The Development of the Corrugated Stems of Some Eastern Australian Trees.

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I. INTRODUCTORY REMARKS.

Several Eastern Australian trees are characterised by flanged stems. Species possessing this feature are enumerated by the writer in a paper published in these Proceedings[1]. Another peculiarity of several species of trees in the same region is the corrugated or longitudinally wrinkled surface of the sapwood. The species exhibiting this modification are recorded in the same paper ([1], p. 215). The observation and recording of the species possessing these somewhat distinctive features were the result of field work. In this paper it is proposed to outline the results obtained by applying laboratory methods of investigation to an example of a species with a flanged stem and to a number of examples of species with corrugated or wrinkled woody cylinders.

II.—METHODS.

Transverse sections of complete stems or of suitable parts of stems were ground down with sandpaper to a smooth surface. The gross structure could then be observed. Selected parts from these large sections were then taken and prepared for microscopic examination. For this purpose the small pieces of wood were alternately boiled and cooled in water until the air was removed from them. They were then immersed in strong hydrofluoric acid for periods varying from two weeks to four months in order to remove the silica and other mineral constituents. When sufficiently softened, sections were cut with a sliding microtome. The sections were stained with Heidenhain's iron hæmatoxylin and safranin, dehydrated, cleared, and mounted.

III.—The Flanged Stem of *Villaresia* (*Chariessa*) *Moorei* F. v. M.

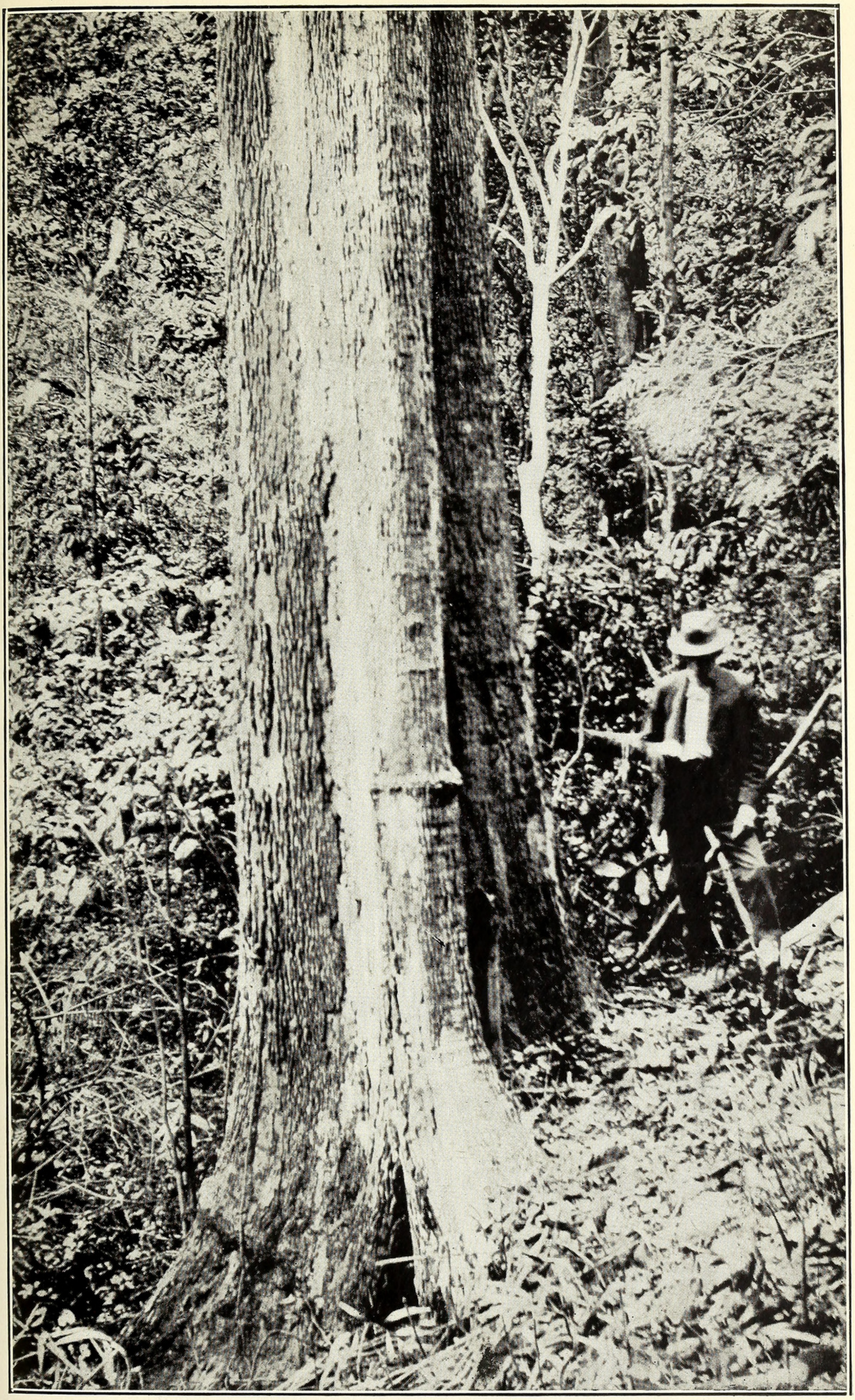
This species is sometimes commonly known as Churnwood or Soap-box. It is found in the rain forests from Shoalhaven (35 deg. S.) in New South Wales to Gympie (26 deg. S.) in Queensland. In the field it is a characteristic tree which can be identified by its flanged stem, thick, furrowed, pale-gray, cork-like bark, and its pale wood with large rays. It is one of the largest rain-forest species, and is frequently found growing on hillsides in Queensland. Mr. C. T. White, Government Botanist, informs the writer that it is one of the most plentiful trees on the Bunya Mountains. The writer has observed it in the rain forests of Kin Kin, Traveston, Tambourine Mountain, and the Macpherson Range near Killarney. The accompanying field photograph and the drawing representing the stem in cross section show the peculiar form of the tree. The species under investigation might be considered to possess a buttressed stem, but, somewhat arbitrarily, perhaps, it was not included with the buttressed trees listed by the writer[2] because the flanged shape is not restricted to the basal portion of the stem, but is frequently continued upwards in a diminishing degree to a great distance, in some cases almost reaching the lowermost branches.

As the woody portion of the stems of dicotyledonous trees (which include all the species discussed in this paper) increases in thickness by the addition of successive increments of wood at the external boundary, a cross section of a stem usually shows the successive changes of shape, if any, which the stem has undergone at the particular plane in which it is sectioned. The degree of differentiation of the successive increments of wood is determined chiefly by their differences in structure and colour. The transverse section of the stem represented by text-figure 1 was cut from a tree in a horizontal plane situated 2·4 metres (8 feet) from the ground. It shows that the young tree retained an approximately cylindrical stem at this height until it attained a stem diameter of about 17·5 cm. (7 in.). Subsequently the stem developed irregularly and formed three large angles and one small one, alternating with four grooves or intrusions. The stem when measured might be described as having a maximum diameter, extending to the outer edges of the angles or extrusions, of 60 cm. (24 in.) and a minimum diameter, bounding the intrusions or grooves, of 31·5 cm. (12·5 in.). By subtracting the diameter of the stem when it was approximately cylindrical from the foregoing maximum and minimum diameters we obtain a measure of the extent of the irregular development of the stem. In this way it is found that during the course of its irregular development the stem added 42·5 cm. (17 in.) to its diameter in the direction of its extrusions and only 14 cm. (5·5 in.) towards the grooves or intrusions. Hence, while irregular expansion was proceeding, growth in thickness towards the extrusions ensued at three times the rate of growth towards the grooves.

The surface of the sapwood is comparatively smooth and even where it bounds the extrusions, but in the grooves it is seen to be thrown into folds which can be traced inwards for some distance. These folds, however, clearly originate some distance outwards from the zone indicating the inception of irregular development.

Text-figure 1.—Transverse section of stem of *Villaresia Moorei*, ¼ natural size. Section cut 8 feet from ground. The dotted lines represent some of the more conspicuous rings of growth. The shaded areas indicate patches of parenchyma. The bark is shown by the heavier shading on the exterior. The section was taken from a tree growing on the Bunya Mountains.

The direction of the rays is a remarkable feature of the section. Two very large rays originate towards the pith, but are not continued very far outwards. They arise by the fusion of a number of smaller rays and do not produce any prominent inward flexion of the periodic zones



Lower portion of stem of *Villaresia* (*Chariessa*) *Moorei*. The tree represented grew on a hillside in rain forest at Kin Kin, about 26.2 deg. S. (eastward from Gympie). The angular form of the stem is evident. The continuity of the projecting angles of the stem with the principal surface roots is shown.

[*Photo. by* W.D.F.

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of tissue, as is shown in the species dealt with in the latter part of this paper. In the earlier stages of growth, while the stem retained an approximately cylindrical shape, the rays diverge from one another in their course outwards, but subsequently to the inception of irregular growth their direction in portions is changed. The divergent direction of the rays is maintained in the extruding sectors, but in the sectors bounded by the grooves their divergent disposition is gradually lost and eventually reversed, for they ultimately become convergent in their outward course.

Anatomical investigation shows that a peculiar structural feature of the wood in the form of patches of thin-walled, almost rectangular cells constituting parenchymatous tissue appears in the sectors bounded by the grooves. These patches of parenchyma appear subsequent to the inception of irregular growth and in areas where the rays are convergent. The vessels and wood fibres present in the normal wood disappear or are only scantily represented in the parenchymatous patches (compare photomicrographs 1 and 2, Plate XIII.). The rays as they approach the patches of parenchyma become broader and are more or less indistinct where they enter them.

The location of the parenchymatous areas in parts of the stem characterised by rays which are convergent in their outward course suggests that these areas might have arisen through lateral pressure on the cambium or generative tissue. The effects of lateral pressure in the neighbourhood of the parenchymatous patches are indicated by the presence of folds in the zones of growth of the outer portion of the sectors bounded by the grooves of the stem. The outwardly convergent rays and the folded zones of growth indicate that the cambium which produced them suffered contraction. On the other hand the divergent rays throughout the extruding sectors of the stem indicate that the cambium which produced them underwent expansion. As the extruding parts of the stem are continuous with and most prominent in the region of the principal surface roots of the tree, the irregular growth of the stem is associated with the development of these surface roots.

IV.—The Corrugated Woody Cylinders of Several Species.

(a) *General.*

When the bark is removed from the stems of some species of trees, the surface of the sapwood is seen to be wrinkled or corrugated in a longitudinal direction (see text-figures 3 and 4). The trees which exhibit this peculiarity are sometimes known as ''Corduroys'' or ''Washing-board Trees'' on account of the resemblance of the sapwood surface to corduroy cloth or washing-boards. In the case of large examples of the Washing-board Tree of Eungella Range, *Cryptocarya corrugata,* the depressions of the sapwood surface are indicated on the outer surface of the bark, but in the majority of the other species the corrugations are not conspicuously represented on the outer surface of the bark. A corrugated sapwood surface was observed by the writer in a number of species of trees belonging to the Natural Order Sapindaceæ and one species of *Cryptocarya,* and a list of these species was published ([1], p. 215). Subsequent observation showed that, in addition to the species of Sapindaceæ and *Cryptocarya,* the peculiarity is exhibited by several species of *Canthium* (Rubiaceæ) and *Casuarina* (Casuarinaceæ).

Following are the species of Eastern Australian trees in which the corrugated sapwood surface has been observed by the writer to be prominent:—

Casuarinaceæ—

Casuarina inophloia F. v. M. and Bail., Thready-bark Oak.
Casuarina torulosa Ait., Forest Oak.
Casuarina suberosa Otto & Dietr., Black Oak.

Lauraceæ—

Cryptocarya corrugata White and Francis, Washing-board Tree.

Sapindaceæ—

Alectryon connatus Radlk. (Nephelium connatum F. v. M.).
Guioa semiglauca Radlk. (Cupania semiglauca F. v. M.).
Diploglottis Cunninghamii Hook f., Native Tamarind.
Sarcopteryx stipitata Radlk. (*Ratonia stipitata* Benth.), Corduroy.
Arytera Lautereriana Radlk. (*Nephelium Lautererianum* Bail.), Corduroy Tamarind.

Rubiaceæ—

Canthium latifolium F. v. M.
Canthium lucidum Hook & Arn.
Canthium coprosmoides F. v. M.
Canthium buxifolium Benth.

R. T. Baker[3] mentions grooves on the surface of the sapwood of *Cryptocarya glaucescens* R.Br., an Eastern Australian species, and states that they are associated with large, multiseriate rays in the wood. A corrugated sapwood surface is also described in an undetermined species of *Cryptocarya* in the mountains of Papua by C. E. Lane-Poole[4]. I. W. Bailey[5] refers to the strongly fluted stem of the American Blue Beech (*Carpinus caroliniana* Walt.) and states that the furrows in the stem correspond to bands of closely approximated compound rays. He describes aggregate rays in several genera of the Natural Order Cupuliferæ, among the lower dicotyledons, similar to structures to be subsequently described in this paper, and ascribes their origin to leaf traces. He states ([5], p. 232) :—"In the development of the large storage systems necessary to plants living in regions of markedly unequal seasonal temperature characteristic of later geological time, the origin of storage tissue about the entering leaf trace has proved a natural starting point for the formation of compound or aggregate rays." The inward flexion of the zones of growth where they are crossed by large rays is discussed by E. C. Jeffrey[6] in a number of species of plants, and is assigned to the retarding effect of the large rays on growth. Herbert Stone[7] figures a section of the wood of the European Hornbeam (*Carpinus Betulus* Linn.) showing the annual rings bending inwards where they are crossed by large aggregate rays, and he states that the indentations indicate deep, spindle-shaped grooves on the exterior of the trunk.

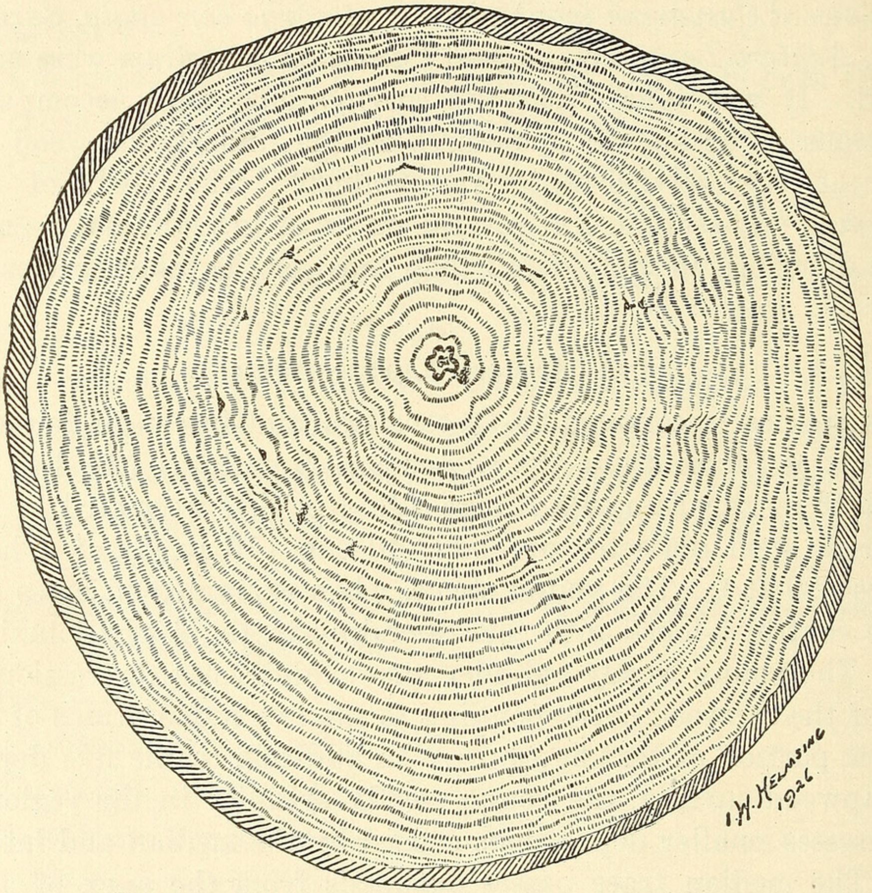
Gross and microscopical sections of the wood beneath the sapwood corrugations of *Casuarina inophloia, Cryptocarya corrugata, Sarcopteryx stipitata, Arytera Lautereriana,* and *Canthium latifolium* were made and examined. It was found that the corrugations were accompanied by modifications of or special structures in the underlying wood in each example of the several species examined. The stem of *Arytera Lautereriana* was sectioned at several stages of growth, and its modifications are described in more detail than those of the other species.

(b) *Arytera Lautereriana.*

This species is confined to Queensland and has been found in the rain-forests as far south as the Glasshouse Mountains (27 deg. S.) and as far north as the Eungella Range (21 deg. S.), westward of Mackay. It attains a stem diameter of about 40 cm. (16 in.) and a height of 27 metres (90 ft.). The young stems, when examined in cross sections, show the central 5-lobed pith corresponding to the $\frac{2}{5}$ phyllotaxis of the species. The young woody cylinder also exhibits five depressions in the surface of the sapwood corresponding to the five indentations of the pith (see inner portion of text-figure 2). In addition to the five depressions of the sapwood surface, the young woody cylinder in the region of the node possesses smaller depressions caused by the median and lateral leaf traces. The median trace passes outwards from the apex of a lobe of the pith, and each of the two lateral traces associated with it passes outwards from the side of the apex of each of the adjacent lobes of the pith. The depressions on the sapwood surface caused by the leaf traces disappear at a distance of 1·2 cm. ($\frac{1}{2}$ in.) above and below the centres of the traces.

Examination of a transverse section of a stem 9 cm. (3·5 in.) in diameter, represented in text-figure 2, shows that slight irregularities in the zones of growth make their appearance after the five indentations of the young stem have disappeared. These slight irregularities frequently become more prominent in outer portions of the stem and produce the slightly sinuous outline of the sapwood surface. In large stems the irregular zones of growth become very conspicuous and terminate in the strongly corrugated surface of the sapwood (see text-figures 3 and 4).

Upon microscopic examination of sections of young stems it is seen that the rays in the wood extending outwards from the projecting lobes of the pith diverge from one another in a fan-like manner, whilst the rays in the wood passing outwards from the indentations of the pith are almost parallel. It is, therefore, indicated that the wood outwards from the projections of the pith expands in a lateral as well as in a radial direction, whilst that outwards from the indentations of the pith undergoes little or no lateral extension. This unequal lateral development of sectors of the stem is shown by the preservation of the outlines of the pith indentations almost unaltered in the zones of growth of the young



Text-figure 2.—Transverse section of stem of young tree of *Arytera Lautereriana*, natural size, showing the 5-lobed pith, a number of small, dark patches (between the pith and the bark) and the sinuate surface of the sapwood.

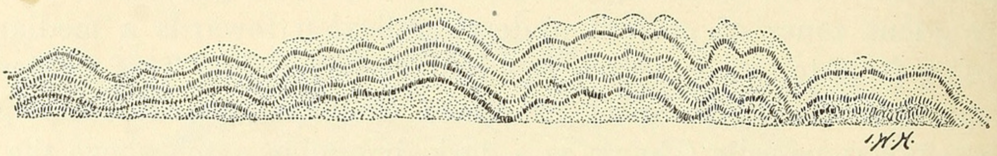
stems. Although the irregularities of growth associated with the pith indentations and the leaf traces are not prominent on the surface of the woody cylinder of one stem measuring 4 cm. (1·6 inch.) in diameter, the inflexions caused by some of the indentations of the pith are still noticeable on the surface of the sapwood of another stem measuring 22·5 cm. (9 in.) in diameter. The narrow band of tissue associated with the leaf traces consists of aggregated rays.

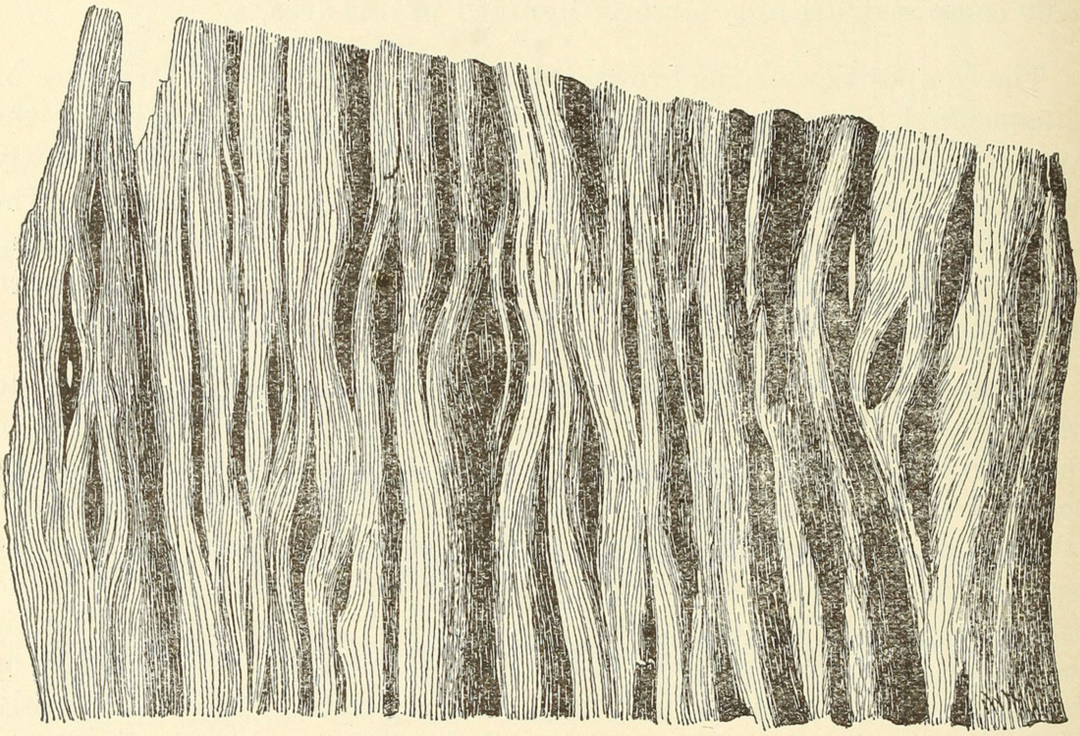
In several instances depressions on the sapwood surface of larger stems have been traced inwards in a radial direction to small, brown-coloured patches. Photomicrographs 5 and 6 show a portion of a section of the tissues in and surrounding one of these brown-coloured patches which was situated about 2 cm. (·8 in.) from the centre of the stem. The dark area shown in the lowermost part of photomicrograph 5 and towards the middle of photomicrograph 6 represents the small, brown-coloured patch. This dark area owes its appearance to a deposit in the cells of the wood. The deposit is a substance which gives the same colour reactions as tannin to reagents such as ferric salts (dark blue colouration) and potassium bichromate. The upper, dense part of the dark, tannin-bearing area is fairly sharply defined by a zone of growth in the wood. Subsequent zones of growth undergo inflexion towards a median line running from top to bottom of the photomicrographs. This median area is characterised by a small group of thick-walled, copiously pitted, parenchymatous cells (shown as a dark, irregular patch above the dark, tannin-bearing zone) and by the absence of vessels and the presence of cells with comparatively large lumina and thin walls. The thin walls indicate that the septate fibres, of which the wood of this species is chiefly composed, are only slightly lignified in this area.

The composition of the brown-coloured patches and the structure of the associated tissues as described and illustrated are suggestive of the effects of injury. On the young stems of this species there are frequently oval or elliptical scars possibly caused by the attacks of insects. The tissues beneath these scars show a deposit of the tannin-containing substance in the fibres of the injured area which consists of confused tissue containing many radially directed and oblique septate fibres.

A polished section showing the small, brown-coloured patches, to which some of the sapwood indentations were traced, was shown to Professor E. C. Jeffrey, who was then on a visit to Brisbane, and he remarked that the brown-coloured patches were "medullary patches" or "pith flecks." Herbert Stone ([7], p. 187) states that pith flecks are the result of injury to the cambium by minute insects, such as *Agromyza carbonaria*, which burrow under the bark. A similar explanation is adopted by S. J. Record[8] who states that pith flecks are composed of irregularly shaped, parenchymatous cells with thick walls copiously pitted with simple pits. These thick-walled cells are evidently similar to those described above by the writer as associated with the small, brown-coloured patches. It is, therefore, evident that some of the sapwood corrugations of *Arytera Lautereriana* are of pathological origin. The cambium of the trees is injured. As a result, concentric growth is arrested in the injured area and the cambium producing the subsequently formed wood loses the ability of forming vessels in radial areas extending outwards from the injured part. It will be shown subsequently that some of the sapwood corrugations are associated with radial bands of tissue from which vessels are excluded.

The wood beneath and in the vicinity of prominent indentations of the sapwood surface in mature trees measuring about 30 cm. (12 in.) in stem diameter, exhibits the structure shown in photomicrographs 3 and 4. The transverse view shows the inflexion of the zones of growth associated with two parallel, dark bands of aggregated rays which are disposed in a radial position in the stem. Vessels are absent from each of the aggregated rays and the rays constituting the aggregations are frequently several cells in breadth, showing that the normal, uniseriate rays of the wood have undergone fusion in many instances. The tissue between the two bands of collected rays consists of a few obliquely cut





Text-figures 3 and 4, natural size. 3 (upper): Transverse section of outer part of stem of large tree of *Arytera Lautereriana* with bark removed, showing the irregular outline of the surface of the sapwood and the irregular zones of growth. 4 (lower): Part of the stem of large tree of *Arytera Lautereriana* with bark removed, showing the corrugated surface of the sapwood.

vessels, a number of isolated, narrow, uniseriate rays, and many obliquely cut, septate fibres, which occupy the greater part of the space. The clearness of the section is marred to a certain extent by the abundance of the tannin-containing deposit present in the lumina of the fibres and in the cells of the rays. The tangential view shows a lens-shaped area almost surrounded by the two bands of approximated rays, which in turn are bounded on each side by tissue containing longitudinally cut vessels and uniseriate rays scattered throughout septate fibres. The lens-shaped area occupying the middle of the picture is characterised by several transversely cut vessels, scattered rays, and very numerous septate fibres cut in longitudinal, oblique, and transverse directions. Sections of the wood in the neighbourhood of some of the indentations show a less specialised development. In these cases there are two parallel bands of radially directed tissue from which vessels are absent. These bands of tissue possibly represent a stage in the development of the aggregate rays which have been described and are represented in photomicrographs 3 and 4.

The tissue situated between the two aggregate rays, which are associated with the sapwood indentations, is often of a less durable character than that of the normal wood. It is sometimes found in a decayed condition and detracts from the commercial value of the wood of the species.

(c) *Sarcopteryx stipitata.*

The anatomical features associated with the depressions in mature trees of *Sarcopteryx stipitata* are similar to those in *Arytera Lautereriana* in the later stages of growth. As in the latter species, the normal, scattered rays are mostly uniseriate or one cell in breadth, but in the two parallel bands of aggregate rays associated with the depressions large rays several cells in breadth are frequent.

(d) *Canthium latifolium.*

The corrugated sapwood surface is evident in trees of *Canthium latifolium* when they attain a stem diameter of 2·5 cm. (1 in.). The sections illustrated in photomicrographs 7 and 8 were prepared from a stem 4 cm. (1·6 in.) in diameter. They show that the anatomical features connected with the sapwood depressions are similar to those in mature trees of *Arytera Lautereriana.* The scattered rays of the wood are mostly one or two cells in breadth, but those approximated in the two parallel bands associated with the indentations are frequently much broader.

(e) *Cryptocarya corrugata.*

Sections of large stems of *Cryptocarya corrugata* also exhibit structural features in connection with sapwood indentations similar to those in *Arytera, Sarcopteryx,* and *Canthium.* In this species the scattered rays of the wood vary from one to three cells in breadth, whilst those approximated and partly fused in bands and related to the sapwood indentations are often considerably larger. The occurrence of two parallel bands of rays, which is remarked upon in the three preceding species, is not shown in the sections represented in photomicrographs 9 and 10. These sections were prepared from a piece of wood collected by the writer from a comparatively small tree about 22 cm. (9 in.) in stem diameter which also furnished the herbarium specimens constituting the type material of the species. The sapwood indentations were not so strongly developed in this instance as in larger trees of the species. In a large tree the indentations attained a length of 13 cm. (5·2 in.) and a depth of 5 mm. (·2 in.). In a specimen of the wood of the species supplied by the Queensland Forest Service, the occurrence of two parallel bands of aggregated rays in connection with inflexions of the zones of growth is frequent.

(F) *Casuarina inophloia.*

The transversely cut surface of the stem of *Casuarina inophloia* shows that the rays are comparatively narrow near the centre, but become gradually broader as they pass outwards. It also shows that the young stem was cylindrical until it attained about 8 mm. (·3 in.) in diameter, and that in subsequent growth the corrugated character of the sapwood gradually made its appearance. The indentations of the sapwood in mature trees attain a length of 3 cm. (1·2 in.) and are a prominent feature of the stem when the bark is removed. The structure of a large aggregate ray related to an indentation is shown in photomicrographs 11 and 12. The tissue composing the ray is much more compact than that of corresponding structures in the other species described in this paper. A few wood fibres are seen traversing the ray in oblique and transverse directions in the tangential view, and uniseriate rays are scattered throughout the wood on each side of the aggregate ray. The double or paired character of the structures in *Arytera, Sarcopteryx*, and *Canthium* is not evident in this instance.

V. Summary.

A transverse section of the stem of *Villaresia Moorei* indicates that the young tree retained an approximately cylindrical stem until it attained a stem diameter of about 17·5 cm. (7 in.). Subsequently the section of the stem assumed an angular contour and growth in thickness towards the extrusions proceeded at three times the rate of growth towards the grooves. The inception of irregular growth was succeeded by the convergence of the wood rays in their outward course in the sectors bounded by the grooves. In these sectors the convergence of the rays was frequently accompanied by an increase in the breadth of the rays, the occasional extinction of vessels and wood fibres, which were replaced by patches of parenchyma, and finally the appearance of folds or crenulations in the outer zones of growth. The convergent rays and the folded zones of growth are suggestive of lateral pressure, which might have caused the peculiar structure of the wood in the sectors bounded by the grooves. The lateral pressure would result from the irregular growth, which, in its turn, is associated with the development of the principal surface roots.

Transverse sections of young stems of *Arytera Lautereriana* exhibit five indentations alternating with an equal number of rounded extrusions on the external surface of the woody cylinder. The configuration of these indentations and extrusions corresponds to the outline of the pith. Smaller indentations occur at the region of the node in relation to the median and lateral leaf traces. In some instances depressions on the surface of the sapwood of a stem measuring 9 cm. (3·5 in.) in diameter were traced inwards to small, brown-coloured patches, which upon sectioning were found to be areas in which the lumina of the cells of the wood are filled with a brown substance, which gave reactions similar to those of tannin on the application of solutions of ferric salts and potassium bichromate. These small, brown patches contain groups of thick-walled, copiously pitted parenchymatous cells in addition to the normal elements of the wood. They appear to be the result of injury, possibly by insects. The prominent indentations of mature trees are connected with pairs of large, aggregate rays terminating in the surface of the sapwood where the indentations occur. The sapwood indentations of *Sarcopteryx stipitata* and *Canthium latifolium* are associated with similar pairs of large, aggregate rays. Large, aggregate rays are also related to the corrugations of *Cryptocarya corrugata* and *Casuarina inophloia*. Aggregate rays in association with sapwood indentations occur in some of the higher dicotyledons as well as in some of the lower orders of that class, as indicated by their occurrence in the Natural Order Rubiaceæ. The indentations were found to be most prominent in large, mature trees of the various species examined.

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[Botanic Gardens, Brisbane.]

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EXPLANATION OF PHOTOMICROGRAPHS WITH NOTES ON THE ANATOMY OF THE WOODS.

Plate XIII.

1. Transverse section of normal wood of *Villaresia Moorei.* Some of the vessels show portions of the scalariform perforations of their terminal walls as bands crossing the lumina. The rays are of two kinds, multiseriate and uniseriate, and constitute the darker bands passing from top to bottom of the picture. The wood parenchyma is shown as dark cells either single and scattered or in rows arranged transversely to the rays or partly surrounding the vessels. The remainder of the tissue consists of the fibrous elements, the tracheides, which have small lumina and thick walls and constitute the lighter portions of the picture. In longitudinal sections the perforations of the tracheides are seen to consist of bordered pits and the lateral walls of the vessels are provided with scalariform openings. According to A. Engler (Engler und Prantl, Die naturl. Pflanzenf, III., V., 235, 1896) the wood of Icacinaceæ (in which *Villaresia* is included by Engler) is characterised by tracheides with bordered pits and vessels with scalariform openings.

2. Transverse section of the wood of *Villaresia Moorei,* showing the transition from the normal wood to parenchymatous tissue in a part of the sector of the stem bounded by a deep groove. In the lower and right side of the picture the vessels, rays, wood parenchyma, and tracheides of the normal wood are seen. In the upper and left side the elements of the normal wood are replaced by large, more or less rectangular cells constituting parenchyma.

3. Transverse section of the wood of *Arytera Lautereriana,* showing two large, aggregate rays as dark bands traversing the median portion of the picture. Three inflexions of the rings of growth are shown on each side of the aggregate rays. Some obliquely cut vessels are seen as elliptical, light spots in the area between

the two aggregate rays. Transversely cut vessels are numerous in the normal wood to the left and right of the pair of aggregate rays and appear as light, round or oval spots. The fine lines passing from the top to the bottom of the picture represent the normal, uniseriate rays of the species.

4. Longitudinal section of the wood of *Arytera Lautereriana,* showing the lens-shaped area enclosed between two large aggregate rays. The lens-shaped area occupies a median position and passes from top to bottom of the picture. In it transversely and obliquely cut vessels are represented as light, round or elliptical spots. The long, light bands passing from top to bottom represent vessels in longitudinal section. The innermost, longitudinally cut vessels are shown as partly bending round the aggregate rays which surround the median, lens-shaped area.

5. Transverse section of the wood of *Arytera Lautereriana,* showing inflexions in the rings of growth. The dark area in the lowermost part of the picture is part of a small, brown-coloured patch to which a sapwood indentation was traced. The opacity of the area is due to the presence in the lumina of the cells of a brown substance which gave reactions for tannin. The upper boundary of the dark area defines the boundary of a growth ring. Subsequent rings of growth are inflexed towards the middle of the picture and vessels are absent from the median area in a narrow band passing from the dark area to the top of the picture. The small, irregular dark area just above the lowermost dark segment consists of a cluster of thick-walled, copiously pitted parenchymatous cells. The normal wood of this species is composed of septate fibres, vessels and rays. The cluster of thick-walled parenchymatous cells appears to be abnormal and to result from injury, possibly by insects. The fine, dark lines passing from top to bottom of the picture represent the rays. The light, round areas represent the vessels.

6. Transverse section of the wood of *Arytera Lautereriana,* showing the same section as represented in the preceding picture but a little further towards the centre of the stem. The dark, tannin-containing area partly shown in the lowermost part of the preceding picture is more fully depicted in this picture.

Plate XIV.

7. Transverse section of wood of *Canthium latifolium,* showing two parallel aggregate rays passing from top to bottom of the picture. These aggregate rays are connected with a depression of the sapwood surface and inflexed zones of growth. The normal 1-2 seriate rays are shown on each side of the aggregate rays. The vessels, which are comparatively small, are absent in the two aggregate rays, but plentiful on each side and between them. Wood parenchyma is present, but is not conspicuous in the picture. It is scattered or adjoins the vessels. The wood fibres have very narrow lumina and thick walls, the lumina being as wide as the walls are thick.

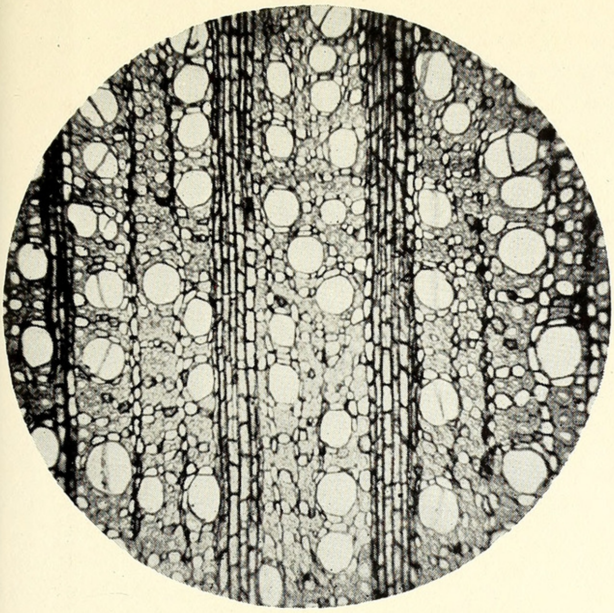
8. Longitudinal section of wood of *Canthium latifolium,* showing two aggregate rays which are associated with a sapwood depression. The two aggregate rays are shown on the right and left sides of the picture, and are characterised by the absence from them of vessels, which are represented as long, light bands. Some wood parenchyma is shown as rectangular cells towards the middle of the picture.

9. Transverse section of wood of *Cryptocarya corrugata,* showing a large aggregate ray situated in the median portion of the picture. The inflexion of the zones of growth in and near the aggregate ray is evident. Further out the aggregate ray terminates in a sapwood indentation. The two dark bands crossing the aggregate ray consist of wood parenchyma, which is arranged in tangential bands. The thickness of the walls of the wood fibres is $\frac{1}{4}$-$\frac{1}{3}$ of the diameter of the lumina, and the pitting of the fibres appears to be confined to their radial walls.

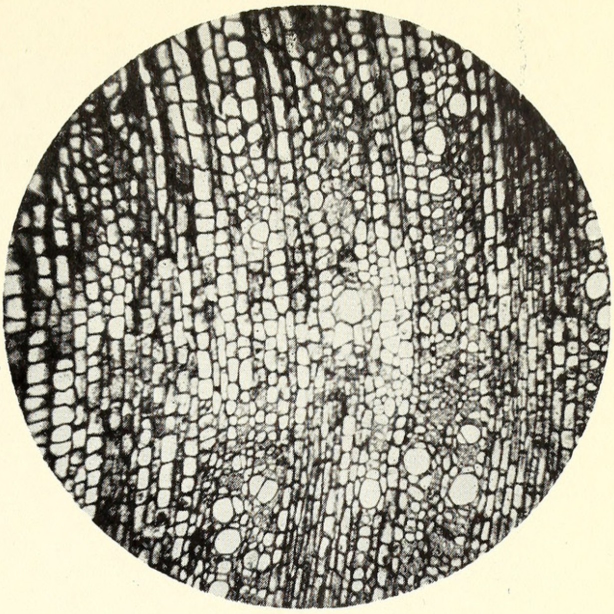
10. Longitudinal section, showing a large aggregate ray in wood of *Cryptocarya corrugata*. The aggregate ray is situated near the middle of the picture. Towards the extreme right and left longitudinally cut vessels are shown. Between the vessels and the large, aggregate ray scattered rays occur.

11. Transverse section of the wood of *Casuarina inophloia*, showing a very large aggregate ray accompanied by a pronounced inflexion of the zones of growth. Further out the aggregate ray terminates in a prominent sapwood indentation. Narrow bands of wood parenchyma, which is arranged in tangential layers, are evident in the picture and are shown as rows of cells, some of which are light and others dark. The walls of the wood fibres vary in thickness from one-half to twice the diameter of the lumina. In longitudinal sections, the lateral walls of the vessels are seen to have scalariform perforations.

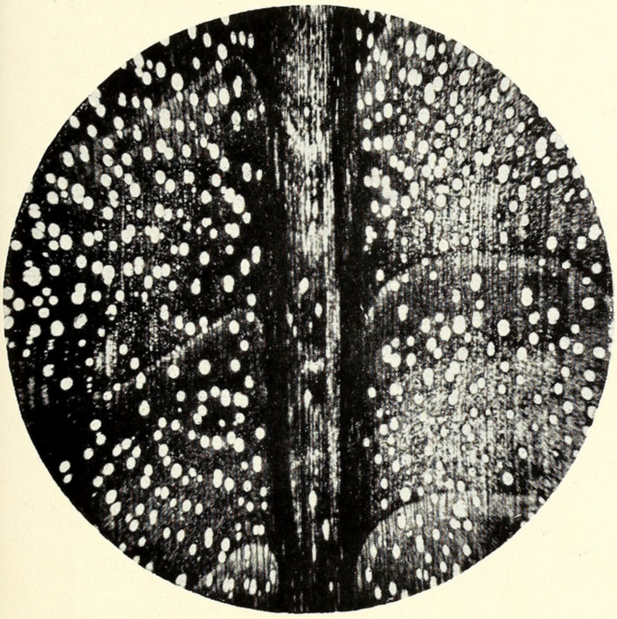
12. Longitudinal section of the wood of *Casuarina inophloia*, showing a large aggregate ray which is connected with a prominent sapwood indentation. The aggregate ray occupies the median portion of the picture; passing through it in transverse and oblique directions is a number of wood fibres. The tissue on the right and left of the aggregate ray consists of wood fibres, vessels (the large light bands in lower part of picture), many uniseriate rays (small, spindle-shaped areas tapering at each end) and wood parenchyma (composed of rectangular cells).



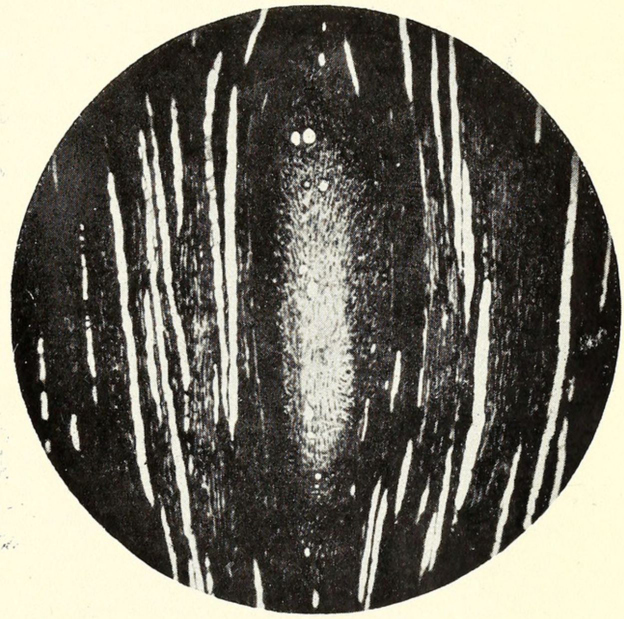
1. Villaresia Moorei × 35



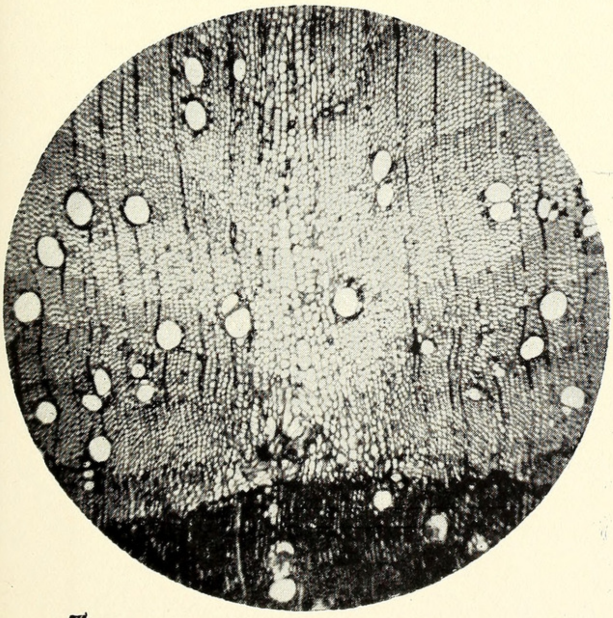
2. Villaresia Moorei × 35



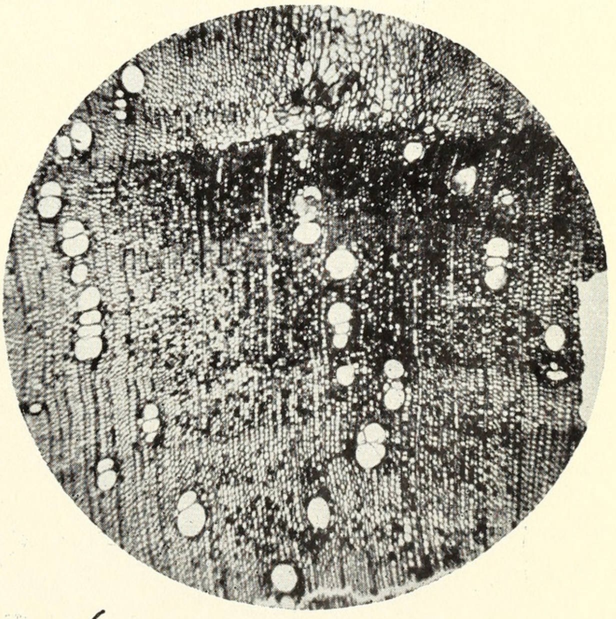
3. Arytera Lautereriana × 8·5



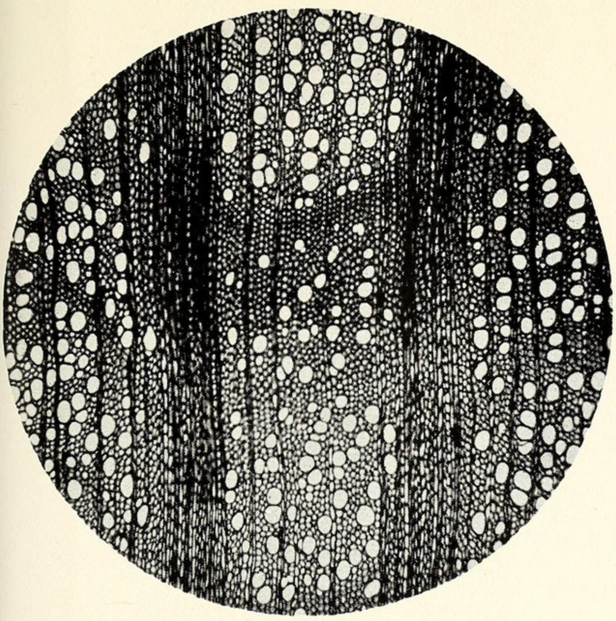
4. Arytera Lautereriana × 8·5



5. Arytera Lautereriana × 35

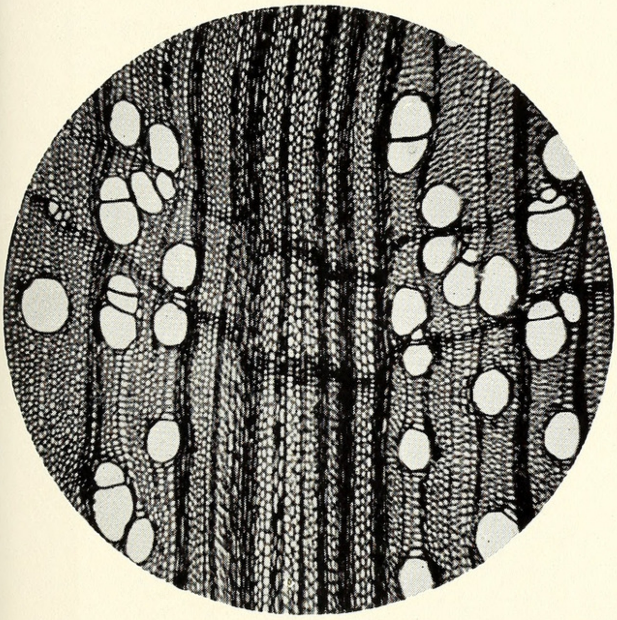


6. Arytera Lautereriana × 35

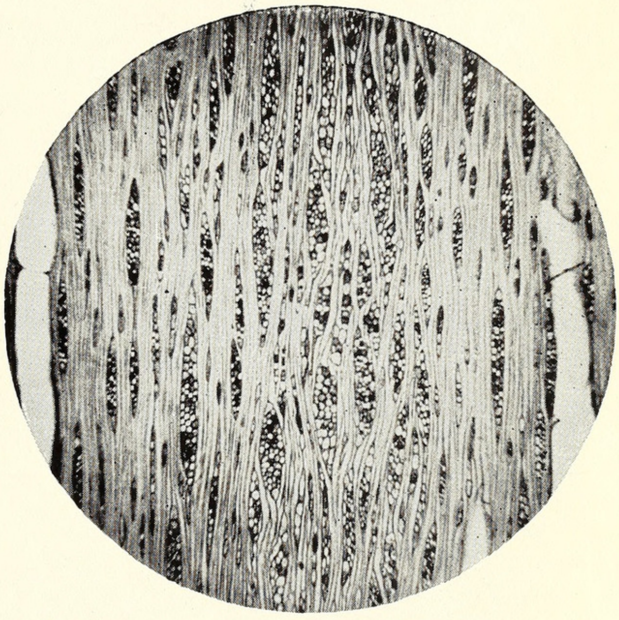


7. Canthium latifolium × 35

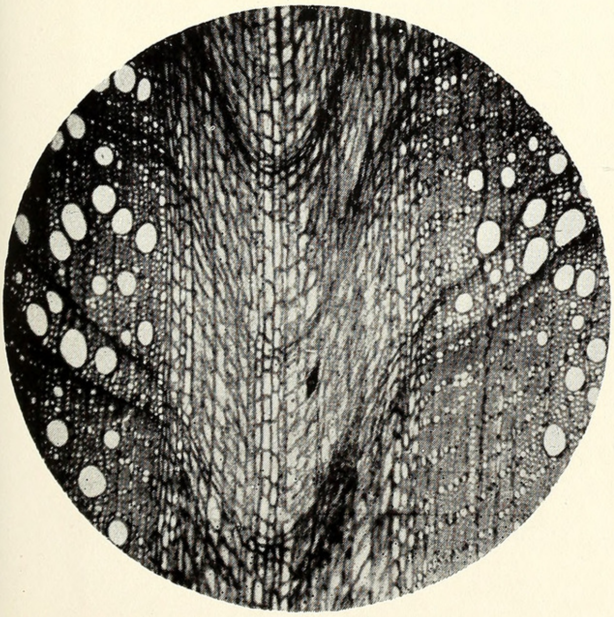
8. Canthium latifolium × 34



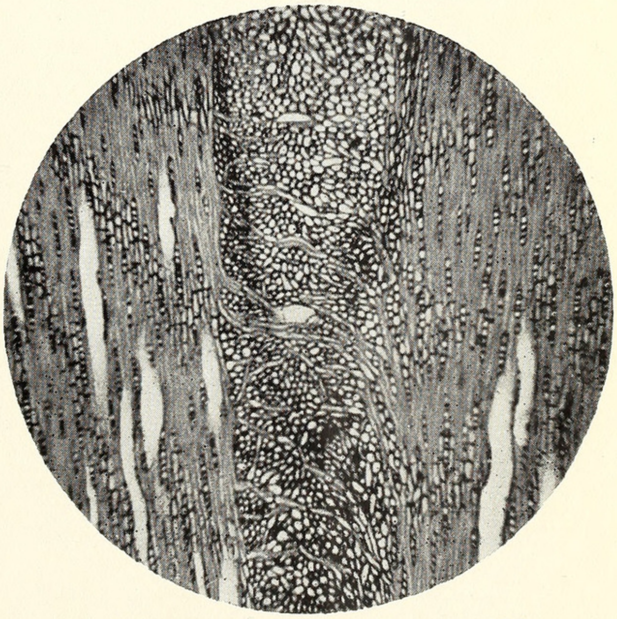
9. Cryptocarya corrugata × 35



10. Cryptocarya corrugata × 34



11. Casuarina inophloia × 37



12. Casuarina inophloia × 36