THE OCCURRENCE OF "GUM VEINS" AND "POCKETS" IN MARRI

(EUCALYPTUS CALOPHYLLA)

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The product referred to as 'gum' throughout this paper is a chemical compound rich in tannin which is secreted in 'veins' and 'pockets' in the timber of Eucalyptus calophylla in such quantities as to cause the tree to be known as redgum in preference to its more euphonious native name of Marri.

The presence of numerous gum veins renders the wood of Marri useless as a commercial timber, with the result that this valuable hardwood, which is light and has great tensile strength, is practically unknown on the timber market. The gum from recent investigations appears to have great possibilities as a commercial tanning agent.

The commercial possibilities of wood and gum are such as to justify a very complete investigation of the theories and conclusions set out hereunder.

The most important conclusion supported by all evidence available is that gum veins and pockets in the wood of Eucalyptus calophylla are a pathological phenomenon developing as a direct result of injury to the tree and that secretions of gum are not formed in the ordinary metabolic processes.

CAUSE OF GUM VEINS.

The injury giving rise to a gum vein must be of such a nature as to cause a break in the bark and thus allow the access of air to the recently formed sapwood. It would seem (as may be gathered from reference to Diagrams Nos. 1 and 2) that the undifferentiated xylem region of the actively dividing cambium must be exposed to the air. The above facts alone are strongly suggestive of bacterial infection.

The most frequent and serious cause of injuries of such nature as to give rise to gum veins and small gum pockets are wood boring larvae of the genus Phorocantha.

Observations concerning the long period of their life history which these larvae spend in the wood of the Marri are set out below.

(1) The small larva has been observed boring within the bark, and one case in which the larva touched the sapwood forming the nucleus of a gum vein and then returned and continued boring in the bark before going into the wood was noticed. In this case the larva was found to have completely bored its way twice around the periphery of a sapling, continuing in the young bark before making a second attempt to enter the wood. A larva was found entering the wood at the beginning of April, which date is of considerable importance in the support of subsequent theories. The entrance hole of the small larva is soon occluded, but invariably forms the nucleus of a gum vein.

(2) The larva which, on entering the wood, may be one inch in length, grows in size as it bores its way through the wood, mounting up the tree in an irregular spiral. The borer may proceed up the trunk of the tree a vertical distance of six feet in this manner. The mode of exit of the imago was worked out as the result of the original investigation carried out at Mundaring Weir in July, 1920, but the length of channel bored by the larva suggested several years' work, and the question of how the growing insect obtained sufficient oxygen to carry on was a perplexing problem. Towards the end of May, 1921, however, traces of sawdust were noticed at the foot of and on the bark of Marri saplings and trees growing at Ludlow. Investigation showed that this sawdust issued from small circular holes in the bark, caused by borers already within the trunk boring their way out to the air, and then turning round and continuing their upward channel in the wood. This boring to the outside and returning in the wood provides a reasonable solution to several difficulties. It explains -

(a) Why it is often difficult to follow the chan nel made by the borer.

(b) The great abundance of holes in the bark from which gum exudes.

(c) How one borer may cause several gum veins by exposing the cambial region of the tree to the air periodically. There is the possibility of the borers observed in different localities being different genera, but I do not regard this as likely.

(3) The third stage in the boring activities of the larva is the elaborate preparations which appear to precede the formation of a pupal chamber. A circular area of sapwood surrounded by a somewhat deeper channel is cleared away directly under the bark, as shown in Diagram No. 6.

Having cut away the sapwood and part of the bark, so as to leave a free exit for the imago, it bores into wood again with the object of making a pupal chamber. The subsequent occlusion of these surface borings gives rise to a ~~species of~~ small gum pocket. The same class of injury due to a species of borer with similar habits may be noticed causing unsightly flaws in Jarrah timber in which they occur with very much less frequency.

After twelve months' search, two specimens of the imago were secured almost simultaneously, one having died in the pupal chamber and the other being caught in a flow of gum when leaving the tree. The large longicorn beetle has been identified by Mr. A. M. Lea, Museum Entomologist, South Australia, as Phorocantha tricuspis, Newm., var. Gigas, Hope. There are many species of Phorocantha and it is feasible that several species are responsible for similar borings all giving rise to gum veins.

Many trees exude gums and resins as the result of insect borings, and similar exudations may be found on the same tree as the result of attacks by very diverse insects. A fact favouring the theory of bacterial infection. The importance of the above-mentioned insect in this case, however, lies in the fact that it is apparently the only borer which attacks living trees of this species; the local 'pin-hole' borers appear to confine their activities to dead or dying timber.

Other sources of infection are burning back of branches, mechanical injury caused by falling timber, etc. The relation of fire to gum veins is obscure, but a mere scorching of the outside bark does not cause the formation of a gum vein.

It is of interest to note that the cutting of the tender green bark of small shoots may give rise to gum veins in the outer xylem region of twigs not more than 0.1 inch in diameter.

THE OCCURRENCE OF GUM VEINS

The wood anatomy of eucalyptus is but little understood and certain peculiarities of cell structure are intimately associated with the occurrence of gum veins. From the centre of infection, as the nucleus of the vein may be called, the development takes place in all directions on a cylindrical surface. Its radial development is invariably limited to a fraction of an inch, usually about one-tenth; while the longitudinal and peripheral development may extend several feet. Gum pockets are only formed by the occlusion of injuries when space may be left under the occluding tissue, which subsequently becomes filled with gum, consequently the presence of pockets containing liquid, even when deeply seated, may usually be located by external swellings.

MACROSCOPICALLY a gum vein in transverse or longitudinal sections shows a series of openings full of gum interspersed with strands of partially lignified tissue.

MICROSCOPICALLY Marri timber shows all the elements of dicotyledonous wood structure. The vessels and wood fibre show no unusual features, but the wood parenchyma is arranged in very decided concentric bands. See Diagrams 4 and 5. These concentric bands consist of slightly lignified isodiametric cells with simple pits in their walls. The development of these bands appears to be seasonal, for they occur with greatest frequency at intervals which may represent either six or twelve months' growth. These isodiametric cells in the heartwood, as well as the sapwood, contain, during certain seasons of the year, large quantities of starch granules. Wood cut in July was found to be rich in starch and granules were found in parenchymatous tissue five inches in from the cambium. This storage of starch in large quantities may account for the development of the wood boring larva mentioned above, which grows from one inch in length on entering to 3 inches in length with proportional girth development before pupating.

Starch is not stored in the medullary rays, which are probably only used in the transference of food supplies.

Gum veins only occur in the xylem region, and never in the bast. They are invariably surrounded and crossed by solid masses of parenchymatous tissue pitted and slightly lignified as described above.

See diagram No. 3.

ORIGIN OF A GUM VEIN.

A gum vein can only develop in the undifferentiated tissue immediately on the xylem side of the cambium. Gum may form and pour out from a vein more deeply seated, but it would appear that the development and enlargement of the inter cellular secretory reservoir only takes place immediately beneath the cambial region.

Diagrams 1 and 2, which show gum veins in the process of formation, were cut from a sapling felled May 20th, 1921, and a study of sections cut from fresh material collected at this time of the year suggested that either with the advent of the rains at the end of April the meristematic tissue of the cambium begins to divide rapidly, giving rise to much parenchymatous tissue, which in the ordinary course of events becomes differentiated into xylem elements, or that the first tissue laid down at the beginning of the autumn growing season is a concentric band of wood parenchyma. If the latter is the case, then the infection of the band and the formation of a gum vein within it must give rise to some stimuli which result in the abnormal development of a much larger concentric band of parenchymatous tissue than is usual.

It seems that, when this undifferentiated tissue is exposed at one point to the external atmosphere, a centre of infection is set up which results in the disintegration of masses of the parenchymatous cells. The disintegration spreads from numerous centres, and the secretory reservoirs formed are soon filled with gum. These inter cellular spaces are rapidly linked up and form the typical gum vein. How the tree succeeds in limiting the radial development of the gum veins requires further investigation; there are three possibilities which may each play a part.

(1) As the growing season progresses, the natural process of differentiation and lignification of wood parenchyma may succeed in isolating the secretory reservoirs from the undifferentiated tissue.

(2) The autumn growing season may be interrupted by cold weather and the development of slight lignification may prevent further infection of the newly formed xylem tissue.

(3) If the development of gum is due to bacterial infection, the concentration of toxic compounds may become such as to arrest the activities of the organism.

If the tree has two growing seasons, one in autumn and one in spring, it is feasible that gum veins may also be formed in spring.

As the tree continues to grow and the gum veins become further from the cambium, the tissue surrounding it develops, as has been indicated above, into typical wood parenchyma.

See diagram No. 3.

The gum also, which is at first a thin fluid, becomes more viscous and consequently there is little to be gained by tapping the heartwood of Marri trees for gum although the hole may traverse numerous veins.

The gum in recently formed veins is under a certain amount of pressure and flows readily through any exit hole or into any occluded 'pocket' within the tree. A comparatively large flow of gum may be obtained from a single vein, as may be seen from the stained condition of the bark of Marri trees attacked by borers. The gum appears to oxidise on reaching the air and masses of the so-called 'crystalline' gum may be found adhering to the bark outside the hole through which it has escaped.

CONCLUSIONS.

(1) That gum veins and pockets are not formed in the ordinary metabolic processes of the tree.

(2) In order that a gum vein may be formed, the sapwood immediately beneath the cambial layer must be exposed to the air.

(3) That the most fruitful cause of gum veins are wood boring larvae of the genus Phorocantha.

(4) That if supplies of gum are required, boring into the sapwood at the right time of the year will cause the formation of a vein and a flow of gum some weeks or months subsequent to the date of boring.

The whole subject requires a much more thorough searching investigation coupled with field experiments extending over several years.

Every effort must be made to work out the full life history of the species of insects which causes such tremendous damage, for I feel assured that, if these insects could be eradicated from the forests of Western Australia, Marri could be grown under forest conditions to provide a timber eminently suited for every many purposes for which we are at present forced to import American hardwoods. Also if the deductions drawn in this paper as to the development of gum veins are correct, it will be a simple matter to organise tapping and gum collecting for tanning purposes from young forests of Marri which spring up so readily on many patches of loamy soil through the Jarrah country.

Experimental work on the lines indicated is being started.

4.7.1921.

S. L. KESSELL.

Diagram No. 1.
Transverse Section of "Gum vein in course of formation
Cut from fresh material May 21st 1921

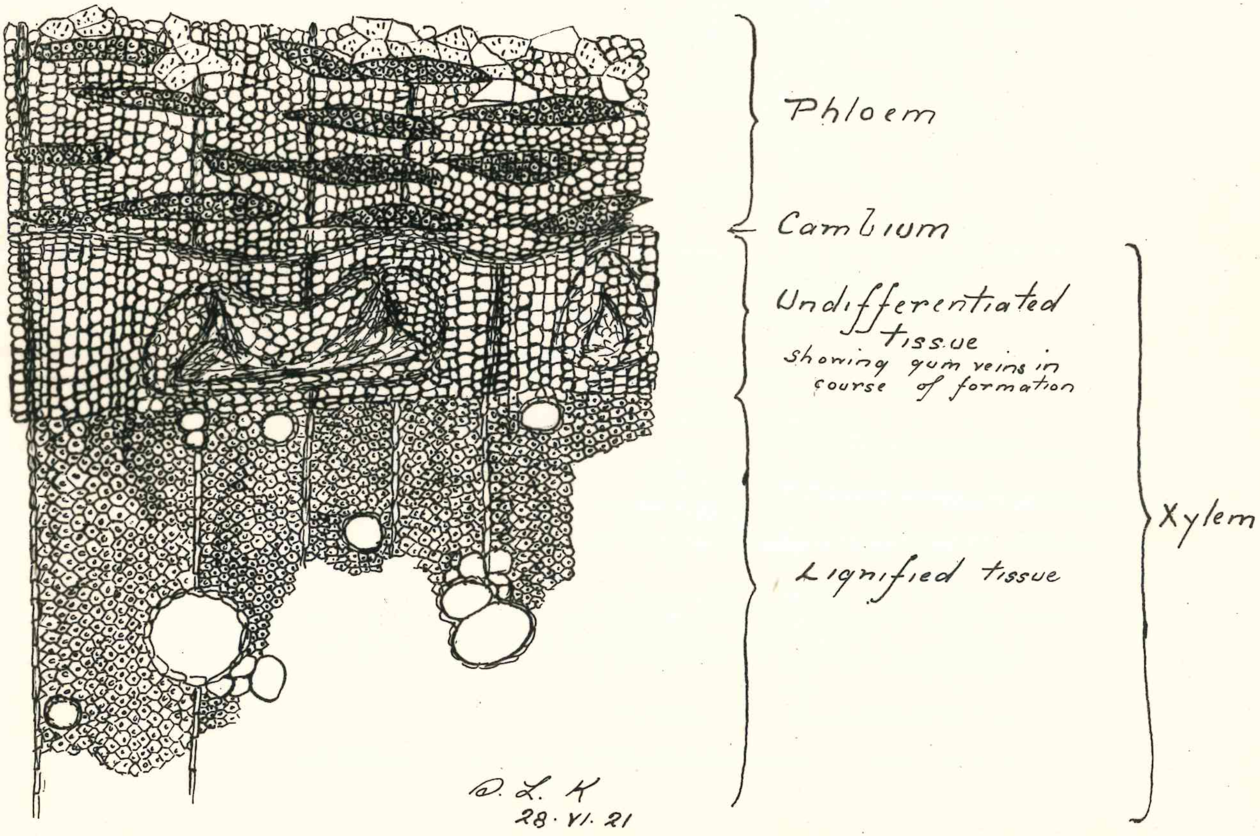

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Diagram No. 2
Longitudinal Section from same material as Diagram No. 1.

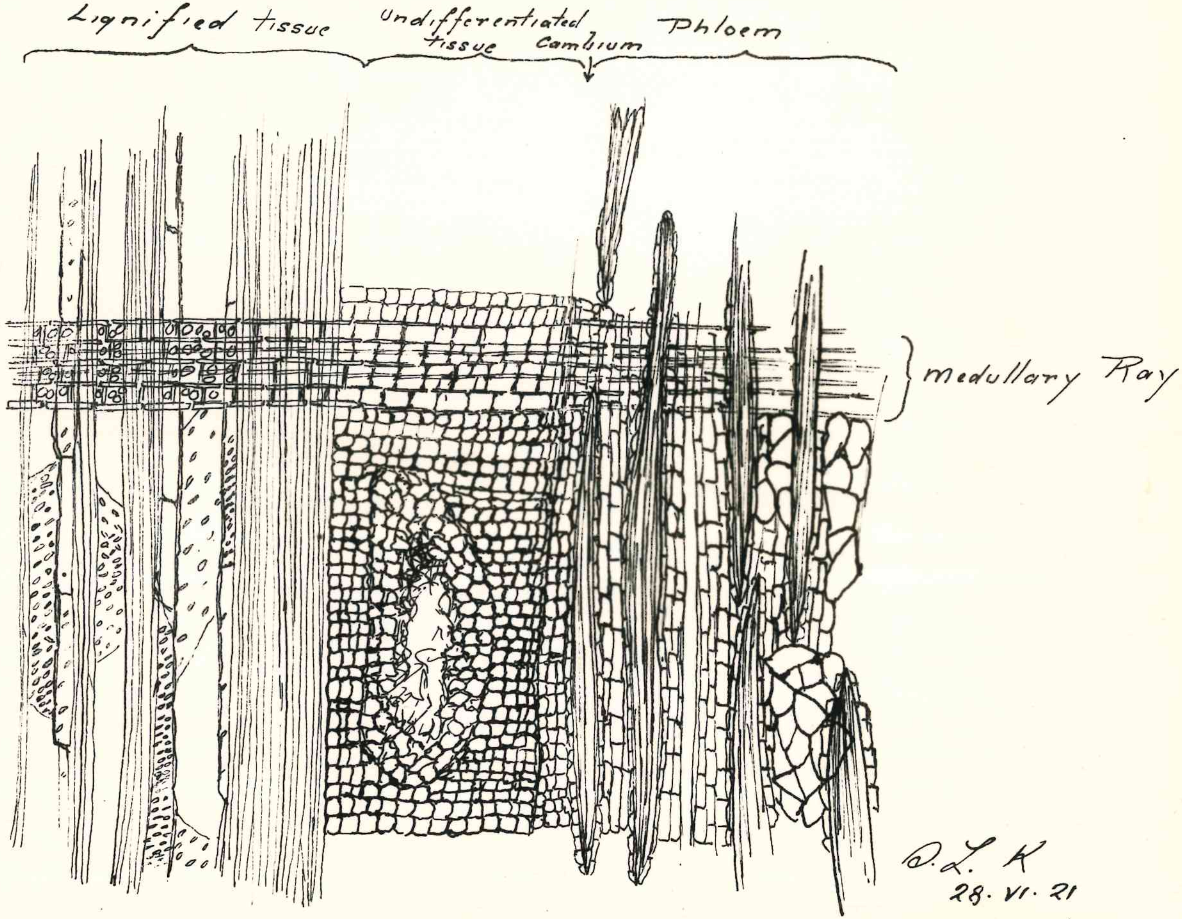

Diagram No. 3

Transverse Section of marri timber showing a small gum vein

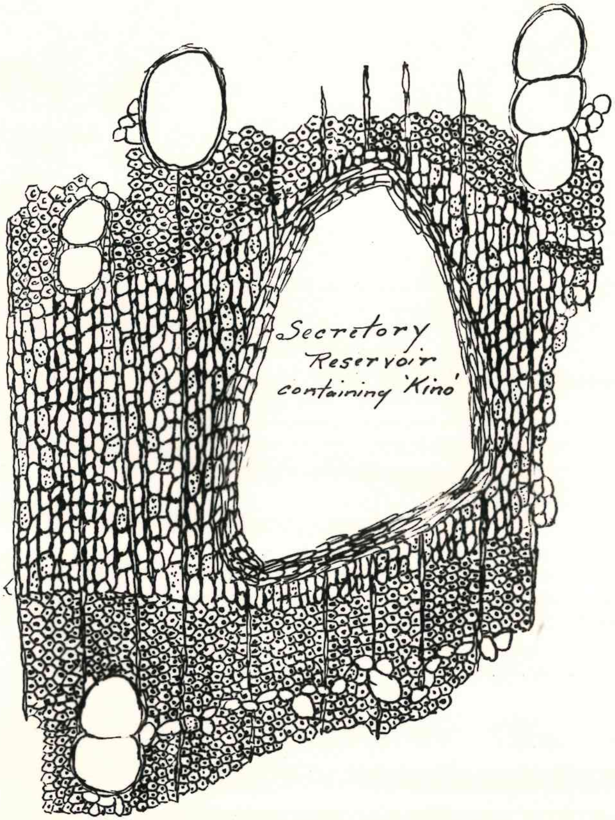

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Diagram N.° 4

Transverse Section showing concentric band of wood parenc
(under high power)

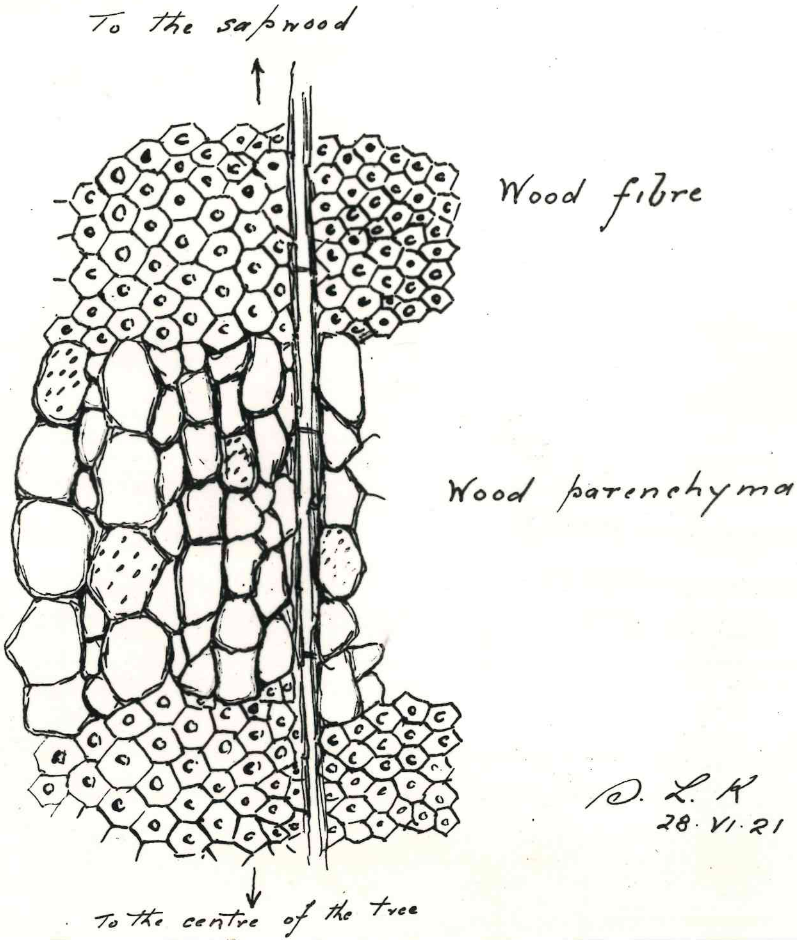

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Diagram No. 5

Longitudinal Radial Section of same material as Diagram No. 4 (under high power)

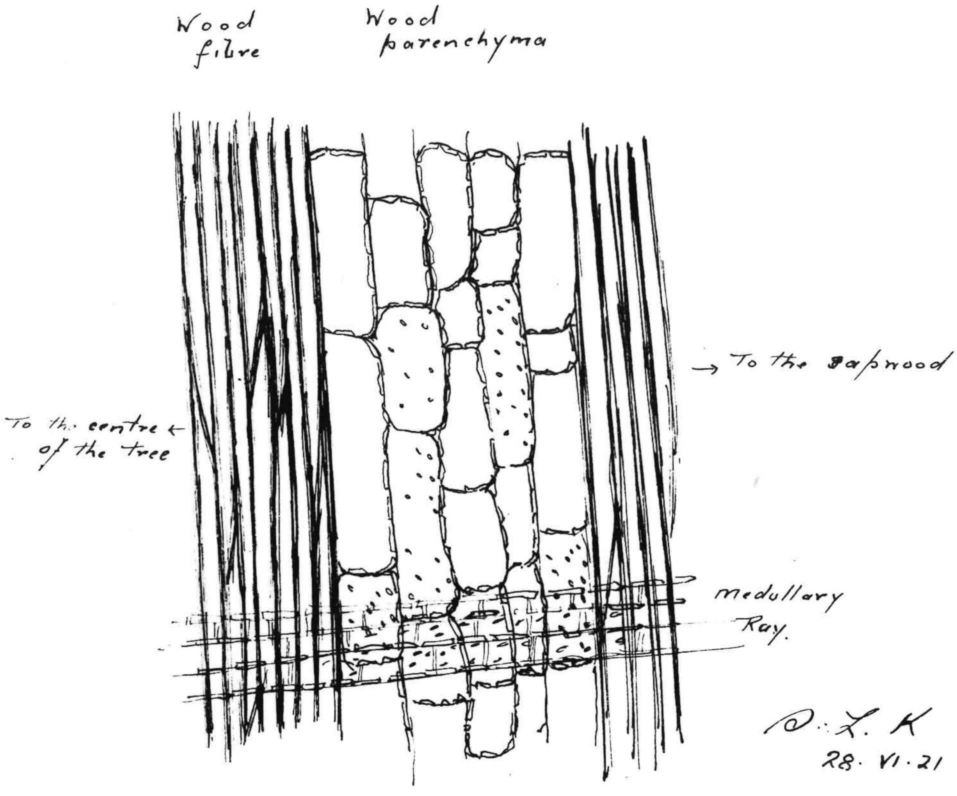

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Diagram No. 6

Sketch showing borings of larva in outer sapwood prior to the preparation of the pupal chamber — bark removed to show surface workings

Actual size

Reduced sketch showing opening in bark for exit of imago

a. Channel made by larva boring out from older wood

b. Entrance to boring leading to the pupal chamber

D. Lk

28. V. 21.