F.v.M.

The venation indicates a predominance of phellandrene in the oil, together with the Peppermint ketone.

[The secondary veins, according to the photo., make an angle of 15 degrees with the midrib.]

First Edition, Plate 8. Second Edition, Plate 10.

Leaf of *Eucalyptus amygdalina* Labill.

The venation denotes that the oil contains phellandrene, together with the Peppermint ketone. The innumerable oil glands shown in this leaf account for the abundance of oil obtained from this species.

Second Edition, Plate 10.

Leaf of *Eucalyptus Australiana* R.T.B. and H.G.S.

The innumerable oil glands shown in this leaf account for the abundance of oil obtained from this species.

[The secondary veins (according to the photo.) make angles of 10 degrees to 15 degrees with the midrib.]

First Edition, Plate 9. Second Edition, Plate 11.

Leaf of *Eucalyptus dives* Schau.

The venation indicates the presence of phellandrene in the oil, together with the Peppermint ketone. Note the characteristic looping arrangement of the principal veins, the commencement of which feature is first seen in the bending of the marginal vein in the venation of the leaves belonging to the Eucalyptol-(cineol in 2nd Edition)pinene Group.

Oils obtained from Eucalyptus species having this leaf venation are now extensively used for the separation of metallic sulphides by a flotation process.

[The secondary veins (according to the photo.) make an angle of 15 degrees with the midrib.]

Correlation of the leaf-venation and chemical constituents of the oils.

The work of Messrs. Baker and Smith does not either in the 1st (1902) or 2nd Edition (1920) of their "Research on the Eucalypts" refer to correlation in so many words; the word "correlation" is used by them for the first time so far as I know in a paper—"The botanical and chemical character of the Eucalypts and their correlation" contributed to a symposium (British Association, 1915). At the same time, the commencement of this work is their 1901 paper already abstracted, entitled "On the relation between leaf-venation and the presence of certain chemical constituents in the oils of the Eucalypts."

Let us examine what this correlation is stated to be.

The 1901 paper (see p. 367) makes three groups:—

1. The Bloodwoods (*corymbosa, intermedia, eximia, trachyphloia, terminalis*); Swamp Mahoganies (*botryoides, robusta*), Blue Gum (*saligna*), Moreton Bay (*tessellaris*), "and a few others."

They contain a preponderance of pinene.

2. "Although tending somewhat towards the venation of that group which gives oils containing a predominance of pinene, yet the parallel transverse venation, like that of a feather, which is characteristic of the pinene group is not marked . . . " They cite *Smithii, globulus, longifolia, goniocalyx,* "or of any other allied species which gives a first-class Eucalyptol oil." Some other species are mentioned incidentally in the paper.

3. "All those species whose oils contain phellandrene and the ketone of peppermint taste and colour."

The species cited are *coriacea, Sieberiana, vitrea, dives, radiata, amygdalina, elegatensis, oreades,* and many others.

How do these three Groups compare with the eight groups (together with six sub-groups or classes) into which the species are divided in the "Research, &c." (2nd Edition) (see p. 26, &c.)? They do not quite compare with each other, which is not surprising, as we consider the development of knowledge during nearly twenty years.

1901 Paper.	1920 ("Research, &c.").
Group I mainly	Group I, with species Nos. 13–21 added, which mainly belong to the Renantherae.
Group II mainly	Group II. Pinene and cineol, the latter not exceeding 40 per cent.
	Group III (*a*). Pinene and cineol, the latter between 40 and 55 per cent.
	In class (*b*) the cineol exceeds 55 per cent.
Between Group II and Group III	Groups 4–7 are based on a 40 per cent. standard of cineol, with or without phellandrene and pinene.
	Group IV (*a*), Phellandrene absent.
	Group IV (*b*), "Phellandrene making its appearance, thus approaching the more pronounced phellandrene-bearing oils."
	Group V contain pinene, phellandrene usually absent.
	Group VI contain pinene and phellandrene.
	Group VII (*a*) contain phellandrene and piperitone.

Group III mainly	Group VII (*b*) contain phellandrene and piperitone, but the cineol is almost or quite absent.
	Group VIII. Oils not readily placed in the other Groups. Cineol almost or quite absent.

Messrs. Baker and Smith's grouping of the species, so far as any natural botanical system is concerned, leads to confusion. Looking upon it as a classification of oils, the arrangement is based, to an important extent, on pharmaceutical requirements, and is, to that extent, of an empirical character.

At p. 423, 2nd Edition of their work, they cite the oils most important to the distiller as yielding rich Cineol oils, viz.,—*polybractea* (*fruticetorum*); *Australiana* (*radiata*); *cneorifolia; Smithii,* but they are not closely allied to each other as regards any other characters.

The Corymbosae will be found spread over their Groups 1, 2, 8.

The Renantherae will be found spread over their Groups 1, 2, 4, 6, 7, 8.

The Coriaceae, a fairly well defined section of the Renantherae, will be found distributed over their Groups 1, 3, 4, 6, 7, 8.

The three Groups of Venation they employ are those which have been used by botanists for very many years (see p. 395), and I have added a sub-group which I call Coriaceae.

I have already, under Baker and Smith (1920), pointed out, almost without comment, the chemical and botanical relations of the Groups, and to this I refer my readers. As a practical correlation of working value, it is intricate and vague, and for purposes of broad classification (it promises nothing more), inferior to Bentham's anthereal system. Incidentally it may be pointed out that at p. 394, I have shown that venation which, in an important degree (though not exclusively) is dependent on the structural requirements of the individual leaf, varies with the width of the leaf. This is a contributing cause to variation in the venation of leaves belonging to the same species.

Messrs. Baker and Smith have supplemented existing evidence in regard to the morphological definiteness of—

(*a*) The Corymbosae (Bloodwoods),
(*b*) The Renantherae,

already strongly differentiated by taxonomists, but they leave, as indeed others do, the vast intermediate group, in much the same rather indefinite position as heretofore.

Their classification being more or less a chemical one, it is the botanist who has to help the chemist towards a natural system, or rather, the classification of plants lies with the botanist, and it is his duty to see if he can obtain any points from the chemist to help in forming a natural one, which will eventually be, as has been pointed out for very many years, based on the accumulation of data from all sources.

This seems an appropriate place for the following passages from my pen in *Proc. Roy. Soc. Tas.,* 1914, p. 24:—

"It is unsafe to generalise in regard to the composition of . . . oils from very few distillations . . . Very many additional oils are required even for generalisations. Before a complete research can be made, a full series of oil-determinations in regard to a particular species should include leaves taken every month of the year, and for as many years as possible, as the meteorological conditions of any year differ from those of every other year, in spite of the search after cycles by meteorologists. Leaves should be collected from the lower branches and from those at the top, from those along the periphery (of the tree) and from those at a distance from it. Then we require leaves from trees of various ages and sizes, from trees growing in as many districts as possible, and in situations exhibiting as much accommodation to environment as possible. The above refer to spontaneous trees; the variation that takes place in cultivated trees is almost a sealed book.

Every charge of leaves submitted to distillation should be backed by specimens in the herbarium, so that any questions that may arise at any time in regard to anomalies, or reputed anomalies, connected with the oil results, may be considered in connection with the corresponding botanical material. The referential material in regard to oil-analysis should be at least as complete as systematists find necessary in their investigations of a species. As regards every oil referred to in literature, there should be a schedule of particulars as to the tree which yielded it, date of collection, and so on. Systematists are by no means free from blame as regards their work. Mueller has placed us under the greatest obligation in regard to his pioneering monograph on Eucalyptus, a foundation on which all succeeding workers must build, but in the vast majority of his plates he gives us no details as to the specimen figured. In effect, he says, 'This is Eucalyptus of such and such a species, never mind whether it is the type, or a South Australian or Queensland form of it' . . . In the vast majority of plates the types certainly are not drawn, and what particular form, attributed to the species, we can only guess at. The value of a botanical drawing may be very greatly discounted if the precise locality, date of collection, and even the name of the collector, be omitted. If these particulars cannot be given, the plate should not be published."

As an illustration of how careful one should be to give the amplest data in regard to the oil from every charge of leaves, Mr. F. W. Wakefield, botanist to an important oil-distilling firm, told Mr. Blakely (one of my botanical assistants) and me that he could obtain three different oils from *E. radiata* (*Australiana*), according as the trees of that species grew on ridges, sides of hills, and flats in the same district.

THE DOGMA OF THE CONSTANCY OF SPECIES.

A fundamental objection I make to some conclusions in Messrs. Baker and Smith's work is that they inculcate and insist upon the exploded dogma of the constancy of characters in species. It is true that sometimes the authors endeavour to tone down the word “constancy” be prefixing the word “comparative.”

In the “History of Botany” by von Sachs, Oxford trans. 1890, chapter III is devoted to “Development of the Natural System under the influence of the Dogma of the Constancy of Species.” I take three brief extracts from the work:—

“ . . . the idea of natural relationship on which the natural system exclusively rests, necessarily remained a mystery to all who believed in the constancy of species; no scientific meaning could be connected with this mysterious conception; and yet the farther the enquiry into affinities proceeded, the more clearly were all the relations brought out, which connect together species, genera, and families. Pyrame de Candolle developed with great clearness a long series of such affinities as revealed to us by comparative morphology, but how were these to be understood, so long as the dogma of the constancy of species severed every real objective connection between two related organisms? . . . ” (p. 110).

“ . . . The barren dogma of the constancy of species which, as Lange wittily remarks, comes direct from Noah's ark . . . ” (p. 138).

(Darwin) “ . . . is always pointing expressly to the fact that the natural system is the form in which it has come to him, which he accepts in the main as the true one, is not built upon the physiological, but upon the morphological value of organs . . . Like Robert Brown and De Candolle, he insists upon the high importance for purposes of classification, of aborted and physiologically useless organs; he points to cases in which very distant affinities are brought to light by numerous transition forms of intermediate stages . . . ” (p. 152).

[The whole chapter should be carefully read.]

Let us take a couple of passages out of Prof. F. O. Bower's suggestive Hooker Lecture, *Journ. Linn. Soc.,* xliv, 110 (1917):—

“ . . . In writing systematic works, the sole endeavour must be to arrange the material so as to indicate phylesis. It seems easy at the present day to grant this in theory, but it is difficult indeed to carry it out consistently in practice. For it involves the whole problem of Natural Relationships, which should be based upon the sum of all knowledge relating to the organisms classified.” (p. 110).

“The outlook of the pre-Darwinian systematist must have been highly unsatisfactory to any intelligent man. On the one hand he found the deeply-ingrained belief in the Constancy of Species. This doctrine, introduced originally by

Linnaeus as a summation of his experience, was for a century accepted by his followers as an accepted truth. But, on the other hand, there was a growing sense of the kinship of living organisms. 'Natural Affinity' was instinctively recognised as a consequence of close comparison. The instinct translated itself into methods of grouping together such forms as have prominent features in common into genera and families. Such relationship and consequent grouping was exemplified in all divisions of the Vegetable Kingdom. If this was merely a reflection of the plan of separate Creation of Constant species, well might Elias Fries remark that there was 'quoddam supernaturale' in the Natural System." (p. 109).

And in "Journal of Heredity" for April, 1919, we have—

"In spite of the epoch-making discoveries of Kolreuterer and Sprengel, biologists still believed in the dogma of fixity of species. A new era was not opened until early in the 19th Century." (p. 152).

Messrs. Baker and Smith's views as to the constancy or fixity of species are quite clear. Mr. Baker has strongly held to the view of the Constancy of Species for very many years. For instance, in *Trans. Aust. Assoc. Adv. Sci.,* viii, 229 (1901), he has a paper "On the Constancy of specific characters of the genus Eucalyptus," and he has converted Mr. H. G. Smith to this point of view in their joint deductions on the results of work on Eucalyptus oils.

I controverted this position in *Journ. Roy. Soc. N.S.W.,* xxxviii, 332 (1904), under the heading "Has variation in Eucalyptus now ceased?" and briefly in Part VIII, p. 247, of the present work under the title "Reputed Constancy of characters in Eucalyptus."

The longer I live and study plants in the bush and the botanic garden, facts crowd upon me which point to the truth of the beautiful dogma of the infinite variation of living organisms. Messrs. Baker and Smith not only hold a contrary view, but, from some of the following passages in their work (2nd Edition), they make pointed reference to a suppositious type of "morphologist" who, so far as Australia is concerned, has long passed away. Under this name a type of botanist is referred to who is assumed to rely upon the physical characters of organs exclusively. I shall refer to the subject more in detail at p. 390.

Following are references to several passages in Messrs. Baker and Smith's work:—

(*a*) The chapter (p. 7) is headed— "Comparative Constancy of specific characters." They go on, "The reputed or supposed great variation of individual Eucalyptus species has arisen probably by the attempts of botanists to found species on *morphological characters alone.*"

The same phrase is used at p. 8.

(*b*) At p. 7 the authors say—

"The most serious objections to Bentham's anthereal system are:—

1. That of placing in the same group and in juxtaposition, species which to those familiar with the trees in the field, are perfectly distinct from each other, and

2. That of separating under various sections trees which by bark, wood, habit, general characters, chemical properties of their oils, kinos, dyes, &c., ought to stand near each other . . . "

And then Messrs. Baker and Smith proceed, on the strength of some very general remarks of the late Rev. Dr. Woolls, to compare his work on Eucalyptus with that of the immortal Bentham, to the detriment of the latter. And when we bear in mind that Bentham was never in Australia, and that he had to depend on herbarium material (often very imperfect) and notes of collectors, it is simply marvellous what he accomplished in classification. His anthereal system is still invaluable.

This criticism of Bentham's placing in juxtaposition some species not naturally closely related to each other, comes ill from authors who propound a number of groups based on oils, and obtain unnatural combinations in the process.

Bentham is again soundly trounced at p. 8 for relying on herbarium specimens, which were all he had to rely upon (over fifty years ago), and if they had been complete, with reliable notes as to habit, bark, and timber, it is not likely he would have made any mistake at all. I, as one of the pioneers in insisting on the use of all the characters available in descriptions of new species, say that it is pleasing to find that there are indications that Messrs. Baker and Smith are coming round to such a view, in spite of their erroneous deductions.

(*c*) At p. 9 they quote Mueller's words from the "Eucalyptographia"—

"*E. obliqua* is distinguished from *E. piperita* by . . . and perhaps by anatomic histologic, and chemical peculiarities of the bark and wood, which characteristics remain yet more comprehensively to be studied."

(*a*) As a specimen of special pleading, see the authors' remarks at p. 9—

"That there are *variations cannot be denied* (my italics, J.H.M.), but they are comparatively few when the extensive range of the genus is considered. With the exception of about half a dozen, all the Eucalypts enumerated in this work will be found to possess comparatively constant characters throughout their geographical distribution. On the whole, therefore, we think that the Eucalypts may be regarded as *fairly* (a buffer-word, J.H.M.) invariable. It must, of course, be admitted that herbarium material of Eucalyptus species can be so arranged (a euphuism for faked, J.H.M.) as to show perfect gradations; but then all other physical characters are ignored."

(I taught Mr. Baker, many years ago, that it would be unscientific, that is to say untruthful, to ignore them, J.M.H.)

How can we presume to set a limit to the variation? It has been going on, it is going on, and it will be going on for all time. The only thing constant, amidst the incessant changes amongst species, is the type of each species.

The authors' arguments, stated at length on pp. 9–11, and based on data deduced from oil-results, confirm the obvious necessity for botanically correct material to be supplied if chemically correct oils are required.

(*e*)

"As a further evidence of the comparative constancy of Eucalyptus species, one need only look to their introduction into other countries, where they retain all their physical characters and morphology, as obtains in their native habitat." (p. 11.)

A statement like this could only have been penned by those ignorant of variation in the same species under cultivation in various parts of the world, *e.g.,* Algiers and California. See, *e.g.,* my paper "The variability of Eucalyptus under cultivation," *Proc. Linn. Soc. N.S.W.,* 887 (1903). The evidence of variation that I have seen as a cultivator, and much of it is in the National Herbarium, Sydney, to-day, is overwhelming.

(*f*)

"Necessarily, our conclusions cannot always be expected to coincide with those who have classified, on morphological grounds alone, so wonderful a genus as the Eucalypts." (p. 20.)

I think that "coinciding" is an ideal which will never be attained. Each worker must contribute his mite to the total. At present the work has only been begun, and new species remain to be discovered, additional facts require to be known about described species, while we are only on the threshold of our knowledge of the complicated relations of species to one another.

(*g*)

"*E. dives.* The oil of *E. dives* shows a comparative constancy similar to those of other individual Eucalypts, so that the species has now been stabilised." (p. 305.)

(As a matter of fact, this was done by Deane and Maiden on morphological grounds in *Proc. Linn. Soc. N.S.W.,* xxiv, 460 (1899), as soon as they obtained access to a type or co-type of *E. dives.* The question of the oil had nothing to do with recognition of the species).

The subject is more fully treated in the article "The comparative constancy of the oil products from individual species of Eucalyptus," at p. 423, which, however, introduces no new facts.

I have on no occasion disputed the usefulness of oil determinations as a supplement to or a check on taxonomy, but I dispute the lengths to which the interpretation of them has been pushed. The vast majority of Eucalyptus names have been given, and will continue to be given, without reference to oils.

At p. 68, under *E. Blaxlandi* Maiden and Cambage, we are told—

"The fruits cannot be separated on herbarium material from those of *E. capitellata.* It requires a field knowledge of the barks, and a chemical test of the oils to differentiate the species from *E. capitellata,* as the two are very closely related."

As a matter of fact, the authors separated this species on morphological grounds. As is usually the case, the assistance of oils, if it comes at all, comes after a decision has been arrived at otherwise.

1. At p. 73 the authors' statement that I confirmed the specific differences between *E. paniculata* Sm. and *E. fasciculosa* F.v.M. by calling in the evidence of bark and timber is testimony that I am broad-minded as to the use of characters.

2. *E. leucoxylon* and *E. sideroxylon* were separated on the evidence of seedlings and juvenile leaves, bark and timber.

3. At p. 177, the authors state—

"Bentham, however, in his *Flora Australiensis,* iii, 230, places *E. eloeophora* with *E. goniocalyx* . . . Bentham's results were founded on herbarium specimens, and as recent experience has shown that Eucalypts cannot be determined on such material alone, &c. . . . "

As a matter of fact, I restored *E. elaeophora* to specific rank on morphological grounds. I only mention these last three cases as well-known examples of the use of as many morphological characters as possible. The use of oils does not come into the question.

Turning to p. 42 (2nd Edition) of Messrs. Baker and Smith's work, in *saligna* var. *pallidivalvis,* there are certain morphological characters together with glaucousness and the texture of the timber, which separate it from *E. saligna.* I call it a new species, *E. grandis,* but Mr. Baker, while admitting there is considerable variation, still keeps it under *E. saligna* as a variety.

I reiterate the question which I asked in Part VIII, p. 251 (referring to oils)—

What variation in amount of a constituent, or what constituent must be present or absent in any particular case to constitute a valid species?" Certainly the oil-character is not the one invariable (Part VIII, p. 249).

Differences in chemical constituents may indicate different species.

The above fact has not been disputed by responsible botanists for very many years, but it is quaint to see Sir J. E. Smith (1797), and Sir W. J. Hooker (1841) brought in to confirm such a position. In an article in the "New South Wales Educational Gazette" for 1st February, 1905, p. 207, Mr. Baker naively states, in speaking of *E. maculata* Hook:—

"This botanist (Hooker), however, was not always guided by morphological characters in his systematic work, but took a wider view of science, and so, in order to give prominence to the chemical constituent of the oil of the leaves, named this Queensland tree *E. citriodora,* which was the subject of article 18 of this series (December, 1903). He was not the first to name Eucalypts from their chemical products, for Sir J. E. Smith, another illustrious botanist, named the Sydney Peppermint *E. piperita* in reference to its oil constituents. This naming of species after chemical properties is not advocated by some botanists, but our researches have led us to support Sir Joseph Hooker and others of his school, and these two species afford a case upon which to discuss the advisability or likewise of this nomenclature."

In Part LXVII, p. 328, of my "Forest Flora of New South Wales," I give a "Tentative Bibliography of Eucalyptus Oil." Sir James Smith briefly refers to the aroma of the leaves of three species, while First Assistant Surgeon D. Considen wrote to Sir Joseph Banks on 18th November, 1788, referring to Eucalyptus oil :—"If there is any merit in applying these and many other simples to the benefit of the poor wretches here, I certainly claim it, being the first who discovered and recommended them."

In 1793 Smith described a plant producing oil under the name of a species we now know as *E. piperita,* and his only two other references to oil, or absence of it, are under *E. capitellata* and *E. obliqua.* Thus, under *E. obliqua L'Herit,* he says : "Leaves . . . . aromatic, but without the flavour of peppermint."

It is on such slender bases as these that Messrs. Baker and Smith, "Research, &c.," 2nd Edition, p. 18, say : " . . . The introduction of the utilisation of chemical constituents in aiding the diagnosis of Eucalyptus trees dates as far back as the foundation of Australia."

We arrive at modern times, and let us consider the lesson in two instructive papers on *Rhus :—*

1. "*The Poisonous Principle of Poison Oak.*"—Poison Oak (*Rhus diversiloba*) and Poison Ivy (*Rhus toxicodendron*) are so much alike from the botanical viewpoint that the slight difference in the shape of the leaflets is the only reason for two species. The conservative botanists, Greene and Engler, consider *R. diversiloba* to be "type" or sub-species of *R. toxicodendron.*

The fact that the pharmacological action of the two species is identical has given the widespread belief that the *poisons* were identical. W. A. Syme claims to have found upon hydrolysis of the poison of *R. toxicodendron,* rhamnose, gallic acid, and fisetin. The author was unable to secure these same constituents in *R. diversiloba,* and thinks it strange that such closely-related plants should have such widely-different poisonous principles. The two species have a slightly different range, but "such a difference in the chemical nature of the poisons could hardly be laid to a difference in climate or soil."

Fisetin, gallic acid, and rhamnose, the constituents of Syme's glucoside, are found in large quantities in *Rhus continus* and *Rhus rhodanthema.* It might be supposed from Syme's observations that these species would be poisonous. As a matter of fact, however, neither of these species is poisonous.

The work of Dr. Syme was repeated, gasoline being used as the extractive material in preference to ether, which Syme used. Chips of limbs were used in one experiment, while leaves were used in another. In the summary the author states that "natural glucoside of fisetin, rhamnose and gallic acid is non-toxic," and "there is not sufficient evidence that a poisonous substance which Syme attempted to decompose was not a complex containing a poisonous body and one or more non-toxic glucosides in addition." (J. B. McNair, in *Journ. Amer. Chem. Soc.,* xxxviii, 1417, 1916.)

2. "*On the Constituents of Poison Ivy.*"—Dr. Syme worked on the ether extract of the leaves and flowers of one species, while McNair worked on the gasoline extract of the limbs of the other species under discussion, and secured different results. He therefore concludes that Syme's work is wrong. The only other comment to be added is that McNair may not have given sufficient weight to the well-known fact that the botanical differences may often be detected only with difficulty, whereas the chemical difference may differ widely. This phase of the work has been discussed a number of times, especially by Schorger. Then it was shown that lavender, fennel, &c., produce different oils when grown under different climatic and soil conditions. Also that the distillate of the *wood* of certain pine-trees differs decidedly from that of the leaves and twigs, so that it would be dangerous to assume that the poison occurring in the *leaves* and *flowers* of *Rhus toxicodendron* should be found in the *bodywood* of this plant, and certainly it would be inadmissible to assume that this same poison, or the same non-toxic constituents should be found in the *limbs* of an entirely different species, *R. diversiloba.*" (S. F. Acree, junior, in *Journ. Amer. Chem. Soc.,* xxxviii, 1421, 1916).

" . . . An instance of this kind has been observed in the case of the so-called 'Bastard Logwood' of Jamaica. The botanical characteristics of this are almost identical with those of the common logwood, but its physiological properties are so different that it is worthless for commercial purposes." (Sir D. Morris, Pres. Address, Brit. Assoc. (Botany), 1919.)

" 'Bastard Logwood' has a much lighter-coloured heartwood, yielding little or no dye. There are no characters of leaf or flower which distinguish it from the true

Logwood. It may be considered a physiological species, and trees should be destroyed wherever found." (*Bull. Torrey. Bot. Club,* xxxi, 367, quoted by Fawcett and Rendle in "Flora of Jamaica," iv, 97.)

Perhaps it may be that further investigation will ascertain that the botanical characteristics "almost" identical with those of the common Logwood (*Haematoxylon Campechianum*), will prove to be fundamental, and others may be found, and these, taken with the physiological properties, may settle the point that the two trees are not identical species.

At the same time we have undoubted cases of variation of chemical constituents in the same species. I give two examples additional to those cited by me at Part VIII, p. 248. See also Acree's paper, just quoted.

1. "*Toxic Principles Affected by Cultivation.*"—"It is generally recognised that plants which, in the wild state, contain poisonous substances of a nitrogenous character, tend, under the influence of cultivation, to contain a smaller amount of these toxic principles. Comes, for example, has stated that if a plant which, in its wild state, was of therapeutic value, be cultivated for several generations on manured and irrigated soil, it becomes in time quite useless, owing to the disappearance of the active principles. A familiar example is afforded by the Almond, the prussic acid-forming glucoside of which, always present in bitter Almonds, has disappeared from the cultivated sweet Almond. Conflicting statements have been made of late years as to the toxicity of different varieties of *Phaseolus* Beans, some of which have been proved to contain prussic acid in the form of a glucoside. Recently Messrs. Scurti and Tommasi, of the Rome Agricultural Chemical Experiment Station, have determined the effect of nitrogenous fertilisers on *Phaseolus vulgaris* and *P. multiflorus,* collecting and analysing the seeds in each case. Particular attention was directed to the amount of non-protein nitrogen, which is taken as a measure of the toxic principle. The results conclusively show the presence of a larger proportion of non-protein in the beans from the unmanured plants. The application of sodium nitrate, for example, reduces the amount of toxic nitrogen in the seeds to about one-third of that present in the seeds of similar plants grown on unmanured soil." *Gardeners' Chronicle,* 28th October, 1911. p. 307.)

2. "*Individnal Variation in the alkaloidal content of Belladonna Plants,*" by Arthur F. Sievers, *U.S. Journ. of Agric. Research,* No. 2, pp. 129–146 (1915).

Some of the conclusions are :—

"Thus far nothing has been found to indicate that any correlation exists between the physical appearance of the plant and the alkaloidal content of its leaves . . . "

"The variation of the percentage of alkaloids in the leaves of the different plants is exceedingly large . . . ”

Mr. W. F. Blakely, who had a good deal of experience amongst sugar-cane in Northern Queensland, informed me that, given the same variety of cane, the Kanakas always chose, for chewing purposes, that from the well-drained hillsides, instead of that from the flats. The cane from elevated situations might only be half the size, but its density for sugar was far greater as compared with that from land with better growing conditions.

Perhaps the following references from Messrs. Baker and Smith may fitly come in here.

(*a*) “*E. rostrata* var. *borealis.* On chemical grounds we have decided to separate the Northern River Gum (Nyngan, N.S.W.) from the Southern River Gum, under the varietal name of *borealis.*” (“Research,” p. 111, 2nd Ed.).

Morphological differences have not been found so far.

(*b*) “*E. tereticornis* var. *cineolifera* nobis. Scarcely any difference exists between the shape of these fruits and its type.” (*Ib.,* p. 181.)

This is therefore also a chemical variety.

“We have received much help towards settling doubtful botanical points since the discovery of this constancy in chemical constituents was made, the results assisting much towards demonstrating differences between the several species, which otherwise could not have been decided so satisfactorily. When these differences have been detected, further research has shown well-marked morphological characters to be also present—in fact, so distinct that the species cannot again be confounded with others, or, in other words, we have learned its history and found its place in nature. The exceptions to this are very rare.” (*Ib.,* p. 11.)

But what of other characters correcting oil determinations?

I have dealt with the subject of variation in oils, and the botanical inferences involved, in Part VIII of the present work, under the following headings :—

1. *Oil an accessory or adaptive character* (p. 248).
2. *Is the oil-character the one invariable* (p. 249).
3. *Variation in oil* (p. 250).
4. *Classification on oils alone associates dissimilar species* (p. 251), and I invite my readers to kindly turn to these pages, to avoid repetition.

Real genetic relationships take cognisance of all the characters.

I have dealt with the matter at some length at p. 247, Part VIII, of the present work, and also in the present Part (p. 383).

Contemplation of as many characters as possible to form a truly natural system is a very old idea, as the following passage shows :—

“But the most comprehensive truth with which we are acquainted respecting plants is that which includes the whole of their general structure, and this we learnt from those great Frenchmen who, in the latter half of the eighteenth century, began to study the external world. The first steps were taken after the middle of the century by Adanson, Duhamel de Monceau, and, above all, Desfontaines; three eminent thinkers, who proved the practicability of a natural method hitherto unknown, and of which even Ray himself had only a faint perception. This by weakening the influence of the artificial system of Linneus . .” (Buckle's “History of Civilisation,” ii, 397, 1861.)

The matter is, of course, bound up with the old dogma of “Constancy of Species” dealt with at p. 381.

Darwin had a strong objection to classification based on a single or few characters. Referring to Owen's paper “On the characters, &c., of the Class Mammalia” (*Proc. Linn. Soc.* (*Zoological*), ii, p. 1, 1858), he says (to Hooker) :—

“ . . . Though I knew nothing whatever about the brain, I felt a conviction that a classification thus founded on a single character would break down . . . ” (“Life and Letters,” iii, 10.)

. . . (to the Marquis de Saporta) . . . “I cannot at present give up my belief in the close relationship of man to the higher Simiae. I do not put much trust in any single character, even that of dentition, but I put the greatest faith in resemblances in many parts of the whole organisation, for I cannot believe that such resemblances can be due to any cause except close blood relationship.” (*Ib.,* p. 162.)

And again, “When the same organ is rigorously compared in many individuals, I always find some slight variability, and consequently that the diagnosis of species from minute differences is always dangerous . . . ”

“After describing a set of forms as distinct species, tearing up my MS., and making them one species, tearing that up, and making them separate, and then making them one again (which has happened to me), I have gnashed my teeth, cursed species, and asked what sin I had committed to be so punished . . . ” (“Life and Letters of Charles Darwin,” ii, 37, 40.)

Sir W. Thistleton-Dyer, F.R.S., the late Director of Kew, says :—

“ . . . From what I have myself heard fall from Mr. Darwin, I am led to believe that in the later years of his life he was disposed to think that every detail of plant structure had some adaptive significance, if only the clue could be found to it.[*] . . . Such a classification, to be perfect, must be the ultimate generalisation of every scrap of knowledge which we can bring to bear upon the study of plant affinity.” (British Association Address as Biological President, 1888, p. 690.)

Mueller early learnt this lesson as regards the genus Eucalyptus, for when on the

North Australian Expedition in 1856 he wrote :—

"The Stringy-bark tree of this part of the country (*E. tetradonta*) differs from the southern species, and although a *Eucalyptus* it produces, *Angophora*-like, a four-toothed calyx. Several other species of this genus, all trees, were noticed, of which two are highly ornamental in producing scarlet flowers and lamellar bark; another in having a double operculum. I found it necessary, for the sake of satisfactory distinctions, to describe all the tropical Eucalypti (nearly thirty species), on the spot, and I was never at a loss how to discriminate between variety and species, by considering *all the characters of the trees collectively* (the italics are mine, J.H.M.), and by paying due attention to the soil, habit, structure, and texture of the bark, the manner of its decortications; consulting likewise, as very important, *the insertion and form of the fruit-valves, which, before opening, form either a flat or more or less convex vertex to the capsule, a character which, beautiful as it is, can only be studied in living plants*. Important also is the structure and form of the *fertile* seeds, most of the ovules becoming abortive. The former are, in many kinds, provided with a very large wing, although the seeds of the generality of the species are wingless . . . " (Hooker's *Journal of Botany*, Vol. ix, p. 165–6.)

The following remarks (Bentham, 1866) show that that eminent man was fully seized with the desirability of employing as many characters as possible:—

"I have thus been compelled to establish groups upon such characters as appeared to me the most constant among those which are supplied by the specimens: in the first place upon the form of the anthers, and secondly upon that of the fruit, and in some cases on the inflorescence of the calyx. It must be admitted, indeed, that these groups, distinct as they may be in the typical species, pass very gradually into each other through intermediate forms, but I have endeavoured to supply cross-references to facilitate the determination of dried specimens in doubtful cases. It is to be hoped that, in the elaborate monograph of the genus with plates representing all the species promised by Dr. Mueller in his 'Fragmenta,' he, form his knowledge of the Gum-trees in a living state, will be able to give us a true natural arrangement founded upon the proposed cortical or any other system which experience may induce him to adopt." (B.Fl., iii, 186.)

"Mr. (Henry) Deane called attention to a means of distinguishing species of plants by qualities and products which are generally overlooked by botanists, but which are of the utmost practical value. Plants only slightly differing outwardly are put down as mere varieties of the same species. Inquiry, however, perhaps shows that their products, such as timber, are quite different in character, in which case, therefore, they ought to be recognised as quite distinct in species. Mr. Deane exhibited timber specimens of three so-called varieties of *Eucalyptus saligna*, the

Sydney Blue-Gum, two of *E. hoemasioma*, and two of *E. goniocalyx* to illustrate his remarks." (*Proc. Linn. Soc. N.S.W.*, xiv, 190, 1889.)

"Mr. Deane exhibited a few specimens of Eucalyptus timbers with a view of showing that their characters are not without value as an aid in the determination of species . . . " (*Ib.*, xvi, 576, 1891.)

These innocent looking remarks refer to what was really a rebellion against authority. Mr. Deane and I had been in close touch as regards the study of Eucalypts for some years, and in the following year a very pleasant publishing partnership in regard to the genus began between us.

In those days Baron von Mueller was the only Australian authority on Eucalyptus; to him all queries were remitted for decision, and he ruled us all with a firm hand. We younger men respectfully demurred to such of the Baron's decisions as ignored the importance of, say, timbers, and Mr. Deane and I were the first to insist that the timber is a part of the plant for descriptive botanical purposes, as important, in its way, as the flowering or fruiting twig. At this time, and for some years previously, I had been busy getting together the collection of logs for the Technological Museum (of which I was Curator, and *de facto* founder) matched with herbarium specimens collected from the identical trees which produced the logs.

The "*E. saligna*" referred to included, in those days, the subsequently described *E. propinqua* Deane and Maiden, and *E. Deanei* Maiden, both of which were, after intervals of years, returned to us as *E. saligna* var. by Mueller. The reference to *E. goniocalyx* referred to the inclusion of *E. elaeophora* with it.

At the same time, in order to contrast the darkly hinted at reactionary morphological methods of unnamed workers, Messrs. Baker and Smith ("Research," 2nd Edition, p. 9) expressly exclude Mueller from criticism. I think that we should never lose sight of our vast indebtedness to Mueller, even if, in an historical survey, we historically state his reactionary views at particular periods.

Messrs. Baker and Smith persistently desire to leave the impression that the present writer is one of the "morphologists" included in their disapproval, while they forget, as regards oil alone, that before I left the Technological Museum, I caused to be constructed (as Superintendent of Technical Education, and in spite of the stupid opposition of years in certain quarters) that very oil-still which rendered possible Mr. Smith's admirable researches. All during the years I pleaded for examination of *all procurable evidence*, in the elucidation of species, and taught them so, while they were my subordinates. I was, indeed, one of the pioneers of this view in Australia. Over twenty years ago I wrote in *Proc. Linn. Soc. N.S.W.*, in my Presidential Address before the Linnean Society:—

"I do not lose sight of the fact for one moment that, in the discrimination of genera and species we should call to our assistance any characters that can be employed to that end. Prof. John M. Coulter in his Vice-Presidential Address, Section F (Biology), *Amer. Assoc. Adv. Science*, 1891, p. 300, eloquently pleads for a philosophical conception of a species in the following passage: “The character of a species is an extremely composite affair, and it must stand or fall by the *sum-total* of its peculiarities and not by a single one. A specific character in one group may be a generic character in a closely-related one, or no character at all. Therefore, there is nothing that involves a broader grasp of facts, the use of an inspiration rather than a rule, than proper discrimination of species. I have a belief that the arbitrary rule-of-three mind will never make a successful taxonomist: and that there is a sort of instinct for specific limitations which the possessor cannot communicate to another. This taking into account the total character of a plant, from *facies* to minute characters, will furnish the basis of future descriptive work. The more obstacles that can be put in the way of hasty determination the better.’ ”

We welcome any hint as to differences between species brought to light by chemical analysis or examination of physical characters of oils obtained from their leaves. Following is an extract from a criticism made by the late Dr. Thomas Hall in the *Australasian* of 22nd November, 1902, on the true place of Eucalyptus oil. It is a character—as regards the vast majority of species it is not even a dominant character. It is sometimes a useful character, and we must assess its proper value, but it is by no means a “Philosopher's Stone.”

“Some months ago attention was drawn to the idea put forward by Messrs. Baker and Smith, that it is, above all things, necessary to consider the nature of the oils and other products of the trees in order to decide what a species was. This suggestion will undoubtedly meet with strong opposition alike from botanists and zoologists. Plants and animals are universally classified on their form, or on those external characters which are capable of detection, either by the unaided eye or by the aid of a microscope. Or to put the case in a scientific way, we say that classification is founded on morphological characters. The method suggested by the authors is to employ other characters, or, in other words, to found classification on physiological ones. It is an elementary rule in classifications of any kind that there should be no cross division. For instance, we cannot divide men into black-haired, yellow-haired and tobacco-smokers, and to allow physiological considerations to have weight in one group would open the door to a complete change in all our ideas. It is true that the classification of bacteria is, to a great extent, physiological, and not a morphological one. It rests on a consideration of function rather than of form, but no one considers the genera and species of bacteria as in any way comparable to those of other organisms founded on the character usually employed.”

Following is an extract from a paper I read before the British Association for the Advancement of Science at its Australasian meeting, August, 1914:—

A species must be judged as a whole. Species may be compared to stones of various sizes and facets. They may lack uniformity, but we are conscious of a general similarity. Each stone is looked upon in its wholeness as a gem; the individual characters, colour, size of facet, &c., are of relatively less importance. This idea of judging a thing as a whole, with the amplest information available concerning it, is not peculiar to the species concept. It is applied to other forms of thought, and in proportion as the botanist grasps it, he becomes a broader-minded man.

Let us take an illustration from the science of history. In March last Lord Haldane, in lecturing on 'The Meaning of Truth in History,' said, "The historian surely must resemble the portrait-painter rather than the photographer. The historian who had a whole period to describe must be more than exact; he had to be a lord over his details. He must marshal those details and tower above them and reject and select in the light of nothing less than the whole.' His chairman, Sir Edward Grey, added, 'I am sure that a mere accumulation of facts and records without interpretation can as little give a true impression of the life, the spirit, the work, and the thought of a past age, as a drawerful of dried and unmounted skins can give an impression of the life of the birds in the air, on the earth, or in the water.' "

We pass to an illustration from the domain of criticism. In Professor, Gerthwohl's recent essay on Edward Dowden (*Fortnightly Review*, June, 1914, p. 1012), we have the same point of view:—

" . . . if he had once understood an author . . . it was a never-ending joy to return at intervals to live with him . . . after a period of intimacy with his author, and still impregnated with that author's sweet fragrance, Dowden . . . dismissing details, surveyed him in his broader structure, in his elevated masses of truth, before setting him forth as an organic whole, artistically reconstructed by the twofold process of conjectural psychology and document."

Consider for a moment a homely comparison taken from industrial legislation. In Australia, with our detailed laws and regulations on the subject, we are frequently confronted with such problems as lie before the Boiler Makers, Shipwrights, and Engineers' Demarcation Board, which has to solve problems of overlapping, and endeavour to empirically preserve the integrity of each trade. And so through the gamut of human affairs the outstanding lesson we have to learn is to view subjects from as many aspects as possible.

What does all this lead to? To the fact that the conception of a species is based on empiricism, and that therefore we must rely upon human judgment in apportionment of a sufficient amount of variation to constitute a species. And in all cases in which we rely upon human judgment we have the potentiality of human error. Although endless fun can be poked at the illogical positions in which we sometimes find ourselves by our conception of species, it is idle to attempt to abandon them, for plants will be labelled species on the evidence of our senses to the end of time.

" . . . Species which are concepts, as I take it, for our convenience in discussing the various questions pertaining to plants, should be distinguished by sufficient morphological characters, the distinctions, based upon physiological differences having subspecific rank. What constitute sufficient morphological characters must be left to the individual judgment." (Prof. J. C. Arthur, Symposium at the Fourteenth Annual Meeting of the Botanic Society of America, p. 248, 1908)."

Prof. Arthur used as illustration three rusts which will each only grow on *Aster, Solidago*, or *Erigeron* but which otherwise appear to be identical; it appears to be question of nutrition. He looks upon the rusts as identical species, although some others hold a different opinion. (Arthur, *op. cit.*, p. 245.)

"The more thoroughly and accurately, however, it (taxonomic practice) takes into account the total sum of the attributes, qualities and capacities of the plant, the greater will be the value of its conclusions, and the greater will be the service it may render to co-ordinate branches of botanical science." (Dr. D. T. Macdougal, *op. cit.*, p. 252.)

As the concept of species does not appear to be as clearly understood in Australia as it should be, I will refer to the subject in a subsequent Part.

Intramarginal Vein, and other notes on Venation.

The following preliminary remarks apply to venation in general:—

"The distribution of the strands (technically known as veins, ribs and nerves) traversing the green tissue is connected in the closest manner with the structure and shape of the leaf-blade. The term vein has some justification, since most of these strands contain cells and vessels which serve to conduct fluid materials to and fro; but since there are also strands which have nothing to do with this conduction, which are developed exclusively for the support of the whole blade, the name is unsuitable, and can only be used figuratively." (Kerner and Oliver "The Natural History of Plants," I, 628).

"If soaked in water, the epidermis and thin-walled green tissues decay, while the tougher strands remain intact. We term these skeletons, though not quite correctly.

"The fact should be emphasised that the distribution and arrangement of the strands in any given species is remarkably constant. This, however, is by no means the case in genera and families. Of course, there are plant families, the whole of whose members exhibit marked agreement in this respect, as, for example, the . . .

Myrtaceae." (p. 635.)

There is, however, much variation in the venation of leaves of individual species of Eucalyptus. This has been shown abundantly at p. 394, &c., and in the illustrations and text of the present work. Mr. Henry Deane (below) refers to the subject.

Coming to the intramarginal vein, the position of this vein is stated in its name, and it is most evident in the juvenile stage, where it is often at a considerable distance from the margin in the youngest leaves, receding towards the margin as growth proceeds. But it does not appear to be a definite entity in the same way that the secondary veins are that emerge from the midrib, but an anastomosis of the ends of such veins. Bentham's definition of (or reference to) the vein will be referred to presently.

The intramarginal vein was earliest referred to by A. P. de Candolle, in *Prodromus*, iii (1828), and in G. Don's translation of the same in 1832 (already referred to at p. 357).

Bentham (B.Fl., iii, 185) has the following passage:—

". . . . the primary veins often scarcely perceptible when the leaves are thick; in some species few, irregular, oblique, and anastomising and passing through every gradation from that to numerous parallel diverging or transverse veins, always converging into an *intramarginal vein*, either close to or more or less distant from the edge . . . "

In the same work he employs the intramarginal vein to some extent in specific descriptions.

Mueller in "Eucalyptographia" adopts intramarginal vein, and introduces a new equivalent, "circumferential vein," sometimes "irregularly remote from the edge of the leaf." The word "circumferential" was the word Mueller preferred in later years, for he did not share Huxley's dictum (see Part L, p. 312) as to the undesirability of coining new terms and definitions when equivalents were already in use.

"Then it has been supposed that the intramarginal vein would be a pretty sure guide. It is, however, found in Myrtaceae generally, in some Proteaceae, in many Apocynaceae, in many species of *Ficus*, and in genera belonging to many other Natural Orders. It is further to be remarked that in Eucalyptus itself its position is very variable, so that while in some leaves it is a considerable distance from the margin, and in others it is so close to the edge as to be barely distinguishable." (Deane in *Proc. Linn. Soc. N.S.W.*, xxv, 586, 1900.)

From what I have already said, it seems unnecessary to take up space in repeating a statement about the distance in every leaf-description, and therefore I propose to eliminate it as a rule.

Following are some species in which the intramarginal vein is marked. This list, like so many others in this Part, is illustrative, not exhaustive:—

E. aggregata.	*E. Kirtoniana*.
E. alpina.	*E. Kitsoniana*.
E. amplifolia and other *tereticornis* series.	*E. loevopinea*.
	E. Lehmanni.
E. Andrewsi.	*E. leucoxylon*.
E. Banksii.	*E. longifolia*.
E. Baueriana.	*E. megacarpa*.
E. Behriana.	*E. melliodora*.
E. calycogona.	*E. Mooreana*.
E. Cambageana.	*E. Muelleri*.
E. capitellata.	*E. neglecta*.
E. conica.	*E. obliqua*.
E. Consideniana.	*E. odorata*.
E. cosmophylla.	*E. ovata*.
E. dealbata.	*E. pilularis*.
E. dives.	*E. regnans*.
E. Dunnii.	*E. sideroxylon*.
E. eloeophora.	*E. Stuartiana*.
E. erythronema.	*E. urnigera*.
E. goniocalyx.	*E. vernicosa*.
E. grossa.	*E. viminalis*.
E. Gunnii.	*E. Yarraensis*.
E. hemiphloia.	

Nearly all, perhaps all, Cornutae.

All Coriaceae.

In Corymbosae the intramarginal vein is close to the margin, or absent, in adult leaves, but in juvenile and intermediate leaves it may be removed by up to 3 mm.

Angles the secondary or lateral veins make with the midrib.

This subject has been already referred to at p. 378. In their “Research, &c.,” Messrs. Baker and Smith have unduly pressed the correlation between the angles the lateral or secondary veins make with the midrib, and the constituents of the oils distilled from each species.

I have already pointed out that it is impossible to say what is the angle pertaining to a particular tree (much less to a particular species), mainly because of the shape of the leaf (usually tapering towards apex and base), and because one of the functions of veins is the mechanical support of the leaf.

The nearest approach to uniformity is secured by the selection of that portion of the leaf where the sides are most parallel, say, the middle third. The upper parts of the leaf taper too much, while, in some forms, the secondary veins cluster towards the petiole, and do not approach uniformity until at some considerable distance from the petiole.

Another point is that when, in the same species, we have considerable difference in the width of a leaf, the angle the secondary vein makes with the midrib changes by reason of this narrowness. In other words, the secondary veins, being more crowded laterally, exhibit a change of angle. This, therefore, is a secondary cause of variation.

We may know more about relationships by laboriously measuring the angles of every species, taking every precaution to take representative leaves for each species. I have made a beginning, only a beginning, of this work. (See also Part LVI, p. 294).

It would be desirable in descriptions to state the approximate angle the secondary veins make with the midrib. Messrs. Deane and Maiden introduced the practice, and I have continued it to some extent, but the practice ought always to be followed.

As already explained, the accepted terms for types of venation are—

1. Longitudinal (call them Longitudinales).
2. Oblique (call them Obliquae).
3. Transverse (call them Transversae).

1. LONGITUDINALES.
(Angles 0–25 degrees.)

It is impossible to say, in the case of almost every species, that the angle the lateral veins make with the middle third of the midrib is a definite number of degrees, consequently in some of them I have given two inclusive figures, which may or may not be sufficiently inclusive. Doubtless two figures should be given in all cases.

Taking the word "longitudinal" in its ordinary meaning, I do not think it can be fairly used to indicate angles of more than 25 degrees. It will be observed that some leaves, while including the maximum of 25, may go beyond this figure, and thus pass over into another section (Obliquae).

As it is impossible to follow the measurements of angles without diagrams, Miss Flockton has drawn a number of leaves, with the middle third drawn to scale, showing all the angles referred to in the text that the secondary veins make with the midrib. I regret that it is not possible to reproduce them in the present Part, as that would be most convenient, but they will be reproduced in an early Part (LX).

The measurements about to be and already quoted have been made by one of my botanical assistants (Mr. R. H. Anderson, B.Sc., Agr.): I have not altered a figure. But I impress on my readers that they are only approximations.

In the following lists Coriaceae indicates a group of the Renantherae, which includes *E. coriacea*, and closely-related species. Renantherae indicates all other species of the Renantherae. The terms Cornutae, Corymbosae, and Eudesmieae are self-explanatory. The Angophoroideae indicate those species with papery fruits, as in Angophora. These terms will be further explained when the grand classification of the species is arrived at.

The majority of species having longitudinal venation belong to the Renantherae (which includes the Coriaceae) in the smaller angles. These are mostly Gums, Peppermints, Stringybarks. In addition we have belonging to groups other than the Porantherae, Gums, Mallees, Boxes.

10 degrees—

E. stellulata (Coriaceae).

10–15 degrees—

E. de Beuzevillei (Coriaceae).	*E. Mitchelliana* (Coriaceae).
E. coriacea (Coriaceae).	*E. vitellina* (Coriaceae).
E. hoemastoma (Renantherae).	

10–20 degrees—

E. coccifera (Coriaceae). *E. coriacea* (Coriaceae).

10–25 degrees—

E. piperita (Renantherae). *E. radiata* (Renantherae).

15 degrees—

E. Mitchelliana (Coriaceae). *E. Simmondsii* (Coriaceae).

15–20 degrees—

E. Mitchelliana (Coriaceae).	*E. vitellina* (Coriaceae).
E. Andrewsi (Renantherae).	*E. obliqua* (Renantherae).
E. dives (Renantherae).	*E. radiata* (Renantherae).
E. ligustrina (Renantherae).	*E. regnans* (Renantherae).
E. populifolia (a Box).	

15–25 degrees—

E. vitrea (Coriaceae).	*E. toeniola* (Renantherae).
E. gigantea (Renantherae).	

E. obliqua (Renantherae). *E. gracilis* (a Mallee).

15–30 degrees—

E. Andrewsi (Renantherae). *E. radiata* (Renantherae).
E. fraxinoides (Renantherae).
E. gracilis (a Mallee). *E. melanophloia* (an Ironbark).

15–35 degrees—

E. toeniola (Renantherae).

20 degrees—

E. Kybeanensis (Coriaceae). *E. Laseroni* (Coriaceae).
E. obtusiflora (Renantherae).

20–25 degrees—

E. de Beuzevillei (Coriaceae).
E. alpina (Renantherae). *E. virgata* (*Luehmanniana*) (Renantherae).
E. amygdalina (Renantherae). *E. Muelleriana* (Renantherae).
E. celastroides (a Mallee). *E. odorata* (a Box).

20–30 degrees—

E. Kybeanensis (Coriaceae). *E. Risdoni* (Coriaceae).
E. Blaxlandi (Renantherae). *E. gigantea* (Renantherae).
E. capitellata (Renantherae). *E. obliqua* (Renantherae).
E. Consideniana (Renantherae). *E. stricta* (Renantherae).
E. diversifolia (Renantherae). *E. regnans* (Renantherae).
E. occidentalis var. *grandiflora* (Cornutae).
E. aggregata (Black Gum). *E. incrassata* (a Mallee).
E. coesia. *E. intertexta* (a Box).
E. Dawsoni (intermediate form) (Red Box). *E. melliodora* (a Box).
E. foecunda (York Gum). *E. odorata* (a Box)
E. Stricklandi.

20–35 degrees—

E. obliqua (Renantherae). *E. platypus* (Cornutae).

20–40 degrees—

E. odorata (a Box). *E. ovata* (a Swamp Gum).
E. spathulata var. *grandiflora* (Cornutae).

20–45 degrees—

E. ovata.

25 degrees—
E. Pilligaensis (a Box).
25–30 degrees—

E. Laseroni (Coriaceae).
E. altior (Renantherae).
E. Andrewsi (Renantherae).
E. laevopinea (Renantherae).
E. numerosa (Renantherae).
E. obtusiflora (Renantherae).
E. aggregata (Black Gum).
E. diptera.
E. elaeophora (Bastard Box or Mountain Apple).
E. gracilis (a Mallee).
E. leptopoda (a Mallee).
E. maculosa (a White Gum).
E. cornuta (Cornutae).
E. Risdoni (Coriaceae).
E. obliqua (Renantherae)
E. pachyloma Renantherae).
E. Penrithensis (Renantherae).
E. Smithii (Renantherae).
E. virgata (Renantherae).
E. parvifolia.
E. polyanthemos (a Box).
E. pumila (a Mallee).
E. scoparia (a Gum).
E. Thozetiana (a Gum).
E. eremophila (Cornutae).

25–35 degrees—

E. Risdoni (Coriaceae).
E. stellulata (Coriaceae).
E. capitellata Renantherae). (Stringybark).
E. eugenioides (Renantherae) (Stringybark).
E. affinis (a Box).
E. Baeuerleni (a Mallee).
E. Caleyi (an Ironbark).
E. vitrea (Coriaceae).
E. macrorrhyncha (Renantherae) (Stringybark).
E. obliqua (Renantherae). (Stringybark).
E. dumosa (a Mallee)
E. Pilligaensis (a Box).
E. viminalis (a White Gum).

25–40 degrees—

E. coccifera (Coriaceae) (a White Gum).
E. capitellata (Renantherae) (Stringybark).
E. pachyloma (Renantherae) (a Mallee).
E. piperita (Renantherae) (a Peppermint).
E. radiata (Renantherae) (a Peppermint).
E. nitens (a Box).
E. occidentalis var. *grandiflora* (*Cornutae*).

25–45 degrees—

E. Perriniana (a White Gum). *E. viminalis* (a White Gum).

25–55 degrees—
E. redunca var. *oxymitra* (Intermediate leaf).

2. OBLIQUae.

(Angles 30–55 degrees.)

Those species which are accounted Obliquae are those which are left after eliminating the better, yet imperfectly, defined groups of Longitudinales and Transversae. The species that come into it are so anomalous that it is of very limited use as a basis of classification. Even a number of Renantherae (Longitudinales) are contained in it, while there are so many Corymbosae, usually looked upon as characteristic of the Transversae, that this relation cannot be maintained in any exclusive sense. The Miscellaneous are so numerous that I have not attempted to further differentiate them as under Longitudinales.

It will be observed that the vast majority of the Obliquae come between the angles 30 and 40 degrees, and up to 45 degrees.

See also the series—

Degrees.	Degrees.	Degrees.
20–30	20–45	25–40
20–35	25–30	25–45
20–40	25–35	25–55

to be found under Longitudinales, and which overlap the Obliquae.

For those which overlap the Obliquae in the opposite direction, see enumeration of angles under Transversae.

30 degrees.—

E. haemastoma (*Renantherae*).	*E. radiata* (*Renantherae*).
E. aggregata.	*E. incrassata*.
E. celastroides.	*E. Maideni*.
E. cinerea.	*E. Muelleri*.
E. doratoxylon.	*E. odorata*.
E. erythronema.	*E. sideroxylon*.
E. fasciculosa.	*E. Thozetiana*.
E. occidentalis (Cornutae).	

30–35 degrees—

E. Camfieldi (Renantherae).	*E. ligustrina* (Renantherae).
E. fraxinoides (Renantherae).	*E. obliqua* (Renantherae).
E. haemastoma (Renantherae).	*E. pilularis* (Renantherae).
E. caesia.	*E. maculosa*.
E. celastroides.	*E. megacarpa*.
E. confluens.	*E. Morrisii*.
E. conglobata.	*E. odorata*.
E. conica.	*E. ovata* var. *camphora*.
E. decipiens.	*E. Pilligaensis*.

E. Dundasi.
E. foecunda.
E. fruticetorum.
E. Gunnii.
E. hybrida.
E. Lehmanni.
E. annulata (Cornutae).
E. Pimpiniana.
E. punctata.
E. pyriformis and var. *Kingsmilli*.
E. redunca.
E. salmonophloia.
E. viridis.
E. occidentalis var. *astringens* (Cornutae).

30–40 degrees—

E. agglomerata (Renantherae).
E. alpina (Renantherae).
E. buprestium (Renantherae).
E. Camfieldi (Renantherae).
E. capitellata (Renantherae).
E. cneorifolia (Renantherae).
E. acaciaeformis.
E. alba.
E. angusta.
E. Baueriana.
E. Benthami.
E. Behriana.
E. bicolor.
E. doratoxylon.
E. dumosa.
E. falcata.
E. Flocktoniae.
E. Campaspe.
E. cinerea.
E. cladocalyx.
E. conglobata.
E. corrugata.
E. foecunda.
E. globulus.
E. Griffithsii.
E. grossa.
E. Gunnii.
E. hybrida.
E. incrassata var. *angulosa*.
E. Isingiana.
E. Kalganensis.
E. leptophleba.
E. leptophylla.
E. linearis.
E. eugenioides (Renantherae).
E. gigantea (Renantherae).
E. laevopinea (Renantherae).
E. obliqua (Renantherae).
E. Penrithensis (Renantherae).
E. pilularis (Renantherae).
E. melliodora.
E. Muelleri.
E. Mundijongensis.
E. nova-anglica.
E. occidentalis.
E. ochrophloia.
E. Oldfieldii.
E. pachyphylla var. *sessilis*.
E. pallidifolia.
E. paniculata.
E. polyanthemos.
E. populifolia.
E. pulverulenta.
E. punctata.
E. pyriformis and var. *elongata*.
E. rariflora.
E. redunca var. *oxymitra*.
E. Rudderi.
E. saligna.
E. sideroxylon.
E. salmonophloia.
E. sepulcralis.
E. Le Souefii.
E. transcontinentalis.
E. unialata.
E. vernicosa.
E. viminalis.
E. Yarraensis.

E. Macarthuri.

E. occidentalis (Cornutae). *E. Stowardii* (Cornutae).

E. platypus and var. *nutans* (Cornutae)

E. Cliftoniana (Corymbosae).

E. Ebbanoensis (Eudesmiae). *E. odontocarpa* (Eudesmiae).

E. eudesmioides (Eudesmiae).

30–45 degrees—

E. gigantea (Renantherae). *E. Planchoniana* (Renantherae).

E. Muelleriana (Renantherae).

E. alba. *E. oligantha*.

E. Bosistoana. *E. ovata*.

E. Drummondii. *E. pachyphylla*.

E. gomphocephala. *E. patellaris*.

E. Hillii. *E. polyanthemos*.

E. Houseana. *E. pyriformis* var. *elongata*.

E. incrassata. *E. redunca*.

E. Kitsoniana. *E. rostrata*.

E. micranthera. *E. rubida*.

E. Normantonensis. *E. Stuartiana* vars. *grossa* and *parviflora*

E. Oldfieldii. *E. vernicosa*.

E. oleosa.

E. macrandra (Cornutae). *E. platypus* var. *nutans* (Cornutae).

30–50 degrees—

E. cinerea. *E. praecox*.

E. falcata var. *ecostata*. *E. siderophloia*.

E. hemiphloia. *E. urnigera*.

E. megacarpa. *E. Woodwardi*.

E. paniculata.

E. eudesmioides (Eudesmiae). *E. odontocarpa* (Eudesmiae).

30–55 degrees—

E. obliqua (Renantherae).

30–60 degrees—

E. redunca. *E. grandifolia*.

35 degrees—

E. capitellata (Renantherae). *E. decurva*.

E. conica. *E. doratoxylon*.

E. annulata (Cornutae).

35–40 degrees—

E. umbra (Renantherae).

E. amplifolia.
E. angophoroides.
E. Baeuerleni.
E. Bakeri.
E. Beyeri.
E. Blakelyi.
E. Bosistoana.
E. Cambageana.
E. cladocalyx.
E. Clelandi.
E. corrugata.
E. decipiens.
E. drepanophylla.
E. dumosa.
E. exserta.
E. falcata.
E. gamophylla.
E. gomphocephala.
E. Griffithsii.
E. hemiphloia.
E. Howittiana.
E. incrassata var. *conglobata.*
E. leucoxylon.
E. ovata.
E. pachyphylla var. *sessilis.*
E. paniculata.
E. phoenicea.
E. pulverulenta.
E. rubida.
E. rudis.
E. Sheathiana.
E. striaticalyx.
E. tereticornis var. *latifolia.*
E. Todtiana.
E. Umbrawarrensis.
E. urnigera.
E. Websteriana.

E. Lehmanni (Cornutae). *E. occidentalis* (Cornutae).

E. erythrocorys (Eudesmiae). *E. tetrodonta* (Eudesmiae).

35–45 degrees—

E. gigantea (Renantherae).
E. marginata var. *Staeri* (Renantherae).
E. adjuncta.
E. alba.
E. Bancrofti.
E. Banksii.
E. Baueriana
E. Blakelyi.
E. Caleyi.
E. Dalrympleana.
E. dealbata.
E. diversicolor.
E. Drummondi.
E. Dundasi.
E. goniantha.
E. leucoxylon.
E. melanophloia.
E. obtusiflora (Renantherae).
E. pilularis var. *pyriformis.*
E. neglecta.
E. ovata.
E. patellaris.
E. patens.
E. pellita.
E. quadrangulata.
E. Raveretiana.
E. rostrata var. *acuminata.*
E. rostrata.
E. Staigeriana.
E. striaticalyx.
E. tereticornis.
E. tetraptera.
E. torquata.
E. viminalis.

E. melliodora.

E. aspera (Angophoroideae).	*E. Spenceriana* (Angophoroideae).
E. cornuta (Cornutae).	
E. Foelscheana (Corymbosae).	*E. miniata* (Corymbosae).
E. maculata (Corymbosae).	*E. Watsoniana* (Corymbosae).
E. Baileyana (Eudesmiae).	*E. lirata* (Eudesmiae).

35–50 degrees—

E. Baueriana.	*E. pellita.*
E. Caleyi.	*E. pyriformis.*
E. Dunnii.	*E. resinfera.*
E. goniocalyx.	*E. rostrata.*
E. Jenseni.	*E. Stuartiana* var. *grossa.*
E. oleosa.	*E. tereticornis.*
E. orbifolia.	*E. Woodwardii.*
E. macrandra (Cornutae).	

35–55 degrees—

E. piperita (Renantherae). *E. Rudderi.*

35–60 degrees—

E. acmenioides (Renantherae).

35–65 degrees—

E. siderophloia.

40 degrees—

E. argillacea.	*E. Hillii.*
E. Campaspe.	*E. incrassata.*
E. Caleyi.	*E. incrassata* var. *conglobata.*
E. cinerea.	*E. Lane-Poolei.*
E. Culleni.	*E. leptopoda.*
E. devorticans.	*E. oleosa.*
E. exserta.	*E. rudis.*
E. foecunda.	*E. scoparia.*
E. goniantha.	*E. torquata.*
E. miniata (Corymbosae).	

40–45 degrees—

E. eugenioides (Renantherae).	*E. microcorys* (Renantherae).
E. hoemastoma (Renantherae).	*E. pilularis* var. *pyriformis.*
E. alba.	*E. Kitsoniana.*
E. Boormani.	*E. longifolia.*

E. Bowmani. *E. maculosa.*
E. Brownii. *E. micranthera.*
E. conica. *E. notabilis.*
E. cosmophylla. *E. ovata* var. *camphora.*
E. crebra. *E. paniculata.*
E. Culleni. *E. pellita.*
E. punctata.
E. Dawsoni. *E. redunca* var. *elata.*
E. dealbata. *E. redunca* var. *melanophloia.*
E. Deanei. *E. robusta.*
E. drepanophylla. *E. rostrata.*
E. Flocktonioe. *E. rostrata* var. *acuminata.*
E. gamophylla. *E. Seeana.*
E. Gillii. *E. squamosa.*
E. grandis. *E. transcontinentalis.*
E. incrassata. *E. Websteriana.*
E. Isingiana.
E. clavigera (Angophoroideae). *E. tessellaris* (Angophoroideae).
E. papuana (Angophoroideae).
E. Foelscheana (Corymbosae).

40–50 degrees—

E. microcorys (Renantherae).
E. amplifolia *E. oleosa.*
E. angophoroides. *E. Parramattensis.*
E. Baeuerleni. *E. Perriniana.*
E. botryoides. *E. pulverulenta.*
E. Cloeziana. *E. punctata.*
E. cosmophylla. *E. resinifera.*
E. Forrestiana. *E. rostrata.*
E. grandis. *E. rudis.*
E. grossa. *E. saligna.*
E. incrassata var. *angulosa.* *E. Seeana.*
E. Irbyi. *E. Stricklandi.*
E. Jacksoni. *E. viminalis.*
E. nova-anglica.
E. aspera (Angophoroideae). *E. papuana* (Angophoroideae).
E. grandifolia (Angophoroideae). *E. Spenceriana* (Angophoroideae).

E. Abergiana (Corymbosae). *E. ferruginea* (Corymbosae).
E. intermedia (Corymbosae). *E. setosa* (Corymbosae).
E. miniata (Corymbosae). *E. trachyphloia* (Corymbosae).
E. perfoliata (Corymbosae). *E. Watsoniana* (Corymbosae).

E. tetradonta (Eudesmiae).

40–55 degrees—

E. marginata (Renantherae). *E. Planchoniana* (Renantherae).
E. longifolia. *E. Stuartiana.*
E. Parramattensis. *E. tereticornis.*
E. Staigeriana.
E. aspera (Angophoroideae).
E. occidentalis var. *astringens* (Cornutae).
E. Foelscheana (Corymbosae). *E. perfoliata* (Corymbosae).
E. erythrocorys (Eudesmiae). *E. tetragona* (Eudesmiae).

40–60 degrees—

E. Cloeziana. *E. grandis.*
E. cordata. *E. pulverulenta.*
E. papuana (Angophoroideae). *E. tetragona* (Eudesmiae).

40–65 degrees—

E. Naudiniana. *E. grandifolia* (Angophoroideae).

40–70 degrees—

E. macrocarpa.

45 degrees—

E. accedens. *E. redunca* var. *angustifolia.*
E. angophoroides. *E. vernicosa.*

45–50 degrees—

E. Bancrofti. *E. Gunnii.*
E. canaliculata. *E. Kirtoniana.*
E. cordata. *E. leptophleba.*
E. drepanophylla. *E. melanophloia.*
E. Gillii. *E. oligantha.*
E. goniocalyx. *E. pellita.*
E. Guilfoylei. *E. rubida.*
E. dichromophloia (Corymbosae).
E. similis (Eudesmiae).

45–55 degrees—

E. acmenioides (Renantherae). *E. microcorys* (Renantherae).
E. alba. *E. rudis.*
E. dealbata. *E. Stuartiana* var. *parviflora.*

E. grandifolia (Angophoroideae). *E. Spenceriana* (Angophoroideae).
E. eximia (Corymbosae). *E. Watsoniana* (Corymbosae).

45–60 degrees—

E. botryoides. *E. pruinosa.*
E. gomphocephala. *E. Raveretiana.*
E. Mooreana. *E. saligna.*
E. pellita.
E. grandifolia (Angophoroideae).
E. Abergiana (Corymbosae). *E. pyrophora* and var. *polycarpa* (Corymbosae).
E. ficifolia (Corymbosae).
E. latifolia (Corymbosae). *E. setosa* (Corymbosae).
E. ptychocarpa (Corymbosae). *E. Torelliana* (Corymbosae).

45–65 degrees—

E. Benthami. *E. Jacksoni.*
E. aspera (Angophoroideae).
E. eximia (Corymbosae). *E. latifolia* (Corymbosae).
E. Foelscheana (Corymbosae). *E. terminalis* (Corymbosae).

45–70 degrees—
E. cordata.
50 degrees—

E. Banksii *E. Howittiana.*
E. hemiphloia.

50–55 degrees—

E. propinqua. *E. Websteriana.*
E. dichromophloia (Corymbosae). *E. Foelscheana* (Corymbosae).
E. ficifolia (Corymbosae).

50–60 degrees—

E. angophoroides. *E. resinifera.*
E. Deanei. *E. robusta.*
E. pruinosa.
E. corymbosa (Corymbosae). *E. latifolia* (Corymbosae).
E. dichromophloia (Corymbosae). *E. pyrophora* (Corymbosae).
E. ferruginea (Corymbosae). *E. terminalis* (Corymbosae).
E. Foelscheana (Corymbosae). *E. trachyphloia* (Corymbosae).
E. hoematoxylon (Corymbosae).
E. erythrocorys (Eudesmiae).

50–65 degrees—

E. botryoides. *E. pellita.*
E. intermedia (Corymbosae). *E. ptychocarpa* (Corymbosae).

50–70 degrees—

E. patens. *E. intermedia* (Corymbosae).

50–75 degrees—

E. Preissiana. *E. robusta.*
E. corymbosa (Corymbosae).

50–80 degrees—

E. dichromophloia (Corymbosae). *E. ptychocarpa* (Corymbosae).

55–65 degrees—

E. Kirtoniana. *E. peltata* (Corymbosae).

55–70 degrees—

E. miniata (Corymbosae). *E. perfoliata* (Corymbosae).

55–75 degrees—
E. eximia.
55–90 degrees—
E. calophylla.

3. TRANSVERSae.

Angles 60 to 90 degrees.)

Taking the word Transversae in its ordinary meaning, it can hardly be stretched beyond 60 degrees as a minimum. At the same time, this excludes such of the Corymbosae (a group usually considered as almost synonymous with the Transversae), for they are to be found in the Obliquae from angles 40 to 60, and are to be found commonly with angles 50 to 60.

The transverse venation is, as a rule, different from that of the other two groups, in that the veins are closer together—more packed, so that there is not room between them for the finer reticulate veins. At the same time, it shades into the oblique venation imperceptibly.

Included in Mueller's and Baker and Smith's Transverse group are *E. botryoides, E. resinifera, E. saligna* and *E. tessellaris,* in addition to certain members of the Corymbosae. Their venation may be seen in the following—*E. botryoides,* Plates 98 and 99; *E. resinifera,* Plate 124; *E. saligna,* Plates 99 and 100; *E. tessellaris,* Plate 156.

It will be seen how close their venation is to that of the Corymbosae.

I have done my best to put all Corymbosae in the Transversae, with species like *E. resinifera* as tend to the Transversae, but by making the range 60 to 90 degrees, I think I have strained the meaning of the word sufficiently.

Corymbosae will be found in the oblique series under the following angles:—

30 to 40 degrees.	45 to 65 degrees.
35 to 45 degrees.	50 to 55 degrees.
40 degrees.	50 to 60 degrees.
40 to 45 degrees.	50 to 65 degrees.
40 to 50 degrees.	50 to 70 degrees.
40 to 55 degrees.	50 to 75 degrees.
45 to 50 degrees.	50 to 80 degrees.
45 to 55 degrees.	55 to 65 degrees.
45 to 60 degrees.	55 to 70 degrees.

See also the series—

45 to 60 degrees.	50 to 75 degrees.
45 to 65 degrees.	50 to 80 degrees.
45 to 70 degrees.	50 to 90 degrees.
45 to 75 degrees.	55 to 65 degrees.
50 to 60 degrees.	55 to 70 degrees.
50 to 65 degrees.	55 to 75 degrees.
50 to 70 degrees.	55 to 90 degrees.

to be found in Obliquae, and which overlap the Transversae.

In the lists which follow, it may be sufficient to say that the species all belong to the Corymbosae except *E. Guilfoylei* and *E. Preissiana*. I am satisfied that, particularly in the Transversae, further measurements require to be undertaken.

60–70 degrees—	65–75 degrees—
E. calophylla.	*E. terminalis.*
E. setosa.	
E. Guilfoylei.	65–90 degrees—
	E. corymbosa.
60–75 degrees—	
E. corymbosa.	70–85 degrees—
E. eximia.	*E. corymbosa.*
E. hoematoxylon.	
60–80 degrees—	80–85 degrees—

E. calophylla. *E. Preissiana.*

Secondary veins of Hybrids.

It will be observed that practically the whole of these leaves belong to the Obliquae series.

15–30 degrees—

E. Forsythii.

25–40 degrees—

E. melliodora var.

30 degrees—

E. Stopfordi. *E. Antipolitensis.*

30–35 degrees—

E. Studleyensis. *E. Algeriensis.*

30–40 degrees—

E. Barmedmanensis.	*E. Insizwaensis.*
E. Auburnensis.	*E. pseudoglobulus.*
E. Cordieri.	*E. Tenandrensis.*

30–45 degrees—

E. Peacockeana.	*E. Forsythii.*
E. leucoxylon-sideroxylon.	

35–40 degrees—

E. jugalis.

35–45 degrees—

E. melliodora var. *E. Barmedmanensis.*
E. Forsythii.

40 degrees—

E. Yagobiei. *E. Bourlieri.*
E. Trabuti.

40–45 degrees—

E. gomphocornuta.	*E. Stopfordi.*
E. jugalis.	*E. Yagobiei.*

45 degrees—

E. Tenandrensis. E. Trabuti.

Secondary veins of Fossil Leaves.

For details as to these Australian species, see Part LIV of the present work.

"By the almost equal proportion of the Eucalyptus leaves of the *wide-angled parallel-veined* (*archaic*) *type, and those in which the veins are acutely disposed to the midrib,* one cannot help concluding that the flora is somewhat in the mid-stage of development, and precludes the idea of one so old even as the Eocene." (F. Chapman, in *Vict. Nat.,* xxxvii, 115, 1921.)

From the following measurements it will be seen that practically the whole of the fossil Eucalypts come under the Oblique section (Obliquae). Only *E. proecoriacea* (Coriaceae) comes into Longitudinales, while *E. Milligani* is the most pronounced of the Transversae, although four species which immediately precede it in the list now submitted have leaves whose angles overlap the Obliquae and the Transversae. I agree, therefore, with Mr. Chapman's statement "the flora is somewhat in the mid-stage of development," but I have not the evidence which would entitle me to agree to the "almost equal proportion," &c., of the earlier part of the statement.

Longitudinales.

71/2 degrees—
E. proecoriacea.

	OBLIQUae.
30–35 degrees—	40–55 degrees—
E. Hayi.	*E. Pluti.*
E. Delftii.	*E. Suttoni.*
30–40 degrees—	45 degrees—
E. Hayi.	*E. Davidsoni.*
E. Pluti.	45–50 degrees—
	E. Oxleyana.
35 degrees—	
E. Kitsoni.	50–55 degrees—
	E. Howitti.
35–45 degrees—	
E. Hermanni.	50–60 degrees—
	E. Houtmanni.
35–50 degrees—	*E. Mitchelli.*
E. Chapmani.	50–65 degrees—
	E. Mitchelli.

40–45 degrees—	*E. Mitchelli.*
E. Pluti.	50–70 degrees—
40–50 degrees—	*E. cretacea.*
E. Hermanni.	55–65 degrees—
E. Kitsoni.	*E. Diemenii.*

TRANSVERSae.

60–70 degrees—
E. Milligani.

Variation in different parts of the same leaf.

I have already pointed out (p. 394) that the angles the secondary veins make with the midrib vary according to the leaf, or the width of the leaf, and, therefore, in order to secure as much uniformity as possible, I divided the leaves into three equal portions, measuring the angles in the middle third. That the angles vary somewhat according to the part of the leaf, can be seen from so many of the leaves figured in the various Plates. Mr. Anderson has taken the following measurements from three species which vary a good deal amongst themselves:—

E. globulus (seven leaves examined).

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Lowest Third	15–30°	30–35°	35–45°	10–15°	25–30°	35–55°	30–40°
Middle Third	40–45°	30–40°	35–45°	35–45°	30–40°	40–50°	30–40°
Top Third	45–60°	40–45°	35–50°	30–45°	40–50°	45–55°	30–45°

Taking all the readings, the angles in the lowest third vary from 15 to 55 degrees, with the majority below 40 degrees.

The middle third varies from 30 to 50 degrees, the majority being between 35 to 45 degrees.

The top third varies from 30 to 55 degrees, average 40 to 50 degrees.

The angles of the lowest and top thirds are here less constant than those of the middle thirds.

E. corymbosa (four leaves examined).

Lowest Third	75–85°	70–75°	75–80°	65–70°
Middle Third	60–70°	60–65°	65–70°	55–65°
Top Third	50–55°	50–60°	50–65°	50–55°

The angles here diminish as they go higher up the leaves.

E. paniculata (three leaves examined).

Lowest Third	50–60°	45–50°	40°

Middle Third	45–50°	40–45°	40°
Top Third	45–50°	40°	40°

Other leaves show less difference in the three sections, while other show differences chiefly at the extreme ends, *e.g., E. Andrewsi.*

Oil Glands.

Don ("Dichlamydeous Plants," ii, p. 818, 1832) in a very few cases refers to Eucalyptus leaves as "full of pellucid dots" or gives some brief reference to dots.

It is, of course, in oil-bearing leaves, an indication, even a quantitative indication, of the presence of oils, but it is so common in the genus that most writers ignore record of the oil-dots unless they are especially abundant.

In the present work I have an occasional note on the subject, *e.g.,* under *E. stellulata,* at Part V, p. 128, under *E. incrassata,* Part IV, p. 98, under *E. Morrisii,* Part XXXII, p. 56.

Prof. G. Briosi has published an important paper, under the auspices of the Botanical Institute of the University of Pavia (under the title "Intorno alla anatomia delle Foglie dell' *Eucalyptus globulus* Labill.," Milan, 1891, with 23 plates). It is a quarto work of 95 pages, and is probably the most exhaustive work ever published in regard to the anatomy of the leaves of a single species of Eucalyptus. (The account of the oil glands is of especial interest.)

"Oils are the more volatile constituents of complex mixtures, secreted by glands of various forms, whose solid constituents, after the oils have been driven off, are resins. These secretions may escape at once upon the surface, or they may be stored in intercellular receptacles and released only by crushing. Even in very small amounts, they may be distilled, and when more abundant they may be expressed and purified." (Coulter, Barnes and Cowles' "Text Book of Botany," I, 413.)

"Many plants possess *internal glands,* which often appear as translucent dots, as in the case of *Citrus* and *Eucalyptus.* In most cases the glands are spherical, there being a peripheral layer of glandular cells which secrete into a common reservoir. Often this structure is surrounded by a relatively impermeable protective layer. Usually the reservoir does not discharge to the exterior, but in *Eucalyptus* and various Rutaceae, there are *cover cells,* which after a time rupture at a definite spot, or along the walls, allowing the secretions to pass off. The secretions secreted by internal glands resemble those secreted by glandular hairs, and likewise often odoriferous." (*Ib.* ii, 623.)

"But little is known concerning the role of volatile oils, &c., though speculation has been abundant. It has been suggested that they are of value in protecting against excessive transpiration, on the ground that they absorb heat in large amount, but it is most unlikely that these oils are present in sufficient abundance to check transpiration . . . Probably there is no adequate reason for believing that such secretions are of any particular value in the economy of plants. Doubtless, for the most part, they represent waste products, whose removal is of greater value than their retention. Any incidental gain that these secretions may have probably is small.” (*Ib.* ii, 624.)

Dawkins, A. E., has a paper “The Calculation of the Oil Content of Foliage from Measurements of the number and size of the Oil-glands,” *Proc. Roy. Soc. Vict.,* XXVIII (new series), 153 (1915).

“The collection and distillation of oil-containing materials is often a matter involving much labour. Since, therefore, the oil is well known to occur in the case of many species in small, well-defined oil-dots or oil-glands, it was thought that it might be possible to forecast the oil-content of any particular species by making a few measurements of the size and number of the oil-dots, weight of leaf, &c.”

The author adopts a not complicated mathematical formula, and shows how it works in the case of three Eucalypts, *radiata, viminalis, Kitsoni (Kitsoniana).* A *Leptospermum* and a *Eugenia* are also chosen. The results are moderately close, and the method is commended for further investigation.

Now we come to two papers by M. B. Welch, B.Sc., the beginning of a broader research:—

1. “Eucalyptus Oil Glands,” *Journ. Roy. Soc. N.S.W.,* liv, 208 (1920).

The author points out that the anatomy of the various parts has been little investigated in Eucalyptus.

“The oil glands occur in the leaves of almost every species, but in varying number, reaching perhaps a minimum in the Bloodwoods, *e.g., E. terminalis,* where they are practically non-existent . . . Although the distribution and number of the glands is not of very great taxonomic value, yet, as pointed out in this paper, certain variations do occur and without doubt hold good throughout the distribution of the species. Again, it is quite possible to recognise certain differences in their arrangement which would permit of a rough classification into groups, of which some examples are given.”

2. “The Occurrence of Oil Ducts in certain Eucalypts and Angophoras” (*Proc. Linn. Soc. N.S.W.,* xlvi, 475 (1921).)

This investigation shows that ducts formed by the linking up of short secretory cavities occur in the medulla of the stems and leaves of certain Eucalypts of the Corymbosae class and also *Angophora lanceolata.* They contain oil similar in nature to that found in the leaf oil glands, and apparently function as storage reservoirs. There is no direct connection between the oil glands and the oil ducts, nor are the latter continuous from stem to leaf. Ducts do not occur in the roots or lower portion of the stems. Apparently these ducts indicate a primitive character in those species in which they occur, and also show a close phylogenetic affinity between the Eucalypts and Angophoras.

A valuable paper, illustrated by many text-figures and micro-photographs.

Resin.

Coats of varnish as protective coverings are especially to be met with on young leaves, which they guard from over-transpiration and desiccation during their development; and when the leaf-laminae become provided with a cuticularised epidermis, these coats disappear.

"The leaves of many desert xerophytes are coated with resin, and often have a varnished aspect, shining in the sunlight. The factors influencing the formation of resin-coats are unknown. Like wax-coats, they may retard transpiration, and it has been suggested that they reflect light, an excess of which may injure the chlorophyll." (Coulter, Barnes and Cowles' "Text Book of Botany" II, 571).

I do not know whether the chemist has actually isolated a resin from *Eucalyptus* leaves; apparently it must be rare in the genus, and the Tasmanian *E. vernicosa* Hook f. would be a possible source. Mitchell (quoted by Bentham, *B.Fl.,* iii, 225), in "Three Expeditions," ii, 175, speaking of *E. alpina* Lindl., which he discovered, says "with short, broad, viscid leaves." They are both from sub-alpine localities.

Shape.

Authors have not much to say, in a general way, concerning the shape of mature Eucalyptus leaves:—

" . . . in the adult shrub or tree of most species vertical (or sometimes horizontal), alternate, petiolate, and passing more or less from broadly ovate to lanceolate acuminate and falcate, always rigid whether thick or thin, penniveined, the midrib conspicuous . . . " (B.Fl. iii, p, 185).

"The form, size and venation of the leaves described have always been taken from those of the flowering branches of what have been supposed to be adult trees or shrubs; when not stated to the contrary, they are always alternate and petiolate." (*Ib.* p. 186).

The following passage refers to leaves in general.

Variation in Shape. "Foliage leaves . . . exhibit an almost inexhaustible variety in their internal structure and external form, a fact partly due, no doubt, to the multifarious duties they have to discharge. The most important of all these functions is the manufacture of organic materials from inorganic food . . .

That those members of the plant to which is allotted the manufacture of organic matter should exhibit such a marvellous diversity can hardly astonish us: for how infinitely varied are the conditions under which this function is performed in the different zones and regions of the globe. Even within the narrow confines of a restricted area we may find habitats damp and dry, sunlit and shady, tranquil and tempest-tossed. Nor should we be surprised to find leaves of diverse shape at different heights on one and the same shoot, and that the foliage borne by any plant may exhibit variations in form in successive seasons of the year." And so on. (Kerner and Oliver, I, 626).

In other words, in shape of leaves, the ideal is not uniformity, or "comparative" uniformity.

The vast majority of mature Eucalyptus leaves are falcate-lanceolate in shape, and those of different shape may be looked upon as exceptions. Sometimes the evolution towards the narrower form is retarded, and hence I have, on occasion, used the expression "Retarded Heteroblasticity."

The following species are normally broad, and it is only of recent years that it has been ascertained that some of them pass into the lanceolate form. Even in species which have been ascertained to have leaves which belong to the lanceolate rather than to the orbicular series, we ascertain from time to time forms even narrower.

Rhomboid or Broad.

E. alba.	*E. Mooreana.*
E. alpina.	*E. Naudiniana.*
E. Baueriana.	*E. oligantha.*
E. Behriana.	*E. orbifolia.*
E. clavigera.	*E. populifolia.*
E. cordata.	*E. Preissiana.*
E. Gillii	*E. pruinosa.*
E. Hillii.	*E. pulvigera.*
E. Kruseana.	*E. rariflora.*
E. latifolia.	*E. vernicosa.*
E. macrocarpa.	*E. Websteriana.*
E. melanophloia.	

Linear.

E. linearis.	*E. apiculata.*
E. Jutsoni.	*E. spathulata.*

Linear-lanceolate.

E. amygdalina	*E. odontocarpa.*
E. approximans.	*E. pachyloma.*
E. Bakeri.	*E. Pilligaensis.*
E. cneorifolia.	*E. Thozetiana.*

E. Dundasi. *E. viridis (acacioides).*
E. Moorei.

Obliquity.

Many species are more or less oblique, but it will be found that it is preponderatingly characteristic of the Renantherae. Amongst these, it is most readily observed in *E. obliqua* L'Herit. See, as regards juvenile leaves, Plate 6, Part II, and mature leaves, Plate 37, Part VIII.

Apex.

The apex varies somewhat, and the following lists are offered to draw attention in a tentative manner to this variation. There is variation within the same species, and much work is required before any important generalisations can be made.

Emarginate, or sometimes so.

E. Blakelyi.	*E. miniata.*
E. Camfieldi.	*E. Muelleri.*
E. cinerea.	*E. platypus.*
E. dealbata.	*E. polyanthemos.*
E. gomphocephala.	*E. pruinosa.*
E. Gunnii.	*E. urnigera.*
E. melanophloia.	

Emarginate and Mucronate.

E. affinis (slightly). *E. decipiens.*

Mucronate.

E. aggregata. In *E. tetraptera* the midrib is continued 5 mm. beyond the leaf, forming a rigid, sharp mucro, unusual in Eucalypts.
E. buprestium.
E. Campaspe.

Blunt or rounded.

E. acacioeformis.	*E. latifolia.*
E. Baileyana.	*E. megacarpa.*
E. Benthami (sometimes).	*E. microtheca.*
E. Cambageana.	*E. Naudiniana.*
E. drepanophylla.	*E. nitens.*
E. ferruginea.	*E. Spenceriana* (not markedly).
E. Foelscheana.	*E. Stuartiana.*
E. globulus (often).	*E. viminalis* (frequently).
E. Hillii.	*E. Websteriana.*
E. Houseana.	

Obtuse.

E. affinis. *E. Blakelyi.*
E. aspera. *E. peltata.*

Hooked.

(Usually most obvious in rigid and succulent, narrow leaves.)

E. apiculata. *E. Moorei.*
E. coccifera. *E. stellulata* and many others.
E. coriacea.

Apiculate.

E. cinerea. *E. pyrophora* (slightly).
E. corymbosa. *E. umbra.*
E. Gillii (bluntly apiculate).

Margins.

It is not easy to classify leaves according to their margins; the following lists are a mere introduction to the subject. The vast majority of species have unindented (entire) margins, with the blades in one plane.

Under margin incurved slightly.

E. capitellata. *E. trachyphloia.*
E. stricta.

Crenate.

E. erythrocorys.

Crenate to Undulate.

E. foecunda.

Crenulate.

E. acacioeformis. *E. dichromophloia.*
E. acacioeformis var. *linearis.* *E. diversicolor.*
E. cordata. *E. Irbyi.*
E. decipiens. *E. Muelleri.*

E. ovata. Labillardiere's artist figured *E. ovata* (see Part XXVII, Plate 113, fig. 1a of the present work), as with crenulate margins, but this is a little diagrammatic. The leaf is undulate rather.

E. patens. *E. urnigera.*

Crenulate to Plicate.

E. marginata.

Undulate to Plicate.

E. botryoides.	*E. ferruginea.*
E. calophylla.	*E. Foelscheana.*
E. cornuta.	*E. grandifolia.*
E. corymbosa.	*E. Hillii.*
E. clavigera.	*E. macrorrhyncha.*
E. Dawsoni.	*E. maculata.*
E. dives.	*E. obliqua.*
E. eugeniodes.	*E. ptychocarpa.*

Undulate.

E. aggregata.	*E. Houseana* (S.).
E. Baileyana (S).	*E. Kirtoniana.*
E. Baueriana.	*E. latifolia.*
E. Blaxlandi (reddish rim when fresh).	*E. Mooreana* (S.).
E. capitellata.	*E. ovata.*
E. drepanophylla	*E. perfoliata* (S.).
E. Dunnii.	*E. Perriniana.*
E. ficifolia (to puckered on half of lamina).	*E. Rudderi.*

Puckered to undulate.

E. Perriniana.

Margin thickened or strongly marked.

(Here we come into venation. This thickening is a question of ensuring stability of the lamina.)

E. calophylla. Lindley (this work, Part XLIII, p. 73), speaks of the leaves of *E. calophylla* having a rich red marginal line.

Margin thickened or strongly marked—*continued.*

E. Foelscheana. In the young leaves some of the margins are distinctly thickened and rounded as if corded; it is a device to secure the stability of so large a leaf.

E. haematoxylon.	*E. patens.*
E. Kybeanensis.	*E. Preissiana* (We have a rich red marginal line in this species also).
E. marginata.	*E. Le Souefii.*
E. nitens (S.)	

For a note on glandular leaf-margins, or those the work of insects, see under *E. nitens,* Part XIX, p. 272.

Twisting of the Petiole.

"Grisebach, in his account of the 'Vegetation of Australia,' dwells on the close relation of inter-dependence which exists between the tree vegetation and the coating of grass which covers the ground beneath it; and remarks that the amount of light allowed by the trees to reach the ground beneath them is rendered more than usually great by the vertical position in which their leaves grow. Hence the growth of the grass beneath is aided.

It may be that this permitting of the growth of other plants beneath them, and consequent protection of the soil from losing its moisture, besides other advantages to be derived, is the principal reason why, as is familiarly known, two widely different groups of Australian trees, the *Eucalypti* and *Acacias,* have arrived at a vertical instead of a horizontal disposition of their leaves by two different methods.

The Acacias have accomplished this by suppressing the true horizontal leaves and flattening the leaf stalks into vertical pseudo-leaves or 'phyllodes.' The gum-trees, on the other hand, have simply twisted their leaf-stalks, and have thus rendered their true leaves vertical in position. There must exist some material advantage, which these different trees derive in common, from this peculiar arrangement, and the benefit derived from relation to other plants by this means may be greater and more important than that arising from the fact that the vertical leaves have a like relation to the light on both sides, and are provided with stomata on both faces." (Moseley's "Challenger," p. 229).

Schimper ("Plant Geography," p. 9) remarks:—

"Other leaf-bearing xerophytes have their leaves or leaf-like cladodes arranged parallel to the incident rays of sunlight, and are consequently less intensely heated and illuminated. In some plants, such as Eucalyptus, the position has become hereditary."

A condition of equilibrium between the Eucalypts and the grass in an open forest has been arrived at, and the twist of the leaf-stalk aids the provision of light. Ringbarking the trees promotes the growth of grass still further; in the first place, the leaves fall, and the gaunt limbs of the tree but little obstruct the light; and secondly, the dead tree no longer absorbs moisture, portion at least of which goes to improve the condition of the grass. See also Ringbarking, Part LII, p. 92.

Where the Eucalyptus petiole is markedly twisted, it is usually notably flattened. The twisting can be seen in a number of figures, *e.g.,* figure 3a, Plate 127, *E. pellita.*

There is a reference to the use of the transverse sections of petioles as aids in the determination of species at Part I, p. 6, of the present work.

Deciduous Leaves.

It is unusual for a Eucalypt to be deciduous, and it is only the case with some tropical species, *e.g., E. alba* (*platyphylla*) which at Kuranda, Northern Queensland, loses its leaves pretty regularly during October and February.

E. Houseana (W.V.F.) Maiden (see Part L, p. 293) of North-western Australia, is also deciduous in some seasons. The matter of deciduousness in Eucalyptus might well attract the consideration of a resident in tropical Australia.

A number of Australian trees become deciduous as colder regions are reached, but this does not apply to Eucalypts, so far as I have observed. But quite a number of trees become deciduous on the approach of a local drought, *e.g.,* in summer (about February), *Ficus Cunninghamii,* in the Sydney district.

The connection between the fall of the leaf and the commencement of the cold period in the case of what are known as "deciduous" trees par excellence is simply explained in the ordinary botanical text-books.

Heat and cold are only the indirect causes; the primary cause of the fall of the leaf is the danger threatened to the plant by the continuance of transpiration when either heat or cold is excessive. The throwing off of the transpiring surfaces becomes necessary when the drought commences. In tropical and sub-tropical regions, where no showers occur for comparatively long periods, the trees lose their leaves, and do not produce fresh ones until the rain comes.

Explanation of Plates (232–235).

Plate 232.

Plate 232: EUCALYPTUS AGGLOMERATA Maiden (1, 2). E. SIMMONDSII n.sp. Lithograph by Margaret Flockton.

E. agglomerata Maiden.

1*a.* Juvenile leaves; 1*b,* fruits. Hill Top, Southern Line, N.S.W. (J.H.M.) (See also figs. 6*a* and 6*b,* Plate 38, Part VIII, then looked upon as intermediate between *E. capitellata* and *E. eugenioides*).
2*a.* Juvenile leaves; 2*b,* intermediate leaf; 2*c,* mature leaf; 2*d,* umbel of buds; 2*e,* buds and flowers; 2*f,* front and back view of anther. Near Jerrimbool Railway Station, 31/2 miles from Hill Top, on main southern road (J. L. Boorman).

E. Simmondsii n.sp.

3*a.* Juvenile leaves, with bases slightly stem-clasping; 3*b,* juvenile leaves a stage further advanced, and still in an almost horizontal position; 3*c,* juvenile leaves in an almost vertical position; 3*d,* mature leaf with hooked apex (with flower buds); 3*e,* mature leaf. Note that 3*e* is in a more advanced stage than 3*d;* it is smaller, and the venation less conspicuous. 3*f,* buds as mature as I have seen them; 3*g,* anther; 3*h,* fruits. Smithton, beyond Burnie, Tasmania (Rev. J. H. Simmonds). The Type.

Plate 233.

Plate 233: EUCALYPTUS SEPULCRALIS F.v.M. (1). E. TORQUATA Luehmann (2, 3). [See also figure 6 Plate 13.] Lithograph by Margaret Flockton.

E. sepulcralis F.v.M.

1*a.* Pendulous branchlet of mature leaves; 1*b,* buds; 1*c,* front and back views of anther; 1*d,* nearly ripe fruits; 1*e,* fruits as ripe as I have seen them. Eyre's Range, 10 miles north of Hopetoun, South Coast of Western Australia (R. K. Wellstead).

E. torquata Luehmann.

2*a,* 2*b.* Juvenile leaves; 2*c,* intermediate leaf; from near Coolgardie, W.A., by District Forest Ranger J. M. Cusack. 3*a,* mature leaf; 3*b,* mature leaf and one flower. Note that the calyx tube shows a little less ribbing than as figured at fig. 6, Plate 13, Part IV. Note also the style obtruded before the stamens have their filaments unbent. This species has a long operculum, as will be seen on reference to the figure quoted.

Plate 234.

Plate 234: EUCALYPTUS KALGANENESIS n.sp. (1). E. MELANOXYLON n.sp. (2, 3). Lithograph by Margaret Flockton.

E. Kalganensis n.sp.

1*a.* Twig, bearing mature leaves and buds; 1*b,* front and back views of anthers; 1*c,* fruits. Kalgan Plains, south of Stirling Range, Western Australia (Dr. F. Stoward, No. 117).

E. melanoxylon n.sp.

2*a,* 2*b,* 2*c.* Various stages of juvenile leaves; 2*d,* mature leaf; 2*e,* mature leaf, showing flattened young peduncle and umbel of very young buds; 2*f,* buds; 2*g,* three views of anther; 2*h,* fruits. Westonia, Western Australia (District Forest Ranger J. M. Cusack).

Since figures 2*a-h* were drawn, I have received additional specimens from the same source, through Mr. S. L. Kessell, Acting Conservator of Forests, W.A. These are in full flower and show more buds with conoid opercula, and a long style with a capitate stigma. They also show that, as growth proceeds, the fruits may have longer pedicels, may become wider at the orifice, and so more conoid in shape, and the valves of the capsule more distinctly exsert. These are referred to on the Plate as 3*a,* buds with conical opercula; 3*b,* the same, with flowers; 3*c,* flower (enlarged) with capitate stigma; 3*d,* ripe fruits.

Plate 235.

Plate 235: EUCALYPTUS ISINGIANA n.sp. (1, 2). E. AGGREGATA Deane and Maiden (3-5). [See also Plate 104.] (No. 6 is E. aggregata Baker and Smith). Lithograph by Margaret Flockton.

E. Isingiana n.sp.

1*a.* Twig, bearing mature leaves, fruits, and a flower with non-capitate, much protruded stigma; 1*b,* front and back views of anther. 407 miles, near Ooldea, South Australia (E. H. Ising, No. 1480, 5th September, 1920).

2. Twig with mature leaf and young fruits in the urceolate stage. (P. Webb).

E. aggregata Deane and Maiden.

3*a.* Juvenile leaves (broader, in proportion, than fig. 8*a,* Plate 104); 3*b,* intermediate leaf (broader, in proportion, than fig. 9, Plate 104, which is really an intermediate leaf, and not a mature leaf, as stated.) Wallerawang, N.S.W. (R.H. Cambage).

4*a,* 4*b.* Mature leaves. Wallerawang, N.S.W., home of the type (J.H.M.).

(Figures 3 and 4 supplement the figures on Plate 104, Part XXV. The mature leaves are not shown on Plate 104 at all, although these are shown in Plate 49, vol. 24, *Proc. Linn. Soc., N.S.W.* (1899), when the species was described. The figures on Plate 104 supplement the Plate 49 as just quoted, and I have already stated, as regards some other species, that it would have been best to have given more figures in the present work, than to assume that my readers would remember to consult another work for the purpose of supplementing my figures in original Plates of the Critical Revision. But I acted in the interests of economy in not repeating details figured elsewhere).

5*a.* Juvenile leaves, in three; 5*b,* juvenile leaves; 5*c,* mature leaf; 5*d,* twig, bearing mature leaves and buds; 5*e,* fruits. Guildford Junction, Tasmania (R. H. Cambage, No. 4101). These specimens are discussed at some length at p. 356.

6. Juvenile leaves of a plant figured by Messrs. Baker and Smith at Plate 79 of "Research on the Eucalypts," 2nd Edition, as *E. aggregata* Deane and Maiden, which obviously it is not. The mistake is important, because, having the idea that *E. aggregata* is a species of narrow juvenile leaves, they felt the coast to be clear to enable them to name *E. aggregata,* occurring in Tasmania, as a new species under the name of *E. Rodwayi,* with broad juvenile leaves.

* "The Tertiary Flora of Australia," by H. Deane, M.A., *Proc. Linn. Soc. N.S.W.,* xxv, 474 (1900).

* In the oil of this species traces of phellandrene were detected, nevertheless it is practically a pinene oil, so has been placed in this Group. (R.T.B. and H.G.S.).

* The name Aromadendral is used throughout this work in a general sense to denote the presence of one or more members of this group of characteristic aldehydes, which includes cuminaldehyde and cryptal. See the article in this work on these aldehydes (R.T.B. and H.G.S.).

* Included in Group III, Class (*a*) in 1st Edition.

* Included in Group III, Class (*b*), 1st Edition.

† Included in Group III, Class (*a*), 1st Edition.

‡ Included in Group III, Class (*c*), 1st Edition.

¶ [In Group IV, 1st Edition.

|| In Group II, 1st Edition].

* [In Group V, 1st Edition.

† [In Group II, 1st Edition.]

‡ [In Group VI, Class (*a*), 1st Edition.]

¶ [In Group VI, Class (*b*), 1st Edition.]

* [In Group VII, 1st Edition.]

* Many years afterwards, I put the same idea in the following words :— “There is no evidence that we may have two plants, precisely similar in morphological characters, which are not specifically identical.”

Part 58

CCCXLI. E. collina W. V. Fitzgerald n.sp.

FOLLOWING is the original description:—

Arborescent, branchlets more or less angular, terminal shoots and inflorescence mealy white; suckers invested with bristly ferruginous hairs, the adult foliage glabrous and shining; leaves scattered or alternate, lanceolate, falcate, acuminate, tapering into the petioles, firm and rigid, the veins slightly ascending, the intramarginal one close to the edge, all much concealed; sucker leaves alternate, ovate, obtuse, shortly petiolate; flowers large, pedicellate, in umbels of 4-6, several together and forming short corymbose pedunculate panicles; pedicels terete, stout, shorter or slightly longer than the calyx; calyx-tube turbinate, lid depressed conical, much shorter and not broader than the summit of the tube, the sutural line irregular; stamens inflected in the bud, very numerous; anthers narrow-ovate, with distinct parallel cells dehiscing longitudinally; style short and thick; fruit broad-cylindrical, smooth, ribless, not constricted at the summit, rim narrow; capsule deeply sunk; valves 4, included.

Height 40–60 feet, trunk to 30 feet, diameter 1–11/2 feet; bark persistent, smooth, greyish-white or white, mottled with dark grey; timber dark brown, hard, and very tough; mature leaves 4–8 inches long; petioles 1/2–1 inch; sucker leaves mostly 2–21/2 inches long; pedicels 1–11/2 inches long when in fruit; calyx-tube ⅓–1/2 inch long, and often above ⅓ inch broad at the summit; filaments white; fruit mostly 11/2 inches, long 3/4 inch diameter; ripe seeds not seen.

Affinity.—*E. maculata* Hook.

Mr. Fitzgerald also states that the young shoots are often conspicuous on the trees, both large and small, and can be seen a great distance away owing to their silvery whiteness, which is a distinctive character of the plant, and also that the trees have the habit of throwing out the young growth all over, and the short, silvery young shoots are usually seen above or exceeding the fruiting branches. These are, of course, mature leaves for the most part. At the same time, the “juvenile leaves” are covered with bristly ferruginous hairs, like some others of the Corymbosae.

This remarkable silveriness above referred to is caused, not by hairs, but by a waxy substance which, in course of time, decomposes into scurfy matter. It is evidently the same as that which, as a rule, produces simple glaucousness.

E. collina is *nomen nudum* until to-day, in spite of the fact that in *The Western Mail,* of Perth, Western Australia, of 2nd June, 1906, Mr. Fitzgerald published a photograph of a flowering and fruiting twig on a reduced scale, with the following note:— “There it (*E. miniata*) is associated (with) a new Bloodwood (*Eucalyptus* *collina* W.V.F.), a moderately tall tree, yielding an excellent timber. This species, which frequently forms forests of fair extent, is easily recognised by the branchlets and often the leaves appearing as if covered with frost." He says that the fruits are not *in situ,* having been placed where they are shown for the convenience of the photographer.

Range.

Bold Bluff; Mount Rason; Packhorse, Synnot Ranges, and to the east and north. In sandy soil, among sandstone and quartzite rocks. In the distance the summits of the trees appear as if covered with frost. (W. V. Fitzgerald).

I have seen the following specimens:—

Summit of Bold Bluff, West Kimberleys (W. V. Fitzgerald, No. 844). The type. Packhorse Range, West Kimberleys (W. V. Fitzgerald, No. 1,012). Mr. Fitzgerald says that his type came from Bold Bluff, which is very little more than an acre in extent on top, and that the only species of Eucalyptus he found growing there were *E. collina, E. Mooreana,* and *E. lirata.*

Mr. Fitzgerald long before stated that *E. collina* is restricted to the sandstone and quartzite ranges, tablelands and sandy foothills, and that the relative degrees of density of growth of trees forming forests are as follows:—*E. collina, E. miniata, E. crebra* (probably *E. melanophloia,* see Part XII, p. 73, J.H.M.), *E. tetrodonta, E. microtheca.* (Kimberley Report, p. 12.)

Affinities.

1. With *E. maculata* Hook.

E. collina is a Bloodwood, and has strong affinities to the rest of the Corymbosae. At the same time it is smooth-barked, and hence is what would be called a Spotted Gum in Eastern Australia, and hence its nearest affinity is to *E. maculata.* The timber of *E. collina* is dark brown, while that of *E. maculata* is pale-coloured, almost white. The timber of *E. collina* is very hard, and Mr. Fitzgerald says the party had to cut a lot of it away; the hardness and toughness of it impressed themselves on his memory. For *E. maculata,* see Part XLIII, p. 84, with Plate 178. The foliage of the two species is very different, and they vary in buds and to some extent in fruit. *E. collina* is only known from the tropics of Western Australia, while *E. maculata* is a native of sub-tropical eastern Australia.

2. With *E. Abergiana* F.v.M.

An obvious difference between the two species (for figure, &c., of *E. Abergiana* see Part XLI, p. 9, Plate 170) seems to be in the leaves, those of *E. Abergiana* being broad, but I confidently expect to see rather narrow mature leaves yet. The timber of *E. Abergiana* is red. At the same time, the two species have some similarity in the shape and size of the fruits, which are, however, usually more sessile in *E. Abergiana,* a species of which very little material is in existence.

CCXII. E. Flocktoniae Maiden.

THIS species has been dealt with in Part XVI, p. 185, and Plate 69, as *E. oleosa* var. *Flocktoni* (ae) and in Part XXXIX, p. 281, as *E. Flocktoniae*. There is also a note on the contrast between this species and *E. Cooperiana* F.v.M. in Part XXXVI, p. 167. At p. 281 I have referred to the remarkable decurrent leaves of the seedlings of this species, and at figs. 3*a*–3*d,* Plate 236, I am able to figure the correlated "juvenile leaves" from the first specimens of the kind I have seen taken from the tree.

Size, bark, timber. Hitherto, from my own observations (Desmond, near Ravensthorpe, W.A., November, 1909), and from those of Mr. W. C. Grasby (Gnowanerup, 30 miles east of Broome Hill, April, 1912), this species has been recorded as a Mallee. The type was described as "an erect, many-stemmed shrub of 6–8 feet."

Mr. C. E. Lane Poole, in sending a photo. (his number 12*a*) of this tree in July, 1919, wrote—

Redwood, *E. oleosa* var. *Flocktoniae,* 8 inches in diameter, 12 miles on the Widgiemooltha-Norseman road. A young specimen of this tree. It will be seen (not yet reproduced) that it has a perfectly smooth bark, unlike *E. oleosa* var. *glauca* (*E. transcontinentalis*), which retains its bark for a few feet up the trunk. The wood of this tree comes in for fuel, and the cutters make no distinction between it and var. *glauca.* The seed vessel is particularly graceful in shape, being like a Grecian urn.

In November, 1920, Prof. E. H. Wilson, of the Arnold Arboretum, took another photograph near Widgiemooltha, when in company with Mr. Lane Poole. He gave its height as 45 feet, and its girth as 2 feet, which, of course, is 8 inches in diameter. Mr. C. E. Gardner, February, 1922, describes it as a tree of 40 to 50 feet.

In the meantime (1916, 1917, 1919) Mr. W. J. Spafford had been collecting material from South Australia, and states it to be at Yeelanna, Eyre's Peninsula,

A Mallee, growing from 6 to 10 feet in height, with numerous stems of small diameter in each clump . . . . I should say, from what I have seen, that it is a fairly small-rooted Mallee, without much tap-root, in these particular conditions.

Therefore, *E. Flocktoniae* is known in two forms, that of the Mallee (the type), and that of the medium-sized tree. We must keep on collecting.

Then Mr. C. E. Gardner makes an important contribution towards our knowledge of the species. He describes it as—

A tree of 40 to 50 feet, known in the Kondinin district of Western Australia under the name of "Merritt," or "Silver Mallet." Erect, not much branched, trunk to 12 inches in diameter. Bark smooth, almost white, about 1/4 inch thick, decorticating tardily in thick plates, some of which adhere to the trunk at the base for a considerable period. Timber pink, fairly dense.

(Mr. Gardner sends a small piece of wood from a small tree, and while it was pale red when received, it has appreciably darkened while it has been in my possession, and I do not doubt that it deserves its local name of Redwood. I do not know the meaning of the word Merritt, or Merrit, but (see Part LXV of my “Forest Flora of New South Wales”) the name Mirret is applied to *E. dumosa.* Perhaps it means a smooth-barked tree. J.H.M.)

Mr. Gardner goes on to say—

The bark is stripped (for tanning purposes) as ‘Silver Mallet,’ although it can scarcely be regarded as a true Mallet, the tree being very like the Salmon Gum (*E. salmonophloia*) in habit and appearance.

Juvenile leaves.—E. Flocktoniae has remarkable seedlings, with decurrent leaves unique in the genus, so far as I know. Seedlings were first raised from my Desmond fruits, which were fortunately ripe and contained sufficient seed. When I come to the Seedlings they will be figured.

Inasmuch as there is an important correlation between the seedlings and the “suckers” or the “juvenile leaves” (so-called), I kept a sharp look-out, and Mr. Spafford not only sent the species from South Australia, but also the hitherto unknown juvenile leaves in November, 1919. Mr. Gardner, in June, 1922, sent even better specimens from Bendering, Western Australia. Unfortunately these were received after Plate 236 was put on the stone, but additional figures will be submitted in due course.

Mr. Gardner remarks—

When a tree of this species is cut down the stump dies, as is the case with some of our Mallets. The same applies to a tree which has been ringbarked or scorched with fire. That is why it is difficult to get suckers, and one has usually to fall back on seedlings.

The seedling leaves have been described by me in *Journ. Roy. Soc. N.S.W.,* xlix, 316, 1915. See also this work, XXXIX, 281.

Buds and Fruits.—Those of the type and co-type (Desmond and Esperance) are figured at figs. 1 and 2, Plate 69, Part XVI. They were from plants of Mallee habit. The Widgiemooltha-Norseman tree (C. E. Lane-Poole) of which a photograph was taken, had fruits of precisely the same shape. The Widgiemooltha tree (E. H. Wilson) collected 18 months later, of which a photograph was also taken, had doubtless similar fruits, for Mr. Lane-Poole pointed out the tree, and he was always most careful in regard to material for identification.

But the Kondinin-Bendering specimens about to be described (and to be figured in the next Part) undoubtedly show morphological differences, although their seedlings and juvenile leaves closely follow those of the type. I confidently expect collectors to find specimens with intermediate buds and fruits.

Dr. Stoward's Kondinin specimens show the fruits more constricted under the rim than any I had previously seen, but his buds were too young to be characteristic. Mr. Gardner sent some buds from Bendering which supply the deficiency. They show the calyx-tube so constricted that the operculum appears to greatly exceed in diameter the calyx-tube at the commissural line, and its diameter is slightly in excess of that of the greatest diameter of the calyx-tube. The bud therefore takes on the shape described as moniliform. The rest of the operuclum is attenuated-rostrate. The buds from South Australia (Eyre's Peninsula) are similar to those of Bendering.

The differences in the buds and fruits of the type and of those of Kondinin-Bendering are sufficiently marked as to bring into consideration that we may have here a distinct species, and I very much lean to this, but the juvenile foliage as present prevents me setting up a second species at the present time. We must complete our collections and investigations.

Range.

Hitherto believed to be confined to Western Australia, we now note its occurrence in South Australia also. Its range may be stated as southern Western Australia, from the eastern Goldfields or Kalgoorlie railway line, then east of Narrogin and Broome Hill on the Great Southern Railway, then east to Desmond (*via* Hopetoun) and Esperance (this and the latter both on the coast), and these localities connect the Kalgoorlie railway line *via* Widgiemooltha. Then very much east to Eyre's Peninsula in South Australia, and I confidently look for its collection in intermediate localities.

Western Australia.—Esperance (Lindley L. Cowen, January, 1902), Desmond, near Ravensthorpe (J.H.M., November, 1909); Gnowangerup, 30 miles east of Broome Hill (W. C. Grasby, April, 1912; Kondinin, 250 miles from Perth, on the Narrogin-Narembeen railway line (Dr. F. Stoward, No. 57, January, 1917); between Woolgangie and Dedari Sidings, Eastern Goldfields railway, 312 miles east of Perth (T. McL., No. 239, through C. E. Lane-Poole, August, 1917); Widgiemooltha-Norseman road (C. E. Lane-Poole and E. H. Wilson, December, 1920); “Merritt,” Bendering 7 miles from Kondinin, in loam, in low flat places associated with *E. salmonophloia* (C. A. Gardner, No. 1,229, February, 1922, and No. 1,686, June, 1922).

South Australia.—Yeelanna, Eyre's Peninsula (W. J. Spafford, No. 1, April, 1916, in bud; No. 18, June, 1917, in flower and early fruit; November, 1919, in flower and nearly ripe fruit). The November, 1919, specimens are figured at 3*a–d,* Plate 236, and, as regards the calyx-tube figured at 3*d,* the ribbing is less marked than it subsequently becomes. This will be supplemented in a subsequent figure.

Affinities.

These have been discussed, as regards *E. oleosa, E. falcata, E. decurva, E. torquata,* and *E. incrassata,* at Part XVI, p. 186, and as regards *E. Cooperiana, E. salmonophloia,* and *E. Gillii,* at Part XXXIX, p. 282. It has some affinity with *E. longicornis* F.v.M.

1. With *E. torquata* Luehmann.

This seems to be the closest affinity (see Part XVI, p. 185), but while *E. Flocktoniae* is a Gum, *E. torquata* is a rough-bark (Rhytiphloiae), and the anthers and juvenile leaves are very different. Its buds and fruits are not known to be so constricted as those of *E. Flocktoniae.*

CCCXLII. E. Shirleyi n.sp.

ARBOR, foliis glaucis, ramulis quadrangulatis, foliis juvenilibus amplexicaulibus, crassiusculis, orbicularibus vel fere ovatis; foliis maturis, crassiusculis, ovatis, amplexicaulibus ad ellipticis et petiolatis, obtusis, venis secundariis ecosta media circa 60° orientibus; inflorescentia in umbella composita; alabastris in brevibus pedicellis; calycis tubo distincte bi v. tricostato; operculo conico calycis tubi dimidium aequante; fructibus sub-cylindraceis in pedicello brevi plano, ad 1·5 cm. long, 1·2 cm. lato, prominenter tricostato; margine tenui, capsula valde depressa.

A tree, size, bark and timber not known, the foliage glaucous or mealy-white, the branchlets quadrangular and almost winged.

Juvenile leaves stem-clasping, rather thick, orbicular to nearly ovate. Intramarginal vein seen at a considerable distance from the edge.

Mature leaves rather thick, ovate and stem-clasping to elliptical and petiolate, obtuse, with a very short apex. The sizes of the leaves (it is very difficult to mark the line between juvenile and mature leaves in this species, with present material) vary from 9 cm. long and broad to smaller dimensions. In the mature leaves the intramarginal vein becomes closer to the margin, and with the secondary veins makes angles of about 60° with the midrib.

Inflorescence.—In a compound umbel, with a very slightly compressed, very long (2 cm.) peduncle supporting each umbel. Distinct, somewhat flattened pedicels, gradually tapering into the calyx-tube; usually seven in the umbel. The calyx-tube with three or four distinct ribs, and commonly with a double operculum. Operculum conical, about half the length of the calyx-tube. Anthers only seen immature, versatile, and with a very large gland at back. Apparently belongs to the Macrantherae.

Fruits sub-cylindrical, on a short flattened pedicel, up to 1·5 cm. long, and 1·2 cm. broad, with three prominent ribs extending from the rim to the peduncle, and often with two or more less prominent ones. Staminal rim prominent; rim thin, capsule much depressed.

[In judging an immature anther, it is always the case that the gland is comparatively large, and, as growth progresses, it becomes less in size, as if its partial absorption were necessary for the development of the anther.]

Type from Stannary Hills, North Queensland (Dr. T. L. Bancroft). Named in honour of my old friend, John Shirley, D.Sc., Local Secretary for Queensland of the Australian Association for the Advancement of Science from the first election of officers in 1888, to the day of his death, 5th April, 1922, a unique happening. We were brought into intimate relations in regard to the Association for many years, and as a botanist, I corresponded with him for an even longer period. As I was working at this plant at the very moment that news of his sudden death came through, it occurred to me to offer the dedication of this interesting species to his memory.

Range.

Confined to North Queensland, so far as we know at present. I only know it from Stannary Hills (Dr. T. L. Bancroft), the type, and from Mount Albion (Samuel Dixon). It can easily be picked up through its ribbed buds and flowers; it is a "Silver-leaved Box," or akin thereto.

Affinities.

With *E. pruinosa* Schauer.

If *E. pruinosa* be turned to, at Part XII, p. 74, Plate 54, the large, ribbed fruits figured at fig. 7*a* (Mount Albion, Q.) are *E. Shirleyi.* Under Range, at p. 74, the specimens recorded from Stannary Hills are also *E. Shirleyi.*

The fruits of *E. pruinosa* are, in the above Plate, drawn from the type, and are quite smooth, entirely free from ribs, finely rimmed, with valves slightly exserted; the petioles are long and delicate. In Mueller's "Eucalyptographia," *E. pruinosa* is depicted, the fruits rather smaller, but agreeing in every essential with the type. Mueller particularly states that in this species "neither lid nor tube of the calyx is angular."

The buds of *E. pruinosa* have the operculum and calyx-tube of equal length, and they are rounded. The leaves of the two species have much in common, and additional material of leaves, with specimens of bark and timber, together with data as to habit are necessary before a full pronouncement as to differences between the two species can be given.

Because of the immaturity of the anthers in the specimen of *E. Shirleyi,* it can only be at present said that they have a very large gland (a sign of youth), and that they seem to belong to the Macrantherae. Those of *E. pruinosa* are Porantheroid, with some tendency to be semi-terminal.

I confidently predict that, when *E. Shirleyi* is better known, a much greater divergence between the shapes of the juvenile and mature leaves will be ascertained. I should not be surprised if mature leaves of a lanceolate shape will be found. The same remarks are applicable to *E. pruinosa.* I have dwelt upon the point as to the importance of being on the look out for the extreme forms of both juvenile and mature leaves in Part LVII.

CCCXLIII. E. Rummeryi n.sp.

ARBOR magna saltus, "Yellow Box" vocata; cortice aspero, tenui, lamelloso-fibroso; ligno flavo ad pallido-bruneo; foliis juvenilibus subtus pallidis, lato-lanceolatis, marginibus undulatis, vena peripherica a margine distincte remota; venis secundariis e costa media 60–70° orientibus; foliis maturis mediocriter tenuibus, petiolatis, angusto-lanceolatis, 2 cm. latis, 11 cm. longis, vena peripherica margini approximata, venis secundariis ex costa 40–50° orientibus; inflorescentia paniculata, umbellis 5-floris, pedunculis pedicellisque planis, calycis tubo operculo aequilongo, operculo conoideo, antheris latis paralleliter dehiscentibus.

Fructibus conoideis vel fere hemispherico, circa 5 mm. diametro, 1 v. 2-angulatis, margine tenui, valvis modo ex orificio exsertis.

A large forest tree, known locally as "Yellow Box," the branchlets somewhat angular. Bark of butt rough, thin, somewhat harsh; may be described as flaky-fibrous; branches smooth, brownish. Timber pale brown when dry (has a yellow tinge when fresh), rather interlocked, somewhat coarse-grained, tough.

Juvenile leaves thin, paler on the underside, petiolate, broadly lanceolate (2·5 to 3 cm. broad, 5 to 6 cm. long), with undulate margins, the intramarginal vein moderately distant from the edge, the secondary veins making an angle of 60–70° with the midrib.

Mature leaves moderately thin, petiolate, narrow-lanceolate, somewhat undulate and falcate, tapering towards the apex (2 cm. broad, and about 11 cm. long), the intramarginal vein close to the edge, the secondary veins making an angle of 40–50° with the midrib.

Inflorescence paniculate, each umbel up to five rather small flowers, buds clavate, the peduncle flattened, the pedicels also flattened but shorter, the calyx-tube of the same length as the operculum, and with at least one distinct ridge, the operculum conoid. Anthers broad, opening in parallel slits, gland at the top and back, filament at base or nearly so.

Fruits conoid, occasionally almost hemispherical, about 5 mm. in greatest diameter, shiny, the calyx-tube with one or two angles or ridges, the rim thin, the tips of the deltoid valves of the capsule just protruding from the orifice.

[Mr. Rummery writes: "The timber has every appearance of being durable and strong. The only uses I have seen it put to so far is for slabs for a small hut, and a few girders, but I am of opinion that it is a valuable timber, and in time will be much used for general purposes. It grows to a large size, both in barrel and height, and is usually straight and round. . . . Timber of a pale yellow colour, and appears to be very durable and strong. I have seen girders squared from this timber, and excepting for a yellow tinge, they were very hard to detect from Grey Ironbark (*E. paniculata*).”]

The type is Busby's Flat, near Casino, New South Wales (G. E. Rummery, October, 1921). Named in honour of George Edward Rummery, District Forester of Casino, New South Wales, who not only sent the original specimens, but who has taken a good deal of trouble concerning this interesting tree.

Range.

At the present time it is only known from the Richmond River district, northern New South Wales. It may be confidently looked for in southern Queensland, and further south in New South Wales. It was first found (March, 1922) in the localities of Mallanganee and Busby's Flat, Richmond Range, with a note that its occurrence is restricted. A month later it was found in the parishes of Carnham and Albert, county of Drake.

So far as I can ascertain, it occurs only on the Richmond Range in the parishes of Sandilands, Black's Camp, and Pikapene (including Busby's Flat), county of Drake, and in parishes Wyan, county of Richmond, parish Dryaaba, county of Rouse, and is found usually on the hill-tops and sides. The country generally is sandstone formation, and the tree is generally found close to pockets of brush containing Hoop Pine (*Araucaria Cunninghamii*). (G. E. Rummery).

The fact that this important tree has been discovered in accessible brush forests, which were supposed to be well known to the forester, is an indication of the surprises that remain for us in regard to the Eucalyptus vegetation.

Affinities.

We do not know its close affinities at present. It is not closely related to the ordinary Yellow Box (*E. melliodora*). It is a member of the Rhytiphloiae (Rough barks).

1. With *E. Normantonensis* Maiden and Cambage.

It resembles this species in its anthers, to some extent in its box-like bark, and in its timber. But there is a North Queensland species of less erect habit, and we require ampler specimens and field notes concerning it.

2. With *E. conica* Maiden.

In the long, thin leaves, and somewhat in the fruits, but in most other characters it seems to be different.

3. With *E. Rudderi* Maiden.

It has the outward appearance of this species, but the anthers are quite different, and so does the timber appear to be.

CCCXLIV. E. Herbertiana n.sp.

MALLEE 15–20' altus, foliis juvenilibus ignotis; foliis maturis obsecure viribus, crassiusculis, petiolis longis, falcatis, lineari-lanceolatis, ad 23 cm. longis, circa 1·5 cm. latis; venis haud prominentibus, venis secundariis e costa media 35–45° orientibus; inflorescentia paniculata, pedunculis circa 1 cm. longis, crassis; alabastris ad 7, sessilibus, nitentibus, clavatis; operculo ovoideo, minus 5 mm. diametro; antheris modo statu immaturo notis; fructibus nitentibus minus 7 mm. diametro; leniter urceolatis, margine mediocriter rotundata, valvis exsertis.

"Stems 15 to 20 feet in height, Mallee-like, from a pedestal-like base, 4 to 9 inches in diameter. Bark yellowish or buff-coloured, smooth, decorticating in ribbon-like strips, which hang round the trunk; branches pendulous. The tree has a resinous scent." (Gardiner.)

Juvenile leaves unknown.

Mature leaves of a dull green (egg-shell lustre) on both sides, not very thick, with long petioles, falcate, linear-lanceolate, gradully tapering into the apex, up to 23 cm. in length, with an average width of under 1·5 cm. Venation not prominent, the secondary veins making an angle of 35–45° with the midrib; the intramarginal vein well removed from the edge.

Inflorescence paniculate, each peduncle usually about 1 cm. long, rather thick, and sometimes flattened, supporting up to seven sessile or nearly sessile buds. Buds shiny, clavate, the short calyx-tube with two angles, operculum ovoid, under 5 mm. in greatest diameter, the commisural line distinct. Anthers rather immature, opening in parallel slits, large gland at the back, filament attached half-way up, versatile.

Fruit shiny, under 7 mm. in diameter, slightly urceolate, the rim moderately domed, and the valves well exsert.

The type is C. A. Gardner, No. 1,471, 7th July, 1921. The species is intended to commemorate the name of Desmond Andrew Herbert, who, during his recent occupation of the post of Government Botanist of Western Australia, was distinguished alike for physiological and taxonomic researches.

Range.

It is only known from the Kimberleys, in north-west Australia, and only from one locality, viz., Donkin's Hill, between the Mitchell River, flowing north into Admiralty Gulf, a river newly discovered by the expedition of which Mr. Gardner was a member. Donkin's Hill is also not far from Hunter River, a short stream flowing into Prince Frederick Harbour, York Sound, close to Mount Anderson.

Affinities.

1. With *E. confluens* (W. V. Fitzgerald) Maiden.

In the narrow leaves, but differing from it in the thick peduncle, and different shaped buds and fruits. We have much to learn about both species yet, and therefore comparisons must be provisional.

2. With *E. exserta* F.v.M.

It is reminiscent of this species in the tendency to long leaves, in the anthers (?), and to some extent in the fruits, but differs in the sessile buds of a different shape. *E. exserta* is a large Queensland tree, with a rough bark, certainly not a Mallee.

CCCXLV. E. Comitae-Vallis n.sp.

FRUTEX procerus erectus vel arbor parva, cortice laevi; foliis juvenilibus invisis; foliis maturis crassis, flavo-viridibus, nitentibus, petiolatis, lanceolatis, minus culis, venis secundariis e costa media 20–40° orientibus; inflorescentia axillari, pedunculis teretibus, umbellis ad 7 in capitulo, pedicellis brevibus; operculo hemispherico non costato, calycis tubi sub-cylindracei dimidium aequante; fructibus sub-cylindraceis, circa 7 mm. diametro, 9–10 mm. longis, margine tenuiore, valvis distincte demersis.

A tall, erect shrub or small tree, with smooth bark.

Juvenile leaves not seen.

Mature leaves thick, yellowish-green on both sides, shiny or with egg-shell lustre, petiolate, lanceolate, rather small, say 12 mm. broad and 7 cm. long, intramarginal vein distinct from the edge, venation spreading, the secondary veins making angles of 20–40° with the midrib.

Inflorescence axillary with long, almost terete peduncles supporting umbels up to seven in the head on distinct pedicels. Operculum hemispherical or with a short umbo, not ribbed, half the length of the sub-cylindrical calyx-tube, which runs rather abruptly into the pedicel. Anthers long, with parallel slits, and with a big gland at the back. Filaments yellowish.

Fruit sub-cylindrical, about 7 mm. in diameter and 9 or 10 mm. long, rim rather thin, the valves distinctly sunk.

Type Comet Vale, Western Australia (J. T. Jutson, No. 239).

Range.

Only known from Western Australia, and from one locality, viz., Comet Vale, 63 miles north of Kalgoorlie (J. T. Jutson, No. 239). The Mallees or Marlocks of Western Australia will well repay the attention of careful collectors in order to decide their range, and also to obtain complete material of some of them, which is not yet available.

Affinities.

1. With *E. incrassata* Labill.

It belongs to the *incrassata* series. *E. incrassata* is figured at Plate 13, Part IV, but there is some doubt about the type of that species. The buds of *E. incrassata* are more conoid than those of *E. Comitoe-Vallis*; larger, and with shorter and coarser peduncles and pedicels. *E. incrassata* is, on the whole, a more coastal species.

2 and 3. With *E. dumosa* A. Cunn., and *E striaticalyx* W. V. Fitzgerald.

It is less closely allied to these species, which attain the dignity of trees, and which differ in their striated opercula and other characters.

CVII. E. longifolia Link and Otto.

Proposed new variety, *multiflora.*

(For *E. longifolia* see Part XX, p. 295, Plate 86).

WE have a variety of Woolly-butt whose bark and timber are much the same as that of normal Woolly-butt (*E. longifolia*). Both variety and normal form vary in the bark, hence the names Peppermint and Grey Gum applied to both of them.

At one time I looked upon the form (as regards the Erina Creek, Gosford, New South Wales, specimens, which I constitute the type of the variety) as a hybrid of *E. longifolia,* in which *E. robusta* Sm. (Swamp Mahogany) played a part. See *Proc. Linn. Soc. N.S.W.,* xxviii, 944, 1903, where I exhibited specimens before the Society; *Trans. Aust. Assoc. Adv. Science,* 303, 1904; my “Forest Flora of New South Wales,” vol. ii, p. 186, and the present work, Part XX, p. 296, where I promised a figure (given on Plate 239). It is a very interesting form of *E. longifolia,* with smaller fruits, seven in the head, while those of *E. longifolia* are persistently in threes.

What appears to be the same variety is a Grey Gum collected by Forest Guard Gallagher in State Forest No. 423, Parish Nowra, county of St. Vincent, New South Wales, on 20th June, 1919. The tree was about 4 miles from Nowra, at an elevation above sea-level of about 100 feet. Complete material is unavailable, as the tree was later “felled and utilised in connection with forestry improvement work.” Its name of Grey Gum indicates that local people are of opinion that the Nowra tree has affinity with *E. punctata* DC., which indeed it has, but one cannot say more until additional material becomes available.

CCCXLVI. E. citriodora Hooker.

Mitchell's *Tropical Australia,* 235 (1848).

THE original will be found at Part XLIII, p. 89.

The description by Bentham is as follows:—

A tree with a smooth bark (F. Mueller), the foliage emitting a strong odour of citron when rubbed (Mitchell), evidently very closely allied to *E. corymbosa.* In the imperfect state of our specimens (in leaf only, with loose fruits or in young bud) it can only be distinguished from that species by the veins of the leaves rather more distinct, the pedicles shorter, the fruit scarcely so large, contracted at the orifice, but without so distinct a neck, and by the seeds almost equally large, but very obscurely or not at all winged. F. Muell. *Fragm.* II, 47 (B. Fl. III, 257.)

Not without doubt, I have come to the conclusion that there is sufficient evidence to keep *E. citriodora* distinct as a species from *E. maculuta.* My reasons are given under "Affinity."

Synonyms.

1. *E. melissiodora* Lindley. See Part XLIII, p. 89, and doubtfully accepted by Bentham as a species in *B.Fl.,* iii, 254. See p. 90 of Part XLIII. Whether we shall accept *E. melissiodora* in preference to *E. citriodora* is a matter of expediency. They were both collected on the same day (16th July, 1846), and they were both described on the same page of Mitchell's "Tropical Australia," p. 235. In an analogous case an eminent botanist said he used the botanical name which came first on the page. In the present instant *E. melissiodora* comes first! I do not think there is any authoritative ruling by a Botanical Congress in a case like this, and I therefore adopt the name *E. citriodora* for the practical reason that its use would least disturb botanical nomenclature.
2. *E. variegata F.*v.M. See this work, Part XLIII, p. 90.
3. *E. maculata* Hook., var. *citriodora* F.v.M. See Part XLIII, p. 88.

Range.

This species is confined to Queensland, and the range is fully dealt with at Part XLIII, p. 91. The following additional notes, which contrast *E. maculata* and *E. citriodora* in Queensland are furnished by Dr. H. I. Jensen, the geologist. Both species are Calciphobe. The letter m refers to *maculata,* and c to *citriodora.*

Soil Texture.	Localities.	Geological formation.	Remarks.
m. Well-drained gravelly stony soil, stone below.	Carnarvon Range, Dividing Range, on Dawson Nogoa Fall, Coastal Ranges, Expedition Range, Dawson Mackenzie basin, on hilly country.	Granite, metamorphic sandstone conglomerate, shale and sometimes leached basalt slopes.	Assoc. with *E. Watsoniana* frequently, with *E. decorticans* and *Acacia doratoxylon,* Clematis Ck. with *E. trachyphloia* and *E. melanophloia,* Meteor Creek.
c. Gravelly slopes . . .	Meteor Creek, Glenhaughton, Clematis Creek.	Conglomeratic sandstone	Assoc. with *E. Watsoniana* throughout the Buckland Tableland region.

Affinity.

With *E. maculata* Hook.

I have gone into the question of maintaining *E. citriodora* as a variety of *E. maculata* or not, in Part XLIII, p. 88, to which I refer my readers. Let us turn to Plate 178. The question of the desirability of separating them into species seems to come under two heads—

1. Morphologically, *E. maculata* appears to be coarser in its organs than *E. citriodora,* or let me say that under the former species I have come across larger leaves and fruits than I have seen in the latter. But this requires further collecting to decide.

2. The very much greater percentage of Citronellal in *E. citriodora* is obvious.

Bentham in his Key (*B.Fl.,* iii, 199) separated the two species mainly on the leaves:—

Ovate-lanceolate, or lanceolate, with numerous fine, close almost transverse veins	*E. citriodora.*
Narrow-lanceolate, rigid, with more oblique veins	*E. maculata.*

But we have a wider knowledge of the species than in Bentham's time. Mueller and Bailey both combined the two species.

XLIII. E. hemiphloia F.v.M.

In *B.Fl.* iii, 216 (1866), and not *Fragm.,* ii, 62, as stated by Bentham.

IN Part XI, p. 14, I have described the remarkable muddle connected with the description of this species. The first formal description of it is by Bentham, and it has not previously apppeared in this work.

A tall tree, sometimes reduced to a shrub. Leaves ovate-lanceolate or lanceolate, falcate or nearly straight, about 3 to 5 inches long, thick and rigid, with very oblique distant veins, almost as in *E. obliqua* and *E. haemastoma.* Peduncles slightly angular, about four to eight-flowered, the umbels mostly forming short terminal panicles, although the fruiting ones are usually lateral below the leaves. Calyx-tube 2 to 21/2 lines long and scarcely so much in diameter, tapering into a short thick pedicel or almost sessile. Operculum conical, acuminate, as long as the calyx-tube, or rarely shorter, and more obtuse. Stamens pale-coloured, about 2 lines long or rather more, all perfect, inflected in the bud; anthers very small, globular, the cells distinct, but opening in pores rather than in slits. Ovary rather deep, slightly conical or convex in the centre. Fruit ovoid-oblong, about 3 to 4 lines long, truncate and slightly contracted at the orifice, very smooth, the rim narrow, the capsule deeply sunk. (*B.Fl.* iii, 216.)

The leaves may be described as follows. Specimens were taken from Blacktown, 21 miles west of Sydney, where it is very abundant:—

Juvenile leaves thin, glabrous, pale green throughout, branches pale to dark green, terete at the base, compressed in the upper internodes or the very young ones all semi-quadrangular. Lower leaves orbicular, shortly petiolate, 4–6 cm. long, 21/2–61/2 cm. broad, with distantly marked veins.

Intermediate leaves broadly lanceolate, with moderately short petioles 6–10 cm. long, 3–7 cm. broad, slightly paler on the lower surface, venation distinct, intramarginal vein distant from the edge; midvein conspicuous, smaller and canaliculate on the upper surface, convex and more prominent on the lower; secondary veins distant, five to seven more distinct than the others, slightly undulate, the lower ones spreading, the upper one branching at an angle of about 45° from the midrib.

The species seems sufficiently figured at Plate 50, figs. 1–6, Part XI. There is a full plate at Plate 22, Part 7 of my “Forest Flora of New South Wales.”

Range.

See Part XI, p. 15, where I record it from New South Wales and Queensland, starting from a few miles south of the Sydney district (counties of Cumberland and Camden) in the south and usually in the coastal areas to as far north as Rockhampton in central coastal Queensland. The following localities are additional to the New South Wales and Queensland ones there given. It likes fairly good soils, *e.g.,* those of shaly origin, in contradistinction to those of poor sandstone.

New South Wales.

Southern Districts.—Theresa Park, also Cobbity, near Camden (J.H.M.); "All young trees flowering for the first time, bark mealy at base, upper trunk and branches white to dark green and occasional ribbons hanging from them." Between Canley Vale and Fairfield (W. F. Blakely, D. W. C. Shiress and H. Bott); Parramatta Park (O. D. Evans).

Western Districts.—"Box, large forest tree, bark near the butt rough, scaly, and of a grey colour. Upper branches smooth and from them bark thrown off in long ribbons. Timber light colour and very hard." Oakville, *via* Windsor (D. Johnston); Medium-sized tree of 30–50 feet, known locally as Black box. Prized by reason of toughness, hardness and durability. Bark box-like, sapwood pale, not showing yellow. When freshly cut centre dark, but becoming paler when dry." Gordon Springs, Merrindee, Mudgee district (A. Murphy, J. L. Boorman).

Northern Districts.—"Bark on trunk furrowed and rough, though soft, very similar to bark of *Angophora intermedia.* Leaves rather thin. Bingara (W. A. W. de Beuzeville, No. 5); Ramornie, Copmanhurst district, Clarence River (W. F. Blakely and D. W. C. Shiress). Mr. Blakely describes the local trees as follows:—

"Usually tall straight trees up to 100 feet or more. Bark variable; on some old trees rough and box-like for a few feet at the base, while the remainder of the tree smooth throughout, except for the ribbons on the branches. Others are smooth to the ground, with all the characteristic markings and appearance usually seen in *E. teteticornis.* On one occasion I could not tell the difference between them without examining the leaves and fruits. Many young trees are much rougher than the old ones, the box-like bark extending for 50–60 feet along the stem. In some saplings the trunk is completely covered, only the branches being smooth. When the bark is smooth, greyish-green and white are the outstanding colours (July, 1922). The foliage is moderately large, and of a dark glossy green colour; no glaucous forms nor very small fruited forms, representing *E. albens* and *E. microcarpa,* were found by us, notwithstanding that we were constantly on the lookout for them or for any change in the species. It was at one time very plentiful in the Ramornie-Copmanhurst district, but it is now represented by a few isolated trees in the settled parts, while all the best trees are cut out from the virgin forest, which still exists in various parts of the district, particularly towards the ranges. Box country has the reputation of being good cattle country."

Busby's Flat and Mallanganee, Richmond Range (District Forester G. E. Rummery); Wallangarra (J. L. Boorman); "White or Grey Gum," Casino (Forester E. G. McLean, No. 56, also L. G. Irby).

Queensland.—Killarney, foot of Macpherson Range (C. T. White, J. L. Boorman). Dr. Jensen reports:—"Gum-top Box; calciphile; found on rich loam stony subsoil; occurs Carnarvon Range, Brown tributaries, Bogantungan, along Nogoa, Clematis Creek. The geological formation is calcareous sandstones, glacial tillite shales, alluvials of porous nature and basalts in Buckland region. It is associated with *E. microtheca* in places, with *E. populifolia* in others, also with *E. tereticornis* and *E. tessellaris,* and frequently with *E. crebra* and *Tristania suaveolens.*"

Affinities.

1 and 2. With *E. microcarpa* Maiden, and *E. albens* Miq.

For our present purpose it will be sufficient to compare *E. hemiphloia* with these two species. See pp. 438 and 440. As regards other species, see Part XI, p. 16.

E. hemiphloia is a much better grown tree than var. *albens* of the western districts of New South Wales. It is a better timber tree with a long straight sound barrel; old trees are, of course, hollow, but not to the same extent as old trees of var. *albens,* which are often as hollow as a drum. In the quality of timber it is classed with *E. crebra* and *E. paniculata,* and is sometimes preferred to both.

CCCXLVII. E. microcarpa n.sp.

ARBOR mediocris v. magna, erecta "Grey Box" v. "Box" nota; cortice sub-fibroso, compacto, cinereo v. cano in trunco; ramulis teretibus, ligno pallido, tenaci, durabili; foliis juvenilibus glaucis utrinque pariter pallido-viridibus, late ovatis, circiter 7·5 cm. longis, 4 cm. latis, vena peripherica a margine remota; foliis maturis coriaceis aliquandi obscuris, lanceolatis paullo obliquis, circiter 10 cm. longis, 2·5 latis, venis non prominentibus patentibus, excosta 45° orientibus; et operculo et calycis tubo conoideis et aequalibus, floribus in paniculis in umbellis 3–7 v. pluribus floris, pedicellis brevibus; antheris *E. hemiphloioe*, stigma paullo dilatata; fructibus parvis sub-cylindraceis ad truncato-ovoideis, valvis valde demersis.

In English it is described in Part XI, pp. 17, 18. It is figured at figs. 7–17, Plate 50, and these seem adequate.

There may be added to the English description already quoted:—Secondary veins of mature leaves distant, making an angle of about 45 deg. with the midrib.

Synonyms.

E. hemiphloia F.v.M., var. *microcarpa* Maiden. See Part XI, p. 17. The additional synonyms quoted at p. 18 are invalid, because we do not know what *E. Woollsiana* R. T. Baker is. (See Part XLVII, p. 199, and Plate 194.)

Range.

See Part XI, p. 18, and Part XLVII, p. 207. It extends from South Australia to Queensland, and the fairly numerous localities quoted in those two Parts should be referred to. It will thus be seen that it is very widely diffused; in some districts it is very abundant. Following are a few brief additional notes.

South Australia.—"Box." Tall tree near Gorge, on Wirrabara side. (Prof. J. B. Cleland, No. 82).

Victoria.—Stawell (J. Staer). Mr H. Hopkins, a competent observer, of Bairnsdale, Gippsland, in "The Advance Australia," September, 1909, has the following note, which I think refers to *E. microcarpa*:—"Grey Box is also a lowland species, rarely, if ever, ascending more than 400 or 500 feet above sea-level, generally upon alluvial flats or limestone formations."

New South Wales.—"Grows up to a height of 80 feet, I should say, timber rather straight as a rule, the smooth bark on the top of a reddish brown," Bynya, Barellan

(W. Burke).

Affinities.

1 and 2. With *E. hemiphloia* F.v.M. and *E. albens* Miq.

See Part XI, p. 19. The only species with whose affinities we are concerned at the present time are the above. These are compared and contrasted at p. 443. Like the other species, *E. microcarpa* has often coarse leaves. Sometimes a twig of a large-fruited *E. microcarpa* and a small-fruited *E. hemiphloia* are hard to distinguish unless juvenile leaves are present.

CCCXLVIII. E. albens Miquel.

In *Ned. Kruidk. Archief.,* iv, 138 (1856), and *B.Fl.* iii, 219 (1866).

IF my readers will refer to Part XI, p. 20, of the present work, they will find that the confusion concerning *E. albens* was as bad (perhaps worse) as that which gathered round *E. hemiphloia.* Bentham took both species in hand. In the Part quoted, at pp. 21 and 22, I have stated my reasons for following Mueller in including *E. albens* under *E. hemiphloia,* but, after fuller consideration, I have come to the conclusion that it is better to keep them apart.

Bentham's description of *E. albens,* which did not exist until 1866, is given herewith:—

A tree, attaining 60 to 80 feet, with a dull green persistent bark (F. Mueller), separating in smooth laminae or strips (C. Stuart), the foliage usually very glaucous or almost mealy-white. Leaves usually large, broad, ovate-lanceolate or lanceolate, often 6 inches long or more; rigid, with oblique veins, the intramarginal one at a distance from the edge. Peduncles lateral, rigid, scarcely flattened, sometimes 3/4 inch long, but often much shorter, bearing four to eight rather large flowers. Buds long and acuminate, apparently sessile, but really tapering into short, thick, angular pedicels. Calyx-tube 3 to 4 lines long and scarcely 2 lines diameter, two-angled or nearly terete. Operculum conical, acuminate, as long as, or rather shorter than, the calyx-tube. Stamens 3 to 4 lines long, all perfect, inflected; anthers very small and globular, with distinct parallel cells, opening at length to the base or nearly so. Ovary short, slightly conical in the centre. Fruit obovoid-oblong, truncate, nearly 1/2 inch long, the rim narrow, the capsule deeply sunk. (*B.Fl.* iii, 219.)

The species is figured at figs. 18–22, Plate 50, and 1–8, Plate 51, Part XI, and these seem adequate.

The leaves may be more fully described as follows:—

Juvenile leaves thick, glabrous and glaucous throughout; branches dark, pruinose, lower ones terete, the upper compressed. Leaves reniform to orbicular, on rather long petioles, 4–7 cm. long, 31/2–9 cm. broad, finely veined on both surfaces, veins purple. Midrib canaliculate on the upper, and slightly raised on the lower surface. Intramarginal vein not conspicuous, moderately distant from the edge, secondary veins distant, spreading at an angle of about 40° from the midrib. (Leaves described from Gulgong, New South Wales, J. L. Boorman, April, 1901.)

The leaves form probably the most valuable fodder of all the New South Wales Eucalypts. For details, chiefly from foresters' reports. see my "Forest Flora of New South Wales," Part LXX, p. 415.

Synonyms.

1. *E. pallens* Miq., non DC.
2. *E. hemiphloia* F.v.M., var *albens* F.v.M.

See Part XI, p. 20, as to both synonyms.

Range.

It is found in South Australia, Victoria, and New South Wales, and although it is usually looked upon as a denizen of moderately dry country, a number of its localities have good rainfalls.

"Probably the tree which most definitely marks the dividing line between the warmer and colder country floras (of New South Wales) is the White Box, the upper margin of its habitat, when met with in a descent from the mountains, being an undoubted sign of an approaching warmer temperature, and in a given latitude the presence or absence of this tree on the western slopes at once supplies the observer with an approximate idea of the elevation. In following this species northerly a splendid example is seen of the warmer effects of northern latitudes, for while in the southern district now described, the White Box is chiefly found below an elevation of 1,300 feet above sea-level, on the northern part of New England it is not uncommon at altitudes exceeding 2,000 feet." (R. H. Cambage in *Proc. Linn. Soc., N.S.W.,* xxix, 687, 1904.) See also xxxvi, 567.

It seems to present a very useful climatic boundary to agriculturists, pastoralists, and others, in that it demarcates the western plains from the tablelands (of New South Wales).

Following are localities additional to those enumerated in Part XI, p. 22 :—

Victoria

Tambo River, Ensay (R. H. Cambage, No. 3678).

New South Wales.

Southern Districts.—Binya, Barellan (W. Burke); near Barmedman, No. 829. Bark whitish, rugose, persistent on trunk, but not on branches, fruits very red, as also the twigs, Temora, No. 116, Cootamundra to Temora, No. 203 (all three, Rev. J. W. Dwyer); "Grey Box." Bark grey and rather wrinkled, Cootamundra (W. D. Francis); Bendick Murrell (W. Burke); "Blue White Box." "My husband tells me that in his experience in the last twenty-five years in this district the sheep will eat readily the ‘Blue White Box,’ which grows on gravelly country, but the ‘Green White Box’ (*E. microcarpa*) which is found on flat country, they do not care for.” Cooyong, Crowther (Mrs. G. L. Pring); Back Yamma State Forest No. 253, parishes of Wise and Dowling, Forbes district, county of Ashburnham (Forester A. H. Lawrence); Bedullick Reserve, about 22 miles from Queanbeyan (Forester R. C. Blacket); Queanbeyan-Yass road, growing on the north-north-east slopes of the hill near Canberra, and not very abundant (C. T. Weston, No. 50); “White or Grey Box.” Fairly common from The Oaks to Yerranderie (J. L. Boorman).

Western Districts.—“Plentiful in direction of Tuena, but close to the township of Trunkey the soil is too poor for this tree to thrive in. Tree most valuable for apiarists who have settled in the district” (J. L. Boorman); Allan Cunningham's Macquarie River specimen collected on Oxley's Expedition in 1817, was distributed under No. 198; Bathurst (Dr. H. I. Jensen).

Northern Districts.—White Box, Murrurundi (Forest Guard L. A. Macqueen, No. 10); White Box, 40 feet high, with girth of 5 feet. On red soil Murrurundi to Timor, county Brisbane (Forest Guard M. H. Simon, No. 47); Currabubula (R. H. Cambage, No. 3,556); by far the most important Eucalypt in the district, on nearly all formations, but most dense on the shaly hills, Tamworth (W. M. Carne); the common Box, Barraba (Rev. H. M. R. Rupp); Box, Kiera, Bingara district (E. H. F. Swain, No. 14); Bora, Bingara district (E. H. F. Swain, No. 16); “Gum, box-like trunk, Gum-top,” Black Soil Plains, Namoi River, 5 miles from Boggabri; also Arrarownie, Borah Creek, Pilliga (Dr. H. I. Jensen, No. 153); “Stunted tree of 30–40 feet, blue-leaf, smooth top (branches), shaggy, sub-fibrous bark,” Ironstone Ridge, Baradine (E. H. F. Swain, No. 21); “Box, smooth top (branches), blue-leaf, low, spreading branches,” Warrumbungle Range (E. H. F. Swain, No. 33); “Height 30 feet, girth 4 feet, Box, smooth, yellow bark on branches, on grey gravelly soil, Forest Reserve No. 1,263, parish Leard, county Nandewar (Forest Guard M. H. Simon, No. 24).

Queensland

Slopes of Bunya Mountains (C. T. White, No. 28); Gowrie, Little Plain (W. F. Gray).

Affinities.

See Part XI, p. 24.

1 and 2. With *E. hemiphloia* F.v.M., and *E. microcarpa* Maiden.

At pp. 21, 22, are enumerated certain specimens which are more or less intermediate between *E. albens* and *E. hemiphloia. E. hemiphloia* and *E. microcarpa* Maiden are the only species with whose affinity to *E. albens* we are concerned at the present moment, and their similarities and differences will be found dealt with in the following table:—

	E. hemiphloia F.v.M.	*E. microcarpa* Maiden.	*E. albens* Miq.
Juvenile leaves . . .	Thin, *green,* throughout . . .	Thick, *slightly glaucous* throughout.	Thick, *very glaucous* throughout.
Lower leaves . . .	Orbicular, shortly petiolate.	Spathulate, petioles short or long.	Reniform to orbicular, petioles long.
Upper or intermediate leaves.	Broadly lanceolate, say, 6–10 cm. x 3–7 cm., slightly paler underneath, petioles moderately short.	Broad lanceolate, 4–8 cm. x 21/2–4 cm., glaucous on both surfaces, petioles long.	Broadly ovate to obliquely lanceolate, 121/2–14 cm. x 7–9 cm., glaucous on both surfaces, petioles long.
Venation	Prominent	Faint	Prominent, very marked on the large leaves.
Mature leaves . . .	Green, broad lanceolate to lanceolate falcate.	Green, broad lanceolate to narrow lanceolate.	Glaucous, broad lanceolate to lanceolate falcate.
Buds	Green, cylindrical, gradually tapering into the pedicels, the whole 10–15 mm. long, 3–4 mm. diameter.	Green, cylindrical, tapering at both ends, about 10 mm. long, 2–3 mm. in diameter.	Glaucous, angular, 15–20 mm. long, up to 5 mm. diameter.
Operculum	Conical, acute to rostrate, about the same length as the calyx.	Conical, blunt or acute, when the latter usually shorter than the calyxtube.	Conical, acute, more or less angular and somewhat rostrate, longer than the calyx-tube.
Fruit	Pear-shaped to slightly urceolate, usually pedicellate, 10–15 mm. long, 5–7 mm. in diameter.	Sub-cylindrical, valves well sunk, shape same as *E. hemiphloia,* 7 mm. long, 4 mm. in diameter in the type, but other specimens about half that size.	Glaucous, elliptical truncate urceolate to pear-shaped, sessile or pedicellate, 12–20 mm. long, up to 10 mm. in diameter.
Timber	Pale	Pale	Pale.

VII. Inflorescence.

A. Its Branching.

(*a*) Peduncle.
(*b*) Pedicel.
(*c*) Receptacle.

"An *inflorescence* is a flowering branch, or the flowering summit of a plant above the last stemleaves, with its branches, bracts, and flowers. . . .

A *peduncle* is the stalk of a solitary flower, or of an inflorescence; that is to say, the portion of the flowering branch from the last stem-leaf to the flower, or to the first ramification of the inflorescence, or even up to its last ramifications; but the portion extending from the first to the last ramifications or the axis of inflorescence is often distinguished under the name of *rachis*. . . .

"A *pedicel* is the last branch of an inflorescence, supporting a single flower." (*B.Fl.* i, 10.)

a and *b*. *Peduncle and Pedicel* (not separately treated).

Historical.

Smith, 1793. Mueller, 1879–84.
Bentham, 1866. Naudin, 1883–91.

Smith, 1793.—The terms "General flowering stalks" (for peduncles), and "partial ones" (for pedicels), are used by Sir J. E. Smith in his description of *E. obliqua* in 1793 (see Part II, p. 51, of this work), and such expressions were occasionally adopted by Mueller.

Robert Brown, 1810, in his Prodromus, employed the terms peduncle and pedicel (in their Latin equivalents).

Bentham, 1866, it is hardly necessary to say, strictly adheres to the terms peduncle and pedicel, as we should expect in such a master of style. The following are extracts from his "Flora Australiensis":—

Flowers large or small, in umbels or heads, usually pedunculate, rarely reduced to a single sessile flower, the peduncles in most species solitary and axillary or lateral (by the abortion of the floral leaves), either at the base of the year's shoot below the leaves or at the end of the older shoot above them. . . . (iii, 186.)

The inflorescence is often characteristic of species or even of groups, but cannot always be taken absolutely in single specimens. The umbels are as a rule universal, but are always in a very few large-flowered species, and occasionally in others, reduced to a single flower. The length of the peduncle supporting it, either absolute or compared to that of the petiole, to which importance is given in the old diagnoses, appears to be rarely available as a specific character. Rarely above 1 inch, generally varying from 1/4 to 3/4 inch, and sometimes entirely disappearing, it is only in the few cases where it is constantly long or short as compared to these dimensions that I have referred to it. These peduncles with their umbels are, however, in their general arrangement, of some importance, constituting three types:— (1) *Axillary or lateral,* that is, solitary in the axils of the leaves or along the branchlets above or below the leaves; (2) *several together in short simple panicles* at the end of the branchlet or in the axils of the leaves; and (3) in a *compound terminal corymbose* panicle. But these forms appear to pass into each other very much in imperfect specimens. In the first and simplest form the floral leaves of the uppermost umbels or of very short axillary flowering branches are sometimes quite abortive, converting the inflorescence into the second form; in this again the lower axillary panicles may be occasionally reduced to single umbels as in the first, and even in the terminal corymb, characteristic of the Corymbosae, a single specimen may here and there show an axillary umbel, or after flowering, the branches of the corymb may occasionally, though rarely, grow out into leafy shoots, leaving the fruiting umbels lateral below the new leaves. (iii, 187.)

It is only when one comes to Series V (Normales) (B. Fl., iii, 193), that the position of the flowers is given some classificatory value by Bentham (but subject to the generalisations already stated):—

Subseries I.—*Subsessiles*: Flowers axillary or lateral.

Subseries II.—*Recurvae*: Flowers axillary or lateral.

Subseries III.—*Robustae*: Peduncles axillary or lateral (peduncles being substituted for flowers), or very rarely the upper ones in a terminal corymb, usually flattened. Sessile or tapering into thick pedicels.

Subseries IV.—*Cornutae*: Peduncles axillary or lateral, flattened (except in *E. cornuta*). Sessile or shortly pedicellate.

Subseries V.—*Exsertae*: Peduncles axillary or lateral, or rarely also the upper ones in a short terminal corymb, terete or scarcely flattened. . . . usually pedunculate.

Subseries VI.—*Subexsertae*: Peduncles axillary or lateral, or also the upper ones more or less paniculate, terete or flattened.

Subseries VII.—*Inclusae*: Umbels usually several-flowered, axillary or lateral. . . .

in lateral clusters or very short panicles. . . . the peduncles terete or scarcely flattened.

Subseries VIII.—*Corymbosae*: The umbels, or very rarely heads, all in a terminal corymbose panicle, or rarely a few of the lower ones axillary.

Mueller, 1879.—Mueller does not appear to have written in the "Eucalyptographia" to a model, and hence the peduncle was variously called by him umbel-stalk, common stalk, flower-stalk, or merely stalk, while he was usually consistent in calling the pedicel "stalklet." Occasionally he called it the "ultimate." Referring to the Renantherae, he speaks of "umbels generally solitary."

Naudin, 1883, 1891.—In Naudin's classification, mainly based on the fruit, it will be observed that he calls in the aid of Inflorescence, including the length, or absence of peduncles and pedicels. No writer on the Inflorescence of Eucalyptus is more voluminous and lucid than Naudin, but the generalisations of Bentham are still true, and it is still necessary to be very cautious in regard to classification based upon such variables as peduncles and pedicels. Professor Ralph Tate points out that the usual form of inflorescence is an umbel which, by lengthening of the axis, passes to the panicle or corymb. The transition from one to the other is so easy, he goes on to remark, and often exemplified in the same tree, that it is obvious the form of the inflorescence is not reliable as a specific character.

The following observations have been translated from Naudin's 1st Memoir, 1883. He grouped thirty-one species cultivated in France and Algiers, according to the Inflorescence (the principal character) and Fruits, as follows:—

(*a*) Flowers solitary, axillary, nodding: *E. tetraptera.*
(*b*) Flowers in three-flowered cymes, axillary, sometimes solitary by suppression of two others.

1. Stamens arranged in four bundles, edge of the calyx quadrilobed (*E. erythrocorys*).
2. Stamens uniformly distributed; edge of the calyx-tube truncate, without lobes. Fruits large (almost the size of a walnut): *E. Preissiana, E. megacarpa, E. globulus.* Fruits small (nearly the size of a pea): *E. viminalis.*

(*c*) Flowers in axillary umbels, ordinarily three-flowered, sometimes five to seven flowered, with long peduncles and nodding: *E. longifolia.*
(*d*) Umbels axillary, normally seven-flowered.

1. Operculum longer than the calyx-tube, stamens straight in the bud: *E. occidentalis, E. obcordata.*
2. Operculum shorter or about the same length as the calyx-tube, stamens inflected in the bud: *E. gracilis, E. melliodora, E. Gunnii, E. goniocalyx, E. coccifera.*

(*e*) Axillary umbels, often seven-flowered, but the number of flowers may vary from seven to eleven: *E. tereticornis, E. leucoxylon, E. rudis, E. botryoides, E. diversicolor.*
(*f*) Axillary umbels pluriflowered, may carry up to twenty-five or more flowers.

1. Operculum four to five times longer than the calyx-tube, stamens straight in the bud: *E. cornuta, E. Lehmanni.*
2. Operculum about the same length as the calyx-tube, or shorter than it; stamens inflected in the bud: *E. robusta, E. diversifolia, E. obliqua, E. amygdalina, E. rostrata, E. Risdoni, E. concolor.*

(*g*) Inflorescence in panicles or in terminal corymbs by the union of three, five, seven flowered umbels.

1. Fruits large (size of a medium-sized walnut): *E. calophylla.*
2. Fruits small (size of a grain of pepper or of a small pea): *E. polyanthema, E. cinerea.*

In general, when the flowers are very large, they are solitary in the axils of the leaves; when they are of moderate size, they are most often, if not always, in three-flowered cymes. (Mem. I, 354.)

Then we come to Naudin's 2nd Memoir (1891):—

The inflorescence is sometimes axillary, sometimes terminal at the ends of the branches. Rarely the flowers are solitary in the axils of the leaves (*E. tetraptera*); in the great majority of cases they are united in cymes or umbellules, and generally in odd numbers, and always borne on a common peduncle; they themselves are most often pedicellate, seldom entirely sessile.

One comes to a certain number of eucalypts in which the flowering branch is obliterated at the summit, so that all the umbels or umbellules change into a panicle, sometimes aphyllous, sometimes with leaves for a portion of its length. This method of inflorescence is characteristic of several species (pages 11 and 12). . . .

Classification of species according to the methods of inflorescence, and the modifications of the flower, without taking note of the disposition and of the shape of the leaves (2nd Mem., p. 17):—

Flowers in Cymes or Axillary Umbels.

(*a*) Cymes or three-flowered umbels—

E. globulus.	*E. cordata.*
E. viminalis.	*E. Preissiana.*
E. urnigera.	*E. megacarpa.*

(*b*) Axillary umbels, regularly seven-flowered, except in the case of suppression of several flowers—

E. occidentalis.	*E. Gunnii.*
E. Muelleri.	*E. Stuartiana.*
E. caerulescens.	*E. goniocalyx.*
E. melliodora.	*E. coccifera.*
E. obcordata.	

(*c*) Axillary umbels, where the number of the flowers is not regular, and may vary in a single species from three to eleven—

E. myrtiformis.	*E. diversicolor.*
E. tereticornis.	*E. leucoxylon.*
E. rudis.	*E. desertorum.*
E. botryoides.	*E. insignis.*

(*d*) Many flowered umbels, that is to say, containing more than eleven flowers, up to twenty-five or more—

E. cornuta.	*E. Risdoni.*
E. Lehmanni.	*E. concolor.*
E. robusta.	*E. Andreana.*
E. diversifolia.	*E. amygdalina.*
E. obliqua.	*E. amplifolia.*
E. rostrata.	

(*e*) The umbels have more or less long peduncles and the flowers themselves are sometimes sessile and sometimes borne by relatively elongated pedicels.

The best characterised species under these two headings are—flowering peduncles often longer than the petiole of the adjacent leaf; the umbel then being generally bent or pendent.—

E. leucoxylon.	*E. obcordata.*
E. gracilipes.	*E. doratoxylon.*
E. occidentalis.	

If the pedicels of the flowers are almost absent or at least very short, the inflorescence takes the form of a capitulum, especially when the fruits are formed—

E. concolor.	*E. decipiens.*
E. goniocalyx.	*E. Lehmanni.*
E. Risdoni.	

The peduncles of the floral umbels are most often cylindrical, sometimes a little flattened in their upper part; but in some species they are dilated so as to resemble plates in the whole or almost the whole of their length—

E. Lehmanni.	*E. gomphocephala.*
E. obcordata.	

(*f*) Takes cognisance of the Operculum. See Operculum, p. 475

There is no (*g*).

(*h*) In several eucalypts the floral umbels in approaching the ends of the branches, which then cease to become elongate, give place to panicles, sometimes aphyllous, sometimes provided with several leaves, towards their base. When the panicles are enlarged they pass into the form of a corymb; this mode of inflorescence is shown in—

E. Behriana.	*E. polyanthema.*
E. cinerea.	*E. citriodora.*
E. crebra.	*E. calophylla,* and some others.

Second Section.

I have included all the species in which the capsule is more or less deeply included in the calyxtube, of which it may exceed the rim, but without exceeding it very much. This section is divided into two groups, subdivided themselves according to the number of the flowers in the umbels or floral cymes. (It will be seen that here he adds Inflorescence to Fruit. Translator.)

1*st Group.*—Inflorescence, composed of cymes or axillary umbels, not forming panicles at the apex of the branches.—

A. Axillary umbels or cymes which are regularly three-flowered:—

E. Preissiana.	*E. viminalis.*
E. globulus.	*E. urnigera.*
E. megacarpa.	*E. cordata.*

B. Axillary umbels, in which the number of the flowers varies from three to seven:—

E. leucoxylon.	*E. longifolia.*
E. gracilipes.	*E. cosmophylla.*
E. jugalis.	*E. gomphocephala* (p. 20).

C. Axillary umbels, containing ordinarily and usually regularly seven flowers, except in case of suppression.

(*a*) "Uniform" tree, with leaves always opposed. (It will be noted that here cognisance is taken of the leaves. Translator.).

E. doratoxylon.

(*b*) “Uniform” trees, with alternate leaves.—

E. Stuartiana.	*E. caerulescens.*
E. Muelleri.	*E. occidentalis.*
E. melliodora.	*E. obcordata.*

(*c*) “Biform” trees, with opposite leaves in the opposite state, alternate and petiolate in the adult state.—

E. Mazeliana.	*E. goniocalyx.*
E. coccifera.	*E. Gunnii.*
E. Huberiana.	

D. Axillary umbels, generally containing more than seven flowers:—

(*a*) “Biform” species.—

E. diversifolia.	*E. Risdoni.*
E. myrtiformis.	*E. Andreana.*

(*b*) “Uniform” species.—

E. marginata.	*E. robusta.*
E. diversicolor.	*E. botryoides.*
E. decipiens.	*E. obliqua.*
E. desertorum.	*E. haemastoma.*
E. resinfera.	*E. amygdalina.*
E. concolor.	*E. cultrifolia.*
E. corynocalyx.	*E. vitellina.*
E. rudis.	*E. redunca* (p. 21).

2*nd Group.*—Paniculate euaclypts, that is to say, those in which the umbels unite at the ends of the branches so as to form panicles, leafy or not leafy, sometimes corymbs.

E. citriodora.	*E. crebra.*
E. Behriana.	*E. cinerea.*
E. polyanthema.	*E. calophylla.*

Then follows (p. 23) the classification Naudin adopted in regard to the species at his disposal:—

First Section.

Inflorescence in Cymes or in Axillary Umbels.

A. Species with exsert capsules, that is to say, extending more or less beyond the edge of the calyx-tube.—

E. Lehmanni. *E. insignis.*
E. cornuta. *E. macrorrhyncha.*
E. tereti cornis. *E. rostrata.*
E. amplifolia.

B. Species with enclosed capsules, which do not sensibly extend beyond the edge of the calyx-tube.—

(*a*) Cymes or three-flowered umbels:—

"Uniform" tree, with leaves always opposite, even in the adult state—

E. cordata.

"Uniform" trees, with leaves always alternate—

E. megacarpa. *E. Preissiana.*

"Biform" trees—

E. globulus. *E. urnigera.*
E. viminalis.

(*b*) Cymes or umbels, containing a variable number of flowers, from three to seven, perhaps sometimes more:—

E. leucoxylon. *E. longifolia.*
E. gracilipes. *E. cosmophylla.*
E. jugalis. *E. gomphocephala.*

(*c*) Cymes or umbels, normally of seven flowers:—

"Uniform" tree, opposite-leaved—

E. doratoxylon.

"Biform" tree, that is to say, with opposite leaves, sessile in the juvenile state—

E. Mazeliana. *E. goniocalyx.*
E. coccifera. *E. Gunnii.*
E. Huberiana.

"Uniform" trees, alternate-leaved, that is to say, with leaves always alternate, except the first ones which follow germination—

E. Stuartiana. *E. caerulescens.*
E. Muelleri. *E. occidentalis.*
E. melliodora. *E. obcordata.*

(*d*) Cymes or axillary umbels with more than seven flowers:—

"Biform" trees—

E. diversifolia.	*E. Risdoni.*
E. myrtiformis.	*E. Andreana.*

"Uniform" trees—

E. marginata.	*E. robusta.*
E. diversicolor.	*E. botryoides.*
E. decipiens.	*E. obliqua.*
E. desertorum.	*E. haemastoma.*
E. resinifera.	*E. amygdalina.*
E. concolor.	*E. cultrifolia.*
E. corynocalyx.	*E. vitellina.*
E. rudis.	*E. redunca.*

Second Section.

Paniculate species, that is to say, those in which the flowers are in terminal panicles or corymbs—

"Uniform" tree, opposite-leaved—

E. cinerea.

"Uniform" trees, alternate-leaved—

E. polyanthema.	*E. citriodora.*
E. Behriana.	*E. calophylla.*
E. crebra.	

In considering Naudin's contributions to classification, it must be borne in mind that they do not refer to all or most of the species known in his day, but to certain cultivated forms, principally in France and Algiers. Although the number of species is so small, and a few seem indeterminable to us, his observations are always valuable.

(a) Peduncle.

The descriptions of both peduncle and pedicel should be made from the full-grown bud, but sometimes we have to be content with immature ones. During the progress of the bud from immaturity, it is found that the length and rotundity or flatness, as applied to both peduncle and pedicel, are usually variable. In *E. pyriformis* (Plates 75 and 76) the thick peduncles and pedicels are round, as if turned in a lathe.

Width of the Peduncle.—This is very variable, and sometimes we have anomalous forms. For example, in *E. tetraptera,* Plate 94, we have a short, strap-shaped peduncle, in outline almost continuous (but bulging out a little), with two opposite wings of the diminishing calyx-tube, the intermediate wings forming a not very prominent ridge along the middle of both sides of the flat portion of the peduncle. The peduncle ends at the calyx-tube. In this species we have a case of a sessile fruit adnate to the peduncle, but with a more or less defined line between the base of the fruit and the top of the peduncle. As the bud or fruit develops, so does the peduncle, until it reaches a length of about 41/2 cm. with a breadth nearly as great. (A further drawing will be offered later.) In this species the peduncle is articulate on the leaf axis, and in all the specimens examined by me it remains attached to the fruit, falling off with it.

In *E. Preissiana,* Plate 78, we have another instance of a broad, winged peduncle, but the wings are not decurrent along the calyx-tube. The sessile fruits are articulate on this peduncle, which is articulate in the axis of the leaves. (Both buds and fruits have been seen by me in threes).

In *E. tetragona* the buds are in threes, the central one being considerably longer than the lateral ones. The compressed quadrangular (oblong in section) pedicels are precurrent, forming or terminating two acute teeth to the calyx-tube. The teeth make their appearance in the young buds as soon as the bracts fall off.

The comparatively great width of the peduncle may be frequently conveniently observed in the young state, *e.g.,* as in *E. gomphocephala,* fig. 2*d,* Plate 92. Here the strap-shaped peduncle is seen tipped by minute immature buds with very short, slender pedicels. Following are some additional species figured:—

	Fig.	Plate.
E annulata	1*c*	145
E. de Beuzevillei	4*d*	192
E. botryoides	10*b*·	98
	3*a* and 5*a*	99
E. Campaspe	3*a* and 4*a*	71
E. capitellata (?)	5*a* and 6*b*	37
E. cneorifolia (?)	16	60
E. cordata	2*c*	84
E. cosmophylla	8*b*	91
E. decipiens	12*a*	63
E. eloeophora	15*a*	82
E. grandis	7*d*	167
E. grossa	1*a*	72
E. incrassata var. *conglobata*	4 and 3*a*	17
E. incrassata var. *dumosa*	6*a* and 6*c*	16
E. Kitsoniana	2*b*	117
E. Lehmanni	2*a*	144

E. Maideni	1*b*	80
E. miniata	3*b*	95
	2*b*	96
E. Muelleri	5*b*	116
E. occidentalis	1*c* and 5*a*	148
	1*c*	149
E. pellita	3*b*	127
E. Planchoniana	1*a*	210
E. platypus	4*a* and 4*b*	145
E. platypus var. *nutans*	1*c* and 1*d*	146
E. redunca	3*c*	140
E. salubris	8*d*	150
E. spathulata	8*b*	146
	1*b*	147
E. Stricklandi	1*b*	71
E. stricta (?)	17*c*	43
E. virgata	6*g*	44

Decumbent Peduncles.

In the following species the peduncles are decumbent, and hence we have decumbent inflorescence or fruits. There are doubtless others.

	Fig.	Plate.
E. alba	5	105
E. cornuta	8	142
E. decurva	1*c*	90
E. diversicolor	12	86
E. doratoxylon	4*d*	70
E. eremophila	7*b*, 9*b*, 10	149
E. erythronema	2*b*	93
E. falcata	2*a*, 2*c*	68
E. falcata var. *ecostata*	6*a*, 9*b*	68
E. Flocktonioe	4*a*, 2*b*	69
E. leptopoda	9*b*	73
E. leucoxylon	13*a*	55
E. longifolia	1*b*, 2*b*	86
E. occidentalis	1*b*, 2, 5*a*	148
	6*a*, 1*e*	149
E. occidentalis var. *grandiflora*	1*b*	150
E. paniculata	9*b*	57
E. Pimpiniana	2*a*	72
E. platypus	5*d*, 6	145

E. platypus var. *nutans*	1*d*	146
E. Preissiana	2	78
E. pyriformis var. *Kingsmilli*	8*c*	171

Articulation with Axis.—In *E. pyriformis* we have peduncles long and scarcely flattened, pedicels very angular, and this angularity is continued into the calyx-tube. The fruits are so angled as to be winged. If we turn, *e.g.,* to figs. 3*a* and 3*b,* Plate 75, and figs. 1*e,* 2*c* and 3, we find distinct articulations between the axis and the peduncle and pedicel (or pedicels). See also *E. pyriformis* var. *Kingsmilli,* fig. 8*c,* Plate 171, and *E. pachyphylla,* figs. 3 and 6, Plate 171. Also *E. Lehmanni,* fig. 5*b,* Plate 144, also *E. erythrocorys,* figs. 2*c* and 2*d,* Plate 184. At the foot of p. 134, Part XLV, there are notes describing the different colours of the axes and peduncles in the latter species (the former dull purple-lake and the latter moss-green), so that the articulations can be readily noted. See also *E. tetradonta,* fig. 3*a,* Plate 185, as to articulation. The two last species belong to the Eudesmieae.

These are large-fruited species and varieties, and characters are often much better observed than in small-fruited ones.

(b) Pedicels.

Characters are sometimes based on the absence of, or the number or length of the pedicel, and hence the following notes are offered:—

1. Number of pedicels on the common peduncle (buds chosen).
2. Pedicels absent or nearly so.
3. Length.

(*a*) Pedicels of the fruit less than half the length of the calyx-tube.
(*b*) Half the length to as long as the fruit calyx-tube.
(*c*) Usually of the same length, but often longer than the fruit calyx-tube.

Stellate buds.

NUMBER OF PEDICELS.

It must be borne in mind that the number of pedicels may vary in the same species, owing to atrophy or other causes. We want very many more examinations in the bush before we can submit a correct classification based on the number of them, but the following figures will help. See Naudin's figures of French grown Eucalypts already quoted. The asterisk means “sometimes almost sessile.” The numbers cited are by my botanical assistant, Mr. R. H. Anderson, B.Sc., Agr.

Pedicel solitary.—There are very few species of Eucalyptus with only one flower to the common peduncle. I only know the following:—

1. *E. macrocarpa.* Peduncle very short, thick, almost terete, *articulate;* buds sessile or sometimes shortly pedicellata.
2. *E. tetraptera.* Peduncle rather long, strap-shaped, with acute edges. Buds sessile. In a plant cultivated in the Botanic Gardens, Sydney, we have flowers for most part single, but on one branch I noticed them in pairs, each flower being quite independent of the other on the strap-shaped peduncle.

E. Forrestiana is figured with a single fruit, but there may be as many as three.

Pedicels in 2's . . .	. . . *E. regnans*	*E. Watsoniana* (sometimes).
Pedicels 1–3 . . .	. . . *E. pyriformis.*	*E. Preissiana.*
2–4 . . .	. . . *E. angustissima.*	*E. Torelliana.*
	E. tessellaris.	*E. Watsoniana.*
2–5 . . .	. . . *E. gamophylla.*	
2–6 . . .	. . . [1]**E. Abergiana.*	*E. leptophleba.*
	E. aspera.	*E. nova-anglica.*
	E. pyrophora.	
2–7 . . .	. . . *E. Ewartiana.*	
In 3's . . .	. . . *E. coesia.*	[1]**E. pachyphylla.*
	E. Dalrympleana.	*E. pyriformis* var. *Kingsmilli.*
	E. Ebbanoensis.	*E. rubida.*
	E. Griffithsii.	*E. tetradonta.*
	E. longifolia.	*E. tetragona.*
	E. maculata.	*E. urnigera* (sometimes solitary).
	E. odontocarpa	*E. viminalis* (one form of).
3–4 . . .	. . . *E. longifolia.*	*E. leucoxylon.*
3–5 . . .	. . . *E. Bosistoana.*	*E. occidentalis.*
	E. brachyandra.	*E. ovata.*
	E. Cliftoniana.	*E. polyanthemos.*
	E. corrugata.	*E. sepulcralis.*
	E. Dunnii.	*E. setosa.*
	E. erythrocorys.	*E. trachyphloia.*
	E. lirata.	
3–6 . . .	. . . *E. alba.*	*E. oligantha.*
	E. angophoroides.	*E. paniculata.*
	E. decorticans.	*E. patens.*
	E. diversicolor.	*E. pruinosa.*
	E. drepanophylla.	*E. Rudderi.*
	E. Drummondii.	*E. similis.*
	E. hybrida.	*E. Staigeriana.*
	[1]**E. melanophloia.*	*E. terminalis.*

	E. microtheca.	
Pedicels 3–7 . . .	. . . *E. affinis.*	*E. Mundijongensis.*
	E. alba.	*E. ochrophloia.*
	E. calophylla.	*E. patellaris.*
	E. cinerea.	[1]**E. Planchoniana.*
	E. Culleni.	*E. proecox.*
	E. decurva.	*E. scoparia.*
	[1]**E. Morrisii.*	
3–8 . . .	. . . *E. bicolor.*	*E. exserta.*
	E. Cambageana.	*E. incrassata.*
	E. eremophila.	
3–9 . . .	. . . *E. Brownii.*	*E. longicornis.*
	E. intermedia.	*E. transcontinentalis.*
3–10 . . .	. . . *E. grandifolia.*	*E. punctata.*
3–15 . . .	. . . *E. Smithii.*	
4 . . .	. . . *E. Hillii.*	
4–6 . . .	. . . *E. argillacea.*	*E. Lane-Poolei.*
	E. confluens.	*E. latifolia.*
	E. Foelscheana.	*E. spathulata.*
4–7 . . .	. . . *E. Blakelyi.*	*E. Parramattensis.*
	E. doratoxylon.	*E. Stuartiana.*
	E. haematoxylon.	
4–8 . . .	. . . *E. approximans.*	*E. pellita.*
	E. clavigera.	*E. Pilligaensis.*
	E. goniantha.	*E. Pimpiniana.*
	E. haemastoma.	*E. radiata.*
	E. hemiphloia.	*E. Risdoni.*
	E. marginata.	*E. rostrata.*
	E. melliodora.	*E. rudis.*
	E. microcorys.	[1]**E. saligna.*
	E. obliqua.	*E. salubris.*
	E. obtusiflora.	*E. stricta.*
	E. oleosa.	*E. tereticornis.*
4–9 . . .	. . . *E. dealbata.*	
4–10 . . .	. . . *E. Penrithensis.*	
4–12 . . .	. . . *E. robusta.*	
5 . . .	. . . *E. orbifolia.*	
5–7 . . .	. . . *E. Baileyana.*	*E. fasciculosa.*
	E. Baueriana.	*E. Normantonensis.*
	E. dichromophloia.	[1]**E. odorata.*
5–8 . . .	. . . [1]**E. Macarthuri.*	*E. vitrea.*
5–10 . . .	. . . *E. coriacea.*	*E. propinqua.*
5–11 . . .	. . . [1]**E. Ravertiana.*	

5–14 . . .	. . . *E. eugenioides.*	
Pedicels up to 6 . . .	. . . *E. canaliculata.*	
6–8 . . .	. . . *E. macrorrhyncha.*	*E. santalifolia.*
	E. oreades.	*E. viminalis* (one form of).
6–9 . . .	. . . *E. umbra.*	
6–10 . . .	. . . *E. buprestium.*	
6–12 . . .	. . . *E. cladocalyx.*	*E. piperita.*
	E. falcata.	*E. redunca.*
	E. gigantea.	*E. siderophloia.*
	E. pilularis.	
Over 6 . . .	. . . *E. grandis.*	
Up to 7	*E. acacioeformis.*	*E. Seeana.*
	E. Bancrofti.	*E. sideroxylon* (sometimes more).
	E. Caleyi.	* *E. Le Souefii.*
	E. Flocktonioe.	*E. Spenceriana.*
	* *E. Guilfoylei.*	*E. Stowardi.*
	E. Kruseana.	*E. torquata.*
	E. ptychocarpa.	
7–8 . . .	. . . *E. fraxinoides.*	
7–9 . . .	. . . *E. amygdalina.*	
7–13 . . .	. . . * *E. pumila.*	
8–12 . . .	. . . *E. dives.*	*E. squamosa.*
Up to 9 . . .	. . . *E. Naudiniana.*	* *E. notabilis.*
About 10 or up to 10 . . .	. . . *E. Kirtoniana.*	*E. salmonophloia.*
	E. resinifera.	
Pedicels 10–13 . . .	. . . *E. Bakeri* (a form).	
10–15 . . .	. . . *E. leptopoda.*	
Up to 11 . . .	. . . *E. virgata.*	
Up to 14 . . .	. . . * *E. populifolia.*	
Up to 17 . . .	. . . *E. Cooperiana.*	
Few to many	*E. papuana.*	
Numerous . . .	. . . *E. amplifolia.*	*E. phoenicea* (up to 28 F.v.M.)
		E. numerosa (up to 40 J.H.M.).
		E. coriacea (Sir Joseph Hooker counted up to 40; I found sometimes as few as three only, F.v.M.).
	E. intertexta,	*E. phoenicea.*
	E. Lehmanni.	* *E. stellulata.*

* Sometimes almost sessile.

LENGTH.—1. Pedicels absent, (*i.e.,* Flowers sessile).
(The asterisk means sessile or very shortly pedicellate.)

Flowers 1–3 in head	*E. alpina.*	*E. vernicosa.*
In pairs	*E. megacarpa.*	
2–3	*E. globulus.*	*E. Muelleri.*
	[1]**E. Oldfieldi.*	
2–4	[1]**E. pachyloma.*	[1]**E. Jutsoni.*
2–9	*E. Maideni.*	
In threes	*E. cordata.*	*E. grossa.*
	[1]**E. cosmophylla.*	*E. Gunnii.*
	E. diptera.	*E. Preissiana.*
	E. Perriniana.	[1]**E. pulverulenta.*
	E. gomphocephala.	
3–6	[1]**E. coccifera.*	[1]**E. micranthera.*
	E. Howittiana.	*E. Stricklandi.*
3–7	[1]**E. goniocalyx*	[1]**E. Dawsoni.*
	E. Kitsoniana.	[1]**E. rubida.*
	[1]**E. Morrisii.*	[1]**E. peltata.*
	[1]**E. Dundasi.*	*E. platypus.*
3–9	*E. neglecta.*	
4–6	[1]**E. grandis.*	*E. perfoliata.*
4–7	*E. Banksii.*	[1]**E. Mooreana.*
	[1]**E. Houseana.*	[1]**E. Todtiana.*
4–8	[1]**E. cneorifolia.*	*E. quadrangulata.*
	[1]**E. dumosa.*	[1]**E. saligna.*
4–10	[1]**E. Moorei.*	[1]**E. botryoides.*
4–11	*E. Kybeanensis.*	
4–20	*E. maculosa.*	
5–6	*E. parvifolia.*	
5–7	*E. miniata.*	
5–10	*E. capitellata.*	
6–8	*E. ligustrina.*	[1]**E. uncinata.*
6–12	*E. annulata.*	*E. cornuta.*
	E. decipiens.	
Up to 7	*E. nitens.*	*E. de Beuzevillei.*
8–16	[1]**E. macrandra.*	
Up to 9	[1]**E. notabilis.*	*E. Camfieldi* (about 9).
Up to 11	[1]**E. Mitchelliana.*	
Numerous	*E. amplifolia.*	*E. nitida.*
	E. Lehmanni.	*E. stellulata.*

2. Pedicels of the Fruit less than half the length of the Calyx-tube. (S.L. = sometimes longer; S.S. = sometimes sessile or nearly so.)

E. accedens.	*E. incrassata.*

E. aggregata (S.L.).	*E. Irbyi* (S.L.).	
E. alba.	*E. Jacksoni.*	
E. angustissima.	*E. leptophleba.*	
E. argillacea.	*E. longicornis* (S.L.)	
E. Baueriana (S.S.).	*E. Macarthuri.*	
E. Behriana (S.S.)	*E. macrocarpa.*	
E. Benthami.	*E. maculosa* (S.S.).	
E. Boormani.	*E. Maideni.*	
E. Bosistoana.	*E. micranthera* (S.S.).	
E. calycogona.	*E. Mooreana* (S.S.).	
E. Campaspe (S.S.).	*E. Muelleriana.*	
E. canaliculata.	*E. nitens.*	
E. cinerea.	*E. Mundijongensis* (S.S.).	
E. cladocalyx.	*E. nova-anglica.*	
E. Clelandi.	*E. odorata.*	
E. Cloeziana.	*E. Oldfieldi.*	
E. confluens.	*E. orbifolia.*	
E. conica.	*E. ovata* (S.S. or S.L.).	
E. corrugata.	*E. pachyphylla* (S.L.).	
E. cosmophylla (SS.).	*E. pallidifolia.*	
E. Dalrympleana.	*E. paniculata.*	
E. Dawsoni.	*E. patens.*	
E. dealbata.	*E. pellita* (S.L.).	
E. Deanei.	*E. proecox.*	
E. decorticans.	*E. pumila.*	
E. diversicolor.	*E. punctata.*	
E. dumosa.	*E. pyriformis.*	
E. Dundasi.	*E. redunca.*	
E. eloeophora.	*E. robusta.*	
E. Ewartiana.	*E. rubida.*	
E. Flocktonioe.	*E. saligna* (S.L.).	
E. foecunda.	*E. occidentalis.*	
E. Forrestiana.	*E. scoparia.*	
E. gamophylla.	*E. sideroxylon.*	
E. Gillii.	*E. Le Souefii.*	
E. gracilis.	*E. squamosa* (S.L.).	
E. grandis (S.S.).	*E. Stuartiana.*	
E. Griffithsii.	*E. Todtiana* (S.S.).	
E. Guilfoylei.	*E. unialata.*	
E. Gunnii (S.S.).	*E. urnigera* (S.L.).	
E. hemiphloia.	*E. vernicosa.*	
E. Houseana.	*E. viminalis.*	
Cornutae	. . . *E. eremophila.*	*E. spathulata.*

	E. macrandra (S.S.).	*E. Stowardi* (S.L.).
	E. occidentalis.	
Eudesmieae	. . . *E. Ebannoensis.*	*E. odontocarpa.*
	E. erythrocorys (S.S.).	*E. similis.*
	E. eudesmioides	*E. tessellaris.*
	E. lirata.	
. . . Coriaceae	*E. coccifera* (S.S.).	*E. stellulata* (S.S.).
	E. coriacea.	*E. vitrea.*
	E. Risdoni.	
. . . Renantherae	*E. amygdalina.*	*E. nitida.*
	E. apiculata.	*E. obliqua.*
	E. approximans.	*E. obtusiflora.*
	E. cneorifolia.	*E. oreades.*
	E. diversifolia.	*E. pachyloma* (S.S.).
	E. eugenioides (S.S.).	*E. pilularis.*
	E. fraxinoides.	*E. piperita* (S.L.).
	E. gigantea.	*E. Planchoniana.*
	E. laevopinea (S.L.).	*E. radiata.*
	E. linearis.	*E. Sieberiana.*
	E. macrorrhyncha (S.L.).	*E. Smithii.*
	E. marginata var. *Staeri.*	*E. virgata* (S.L.).
	E. Muelleriana.	
Corymbosae	. . . *E. Abergiana* (S.S.).	*E. peltata* (S.S.).
	E. Cliftoniana.	*E. perfoliata.*
	E. corymbosa (S.L.).	*E. phoenicea.*
	E. ferruginea.	*E. ptychocarpa.*
	E. Foelscheana (S.S.).	*E. terminalis.*
	E. maculata (S.L.).	*E. setosa.*

3. Pedicels of Fruits half the length to as long as the Fruit Calyx-tube. (S.S. = Sometimes shorter than half the length of the tube; S.L. = sometimes longer than tube.)

E. acaciaeformis.	*E. Howittiana.*
E. acacioides.	*E. intertexta.*
E. adjuncta.	*E. Kirtoniana.*
E. affinis.	*E. Kruseana.*
E. angophoroides.	*E. Lane-Poolei.*
E. Bakeri (S.S.).	*E. leptophleba.*
E. Bancrofti (S.S.).	*E. leptopoda* (S.L.).
E. Beyeri.	*E. leucoxylon* (S.S.).
E. bicolor.	*E. longifolia* (S.L.)
E. Blakelyi (S.L.)	*E. Maideni.*
E. Bosistoana.	*E. melanophloia.*

	E. Brownii.	*E. melliodora.*
	E. Caleyi.	*E. microtheca.*
	E. Cambageana.	*E. Muelleriana.*
	E. celastroides.	*E. Normantonensis.*
	E. cinerea var. *multiflora.*	*E. notabilis* (S.S.).
	E. cladocalyx.	*E. ochrophloia* (S.S.).
	E. corrugata.	*E. oleosa.*
	E. crebra.	*E. oligantha.*
	E. dealbata.	*E. ovata* (S.S.).
	E. Deanei.	*E. paniculata.*
	E. decurva.	*E. patellaris.*
	E. diversicolor.	*E. Parramattensis.*
	E. doratoxylon.	*E. Pilligaensis.*
	E. drepanophylla.	*E. Pimpiniana.*
	E. Drummondii.	*E. polyanthemos.*
	E. Dunnii.	*E. populifolia.*
	E. exserta.	*E. propinqua* (S.S.).
	E. falcata, var. *ecostata.*	*E. pruinosa.*
	E. fasciculosa.	*E. punctata.*
	E. Flocktoniae.	*E. pyriformis.*
	E. fruticetorum.	*E. rariflora.*
	E. Gillii.	*E. resinifera.*
	E. goniocalyx (S.S.).	*E. robusta.*
	E. gracilis.	*E. rostrata* (S.L.).
	E. hemiphloia.	
	E. Rudderi.	*E. striaticalyx* (S.S.).
	E. rudis (S.L.).	*E. parviflora.*
	E. saligna (S.S.).	*E. tereticornis.*
	E. salmonophloia (S.L.).	*E. tetraptera.*
	E. Seeana.	*E. Thozetiana.*
	E. Sheathiana.	*E. transcontinentalis.*
	E. sideroxylon.	*E. Websteriana.*
	E. Le Souefii.	*E. Woodwardii* (S.S.).
	E. Staigeriana.	*E. Yarraensis.*
Cornutae	*E. eremophila.*	*E. spathulata.*
	E. occidentalis.	
Eudesmieae	*E. Baileyana.*	*E. tetragona* (S.S.).
	E. odontocarpa.	*E. tetrodonta* (S.S.).
Angophoroideae	*E. aspera.*	*E. Spenceriana.*
	E. brachyandra (S.L.).	*E. vilellina.*
	E. papuana.	
Renanthreae	*E. acmenioides.*	*E. Muelleriana.*
	E. altior.	*E. numerosa.*

	E. Andrewsi.	*E. obliqua* (S.S.).
	E. Consideniana (S.S.).	*E. Penrithensis.*
	E. dives.	*E. pilularis.*
	E. globulus.	*E. radiata.*
	E. haemastoma (S.S.)	*E. taeniola* (S.S.).
	E. macrorrhyncha.	*E. umbra.*
	E. microcorys.	*E. virgata* (S.S.).
Corymbosae	*E. caesia*	*E. intermedia.*
	E. calophylla.	*E. latifolia.*
	E. corymbosa (S.S.).	*E. maculata* (S.S.).
	E. dichromophloia.	*E. ptychocarpa.*
	E. ficifolia (S.L.).	*E. setosa.*
	E. Foelscheana (S.S.).	*E. terminalis.*
	E. haematoxylon.	

3*c*. Pedicel usually the same length, but often longer than the fruit calyx-tube—

	E. amplifolia.	*E. longicornis.*
	E. Cooperiana.	*E. longifolia.*
	E. crebra.	*E. Naudiniana.*
	E. Culleni.	*E. patellaris.*
	E. decurva.	*E. pyriformis* var. *Kingsmilli.*
	E. drepanophylla.	*E. Raveretiana.*
	E. Drummondii.	*E. resinifera.*
	E. erythronema.	*E. rostrata.*
	E. falcata.	*E. rudis.*
	E. Hillii.	*E. salmonophloia.*
	E. leptopoda.	*E. torquata.*
Angophoroideae . . .	*E. clavigera.*	*E. grandifolia.*
Renantherae . . .	*E. acmenioides.*	*E. Andrewsi.*
Corymbosae . . .	*E. ficifolia.*	

STELLATE BUDS.

We sometimes have sessile umbels, where they present a star-shaped appearance. A characteristic example is—

E. stellulata, fig. 1*b,* Plate 25.

See also—

E. amplifolia, fig. 4*c,* Plate 131, Part XXXI;

E. Bakeri, fig. 5*b,* Plate 183, Part XLIV;

E. Mitchelliana, fig. 52, Plate 192, Part XLVII.

(c) Receptacle.

The Peduncle naturally leads us to the Receptacle, but I find that Bentham only refers to it once, and Mueller not at all. Under *E. Lehmanni* Preiss, the former (*B.*

Fl. iii, 233) refers to "the receptacle forming a globose mass of 1/2 in. or more diameter, in which the calyx-tubes (usually two to three lines diameter) are more or less immersed.. . . . Fruits half immersed in the receptacle . . . "

Turning to Plate 144, at 5*b,* between the articulation and the buds, we find the lower part of the receptacle. In 5*c,* under the fruits, we see the receptacle as an irregular mass, in which, as Bentham states, the fruits are half immersed. The swelling of the peduncle and its relation to the receptacle is seen at fig. 4*a.* The receptacle and its relation to the fruits is, however, best shown in a longitudinal section which I shall present later on as a figure.

In *E. cornuta* Labill., there is always a tendency to the formation of a receptacle; in those forms which approach *E. Lehmanni* the receptacle can be distinctly seen. Indeed, in a number of species (Cornutae and others), we have incipient receptacles.

In *E. pachyphylla* var. *sessilis* (Glen of Palms) there is a small circular disc between the sessile head and the stem in this species. See figs. 4*c,* 4*b,* Plate 171, Part XLI. This is a receptacle.

There is sometimes an expansion of the top of the peduncle in *E. pyriformis* var. *Kingsmilli, e.g.,* figs. 4*c,* 4*b,* Plate 171. In this case we have pedicellate flowers, with the peduncle and pedicels of about the same length. The apex of the peduncle is slightly expanded, to allow for the thickness of the three pedicels at the point of attachment to the peduncle.

In the previous two species the flowers are sessile on a remarkably thick peduncle, and therefore the expanded top or receptacle is more prominent than in var. *Kingsmilli.* As the latter has elongated terete slender peduncles and pedicels, it can hardly be referred to as a receptacle, *i.e.,* in which the calyx-tubes are more or less immersed, but analogous thereto.

B. Bracts and Bracteoles.

(a) Bracts.

Historical.

1814—Robert Brown.	1883—Naudin.
1866—Bentham.	1879–84—Mueller.

Bracts which enclose the young umbel have been found in a number of species. They have been termed by Naudin "sort of involucre" (which is correct), by others "operculum of the umbel," and "double operculum," which embody false analogies, and which are therefore not strictly correct.

Generally (following Jussieu) these bracts are spoken of as two confluent bracts.

Naudin says the same, and is followed by Mueller. But are the bracts confined to two in all species? I will refer to the matter under "Bracteoles," and will subsequently offer a figure showing apparently six bracts in *E. ficifolia.*

1814. *Robert Brown.*—In the following passage Brown refers both to the opercula of the single flower, and also to the enveloping bracts of the umbel.

Eudesmia (tetragona) . . . . "differs from *Eucalyptus* solely in having a striated operculum placed within a distinctly toothed calyx, and in its filaments being collected into bundles.* The operculum in *Eudesmia,* from the nature of its striae, and their relation to the teeth of the calyx, appears to be formed of the confluent petals only; whereas that of *Eucalyptus,* which is neither striated nor placed within a distinct calyx, is more probably composed, in several cases at least, of both floral envelopes united.* But in many species of Eucalyptus a double operculum has been observed; in these the outer operculum, which generally separates at a much earlier stage, may, perhaps, be considered as formed of the calyx, and the inner consequently of corolla alone, as in *Eudesmia;* this view of the structure appears at least very probable in contemplating *Eucalyptus globulus,* in which the cicatrix caused by the separation of the outer operculum is particularly obvious, and in which also the inner operculum is of an evidently different form." (So far we are dealing with the operculum of the single flower, J.H.M.)

* These two sentences (see also p. 488 below), which include consideration of the Operculum in the Eudesmieae, can be better understood when (a) an additional figure or figures of the operculum is offered, and (b) when the affinities of the Eudesmieae are considered in detail.

"Jussieu (*Ann. Mus.* 19, p. 432), seems inclined to consider the operculum of *Eucalyptus* as formed of two confluent bracteae, as is certainly the case with respect to the calyptra of *Pileanthus,** and of a nearly related genus of the same natural family. This account of its origin in *Eucalyptus,* however, is hardly consistent with the usual umbellate inflorescence of that genus; the pedicelli of an umbel being always destitute of bracteae; and in *E. globulus,* where the flowers are solitary, two distinct bracteae are present, as well as a double operculum. But a calyptra analogous to that of *Pileanthus* exists also in most of the species of *Eucalyptus,* where it is formed of the confluent bracteae common to the whole umbel, and falls off at a very early period." Robert Brown, "Gen. Remarks, Botany Terra Australis." (*Flinders' Voyage,* 1814.)

1866. *Bentham* remarks:

"Bracts and bracteoles when present, so early deciduous as only to have been observed in a very few species." (*B. Fl.,* iii, 186)

1883. *Naudin:*

"In *E. botryoides* the floral umbels are at first enveloped in a sort of involucre composed of two leaflets fused one to the other, and which has a good deal of analogy with the corolline operculum which has been spoken of above. Like this last, this involucre is detached altogether in a piece by circumcision below the umbel, which is then as encased in a cupule of which the contour is more or less pointed, sometimes reduced to a simple ring. It is possible that this peculiarity is present in other species, but is the only example I know of so far." (Mem. i, 352, footnote. Translation.)

I have not noticed this "simple ring" in *E. botryoides.* I do not doubt its presence for a moment, but it is probably analogous to what is shown in 4*b* and 4*c* of Plate 171, *E. pyriformis* var. *Kingsmilli,* where there is shown either a "simple ring," the scar of the bracts or involucre or perhaps of the expanded peduncle.

1879–1884. *Mueller:*

(1) "Umbels . . . . while very young enclosed within a pair of fugacious and sometimes diminutive bracts." ("Eucalyptographia," Definition of the Genus.)

(2) "Buds of the umbels of *E. doratoxylon* enclosed in two connate bracts." ("Eucalyptographia." See also *E. coriacea,* &c., below.)

I have seen these bracts, more or less perfect, in a number of species, some of which have been figured in the present work as indicated. I believe that if we are fortunate to be early enough, we shall see them in all species, although they vary in persistence. In a number of cases I believe that the thickening of the peduncle exhibits the scar, which shows the base of the former connate or conjoint pair of enveloping bracts. (See *E. pyriformis* below.)

E. altior (Syn. *E. oreades*).—Fig. 7*e,* Plate 44. In this figure the bracts are beginning to be lifted from the base and to be longitudinally separated.

E. brachyandra.—See fig. *e* (lower fig.), Plate 127, where there is one small, almost persistent, leafy bract.

* In *Pileanthus* of Western Australia (B. Fl. iii, 34) we have ten equal petal-like calycine lobes, five petals exceeding the calyx, scarious bracteoles, united and enclosing the bud, circumsciss at or below the middle, and falling off together.

E. calophylla R. Br.—The bracts are present on some of the young umbels cultivated in the Botanic Gardens, Sydney, June, 1922, but bracteoles were not present in these particular specimens. For a note on bracteoles in this species, see p. 466.

E. Camfieldi Maiden.—An illustration will be shown later showing bracts in this species. No bracteoles have been found so far. Galston-road, Hornsby, near Sydney (W. F. Blakely and D. W. C. Shiress).

E. capitellata Sm.—As "commonly found with a double operculum." (Part VIII, p. 212). These are cases of enveloping bracts.

E. cinerea F.v.M.—Deane and Maiden record a "double operculum" in *E. pulverulenta* Sims (really *E. cinerea* F.v.M.) at Marulan, New South Wales (*Proc. Linn Soc. N.S.W.,* xxiv, 465, 1899).

E. coriacea.—A pair of lanceolar bracts enclose the umbel in its earliest stage ("Eucalyptographia").

E. ficifolia F.v.M.—See under "Bracteoles," below.

E. hemiphloia F.v.M. (including *E. microcarpa* and *E. albens*), figs. 6, 9, 20*a,* Plate 50.

E. miniata A. Cunn.—See fig. 3*b,* Plate 95.

E. Mooreana.—Fig. 1*b,* Plate 179.

E. nitens F.v.M.—See fig. 10, Plate 81. The double bract is being lifted bodily, although it is showing the line of separation between the two bracts.

E. peltata Benth.—See fig. 2*d,* Plate 173, Alma-den, North Queensland (R. H. Cambage). Bracts of the umbel narrow to broad lanceolate, concave, usually one to each outer bud of the umbel, 2–3 mm. long, 1–11/2 mm. broad. Bracteoles have also been observed in this species.

E. pilularis Sm. var. *pyriformis* Maiden.—See fig. 1*d,* Plate 206, Part L.

E. polyanthemos Schauer.—Lid double in early stage, the outer minute and fugacious. ("Eucalyptographia.")

E. Preissiana Schauer.—In this species bracts are common. See Part XVIII, fig. 4*c,* Plate 77. In the left-hand part of the figure the bracts are beginning to be lifted from the base of the umbel.

E. pyriformis Turcz.—See figs. 3*b* and 4*c,* Plate 75. Note the scar at the flattened top of each peduncle. This scar is often seen in a species where one is too late to see the fugacious bracts.

E. pyrophora Benth.—Saxby River, North Queensland. (A. Sulman, through Miss F. Sulman.) This specimen shows, in the early stage of the flower buds, abundant bracts and bracteoles. The bracts are slightly hoary, unequal, narrow to broad lanceolate, and in no specimen examined as numerous as the buds (*i.e.,* one to each bud); they are always fewer.

E. setosa Schauer.—Has bracts and bractoles. For bracts, see fig. 1*a,* and bracteoles, figs. 1*a* and 4*b,* all in Plate 158.

E. Shirleyi Maiden.—The marks of the enveloping bracts are clearly seen in this species.

E. Sieberiana F.v.M.—I have seen enveloping bracts in this species in the Blue Mountains, New South Wales.

E. stricta Sieb.—I have seen an enveloping bract in this species at Mount Victoria, New South Wales.

E. tetragona F.v.M.—Bracts of the umbel two, semifoliaceous, narrow lanceolate to concave, keeled. Near Esperance, Western Australia.

E. tetrodonta F.v.M.—Bracts at the summit of the flower-stalk boat-shaped, lanceolar. ("Eucalyptographia.")

E. virgata Sieb.—See fig. 6*f,* Plate 44.

(b) Bracteoles.

Bentham (already quoted) appears to me to be the only botanist who refers to bracteoles in addition to bracts. From what follows, and I will offer some figures in due course, I make the following observations:—

1. There may be a bracteole for each bud, as well as bracts enveloping the whole umbel.
2. The occurrence of bracteoles appears to be confined to the Corymbosae.
3. There may be six bracteoles alternating with the six bracts of an umbel.
4. The bracts appear to be broader and slightly shorter than the bracteoles, but that may be only apparent; the bracteoles appear to wilt more readily.

Doubtless botanists will give special attention to both bracts and bracteoles in the future, and may be able to offer useful generalisations.

E. calophylla R. Br.—Mr. Blakely brought me (31st July, 1918) specimens (cultivated, of course) from the Botanic Gardens, Sydney, that I cannot differentiate from the bracts and bracteoles of *E. ficifolia,* to be immediately referred to. In May, 1919, on further examining some fresh specimens, I noted that in *E. calophylla* each somewhat subulate bracteole persists until the bud is on the point of opening. See also fig. 2, Plate 176.

E. ficifola F.v.M.—From a tree cultivated in the Botanic Gardens, Sydney, near the foot of the Victoria Lodge, Messrs. W. F. Blakely and J. P. Shelton brought me, on 26th July, 1918, specimens showing both bracts and bracteoles, which Miss Flockton has figured, and her drawings will be reproduced in due course.

The bracts and the bracteoles alternate, and they each show six segments. Each segment appears to be of equal size, and texture, but, as already suggested, there is an apparent difference in the size and texture of bracts and bracteoles. Each umbel shows seven buds, and it may be that one bracteole has aborted, or it was so early deciduous that it was not seen. It requires further specimens to see if the number of bracts was six. I did not see the segments split completely down to the base. See also fig. 7, Plate 176.

E. peltata Benth.—Bracteoles narrow lanceolate, slightly curved, thin and almost transparent, rarely exceeding 2 mm. long and barely 1 mm. broad, only present on the outer buds: none on the inner buds. (R. H. Cambage, Alma-den, Northern Queensland, already referred to under Bracts.)

E. pyrophora Benth.—Bracteoles glabrous, narrow lingulate, rather thick, sometimes broad, as if two are fused together, but usually more uniform in size and shape than the bracts. The specimens examined are dry, but there appears to have been one bracteole to each flower, as only one was missing in some of the umbels. They are more deciduous than the bracts. (A. Sulman, Saxby River, Northern Queensland. See also under Bracts.)

E. setosa F.v.M.—For bracteoles, see "Bracts"; for figures of the former, fig. 1*a,* Plate 158.

C. The Bud.

a. The bud as a whole.
b. Calyx-tube.
c. Operculum.
d. Outer and Inner Operculum.

(a) The Bud as a Whole.

The bud is often referred to as a whole, *i.e.,* in shape we may speak of it as clavate. Our ideal is to describe the plump bud—the nearly bursting bud.

Buds may be reminiscent of cloves in shape, thus:—

E. tetrodonta (fig. 3*a,* Plate 185), and

E. odontocarpa (fig. 1*b,* Plate 186).

Those of *E. buprestium* are reminiscent in shape of those of the not closely related *E. Baileyana.*

In *E. Flocktonioe* we may have peculiar moniliform buds, referred to in Part LVIII. (Perhaps a second species is indicated.)

References to the bud as a whole are scattered throughout the work, particularly in descriptions of individual species.

(b) Calyx-tube.

Historical.
Fleshiness and other characters.
Colour.
Shape.
Sculpture—

(*a*) Angles and ribs.
(*b*) Ribbing confined to the calyx-tube.

Calyx-tube.—Obconical, campanulate or oblong, adnate to the ovary at the base or rarely to the top, truncate and entire after the falling off of the operculum or with four minute teeth. (*B. Fl.* iii, 185). The form and dimensions of the calyx-tube (*hypanthium* of Schauer, *cupula* of De Candolle) are taken when the stamens are expanded but still adhering; after they fall, it often alters so much that it neither indicates the form it had in flower nor yet that which it will assume in fruit. (*ib.* p. 187).

(The reference to the "4 minute teeth" more particularly applies to the Eudesmieae, but in *E. tetraptera* (and to a less extent *E. Forrestiana*), there some is approach to a 4-toothed calyx, and therefore affinity to the Eudesmieae.)

Calyx-tubes usually free."—The tendency of the *alabastra* (buds) to become concrete (united in growth) is well shown in such species as *E. rudis* and *E. obliqua,* in which species they often (?) form dense, spherical masses, their contiguous surfaces being quite flattened, so that the lower portions of the mature seed-vessels assume the form of an inverted hexagonal pyramid, but actual concretion of these organs never occurs in either of these species. The extraordinary form *E.* (*Symphyomyrtus*) *Lehmanni,* offers a remarkable instance of the concretion of the alabastra (buds) into a hard, woody mass, though each separate flower still retains its individuality, and from the consideration of this fact, we are enabled to assert its immediate derivation from *E. cornuta,* by the simple concretion of the alabastra. In this genus, and indeed throughout the vegetable series generally, as compared with the higher animal orders, there seem to have been preserved a vast number of transition forms, a fact that may be regarded as indicative of vicissitudes in the conditions under which those forms exist rather than of any excess of susceptibility for variation inherent in the forms themselves." (MSS. of Augustus Oldfield, about 1864.)

As to *E. Lehmanni*—see Part XXXV, pp. 111, 112, with Plate 144. Bentham (*B. Fl.* iii, 233) refers to the calyx-tubes being more or less immersed in the globose mass of the receptacle.

Lateral connation of fruits is rare. Mr. A. D. Hardy figures (fig. 3, *b, c,* Plate 13), *Proc. Roy. Soc. Vict.,* xxix (New Series), 171, two cases in *E. cordata.* I have seen a similar fusion of calyx-tubes in *E. similis* from Emerald, Queensland, collected by R. Simmonds.

Fleshiness and Other Characters.

See under *E. terminalis;* walls may be very thick, which dry in folds when not ripe. Fleshiness is also notable in *E. macrocarpa, E. pyriformis, E. tetraptera,* and some other species.

We have a glandular calyx-tube in *E. gracilis.* See fig. D, Plate 12, Part III.

In *E. setosa,* the calyx-tube is often more or less covered with bristles. See fig. 6*b,* Plate 157, Part XXXVIII.

Colour.

As a rule, the calyx-tube is green. Exceptionally it is of a different colour, and exceptions should be noted in the bush. The calyx is Lincoln-red in *E. tetraptera.* In this species the top of the calyx or the inner flattish rim is bronze-yellow.

E. buprestium—Buds warm brown.

E. corrugata—Calyx-tube brownish.

E. Forrestiana—Calyx-tube scarlet.

Shape.

(Mr. R. H. Anderson, B.Sc., Agr., one of my assistants, has endeavoured to construct types of calyx-tubes from the drawings. This classification can only be tentative and uncertain, because of the varying shapes and degrees of maturity of the calyx-tube. The calyx-tube of the bud or flower imperceptibly becomes the calyx-tube of the fruit.)

1. More or less hemispherical, including depressed and flattened hemispherical.
2. More or less cylindrical or oblong turbinate. This includes forms which taper towards the base, but only slightly.
3. Truncate-ovate or oval. Oval in outline with rounded base.
4. Turbinate, regular and usually narrow. The calyx narrows evenly and gradually into the pedicel.
5. Rounded-turbinate or campanulate. A form intermediate between an oval or hemisphere and a regularly turbinate form. Usually rounded at the top, but becoming cone-shaped. This embraces most broad turbinate forms.
6. Urceolate. 5 and 6 are inter-related.
7. Pear-shaped.
8. Turbinate-quadrangular. Cone-shaped, but with four sides.

1. More or less Hemispherical.

E. alba.
E. annulata.
E. Bancrofti (2-edged).
E. Banksii (or angled).
E. Camfieldi (angular).
E. corrugata.
E. cosmophylla (or 2).
E. Culleni.
E. Drummondii.
E. erythronema.
E. Lane-Poolei (or 5).
E. Lehmanni.
E. leptopoda (or 5).
E. longicornis.
E. longifolia.
E. macrocarpa.
E. megacarpa (or 5).
E. Morrisii.
E. Muelleri.
E. Naudiniana (or 5).

E. Ewartiana.	*E. neglecta.*
E. nova-anglica (or 5).	*E. pyriformis.*
E. Oldfieldii.	*E. pyriformis* var. *Kingsmilli.*
E. orbifolia.	*E. Raveretiana.*
E. pachyphylla.	*E. rostrata.*
E. pachyphylla var. *sessilis.*	*E. Rudderi.*
E. pachyloma (or 5).	*E. salmonophloia* (or 3).
E. pallidifolia.	*E. Seeana.*
E. pilularis (or 5).	*E. Todtiana* (or 5).
E. propinqua (or 5).	*E. Websteriana.*
Depressed Hemispherical—	
E. angustissima.	*E. falcata.*
Flattened (laterally) Hemispherical—	
E. diptera.	

2. More or less Cylindrical or oblong Turbinate.

E. de Beuzevillei.	*E. Guilfoylei.* At times.
E. botryoides.	*E. Gunnii.*
E. cladocalyx (or urceolate).	*E. Kitsoniana.*
E. Cooperiana.	*E. macrandra.*
E. cornuta.	*E. miniata.*
E. dumosa.	*E. nitens* (or 4).
E. Dundasi.	*E. oleosa* (or 5). At times.
E. eremophila.	*E. phoenicea* (or 7).
E. Flocktonioe.	*E. Torelliana.*
E. goniocalyx.	*E. uncinata.*
E. grossa.	*E. vernicosa.*

3. Truncate Ovate or Truncate Oval.

E. Abergiana.	*E. leucoxylon* (or 5).
E. brachyandra.	*E. peltata* (or 5).
E. Brownii.	*E. salmonophloia* (or 1).
E. Dalrympleana.	*E. salubris.*
E. doratoxylon (or 5).	*E. Stuartiana* (or 1).
E. Howittiana.	*E. squamosa.*

4. Turbinate Regular.

E. affinis.	*E. Mooreana.*
E. argillacea.	*E. Moorei.*
E. Bakeri.	*E. nitida.*
E. Behriana.	*E. obtusiflora.*
E. Beyeri.	*E. odorata.*

E. bicolor.	*E. ochrophloia.*
E. Bosistoana.	*E. oreades.*
E. Cambageana.	*E. paniculata.*
E. capitellata.	*E. pellita* (or 5).
E. cinerea.	*E. Penrithensis.*
E. clavigera.	*E. Pilligaensis.*
E. coccifera.	*E. Planchoniana.*
E. conica.	*E. platypus.*
E. coriacea.	*E. pruinosa.*
E. decorticans.	*E. pulvigera.*
E. diversicolor.	*E. quadrangulata.*
E. dives.	*E. redunca.*
E. drepanophylla.	*E. regnans.*
E. hemiphloia.	*E. Risdoni.*
E. Jacksoni.	*E. saligna.*
E. Kirtoniana.	*E. siderophloia.*
E. Kybeanensis.	*E. Staigeriana.*
E. Laseroni.	*E. stellulata.*
E. linearis.	*E. stricta.*
E. macrorrhyncha.	*E. Stowardi.*
E. melanophloia.	*E. viminalis* (or 5).
E. melliodora.	*E. virgata.*
E. Mitchelliana.	*E. vitrea.*

5. Rounded-Turbinate or Campanulate.

E. angophoroides.	*E. decipiens.*
E. approximans.	*E. diversifolia* (or 4).
E. Blakelyi.	*E. doratoxylon* (or 3).
E. Brownii.	*E. Dunnii.*
E. calophylla.	*E. Ebbanoensis.*
E. canaliculata (or 4).	*E. fraxinoides* (or 4).
E. Cliftoniana.	*E. gigantea.*
E. confluens.	*E. globulus.*
E. cordata.	*E. goniantha.*
E. dealbata (or 1).	*E. Griffithsii.*
E. hoemastoma.	*E. perfoliata* (or 1).
E. hoematoxylon.	*E. piperita.*
E. Hillii (or 7).	*E. polyanthemos.*
E. hybrida (or 4).	*E. populifolia.*
E. intermedia (or 7).	*E. proecox.*
E. intertexta.	*E. Preissiana.*
E. Kruseana.	*E. ptychocarpa.*
E. latifolia.	*E. punctata.*

E. ligustrina.	*E. radiata.*
E. maculosa.	*E. resinifera* (or 1).
E. Maideni (or 4).	*E. Risdoni.*
E. micranthera (or 4).	*E. robusta* (irregular).
E. microcorys.	*E. rubida* (or 1 or 4).
E. microtheca (or 4).	*E. rudis.*
E. Normantonensis.	*E. setosa.*
E. notabilis.	*E. sideroxylon.*
E. numerosa.	*E. Sieberiana.*
E. obliqua.	*E. Smithii.*
E. oleosa (varying).	*E. spathulata.*
E. oligantha.	*E. Spenceriana* (or 6).
E. ovata.	*E. tereticornis* (or 1).
E. Parramattensis (or 1).	*E. tetrodonta* (or 2).
E. patellaris.	*E. trachyphloia.*
E. patens.	*E. Watsoniana.*

6. Urceolate.

E. cladocalyx.	*E. transcontinentalis* (or 7).
E. torquata (or 7).	*E. urnigera* (or 7).

7. Pear-shaped.

E. aspera.	*E. occidentalis.*
E. Baileyana.	*E. papuana.*
E. decurva.	*E. phoenicea* (or 2).
E. eximia.	*E. pyrophora.*
E. Foelscheana.	*E. scoparia.*
E. Gillii.	*E. Spenceriana.*
E. grandis.	*E. terminalis.*
E. incrassata.	*E. tessellaris.*
E. intermedia.	*E. Woodwardi.*

8. Turbinate-Quadrangular.

E. Forrestiana. *E. tetraptera.*

Sculpture.

(Angles and ribs,—raised markings.)

Augustus Oldfield, Mueller's collector of over seventy years ago in Western Australia and elsewhere, referred to this, and I quote from his MSS. about 1864:—

Among vegetables we find no less striking evidences of the derivation of one species from another, by the blending of organs, the generally superior size, and diminished number of such organs—besides the evidence offered by the presence of ridges, grooves, and minute striae marking the points of concretion of the blended individuals—invariably betraying their true origin. The genus Eucalyptus affords a remarkable instance of this derivation of species, for starting from *E. microtheca* with its flowers in panicles containing numerous individuals which are minute and semi-herbaceous, we may pass on by *E. floribunda* and *E. rudis,* to *E. gomphocephala* and *E. hypoleuca,* and thence to such noble (*sic*) species as *E. calopyhylla, E. Preissii, E. erythrocorys* and *E. erythrocalyx,* finally reaching that remarkable form *E. tetraptera,* the last of this series, throughout which there is a gradual diminution in the number of alabastra (buds) in each aggregation of the same, attended by a consequent increase in the dimensions of these organs. As we descend in this series, we generally find the complexity of structure of the alabastra indicated by raised ridges (4–16), as in *E. erythrocorys, E. Preissii, E. tetraptera, E. erythrocalyx,* as well as in *E. globulus* and many other species; by grooves (16–32), as in *E. costata* and *E. pleurocarpa*; or by an immense number of delicate *strioe,* as in *E. calophylla, E. rudis,* &c., and the same thing is oftentimes manifest in the aggregation of stamens into four bundles, as in *E. erythrocorys, E. eudesmioides,* &c., a condition carried a step further in *Eudesmia* (a genus which ought certainly to be included in Eucalyptus) where the operculum (combined petals and sepals) is quadripartite.

The following are arranged according to the numbers of the angles, ridges, or ribs. They vary—(*a*) in number, and in some species may be absent; and (*b*) in their prominence.

E. Mooreana.—With one or two angles.

E. canaliculata.—One or two opposite sharp ridges.

E. Bancrofti.—Usually with two angles.

E. Lane-Poolei.—Two slightly raised ribs.

E. diptera.—With two wings.

E. Griffithsii.—Two of the ribs broadened almost into wings.

E. notabilis.—Two angles or ribs sometimes so prominent as to be winged.

E. platypus.—Terete or with two to four more or less prominent ribs or angles.

E. pyriformis.—More or less prominent two-four ribbed or almost winged.

E. goniocalyx.—Often two to four prominently angled.

E. Shirleyi.—Three prominent ribs with two or three less prominent ones.

E. Forrestiana, E. tetraptera.—Quadrangular. In the latter species the ribs, which are so wide as to be “wings,” terminate in short teeth at the commissure.

E. Stowardi.—Five prominent ribs.

E. corrugata.—Six to eight very prominent ridges.

E. ptychocarpa.—About eight prominent ridges.

E. torquata.—Seven to ten ridges.

E. setosa.—Often slightly eight-ribbed.

E. miniata.—More or less prominently eight-angled.

Following are more general references:—

E. Bosistoana, E. Howittiana.—Slightly angular.

E. Woodwardi.—Slightly ribbed.

E. occidentalis.—Smooth or obscurely ribbed.

E. macrocarpa, E. phoenicea.—Obscurely ribbed.

E. longifolia.—Sometimes with ribs.

E. Dalrympleana.—Angled.

E. odorata.—Angular.

E. Banksii.—Usually angular.

E. pellita.—More or less angular.

E. globulus.—More or less ribbed and rugose or warty.

E. erythronema, E. falcata.—More or less distinctly ribbed.

E. eximia, E. Johnstoni.—Somewhat angular.

E. similis.—Irregularly ribbed.

E. coccifera.—Prominently angular.

E. angulosa, E. grossa.—Prominently ribbed.

E. goniantha.—Very prominently ribbed.

E. Camfieldi.—Very angular.

E. de Beuzevillei.—Almost winged.

RIBBING CONFINED TO CALYX-TUBE.

For ribbing on both Operculum and Calyx-tube, see p. 473.)

* = only slightly ribbed.

E. calycogona.	* *E. Maideni.*
E. canaliculata.	* *E. Muelleri.*
E. cladocalyx.	* *E. notabilis.*
E. coccifera.	*E. pellita.*
* *E. cosmophylla.*	* *E. platypus.*
* *E. erythronema.*	* *E. spathulata.*
* *E. eximia.*	* *E. Stowardi.*
E. falcata.	*E. Stricklandi.*
E. Flocktonioe.	*E. tetragona.*
E. Forrestiana.	*E. tetraptera.*
* *E. longifolia.*	* *E. Watsoniana.*

(c) The Operculum.

Shape (including Historical, 1788 (L'Héritier); 1797 (Smith); 1825 (De

Candolle)).

Sculpture (including calyx-tube).

Comparative length of operculum and calyx-tube.

Note on *E. tetraptera.*

Rather solid operculum.

Colour of operculum.

Shape.

1788.—L'Héritier, in his original description of Eucalyptus, has the words “Operculum superum, integerrimum, truncatum” (Operculum above, quite entire, truncate). He was describing *E. obliqua,* from Tasmania. See Plate 5, Part II.

1797 “There is not a more natural genus in the whole Linnean system than this (Eucalyptus). It is clearly characterised at first sight by the singular operculum which closes the calyx, and covers up the stamina and style till they arrive at maturity.” (Smith in *Trans. Linn. Soc.,* iii, 283, 1797.)

He grouped a number of species according as the operculum was conical or hemispherical, as follows. He only knew twelve species, and divided them into two classes according to the operculum:—

1. Operculo conico.

E. robusta.	*E. resinifera.*
E. pilularis.	*E. capitellata.*
E. tereticornis.	*E. saligna.*

2. Operculo hemisphaerico.

E. botryoides.	*E. obliqua.*
E. haemastoma.	*E. corymbosa.*
E. piperita.	*E. paniculata.*

This was followed by Willdenow (*Species Plantarum,* 1799) and Persoon (*Synopsis Plantarum,* 1807).

1825.—De Candolle, in his *Prodromus* III (1825), of which Don (*Dichlamydeous Plants*), ii, 818 (1832), is mainly a translation, also used the operculum in his subdivision of the species with alternate leaves. He recognised five distinctive shapes:—

1. Conical, longer than the calyx-tube, *e.g., E. cornuta.*
2. Conical, equal in length to the calyx-tube, *e.g., E. stellulata.*
3. Nearly conical or hemispherical, shorter than the calyx-tube, *e.g., E. amygdalina.*
4. Hemispherical, much broader than the calyx-tube, *e.g., E. gomphocephala.*
5. Depressed in the centre, shorter than the calyx-tube, *e.g., E. globulus.*

The operculum is a useful character in the discrimination of species, but variable, like everything else in Eucalyptus.

Mr. R. H. Anderson has assisted me in the following grouping from the drawings, but it must be borne in mind that shrinkage sometimes alters the shape of the operculum. It will be seen that the majority of species fall into Groups 3 and 5.

1. Hemispherical. This and the next group run into each other.
2. Hemispherical in outline, but with a mucro or umbo.
3. Hemispherical-conical. These are intermediate between the hemispherical and conical. Some under this heading tend to fall within Group 2.
4. Egg-shaped. These are obtusely and symmetrically conical, like the end of an egg.
5. Conical. Usually acute. Merges into 3.
6. Tapering or elongated. In this group there are readily distinguishable two sub-groups:—

(*a*) Tapering symmetrically.
(*b*) Broad at base, but narrowing quickly into a narrow beak.

7. Oblong, rounded at apex.
8. Pileiform or dilated.
9. Special forms. Buds reminiscent of cloves in shape.

1. Hemispherical.

E. amygdalina (flattened).	*E. Kybeanensis* (or 3).
E. aspera (or 3).	*E. nitida* (flattened).
E. capitellata (or 3).	*E. obtusiflora* (sometimes pointed).
E. clavigera.	*E. papuana* (or 3).
E. coriacea (or 3) (sometimes flattened).	*E. Risdoni.*
E. gigantea (or 4).	*E. Sieberiana* (or slightly umbonate).
E. alba.	*E. Griffithsii.*
E. angulosa.	*E. Guilfoylei.*
E. Campaspe.	*E. Houseana.*
E. collina.	*E. odorata* var. *calcicultrix.*
E. corrugata.	*E. Preissiana.*
E. gamophylla.	*E. salmonophloia.*
E. gracilis.	
E. tessellaris (or with a mucro).	
E. Abergiana (or egg-shaped).	*E. phoenicea.*
E. dichromophloia (or 3).	*E. odontocarpa* (flattened).
E. Ebbanoensis (or pileiform).	*E. tetragona.*
E. eudesmioides.	*E. tetrodonta.*
E. Foelscheana (or 3).	

2. Hemispherical, but with a mucro or umbo.

E. altior.	
E. alba.	*E. macrocarpa.*
E. canaliculata.	*E. Oldfieldi.*
E. cordata.	*E. patellaris.*
E. cosmophylla.	*E. pyriformis.*
E. diversicolor.	*E. Sheathiana.*
E. elaeophora.	*E. striaticalyx.*
E. Ewartiana.	*E. Stuartiana.*
E. globulus.	*E. Todtiana.*
E. Hillii.	*E. unialata.*
E. Johnstoni	*E. vernicosa.*
E. megacarpa.	
E. grandifolia.	
E. eximia.	*E. pyrophora.*
E. Foelscheana.	*E. Torelliana* (or 5).
E. maculata.	*E. Watsoniana* (depressed or hemispherical).
E. miniata.	
E. similis.	

3. Hemispherical—Conical.

Hemispherical in outline, but tapering somewhat towards the apex. Allied to Group 2, but more inclined to be conical.

E. Andrewsi.	*E. laevopinea.*
E. approximans.	*E. linearis.*
E. Camfieldi.	*E. microcorys* (somewhat flattened)
E. capitellata (or 1).	*E. obliqua.*
E. coccifera (or flattened).	*E. Penrithensis.*
E. Consideniana (or 5).	*E. radiata.*
E. coriacea (or 1).	*E. taeniola* (or 1).
E. dives.	*E. vitrea* (or 5).
E. haemastoma.	
E. acaciaeformis.	*E. foecunda.*
E. aggregata.	*E. fruticetorum.*
E. angophoroides.	*E. Gunnii.*
E. argillacea.	*E. Irbyi.*
E. Banksii.	*E. Kitsoniana.*
E. Baueriana.	*E. Macarthuri.*
E. Benthami.	*E. melliodora.*
E. bicolor.	*E. micranthera.*
E. Bosistoana.	*E. Muelleriana.*
E. botryoides.	*E. Normantonensis.*

E. Brownii.
E. Cambageana.
E. celastroides.
E. cladocalyx.
E. Cloeziana.
E. conica.
E. Culleni.
E. Dawsoni.
E. Deanei.
E. decurva.
E. dumosa.
E. Dunnii.
E. fasciculosa.
E. nova-anglica.
E. odorata.
E. pallidifolia.
E. parviflora.
E. patens.
E. Perriniana.
E. praecox.
E. propinqua.
E. quadrangulata.
E. rubida.
E. Stuartiana var. *grossa.*
E. Yarraensis.

E. aspera (or 1).
E. brachyandra.
E. calophylla.
E. corymbosa.
E. dichromophloia (or 1).
E. ferruginea.
E. ficifolia (or 1).
E. Baileyana.
E. papuana (or 1).
E. Spenceriana.
E. haematoxylon.
E. latifolia (or 5).
E. ptychocarpa.
E. terminalis.
E. trachyphloia.

4. More or less Egg-shaped. (Obtusely and symmetrically conical).

E. gigantea (or 1).
E. accedens.
E. affinis.
E. alba.
E. angustissima.
E. Behriana.
E. Bosistoana (sometimes acute conical).
E. botryoides.
E. Dalrympleana.
E. dealbata.
E. Drummondii (also hemispherical or conical).
E. foecunda.
E. Jacksoni.
E. Lane-Poolei.
E. platypus var. *nutans.*
E. Abergiana (or hemispherical).
E. leptophleba.
E. Morrisii.
E. Mundijongensis.
E. neglecta.
E. occidentalis.
E. oleosa (or conical acute).
E. oligantha.
E. pumila.
E. rariflora.
E. rubida.
E. rudis.
E. tereticornis var. *latifolia.*
E. Websteriana.

5. Conical.

(This merges into Group 3.)

E. acmenioides.
E. de Beuzevillei.
E. cneorifolia.
E. Consideniana (or 3).
E. diversifolia.
E. eugenioides.
E. fraxinoides.
E. Laseroni.
E. macrorrhyncha.
E. Mitchelliana.
E. Moorei.
E. Muelleriana.
E. numerosa (or 3).
E. pilularis.
E. piperita.
E. Planchoniana.
E. regnans.
E. Smithii.
E. stellulata.
E. umbra.
E. virgata.

E. acacioides.
E. adjuncta.
E. albens.
E. angulosa.
E. Baeuerleni.
E. Beyeri.
E. Boormani.
E. Caleyi.
E. calycogona.
E. cinerea.
E. confluens.
E. Dawsoni.
E. decorticans.
E. drepanophylla.
E. Dundasi.
E. eloeophora.
E. exserta.
E. Forrestiana.
E. goniocalyx.
E. grandis.
E. hemiphloia
E. Howittiana.
E. hybrida.
E. incrassata
E. intertexta.
E. Jutsoni.
E. Kruseana.
E. leptophleba.
E. leptopoda.
E. longicornis.
E. longifolia.
E. maculosa.
E. Maideni.
E. melanophloia.
E. microcarpa.
E. microtheca.
E. Mooreana.
E. Naudiniana.
E. nitens.
E. ovata.
E. pachyphylla var. *sessilis.*
E. ovata var. *camphora.*
E. paniculata.
E. Parramattensis.
E. parvifolia.
E. Pilligaensis.
E. polyanthemos.
E. populifolia.
E. pulvigera.
E. punctata.
E. pyriformis.
E. redunca and varieties.
E. rostrata.
E. rubida.
E. Rudderi.
E. rudis.
E. saligna.
E. scoparia.
E. sideroxylon.
E. squamosa.
E. Staigeriana.
E. viminalis.

E. intermedia.	*E. perfoliata.*
E. peltata (also 4).	

6. Tapering or Elongated.

(*a*) Tapering symmetrically.
(*b*) Broad at base, but narrowing quickly into a narrow beak.

6*a.*

E. amplifolia.	*E. redunca.*
E. Blakelyi.	*E. resinifera* (also in 6*b*).
E. falcata.	*E. Seeana.*
E. Lehmanni.	*E. siderophloia.*
E. longicornis	
E. cornuta.	*E. occidentalis.*
E. eremophila.	*E. platypus.*
E. macrandra.	

6*b.*

E. doratoxylon.	*E. ovata.*
E. erythronema.	*E. pyriformis* var. *Kingsmilli.*
E. Gillii (transit forms to *E. oleosa*).	*E. robusta.*
E. incrassata (form of).	*E. rostrata.*
E. Kirtoniana.	*E. transcontinentalis.*
E. ochrophloia.	*E. Woodwardii.*
E. oleosa (also conical, &c.).	

E. coesia. Bluntly conoid operculum about 1 cm. long. Buds elongated, pear-shaped, 2–3 cm. long.

E. setosa.

7. Oblong, rounded at apex.

E. Bakeri.	*E. Stricklandi.*
E. Bancrofti.	*E. tereticornis.*
E. occidentalis (also 6).	*E. spathulata.*

8. Pileiform, or dilatation of the operculum.

Bentham, speaking of *E. gomphocephala,* speaks of it as—.

“Operculum globular, very thick and hard, broader than the calyx-tube.” (*B. Fl.* iii, 231.)

“Sometimes the operculum is remarkable in the dilatation of its base, which notably projects over the contour of the calyx-tube. One sees examples of this in *E.*

gomphocephala and *E. robusta.*" (Naudin, Mem. ii, 18.)

The most obvious character is the much greater diameter of the operculum as compared with the calyx-tube (cupula). The original described aptly alludes to it as "pileiform," reminding one of a mushroom. To have the operculum of greater diameter at all, no matter how little, is not common in Eucalyptus. There is a note on *E. gomphocephala* in Part XXI, p. 19, of the present work.

Mueller quotes *E. robusta* and *E. Watsoniana* in this comparison, and also *E. cladocalyx* (*corynocalyx*) and *E. urnigera.* The following species have been illustrated in the present work as being more or less pileiform:—

	Fig.	Plate.
E. Bancrofti	1*a*	130
E. Clelandi	8*d*	69
E. erythronema	2*b*	93
E. Flocktonioe	1*c*	69
E. Gillii	7*a*	67
E. goniantha	1*a*	18
E. Griffithsii (?)	5*a*	15
E. incrassata var. *scyphocalyx* (?)	1*a*	15
E. notabilis	7*a*	125
E. oleosa	14*b*	66
E. pellita	4*b*	126
E. robusta	3*b* and 6*b*	97
E. Seeana	1*a*	130
E. Le Souefii	6*a* and 6*b*	69
E. torquata	6*a*	13
E. urnigera	14*b*	80
E. Watsoniana	1*b*	174

Sometimes (*e.g., E. Watsoniana*) in drying, the calyx-tube shrinks from the operculum, and the bud thus assumes the form of a mushroom. This shrinking of the calyx-tube is also sometimes seen in another shiny-budded species, *E. eximia,* and doubtless in others.

9. Special.

1. Biretta-like operculum, old-carmine-lake in colour, *e.g., E. erythrocorys.*
2. Cruciform, with raised ribs, in this respect showing affinity with *E. erythrocorys e.g., E. tetraptera.*
3. Constricted in middle with dilated apical portion, *e.g., E. goniantha.*
4. Broadening towards the apex, *e.g., E. annulata.*

Sculpture.

The sculpture of the buds cannot be separated from the calyx-tube on the one hand, and from the operculum on the other.

1. Warted or rugose operculum.
2. Operculum ribbed as well as the calyx-tube.
3. Ribbing confined to operculum.

1. Warted or rugose operculum.

E. alpina (figs. 2*a,* 4*a,* Plate 41) (the rugosity often in parallel ridges).
E. capitellata (fig. 12*b,* Plate 37).
E. coccifera (fig. 4*b,* Plate 28).
E. coriacea (tuberculate-corrugate).
E. elaeophora (fig. 1*b,* Plate 83).
E. erythrocorys.
E. globulus (fig. 3, Plate 79).
E. stricta (fig. 13*a,* Plate 43).

(See also Part VIII, p. 217, under *E. capitellata,* Part IX, p. 259, under *E. alpina.*)

2. Operculum ribbed as well as calyx-tube.

E. albens.
E. alpina (fig. 2*a,* Plate 41).
E. Clelandi.
E. corrugata.
E. diptera.
E. goniantha (Plate 18).
E. Flocktoniae.
E. Griffithsii.
E. Lehmanni.
E. de Beuzevillei.
E. miniata.
E. incrassata.
E. pachyphylla var. *sessilis.*
E. pyriformis (fig. 1*d,* Plate 76).
E. pyriformis var. *Kingsmillii.*
E. Shirleyi.
E. Le Souefii (fig. 6*b,* Plate 69).
E. torquata (fig. 6*a,* Plate 13).
E. tetrodonta.
E. Planchoniana.
E. ptychocarpa.

(Under Calyx-tube, p. 474, will be found a list of species in which the ribbing is confined to the calyx-tube.)

3. Ribbing confined to operculum.

E. dumosa (fig. 6*a,* Plate 16).

Comparative Length of Operculum and Calyx-tube.

“The second character generally made use of in books, the comparative length of the operculum and calyx-tube, is too indefinite for practical use.” (*B. Fl.* iii, 186.)

“The opercula of the flowers sometimes show good characteristics, distinctive of the species or the group of species by their shape, and especially by their length, compared to that of the calyx-tube. In a large number of species they are sensibly of the same length as the latter; in others they are much longer or much shorter. The operculum is from two to four or five times longer than in—

E. Lehmanni.	*E. cornuta.*
E. occidentalis.	*E. tereticornis.*
E. amplifolia.	*E. redunca.*

It is much shorter, often rounded in the shape of a hemispherical cap, or even almost flat in—

E. coccifera.	*E. amygdalina.*
E. Andreana.	*E. calophylla.*

(Naudin, 2nd Mem., 18, 1883.)

GROUP 1.—Operculum very short, less than half the length of calyx-tube.

(* Sometimes tend towards Group 2.)

E. amygdalina.	* *E. nitida.*
E. Consideniana.	* *E. numerosa.*
E. dives.	*E. obtusiflora.*
* *E. haemastoma.*	* *E. virgata.*
E. microcorys.	
E. coccifera.	* *E. Risdoni.*
* *E. coriacea.*	
* *E. botryoides.*	* *E. foecunda.*
E. celastroides.	*E. Forrestiana.*
E. cladocalyx.	*E. gamophylla.*
E. conica.	*E. Griffithsii.*
E. Cooperiana	*E. Muelleriana.*
E. cordata.	*E. Mundijongensis.*
E. Dawsoni.	*E. Normantonensis.*
* *E. diversicolor.*	*E. tetraptera.*
E. dumosa.	*E. urnigera.*
E. clavigera.	*E. tessellaris.*
E. papuana.	
E. calophylla.	*E. latifolia.*
E. corymbosa.	*E. phaenicea.*
E. ferruginea.	* *E. setosa.*
E. ficifolia.	*E. terminalis.*
E. Foelscheana.	*E. ptychocarpa.*
E. haematoxylon.	*E. pyrophora.*
E. intermedia.	*E. Watsoniana.*
E. odontocarpa.	*E. tetragona.*

GROUP 2.—Operculum shorter than calyx-tube, varying from half as long to almost equal.

E. alpina.
E. altior.
E. Andrewsi.
E. approximans.
E. cneorifolia.
E. gigantea.
E. laevopinea.
E. linearis.
E. de Beuzevillei.
E. Kybeanensis.
E. Laseroni.
E. Muelleriana.
E. obliqua.
E. Penrithensis.
E. Planchoniana.
E. radiata.
E. regnans.
E. virgata.
E. taeniola.
E. Mitchelliana.
E. vitrea.

E. accedens.
E. affinis.
E. argillacea.
E. Baueriana.
E. Behriana.
E. Benthami.
E. Beyeri.
E. bicolor.
E. Boormani.
E. Bosistoana.
E. botryoides.
E. Brownii.
E. Caleyi.
E. Cambageana.
E. Campaspe.
E. canaliculata.
E. cinerea var. *multiflora.*
E. Cloeziana.
E. Dawsoni.
E. Deanei.
E. decorticans.
E. decurva.
E. diversicolor.
E. Dundasi.
E. elaeophora.
E. fasciculosa.
E. foecunda.
E. fruticetorum.
E. globulus.
E. goniocalyx (fig. 3, Plate 81).
E. gracilis.
E. Guilfoylei.
E. Gunnii.
E. intertexta.
E. Jacksoni.
E. Kitsoniana.
E. leptophleba.
E. megacarpa.
E. micranthera.
E. Muelleri.
E. nitens.
E. ochrophloia.
E. odorata.
E. oligantha.
E. pallidifolia.
E. parvifolia.
E. patellaris.
E. patens.
E. Perriniana.
E. polyanthemos.
E. praecox.
E. Preissiana.
E. pulvigera.
E. quadrangulata.
E. rariflora.
E. Rudderi.
E. scoparia.
E. sideroxylon.
E. Staigeriana.
E. striaticalyx.
E. vernicosa.
E. viridis

E. grandis.
E. aspera.
E. brachyandra.
E. Abergiana.
E. caesia.
E. dichromophloia.
E. eximia.
E. maculata.
E. Woodwardi.
E. grandifolia.
E. Spenceriana.
E. peltata.
E. perfoliata.
E. Torelliana.
E. trachyphloia.

E. Baileyana.
E. Ebbanoensis.
E. erythrocorys.
E. similis.

GROUP 3.—Operculum equal in length to the calyx-tube. (Figure after name denotes tendency to fall also within that Group.)

E. acmenioides.
E. Camfieldi.
E. capitellata.
E. diversifolia.
E. eugenioides.
E. Moorei.
E. piperita.
E. Sieberiana (2).
E. Smithii.
E. stellulata.
E. umbra.

E. acaciaeformis.
E. aggregata.
E. alba (2).
E. angophoroides (2).
E. angustissima.
E. Banksii.
E. Boormani (2).
E. Clelandi (4).
E. confluens.
E. cosmophylla (2).
E. Culleni.
E. Dalrympleana.
E. doratoxylon.
E. drepanophylla.
E. Dunnii (2).
E. Ewartiana.
E. Flocktoniae. (4).
E. goniantha (4).
E. hemiphloia (2).
E. Hillii (2).
E. Houseana (2).
E. hybrida.
E. incrassata.
E. Irbyi (2).
E. Macarthuri.
E. maculosa.
E. Maideni.
E. melanophloia (2).
E. melliodora (2 or 4).
E. microtheca.
E. Mooreana.
E. Naudiniana.
E. neglecta (2).
E. notabilis.
E. nova-anglica.
E. Oldfieldi (4).
E. oleosa.
E. ovata.
E. paniculata (2).
E. pellita (4).
E. Pilligaensis.
E. populifolia (2).
E. propinqua.
E. punctata (4).
E. rubida.
E. saligna.
E. salmonophloia (2).
E. Sheathiana (2).

E. Jutsoni.	*E. squamosa.*
E. Kirtoniana (4).	*E. Stricklandi* (2).
E. Kruseana.	*E. Stuartiana.*
E. Lane-Poolei.	*E. torquata* (4).
E. leucoxylon (2).	*E. viminalis.*
E. longifolia (4).	*E. Yarraensis* (2).
E. tetrodonta (or very much shorter).	

GROUP 4.—Operculum up to twice as long as the calyx-tube.

E. macrorrhyncha.	
E. adjuncta.	*E. Morrisii.*
E. amplifolia.	*E. pachyphylla.*
E. Bakeri.	*E. Parramattensis.*
E. Bancrofti (sometimes more than twice).	*E. pumila.*
E. Blakelyi (sometimes more than twice).	*E. pyriformis.*
E. dealbata.	*E. robusta.*
E. Drummondii.	*E. rostrata.*
E. erythronema.	*E. rudis.*
E. exserta.	*E. salubris.*
E. Gillii.	*E. siderophloia.*
E. Howittiana.	*E. Le Souefii.*
E. Kirtoniana.	*E. tereticornis* var. *latifolia.*
E. leptopoda.	*E. tereticornis* (also more than twice).
E. longifolia.	*E. Todtiana.*
E. macrocarpa.	*E. Websteriana.*
E. spathulata.	*E. Stowardi.*

GROUP 5.—Operculum more than twice as long as the calyx-tube.

E. annulata.	*E. macrandra.*
E. cornuta.	*E. platypus.*
E. eremophila.	
E. falcata.	*E. resinifera.*
E. Lehmanni.	*E. Seeana.*
E. longicornis.	*E. tereticornis* (also less than 2).
E. redunca varieties.	*E. transcontinentalis.*

Operculum conical and less in diameter than the winged and reddish calyx-tube. *E. tetraptera.*

RATHER SOLID OPERCULUM.

Certain Western Australian species, particularly *E. tetraptera,* and also *E. pyriformis* and *E. macrocarpa* (see a note in *Journ. Roy. Soc. N.S.W.,* li, 453), have rather solid opercula (the walls of the calyx-tube also). Drawings, which will be reproduced, are necessary to show them clearly, but it will be found these rather solid opercula form moulds, so to speak, of the upper portion of the style and also of the stigma, protecting them from harm in a most effective manner. The effect of this arrangement of very fleshy opercula and calyx-tube is to protect the floral organs. The species are dwarf mallees, growing on plains, which are sometimes devastated by fire.

A figure of the operculum of *E. pyriformis* var. *Kingsmilli* has been already given, see fig. 8*e,* Plate 171.

COLOUR OF OPERCULUM.

Botanists seem rarely to have touched upon this character. In *Bot. Mag.* t. 6140, Hook. f., shows *E. Lehmanni* with rich scarlet opercula. I do not doubt that they are coloured like the cultivated specimen, but I have not had the good fortune to see so richly coloured a specimen in nature.

"Their colour is generally white, varying sometimes to green, more rarely they are yellow, orange or purple." (Naudin, Mem. ii, 13.)

Here are a few notes on coloured opercula, which will doubtless be amplified in due course. They can, of course, only be observed in fresh specimens:—

Red, and especially prominent in contrast with the green calyx-tube	*E. erythrocorys.*
Bright rosy red in such specimens in which the filaments are white	*E. erythronema, E. tetraptera.*
Colour very marked yellow to orange and red	*E. Perriniana.*
Brown	*E. maculata, E. eximia.*
Pale coloured	*E. Sieberiana.*

(d) Outer and Inner Operculum.

Historical.—

1793.	Smith.
1814.	Brown.
1844.	Hooker.
1866.	Bentham.
1879–84.	Mueller (including hinged operculum, and homology with other genera).
1891.	Naudin.
1897.	Deane.

Smith, 1793. Smith, in his original description of *E. corymbosa* (1793) says "Lid somewhat membranous." (The operculum is rather thin in this species, but is not the delicate or outer operculum referred to under, *e.g., E. eximia.*)

Brown, 1814. *E. (Eudesmia) tetragona.* "Operculum depressed hemispherical, with a point, glandular, *whitish,* marked with four cruciform striae, slightly depressed opposite the teeth of the calyx, *as if composed of the four petals,* deciduous." (Robert Brown in Flinders' Voyage.) See also p. 463, and footnote.

Hooker, 1844. In the original description of *E. maculata,* Hooker observes:—

"The lid or operculum is double; the inner one is membraneous; the inner one has justly been considered by Mr. Brown as the corolla, and it here forms an exactly hemispherical glossy membranaceous cup, which often continues to adhere after the outer one has fallen away." (See Part XLIII, 84.)

(1) The ordinary single operculum, probably corolline. *Bentham,* 1866, says—

" . . . . the orifice (of the calyx-tube) closed by a hemispherical conical or elongated operculum covering the stamens in the bud and falling off entire when the stamens expand, this operculum usually simple (formed of the concrete petals?), thin or more frequently thick, fleshy or woody, the veins longitudinal, numerous and parallel or rarely anastomosing, the separation from the calyx-tube usually but not always marked in the bud by a distinct line . . . ." (*B. Fl.* iii, 185) " . . . . the operculum described is always the single one, probably representing the petals, as it appears when ready to fall off for the expansion of the stamens." (p. 187.)

(2) The two thin opercula, the outer calycine, and the inner corolline.

" . . . . there is also frequently in the very young bud a very thin membraneous external operculum more continuous with the calyx-tube and very rarely this external one persists nearly as long as the internal one and is as thick or nearly so." (*B. Fl.* iii, 185.)

"The outer one, of whose nature there is still much doubt, exists *probably in nearly all species at an early stage* (my italics), but it is usually thin and falls off too soon to be worth mentioning in descriptions. Where, as in *E. platyphylla,* it persists rather longer, it appears to do so in a very variable degree in the same species. It is only, as far as hitherto observed, in *E. variegata* and *E. eximia* that it is more constantly persistent till nearly the time of expansion of the flower, and equals or exceeds in thickness and consistency the inner one." (p. 187.)

(3) *E. maculata.*

"Operculum . . . . the outer one much thicker and more persistent than in most species where it has been observed, and usually umbonate or shortly acuminate, the inner one (corresponding to the single one of most species) thin, obtuse, smooth and shining." Bentham (*B. Fl.* iii, 258) under *E. maculata.* (See also fig. 4*a,* Plate 178.)

(4) *E. eximia.*

"Operculum broadly conical or shortly acuminate, always much shorter than the calyx-tube, and double, as in *E. maculata,* but the inner one not readily separable in the dried specimens till the flower is ready to open." (*B. Fl.* iii, 258, under *E. eximia.*)

(5) *E. Behriana.*

"Operculum short . . . . the outer membraneous one often still persistent in the advanced bud. (*B. Fl.* iii, 214.)

Mueller, 1879–1884, speaking of the genus says (Introduction to "Eucalyptographia," 1) "Petals none, unless represented in some few species by an *inner* separate or separable opercular membrane."

(2) " . . . . lid (operculum) not rarely provided with a minute early dropping accessory *outer* layer." (*ib.*)

(3) "*Lid thin, imperfectly double* almost hemispherical . . . . *inner lid tender membraneous.*" (*E. eximia* in "Eucalyptographia.") [Italics as in original.]

Further, Mueller says "The lid of *E. eximia* affords excellent material for tracing the metamorphosis of a calyx into a corolla, and gives in this genus additional evidence for estimating the nature of the opercular organ; it shows that the ordinary lid of Eucalyptus flowers must be regarded as calycine, though it may consist of two layers, the outer of which, when it occurs, being sometimes fugacious and occasionally minute. The homogeny of the opercular with the tubular portion of the calyx is clearly evidenced by the species of Eucalypts pertaining to the series of *E. corymbosa,* as pointed out previously in these pages; because both lid and tube are homogeneously confluent while in bud, and when their severance takes place by force of extrusion of the stamens, we find the transverse line of separation not one of clear dehiscence, but one of more or less irregular tearing; nor does this rupture lead always to a shedding of the lid, it being often retained during the whole time of flowering, and thrown simply back from the remaining place of alligation (attachment.) Nevertheless, the lid of Eucalyptus may in some instances be regarded as externally calycine and internally petaline (corolline;) this view obtains complete confirmation by the species now before us (*eximia*), and by a few other congeners.

When the lid of *E. eximia* has been well macerated, a tender petaloid (corolloid) inner membrane may readily be drawn off from the thinly cartilagineous calycine portion of the lid; this inner stratum, which in nature seems often to be set spontaneously free at last, as I found this to be the case with a few other congeners, produces from its centre a short descending tube, which encloses the summit of the style and the stigma before the flower expands.

Such tubule descending from the inner lid is not to be found on the operculum of the closely allied *E. maculata,* in which species the two opercular strata are also far less dissimilar than in *E. eximia,* thus more conformous to the occasional two of *E. rostrata* and the regular two of *E. peltata,* not to speak of some others; yet the inner may be regarded as petaline also in *E. peltata;* and we would perhaps be justified in assuming that the lid of Eucalyptus calyces is formed generally by the permanent confluence of an inner petaloid and outer calycoid layer.

Additional light is shed on the structure of the lid of Eucalypts and some other myrtaceous genera by *Pleurocalyptus,* in which the operculum is retained on one side after the irregular transverse bursting of the calyx, similarly to what occurs in *Eucalyptus corymbosa* and its allies; petals are, however, conspicuously developed. But in *Acicalyptus* and *Piliocalyx* the petals, although distinctly formed, are of irregular and diminutive size and even somewhat coherent or concrescent, whereby some transit to the petaloid inner lid of some Eucalypts is established, just as in a similar manner the petals of several species of *Eugenia* belonging to the section *Acmena* or *Syzygium,* become very much reduced in dimensions and also sometimes connate. It is different with *Angophora,* which genus finds habitual repetitions in some Eucalypts, for instance, *E. setosa* and *E. aspera;* here the calycine lobes assume the appearance of petals; but they are sessile with broad base, and only petaloid towards the margin, as to some extent in *Leptospermum, Eugenia* and many other Myrtaceous genera; while the five alternating points, continuous to the main ridges of the calyx-tube, are equivalent to the calyx-teeth developed in *E. tetraptera,* and still more distinctly in *E. odontocalyx* and *E. tetrodonta,* the lid of all being calycine also." ("Eucalyptographia" under *E. eximia.*)

(4) "In *E. Preissii, E. terminalis, E. Abergiana,* and a few other species, the calyx is rather irregularly ruptured than circumcised by a clearly defined sutural line; at best only the inner layer of the lid could be assumed to be corollaceous, but it is closely connate with the outer stratum as usual in the genus." (*ib.* under *E. tetrodonta.*)

(5) "A narrow and elongated outer quickly deciduous operculum covers not rarely the normal lid." (*ib.* under *E. rostrata.*)

Naudin, 1891. (1) "The operculum, which is not, in my opinion, any different to the corolla of which the pieces are fused congenitally, often furnishing good specific characters by their shape and relative size." (Mem. ii, 13) (translation.)

(2) "There are in reality two superposed opercula, the exterior, attributed to the transformation of the calyx, is reduced to a scarious skin, very fugacious, which caps the corolline operculum. One only sees it in very young buds, for it falls early. It seldom develops as much as the interior operculum, which then appears to be double." (*ib.*)

Deane, 1897. "The flowers themselves have lost the power of producing petals, except as such may be represented in the deciduous operculum, and this gives a still stronger hint of the whole plant having become modified in the course of long ages to resist drought, whereas its closest congeners, *Tristania* and *Angophora,* which have petals, are confined respectively entirely to the coast districts or to damper situations on the eastern side of Australia, not having been able to penetrate very far into the droughty interior." (H. Deane, *Proc. Linn. Soc. N.S.W.,* xxii, 471, 1897.)

The operculum therefore often (perhaps always) consists of two layers or sub-opercula, the outer operculum of calycine origin, and the inner operculum corolline.

One of the opercula is scarious or membraneous; this varies with different species; as a rule it is the outer one which is thin, and, generally speaking, it is deciduous at an early stage, and hence it is not often observed.

Following are examples of the

(*a*) Thin outer operculum—*E. microtheca, E. microcorys, E. rostrata, E. brachyandra.* "Species generally," (Bentham, Mueller, Naudin).
(*b*) Thin inner operculum—*E. maculata, E. eximia, E. peltata, E. Watsoniana, E. terminalis, E. Abergiana, E. Preissii.* "Species few," (Mueller).

The scales of *E. brachyandra* shown at 6*e* (two figs.) Plate 127, cover the operculum. In some cases they are uniform in size and show a keel or external rib. They are, however, usually irregular in shape, and are doubtless the five portions of an outer or double operculum covering a single bud, and have become torn by the growth of the bud (See Part XXX, p. 223). Since the above was written, it has been ascertained that the scales form an entire outer operculum in younger buds. It may be desirable to study this, as an illustrative example of the organ. This outer operculum is remarkably membraneous, and particularly at the top and also at almost regular intervals around it, it sometimes shows a microscopic ribbing or thickening in places, sometimes more evident in the process of drying. With the expansion of the bud, the operculum being thinner (more membraneous) at the top, splits downwards between the thickenings (ribs or nerves ?) into almost equal lanceolate parts, which sometimes show a nerve-like vein in the middle. The splitting up of the operculum does not appear to affect the growth of each part, as it continues to grow for some time afterwards. The attachment at the base is sufficiently strong enough to allow for this until the whole operculum is pushed off by the further development of the bud.

In *E. microtheca* the outer operculum seems to split up in an opposite manner, that is, from the base upwards, which indicates that the dome or top of the operculum is the strongest part (least membraneous).

E. eximia. When the petaline or corolline operculum is seemingly not present (as in the case of *E. eximia,* for example), it would appear that it is completely fused into the calycine operculum. The only alternative is that some species are acorolline. This would not be without analogy, for we have in other genera a similar occurrence, just as we have in Eucalyptus a variation in such characters as stamens arranged in bundles and also in an unbroken or staminal ring, or again in the differences as to shape, texture, &c., in the calyx, and still further in the morphology of the anthers.

I believe that the double operculum (*i.e.,* two opercula) will be found in all species, but it is very early deciduous in most. I have found the scar in very many.

In the Corymbosae in particular, we have already seen that the two opercula cohere (or adhere, being of different origin.) A number of cases of double opercula have been enumerated; following are a few additional notes:—

E. bicolor.—"Outer lid not always independently developed or very fugacious or consolidated with the inner one." ("Eucalyptographia," under *E. largiflorens.*)

E. microcorys.—In this species, even when quite young, one can see a second operculum on every bud of an umbel—on the very top of the bud, *i.e.,* pushed on the top by the force of expansion.

E. rostrata.—"Did you notice that on the top of the operculum of *E. rostrata* there is a small membraneous red cap, as it were a second operculum?" (Rev. Father J. W. Dwyer, Temora, N.S.W.)

E. Shirleyi has a double operculum.

E. tetraptera.—The pagoda-like (owing to shrivelling) outer operculum will be figured in due course.

The Hinged Operculum.

As a general rule, the operculum becomes severed from the calyx-tube at the time of the ripening of the stamens by a "clean" severance. But in some cases there is more or less irregular tear, that is to say, the inner operculum remains attached to a portion of the calyx-tube by means of what may be termed a hinge, the inner thin membraneous operculum (there are usually in species which tear two opercula) becoming thus irregularly severed. Sometimes the severance is so irregular that jagged is a descriptive word. (See *E. pyriformis,* fig. 3*a,* Plate 75.) The outer operculum may not form part of this hinge. Shortly after the emergence of the stamens the operculum (or opercula) ceases to grow, while the calyx-tube continues to develop, as will be shown in figures to be produced later.

1841. Lindley (1841) was apparently the first to notice the laceration of the inner operculum, where it is attached to the calyx-tube, as, in his description of the operculum of *E. calophylla,* he speaks of it being fixed to the calyx-tube by a hinge.

" . . . . the cup is obconical, 6 lines long, and as much across the mouth; the lid, however, is only half that diameter, and hangs to the edge of the cup on one side, by a narrow neck, so that it cannot fall off; this arises from the cup continuing to enlarge after the separation of the lid" (this work, Part XLIII, p. 73).

For a figure of the lid (operculum) which has ceased to grow, and which is adherent to the calyx-tube by a sort of hinge, see fig. 3*a,* Plate 75, and also the description at Part XVII, p. 229.

1843. Schauer (1843), speaking of *E. eximia,* says (*Walp. Rep.* ii, 925)—

"Operculo coriaceo convexo umbonato, post anthesin aliquamdiu' cupulae cardine quasi adligato cum cupula obconica rugoso-angulata (et reliquis partibus? . . . .)", which may be translated— ". . . . the coriaceous convex, umbonate operculum some time after the flowering (of the calyx-tube) having the hinge almost bound with the obconical rugose-angular calyx-tube (also the remaining parts?) . . . ."

1844. See also *E. maculata* (Hooker, 1844).

1879–84. Mueller's "Eucalyptographia" (1). See also *E. eximia* quoted at p. 490, and *E. Preissii, E. terminalis, E. Abergiana,* quoted at p. 9, Part XLI.

(2) Operculum "tearing off along a rather irregular transverse line" (under *E. corymbosa*).

Other species in which I have seen the hinged operculum are *E. Abergiana, E. ficifolia, E. Foelscheana, E. hoematoxylon* and *E. trachyphloia.* (All these belong to the Corymbosae. It appears, indeed, to be more or less characteristic of that group).

Drawings of the hinged operculum in *E. ficifolia* and *E. hoematoxylon* will be shown later.

In addition, I have seen it in *E. cosmophylla* (fig. 8*b,* Plate 91), *E. grandifolia* (fig. 2*b,* Plate 153).

To recapitulate, we have—

E. Abergiana.	*E. hoematoxylon.*
E. cosmophylla.	*E. Preissii.*
E. ficifolia.	*E. pyriformis,* fig. 3*a,* Plate 75.
E. Foelscheana.	*E. trachyphloia,*
E. grandifolia.	

and I am confident that special search will add to this list.

Commisural Line (or Egg in Egg-cup Appearance).

Above, p. 464, Robert Brown (1814) had referred to the commisural line as ". . . . . the cicatrix caused by the separation of the outer operculum is particularly obvious . . . ."

Under *E. rudis* in "Eucalyptographia," Mueller uses the term "*Commisural line* between the lid and tube of the calyx rather prominent," &c. I have explained the matter under *E. rudis,* Part XXXIII, p. 75.

This Commisural line, which results in an "egg in egg-cup" appearance, as I have often called it, is the sign of a double operculum. It can be observed in most species, and will probably be found in all, and therefore be found to be generic. It can be distinctly seen in figures of the buds of the following species in the present work:—

	Fig.	Plate.
E. amplifolia	2*c*	131
E. angustissima	7*a*	84
E. Bancrofti	6*c*	129
	3*b* and 3*a*	130
E. Caleyi	13*c*	56
E. intertexta	6*c*	151
E. oleosa	4*a*	66
E. platypus var. *nutans*	1*d*	146
E. punctata	2*a*	122
E. resinifera	3 and 6	124
E. canaliculata	9*b*	122
E. cneorifolia	15*a*	60
E. falcata	3*a*	68
E. Forrestiana	1*a*	95
E. siderophloia	33*b*	47
E. sideroxylon	10	55
E. spathulata	7*b*	146
E. Stricklandi	1*b*	71
E. tetragona	4*a* and 6*b*	188

Explanation of Plates (236–239.)

Plate 236.

Plate 236: EUCALYPTUS COLLINA, W. V. Fitzgerald (1, 2). E. FLOCKTONIÆ, Maiden (3). [See also Plate 69, Part xvi.] Lithograph by Margaret Flockton.

E. collina W. V. Fitzgerald.

1*a.* Juvenile leaves (two pairs). 1*b.* Mature leaf. 1*c.* Buds. 1*d.* Fruit with short pedicel. Summit of Bold Bluff, Kimberleys, Western Australia (W. V. Fitzgerald, No. 844). The type.
2*a.* Two mature leaves. Note the parallel insect markings, which are similar to those in *E. latifolia,* see Part XLI, p. 1. 2*c.* Immature fruits. 2*d.* Fruit, with a longer pedicel than 1*d.* Packhorse Range, Kimberleys, Western Australia (W. V. Fitzgerald, No. 1012).

E. Flocktoniae Maiden.
(See also figs. 1–4, Plate 69.)

3*a,* 3*b,* 3*c.* Three pairs of juvenile leaves showing their decurrence and also quadrangular rachis. 3*d.* Buds and partly expanded flowers, and quadrangular rachis (axis.) Yeelanna, Eyre's Peninsula, South Australia (W. J. Spafford, November, 1919).

Plate 237.

Plate 237: EUCALYPTUS SHIRLEYI, n.sp. Lithograph by Margaret Flockton.

E. Shirleyi n.sp.

1*a.* Juvenile leaves, rachis quadrangular. 1*b.* Leaves the most mature seen, with buds. 1*c.* Individual bud, showing ribs on calyx-tube and persistent double operculum. 1*d.* Young fruits. 1*e.* Ripe fruits, showing ribs and rim. Stannary Hills, North Queensland (Dr. T. L. Bancroft, December, 1908). The type.
2*a.* Juvenile leaves, showing marked quadrangular rachis. 2*b.* Transverse section of the stem or rachis. Mount Albion, Northern Queensland (Samucl Dixon).

Plate 238.

Plate 238: EUCALYPTUS RUMMERYI, n.sp. (1). E. HERBERTIANA, n.sp. (2). Lithograph by Margaret Flockton.

E. Rummeryi n.sp.

1*a,* 1*b.* Juvenile leaves. 1*c.* Twig showing mature leaves, buds and flowers. 1*d.* Three views of the anther. 1*e.* Immature fruits. 1*f.* Mature fruits, showing tips of capsules slightly exsert. Vicinity of Busby's Flat and Mallanganee, Casino district, Richmond River, N.S.W. (District Forester George Edward Rummery, October, 1921). The type.

E. Herbertiana n.sp.

2*a.* Mature leaves. 2*b.* Buds. 2*c.* Back and front views of anther. 2*d.* Fruits. Rocky places, Mitchell River, 20 miles south of Admiralty Gulf, Kimberleys, Western Australia (C. A. Gardner, No. 1471). The type.

Plate 239.

Plate 239: EUCALYPTUS COMITÆ-VALLIS, n.sp. (1). E. LONGIFOLIA, Link and Otto, new var. multiflora (2, 3). [See also Plate 86, Part XX.] Lithograph by Margaret Flockton.

E. Comitae-Vallis n.sp.

1*a.* Twig with mature leaves, buds and flowers. 1*b.* Front and back views of anther. 1*c.* Fruits. Comet Vale, 65 miles north of Kalgoorlie, Western Australia (J. T. Jutson, No. 239). The type.

E. longifolia Link and Otto. *multiflora* n.var.

2*a.* Pair of juvenile leaves. 2*b.* Intermediate leaf. 2*c.* Mature leaf. Erina Creek, Gosford, N.S.W. (Andrew Murphy and J. L. Boorman, October, 1903). The type.
3*a.* Mature leaf. 3*b.* Fruits. State Forest, No. 423, four miles from Nowra N.S.W. (Forest Guard Alexander Joseph Gallagher, June, 1919).

Part 59

LIV. E. pruinosa Schauer.

SEE Part XII, p. 74, of the present work. A description has not yet been given of the present species. That by Bentham is as follows:—

A tree with a persistent whitish-grey rough and fissured bark (F. Mueller), the foliage often glaucous or mealy-white. Leaves sessile, opposite or nearly so, very rigid, orbicular-cordate, ovate or oblong, obtuse or rarely almost acute, mostly 2 to 4 inches long. Umbels 3- to 6-flowered, on short peduncles in a terminal corymb or rarely in the upper axils. Pedicels terete, nearly or quite as long as the calyx-tube. Calyx-tube 2 to 3 lines diameter, not angled, more or less tapering into the pedicel. Operculum hemispherical or shortly conical, more or less acuminate, rarely as long as the calyx. Stamens 2 to nearly 3 lines long, inflected in the bud; anthers very small and globular, with distinct parallel cells, opening in very short slits or circular pores. Ovary slightly convex in the centre. Fruit from ovoid-truncate to almost cylindrical, 3 to 5 lines diameter, scarcely or not at all contracted at the orifice, the rim narrow, the capsule slightly sunk, the valves sometimes protruding. (B.Fl. iii, 213.)

Range.

It is confined to the tropics, and extends from Northern Queensland to the Northern Territory and north Western Australia. Following are some localities additional to those quoted in Part XII, p. 74. See *E. Shirleyi,* Part LVIII, p. 425, for some localities recorded under *E. pruinosa,* and since shown to belong to *E. Shirleyi.*

Queensland.—" Grows more on flats with soils rich in lime, especially in the Etheridge" (Dr. H. I. Jensen); near Normanton cemetery *E. pruinosa* is growing with *E. tetrodonta* on a soil rather more siliceous than that usually selected by Box trees (R. H. Cambage).

Northern Territory.—Lat. 18° 27', long. 132°. 6th July, 1911. Tree, 4 ft. 6 in. in diameter. Leaves and fruits (G. F. Hill, No. 446): also 20 miles south-west of Borroloola, 7th September, 1911. Leaves, buds and flowers (No. 566). The type came from the Gulf of Carpentaria (Ferdinand Bauer), probably from the same class of country as No. 566 (G. F. Hill); "Apple-Gum," Roper River Flats and Red Lily Lagoon; also between Bull Oak and Crescent Lagoons and on to Strangway's Crossing and Mole's Hill (Professor Baldwin Spencer, Expedition from Darwin to the Roper River, 1911). It will be seen (Part XII, p. 74) that "Apple Gum" is a name also borne in the Kimberleys, north West Australia. I have not seen the tree and do not know to what extent there are differences in the bark between the trees called "Gum" and "Box" respectively. Dr. H. I. Jensen calls it the "Silver-leaved Box" and mentions that it is calciphile. It occurs in heavy soil and its geological formation is basalt limestone alluvial. It is associated with Gidgea (*Acacia Cambagei* and *Georginoe* presumably) on Barkly Tableland. "Twin-leaf or Hollow Box, characteristic of Tablelands, mixed with limestone and basalt soils." Armstrong River, Victoria River district (collected by R. J. Winters for G. F. Hill, No. 458).

Western Australia.—Nine-Mile Ridge, near Wyndham (W. V. Fitzgerald). To a height of 40 feet; stem diameter about 1 foot; bark persistent, grey, fibrous, thin; wood reddish, tough; stamens white and valves of fruits much exserted. On quartzite. Mr. Fitzgerald further says it extends from the sources of Sturt's Creek to the Ord River.

Affinities.

1. With *E. Shirleyi* Maiden.

Dealt with at Part LVIII, p. 426.

2. With *E. melanophloia* F.v.M.

Dealt with at p. 499. "There is no doubt, as Mueller points out ('Eucalyptographia'), that Leichhardt records the Silver-leaved Ironbark (*E. melanophloia*) on many occasions instead of the Silver-leaved Box (*E. pruinosa*)." (R. H. Cambage in *Journ. Roy. Soc. N.S.W.,* xlix, 424, 1915.)

LIII. E. melanophloia F.v.M.

In *Journ. Linn. Soc.,* iii, 93 (1859).

FOLLOWING is a translation of the original description:—

Tree-like, branchlets tetragonal at the apex; leaves glaucous, seldom green, almost always hoary, opposite, sessile, embracing at the base, cordate-ovate, finely penniveined and reticulate-veined, scarcely pellucidly dotted, marginal vein obsolete; umbels paniculate or axillary, solitary, 3–6 flowered, calyx-tube two or three times shorter than the angular peduncle, exceeding the length of the pedicel by a little, or many times a little longer than the broadly conical, acute operculum; fruits semi-ovate or subpyriform, 2–4 ribbed, orifice slightly contracted, 4–5 celled, valves inserted below the margin, somewhat included, slightly convex; seeds wingless.

Habitat.—From the mountainous region, Newcastle Range to Moreton Bay, plentifully associated with *E. crebra,* characteristic of a rather barren soil (N. Holl. Sub-Trop. Mitchell; Moreton Bay, Moore; Sydney Woods, Paris Exhib. No. 66, in hb. Hook.). Flowers in spring.

A small tree with an irregular trunk, bark persistent, thick, deeply furrowed, wrinkled, blackish. Leaves 1 1/2–3 inches long, 1–2 inches broad, obtuse or cuspidate-acuminate, sometimes cordate-lanceolate or entirely cordate. Peduncles an inch long. Buds about 4 lines long. Capsules shortly or very shortly pedicellate, 2 1/2–4 lines long, convex at the vertex, seldom 6-celled. Fertile seeds angular-ovate, brown-blackish, smooth, 1 line shorter.

A small tree called "Silver-leaved Ironbark" by the settlers, to be easily recognised by its own peculiar habit, but difficult to describe botanically owing to the variations of its floral characteristics and its fruit. The luckless Leichhardt in his work ("Overland Expedition," &c.), understood by this above-mentioned name yet another species beyond the normal, very like this one, but differing in its dirty white bark, very frequent round about the Gulf of Carpentaria and in north-west Australia.

Affinity with *E. pruinosa* Schauer (non Turez.).

No description appeared when this species was formerly dealt with in Part XII, p. 71, with Plates 53 and 54, so that Bentham's description will be useful:—

A small tree with a blackish persistent deeply-furrowed bark (F. Mueller), the foliage more or less glaucous or mealy-white. Leaves sessile, opposite, from cordate-ovate or orbicular to ovate-lanceolate, obtuse or acute. Peduncles short, terete or nearly so, 3- to 6-flowered, axillary or several in a short terminal corymb. Buds tapering into a pedicel shorter than the calyx-tube or almost sessile. Calyx-tube slightly angular, about 2 lines long or rather more, and as much in diameter. Operculum obtusely conical, shorter than the calyx-tube. Stamens 2 to 3 lines long, inflected in the bud; anthers very small and globular, but the cells parallel and distinct. Fruit pear-shaped or globular-truncate, 2 to nearly 3 lines diameter, more or less contracted at the orifice, the rim thin, the capsule nearly on a level with it, and the valves slightly protruding, or more sunk with the valves included. (B.Fl. iii, 220.)

Leaf variation in this species has been dealt with at some length in Part XII, p. 71.

Range.

Dealt with at Part XII, p. 72. The following localities are additional:—

New South Wales.—"Silver-leaved Ironbark." Arrara, Paroo district (J. L. Boorman); "Fairly large trees, with bark cork-like or fibrous of a blackish cast. Has silvery leaves, hence one of its names. Timber often faulty. Grows in masses at the foot-hills of the western slopes." Narromine (J. L. Boorman); "Three feet in diameter and over ninety feet high," 40 and 50 miles north-west of Collarendebri (Sid. W. Jackson); "Silver-leaved Ironbark," Wee Waa (J. W. Taylor); "Silver-leaf Ironbark," 2nd bore, Yarrie Lake Road, Pilliga Scrub, about 14 miles W.S.W. of Narrabri (Dr. H. I. Jensen, No. 16); About 10 miles north from Baradine, Pilliga Road (Dr. H. I. Jensen, No. 73); Fine belt 17–14 miles from Narrabri, Gunnedah Road. Occurs on sand-ironstone, basalt, &c., red loams, always on good wheat soils. Accompanies Pine (*Callitris*) and Box (*E. albens*). (Dr. H. I. Jensen, No. 158); 4 feet girth, 40 feet high. Manilla, Parish Namoi, County Darling (Forest Guard M. H. Simon, No. 121); Glaucous foliage, short, dark bole, 3–4 feet in girth, height 45 feet. Hollow, eaten by white ants, containing 5–14 posts. Gregarious, but scattered in grassy country. Warialda, and between the Gwydir and McIntyre Rivers generally (District Forester E. H. F. Swain, No. 7); also, Warialda (W. A. W. de Beuzeville), with lanceolate leaves (see Part XII, p. 71). This particular specimen is referred to at length by me in *Journ. Roy. Soc. N.S.W.*, xlvii, 223 (1913), and also liii, 71 (1919).

Queensland.—Inglewood, South-Western Line, near New South Wales border (J. L. Boorman); Toowoomba, Western Line, 101 miles from Brisbane (H. A. Longman); Roma, 318 miles, and Mitchell, 372 miles (Rev. J. H. Simmonds); Charleville, 483 miles (E. B. Atkins); Broad or Silver-leaved Ironbark, Esk (L. Lewis); "Silver-leaved Ironbark," Kilcoy (J. C. McMinn); Gayndah (C. T. White); Eidsvold (Dr. T. L. Bancroft); "The local Ironbark. Does not attain a large size, nor is it too sound. It is, however, recognised as a useful timber in constructive work when it is sound." Emerald, Central Railway Line, 166 miles from Rockhampton (J.

L. Boorman); Sapphire or Anakie, 193 miles west of Rockhampton, just south of Clermont (A. Morrison); Bogantungan, at 1,100 feet, 220 miles (R. H. Cambage, No. 3974); "Ironbark," Gadwall, Alpha, 273 miles (G. T. Wood); Broad-leaved Ironbark, Reid River, *via* Townsville (Nicholas Daley); "Broad-leaved Ironbark," The Plains, Prairie, North Queensland (J. R. Chisholm); Gilbert River (C. T. White); "Tree of 30–40 feet, Silver-leaved Box." Croydon, North Queensland (R. H. Cambage, No. 4006, also James Gill).

Dr. H. I. Jensen (in a letter) says that—

"*E. melanophloia* is very widespread on dry stony ridges, both volcanic and slate, with good but shallow soil throughout North Queensland. I call it 'Silver-leaf Ironbark,' and state that it is calciphile, but does not grow on limestone. The soil texture is heavy—fair capillarity, stone subsoil on volcanic rocks, Springsure district (occurs on basalt, porphyry and rhyolite in Springsure district); on volcanic rocks, Stanthorpe (the rocks on which it occurs here are tuffs, porphyries, &c.); on basalt in the Carnarvon Range; on calcareous sandstone, but only on high, well-drained, ground with rock near surface in the Roma, Mitchell and Maranoa district generally, also in Central West Emerald, Bogantungan, Drummond Range, on calcareous sandstones, on high dry ground. Hybridisation with *E. populifolia* appears to take place—noted at Roma, Box Vale and Glenhaughton. Hybridised with *E. decorticans* at Glenhaughton. [I have not seen specimens of these reputed hybrids.—J.H.M.] On alluvial only in mountain gullies like Clematis Creek, where the run-off is quick; on dacites, Mt. Coolon occurs a stunted, fluffy barked, blue-leaved Silver-leaf—to my mind like *E. pruinosa,* but Mr. C. T. White says it is *E. melanophloia.* This variety grows on dacites and rhyolites, Mt. Coolon, Kangaroo Hills, Featherbed Range. Coolon, a stunted tree, sessile leaves, large fruits—growing on dacite, porphyry and rhyolite. It resembles *E. pruinosa."*

Dr. Jensen adds that this timber is invariably on a lime-rich formation, with good subdrainage, associated with *E. populifolia, E. maculata* and *Acacia excelsa.*

Western Australia.—"On gravelly plains between the Isdell River and Scented Knob occurs, of a few square miles in extent, an open forest of Ironbark" (referred to as *E. crebra*). (Fitzgerald, Kimberley Report, p. 12.)

Affinities.

1. With *E. pruinosa* Schauer.

Dealt with at Part XII, p. 73. Mr. Cambage's Croydon specimen is large-leaved, and also bearing in mind that it is known as a Box (I have often pointed out that Ironbarks lose much of their Ironbark character in the tropics), I looked upon it as *E.*

pruinosa Schauer. It is, I am satisfied, *E. melanophloia*—a sessile, large-fruited form, with coarse leaves. It is figured at figs. 2a–d, Plate 240, and these figures should be compared with those of normal *E. melanophloia* at Plate 54, Part XII. These specimens show that the leaves of *E. melanophloia* may, exceptionally, be as large as those of *E. pruinosa,* but the fruits of the two species are very different.

2. With *E. Jenseni* Maiden.

For this species see Part LVI, p. 255, and Plate 228. *E. Jenseni* is also an Ironbark, and is analogous to the lanceolate-leaved form of *E. melanophloia* (see Part XII, p. 71, and Plates 53 and 54). This lanceolate-leaved form is a more advanced or "further grown up" stage of what we know as the normal, or broad-leaved form. We are, indeed, always on the lookout for a narrower leaf in a species which we only know with broad leaves. Speaking generally, we look upon the broad leaf as a sign of youth, and the narrow one (usually lanceolate) as a sign of maturity. Comparing, therefore, the two species, we find they differ in the very broad and stem-clasping juvenile leaves of *E. melanophloia* (it may be that eventually we may find juvenile leaves of *E. Jenseni* which more closely approach them), the more hemispherical fruits, sunk valves, and pedicels of *E. melanophloia.*

CXXXIX. E. Gunnii Hook. f.

Synonym.

E. Whittingehamensis Hort., in "Kew Handbook of Trees and Shrubs," p. 395 (1902), under the reference *E. urnigera* Hook. f., *Gard. Chron.* 1888, iii, 460, f. 64.

The name is spelt erroneously in horticultural literature as Whittinghame and Whittingham. The tree which bears the above name is growing at *Whittingehame,* near Prestonkirk, Scotland, the ancestral home of the Right Honourable the Earl of Balfour, K.G., and his sister (the Lady Alice Balfour) has not only provided me with a suite of specimens, but has also informed me that the tree arose from seed collected by the late Marquis of Salisbury, K.G., when he visited Tasmania. That year was 1852. Later on it will be seen that the date of the tree was given as 1845, but that must have been from memory.

It was figured in *Gardeners' Chronicle,* at pp. 460, fig. 64, 461, fig. 65, 14th April, 1888, as *E. urnigera* Hook. f. A twig was shown without juvenile leaves and the fruit not quite ripe, also an excellent wood-cut showing the tree itself. The Journal says: "We suspect the tree now figured is the one alluded to by Rev. D. Landsborough in the *Trans. Bot. Edin.* 1887, p. 21, under the name of *E. Gunnii."* This evoked a reply from Dr. Landsborough in the issue of 12th May, 1888, p. 595, part of which was as follows:—

"You were right in supposing that it was to it that I alluded in my paper to the Edinburgh Botanical Society which appeared in the *Transactions,* and also in the *Gardeners' Chronicle* (27th November and 4th December, 1886). In it I mentioned that 'it was planted (? sown) at Whittinghame in 1845, was cut down to the ground by frost in 1860, and is now more than 60 feet in height.' "

It produces fertile seed, which is a remarkable thing for a Eucalyptus tree to do in Scotland. He then proceeds to say that botanists gave it no less than four different names:—

1. *E. viminalis.*
2. *E. Gunnii.*
3. *E. urnigera* (already referred to).
4. *E. cordata,* "of which *E. urnigera* is a variety. Both *E. cordata* and *E. cordata* var. *urnigera* grow in Arran." (Dr. Landsborough.)

E. cordata is a species quite distinct from *E. urnigera,* but all four species are recorded here for convenience. It is not *E. viminalis,* as the juvenile leaves and fruits are very different, neither is it *E. cordata* (see Part XIX of the present work). There remain *E. Gunnii* and *E. urnigera.* For *E. Gunnii* see Plates 108 and 109, Part XXVI, and for *E. urnigera* see Plate 80, Part XVIII, of the present work.

I have no doubt that the determination originally cited by Dr. Landsborough (probably made by Kew) is the correct one. The chief difficulty concerning this Scotch introduced tree as between *E. Gunnii* and *E. urnigera* lies in the fact that, although it produces fertile seed, the shape of the fruit is always a little pinched or slender as compared with that of the typical Tasmanian tree. Or, on the other hand, the urceolate shape of the fruit (fig. 14d, Plate 80) is never present in the Whittingehame tree. Fig. 16, it may be pointed out, is much less urceolate, but this is quite exceptional. The fruit of *E. urnigera* is also much larger than that of *E. Gunnii* or of the Whittingehame tree.

The correspondence in the *Gardeners' Chronicle* already referred to was continued in the issue of 19th May, 1888, p. 628, by Mr. John Garrett, the gardener at Whittingehame. He gives the then height as 63 feet, with girth of trunk 10 feet. In 1860 it was sawn over at a height of 9 feet and was believed to be dead for over a year, and in starting to root it out a young shoot (the present tree) was observed. He goes on to say:—

"Whatever may be the true name of the tree, I think Dr. Landsborough right in saying it is not *urnigera*—at least a young plant of that variety (species) we have here bears no resemblance to a plant of the same age, raised from our own tree, the leaves of the former being quite green, and of the latter glaucous, as well as being both shorter and rounder."

There is a further note in the *Gardeners' Chronicle* of 14th January, 1899, p. 19.

In Part XVIII, p. 262, I provisionally adopted the very pardonable error of the *Gardeners' Chronicle* that the Whittingehame tree is *E. urnigera,* but I had very poor material at the time.

Dr. A. W. Hill, F.R.S., Director of Kew, gives me the further references of—

(a) Landsborough, in *Trans. Bol. Soc. Edin.,* xx, 516 (1896), and
(b) Elwes and Henry, "Trees of Great Britain," vol. vi., p. 1642, with Plates 363 and 365.

The slight difference from the type (in my view readily explained by the change in environment) has been got over by some observers by suggesting that the Whittingehame tree is a hybrid. In a recent letter to Kew, Lady Alice Balfour, who is well acquainted with the history and botanical opinions concerning this interesting tree, makes the shrewd observation that, "It seems most unlikely that Lord Salisbury should have happened to have hit on the seed of a natural hybrid." I think that is the correct view to take. The Whittingehame tree is especially resistant to cold.

Affinity.

1. With *E. urnigera* Hook. f.

The relations of *E. Gunnii* and *E. urnigera* are obscure to the extent that *E. urnigera* is a "strong," *i.e.,* somewhat botanically isolated species. Compare Plate 80 (*urnigera*) with 108 and 109 (*Gunnii*). The juvenile leaves of *E. Gunnii* are comparatively small, more glaucous, with the rachis more glandular; the mature leaves are more glaucous and much shorter; the buds have the calyx-tubes less markedly urceolate and the opercula less pileiform; the fruits are with much shorter peduncles, are smaller, hemispherical to cylindroid rather than urceolate, the rim not prominent and recurved as in *E. urnigera.* The two species are White Gums. *E. Gunnii* is the larger tree, more glaucous, and, in tree form, ascends to higher elevations, and therefore is more accustomed to severe cold than *E. urnigera.*

CCXI. E. longicornis F.v.M.

"RED MORREL."

FOR an account of this species see Part XXXIX, p. 272, with illustrations as there cited. It will be observed that in the figures of *E. longicornis* in Part XV, Plate 66, not a single juvenile leaf was depicted. (In Plate 67 the "Poot" was attributed to *E. longicornis,* and juvenile leaves shown, stated to have been obtained from a "Poot" tree, but those juvenile leaves should be held in abeyance.)

Following are descriptions of juvenile and intermediate leaves which will be found figured on Plate 241 in the present Part.

(1) **Juvenile leaves.**—Stems distinctly quadrangular (lowest ones available), opposite. Leaves oblong, almost sessile, crowded and decussate, terminating in a small curved point, glaucous, copiously dotted with oil-cells, 2–4 cm. long, 5–15 mm. broad, the midrib and lateral veins more or less indistinct. (Wagin, C. H. Gardner, No. 1234).

(2) **Intermediate leaves.**—Stems angular; leaves alternate, glaucous, almost sessile to distinctly petiolate, oblong to lanceolate, thickish, 3–6 cm. long, 10–15 mm. broad. (Westonia, Forester J. M. Cusack).

Range.

For particulars of this Western Australian species see Part XXXIX, p. 272 In sending me specimens from Westonia (Eastern Goldfields), Mr. C. A. Gardner, in reply to my question as to the range of this species, says, "It has not been continuously traced to the Eastern Goldfields." But see what Mr. Lane-Poole says below. Both statements are probably correct; but authentic observations, or herbarium specimens, absolutely proving that the species is approximately continuous from the Goldfields to the Great Southern Railway, are desirable.

I have two photographs of the tree, both taken by Mr. C. E. Lane-Poole, late Conservator of Forests, Western Australia.

9*b.* "Head of the Kurrawang Line, 82 miles from Kurrawang. Girth, 6 ft. 11 inches. It will be seen that this tree attains a very large size."

4*b.* "Westonia State Forest. This tree grows in the western portion of the Goldfields and spreads away down to the south along the Great Southern Line. It is a magnificent tree, and, unlike some other trees, it carries its (rough) bark right up to the base of the crown. The wood can be used for all manner of purposes, such as spokes and felloes, waggon scantling, handles and general wheelwright and coach-building work. Unfortunately, the bulk of it is going into the mines for fuel, and only a very small proportion is sawn up into boards at the Kurrawang Mill, the Golden Horseshoe Mill, and other similar small mills in Kalgoorlie."

Affinities.

(See Part XXXIX, pp. 274 and 280, eliminating the reputed juvenile leaves of Poot.)

1. With *E. melanoxylon* Maiden, the "Black Morrel," see Part LVII and Plate 234.

Both these species are known in Western Australia as Morrel (I do not know its precise application in describing a tree); *E. melanoxylon* has a deep brown (nearly black) timber, while that of *E. longicornis* is reddish, hence "Red Morrel." The juvenile leaves of *E. melanoxylon* are large and broad, the peduncles are comparatively long and broad, the opercula are much shorter, and the fruits hemispherical rather than globular.

2. With *E. leptophylla* F.v.M.

For this species, see Part LVI, with Plate 229. The juvenile leaves of the two species are somewhat similar in shape, but those of *E. leptophylla* are not always glaucous; they are thinner and more lanceolate than those of *E. longicornis,* while those of *E. leptophylla* are not perfectly sessile. The opercula of *E. longicornis* are longer, the fruits more pilular and with exserted valves. *E. longicornis* is a fairly large tree, while *E. leptophylla* is only a shrub.

CLII. E. propinqua Deane and Maiden, var. major n. var.

SEE *E. propinqua* in Part XXIX, p. 191, Plate 121, also my "Forest Flora of New South Wales," Part LXI, Plate 228.

From Mr. C. T. White (Government Botanist of Queensland) I have received specimens which are decidedly coarser than those of the type, *i.e.,* in the leaves, buds, and fruits, and think it necessary to indicate this by a name, viz., variety *major.* The affinities of *E. propinqua* and *E. punctata* are indicated at Part XXIX, p. 192, and it approaches *E. punctata* in its large size, but the organs are those of *E. propinqua.*

Range.

(Of the Variety.)

Queensland.—Kandanga, 70 miles north of Brisbane, 14 miles south of Gympie, on Mary Valley Line (E. H. F. Swain, Nos. 144, 170, through C. T. White); "Leaves and buds larger than usual," Norman Creek, near Brisbane (C. T. White) (I constitute it the type); Crow's Nest, Darling Downs (C. T. White).

(Of the Normal Species.)

Queensland.—Imbil (Weatherhead, through C. T. White); Enoggera (Dr. J. Shirley); Warwick district (W. E. Moore, through C. T. White); Goodna (C. T. White).

New South Wales.—Plenty of it near Apiary, began to flower 20th January, 1919, Wauchope, Hastings River (W. D. Goodacre, Government Apiarist); Craven State Forest, near Gloucester (W. A. W. de Beuzeville).

Tall, straight trees, 50 to over 100 feet high, with a clean, smooth barrel, sometimes 80 feet to the first branch. The beautiful mottled marking of the bark, with its varying shades of blue, grey, and pink, here and there relieved by irregular splashes of salmon red, shooting flame-like from a deep metallic, lead-coloured zone, is a striking feature of this handsome tree, and it might well be designated "Queen of the Northern Eucalyptus Forests." It is very much like *E. punctata* in the nature of the bark, but it is more artistically coloured, with a larger range of colours of the most delicate shades, particularly at this time of the year (August, 1992.) A belt of this timber extends from Mount Mullingen, 4 miles north of Copmanhurst, for a couple of miles towards Smith's Creek. It was also noted about 12 miles north of Mount Mullingen and in various parts of Ramornie Station. It is regarded as a valuable timber throughout the district. (W. F. Blakely and D. W. C. Shiress).

XXXV. E. haemastoma Sm.

THE original description will be found at Part X, p. 317, and at Part XXXVII, p. 104, of my "Forest Flora of New South Wales," where it is figured at Plate 140. In the present work it is figured at Plate 46, figs. 12 and 13, and Plate 47, figs. 11–14, and no additional figures appear necessary. It may be described as follows:—

A smooth-barked, scraggy-looking tree, rarely reaching 30 feet, 15–20 feet being a fair average on the coastal sandstone in the Hornsby (Sydney) district. In some places, *i.e.,* on heathy slopes or windswept plateaux in the Hawkesbury district, in association with the Mallee-form of *E. eugenioides* and *E. Camfieldi,* it forms mallee-like thickets of 3–8 feet, here and there relieved by single-stemmed specimens up to 20 feet.

The factors which seem to be responsible for the mallee-like growth are elevation, shallow nature of the soil, and bush fires, which sweep over such places every two or three years. The mallee growth has not time to flower before it is burnt off, hence it rarely matures seed, but depends largely upon vegetative reproduction.

The mature leaves are coarse, dark, glossy green, somewhat resembling those of *E. coriacea.* In the growing season the young branchlets are often yellowish.

The following leaves, collected by Messrs. W. F. Blakely and D. W. C. Shiress from near Mount Colah gates, Kuring-gai Chase (Hornsby district), may be taken as typical.

Juvenile leaves pale green or somewhat glaucous on both surfaces.

Lower leaves almost sessile, broadly oblong to orbicular, 4–5 cm. long, 3–4 cm. broad, equally venulose on both sides, the veins branching towards the top; midrib conspicuous, slightly reddish; intramarginal vein fairly close to the edge. (The "lower leaves" are the successors of those pairs which succeed the cotyledon leaves, and which precede the ordinary intermediate or mature leaves).

Intermediate leaves shortly petiolate, broadly lanceolate, acute, 7–10 cm. long, 3–4 cm. broad, venulose on the lower surface; midrib prominent; intramarginal vein distant from the revolute margin, more or less undulate through its connection with the secondary nerves.

Range.

In Part X, p. 321, I have stated that *E. hoemastoma* apparently does not extend beyond the Hawkesbury sandstone (at least as west as Mount Wilson), and that it is most abundant not far from Port Jackson, the Hawkesbury and George's Rivers, and the ridges and broken country in the vicinity. It also extends to as far south as Tumut, and north to Kempsey and to southern Queensland. The Castlereagh River and Queensland localities belong to *E. micrantha.*

TASMANIA.

I have the following note in *Journ. Roy. Soc. Tas.* (1914), p. 29:—"In Part II, p. 71, of my 'Critical Revision,' after drawing attention to the confusion which has grown around the erroneous use of *E. hoemastoma* for a Tasmanian tree, I say that the name should be dropped. In Part X, p. 321, of the same work, I expressly exclude *E. hoemastoma* from Tasmania, and do the same at Part XXXVII of my 'Forest Flora."'

The following two specimens are not very satisfactory. They were not collected from Tasmania itself, but from Bass's Straits. In Part VI, p. 162, I referred them to *E. amygdalina* var. *nitida* (which is not perfectly understood), and I hope the matter will be further inquired into.

1. Deal Island (the largest island of Kent Group), Bass's Straits. (Expedition of the Field Naturalists' Club of Victoria, 1890). Labelled *E. hoemastoma* by Mueller.
2. "Fairly rough bark at base, branches smooth." Flinders' Island, Bass's Straits (Dr. J. B. Cleland).

New South Wales

Southern Localities.—Jervis Bay, fruits nearly as large as those of the type (J.H.M.); Badgery's Crossing, Shoalhaven River, to Nowra, not perfectly typical (W. Forsyth and A. A. Hamilton); Bowral (W. Greenwood, No. 216); Hill Top, on flats and also on ridges (J.H.M.); Cataract Dam (E. Cheel).

Western Localities.—Blackheath, overlooking the Dam (J.H.M.); a smooth White Gum, showing patches on the otherwise clean stem of loose bark, Mount Victoria between the houses Manor House and Rossmoyne, and other parts (J.H.M.); quite smooth bark, fruits in umbels, showing affinity to var. *capitata* Maiden. Fairy Bower, Mount Victoria (J.H.M.).

Sydney District.—Kurnell, Botany Bay. Here Captain Cook landed in the "Endeavour," April 28—May 6, 1770, and Banks and Solander made botanical collections; Loftus and National Park (J. H. Camfield).

The following were collected by George Caley in the Sydney district (1800–1810), and were presented by the British Museum through Dr. A. B. Rendle, F.R.S. Nos. 7; 52 (possibly *micrantha,* but no fruits); 5, "On the South Head Road" (in Caley's handwriting); 53.

"White Gum," north shore of Port Jackson (Rev. Dr. Woolls); Manly (J. L. Boorman, No. 102); "From small saplings, smooth bark." North side of Suspension

Bridge, Middle Harbour; "Quite smooth bark, south side of Spit (both J. H. Camfield); Spit Road, Manly (J. L. Boorman and J.H.M.); White Gum. Rather small trees, with a smooth mottled bark, or occasionally the trunk with patches of rough bark. Usually found on the sandstone in moist places, and in such is nearly always stunted, Swamps, Hornsby (W. F. Blakely); a rigid-looking tree, foliage heavy, bark similar to *micrantha,* Gibberagong Creek, Kuring-gai Chase boundary line (W. F. Blakely and D. W. C. Shiress); a low, stunted, shrubby tree, rarely more than 15 feet high at this spot, where it is closely associated with *E. virgata* Sieb. Tumble Down Dick, Gordon-Pittwater Road; also near Mount Colah Gates, Kuring-gai Chase; also new Cowan Station (the same).

Northern Districts.—Sugar Loaf Mountain, Woy Woy (A. Murphy); Brisbane Water (A. D. Francis, No. 4); Popran Trig. Station, 1,158 feet above Gosford (W. A. W. de Beuzeville, No. 6); "Mountain White Gum," Hogan's Bush, Gosford (W. A. W. de Beuzeville, No. 34); Blue-green foliage, a little glaucous, twigs purple-brown, Port Macquarie (J.H.M.). "White Gum:" medium sized tree, with a grey, mottled stem, and very crooked, gnarled branches. On the summit of the highest ranges near Torrington (J. L. Boorman).

Affinities.

1. With *E. micrantha* DC.

Speaking generally, *E. haemastoma* grows on sour, rocky land, while *E. micrantha* grows on better drained, sandy soil. *E. haemastoma* differs from *E. micrantha* in the following characters: It is a smaller tree, with broad, glossy, green leaves, larger buds and fruits, and also has thicker peduncles and pedicels. The suckers, which are broad, are also a useful character to separate it from *E. micrantha.*

2. With *E. Sieberiana* F.v.M.

These species are allied in the broad, lanceolate, juvenile leaves, and in the heavy adult foliage; also in the large buds and large pear-shaped fruits. Some of the fruits when detached are difficult to separate from those of *E. Sieberiana* and also from *E. Consideniana*; but the two species, except as depauperate growths, are very different, *E. haemastoma* being a somewhat scrambling White Gum, and *E. Sieberiana* a tall, erect tree, with bark often resembling that of an Ironbark.

CCCXLIX. E. micrantha DC.

In *Prod.* III, 217 (1828), and *Mém. Myrt.,* t. 5.

THE original Latin description will be found at Part X, p. 319, of the present work, and the following translation is offered:—

Operculum conical, the length of the calyx-tube, peduncles angular, the length of the petiole, axillary and subterminal, umbels 15–20 flowered, leaves oblong, coriaceous, narrowed at the base, long acuminate, secondary veins coming together at the margin. In New Holland, Sieb., plant ex. n. 497. Leaves bright on both sides, petiole about 1/2 inch long, leaf blade 6–7 inches long, an inch broad, veins penniform. Buds ovoid, the smallest of the genus.

A full description will be found at p. 318. See also my "Forest Flora of New South Wales," vol. IV, p. 105. It seems to be adequately figured in Plate 46, figs. 10, 11, 14, 15, 16, 17, and Plate 47, figs. 1–10, Part X of the present work.

It is a medium-sized tree with spreading branches and somewhat drooping branchlets, which often give it a willowy appearance. In favourable situations it exceeds 50 feet in height, but in many parts of the Hornsby district (where it is common, and where Mr. Blakely has especially studied it) 20–40 feet is a fair average. Several trees at Meadowbank, near Ryde, Port Jackson, are fully 60 feet high, with clean straight boles. In the Liverpool district some very fine specimens were observed by Messrs. Blakely and Shiress.

The juvenile leaves are pale green or slightly glaucous on both surfaces, only two or three pairs of the lower leaves remaining opposite, the lowest nearly sessile, narrow oblong, 10–30 mm. long, 5–8 mm. broad; intermediate leaves passing gradually into the adult, varying from narrow oblong to narrow lanceolate, shortly petiolate, penninerved, the intramarginal vein somewhat removed from the edge, 4–7 cm. long, 6–15 mm. broad. The description of leaves was drawn up by Mr. Blakely from average specimens in the field at Marrangaroo, with Dr. C. E. Chisholm, about 5 miles west of Lithgow, N.S.W.

Mr. Blakely pleads for it as a suitable subject for park planting in poor soils in the following words:—

"Large trees are very picturesque. The large blue and white patchy boles and spreading branches of similar shades, together with the drooping branchlets, often tinged with red, and the narrow semi-glaucous leaves make a very pleasing effect, especially in association with its sombre looking congeners, *E. eugenioides* and *E. piperita.*

Synonyms.

1. *E. haemastoma* Sm. var. *micrantha* Benth. in B.Fl. III, 212. Mueller followed Bentham, and I took the same view in Part X, p. 319. I am now fully convinced that the original name of *E. micrantha* DC. should be revived.
2. *E. signata* F.v.M. See Part X, p. 319, of the present work.

Range.

E. micrantha is much more widely distributed than *E. haemastoma.* See Part X, p. 321, where all the Queensland localities and those north of Kempsey belong to *E. micrantha.* Specific localities will be indicated presently, and, speaking generally, it may be stated that it occurs in coastal localities from near the Victorian border to Rockhampton, Queensland, and, speaking of New South Wales, freely on the Hawkesbury sandstone (though not confined to it) and the southern tableland, and north-west to the Castlereagh River.

NEW SOUTH WALES.

Southern Localities.—See Cambewarra, Nowra, Bankstown, and Cabramatta, Appin, Picton to Bargo, Wingello, Barber's Creek, Goulburn, Bungendore, Queanbeyan, Adelong, Cooma, all noted at Part X, p. 321.

"Brittle Gum." Timber largely used for fencing posts. It is very durable in the ground, very fissile, and very easily broken across section. Parish Carwoola, Co. Murray, Cooma district (Forester G. Boyd). He adds, "Common on the Southern tablelands"; Hills near Gooradigby and Burrinjuck, Yass district (Rev. J. W. Dwyer, No. 4); Mt. Stromlo, Federal Territory (C. T. Weston, No. 10); bark in appearance like *E. rubida,* Hospital Ridge, Canberra (C. T. Weston, Nos. 23 and 24); "Persistent bark near the ground, say for 3 or 4 feet, the remainder of the trunk and branches peel annually. The tree is dense in habit, after the form of *E. Baueriana,* Hospital Ridge, Canberra (C. T. Weston, No. 25); Brittle Gum, mostly 20–30 feet. high. Stems smooth. Chiefly along the water-course in a sedimentary formation. Colombo, Braidwood district, near the Shoalhaven River (F. W. Wakefield); Nerriga (J. L. Boorman); Hoskinton (W. A. W. de Beuzeville); 30 feet, smooth bark, Moonie Creek, Jervis Bay (Dr. F. R. Rodway).

Western Localities.—Grenfell, Penrith, Capertee, Mudgee, Apsley, Perth, head of Castlereagh River (see Part X, p. 322).

"A White Gum, *E. micrantha.* In some respects like *E. haemastoma,* but the flowers much smaller and never half-barked," Parramatta (Rev. Dr. Woolls); also from Richmond and the Blue Mountains (W.W.); Faulconbridge (J.H.M.);

Wentworth Falls (J.H.M.); Mount Victoria, Fairy Dell, and other places (J.H.M.); Mount Wilson (Jesse Gregson and J.H.M.); Cox's River, the specific locality for many of the specimens collected by Allan Cunningham in 1817 and October, 1822, and described by him in Barron Field's "Geog. Memoirs on N.S.W." pp. 323–365 (R. H. Cambage and J.H.M.); "On the flats this grows into a fairly large tree. In such situations one would expect to find the typical form, but it does not appear to exist in any part of the district. It is largely used for fuel. Marrangaroo on the flats. We did not see any typical *E. haemastoma* at Marrangaroo. *E. micrantha* is very common on the hills and occasionally on the flats. Considerably smaller than the coastal trees, with the same branching habit from a usually irregularly-shaped short bole; 30 feet is about the tallest tree met with, and 20 feet is a fair average." (W. F. Blakely and Dr. E. C. Chisholm); Bathurst to Sofala *via* Peel and Wattle Flat, returning *via* Limekilns, on the track taken by Allan Cunningham in April, 1823. See his "Journal of a Route from Bathurst to Liverpool Plains," as described by him in Barron Field's "Geog. Memoirs on N.S.W.," pp. 133, &c. (R. H. Cambage and J.H.M.); Hill End (J. L. Boorman); Bumberry, near Molong (Dr. J. B. Cleland); "Snappy or Cabbage Gum." A much-branched tree of pendulous habit with silvery leaves. Useless for any purpose except firewood. Grattai, Mudgee district (A. Murphy and J. L. Boorman); Dunedoo, on the range dividing Talbragar and the Castlereagh River (C. H. Gardner, per Forestry Commission); Coonabarabran (B. C. Meek); Coonabarabran (Sabina Helms, No. 602); White Gum, Warrumbungle Range sandstone, 3–7 miles from Coonabarabran, Bugaldi, &c. (Dr. H. I. Jensen, No. 105); about 40 feet high, Pilliga Scrub (Gordon Burrow, No. 17); White Gum. With Red Gum, *Styphelias,* &c., poor soil, Pilliga Scrub (E. H. F. Swain, No. 15); Grey Gum, a fair-sized tree, strongly resembling *E. punctata.* Occurring on the range-top at 2,000 feet. Parish Terrergee, Co. Courallie (E. H. F. Swain, No. 6); White Gum, 40 feet high, 7–8 feet girth, Warrumbungle Range (E. H. F. Swain, No. 1); White Gum. Very smooth, very white bark, cleaning from the ground, timber very brittle. Height of about 60 feet, girth of about 5 feet, Warialda (W. A. W. de Beuzeville).

Sydney District.—Field of Mars, Port Jackson (J. J. Fletcher, R. H. Cambage, J.H.M.); Garden Palace Grounds, Sydney (J. H. Camfield). From one of the two remaining original trees of the forest of White Gums which at one time covered large swampy areas in the Outer Domain. The following specimens were presented by the British Museum (through Dr. A. B. Rendle, F.R.S.). They were collected by George Caley (Sir Joseph Banks's botanical collector) in the year 1805. No. 19 "White Gum, P. (? Parramatta), Feb. 16, 1805" (in Caley's handwriting). Also No. 57.

A rather graceful-looking tree with slender branches, very similar to *E. haemastoma* in the bark, but differing in the consistently small leaves and small fruits. Gibberagong Creek, Kuring-gai Chase (boundary) (W. F. Blakely and D. W. C. Shiress); 1 mile north-west of Kuring-gai Station (ditto); Galston Road, near 17 mile post (ditto) Trig. Ridge, 1 mile north-west of Mt. Colah Station (ditto); bark smooth, grey and white. Peat's Ferry, Hawkesbury River (H. Deane).

Northern Localities.—Tuggerah Lakes, Belmont, Raymond Terrace, Failford, Port Macquarie, Brunswick River, Hillgrove, Emmaville (see Part X, p. 322).

Narrow-leaved White Gum. Very white to the ground, straight, valuable for posts and rails. Timber durable and not easily destroyed by bush fires as it will not burn well. Morrisset (Andrew Murphy); White or Scribbly Gum, a fairly common tree in poor sour land all over the district. Only used for fuel, because of its free cutting purposes, but it has no other use. Bucca Creek, near Coff's Harbour (J. L. Boorman); Sandy Hills, 20 miles east of Tenterfield (R. H. Cambage, No. 2,924).

QUEENSLAND.

See various localities, Part X, p. 322.

"White Gum," Fraser Island (W. R. Petrie, No. 6); White or Scribbly Gum, Sunnybank, near Brisbane (C. T. White); up to 40 feet with a diameter of 3–4 feet, foliage of silvery sheen, a handsome tree for street planting in coastal areas. Wellington Point, Brisbane (J. L. Boorman). Found also at the Waterworks, towards Ennoggera, &c.

Affinities.

1. With *E. hoemastoma* Sm.

Mr. Andrew Murphy calls this species "Broad-leaved White Gum," and *E. micrantha* "Narrow-leaved White Gum." See his remarks at Part X, p. 318.

The timber of *E. micrantha,* like that of *E. hoemastoma,* is very largely used for fuel, but, unlike the latter, it is cut for fence posts and rough pickets; *E. hoemastoma* is too small and too crooked to be cut for anything but firewood. When growing in association with *E. hoemastoma,* it can be easily separated from that species by the larger trees with a somewhat drooping habit, and particularly in the narrower, slightly glaucous, leaves.

2. With *E. maculosa* R. T. Baker.

Both have much the same habit and also the general facies, but *E. micrantha* is generally a larger tree and is more bluish in the bark. The juvenile leaves, buds, and fruits are different. For *E. maculosa,* see Part XXVII, Plate 112.

CCCL. E. Shiressii Maiden and Blakely, n.sp.

Arbor mediocris, ramulis patentibus, cortice laevi, ligno rubro; foliis juvenilibus petiolatis, infra pallidioribus, angusto-lanceolatis v. lanceolatis, venis obscuris, venis secundariis ex costa media 45–55° orientibus; foliis maturis crassiusculis, glabris, lanceolatis, paulo falcatis, mediocribus, venis tenuibus et obscuris, ex costa media 45–55° orientibus; inflorescentia axillari, ad 7 in umbella, pedunculis longiusculis; calycis tubo sub-cylindraceo, operculo ovoideo, antheris Macrantherae; fructibus sub-cylindricis ad fere hemisphericis ad 8 mm. diametro, valyis distincte non manifeste exsertis.

A medium-sized tree from 30 to over 60 feet high with a moderately straight stem and spreading branches. Bark more or less smooth, deciduous, falling off in fairly thick flakes, variously mottled. When newly shed a pale salmon pink, changing to lighter and darker shades with age, interspersed with very pale smoky-blue patches, which deepen with age to lead-colour. Timber reddish, more or less impregnated with kino; grain close and interlocked. It is a serviceable timber, and is used for many purposes.

Juvenile leaves petiolate, thin, not glaucous, paler on the underside, narrow-lanceolate to lanceolate, up to 8 or 9 cm. long and as narrow as 1 cm., intramarginal vein not far removed from the edge, venation indistinct, the secondary veins making an angle of 45–55 degrees with the midrib.

Mature leaves petiolate, rather thick, glabrous, lanceolate, slightly falcate, of medium size, say 14 cm. long with 2·5 cm. at greatest width, no intramarginal vein, venation fine and indistinct, the secondary veins making an angle of 45–55 degrees with the midrib.

Inflorescence axillary, up to 7 in the umbel, with an upward broadening and rather long peduncle, the comparatively short and flattened or angular pedicels tapering gradually, but not imperceptibly into the sub-cylindrical calyx-tube, which is of approximately the same depth as the operculum. Operculum ovoid or probably nearly hemispherical when ripe, tapering into a sharp point when immature. Anthers not seen fully ripe, almost oblong, but upwards broader, versatile, opening in parallel slits. Gland at the back, sometimes showing in front. Belong to the Macrantherae.

Fruits sub-cylindrical to nearly hemispherical, up to 8 mm. in diameter, rim thinnish to moderately broad, slightly domed or ascending, the valves distinctly but not prominently exsert.

[See remarks concerning the following paragraph under *E. crucis* at p. 514:—

Floral disc forming a thin light-coloured skin-like lining to the side of the shallow calyx-tube and extending over the top of the truncate ovary. Capsular disc small, truncate, forming with the staminal ring a narrow dark ring around the inner edge of the capsule, but quite free from the valves. The slightly exsert valves are tipped with white, which appears to be part of the discal lining referred to elsewhere under floral disc.]

A specimen from near the 16 mile post, Galston Road, near Hornsby (W. F. Blakely and D. W. C. Shiress) constitutes the type.

The name is given in honour of David William Campbell Shiress, who, during the last few years, has proved himself remarkably observant in regard to the distribution of Eucalypts in a number of districts in New South Wales.

On some trees, and in certain seasons, the blue colour of the bark predominates for a considerable period, ultimately changing to lead colour, relieved here and there with pale pink and blue blotches. In the colouring of the bark no other species in the Sydney district, except *E. punctata,* shows a greater range of colour than *E. Shiressii.* At certain seasons of the year it is a striking and pleasing feature of the sandstone vegetation.

Range.

So far as we know at present, this species is confined to New South Wales and to the Hawkesbury sandstone. As it has hitherto been confused with *E. punctata,* it will doubtless prove that clumps of trees hitherto unquestioningly referred to that species, and perhaps to *E. propinqua* will, on critical examination, prove to be more or less composed of *E. Shiressii.* It should be especially searched for in the counties of Cumberland and Cook.

Somewhat extended observations by one of us (W.F.B.) and D. W. C. Shiress, show that the new species extends from Hornsby (Galston Road) to the Hawkesbury River, a distance of 15 miles by rail, and it is fairly plentiful in the area bounded by the hills on the Galston side of Berowra Creek for a couple of miles above the head of the salt water on the one side, and Cowan Creek on the other. (We have specimens, Cowan Creek, Kuring-gai Chase, near house-boat, 10th July, 1915, and August, 1916; Galston Road [type locality], March, 1919, October, 1920, February 1922.) Fairly common from Wondabyne to Woy Woy, in association with *E. punctata.* (W. F. Blakely and D. W. C. Shiress.)

The former observer and Dr. E. C. Chisholm have also (September, 1922) found it not very far from the Blaxland Railway Station, on the lower slopes of the Blue Mountains. The actual spot is a little below the old Pilgrim Inn, on the old main road, say about 43 miles from Sydney. The nearest point from the Hornsby-Hawkesbury River locality to the Blue Mountains one is about 32 miles as the crow flies.

Affinities.

1. With *E. punctata* DC.

This is the natural affinity to *E. Shiressii,* and in the present state of our knowledge it is difficult to separate them in the absence of seedlings or juvenile foliage. See Plates 121, 122, Part XXIX. The broad juvenile leaves of *E. punctata* are sharply distinct and fundamental. Further dissimilarities will be drawn attention to later.

2. With *E. Seeana* Maiden.

The seedlings of the two species seem to be almost identical. Those of *E. Shiressii* are, however, a little broader, and also much paler on the under surface. For *E. Seeana* see Part XXXII, Plate 132. Almost every other organ seems to be different. The timbers and the barks have much in common.

CCCLI. E. crucis n.sp.

"Mallee," foliis glaucis; foliis juvenilibus crassis, brevissime petiolatis, lato-lanceolatis ad ovatis v. oblongis, apice distincto, venis obscuris, venis secundariis ex costa media 30–40° orientibus; inflorescentia glauca, axillari, umbellis ad 7 in capitulo, pedunculis pedicellisque gracilibus; alabastris ovoideis, operculo hemispherico; antheris *E. pyriformi* similibus; fructibus hemisphericis, 1·5 cm. diametro, valvis distincte exsertis.

A Mallee up to 25 feet (C. A. Gardner), with glaucous leaves "throughout." Branchlets mostly not angular.

Juvenile leaves thick, very shortly petiolate (while in the opposite state; when more material is available, sessile leaves may be looked for), broadly-lanceolate to ovate or oblong, under 3 cm. in greatest width and 6 cm. in greatest length, tapering into a distinct apex, intramarginal vein close to the edge; venation indistinct, the secondary veins making an angle of 35 to 55 degrees with the midrib.

Mature leaves rather thick, very shortly petiolate, from lanceolate to nearly ovoid and ovoid-lanceolate, gradually but distinctly apiculate; small, usually about 4 cm. long and rarely attaining 5 cm., but varying in greatest width from under 13 to 25 cm. Venation indistinct, intramarginal vein close to the edge, the secondary veins making an angle of 30–45 degrees (mainly 30–40) with the midrib.

Inflorescence glaucous, axillary, in umbels up to 7 flowers on slender, slightly flattened peduncles of 1 cm., with pedicels of half that length. Buds ovoid, the operculum hemispherical or with a slight umbo, the calyx-tube very slightly longer than the operculum, and not tapering into the pedicel. Anthers broad, opening laterally in long, oblique slits. They are widest at the base, have a small gland at the top or a little to the front, filament at the base. Closely allied to *E. pyriformis.*

Fruits hemispherical or shallower, about 1·5 cm. in diameter, with a domed rim, and the valves distinctly exsert.

[In Part LXI I shall explain and freely figure the Floral disc and Capsular disc in Eucalyptus. Subsequently it may be desirable to describe these organs in describing species, and the following is given for *E. crucis:*—

Floral disc forming a carnose covering around the base of and extending half-way up the conical ovary. Staminal ring thin, lower than the top of the calyx.

Capsular disc broad, domed, free or not fused to the valves of the capsule, slightly higher than the sutural line of the operculum. The Capsular disc is referred to briefly as the rim and valves of the fruit.]

Type from Southern Cross, Western Australia, Henry Steedman, April, 1922, from which the drawings were made. Further specimens received June, 1922, from the same locality show, *inter alia,* broader leaves. These differences have been taken cognisance of in the description.

The name *crucis* is given in reference to Southern Cross; I find that astronomers have no other Latin name for that constellation, after which the little mining township was named.

Range.

So far as we know at present, it is confined to Western Australia, for it has only been collected at Southern Cross, near Coolgardie, and Kalgoorlie (H. Steedman), also Yorkrakine Rocks, Westonia (C. A. Gardner). Distances are great and the population sparse in the botanically interesting western State.

Affinity.

1. With *E. Websteriana* Maiden.

E. crucis appears to have the floral and fruiting characters of *E. Websteriana* (*e.g.,* the Capsular disc is the same in each case), but differs very much from the latter in its leaves, which are lanceolate, terminating in a very fine point, thin, with spreading venation, shortly petiolate. In *E. Websteriana* the leaves are usually obovate-spathulate, invariably emarginate, on long petioles, thick, venation obscure, or when visible not fine and close like *E. crucis.*

CCXII. E. Flocktoniae Maiden.

THIS species was further described in Part LVIII, p. 421, and further illustrated in Plate 236. In Plate 243 of the present Part additional figures are given to illustrate the points set out at page 422. Briefly they refer to (*a*) Decurrent juvenile leaves, (*b*) Constriction of buds, giving them a moniliform appearance, (*c*) Constriction of fruits just below the orifice.

For further particulars see the Explanation of Plates at p. 570.

VII. Inflorescence (in part).

D. ANDROECIUM.
ANTHER.

Historical.

Bentham, 1866.—The study of the Eucalyptus anther practically begins with Bentham's “Flora Australiensis”; at all events, he first used this organ for the purpose of classification, often referred to as “Bentham's Anthereal Classification.” It becomes therefore necessary to ascertain what he said.

“This usual form (of stamen) is a stalk called the *filament,* bearing at the top an *anther* divided into two pouches or *cells.* These anther-cells are filled with *pollen,* consisting of minute grains, usually forming a yellow dust, which, when the flower expands, is scattered from an opening in each cell. When the two cells are not closely contiguous, the portion of the anther that unites them is called the *connectivum* (connective). (B. Fl. I, xv.)

“ . . . . Stamens numerous, in several series, free or very rarely (*Eudesmieae*), very shortly united at the base into 4 clusters; anthers versatile or attached at or close to the base, the cells parallel and distinct or divergent and confluent at the apex, opening in longitudinal slits or rarely in terminal pores, the *connective often thickened into a small gland* (my italics), either separating the cells or behind them when they are contiguous . . . . (ib. III, 185). . . . In the meantime, as far as I can gather from the information supplied, it appears to me that among large trees the majority of the “Stringy-barks” are to be found in my first series with reniform anthers, and of the “Iron-barks” and “Box-trees” in the following three series with very small globular or truncate anthers, that other marked peculiarities in the bark are typical rather of species than of groups, and that, among shrubs or small stunted or scrubby trees, the cortical character is of very little avail, even for the discrimination of species . . . . ” (p. 186).

The correlation of anthers and barks is interesting.

This Series, No. V, is subdivided into nine Sub-series, viz.:—

1. Subsessiles.
2. Recurvae.
3. Robustae.
4. Cornutae.

5. Exsertae.
6. Subexsertae.
7. Inclusae.
8. Corymbosae.
9. Eudesmiae.

The characters of these Sub-series (with the incidental references to stamens in Nos. 4 and 9, viz., Cornutae, "Stamens erect or flexuose in the bud, but not inflected," and Eudesmiae, "Stamens sometimes in four clusters"), are founded on flower attachments, position of the valves in the fruit, and the nature of the fruit itself, and need not be further discussed at this place.

He groups the species into :—

Series I, Renantherae.—Stamens all perfect or very rarely (especially *E. virgata*). (This is really *E. Sieberiana.*—J.H.M.). Some of the outer ones with abortive anthers; anthers reniform or broad and flat, the cells divergent or at length divaricate, contiguous and usually confluent at the apex.

Series II, Heterostemones.—Outer stamens (usually longer than the others) anantherous or with small abortive anthers; anthers of the perfect ones small, globose or truncate; the cells contiguous, opening in pores or oblong slits, sometimes at length confluent.

Series III, Porantherae.—Stamens all perfect, except rarely in *E. bicolor* and perhaps in *E. polyanthemos;* anthers small and globular or broader than long, the cells distinct, opening in terminal or more or less lateral circular pores, sometimes extending at length into oblong slits.

Series IV, Micrantherae.—Anthers very small and globular or broader than long, almost as in the Porantherae, but opening in more oblong or longitudinal slits, almost as in the Normales, the cells more distinct than in the Porantherae, less so than in the Normales.

Series V, Normales.—Stamens all perfect; anthers oblong-ovate or nearly globose, the cells perfectly distinct, parallel, and opening longitudinally, either contiguous with the connective gland behind them or back to back with the connective between them.

(It will be seen that, in the above definitions, the species are grouped according to the shape and mode of dehiscence of the anthers.)

Series I, Renantherae.

E. Risdoni.	*E. coccifera.*
E. dives.	*E. piperita.*
E. stellulata.	*E. capitellata.*

E. coriacea.

E. virgata. (This is really *E. Sieberiana,* or *virgata* in addition to *Sieberiana*).

E. obtusiflora.

E. obliqua.

E. buprestium.

E. amygdalina.

E. macrorrhyncha.

E. santalifolia.

E. pilularis var. *acmenioides* (*E. acmenioides*).

E. pilularis.

E. marginata.

(This is a very natural group; I will make some suggestions later on.)

Series II, Heterostemones.

E. leucoxylon.	*E. bicolor.*
E. melliodora.	*E. paniculata.*
E. gracilis.	*E. haemastoma.*
E. virgata.	*E. microcorys.*

(In this group we have *virgata,* included by Bentham himself also in the Renantherae, and also *haemastoma* and *microcorys,* placed by Mueller in the Renantherae. *E. leucoxylon, melliodora,* and *paniculata* have truncate anthers, see p. 530.)

Series III, Porantherae.—Stamens all perfect (except rarely in *E. bicolor* and perhaps in *E. polyanthemos*); anthers small and globular or broader than long, the cells distinct, opening in small circular pores, sometimes extending at length into oblong slits.

The species are all Eastern or Tropical, including most of the "Box-trees," *E. uncinata* alone extending also into West Australia. The leaves when narrow have always an oblique irregular venation. The operculum is short, and the capsule sunk in the fruit.

This series passes through *E. bicolor* into the Heterostemones, and, when fully out, the anthers sometimes are very nearly those of the Micrantherae, whilst amongst Micrantherae there are several species, especially 36, *E. albens,* 38, *E. siderophloia,* 32, *E. stricta,* and 34, *E. decipiens,* in which the anther-cells are so short that their slits are at first little more than pores. (B. Fl. III, 191.)

E. pruinosa.	*E. hemiphloia.*
E. oligantha.	*E. siderophloia.*
E. polyanthemos.	*E. albens.*
E. Behriana.	*E. odorata.*
E. bicolor.	*E. uncinata.*
E. stricta.	

(*E. polyanthemos* and *E. uncinata* have truncate anthers; those of *E. stricta* are reniform, as already explained.)

Series IV, Micrantherae.—Anthers very small, globular, or broader than long, with globular distinct cells opening in lateral slits.

The species, with the exception of the Western *E. micranthera* and *E. decipiens,* are all Eastern or tropical, and include most of the Ironbarks—one species, *E. brachypoda,* extending also into the west. The series, which closely connects the Porantherae with the Normales, is by no means a distinctly marked one. The anthers have at first sight, in their shape and small size, the appearance of the former, whilst their dehiscence is almost or quite that of the Normales. As in Porantherae, the operculum is short, rarely slightly longer than the clayx-tube, and the capsule more or less sunk, although the points of the valves often protrude.

E. melanophloia.	*E. decipiens.*
E. cneorifolia.	*E. drepanophylla.*
E. stricta.	*E. trachyphloia.*
E. albens.	*E. crebra.*
E. Bowmani (too imperfectly known).	*E. leptophleba.*
E. siderophloia (also in Series III)	*E. brachypoda (microtheca).*
E. corynocalyx.	*E. brachyandra.*
E. micranthera.	

Series V, Normales.—Stamens all perfect; anthers oblong-ovate or nearly globose, the cells perfectly distinct, parallel (either contiguous with the connective-gland behind them, or back to back, with the connective between them) and opening longitudinally.

(In 103, *E. oleosa,* and its allies, the anthers are smaller, almost globular, and passing into those of the Micrantherae).

Then come the nine Sub-series already referred to.

Bentham's anthereal system takes cognisance of:—

(*a*) Whether anther is perfect or not.
(*b*) Shape, including relative position of the cells.
(*c*) Size.
(*d*) Nature of dehiscence—pores or slits.
(*e*) Connective (gland).

Mueller, 1882, 1889. In the First (1882) and Second Systematic Census (1889), Mueller adopts the simple classification of:—

I. Renantherae.
II. Porantherae.
III. Parallelantherae.

The species in the two Censuses are practically the same; the following shows the differences:—

	1882.	1889.	
Renantherae	22	23	(*virgata* is added after *stricta.*)
Porantherae	14	14	No difference.
Parallelantherae	95	97	(*Staigeriana* is added after *crebra,* and *Foelscheana* after *terminalis.*)
	131	134	species.

It will be observed that the two Censuses were published in the years 1882 and 1889, and the "Eucalyptographia" from 1879 to 1884. Mueller began his classification of three groups of anthers in 1882 and did not alter it in 1889, but in 1884 (Part X of the "Eucalyptographia") he divided Parallelantherae into two groups, Strongylantherae and Orthantherae. According to dates, it may be assumed that in 1889 he went back to his views of 1882.

The species enumerated in the Second Census are as follows:—

I. Renantherae.

E. stellulata.	*E. marginata.*
E. pauciflora.	*E. santalifolia.*
E. regnans.	*E. macrorrhyncha.*
E. amygdalina.	*E. capitellata.*
E. coccifera.	*E. eugeniodes.*
E. obliqua.	*E. piperita.*
E. stricta.	*E. pilularis.*
E. virgata.	*E. triantha (acmenioides).*
E. Planchoniana.	*E. haemastoma.*
E. Baileyana.	*E. Sieberiana.*
E. sepulcralis.	*E. microcorys.*
E. buprestium.	

(*E. Baileyana* belongs to the Eudesmiae. Mueller mixed it with *E. eugenioides.* See Part XLIV, p. 113.)

II. Porantherae.

Porantherae, the anthers small and opening in pores.

E. paniculata.	*E. uncinata.*
E. leucoxylon.	*E. odorata.*
E. melliodora.	*E. largiflorens.*
E. polyanthema.	*E. Behriana.*
E. populifolia.	*E. hemiphloia.*
E. ochrophloia.	*E. pruinosa.*
E. gracilis.	*E. melanophloia.*

(The species in the above list with truncated anthers will be dealt with separately.—J.H.M.)

This section mostly includes Boxes and some Mallees, and includes the Silver-leaved Ironbark (*melanophloia*), while *E. crebra,* which is very closely allied to it, is placed in another section.

III. Parallelantherae:

(Parallelantherae, such as have the anthers ovate or oblong and opening in parallel slits, but I cannot find where Mueller defined his term. Mr. Laidlaw, the Government Botanist of Victoria, cannot trace that Mueller used it earlier than the First Census, 1882. I have just referred to the matter at p. 519.)

E. Cloeziana.	*E. pyriformis.*
E. Howittiana.	*E. macrocarpa.*
E. drepanophylla.	*E. Preissiana.*
E. crebra.	*E. alpina.*
E. Staigeriana.	*E. globulus.*
E. decipiens.	*E. megacarpa.*
E. concolor.	*E. cosmophylla.*
E. siderophloia.	*E. cordata.*
E. microtheca.	*E. urnigera.*
E. Raveretiana.	*E. longifolia.*
E. brachyandra.	*E. resinifera.*
E. erythronema.	*E. saligna.*
E. caesia.	*E. punctata.*
E. tetraptera.	*E. oligantha.*
E. miniata.	*E. alba.*
E. phoenicea.	*E. pulverulenta.*
E. robusta.	*E. Stuartiana.*
E. botryoides.	*E. viminalis.*
E. goniocalyx.	*E. rostrata.*
E. pallidifolia.	*E. tereticornis.*
E. incrassata.	*E. rudis.*
E. oleosa.	*E. foecunda.*
E. goniantha.	*E. redunca.*
E. falcata.	*E. grossa.*
E. salmonophloia.	*E. obcordata.*
E. leptopoda.	*E. occidentalis.*
E. salubris.	*E. cornuta.*
E. angustissima.	*E. gamophylla.*
E. doratoxylon.	*E. perfoliata.*
E. decurva.	*E. setosa.*
E. Cooperiana.	*E. Torelliana.*

E. corynocalyx.	*E. peltata.*
E. gomphocephala.	*E. latifolia.*
E. Oldfieldii.	*E. ptychocarpa.*
E. orbifolia.	*E. Abergiana.*
E. diversicolor.	*E. calophylla.*
E. patellaris.	*E. ficifolia.*
E. tessellaris.	*E. corymbosa.*
E. clavigera.	*E. terminalis.*
E. ferruginea.	*E. Foelscheana.*
E. grandifolia.	*E. dichromophloia.*
E. aspera.	*E. trachyphloia.*
E. patens.	*E. eximia.*
E. Todtiana.	*E. maculata.*
E. vernicosa.	*E. Watsoniana.*
E. Gunnii.	*E. erythrocorys.*
E. odontocarpa.	*E. tetragona.*
E. tetrodonta.	*E. eudesmioides.*
E. pachyphylla.	

1879. Mueller, in "Eucalyptographia" (Preface, p. 4, dated 1879), says that from Bentham's "Series of Normales should be dismembered the sub-series of Cornutae, to which as forming really a distinct full series the appellation 'Orthostemones' might most expressively be applied. Some further separations from the Normales may aptly be effected, still. . . . " (but he does not particularise them).

I see no advantage in substituting the term "Orthostemones" for "Cornutae," and it is of course quite different from Mueller's term "Orthantherae."

Mueller, 1884.—In 1884, in the concluding Part (X) of the "Eucalyptographia," Mueller, under the caption, "The species of the genus Eucalyptus systematically arranged and their leading characteristics defined," grouped them by anthers in four groups, viz.:—

I. Renantherae.
II. Porantherae.
III. Strongylantherae.
IV. Orthantherae.

(In other words, Groups III and IV take the place of Parallelantherae.)

At the end of the lists he says, "The characteristics of aberrant forms of any species are not covered by this synopsis."

I. Renantherae.

Anthers mostly broader than long, usually kidney-shaped, opening anteriorly by divergent, upward, confluent slits. Umbels generally solitary. Fertile and sterile seeds mostly conformous.

E. pauciflora (coriacea).	*E. capitellata.*
E. stellulata.	*E. macrorrhyncha.*
E. amygdalina.	*E. hoemastoma.*
E. eugenioides.	*E. Sieberiana.*
E. piperita.	*E. microcorys.*
E. pilularis.	*E. marginata.*
E. acmenioides.	*E. Baileyana.*
E. obliqua.	*E. Todtiana.*
E. stricta.	*E. coesia.*
E. angustissima.	*E. buprestium.*
E. Oldfieldii.	*E. sepulcralis.*
E. santalifolia.	

II. Porantherae.

(Anthers not, or hardly, broader than long, usually roundish, opening by pores [always minute].)

E. paniculata.	*E. uncinata.*
E. leucoxylon.	*E. odorata.*
E. melliodora.	*E. largiflorens (bicolor).*
E. polyanthema.	*E. hemiphloia.*
E. ochrophloia.	*E. Behriana.*
E. gracilis.	*E. populifolia.*

III. Strongylantherae.

Anthers not or scarcely longer than broad, usually roundish, opening by longitudinal slits.

(Transits from Renantherae—*E. santalifolia, E. Oldfieldii, E. Todtiana, E. sepulcralis, E. alpina.*)

E. alba.	*E. microtheca.*
E. platyphylla.	*E. siderophloia.*
E. doratoxylon.	*E. Planchoniana.*
E. gamophylla.	*E. incrassata.*
E. pruinosa.	*E. oleosa.*
E. melanophloia.	*E. cneorifolia.*
E. drepanophylla.	*E. salmonophloia.*
E. crebra.	*E. decipiens.*
E. brachyandra.	*E. patens.*
E. Cloeziana.	*E. diversicolor.*
E. Howittiana.	*E. phoenicea.*

E. Raveretiana.

IV. Orthantherae.

(Anthers distinctly longer than broad, from ovate to narrow-oblong, opening by almost parallel slits.)

E. miniata.	*E. salubris.*
E. ptychocarpa.	*E. saligna.*
E. ficifolia.	*E. resinifera.*
E. calophylla.	*E. punctata.*
E. Abergiana.	*E. botryoides.*
E. Foelscheana.	*E. goniocalyx.*
E. latifolia.	*E. robusta.*
E. terminalis.	*E. cornuta.*
E. corymbosa.	*E. occidentalis.*
E. trachyphloia.	*E. obcordata.*
E. clavigera.	*E. pachypoda.*
E. tessellaris.	*E. erythronema.*
E. corynocalyx (cladocalyx):	*E. longifolia.*
E. maculata.	*E. cosmophylla.*
E. eximia.	*E. megacarpa.*
E. Watsoniana.	*E. globulus.*
E. peltata.	*E. alpina.*
E. Torelliana.	*E. gomphocephala.*
E. setosa.	*E. Preissiana.*
E. cordata.	*E. pachyphylla.*
E. urnigera.	*E. pyriformis.*
E. pulverulenta.	*E. macrocarpa.*
E. Stuartiana.	*E. tetraptera.*
E. viminalis.	*E. tetrodonta.*
E. rostrata.	*E. odontocarpa.*
E. tereticornis.	*E. eudesmioides.*
E. Gunnii.	*E. tetragona.*
E. vernicosa.	*E. erythrocorys.*
E. rudis.	*E. redunca.*
E. foecunda.	

In Decade III (end of *E. populifolia*) of the "Eucalyptographia," we have Mueller, in speaking of anthers, quoting "Heterostemones (Hemiantherae)" (no other reference there).

In Decade IV, under *E. clavigera,* he says: "The sections Renantherae and Hemiantherae are, as far as hitherto known, not represented in North Australia." I have spent a good deal of time in a vain endeavour to find any further reference to the word "Hemiantherae," but without success. In January, 1908, I appealed to

Professor Ewart, and he told me he was unable to trace it. The term “Hemiantherae” seems not to have been taken up by Mueller or anyone else; it is indeed one of those superfluous terms foisted on a science already overburdened with terms.

1895. “Eucalyptus,” by Abbot Kinney, Los Angeles, U.S.A. The botany by A. J. McClatchie.

Mr. McClatchie adopts Mueller's four groups of the “Eucalyptographia,” but makes certain alterations as to species in the Renantherae (p. 180) and other groups. He offers greatly enlarged drawings of anthers, viz.:—

Renantherae (*E. amygdalina*).

Porantherae (he chooses *E. polyanthemos,* a species I have put in the Terminales).

Strongylantherae (*E. diversicolor,* which has a large gland, the cells a little divergent, and opening in slits; *E. siderophloia,* gland small, and cells opening in pores).

Orthantherae (*E. rostrata* and *E Gunnii,* both opening in slits, but the former with cells narrower than the latter).

1898. *Luehmann* (*Proc. Aust. Ass. Adv. Sci.* vii, 523, 1898) expresses the opinion that the anther system is the most reliable which, with our present knowledge, can be devised.

Andrews, 1913. E. C. Andrews in his paper, “The Development of the Natural Order Myrtaceae,” *Proc. Linn. Soc. N.S.W.,* xxxviii (1913), makes an extensive use of the anther in Eucalyptus. The whole paper should be carefully read. Following is a mere paragraph:—

“The typical anthers of the family are versatile, the cells parallel and opening longitudinally. Thus the Angophoras and Corymbosas have the typical anthers of Myrtaceae, but the Boxes and Ironbarks possess peculiar porose or truncate anthers, and the Stringybarks, Peppermints, Messmates, Mountain-Ashes and some Mountain Gums possess kidney-shaped anthers” (p. 566).

Cambage, 1913. Following is from Mr. R. H. Cambage's Presidential Address read before the Royal Society of New South Wales. He deals with climate and soil in relation to the anthers:—

“. . . . In a large genus like Eucalyptus it is not surprising to find that there is a gradation of characters from one species to another, and this varietal tendency applies in a marked degree to the anthers. But on studying the distribution of the three general types of anther, it becomes evident that to some extent such distribution is regulated by climatic influence, or that a certain form of anther is often better represented in one class of climate than another.

“*Renantherae*. . . . is practically confined to South-eastern Australia, and is the principal form occurring in the higher Mountain Region. . . . Next to the mountains it is most common in the Coastal Area, but on the drier Western Slopes is rare indeed, while in the still drier Interior of New South Wales this form of anther does not occur at all.

"Considering this general distribution of the last named two types of anther, there seem reasonable grounds for assuming that one necessary condition for the development of the former is warmth, while the latter is largely the result of moist and cool surroundings.

"There are anomalous members of the section Renantherae, which in an evolving genus is not a matter for surprise, examples being found in such species as *E. Smithii* and *microcorys*. . . .

"*Porantherae.*—The Porantherae section is largely confined to the inland portions of Eastern Australia, and compared with the last-mentioned type, is a comparatively small section, being chiefly found amongst the Box-trees, Ironbarks and some Mallees. For the purpose of this address it is made to include the form known as the truncate anther. In New South Wales the Porantherae has its greatest number of representatives in the Interior and Western Slopes, and occurs to a less extent in the Coastal Area. The one condition that it distinctly avoids is the cold, and it is absent from the Mountain Region above elevations of about 3,000 feet, south of latitude 31°, and also from Tasmania, one of the trees with this type of anther best able to face the cold being *E. melliodora*. . . .

"It is pointed out that the Eucalypts which belong to the Porantherae section rather favour the basic than the siliceous formations, and it seems not improbable that an extended study of that phase of development which results from response to certain plant food, may largely help to elucidate some of the mysteries of evolution in the genus.

"*Parallelantherae.*—The parallel anther is by far the commonest type of anther in the genus, being found all over Australia, and is the form which belongs to the closely allied genus *Angophora.* It has been noticed, however, that this form becomes less common above an altitude of 4,000 feet. If we consider that all the present forms of anther have been evolved from one original type, then it would seem that the type known as Parallelantherae bears the nearest resemblance to the original. This hypothesis is supported by the wide distribution of this particular form, and the fact that it passes by gradual stages to the Porantherae on the one hand and the Renantherae on the other. . . . " (*Proc. Roy. Soc., N.S.W.* xlvii, 52, 1913.)

Maiden (1916) in Maiden and Betche's "Census of New South Wales Plants," made the following tentative classification (N.B. For New South Wales species only!):

A. *Renantherae.* (Kidney-shaped anthers.)
B. *Terminales.* (Anthers with terminal pores, erect or oblique on the filament).
C. *Porantheroideae.* (Small globular anthers, gland at top, filament at base or nearly so).*
D. *Macrantherae.* (A large group, to be subdivided later, of anthers having the openings parallel, with gland at back. Some are versatile, others nonversatile).
E. *Corymbosae.* (The following species, with anthers belonging to the Macrantherae may, for convenience, be kept apart as belonging to a well-defined group termed Bloodwoods. See B.Fl. iii, 198.)
F. *Eudesmieae.* (This and the Corymbosae are Bentham's sub-series. See B.Fl. iii, 199.)

* "The following three species may perhaps be looked upon, as regards anthers, as intermediate between Porantheroidae and the Micrantherae."

In regard to the above, it may be pointed out:—

1. That D. includes E. and F.
2. That this 1916 classification has special application to New South Wales species, and therefore omits altogether, *e.g.,* Cornutae, which are confined to Western Australia.

Maiden (1922). I now submit an improved tentative classification:—

A. *Renantherae,* with two sub-sections—

- (*a*) Alpinae.*
- (*b*) Brachyandrae*

B. *Renantheroideae.*
C. *Porantheroideae.*
D. *Terminales.*
E. *Platyantherae,* with two sub-sections—

- (*a*) Graciles.*
- (*b*) Pyriformes.*

F. *Macrantherae.*

1. Tereticornes.*
   Miscellaneous.
2. Longiores.

I. Corymbosae.
II. Non-Corymbosae.

(*a*) Miscellaneous, embodying extra characters.
(*b*) Papery fruits (Clavigerae).*
(*c*) Serrulate filaments (Cornutae).
(*d*) Stamens in four clusters (Eudesmiae).

A. RENANTHERae (46), with two sub-sections—

(*a*) Alpinae.
(*b*) Brachyandrae.

Renantherae.—The anthers are kidney-shaped and very uniform. Like all anthers, they have two pollen cells, but eventually, by absorption of the dissepiment, they form a single cavity. Bentham was fond of the term "confluent at the apex." There is a medium-sized gland in the front.

* After well-known species in the respective sub-sections.

E. acmenioides.	*E. Moorei.*
E. altior.	*E. Muelleriana.*
E. amygdalina.	*E. nitida.*
E. Andrewsi.	*E. numerosa.*
E. apiculata.	*E. obliqua.*
E. approximans.	*E. obtusiflora.*
E. de Beuzevillei.	*E. Penrithensis.*
E. Camfieldi.	*E. pilularis.*
E. capitellata.	*E. piperita.*
E. coccifera.	*E. Planchoniana.* (I used the term Renantheroid in connection with this anther in *Proc. Roy. Soc. N.S.W.,* xlvii, 235, but I am satisfied, with further examination, that it is Renantherae.)
E. Consideniana.	
E. coriacea.	
E. diversifolia.	
E. dives.	
E. eugenioides.	*E. radiata.*
E. fraxinoides.	*E regnans.*
E. gigantea.	*E. Risdoni.*
E. haemastoma.	*E. Sieberiana.*
E. Kybeanensis.	*E. Smithii.* (*See* XII, 77, for notes on a supposed anomaly.)
E. laevopinea.	
E. Laseroni.	*E. stellulata.*
E. ligustrina.	*E. stricta.*
E. linearis.	*E. umbra.*
E.	*E. virgata.*

macrorrhyncha.

E. micrantha.	*E. vitrea.*
E. Mitchelliana.	

All the above are Eastern Australian or Tasmanian. *E. diversifolia,* which extends to Western Victoria, appears to come farthest west. They occur in coastal and tablelands localities, and New South Wales is practically their northern limit.

For a classification of the Renantherae (in part) according to Barks, see Part LI, p. 33, and according to Timbers, Part LIII, p. 142.

(*a*) Sub-section Alpinae (5).

These anthers are very large and are like Renantherae in shape except that they are rather longer in the lobes and open more widely. These comprise—

E. alpina.	*E. sepulcralis.*
E. buprestium.	*E. Todtiana.*
E. patens.	

Four belong to South-Western Australia, *E. sepulcralis* going furthest east. *E. alpina* is endemic to Victoria, and has relations with both *E. globulus* and *E. capitellata.*

E. alpina.—Although, as Bentham states (B.Fl. iii, 225), this species has parallel cells, it often happens that there is divergence. Those of *E. capitellata* (Renantherae) have sometimes a tendency to be parallel, and thus the two species show close affinity.

E. buprestium.—"Short divergent slits, confluent at the apex." (B.Fl. iii, 205.) Not strictly reniform.

E. patens.—Bentham (B.Fl. iii, 247) speaks of the anther cells as "parallel and distinct." They are slightly divergent, but only partly reniform.

E. sepulcralis.—Between Renantherae and those with parallel cells. Filaments versatile.

E. Todtiana.—Mueller describes them as "anthers rather large truncate, broader on top than at base, opening by longitudinal parallel cells." As a matter of fact they are broader at the base. It is a large white anther with a large gland at the back, and with divergent rather than parallel cells. It is closely allied to the Renantherae, yet closely allied to those of *E. patens* and *E. sepulcralis.*

(*b*) Sub-section Brachyandrae (8).

In shape nearest to Renantherae; variable in size, some (*e.g., brachyandra* and *Raveretiana*) being very small. Cells tardily confluent.

These comprise—

E. brachyandra.	*E. microcorys.*
E. Jutsoni.	*E. Naudiniana.*
E. Kalganensis.	*E. Raveretiana.*
E. marginata.	*E. Guilfoylei.*

Four are from Western Australia, three from the well-watered south-west, and one (*Jutsoni*) from a dry area. *E. microcorys* and *E. Raveretiana* are from coastal New South Wales and Queensland respectively; *E. Naudiniana* is from New Britain and the Philippines, while *E. brachyandra* comes from the Northern Territory.

E. brachyandra.—A very small anther, might be described as minute.

E. Jutsoni.—Apparently near to those of *E. angustissima.* See Part L, p. 296.

E. Kalganensis.—Only immature anthers available.

E. marginata.—Very near the true Renantherae, but certainly different in the broader appearance of the two lobes, tapering to a blunt top.

E. microcorys.—Very similar to those of *E. marginata.*

E. Naudiniana.—See note at Part XI, p. 77, apparently slightly anomalous as regards Renantherae. The cells are not confluent. Versatile.

E. Raveretiana.—Very close to normal Renantherae, though with the cells not necessarily confluent. Very small. Closely allied to *E. brachyandra.*

E. Guilfoylei.—Referred to at Part XX. p. 301, but material scanty. They are closely allied to the Renantherae, but still anomalous. They open in two horizontal slits at the base of the lobes and open widely like the wings of a butterfly. They are one-celled. Filament at base, small gland immediately above it.

B. RENANTHEROIDEae (8).

As the proposed name denotes, these anthers have some resemblance to those of the Renantherae, and indeed a number of them have already, by some authors, been placed in that section. They are all one-celled, or rather confluent, but the lobes often vary from the divergence of the typical Renantherae, and are sometimes nearly parallel. In a number of cases the amount of departure from Renantherae may be exaggerated by the immaturity or other incompleteness of the anthers.

E. angustissima.—The same remarks apply in this species, which has parallel cells (B.Fl. iii, 238) and also divergent ones.

E. Bakeri.—Anthers large (small in Part XLIV, p. 123, in error); spherical gland at top and back; has some affinity with the Platyantherae. I have already used the term Renantheroid in connection with this species.

E. Cloeziana.—A small anther, cells more parallel than divergent. A connecting link between Renantherae and Platyantherae.

E. diversifolia—Large white anther, cells sometimes parallel, sometimes rather widely divergent. Gland absent or very small.

E. oligantha.—Somewhat similar to the preceding. Perhaps may be looked upon as a connecting link between the Renantherae and the Porantheroideae.

E. pachyloma.—Anther cells parallel to divergent. Similar to those of *diversifolia* (*santalifolia*). In Part VII, p. 201 (following Bentham), the anthers are spoken of as "ovate, with distinct parallel cells." There is some divergence, but the anther is not typically reniform.

E. Preissiana.—With parallel rather than divergent cells, yet with some affinity to Renantherae. Filaments versatile, glandular.

E. angustissima.	*E. diversifolia.*
E. Bakeri.	*E. oligantha.*
E. Cloeziana.	*E. pachyloma.*
E. cneorifolia.	*E. Preissiana.*

E. angustissima, pachyloma, and *Preissiana* are exclusively coastal Western Australian; *diversifolia* and *cneorifolia* are coastal South Australian, the former extending to Western Australia. *E. Bakeri* is northern New South Wales, extending to Queensland, while *Cloeziana* is endemic to Queensland and *oligantha* to the Northern Territory.

C. PORANTHEROIDEae (32).

Small globular anthers, gland at top, filament at base or nearly so.

I coined this term because the members of it have a good deal of resemblance to the Porantherae of Bentham (B.Fl. iii, 191). Bentham includes *E. polyanthemos* and *E. uncinata* (which I place under Terminales) and also *E. stricta.* I add a number of species.

The Porantheroideae are closely allied to the Terminales; indeed at one time I looked upon them as "nearly-Terminales," or "semi-Terminales." In the vast majority of cases Eucalyptus anthers do not open by pores in the sense of Kerner ii, 92 (figs. 8, 11, 12, 14); they are rather slits. As a group, we have a higher percentage of true pores in the Terminales than in any other.

E. acacioides.	*E. hemiphloia.*
E. albens	*E. Hillii.* (N.B. This is therefore allied to the Boxes rather than to the Bloodwoods, as far as Anthers are concerned.)
E. Behriana.	
E. bicolor. (Some show affinity to the Terminales.)	
	E. hybrida.
E. Boormani.	*E. leptophleba.*
E. Bosistoana.	*E. melanophloia.*
E. Bowmani.	*E. microcarpa.*

E. Brownii. (Shows affinity to Terminales).	*E. microtheca.*
	E. Normantonensis.
E. Cambageana.	*E. ochrophloia.*
E. crebra.	*E. odorata.*
E. Culleni. (Anther apparently identical with that of *E. crebra.*)	*E. populifolia.*
	E. pruinosa.
E. decipiens. (Shows some affinity to Renantherae.)	*E. rariflora.*
	E. siderophloia.
E. decorticans.	*E. Spenceriana.*
E. drepanophylla.	*E. Staigeriana.*
E. fruticetorum.	*E. Thozetiana.*

The above list is preponderatingly one of "Boxes," but it includes a number of Ironbarks, viz., *crebra, Culleni, decorticans, drepanophylla, melanophloia, siderophloia, Staigeriana.* In addition it includes *Boormani* and *hybrida,* which are reputed Box-Ironbark hybrids. All the above affords evidence in support of the view that many Boxes and Ironbarks are closely related, and also that they cross with considerable facility.

The species, almost without exception, are Eastern Australian.

D. TERMINALES (16).

Anthers with terminal pores, erect or oblique on the filament.

Boxes, although the character of the bark on the butt varies from sub-fibrous to hard-flaky, and also to distance up the trunk.

E. Blackburniana.	*E. leucoxylon.*
E. Baueriana.	*E. melliodora.*
E. conica.	*E. polyanthemos.*
E. Dawsoni.	*E. Rudderi.*
E. fasciculosa.	
Ironbark-Box.—	
E. affinis.	
Ironbarks.—	
E. Caleyi.	*E. sideroxylon.*
E. paniculata.	
Mallees.—	
E. angusta. (Anthers immature but undoubtedly terminal.)	*E. leptophylla.*
	E. uncinata.

This kind of anther is preponderatingly Eastern Australian, and commonest in New South Wales. *E. angusta, uncinata* are Western Australian, while *fasciculosa, leucoxylon,* and *leptophylla* are commonest in South Australia, and *Blackburniana* is Victorian.

Bentham, 1866, says, under Renantherae: “The truncate anthers of *E. leucoxylon* and a few others among the Heterostemones sometimes open out when old so as to assume almost the appearance of the Renantherae.” (B.Fl. iii, 189.)

This does not, however, cause any real confusion between the Terminales and the Renantherae.

Under Heterostemones we have . . . . “anthers of the perfect ones small, globular or truncate.” (p. 190.)

E. leucoxylon.—“Anthers very small, truncate, with contiguous cells opening in *terminal* pores or short oblong slits, sometimes at length confluent.” (p. 210.)

E. melliodora.—“Stamens about two lines long, the outer ones rather longer and anantherous, anthers of the others small, with contiguous cells opening in *terminal* pores, sometimes at length confluent.” (p. 210.)

E. paniculata.—“. . . . Anthers of the perfect ones small, at first truncate, the cells opening in *terminal* pores or at length spreading out, divaricate and confluent. (p. 211.)

E. uncinata.—“. . . . Anthers very small, nearly globular, with contiguous cells opening in *terminal* pores.” (p. 216.)

In Part XIV, p. 143, speaking of *E. uncinata,* I state : “The anthers are not terminal-truncate like those of *E. melliodora, paniculata,* and others, but (see Fig. 1*b,* Plate 62) of an allied and peculiar shape, for which I propose the name semi-truncate.” On further consideration I find the anthers of *E. uncinata* are not really different from those of the remainder of the Terminales.

Bentham therefore uses the words “truncate” and “terminal” in regard to such anthers, preferring the word terminal, which led me to adopt the term “Terminales” in the year 1916.

E. polyanthemos.—“. . . . Anthers small, with globular distinct cells, opening in round pores.” (B.Fl. iii, 214.) He makes no mention of truncate or terminal. They are, however, referred to as “truncated” in “Eucalyptographia.” McClatchie (Kinney) refers to them as “Anthers truncated, opening at the summit,” but includes them in his Porantherae.

Mueller, neither in his “Eucalyptographia,” nor in any other work, appears to have decided upon a name for this class of anther. Indeed, he includes it in his Porantherae, and refers to the anthers of various species in different forms of words. I will begin with those species already dealt with by Bentham, giving both shape and dehiscence.

E. leucoxylon.— “Very minute, nearly as broad as long, upwards dilated; opening towards the summit with short slits.”

E. melliodora— “Very minute, nearly as broad as long, upwards dilated; opening near the summit with pores or short slits.”

E. paniculata.— “Minute, quadrangular-roundish; opening with pores at the truncated summit.” (The “Eucalyptographia” plates of the last two species do not, however, show terminal pores as indicated.) Then we have—.

E. polyanthemos.— “Truncated; opening by terminal pores.” (They are so figured.)

E. uncinata.— “Opening towards the summit with lateral pores.” (He has figured them with what I may term north-west and north-east pores.)

He mistakenly adds *E. goniocalyx* in the following passage: “Almost oval, upwards slightly dilated, and at the summit truncated,” but there must be some misapprehension, for the figure shows the anther to be Macrantherae, where it properly belongs.

1895.—A. J. McClatchie, in Abbot Kinney's “Eucalyptus,” describes *E. leucoxylon, E. melliodora,* and *E. paniculata* as with anthers truncated, opening at the summit.

Under *E. sideroxylon* at Part XII, p. 83 of the present work, I have published a note on “Anthers with terminal pores.”

E. PLATYANTHERae (17), with two sub-sections—

(*a*) Graciles (4).
(*b*) Pyriformes (5).

Broad, thick, white anthers, the cells parallel or nearly so, sometimes a little wider at the base, the gland visible at the top or slightly at front. Filament at the base.

The anther of *E. oleosa* may be taken as the type.

The section is nearest to the Porantheroideae, in spite of the fact that the gland may be large, and at the back. It includes the following:—

Mallees, or Marlocks, or of doubtful size—

E. cneorifolia. Some confusion has arisen between this species and *E. stricta,* which is explained at Part IX, p. 279. Comparative examinations of fresh material of this species and *E. cneorifolia* should be made.

E. Cooperiana. Opening widely at the sides (a little to the front).

E. Ewartiana.

E. falcata.

E. Gillii.

E. Isingiana. Gland entirely (?) at back.

E. oleosa.

E. orbifolia. Apparently variable, but very little material extant. Is much closer to *E. oleosa* than to *E. pyriformis.*

E. transcontinentalis. Gland large.

E. Websteriana. Opens widely at the sides.

A small Ironbark—

E. Jenseni.

Gums of different sizes—

E. Drummondii.

E. Flocktonioe. Large gland at back (?).

E. Lane-Poolei. Long gland, faintly visible from the back. Cf. *Forrestiana.*

E. salmonophloia. Opens widely at the sides.

E. squamosa. The unique position of the gland, referred to in Part XVII, p. 221, appears to be more apparent than real, on comparison with additional specimens.

E. Umbrawarrensis.

The species are mainly Western Australian, and the majority are endemic in the State. Exceptions are *cneorifolia* and *Gillii,* which are South Australian, *Umbrawarrensis,* belonging to the Northern Territory, while *squamosa* belongs to a limited area in coastal New South Wales.

(*a*) Sub-section Graciles (4).

(Named from the best-known member of the Sub-section.)

Very large white anthers, opening obliquely, filament at base, gland small or absent, cells widely opened with parallel slits.

E. calycogona.	*E. gracilis.*
E. celastroides.	*E. Pilligaensis.*

E. calycogona, celastroides, and *gracilis* are species so closely allied that botanists followed Bentham in combining them, and only during the last few years have I shown that they should be kept apart.

(*b*) Sub-section Pyriformes (5).

Anthers in shape a truncated cube or nearly spheroid; filament at base gland in front, the cells widely opened to the base.

E. leptopoda (?). Sometimes broadish at the base, but not normal.	*E. pachyphylla.*
	E. Oldfieldii.
E. macrocarpa.	*E. pyriformis.*

These are Western Australian species (with a wider area for *pachyphylla*). The anther is peculiar in shape and nearest to the Platyantherae.

F. MACRANTHERae.

Anthers opening in parallel slits. The gland at the back, sometimes showing in front also. The filaments generally attached beneath the gland half-way up or less. Versatile as a rule.

This is a very large group, and it may be subdivided in the following manner:—

1. Tereticornes.

Anther lobes not quite parallel, and approximately as broad as long, but frequently longer in proportion.

Leiophloioe—

E. accedens (W.A.).	*E. Dalrympleana.*
E. adjuncta.	*E. dealbata.*
E. amplifolia.	*E. Deanei.*
E. Bancrofti.	*E. Dundasi.*
E. Blakelyi.	*E. Dunnii.*
E. canaliculata.	*E. globulus.*
E. cladocalyx.	*E. goniocalyx.*
E. confluens.	*E. grandis.*
E. cordata.	*E. Gunnii.*
E. corrugata.	*E. Houseana.*
E. cosmophylla.	*E. intertexta.*
E. Johnstoni (*Muelleri*).	*E. punctata.*
E. Kitsoniana.	*E. rostrata.*
E. maculosa.	*E. rubida.*
E. Maideni.	*E. saligna.*
E. Mooreana.	*E. scoparia.*
E. pallidifolia.	*E. Seeana.*
E. Parramattensis.	*E. Le Souefii* (W.A.).
E. Perriniana.	*E. Stricklandii* (W.A.).
E. proecox.	*E. tereticornis.*
E. propinqua.	*E. viminalis.*

Hemiphloioe—

E. aggregata.	*E. nitens.*
E. argillacea.	*E. ovata.*
E. Banksii.	*E. Macarthuri.*
E. cinerea.	*E. papuana.*
E. foecunda.	*E. quadrangulata.*
E. gamophylla.	*E. Yarraensis.*
E. Howittiana.	

Rhytiphloioe—

E. acacioeformis.	*E. longifolia.*
E. angophoroides.	*E. notabilis.*
E. botryoides.	*E. robusta.*
E. eloeophora.	*E. rudis* (W.A.).
E. exserta.	*E. Stuartiana.*
E. Jacksoni.	*E. Studleyensis.*
E. Kirtoniana.	*E. torquata.*

Mallees and Marlocks—

E. angulosa.	*E. Kruseana.*
E. Baeuerleni.	*E. Morrisii.*
E. conglobata.	*E. neglecta.*
E. decurva.	*E. parvifolia.*
E. doratoxylon.	*E. Pimpiniana.*
E. dumosa.	*E. pulverulenta.*
E. grossa.	*E. vernicosa.*
E. incrassata.	

Lepidophloioe—

E. ferruginea.	*E. urnigera.*
E. Herbertiana.	*E. Yagobiei.*
E. McIntyrensis.	

Miscellaneous (4).

These anthers all open in parallel slits. They have a large gland at the back showing in front when the anther is young. In *E. megacarpa* after dehiscence the anther recurves.

E. diversicolor. (The anther depicted at fig. 14, Plate 86, is wrong, and I cannot find the material from which it was stated to have been drawn.)	*E. goniantha.*
	E. megacarpa.
	E. Woodwardii.

These are Western Australian species, *diversicolor* and *megacarpa* from the well-watered south-west.

2. Longiores.

Longer than broad; long narrow anthers.

These may be called long anthers, and they include the majority of those which follow:—

(i) Corymbosae.

(The Corymbosae of B.Fl. iii, 198.)

E. Abergiana.
E. calophylla.
E. Cliftoniana.
E. collina.
E. corymbosa.
E. dichromophloia.
E. eximia.
E. ficifolia.
E. Foelscheana.
E. hoematoxylon.
E. intermedia.
E. latifolia.
E. maculata.
E. peltata.
E. perfoliata. (Anthers very small.)
E. ptychocarpa.
E. pyrophora.
E. setosa.
E. Stricklandi.
E. terminalis.
E. Torelliana.
E. trachyphloia.
E. Watsoniana.

(*a*) Intermediate in character.

E. corymbosa (some). *E. trachyphloia.*
E. pyrophora.

(*b*) A little less long and somewhat anomalous.

E. miniata. *E. phoenicea.*

(ii) Non-Corymbosae.

(*a*) Miscellaneous. Embodying extra characters.
(*b*) Papery fruits (Clavigerae).
(*c*) Serrulate filaments (Cornutae).
(*d*) Stamens in four clusters (Eudesmieae).

(*a*) Miscellaneous.

E. alba.

E. diptera. (See Part XVI, p. 203. Affinity in anther with *E. Campaspe* and *E. torquata.*)

E. erythronema.

E. gomphocephala.

E. Griffithsii.

E. pellita. It is interesting to find an anther of this species in this section, in view of the fact that the mature leaves have some affinity with the Corymbosae in the venation.

E. redunca.

E. resinifera. (See remarks under *E. pellita.*)

E. tetraptera. Very long white anther.

E. Campaspe and *E. salubris.* These two species have long white anthers, opening completely down each side, the gland or connective showing back and front from the apex to the base. Filament at the base. The anther has the appearance of being four-sided, the empty anther cells and the back and front all looking alike.

(*b*) Clavigerae.

E. aspera.	*E. grandifolia.*
E. clavigera.	*E. tesselaris.*

(*c*) Cornutae.

With crisped or polygonal-serrulate filaments. See fig. 9*b,* Plate 88. (The Cornutae of B.Fl. iii., 195.)

E. annulata.	*E. micranthera.*
E. cornuta.	*E. occidentalis.*
E. eremophila.	*E. platypus.*
E. Lehmanni.	*E. spathulata.*
E. macrandra.	*E. Stowardi.*

(*d*) Eudesmieae.

Stamens often in four clusters. (The Eudesmieae of B.Fl. iii., 199.)

E. Baileyana.	*E. odontocarpa.*
E. Ebbanoensis.	*E. similis.*
E. erythrocorys.	*E. tetrodonta.*
E. eudesmioides.	*E. tetragona.*
E. lirata.	

While on the subject of Anthers, it is proper to say that I am more indebted to Miss Flockton than to anyone else for co-operation in regard to them. Twenty years ago we used to work together on these organs almost every day, and separated out, after discussion (Miss Flockton figured them) no less than precisely forty kinds of anthers, based on size, shape, dehiscence, gland, attachment of filament—indeed, everything we could think of. Later on it was found that there was a good deal of variation in anthers attributed to the same species, and that they changed according to age. With the experience we gained, it was found to be desirable to reduce the sections to the present number, and although I am responsible for this, I have had the advantage of the co-operation of Miss Flockton at every stage. Without her facile pencil it would have been impossible to have taken comprehensive views of them, and for this over 2,000 detailed drawings were necessary. The subject has not been absent from our minds for any length of time during these twenty years, and we find it is most puzzling, and there is a good deal of variation in anthers, as, indeed, in every organ in Eucalyptus. The classification offered will form a basis for further investigation, which should be made, as far as possible, on perfectly fresh material. At the same time it will be necessary to work upon material of various degrees of age.

Shape.

Bentham, Flora Australiensis. In the Group Renantherae, since it refers to the shape of the anther, Bentham has not found it necessary to repeat this word or "reniform." Following are exceptions:—

Reniform—

E. coccifera.	*E. macrorrhyncha.*
E. diversifolia.	*E. marginata.*

Reniform or broad—

E. pilularis.

Small reniform—

E. coriacea.	*E. stellulata.*

In the other groups he only uses the words "ovate" or "oblong." Ovate—

E. alpina.	*E. pachyloma.*
E. dealbata.	*E. pallidifolia.*
E. diversicolor.	*E. patens.*
E. exserta.	*E. phoenicea.*
E. falcata.	*E. Preissiana.*
E. globulus.	*E. pyriformis.*
E. goniocalyx.	*E. saligna.*
E. Gunnii.	*E. vernicosa.*
E. orbifolia.	*E. viminalis.*

Small ovate—

E. goniantha.	*E. rostrata.*
E. oleosa.	*E. tereticornis.*

Small, but ovate—

E. cinerea. E. pulverulenta.

Rather small, but ovate—

E. cosmophylla.

Ovate or almost globose—

E. leptopoda.

Ovate-oblong—

E. cordata.	*E. longifolia.*
E. doratoxylon.	*E. megacarpa.*
E. grossa.	*E. pellita.*

Ovate or oblong—

E. macrocarpa. E. rudis.

Ovoid-oblong—

E. botryoides. E. robusta.

Oblong—

E. cornuta.	*E. Oldfieldii.*
E. erythronema.	*E. platyphylla.*
E. gomphocephala.	*E. redunca.*
E. miniata.	*E. tetraptera.*

Mueller ("Eucalyptographia").

In dealing with the *Renantheroe,* he calls them "kidney-shaped," "cordate kidney-shaped," "renate," and includes under the names "renate" and "cordate" the following species which are not usually included in the Renantherae, viz., *E. decipiens, Howittiana.* It will be seen that he has a great play of adjectives and adverbs.

Kidney-shaped—

E. acmenioides.	*E. piperita.*
E. obliqua.	*E. stricta.*
E. pilularis.	

Very small, nearly kidney-shaped—

E. amygdalina.

Almost kidney-shaped—

E. coriacea.

Almost kidney-shaped, pale—

E. Sieberiana.

Roundish or somewhat renate—

E. decipiens.

Cordate kidney-shaped—

E. buprestium.	*E. marginata.*
E. hoemastoma.	*E. stellulata.*
E. macrorrhyncha.	

Broadly cordate or somewhat kidney-shaped—

E. capitellata.

Kidney-shaped or verging to a cordate form—

E. eugenioides.

Renate-cordate—

E. Raveretiana.

Roundish cordate—

E. santalifolia.

Ovate or roundish cordate—

E. Planchoniana. *E. sepulcralis.*

Nearly heart-shaped—

E. Todtiana.

Very minute, almost heart-shaped—

E. microcorys.

Minute, cordate- or renate-globular—

E. Howittiana. (The anthers do not, however, belong to the Renantherae; see figs. 8*b,* 8*c,* Plate 135.)

Now we come to the species *other than Renantherae,* classified into shapes.

Roundish—

E. salmonophloia.

Globular—

E. bicolor.

Ellipsoid—

E. occidentalis.

Narrow-ellipsoid—

E. cornuta.

Oblong—

E. gomphocephala.	*E. redunca.*
E. obcordata.	

Narrow-oblong—
E. Watsoniana.
Oblong, nearly basifixed—
E. erythronema.
Oblong or wedge-shaped oval, with a broad connective—
E. resinifera.
Almost oblong, but upwards broader—
E. punctata.
Oval—

E. Abergiana.	*E. ptychocarpa.*
E. eximia.	*E. saligna.*

Oval club-shaped—
E. maculata.
Oval, terminated by a black-purple gland—
E. tetraptera.
Nearly or almost oval—

E. botryoides.	*E. pyriformis.*
E. cladocalyx.	*E. Stuartiana.*
E. Gunnii.	*E. tereticornis.*
E. macrocarpa.	

Almost oval, upwards slightly dilated, and at the summit truncated—
E. goniocalyx.
Ellipsoid-oval, with dorsally broadish connective—
E. miniata.
Oblong-oval, blunt—

E. corymbosa.	*E. robusta.*
E. clavigera.	*E. setosa.*
E. globulus.	*E. tesselaris.*
E. megacarpa.	*E. tetrodonta.*
E. peltata.	

Oval-oblong, almost basifixed—
E. salubris.
Roundish or blunt oval—
E. phoenicea.
From roundish oval to almost oblong—
E. incrassata.

Ovate-cordate—

E. alpina. *E. patens.*

Globular-cordate—

E. Oldfieldii.

Almost heart-shaped—

E. diversicolor.

From cordate to nearly oblong-ovate, short-lobed at the base—

E. Preissiana.

Cordate-oval—

A*E. erythrocorys.*

Cuneate- or oval-oblong—

E. alba. *E. longifolia.*
E. calophylla.

Almost cuneate-ovate or the inner more oblong, and the outer slightly cordate—

E. Foelscheana.

Nearly or almost ovate—

E. cinerea. *E. pachyphylla.*
E. cordata. *E. rostrata.*
E. cosmophylla. *E. viminalis.*
E. foecunda.

Ovate, with contracted base—

E. rudis.

Ovate, somewhat truncated—

E. trachyphloia.

Ovate-ellipsoid—

E. ficifolia.

Roundish-ovate—

E. populifolia.

Roundish-ovate or almost globular—

E. oleosa.

Minute, oval-globular—

E. tetragona.

Very minute, nearly globular—

E. Behriana.

Minute, roundish-ovate or almost globular—

E. microtheca.
Very minute, almost globular—
E. uncinata.
Very minute, globular—
E. hemiphloia.
Very minute, roundish—

E. crebra. *E. siderophloia.*

Very minute, nearly oval—
E. doratoxylon.
Very minute, cordate or ovate roundish—
E. gamophylla.
Very minute, roundish or verging into a kidney-shaped form—
E. gracilis.
Minute, almost globular—
E. pruinosa.
Minute, roundish—
E. odorata.

Size.

Bentham rarely mentions size, and in the few examples he quotes, where he quotes Shape in addition, it is almost invariably globular. Following are the examples:—

Very small and globular—

E. decipiens.	*E. oligantha.*
E. decurva.	*E. pruinosa.*
E. hemiphloia.	*E. stricta.*
E. microtheca,	

Very small, nearly globular—

E. cneorifolia.	*E. siderophloia.*
E. drepanophylla.	*E. uncinata.*

Small, globular—
E. Behriana.
Small, with two globular cells—
E. bicolor.
Rather small—
E. Drummondi.

Very small—
E. odorata.
Very minute—
E. micranthera.
Small—

E. hoemastoma. E. microcorys
E. melliodora.

Small, at first truncate—
E. paniculata.
Broad and flat—
E. buprestium.

Dehiscence.

Bentham (B.Fl. iii, 185) says:—". . . . opening in longitudinal slits or rarely in terminal pores. . . . "

Renantheroe.—"Anthers reniform or broad and flat, the cells divergent or at length divaricate, contiguous and usually confluent at the apex." (p. 189.) [The apertures are in fact slits which are roughly parallel with the dorsal sides of the reniform anther. In other words, they are curved. J.H.M.]

Heterostemones.—". . . . opening in pores or oblong slits, sometimes extending at length confluent." (p. 190).

Porantheroe.—". . . . opening in small circular pores, sometimes extending at length into oblong slits." (p. 191).

Micrantheroe.—". . . . with globular distinct cells opening in lateral slits." (p. 192).

Normales.—". . . . opening longitudinally." (p. 193).

Then coming to individual species, we have:—

E. gracilis. "Circular or oblong pores."
E. paniculata. "Terminal pores."
E. hoemastoma. "Short oblong divergent at length confluent slits."
E. pruinosa. "Short slits or circular pores."
E. oligantha. "Circular pores or very short slits."
E. Behriana. "Circular pores, rarely at length confluent."
E. bicolor, E. odorata. "Round pores or short oblong slits."
E. uncinata. "With contiguous cells opening in terminal pores."
E. hemiphloia. "In pores rather than in slits."
E. decipiens. "In round pores which become at length longitudinal slits."
E. albens. "Opening at length to the base or nearly so."

E. siderophloia. “Opening at first in oblong slits, extending at length to the base or almost confluent.”

E. crebra. “Opening longitudinally to the base.”

The “opening longitudinally of the Normales” is usually supplemented in each species with “distinct parallel cells.” This includes the majority of the anthers, and Mueller subsequently made it a separate group under the name of Parallelantherae.

Mueller (“Eucalyptographia”). I have been very carefully through this work, and have classified Mueller's descriptions of dehiscence according to the terms he uses. Thus those with divergent slits fall very well into Bentham's Renantherae (see his qualifying note at end), and those with pore-like slits or pores come very well into the Porantherae, except *pruinosa,* which is Strongylantherae. It is when we get to Strongylantherae and Orthantherae that there is difficulty.

Renantherae.

“Divergent slits.”

E. acmenioides.	*E. pilularis.*
E. amygdalina.	*E. piperita.*
E. eugenioides.	*E. stricta.*

“Very diverging slits.”

E. coriacea (pauciflora).

“Much diverging slits.”

E. stellulata.

“The outer ones opening by divergent short slits, the inner ones by more roundish large pores.”

E. buprestium.

“Upward confluent slits.”

E. sepulcralis.

“Slits.”

E. microcorys.

Although the following are placed under Renantherae, Mueller has the note under Strongylantherae. “The following are transits to Strongylantherae—*santalifolia, Oldfieldii, Todtiana, sepulcralis, alpina.*”

Porantherae (according to Mueller).

“Opening laterally by pore-like apertures.”

E. Behriana.	*E. hemiphloia.*
E. bicolor (largiflorens).	*E. odorata.*
E. gracilis.	

"Below the summit by pores or abbreviated slits."

E. populifolia.

"Lateral pore-like slits."

E. pruinosa (Strongylantherae).

"Towards the summit with lateral pores."

E. uncinata.

Orthantherae (Mueller). In the following list, where there is no letter, Orthantherae may be assumed; where there is the letter (S), it is a member of Mueller's Strongylantherae.

"Longitudinal slits."

E. alpina.
E. botryoides.
E. cinerea (pulverulenta).
E. cladocalyx.
E. clavigera.
E. cordata.
E. cornuta.
E. cosmophylla.
E. doratoxylon (S).
E. occidentalis.
E. pachyphylla.
E. phoenicea (S).
E. Planchoniana (S).
E. Preissiana.
E. ptychocarpa.
E. Raveretiana (S).
E. resinifera.
E. robusta.
E. rostrata.
E. erythrocorys.
E. eximia.
E. ficifolia.
E. Foelscheana.
E. gamophylla (S).
E. goniocalyx.
E. Howittiana (S).
E. marginata (R).
E. microtheca.
E. salmonophloia (S).
E. Stuartiana.
E. tereticornis.
E. tesselaris.
E. tetragona.
E. tetraptera.
E. tetrodonta.
E. viminalis.
E. Watsoniana.

"Longitudinal at the summit, converging slits."

E. santalifolia (R).

"Longitudinal, almost parallel at the summit, confluent slits."

E. patens (S).

"Longitudinal upwards confluent slits."

E. Todtiana (R).

"Broadish parallel slits or apertures."

E. siderophloia (S).

"Longitudinal slits, enlarged by a conspicuous dorsal terminal gland."

E. diversicolor (S).

"Longitudinal, almost parallel, slits."

E. saligna.

"Longitudinal parallel slits."

E. setosa.

"Parallel slits."

E. alba (S).	*E. miniata.*
E. foecunda.	*E. peltata.*
E. gomphocephala.	*E. redunca.*
E. maculata.	*E. rudis.*
E. megacarpa.	*E. trachyphloia.*

"Nearly longitudinal dehiscence."

E. Abergiana.

"Ample longitudinal slits."

E. crebra (S). *E. incrassata* (S).

"Wide longitudinal slits."

E. Oldfieldi (R).

"Parallel longitudinal slits."

E. calophylla.	*E. longifolia.*
E. corymbosa.	*E. obcordata.*
E. globulus.	*E. punctata.*
E. Gunnii.	

"Broad slits in their whole length."

E. oleosa.

"Short broad marginal slits."

E. decipiens (S).

"Whole length by almost marginal slits."

E. erythronema.

"Marginal slits."

E. macrocarpa.	*E. salubris.*
E. pyriformis.	

Sections.

Under *E. tetraptera* in "Eucalyptographia" Mueller writes :—

"The bye following lithographic plate presents transverse anther-sections of many Eucalypts pertaining to Bentham's series Normales (Parallelantherae) to which also *E. tetraptera* belongs. These lithographs give readily an idea of the relative width, the distance of the dehiscence-lines and the curvature of the valves peculiar to the anthers of the various species; and thus at a glance the size and form of the connective may be contrasted. In a similar manner hereafter sections of the Renantherae, Heterostemones, Porantherae and Micrantherae will be provided, to be followed by full drawings of the anthers of many different species of all the series, side by side."

(These promises were only carried out as below. J.H.M.)

Mueller proceeds: "Transverse sections of anthers of various Eucalypts. (Series Normales, diametric augmentation, 28 times.)" Then follows a list of fifty-eight species.

Under *E. populifolia,* he says :—

"The bye-following lithographic plate represents diagrams of anthers (after dehiscence) of many Eucalypts pertaining to Bentham's series Renantherae, Heterostemones (Hemiantherae), Porantherae and Micrantherae, in continuation of the transverse anther-sections (solely of the Parallelantherae) given with *E. tetraptera* in the second decade. (Diametric augmentation 28 times.")

Then follows numbers 59 to 105.

The value of these drawings is greatly diminished by the absence of any key or descriptive matter whatever. If the section is cut through the centre of the anthers, it may not traverse the centre of the gland or connective. Nor do we know the botanical history of the stamens employed. If a drawing is worthy of presentation, it is worthy of ample description.

Number of Stamens.

Bentham (B.Fl. iii. 185) speaks of "stamens numerous, in several series, free or very rarely very shortly united at the base into 4 clusters." The only specific references he makes, so far as I see, are: "Exceedingly numerous," *E. gomphocephala,* and "very numerous," *E. orbifolia.*

Mueller ("Eucalyptographia"), in defining the genus, speaks of the stamens as "very numerous." I do not find any references under species. Obviously the flowers of some species have more stamens than those of others, apparently connected with the thickness of the filaments or the size of the flowers (*e.g., E. macrocarpa*), but I have made no count, and I do not know anyone who has.

Pollen.

In my "Forest Flora of New South Wales," Part LXIV, pp. 188–9, I have some notes on pollen in Eucalyptus, which show that very little has been published on the subject. In addition to the illustrations of Pollen-grains in Edgeworth's work, see those in Kerner and Oliver II, fig. 217, &c., and it is charming to read the chapters in that work under the headings of "Pollen," "Protection of Pollen," "Dispersion of

Pollen by Animals," "Allurements of Animals with the view to the dispersion of Pollen."

"Although they possessed very imperfect means of observation, our predecessors were nevertheless struck by the variety of the pollen grains. Adanson, who pushed his mania for classification so far as to produce sixty-five, and who based them on the first things which struck him, even the smell and taste of plants, did not omit to form a classification based on the configuration of the pollen." Adanson, *Familles des Plantes,* Paris, 1763, preface, p. 286 (Pouchy, p. 276).

No doubt the matter will attract the attention of a botanist skilled in the use of the microscope, in due course. To what extent the pollen-grains of Eucalyptus display variation, and indeed what are their sizes, shapes, and sculpture, we are almost entirely ignorant.

Filament.

Position in Bud.

Bentham (B.Fl. iii) does not frequently refer to the above, but Mueller ("Eucalyptographia") does. I quote Bentham's references:—

E. alpina.—Much inflected.

E. redunca.—More or less inflected in the bud.

E. tereticornis.—More or less inflected in the bud, but sometimes only very shortly so at the ends.

E. macrocarpa.—Connivent (converging) and inflected at the end.

E. siderophloia—Hardly inflected.

Bentham's Subseries Cornutae of Normales includes as one of its characters "Stamens erect or flexuose (having turns or windings or bendings, J.H.M.) in the bud, but not inflected." This includes:—

E. Lehmanni (Erect in bud as in *E. cornuta*).

E. cornuta (Erect or slightly flexuose in bud, but not inflected).

E. annulata (Straight as in *E. cornuta*).

E. platypus, E. macrandra, E. occidentalis (Erect as in *E. cornuta*).

E. spathulata (Erect, slightly flexuose).

Though not in the same Subseries, we may add—

E. leptopoda "Flexuose."

E. marginata "Very flexuose, but not inflected in the bud."

It may be desirable to consider what different authors mean by "flexuose." If we turn to "Eucalyptographia" we see illustrations of a waviness or flexuosity (a comparatively gross character) in a number of species, but this must not be confused with the minute crimpiness or waviness of each filament, particularly observable in the Cornutae.

The inflection is so sharp in some species as to be referred to in the vernacular as a “kink.” Bentham has the following notes on four species:—

E. uncinata.—Filaments inflected with an acute angle, as in *E. corynocalyx* and *E. decurva.* (See fig, 8*b,* Plate 62.)

E. micranthera.—Inflected, sometimes almost as acutely so as in *E. corynocalyx* and *E. uncinata.*

E. corynocalyx.—Filaments . . . acutely inflected in the bud as in *E. uncinata:*

E. decurva.—Acutely inflected as in *E. uncinata* and *E. corynocalyx.*

(I have added *E. falcata;* also *E. leptophylla,* until recently confused with *E. uncinata.*)

Mueller (“Eucalyptographia”). In the definition of the genus we have “ . . . filaments all inflexed while in bud or rarely the outer or very seldom all filaments straight before expansion.”

The inflexion, or absence of it, is a question of length of operculum. Mueller realises this, when, under *E. occidentalis,* he says:—

“Inflection of filaments not an absolute specific character, as they accommodate themselves in *E. tereticornis* according to the length of the operculum, being quite straight in bud when the lid is so elongated as to allow them full space.” Also, under *E. rostrata,* he says: “The filaments are also often straight while in bud, as in *E. cornuta* and its allies, through not being forced to inflexion within the long cavity of the lid.”

In this work, Part VII, p. 198, under *E. diversifolia* (*santalifolia* of Mueller) a passage is quoted from the “Eucalyptographia,” saying “The cardinal characteristics of *E. santalifolia* rests in the position of the stamens before their expansion,” &c., with a reference to those of *E. Planchoniana.* I have examined the filaments of these two species, but have failed to find any distinct bend in the lower portion of the filament. In a dry state many are flexuose, while others are straight.

Mueller's favourite words concerning the bending of the filaments are “inflexed” (or incurved) “while in bud.” They have not been repeated in the following notes on species:—

E. clavigera.—Deeply inflexed.

E. erythronema.—Sharply inflexed.

E. gracilis.—Strongly inflexed.

E. salubris.—Rather sharply bent inward.

E. uncinata.—Filaments suddenly and sharply inflected, but not flexuous.

E. rudis, E. redunca.—Inflexed, except some of the outermost. *E. microtheca.*—

Inflexed, except some of the outermost. Stamens very short.

E. siderophloia, E. salmonophloia.—Outer filaments not inflexed.

E. pyriformis.—The outer only incurved at the apex.

E. gomphocephala.—Outer stamens almost straight in bud, inner stamens more or less inflexed.

E. Oldfieldii.—Not inflexed, inner stamens only slightly bent inward while in bud.

E. macrocarpa.—The inner much inflexed.

E. santalifolia.—Filaments ascendant, not inflexed.

E. oleosa.—Flexuose and inflexed.

E. Howittiana.—Flexuose and towards the summit bent inwards.

E. ficifolia.—Inflexed and dependent.

E. cornuta.—Not inflexed.

E. obcordata, E. occidentalis.—Straight.

E. marginata.—Not bent back, but the figure shows the inner ones inflexed.

Naudin in 1891 noted that the shape of the operculum determines the bending, or otherwise, of the filament.

"When it is short, which is the ordinary case, the stamens, always very numerous, and pressing one against the other, bend themselves back towards the centre of the flower; they remain straight when the very elongated operculum leaves them a free field; for example in *E. cornuta* and *E. Lehmanni.*" (Naudin, Mem. II, 13.)

I have neither figured nor described the inflexion of the stamens, as Mueller has done, as it seemed to me dependent on the length of the operculum, as already stated.

Crimpiness in Cornutae.

The original description of *E. Lehmanni* says, "Filaments quadrangular filiform." (Schauer.)

Bentham (*ante,* p. 195), speaks of the Cornutae having "flexuose" filaments.

Mueller, in "Eucalyptographia," under *E. cornuta,* says, "always quite straight in bud, except slight flexuosities, as noted by the author in 1865," and, under

E. occidentalis. "Filaments thicker than those of very many other congeners, rather bristly than capillary . . . dotted with oil glands."

"We have in *E. macrandra* not only angular filaments (as occur in most of the Cornutae), but these are crinkly or bent, and in each bend is an oil-gland or a resinous mass. In filaments which are truly thread-like, where there are glands, they stand out like tubercles (*e.g., E. megacarpa,* fig. 6*b,* Plate 78); but in the Cornutae, while studding the surface of the filament, they do not appear to project beyond its outline." (This work, Part XXXVI, p. 153.)

This crimpiness is also figured in fig. 9*b*, Plate 88 (*E. micranthera*).

This polygonal character of the filaments (in contradistinction to the terete or filiform appearance of those of most species) seems to be a consequence of tight packing in the operculum, and it is accompanied by serrulations along the margins.

This serrulation is not to be confused with the much coarser bendings known as "flexuose" of terete filaments. Bentham speaks of those of the Cornutae (as a whole) being "flexuose," and, in detail, as "slightly flexuose," but it seems to me that the Cornutae should be treated as a group by themselves, with filaments "polygonal-serrulate."

Length.

Bentham, 1866.—"The dimensions given for the stamens refer to the outer ones; the inner ones are almost universally gradually shorter." (B.Fl. iii, 187.)

Bentham seems to have been the only botanist who systematically mentions the length of the filaments. The measurements have, however, limited diagnostic value.

Following are the measurements he gives, varying from a line to an inch:—

1–2 lines.—

E. bicolor. *E. microtheca.*

Not 2 lines.—

E. Behriana. *E. leptopoda.*

Not above 2 lines.—

E. stellulata. *E. stricta.*

About 2 lines.—

E. cneorifolia.	*E. pallidifolia.*
E. drepanophylla.	*E. piperita.*
E. exserta.	*E. rostrata.*
E. hemiphloia.	*E. uncinata.*
E. melliodora.	

2 to nearly 3 lines.—

E. Gunnii. *E. pruinosa.*

2 or 3 lines.—

E. buprestium.	*E. oleosa.*
E. capitellata.	*E. oligantha.*
E. cinerea.	*E. pilularis.*
E. coriacea.	*E. saligna.*
E. doratoxylon.	*E. siderophloia.*
E. odorata.	

2–3 lines or rather more.—

E. falcata.	*E. paniculata.*

About 3 lines.—

E. coccifera.	*E. patens.*
E. dealbata.	*E. Risdoni.*
E. goniocalyx.	*E. virgata.*

At least (or fully) 3 lines.—

E. diversifolia.	*E. urnigera.*
E. obliqua.	

About 3 lines or rather more.—

E. botryoides.

3–4 lines.—

E. cordata.	*E. pulverulenta.*
E. marginata.	*E. redunca.*
E. platyphylla.	*E. rudis.*

Nearly 4 lines.—

E. gomphocephala.

4–5 lines.—

E. goniantha.

4–6 lines.—

E. cosmophylla.	*E. robusta.*

Nearly 1/2 inch (*i.e.,* 6 lines).—

E. miniata.	*E. tetraptera.*
E. tereticornis.	

About 1/2 inch.—

E. grossa.	*E. pellita.*
E. megacarpa.	*E. phoenicea.*

E. Drummondii.

Fully 1/2 inch.—

E. longifolia.

1/2 inch or more.—

E. pachyloma.

Above 1/2 inch.—

E. globulus.

6–8 lines.—

E. Preissiana.

Often 3/4 inch or rather more—

E. pyriformis.

About 1 inch.—

E. macrocarpa.

Also we have the somewhat vague references :—

2–3 lines long, the outer ones longer.—

E. haemastoma.

Outer ones about 3 lines long, inner ones much shorter.—

E. microcorys.

The outer ones often above 1 inch long, the inner ones much shorter.—

E. cornuta.

Stamens usually very unequal, the outer ones often 1/2 inch long or more, the inner much shorter.—

E. leucoxylon.

Perfect stamens shorter.—

E. gracilis.

Inner ones shorter.—

E. microcorys.

Mueller ("Eucalyptographia") says—

E. cornuta, "Stamens of large flowers to 11/4 inch long."

E. microtheca, "Stamens very short."

Some species have filaments short and stiff, like some brushes. Representative examples are :—

E. bicolor.	*E. oligantha.*
E. Behriana.	*E. populifolia.*
E. Ewartiana (also sparse).	*E. transcontinentalis.*

Perhaps Bentham's observation (B.Fl. iii, 255) under *E. ptychocarpa* of "filaments rigid" refers to a similar state. The filaments of *E. terminalis* are not very long. In certain of the Eudesmieae, as specially explained under *E. erythrocorys* in Part XLV, p. 135, the lengths of the filaments vary a good deal, to bring the anthers up to approximately the same level. This is analogous to variation in lengths of peduncles and pedicels in a Corymb.

E. macrocarpa. For a note in regard to the "arrangement of the filaments in the mass," see Maiden in *Journ. Roy. Soc. N.S.W.,* li, 452–3. The "square-cut" or "straight-sided" appearances obviously depend on the lengths, or apparent lengths, of the filaments, which again depend on the shape of the staminal rings.

Width.

The filament is usually filiform or hair-like. It is rarely that a writer refers to the width, as it is usually not measurable, except by instruments of precision.

E. macrocarpa.—Commonly 4 cm. *long,* flattish, 2 mm. *broad* at the base and gradually tapering into a hair-like process at the point of attachment to the anther. (Flowers grown in Botanic Gardens, Sydney, October, 1919).

E. tetraptera.—The filaments may be described as flattish at the base, and tapering very gradually almost as in *E. macrocarpa.* They are incurved or slightly inflected.

Glands (?).

I believe Mueller ("Eucalyptographia") was the first to draw attention to this character when, under *E. leucoxylon,* he wrote "Filaments. . . . rather thick and somewhat glandular." Under that species at Part XII, p. 90, I wrote—"Note the glands on the filaments (see figs. 1*e,* 1*f,* p. 56.) Mueller first drew attention to this (see his figure in Eucalyptographia.) I have only seen this glandular appearance on *E. leucoxylon* and *E. Caleyi,* and it should be looked for on other species. Diels figures it on his *E. Forrestiana.*" This may be seen in fig. 1*c,* Plate 95. I omitted to figure it in *E. Caleyi.* I have also observed it in *E. megacarpa,* see fig. 6*b,* Plate 78, and also

	Fig.	Plate.
E. Forrestiana	1*c*	95
E. eremophila	7*c*	149
E. macrandra	5*c*	150
E. occidentalis var. *grandiflora*	1*c*	150
E. occidentalis	8*c*	148
	1*d*	149

E. occidentalis var. *astringens*	3*d*	149
E. Stowardi	3*d*	179,

and also (not figured) in filaments of *E. pyrophora* Benth., from near Meda, North-west Australia (W. V. Fitzgerald.) It will be observed that these glandular filaments are common in the Cornutae.

Nectaries.

To what extent the filaments of Eucalyptus assist in elaboration of nectar or honey remains a subject for research. It is still more problematical what are the functions of the glands on the filaments to which we have just referred. We know that a filament is one of many organs that may perform the function of a nectary, and so the present may be taken as a convenient opportunity for some generalisations in regard to Nectaries.

In Henslow's "Origin of Floral Structures," 141 (1888), speaking of the function of nectaries in flowers, he says: "In Violets, *Atragene, Pentstemon,* and *Stellaria,* the filaments undertake the duty," but the examples cited are not identical with what obtains in the filaments of Eucalyptus. Nor does *Fagopyrum,* the genus quoted by Goebel ("Outlines of Classification and Special Morphology," p. 381) as having outgrowths or warts between the filaments come even as close to the character noted in Eucalyptus. Coulter, Barnes, and Cowles, II, 844, remark that nectaries may be connected with the stamens or with any other floral part.

"They are usually very inconspicuous, and—which is very significant with respect to the relation of morphology with physiology—notwithstanding their enormous physiological importance, they are attached to no definite part of the plant in a morphological sense, almost every part is able to perform the function of a nectary." (Sach's "Text-book of Botany," p. 430.)

The subject is discussed in the usually lucid manner of the authors in Kerner and Oliver, II, 170 to 182. At p. 172 we have notes on the secretion of honey through stomata; bracts (p. 173); fleshy disc (p. 173); base of ovary (p. 174); carpels (p. 175). "Nectaries are found much more frequently on the stamens. They occur there in all shapes and sizes." And so on (p. 175.) Floral leaves (p. 176); region of the corolla (p. 177); nectaries interpolated between the floral leaves and the stamens (p. 178).

Speaking of *E. erythrocorys,* Part XLV, p. 135, I refer to. . . . "four equidistant ribs or spoke-shaped processes which enclose four shallow troughs which are filled with honey, and are therefore nectaries." These troughs are morphologically formed by the raised wheel-shaped disc, and the upper portion of the calyx. There is also a deep ovarian nectary around the base of the style. They can easily be seen in the immature fruits of large species such as *erythrocorys, pyriformis, macrocarpa.* They may be mere honey-troughs; on the other hand, these discal surfaces secrete honey (nectar) in other plants besides Eucalyptus. It appears to do so in that genus as well as supplying storage reservoirs.

In *E. erythrocorys* the nectar-trough or honey storage cavity may in addition be a functioning nectary; that is to say, its carnose lining (variously known as "discal lining," "discal space," "discal cavity") exudes or elaborates the nectar. In *E. robusta* there are four or five deep ovarian nectaries, similar, but deeper than those of *E. tetradonta* (which are closely related to *E. erythrocorys*).

The matter is, of course, of direct practical importance to the apiarist, and for that reason alone I hope that the flowers of Eucalyptus will be investigated in this direction at an early date.

Some general notes on the subject will be found on Eucalyptus flowers and honey under *E. hemiphloia* in my "Forest Flora of New South Wales," Part VI, p. 132. In the same work we have "Notes as to the flowering periods of a few Eucalypts," Part LXIV, p. 169, "Honey and Eucalyptus Flowers." The notes are enumerated under States and species (p. 177–188.) There are useful articles on "Bee-keeping and Forests," by W. Somerville in "Jarrah," Aug., 1920, p. 19, and "Flowering of Eucalypts" (W.A.) in "The Australian Forestry Journal," June, 1921, p. 173.

Mr. Max Koch told me that he has heard it said by orchardists that when *E. calophylla* is in full bloom, every other year or so, the fruit-crops are almost free from the ravages of the Silver-eye (*Zosterops gouldii*) (great devourers of ripe fruit). The same remark would probably apply more or less to the honey-laden blossoms of other Corymbosae.

Colour.

Bentham (B.Fl. iii, 1866) does not often mention colour. He had little opportunity of doing so, as he could rarely have seen fresh filaments. He has—

"Pale-coloured"—*E. hemiphloia, E. pachyloma, E. patens.*

"Dark-coloured"—*E. Oldfieldii.*

"Richly-coloured"—*E. miniata.*

"Orange or scarlet"—*E. phoenicea.*

"White or red"—*E. tetraptera.*

The genus *Eucalyptus,* which comprises about 350 species, comes second only to *Acacia* in point of number amongst Australian genera, but it is so widespread and so abundant that it is the most numerous in individuals of any. The vast majority of flowers of Eucalyptus have white or cream-coloured filaments; those with very showy crimson or scarlet or yellow filaments are mostly entirely confined to western and tropical Australia. In eastern Australia *E. sideroxylon* A. Cunn., an Ironbark, very commonly has individual trees with pink or crimson filaments. In the western New South Wales Drooping Box (*bicolor*) the filaments are often pink, as well as white, but never in anything like the abundance of *sideroxylon,* while in a number of species such variation in coloration has also been observed, but only rarely. In Western Australia there are *E. erythrocorys* F.v.M. and *E. Preissiana* Schauer, with bright yellow filaments, and *E. ficifolia* F.v.M., *E. macrocarpa* Hook., *E. pyriformis* Turcz, *E. torquata* Luehmann, *E. erythronema* Turcz., *E. phoenicea* F.v.M., and a few others have pink to crimson filaments, while those of *E. miniata* A. Cunn. are orange-coloured.

The nature of the pigments in flowers is known to chemists who specialise on the subject, but much remains to be done. A pointer is an article, "The Colours of Flowers," in "The Gardeners' Chronicle" for 29th September, 1917, p. 130. See also the brief notes on Anthocyanin offered at Part LVI, p. 331. The colour of a Eucalyptus flower depends almost entirely on the colour of the filaments, the exceptions being the few cases of contrast of filament with anther.

Arrangement of species according to colours is not as simple as appears at first sight, because so many of them are bi-coloured, and some could, without any stretch of the imagination, be considered as having at least one additional colour. The following list shows all the bi-coloured species that I have seen or heard of. It is probable that very many more will be found. The normal colour is white or cream, except where otherwise indicated.

1. Pink to Crimson; Scarlet.

E. angulosa (*E. incrassata* var. *angulosa*).—Purple bases to filaments. See Part IV, 108.

E. bicolor are normally cream-coloured, but occasionally pink or purple. In p. 312, Allan Cunningham's MS. Journal, under date 30th June, 1817, we have: "We made the angle of a large deep lagoon, of considerable depth, thinly dotted with trees that had marks of inundation about 4 feet above the present level of water and a few inches above the general flatness of the plains. I here gathered specimens of a species of Eucalyptus having a submucronated hemispherical operculum, and flowers in terminal panicles of two colours (red and white), a tree of about 30 feet."

E. Bosistoana F.v.M.—Filaments more or less suffused with purple. Marulan, New South Wales, January, 1904.

E. caesia.—Pink or vieux-rose. I have also seen the colour crimson. Pink, I think, is the normal colour.

E. calophylla.—In Part XLIII, pp. 79, 80, I have discussed at some length the colours of the filaments in this species and the allied *E. ficifolia.* They both display considerable range in colour, though *E. calophylla* is normally white or cream, and *E. ficifolia* is orange to scarlet.

E. conica.—Some purplish filaments. Jennings, New South Wales.

E. erythrocorys.—A species normally with yellow filaments, but rarely purplish. See p. 557.

E. erythronema.—We have in the Dowerin district, Western Australia (C. A. Fauntleroy), a white filamented form in which the pigment is alone in the opercula, which are of a bright rosy red. The usual colour of the filaments is crimson. I have seen them pink.

E. eudesmioides.—Filaments rose-coloured at base (original description).

E. ficifolia.—See under *E. calophylla.* "I have noticed two distinct colours in the blossom of *E. ficifolia, i.e.,* scarlet and a much paler colour, pink I would say." E. J. T. Brockman, of Balingup, Western Australia, where the tree grows naturally. This is normally a species orange to scarlet. I have exceptionally seen white filaments.

E. hemiphloia.—T. W. Shepherd is quoted to have found one specimen of this species with red flowers (W. Woolls "Lectures on the Vegetable Kingdom," p. 221). Mueller ("Eucalyptographia") speaks of it as "occasionally very deep purplish colour." It must be very occasionally. Perhaps he is thinking of *E. odorata* in South Australia.

E. macrocarpa.—"The flowers were pale-coloured. I took very careful note of the tint and would describe it as pale carmine red, with a tendency to blue. I think, perhaps, crimson is the best general description of the flower's colour, but I cannot at all agree to 'rich' crimson; bright crimson I should say at the utmost. Never have I seen a blossom of the species with anything like the depth of colour that is found in the flowers of *E. ficifolia."* (O. H. Sargent, York, Western Australia.) See Part II, p. 241, and *Journ. Roy. Soc. N.S.W.,* li., 451, 453. This species is normally pink; I have heard of an exceptional white specimen.

E. melliodora.—Pink flowering Yellow Box. Deep-coloured and very beautiful. Just outside town of Coonabarabran, New South Wales. (Forester B. C. Meek.)

E. odorata var. *purpurascens.*—Filaments white or cream-coloured to palepurplish or pink and crimson.

E. polyanthemos.—"Flowers red. Flowering as a shrub." Quiedong, near Bombala, New South Wales. (W. Baeuerlen.)

E. ptychocarpa F.v.M.—809. Eight-mile Spring on to Tanumbirini, Northern Territory. Found near creeks and springs, 26th March, 1912. Stem like Bloodwood. Crimson filaments. Leaves, buds and flowers. 810. Eight-mile Creek on to

Tanumbirini, 26th March, 1912. Cream-coloured filaments. Leaves, flowers. (Tree similar to 809.)

It is to be noted that this species has filaments of two colours. This character is not rare; on the other hand it is not common. (G. F. Hill's Northern Territory collections.) See also Part XLIV, pp. 105, 106, for a further note on the varying colours of the filaments.

E. pyriformis.—The colour of the filaments varies a good deal. Diels and Pritzel speak of them as crimson, rose-coloured, and sulphur-coloured admixed on the same group of plants. I have seen them crimson and yellow, and there seems to be absolutely no botanical difference in the forms. White is an exceptional colour.

E. pyriformis var. *elongata.*—Pink and white filaments, the former predominant.

E. pyrophora var. *polycarpa.*—Filaments cream, sometimes pink. Broken Hill, New South Wales. (A. Morris.)

E. sideroxylon.—In New South Wales this tree of white or cream-coloured filaments has very frequently pink and often crimson ones. In some seasons nearly all the filaments appear to be highly coloured. It is the most showy of New South Wales trees for that reason.

E. Sieberiana.—On the cliffs at Eden, also Pipe Clay to Eden, New South Wales, (J.H.M.). The lower parts of the filaments (especially before expansion) are purple, giving the flowers an ornamental "eye" (ocellate), and this character is sometimes useful in distinguishing it from plants with which it is associated.

E. tereticornis.—Flowers on upper part of tree all pink. I have seen purple filaments in this species in trees in the Sydney Botanic Gardens, Watson's Bay, Port Jackson, and Casino, Richmond River, New South Wales.

E. tetraptera Turcz.—Deep rose pink (Dauthenay's Plate 120, figs. 1–3.) The filaments threw off the operculum within a week on 20th July, 1918. Another description is deep cerise. I am in doubt as to whether I have seen "white" filaments in the species.

E. torquata.—Pink to crimson. I have seen them occasionally cream-coloured, but pink appears to be the normal colour.

E. viminalis.—Occasionally with purple bases of filaments.

2. The following species I have not seen with white or cream-coloured filaments:

E. miniata.—Orange to nearly scarlet. Much like *E. phoenicea.*

E. phoenicea.—Light orange to scarlet, and it is a gorgeous species. Both belong to the tropics.

3. Yellow or Yellowish.

It is sometimes difficult to draw the line between indubitable yellows and greenish-yellows. Sometimes the creamy filaments come very close to the pale- or greenish-yellows. The question of colour is but one of the many branches of Eucalyptology in which we want to gather additional facts.

E. erythrocorys.—Colour of filaments at first greenish-yellow (primrose-yellow), and afterwards lemon- or golden-yellow (Dauthenay Plate 16, shades 2 and 3.) On the whole a pure yellow. "Filaments sometimes purplish" ("Eucalyptographia.") This tint is, however, but a supplementary tint, such as is very common amongst filaments normally white.

E. erythrocorys.—In species with filaments other than white, there is usually more deepening of the colour after the falling of the operculum. Thus, in the present species, they are at first greenish yellow (primrose-yellow), and afterwards lemon or golden-yellow (see Dauthenay, Plate 16, shades 2 and 3). The shades of colour, and the changes of colour, of the filaments can best be studied in Western Australia, where the colours are best developed, and the subject is well worthy of the attention of a student.

Then we have the Cornutae, all more or less yellowish, but variously described by different observers. They will repay careful examination in various districts during various seasons, thus:—

E. annulata.—Yellowish-white; greenish-yellow.

E. cornuta.—Yellow (fawn); greenish-yellow.

E. Lehmanni.—Dirty white (Preiss). Greenish-yellow.

E. macrandra.—Yellowish-white.

E. occidentalis.—Creamy yellow.

E. platypus.—Sulphur-coloured.

E. platypus var. *nutans.*—Crimson, which contrast well with the yellow anthers. (Whether this variety has ever yellow filaments, I do not know.)

E. spathulata.—Yellowish.

E. Stowardi.—Pale yellow.

Other than Cornutae are—

E. decurva.—Yellowish.

E. eremophila.—Cream.

E. foecunda—Pale yellow.

E. Forrestiana.—Yellow.

E. micranthera.—Yellowish or yellowish-green.

E. oleosa.—Yellowish.

E. Preissiana.—Bright yellow.

E. sepulcralis.—Yellow.

E. terminalis.—Cream.

E. tetragona.—Cream.

Filaments and anthers decoratively contrasting.

E. caesia.—Filaments vieux-rose, anthers bright yellow. (See J.H.M., in *Journ. Roy. Soc. N.S.W.,* li, 446.)

E. calophylla var. *rosea.* Filaments pink to purple.

E. ficifolia.—Filaments orange to scarlet. The anthers in this and the preceding species are yellow, but pale-coloured (white) when the yellow pollen is shed.

E. platypus var. *nutans.*—Filaments crimson, anthers yellow.

E. tetraptera.—Filaments pink, contrasting with the not very large grey anthers.

Odour.

Eucalyptus flowers do not, as a general rule, attract attention by reason of their odour (which is usually not unpleasant), although they often flower in large masses. At all events, we do not often speak of them as "sweet scented." The flowers of *E. erythronema* are so described by a Western Australian correspondent. Mueller speaks of those of *E. microtheca* as "agreeably scented."

A few species of Eucalyptus frequently receive attention because of their heavy odour or even sourness. These seem to be those which grow in deep, undrained, coastal soils, such as *E. robusta, botryoides.* I would invite the attention of my readers to my "Forest Flora of New South Wales," Part lxiv, "Honey and Eucalyptus Flowers," pp. 177–188.

Staminodia.

The character of having anantherous stamens must be applied with care because of the fact that anthers, particularly the outer ones, may disappear through accidental circumstances. Bentham first noted that anthers may be absent from the stamens, and Mueller continued the observations. I have not been able to use staminodia in the genus for diagnostic purposes, and do not know of any of my contemporaries who do. I think the character unimportant, with such knowledge as I possess.

Bentham, 1867.—In his Key to Series I, Renantherae, Bentham (B. Fl. III, 189) says—

"Stamens all perfect or very rarely (especially in *E. virgata*) some of the outer ones with abortive anthers." Under *E. coriacea* (at p. 201) we have— "All perfect or perhaps occasionally a few of the outer ones with abortive anthers." At p. 214 he notes that the stamens of *E. Behriana* are "all perfect."

His Series II, Heterostemones, has "Outer stamens anantherous or small abortive anthers." This includes—

E. leucoxylon, E. melliodora, E. gracilis, E. bicolor (all perfect or occasionally a few of the ones without anthers. *Bicolor,* p. 216).

E. paniculata, E. hoemastoma, E. microcorys.

Under *E. polyanthemos,* at p. 214, he says—"All perfect or rarely a few of the outer ones anantherous."

A footnote (under Heterostemones), at p. 190, reads—

"The outer stamens appear also to be anantherous, or with abortive anthers only in *E. virgata,* and perhaps occasionally, but only in a slight degree, in some others of the Renantherae, and sometimes, but rarely, in *E. bicolor,* amongst Porantherae, but I have never found them so in any of the other species."

Mueller, 1879–84. In "Eucalyptographia" the species in which it is simply stated "all fertile" have been omitted.

"Stamens all fertile, *except* (my italics) some of the outermost inflexed before expansion."—

E. acmenioides.

E. stricta.

E. Todtiana.

"Outer filaments without anthers."—

E. doratoxylon.

"Outer filaments with imperfect or mostly without anthers."—

E. microcorys.

". . . . unless some of the outer imperfect."—

E. largiflorens (*bicolor*).

"Generally all fertile."—

E. pauciflora (*coriacea*)

"Outer stamens destitute of anthers."—

E. leucoxylon, E. melliodora.

"Outer stamens sterile."—

E. gracilis, E. hoemastoma, E. paniculata, E. polyanthemos, E. Sieberiana.

It will be seen that Mueller's list includes the following species not in Bentham's:

E. acmenioides. *E. stricta.*
E. doratoxylon. *E. Todtiana.*

Of these, the first and the last were not in the latter's list of species.

Connective (Gland).

"When the two cells are not closely contiguous, the portion of the anther that unites them is called the Connective . . . . ” (B. Fl. I, xv.). “. . . . the connective often thickened into a small gland either separating the cells or behind them when they are contiguous.” (III, 185). “Normales . . . . cells perfectly distinct, parallel (either contiguous with the connective gland behind them, or back to back, with the connective between them) . . . . ” (p. 193).

I cannot find that Bentham described the gland of any particular species. In Sachs’ “Botany” (English translation), we have—

“The anther therefore usually consists of two longitudinal halves, united and at the same time separated by a part of the filament termed the Connective. The two pollen-sacs of each half of the anther are contiguous throughout their length, and frequently both halves of the anther are in close apposition. The separate pollen-sacs then appear as compartments of the anther, which is in this case quadrilocular, in contrast to those anthers (of rare occurrence) in which each half contains only a single pollen-sac, and which are therefore bilocular.” (Sachs, 427.) It is “convenient to term them (the stamens) Staminal leaves; the filament, together with the connective, being considered as the leaf of which the two anther-lobes are appendages.” (p. 473).

Mueller (“Eucalyptographia”) has not much to say about the gland; following are all the passages I can trace. His references are scattered, and I do not think he considered it as an important character. In addition, he often figures the gland (sometimes diagrammatically).

“. . . . Connective of anthers usually raised at the summit or dorsally towards the top into a callous gland . . . . ” (End of Part x, description of the genus).

E. diversicolor. Longitudinal slits, enlarged by a conspicuous terminal gland.

E. gomphocephala. Dorsal gland of anther conspicuous.

E. incrassata. Connective conspicuously glandular turgid at the back.

E. longifolia. Connective of the anthers conspicuously callous-glandular.

E. maculata. Connective of the anthers broader than the very narrow glandular portion.

E. marginata. Gland of the connective extremely minute.

E. miniata.—Ellipsoid-oval, with dorsally broadish connective.

E. occidentalis.—Connective dorsally rather broad, glandular-turgid towards the summit beneath.

E. Oldfieldii.—Anther-cells separated by the narrow but distinct connective.

E. Preissiana.—Sub-terminal gland of the anthers conspicuous.

E. resinifera.—With a broad connective.

E. sepulcralis.—Dorsal gland small, seated near the summit.

E. tetraptera.—Terminated by a black-purple gland.

E. uncinata.—Anthers with no glandular turgidity.

In my descriptions of species I have given attention to the gland, invariably describing it in recent years. At pp. 525 to 537, where a classification of anthers is submitted, and also in the figures of individual species, the gland has been freely employed, probably to a greater extent than by any previous author, but we are far from finality as to the morphology and classificatory value of these minute organs.

E. Gynoecium.

Ovary.

The following are portions of generic descriptions referring to the ovary:—

"Ovary inferior, the summit glabrous, flat, convex or conical, 3- to 6-celled, with numerous ovules in each cell, in 2 to 4 rows, on an adnate or oblong and peltate axile placenta." (B. Fl. III, 185) . . . . "The number of cells of the ovary is also very rarely a guide to the species. They generally vary from 3 to 4 or from 4 to 5, very rarely 6, and not constantly so in any species I have seen. In *E. phoenicea* I have only seen two; but as the specimens known are but few, and all probably gathered from one tree, we have no means of judging whether the character is constant," (*ib.,* 188). (Mueller says constant, and that is my experience. J.H.M.).

"3–6 celled, very rarely or quite exceptionally 2-celled; its lower portion adnate; its upper portion more or less free." (Eucalyptographia.)

"The ovary is never entirely free; it is intimately fused to the calyx-tube or receptacle, sometimes entirely, sometimes solely for a half or third of its length, the summit remaining free. It is surmounted by a simple style, with a stigma pointed or a little dilated." (Naudin II, 13.)

Top of the Ovary.

Bentham is the only botanist who makes a point of referring to this character, and, as will be seen, there is not much variation, the top usually being flat, and, to a less extent, convex, and sometimes conical.

[Mueller makes the following statement:— "The insertion and form of the fruit valves, which, before opening, form either a flat or more or less convex vertex to the capsule, a character which, beautiful as it is, can only be studied in living plants." (Hooker's *Journ. Bot.* ix, 165, 1857), and from the diagrams of longitudinal fruits in "Eucalyptographia" (under *E. Preissiana*) the shape of the top of the ovary may be seen in a number of species, but he does not refer to the character in the text. It does not appear to be used by any botanist for the purpose of diagnosis.]

Flat-topped—

E. amygdalina.	*E. miniata.*
E. Behriana.	*E. obliqua.*
E. bicolor.	*E. odorata.*
E. capitellata.	*E. Oldfieldii.*
E. cladocalyx (*corynocalyx*).	*E. pallidifolia.*
E. clavigera.	*E. paniculata.*
E. coccifera.	*E. patens.*
E. coriacea.	*E. pilularis.*
E. corymbosa.	*E. piperita.*
E. dumosa.	*E. platyphylla.*
E. eximia.	*E. polyanthemos.*
E. foecunda.	*E. Risdoni.*
E. grandifolia.	*E. setosa.*
E. Gunnii.	*E. stellulata.*
E. leucoxylon.	*E. Stuartiana.*
E. maculata.	*E. tessellaris.*
E. melliodora.	*E. tetrodonta.*
E. micranthera.	*E. uncinata.*
E. microcorys.	*E. viminalis.*

Short—*E. gracilis.*

Flat-topped, the style not thickened at the base—*E. macrandra.*

Depressed top—*E. pyriformis.*

Much depressed, flat-topped—*E. erythrocorys.*

Flat-topped, or slightly conical in the centre—*E. robusta.*

Flat-topped, or slightly convex in the centre—*E. crebra, E. cosmophylla.*

Flat, or slightly convex on the top—*E. calophylla.*

Flat, or convex in the centre—*E. marginata.*

Convex at the top—*E. Lehmanni.*

Convex in the centre—*E. botryoides, E. brachypoda* (*microtheca*), *E. cinerea, E. gomphocephala.*

Short, convex in the centre—*E. grossa.*

Short, but somewhat convex in the centre—*E. tetraptera.*

Shorter than the calyx, convex in the centre—*E. alpina.*

Rather shorter than the calyx, convex in the centre—*E. longifolia.*

Slightly convex in the centre—*E. pruinosa.*

As long as the calyx, slightly convex—*E. globulus.*

Almost on a level with the calyx-rim, the top flat or at length slightly convex—*E. cornuta.*

Short, convex or conical in the centre—*E. oleosa, E. decurva, E. rostrata.*

Conical in the centre—*E. decipiens, E. diversicolor, E. saligna.*

Short, slightly conical in the centre—*E. albens.*

Very conical in the centre—*E. pellita.*

Conical in the centre and tapering into the style—*E. goniocalyx.*

More or less conical in the centre, tapering into the style—*E. dealbata.*

Conical at the top, tapering into the style—*E. annulata.*

Shorter than the calyx, conical in the centre—*E. rudis.*

Not much shorter than the calyx, conical in the centre—*E. resinifera.*

Conical in the centre, with as many raised lines as cells—*E. platypus.*

Convex or conical in the centre—*E. siderophloia.*

Conical or convex in the centre—*E. concolor.*

Very convex, or conical at the top—*E. occidentalis.*

Convex or shortly conical in the centre—*E. redunca.*

Rather deep, slightly conical or convex in the centre—*E. hemiphloia.*

Nearly as long as the calyx-tube and convex or conical in the centre—*E. tereticornis.*

Not much shorter than the calyx-tube—*E. vernicosa.*

Placenta.

"Ovary . . . . with numerous ovules in each cell, in 2 to 4 rows, on an adnate or oblong and peltate axile placenta." (B.Fl. iii, 185.) I can find no references to the Placenta under species.

". . . . with a thick central somewhat columnar or rarely pyramidal axis." (Mueller in "Eucalyptographia".)

When we come to individual species we find that Mueller speaks of the Placental Column in six cases and Placental Axis in the remaining ten. In a few instances he describes the shape of the axis, but, as a rule, he contents himself with a statement as to their relative length and breadth, thus—

Pyramidal-semiovate—*E. pyriformis.*

At last semiovate pyramidal, the cavity of the cells penetrating beneath the placentas—*E. macrocarpa.*

Wide—*E. megacarpa.*

Conical or oval-cylindrical, almost twice as long as broad—*E. Preissiana.*

Comparatively short—*E. sepulcralis.*

Nearly as broad as long—*E. pachyphylla.*

Not twice as long as broad—*E. alba.*

About twice as long as broad—*E. cordata, E. erythrocorys, E. haemastoma, E. Raveretiana.*

Hardly twice as long as broad—*E. melliodora.*

At least twice as long as broad—*E. odorata, E. resinifera.*

More than twice as long as broad—*E. microcorys.*

About three times as long as wide—*E. cladocalyx* (*corynocalyx*).

Style and Stigma.

a. Style.

Bentham, 1866.—Following appear to be Bentham's few references to the style:—

"Style subulate or rarely almost clavate, with a small truncate capitate or rarely peltate stigma." (B. Fl. III, 185.)

"The style is omitted in the specific descriptions, because I have been unable to ascertain the constancy of the few differences observed. It is certainly longer in some species, thicker in others, the stigma a mere point or more or less dilated, but these differences appear to be almost as frequently individual as specific." (*ib.* p. 187.)

Under species, the following appear to be all the references:—

Ovary tapering into the style—*E. dealbata, E. goniocalyx.*

Thickened at the base—*E. cornuta.*

Slightly thickened at the base—*E. spathulata.*

Short, thick—*E. orbifolia, E. setosa.*

The valves often acuminate by the split base of the style, and then the subulate tips protruding—*E. uncinata* (and practically the same under *E. oleosa* and *E. pallidifolia*).

Mueller, 1879–84 ("Eucalyptographia") takes cognisance of more species:—

Very short, thin—*E. microcorys.*

Very short—*E. bicolor.*	*E. corynocalyx* (*cladocalyx*), also *E. populifolia,* yet he shows them in the figures going to the top of the operculum.
E. haemastoma.	
E. Stuartiana.	
E. trachyphloia.	

Short—*E. cinerea* (as *pulverulenta*), *E. setosa, E. pruinosa, E. tetragona.*

Comparatively long—*E. leucoxylon.*

Half included within the calyx, exceeded by the stamens—*E. Abergiana.*

Shorter than the stamens—*E. diversicolor.*

Exceeded in length by the stamens—*E. tetraptera.*

Longer than the stamens, thickened at the summit, very short, *E. gamophylla.*

Nearly as long as the stamens—*E. miniata.*

About as long as the stamens—*E. obcordata, E. occidentalis.*

Elongated—*E. marginata, E. pachyphylla, E. sepulcralis.*
Considerably elongated—*E. redunca.*
Comparatively long—*E. Raveretiana.*
Rather long—*E. Planchoniana, E. Preissiana.*
Thickness—
Rather thick—*E. incrassata, E. ptychocarpa.*
Capillary—*E. piperita.*
Of bristly thinness—*E. uncinata.*
Slender—*E. oleosa.*

Following are some additional notes by Mueller:—
Short—*E. Bosistoana.*
Shortly exsert—*E. Cooperiana.*
Only about ⅛-inch long—*E. Naudiniana.*

Following are some additional notes on Styles. (I have not made a comprehensive examination.)
Short—*E. acaciaeformis.*
Long—*E. angulosa.*
Long, much protruded—*E. corymbosa.*
Long, as long or longer than the stamens—*E. Flocktoniae.*
Exceedingly thin, considerably extended beyond the calyx-tube—*E. hemiphloia.*
Conspicuous—*E. Hillii.*
Very protruding—*E. Isingiana.*
Slightly exserted—*E. leptophleba.*
Flattish—*E. terminalis.*

For referential purposes the following paper may be useful— “The Floral Mechanism of the genus Sebaea,” by A. W. Hill, *Ann. Bot.,* July, 1913, xxvii, p. 479. There is a curious pair of swellings or glands on the style, or auxiliary stigmatic surfaces. The paper is well illustrated, and otherwise valuable. I do not know of corresponding glands in the styles of Eucalyptus.

b. Stigma.

Under Style, I have already quoted Bentham as saying: “With a small truncate capitate or rarely peltate stigma . . . the stigma a mere point or more or less dilated, but these differences appear to be almost as frequently individual as specific.”

The only reference under a species that I can see is under *E. melliodora*—“Stigma dilated.” (B. Fl III, 210.)

Mueller (“Eucalyptographia”) refers to the stigma frequently, as under:—

Not dilated (in two cases "Not expanded")—

E. acmenioides.	*E. microcorys.*
E. alba (yet shown somewhat dilated).	*E. miniata.*
	E. obliqua.
E. alpina.	*E. Oldfieldii.*
E. cinerea (as *pulverulenta*).	*E. peltata.*
E. cladocalyx.	*E. pilularis.*
E. clavigera.	*E. piperita.*
E. cordata.	*E. Planchoniana.*
E. diversicolor.	*E. Preissiana.*
E. ficifolia.	*E. pruinosa.*
E. Foelscheana.	*E. rostrata.*
E. gamophylla.	*E. sepulcralis.*
E. gomphocephala.	*E. setosa.*
E. haemastoma.	*E. Sieberiana.*
E. incrassata.	*E. stellulata.*
E. longifolia.	*E. tereticornis.*
E. marginata.	*E. tetragona.*
E. megacarpa.	*E. Todtiana.*

Not broader than the summit (or apex) of the style, or not broader than the style—

E. buprestium.	*E. macrocarpa.*
E. capitellata.	*E. macrorrhyncha.*
E. coriacea.	*E. maculata.*
E. cosmophylla.	*E. microtheca.*
E. decipiens.	*E. pachyloma* (as *santalifolia*).
E. eximia.	*E. patens.*
E. foecunda.	*E. pyriformis.*
E. goniocalyx.	*E. redunca.*
E. Howittiana.	*E. robusta.*
E. rudis.	*E. stricta.*
E. salmonophloia.	*E. tessellaris.*
E. salubris.	*E. Watsoniana.*

Not broader than the summit of the elongated style—*E. resinifera.*

Not broader than the short style—*E. Behriana.*

Not, or hardly broader than style—*E. globulus, E. punctata, E. siderophloia.*

Hardly broader than the style or "hardly dilated"—

E. amygdalina.	*E. erythrocorys.*
E. bicolor.	*E. eugenioides.*
E. botryoides.	*E. gracilis.*

E. calophylla. E. saligna.
E. cornuta. E. tetraptera.
E. corymbosa. E. tetrodonta.
E. doratoxylon.

Dilated, evidently broader than the summit of the style—*E. paniculata.*

Broader than the short style—*E. crebra.*

Dilated—*E. leucoxylon.*

Somewhat dilated—*E. obcordata, E. polyanthemos, E. populifolia.*

Slightly dilated— *E. occidentalis. E. Stuartiana.*

E. odorata. E. trachyphloia.

E. Raveretiana.

Slightly broader than the summit of the style—*E. viminalis.*

Very slightly dilated—*E. Abergiana.*

Slightly or not broader than the style—*E. hemiphloia.*

Much dilated—*E. melliodora.*

Exceedingly minute—*E. uncinata.*

Elongated—*E. pachyphylla.*

Depressed—*E. Gunnii.*

Following are some additional notes on Stigmas from my own notes, but an exhaustive examination of all species from fresh material is a desideratum:—

Dilated somewhat—*E. acacioeformis, E. Bosistoana.*

Without thickening (see fig. 3*a,* Plate 14, Part IV)—*E. angulosa.*

Hardly dilated—*E. conica.*

Scarcely thicker than the style—*E. Cooperiana.*

Flattened—*E. corymbosa.*

Rounded and expanded like a little knob—*E. decorticans.*

Punctate and green, thus contrasting with the stamens—*E. erythrocorys.*

Not dilated—*E. Ewartiana, E. Flocktonioe.*

Enlarged—*E. fruticetorum, E. odorata.*

Slightly swollen or rounded (see fig. D, Plate 12, Part III)—*E. gracilis.*

Not exceeding style in width—*E. Hillii.*

Not capitate—*E. Isingiana.*

Peltate, scarcely larger than the style—*E. leptophleba.*

Pointed—*E. macrocarpa.*

Capitate—*E. melanoxylon.*

Slightly dilated—*E. Pilligaensis.*

A little knob—*E. Spenceriana.*

More or less truncate, slightly hollow, with a microscopic fringe (cilia) round the

edge—*E. terminalis.*
Short, blunt-pointed—*E. tetraptera.*
Blunt-pointed, not expanded at tip—*E. Watsoniana.*

Explanation of Plates 240–243.

Plate 240.

Plate 240: EUCALYPTUS PRUINOSA Schauer (1). [See also Plate 54.] E. MELANPHLOIA F.v.M. (2). [See also Plates 53 and 54.] E. GUNNII Hook. f. (3). [See also Plates 108 and 109.] Lithograph by Margaret Flockton.

Eucalyptus pruinosa Schauer.
(See also figs. 5, 6, 8 (not 7), Plate 54, Part XII.)

1*a,* 1*b.* Juvenile leaves (1*b* tending to be lanceolate.) 1*c.* Fruits. Armstrong River, Victoria River district, Northern ferritory (P. J. Winters for G. F. Hill, No. 458). I have never seen the buds of this species, or any leaves narrower than those of 1*b.* They should be searched for near the top of the tree.

Eucalpytus melanophloia F.v.M.
(See also figs. 13–15, Plate 53, and figs. 1–4, Plate 54, Part XII.)

2*a.* Juvenile leaves, prominently stem-clasping. 2*b.* Flower-buds, with subtending leaves. 2*c.* Four anthers, showing variation (compare fig. 13*b* of Plate 53). 2*d.* Fruits which, as compared with figs. 3*b* and 4*b* of Plate 54, are sessile. Note also that leaves, buds and fruits are all much larger than those figured in Plates 53 and 54. Croydon, North Queensland (R. H. Cambage, No. 4006).

Eucalyptus Gunnii Hook. f.

3*a,* 3*b,* 3*c.* Three juvenile leaves in progressive stages of development. 3*d.* Mature leaf with three flower-buds. 3*e.* Two views of anther. 3*f.* Fruits, with an end-on view of one (these are as ripe as can be got).

All from the well-known tree at Whittingehame, near Prestonkirk, Scotland, the seat of the Earl of Balfour, K.G., and sent by Lady Alice Balfour. See p. 500. It has been given a special name, but (compare Plates 108 and 109 of Part XXVI) I can see no specific difference between it and *E. Gunnii.*

Plate 241.

Plate 241: EUCALYPTUS LONGICORNIS F.v.M. (1, 2). [See also Plate 66.] E. PROPINQUA Deane and Maiden (3, 4). [See also Plate 121.] Lithograph by Margaret Flockton.

Eucalyptus longicornis F.v.M.
(See also Plate 66, Part XV, as *E. oleosa* var. *longicornis.*)

1*a.* Juvenile leaves. 1*b.* Part of young rachis, almost winged. 1*c.* Mature leaf and flower buds. 1*d.* The same, with a longer, broader peduncle, not springing precisely from the axil of the leaf. 1*e.* Anthers. 1*f.* Fruits. Wagin, Great Southern Railway Line, W.A. (C. A. Gardner, No. 1234).
2*a.* Intermediate leaves. 2*b.* Mature leaves with immature buds. 2*c.* Fruits, smaller, less globular and with thicker rims than 1*f.* Westonia, about 200 miles east of Perth, W.A. (Forester J. M. Cusack, No. 2).

Eucalyptus propinqua Deane and Maiden.
(See also Plate 121, Part XXIX.)
var. *major,* var. nov.

3. Twig with buds. Norman Creek, near Brisbane, Queensland (C. T. White). Type of the variety.
4. Fruits. Kandanga, South Queensland (E. H. F. Swain, No. 170, through C. T. White).

Plate 242.

Plate 242: EUCALYPTUS HAEMASTOMA Sm. (1-3). [See also Plates 46 and 47.] E. MICRANTHA DC. (4-6). [See also Plates 46 and 47.] E. CRUCIS n.sp. (7). Lithograph by Margaret Flockton.

Eucalyptus hoemastoma Sm.
(See also figs. 12 and 13, Plate 46, and figs. 11–14, Plate 47.)

1. Juvenile leaf, thick. Tumbledown Dick, Gordon-Pittwater Road, between Sydney and Broken Bay (W. F. Blakely and D. W. C. Shiress).
2. Juvenile leaf, a stage further advanced, very thick. Near Cowan Railway Station, 20 miles north of Sydney (W. F. Blakely and D. W. C. Shiress).
3*a.* Mature leaf and buds. 3*b.* Fruits. South side of Spit, Middle Harbour, Port Jackson (J. H. Camfield). Observe the coarseness of *E. hoemastoma* as compared with *E. micrantha,* below.

Eucalyptus micrantha DC.
(See also figs. 10, 11, 14–17, Plate 46, and figs. 1–10, Plate 47.)

4. Juvenile leaves. Opposite Railway Camp No. 2, May, 1922, Marrangaroo, N.S.W. (Dr. E. C. Chisholm and W. F. Blakely).
5. Juvenile leaves, 1 mile north-west of Kuring-gai Railway Station, near Sydney (W. F. Blakely and D. W. C. Shiress.) This variation in leaves will be discussed when the broader subject of "Intermediate Leaves" is separately discussed.

6*a.* Mature leaves and not perfectly ripe flower-buds. 6*b.* Fruits. Gibberagong Creek, Kuring-gai Chase boundary line (W. F. Blakely and D. W. C. Shiress).

Eucalyptus crucis n. sp.

7*a.* Juvenile leaf. 7*b.* Intermediate leaves. (N.B.—Since these were figured I have received juvenile leaves in the earliest stages, which will be figured in an early Part.) 7*c.* Twig showing mature leaves, buds, flowers and early fruits. 7*e.* Two fruits. 7*f.* The largest fruit I have seen. All from Southern Cross, near Coolgardie, Western Australia. (From Mr. Henry Steedman.)

Plate 243.

Plate 243: EUCALYPTUS SHIRESSII Maiden and Blakely, n.sp. (1, 2). E. FLOCKTONIÆ Maiden (3-5). [See also Plates 69 and 236.] Lithograph by Margaret Flockton.

Eucalyptus Shiressii Maiden and Blakely, n. sp.

1*a.* Juvenile leaf (one of the early "First Leaves," which will be discussed later, as stated under fig. 5, Plate 242). 1*b.* Juvenile leaf. 1*c.* Juvenile leaves becoming a little further advanced. 1*d.* Fruits. Galston Road, Hornsby, a few miles north of Sydney. Near the 16-mile post (W. F. Blakely and D. W. C. Shiress), March, 1919.) Type locality.
2*a.* Juvenile leaf. 2*b.* Intermediate leaf. 2*c.* Mature leaf, with flower-buds. 2*d.* Front and back views of anther. 2*e.* Fruits. (Same locality and collectors, October, 1920).

Eucalyptus Flocktonioe Maiden.
(See also Plate 69, Part XVI, and Plate 236, Part LVIII.)

3*a.* Juvenile leaf, unique in the genus, so far as I am aware. Bendering, W.A. (C. A. Gardner, No. 1686). 3*b.* Twig with mature leaves and peculiar moniliform or constricted buds. No. 4 is also "Merritt." (Bendering, W. A. (C. A. Gardner, No. 1229). Nos. 3 and 4 are dealt with at p. 422, Part LVIII.
4*a.* Twig, with mature leaves and immature buds. 4*b.* Fruits, much constricted, of "Merritt," Kondinin, W.A. (Dr. F. Stoward, No. 57).
5*a.* Twig, showing buds and immature fruits, with styles. The calyx-tubes show more ribbing than those from the same locality do in fig. 3*d,* Plate 236. 5*b.* Front and back views of anther. Yeelanna, Eyre's Peninsula, South Australia (W. J. Spafford, No. 18).

Part 60

Definitions

1. “Fruit consisting of the more or less enlarged truncate calyx-tube enclosing the capsule, usually of a hard and woody texture, and interspersed with resinous (*sic*) receptacles, the persistent disk usually thin and lining the orifice of the calyx-tube when the capsule is deeply sunk; concave, horizontal, convex or conically projecting, and more or less contracting the orifice when the capsule is not much shorter than, as long as, or longer than the calyx-tube; the capsule always adnate to the calyx-tube, although often readily separable from it when quite ripe and dry, very rarely protruding from the orifice left by the disk before maturity, but opening at the apex in as many valves as there are cells, which often protrude, especially when acuminate by the persistent and split base of the style.” (B.Fl. iii, 185).

2. “Fruit consisting of the variously enlarged indurated and truncated or rarely four-toothed calyx-tube, and an hardened inferiorly adnate capsule; the latter with 3–5, rarely 2 or 6, wholly or partially exserted or entirely enclosed valves, and with a thick central somewhat columnar or rarely pyramidal axis.” (Mueller, “Eucalyptographia.”)

3. “The fruit is formed by the calyx-tube adnate congenitally with the ovary developed into the capsule.” (Naudin.)

4. “Fruit a many-seeded capsule, dehiscing loculicidally at the apex.” (Lubbock.)

The Fruit in General.

Historical.

Bentham, 1866.—Bentham made a minor use of the fruit for classificatory purposes. What he actually said as regards the fruit (or parts of the fruit) was as follows:—

Series V.—*Normates.*

Subseries III.—*Robustoe.*

“Rim of the fruit concave, with a sunk capsule.” (B.Fl. iii, 194.)

Subseries IV.—*Cornutoe.*

“Fruit turbinate, urceolate or obovoid, the capsule not much sunk.”

Subseries V.—*Exsertoe.*

“Fruit globose or depressed, usually more or less contracted at the orifice, the rim convex or prominent, rarely flat, the capsule-valves protruding beyond it.”

Subseries VI.—*Subexsertoe.*

“Fruit turbinate, the orifice not contracted, the capsule level or slightly sunk, the valves often protruding when open.”

Subseries VII.—*Inclusoe.*

“Fruit more or less contracted at the orifice, the capsule sunk, the valves not protruding, excepting their points when acuminate by the split base of the style.”

Subseries *Corymbosoe.* VIII.—

“Fruit often large, more or less urceolate, the capsule deeply sunk.”

Mueller, 1887.—In Mueller's “Key to the System of Victorian Plants,” (1887–8), which is a dichotomous arrangement, the fruit is to a very slight extent made use of in running down the species, viz.:—

1089.—Fruit semiovate . . . . (*hoemastoma*).

Fruit truncate-ovate . . . . (*Sieberiana*).

1092.—Fruit valves wholly exserted . . . . (*macrorrhyncha*).

1093.—Fruit valves wholly enclosed or slightly exserted.

Fruit truncate-globular, its border depressed . . . . (*eugenioides*).

Fruit truncate-ovate, its border depressed . . . . (*piperita*).

R. Tate, 1890.—“Handbook of the Flora . . . . of South Australia.” His Key to Eucalyptus (p. 93) combines the use of the fruit as a main character, and the anthers as a subordinate one, with specific differences indicated by the leaves and inflorescence. He deals with only 34 species.

I.—Fruit cylindrical-ovate, about twice as long as wide.

II.—Fruit truncate-ovate, longer than wide, base narrowed. (Here follow subdivisions *a* to *d,* by anthers.)

III.—Fruit semi-ovate to semiglobose, about as long as wide, base rounded (*a* to *c,* by anthers).

IV.—Fruit more or less biconic, the dorsal portion hemispheric; valves exsert; umbels solitary.

Here follow two subdivisions, mainly also based on the fruits, viz.:—

(*a*) Upper portion of fruit obtusely conical, truncate. Anthers kidney-shaped, opening by divergent slits.

(*b*) Upper portion of fruit acutely conical, truncate; umbels solitary. Fruits very large.

Naudin, 1891.—C. Classification of species (grown in France, J.H.M.) according to the shape and size of the fruits. (Naudin II, 18.) Following is a translation:—

The fruits of Eucalypts, generally woody and hard, are, as we have already understood, formed by the calyx-tube or receptacle, adnate congenitally with the ovary developed into the capsule. This last is sometimes free in the upper part, and when it sensibly exceeds the calyx-tube it becomes exsert. In a large number of cases it is entirely enclosed in the calyx-tube. Often also it is flush with the margin. It opens either by the straightening of its valves, or by their separation at their base without straightening themselves, and in this latter case it is frequently of a flattened appearance. These diverse modifications, added to the size of the fruit when mature, will furnish us with good distinctive characters.

The fruits of the Eucalypts vary greatly in size and shape in the series of species. In some their bulk attains almost or even surpasses that of a walnut; in others it is scarcely of the size of a hemp seed. Between these two extremes one finds all intermediates. Let us note the most remarkable under these two headings:—

Species with large fruits:—

E. globulus.	*E. megacarpa.*
E. Preissiana.	*E. cosmophylla.*
E. calophylla.	

Species with very small fruits:—

E. crebra.	*E. amygdalina.*
E. myrtiformis.	*E. desertorum.* &c. (p. 19).
E. Andréana.	

The fruits of the Eucalypts are always free, that is to say, independent of each other, in a single inflorescence. Only one known species is an exception under this heading, by the cohesion of its fruits into a single mass. This is *E. Lehmanni.*

The configuration of the fruits and the relation between the length of the capsule and the calyx-tube show characters less vague than the size, which is moreover sufficiently variable in a single species. In fixing on these modifications easy to grasp, we can establish the following groups:—

(*a*) Capsule more or less exsert, that is to say, notably exceeding the calyx-tube:—

E. Lehmanni.	*E. tereticornis.*
E. cornuta.	*E. insignis.*
E. amplifolia.	*E. rostrata* (p. 19).
E. macrorrhyncha.	

This is equivalent to his “First Section” in his classification at p. 20.

(*b*) Capsule sunk more or less deeply; its straightened valves hardly attaining, or not attaining at all, the margin of the calyx-tube:—

E. Preissiana. *E. botryoides.*
E. robusta. *E. calophylla,* and many others (p. 19).
E. goniocalyx.

This forms the basis of his "Second Section" in classification, p. 20.

(*c*) Capsule nearly of the same length as the calyx-tube. It can then open and project the point of the valves a little above the contour of the calyx-tube:—

E. Muelleri. *E. resinifera.*
E. viminalis.

Either remaining flat on the upper side, its valves not becoming erect, and turning aside at their base to let the seeds fall out:—

E. globulus. *E. diversifolia* (p. 19).
E. megacarpa.

(*d*) As to the exterior shape of the fruit, it is characteristic in some species or groups of species; thus it is obconic, that is to say, with a reversed cone, in—

E. Preissiana. *E. coccifera.*
E. globulus. *E. gomphocephala,* &c.

In a large number of species the fruit is pear-shaped, ovoid, hemispherical, or almost spherical, more or less widely open at its apex, all peculiarities which will be shown in the descriptive part of this memoir. Let us now show how the fruits may be nearly spherical by the contraction of their opening—

E. marginata. *E. doratoxylon.*
E. diversicolor.

Lastly other Eucalypts are distinguished by fruits more or less urn-shaped, short or elongated, as one sees in—

E. urnigera. *E. corynocalyx,* and especially
E. calophylla, whose large fruit represents a very bulging urn (p. 19).

(p. 20.) As we have noted by reading the preceding pages, the characters that may be considered specific in Eucalypts cross each other to such an extent in the series of species, that it does not seem possible to distribute the latter in truly natural groups, analogous, for example, with what is called sub-genera in other families of plants. Still, in order to facilitate as much as possible the separation of the species described in this memoir, I have divided them into sections based on their characters which are sufficiently apparent so as to be easily noted by the reader, although the sections are purely artificial.

First Section.—It comprises all the Eucalypts whose capsule at maturity is more or less exsert that is to say, exceeding by a half or a third of its length the tube or calycine receptacle with which it is closely welded in its lower part. To this section belong—

E. Lehmanni.	*E. rostrata.*
E. cornuta.	*E. tereticornis.*
E. macrorrhyncha.	*E. insignis.*
E. amplifolia.	

(Here follows the "Second Section," which is combined with the number of flowers in the umbels, &c. See p. 21.)

Then follow the simultaneous suggestions of Luehmann and Tate made in papers in *Report Aust. Assoc. Adv. Science,* VII, pp. 523 and 544 respectively (1898), and as neither makes any reference to Naudin's paper, it was doubtless unknown to them.

I again remind my readers that Naudin's paper deals only with the limited number of species cultivated in France and Algeria. Luehmann's paper deals with 140 species, Tate's with 90, apparently mainly based on the figures in Mueller's "Eucalyptographia."

Luehmann, 1898.—Luehmann's paper is "A Short Dichotomous Key to the hitherto known species of Eucalyptus." He says that his paper should be looked upon as an "auxilliary guide only, without any full descriptions, and is for this reason submitted in the form of a Key. The primarily character chosen is that of the fruit-valves, whether quite enclosed, or whether the points protrude beyond the rim, or whether the top of the rim is convex with every part raised above the rim; secondarily the shape and size of the fruit are taken into consideration." In the above he unconsciously follows Naudin. The paper, from its nature, will not bear abstracting; it contains various useful hints. 140 species are dealt with, and characters associated with the fruit taken in about a third of the species.

Tate, 1898.—Prof. Ralph Tate gives "A Review of the characters available for the classification of the Eucalypts, with a synopsis of the species based on a carpological basis." See a note at Part I, p. 11 of the present work. Following are extracts from the paper:—

There is obviously the need of an organ which exhibits greater diversity of form and structure, and admits of a greater number of combinations than is afforded by the anther, or indeed any single structure as yet considered. The requirements seem to me to be best fulfilled by the fruit offering, for the most part, microscopic characters, and the special advantage that it is nearly always possible to obtain them, whilst the flowering season is of limited duration, and is not always of annual recurrence. At the same time, the characteristics are readily interpreted, needing no special manipulation . . . .

I would now review the nature and value of the component elements embraced by a carpological scheme of classification:—

1. Shape of Fruit.—The shape to be described is that of a fully-ripe specimen, as immature states may prove delusive when testing the carpological system. . . . Thus in *E. pyriformis* the calyx-tube, on the fall of the operculum, is obconic, with a horizontal summit, but in the adult state it becomes biconic. Again, *E. cosmophylla* ranges from ovoid-conic in the early stages to hemispheric when mature.

The calycine portion of the fruit may extend beyond the capsular portion to varying heights; its rim or margin may be acute, as in *E. Foelscheana,* or it may be of varying width, remain horizontal, as in *E. goniocalyx* (*E. eloeophora* is meant, J.H.M.), or become ascending with a convex slope, as in *E. capitellata,* or with a concave slope, as in *E. longifolia, E. pyriformis,* &c.

In the appended carpological schedule I have set forth the leading geometric forms assumed by the Eucalyptine fruits, so there is no need to describe them in this place; but a fundamental investigation is that of the persistency of shape for each species. From my own experience, the shape of the fruit is constant within natural and reasonable limits. (What the ascertained amount of variation is in each species is one of the objects of the illustrations in the present work, J.H.M.) Thus *E. Foelscheana* is usually globosely urn-shaped; but by contraction at the summit becomes globosely-oval—a natural transition. *E. capitellata* is usually biconic, but may become roundly depressed atop, thus passing to globulose or ovoid-conic. I do not find any variation of shape that does violence to a geometric development. . . .

2. External Sculpture and Ornament.—Though the outer surface of the fruit is usually smooth, with a more or less circular outline in transverse section, yet it becomes prismatic in *E. goniocalyx,* axially ridged in *E. incrassata, E. pyriformis,* &c., or ornamented with asperities, as in *E. Foelscheana.* . . .

3. Capsular Teeth.—In the larger number of campanulate and ovoid fruits the capsule is extensively overtopped by the calyx-tube—in these deeply sunken capsules the capsular teeth are usually included, but they are prominently exsert in *E. oleosa, E. salmonophloia,* whilst the obconic fruits must obviously have exsert capsular teeth. Apart from the exsert or included position of the teeth, their shape and length offer considerable variation, and may be usefully employed as minor

distinctive specific characters.

4. Capsule-cells.—The number of the fruit cells varies from three to six, and is not constant for each species, though a given number may largely prevail.

It may now be concluded that by the employment of a carpological system in the classification of the Eucalypts, we have several factors available, which, taken in their varying combinations, permit of a more detailed classification than is possible by the use of any other single structure; if to the fruit we add the characters afforded by the pedicels which usually can be found with the fruits, then increased means of discrimination are afforded. . . .

Series A.—Ovoid, medially inflated, attenuated below, truncated above the middle.

1. Ovoid.

E. Behriana.	*E. diversicolor.*
E. hoemastoma.	*E. maculata.*
E. populifolia.	*E. redunca.*
E. piperita.	*E. oleosa.*
E. pauciflora (*coriacea*).	*E. patens.*
E. melliodora.	*E. uncinata.*
E. obliqua.	*E. salmonophloia.*
E. saligna.	*E. trachyphloia.*
E. marginata.	

2. Ovoid-oblong.

E. crebra.	*E. punctata.*
E. corymbosa.	*E. Planchoniana.*
E. occidentalis.	*E. salubris.*
E. robusta.	*E. tetragona.*
E. stricta.	*E. buprestium.*
E. leucoxylon.	*E. goniocalyx* (*eloephora* is meant).
E. Landsdowneana.	

3. Ovoid-conic, passing to Series Biconic.

E. amygdalina.	*E. largiflorens* (*bicolor*).
E. acmenioides.	*E. santalifolia* (pars).
E. odorata.	*E. capitellata* (pars).
E. paniculata.	*E. Gunnii.*

Series B.—Biconic.

1. Base elongate, longer than wide. Exs. *longifolia, cornuta, gomphocephala.*

2. Base hemispheric or ovoid, as wide as long:—

(*a*) Fruit very large, 2 or more inches diameter. Exs. *pyriformis, macrocarpa.*
(*b*) Fruit medium-sized, 1/2 to 1 inch diameter. Exs. *Oldfieldii, pachyphylla, capitellata.*
(*c*) Fruit small, under 1/2 inch diameter. Exs. *macrorrhyncha, rudis, rostrata, decipiens, Stuartiana, tereticornis, viminalis, salubris.*

Series C.—Globulose to hemispheric.

1. Globulose. Exs. *Howittiana, stellulata, Todtiana, eugenioides.*
2. Globulose-ovoid. Exs. *doratoxylon, eudesmioides, salmonophloia, cneorifolia, capitellata* (pars).
3. Hemispheric. Exs. *cosmophylla, cordata.*

Series D.—Ellipsoid, sides approximately parallel; length at least two times the breadth.

1. Ellipsoid, ridged. Ex. *tetrodonta.*
2. Ellipsoid-obconic.

(*a*) Base gradually attenuated. Exs. *gracilis, diversicolor, microcorys.*
(*b*) Base more abruptly attenuated. Exs. *foecunda, hemiphloia, botryoides.*

3. Ellipsoid-ovoid, slightly narrowed towards the summit.

(*a*) Externally ridged. Exs. *tetragona, ptychocarpa, corynocalyx, incrassata, clavigera.*
(*b*) Not ridged. Ex. *gamophylla.*

4. Ellipsoid-urn-shaped, slightly narrowed towards the summit, thence slightly dilated.

(*a*) Smooth. Ex. *phoenicea.*
(*b*) Ridged. Ex. *clavigera.*

Series E.—Campanulate, general outline ovoid-oblong, more or less dilated at the summit.

1. Urn-shaped, distinctly dilated at the summit.

(*a*) Fruit 1 inch or more long. Exs. *Foelscheana, Watsoniana.*
(*b*) Fruit under 1 inch long. (I) Fruit somewhat globulose. Ex. *Baileyana.* (II) Fruit oblong. Exs. *obcordata, eximia, peltata, tessellaris, terminalis* (axially streaked).

2. Urn-shaped ovoid, not markedly dilated at the summit.

(*a*) Fruit 1 inch or more long.

I. Longitudinally wrinkled. Exs. *calophylla, sepulcralis, miniata.*
II. Smooth. Ex. *setosa.*
III. Hispid. Ex. *Foelscheana* (pars).

(*b*) Fruit under 1/2 inch long. Ex. *pruinosa.*

Shape.

As a rule the shape and sculpture of the fruit have been pretty clearly foretold or indicated under Calyx-tube; see Part LVIII, p. 469, and it would be largely repetition to deal with these fruits under Fruit, with the same amount of detail. I ask my readers to refer to what was there said. Fruits vary, as do all other organs, and the subject has several times been referred to, *e.g.,* under *E. pilularis,* Part I, p. 28 (although we do not now consider the species to be so comprehensive); *E. piperita,* Part X, p. 300; *E. Andrewsi,* Part XLVI, p. 171.

The urceolate shape is more or less a character of the Corymbosae, but it is by no means confined to that Section, *urnigera* and *grandifolia* being cases in point, while we have many species with fruits more or less urceolate.

As a rule Euclayptus fruits are rigid in texture, but in *E. clavigera, brachyandra, Spenceriana,* &c., which I have termed Clavigerae, they may be papery in texture, like most of the *Angophoras* (Apple-trees).

The shapes of the fruits have been dealt with already to some extent by Naudin and Tate, in addition to Bentham and Mueller. Mr. R. H. Anderson, B.Sc., Agr., has compiled the list which follows from the illustrations of the present work, and it is useful, but there is so much variation in a species, that no classification can be absolute.

1. Globose, sub-globose or globose-truncate (includes pilular).
2. Urceolate globose.
3. Ovoid or ovoid-truncate.
4. Campanulate.

5. Cylindrical, sub-cylindrical or oboid-oblong.
6. Hemispherical.
7. Pyriform.
8. Urceolate.
9. Conoil.
10. Quadrangular.
11. Obovoid-truncate.

(This classification does not include every species The numbers after a name indicate that the species at times falls within the group represented by that number.)

1. Globose, sub-globose, globose-truncate, pilular.

E. alpina.	*E. Ebbanoensis* (6).
E. angustissima.	*E. eremophila* (5).
E. Bakeri.	*E. eugenioides* (6).
E. Bancrofti.	*E. exserta* (9).
E. de Beuzevillei.	*E. falcata.*
E. buprestium.	*E. fraxinoides* (8).
E. capitellata.	*E. globulus.*
E. cinerea.	*E. haemastoma* (6).
E. Cliftoniana.	*E. Howittiana.*
E. cneorifolia (6).	*E. intertexta* (3).
E. cordata (3) (5).	*E. Jacksoni.*
E. cosmophylla.	*E. Johnstoni* (3).
E. decipiens (7).	*E. leptophleba* (3).
E. diversifolia.	*E. leptopoda.*
E. doratoxylon.	*E. macrorrhyncha.*
E. drepanophylla.	*E. megacarpa.*

Globose, sub-globose, globose-truncate, pilular—*continued.*

E. melliodora (3).	*E. patens.*
E. Mitchelliana (4) (5).	*E. Penrithensis* (6).
E. Mooeri.	*E. pilularis.*
E. Morrisii.	*E. pulverulenta.*
E. numerosa (7).	*E. radiata* (6).
E. Oldfieldii (6).	*E. Risdoni.*
E. oleosa (3).	*E. rostrata.*
E. pachyloma.	*E. stellulata* (7).
E. paniculata (3).	*E. uncinata* (7).
E. parvifolia.	*E. viminalis.*

2. Urceolate globose.

E. Baileyana.	*E. latifolia.*
E. brachyandra.	*E. peltata.*
E. dichromophloia.	*E. setosa.*

3. Ovoid or ovoid-truncate.

E. affinis.	*E. miniata* (8) (5).
E. aspera.	*E. nitens.*
E. Boormani.	*E. oleosa* (1).
E. Bosistoana (1).	*E. Perriniania* (6).
E. caesia (8).	*E. pruinosa* (5).
E. cladocalyx.	*E. ptychocarpa* (8 slightly).
E. confluens.	*E. punctata* (6).
E. decurva.	*E. similis.*
E. diversicolor.	*E. Spenceriana.*
E. ferruginea.	*E. tesselaris* (5).
E. ficifolia (8).	*E. tetragona* (5).
E. haematoxylon (8).	*E. trachyphloia.*
E. longicornis (1).	*E. vernicosa* (8).
E. macrandra (5).	

4. Campanulate.

E. aspera.	*E. Preissiana.*
E. gomphocephala.	*E. quadrangulata.*
E. occidentalis (8).	*E. spathulata* (9).
E. oligantha (Campanulo-urceolate).	*E. Watsoniana.*
E. patellaris.	

5. Cylindrical, sub-cylindrical, or ovoid-oblong.

E. approximans.	*E. lirata.*
E. botryoides.	*E. Mooreana.*
E. clavigera (8).	*E. Mundijongensis.*
E. Deanei.	*E. odontocarpa* (8).
E. Dundasi.	*E. odorata* (6) (3).
E. gamophylla.	*E. papuana.*
E. grandis.	*E. platypus* (9).
E. Gunnii (6).	*E. redunca* (7).
E. hemiphloia.	*E. robusta.*
E. hybrida.	*E. scoparia* (3).
E. incrassata.	*E. Stricklandi* (slightly 8).
E. Kruseana.	*E. tetrodonta.*
E. linearis.	*E. virgata* (6) (9).

6. Hemispherical.

E. acacioeformis.
E. adjuncta.
E. alba.
E. amygdalina (9).
E. Andrewsi (slightly 7).
E. angophoroides (slightly 7).
E. annulata (9).
E. Banksii.
E. Camfieldi.
E. canaliculata.
E. Cloeziana.
E. corrugata.
E. Culleni.
E. dealbata.
E. dives (9).
E. Dunni.
E. erythrocorys (4).
E. Houseana.
E. Kitsoniana (5).
E. Kybeanensis.
E. Lane-Poolei.
E. Laseroni.
E. Macarthuri.
E. macrocarpa.
E. Maideni (1).
E. microtheca.
E. neglecta.
E. nitida.
E. notabilis.
E. ovata.
E. pachyphylla.
E. Parramattensis.
E. pellita.
E. Penrithensis (1).
E. Perriniana (or obovate truncate).
E. populifolia (9).
E. praecox.
E. propinqua.
E. pumila.
E. pyriformis.
E. regnans (7).
E. resinifera.
E. rubida (9).
E. rudis (9).
E. salubris.
E. Seeana (9).
E. Le Souefii.
E. squamosa.
E. Stuartiana (8).
E. tereticornis.
E. Websteriana.

7. Pyriform.

E. Beyeri.
E. bicolor.
E. Caleyi.
E. Consideniana (9).
E. coriacea (6).
E. decipiens (1).
E. gigantea.
E. goniocalyx (6).
E. Guilfoylei.
E. longifolia (5).
E. obliqua.
E. Pimpiniana (5).
E. regnans.
E. sideroxylon (1).
E. Sieberiana.
E. stricta (1).
E. Stowardi.
E. uncinata (1).

8. Urceolate.

E. Abergiana.
E. calophylla.
E. corymbosa.
E. miniata (5).
E. perfoliata.
E. phoenicea.

E. dichromophloia.	*E. piperita* (3) (1).
E. eximia.	*E. terminalis.*
E. Flocktonioe.	*E. Torelliana* (spheroid urceolate).
E. Foelscheana.	*E. trachyphloia.*
E. grandifolia.	*E. transcontinentalis* (3).
E. haematoxylon.	*E. urnigera.*
E. intermedia.	*E. Watsoniana.*
E. maculata.	*E. Woodwardi* (4).
E. microcorys (5).	

9. Turbinate or Conoid.

E. argillacea.	*E. erythronema.*
E. Baueriana.	*E. fasciculosa* (6).
E. Behriana.	*E. Griffithsii.*
E. Blakelyi (6).	*E. maculosa* (6).
E. Brownii.	*E. Pilligaensis.*
E. Cambageana.	*E. polyanthemos.*
E. conica.	*E. populifolia* (6).
E. Consideniana.	*E. Rudderi* (6).
E. Dawsoni.	

10. Quadrangular.

E. eudesmioides.	*E. tetraptera.*
E. Forrestiana.	

11. Obovoid truncate.

E. coccifera.	*E. Dalrympleana.*
E. cornuta.	*E. dumosa.*

Size.

Mueller ("Eucalyptographia," under *E. tetraptera*), has some notes under "Large fruits." So has Naudin, II, 18, on the same subject (quoted at p. 572), but his large fruits or very small ones are limited to those of species cultivated in France.

The following notes are based on the illustrations in the present work.

The greatest measurement of the fruit was taken, *i.e.*, diameter in globular or hemispherical fruits, length in conical or cylindrical types. They may be provisionally grouped as—

1. Very small, *i.e.*, under 2 mm.
2. Small, under 5 mm.

3. Fairly small to medium, 5–9 mm.
4. Moderately large, 9–14 mm.
5. Large, 15–20 mm.
6. Very large, viz.,

(*a*) Up to 2·5 cm.
(*b*) Up to 4 cm.

7. Largest, up to or exceeding 5 cm.

1. Very small, under 2 mm.

E. brachyandra. *E. Raveretiana.*

2. Small, under 5 mm.

E. Behriana.	*E. Normantonensis.*
E. bicolor.	*E. numerosa.*
E. Blakelyi.	*E. odorata.*
E. Brownii.	*E. parvifolia.*
E. Dawsoni.	*E. Pilligaensis.*
E. Deanei.	*E. piperita* (one form).
E. Howittiana.	*E. scoparia.*
E. Macarthuri.	*E. Seeana.*
E. maculosa.	*E. stellulata.*
E. microtheca.	*E. uncinata.*
E. neglecta.	

3. Fairly small to medium, 5–9 mm.

E. acacioeformis.	*E. intermedia.*
E. affinis.	*E. intertexta.*
E. amplifolia.	*E. Johnstoni.*
E. amygdalina.	*E. Kitsoniana.*
E. Andrewsi.	*E. Kruseana.*
E. angophoroides.	*E. Laseroni.*
E. angustissima.	*E. latifolia.*
E. approximans.	*E. leptophleba.*
E. argillacea.	*E. leptopoda.*
E. aspera.	*E. macrandra.*
E. Bakeri.	*E. micranthera.*
E. Banksii.	*E. microcorys.*
E. Beyeri.	*E. Mitchelliana.*
E. Boormani.	*E. Morrisii.*

E. Cambageana.
E. cinerea.
E. cneorifolia.
E. confluens.
E. Consideniana.
E. coriacea.
E. cornuta.
E. Culleni.
E. Dalrympleana.
E. dealbata.
E. decipiens.
E. decurva.
E. doratoxylon.
E. drepanophylla.
E. Dundasi.
E. dumosa.
E. Dunnii.
E. exserta.
E. falcata.
E. fasciculosa.
E. goniocalyx.
E. grandis.
E. Gunnii.
E. haemastoma.
E. hemiphloia.
E. Houseana.
E. hybrida.
E. nitens.
E. notabilis.
E. oleosa.
E. pallidifolia.
E. paniculata.
E. Parramattensis.
E. peltata.
E. Penrithensis.
E. piperita.
E. praecox.
E. pruinosa.
E. pulverulenta.
E. pumila.
E. radiata.
E. Risdoni.
E. rostrata.
E. siderophloia.
E. spathulata.
E. Spenceriana.
E. squamosa.
E. stricta.
E. Stuartiana.
E. tereticornis.
E. Torelliana.
E. trachyphloia.
E. transcontinentalis.
E. vernicosa.

4. Moderately large, 9–14 mm.

E. adjuncta.
E. alba.
E. annulata.
E. Bancrofti.
E. Baueriana.
E. botryoides.
E. Caleyi.
E. Camfieldi.
E. capitellata.
E. caldocalyx.
E. clavigera.
E. Cloeziana.
E. coccifera.
E. conica.
E. Guilfoylei.
E. Jacksoni.
E. Kybeanensis.
E. Lane-Poolei.
E. lirata.
E. macrorrhyncha.
E. maculata.
E. marginata.
E. Mooreana.
E. obliqua (or smaller).
E. odontocarpa.
E. Oldfieldii.
E. papuana.
E. patens.

E. cordata.	*E. pilularis.*
E. dichromophloia.	*E. redunca.*
E. diversicolor.	*E. robusta.*
E. diversifolia.	*E. rudis.*
E. Ebbanoensis.	*E. sideroxylon.*
E. erythronema.	*E. similis.*
E. Ewartiana.	*E. Le Souefii.*
E. Flocktoniae.	*E. viminalis.*
E. fraxinoides.	*E. Websteriana.*
E. gonianтha.	

5. Large, 15–20 cm.

E. Baileyana.	*E. pachyloma.*
E. canaliculata.	*E. pachyphylla.*
E. Cliftoniana.	*E. pellita.*
E. cosmophylla.	*E. Pimpiniana.*
E. gomphocephala.	*E. platypus.*
E. longifolia.	*E. setosa.*
E. Mundijongensis.	*E. Stricklandi.*
E. occidentalis.	*E. Woodwardii.*

6. Very large.

(*a*) Up to 25 mm. (2·5 cm.)

E. Abergiana.	*E. ferruginea.*
E. alpina.	*E. globulus.*
E. buprestium.	*E. incrassata.*
E. caesia.	*E. phoenicea.*
E. eximia.	*E. Watsoniana.*

(*b*) Up to 4 cm.

E. collina.	*E. megacarpa.*
E. ficifolia.	*E. perfoliata.*
E. Forrestiana.	*E. Preissiana.*
E. hoematoxylon.	*E. Todtiana.*

7. Largest—Up to or exceeding 5 cm.

E. calophylla.	*E. ptychocarpa.*
E. macrocarpa.	*E. pyriformis.*
E. miniata.	

Corky Patches.

We have corky patches or warts on some fruits, *e.g.,*

E. erythrocorys (?)	Fig.2*f,*	Plate 184.
E. globulus	Fig. 9*a,* &c.,	Plate 79.
E. grandifolia	(Not figured).	
E. leucoxylon	Fig 5,	Plate 56.
E. maculata	Fig 2*c* & 4*c,*	Plate 178.
E. obtusiflora	Fig 8*c,*	Plate 43.
E. peltata	Fig 2*b,*	Plate 173.
E. sideroxylon	Fig 12,	Plate 55.
E. Watsoniana	Fig 3*b* & 3*d,*	Plate 173.

We may have glandular warts, *e.g., E. Maideni,* Fig. 12*b,* Plate 80, and also warted operculum in *E. eloeophora,* Fig. 1*b,* Plate 83.

For remarks on scurfiness of fruits, see Part XXXIX, p. 243, under *E. corymbosa.*

For notes on cork warts on leaves, see Soledərer, II, 1133.

An inquiry into corky patches on the organs will doubtless receive attention some day.

The Capsule.

Capsule sometimes free or nearly so.

Gaertner's (1788) figure of *Metrosideros gumifera,* tab. xxxiv, fig. 1, which is *E. corymbosa,* shows the capsule separate from the calyx-tube. It will be figured in due course showing the capsule free.

In the original description of *E. dichromophloia,* Mueller says: “Capsule finally coming away from the calyx-tube.”

Bentham (*B. Fl.* iii, 185, 1866) says, as regards the genus, “the capsule always adnate to the calyx-tube, although often readily separable from it when quite ripe and dry.”

Mueller (preface to “Eucalyptographia,” 1879) similarly says: “Capsular portion of the fruit largely adnate to the calyx-tube, only exceptionally much seceding.”

It is in the Corymbosae that this separation of the capsule from the wall of the calyx-tube mainly occurs, *e.g.,* I have noted it in *E. corymbosa, E. terminalis* and *E. dichromophloia,* but it is usually only observed after some desiccation.

Dehiscence of the Capsule.

In *Mem.* i, 23, Naudin (1883) includes the classification (this Part, p. 573):—

(*a*) Species with exsert capsules.
(*b*) Species with enclosed capsules.

To use his words, a group (*a*) and First Section, “Capsule more or less exsert, that is to say, notably exceeding the calyx-tube"; and a group (*b*) and Second Section, "where the tips of the capsule valves are either sunk or hardly attain the margin of the calyx-tube," it is, of course, understood that the lines of demarcation are not sharp. He has other groups based on the valves.

At an extraordinary meeting of the Société Botanique de France held in Algiers in April, 1892, Professor L. Trabut read a paper (p. xli), "Sur la dehiscence des Capsules dans le genre Eucalyptus," of which the following is a translation:—

There are fine collections of Eucalypts in Algiers, the most interesting, without doubt, being that of M. Cordier, established in 1863. For more than fifteen years M. Cordier planted in his different properties more than 2,000 to 3,000 Eucalyptus trees each year, and at the present time, at Maison-Carrée in the domain of El-Alia, more than 5,000 trees have grown into fine specimens, representing more than 100 species or varieties.

It was in seeking to utilise these precious materials with the view of finding indications as to the best species to propagate that I have been verifying the determinations, and have been noting certain peculiarities which appear to me to be worthy of interest. The variations in the mode of dehiscence of the capsule may perhaps be taken into consideration, and furnish some useful characters to complete the descriptions which one does not take too rigorously in a genus of allied and polymorphic species.

We know that the capsule in Eucalyptus is not entirely free, but adnate to the calyx-tube, resulting from the concrescence of external verticels, the summit alone of the capsule remaining free. This summit sometimes projects outside the calyx-tube, and sometimes is surmounted by the edges of the calyx-tube; the capsule is then included. At maturity the fruit opens by slits on a level with the dorsal vein of the part remaining free of the carpels; this is a loculicidal dehiscence; but this loculicidal dehiscence is not as uniform as one might think, and its variations can be classified in the following way:—

(*a*) The capsule opens by 3–5 loculicidal slits; but the summits of the valves remain united at the centre of the stylic column (style), of which the base is more or less persistent. The slits open at the maturity of the capsule on the plant; but the seeds do not fall out except after a half-opening, which produces the desiccation of the capsule (figs. 1 and 2, to be reproduced later, J.H.M.).

(*b*) The capsule opens by 3–5 loculicidal slits; the very thick valves converge towards the centre, remaining adherent to the partition so well that the whole of the slits form a star. The mass of the piled up seeds has the appearance of a projecting cushion with a hole in the middle, after the fashion of a star, and the seeds, obstructing the slits of the capsule, may remain in that state for years; but, when the capsule dries, which rapidly happens when it is separated from the tree, the seeds fall out because of the contraction of the valves and of the membrane surrounding the cavity of the ovary (fig. 3, to be reproduced later, J.H.M.).

(*c*) The valves, more or less membranous, deltoid or linear, converge at the beginning towards the centre, then, becoming free, they rearrange themselves, leaving the cells largely open (fig. 4, to be reproduced later). These valves may be also deeply inserted in the calyx-tube.

(*d*) The valves, neatly arranged on the summit of the capsule, lose their tops by decay and drying, and assume the form of a triangular fragment. These apices of the valves remain for a greater or shorter period in their place; after their fall, the seeds which appear are retained by the bases of the valves remaining in a living state. The central opening in obliterated by piled-up seeds; then the seeds escape by the contraction of the base of the valves, and the desiccation of the capsule. The whole of the valves can also dry off and fall in the shape of an operculum; the valves are also partly or wholly deciduous in a large number of species (fig. 5, to be reproduced later).

In taking cognisance of the characters of the capsule, we may establish the following divisions in the genus Eucalyptus:—

I. Valves of the capsule adherent by the summit to the persistent base of the style. Examples: *E. Lehmanni, E. cornuta, E. robusta.*

II. The thick valves convergent and adherent to the partition. Capsule opening by a slit in the form of a star, by the contraction of the original contiguous valves. Examples: *E. globulus, E. megacarpa.*

III. The free membranous valves stand erect; the cells are widely open. Examples: *E. rostrata, E. tereticornis, E. resinifera, E. rudis, E. macrorrhyncha, E. Gunnii, E. Stuartiana,* &c.

IV. The valves decay, either partly or wholly, the dead united portions falling in the shape of an operculum. Examples: *E. Rameliana* (*Trabuti*), *E. calophylla, E. oppositifolia, E. populifolia, E. occidentalis, E. botryoides, E. obliqua,* &c.

Depth of the Capsule.

This is another way of implying that the valves are enclosed.

The depth of the capsule within the encasing calyx-tube is referred to chiefly by Bentham. Thus, in the sub-series Robustae he speaks of "capsule sunk", Cornutae "not much sunk"; Sub-exsertae, "level or slightly sunk." He refers to the capsule in almost every description of a species, as follows:—

(In most cases the depression (if any) of the capsule can be seen by the figures of the fruits of each species in the present work. We now come to consideration of the valves, and it is obvious that where the capsule is sunk so are the valves.)

Not sunk.—

E. exserta. *E. Risdoni.*
E. leptopoda. *E. rostrata.*
E. pachyloma. *E. tereticornis.*
E. pallidifolia. *E. viminalis.*

Not depressed.—
E. Lehmanni.
On a level with rim.—

E. angustissima. *E. santalifolia.*

Nearly level with rim.—

E. globulus. *E. platyphylla.*
E. melanophloia.

On a level with the rim, or slightly sunk.—
E. Stuartiana.
Level with the rim, or more or less depressed.—
E. erythronema (conoidea).
Somewhat depressed in the centre.—
E. Oldfieldii.
Depressed in the centre.—
E. erythrocorys.
Somewhat sunk, but very convex or conical in the centre.—
E. rudis.
Depressed below the rim.—
E. pachyphylla.
Not at all, or scarcely sunk.—

E. alpina. *E. amygdalina.*

Not much, or sometimes scarcely sunk.—
E. siderophloia.
Very slightly sunk.—

E. cinerea. *E. micranthera.*

Slightly sunk.—

E. Behriana. *E. longifolia.*
E. eudesmioides. *E. microtheca.*

E. odontocarpa. *E. pruinosa.*

Slightly depressed.—

E. alba. *E. leucoxylon.*
E. haemastoma. *E. Preissiana.*

Scarcely sunk.—

E. coccifera. *E. pellita.*
E. gomphocephala.

Slightly or scarcely sunk.—
E. stellulata.
Scarcely depressed.—
E. pulverulenta.
More or less sunk.—

E. cneorifolia. *E. decipiens.*
E. crebra. *E. paniculata.*

Somewhat depressed.—
E. bicolor.
Somewhat sunk.—

E. cordata. *E. pyriformis.*
E. goniantha. *E. vernicosa.*
E. melanophloia. *E. virgata.*
E. platypus.

Somewhat or scarcely sunk.—
E. saligna.
Somewhat sunk or nearly level.—
E. pilularis.
Somewhat sunk or nearly on a level with the border.—
E. coriacea.
Somewhat sunk or nearly level with rim —
E. resinifera.
Somewhat sunk, but conical in the centre.—
E. occidentalis.
More or less sunk.—

E. botryoides. *E. goniocalyx.*
E. corymbosa *E. Gunnii.*

E. dichromophloia.	*E. obliqua.*
E. dumosa	

More or less depressed.—

E. melliodora.	*E. obliqua.*

Sunk.—

E. brachyandra.	*E. piperita.*
E. buprestium.	*E. polyanthemos.*
E. concolor.	*E. ptychocarpa.*
E. cosmophylla.	*E. setosa.*
E. falcata.	*E. spathulata.*
E. marginata.	*E. stricta.*
E. microcorys.	*E. tetragona.*
E. oleosa.	*E. tetradonta.*
E. perfoliata.	*E. uncinata.*

Depressed.—
E. obtusiflora.
Sunk, but not deep.—
E. patens.
Sunk to the base of the neck.—
E. phoenicea.
Considerably sunk.—
E. redunca.
Much sunk.—

E. robusta.	*E. urnigera.*

Rather deeply sunk.—
E. tetraptera.
Deeply sunk.—

E. albens.	*E. gracilis.*
E. aspera.	*E. hemiphloia.*
E. caesia.	*E. incrassata.*
E. calophylla.	*E. latifolia.*
E. cladocalyx.	*E. maculata.*
E. clavigera.	*E. miniata.*
E. decurva.	*E. odorata.*
E. doratoxylon.	*E. peltata.*
E. eximia.	*E. tesselaris.*

E. ferruginea. *E. trachyphloia.*
E. foecunda.

Deeply sunk with a conical top.—
E. diversicolor.

Valves—Enclosed or Protruding.

1*a.* Bentham.—Enclosed in Calyx-tube.
1*b.* Bentham.—Protruding.
2*a.* Mueller.—Enclosed.
2*b.* Mueller.—Protruding.
3*a.* Maiden.—Enclosed.
3*b.* Maiden.—Protruding.

1*a.* Bentham. Enclosed in Calyx-tube. (Dealt with under "Depth of Capsule," at p. 586.)

1b. Protruding.

Bentham, 1866.—I have followed Bentham's verbiage as far as I could, for he is a master of description. He rarely sees it necessary to give the shapes of valves. We have already seen that, in speaking of the Capsule, he often uses the word "sunk." Coming to a part of the Capsule, viz., a valve, sometimes the words "points of valves" are substituted for "valves," and sometimes the words "when open" are added. This means that Bentham felt that he sometimes had to deal with fruits of varying degrees of ripeness. He uses the word "protrude," or the reverse, to indicate the position of the valves with respect to the rest of the fruit.

Occasionally Bentham substitutes the word "prominent" for "protruding." He rarely (*e.g., alba*) uses the word "exsert," so commonly in use now.

Not protruding, *E. botryoides, E. cosmophylla, E. globulus, E. marginata, E. patens, E. stricta.*

Rarely protruding, *E. redunca, E. cordata.*

Sometimes protruding, *E. longifolia.*

Sometimes slightly protruding, *E. Gunnii.*

Often slightly protruding, *E. drepanophylla.*

Flat or slightly protruding, *E. amygdalina, E. Risdoni.*

Only slightly protruding, *E. cneorifolia.*

Slightly protruding or more sunk with the valves included, *E. melanophloia.*

More or less protruding, *E. goniocalyx.*

Scarcely protruding, *E. pachyphylla.*

Not at all or scarcely protruding, *E. piperita.*

Horizontal or scarcely protruding, *E. coriacea.*

Much shorter than border of fruit (they are distinctly sunk, J.H.M.), *E. diversicolor.*

Often protruding when open, but very soon falling away, *E. haemastoma.*

Usually horizontal (really sunk, J.H.M.), *E. pilularis.* (The same term is applied to (*diversifolia*) *santalifolia* below.)

Protruding from centre of disc, but shorter than border of fruit, *E. caesia.*

When open raised and acuminate by the long often connivent points formed by the split and persistent base of the style, *E. cornuta.*

Protrude much, tapering into long erect or connivent points formed by the persistent base of the style, *E. annulata.*

Often acuminate by the split base of the style with the points protruding, *E. platypus.*

Small, not protruding, *E. macrandra.*

Protruding when open, *E. occidentalis.*

Points sometimes slightly protruding, *E. spathulata.*

Sometimes base of style splits into long points to the valves protruding beyond the border of the fruit, *E. foecunda.*

Slightly protruding, *E. pulverulenta.*

Slightly prominent, *E. Oldfieldii.*

Occasionally protruding, *E. goniantha.*

Shortly protruding, *E. platyphylla.*

Usually horizontal, *diversifolia* (*E. santalifolia*). Really refers to slightly exsert valves.

Sometimes protruding, *E. pruinosa.*

Often protruding, *E. siderophloia, E. crebra, E. erythronema* (*conoidea*).

More or less protruding, *E. saligna.*

Usually protruding, *E. decipiens (E. concolor).*

Exserted, *E. alba.*

Protruding, *E. alpina, E. capitellata, E. cinerea, E. gomphocephala, E. leptopoda, E. microtheca, E. patellaris, E. resinifera, E. rudis, E. vernicosa.*

Horizontal or protruding, *E. Stuartiana.*

Not protruding beyond the rim, *E. pyriformis.*

Broad, protruding still further in the centre (than raised rim), *E. macrocarpa.*

Projecting beyond rim, *E. macrorrhyncha.*

Protruding beyond rim, *E. terelicornis.*

Sometimes prominent, *E. melliodora.*

Much projecting, *E. pellita.*

Protruding even before they open, *E. dealbata.*

Short, horizontal or protruding when open, *E. viminalis.*

Entirely protruding even before they open, *E. exserta, E. rostrata.*

The long points of the valves, formed by the split base of the style usually protruding, *E. falcata.*

The slender points of the valves, formed by the split base of the style often protruding, *E. oleosa.*

Sometimes acuminate by the persistent split base of the style, *E. pallidifolia.*

Sometimes terminating in long protruding points formed by the split base of the style, *E. incrassata.*

Mueller, 1879–84. ("Eucalyptographia") ". . . . the latter (capsule) with 3–5, rarely 2 or 6, wholly or partially exserted or entirely enclosed valves . . . ."

I reproduce Mueller's quaint language, as it is often remarkably descriptive, although sometimes not as English as he intended. Many a time, both verbally and in writing, has he corrected me, explaining that he understood the nuances of the English language and I didn't. His improvements of the language extended not only to verbiage and phraseology, but also to the structure of whole sentences.

As regards Valves, he is very fond of the word "deltoid," and employs it no less than 53 times (out of a hundred species) and sometimes the equivalent "delta-shaped." It really means an equilateral triangle.

2a. Enclosed.

Well enclosed—

Deltoid, *E. tetraptera.*

Perfectly enclosed—

3 or much oftener 4, deltoid, *E. piperita.* Rim extending considerably before the very short valves, *E. tessellaris.*

Deeply enclosed—

Almost deltoid, *E. calophylla.*

Short, *E. cladocalyx (corynocalyx), E. miniata.*

Deltoid, sometimes remaining coherent and then seceding as a circular disc, *E. corymbosa.*

Deltoid, at first flatly converging, at last quite descending, *E. ficifolia.*

Generally 4, nearly deltoid, inserted much below the narrow edge of the fruit, at last deeply enclosed, *E. Foelscheana.*

Deeply enclosed, *E. clavigera, E. phoenicea.*

Very short and quite retracted, *E. maculata.*

Horizontal, deltoid, *E. ptychocarpa.*

Very short, deltoid, *E. sepulcralis.*

Deltoid, *E. setosa.*

Delta-shaped, *E. trachyphloia.*

Rather deeply enclosed—

Short, deltoid, *E. Planchoniana.*

Quite enclosed—

Deltoid, *E. buprestium, E. peltata, E. Watsoniana.*

Short; summits of the valves often long, cohering and breaking off connectedly, *E. hemiphloia.*

Their fragile and pointed ends only exserted, *E. incrassata.*

Very short, *E. melliodora.*

Short, converging flatly before expansion, *E. odorata.*

Short, *E. leucoxylon.*

Almost deltoid, *E. paniculata.*

Slightly sunk—

Deltoid and short-acuminate, *E. obcordata.*

Enclosed—

Enclosed, *E. eximia, E. longifolia, E. tetrodonta.*

At first horizontal, very deltoid, *E. Abergiana.*

Cohering before maturation into a pyramidal cone, *E. diversicolor.*

Deltoid, *E. gracilis.*

But slightly exserted; broader than long, inserted not far below the orifice; short, *E. marginata.*

Very short, almost deltoid, *E. patens.*

Very short, *E. Behriana, E. polyanthemos, E. Todtiana.*

Short, *E. obliqua, E. stellulata.*

Valves inserted near the Orifice

(*i.e.,* hardly sunk; these are allied to those in the “Protruding Section” which tend to be “hardly sunk”):—

Inserted not much below the . . . . rim. Deltoid, *E. acmenioides.*

Close to the orifice, slightly or not exserted. Tender, convergent, deltoid, *E. amygdalina.*

Not distant from the rim. Very short, *E. bicolor (largiflorens).*

Inserted close beneath the orifice, not emerging. Short, *E. botyroides.*

Affixed not far below the orifice, but quite enclosed, or only their apex exserted.

Deltoid, *E. cordata.*

Convergent from near the summit of the orifice, not or but slightly exserted. Almost deltoid. Very short, *E. coriacea (pauciflora).*

Affixed not far below the orifice, enclosed or slightly exserted. Short, convergent, *E. cosmophylla.*

Affixed close below the summit, or provided with slightly exserted points. Deltoid, *E. crebra.*

Inserted not distant from the orifice. Enclosed, but reaching nearly or fully to the rim; very short, *E. doratoxylon.*

Affixed to the summit of the orifice. Convergent and thus scarcely emersed, though terminal. Short, deltoid, *E. erythronema.*

Affixed near the orifice of the fruit, enclosed or slightly exserted. Deltoid, *E. eugenioides.*

Inserted not far below the orifice. Very short, *E. gamophylla.*

Inserted very near the narrow margin of the orifice, enclosed or less often semi-exserted. Deltoid, *E. goniocalyx.*

Fixed close to the orifice, almost enclosed. Very short, deltoid, *E. Gunnii.*

Usually affixed very close to the summit of fruit. Very short, deltoid, convergent, *E. haemastoma.*

Inserted near the orifice. Minute, almost deltoid, *E. Howittiana.*

Reaching to near the summit of the fruit or slightly beyond it. Deltoid, *E. microcorys.*

Inserted slightly below the . . . . rim. Deltoid, *E. pilularis.*

Situated close beneath the rim. Very short, *E. populifolia.*

Reaching to the narrow rim or slightly protruding beyond it; fruits sometimes barely half the length and width of those illustrated, and the valves occasionally more terminal. Short, *E. pruinosa.*

Exserted or almost quite enclosed deltoid, Nearly *E. pyriformis.*

Reaching the summit of the fruit-tube or extending slightly beyond it. Short, pointed, *E. redunca.*

Frequently reaching to near the summit or sometimes slightly beyond it. Enclosed, permanently or long-coherent, rather narrow, *E. robusta.*

Semi-exserted. Short, *E. saligna.*

Usually affixed very close to the summit of the fruit. Deltoid, very short, convergent, *E. Sieberiana.*

Inserted rather near the orifice. Deltoid, enclosed, *E. stricta.*

Enclosed near the orifice. Very short, *E. tetragona.*

2b. Protruding.

Slightly exserted; inserted not much beneath the orifice, quite enclosed or with their pointed summits slightly exserted. May occur sometimes more elongated and fine-pointed from the persistent basal remnants of the style, *E. uncinata.*

Or hardly extending beyond the orifice; deltoid, *E. Baileyana.*

Slightly exserted valves, *E. pachyphylla.*

Quite exserted; much elongated, from a broad turgid base very narrowly attenuated, towards the summit coherent. Towards the summit far united and passing into the remnant of the style, externally streaked, particularly when aged, points of the valves wearing away finally, leaving the usmmit of old fruits quite blunt, *E. cornuta.*

Deltoid, *E. rudis.*

Finally quite exserted. Deltoid, *E. viminalis.*

At last exserted or convergent from the rim. Short; deltoid, *E. punctata.*

Near the orifice, at a level with the rim or half-emerging. *E. siderophloia.*

Almost at the orifice, very small, deltoid, convergent, *E. cinerea (pulverulenta).*

Half-exserted; delta-shaped, *E. alpina.*

About half-exserted, awl-shaped-pointed, free; "sometimes abbreviated," *E. occidentalis.*

Half-exserted, forming an almost hemispheric summit of the fruit, *E. Raveretiana.*

Fully or sometimes half-exserted, almost deltoid, *E. microtheca.*

Exserted, at the base broad, thence awl-shaped, fragile, somewhat variable in length, but always narrow-pointed, and for a long while or even permanently coherent at the summit, *E. oleosa.*

Emersed, afterwards awl-shaped, *E. decipiens.*

Emersed, short, nearly deltoid, *E. salubris.*

Emergent or convergent; deltoid, *E. globulus.*

Exserted, deltoid, *E. alba, E. Stuartiana.*

Exserted, shorter than the space intervening between them and the edge of the calyx-tube, often very considerably so. Short; mostly deltoid, *E. diversifolia (santalifolia).*

Exserted, large, nearly deltoid, finally erect, *E. macrocarpa.*

Exserted, almost awl-shaped-pointed, *E. salmonophloia.*

Wholly exserted, hardly as long as or shorter than the width of the rim. Deltoid, *E. capitellata.*

Wholly exserted, shorter than the broad rim, *E. macrorrhyncha.*

Perfectly exserted. Pointed or simply acute. Deltoid-pointed, *E. Oldfieldii.*

Conspicuously protruding; deltoid-semi-lanceolar, *E. resinifera.*

High-exserted; deltoid, *E. rostrata.*

High-exserted; almost deltoid or semi-lanceolar, *E. tereticornis.*

The following is "domed," but not strictly with exsert valves:—

Deltoid, *E. gomphocephala.* (See also Part XXI, p. 19.)

Here is another domed rim—

Deltoid, red, *E. erythrocorys.* (See also Part XLV, p. 133.)

There is an amount of variation in the exsertion of valves, which, perhaps, even Mueller did not fully appreciate.

At the present day botanists find it unnecessary to describe valves with the elaboration employed by Mueller. The characters are, in modern descriptions, used as follows:—

Sunk, and to what extent; flush with the orifice; if exsert, then to what extent; how many valves (they vary); and, briefly, their shape.

3a. Enclosed.

These lists have been mainly compiled from the illustrations in the present work. Valves slightly sunk ([1]*at times slightly exsert)—

E. accedens.	[1]**E. diversifolia.*
[1]**E. acmenioides.*	*E. goniocalyx.*
[1]**E. Andrewsi.*	[1]**E. Guilfoylei.*
[1]**E. Boormani.*	*E. haemastoma.*
E. brachyandra.	*E. Howittiana.*
E. Brownii.	*E. intertexta.*
E. caesia.	*E. Jacksoni.*
E. Cambageana.	*E. Kruseana.*
[1]**E. Consideniana.*	*E. linearis.*
E. cordata.	*E. longifolia.*
[1]**E. crebra.*	[1]**E. melanophloia.*
[1]**E. Dawsoni.*	*E. Mitchelliana.*
[1]**E. diversicolor.*	*E. Muelleriana.*

Valves slightly sunk ([1]*=at times slightly exsert)—*continued.*

[1]**E. nitens.*	[1]**E. robusta.*
E. oreades.	*E. Sheathiana.*
[1]**E. paniculata.*	*E. Sieberiana.*
E. Pilliaegnsis.	[1]**E. Spenceriana.*
E. pilularis.	[1]**E. Stricklandi.*
E. populifolia.	*E. Todtiana.*
[1]**E. Preissiana.*	*E. vernicosa.*

E. rariflora.

E. redunca.

[1]**E. virgata.*

E. Woodwardi.

Valves moderately sunk—

E. acacioides.

E. apiculata.

E. approximans.

E. aspera.

E. Baueriana.

E. Behriana.

E. de Beuzevillei.

E. Beyeri.

E. bicolor.

E. Bosistoana.

E. botryoides.

E. clavigera.

E. doratoxylon.

E. erythrocorys.

E. eudesmioides.

E. fasciculosa.

E. foecunda.

E. fruticetorum.

E. gamophylla.

E. gracilis.

E. leptophleba.

E. leucoxylon (or deep).

E. melliodora.

E. Mundijongensis.

E. obliqua.

E. papuana.

E. parvifolia.

E. patens.

E. pilularis.

E. piperita.

E. polyanthemos.

E. redunca var. *elata.*

E. Risdoni.

E. Rudderi.

E. stricta.

E. taeniola.

E. tetragona.

E. tetrodonta.

E. Thozetiana.

Valves deeply sunk—

E. Abergiana.

E. affinis.

E. calycogona.

E. Caleyi (or slightly sunken; at times exserted).

E. calophylla.

E. cladocalyx.

E. Cliftoniana.

E. corymbosa.

E. decurva.

E. dichromophloia.

E. ferruginea.

E. ficifolia.

E. Foelscheana.

E. fraxinoides.

E. gigantea

E. grandifolia (or moderately).

E. haemastoma.

E. hemiphloia.

E. intermedia.

E. latifolia.

E. maculata.

E. miniata.

E. Pimpiniana.

E. ptychocarpa.

E. pyrophora.

E. setosa.

E. sideroxylon.

E. stellulata.

E. terminalis.

E. tesselaris.

E. obtusiflora.
E. ochrophloia.
E. odorata.
E. peltata.
E. perfoliata.
E. Torelliana.
E. torquata.
E. trachyphloia.
E. urnigera.
E. Watsoniana.

3b. Protruding.

One has not much choice in the use of terms to express the morphology of such portions of the valves as protrude beyond the calyx-tube. Because they are evident, they are more frequently recorded than those which are sunk, especially as one sometimes has the feeling that, in the case of a species having a reputedly sunken capsule, we may find later on that it may become flush with and even emerge beyond the calyx-tube. Everything is variable in Eucalyptus.

Deltoid—

E. acaciaeformis.
E. aggregata.
E. alba.
E. alpina (or slightly exserted).
E. angophoroides.
E. annulata (sometimes somewhat attenuated).
E. Baeuerleni.
E. Banksii.
E. Camfieldi.
E. canaliculata.
E. capitellata (or slightly exserted).
E. cinerea.
E. Cloeziana.
E. confluens.
E. corrugata.
E. Culleni.
E. Dalrympleana.
E. maculosa.
E. Maideni.
E. microtheca.
E. Morrisii.
E. Muelleri.
E. Muelleriana.
E. Naudiniana.
E. neglecta.
E. notabilis.
E. dealbata.
E. Dundasi.
E. Dunnii.
E. Ebbanoensis.
E. elaeophora.
E. Ewartiana.
E. globulus.
E. goniocalyx.
E. Griffithsii (s. narrow).
E. Hillii.
E. Irbyi.
E. Kirtoniana.
E. laevopinea.
E. Lane-Poolei.
E. Macarthuri.
E. macrocarpa.
E. macrorrhyncha.
E. praecox.
E. propinqua.
E. pruinosa.
E. pulverulenta.
E. pumila.
E. punctata.
E. pyriformis var. *Kingsmilli.*
E. quadrangulata.
E. Raveretiana.

E. nova-anglica.
E. occidentalis.
E. Oldfieldii.
E. ovata.
E. ovata var. *camphora.*
E. pachyphylla var. *sessilis.*
E. pallidifolia.
E. Parramattensis.
E. parviflora.
E. patellaris.
E. pellita.
E. rubida.
E. rudis.
E. salubris.
E. scoparia.
E. Smithii.
E. squamosa.
E. Stuartiana var. *grossa.*
E. tereticornis.
E. unialata.
E. viminalis.

Narrow triangular or deltoid—

E. Bakeri.
E. Blakelyi.
E. Camfieldi (or broader).
E. cneorifolia.
E. drepanophylla.
E. Drummondii.
E. dumosa.
E. grandis.
E. Gunnii.
E. leptopoda.
E. microtheca.
E. Normantonensis.
E. occidentalis.
E. saligna.
E. Seeana.
E. siderophloia.
E. Yarraensis.

Valves hooked—

E. amplifolia.
E. Bancrofti.
E. exserta.
E. punctata (sometimes).
E. rostrata.
E. rudis (at times).
E. viminalis (at times).

Valves reflexed or recurved—

E. Deanei.
E. decipiens.
E. drepanophylla.
E. Drummondii.
E. resinifera.
E. viminalis.
E. Stuartiana.

Subulate valves—

E. Clelandi.
E. decipiens.
E. eremophila.
E. falcata.
E. falcata var. *ecostata.*
E. Gillii.
E. longifolia.
E. occidentalis var. *astringens.*
E. oleosa.
E. salmonophloia.
E. spathulata.
E. Stowardi.

E. longicornis. *E. transcontinentalis.*

Special types—

Valves attenuated, connivant into a cone	*E. Lehmanni.*
Valves obtuse, rounded	*E. megacarpa.*
Valves very attenuate	*E. cornuta.*

Valves slightly exserted (sometimes sunk)—

E. alpina.
E. amygdalina.
E. Andrewsi.
E. Baileyana.
E. Benthami.
E. bicolor.
E. Bosistoana.
E. Caleyi.
E. Campaspe.
E. coccifera.
E. Consideniana.
E. coriacea (often sunken.)
E. cosmophylla.
E. decorticans.
E. diversifolia.
E. dives.
E. erythronema.
E. eugenioides.
E. Flocktonioe.
E. incrassata.
E. Kitsoniana.
E. Kybeanensis.
E. Laseroni.
E. ligustrina.
E. lirata.
E. macrandra.
E. marginata var. *Staeri.*
E. micranthera.
E. microcorys.
E. nitens.
E. pachyloma.
E. paniculata.
E. Penrithensis.
E. Perriniana.
E. pilularis
E. platypus
E. radiata.
E. redunca.
E. robusta.
E. similis.
E. Le Souefii.
E. Staigeriana.
E. striaticalyx
E. Stricklandi.
E. umbra.
E. vitrea.
E. Websteriana.

Numbers of the Valves.

Bentham ignores them. Mueller gives numbers for 27 out of about 100 (“Eucalyptographia”) with the following results (the number of species is given in brackets):—

3 valves (1); 3, rarely 2 or 4 (1); 3–4 (3); 3, rarely 4 (3); 3 or much oftener 4 (1); 3 or oftener 4, rarely 5 (1); 3 or 4, exceptionally 5 (2); 3, rarely 5 (1); 4 (2); 4 or sometimes 3 or 5 (1); 4, rarely 5 (2); 4, rarely 3 or 5 (2); 4 or 5, rarely 3 (1); 4 or 5, rarely 6 (2); 4–6 (1); exceptionally 5 (1); 5 or sometimes 4 or 6 (1); 5–6 or rarely 4 (1). Could anything be more confusing?

I have often sat under a tree examining the fruiting branches I had broken off, and found the variation in the number of valves such that I came to the conclusion that they had no diagnostic value in many species.

Anomalous Valves.

E. megacarpa F.v.M. Figured at fig. 6*c,* Plate 78, Part XVIII.

" . . . . the rim very convex and prominent, continuous with the thick, conical, obtuse, incurved and prominent valves of the capsule." (B.Fl. iii, 232.)

" . . . . with 5 or sometimes 4 or 6 thick, emersed, convergent valves. . . . " ("Eucalyptographia.")

The valves of this species are anomalous in being fleshy and incurved. The valves of *E. globulus* are somewhat similar to *E. megacarpa* in that in both species the accessory covering of the valves is simply an enlargement of the disc which expands and becomes considerably thicker than the valves as the fruit or capsule develops. See Disc, Part LXI.

E. Preissiana. Figured at fig. 3. Plate 78, Part XVIII.

"Disc broad and concave, the ovary with as many protuberances in the centre as valves." (B.Fl. iii, 233.)

"Valves 5–6, rarely 4, short, deltoid, permanently connivent, not protruding, surrounded by as many or twice as many depressed protuberances." ("Eucalyptographia.")

This species is anomalous in that the fruits have spheroidal protuberances on the depressed rim. They are figured as above, and, under Fruits, I will later submit more detailed drawings. The protuberances are not always 12 in number; they may be 10, and the alternate ones may be absorbed, leaving 6 or 5. Their morphological significance will be explained in Part LXI.

Rim.

No one appears to have defined the "rim," and indeed it is somewhat vague. It is usually taken to include everything from the commisural line or where the calyx-tube meets the operculum, to the base of the valves of the capsule where the capsule is not much sunk.

The thin calycine rim may, as ripening proceeds, contract, and it may have the appearance of being cracked, or with pieces out of it, *e.g., E. sideroxylon,* fig, 13*a,* Plate 55; *E. Caleyi,* fig. 16, 56. I have seen this cracking in *E. Baueriana, E. polyanthemos* and *E. Dawsoni,* although I have not figured it, also in *E. clavigera,* and, less frequently, in one or two of the Corymbosae. The thin or narrow rims will be separately enumerated presently.

Bentham, 1866.—I quote Bentham's remarks, as I have done those of other botanists in regard to various organs. The varying phrases often convey shades of meaning which might be destroyed or impaired if they were paraphrased.

Bentham, under Normales, gives the rim some classifactory value, thus—

Sub-series *Robustoe.*—“Rim of the fruit concave.” Sub-series *Exserloe.*—“Rim convex or prominent, rarely flat, the capsule-valves protruding beyond it.”

He does not, however, appear to have formally defined the “rim,” although I proceed to show that he uses it very frequently.

Rim very narrow, *E. Lehmanni.*

Narrow, *E. botryoides, E. buprestium, E. corymbosa, E. corynocalyx, E. crebra, E. ferruginea, E. gracilis, E. hemiphloia, E. loxophleba, E. maculata, E. microcorys, E. microtheca* (*brachypoda*), *E. paniculata, E. patens, E. polyanthemos, E. pruinosa, E. redunca, E. rudis, E. setosa, E. stricta.*

Narrow, not prominent, *E. occidentalis.*

Narrow, slightly prominent, *E. urnigera.*

Slightly prominent, *E. siderophloia.*

Narrow, slightly raised above the calyx border, *E. saligna.*

Not broad, *E. odorata.*

Usually flat and not very broad, *E. marginata.*

Flat and rather broad, *E. coccifera, E. spathulata.*

Rather broad, flat or nearly so, *E. melliodora.*

Rather broad, flat or depressed, *E. bicolor.*

Broad, *E. micranthera.*

Broad and flat, *E. patellaris.*

Broad, flat or nearly so, usually deeply coloured, *E. haemastoma.*

Broad rim prominent, *E. longifolia.*

Fully 3 lines diameter, *E. Preissiana.*

Thin, *E. aspera, E. brachyandra, E. cinerea, E. clavigera, E. dichromophloia, E. eximia, E. foecunda, E. latifolia, E. melanophloia, E. peltata, E. phoenicea, E. pyro phora, E. tesselaris, E. trachyphloia.*

Rather thin, *E. drepanophylla, E. goniocalyx.*

Rather thin and scarcely protruding, *E. Gunnii.*

Thin and slightly prominent, *E. robusta.*

Not thick, slightly prominent, *E. Stuartiana.*

Not very thick, *E. dumosa.*

Not very thick when the flowers are small, very broad and flat in some large-flowered forms (species now reconstructed, J.H.M.), *E. incrassata.*

Rather thick, *E. diversicolor, E. miniata.*

Thick, *E. ptychocarpa.*

Flat, *E. Behriana, E. dealbata.*

Concave, *E. perfoliata, E. tetraptera.*

Flat or slightly concave, *E. stellulata.*

Concave or nearly flat, *E. piperita.*

Flat or concave, *E. coriacea.*

Flat or slightly concave and rather broad, *E. amygdalina.*

Concave or at length nearly flat, *E. uncinata.*

Rather broad and concave, *E. obliqua, E. obtusiflora.*

Very broad and concave, with a thin edge, *E. caesia.*

Raised above the calyx-border, broad and flat and concave, *E. conoidea.*

Broad and at first concave, but generally flat when quite ripe, *E. virgata* (*Sieberiana*).

Rather broad, flat or slightly convex or concave, *E. pilularis.*

Rather broad, flat or scarcely convex, *E. decipiens.*

Rather thick, flat or slightly convex, *E. cneorifolia.*

Thick and slightly convex, *E. cosmophylla.*

Thick, flat or slightly convex, *E. leucoxylon* (and *sideroxylon*).

Broad, flat or slightly convex, *E. leptopoda.*

Rather broad, flat or slightly convex, *E. Risdoni.*

Narrow, and scarcely distinct from the slightly convex summit of the fruit. *E. cornuta.*

Raised above the calyx-border, slightly convex and rather broad, *E. pellita.*

Somewhat convex and rather broad, *E. alba.*

Rather broad, convex, *E. platypus.*

Broad rim convex, *E. alpina, E. gomphocephala.*

Broad, convex and prominent, *E. pallidifolia, E. santalifolia.*

Not broad, convex or prominent, *E. resinifera.*

Very broad, convex and prominent, *E. macrorrhyncha.*

Very broad, at length convex and much raised, *E. Oldfieldii.*

Thick, convex and prominent, *E. platyphylla.*

Broad rim convex and often very prominent, the valves of the capsule usually protruding beyond it, *E. capitellata.*

Broad, flat or scarcely convex, *E. concolor.*

Flat or slightly convex, *E. vernicosa.*

Very convex and prominent, continuous with the thick, conical, obtuse, incurved and prominent valves of the capsule, *E. megacarpa.*

Thick and convex, *E. pulverulenta.*

Slightly projecting, *E. cordata.*

The broad flat-topped disc or rim projecting above the calyx, *E. globulus.*

The very broad disc forming a raised rim, *E. macrocarpa.*

Ring formed by the disc remaining very prominent round the somewhat sunk convex-topped capsule, *E. pyriformis.*

Convex rim protruding into a thick ring, quite distinct from the valves, *E. annulata.*

With the very thick, broad, convex and raised rim of *E. Oldfieldii,* but without any depressed centre, *E. pachyloma.*

Convex, the capsule on a level with it, *E. angustissima.*

Rather broad, at first flat, but if well ripened usually prominent above the border of the calyx, *E. viminalis.*

The rim very broad and conically exserted, the capsule depressed below the rim, the valves scarcely protruding, *E. pachyphylla.*

Broad and very prominent, almost conical, *E. rostrata, E. exserta.*

Broad and very prominent, *E. tereticornis.*

(The rim of the *E. rostrata, exserta, tereticornis* class will be found described in some detail in a footnote to *E. exserta,* at p. 33, Part XXXII, to which I beg to refer my readers.)

Narrow, on a level with the calyx as well as the flat-topped capsule, *E. macrandra.*

Disc very broad and obtusely prominent, giving it the shape of an old-fashioned hat, *E. erythrocorys.*

Rim scarcely distinct, *E. tetragona.*

Rim concave, not broad, *E. eudesmioides.*

Rim narrow concave, *E. odontocarpa.*

Rim narrow, but forming an acutely prominent ring, *E. tetrodonta.*

Not seen or not described.

E. calophylla.	*E. grossa* (not seen).
E. citriodora.	*E. leptophleba* (not mentioned).
E. dives (fruit unknown).	*E. oligantha* (fruit unknown).
E. Drummondii (fruit unknown.)	*E. orbifolia* (fruit unknown).
E. ficifolia.	*E. terminalis* (fruit unknown).
E. grandifolia (fruit unknown).	

Mueller, 1879–84—“Eucalyptographia.”

Mueller had usually something to say about the rim of the fruit, but he does not appear to have formally defined it. We have not only his words, but also his figures, to explain his meaning. Sometimes his words and expressions lack uniformity, but his language is quaint and often instructive in its nuances. Following are some of his synonyms for Rim:—

Margin.	Fruit calyx.
Margin of the summit.	Edge of the summit.
Margin of the orifice.	Edge.
Vertical margin.	Discal summit.
Border.	Discal portion, &c.
Fruit border.	

Rim very narrow, *E. clavigera, E. trachyphloia.*

Border very narrow, *E. microtheca.*

Rather narrow, *E. bicolor* (*largiflorens*), *E. crebra, E. Gunnii.*

Narrow in age, *E. siderophloia.*

Rim flat, but rather narrow, *E. diversicolor.*

Rather narrow, finally prominent, *E. occidentalis.*

Narrow, *E. Behriana, E. botryoides, E. calophylla, E. cornuta, E. corymbosa, E. doratoxylon, E. ficifolia, E. microcorys, E. maculata, E. pruinosa, E. redunca, E. robusta.*

Margin of the summit rather narrow, but finally flat, *E. marginata.*

Margin narrow, *E. salubris.*

Narrow margin of the orifice, *E. goniocalyx.*

Narrow at the margin, *E. Howittiana.*

Fruit border narrow, extending considerably beyond the valves, *E. foecunda.*

Fruit border sharply prominent externally, *E. stricta.*

Edge of the summit narrow, *E. sepulcralis.*

Outwards narrow, *E. obliqua.*

Narrow, prominent. *E. peltata.*

Rim prominently edged, *E. buprestium.*

Narrow edged, *E. piperita.*

Rim narrow-edged, descending, *E. eximia.*

Narrowly edged at summit (of fruit), *E. patens.*

Rim narrow compressed, *E. corynocalyx* (*cladocalyx*), *E. paniculata.*

Narrowly prominent, *E. obcordata.*

Narrow, vertically descending, *E. Planchoniana.*

Narrow, descendent, *E. saligna.*

Narrow or inward descending rim, *E. acmenioides.*

Rim narrow, slightly annular, *E. cordata.*

Flat, but narrow, *E. oleosa.*

Narrow-compressed, prominent, *E. hemiphloia.*

Narrow, compressed, fragile, occasionally somewhat indented margin, *E. polyanthemos.*

Strongly compressed or seldom slightly flat, *E. leucoxylon.*

Compressed vertical margin, *E. odorata.*

Oftener narrow than conspicuously broad; seldom flat, *E. incrassata.*

Corymbosae sunk—calycine, thin margin, *E. Abergiana.*

Rim thin, *E. gracilis.*

Margin (of fruits) thin, *E. Todtiana.*

Thin, extending considerably beyond the very short valves, *E. tesselaris.*

The thin edge around the orifice turned slightly inward, *E. gamophylla.*

Margin of the orifice thinly compressed, *E. Baileyana.*

Fruit bell-shaped quadrangular, or sometimes only with two angular ridges, *E. tetraptera.*

Descending (really so sharp that it has no rim), *E. setosa.*

Depressed or quite flat, seldom through descent narrowed, *E. Sieberiana.*

Broadish, somewhat flat or inward descending, *E. pilularis.*

Broadish and flat or internally descending, *E. uncinata.*

Comparatively broad, *E. stellulata.*

Comparatively broad and rim depressed, *E. decipiens.*

Comparatively broad and margin depressed, *E. rudis.*

Comparatively broad and not strongly compressed or ascendant, *E. melliodora.*

Rather broad . . . . . . rim finally flat and usually rather broad, *E. amygdalina.*

Broad rim, *E. cosmophylla, E. megacarpa.*

Broad, ascending, *E. pachyphylla.*

Not very broad vertical margin, but suddenly and amply descending to the orifice, *E. ptychocarpa.*

Rim of the ripe fruit exserted, broad, somewhat turgid, *E. gomphocephala.*

Very broad, descending, separated by a conspicuous furrow from the edge of the calyx-tube, *E. Watsoniana.*

Rim flat, *E. alba.*

Rim depressed or quite flat, *E. haemastoma.*

More or less flat, *E. coriacea* (*pauciflora*).

Descending, not flat, *E. tetragona.*

Comparatively broad, convex rim, *E. Stuartiana.*

Broad protruding convex rim, *E. rostrata, E. tereticornis.*

Broad, convex, rising towards the orifice, *E. viminalis.*

Very convex vertex . . . . broad rim, *E. macrorrhyncha.*

Fruit-calyx almost hemispherical, with an amply protruding convex vertex, valves . . . . hardly as long as the width of the rim, the latter rarely flat, *E. capitellata.*

Discal summit very convex and finally far-protruding or sometimes rather depressed, always occupying a broad space between the valves and the margin of the calyx-tube, *E. santalifolia* (*diversifolia*).

Rather broad, somewhat convex, *E. cinerea* (*pulverulenta*).

Finally rather broadish, flat or convex, *E. punctata.*

Rim broad, depressed or convex at the edge separated from the calyx-tube by an ample furrow, *E. globulus.*

Vertical margin (of fruits) broad, slightly protruding and ascending, finally convex . . . . , *E. alpina.*

Lower half of ripe fruit consisting of very broad convex rim, and . . . . valves, *E. Oldfieldii.*

Ascendent or channelled, the vertex very convex, *E. longifolia.*

Fruit surrounded beneath the broad and flat rim by an annular impression, *E. erythronema.*

Raised, almost annular, *E. resinifera.*

Discal portion very broad, much ascending and upwards contracted, *E. pyriformis.*

The calycine portion depressed turbinate, not angular, the discal portion very broad, ascending, *E. macrocarpa.*

Discal vertex. Space of the discal vertex from the edge to the valves nearly or fully as broad as the orifice, slightly convex or oftener descending, severed from the calyx-tube by a narrow furrow, *E. Preissiana.*

Fruit . . . . at the marginal summit first ascending then flat and at the deltoid red valves impressed . . . ., *E. erythrocorys.*

The discal expansion forming a narrow rim beyond the calyx-teeth, *E. tetrodonta.*

Not stated.—

E. eugenioides.	*E. populifolia.*
E. Foelscheana.	*E. Raveretiana.*
E. miniata.	*E. salmonophloia.*
E. phoenicea.	

ILLUSTRATIONS.

In the present work figures will be found illustrating the rims of all the species enumerated above, together with a number of additional ones. It seems therefore unnecessary to make a further descriptive list, with modified verbiage perhaps, of rims of fruits.

Colour of Rim.

There is a limited amount of variation observable in the rim in a number of species. In some it appears to be variable, but these colour notes have not been systematically recorded, so far as I am aware. The reddish colour of the rim in *E. hoemastoma* was early noted, and gave the specific name. We find that it is a useful character to this day. Other species have fruits with coloured rims, usually reddish-brown, *e.g., E. dives, E. eugenioides, E. capitellata.* It is one of the points that might be looked into by the young student, for Eucalyptus is a vast subject, and offers miscellaneous fields for inquiry, of varying degrees of importance.

Explanation of Plates (244–247).

Angles the lateral veins make with the midrib.
(See also the full text contained in Part LVII.)

Plate 244.

Plate 244: Angles the lateral veins make with the midrib. LONGITUDINALES (1-5). OBLIQUÆ (6-9). [See also figs. 10 and 11, Plate 245.] Lithograph by Margaret Flockton.

Longitudinales.

Fig. 1. 0°. This shows ideally parallel venation.

2. 71/2°. *E. stellulata, coriacea,* &c.

3. 10°. Messrs. Baker and Smith ("Research on the Eucalypts," Ed. 1, Plate 8, as *E. amygdalina,* and Ed. 2, as *E. australiana*). In my nomenclature the species is *E. radiata* (10–15°).

4. 15°. *E. dives* (1st Ed., Plate 9; 2nd Ed., Plate 11, "Research, &c."), *E. Sieberiana* (1st Ed., Plate 7; 2nd Ed., Plate 9).

5. 25–30°. Coriaceae and some other Renantherae.

Obliquoe.

6. 30°. *E. Smithii* (1st Ed., Plate 5; 2nd Ed., Plate 8, "Research, &c.") (30–45°.) Also Coriaceae and other Renantherae, Porantheroideae, Cornutae.

7. 30–35°. Coriaceae and other Renantherae, Porantheroideae, Cornutae, also Macrantherae.

8. 40°. Coriaceae and other Renantherae, Porantheroideae, Cornutae, also Angophoroideae.

9. 45°. *E. globulus* (1st Ed., Plate 4; 2nd Ed., Plate 7, "Research, &c.").

Plate 245.

Plate 245: Angles the lateral veins make with the midrib. OBLIQUÆ (1-4). [See also figs. 6-9, Plate 244.] TRANSVERSÆ (5-7). [See also figs. 1-4, Plate 246.] Lithograph by Margaret Flockton.

Obliquoe (*concluded*).

Fig. 1. 45–60°. *E. botryoides* (1st Ed., Plate 3; 2nd Ed.. Plate 6, "Research, &c."). See also "Eucalyptographia" leaf.

Also Macrantherae, Angophoroideae, Corymbosae.

2. 50°. Macrantherae, Corymbosae.

3. 50–55°. *E. maculata,* Wyong, N.S.W., the lateral veins in this member of the Corymbosae closer together than the preceding.

4. 50–65°. *E. botryoides* ("Eucalyptographia"). Also Macrantherae, Corymbosae. (See also fig. 1.)

5. 50–70°. *E. saligna* ("Eucalyptographia"). Also Macrantherae, Corymbosae.

6. 60°. See *E. longifolia* (1st Ed., Plate 6, "Research, &c."), with the lateral veins further apart than shown in fig.

7. 65–75°. *E. ficifolia* (fresh leaf).

Plate 246.

Plate 246: Angles the lateral veins make with the midrib. TRANSVERSÆ (1-4). [See also figs. 5-7, Plate 245.] A secondary intra-marginal vein (5-9). Lithograph by Margaret Flockton.

Transversoe (*concluded*).

Fig. 1. 65–75°. *E. resinifera* ("Eucalyptographia.").

2. 75°. *E. corymbosa* (1st Ed., Plate 2; 2nd Ed., Plate 5, "Research, &c.").

3. 80°. *E. corymbosa* (fresh leaf).

4. 85°. *E. corymbosa.* The most transverse leaf of this species that could be found.

[In the diagrams, the middle third of each leaf is alone shown, for the reason referred to at Part LVII, p. 394.]

To recapitulate, these drawings illustrate the three groups—

1. Longitudinales (0–25°).
2. Obliquae (30–55°).
3. Transversae (50–90°).

Speaking generally, the Transversae have the lateral veins closer to one another than is the case of the other two groups.

On the other hand, in the diagrams, the Longitudinales and the Obliquae and the Transversae are sometimes shown, for clearness, with the veins further apart than they really are.

The abruptness between the width of the lateral veins in Plate 245, fig. 2 (50°) and in fig. 3 (50–55°) is diagrammatic.

The figures of *E. maculata* (50–55°), *E. ficifolia* (65–75°), *E. corymbosa* (80°) are fair average examples of the width between the lateral veins in the Corymbosae.

In the Transversae, although the lateral veins are usually closer together than in other sections, they are further apart than shown in most of the diagrams of 50 to 90°. Thus, *E. robusta, E. botryoides, E. saligna, E. resinifera,* are referred to by most writers as being close to the Corymbosae, which include most of the Transversae. Of these species I show facsimiles of leaves in the "Eucalyptographia," and it will be found that *E. robusta* is 45–60°, *E. botryoides* 50–65°, *E. saligna* 50–70°, and *E. resinifera* 65–75°.

The following species, which also do not belong to the Corymbosae, have also venation more or less belonging to the Transversae:—

E. tetraptera, 30–50°; *E. propinqua,* 50°; *E. brachyandra,* 45–55°; *E. Spenceriana,* 45–50°; *E. tessellaris,* 55–60°.

E. punctata and *E. Shiressii* may be added to this list, and perhaps others.

Sometimes the transverse venation of a juvenile leaf (*e.g., E. acmenioides,* fig. 5a, Plate 42), with lateral veins 45–55°, simulates that of the Corymbosae. It belongs to the Renantherae.

Here I may insert a reminder to read Part LVII, pp. 392 to 408. Thus Longitudinales, p. 394; Obliquae, p. 398; Transversae, p. 406. The narrowing of a leaf causing a tendency to greater acuteness of the lateral veins, p. 394.

Plate 246 (Figs. 5–9).

A Secondary Intramarginal Vein.

Mr. E. Cheel has drawn my attention to the vein which is parallel and close to the margin in some specimens of *E. radiata,* and which is distinct from the looped or irregular secondary vein, which really consists of the curved ends of the secondary veins, which, at their other ends, join the midrib. He suggests that it may have some taxonomic value. As it occurs in the leaves of various forms of this species, as shown in the drawings, and also in the widely separated *E. sideroxylon* and *E. conica,* both reproduced, and in, *e.g., E. Sieberiana,* and in some other species (it is overlooked because it is usually so minute, and at times very close to the margin), I think it is rather to be looked upon as a simple morphological character—a mechanical necessity to support the leaf-tissue in leaves of varying thickness and width. Following are some figures of leaves showing this faint secondary Intramarginal Vein:—

Fig. 5. *E. radiata* Sieb. Ashfield, near Sydney, N.S.W., a cultivated plant raised from seed obtained from Wyndham, N.S.W. (E. Cheel).

6. *E. radiata* Sieb. Bellimbella, near Nerrigundah, N.S.W. (E. Cheel).

7. *E. radiata* Sieb. Mittagong, N.S.W. (District Forester C. J. Clulee).

8. *E. sideroxylon* A. Cunn. Harvey Range, near Peak Hill, N.S.W. (J. L. Boorman).

9. *E. conica* Maiden. Cowra, N.S.W. (R. H. Cambage).

All the leaves juvenile or nearly so.

Plate 247.

Plate 247: Decurrence of lamina and midrib (1-5). Triphylly (6). Receptacle (7). Very broad peduncle (8). Calyx-tubes (9, 10). Lithograph by Margaret Flockton.

DECURRENCE.

1. Of the Midrib.

Where the branchlet (rachis) is markedly angular (quadrangular) it is commonly seen that the petiole, or continuation of the midrib, is decurrent and expanded, its outer edges forming the quadrangular edges of the branchlet. For examples see figs. 1–4, Plate 247.

I have some notes on "Angularity of Branchlets" at Part LVI, p. 315. The state of being decurrent is always accompanied by angularity of the branchlets.

2. Of the Leaf.

It is a much rarer case for the tissue of the leaf or lamina to expand (not to the full width of the lamina), at the place where the petiole would normally be. In such a case the midrib is seen distinct from the lamina and often thickened, *e.g.,* 3a–3c, Plate 236 (*E. Flocktonioe*). In no species of Eucalyptus hitherto recorded is the lamina so expanded at the base as in the present one. In cases in which there is no obvious decurrence of the lamina, *e.g.,* figs. 1–4, Plate 247, the midrib is distinctly seen decurrent on the rachis, and, in addition, angles decurrent from the margins of the lamina. In other words, contemplation of figs. 1*b* and 1*c* show that there is decurrence of both midrib and lamina, but in most cases the lamina (as regards decurrence) is suppressed.

In *E. Flocktonioe* the decurrent portion of the lamina is adnate to the rachis. So also is the midrib in this and other species figured. No doubt a future botanist will make sections and illustrate the anatomical relations of the decurrent part of the lamina to the decurrent part of the midrib to the rachis, and of the two latter organs to each other. See also Part LIX.

1*a,* 1*b,* 1*c.* Intermediate leaves of *E. longicornis* F.v.M., Wagin, W.A. (C. A. Gardner, No. 1234). 1*b* and 1*c* enlarged.

These exhibit decurrence of the midrib down the rachis, while the outer portions of the lamina most remote from the midrib are decurrent also, and develop a more or less winged rachis.

2*a,* 2*b.* Intermediate leaves of *E. longicornis* F.v.M., Westonia, W.A. (Forester J. M. Cusack). To be compared with figs. 1*a*–1*c.*

2. Of the Leaf—*continued.*

3. Mature leaf of *E. calycogona* Turcz., Yeelanna, Eyre's Peninsula, South Australia (W. J. Spafford, No. 3). Showing decurrence of midrib.
4. Intermediate leaf of *E. Flocktonioe* Maiden, Bendering, W.A. (C. A. Gardner, No. 1686). Showing decurrence of the midrib.
5. Intermediate leaf of *E. Preissiana* Schauer, cultivated in Botanic Garden, Hobart, Tasmania (collected, J. H. Maiden, March, 1908). Showing a tendency to decurrence, both of midrib and lamina.

Triphylly.

6. Case of triphylly in *E. Gillii* Maiden. Here the three juvenile leaves cohere by nearly half their margins. A list of species in which triphylly has been observed will be given in a subsequent Part.

Receptacle.

7. Vertical section through a head of syncarpous fruits of *E. Lehmanni* Preiss. (Compare Plate 144). Note the swelling of the peduncle, immediately under the fruits, forming a quadrangular receptacle.

Very Broad Peduncle.

8. Fruit of *E. tetraptera* Turcz., Desmond, near Ravensthorpe, W.A. (L. Reid).

(*a*) Note the place of articulation to the calyx-tube of
(*b*) the very broad, ribbon-like, flexuose peduncle.

Calyx-tubes.

9. Young fruit of *E. tetraptera* Turcz., Bremer Bay, W.A. (J. Wellstead), showing the four acute points to the calyx-tube (there is affinity to the Eudesmieae here); the stigma and a portion of the style, and also the broad peduncle.
10. Winged calyx-tube of a flower of *E. Forrestiana* Diels. Compare Plate 95.

The specimen was collected at Esperance in 1903 by Mr. Babington. The fruits are smaller and the wings are thinner and proportionately wider than have been described or figured. In Mr. Babington's fruits the width (excluding the wings) is about 1 cm., and the width (including the wings) about 1.5 cm. leaving the width of each wing at 2–3 mm. (See Maiden in *Journ. Roy. Soc. N.S.W.,* li., p. 449 (1917).

Compare also *E. pyriformis* and its varieties.