THE WOOD STRUCTURE OF CERTAIN EUCALYPTS BELONGING CHIEFLY TO THE "ASH" GROUP.

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(With Plates IX.-XII.)

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The term "ash" is used in Australia to denote trees belonging to widely different Natural Orders, which have no connection botanically with the European Ash (*Fraxinus*). The chief resemblance is usually one of colour, the majority of the Australian woods being pale coloured, but exceptions such as the Red Ash, *Alphitonia excelsa,* and *Tarrietia argyrodendron,* var., occur. In this paper the wood structure of certain Eucalypts, namely, *Eucalyptus Dalrympleana* J.H.M.; *E. Delegatensis* R.T.B., *E. fastigata* Deane and Maiden; *E. fraxinoides* Deane and Maiden; *E. obliqua* L'Her; *E. oreades* R.T.B. and *E. regnans* F.v.M., some of which possess the vernacular name of "Ash," is described. The reason for the inclusion of several other species, not strictly classed in this group, is that they possess timber closely resembling the "Ashes" and occur in the same districts, so that confusion is likely to arise. The woods are pale coloured, normally of moderate weight and hardness and possess, in general, remarkable strength; they are therefore an important commercial group which must eventually play an important part as a substitute for Oregon as a scantling timber. The species generally occur in large quantities, especially in southern New South Wales, Victoria, and Tasmania; moreover, they regenerate readily and there is no reason

why supplies of the timber should not be assured for all time. The trees grow in regions of comparatively high rainfall and often attain an enormous size; in fact, probably the largest trees in Australia belong to this group, forest giants exceeding 300 feet having been measured in the Gippsland district of Victoria.

On account of their increasing commercial importance, it was thought desirable to examine the woods microscopically to see whether any reliable method could be found whereby they could be identified with accuracy.

The group is an exceedingly difficult one, and although those accustomed to handling the timbers might be able to separate the species growing in their districts, it is sometimes doubtful whether their confidence is always justified. When, however, even the locality is doubtful, the problem becomes still more difficult. Botanically, considerable confusion has existed in the past in reference to the systematic position of certain species, and even to-day opinions differ as to whether one species at least is entitled to specific rank. The synonymy and confusion in connection with *E. obliqua, E. regnans, E. Delegatensis* and *E. fastigata* are dealt with rather fully in a paper on the Eucalypts of Tasmania, by Baker and Smith;* other references can be found in the exhaustive work of the late J. H. Maiden.**

As perhaps might have been anticipated, the results have proved rather disappointing from the point of view of identification, on account of the variation found to occur in the wood of the same species, but it was thought advisable to place them on record.

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* R. T. Baker and H. G. Smith. A research on the Eucalypts of Tasmania and their Essential Oils. Proc. Roy. Soc. Tasmania, 1912.

** J. H. Maiden. A Critical Revision of the Genus Eucalyptus. Govt. Printer, Sydney.

The following notes apply principally to the microscopic wood structure of the individual species, but a short description is given of the tree and the uses to which the wood is put. Systematic descriptions can be found in Maiden (loc. cit.) or in the Eucalypts and their Essential Oils.† A short account of the anatomy of the woods of *E. Delegatensis, E. oreades* and *E. regnans* is given in the "Hardwoods of Australia";* *E. Dalrympleana*† was described after the publication of that work. The structures of the various species are illustrated by means of photo-micrographs of transverse sections taken with a comparatively low magnification, in order to include as large a field as possible without losing too many details. There is frequently, of course, considerable variation in the appearance of different parts of a transverse section, and it is impossible to do more than show a very small area.

Eucalyptus Dalrympleana J. H. Maiden.

Mountain or White Gum.

A large forest tree attaining a height of several hundred feet and 30 feet in girth, found at moderately high elevations in central and southern portions of the dividing range and spurs in New South Wales. The wood is white to pinkish in colour, of moderately open texture, straight-grained and fissile. It is largely used for building construction, e.g., flooring, lining, weatherboards; hoe and light hammer handles, etc. It seasons well when cut from matured trees, but is sometimes inclined to warp and show

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† R. T. Baker and H. G. Smith. A Research on the Eucalypts and their Essential Oils. 2nd Edition, Govt. Printer, Sydney, 1920.

* R. T. Baker. Hardwoods of Australia and their Economics. Govt. Printer, Sydney, 1919.

† J. H. Maiden. Forest Flora of New South Wales, vol. 7, p. 137. Govt. Printer, Sydney, 1920.

collapse. Weight, 40-48 lbs. per cubic foot. Hardness = Moderately hard.

Macroscopical characters.—Pores medium-sized to small, easily visible on end section with the naked eye; usually in short oblique rows; distribution irregular, more crowded in early wood, often absent in late wood. Vessels practically without contents. Soft tissue not apparent. Rays scarcely visible on end or tangential sections without lens; easily visible radially, being slightly darker in colour than the surrounding tissue. Growth rings fairly prominent, due to darker colour of late wood, and more or less complete absence of pores; more pronounced in specimens from Laurel Hill, New South Wales, at an elevation of 4,000 feet, than in specimens from the Blue Mountains.

Microscopical characters.—Pores almost always single, very variable in size, being very small in late wood; single pores usually elliptical; radial diameter, 45-300μ, mean 240μ; tangential diameter, 30-225μ, mean 165μ; vessel segments 200-500μ; walls 4-6μ in thickness; lateral pits narrow, slit-like, border circular or almost so; ray pits irregularly elliptical, simple; end walls transverse or inclined up to 20°; end perforation always simple; end projection up to 90μ in length; tyloses occasionally present but rarely filling whole of cell cavity; number per sq. mm. 1-9. Wood fibres (fibre-tracheids) in radial rows; 750-1350μ in length; average diameter 13μ; lumen often reduced to 1.5μ, walls very variable in thickness 3-5μ; pits narrow, bordered; transitions to narrow irregularly shaped tracheids occur, the latter with numerous bordered or simple pits and measure up to 600μ in length and 20μ in diameter. Wood parenchyma largely developed, chiefly vasicentric, also diffuse, even approaching short irregular metatracheal bands; cells usually devoid of contents, pits elliptical crowded; at times conjugate; cells up to 270μ in length and 35μ in width. Rays uniseriate, 2-18 cells in

height; biseriate, or even triseriate, particularly in wood from Laurel Hill district; larger rays up to 450μ in height and 40μ in width; ray cells usually with dark contents more or less filling inner cells; rays becoming heterogeneous, due to increase in size and depth of outer cells; 10-15 per mm. of transverse section.

Burns with a fair percentage of unburnt carbon and a small greyish ash. Alcoholic extract yellow; no evidence of flavone; slight turbidity on adding water; pale blue to blue colouration with ferrous sulphate; medium precipitate with lead acetate.

Eucalyptus Delegatensis R. T. Baker.

Alpine Ash, Mountain Ash, Red Mountain Ash, Victorian Woollybutt, Gum-topped Stringybark, Tasmanian Oak.*

A large forest tree found at high elevations (over 4000 feet) on the southern tablelands of New South Wales, and also in parts of Victoria and Tasmania. This tree yields one of the most valuable light-weight hardwoods in Australia, the wood being remarkably strong and tough for its weight, and it possesses also a high modulus of elasticity. Provided it is cut from mature trees the wood usually seasons well, without evidence of collapse or washboarding, whilst the shrinkage is not excessive. Too rapid seasoning is liable to cause honeycombing, however, and should be avoided. It is usually pale coloured but at times pinkish, moderately open textured, usually straight-grained and fissile, and is used for general building purposes, e.g., flooring, etc., motor body and carriage building, furniture and cabinet work, interior panelling, boat oars, light hammer and hoe handles, spokes, billiard cues, bentwork,

* Of these the name "Alpine Ash" is usually adopted for the timber grown in New South Wales.

casks, etc. Weight, 41-55 lbs. per cubic foot.† Hardness = Moderately hard.

Macroscopical characters..—Pores easily visible with the naked eye on end section, crowded in early wood, occasionally absent in late wood, often in short oblique rows. Soft tissue not apparent. Rays visible on end section, particularly in darker wood, also on radial and tangential faces. Growth rings very pronounced; late wood much darker and denser than early wood.

Microscopical characters.—Pores usually single, rarely in obliquely joined pairs; single pores elliptical in section; very irregularly distributed, due to their complete absence in some specimens in the late wood, this being possibly the nearest approach to a ring-porous timber in the Eucalypts; uneven in size, late wood pores much smaller; radial diameter 105-350μ, mean 250μ; tangential diameter 60-225μ, mean 150μ; vessel segments 300-500μ in length; walls 3-6μ in thickness; lateral pits narrow, slit-like, borders circular to elliptical; ray pits irregularly oval, simple; end perforation always simple; end wall transverse or oblique, up to 45°; end projection up to 200μ in length; tyloses often present in varying amount, at times filling whole of vessel cavity; number per sq. mm. 0-1 in late wood, 7-11 in early wood. Wood fibres variable in size and thickness; 450-1500μ in length; average diameter 15μ; walls 3-4μ in thickness; lumen often reduced to 3μ; pits slit-like bordered; transitions occur to elongated tracheids measuring up to 800μ in length and 30μ in diameter. Wood parenchyma not abundant, principally vasicentric or a little diffuse; cells measuring up to 185μ in length and 26μ in diameter. Rays chiefly uniseriate, 2-16 cells in height; varying in width from a mean of 7μ

† The higher figure was obtained from a Tasmanian specimen. It is exceptionally high; the weight does not usually exceed 48 lbs. per cubic foot.

in late wood to 11μ in early wood; a few rays show the division of a few cells, about the middle, to form narrow biseriate rays; almost homogeneous, but frequently the outer cells become enlarged; the cells usually with small light brownish coloured granular or amorphous bodies; 10-12 per mm. of transverse section.

Burns with a comparatively small percentage of unburnt carbon, smouldering to a small brownish-grey ash. Alcoholic extract yellow in colour; slight trace of flavone in one sample; no turbidity on adding water; blue colouration with ferrous sulphate; slight to medium precipitate with lead acetate; no marked fluorescence.

Eucalyptus fastigata Deane and Maiden.

Brown Barrel, Cut-tail, Blackbutt, Stringbark.

A large forest tree found in central and southern parts of the main Dividing Range, extending into Victoria. The wood is pale coloured, moderately open textured, and usually straight-grained. It is a tough, strong wood, possessing a high modulus of rupture and elasticity, usually rather denser than the other members of the group, and is said to be durable in the ground. The principal uses at present appear to be for general building purposes. Weight 41-56 lbs. per cubic foot. Hardness = Moderately hard to hard.

Macroscopical characters.—Pores moderately large to small, easily seen on end section, often with dark contents, usually arranged in short oblique rows, rather more crowded in early wood. Soft tissue not apparent. Rays scarcely visible on end or tangential sections, more pronounced radially but not much darker than the surrounding tissue. Growth rings usually not very prominent. The sapwood is not clearly differentiated, there being little alteration in colour in the heartwood.

Microscopical characters.—Pores usually rather evenly distributed except in late wood, single, rarely in pairs; single pores usually elliptical, variable in size; radial diameter 50-300μ, mean 210μ; tangential diameter 50-210μ, mean 165μ. Vessel segments 200-500μ in length, walls 4-6μ in thickness; lateral pits slit-like, rather crowded, borders circular or almost so; ray pits irregularly oval, simple, end walls transverse or oblique, the angle being as much as 50° in some cases; end perforation always simple, end projection up to 140μ in length; tyloses only present in comparatively few vessels, and not filling whole cavity; number per sq. mm. 1-12. Wood fibres in radial rows; 600-1500μ in length; average diameter 15μ; walls 2-4μ in thickness; lumen often reduced to 3μ; pits narrow, slit-like, bordered; transitions occur from these fibre-tracheids to copiously pitted tracheids which are in close proximity to the vessels, and measure up to 675μ in length and 30μ in diameter. Wood parenchyma fairly abundant, chiefly vasicentric, or diffuse; cells with large simple pits; up to 185μ in length, and 37μ in width. Rays uniseriate or often biseriate; uniseriate rays 2-30 cells in height; biseriate rays up to 400μ in height and 38μ in width; almost homogeneous, though at times the outer cells are enlarged; cells frequently with amorphous or granular brownish contents; 13-15 per mm. of transverse section.

Burns without smouldering, leaving a large amount of unburnt carbon. Alcoholic extract yellow to yellow-brown in colour; no evidence of flavone; clear or a very slight turbidity on adding water; blue to deep blue colouration with ferrous sulphate; heavy precipitate with lead acetate; no marked fluorescence.

A specimen from Rydal, New South Wales, showed very numerous biseriate rays.

EUCALYPTUS FRAXINOIDES Deane and Maiden.

White Ash, White Mountain Ash.

A tall forest tree found in southern New South Wales at moderately high elevations, valuable forests occurring on the Main Dividing Range east of Cooma. The wood is very pale coloured, moderately open in texture, usually straight-grained and fissile, and is used for general building purposes, cabinet work, staves, etc., whilst its high strength-weight-factor makes it a suitable timber for certain aeroplane parts. Weight, 41-45 lbs. per cubic foot. Hardness = Moderately hard.

Macroscopical characters.—Pores medium-sized to small, easily visible on end section with naked eye, usually in oblique or even radial rows, especially in late wood; crowded in early wood; often with brownish contents. Soft tissue not apparent. Rays not or scarcely visible on end section without lens, easily visible on a radial section, being rather darker than the surrounding tissue. Growth rings fairly prominent on end section, the late wood being denser and darker in colour.

Microscopical characters.—Pores usually single, rarely in pairs, fairly evenly distributed, usually elliptical; radial diameter 45-300μ; mean 240μ tangential diameter 30-210μ, mean 165μ; vessel segments 180-525μ in length; walls 4-6μ in thickness; lateral pits narrow, slit-like in irregular longitudinal rows, borders usually elliptical; ray pits irregularly elliptical or almost circular; end perforation always simple; end wall transverse or almost so; end projection up to 120μ in length; tyloses often present but usually only partially filling cavity; number per sq. mm., 6-12. Wood fibres moderately thick-walled, in radial rows, rather irregular in size and shape; length 750-1400μ, the average length being greater than in most species; average diameter 15μ; lumen often reduced to 2μ; pits slit-like, bordered;

gradations occur to narrow tracheids measuring up to 700μ in length and 35μ in diameter, with numerous elliptical bordered pits in contact with vessels; fibres often with dark contents extending for a short distance in the lumen. Wood parenchyma not abundant, vasicentric or very little diffuse; cells up to 185μ in length and 30μ in width, with numerous crowded elliptical simple pits approaching a conjugate nature; usually without contents. Rays almost exclusively uniseriate, rarely biseriate, and even then the biseriate portion is not more than one cell in height; uniseriate rays almost homogeneous, narrow, not exceeding 11μ in width, average 6μ; 2-22 cells in height; walls moderately thick; cells usually with rounded irregular brownish contents; 7-12 per mm. of transverse section.

Burns with a small percentage of unburnt carbon, smouldering to a small ash. Alcoholic extract pale to yellow in colour; no evidence of flavone; very slight turbidity on adding water; pale blue to blue colouration with ferrous sulphate; slight to medium precipitate with lead acetate; no marked fluorescence.

Eucalyptus obliqua L'Heritier.

Stringybark, Messmate, Tasmanian Oak.

A large forest tree reaching a height of 250 feet and a girth of 35 feet, found principally in Victoria and Tasmania, in New South Wales along parts of the Dividing Range, and extending into South Australia. The wood is pale coloured, almost white to light brown, moderately open textured, usually straight-grained and fissile. It is used for general building purposes, furniture and cabinet work, piles, railway sleepers, poles, etc. The wood is tough and strong and tests showed great stiffness, the modulus of

elasticity exceeding 3,000,000 lbs. per sq in. Weight, 46-56 lbs. per cubic foot.* Hardness = Moderately hard to hard.

Macroscopical characters.—Pores medium-sized to large, easily visible on end section; often arranged in oblique or even tangential rows, especially in late wood; crowded in early wood. Soft tissue not apparent. Rays not or scarcely visible on end or tangential section, readily seen on radial face. Growth rings fairly well defined, due to uneven pore development.

Microscopical characters.—Pores usually single, but occasionally in pairs, very variable in size and shape, elliptical to almost circular; radial diameter 60-390μ, mean 270μ; tangential diameter 45-300μ, mean 225μ; vessel segments 180-525μ in length; walls 3-4μ in thickness; lateral pits slit-like, borders usually circular or elliptical; ray pits irregularly elliptical; end perforation always simple; end walls usually oblique, up to 30°, but occasionally transverse; end projection measuring up to 150μ in length. A few vessel segments often with dark granular contents which usually only fringe the cavity; tyloses often present, but rarely filling whole of cell; number per sq. mm. 4-10. Wood fibres in radial rows, irregular in shape, particularly in early wood; 675-1500μ in length, average diameter 19μ; walls 3-4μ; lumen reduced to 3μ in late wood; pits slit-like, border usually circular. Gradations occur to irregularly shaped tracheids with numerous bordered pits; up to 800μ in length and 40μ in diameter. Wood parenchyma abundant, principally vasicentric, a little diffuse; a few cells with dark granular contents, but usually empty; up to 200μ in length and 22μ in diameter. Rays numerous, uniseriate or frequently biseriate; uniseriate rays 2-17 cells in height; ray cells wide, up to

* A range of 48-66 lbs per cubic foot is given in the 2nd Edition of Tasmanian Forests, Timber Products and Sawmilling Industry. Govt. Printer, Tasmania, 1910.

40μ, average 22μ; biseriate rays up to 40μ in width; 9-13 per mm. of transverse section.

Burns without smouldering, with a very large amount of unburnt carbon, but pale-coloured specimens from Mt. Wellington, Tasmania, and from the Victorian Forestry Commission, smouldered to a greyish-brown ash. Alcoholic extract pale to deep yellow-brown; no definite evidence of flavones; no turbidity on adding water; blue to deep blue with ferrous sulphate; slight to heavy precipitate with lead acetate; no marked fluorescence.

Eucalyptus oreades R. T. Baker.*

Smooth-barked Mountain Ash.

A tall tree found at moderately high elevations on the Main Dividing Range and spurs, from central New South Wales to southern Queensland. The wood is pale coloured, moderately open in texture, straight-grained and fissile. It is occasionally marred by the development of "gum-veins," but this fault occurs in practically every Eucalypt to a greater or lesser extent. The wood is used for general building purposes, joinery and cabinet work, casks, carriage work, billiard cues, etc. Weight, 41-46 lbs. per cubic foot. Hardness = Moderately hard.

Macroscopical characters.—Pores medium-sized to small, easily visible on end section, usually in short oblique rows, especially in late wood, scarcely crowded in early wood. Soft tissue not apparent. Rays scarcely visible on end or tangential sections without lens; easily visible on radial surface, being slightly darker than the surrounding tissue. Growth rings fairly well-defined, due to darker colour of late wood, and reduction in number of pores. There is no sharp differentiation between sapwood and heartwood, but the latter is somewhat darker in colour.

* This is *E. altior*, (Deane and Maiden) Maiden. Critical Revision of Genus Eucalyptus, 1922, 6, 272.

Microscopical characters.—Pores comparatively evenly distributed, almost always single, rarely in pairs; single pores usually elliptical, variable in size; radial diameter 55-300μ, mean 210μ; tangential diameter 40-225μ, mean 165μ; vessel segments 120-525μ in length; walls 4-6μ in thickness; lateral pits narrow, slit-like, borders circular or almost so, distribution in irregular rows corresponding with the position of adjoining tracheids; ray pits irregularly elliptical; end perforation always simple; end walls transverse or nearly so; end projection up to 150μ in length; tyloses not common, and where present, only partially filling cavity; number per sq. mm., 5-12. Wood fibres in radial rows, fairly regular in size, exceptionally long, measuring up to 1650μ in length; average diameter 16μ; walls 2-4μ in thickness; lumen often reduced to 4μ; pits slit-like, bordered. Gradations occur to narrow, elongated tracheids with numerous pits, measuring up to 1000μ in length and 30μ in width. Wood parenchyma not abundant, chiefly vasicentric or a little diffuse; pitting crowded; elliptical; cells measure up to 185μ in length and 20μ in diameter. Rays almost entirely uniseriate, 2-20 cells in height, narrow, average width 15μ; almost homogeneous, the outer cells being usually without contents; a few rays showing division of one or two cells.

Burns with a little grey ash, and small percentage of unburnt carbon. Alcoholic extract pale coloured; no evidence of flavones; pale blue to blue colouration with ferrous sulphate; slight precipitate with lead acetate; no turbidity on adding water; no marked fluorescence.

Eucalyptus regnans F.v.Mueller.

Mountain Ash, Tasmanian Oak, Swamp Gum, Giant Gum, White Gum, Blackbutt.

A large forest tree often attaining an enormous size, found in south-eastern Victoria and Tasmania. The wood

is pale-coloured, moderately open textured, usually straight-grained and fissile, and is used for general building purposes, interior joinery and cabinet work, coach and carriage building, etc. It often possesses remarkable stiffness, specimens tested giving a mean modulus of elasticity of over 3,000,000 lbs. per sq. in. Weight, 37-46 lbs. per cubic foot.† Hardness = Moderately hard to hard.

Macroscopical characters.—Pores medium-sized, easily seen with the naked eye on end section, usually single but often distributed in oblique rows, especially in late wood. Soft tissue not apparent. Rays faint on end and tangential sections without lens, easily visible on radial surface. Growth rings fairly well-defined by the crowding of pores in early wood, and their more or less complete absence in late wood.

Microscopical characters.—Pores almost entirely single, though sometimes approaching each other closely; single pores more or less elliptical; radial diameter 75-330μ, mean 240μ; tangential diameter 45-260μ, mean 180μ.* Vessel segments 300-600μ in length; walls 3μ in thickness; lateral pits small, slit-like, arranged in irregular longitudinal rows, borders circular; ray pits larger, more or less oval; end perforation simple; end wall transverse or obliquely inclined up to 20°; end projection up to 150μ in length; tyloses rare but occasionally present in a few cells; vessels usually without contents; number per sq. mm., 4-10. Wood fibres arranged in radial rows, often compressed radially;

† 48-54 lbs. per cubic ft., according to Tasmanian Forestry, 2nd Edition.

* Sections of a small tree of *E. regnans* from Mt. Wellington, Tasmania (fig. 7) gave an average radial diameter of 150μ and a tangential diameter of 120μ. This reduction in size of the pores is usual in the wood of small trees, and care should be taken therefore that the specimens for microscopical examination are not taken from near the heart or from immature timber, e.g., branches, saplings, etc.

550-1200μ in length;* average diameter 15μ; walls 3-4μ in thickness; lumen often reduced to 3μ; pits small, slit-like, borders circular. Gradations occur to copiously pitted tracheids, irregular in shape and measuring up to 600μ in length and 50μ in diameter. Fibres occasionally contain dark contents which only extend for a short distance in the lumen. Wood parenchyma not abundant, principally vasicentric, a few cells diffuse; cells measure up to 110μ in length and 22μ in diameter, usually without contents. Rays almost entirely uniseriate, 2-19 cells in height; end walls usually oblique; almost homogeneous, though outer cells deeper; dark granular contents often present; 9-11 per mm. of transverse section.

Burns with small ash and medium amount of unburnt carbon. Alcoholic extract pale to yellow; no evidence of flavone; very slight turbidity on adding water; blue colouration with ferrous sulphate; moderate precipitate with lead acetate; no marked fluorescence.

Summary.

The pores are typically arranged in short, more or less oblique, rows, more crowded and larger in the early wood. They are particularly variable in size in *E. obliqua* and to a lesser extent in *E. Dalrympleana.* The irregular or zonal distribution reaches a maximum in *E. Delegatensis,* whilst in *E. oreades* and *E. fraxinoides* they are comparatively evenly distributed. The maximum radial diameter of the pores in the specimens examined was found in *E. obliqua,* the measurement being 390μ; this species has also the greatest average pore size. The minimum mean radial diameter of 210μ was observed in *E. oreades* and *E. fastigata.* The vessel segments are fairly uniform, the limits being 120μ (minimum) in *E. oreades* and 600μ (maximum) in *E. regnans.* Any measurements must be regarded with

* Mt. Wellington specimen up to 1400μ.

caution, since, as pointed out under *E. regnans,* considerable variation can occur in the one species, and even in the one tree; they should only be regarded as an indication of the size. The vessel pitting is usually not crowded, the bordered vessel-tracheid pits being arranged in undulating longitudinal rows, corresponding to the position of the tracheids. The end projection is always simple, whilst the end walls vary from transverse to oblique, a maximum inclination of 50° to the horizontal being observed in *E. fastigata;* the inclination is too variable to be of much value for diagnosis. Tyloses were found to be more or less common in *E. fraxinoides, E. Delegatensis, E. obliqua,* and *E. Dalrympleana,* and comparatively rare in *E. fastigata, E. oreades* and *E. regnans.* The pore distribution reached a maximum of 12 per sq. mm. in *E. fastigata, E. fraxinoides,* and *E. oreades,* in the early wood.

As in other Eucalyptus woods so far examined,* the wood fibres possess definitely bordered pits and therefore approach the condition of fibre-tracheids. Irregularly-shaped tracheids, often blunt-ended, and not necessarily fusiform, occur in close proximity to the vessels, and between this type and the wood fibres are connecting links in the shape of prosenchymatous cells, thinner walled than the latter but with more numerous bordered pits which are simple in contact with the ray cells.

Wood parenchyma is principally vasicentric, although in *E. obliqua* and *E. Dalrympleana,* where it is particularly abundant, it approaches a metatracheal condition. Parenchyma is fairly abundant in *E. fastigata,* and is developed to a lesser extent in *E. Delegatensis, E. fraxinoides, E. oreades* and *E. regnans.* This feature might prove of some

* Welch M.B. Notes on the Structure of some Eucalyptus Woods. Journ. Roy. Soc. N.S.W., 1924, 58, 169.

Welch M.B. The Identification of the principal Ironbarks and allied Woods. Journ. Roy. Soc. N.S.W., 1925, 59, 329.

diagnostic value, as it appeared to be fairly constant in the material examined. The cells are often much elongated, especially at the end of a row, and at times become conjugate; pits are numerous.

The rays are typically uniseriate but biseriate rays occur frequently in *E. Dalrympleana* and *E. obliqua, E. fastigata,* and to a lesser extent in *E. Delegatensis* and *E. fraxinoides;* triseriate rays were observed in *E. Dalrympleana,* to a small extent; uniseriate rays, with very few exceptions, were found in *E. oreades* and *E. regnans.* The usual range of vertical depth of the uniseriate rays is from 2-20 cells, but in *E. fastigata* rays were measured up to 30 cells in height. Particularly narrow rays were found in *E. oreades* and *E. fraxinoides,* the average width being only 8μ; a specimen of *E. regnans* from Mt. Wellington (young tree) showed an average width of 12μ, whilst mature wood from Victoria of the same species gave a mean of 8μ. The variation in width of one ray in the early and late wood has been indicated under *E. Delegatensis.* The relative development of uniseriate and biseriate rays was found to vary considerably in *E. fastigata,* from different localities, but was otherwise fairly constant. Similarly, in *E. Dalrympleana* triseriate rays were more numerous and biseriate rays much more strongly developed in wood from the Laurel Hill district, than from the Blue Mountains. The simple ray pits are occasionally in a single row, but more frequently appear to be biseriate.

The colour of the alcoholic extract and its behaviour with various reagents is largely due to what are apparently tannins or their products. The variation in the depth of colour of the extract is chiefly governed by the original colour of the wood. Burning the shavings, though of undoubted value in the separation of some woods, did not give very conclusive results, considerable variation being observed in *E. obliqua,* in which darker coloured wood

burnt "black," whilst pale-coloured wood smouldered to an ash.

Growth rings are usually very prominent in *E. Delegatensis* and are least pronounced in *E. fastigata;* the definition seems to vary to some extent in the majority of the specimens examined.

The colour of the woods of *E. obliqua* and *E. fastigata* varies from very pale to light brown; *E. Dalrympleana* is often quite pink, at times almost white, a similar variation occurring also in *E. Delegatensis,* though the latter does not reach the same depth of colour as *E. Dalrympleana. E. fraxinoides,* in the material so far examined, was almost white; *E. regnans* and *E. oreades* are also usually pale-coloured.

The heartwood is seldom clearly defined, although in those specimens in which this part becomes brownish or pink, the sapwood can be more easily differentiated. In the more rapidly grown trees the sapwood is often over an inch in width, and since it is always liable to destruction by the Powder Post beetle (*Lyctus brunneus*), it should be rejected, unless specially treated with some preventive.

The weight of the woods varies considerably, and therefore a range is given, but it is not claimed that these are the outside limits; they only represent the maximum and minimum figures obtained from specimens in the Technological Museum. The results sometimes given, in which lbs. per cubic foot are expressed to several places of decimals, can only apply to the particular sample measured, and may be nowhere near the average weight. The figures are for air-seasoned wood, with about 12% moisture on the dry weight.

The descriptions under "hardness" are roughly comparative, and are obtained by measuring the indentation made by a falling weight; the method is described in the "Hardwoods of Australia" (loc. cit.).

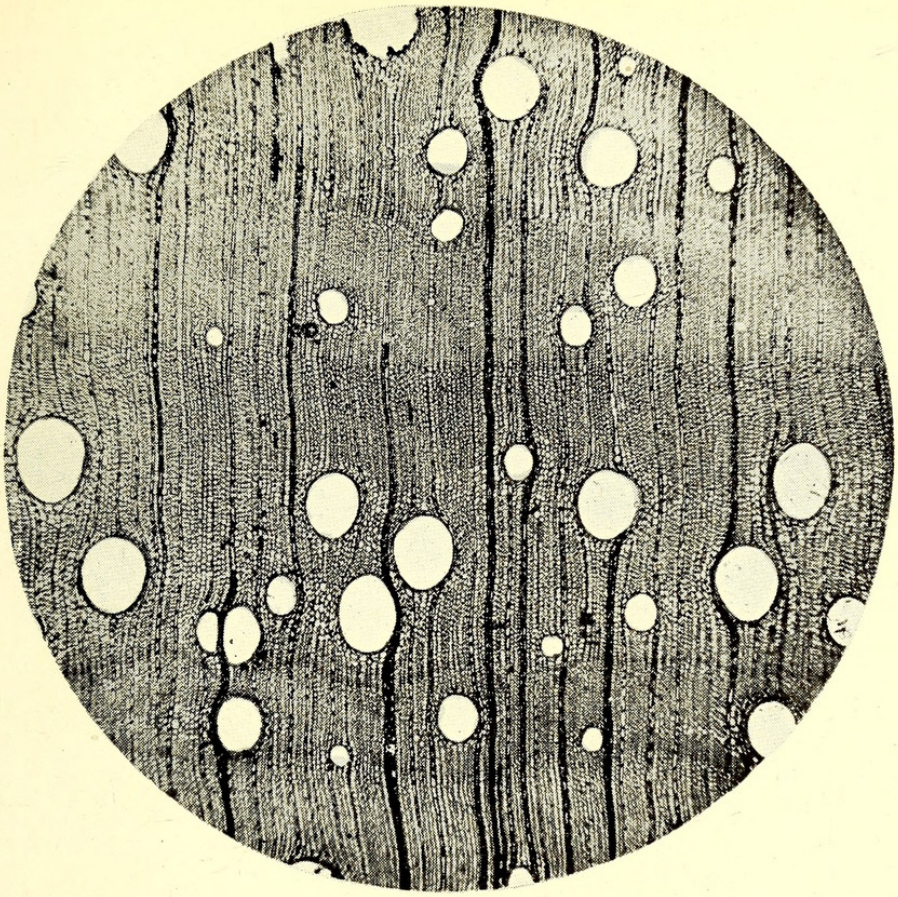


Fig 1.

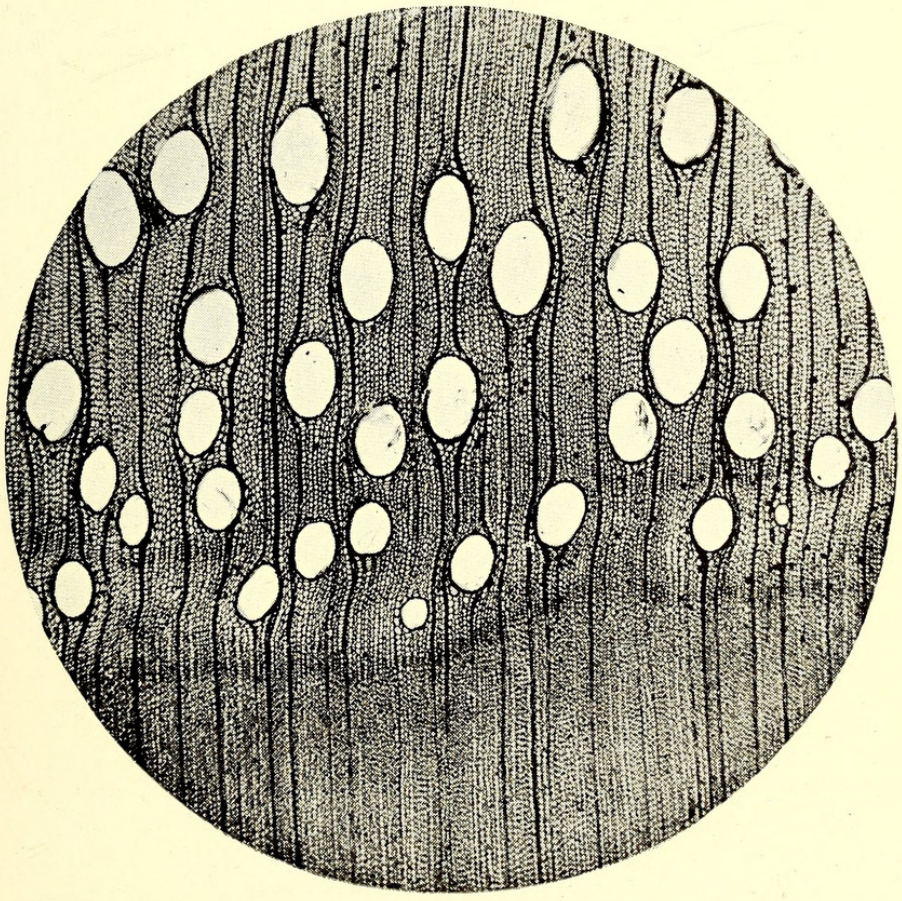
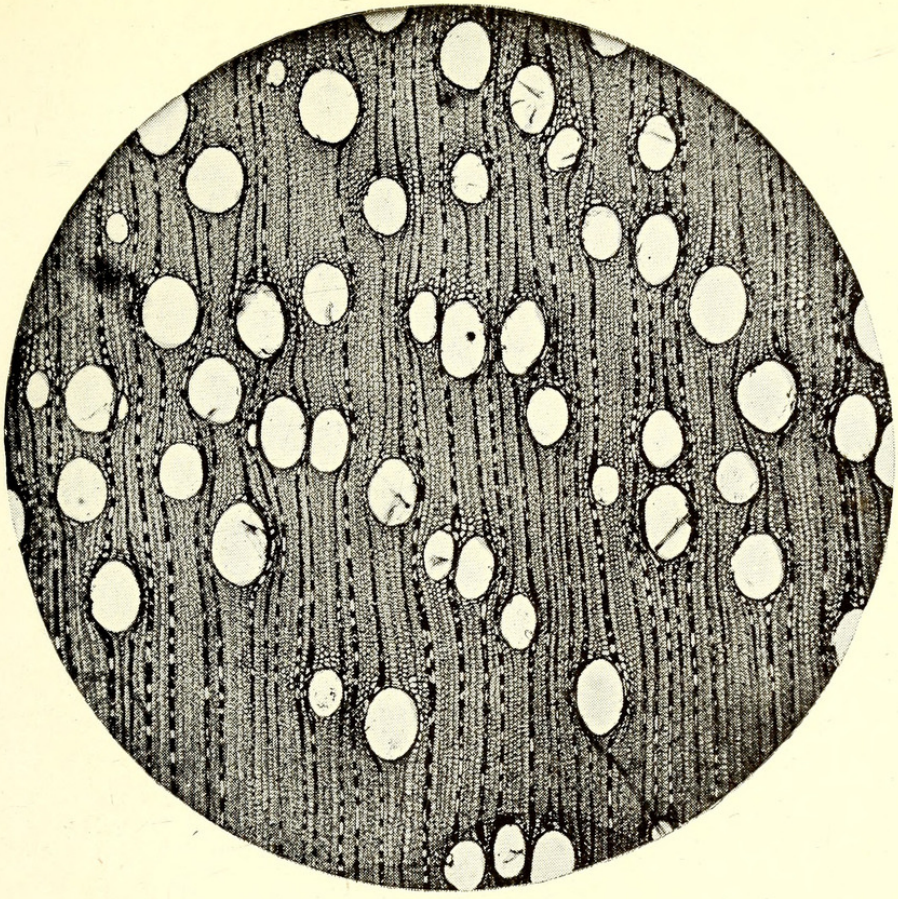


Fig. 2.

Fig. 1.

Fig. 2.



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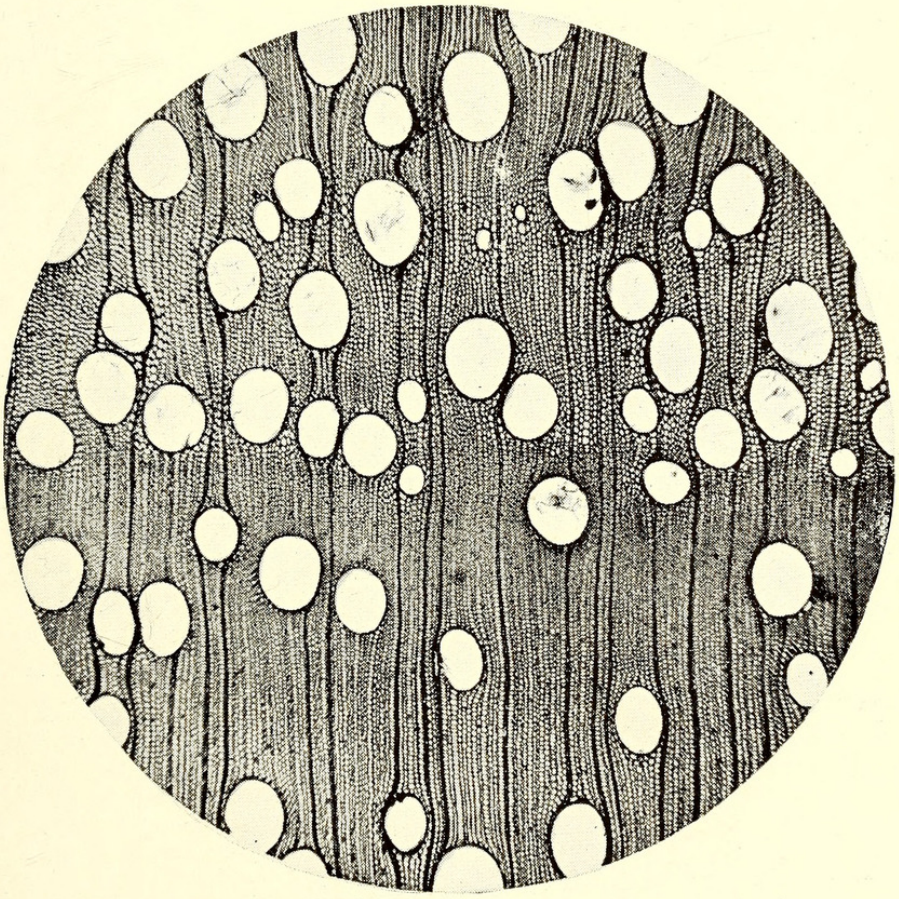

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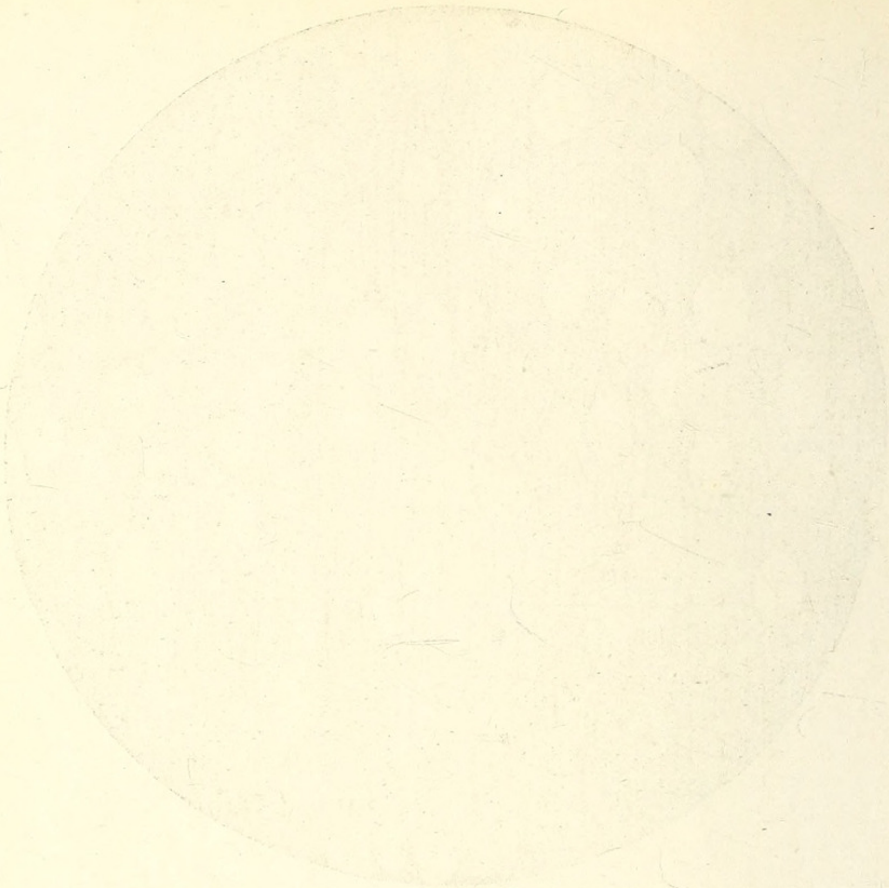

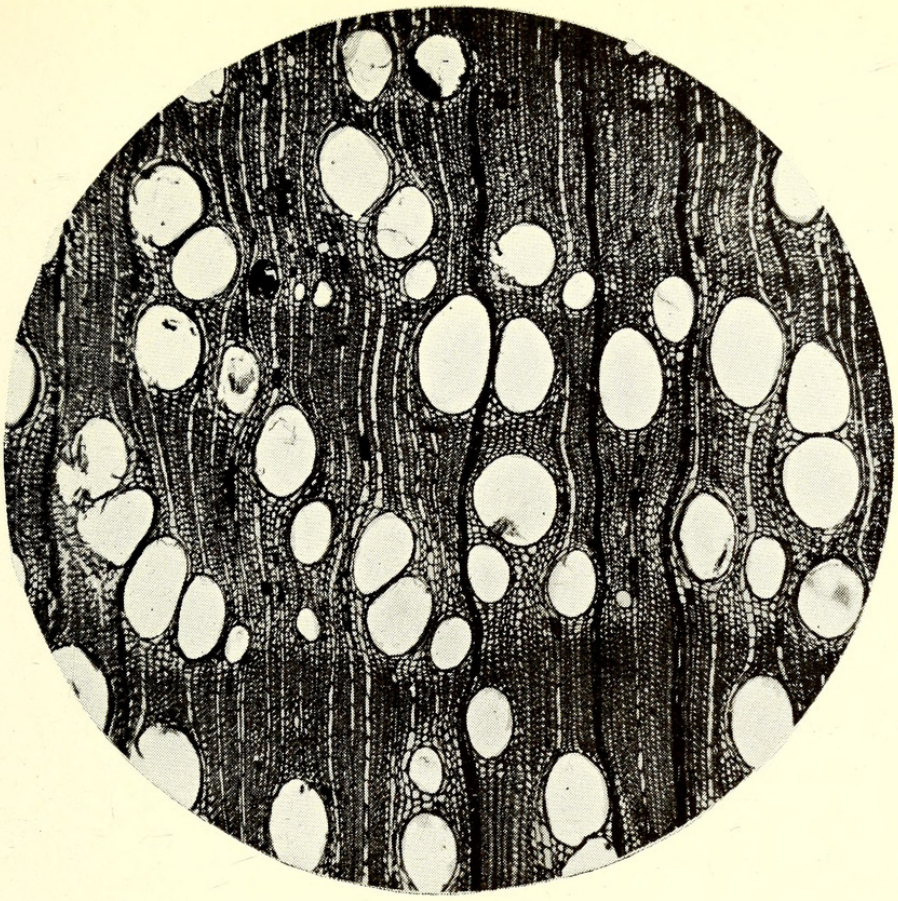

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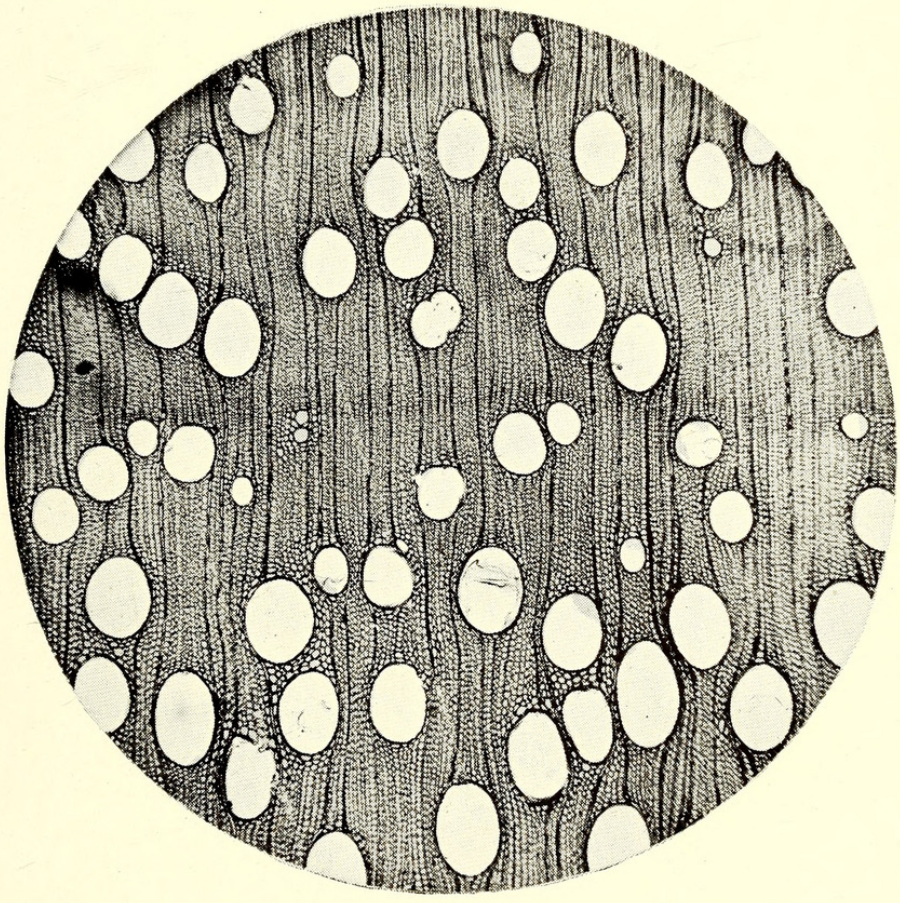
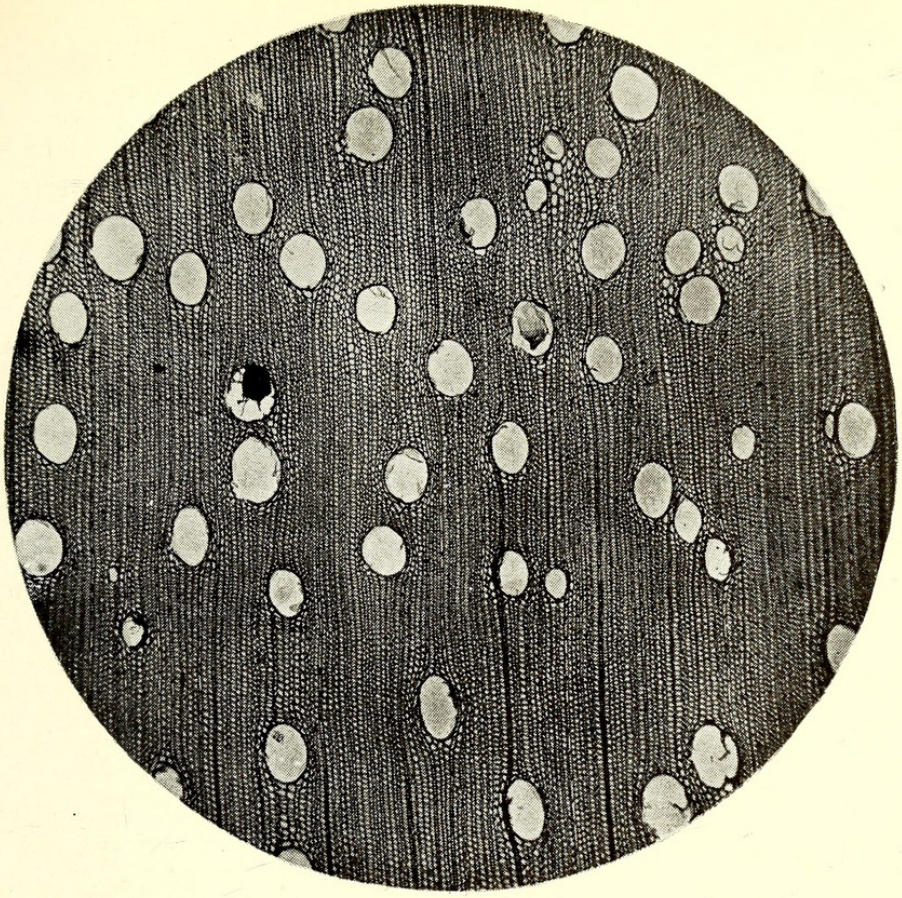


Fig. 6.

Fig. 6.



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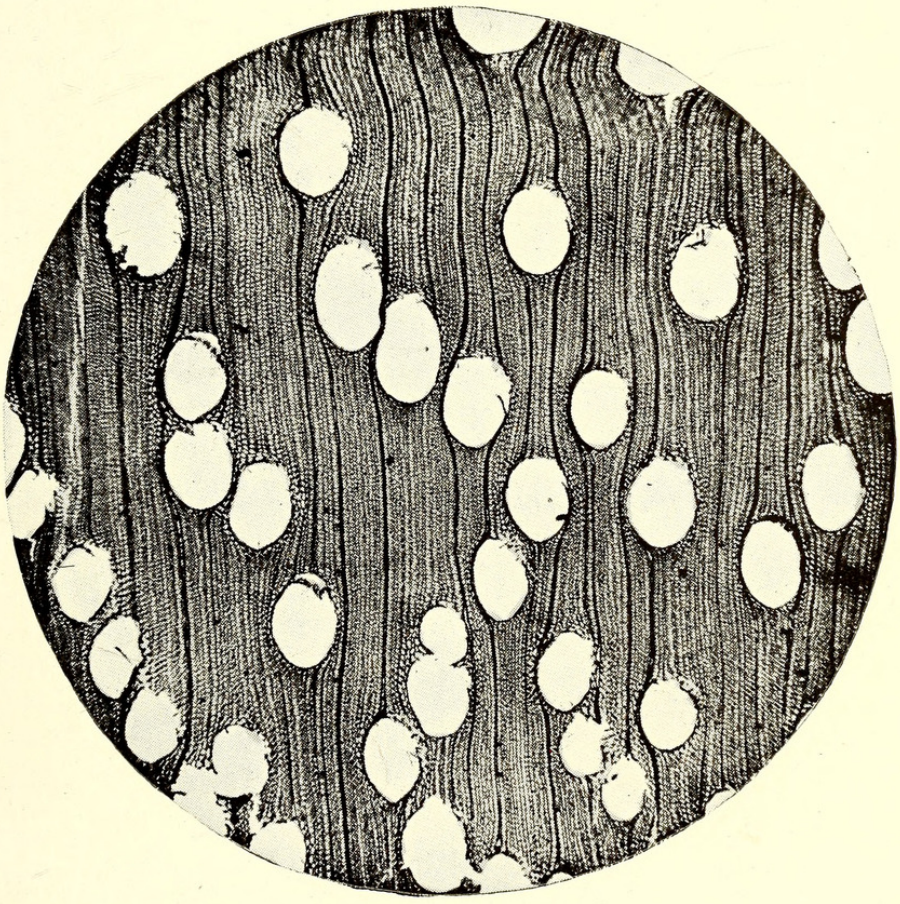

Fig. 8.

Fig. 7.

Fig. 8.

One of the principal faults in the woods of this group, apart from "gum-veins," which seem to occur chiefly as the result of injury to the cambium, is the presence of concealed checks or cracks, especially in *E. Delegatensis*, *E. obliqua* and *E. regnans*. Although these are frequently caused by case-hardening, due to faulty seasoning bringing about a condition of great internal stress, with the result that "honeycombing" occurs; yet it seems doubtful whether seasoning is always responsible. It might perhaps be possible that collapse occurs during the life of the tree.

In conclusion I wish to express my thanks to Messrs. D. Cannon and F. Shambler, of the Museum Staff, for their assistance in many ways.

The Technological Museum,
Sydney.

EXPLANATION OF PLATES.

Plate IX.

E. Dalrympleana J.H.M., transverse section of wood showing considerable variation in size of the pores, which are usually single. The comparatively large amount of wood parenchyma, principally vasicentric, is characteristic. The broad biseriate or even triseriate rays are prominent. Fig. 1 × 30.

E. Delegatensis R.T.B., transverse section of wood at junction of early and late wood. The absence of pores in the denser late wood is usually characteristic of this species. Tyloses are present in many of the vessels of the early wood, which are seen to be clearly separated, though appearing as oblique rows when viewed macroscopically. The reduction in width of the rays in the late wood is clearly shown. There is no great development of wood parenchyma. Fig. 2 × 30.

Plate X.

E. fastigata H.D. and J.H.M., transverse section of wood showing comparatively even distribution of pores,

in many of which can be seen tyloses. The wood parenchyma is abundant and chiefly vasicentric. The rather regular alternating dark and light patches in the rays are due to the crowding of the contents towards the ends of the cells. Fig. 3 × 30.

E. fraxinoides H.D. and J.H.M., transverse section of wood at junction of early and late wood, the difference in thickness of the fibres being very marked. The pores are crowded and fairly evenly distributed, though smaller in the late wood; tyloses is present in several of the cells. There is comparatively little wood parenchyma. Fig. 4 × 30.

Plate XI.

E. obliqua L'Her., transverse section of wood showing extremely variable size and shape of pores, several of which contain tyloses, and also dark phlobaphene-like masses. The most striking feature is the very great development of the wood parenchyma, especially in the vicinity of the vessels. Fig. 5 × 30.

E. oreades R.T.B., transverse section of wood showing comparatively even distribution of pores, and the comparatively indefinite demarcation of the growth rings, which however are actually rather more pronounced than is indicated by the figure. Tyloses occur in several of the vessels. The wood parenchyma is almost entirely vasicentric, whilst the rays are narrow. Fig. 6 × 30.

Plate XII.

E. regnans F.v.M., transverse section of wood from a young tree from Mt. Wellington, Tasmania, showing even arrangement of comparatively small pores. There is a slight reduction in pore size in the late wood. Fig. 7 × 30.

E. regnans F.v.M., transverse section of wood of mature tree with same magnification as Fig. 7, showing the considerable variation in pore size. The arrangement of the pores in more or less oblique rows is typical of most Eucalypts. Wood parenchyma is not abundant, being confined practically to the vasicentric condition. Fig. 8 × 30.