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Department of Conservation
and Land Management

Wood Utilisation Research Centre

KNOT SIZE AND ASSOCIATED DISTRIBUTION OF DEGRADED TIMBER IN KARRI

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SUMMARY

The presence of knots is generally the major cause for downgrading sawn boards of karri (*Eucalyptus diversicolor* F. Muell). A preliminary trial was conducted to obtain quantitative data on branch development in karri, and to relate branch size at the time of shedding to subsequent kino and rot development. These data are required in developing silvicultural management strategies which would result in increased recovery of high grade timber products.

Knot diameter was not related to the height of knots from the ground, and no relationship was found between the area of knot-associated kino or rot with either knot diameter or the height of the knot above the ground. Further research, examining trees from various sites, is required to determine whether these results relating knot size and associated degraded timber are representative of karri.

INTRODUCTION

The genus *Eucalyptus* has a highly efficient mechanism of shedding lower branches which have reduced utility owing to the effects of shading from the upper branches and nearby trees. After lower branches become moribund and die, a brittle or abscission zone develops close to where the branch emerges from the stem. The branches break off at this position and the remaining stubs are subsequently occluded by the radial growth of the tree (Jacobs 1955).

Branch diameter at the time of shedding influences the amount of degrade in timber caused by knots (Jacobs 1955). Jacobs observed that eucalypt branches up to 25 mm diameter tend to be shed with a clean chalky fracture at their base, and are likely to be occluded rapidly. However, larger branches (25 to 40 mm diameter) do not fracture cleanly, leaving a jagged or splintery surface, and once occluded are more likely to become centres of fungal infection and consequent rot and kino formation.

Of all the factors leading to the downgrading of sawn hardwood boards, the occurrence of knots is the greatest limiting defect. Bradshaw (personal communication*) suggested that perhaps the highest recovery of sawn timber is obtained from the clean bole section, followed by the green limb section, with the lowest recovery from the dead limb section.

There are approximately 126 000 ha of karri (*Eucalyptus diversicolor* F. Muell.) forest in CALM's estate, and about half is available for wood production. Sawn timber includes both structural and appearance products, and current grading criteria for appearance grade hardwoods (Standards Association of Australia 1985) favour clear wood.

This trial was preliminary research to obtain quantitative data on the branching habits of karri, and to ascertain whether branch development in karri is typical of the general model for eucalypts developed by Jacobs (1955). Silvicultural strategies could then be designed to maximise the recovery of high grade timber by reducing knot size and the occurrence of defect.

MATERIALS AND METHODS

Six codominant regrowth karri trees, approximately 65-years-old, from Treen Brook near Pemberton in the south-west of Western Australia, were selected to investigate their branching habits. The trees were docked to 4.8 m length logs up into the crown and each log was identified. They were then transported to the Wood Utilisation Research Centre at Harvey.

At the W.U.R.C., logs were docked to 2.4 m lengths, debarked manually, and sawn using the radial sawing pattern shown in Figure 1. This pattern was chosen to expose knots in cross section on the sawn boards. Logs were oriented for the first cut to maximise the sample size of green branches or branch stubs, indicated by lumps on the log's surface. Initially, two passes were made with a 'Forester 150' horizontal bandsaw to enable a 15 mm sap-to-sap board to be obtained through the centre of the log. The log halves were then placed together, rotated through 90° and dogged in position so that a further two half-width boards, aligned with the original location of the pith, could be sawn. The logs were thus split longitudinally into quarters. Each quarter was further processed using a 'Jonsered' vertical band re-saw to remove a 15 mm board from its centre.

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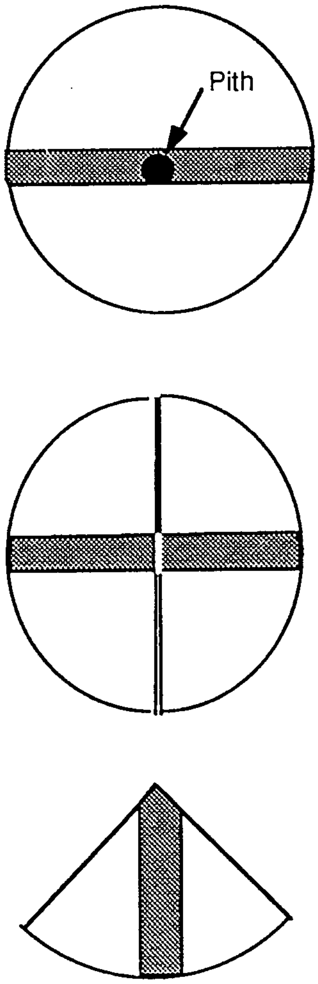
* Mr J. Bradshaw, Department of Conservation and Land Management, Manjimup.

Data obtained

The following data, where applicable, were recorded for each knot:

- knot diameter, measured at the fracture plane of the branch in the stem
- height of knot from the ground
- radius of green knotty core (the horizontal distance from the pith of the main stem to the inside edge of the occluded stub. Green knots are defined as those which are intergrown with the surrounding wood tissue)
- distance from the pith to the point of complete occlusion
- presence of rot or gum, brown wood (incipient rot), and borer activity associated with knots.

Owing to an oversight by the logging contractor, only one of the six 4.8 m butt logs was delivered to the research mill, and thus data from the important clean bole section of the tree are lacking. The data for the single butt log were also excluded in these circumstances.



Step 1.
15 mm board sawn through centre of log.

Step 2.
Log halves turned 90 degrees and two 15 mm half-width boards sawn through centre of log.

Step 3
15 mm board removed from centre of each quarter resulting from step 2.

Figure 1.
Radial sawing pattern used to expose knots in cross section

RESULTS AND DISCUSSION

From the six trees felled, 68 logs 2.4 m in length were sawn using the radial sawing pattern, revealing 148 knots in cross-section.

Knot diameter ranged from 7 to 115 mm with a mean diameter of 45 mm (S.D. 23 mm). Mean diameter probably would have been considerably lower if the 4.8 m butt logs had been included, because Jacobs (1937) had found a proliferation of small branches (less than 20 mm diameter) in similar material, whereas only 12 per cent of knots sampled in this trial with missing butt logs were 20 mm diameter or smaller.

There was no apparent relationship between knot diameter and height of the knot above the ground, but a large variation in branch diameters was found for heights above 7 m (Fig. 2). The size of the largest branches increased with height up to 15 m, approximately half of the bole height, where the maximum knot diameter of 120 mm occurred. Above this height the largest branch size was constant at about 80 mm. This pattern of knot size distribution was not consistent with the general description for eucalypts given by Jacobs (1937), who found that the size of the largest branches continued to increase with bole height and that branches of a range of sizes occurred only in the upper regions.

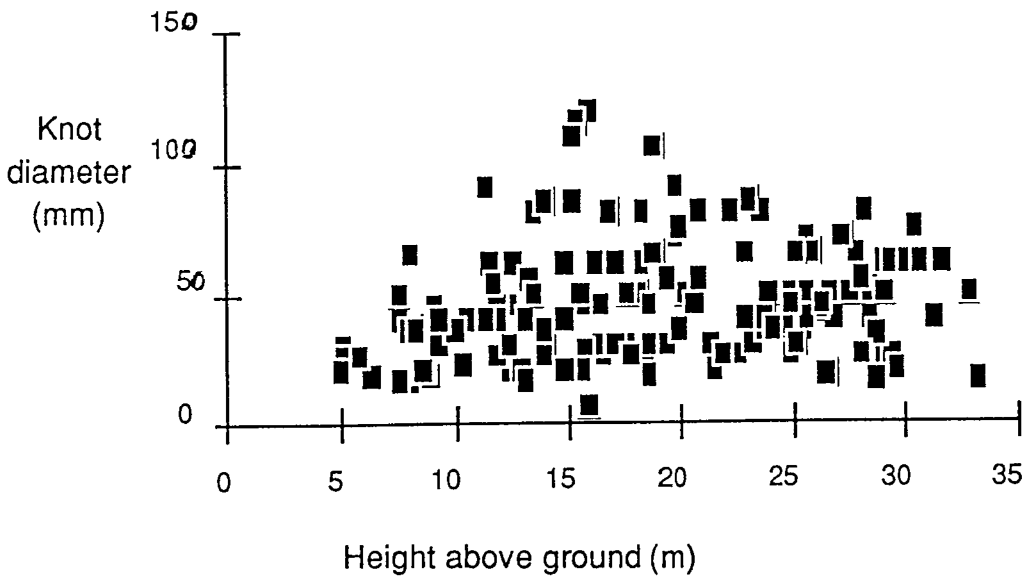


Figure 2.
Relationship between knot diameter and height of knot above the ground

No clear relationship was found between the diameter of encased knots and the area of associated gum or rot (Fig. 3). While some small branches (15 mm diameter) had up to 1700 mm² of associated gum and/or rot (including brown wood), some knots up to 80 mm diameter were clean. The amount of gum or rot associated with some knots of the same diameter varied considerably. For example, the area of gum or rot on boards with exposed knots of 45 mm diameter ranged from 0 to 7200 mm². These results differ from those of Jacobs (1955), who suggested that eucalypt branches larger than 30 mm in diameter do not shed cleanly, with the stubs remaining to occlude as dead knots, subsequently resulting in the formation of pockets of rot.

The silvicultural recommendations of Jacobs (1955), which aimed to limit branch diameters to 25 mm or less to minimise the extent of degraded wood caused by rot in occluded branch stubs, are less appropriate in karri if the small number of sample trees is representative. The value of this strategy would derive from reducing the volume of knots which downgrade structural graded karri, rather than affecting the volume of associated rot or gum.

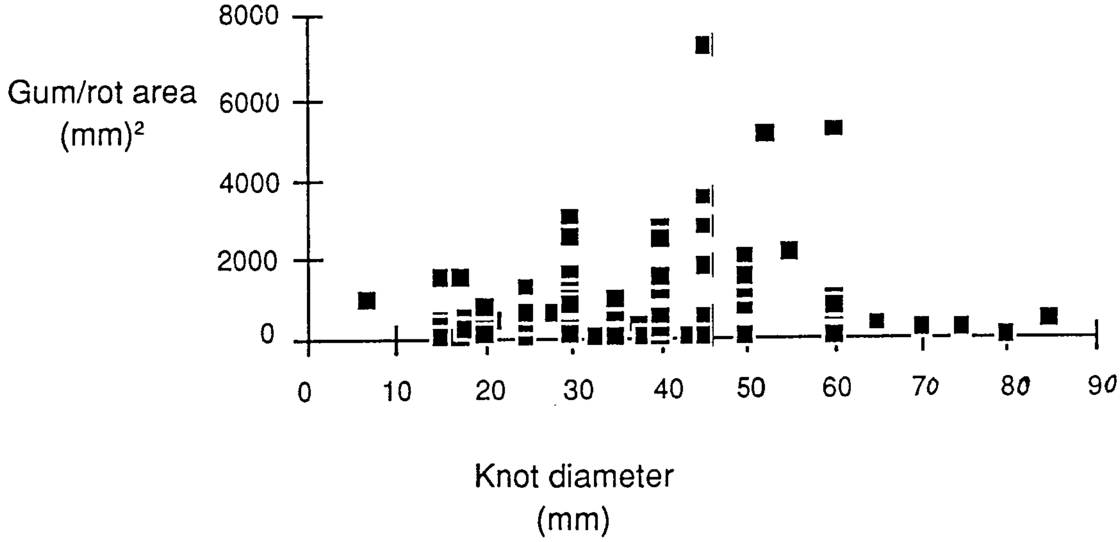


Figure 3.
Effect of knot diameter on gum/rot area

There was no pattern in the distribution of the gum or rot associated with occluded knots, and tree height (Fig. 4). This result, together with the randomness of knot-size distribution (Fig. 2), suggests that in the karri trees sampled any differences in recovery from various sections of the trees were not caused by knots. This contrasts with the results of Brennan (personal communication), who identified knots as the most important timber down-grading defect in karri..

* Mr G. Brennan, Department of CALM, Harvey.

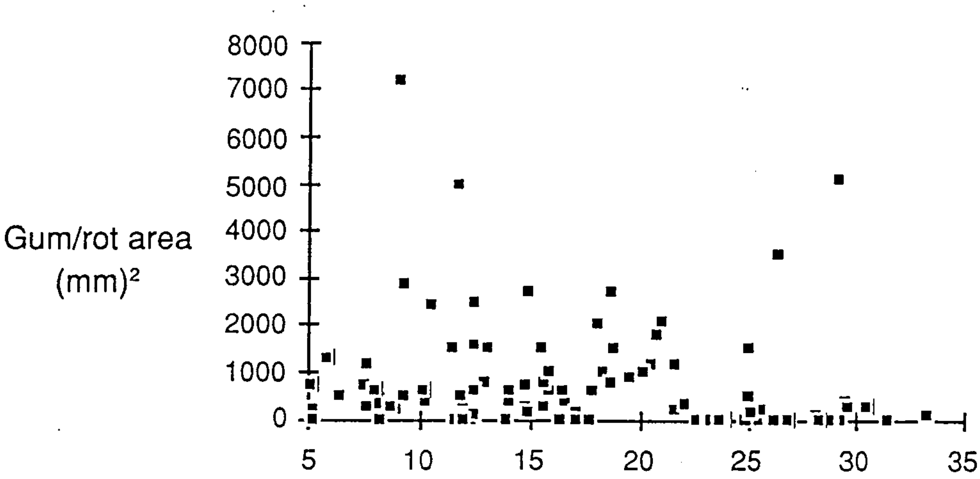


Figure 4.
Effect of height from ground on the area of gum/rot associated with occluded knots in regrowth karri

Further data are needed to determine whether branch size distribution and the relationship between knot size and associated gum or rot in the sample trees are representative of the species. Site factors and silvicultural history may influence the distribution of knot size with height and the occurrence of associated gum or rot, and these results need to be supplemented with data from other sites.

The regression of knot diameter against the green knotty core diameter (Fig. 5) yielded the following relationship:

$$y = -0.209 + 0.205x$$

where y = knot diameter

x = green knotty core diameter

Thus the diameter of the green knotty core was approximately five times the diameter of knots, measured at their points of abscission. This is consistent with results obtained for nine eucalypt species by Jacobs (1955), and it indicates the diameter a tree must attain to yield a given thickness of clear wood. However, considerable variation was associated with these grouped data ($r^2 = 0.55$). Similarly large variations were found on an individual tree basis.

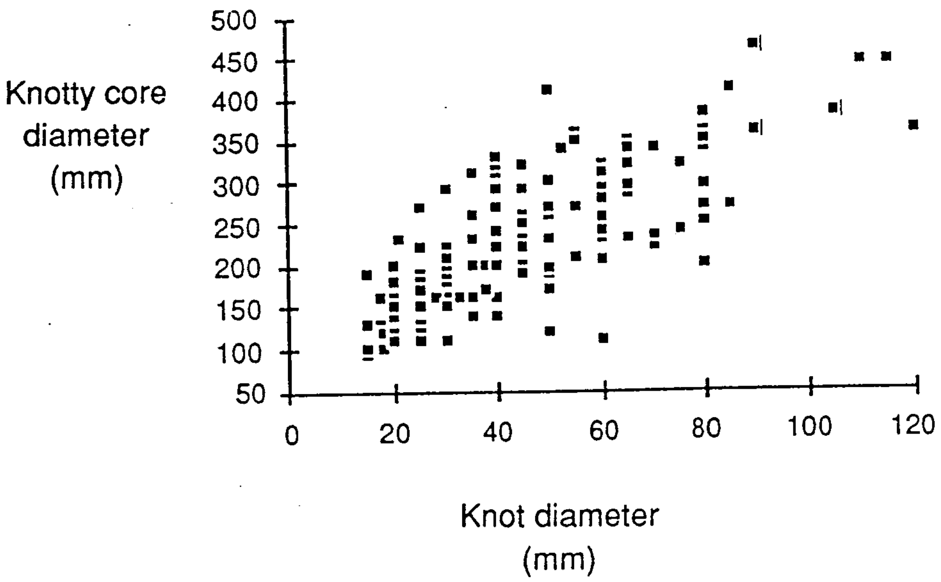


Figure 5.
Relationship between knot diameter and diameter of the associated knotty core

Brown wood, an indicator of incipient rot in karri, was associated with 36 per cent of knots, with an average area of 1700 mm^2. There was no correlation between the area of brown wood and knot diameter or knot height above the ground. Incoll and McKimm (1985) had found that brown wood was an indicator of rot in alpine ash (*E. delegatensis* R. T. Bak.).

Evidence of borer activity was associated with 8 per cent of knots examined. Such holes ranged from a few millimetres in diameter (suggesting that these knots could have been the points of successful oviposition) to extensive galleries whose location may have been coincidental with knot location.

In summary, the results obtained in this investigation differ from the usual situation with the branch shedding mechanism in eucalypts, suggesting that karri may have different branching characteristics. However, these data were obtained from a single site, and need to be verified with data from various locations because factors such as site conditions, stocking rates, and management history may influence the relationships discussed in this paper.

An understanding of branching in karri, and its implications for wood quality or yield is essential in developing optimum forest management policies. Further research is required.

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