TP
958
B2

UC-NRLF

\$B 576 264

GIFT OF

EX LIBRIS

AUG 20 1913

A RESEARCH
ON THE
Eucalypts of Tasmania
AND THEIR
ESSENTIAL OILS

BY
R. T. BAKER, F.L.S., AND H. G. SMITH, F.C.S.
Technological Museum, Sydney

Read before the Royal Society of Tasmania
Communicated by L. Rodway, Esq., Government Botanist
October 14, 1912

JOHN VAIL, Government Printer, Hobart, Tasmania

A RESEARCH
ON THE
EUCALYPTS OF TASMANIA
AND THEIR
ESSENTIAL OILS

BY

R. T. BAKER, F.L.S., AND H. G. SMITH, F.C.S.
Technological Museum, Sydney

Read before the Royal Society of Tasmania

Communicated by L. Rodway, Esq., Government Botanist
October 14, 1912

JOHN VAIL, Government Printer, Tasmania

TP958
B2

UNIV. OF
CALIFORNIA

CONTENTS.

	PAGE
1. ACKNOWLEDGMENTS	1
2. INTRODUCTION	1
3. SPECIES, WITH THEIR SYSTEMATIC, TECHNOLOGICAL, AND CHEMICAL DATA	10
4. AVERAGE YIELD OF OIL FROM THE SEVERAL SPECIES OF EUCALYPTUS	67
5. TABULATED RESULTS WITH THE CRUDE OILS, TOGETHER WITH THEIR PRINCIPAL CONSTITUENTS	68
6. ILLUSTRATIONS—	
E. UNIALATA, SP. NOV.	71
E. RODWAYI, SP. NOV.	71
E. TAENIOLA, SP. NOV.	71
COLLECTING EUCALYPTUS LEAVES IN TASMANIA ...	71
7. INDEX TO SPECIES... ..	71

CONTENTS

PAGE

i

ii

iii

iv

v

vi

vii

viii

ix

x

A RESEARCH ON THE EUCALYPTS OF TASMANIA AND THEIR ESSENTIAL OILS.

By R. T. BAKER, F.L.S., and H. G. SMITH, F.C.S.,
Technological Museum, Sydney.

[Communicated by L. RODWAY, F.L.S., Government Botanist.]

1.—ACKNOWLEDGMENTS.

IN the preparation of this paper we have to acknowledge our indebtedness to Mr. L. Rodway, Government Botanist, who placed his knowledge of Tasmanian Eucalypts at our disposal, and gave up much of his time to procuring material.

We would also like to thank the following gentlemen for assistance rendered:—Messrs. T. Stephens, R. A. Black, D'Arcy Addison, G. Ellis, and A. H. Higgs.

The collector, Mr. L. G. Irby, met with the greatest assistance and help from every one in the island with whom he came in contact in this connection, as did also Mr. C. Laseron when collecting previously.

2.—INTRODUCTION.

The Tasmanian Eucalypts will always possess an historical interest over their confreres, as it was from Van Diemen's Land that specimens of the genus were first made known to science, the honour being conferred on the well-known "Eucalyptus" of Tasmania—*E. obliqua*, by L'Heritier, in 1788—the "Stringy-bark colonorum," as mentioned by Hooker in the "London Journal of Botany," when describing this tree under the name of *E. gigantea*, in 1847. Since that date several famous botanists have worked at the genus as represented in Tasmania, the late Sir Joseph D. Hooker giving special attention to it in his classical work *The Flora of Tasmania*, published in 1860.

This investigation is, however, the first that has treated the subject from a technological point of view. It is the work of a joint research in botany and chemistry, consequently the results, as might be expected by working on so extended a field, are not quite in accord with past classifications of these Eucalypts.

The economics of one at least of Tasmania's Eucalypts are world-wide, those of *E. globulus*, and probably there has been more literature published in connection with this species than any other belonging to the whole genus.

In the United States of America it is more cultivated than any other, thousands of acres being planted with it as a source of timber-supply; but its essential oil has made its name better known than its wood.

However, this research now shows that Tasmania possesses other trees yielding oil of equal therapeutic value, and what is of quite as much importance, possesses several other trees yielding phellandrene oils, now so extensively used in mineral separation.

The Eucalypts of Tasmania we make out to be as follows, on a cortical classification:—

SMOOTH BARKS OR GUMS—

- * *Eucalyptus acervula*, Hook. f.
- * *Eucalyptus cordata*, Labill.
- Eucalyptus globulus*, Labill.
- * *Eucalyptus Gunnii*, Hook.
- * *Eucalyptus linearis*, A. Cunn.
- * *Eucalyptus Muelleri*, T. B. Moore.
- Eucalyptus Perriniana*, R. T. B. et H. G. S.
- Eucalyptus phlebophylla*, F. v. M. et Miq.
- Eucalyptus regnans*, F. v. M.
- * *Eucalyptus Risdoni*, Hook.
- * *Eucalyptus unialata*, sp. nov.
- * *Eucalyptus urnigera*, Hook.
- * *Eucalyptus vernicosa*, Hook.
- Eucalyptus viminalis*, Labill.

HALF-BARKS—

- Eucalyptus Delegatensis*, R. T. B.
- Eucalyptus regnans*, F. v. M. (occasionally).

STRINGY-BARK—

- Eucalyptus obliqua*, L'Her.

HARD, ROUGH BARKS—

- * *Eucalyptus Rodwayi*, sp. nov.
- Eucalyptus virgata*, Sieb.
- * *Eucalyptus taeniola*, sp. nov.

PEPPERMINTS —

- Eucalyptus amygdalina*, Labill.
- * *Eucalyptus coccifera*, Hook. f.

* Endemic to Tasmania.

This brings the record up to 21, and of these no less than 12 are endemic, which is a large percentage of the whole number, and probably due to the great length or period of isolation of Tasmania from the mainland. No doubt other endemic species exist, but remain as yet unrecorded, as much country is not yet opened up.

Rodway, in his "Flora of Tasmania," estimates 17 species, most of which stand, with the following additions and alterations. In his list we replace—

E. Sieberiana with *E. virgata*,
E. haemastoma with *E. Delegatensis*,
E. pauciflora with *E. phlebophylla*,

while the following are added as new species:—

E. Rodwayi,
E. taeniola,
E. unialata.

E. linearis, Dehn., is superseded by *E. linearis*, A. Cunn. Records new for Tasmania are—

E. Delegatensis,
E. Perriniana,

and we determine two species, which had hitherto been regarded as common to both the mainland and Tasmania, as now distinct, viz.—

E. amygdalina from *E. amygdalina* on the mainland,
 and—

E. acervula from *E. paludosa*.

It will no doubt come as a surprise to Eucalyptologists to know that the Tasmanian *E. amygdalina* is not indentical with the species on the mainland which has for so long passed under that name; but the error has probably been caused through various reasons. One, no doubt, has been the want of access to Labillardier's original specimens, or at least his plate, of the species, or a wider method of classification, such as this investigation covers. However, we have refrained from introducing a new name into the already long nomenclature, and suggest a compromise as stated under *E. amygdalina*.

E. radiata of Hooker's "Flora Tasmaniae" we have not been able to place with the mainland tree of that name, and are disposed to regard the remarks (*loc. cit.*) as referring partly to material of *E. amygdalina*, *E. linearis*, or even *E. Risdoni*.

E. Gunnii we consider as endemic to Tasmania, as up to the present there appears no true evidence of this "Cider Gum" tree occurring on the mainland.

Four species previously recorded as Tasmanian are, as the result of this investigation, found not to exist in the island. These are—

E. haemastoma,
E. Sieberiana,
E. Macarthuri,
E. Maidenii.

The variety *hypericifolia*, generally placed with *E. amygdalina*, we find to belong to *E. Risdoni*, so that this latter species, as now understood, includes the varieties—

E. amygdalina, var. *hypericifolia*,
E. Risdoni, var. *elata*,
E. nitida.

Eucalyptus nitida Hooker figures in his "Flora Tasmaniae" as a distinct species, and material collected at Strickland by Mr. L. G. Irby exactly matches his drawings. Many of the botanical features of this tree we find now also match forms of *E. Risdoni* that have come to light since that work was published, and these, together with their chemistry, show that this *Eucalyptus* is no other than *E. Risdoni*, although the fruits may be regarded as an extreme form.

Rodway's variety *macrocarpa* of *E. viminalis* does not belong to *E. globulus* as considered by Mueller, nor *E. Maidenii* as recorded by J. H. Maiden (A.A.A.S. 1902). It is now given specific rank under the name of *E. unialata*. It is worthy of note that several groups of *Eucalypts* common on the mainland have no representatives in Tasmania, as, for instance, the "Bloodwoods," "Boxes," "Mallees," and the "Iron Barks"; and it is also of more than passing interest that without exception no red-coloured timbers occur in the whole group of Tasmanian *Eucalypts*.

Anyhow a high percentage of good timbers obtains amongst these gums over those of any other State in the Commonwealth, and only those of stunted growth near the snow-line are to be discarded as not possessing timber of economic value in some direction.

Altogether there should be a great future before the forestry outlook of the State.

As certain groups of *Eucalypts* (*supra*) are found to occur on the mainland only, it would at least be of scientific interest if experiments with these could be carried out by introducing into cultivation in the island those of the greatest economic value on the mainland, and recording the results.

The pale-coloured hardwood timbers of Tasmania are excellent, and have long occupied a front position in the world's timber markets, but there is one feature worthy of notice, and that is the utilisation of some of these for cabinet work, such as *E. obliqua* and *E. Delegatensis* as "Tasmanian Oak." To these might be added the timber of *E. Rodwayi*, which appears to be of equal excellence in this connection.

SPECIES YIELDING COMMERCIAL TIMBERS.

Gums—

- E. acervula* (Red Gum).
- E. globulus* (Blue Gum).
- E. Gunnii* (Cider Gum).
- E. linearis* (White Peppermint).
- E. viminalis* (Manna Gum).
- E. Muelleri* (Brown Gum).
- E. Delegatensis* (Gum-topped Stringy-bark or Tasmanian Oak).

Stringy-barks—

- ...
- E. obliqua* (Stringy-bark).

Hard, Furrowed, Compact Barks—

- E. virgata* (Ironbark).
- E. Rodwayi* (Black Gum).
- E. taeniola*.

Peppermint—

- E. amygdalina* (Black Peppermint).

The evidence now brought forward in this paper respecting the affinities and differences between the Tasmanian Eucalypts and identical species or allied forms growing on the mainland appears to further emphasise the evolutionary differentiation of the various species, first brought forward in our work on the Eucalypts published in 1902.

Variation in altitude and climatic conditions, the result of considerable earth-movement, would naturally force the species thus separated to endeavour to overcome this interference, and to adapt themselves to these new conditions. This environmental change would thus tend to establish new features and constituents.

For instance, the affinity existing between *E. amygdalina* of Tasmania and the form of *E. amygdalina* growing on the mainland is evidently close, yet they are not now identical species, in the present acceptance of such, either botanically or chemically, and the divergence has gone sufficiently far for specific differences to be observed.

This is also the case with *E. acervula* and *E. paludosa* and whatever agreement there might have been originally between these two species they have now diverged sufficiently far to enable constant and well-defined differences to be established.

Other species, again, in which distinctive characters cannot be detected between the Tasmanian and mainland trees, as *E. regnans*, *E. Delegatensis*, *E. Perriniana*, *E. obliqua*, &c., may have remained constant because the conditions governing their retention in both localities might have undergone comparatively little alteration under the new arrangement. It will be observed that these are species mostly found in somewhat high altitudes, and growing in both countries under similar conditions.

Although the species supposed to be endemic in Tasmania, as *E. vernicosa*, *E. urnigera*, *E. Rodwayi*, *E. Risdoni*, &c., have no very close affinities with mainland species, so far as at present known, yet it must not be forgotten that each of them has its nearly related species with approaching characteristics, and that they all certainly fall into well-defined botanical and chemical groups, the peculiarities of which are now well known.

Another point, of a chemical nature, which strongly supports these suggestions, is that in the oil of only one species growing in Tasmania does the aromatic aldehyde aromadendral occur. This constituent is common in the oils of several species in Eastern Australia, notably the "Boxes," of which *E. hemiphloia* may be considered the type. These trees are generally lowland species, *E. hemiphloia* particularly being a common species of the plains on the eastern side of the Blue Mountains. *E. obliqua* is common on the mainland as well as in Tasmania, and does not appear to be so restricted to a narrow range of altitude as many species, consequently it stood a better chance of survival when the subsidence took place which formed Tasmania, whilst the more strictly lowland species were submerged and thus destroyed.

We purpose dealing more fully with this question as it affects the whole genus, at the British Association meeting in Sydney in 1914.

With reference to the oils distilled from the leaves of the several species, these agree in general constituents with those occurring in the oils of the members of the main groups, whether from species growing in Tasmania or on the mainland—of course varying in amount as the botanical characters of the group become more defined.

The occurrence of the terpene phellandrene in the oils of a majority of the species is a character of some importance, and one which may eventually be shown to have some significance in determining distribution of species.

The oil of *E. Risdoni* is specially worthy of mention, because of the large amount of eucalyptol which occurs in it, together with phellandrene. It has latterly been the practice in England, America, and in Europe to demand oils rich in eucalyptol (cineol) for pharmaceutical purposes, and the presence of phellandrene has been looked upon with considerable disfavour. But when we consider that the medicinal value of Eucalyptus oil was first determined on oils of the "amygdalina" group, even including that of *E. dives* (in which eucalyptol is almost absent), it may be that the present condemnation of a phellandrene-bearing oil like *E. Risdoni* is hardly warranted, and is perhaps, at the least, injudicious. Dr. Cuthbert Hall, of Parramatta, in 1904, showed that eucalyptol when pure had very little antiseptic power—much less than that of many other constituents of Eucalyptus oils, including phellandrene. Dr. Martindale has also recently shown that eucalyptol has very weak antiseptic power in comparison with many other substances. Piperitone, a constituent of the oils of the "Peppermint" group, was shown by Dr. Hall to be very energetic in its action, and this is a constant constituent in the oils of *E. amygdalina*, and *E. Risdoni*. Perhaps, however, the efficacy of Eucalyptus oil is more largely due to the mixture of constituents than to the action of the constituents themselves when these are isolated in a pure condition. Certainly all is not yet known about the therapeutic value of Eucalyptus oils, and the present official conclusions in this respect appear to us to have been based on insufficient experimental data. Bearing in mind, however, the reputed efficacy of the other constituents, it might be well to insist on a minimum of 50 per cent. of eucalyptol in any Eucalyptus oil to be used for pharmaceutical purposes, and we do not, for several reasons, suggest a less amount. If this standard is eventually arrived at, and phellandrene not condemned, then *E. Risdoni* would be a very good species to exploit for its oil. The volatile aldehydes in the oil of this species are small in amount and are not at all objectionable. The above remarks apply in a lesser degree to the oil of *E. linearis*. If oils similar to *E. Risdoni* are eventually recognised officially, it would be necessary to reduce the standard for specific gravity to 0.905 at 15° C.

The Tasmanian eucalyptol-pinene oils in which phellandrene is absent, with the exception of those of *E. globulus* and *E. cordata*, are inclined to be of lighter gravity than the "Mallee" oils; this is due to the presence of rather a larger amount of pinene, and less high boiling constituents (which are naturally heavy), but they mostly contain over 50 per cent. eucalyptol. The yield of oil would be, of course, an important factor governing the commercial possibility of these species for oil-distillation, and for that reason the yields are given in a separate table.

The oil of *E. acervula* was found to be of special interest from a scientific point of view, and from it was isolated a solid stearoptene belonging to the paraffin series. It is announced in this paper as a new constituent in some Eucalyptus oils. The oil of this species also contains a considerable amount of geraniol and geranyl-acetate.

The strong resemblance between the essential oil of *E. Gunnii* and that of *E. viminalis* shows a close affinity existing between these two species. There is rather more phellandrene and less eucalyptol present in the oil of *E. Gunnii* than in that of *E. viminalis*, otherwise the oils are similar. The vernacular names, "Manna Gum" for *E. viminalis* and "Cider Tree" for *E. Gunnii*, indicate that a sweetish sap is common to both trees, and this well-known fact also points to a strong chemical relationship between them.

Over 50 years ago, Hooker, in his "Flora Tasmaniae," pointed out from botanical evidence the close agreement between these two Eucalypts, a suggestion which is now confirmed by the results of this investigation. Although showing such close affinity both are distinct species, and although *E. viminalis* is a common tree in Australia, yet so far as we are aware *E. Gunnii* does not occur on the mainland.

The peculiarities of the oils of the Tasmanian Eucalypts will be found described under the several species, but we cannot refrain from again pointing out the remarkable agreement—in most instances—between the oil constituents of the leaves and the botanical features of the plant. The practical constancy of constituents in the oils of identical species, wherever growing, is again shown most distinctly by the results recorded in this paper, and much trouble has been taken to secure authentic data to further support the previous statements concerning this very useful aid towards the correct determination of the several Eucalyptus species.

The commercial possibilities of the several species for oil-production, in comparison with those of the mainland, can be judged from the results recorded in this paper, but it might be well to direct attention to the glaucous species, *Eucalyptus Delegatensis*, which is generally known throughout the island as "Gum-topped Stringy-bark." This species is now being used somewhat extensively in Tasmania as a timber-producing tree, and it might be well, therefore, to consider the advisability of utilising the leaves for their oil, instead of wasting them as at present. The method of extracting the oil is most simple, and can be carried out by ordinary labour, nor is there required much outlay for plant, as one or two 400-gallon iron tanks, fitted for the purpose, is all that is necessary, provided water is available. The oil of this species could be used for mineral separation, for which purpose it is in considerable demand.

The following list summarises the species and their oil relations:—

Eucalypts which yield oils containing over 50 per cent. of eucalyptol, the principal terpene being pinene: both phellandrene and piperitone are absent:—

- E. cordata.*
- E. globulus.*
- E. Muelleri.*
- E. Perriniana.*
- E. Rodwayi.*
- E. unialata.*
- E. urnigera.*
- E. vernicosa.*

Eucalypts which yield oils containing eucalyptol, pinene, and phellandrene: eucalyptol between 50 and 25 per cent.:—

- E. Gunnii.*
- E. viminalis.*

Eucalypts which yield oils containing over 50 per cent. of eucalyptol, in which the terpene phellandrene has largely replaced the pinene: piperitone is present:—

- E. linearis.*
- E. Risdoni.*

Eucalypts which yield oils consisting largely of phellandrene, and containing less than 25 per cent. of eucalyptol: piperitone is present:—

- E. amygdalina.*
- E. coccifera.*

E. Delegatensis.

E. regnans.

E. taeniola.

E. virgata.

*E. obliqua.**

Eucalypts which yield oils not readily placed in the above groups:—

E. acervula.

E. phlebophylla.

The altitudes given in this paper can only be considered as approximate, but this, for all practical purposes, is sufficient.

3.—SPECIES WITH THEIR SYSTEMATIC, TECHNOLOGICAL, AND CHEMICAL DATA.

EUCALYPTUS ACERVULA, Hook. f.

(“Red Gum” of Tasmania.)

BOTANY.

Historical.—This species was originally described by Hooker in his “Flora Tasmaniae” (1859), but Mueller, in his “Eucalyptographia” (1879), places it under *E. Gunnii*, another species described by Hooker in the “London Journal of Botany” (III. 499. 1844). Bentham, in his “Flora Australiensis” (1866, Vol. III., p. 244), synonymises it under *E. Stuartiana*, a Victorian species. Maiden, in A.A.A.S. 1902, p. 377, classifies it as *E. Gunnii*, Hook., var. *acervula*, Deane and Maiden, whilst Rodway, in his “Flora of Tasmania” (1902), gives to it its due specific rank.

Remarks.—Morphologically the herbarium material has a resemblance to *E. paludosa*, R. T. B., a mainland species described in 1898 (Proc. Linn. Soc. N.S.W.), and especially are the fruits alike.

Maiden (Proc. Linn. Soc. N.S.W., 1901), in a paper on *E. Gunnii*, Hook. f., places both the mainland *E. paludosa*, R. T. B., and the Tasmanian *E. acervula*, Hook. f., under *E. Gunnii*.

The results of this investigation show that these three are distinct both botanically and chemically.

* In the oil of this species the aldehyde aromadendral replaces the piperitone

E. paludosa, R. T. B., has a smooth bark, whilst *E. acervula*, Sieb., has mostly a rough bark, and could perhaps on occasions be classified with the hemiphloïæ group of Eucalypts.

"The tree has usually a very bushy top, and the leaves are of rather a pendulous growth."—(L. G. Irby.) *E. paludosa* is a fine typical tree, with stout outstretching branches and a straight stem. The "sucker" leaves are very different in appearance, shape, and colour from those of *E. Gunnii*, from which species it also differs in the number of flowers in the umbel, bark, timber, and chemical constituents.

From our investigations it would appear that the chief botanical differences between *E. acervula*, Hook. f., and *E. paludosa*, R. T. B., are the timber and bark and the chemical constituents.

E. acervula timber is harder, closer grained, and altogether superior to that of *E. paludosa*.

CHEMISTRY.

Essential Oil.—This material for distillation was collected at Hobart in April, 1912. The average yield of oil was 0.212 per cent. The crude oil was reddish in colour, and had an odour resembling geranyl-acetate, which, together with its appearance, reminded one of the oil of *E. Macarthuri* of New South Wales. The chief constituents present were dextro-rotatory pinene, laevo-rotatory phellandrene, eucalyptol, geranyl-acetate, free geraniol, together with a small amount of an undetermined alcohol, and its ester, and what is more important from a scientific point of view, a solid paraffin-like stearoptene, and a paraffin, liquid at ordinary temperatures. The presence of such a stearoptene in Eucalyptus oils has not previously been recorded, but it does not appear to be peculiar to this species, for traces of it in the oils from two New South Wales Eucalypts have already been detected. It most probably belongs to the $C_n H_{2n} + 2$ group, as it is a saturated substance. This solid aliphatic stearoptene is related to a similar substance found in Rose oil, although melting at a higher temperature, and it is remarkable that the principal alcohol in both Rose oil and in the oil of this Eucalypt is geraniol. The oil of *E. Macarthuri*, however, does not contain it. Similar paraffins, with varying melting-points, have been isolated from the oils of a few other plants, and in some cases from the oils of their leaves. This stearoptene, from this Eucalypt, is without doubt from the

oil of the leaves, because the trees were not in flower at this time of the year. The oil of *E. acervula* does not agree entirely in general characters with that of *E. paludosa* of New South Wales, as the former contains phellandrene and not much pinene, while the principal constituent in the oil of *E. paludosa* is pinene, and phellandrene does not appear to occur in it. The esters, too, were not identical in composition. It contained, however, about the same amount of eucalyptol as that of *E. acervula*, and the paraffin stearoptene was also found in it, but in much smaller quantity. The two species may therefore be considered to be closely related.

The specific gravity of the crude oil at $15^{\circ}\text{C.} = 0.8956$; rotation $a_D = -1.1^{\circ}$; refractive index at $18^{\circ} = 1.4756$; and it was soluble in 1 volume 80 per cent. alcohol, but became turbid with 4 volumes, and remained turbid with further addition of alcohol in the cold, forming a flocculent precipitate on standing. On warming the turbid solution it became clear, but the substance was deposited again on cooling.

The saponification number of the esters and free acid was 32.8 by boiling, and 21.4 in the cold with two hours' contact, this represents 7.5 per cent. of geranyl-acetate in the crude oil, and 4 per cent. of another ester if calculated for an alcohol having a similar molecular weight. The odour of geraniol in the separated oil, after saponification, was most distinct and well marked, and although the amount of oil at our disposal did not permit of its separation and purification, yet there is no doubt of its identity, particularly as geraniol and geranyl-acetate are such common constituents in certain classes of Eucalyptus oils.

The amount of free geraniol in the oil was considerable; and another undetermined alcohol was also present. A portion of the crude oil was boiled for two hours with acetic anhydride and anhydrous sodium-acetate in the usual way. The separated oil was somewhat mobile, and had a marked odour of geranyl-acetate. The saponification number with this esterified oil by boiling was 105.3, and in the cold with two hours' contact 69.5. This latter figure represents 24.3 per cent. of ester as geranyl-acetate, and indicates that 13.2 per cent. of free geraniol was present in the oil, as well as 6.6 per cent. of another alcohol, assumed to have the same molecular weight.

It is worthy of notice that over 50 years ago, when this species was described by Hooker in his "Flora Tasmaniae," he remarked that "The bruised foliage has a

much sweeter odour than is usual in the genus." The discovery of geraniol and its ester in the oil not only confirms this remark, but also indicates the constant character of the chemical constituents.

The acid in the original ester was separated and found to be largely acetic.

On rectification of the crude oil a little acid water and rather a larger amount than usual of objectionable smelling volatile aldehydes came over below 175° (corr.). Between 175 - 200° C. 42 per cent. distilled; between 200 - 228° 8 per cent.; the thermometer then quickly rose to 255° C., and between that temperature and 285° 36 per cent. distilled. These fractions gave the following:—

	Sp. gr. at 15° C.		Rotation a_D		Ref. Index at 18° C.
First fraction	0.8796	..	- 2.6	...	1.4659
Second fraction.....	0.8913	...	- 1.2	...	1.4688
Third fraction	0.9007	...	+ 4.8	...	1.4884

The residue, when poured from the still, became solid when cold; this was boiled in alcohol, and the alcohol separated while hot. On cooling, a crystalline paraffin-like substance separated.

To prove the presence of pinene another 100 c.c. of the oil was distilled, and the added two first fractions gave 32 c.c. distilling below 170° (corr.). This was again distilled, when 15 c.c. was obtained below 162° . This contained some eucalyptol, which was removed by shaking with 50 per cent. resorcinol. The remaining 9 c.c. of oil had a pinene odour; its specific gravity at 15° = 0.8594; rotation a_D = + 10° ; and refractive index at 18° C. = 1.4699. A small quantity of phellandrene was still present, but this did not interfere with the formation of the nitrosochloride, which, when purified, melted at the correct temperature for the pinene compound.

The eucalyptol was determined in the portion of oil distilling below 195° C., and the result showed that 21 per cent. of that constituent was present in the crude oil. A portion of the high boiling constituents was most probably a sesquiterpene.

Material of this species was obtained at Little Swanport in June, 1908. The oil was practically identical with that of the above sample, with the exception that a little more pinene was present at this time of the year. The specific gravity at 15° = 0.898, and the refractive index at 22°

= 1.4715. The saponification number for ester and free acid was 34.3° , and the ester consisted mostly of geranyl-acetate. The oil contained the paraffin-like substance in slightly greater amount than the Hobart specimen.

The Stearoptene.—When the crude oils of both consignments were dissolved in a large excess of 80 per cent. alcohol, a copious flocculent substance separated. The temperature of the solution was 18° C. It was filtered through a hardened filter, washed with alcohol, and the solid fat-like substance melted on the water bath to separate adhering water and alcohol. The amount of crude material thus obtained from the oil of the Hobart sample was equal to 0.764 per cent., and from the Little Swanport material 0.816 per cent. This method naturally wasted the oil, as only such a small amount of the stearoptene was present. The portion of the oil distilling above 280° C. became semi-solid when cold; this was boiled in alcohol, filtered boiling hot, and the process repeated three times. On cooling, the substance separated in flocks. After standing some time it was filtered off and boiled in acetic ether, which was found to be a good solvent for the purpose; on cooling, the substance separated, most of the impurities remaining in solution. The stearoptene was but little soluble in cold acetic ether, but readily in hot. The crystalline fat-like substance was then boiled in alcohol with a little animal charcoal, and filtered hot. It was finally dissolved in chloroform and precipitated by the addition of alcohol. When thus obtained it differed in no respect from the corresponding material precipitated directly from the oil by alcohol.

When finally purified the stearoptene was perfectly white, of a paraffin-like nature, without odour, easily melted, and burnt away identically in odour and manner with ordinary paraffin when similarly heated and ignited. The melting-point was 55 to 56° C. determined by the capillary tube method in water, and in other ways.

Under the microscope it was seen to be crystalline, and when melted on glass and allowed to slowly cool, the crystals polarised well in bright colours; but these crystals were not very symmetrical, but vermiform, often tending to the shape of the letter S. When dissolved in carbon tetrachloride, and bromine dissolved in the same substance added, the colour was not removed; it was thus saturated. Concentrated sulphuric acid had no action upon it in the cold, nor did the usual oxidising mixture of potassium bichromate in sulphuric acid act upon it in the cold, and

only slightly on continued boiling. Concentrated nitric acid appeared to have no action in the cold, and it was but very slowly attacked on boiling, acting in this respect similarly to the paraffins themselves. A solution of potassium permanganate in the cold had no action on it after many days. It thus acted similarly to the solid members of the paraffin group of the general formula $C_n H_{2n} + 2$.

When the alcoholic filtrate from the precipitated oil was cooled in ice, a further solid substance separated, which was thought to be more of the same stearoptene; it was filtered as cold as possible, but the solid, which was removed quickly, became liquid under ordinary temperatures, and remained as an oil. It was small in amount, but it is apparent that at least two members of this group were present in the oil of this Eucalypt.

EUCALYPTUS CORDATA, Labill.

BOTANY.

Historical.—This species was described by Labillardier in his "Plants of New Holland," published in 1799.

Remarks.—This Eucalypt is endemic to Tasmania, and is in the fortunate position of having no synonyms. Deane and Maiden (Proc. Linn. Soc. N.S.W., 1901, p. 125) state that it grows in New South Wales, but Maiden later (same Proceedings, same year, p. 551) does not appear to support this claim. The species recorded for New South Wales under this name is *E. pulverulenta*, Sims., as maintained by one of us in a paper read before the A.A.A.S. Hobart in 1902, and this contention now is supported by investigations made by us since that date. Our researches go to prove that *E. cordata*, *E. pulverulenta*, and *E. cinerea* are specifically distinct.

CHEMISTRY.

Essential Oil.—The oil of this Tasmanian species was determined some years ago, and the results published in our work "Research on the Eucalypts" (p. 210). The yield of oil from leaves and terminal branchlets was large for a rich eucalyptol-pinene oil, and was equal to 2.32 per cent.

Eucalyptol was the chief constituent; pinene was present, but phellandrene was absent. The oil was very soluble, requiring only $1\frac{1}{4}$ volumes of 70 per cent. alcohol. The

saponification number for the esters and free acid was 14·8. The specific gravity of the crude oil at 15° C. = 0·9138, and of the rectified oil = 0·9117. The rotation $a_D = + 8\cdot5^\circ$; and refractive index at 16° = 1·4695. The rectified oil may be considered of excellent quality for pharmaceutical purposes, judged by the present standard for these oils.

EUCALYPTUS GLOBULUS, Labill.

(“ Blue Gum.”)

BOTANY.

Historical.—This species was described by Labillardier from trees growing in Tasmania, and recorded in his “ Voyage ” (I. 153. f. 13.), published in 1799.

Remarks.—Tasmania may be regarded as the home of *E. globulus*, and to-day it has such a world-wide reputation, and is so familiar to botanists, foresters, and the commercial world generally, that nothing is required here to mark its identification. It is known the world over.

Its botanical and chemical characters never seem to alter whatever hemisphere it may be planted in.

E. globulus has been recorded as far north in New South Wales as Rylstone (R. T. B., Proc. Linn. Soc. N.S.W., 1896).

CHEMISTRY.

Essential Oil.—The oil of this species is so well known that it is quite unnecessary to describe it here. It is now generally recognised that wherever this species grows the general characters of the oil are the same. We have determined this to be also the case with trees of *E. globulus* growing in New South Wales, and no matter whether these were growing naturally or under cultivation the oil was always in agreement with that obtained from Tasmanian trees. There is nothing unusual, however, about this, nor is it peculiar to this species. From hundreds of analyses we have now made from various species, and from authentic botanical material, it is found that the chemical characteristics of a *Eucalyptus* species are some of the most constant features of the plant, and the determination of these has now become of considerable aid in the botanical characterisation between doubtful species and supposed allied forms.

EUCALYPTUS GUNNII, Hook. f.

(“Cider Tree” or “Cider Gum.”)

BOTANY.

Historical.—This species was described by Sir J. D. Hooker in 1844 in the “London Journal of Botany” (III. 499), and later in “Flora Tasmaniae” (I. 134. t. 27). Bentham also records it in his “Flora Australiensis” (1866, III., p. 246), whilst Mueller, in his “Eucalyptographia” (1879, Dec. IV.), gives a very full description, together with a plate. (See under “Remarks.”)

Deane and Maiden treat pretty fully of the species, its allies and affinities, in the Proc. Linn. Soc. N.S.W. 1901, and later Maiden devotes special attention to the species in Proc. A.A.A.S. 1902, which practically covers the ground of his paper on *E. Gunnii*, Hook. f., read before the Linn. Soc. N.S.W. in the previous year. In this paper a long list of synonyms is given, together with many proposed new varieties.

Remarks.—The name *E. Gunnii* was bestowed by Sir J. D. Hooker on what is known as the “Cider Tree” of Tasmania, as shown by his own writings, and repeated by Bentham, Mueller, Rodway, and others; and this point should be borne in mind when writing on the species.

Now, this “Cider Gum” Eucalyptus, as far as we have been able to trace, is only found in Tasmania—and only there in certain localities, on the central plateau as far as we can ascertain—but never on the mainland of Australia. In fact one of us paid a special visit to the Kosciusko Ranges and their branches to search for it, but so far without success. Of course it may be there all the same, although museum collectors, settlers, schoolmasters, and others have all joined in the search, but have so far failed to locate it.

Whatever tree is now placed under the name it must be a *sine qua non* that it is identical with the “Cider Tree” of Tasmania, for that was the original intention of Hooker. His description accords with that particular tree, and Bentham’s reproduction in “Flora Australiensis” (III., p. 246) equally so, for it accurately describes the material in this museum obtained from the Tasmanian “Cider Tree” by Mr. L. G. Irby, the museum collector, acting under Mr. L. Rodway’s direction.

Mr. Irby states in this connection: “This tree gets its local name from a sweet exudation which flows from it at

certain times of the year. This exudation appears to be just the sap of the tree, for by cutting the bark the sweet flavour may be tasted at any time. Where wounded the sap exudes, and crystallises as it flows down the side of the tree. At this time of the year (May) the 'cider' will only flow in very small quantities, and cannot be collected. I was informed by local residents that to obtain it in any quantity it is necessary to tap the trees during the spring or summer months. Like manna, this exudation is of a very pleasing flavour, and is rather sought after in consequence. Opossums are extremely fond of it, as also are many birds. I am informed that at certain times of the year the wattle-birds appear to almost live on it."

The central figure and "sucker" leaves in Mueller's plate in the "Eucalyptographia" is a faithful reproduction of the material in our possession, upon which the research has been undertaken, and known in the locality from which it was obtained as "Cider Tree."

In this latter connection one may quote Mueller in his "Eucalyptographia": The sap of at least the alpine *variety* has not an unpleasant taste, and bush people have converted it into a kind of cider." The variety in this case is the original species of Hooker, and so regarded by Bentham, Gunn, Oldfield, and Rodway.

*The fruits to the right in Mueller's plate (*loc. cit.*) apparently represent those of *E. Perriniana*, which is quite a distinct tree, as shown in this paper.

Herbarium material of *E. acervula*, Hook. f., *E. paludosa*, R. T. B., and *E. camphora*, R. T. B., and the Cider Gum, *E. Gunnii*, Hook. f., are all somewhat alike, and on the morphology of the fruits these species might possibly be confounded; and it is probably on these grounds that some authors have regarded them as varieties of one species, but when studied on a broad basis of species classification, such as recommended by us, the differences are too great to allow of anything but a specific rank in each case. Nor can we under such a system include such good species as *E. maculosa*, R. T. B., *E. rubida*, H. D. et J. H. M., as proposed by Maiden (*loc. cit.*), with their distinct botanical and chemical differences.

Timber.—The timber is pale-coloured, and very hard and heavy, and Mr. L. G. Irby states that it is almost if not quite as hard as that of the Australian Ironbarks *E. paniculata* and *E. crebra*.

CHEMISTRY.

Essential Oil.—This material was collected at Interlaken in May, 1912, and was distilled in the fresh condition just as would be done commercially. The average yield of oil from the leaves and terminal branchlets was 0·387 per cent. The crude oil was dark-coloured, and had a terpene odour, together with that of eucalyptol. The chief constituents in the oil of this species are dextro-rotatory pinene, laevo-rotatory phellandrene, eucalyptol, some sesquiterpene, and a small amount of ester.

The crude oil had specific gravity at 15° C. = 0·9014; rotation $a_D = + 1·5^\circ$; refractive index at 18° = 1·4752; and was soluble in 4 volumes 80 per cent. alcohol.

On rectification, a small amount of acid water and volatile aldehydes came over below 165° C. (corr.). Between 165-173° C. 30 per cent. distilled; between 173-198° C. 52 per cent.; the thermometer then rose to 254°, and between 254-270° C. 14 per cent. distilled. The fractions gave the following results:—

	Sp. gr. at 15° C.		Rotation a_D .		Ref. Index at 18° C.
First fraction.....	0·8813	...	+ 5·4°	...	1·4680
Second fraction	0·8930	...	− 4·2°	...	1·4686
Third fraction	0·9377	...	+ 8·9	...	1·5013

The eucalyptol was determined in the oil distilling below 198° and calculated for the crude oil, which was thus shown to contain 41 per cent. of that constituent.

The saponification number for the esters and free acid was 6·7. The results of this investigation show the oil of this species to be quite distinct from that of *E. camphora* of New South Wales. *E. Gunnii* has no value as an oil-producing tree, as the yield is small, and the main constituents only of an ordinary nature.

EUCALYPTUS LINEARIS, A. Cunn.

(“ *White Peppermint*.”)

BOTANY.

Remarks.—It has been customary to regard the smooth-barked narrow-leaved Eucalyptus growing near Hobart, and distributed throughout Tasmania generally, as this species, but in going over the literature and specimens procurable to-day it would seem that such a classification is hardly correct.

Bentham, in "Flora Australiensis" (III., p. 200), states in connection with this and one or two other species that "although evidently seen by the authors in bud or in flower as well as in leaf, are far too imperfectly described to render *their identification possible*"; and Mueller, in his "Eucalyptographia," under "*E. amygdalina*," states: "*E. linearis*, Dehn., seems merely to indicate a variety remarkable for the extraordinary narrowness of its leaves, but neither flowers nor fruits occur in authentic specimens, preserved in the collection of Baron Cesari, who kindly placed samples of Dehnhardt's original plants at my disposal."

In Walpole's "Repertorium" (II., 164) the locality is given as New Holland.

The leaves of this Tasmanian Eucalyptus are narrow, but not extraordinarily so, certainly not *viminalis*, willowy, as given by Walpole (*loc. cit.*), and the locality—New Holland in 1839—is suspicious that the tree was not from Van Diemen's Land.

The original description is far too brief for identification purposes, and as Dehnhardt's plant was probably a cultivated one, it seems it is only wasting time to give it any attention, especially as the original specimen in the Imperial History Museum of Vienna is in bud only, and is, therefore, almost worthless from a systematic point of view.

It is stated that A. Cunningham collected specimens, and labelled them "*E. linearis*, Hobart Town, 1819, A. Cunn.," in which case it might be surmised that this is the tree; but this is only a surmise, for the tree going under the name of *E. amygdalina* in Tasmania has very narrow leaves in some instances, and the name "*linearis*" quite describes them. Maiden (Proc. Roy. Soc. Tas. 1902), under "*E. linearis*," states that: "The upshot of my investigation is that *E. linearis*, Dehnhardt, and *E. pulchella*, Desfontaines, are specifically identical. Both were named from plants raised in Europe. In my Australasian Association for the Advancement of Science paper I have put forth a plea for a final investigation by Tasmanian botanists as to whether a certain Mt. Wellington tree is identical with *E. linearis*, Dehn., and, if so, whether it is con-specific with *E. amygdalina*, Labill."

We, however, think there is not sufficient evidence to prove that the tree now going under the name of *E. linearis* is that so-called by Dehnhardt and *E. pulchella* by Desfontaines—names founded on plants raised in Europe. But

rather than add another name to the already long list of Eucalyptus species we have decided to let the name stand, but give the authorship to A. Cunningham, and this will accord with his specimen from Hobart (1819) at Kew and bearing his name, as he has thus a priority claim to the name over that of the last two authors.

The tree to which these remarks refer is the smooth-barked, tall, upstanding Gum at the head of Gentle Annie Falls, Hobart, but it is fairly distributed throughout the island.

Description of Species.—It is a fairly tall tree, with clean, smooth, yellow or whitish bark, sometimes rough for a few feet at the base. Sucker leaves opposite or alternate, very narrow, mostly 1 line wide and about 2 inches long, on filiform rugose branchlets; only midrib showing, edges thickened. The leaves (normal) narrow, lanceolate, petiolate, to narrow linear, lanceolate, under 3 inches long and up to $\frac{1}{4}$ -inch wide, not shining, venation hidden in the leaf texture, midrib only showing on the underside, alternate. Peduncles axillary, with few flowers in the head. Buds clavate, operculum depressed, hemispherical.

Fruits hemispherical, $\frac{1}{4}$ -inch in diameter, slightly shining, on a rather slender pedicel, rim red scarcely domed, or truncate. tips of the valves just exerted.

Timber.—Pinkish, fissile, easy to work, and specifically light, and suitable for indoor work only.

CHEMISTRY.

Essential Oil.—Material of this species was obtained from the Springs, Mt. Wellington, and collected in January, 1912, at a time of the year when a maximum yield of oil might be expected. The average yield of oil from leaves and terminal branchlets, collected as would be done for commercial oil-distillation, was 1·8 per cent. The crude oil was reddish in colour, caused by the small amount of iron from the still, and had a peppermint odour, due to the piperitone present. It contained much phellandrene and a considerable amount of eucalyptol. Pinene was absent, or present only in very small quantity. The specific gravity of the crude oil at 15° C. = 0·9096; rotation a_D = $-10\cdot2^\circ$; refractive index at 24° C. = 1·4659; and was soluble in 6 volumes 70 per cent. alcohol.

On rectification, only a few drops of acid water and volatile aldehydes came over below 173° C. (corr.), at which

temperature the oil commenced to distil. Between 173-188° 82 per cent. distilled; between 188-290° 10 per cent. distilled, the greater portion (7 per cent.) above 260°. These fractions gave the following results:—

	Rotation a_D .		Sp. gr. at 15° C.		Ref. Index at 24°.
First fraction.	- 12°	...	0.8987	...	1.4619
Second fraction	+ 3.2°	...	0.9501	...	1.4869

There is evidently a heavy, high boiling constituent in the oil of this species, which has a right rotation, but it was not isolated. Saponification number for the esters and free acid of crude oil = 5.8.

The eucalyptol was determined in the first fraction by the resorcinol method; this amount, when calculated for the crude oil, showed that 52 per cent. of that constituent was present.

Material of this species was collected at Little Swanport, Tasmania, in June, 1908. The oil distilled from this agreed in characters and constituents with the above. Average yield of oil = 1.38 per cent. Specific gravity at 15° C. = 0.9036; rotation a_D = - 9.9°; refractive index at 24° = 1.4687, and was soluble in 7 volumes 70 per cent. alcohol. Below 193° C. 77 per cent. distilled. The eucalyptol was determined in this fraction by the resorcinol method, and gave 51 per cent. of that constituent for the crude oil.

Material for this species was also collected at Nubeena, Tasman Peninsula, in April, 1912. It agreed in general characters with the oil from the previous consignments, only at this time of the year rather a large amount of phellandrene was present, consequently the rotation to the left was higher; the eucalyptol was also slightly less in amount, but still exceeded 40 per cent. in the crude oil. Average yield of oil = 1.1 per cent. Specific gravity at 15° C. = 0.9045; rotation a_D = - 23.1°; refractive index at 18° = 1.4743, and it was soluble in 8 volumes 70 per cent. alcohol. Below 193° C. 79 per cent. distilled. The eucalyptol in this portion was determined by the resorcinol method; the result showed that 44 per cent. of that constituent was present in the crude oil. The oil of this species somewhat closely agrees with that of the form of *E. amygdalina* of the mainland, both in constituents and physical characters, much more so than with the oil of the Tasmanian form described in this paper.

EUCALYPTUS MUELLERI, T. B. Moore.

("Brown Gum.")

BOTANY.

Historical.—This tree was first brought under the notice of Baron von Mueller by Mr. T. B. Moore, who was anxious to dedicate a species of *Eucalyptus* to the then Victorian Government Botanist.

Remarks.—From the correspondence now at the Melbourne Herbarium, which we have been able to peruse through the kindness of Professor Ewart, it is shown that Baron von Mueller always hesitated to name this species as distinct from *E. vernicosa*.

There can be no doubt that the two are allied, but *E. vernicosa* is a dwarf tree, whilst *E. Muellerei* is a very fine specimen of the Tasmanian forests, and yields a first-class hardwood timber in addition to a eucalyptol oil in its leaves.

Its economies thus outweigh those of its congener *E. vernicosa*, which cannot be ranked as a timber tree, and thus for commercial reasons alone we think the two should remain as separate species. We have seen no intermediate forms between the two.

Timber.—The timber was pronounced by Mr. Moore, its discoverer, as extremely hard, close-grained, tough, and heavy, and suitable for heavy construction work as well as furniture, and in this we concur.

CHEMISTRY.

Essential Oil.—Material of this species was obtained from Mt. Wellington, at an altitude of about 3000 feet. It was collected in July, 1908. The principal constituent in the oil of this species is eucalyptol, accompanied with a fairly large amount of pinene. Phellandrene was not present, nor was it to be expected, judging from the botanical features of the species. There was rather a large amount of ester for oils of this class, and this appeared to be largely geranyl-acetate, as it was mostly saponified in the cold with two hours' contact. The crude oil was of a light-amber colour, and had an odour resembling the oils of the group of which *E. Smithii* may be considered the type; the usual amount of volatile aldehydes was present, but these were separated without difficulty on redistillation.

The average yield of oil from leaves and terminal branchlets was 1.28 per cent. The crude oil had specific gravity at 15° C. = 0.9096; rotation $a_D = + 10.4^\circ$; refractive index at 24° C. = 1.4629, and was soluble in 4

volumes 70 per cent. alcohol. The saponification number of the ester and free acid = 15.3, while in the cold with two hours' contact it was 11.7.

On rectification, the usual amount of acid water and volatile aldehydes were obtained below 166° C. (corr.), at which temperature the oil commenced to distil. Between 166-173° 44 per cent. distilled; between 173-195° 45 per cent.; the temperature then quickly rose to 225°, and between this and 252° 5 per cent. distilled. These fractions gave the following results:—

	Rotation α_D .		Sp. gr. at 15° C.		Ref. Index at 24° C.
First fraction.....	+ 14.1°	...	0.9022	...	1.4585
Second fraction...	+ 6.6°	...	0.9149	...	1.4593
Third fraction....	—	...	0.9309	...	1.4841

The eucalyptol was determined in the portion distilling below 195° by the resorcinol method, and 60 per cent. of that constituent was thus shown to be present in the crude oil.

The rectified oil was practically colourless, and both odour and taste were satisfactory. The results obtained with this oil, and also with those of *E. urnigera* and *E. vernicosa*, show them all to belong to the best class of eucalyptol-pinene oils, but they suffer from the defect of containing rather too much pinene, consequently their specific gravities are reduced below 0.91, which figure is demanded by the Pharmacopoeia for Eucalyptus oils. However, considerably more than half of the rectified oils of these species would consist of eucalyptol, and the supposed defect of specific gravity could easily be remedied if desired.

It is interesting to notice how closely the oil of this species agrees with that of *E. vernicosa*, as may be seen from the following table. The difference in yield is due to the coarser stems and less expansive leaves of *E. vernicosa*:—

<i>E. Muelleri.</i>		<i>E. vernicosa.</i>	
Eucalyptol-pinene oil, no phellandrene.		Eucalyptol-pinene oil, no phellandrene.	
Yield per cent...	1.28		0.807
Specific gravity at 15° C.....	0.9097		0.9038
Rotation α_D ...	+ 10.4°		+ 11.3°
Refractive index	At 24° C. = 1.4629		At 18° = 1.4651
S.N. esters, &c.	15.3		5.9
First fraction....	Below 173° C. = + 14.1°		Below 173° = + 16.7°
Second fraction.	Below 195° C. = + 6.6		Below 194° = + 9.4°
Eucalyptol	60 per cent.		59 per cent.

There was rather more pinene and less ester in *E. vernicosa*, but this may be due to difference in the time of year and location. The only difference worthy of notice is the larger amount of ester in the oil of *E. Muelleri*.

EUCALYPTUS PERRINIANA, R. T. B. et H. G. S.
BOTANY.

Historical.—The history of this species can perhaps be better told by reproducing the following from the museum collector's letter received from Mr. L. G. Irby when in the field in search of the material for this investigation:—

“Mr. Ellis informed me that many years ago he dug up some of these small trees, and planted them at his home on the Dee. At the present time only one of them is still alive, and it is about 18 inches in diameter, proving, therefore, that *E. Perriniana* attains some size. He states that Perrin never saw the patch of trees in the bush, but that he (Ellis) showed him the one he had growing at his house, and that it was only this one tree that Perrin wrote about. He told me this scrap of information, although I had not mentioned the name of Perrin at all. Afterwards I told him that Mueller had named this tree *Perriniana* after Perrin, and the old gentleman was quite surprised, as he appears to look upon this tree as his own find. I mention this as it seems to prove that, thanks to Mr. Ellis, I have come upon the original clump of trees from which this species was first written up. Indeed, it would appear that no more are known in Tasmania; at least, not recorded.”

It was really first announced to science by Mr. C. S. Perrin, F.L.S., Conservator of Forests, Victoria, before the A.A.A.S. (1890, 557). Mr. Rodway (Proc. Roy. Soc. Tas. 1893, p. 181) gives additional data concerning the plant.

Remarks.—It appears that no other systematic description of this Eucalyptus has been published except that given by us in “Eucalypts and their Essential Oils,” although Rodway (*loc. cit.*) gives the authorship to Mueller. We certainly were under the impression that Mueller had described it when writing our previous work, but through the kindness of Professor Ewart we have been enabled to read all the correspondence that passed through the Melbourne Herbarium in connection with it, and also to examine the original specimens of Perrin, and find that such is not the case.

The remarks made by Mr. Perrin when exhibiting the material before the A.A.A.S. in 1890, that "he was of opinion that the new claimant would be found to be a new species," are now confirmed, for our investigations show that it is distinct from any previously described, and is far removed systematically from *E. Gunnii*, Hook. f., with which some affinity has been claimed for it.

The following description of this species is from our work "Eucalypts and their Essential Oils":—

Systematic description.—A "mallee" or small tree attaining a diameter of $1\frac{1}{2}$ feet and sometimes up to 30 feet in height, with a smooth bark. The broad, expanded base, from which spring a number of small stems, is very characteristic of this species. Branchlets terete and glaucous. Leaves also glaucous, variable both in size and shape, perfoliate, sessile cordate, orbicular, ovate, ovate-lanceolate, lanceolate elliptical, decussate, opposite or alternate; venation faintly marked, lateral veins oblique, spreading, intramarginal vein well removed from the edge. Oil-glands very numerous. Flowers in short axillary peduncles mostly, generally in threes, sessile or on a pedicel. Calyx 2 to 3 lines long, 2 lines in diameter, bell-shaped. Ovary flat-topped. Operculum shortly conical, edge overlapping the calyx. Stamens all fertile; anthers parallel, opening by longitudinal slits.

Fruits hemispherical to elongated or cylindrical, up to 5 lines long and under 3 lines in diameter, rim thickened, capsule sunk.

Timber.—A pale-coloured, rather soft, porous timber.

Habitat.—There appears to be only one locality known where this species occurs in Tasmania, viz., that discovered by Mr. G. Ellis, who showed the tree to Mr. Perrin. It grows in swampy ground (the same as on Mt. Kosciusko, N.S.W.—R.T.B.), about 2 miles beyond Strickland, between the Ouse and Dee Rivers, 20 miles from Dee, at a high elevation (1200 to 1500 feet).

It is the same as that recorded by us on Mt. Kosciusko in "Eucalypts and Essential Oils" (p. 205).

CHEMISTRY.

Essential Oil.—This material for distillation was collected at Strickland in July, 1912. The average yield of oil was 1 per cent. The crude oil was reddish in colour, due to the iron from the still, for when this red colour was removed the oil was a light amber tint. It contained a

considerable amount of eucalyptol; pinene was present in rather a large amount for a rich eucalyptol oil, and phellandrene was quite absent. Volatile aldehydes were pronounced, and these had an objectionable odour, which is usual with this group of *Eucalyptus* oils. The odour of the rectified oil was that given by the members of this class of eucalyptol-pinene oils generally. It is a very fair commercial oil for pharmaceutical purposes, although the pinene is a little too pronounced. For this reason the specific gravity borders on the minimum allowed, and the dextro-rotation is a little too high.

The crude oil had specific gravity at 15° C. = 0.9119; rotation $a_D = +8.90^{\circ}$; refractive index at 15° = 1.4651, and was soluble in 2 volumes 70 per cent. alcohol. The saponification number of the esters and free acid was 10.3. On rectification, a few drops of acid water and volatile aldehydes came over below 167° C. (corr.). Between $167-173^{\circ}$ 18 per cent. distilled; between $173-194^{\circ}$ 72 per cent. distilled; the temperature then quickly rose to 250° with only a few drops, while between $250-268^{\circ}$ 4 per cent. distilled. These fractions gave the following results:—

	Sp. gr. at 15° C.		Rotation a_D .		Ref. Index at 15° .
First fraction.....	0.8988	...	$+13.5^{\circ}$	...	1.4619
Second fraction....	0.9118	...	$+8.6^{\circ}$	...	1.4631
Third fraction	0.9256	...	$+5.2^{\circ}$	...	1.4868

The eucalyptol was determined in the portion distilling below 194° and calculated for the crude oil; 68 per cent. of that constituent was thus shown to be present. The rectified oil of this species is tinged yellow, as is usual with most of the oils of this group.

EUCALYPTUS PHLEBOPHYLLA, F. v. M.

(“*Cabbage*” or “*Weeping Gum*.”)

BOTANY.

Historical.—This tree was described by Miquel in 1856 (“*Ned. Kruidk. Arch.*” IV. 140), on behalf of Baron Mueller, from the Tasmanian specimens of Stuart.

Bentham, in his “*Flora Australiensis*” (Vol. III., p. 201), synonymises it with *E. coriacea*, A. Cunningham, under which species Mueller also places it in his “*Eucalyptographia*” (1879).

Remarks.—In all probability Mueller had not seen specimens of Cunningham’s *E. coriacea* when he described this

species in conjunction with Miquel, and so was not acquainted with the New South Wales and mainland trees now going under the name of *E. coriacea*, that is, Cunningham's and Sieber's tree—*E. pauciflora* of the latter—and so considered he had a new species at the time, for we know later he placed it under *E. coriacea*. Since that date it has been customary to regard the Tasmanian and mainland trees as one species; but the investigation taken in connection with this paper shows that such is not the case, and that the two are separate species, and so Mueller was correct after all. The original name of *E. phlebophylla* is thus here restored.

Mueller, however, concurs in Bentham's synonymy (*supra*) in his "Eucalyptographia," and places Tasmanian and mainland trees under *E. coriacea* in that book. This lumping of species, even his own, was characteristic of the Baron in his later work. Maiden, in his "Critical Revision of Eucalypts," agrees with Bentham's and Mueller's later classification. The original description is in Latin, and therefore does not permit of the finer points of determination as obtains when given in English.

As far as we have been able to determine, the chief differences between *E. phlebophylla*, F. v. M., and *E. coriacea*, A. Cunn., are:—

- (1) Field Characters:—Hooker, in his "Flora Tasmaniae," calls *E. phlebophylla* the "Weeping Gum," with generally spreading limbs and weeping branches, and branchlets that hang down 10 or 12 feet, and gives the height from 40 to 50 feet.
E. coriacea has not this field character, but is a tall, upstanding tree with large, spreading branches.
- (2) The leaves of *E. phlebophylla* are rather smaller, less coriaceous, and the venation by careful observation will be seen to be different, in that the lateral veins are not so long, and earlier anastomise than in *E. coriacea*.
- (3) The operculum of *E. phlebophylla* is pointed, as against the domed form of *E. coriacea*.
- (4) The fruits are larger and "woody" compared with those of *E. coriacea*.
- (5) Timber (see *infra*).
- (6) Chemical constituents of the oil.

Maiden, in his paper on the "Tasmanian Eucalypts" (Proc. A.A.A.S., p. 254), under "*E. coriacea*," speaking of its synonym *E. submultiplinervis*, states: "The material as far as it goes in the venation of the leaves and their hooked apices, their length and breadth in the very young buds, in the calyces and flowers, absolutely match much of the *E. coriacea* from New South Wales. Bentham ('B. Fl.' III. 201) speaks of this variety as a narrow, straight-leaved variety of the ordinary size. *E. phlebophylla*, F. v. M., is also interesting to the Tasmanian botanist from the circumstance that Miquel ('Ned. Kruidk.' IV. 140, 1856), who described the species on behalf of Mueller, gave Stuart's Tasmanian specimens as co-types. I have examined Stuart's specimen, and it bears, in Miquel's handwriting, the words '*E. phlebophylla*, M.' (Mueller), with the words '*E. submultiplinervis*, affinis,' cancelled. (Herb., Melb.)."

The "much" (*supra*) is without doubt this species on the mainland, and we are able to show that such does exist on the Continent of Australia. Bentham's remarks (*supra*) also describe this species all right. In the light of personal knowledge it seems strange that this confounding of species should have lasted so long, for the timbers alone of the two are different, and the chemical characters are distinct.

Timber.—This is not easily confounded with *E. coriacea*. It is fairly light in weight, pale-coloured, dresses well, and in figure is not at all unlike coachwood—*Ceratopetalum apetalum*—but has not the characteristic aroma. It would make a good cabinet timber.

CHEMISTRY.

Essential Oil.—This material for distillation was collected at Tunbridge in June, 1912. The average yield was 1 per cent. The crude oil was light olive-brown in colour, had a terpene-like odour, and consisted principally of laevo-rotatory pinene; it also contained phellandrene, eucalyptol, and eudesmol. This last constituent crystallised from the high boiling fraction. This is not the first time that a pinene oil has been distilled from the so-called "Cabbage Gum," so that the species is common to both Australia and Tasmania. Oil was first distilled from this Eucalypt by Mr. Marsden, at Muloon, near Boro, New South Wales, in February, 1908, and was brought under our notice by Mr. Farrell, of the Australian Eucalyptus Oil Company, on account of its strong odour of turpentine,

and its low boiling point. It was a colourless oil—as it had been rectified—and contained a very small amount of eucalyptol. It consisted almost entirely of laevo-rotatory pinene, with a little phellandrene. In September, 1910, Mr. Farrell noted this species growing at Monga, New South Wales, and he caused it to be distilled, and submitted the crude oil to us for investigation. The oil was light olive-brown in colour, had an odour of turpentine, was very mobile, and besides consisting largely of laevo-rotatory pinene, contained small quantities of phellandrene and eucalyptol. Even more pinene was present than in the Tasmanian oil, but this may be due to the difference in the time of the year, or partly to the mode of distillation, as the Monga oil had been distilled from an ordinary pot-tank still, which naturally does not bring over the high boiling constituents so completely as when the steam is supplied from a boiler. The Monga oil had specific gravity at 15° C. = 0.8766; rotation $a_D = -32.5^{\circ}$; refractive index at 15° = 1.4702; and contained 11 per cent. eucalyptol, and over 80 per cent. of the total oil distilled below 170° C. (corr.).

The oil from the Tasmanian trees had specific gravity at 15° C. = 0.8925; rotation $a_D = -22.4^{\circ}$; refractive index at 18° = 1.4761; and was insoluble in 10 volumes 80 per cent. alcohol. The saponification number for the esters and free acid was 3.2. The ester is thus very small in amount.

On rectification, a very small amount of acid water and volatile aldehydes came over below 157° C. (corr.). Between $157-172^{\circ}$ C. 66 per cent. distilled; between $172-192^{\circ}$ 9 per cent.; the temperature then quickly rose to 265° , only a few drops distilling, and between $265-282^{\circ}$ 20 per cent. distilled, which apparently largely consisted of a sesquiterpene. These fractions gave the following results:—

	Sp. Gr. at 15° C.		Rotation a_D .		Ref. Index at 18° C.
First fraction.....	0.8710	...	-35.2°	...	1.4667
Second fraction...	0.8809	...	-21.2°	...	1.4680
Third fraction....	0.9418	...	—	...	1.5019

The eucalyptol was determined by the resorcinol method in the portion distilling below 192° C., and when calculated for the whole oil gave 9 per cent. of that constituent. The pinene was determined in the first fraction, and an amount equal to 30 per cent. of the total oil came over

between 156-157° C. It had a marked odour resembling ordinary turpentine; specific gravity at 15° C. = 0.8661; rotation $a_D = -38.1^\circ$; and refractive index at 18° = 1.4659. The nitrosochloride was easily prepared with it, and this melted at the correct temperature. It may be assumed, therefore, that 50 or 60 per cent. of the oil of this *Eucalyptus* consists of laevo-rotatory pinene, and this is confirmed by both the Monga and Muloon samples. Whilst the chief constituent of the oil is pinene, that of the oil of *E. coriacea* is phellandrene.

EUCALYPTUS REGNANS, F. v. M.

("Swamp Gum.")

[SYN.: *E. gigantea*, Hook. f. ("Fl. Tas."), *partim*.
E. gigantea, Hook. f. ("Lond. Journ. Bot." VI.
 479. 1847), *partim*. See remarks under *E.*
obliqua, this paper.]

BOTANY.

Historical.—This *Eucalyptus* was first brought under the notice of the scientific world by Baron von Mueller in 1870 (Report of Acc. Soc. Vict. 7th Rep., p. 48). Although included by Mueller under *E. amygdalina* in his "Eucalyptographia" when referring to the giant trees of the Dandenong Ranges, yet he did not give a full botanical description of it till 1887-8 ("Key to Sys. of Vict. Plants," p. 236).

Maiden, in his "Critical Revision of Genus *Eucalyptus*" (1905) synonymises *E. fastigata*, Deane and Maiden (Proc. Linn. Soc. N.S.W. 1895), under this species.

Remarks.—Hooker, in his "Flora Tasmaniae," under "*E. gigantea*," gives a composite description covering three species of *Eucalyptus*, and this is one of them (the "Swamp Gum"), the other two being *E. obliqua* (the "Stringy-bark") and *E. Delegatensis* (the "Gum-topped Stringy-bark").

This tree is found to occur in Tasmania in similar situations and gregarious with *E. obliqua*, as on the mainland in Victoria, and is one of the trees referred to by Hooker (*loc. cit.*) when he states: "This forms a gigantic tree; and specimens have been felled in the valleys at the base of Mt. Wellington 300 feet high and 100 feet in girth." *E. Delegatensis* does not occur in the valleys at the base of Mt. Wellington.

In our work on "Eucalypts and Their Essential Oils" (1902, p. 145), under "*E. fastigata*," occurs the following:—

"The authors of this species (Deane and Maiden) are inclined to regard it as not specifically different from *E. regnans*, of Mueller (Proc. Linn. Soc. N.S.W., 1889, p. 460). We, however, prefer to consider these two Eucalypts as distinct, for Mueller's description of the latter species (Report Acclim. Soc. Vict. 1870) is so very clear and precise that he could hardly have confounded the material of *E. fastigata* when describing *E. regnans*. Specimens of *E. fastigata* were first sent by W. Bauerlen from Delegate to Baron von Mueller under the name of "Cut Tail," who hesitatingly named it *E. amygdalina*, var., showing that he never associated it with his *E. regnans*, a species of his own collecting."

Although written over 10 years ago, our researches since with these two species have not led us to alter the wording in any way. In fact, they have brought to light new facts which substantiate our contention that the two are distinct.

The material of *E. fastigata* now in this museum has been collected at Rylstone, Kirkconnell near Bathurst, Bowral, Monga, and Delegate, and in every case are all identical. A tree, therefore, with such a constancy of characters over such a range should, we think, carry more than a varietal rank. The material of *E. regnans* has been obtained from Yarra Junction, Victoria, and now from Mt. Wellington, Tasmania, and agree in every particular with each other, and at the same time show a distinct difference from *E. fastigata*.

It perhaps would not be out of place if a few notes were given here that would assist others in the differentiation of the species.

E. fastigata is best detected by its fruits, which have domed, red-rims, and slightly exserted valves.

E. regnans fruits, although pear-shaped like those of its congener, have a truncate or counter-sunk rim; and these two features are the best to distinguish the species morphologically.

The peduncles are often in pairs in each case. The seedling leaves differ, for in *E. regnans* they are very broad, almost ovate, and in *E. fastigata* lanceolate. The bark of *E. fastigata* is invariably rough and stringy, and *E. regnans* is mostly smooth—hence its common name "Giant Gum" of Victoria. The timbers,

although both pale-coloured and specifically light, yet have a specific difference, *E. regnans* being the more fissile. Then, again, their ecology is not in accord, for each seems restricted to its one particular geological formation, and *E. regnans* is found near water and damp grounds or sides of gullies, whilst *E. fastigata* favours a dry hillside locality. The two are also chemically distinct.

Habitat.—*E. regnans*, so far as our observations go, is restricted to Victoria and Tasmania.

CHEMISTRY.

Essential Oil.—This material was collected on Mt. Wellington, Tasmania, in July, 1908. One sample of leaves with terminal branchlets was collected at a height of about 2000 feet above sea-level, and another at about 2500 feet. This tree is known locally in Tasmania as "Swamp Gum." The oils from both consignments were alike, showing that a difference in altitude has little influence on the secreted oil. The composition of the oil was also in agreement with that of *E. regnans*, from material kindly sent for distillation from Yarra Junction, Victoria, by Cuming, Smith, and Company. This is shown from the appended results, and is particularly marked with those derived from the several fractions. The comparative absence of dextro-rotatory pinene in the oil of *E. regnans* shows it to be a species distinct from *E. fastigata*, irrespective of botanical differences.

The oil of *E. regnans* consists largely of the terpene phellandrene, and contains a fair quantity of the stearoptene eudesmol. This substance was obtained in larger amount than is usual, by increasing the pressure of steam considerably, after the oil had distilled off in the usual manner, and allowing the distillate to remain for some hours in open vessels; it could then be removed as a crystalline fat-like mass from the surface of the water, and purified in the ordinary way.

The presence of eucalyptol was doubtful in the portion distilling at about 176° C., so that this frequent constituent in Eucalyptus oils is only present in traces in that of *E. regnans*. The ester appears to be almost entirely geranyl-acetate, as it saponified readily in the cold, and the ketone piperitone is also present in small amount. A considerable portion of the oil consists of high-boiling constituents, probably a sesquiterpene largely; and this high-boiling portion soon became solid in the bottle, caused by the presence of eudesmol.

The crude oils were reddish in colour, due to the action of the acetic acid on the iron of the still. On removing the colour the oil was of a light-primrose tint. The two samples of oil had the following characters:—

	Altitude 2500 feet.	Altitude 2000 feet.
Yield of oil (per cent.) ...	0·823	0·782
Rotation a_D	$-28\cdot4^\circ$	$a_D = -31\cdot1^\circ$
Specific gravity at 15°C .	0·8802	0·8879
Refractive index at 20°C .	1·4882	1·4901
Soluble	In 5 vols. $70^\circ/\text{o}$ alcohol, by weight	In 5 vols. $70^\circ/\text{o}$ alcohol, by weight
Eucalyptol	Practically absent	Practically absent
Eudesmol	In quantity	In quantity
Phellandrene	In abundance	In abundance
S.N. of ester and free acid	13·2	S.N. = 15·4

One of these oils was then rectified. The results are tabulated with those obtained with the oil of this species from Yarra Junction, in Victoria. Both oils commenced to distil at 170°C . (corr.)

	Tasmanian Oil.	Victorian Oil.
170–176° C	12 per cent.	10 per cent.
176–190° C	48 per cent.	35 per cent.
190–240° C	10 per cent.	4 per cent.
240–280° C	23 per cent.	45 per cent.
Specific gravity at 15°C , first fraction	0·8532	0·8531
Ditto, second fraction	0·8559	0·8586
Ditto, third fraction	0·8818	0·8845
Ditto, fourth fraction, before solidification.....	0·9515	Not taken, soon became solid
Rotation a_D , first fraction	$-41\cdot8^\circ$	$a_D = -49\cdot7$
Ditto, second fraction.....	$-40\cdot2^\circ$	$a_D = -46\cdot4$
Ditto, third fraction	Light did not pass	Light did not pass
Refractive index at 20°C , first	1·4796	At 19°C . 1·4761
Ditto, second	1·4821	ditto 1·4801
Ditto, third	1·4852	ditto 1·4851

The higher laevo-rotation of the first fraction over that of the second fraction, together with other indications that dextro-rotatory pinene was absent, and these, along with

the want of eucalyptol, show the oil to be distinct from that of *E. fastigata*. (See "Research on the Eucalypts," p. 146, for data concerning the oil of that species.) The saponification number of the Victorian oil was 12·4. The comparatively small yield of oil from the leaves and branchlets of *E. regnans* renders this species of little value as an oil-producing tree, and quite a number of Eucalypts are now known which yield phellandrene oils in much greater abundance.

EUCALYPTUS RISDONI, Hook. f.

("Blue Peppermint.")

BOTANY.

Historical.—This species was described by J. D. Hooker in his "London Journal of Botany," published in 1847, but was synonymised by Mueller under *E. amygdalina* in his "Eucalyptographia" (Dec. V.).

Remarks.—Those given in our work on the "Eucalypts and their Essential Oils" (p. 208) apply equally well to-day.

They read as follows:—"The life history (if one may use the expression in this connection) of this Eucalyptus is identical with that of the mainland species *E. dives*, Schau., in that it flowers and fruits when quite a small shrub, and when all its leaves are in the opposite, sessile, cordate form. Singularly enough, both Hook. f. and Schauer founded their species on the shrubby form only, and in the case of *E. dives* it was not, till shown by this research that the mature trees became identified, whilst Hook. f. figures and describes (*loc. cit.*) what has since been shown to be the primary stage of growth of his species, the mature trees of which are recorded by Benth in his 'Flora Australiensis' (III., 203) as var. *elata* on material collected by Gunn. The dried material of the early and mature forms of this tree, when compared, would easily mislead one not acquainted with the trees in the field. Mueller unites *E. Risdoni* altogether with *E. amygdalina*, but our results agree with those of J. D. Hooker and Oldfield, and in no way do we see so close an affinity between these two trees."

Rodway, in his "Flora of Tasmania," follows Benth, and records a variety *elata*. Our investigations, however, show that the trees growing at the foot of Mt. Wellington, and regarded by Rodway as var. *elata*, are merely taller trees of the species, and differ in minor respects only, botanically or chemically, from the smaller trees or shrubs.

The tree collected by Gunn at Lake St. Clair and upon which Bentham founded the variety *elata*, is just possibly *E. Delegatensis*.

The variety *hypericifolia* of *E. amygdalina* recorded by Bentham is found by us to belong to *E. Risdoni*.

Mr. T. Stephens informs us that *E. Risdoni* only grows on mudstone formation—geologically classed as Upper Palæozoic, Permo-Carboniferous.

CHEMISTRY.

Essential Oil.—The results obtained with the oil of *E. Risdoni* are recorded in our work "Research on the Eucalypts" (p. 209). The yield of oil then obtained was 1.35 per cent.; saponification number for ester and free acid = 27.1; eucalyptol 64 per cent. in the fraction, and 95 per cent. distilled below 198° C. It contained phellandrene, and was exceedingly rich in eucalyptol for a phellandrene-bearing oil.

To enable the present research to be somewhat complete, we obtained material for distillation of the reputed *E. Risdoni*, var. *elata*, from Mt. Wellington, collected in August, 1912. The results show the oil to be in agreement with that of the ordinary form previously determined.

We also received material for distillation of the so-called *E. amygdalina*, var. *hypericifolia*, collected by Mr. Irby, near Hobart, at the end of April, 1912, under the kind direction of Mr. Rodway. This also gave results identical with those of *E. Risdoni*, and as the botanical features are also in agreement with that species, we consider it to be *E. Risdoni*. The chief characteristics in the oil of *E. Risdoni* are that it contains over 55 per cent. of eucalyptol; a somewhat large amount of phellandrene; belongs to the "peppermint" group, as it contains some piperitone; has a somewhat high saponification number by boiling, and a low one by the cold saponification method; gives over 90 per cent. distilling below 195° C.; and has scarcely any objectionable volatile aldehydes.

The crude oil of *E. Risdoni* (supposed variety *elata*) from Mt. Wellington was lemon-yellow in colour, and responded to all the tests and requirements recorded above. Average yield of oil = 1.52 per cent. Specific gravity at 15° C. = 0.9061; rotation $a_D = -14.1^\circ$; refractive index at 18° = 1.4679, and was soluble in 3 volumes 70 per cent.

alcohol. The slightly larger amount of phellandrene and correspondingly less eucalyptol at this time, accounts for the differences in amount of rotation, in gravity, and solubility to those previously recorded. On rectification, only the usual amount of acid water and volatile aldehydes came over below 173°C. (corr.). Between $173\text{--}184^{\circ}$ 82 per cent. distilled, and between $184\text{--}195^{\circ}$ 11 per cent. distilled. These fractions gave results as follows:—

	Sp. gr. at 15°C.		Rotation a_D .		Ref. Index at 18°C.
First fraction.....	0.8995	...	-16.6°	...	1.4655
Second fraction....	0.9010	...	-9.3°	...	1.4628

The eucalyptol was determined by the resorcinol method, the result indicating 58 per cent. of that constituent in the crude oil. The saponification number of the esters and free acid by boiling was 21.3; and in the cold, with two hours' contact, 5.5.

The supposed variety *hypericifolia* gave a light amber-coloured oil, having a somewhat pleasant odour; the average yield was 1.24 per cent., and the oil agreed in all respects with the requirements for that of *E. Risdoni*.

The specific gravity of the crude oil at $15^{\circ}\text{C.} = 0.9045$; rotation $a_D = -14.6$; refractive index at $19^{\circ} = 1.4660$, and was soluble in 5 volumes 70 per cent. alcohol. The saponification number of the esters and free acid by boiling was 23.8; and in the cold, with two hours' contact, 3.9. It is thus evident that the main ester in the oil of *E. Risdoni* is not geranyl-acetate.

On rectification, only a few drops of acid water and volatile aldehydes came over below 173°C. (corr.). These aldehydes had no objectionable odour. Between $173\text{--}198^{\circ}$ 94 per cent. distilled. This had specific gravity at $15^{\circ} = 0.8991$; rotation $a_D = -15.4$; refractive index at $19^{\circ} = 1.4641$. The comparative absence of high boiling constituents is worthy of notice.

The eucalyptol was determined by the resorcinol method, and gave 56 per cent. calculated for the crude oil.

If these results are tabulated it can be seen at a glance how closely the oils agree in general characters, and, allowing for the slight increase in eucalyptol and less phellandrene at the time of distillation, with the type of *E. Risdoni* also.

	Supposed Variety <i>elata</i> .	So-called Variety <i>hypericifolia</i> .
Yield of oil	1·2 per cent.	1·24
Rotation a_D	— 14·1°	— 14·6°
Specific gravity at 15° C. ...	0·9061	0·9045
Refractive index at 18°	1·4679	At 19° = 1·4660
Eucalyptol	58 per cent.	56 per cent.
S.N., hot method	21·35	23·8
S.N., cold method.....	5·5	3·9
Boiling, between 173-195°...	93 per cent.	Bet. 173-198° 94°/o
Soluble	In 3 vols. 70°/o alcohol	In 5 vols. 70 °/o alcohol

Material of trees growing at Strickland, and thought by the collector to be *E. radiata*, as the fruits were more clustered than usual, was obtained in August, 1912. The oil distilled from the leaves of these trees shows them to be *E. Risdoni* also, and it responded to all the tests required for the oil of that species. The yield of oil was 1·5 per cent.; specific gravity at 15° C. = 0·9079; rotation a_D = - 9·9°; refractive index at 15·5° = 1·4698; and was soluble in 5 volumes 70 per cent. alcohol. The eucalyptol, determined by the resorcinol method, was 58 per cent. in the crude oil. The saponification number by boiling was 21·1; and in the cold, with two hours' contact, 6·6. The presence of amyl-acetate in the portion first distilling was also indicated by the pear odour, after the aldehydes had been removed, and this odour was further intensified after acetylation.

EUCALYPTUS UNIALATA (*sp. nov.*).

[SYN.: *E. viminalis*, var. *macrocarpa*.]

(Plate I.)

BOTANY.

Historical.—Maiden, in the A.A.A.S., 1902, records this Eucalyptus under the name of *E. Maideni*, F. v. M., but Rodway, in his "Flora of Tasmania," places it under *E. viminalis*, var. *macrocarpa*.

Remarks.—It is a particularly rare tree apparently, for after much search by the museum collector, Mr. Irby, only two trees were found, and those on Mt. Nelson. The original tree discovered by Mr. Rodway is at Proctor's-road (Mt. Nelson), 5 miles from Hobart, and is about 30 to 40 feet in height, and about 12 inches in diameter. "Bark flaky at the butt, smooth above, very similar to *E. viminalis*." Mueller considered it a form of *E. globulus*, and J. H. Maiden a form of *E. Maideni*, F. v. M.

(Rodway, "Fl. Tas.," p. 57). The herbarium material generally differs in several respects from all those species, and so we have been induced to record it as a new species. The buds are in threes, just as in *E. viminalis*, and that is the only resemblance to this species in the inflorescence.

The fruits and buds are distinct in shape from those of *E. globulus* and *E. Maidenii*, and what is of greater systematic importance, the leaves of both forms match neither of these.

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.

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 1½ 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, ¼-inch long, three sessile flowered. Calyx, compressed, angular, under ½-inch long; operculum conical.

Fruit hemispherical, ½-inch in diameter, shining, rim thickened, convex with a very narrow groove below it, valves well exserted.

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

Fructus hemispherici, vitrei unialata, 6''' longi; margo orassus valva exserta.

CHEMISTRY.

Essential Oil.—This material was collected near Hobart in August, 1912. It was quite fresh and green when

received at the Museum. The average yield of oil from leaves and terminal branchlets was 0·897 per cent. The crude oil was light-amber in colour, and had an odour resembling that of the crude oil of *E. globulus*. It was fairly rich in eucalyptol, and contained dextro-rotatory pinene, while phellandrene was absent. The saponification number was somewhat high, and the oil contained rather a large amount of high boiling constituents. The rectified oil had a distinctly yellow tinge.

The crude oil had specific gravity at $15^{\circ} = 0\cdot9179$; rotation $a_D = + 3\cdot1^{\circ}$; refractive index at $18^{\circ} = 1\cdot4690$; and was soluble in $1\frac{3}{4}$ volumes of 70 per cent. alcohol. On the addition of about 10 volumes of this alcohol the oil became again somewhat turbid, indicating the presence of traces of the solid paraffin found in the oil of *E. acervula*.

On rectification, a small amount of acid water and some volatile aldehydes, having an objectionable odour, came over below 170° C. (corr.). Between 170 - 193° 83 per cent. distilled, and between 193 - 268° 11 per cent. distilled, mostly above 260° . These fractions gave the following results:—

	Sp. gr. at 15° C.		Rotation a_D .		Ref. Index at 18° .
First fraction	0·9104	...	+ 4·3	...	1·4632
Second fraction	0·9294	...	—	...	1·4909

The eucalyptol was determined in the first fraction by the resorcinol method, with the result that 62 per cent. of that constituent was shown to be present in the crude oil.

The saponification number for the ester and free acid was 11·1.

EUCALYPTUS URNIGERA, Hook. f.

("Urn Gum.")

BOTANY.

Historical.—J. D. Hooker first recorded this species in 1847, in his "London Journal of Botany" (VI. 477), although it had previously been collected by Robert Brown many years previously.

Remarks.—It is a species that is endemic to Tasmania, and fortunately has no synonyms. The fruits are characteristic, and so the specific name is a good one. Hooker describes it as small, but Rodway refers to it in his "Flora of Tasmania" as a "rather tall tree."

CHEMISTRY.

Essential Oil.—This material for distillation was obtained at Mt. Wellington, at an altitude of about 2500 feet. It was collected in July, 1908; and this being the depth of winter, the yield is probably less than would be obtained generally, as this species most likely follows the rule in this respect. The principal constituents in the oil of this species are dextro-rotatory pinene and eucalyptol, over 60 per cent. of the latter constituent being present. Phellandrene does not occur, nor were either eudesmol, piperitone, or aromadendral detected. The ester is probably geranyl-acetate largely, as the greater portion was saponified in the cold with two hours' contact. The small amount of high boiling constituents in the oil of this species causes it to have a specific gravity below 0.91 at 15° C., while the presence of the pinene in rather large excess gives a somewhat high dextro-rotation. The rectified oil, however, is practically colourless—almost water-white—and it has, for an ordinary Eucalyptus oil, a very agreeable odour, and no objectionable flavour. The average yield of oil from leaves with terminal branchlets was 1.132 per cent. The crude oil was reddish in colour, as is usual with oils of this class when the leaves are distilled from iron digesters. Its specific gravity at 15° C. = 0.9088; rotation $a_D = +11.8^\circ$; refractive index at 23° C. = 1.4638; and it was soluble in 5 volumes 70 per cent. alcohol by weight.

On rectification, the usual amount of acid water and volatile aldehydes, from oils of this class, were obtained below 165° C. (corr.). Between 165-174° C. 54 per cent. distilled; between 174-193° C. 36 per cent.; the thermometer then quickly rose to 230°, and between that temperature and 246° C. 5 per cent. distilled.

	Rotation a_D .		Sp. Gr. at 15° C.		Ref. Index at 23° C.
First fraction	+ 15.7°	...	0.9001	...	1.4599
Second fraction ...	+ 6.4°	...	0.9165	...	1.4602
Third fraction.....	--	...	0.9285	...	1.4836

The eucalyptol was determined in the oil distilling below 193° C. by the resorcinol method, which result showed that 63 per cent. of that constituent was present in the crude oil. The saponification number of the ester and free acid = 18.3. In the cold, with two hours' contact, it was 10.7, equal to 3.7 per cent. of geranyl-acetate if calculated for that ester.

A portion of the crude oil was rectified by steam. The product was almost colourless and the odour good, whilst but little residue remained. The oil thus rectified had specific gravity at 15° C. = 0.9071; rotation $a_D = + 12.1^{\circ}$; refractive index at 22° C. = 1.4612. A determination of the eucalyptol by the resorcinol method gave 66 per cent. of that constituent in this rectified oil.

Although the specific gravity is a little low, and the rotation a little high, yet the oil of this species may be considered of fair value as a eucalyptol-pinene Eucalyptus oil.

EUCALYPTUS VERNICOSA, Hook. f.

BOTANY.

Historical.—This species was described in 1847 by J. D. Hooker in "London Journal of Botany" (VI., p. 478), and the name has stood unchallenged ever since.

Remarks.—Rodway suggests in his "Flora of Tasmania" (p. 58) that it is just possible this species is a mountain form of *E. Muelleri*, but we are of opinion that technology at least would be better served if the two were recognised as distinct species—*vide* note under that species. "This species has the same form of leaves throughout its life history, which *E. Muelleri* does not appear to have."—L. G. Irby.

CHEMISTRY.

Essential Oil.—This material for distillation was obtained on the Hartz Mountains in May, 1912. It reached Sydney in excellent condition. The average yield of oil was 0.807 per cent. The crude oil was but little coloured, and was rich in eucalyptol. It contained, however, rather a large amount of dextro-rotatory pinene, consequently the specific gravity was somewhat low; this was also influenced by the remarkable freedom from high boiling constituents, and no less than 96 per cent. of the crude oil distilled below 194° C. The terpene phellandrene was quite absent in the oil of this species.

The crude oil had specific gravity at 15° C. = 0.9038; rotation $a_D = + 11.3^{\circ}$; refractive index at 18° C. = 1.4651; and was soluble in 1 volume 80 per cent. alcohol, but not in 10 volumes 70 per cent.

On rectification, a small amount of acid water, and rather a large amount of objectionable smelling aldehydes, came over below 167° C. (corr.). Between 167 - 172° C. 32

per cent. distilled; and between 172-194° C. 63 per cent. came over. These fractions gave the following:—

	Sp. Gr. at 15° C.		Rotation α_D .		Ref. Index at 18° C.
First fraction	0·8967	...	+ 16·7	...	1·4639
Second fraction	0·9086	...	+ 9·4	...	1·4640

The eucalyptol was determined by the resorcinol method in the portion distilling below 194°, and when calculated for the crude oil 59 per cent. of that constituent was shown to be present.

The saponification number for the esters and free acid was 5·9. The oil of this species is thus one of the oils of the eucalyptol-pinene group, which oils are found so frequently occurring in the Eucalypts of a certain class.

The oil of this species and that of *E. Muelleri* are very closely related, in fact, almost identical in composition, as can be seen by referring to the results for that species recorded in this paper.

EUCALYPTUS VIMINALIS, Labill.

(“Manna Gum.”)

BOTANY.

Historical.—This species was originally named by Labillardier from a Tasmanian tree, and has retained its specific status ever since.

Remarks.—This tree has also a very wide distribution on the mainland, where the most common name is “Manna Gum.”

The material here examined corresponds with that from trees growing on the mainland from which our original determinations were made, and published in our work “Eucalypts and Their Essential Oils” (p. 137).

The variety *macrocarpa* in Rodway’s “Flora of Tasmania” (p. 57) we have determined as distinct, and specifically described under the name of *E. unialata*.

At Alma Tier, Interlaken, are to be found trees growing amongst *E. Gunnii*, but different from that species, and known locally as “White Gum”—evidently considered by settlers to have affinity with the “Manna Gum,” *E. viminalis*, but yet distinct from the “Cider Gum.”

The “sucker” leaves are larger than those of *E. viminalis*, and resemble those of *E. Gunnii*; then, again, the normal ones are larger and broader than usually obtain in *E. viminalis*, whilst the fruits favour the latter species, as do also the timber and oil.

It was probably this tree that gave Hooker grounds for the statement in his "Flora Tasmaniae," under "*E. Gunnii*"—"sometimes, however, solitary trees may be found of much greater size, and so like *E. viminalis*, that without fruit it is impossible to distinguish it from an Alpine form of that species."

Mr. L. G. Irby, when collecting in Tasmania, stated in this connection that this form could always be distinguished from normal *Gunnii* in having longer leaves and a pale or ashy-coloured bark agreeing with *E. viminalis*, whilst *E. Gunnii* has a blotched appearance.

CHEMISTRY.

Essential Oil.—This material for distillation was obtained at Hobart in April, 1912. It consisted of the leaves and terminal branchlets, collected as would be done for commercial purposes. The crude oil was of an olive-brown colour, was fairly rich in eucalyptol, contained pinene, and resembled in appearance and constitution the oils of the pinene-eucalyptol group, with the exception that a small amount of phellandrene was present. This terpene appears to be a constant constituent in the oil of *E. viminalis*, and helps to distinguish the normal form from closely related species. A considerable quantity of high boiling constituents was present, consisting largely of the sesquiterpene. The oil is in consequence somewhat insoluble in alcohol. The results obtained with the oil agree most closely with those recorded in the "Research on the Eucalypts" for *E. viminalis* of New South Wales, showing the Tasmanian trees to be identical with those on the mainland, and thus supporting botanical indications.

The average yield of oil was 0.741 per cent. The specific gravity at 15° C. = 0.9154; rotation a_D = + 4.2°; refractive index at 19° = 1.4711; and was soluble in 1 volume 80 per cent. alcohol.

On rectification, the usual amount of acid water and objectionable volatile aldehydes came over below 167° C. (corr.), at which temperature the oil commenced to distil. Between 167-173° 22 per cent. distilled; between 173-194° 54 per cent. distilled; and between 194-269° 20 per cent. (the greater portion above 255° C.). These fractions gave the following results:—

	Sp. Gr. at 15° C.		Rotation a_D		Ref. Index at 19°.
First fraction	0.8969	...	+ 11.5°	...	1.4626
Second fraction ...	0.9088	...	+ 3.4°	...	1.4629
Third fraction	0.9308	...	+ 4.1	...	1.4932

The rectified oil was yellowish in tint, resembling in this respect the oil of *E. globulus*, *E. goniocalyx*, &c.

The amount of eucalyptol in the crude oil was 50 per cent., determined by the resorcinol method in the portion boiling below 194° C. The saponification number of the esters and free acid was 9·5, which represents about 3 per cent. of ester calculated as geranyl-acetate.

Material of the "White Gum" growing at Interlaken was sent for distillation in August, 1912. The leaves and terminal branchlets were, at this time, largely attacked with a blight, and the trees were thus not healthy. The yield of oil was less in amount than that from the Hobart material, otherwise it agreed generally in characters and constituents with the oil of this species. The phellandrene, however, was present in rather larger amount than usual, and the eucalyptol somewhat less abundant. There was a very strong resemblance between this oil and that of *E. viminalis* from Moss Vale, New South Wales, recorded in the "Research on the Eucalypts" (p. 138).

EUCALYPTUS DELEGATENSIS, R. T. B.

[SYN.: *E. gigantea*, Hook. f. ("Fl. Tas."), *partim*.

Not *E. gigantea*, Hook. f. ("Lond. Journ. Bot." VI. 479. 1847). See remarks under *E. obliqua* and *E. regnans*, this paper.]

("Gum-topped Stringy-bark.")

BOTANY.

Historical.—This tree was first collected in Tasmania by Gunn (*infra*), but was first brought under the notice of Australian botanists by Mr. T. Stephens, who forwarded a specimen to Baron von Mueller, who named it for him *E. haemastoma*, Sm.; and this was recorded in Proc. Roy. Soc. Tas. 1881 (p. 24). Under that species Mr. Maiden goes pretty fully into the subject of the "Gum-topped Stringy-barks" of Tasmania in the Proc. A.A.A.S. 1902 (p. 369 onward); also in his "Cr. Rev. Euc." on *E. obliqua* (Pt. 2), and again in the Vict. Nat. XVIII. (p. 127). The species recorded by him (*loc. cit.*) under *E. virgata* is this species. This particular "Gum-topped Stringy-bark" was, however, given specific rank under the name of *E. Delegatensis*, R. T. B. (Proc. Linn. Soc. N.S.W. 1900), from material obtained from Mt. Delegate N.S.W., its Tasmanian habitat at the time not being known to the author.

Remarks.—This is now the first definite record of this tree as a species in Tasmania.

Hooker, in his “*Flora Tasmaniae*” (1859), gives additional data to his original description of *E. gigantea* (“*Lond. Journ. of Bot.*” VI. 479. 1847)), and in this additional data he includes two other trees besides his original “Stringy-bark”—*E. gigantea* (*E. obliqua*). The one he mentions under the name of “Stringy-bark Gum” (*loc. cit.*) growing up to 4000 feet altitude is *E. Delegatensis*.

E. obliqua and *E. regnans* grow intermixed at lower elevations, and these are what Hooker evidently refers to in “*Flora Tasmaniae*”: “Specimens have been felled in the valleys at the base of Mt. Wellington.” Hooker’s description of *E. gigantea* in his classical work must therefore be regarded as a composite one, and this is well brought out by Maiden in his “Critical Revision of the Genus *Eucalyptus*” (Vol. I., p. 58), under “*E. obliqua*,”

This species, *E. Delegatensis*, cannot be included under *E. gigantea*, for that name belongs undoubtedly to *E. obliqua*, as shown by the original description of Hooker in his “*London Journal of Botany*” (1847), and later by Bentham and Mueller.

Hooker, in his introduction to the genus (“*Fl. Tas.*”), speaks “of a possibility of his having confounded two species in that work—the ‘Swamp Gum’ and ‘Stringy-bark’—under that species.” These two are now known as *E. regnans* and *E. obliqua* respectively—the original of his description in “*London Journal of Botany*” will certainly not match *E. Delegatensis*, for it is not the “Stringy-bark colonorum” as stated by him.

Again, Hooker’s remarks (“*Fl. Tas.*”): “In some varieties the young branches have a fine glaucous-purple bloom in them, especially in Alpine localities; such is the case with Mr. Gunn’s No. 1095, from the banks of Lake St. Clair, where it forms a forest on one side of the lake only, to the exclusion of all other timbers”—apply to this species, and not his *E. gigantea* (*E. obliqua*), (“*Lond. Journ. Bot.*” 1847).

The material was first collected for the museum by Mr. C. F. Laceron in 1908, on Mt. Wellington, where it is a very common tree, occurring chiefly above 2500 feet. This altitude is interesting, as in the original locality from which the species was described—Delegate Mt.—it occurs at an elevation between 4000 and 5000 feet.

Mr. L. G. Irby, the museum collector, personally interviewed Mr. Stephens, in order to ascertain exactly where

he could find the tree of the so-called *E. haemastoma* (*supra*), in order that his material might be compared with that upon which this investigation is based. This "Gum-topped Stringy-bark" proved to be identical with the material previously sent by Mr. Laseron, and also with the Mountain Ash trees at Mt. Delegate, New South Wales, upon which the specific name was bestowed.

Mr. Stephen's remarks (Proc. Roy. Soc. Tas. 1881, p. 24), viz.: "The chief peculiarity of this tree is, that while the lower part of the butt is clothed with a thick fibrous bark closely resembling that of the common 'Stringy-bark' (*E. obliqua*), the upper part and the smaller limbs and branches are quite smooth, whence its popular name. The timber is highly prized by splitters, and, for general purposes, it is described by many competent authorities as second only to the 'Blue Gum,' though opinions seem to differ as to its durability."

It may thus be concluded, from the evidence adduced, that the "Gum-topped Stringy-bark" of Tasmania growing at an altitude of about 2500 feet and above is this species. The fruits vary somewhat in appearance, and are not always uniform, even for the same tree, the flat-topped or oval-topped rim of some forms being interspersed with thin-rimmed, countersunk fruits. The chemical characters of the trees, however, appear to be constant.

Whilst this investigation shows that the botanical and chemical characters of the mainland and island trees correspond, it may be mentioned *en passant* that it is the species recorded by Rodway in the "Flora of Tasmania" (p. 57) as *E. haemastoma*, from Mueller's naming. The timber of this tree is used in Tasmania, and exported under the name of "Tasmanian Oak."

The species is described and illustrated in Proc. Linn. Soc. N.S.W., 1900 (p. 305 and Plate XVI.), and this description again amplified in our work "Eucalypts and Their Essential Oils" (p. 186), so need not be repeated here.

E. haemastoma, Sm., as far as we have been able to ascertain, does not occur in Tasmania.

Habitat.—Mr. L. Rodway informs me *E. Delegatensis* is common in North-Eastern Tasmania. It is thus widely distributed in the island.

CHEMISTRY.

Essential Oil.—Material of this species was collected in July, 1908, at Mt. Wellington, at an altitude of about

2500 feet above sea-level. The principal constituents in the oil of this species is phellandrene, and both eucalyptol and pinene are practically absent. The peppermint constituent was present in small amount. The results obtained with the oil of this species from Tasmania are in remarkable agreement with those of the oil of *E. Delegatensis*, from Delegate Mountain, Southern New South Wales, collected in February, 1899; although the distance separating these localities is very great. The difference in the time of the year when the material was collected naturally influences the physical characters somewhat, because the principal terpene common to the oil of Eucalyptus species is usually present in greatest amount during the early summer months.

The average yield of oil from leaves and terminal branchlets was 1·88 per cent. The crude oil was of a lemon-yellow colour. It had specific gravity at 15° C. = 0·8664; rotation $a_D = -48·4^\circ$; refractive index at 24° = 1·4828; and was insoluble in 10 volumes 80 per cent. alcohol. The saponification number for ester and free acid = 3·1. On rectification, the usual small amount of acid water and volatile aldehydes came over below 172° C. (corr.), at which temperature the oil commenced to distil. Between 172-183° C. 65 per cent. distilled; between 183-234° 12 per cent.; and between 234-270° 16 per cent. These fractions gave the following results:—

	Rotation a_D .		Sp. Gr. at 15° C.		Ref. Index at 24° C.
First fraction	— 54·2°	...	0·8532	...	1·4777
Second fraction ...	— 35·6°	...	0·8764	...	1·4812
Third fraction	—	...	0·9004	...	1·4914

The low specific gravity of the high boiling constituents of the oil of this species is remarkable and most unusual.

The original results with the oil of this species were published in our work "Research on the Eucalypts" (p. 187). That they are in agreement with those of the oil from the Tasmanian trees is shown from the following tabulated results:—

	Oil of <i>E. Delegatensis</i> . (Mt. Wellington, Tas., 1908.)	Oil of <i>E. Delegatensis</i> . (Mt. Delegate, N.S.W., 1899.)
Yield of oil	1·88 per cent.	1·76 per cent.
Colour of crude oil	Lemon-yellow	Lemon-yellow
Phellandrene	Abundant	Abundant
Eucalyptol	Practically absent	Practically absent
Piperitone	Present in small amount	Present in small amount

	Oil of <i>E. Delegatensis</i> . (Mt. Wellington, Tas., 1908.)	Oil of <i>E. Delegatensis</i> . (Mt. Delegate, N.S.W., 1899.)
Specific gravity; crude oil at 15° C.	0·8664	0·8602
Rotation a_D , ditto	— 48·4°	— 58·6°
Refractive index at 24°	1·4828	At 16° = 1·4881
S.N. ester and free acid	3·1	3·5
Insoluble	In 10 vols. 80% alcohol	In 10 vols. 80% alcohol
Specific gravity, first frac- tion at 15°	0·8532	0·8513
Ditto, second fraction	0·8764	0·8712
Ditto, third fraction ...	0·9004	0·9017

It is thus seen that the characteristic features of the one oil are also shown with the other, and as the botanical results are also in agreement it is evident that this tree is common to both Tasmania and the mainland.

Material of the "Gum-topped Stringy-bark" for distillation was collected at Strickland in August, 1912. The oil was found to agree in all respects with that of *E. Delegatensis* from Mt. Wellington and from New South Wales. It contained the same constituents, practically the same amounts, and the physical characters of the oil agreed most closely. The specific gravity at 15° = 0·8596; rotation a_D = — 47·4°; refractive index at 17° = 1·4826, and was insoluble in 10 volumes 80 per cent. alcohol. The saponification number of ester and free acid was 3·2. The yield of oil was 1·3 per cent., which is somewhat less than is usual with this species; but the time of the year is most probably answerable for this.

Material of the "Gum-topped Stringy-bark" growing at Lake Sorell was sent for distillation in August, 1912. The trees were those originally mentioned by Mr. Stephens as growing at this locality. These trees are *Eucalyptus Delegatensis*, and the oil agreed in all respects with that from the "Gum-topped Stringy-bark" at Strickland, also from the same species growing at Mt. Wellington, and also that from the New South Wales trees of this species. It contained the same constituents and in practically the same amounts, and the physical characters agreed most closely. The specific gravity of the crude oil at 15° C. = 0·8676; rotation a_D = — 47·7°; refractive index at 20° = 1·4819; and was insoluble in 10 volumes 80 per cent. alcohol. The comparative constancy in the characters of the oil of this *Eucalyptus* species is, from these results, shown conclusively.

EUCALYPTUS OBLIQUA, L'Her.

[SYN.: *E. gigantea*, Hook. f. ("Lond. Journ. Bot." VI. 479. 1847), and
E. gigantea, Hook. f. ("Fl. Tas." 1859), *partim.*]
 ("Stringy-bark.")

BOTANY.

Historical.—This was the first species of the genus described, the author being L'Heritier, who recorded it in 1788 in "Sertum Anglicum" (18, t. 20).

Hooker redescribed it under the name of *E. gigantea* ("Lond. Journ. Bot." VI. 479. 1847).

Bentham, in his "Flora Australiensis" (Vol. III., p. 204), acknowledged its specific rank, whilst placing under it as synonyms *E. gigantea*, Hook. f. *E. falcifolia*, Miq., and *E. nervosa*, F. v. M. (1866).

Mueller also describes and figures it in his "Eucalyptographia" (Dec. III. 1879).

Remarks.—Hooker, when he described his species of *E. gigantea* in the "London Journal of Botany" (VI. 479. 1847), was unaware that L'Heritier had described the species under the name of *E. obliqua*, as his (Hooker's) description (*loc. cit.*) applies in every detail to this species, for it is indeed "the Stringy-bark colonorum, and abundant throughout Tasmania," as stated by him, and is to-day the "Stringy-bark" of the island.

When writing his "Flora Tasmaniae" (1859), Hooker, having, in addition to his own, Gunn's and other collectors' material to work upon, included two other trees under his original name in his classical work. One growing intermixed with *E. obliqua* has since been separated by Mueller under the name of *E. regnans*, and the other, growing at 4000 feet elevation, known as "Stringy-bark Gum" or "Gum-topped Stringy-bark," was described by one of us in Proc. Linn. Soc. N.S.W. in 1900, under the name of *E. Delegatensis*.

These three trees occur at different altitudes, and the respective species in the above order can be traced in Hooker's two descriptions (*loc. cit.*). Hooker's reference that "trees are felled in the valleys at the foot of Mt. Wellington," in his "Flora Tasmaniae," evidently refers to this species and *E. regnans*, for they only occur on the lower elevations there—the tree of the higher altitudes is *E. Delegatensis* in the same quotation.

In this connection the following remarks of Hooker in his "Flora Tasmaniae" (p. 132) are interesting:—"In the Proceedings of the Royal Society of Tasmania I find some very valuable notices respecting the Blue Gum, Swamp Gum, Stringy Bark, Peppermint Gum, Myrtle-leaved Gum, Ash Gum, Ironwood, Mountain Gum, Weeping Gum, Black-butt Gum, and White Gum. The Swamp Gum and Stringy-bark are perhaps both referable to my *E. gigantea*, under which two species may be confounded by me, or the Swamp Gum may be some other species attaining a gigantic size in damp hollows. Mr. Mitchell describes the Swamp Gum as so very like the *E. globulus* as not to be easily distinguished, but with smaller leaves and thinner bark, as being the largest of the genus, and growing twice as fast as *E. globulus*; he mentions trees 250 feet to the first branch. The Stringy-bark he distinguishes by its much thicker, fibrous bark; Mr. Milligan, however, adds in a note that this Stringy-bark is the most gigantic of all, that it is well named *gigantea* by me, and that he has measured a sound trunk 64 feet in girth at 4 feet above the ground, and 200 feet high to where it was broken off, and containing 200 tons of timber."

Here we see that Hooker suspects that he has confounded two species under his *E. gigantea* of that particular work, and indeed he really has, for the "Swamp Gum" is known as *E. regnans*, and "Stringy-bark" (*E. gigantea*) as the true *E. obliqua*; but he has even gone further, and included by slight references *E. Delegatensis* (Gunn's specimens).

His figure (*loc. cit.*) might pass for any of these three.

Hooker's common name of "Stringy-bark" in the "London Journal of Botany" must refer to *E. obliqua*, for that is practically the only true "Stringy-bark" in Tasmania.

Baron von Mueller, who certainly gave the subject serious study, correctly places Hooker's *E. gigantea* under *E. obliqua* in his "Eucalyptographia," and, like Hooker, refers to it as the Stringy-bark tree of Tasmania.

Hooker's description of *E. gigantea* ("London Journal of Botany") faithfully describes *E. obliqua*, whilst his description in "Flora Tasmaniae" is certainly a composite one.

It is a well-marked species, with a wide geographical range, and is quite constant in specific and chemical character, whether found in Northern New South Wales on the mainland, or in Tasmania, where it is the most common "Stringy-bark."

It is easy of recognition both in the field and herbarium.

The timber is characteristic, and is closely related to the "Gum-topped Stringy-barks" of Tasmania, *E. Delegatensis* and *E. regnans*, but the sapwood is very liable to the attacks of borers, which is not so in the case of *E. Delegatensis*.

CHEMISTRY.

Essential Oil.—Material of this species was collected in July, 1908, at Mt. Wellington, at an altitude of about 2000 feet; and also at about the same time of the year at Williamsford, on the West Coast of Tasmania. Both the crude oils were of a reddish-brown colour, due to the iron of the still, and both contained the same constituents, and thus were similar in all characters. The results also agreed with those obtained with the oil of this species from Monga, New South Wales, collected in 1898, and published in our work "Research on the Eucalypts" (p. 188). The chief constituent of this oil is phellandrene, and the high boiling aromatic aldehyde (aromadendral) occurs in some quantity. Eucalyptol is present in very small amount. Both eudesmol and piperitone are absent. The following are the tabulated results for the crude oils from the two localities:—

	Mt. Wellington.	Williamsford.
Yield of oil	0·66 per cent.	0·66 per cent.
Phellandrene	Abundant	Abundant
Aromadendral	Pronounced	Pronounced
Specific gravity at 15° C ..	0·8836	0·8854
Rotation α_D	— 28·1°	— 24·2°
Refractive index at 24°	1·4852	1·4843
Soluble	In 3½ vols. 80% alcohol	In 4 vols. 80% alcohol
S.N. ester and free acid	8·1	7·2

These results, together with the botanical characters, indicate that the Tasmanian trees of this species are identical with those of New South Wales and Victoria.

In August, 1912, leaves for distillation were collected by Mr. Irby from doubtful trees, which, although growing amongst *E. obliqua* on Mt. Wellington at an altitude of about 1000 feet, had a smooth top, the "stringy-bark" only reaching to the branches. The oil distilled from this material was identical in all respects with that of the typical *E. obliqua*. The yield of oil was 0·768 per cent.; specific gravity of crude oil at 15° C. = 0·8845; rotation α_D = —28·8°; refractive index at 19° = 1·4839, and

was soluble in 3 volumes 80 per cent. alcohol. The presence of aromadendral and absence of piperitone in the oil of *E. obliqua* is a distinguishing feature, and enables these trees to be easily separated from all allied forms growing in Tasmania.

EUCALYPTUS RODWAYI (*nobis*).

("Apple-scented Gum" or "Black Gum.")

(Plate II.)

BOTANY.

Historical.—This species was introduced to the scientific world by Mr. J. H. Maiden, who recorded it in Proc. Roy. Soc. Tas. 1902 (p. 83) under the name of *E. Macarthuri*, as he considered it to be identical with the New South Wales tree of that name, his attention having been drawn to it by Mr. R. H. Cambage, F.L.S., who first saw it at Deloraine.

Remarks.—It was hoped when this research was undertaken that this species would be found to be the true *E. Macarthuri*, on account of the valuable oil yielded by that species, but the investigation has proved otherwise. The species is now fully described here, and is dedicated to Mr. L. Rodway, Government Botanist of Tasmania, who has laboured so long and done so much for botanical research in the island State.

The "sucker" leaves are quite distinct from those of *E. Macarthuri*, whilst the fruits, normal leaves, and buds are, as a rule, smaller. It differs also from that species in the nature of the bark and timber, as well as chemical constituents of the oil.

In a botanical sequence it might be placed in the Hemiphloïæ group of Eucalypts.

It is a valuable addition to the timber industry of Tasmania.

Systematic Description.—A large forest tree, specimens 4 feet in diameter being common. Bark more like the Box barks than any other cortical section of the Eucalypts, and persistent on the stem and branches. "Sucker" leaves under 3 inches long and about $\frac{1}{2}$ -inch broad, oval-lanceolate to ovate-lanceolate inclined slightly to falcate, petiolate, alternate, almost membranous, same shade of green on both sides, venation not well pronounced, lateral veins distinctly oblique at the base and less so upwards towards the apex.

Normal leaves petiolate, lanceolate, sometimes falcate up to 6 inches long, but mostly less than 4 inches, rarely 1 inch wide, mostly about $\frac{1}{2}$ -inch wide, rather thicker than the "sucker" leaves. Venation not specially prominent, lateral veins oblique, intramarginal vein slightly removed from the edge. Peduncles axillary, about $\frac{1}{4}$ -inch long, bearing generally under six small flowers, calyx in bud 1 inch long, operculum equal in length, conical acuminate.

Fruit hemispherical to slightly pyriform, 2 lines in diameter, rim convex, valves slightly exserted.

Arbor altitudinem saltem 150' attenens, 4' diemente. Cortex trunco ramisque persistens; cortex trunci similis Eucalyptis "Box." Folia numerosa, ovata v. lanceolata v. falcata, leviter alternata, petiolata, 3"-4" longa, infra 1", lata; vena non clara, obliqua, pauca, longitudinalina dua leviter a margine remota. Pedunculus 3-7 floribus. Pedicellus paene 2''' longus; calyx pyriformis; operculum non calycem excedente, semiglobulosum in rostrum fere conicum, acuminatum. Capsula hemispherica, 2''' lata. Species loco natali "Black Gum" vocatur.

Habitat.—Deloraine (R. H. Cambage, F.L.S.). Between Interlaken and Tunbridge, about 3000 feet, and drops down the western slopes to quite a low altitude; also Strickland (L. G. Irby).

Timber.—The heartwood is very pale pinky in colour to almost white, with quite an ash appearance and texture. It dresses well with a pleasing sheen, is not heavy, but fairly hard, fissile, and close-grained. It should prove a splendid substitute for imported Ashes, being quite equal to any Australian Eucalyptus classified as Ash by the local timber world. It is a distinct and important addition to Tasmanian timbers, and might commercially be called "Tasmanian Ash."

CHEMISTRY.

Essential Oil.—Material of this species for distillation was collected at Deloraine in June, 1912. Leaves with terminal branchlets were utilised as would be done for commercial purposes. The crude oil when cleared was light olive-brown in colour, and had a terpene odour, together with that of eucalyptol, but with no resemblance to

geranyl-acetate. It contained pinene as the chief terpene, and phellandrene could not be detected in it. It was rich in eucalyptol, over 60 per cent. of the crude oil being that constituent. The saponification number for the esters and free acid was only 3.96, representing 1.38 per cent. of ester if calculated entirely as geranyl-acetate. The amount of ester in the oil of this species is thus very small. The average yield of oil was 0.482 per cent.—a comparatively small one for a commercial oil.

The crude oil had specific gravity at $15^{\circ}\text{C.} = 0.9075$; rotation $a_D = +10.6$; refractive index at $24^{\circ} = 1.4653$; and was soluble in 6 volumes 70 per cent. alcohol.

On rectification, the usual amount of acid water and volatile aldehydes were obtained below $164^{\circ}\text{C. (corr.)}$, at which temperature the oil commenced to distil. Between $164\text{--}173^{\circ}$ 33 per cent. distilled; between $173\text{--}198^{\circ}$ 57 per cent.; between $198\text{--}265^{\circ}$ 5 per cent. distilled. The high boiling fraction contained a constituent with rotation to the right, but it was not isolated. The following results were obtained with the several fractions:—

	Sp. Gr. at 15°C.		Rotation a_D .		Ref. Index at 16°C.
First fraction	0.8979	...	+ 15.8°	...	1.4629
Second fraction...	0.9119	...	+ 8.4	...	1.4638
Third fraction.....	0.9231	...	+ 5.2	...	1.4805

The eucalyptol was determined by the resorcinol method in that portion of the oil distilling below 198°C. and calculated for the crude oil, which was shown to contain 64 per cent. of that constituent. The rectified oil had a yellowish tinge, a peculiarity often found with the eucalyptol-pinene oils distilled from the leaves of the smooth-bark Gums like *E. globulus*, *E. goniocalyx*, &c. Pinene was isolated from the first fraction, and proved to be that substance by the formation of the nitrosochloride, which melted at the correct temperature.

The oil from the leaves of *E. Macarthuri* of New South Wales appears never to contain less than 60 per cent. of geranyl-acetate at any time, this ester often rising to 75 per cent., and one determination of the oil from the "suckers" showed that it contained over 77 per cent. of geranyl-acetate. Eucalyptol does not appear to occur in the oil of *E. Macarthuri*, although pinene is usually present in small amount.

EUCALYPTUS VIRGATA, Sieb.

("Ironbark.")

BOTANY.

Historical.—This is the first published record of this tree in Tasmania, although it was originally described by Sieber in 1827, from New South Wales material.

It is the same tree as described by us in "Eucalypts and Essential Oils" (1902), under "*E. virgata*," which was placed by Bentham in his "Flora Australiensis" (1886, Vol. III.) with *E. Sieberiana*, who of course had to work on herbarium material alone.

Remarks.—Up to the present time this tree has generally been regarded as *E. Sieberiana* by botanists working on the Tasmanian flora. Its correct systematic position, however, was latterly suspected by us, for under *E. Sieberiana* (Proc. A.A.A.S. 1902, p. 372), by J. H. Maiden, occurs this statement: "I give the following Tasmanian locality for this species as far as I have examined authentic specimens: 'Ironbark,' George's Bay, August, 1878, Augustus Simson (comm. W. W. Spicer). With shiny fruits. First labelled *E. virgata*, Sieb., and then *E. Sieberiana*, F. v. M., by Mueller."

From this it appears that Mueller must have associated these two trees as morphologically very close, thus following the determinations of Bentham in his "Flora Australiensis" (Vol. III., p. 202).

In this connection the following remarks in our work on "Eucalypts and Essential Oils" are interesting:—

"Much has been written recently in regard to the identification of Sieber's tree (*vide* Proc. Linn. Soc. N.S.W. 1896-1900).

"From Sieber's specific name there can be little doubt but that he intended his description to apply to a small twiggy *Eucalyptus*, with exactly the same morphological characters (as later researches have shown) as the present 'Mountain Ash' (*E. Sieberiana*, F. v. M.), and these characteristics of the two species are proved by Bentham's note ('B. Fl.' III., p. 202), for under '*E. virgata*' he states: 'I have described this species chiefly from Oldfield's, Woolls', and F. Mueller's specimens; Sieber's appear to be the same, but they are only in young bud, and therefore uncertain.'

"There is on the Blue Mountains a dwarf Eucalyptus, or 'Mallee,' the herbarium material of which cannot be separated from that of the tall tree—*E. Sieberiana*—but the chemical constituents of each are quite different.

"It is very probable that Oldfield's, Woolls', and Mueller's specimens belong to the tall tree, known as 'Mountain Ash,' and since named by Mueller as *E. Sieberiana*, whilst Sieber's specimens no doubt belong to the dwarf tree or 'Mallee,' and, as Bentham found, quite impossible of separation in dried material. If this is correct, then Sieber's tree only differs in field and chemical characters, and on these we accept Sieber's name for the mountain shrub which has identical morphological characters with *E. Sieberiana*, F. v. M."

Deane and Maiden at first (Proc. Linn. Soc. N.S.W., 1897, p. 719) were inclined to regard it as a glabrous form of *E. Luehmanniana* or a pointed operculum form of *E. obtusiflora*, and to speak as definitely as possible define it as a glabrous form of *E. Luehmanniana*. Later, however (Proc. A.A.A.S. 1902, Hobart), and in 1907 "Cr. Rev. G. Eu." (Vol. I., p. 273), Maiden restores the name *E. virgata*, Sieb., placing under it *E. obtusiflora*, D. C., and *E. stricta*, Sieb., which are arranged by Bentham in his "Flora Australiensis" in the following order, 3, 9, and 32, of his systematic classification of the Eucalypts, thus showing that he regarded the material he examined of the three as quite distinct. It seems hardly likely either that Sieber, having himself collected his two species in the field, should have given separate names to one and the same tree, for he was thus able to speak from actual acquaintance with their field characters, an experience that is invaluable as regards a knowledge of the Eucalypts.

The discovery, or rather the identification botanically and chemically, of this tree with the mainland one is of scientific interest, for whereas the latter, as far as known, is only a "Mallee" on the Blue Mountains in New South Wales, in Tasmania it is a medium-sized tree.

Mueller, in his "Eucalyptographia" (Dec. 11), under "*E. Sieberiana*," states: "The specific appellation now offered is also a new one, inasmuch as the original adjective '*virgata*' is very misleading, because only under very exceptional circumstances is this usually tall timber-tree reduced to a virgate or twiggy state; neither is there anything streaked or striped about the stem to justify the designation '*virgate*' in any other sense of the word."

It would appear now, in view of our increased knowledge, that the name is very appropriate, for the Blue Mountain specimens are all "twiggy or virgate," and the bark of the Tasmanian tree is "streaked or striped," for the hard compact bark runs down in streaks or ridges.

It is quite possible, in fact highly probable, that this tree occurs farther south than recorded for New South Wales, and also in Victoria, for it is easy enough to confound it with *E. Sieberiana*.

It appears that the name "*E. Sieberiana*" must now be deleted from the flora of Tasmania.

An amended description of the original, by Sieber (D. C. Prod. III., p. 217), is here given, by the addition of mature fruits, timber, and bark.

Systematic Description.—An average forest tree, attaining over 100 feet (Rodway), branchlets glaucous. Bark thick, laminated, running down in ridges, friable but no kino on outer portion, inner portion hard, close, compact, in cross-section, the duramen difficult to determine from the normal wood, inner portion fibrous longitudinally. "Sucker" leaves mostly alternate, petiolate, sometimes glaucous, thin, oval-lanceolate to lanceolate, acuminate, venation distinctly marked, lateral veins not very oblique, intramarginal veins removed from the edge, 4 to 5 inches long, up to $1\frac{1}{2}$ inch broad. Normal leaves comparatively small, rarely 5 inches long, mostly from 2 to 4 inches long, up to $\frac{1}{2}$ -inch broad, lanceolate, shining, subcoriaceous. Venation inconspicuous, lateral veins well oblique, a few running from the petiole intramarginal vein removed from the edge. Flowers on axillary peduncles or in short panicles, operculum hemispherical, shortly acuminate.

Fruits pyriform without pedicel, $\frac{1}{2}$ -inch long, $\frac{1}{4}$ -inch in diameter, contracted at the top, rim countersunk.

The differences between *E. virgata*, Sieb., and *E. Sieberiana* are found principally in the smaller leaves, countersunk rim of the smaller fruits, timber and chemical constituents of the oil of the former. They are rather difficult to separate, in herbarium material alone.

Timber.—This is known in the trade as "Tasmanian Ironbark," but this is not a good name, for it falls below the qualities of the mainland Ironbarks. The presence of gum veins detracts from it to a certain degree, but otherwise it is a close-grained, hard, fairly heavy timber, with an oak colour. It requires careful seasoning.

CHEMISTRY.

Essential Oil.—This material for distillation was obtained at St. Marys in June, 1912. The average yield of oil from the leaves with terminal branchlets was 0.793 per cent. The crude oil was but little coloured, it being of a light yellowish-brown tint. It had a slight second-

ary odour of peppermint, due to the presence of a small amount of piperitone, and eucalyptol could also be readily detected: The principal constituent in the oil of this species is phellandrene, and pinene is probably absent. Eudesmol was present in some quantity, the high boiling fraction becoming solid in the bottle after a few hours. Only a very small amount of ester was determined. Although the phellandrene shows the laevo-rotatory modification to be in excess, yet, judging from the comparatively small rotation, and the almost entire absence of pinene, it is possible that the phellandrene of opposite rotation may be present also. So far dextro-rotatory phellandrene has not been isolated from *Eucalyptus* oil. The crude oil had specific gravity at $15^{\circ}\text{C.} = 0.8883$; rotation $a_D = -20.9^{\circ}$; refractive index at $18^{\circ} = 1.4819$; and was soluble in 3 volumes 80 per cent. alcohol. This comparatively ready solubility is due to the eucalyptol and the eudesmol.

On rectification, the usual amount of acid water and volatile aldehydes were obtained below 173°C. (corr.); the aldehydes, however, were much less pungent and objectionable than those from the oils of the pinene-eucalyptol group. Between $173\text{--}198^{\circ}\text{C.}$ 78 per cent. distilled; the temperature then rose quickly to 265° , only 1 c.c. distilling; between $265\text{--}282^{\circ}$ 17 per cent. distilled. These fractions gave the following results:—

	Sp. Gr. at 15°C.		Rotation a_D .		Ref. Index at 23°C.
First fraction	0.8713	...	-29.5°	...	1.4782
Second fraction ($265\text{--}282^{\circ}$)	0.9421	...	—	...	1.5048

The eucalyptol was determined in the first fraction by the resorcinol method and calculated for the crude oil, which was thus shown to contain 21 per cent. of that constituent.

The saponification number of the ester and free acid was only 3.3. The oil of this species has a strong resemblance to that of the *E. virgata* originally investigated at this museum, and recorded in the "Research on the Eucalypts" (p. 194). The large amount of eudesmol causes the high boiling fraction to soon become solid; and this appears to be a distinguishing feature with the oil of *E. virgata*, because the oil of *E. Sieberiana* did not contain eudesmol in the samples tested. The presence of the eucalyptol in the oil of *E. virgata* also distinguishes it from that of *E. Sieberiana*.

EUCALYPTUS TAENIOLA (*sp. nov.*).

(Plate III.)

Historical.—This appears to be the first actual scientific record of this Eucalyptus.

Remarks.—The specimens upon which this species is founded were obtained by Mr. L. G. Irby at St. Mary's Pass, Tasmania, where it was found growing amongst trees of *E. virgata*, and *E. amygdalina*, Labill., and from which he 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).

Systematic Description.—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, $\frac{1}{2}$ -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, $\frac{1}{2}$ -inch long and $\frac{1}{4}$ -inch wide, tapering into a short pedicel, rim countersunk, valves not exserted.

Arbor medioicra, attitudinem 40-50' attinens; ramusculi teretes, graciles. Cortex trunci in laminis duris, similiter "Peppermint" generis. Folia alternata, semi-coriacea, angusta lanceolata v. lineata (taeniola) 12" longa $\frac{1}{2}$ " lata; venis parum insignis acutis obliquis, vena peripherica a folii margine conspicue remora. Pedunculis axillaris, solitariis 5-9 floris pedi-

cellis vix ullis. Calyx turbinatis, operculum hemisphericum v. conicum.

Fructus turbinatus, margo contracto, concavo $\frac{1}{2}$ " longa, $\frac{1}{4}$ " lata, valvae prorsus inclusae.

CHEMISTRY.

Essential Oil.—The material of this form for distillation was collected at St. Marys in June, 1912. The average yield of oil was 0.657. The crude oil was little coloured, of a terpene odour, and contained much phellandrene, scarcely any pinene, and a very small amount of eucalyptol. Eudesmol was detected in it. The oil belongs to the "Peppermint" group, as it contained a small amount of piperitone, and a considerable quantity of high boiling constituents was also present. The yield of oil was small, and for this and other reasons can have little commercial value. The principal constituent in the high boiling fraction appeared to be the sesquiterpene.

The specific gravity of the crude oil at 15° C. = 0.8864; rotation $a_D = -27.6^\circ$; refractive index at 17° = 1.4872, and was soluble in 5 volumes 80 per cent. alcohol. The saponification number for the esters and free acid was only 3.2.

On rectification, a few drops of acid water, and a little volatile aldehydes of a not unpleasant odour, came over below 173° C. (corr.). Between 172-198° 68 per cent. distilled; between 198-265° only 1 c.c. came over; and between 265-282° 26 per cent. distilled. These fractions gave the following results:—

	Sp. Gr. at 15° C.	Rotation a_D .	Ref. Index at 17°.
First fraction	0.8592	... — 45.1° ...	1.4808
Second fraction (265-282°)	0.9408	... Dextro-rotatory ... 8 to 10°, but light did not pass well	1.5029

The eucalyptol was determined by the resorcinol method in the portion distilling below 198°, and gave a result equal to 7 per cent. of that constituent in the crude oil.

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.

EUCALYPTUS AMYGDALINA, Labill.

("Black Peppermint.")

BOTANY.

Historical.—This *Eucalyptus* was described by Labillardier in his "Plants of New Holland" (1806).

Remarks.—This name, *E. amygdalina*, has almost since the beginning of Eucalyptology been associated with the Tasmanian flora, for it was from Van Diemen's Land that Labillardier obtained his specimens. It is, however, with much reluctance that we announce that we have failed to find this tree on the mainland of Australia.

The tree passing as *E. amygdalina* in the Eastern States is of medium size with a "Peppermint" bark, opposite, sessile, cordate-lanceolate "sucker" leaves, medium-sized lanceolate normal leaves, small hemispherical fruits with a truncate or depressed rim, and the leaves yielding a particular oil.

As far as our researches go, trees having these characteristics do not appear to occur in Tasmania, where the name was originally ascribed to this species. Thus the trees going under the name of *E. amygdalina* in Tasmania and *E. amygdalina* in Victoria and New South Wales are not the same.

As, however, the name has become so interwoven with the *Eucalyptus* literature of Victoria and New South Wales in connection with the economics of the tree found there, it is now almost next to impossible to supersede the name of the tree of the Eastern States, or at least without adding to the already long nomenclature of the genus.

That the latter is not Labillardier's tree we are firmly convinced, and on the following grounds:—

- (1) The plate of *E. amygdalina* of Labillardier in his "Plants of New Holland" depicts the Tasmanian *Eucalypt*, and certainly not the mainland one.
- (2) The "sucker" leaves of the former are petiolate, alternate, and the latter opposite, sessile, cordate, obtuse.
- (3) The normal leaves of the former are smaller and narrower.
- (4) The fruits of the Tasmanian tree are practically identical in shape with those of *E. dives*, Sch., and not hemispherical like those of the mainland *E. amygdalina*.

- (5) The oil of the Tasmanian tree closely approaches in chemical composition that of *E. dives*, Sch.

Labillardier's name for the Tasmanian tree must, of course, stand, as that has priority, and to us it appears too late in the day to alter the specific appellation of the other; but if a systematic distinction is necessary in future, we would suggest that it might be known, to botanists at least, as *E. amygdalina*, var. *Australiana*. This form is faithfully figured by Mueller in his "Eucalyptographia," and is also illustrated by us in our work "Eucalypts and Their Essential Oils" (p. 168). The varieties recorded by Bentham, we find, belong to *E. Risdoni* rather than *E. amygdalina*.

CHEMISTRY.

Essential Oil.—Material of this species—known as "Black Peppermint"—was received from various localities in Tasmania, collected at various times of the year, in order that definite conclusions might be formed as to the specific differences between the oil of *E. amygdalina* of Tasmania and that of the tree known in New South Wales and Victoria as *E. amygdalina*. Although the general character of the oil of the Tasmanian tree places it in the "*amygdalina* group" of these oils, yet it differs considerably from that of the New South Wales form, and more closely approaches in constituents and physical properties the oil of *E. dives*, with the exception that the Tasmanian *E. amygdalina* contains a little more eucalyptol than does that of *E. dives*. Commercially the oil could be utilised for purposes similar to those to which that of *E. dives* is put, but it would not pay to submit it to fractional distillation in order to separate the eucalyptol portion, as is now often carried out with the oil of the New South Wales form, any more than it would pay to do so with the oil of *E. dives*. The yield of oil of the New South Wales form of *E. amygdalina* is almost twice that obtained with the Tasmanian trees, and even *E. dives* appears to yield a greater quantity of oil than does the *E. amygdalina* of Tasmania. The oil of the Tasmanian *E. amygdalina* differs from that of the New South Wales form in that it contains much less eucalyptol, has a very high laevo-rotation, contains more phellandrene, and is much less soluble in alcohol. The odour of the oil is also much less aromatic.

The following tabulated results give the general characters of the crude oil from three consignments, collected at the localities and on the dates given:—

	Hobart. (16.4.12.)	Nubeena, Tasman Peninsula. (18.4.12.)	Hobart. (15.5.12.)
Yield of oil	1.64 per cent.	2.04 per cent.	1.62 per cent.
Specific gravity at 15° C.	0.883	0.8668	0.8848
Rotation a_D ...	— 75.1°	— 59.1°	— 67.3°
Ref. index at 18°.	1.4790	At 20°=1.4767	At 18°=1.4761
Soluble	In 1 vol. 80% alcohol	7 vols. 70% alcohol	1 vol. 80% alcohol
Eucalyptol:.....	12 per cent.	24 per cent.	16 per cent.
S.N. of ester and free acid	3.1	S.N. = 2.9	S.N. = 3.2

The eucalyptol was determined by the resorcinol method and although this would seem to indicate the presence of a larger amount of that constituent, yet the result is more accurate than would be the case if determined by the phosphoric acid method.

The Nubeena sample contained less high boiling constituents than did the Hobart material, and consequently was of less specific gravity. It also contained a little more eucalyptol.

On rectification, nothing distilled below 174° C. (corr.) with either sample. The Hobart (16.4.12) oil gave 57 per cent. distilling between 174-195° C., and 37 per cent. between 195-255°, mostly between 230-240°. The Hobart sample (15.5.12) gave 63 per cent. between 174-195°, and 32 per cent. between 195-245°. The Nubeena sample gave 83 per cent. distilling between 174-195°, and 10 per cent. between 195-266°.

These fractions gave the following results:—

	Hobart. (16.4.12.)	Hobart. (15.5.12.)	Nubeena. (18.4.12.)
First Fractions—			
Specific gravity at 15° C.	0.8589	0.8662	0.8605
Rotation a_D .	— 86.8°	— 73.3°	— 62.8°
Refractive index	At 18°=1.4738	At 18°=1.4729	At 20°=1.4748
Second Fractions—			
Specific gravity at 15° C.	0.9191	0.9184	0.8939
Rotation a_D ...	— 14.9°	— 17.2	— 23.9°
Refractive index	At 18°=1.4833	At 18°=1.4823	At 20°=1.482

The high boiling portions of these oils contained a considerable quantity of piperitone, as is the case with *E. dives*; thus the temperature did not rise much above 255° C.

Besides the above material, sent by the museum collector, we also received the leaves of the "Black Peppermint" from Scottsdale, forwarded by Mr. A. H. Higgs (6.3.12.). This material gave a yield of oil equal to 2.32 per cent., and this crude oil had the following characters:—Specific gravity at 15° = 0.8765; rotation $a_D = -42.9^\circ$; refractive index at 23° = 1.4787; soluble in 5 volumes 80 per cent. alcohol; had saponification number for esters and free acid = 2.9; and contained 20 per cent. eucalyptol. On rectification, 80 per cent. distilled between 174-193° C. and 13 per cent. between 193-262°.

The fractions gave the following:—

	Sp. Gr. at 15°.		Rotation a_D .		Ref. Index at 18° C.
First fraction	0.8599	...	— 53.2°	...	1.4779
Second fraction....	0.9092	...	— 7.1°	...	1.4936

The oil distilled from the leaves of the "Black Peppermint" of Tasmania, *E. amygdalina*, from material all over the island, is thus seen to have considerable uniformity in composition.

EUCALYPTUS COCCIFERA, Hook. f.

("Mountain Peppermint.")

BOTANY.

Historical.—This tree was described by Hooker fil. in the "London Journal of Botany" (VI. 477) in 1847, and afterwards by Miquel, in "Ned. Kruidk. Arch." (IV. 133), in 1859, under the name of *E. daphnoides*.

Remarks.—It is generally recorded as one of the few endemic Eucalypts of Tasmania, and as it only occurs near or on the snow-line does not assume large proportions, consequently its economics are limited.

So far, at least, it has not been recorded from the mainland.

CHEMISTRY.

Essential Oil.—Material of this species was obtained from Mt. Wellington, at an altitude of about 4000 feet. It was collected in July, 1908. The principal constituent in the oil of this species is phellandrene, and pinene was practically absent. Eucalyptol was present only in small amount, probably not more than 3 per cent. in the first fraction. Traces of eudesmol were detected when the oil was first distilled. This oil also contains a small amount of the "Peppermint" constituent (piperitone), and thus belongs to the "Peppermint" group of these oils, of which group *E. dives* may be considered the type. The chemical results show *E. coccifera* to be very closely related to *E. coriacea*. The yield of oil is somewhat small for a phellandrene-bearing *Eucalyptus* species, and consequently *E. coccifera* has no commercial value as an oil-producing tree.

The average yield of oil from leaves and terminal branchlets = 0.609 per cent. The crude oil was of an amber colour. It had specific gravity at 15° C. = 0.8810, rotation $a_D = -35.8^\circ$; refractive index at 24° C. = 1.4831, and was insoluble in 10 volumes 80 per cent. alcohol. The saponification number for the esters and free acid was only 4.9.

On rectification, a small quantity of acid water and volatile aldehydes came over below 170° C. (corr.), at which temperature the oil commenced to distil. Between 170-183° C. 69 per cent. distilled; between 183-235° 5 per cent.; and between 235-278° 20 per cent. These fractions gave the following results:—

	Rotation a_D .		Sp. Gr. at 15° C.		Ref. Index at 24° C.
First fraction.....	— 43.4°	...	0.8561	...	1.4773
Second fraction....	— 25.2°	...	0.8705	...	1.4813
Third fraction	—	...	0.9199	...	1.4952

The high boiling fraction consisted largely of a sesquiterpene.

4.—AVERAGE YIELD OF OIL FROM THE SEVERAL SPECIES OF EUCALYPTUS.

The leaves and branchlets were taken in all cases just as would be done for commercial purposes, and the leaves were as fresh as it was possible to obtain them. The average yield has been given in preference to that of any one distillation, as this mean more nearly represents the commercial production. The percentage amount has been calculated into weight of oil from 1000 lb. of material, for the means of ready reference. The results are all of our own distillation from Tasmanian material. For comparative results see the tables for the mainland species published in our work "Research on the Eucalypts" (pp. 273 and 284). It will be noticed that much of this Tasmanian material was collected during the winter months, at a time of the year when the oil is not so abundant in the leaf; consequently these results may be considered a minimum yield for the species.

Species.	Number of Distil- lations.	Percentage Yield.	Yield per 1000 lb., Leaves and Termin- al Branchlets.		Dates of Collection.
			lb.	oz.	
<i>E. cordata</i>	1	2·32	23	3	3—1902
<i>E. amygdalina</i> ...	4	1·90	19	0	4—1912 5—1912 3—1912
<i>E. Delegatensis</i> ...	4	1·52	15	3	7—1908 8—1912
<i>E. linearis</i>	3	1·45	14	8	1—1912 6—1908 4—1912
<i>E. Risdoni</i>	4	1·38	13	13	3—1902 4—1912
<i>E. Muelleri</i>	2	1·28	12	13	7—1908
<i>E. urnigera</i>	2	1·13	11	5	7—1908
<i>E. Perriniana</i>	3	1·01	10	0	7—1912
<i>E. phlebophylla</i> ...	3	1·01	10	0	6—1912
<i>E. unialata</i>	1	·897	8	15	8—1912
<i>E. regnans</i>	2	·802	8	0	7—1908
<i>E. virgata</i>	2	·793	7	15	6—1912
<i>E. vernicosa</i>	2	·764	7	10	5—1912
<i>E. obliqua</i>	4	·695	6	15	7—1908
<i>E. taeniola</i>	1	·657	6	9	6—1912
<i>E. coccifera</i>	2	·609	6	1	7—1908
<i>E. viminalis</i>	3	·544	5	7	4—1912 8—1912
<i>E. Rodwayi</i>	2	·482	4	13	6—1912
<i>E. Gunnii</i>	4	·387	3	14	5—1912
<i>E. acervula</i>	6	·163	1	10	4—1912

5.—TABULATED RESULTS WITH THE CRUDE OILS, TOGETHER WITH THEIR PRINCIPAL CONSTITUENTS.

The full analysis of any particular oil will be found described under that species. Where more than one result is given, the figures represent the highest and lowest obtained by us. Constituents, other than those enumerated, may be present in small amount in many of the oils, but only those found have been enumerated. Volatile aldehydes are always present in the crude oils in small amount, but they are not identical in all the species. The saponification number includes that of the free acid as well as the ester. The alcohol used in determining the solubilities was standardised for percentage of absolute alcohol by weight. The refractive indices were taken with a Zeiss Abbé refractometer, and the temperatures given are those of the circulating water. The yield of oil we obtained with the several species is given in a separate table; these results were from green material collected as would be done for commercial oil distillation. *E. globulus* is not included in this list, as the oil is so well known; for that reason we did not obtain leaves from Tasmania for distillation.

Species.	Specific Gravity at 15° C.	Optical Rotation _a D.	Saponification Number.	Refractive Index.	Solubility in Alcoh. l.	Eucalyptol. Per cent.	Chief Constituents Found.
<i>E. acervula</i>	0·8956	—1·1°	32·8	1·4756 at 18°	1 vol. 80°/o	21°/o	Dextro-rotatory pinene, phellandrene, eucalyptol, geraniol, geranyl-acetate, solid and liquid paraffins, sesquiterpene
<i>E. amygdalina</i>	0·8668 to 0·8848	—59·1° to —75·1°	2·9 to 3·2	1·4761 to 1·4790 at 18°	7 vols. 70°/o to 1 vol. 80°/o	12 to 24°/o	Phellandrene, eucalyptol, piperitone, sesquiterpene
<i>E. coccifera</i>	0·8810	—35·8°	4·9	1·4831 at 24°	insoluble	under 5°/o	Phellandrene, eucalyptol, piperitone, eudesmol
<i>E. cordata</i>	0·9138	+ 9·3°	14·8	1·4695 at 16°	10 vols. 80°/o 1½ vol. 70°/o	62°/o	Eucalyptol, dextro-rotatory pinene, esters
<i>E. Delegatensis</i>	0·8664	—48·4°	3·1	1·4828 at 24°	insoluble	traces only	Phellandrene, piperitone, sesquiterpene
<i>E. Gunnii</i>	0·9014	+ 1·5°	6·7	1·4752 at 18°	10 vols. 80°/o 4 vols. 80°/o	41°/o	Dextro-rotatory pinene, phellandrene, eucalyptol, esters, sesquiterpene
<i>E. linearis</i>	0·9096	—10·2°	5·8	1·4659 at 24°	6 vols. 70°/o	52°/o	Eucalyptol, phellandrene, piperitone, sesquiterpene
<i>E. Muelleri</i>	0·9096	+ 10·4°	15·3	1·4629 at 24°	4 vols. 70°/o	60°/o	Eucalyptol, dextro-rotatory pinene, esters
<i>E. obliqua</i>	0·8836 to 0·8845	—24·2° to —28·8°	7·2 to 8·1	1·4839 at 19° to 1·4852 at 24°	3 vols. to 4 vols. 70°/o	less than 5°/o	Phellandrene, eucalyptol, aromadendral
<i>E. Perriniana</i>	0·9119	+ 8·9°	10·3	1·4651 at 15°	2 vols. 70°/o	68°/o	Eucalyptol, dextro-rotatory pinene, esters, sesquiterpene

[Continued on next page.]

5. TABULATED RESULTS—continued.

Species.	Specific Gravity at 15° C.	Optical Rotation α_D .	Saponification Number.	Refractive Index.	Solubility in Alcohol.	Eucalyptol. Per cent.	Chief Constituents Found.
<i>E. phlebophylla</i>	0.8925	—22.4°	3.2	1.4761 at 18°	insoluble	9°/o	Laevo-rotatory pinene, phellandrene, eucalyptol, eudesmol
<i>E. regnans</i>	0.8802	—28.4° to	13.2 to	1.4882 at 20° to	10 vols. 80°/o 5 vols. 80°/o	traces	Phellandrene, eudesmol, piperitone, esters, sesquiterpene
<i>E. Risdoni</i>	0.8879 0.9045	—31.1° — 0.3°	15.4 21.3	1.4901 at 20° 1.4660 at 19°			
	to	to	to	to	1½ vol. 70°/o	56 to 58°/o	Eucalyptol, phellandrene, piperitone, esters
<i>E. Rodwayi</i>	0.9145 0.9075	—14.6° + 10.6°	27 3.9	1.4733 at 16° 1.4653 at 24°	5 vols. 70°/o 6 vols. 70°/o	64°/o	Eucalyptol, dextro-rotatory pinene, sesquiterpene
<i>E. taeniola</i>	0.8864	—27.6°	3.2	1.4872 at 17°	5 vols. 80°/o	7°/o	Phellandrene, eucalyptol, piperitone, eudesmol, sesquiterpene
<i>E. urnigera</i>	0.9088	+ 11.8°	18.3	1.4638 at 23°	5 vols. 70°/o	63°/o	Eucalyptol, dextro-rotatory pinene, esters
<i>E. unialata</i>	0.9179	+ 3.1°	11.1	1.4690 at 18°	1½ vol. 70°/o	62°/o	Eucalyptol, dextro-rotatory pinene, esters, sesquiterpene
<i>E. vernicosa</i>	0.9038	+ 11.3°	5.9	1.4651 at 18°	1 vol. 80°/o	59°/o	Eucalyptol, dextro-rotatory pinene
<i>E. viminalis</i>	0.9154	+ 4.2°	9.5	1.4711 at 19°	1 vol. 80°/o	50°/o	Eucalyptol, dextro-rotatory pinene, phellandrene, esters, sesquiterpene
<i>E. virgata</i>	0.8883	—20.9°	3.3	1.4819 at 18°	3 vols. 80°/o	21°/o	Phellandrene, eucalyptol, piperitone, eudesmol, sesquiterpene

6.—ILLUSTRATIONS.

E. unialata, *sp. nov.*

1. Abnormal or "Sucker" leaves.
2. Twig with buds and normal leaves.
3. Branchlets with fruits.

E. Rodwayi, *sp. nov.*

1. Abnormal or "Sucker" leaves.
2. Twig with buds and normal leaves.
3. Branchlets with fruits.

E. taeniola, *sp. nov.*

1. Abnormal or "Sucker" leaves.
2. Individual leaf.
3. Branchlet with buds, flowers, and fruits (an unusual occurrence).

[All natural size.]

Collecting Eucalyptus leaves in Tasmania.

7.—INDEX TO SPECIES.

	PAGE
<i>E. ACERVULA</i>	10
<i>E. CORDATA</i>	15
<i>E. GLOBULUS</i>	16
<i>E. GUNNII</i>	17
<i>E. LINEARIS</i>	19
<i>E. MUELLERI</i>	23
<i>E. PERRINIANA</i>	25
<i>E. PHLEBOPHYLLA</i>	27
<i>E. REGNANS</i>	31
<i>E. RISDONI</i>	35
<i>E. UNIALATA</i>	38
<i>E. URNIGERA</i>	40
<i>E. VERNICOSA</i>	42
<i>E. VIMINALIS</i>	43
<i>E. DELEGATENSIS</i>	45
<i>E. OBLIQUA</i>	50
<i>E. RODWAYI</i>	53
<i>E. VIRGATA</i>	56
<i>E. TAENIOLA</i>	60
<i>E. AMYGDALINA</i>	62
<i>E. COCCIFERA</i>	65

R.T.B. del.

EUCALYPTUS UNIALATA, R.T.B. et H.G.S.

to the
attention of

R.T.B. del.

EUCALYPTUS RODWAYI, R.T.B. et H.G.S.

R.T.B. del.

EUCALYPTUS TÆNIOLA, R.T.B. et H.G.S.

Small decorative marks or characters at the top of the page, possibly a header or a small illustration.

E. vernicosa,
4000 FT. ABOVE SEA LEVEL
ON THE HARTZ MOUNTAINS. LEAVES CARRIED
2 MILES.

THE SAME THEN
"PACKED," 12 MILES TO
GEEVESTON, THENCE BY
BOAT TO HOBART AND
SYDNEY.
2 CWT. TO THE LOAD.

DRAWING *E. Perrinia*
12 MILES TO OUSE BRIDGE
THEN 25 MILES BY HORSE
TEAM TO MACQUARIE
PLAINS, THENCE BY TRAIN
TO HOBART AND BOAT
SYDNEY.

COLLECTING EUCALYPTUS LEAVES IN TASMANIA.

~~14 DAY USE~~

RETURN TO DESK FROM WHICH BORROWED

CIRCULATION DEPARTMENT

This book is due on the last date stamped below, or
on the date to which renewed.

Renewed books are subject to immediate recall.

JUN 1 1 1974 7 0

RECEIVED

MAY 22 REC'D -12 M

MAY 22 -1 PM

EDUC.-PSYCH. LIBRARY

REC'D CIRC DEPT

MAY 28 1974 S
MAY 28 '74 S

Baker, R.T. 264623
A research on the
eucalypts of Tasmania

TP958

B2

264623

Baker TP958

B2

UNIVERSITY OF CALIFORNIA LIBRARY