Forest Focus

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Cover photograph: Jarrah regeneration in the '100 year old' forest — Mundlimup — regenerated in 1875 following the logging of 1872.

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An electron microscope was used to take this highly magnified ▲ picture of *Phytophthora cinnamomi* mycelium invading the bark cells of a jarrah root.

Microscopic research of *Phytophthora cinnamomi* — compare this equipment with the grossness of the Rocksaw on page 11.

Severely diseased jarrah forest. Thousands of hectares of forest were killed by *Phytophthora cinnamomi* in the period 1945-1965.

A NEW PERSPECTIVE ON JARRAH DIEBACK

by
S.R. Shea, B.L. Shearer, J. Tippett and P.M. Deegan

Jarrah dieback has been a major factor affecting South West Australian forest management and land use practice for over thirty years. The disease caused the decline and death of thousands of hectares of jarrah forest between 1940-1965, but it was not until 1965, after years of research by many scientists, that the cause of the disease was identified by Dr. Frank Podger as *Phytophthora cinnamomi*.

An introduced, soil-borne fungus, *Phytophthora cinnamomi* is believed to have evolved in the tropical and subtropical regions of South East Asia. Even though it grows and multiplies best under tropical conditions, this fungus has proved to be one of the most widespread plant pathogens known to man. It attacks nearly one thousand different plant species and is a major problem in horticulture, agriculture and forestry throughout the world.

It is not surprising, therefore, given *Phytophthora cinnamomi's* record as a 'plant destroyer' and its demonstrated capacity to kill large areas of jarrah forest, that there was grave concern that in the long term it would destroy the whole forest. Recent research, however, has provided the basis for a more optimistic outlook.

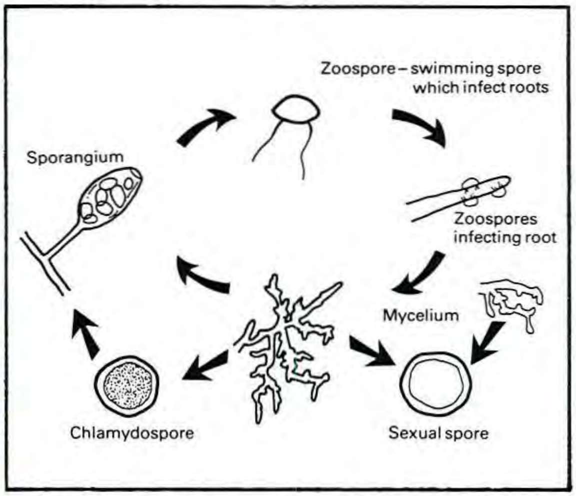
Phytophthora cinnamomi in the Jarrah Forest Environment

Following the identification of *Phytophthora cinnamomi*, a major research programme was commenced.

Phytophthora cinnamomi had been the subject of intensive investigation in many different countries, and much was known about its life cycle, but there was virtually no data on how the fungus reproduced and survived in West Australian soils. One of the first studies undertaken needed to determine how *Phytophthora cinnamomi* functioned in the jarrah forest environment.

Understandably, given its tropical origins, *Phytophthora cinnamomi* only thrives when soil conditions are warm and wet. Prolonged soil drying kills the fungal spores.

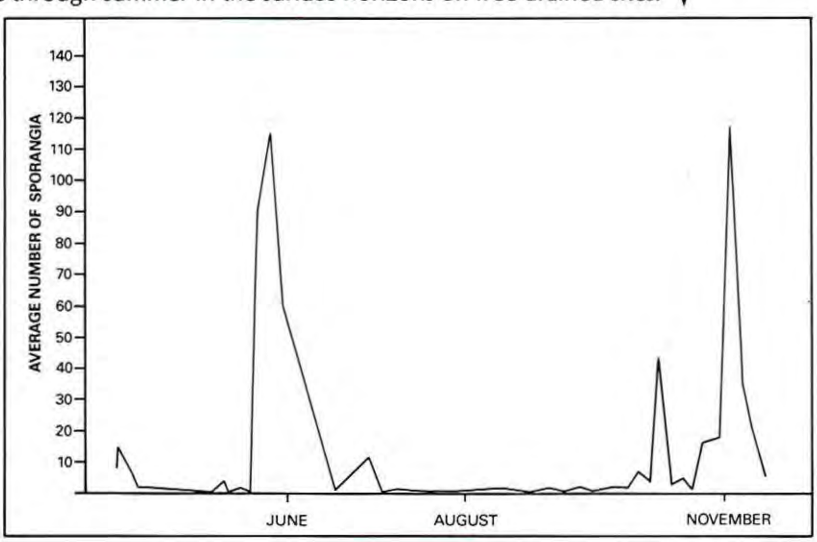
Phytophthora cinnamomi mycelium. ▲



▲ Life cycle of *Phytophthora cinnamomi*.

◄ Sporangia of *Phytophthora cinnamomi* releasing mobile zoospores. Saturated soil conditions are required for zoospore release and transmission.

Phytophthora cinnamomi is readily detected in soil throughout the year in the moisture gaining valley sites. The fungus is frequently difficult to recover from the surface soil horizons and does not survive through summer in the surface horizons on free drained sites. ▼



In the valley floors of the jarrah forest the soil remains moist for most of the year, creating a favourable soil environment for the fungus. These areas form only a relatively small proportion of the jarrah forest landscape, and many of the shrub and understorey species growing in these valleys are resistant to *Phytophthora cinnamomi*.

The majority of the jarrah forest grows on upland slopes and ridges, where the surface soil layers are well drained. Detailed measurements of soil moisture and temperature over several years showed that the soil environment on these sites is only marginally suitable for *Phytophthora cinnamomi*. On the ridges and slopes it was found that the fungus could only produce mobile spores during brief periods in autumn and spring, when the soil is warm and wet. During the summer months, soil conditions are so dry the fungus is almost eradicated. Rapid movement of the fungus, apart from its transport in infected soil, is restricted to areas where the soil has been disturbed and an overland flow of water occurs.

Detection of *Phytophthora* species in soil has always been difficult. In recent years, however, a variety of reliable techniques have been developed, and thousands of soil samples taken from infected sites have now been analysed for *Phytophthora cinnamomi*. While it was possible to readily detect *Phytophthora cinnamomi* in the infected valley floor sites, the recovery rates from surface soil layers on slopes and ridges were usually low. Even on severely diseased sites, less than 10 samples in every 100 analysed yielded *Phytophthora cinnamomi*.

The surprising conclusion from these studies was that despite the fact that the fungus caused mass destruction of the forest on some upland sites, all measurements of the soil environment and the activity of the fungus in the surface layers on these sites indicated that they should not be subject to severe disease. Two of the most perplexing questions which confronted jarrah dieback research workers were : how did *Phytophthora cinnamomi* operate in a soil environment which was only marginally favourable; and how could it cause so much damage at apparently low soil population levels?

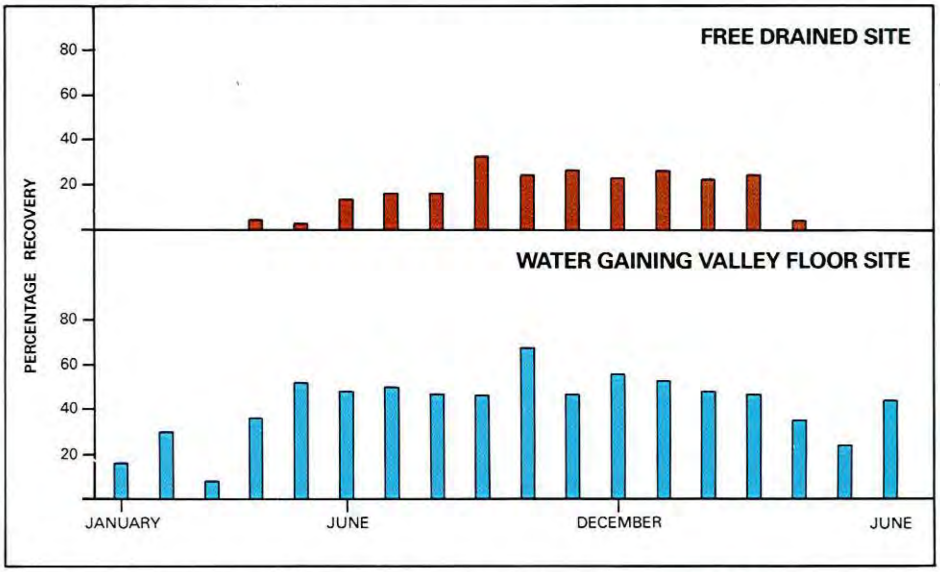
The Role of the Banksia Understorey

Investigation of the highly susceptible *Banksia grandis* understorey helped to explain why *Phytophthora cinnamomi* is able to survive and spread in jarrah forest soils. This species is usually the first to die, after the fungus is introduced into healthy forest.

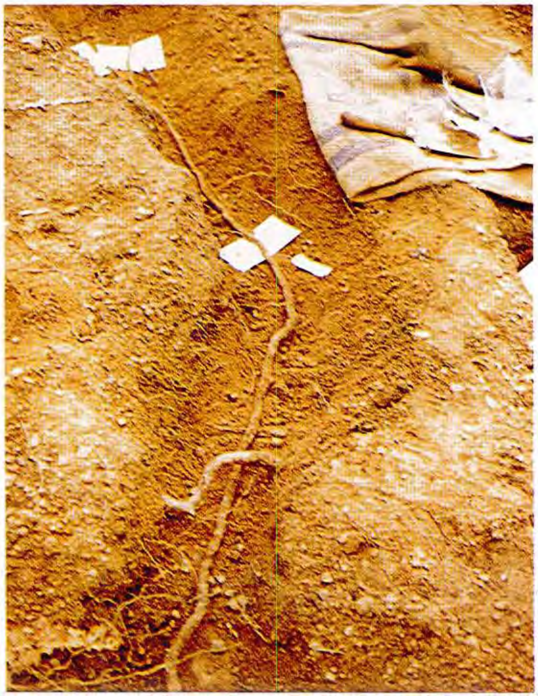
Banksia grandis tissue is so favourable to the fungus, that the rate of mycelial growth through banksia roots (up to 1.5cm per day) is as rapid as any observed on the most advanced laboratory produced media. This rapid growth, combined with the fact that banksia trees have extensive vertical and horizontal roots, means the fungus can spread through the forest without having to move into the soil. Banksia tissue thus provides a buffer from the often hostile soil environment and allows the fungus to persist in infected areas, even after most of the vegetation has been killed. In one study, for example, it was found that the fungus could survive for more than two years in dead *Banksia grandis* roots.

Although the Banksia understorey has proved to be a major contributor to the spread and intensification of the disease, this factor alone could not entirely explain the mass collapse of jarrah trees and the death of other species in severely diseased areas.

Banksia grandis is usually the first species to die in recently infected healthy forest. The perimeter of a diseased area is often marked by a wall of dead banksia. ▲



In the surface horizons of the soil on slopes and ridges in the forest the environment is only marginally suitable for spore production. Spores can only be produced during relatively brief periods in autumn and spring when the soil is warm and wet.



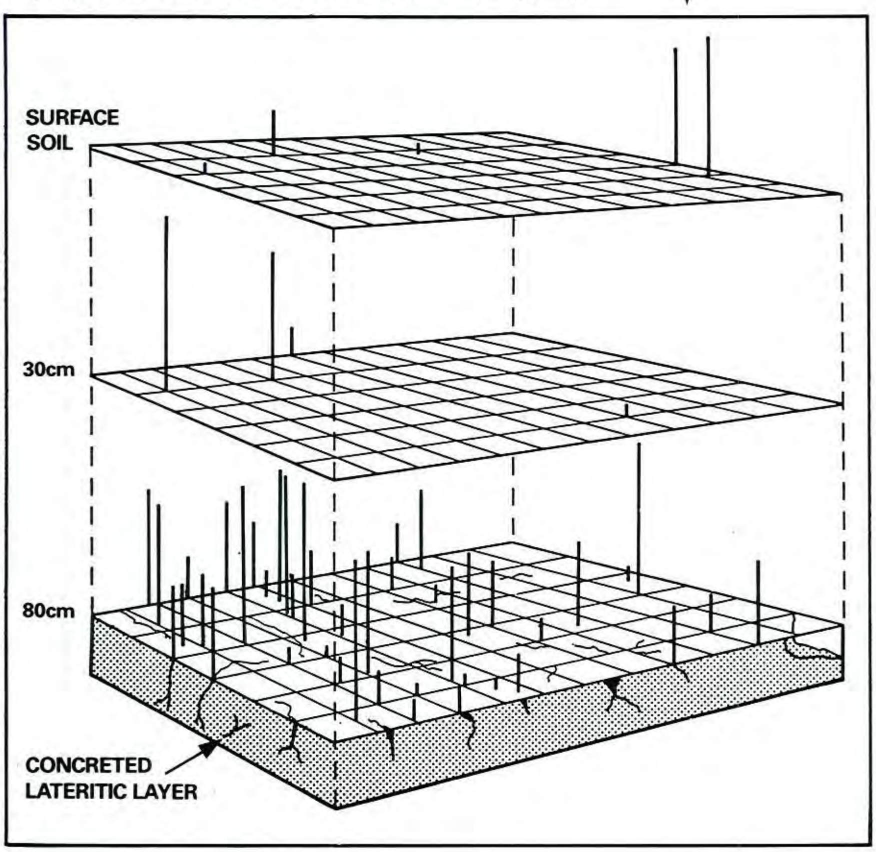
Left: Horizontal root of *Banksia grandis*. *Phytophthora cinnamomi* can extend through Banksia tissue at rates up to 1.5cm per day. ➤

Right: *Phytophthora cinnamomi* has been recovered from the vertical roots of *Banksia grandis* at depths exceeding 1.5 metres. ➤

Sampling soil for *Phytophthora cinnamomi* in severely diseased sites.

Concreted lateritic layer which underlies soil on sites where mass decline and collapse of forest occurs. Water pools on the surface of the layer providing ideal conditions for spore production. Spores are spread in water moving laterally over the surface of the layer.

Phytophthora cinnamomi occurs at high density in soil at the surface of the lateritic layer. Spores are concentrated in the root channels. (Vertical bars show relative concentration of *Phytophthora cinnamomi* spores at each sample point).



Unseasonal Rainfall

Other tests, made to reconcile the conflict between field observations of the disease and the analysis of the pathogen-environment, sought to recreate heavy unseasonal rainfall. Although this heavy irrigation during warm weather favoured the fungus, fungal activity and mobility in the surface soil layers was, again, not sufficient to explain the severity of the disease observed.

Detection of *Phytophthora cinnamomi* at Depth

Another early assumption was that *Phytophthora cinnamomi* primarily occurred in the surface soil, where soil temperatures and oxygen levels were highest, and where a large food base of fine feeder roots existed. Although the soil on some sites had been sampled at depth, the fungus was not detected.

It had also been assumed that the lateritic soils of the uplands were very porous and that vertical water flow would not be impeded. However, during root excavations of trees undergoing rapid decline, it was found that all the sites were characterized by the presence of a concreted layer of laterite, at depths between 10 and 100cm. Water was observed to pond on this layer, and it was decided to test movement by sampling surface soil and the deeper soil adjacent to the concreted lateritic layer. There was a dramatic difference in the recovery rates, with the deeper soil showing high concentrations of the fungus — between 60-90%. Subsequently it was proved that, on these specific upland sites, water in the root channels of the concreted lateritic layer provides ideal conditions for spore production. Water flowing across the layer spreads the zoospores and accounts for the rapid disease extensions which have been observed.

The discovery that *Phytophthora cinnamomi* could reproduce and survive at depth in the soil had never been reported previously, and was a major advance in our understanding of how this remarkable pathogen can cause mass destruction of vegetation.

How did *Phytophthora cinnamomi* kill Jarrah Trees?

Although *Phytophthora cinnamomi* has been known to attack the lower stems of some plants, it had been generally assumed that for most tree species the fungus could only kill the fine feeder root system. It had also been assumed that repeated attacks on the fine roots would cause trees to slowly decline; but this did not explain the rapid collapse of jarrah trees.

Over a number of years, attempts were made by a number of research workers to determine if *Phytophthora* could invade the trunk and large roots of jarrah trees. It was not until 1979, however, that *Phytophthora cinnamomi* was detected in the large roots and lower trunks of a number of recently killed jarrah.

Phytophthora cinnamomi lesion (see darkened tissue) formed in the stem of a small jarrah tree. It had previously been assumed that the fungus could only attack the fine feeder roots of jarrah trees.

Rapid collapse of large trees could not be explained by fine feeder root attrition.

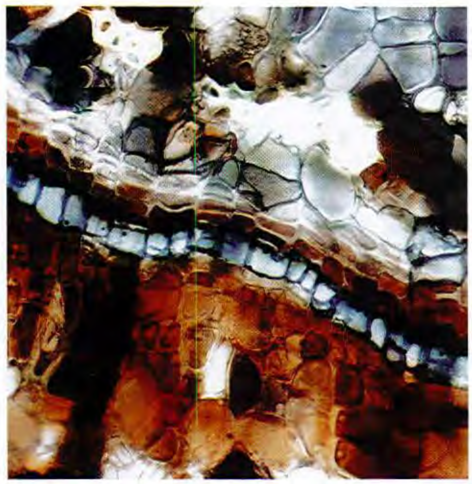
Jarrah — A Resistant Species?

This discovery posed another question. If *Phytophthora cinnamomi* could invade jarrah roots and trunks why didn't jarrah trees always die in large numbers like the banksia understorey? Detailed aerial colour photography had shown that, in large areas of forest where the banksia understorey had been killed by *Phytophthora cinnamomi*, the jarrah death rate was less than one tree per hectare per annum.

Overseas research had shown that some tree species became highly susceptible to *Phytophthora* species for only short periods of the year. It was thought that a possible explanation of jarrah's patchy response was some environmental factor which affected the ability of jarrah to withstand infection and invasion by *Phytophthora cinnamomi*.

A number of ideas were formulated and tested in field trials.

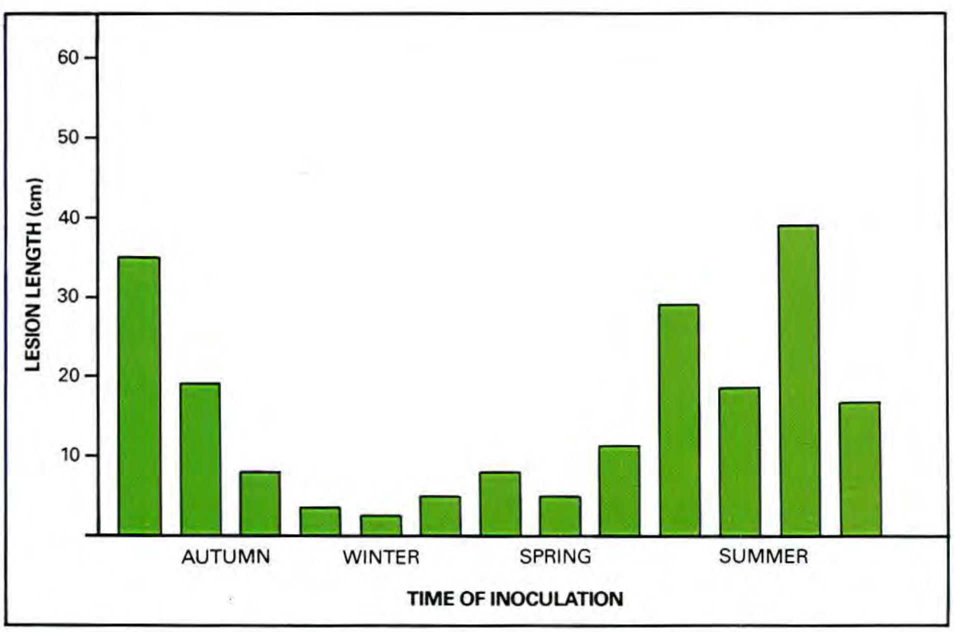
Aerial photograph of patch death of jarrah trees caused by *Phytophthora cinnamomi*.



Left: Inoculating a jarrah stem with *Phytophthora cinnamomi* mycelium.

Top Right: *Phytophthora* lesion contained by host resistance mechanisms.

Bottom Right: Barrier formed by jarrah root to prevent Phytophthora mycelial extension. Jarrah appears to have a number of mechanisms which, under normal conditions, makes it relatively resistant to *Phytophthora cinnamomi.*



The rate at which *Phytophthora cinnamomi* can invade jarrah tissues varies with season.

In one trial, some 3000 root and stem inoculations were carried out, over a period of 18 months, and the progress of the fungus was monitored by microscopic examination of the tree's tissue. The conclusion from this study was that jarrah trees have a range of defence mechanisms which curtail the spread of the fungus, even when it is introduced directly into a wound. Seasonal variation in susceptibility was observed, but it was proved that the trees have the capacity to form a barrier to the invading fungus.

Again, it didn't add up. If jarrah was tolerant to *Phytophthora cinnamomi,* how could the fungus cause the rapid collapse of some trees? The missing factor had to be a variable which would account for the fact that in some situations, in some years, mass death of jarrah occurred, while in other areas the fungus was present and jarrah root systems were exposed to it, but the trees did not die.

Identification of Highly Susceptible Sites

Although the layer of lateritic soils that occurs over most of the jarrah forest is of uniform surface appearance, the forest grows in a mosaic of different soil structures. It was recognized in early studies that trees on some upland sites were much more prone to *Phytophthora cinnamomi* than those on other sites. The upland sites were frequently characterized by the presence of black gravels on the soil surface. Although this site variation in the impact of *Phytophthora cinnamomi* had been observed, previous attempts to determine the biological reasons for these differences had failed, and there was no objective method of identifying the sites.

During the summer of 1981 and 1982 several sites were located where the process of rapid collapse of forest was occurring. This was the first time since the early period of mass decline and death (1945-1965) that this phenomenon had been observed in action.

Initial attempts to detect *Phytophthora cinnamomi* in the surface roots of the dying trees failed. On one site, extensive excavation and sampling of the horizontal root systems of more than 20 dying trees also failed to identify any pathogen. In a final attempt to locate the fungus the vertical root systems were exposed.

At the points where the vertical roots passed through channels formed in the layer of concreted laterite, one metre below the soil surface, the roots were found to be lesioned. *Phytophthora cinnamomi* was recovered from the lesions.

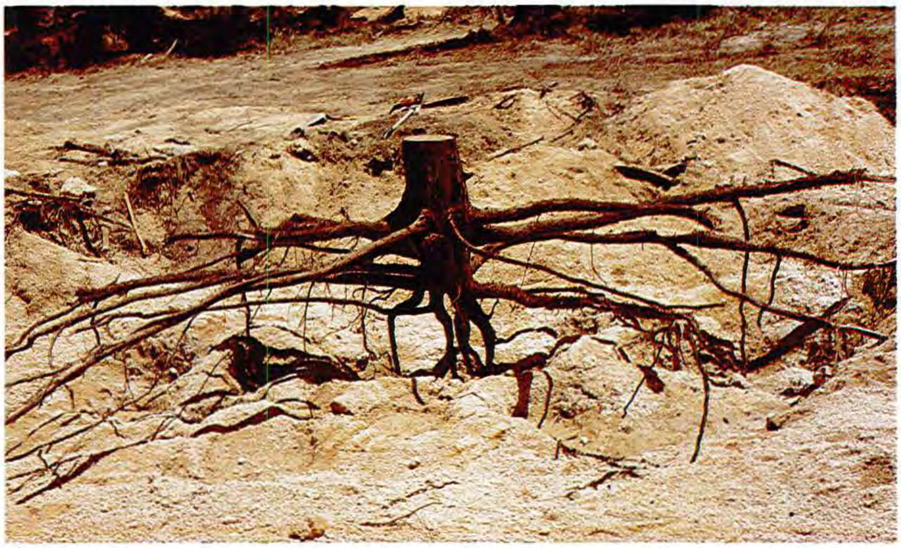
Following this discovery, over 50 trees were excavated on a number of severely diseased sites. On every site the concreted layer of laterite was present and the vertical roots of the jarrah trees were infected by *Phytophthora cinnamomi.*

Prognosis

Disease results from often complex interactions between host, pathogen and the environment. It is only by understanding the processes which drive these interactions that it is possible to predict how a disease will develop. Methods of control, then, reflect the level of knowledge about these processes.

The major problem which has been confronting jarrah forest managers was the prospect that the conditions, which caused the death of thousands of hectares of forest between 1945-1965, would recur. For, although the death rate of jarrah trees has declined markedly in the past fifteen years, the infected area has expanded. It was thought that if the process which caused mass collapse was triggered by unusual climatic events, such as heavy summer rainfall, the severity of damage in large areas of infected forest would increase sharply.

▲ Forests Department fire tankers, supplied with water from large tankers provided by Alcoa, were used for the hydraulic excavation of root systems.

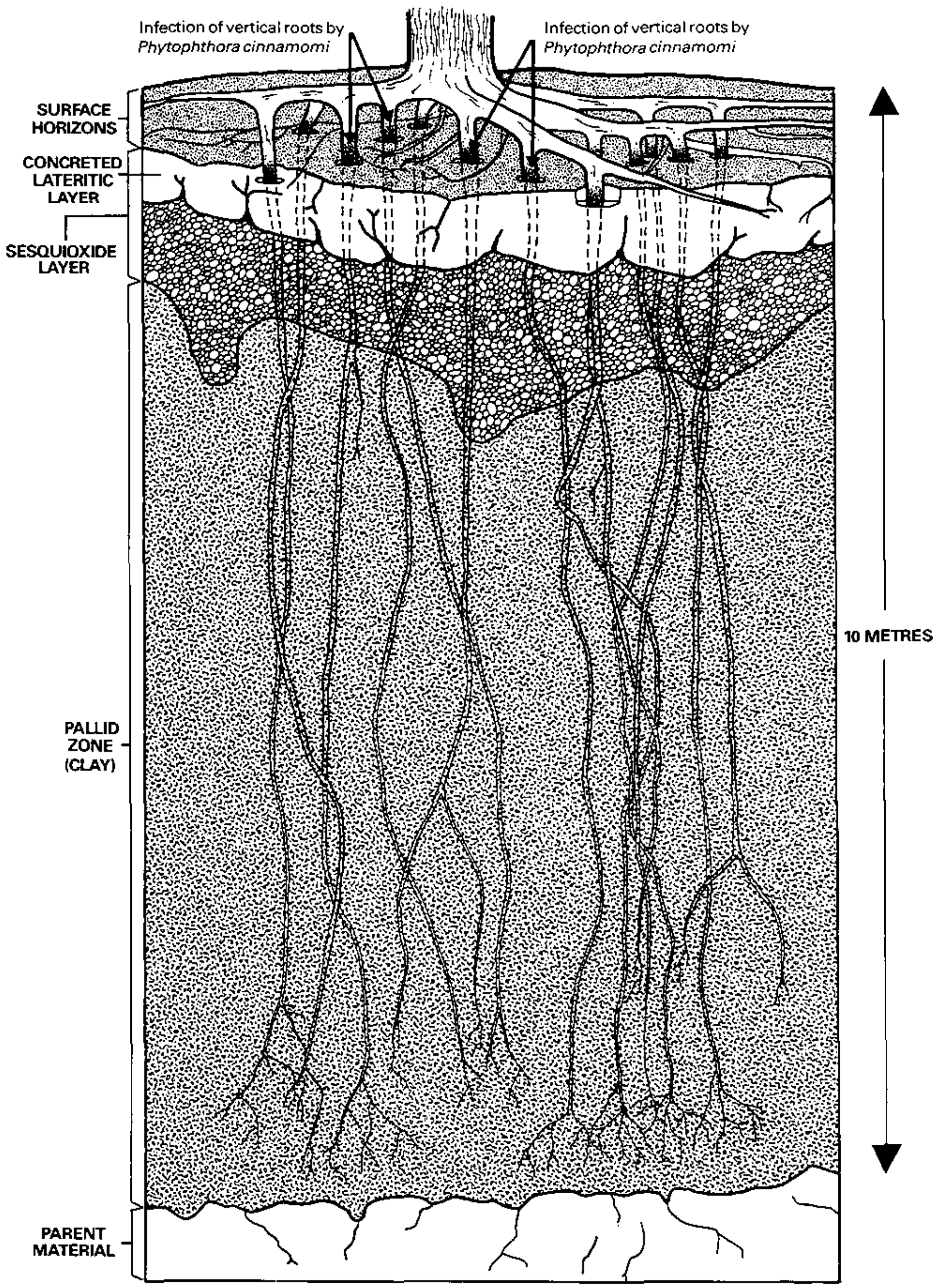


▲ All of the vertical roots of this tree were killed by *Phytophthora cinnamomi* at the point where they passed through the concreted lateritic layer.

▲ Vertical roots of jarrah trees (painted silver) extend to the water table which may be more than 30 metres below the soil surface.

The discoveries that *Phytophthora cinnamomi* could invade woody tissue, that the fungus can occur at high density at depth in the soil of specific site types, and that the tree's vertical root system is vulnerable, gave a new perspective on how *Phytophthora cinnamomi* operated in upland sites of the jarrah forest environment.

Only now is it possible to answer some of the fundamental questions and to formulate the beginnings of a rational model for the disease.



Diagrammatic representation of jarrah root system. Jarrah's ability to tap groundwater at depth permits it to use water at a high rate during summer months. But on specific sites *Phytophthora cinnamomi* is able to infect and kill the vertical roots causing the trees to die from drought.

Jarrah trees appear normally to be resistant to the fungus. The fine root system is infected and some invasion of major horizontal roots can take place but, over large areas of forest, where *Phytophthora cinnamomi* has killed the banksia understorey, the rate of spread of the disease and the death rate of jarrah trees is relatively low.

The ability of *Phytophthora cinnamomi* to cause rapid destruction of some jarrah forest is the consequence of a bizarre combination of factors.

Jarrah trees have evolved to cope with long dry summers by developing an extensive root system to tap groundwater supplies. This allows the trees to continue to use large amounts of water over the summer, but has left them vulnerable to root attack by *Phytophthora cinnamomi.*

On *specific site types,* where there is a layer of concreted laterite present, vertical movement of water is impeded and lateral flow occurs. These are ideal conditions for spore production and movement just below the surface. Vertical roots of jarrah and banksia pass through depressions in the concreted layer. The presence of infected banksia roots and the fact that the root channels are formed in depressions which accumulate water, cause zoospores to be concentrated around jarrah's vertical roots. The fungus first infects jarrah's fine roots, which often profilerate in the root channels, then invades and kills the major vertical roots. Whereas fungal invasion of a horizontal root (unless it takes place near the trunk) appears to have little impact on the tree's capacity to obtain water, the fungus has only to invade a small distance into a vertical root to cut off the water supply. Once the tree's vertical roots are destroyed, its unsated demand for water results in desiccation and death.

While climatic conditions, particularly unseasonal rainfall, play an important role in determining disease intensity, *it*

▲ This giant 'Rocsaw', provided by ALCOA, was used to cut sections through the soil profile on severely diseased sites in an attempt to identify the characteristics of the laterite layer.

◄ Jarrah vertical root passing through concreted lateritic layer. *Phytophthora cinnamomi* zoospores are concentrated in these root channels where they infect the vertical roots.

appears that the processes which cause mass death of jarrah and rapid spread of the fungus operate only on specific site types. There is little prospect of controlling the disease on these sites.

It is not known how much forest which has not been affected by *Phytophthora cinnamomi* is growing on these highly susceptible sites, but there are large areas of forest growing on soils that do not have the properties which permit rapid disease development. The forest growing on these free draining sites has the greatest potential for management and protection from *Phytophthora cinnamomi.* Scientists are optimistic that on these sites long term control of jarrah dieback disease can be achieved.

Current management practices now include reducing the density of the banksia understorey, the maintenance of the free draining characteristics by minimizing soil disturbance, the employment of stringent hygiene techniques, and the promotion of resistant understorey species such as legumes.

Where do we go from here?

Control of serious forest diseases has rarely been achieved. Although the prognosis for the jarrah forest is now much more optimistic, key questions remain to be answered. What proportion of the forest is growing on highly susceptible sites for which there is little prospect for control? How can these sites be identified in the forest? Are there factors, other than vertical root destruction, which will cause jarrah death? What are the factors which affect the ability of jarrah to withstand infection and invasion by *Phytophthora cinnamomi?* Can the *Banksia grandis* understorey be controlled? How much soil disturbance or increase in rainfall is required to make normally resistant forest susceptible? What are long-term effects on forest quality of *Phytophthora cinnamomi* infection in sites which are not subject to mass collapse? These questions are currently being researched and will be the subject of future reports.

ACKNOWLEDGEMENTS

The research reported in this article involved a large number of people working in the field and the laboratory. We acknowledge the contribution of M. Dillon, R. Buehrig, R. Fairman, R. Turner, T. Birmingham, H. Warren, D. Schilds, J. Maranta, B. Michaelsen, J. Kinal, M. Sears, L. McGann, E. Vickery, R. Warren, J. Payze, T. Bresser, M. Mason and members of Dwellingup and Jarrahdale Divisional workforce. We also acknowledge logistical support provided by ALCOA for field studies.

KING JARRAH

by
Ian Abbott and Owen Loneragan

One of the many interesting features of the jarrah forest is the variety of tree sizes present. Some trees are tall and have thick trunks, whereas others are short and thin. Several years ago we became interested in the size of trees throughout the jarrah forest, and wondered about the size of the biggest trees and how common they were.

People ususally express the size of a tree as its total height. The height of individual trees, however, is often difficult to measure accurately and quickly, so foresters prefer to measure the diameter (over the bark at breast height) 1.3m above ground.

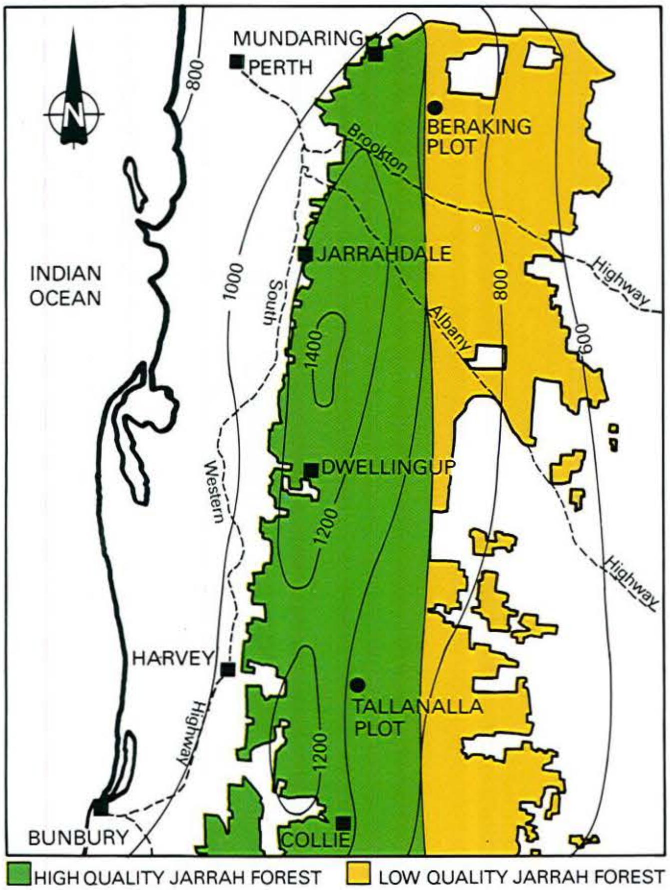
Before 1956, thousands of trees and stumps were measured throughout the jarrah forest to provide an inventory of how much timber was available and how much had already been extracted by logging. The trees and stumps measured were not selected at random, but were instead located along many narrow (20m or 40m wide) belt transects, totalling some 900km in length. This statistical information is held in the archives at the Institute of Forest Research, Como.

Most transects were confined to the jarrah forest that yielded most timber per hectare, so called high quality jarrah forest (Fig. 1). The occurrence of high and low quality jarrah forest is closely related to rainfall and fertility of the topsoil. High quality forest occurs on more fertile land where average yearly rainfall exceeds 1000mm, whereas low quality forest is present on soils of lower fertility, in a lower rainfall zone east of the high quality forest (Fig. 1).

What sizes are big trees?

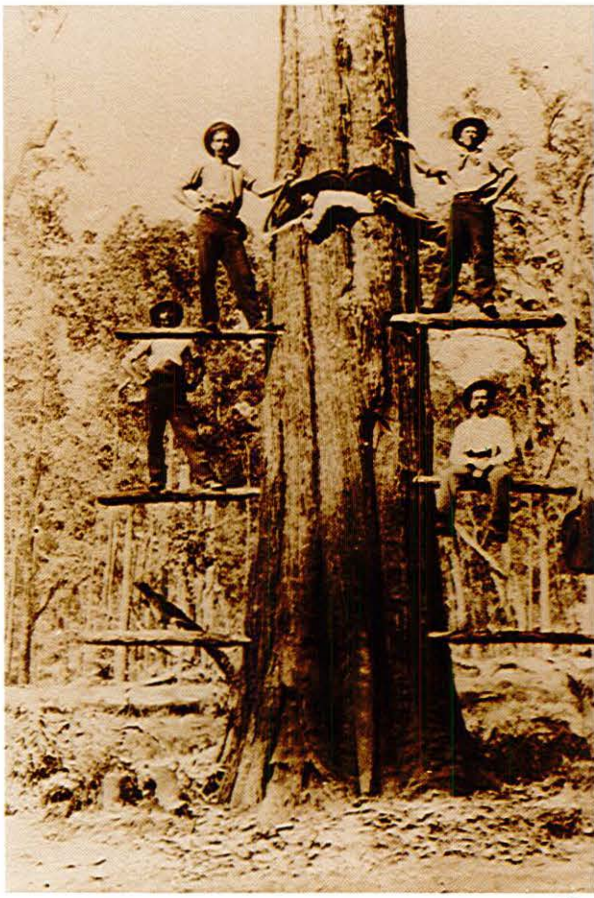
In 1934 members of the Forests Department measured all live trees of diameter 20cm or more, in two 4.05 ha plots, in jarrah forest that was then unlogged. One plot was near Tallanalla (Fig. 1), in high quality forest, and the other was near Beraking (Fig. 1), in low quality forest. The proportion of

Forest mensuration — measuring the diameter over bark at breast height — to ▲ calculate timber volume and annual tree growth.



◄ **Figure 1**
Extent of high and low quality jarrah forest north of Collie, annual rainfall, and plot locations.

Felling and utilizing large jarrah posed a real ▼ challenge for the early pioneers.



JARRAH FOREST
THE SIZE RANGE IN HIGH AND LOW QUALITY FOREST PLOTS

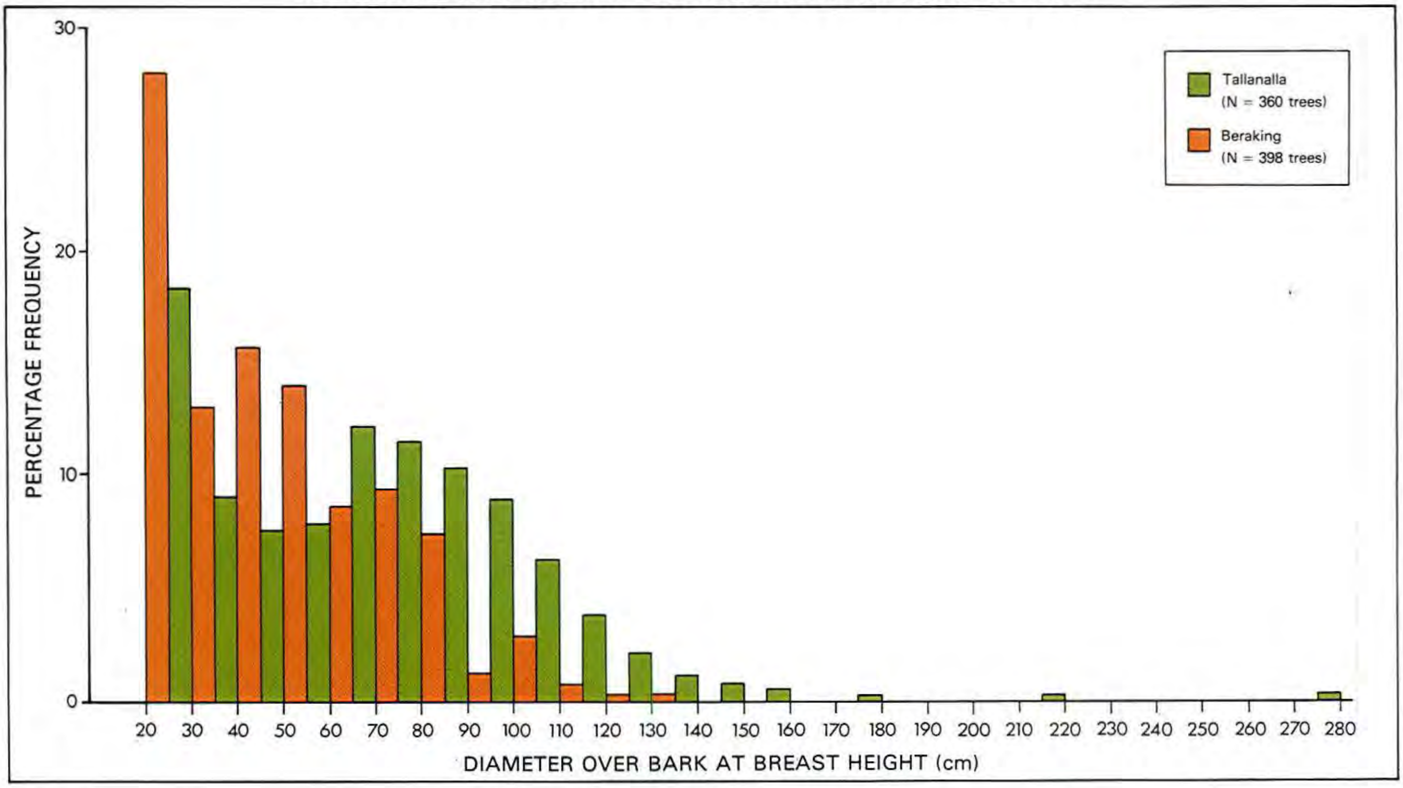


Figure 2 Diameters of jarrah trees in two plots in the jarrah forest; Tallanalla plot (based on 360 trees) and Beraking plot (based on 398 trees).

JARRAH FOREST
THE SIZE RANGE OF BIG TREES IN BELT TRANSECTS

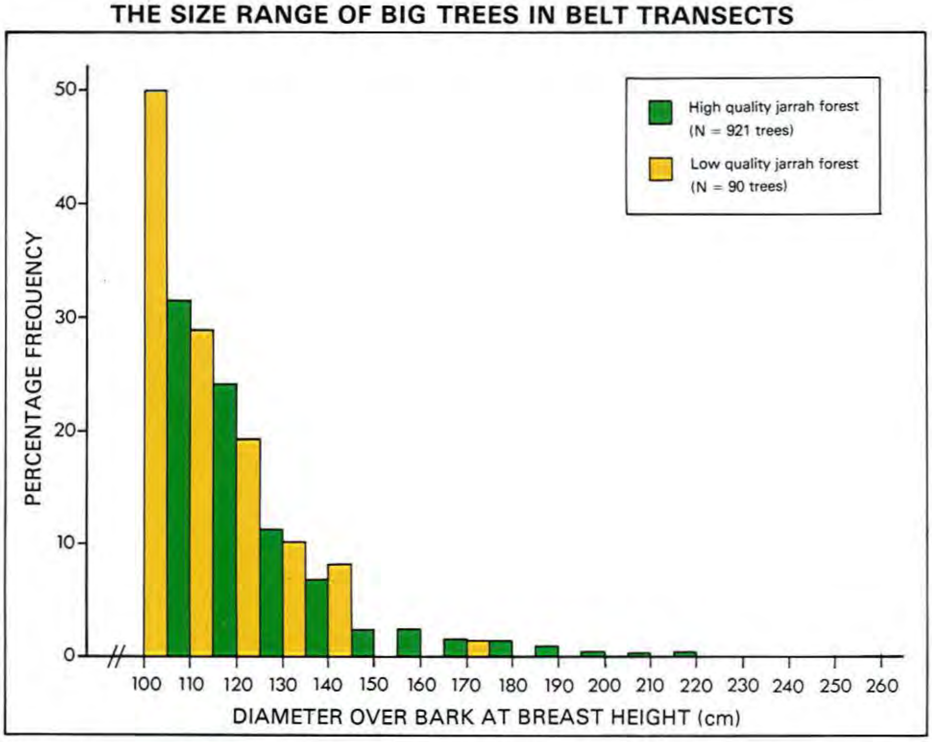


Figure 3 Diameters of big jarrah trees in high and low quality forest; based on 921 trees for high quality forest and 90 trees for low quality forest.

trees in each 10cm diameter class (that is, 20-30cm, 30-40cm, etc) is displayed graphically (Fig. 2). There were many more small trees than large trees in each plot.

We refer to trees with diameters of 100cm or more as big trees, and there is a striking difference in the representation of big trees between the plots — 15.3% at Tallanalla compared with 4% at Beraking.

Particularly large trees in Western Australian forests are popularly known as king trees. To be more precise, we decided to call those jarrah trees with a diameter of at least 200cm, King Jarrahs.

The belt transects already referred to are helpful in assessing generally the range of sizes attained by big trees in high and low quality forest (Fig. 3). In high quality forest about 80% of big trees are of diameter 100-140cm, whereas in low quality forest the same proportion is in the diameter range 100-120cm.

King Jarrah (poster)
photograph by Cliff Winfield

The largest tree recorded from these transects in low quality forest was about 180cm, in contrast to 260cm in high quality forest. Only 0.5% of all big trees in high quality forest can be classed as King Jarrahs, and none have been recorded in low quality forest areas.

Population of big trees in high and low quality forest

In high quality forest there are about three to four times as many big trees per hectare as there are in low quality forest (Table 1). The average population density of King Jarrahs in high quality forest is 4.2 per 100ha.

Why do only some trees grow into big trees?

It can be seen from Fig. 2 that most jarrah trees in the forest are of small diameter. This is typical of the bulk of the jarrah forest. The main reason so few trees grow to reach the status of a big tree in the jarrah forest is because individual trees compete for both crown space and root space, and hence for light, water and nutrients. As a result of this competition the forest thins itself out, with some trees gaining dominance. Only the fastest growing individuals achieve a position of dominance over nearby trees.

Another important factor is the occurrence of hazards. Before the jarrah forest was logged last century, the main hazard to the tree was fire started by aborigines or lightning. A fast growing dominant tree might be injured or even killed by fire before it reached the status of a big tree.

How long does it take a jarrah to become a big tree?

Jarrah, as has long been recognized, grows very slowly. In high quality forest the *average* increase in diameter each year is only 0.17cm. In low quality forest this increment is even lower, 0.10cm. Simple calculations show that a diameter of 100cm would be attained in high and low quality forest in 600 years and 1000 years respectively. At that rate, in high quality forest it would take 1200 years for jarrah to become a King Jarrah.

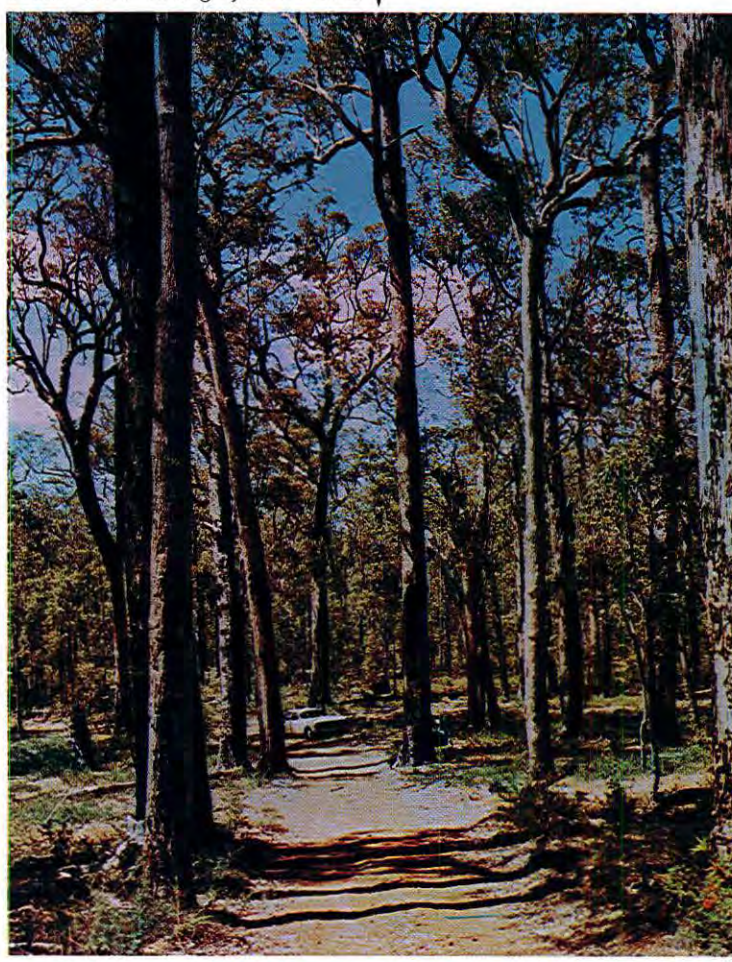
However, it is most likely that only fastest growing individuals attain the status of big trees. In jarrah forest we have found that about 25% of the trees increase in diameter 0.31cm each year in high quality forest and 0.26cm each year in low quality forest. Simple calculations show that the fastest growing trees in high quality forest would attain 100cm diameter in about 300 years and 200cm in 600 years. In low quality forest a diameter of 100cm would be reached in 400 years. Occasionally, some jarrah trees in high quality forest have been recorded growing at the exceptionally fast rate of 0.60cm per year. It would take such trees less than 200 years to reach 100cm diameter and less than 350 years to become King Jarrahs.

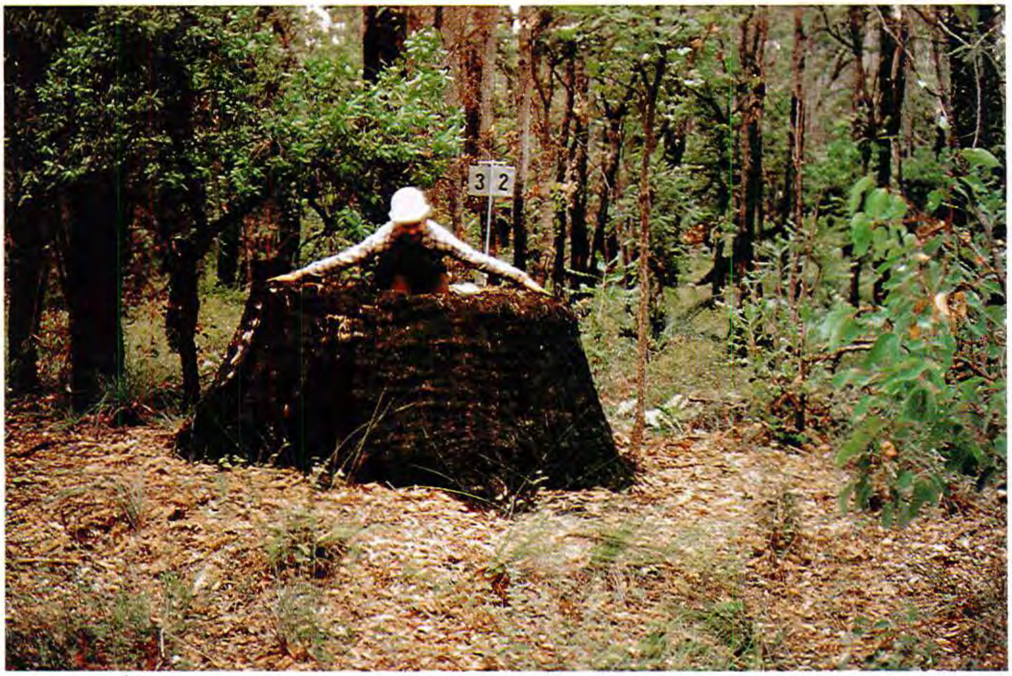
TABLE 1

Density of Big Trees in high and low quality Jarrah forest.

Site Quality	Density of big trees (Diameter ≥ 100cm) per ha — Mean	Range
High	7.6	6.0 - 10.6
Low	2.1	1.6 - 3.0

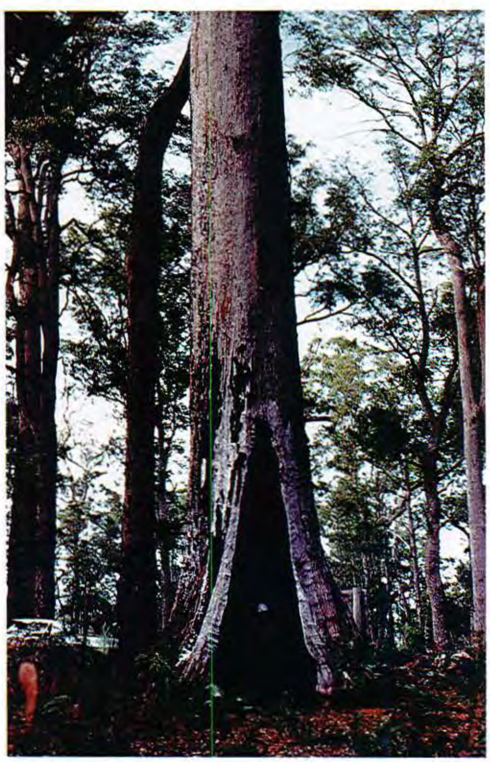
Scenic drive through jarrah forest. ▼





▲
The stump of a King Jarrah at Mundlimup — felled in 1872.

Unfortunately the crowns and butts of many big jarrah have suffered fire damage over the years.



King Jarrahs

We sawed a cross section of wood from the stump of a King Jarrah in Mundlimup Block, 5km east of Jarrahdale. The diameter of the tree at breast height was 200cm. We prepared this section for a count of the annual growth rings, by planing it. There were 397 rings, indicating that the tree was about 400 years old when felled in 1954.

As a check, we then submitted a sample of heartwood to the Sydney University radiocarbon laboratory. The date found by this method was 300 years. This is satisfactory agreement between the two methods. We concluded that this tree began life in the late sixteenth century or early seventeenth century and grew with an average annual increase in diameter of 0.5cm.

Unfortunately most King Jarrahs left in the forest are either dead, or nearly dead, through extensive damage by wild fire to the lower trunk and branches. Few carry vigorous crowns.

Some fine examples of King Jarrahs in the northern jarrah forest may be found in Sawyers forest block near Mundaring, in Lowden block near Collie, in Hadfield block near Harvey, and in the Nanga, Holmes and Amphion blocks near Dwellingup. The tree in Hadfield is, in fact, the biggest jarrah tree yet found, with a diameter of 319.3cm. Enquiries about the location of these trees should be directed to the Forests Department offices in the above towns.

FURTHER READING

Abbott, I. and O. Loneragan. Growth rate of jarrah (*Eucalyptus marginata*) in relation to site quality in cut-over forest; Western Australia. **Australian Forestry,** 46(2):91-102, 1983.

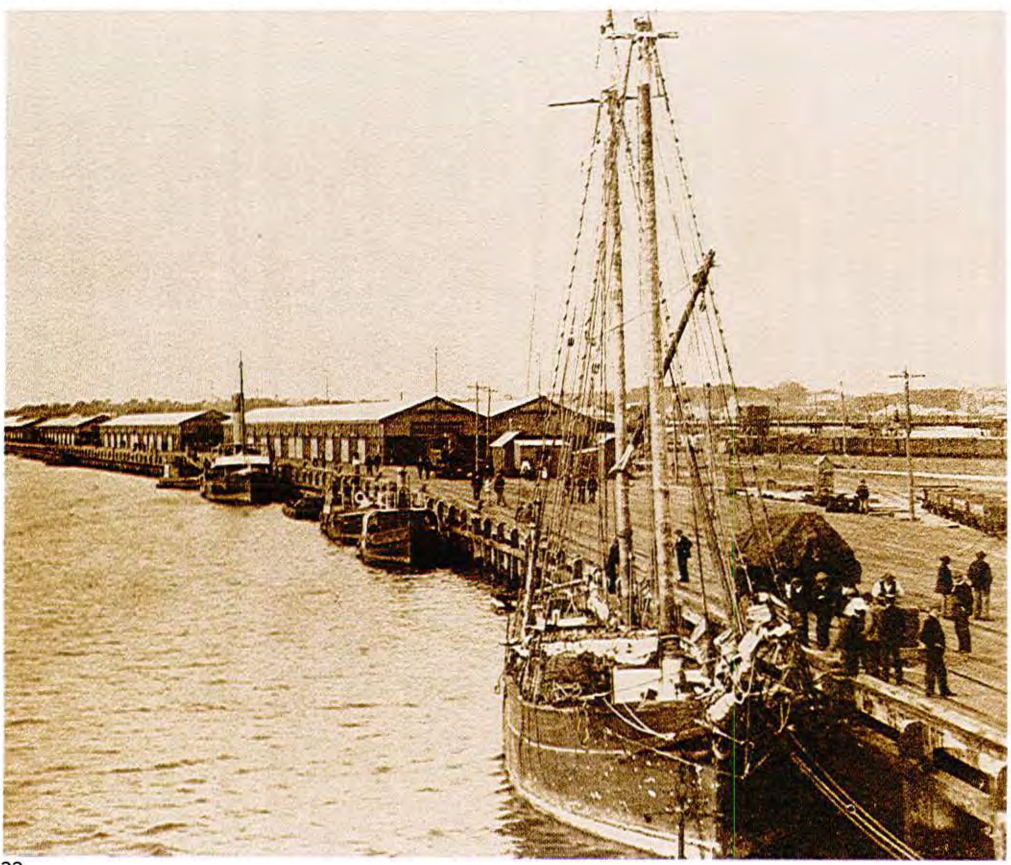
Looking a million dollars, the jarrah living room designed and made to order by Ed Janes and his team of craftsman, at the Fremantle Furniture Company.

BEAUTY AND VERSATILITY

by Ian Kay

Jarrah is a remarkable timber. Growing only in Western Australia, it is a hardwood unique in the world, possessing great natural beauty, durability and immense strength. From the earliest days of utilization, jarrah's strength and durability led to its world-wide use as a wood pre-eminently suitable for railway sleepers, bridge and dock piles, and general construction. New opportunities now developing will tend to highlight its beauty.

The historic use of jarrah — 3 miles of water front street paving in Hastings, England ▲ (1897), and wharves and sheds at Fremantle (1902). ▼



As early as 1903, Millars Karri & Jarrah Co. of England were extolling the virtues of jarrah in a pamphlet designed "to bring to the notice of engineers, and others, the suitability of Western Australian ... jarrah (*Eucalyptus marginata*) for engineering works, street paving and all other purposes where hardwood is required." Photographs depicted city road construction using jarrah paving blocks and dock works using jarrah piles, and the text alluded to the timber's remarkable "imperviousness to destructive (marine and land) insects and damp." The timber's strength and fire resistance were also promoted in its use for warehouse construction and railway sleepers.

Indeed, subsequent use proved the useful life of jarrah sleepers to average 50 years in London's tube rail system. Notwithstanding the timber's workmanlike qualities, the company also demonstrated jarrah's versatility by using it to dress their office frontage, and made mention of its use for cabinet and art work. They compared jarrah's grain and colour with high class mahogany — four lines in the corner of the 20 page 'utility' promotion.

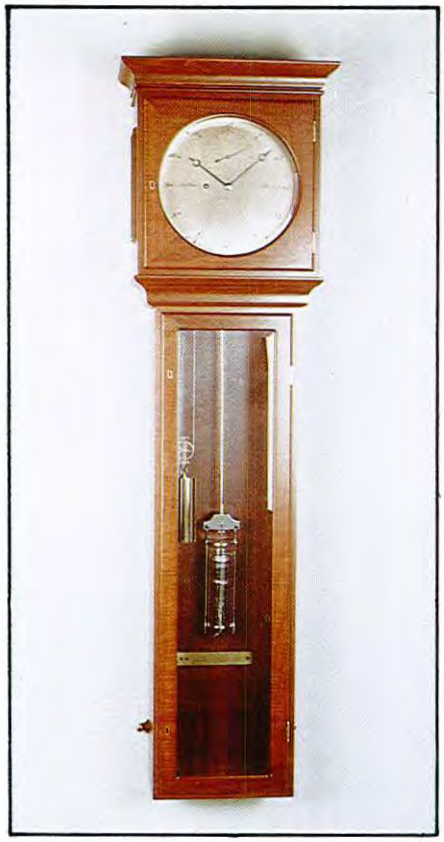
Patterns unchanged

Today, after ninety year's trading, utilization patterns are beginning to change. Though still favoured for its durability — less than 5% of the total jarrah logged is used for furniture production — there is a growing awareness of the need to better utilize the dwindling hardwood resource. Greater emphasis is now being placed on the use of jarrah in higher priced wood products. Last year the Forests Department instigated research into improved seasoning, using a Harvey kiln designed ten years ago to promote better pine utilization.

Albeit a late start for the industry in general, many individual craftsmen have, over the years, grown to cherish jarrah's finer qualities. Excellent pieces of jarrah furniture have been produced and admired. Shop and office fittings, billiard tables, dining and bedroom suites — all worked to the dark red-brown high quality finish that is so attractive. Over the years, styles have changed, but jarrah's popularity in furniture and craft work has continued to mature.

Furniture craft

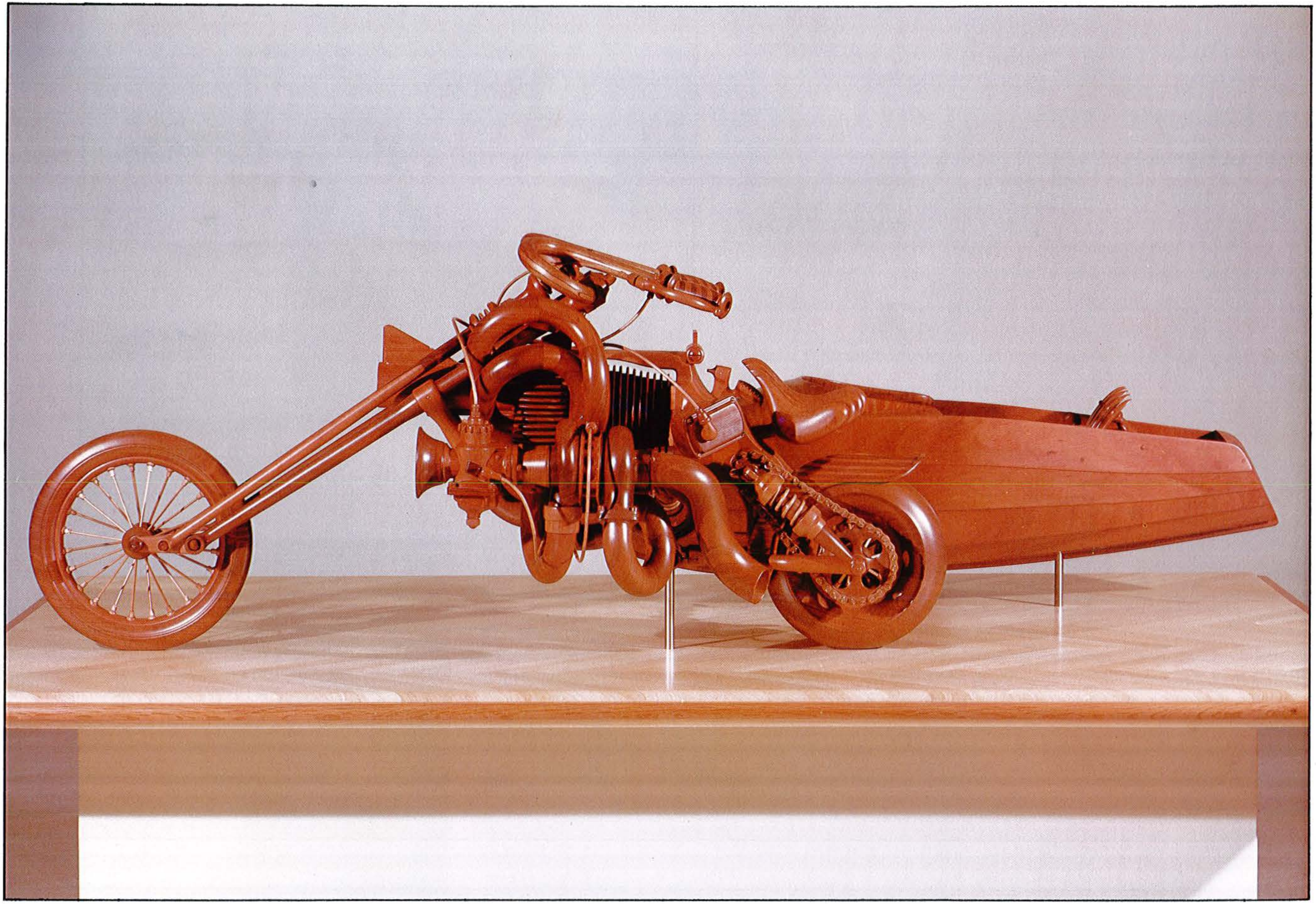
Until recently, Ed Janes shared his 115 years of family craft experience with the Fremantle Furniture Company. Ed's great grandfather started his cabinet making apprenticeship in High Wycombe, 30 years before jarrah was available on the English market, and traditional pride is clearly stamped on every piece designed and produced by Ed's team. A registered architect and builder, Ed now devotes most of his time to the custom design of quality jarrah furniture. His appreciation of the timber's qualities is deep and his treatment simple. "Durable craftsmanship should be designed to transcend fashion," he said. "Having settled on a design for a customer, I go to great trouble to find jarrah with colour and grain to suit. I prefer to match the timber and make the most of its natural colour, rather than use stains to impose artificial uniformity," he explained. "Apart from that, we use materials and construction techniques designed to match the timber's tremendous durability." Special factory projects include the crafting of forty-four chairs, and tables, for the State Premier's dining room, a solid jarrah board room table 12' x 5', furniture for a millionaire's living room and grandfather clock cases. The cases are made exclusively for the world renowned horologist David Walter, and often feature jarrah's rare curly grain.



A jarrah clock-case, produced exclusively for horologist David Walter by the Fremantle Furniture Company.

One of the forty-four chairs hand crafted for the State Premier's dining room.

Ed Janes, custom designer of fine jarrah furniture.



The jarrah sculpture by Michael Cooper, 'Split personality' is now in the collection of the Art Gallery of Western Australia, and was sponsored by Bunnings Ltd., 1982. Note the choice of natural colour used to highlight many parts.

Sculpture

In 1979, the Fremantle Furniture Factory provided six months jarrah work experience for visiting Australian Crafts Council fellow, Michael Cooper. A highly regarded Californian sculptor, Michael Cooper later submitted to the West Australian Art Gallery conceptual drawings for a jarrah sculpture. Titled 'Split Personality', the work was to be the last of a series of anti-gun statements, but incorporated his overriding love of speed and sailing. The commission was granted by the Art Gallery and sponsored by Bunnings Bros. (Pty) Ltd.

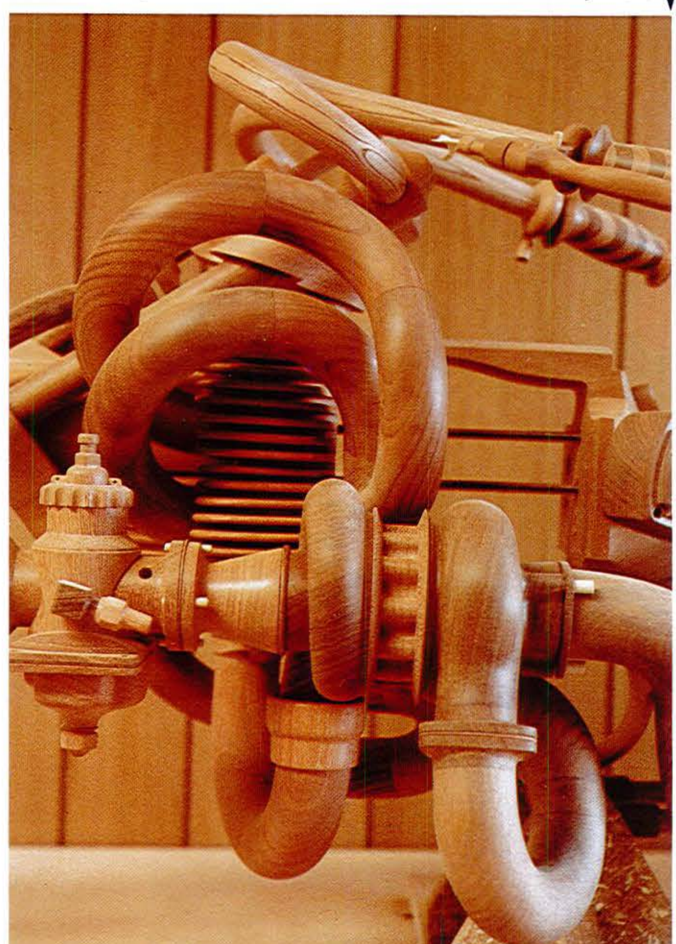
Michael arrived, set up a studio in Fremantle and began three month's feverish work. He particularly looked for jarrah in contrasting colours, to highlight many of the separate parts used in the construction. He also needed to invent many of the jigs and tools he required. Working by 'eye', Michael machined each part with minute attention to detail, and eventually pieced together the highly acclaimed sculpture like a giant three dimensional jigsaw. "The timber is a joy to work with," he said. "It is not as hard as some I have worked, but it retains a high finish."

Some of the most difficult pieces involved the use of jarrah 'boards', less than 4mm thick, for the construction of the clinker styled side car, and the lamination of the curly handle bars.

Sculptor Michael Cooper working on the clinker styled side car — his love of sailing expressed in the sculpture 'Split Personality'.

All the individually machined parts went together like a giant three-dimensional jigsaw puzzle.

A close-up of the carburettor detail — all worked in jarrah.



▲
Fremantle luthier Scott Wise, at work in his studio.

Musical instrument made from jarrah by Fremantle luthier Scott Wise. ▼

Bright note

In a neighbouring studio, Scott Wise shares many of Michael's construction problems in his chosen craft as a luthier. A musician by profession, Scott started his craft career repairing the stringed instruments of fellow musicians. Over the years his craft knowledge and musicianship have expanded side by side.

Scott now specializes in the manufacture of instruments such as acoustic guitars, mandolas, dulcimers and lutes, using a variety of native timbers. Jarrah features predominantly in the construction as head stocks, finger boards and the binding on edges.

Like Michael, Scott has had to make many of his own tools and jigs. He uses a bandsaw to quarter cut boards to 5mm thick and then thickness sands them to between 2-2.5mm. Steam forming timber this thick, Scott has crafted many of the smaller instruments completely from jarrah. Unfortunately, the larger acoustic guitars require a more resonant wood for the face, but the contrast here, between the dark curves of the jarrah and the fair skin of the face, is magnificent. The tone too is beautiful, and Scott believes jarrah has tremendous potential as an instrument wood.

"It has colour, stability and gives good sound," he said. "With practise it can be worked, and I have set my heart on carving a name for myself as a luthier using jarrah and other contrasting West Australian timbers."

Finding suitably milled and seasoned timber has been a major problem for each of these craftsmen. "With so little of the total jarrah cut being used for furniture manufacture in the past, it has taken time to persuade millers to take our requirements seriously," said Ed Janes. "They basically cut for construction materials, with little thought given to quarter-sawing or controlled seasoning."

Scott Wise agreed. "Green timber needs to be carefully seasoned," he said. "I store some jarrah for up to six years, so selecting the right piece is vital. I used to spend days at a mill waiting for the required sections to come through the system, and often found it easier to salvage from old flooring and outdated furniture."

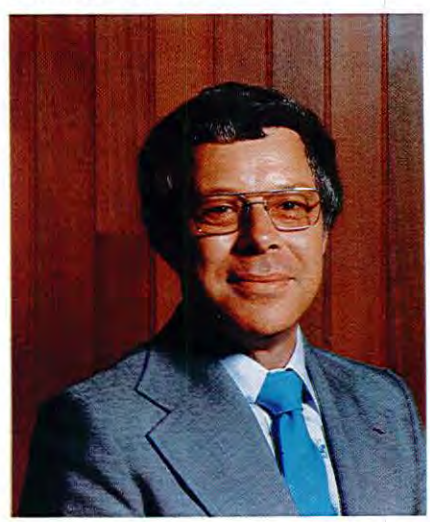
With their difficulties, however, they also share their satisfactions. Ed, Michael and Scott inspire others with their work and continue to demonstrate to many the previously unimagined beauty and versatility of jarrah.

New age

Attitudes are changing in the milling industry according to Allan Forbes, special projects officer with Bunning Bros. (Pty) Ltd. "Past practice was to cut for recovery," he said in a recent interview, "but we are now changing the utilization pattern to account for market changes".

"Logically, the next step in upgrading the market value of jarrah is the improved seasoning of better grades, for furniture and decorative work. Bunnings are working on this and have dovetailed their research with the Forests Department's studies at Harvey," he said. Begun in late 1982, in direct response to the

Allan Forbes
Special Project Officer
Bunnings Bros. Ltd.



growing need to better utilize forest resources, the research programme shares facilities at Yarloop mill and the Forests Department's high temperature kiln at Harvey.

So far, the results have been very encouraging, according to Phil Shedley, Forests Department's spokesman for the joint working group. "Australian eucalypts have always been difficult to season naturally," he said, "but jarrah, in particular, has excellent potential, and we must make every effort to improve its utilization."

Tests indicate that present drying from green must be slow, to avoid surface checking. However, once the wood has reached fibre saturation point (about 28% moisture content), drying to stable moisture content (10%) can be achieved within one day, without detrimental effects, using a high temperature (120°C) kiln.

Upgraded

As well as improving the kiln schedules, an ongoing programme is testing a variety of methods to control the initial drying down to fibre saturation point, during all seasons of the year. Industry practice has been to confine the sawing of finishing quality timber to the cooler months of the year. Year round control of seasoning would therefore increase the availability of high grade timber.

One of the methods to be tested will use a Harvey version of the progressive tunnel kiln, developed by the CSIRO in Melbourne. This system provides high humidity, low temperature conditions in the early stages of drying, followed by a gradual reduction in humidity and an increase in temperature as the timber dries.

Jarrah veneer products are attracting increasing attention from researchers and in the market for decorative purposes. This is perhaps the ultimate in present day utilization of valuable timbers.

Allan Forbes was the instigator of the Furniture Grades Standards Committee, an off-shoot of the Forests Products Association, which is currently formulating specifications for the up-grading of the timber.

"Exponents of jarrah's decorative use have been in the minority," said Allan, "but they have always been around. You only have to look at the work in buildings such as the Cottesloe Civic Centre (remodeled in 1936) to see that."

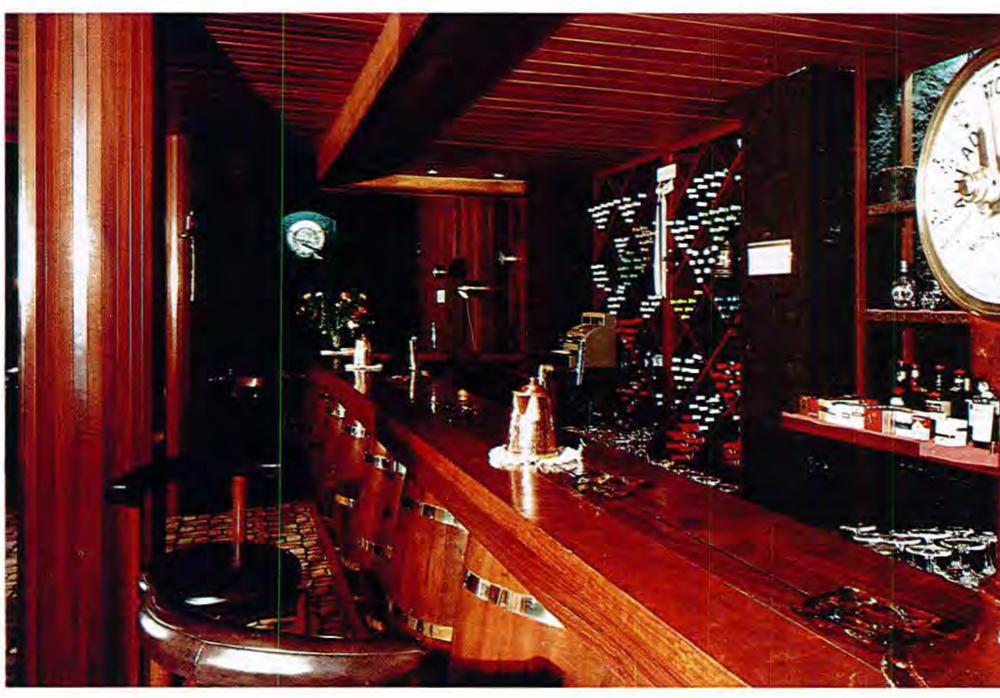
Wider appeal

"David Foulkes-Taylor was the modern pioneer of jarrah in home furniture — as expressed in the range and popularity of his designs (1960-70) manufactured by Catts — but Bunnings tend to take the wider view of jarrah's decorative use. We see the total interior of a home or office as suitable for jarrah's fine finish," said Allan, enthusiastic in his praise of the new Australian Bank in Saint Georges Terrace, Perth.

Current market strategy is aimed at popularizing jarrah in the kitchen, in flooring, stairways and exposed beams (as well as in furniture and panelling) in an effort to improve jarrah's share of the decorative market. Figures gathered in a recent survey of manufacturers suggest significant potential.

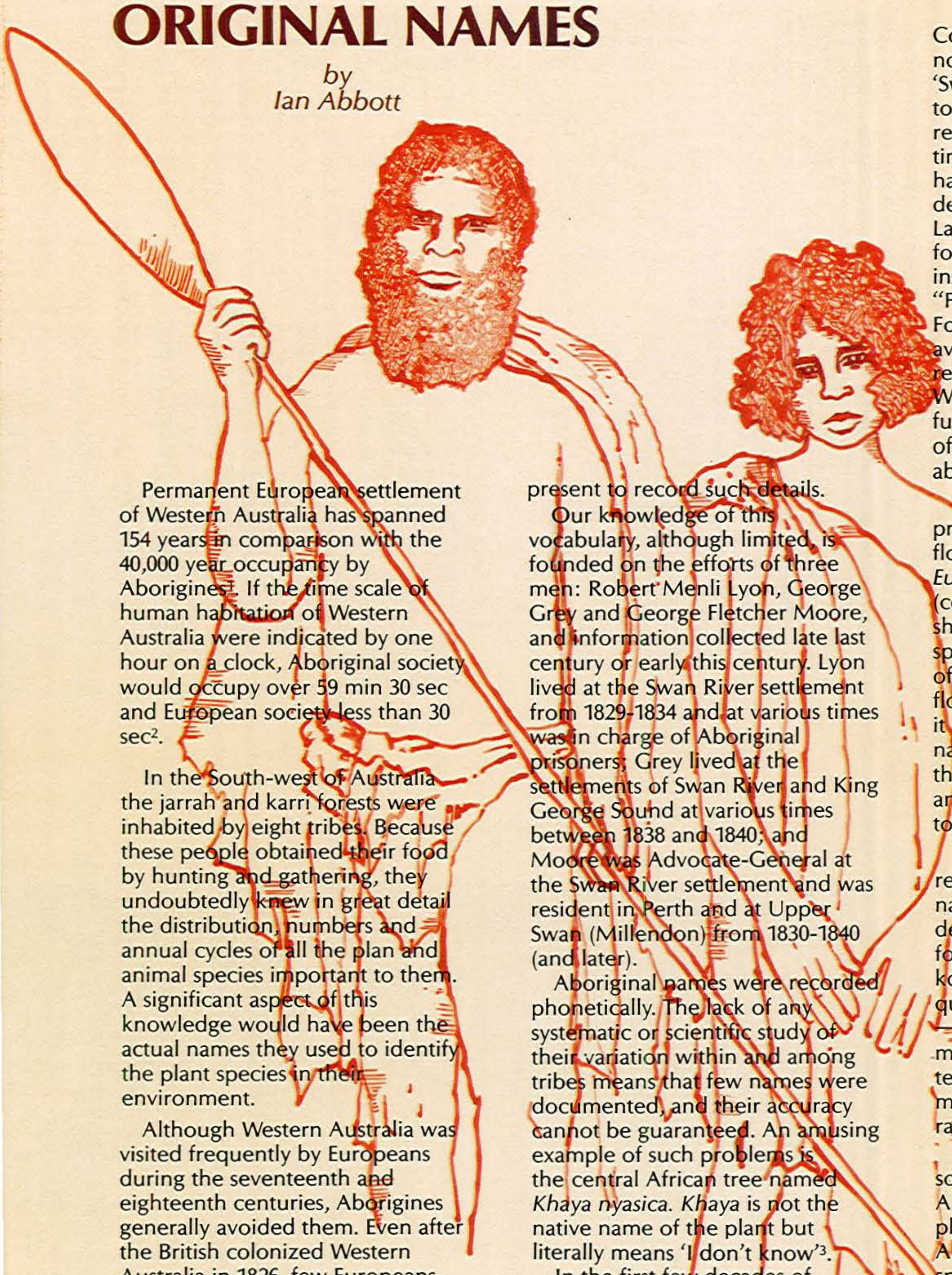
Another marketing thrust aimed at improved utilization, is the manufacture of outdoor furniture, exporting to England, New Zealand and the Eastern States. It is a new market area and better utilizes the shorter lengths of good quality jarrah. Again, jarrah's weight and durability stand it in good stead, for it is particularly suited to outdoor use in the wetter climates. "More importantly," said Allan, "the industry has moved towards processing the smaller lengths to generate improved returns. The emphasis now must be on getting the very best from the resource available."

Jarrah decoration provides a warm atmosphere in many Australian hotels and restaurants. ▼



ORIGINAL NAMES

by
Ian Abbott



Permanent European settlement of Western Australia has spanned 154 years in comparison with the 40,000 year occupancy by Aborigines[1]. If the time scale of human habitation of Western Australia were indicated by one hour on a clock, Aboriginal society would occupy over 59 min 30 sec and European society less than 30 sec[2].

In the South-west of Australia the jarrah and karri forests were inhabited by eight tribes. Because these people obtained their food by hunting and gathering, they undoubtedly knew in great detail the distribution, numbers and annual cycles of all the plan and animal species important to them. A significant aspect of this knowledge would have been the actual names they used to identify the plant species in their environment.

Although Western Australia was visited frequently by Europeans during the seventeenth and eighteenth centuries, Aborigines generally avoided them. Even after the British colonized Western Australia in 1826, few Europeans befriended individual Aborigines or made extensive observations of their customs, behaviour or language, and the destruction of Aboriginal society in the south-west was far advanced before professional anthropologists were present to record such details.

Our knowledge of this vocabulary, although limited, is founded on the efforts of three men: Robert Menli Lyon, George Grey and George Fletcher Moore, and information collected late last century or early this century. Lyon lived at the Swan River settlement from 1829-1834 and at various times was in charge of Aboriginal prisoners; Grey lived at the settlements of Swan River and King George Sound at various times between 1838 and 1840; and Moore was Advocate-General at the Swan River settlement and was resident in Perth and at Upper Swan (Millendon) from 1830-1840 (and later).

Aboriginal names were recorded phonetically. The lack of any systematic or scientific study of their variation within and among tribes means that few names were documented, and their accuracy cannot be guaranteed. An amusing example of such problems is the central African tree named *Khaya nyasica*. *Khaya* is not the native name of the plant but literally means 'I don't know'[3].

In the first few decades of settlement in Western Australia, many English names for plants came into use. Frequently, these names were descriptive (red gum, white gum) or alluded to some similarity with a familiar species (mahogany, native pear, willow).

The Forests Department's first Conservator, Charles Lane-Poole noted that about 1860 the name 'Swan River mahogany' was altered to jarrah, "as it was generally recognized that this was better timber than mahogany, and that it had so many fine qualities that it deserved a name of its own". Lane-Poole was also responsible for promoting the use of marri instead of redgum. He wrote "Following the decision of the Forestry Conference, in order to avoid confusion with Murray River redgum (*Eucalyptus rostrata**). Western Australian redgum will in future be called 'marri' in all official publications. Marri is the aboriginal name."

Lane-Poole's logic and procedure seem also applicable to flooded gum (confused with *Eucalyptus grandis*), blackbutt (confused with *E. pilularis*) and she-oak (of which there are many species). We should extend the use of Aboriginal names for native flora in Western Australia wherever it is feasible to do so. Aboriginal names are more appropriate than the often clumsy European names, and they would serve as a tribute to the original inhabitants.

This process is well advanced in respect of mammals. Vernacular names of Australian mammals derive from Aboriginal names — for example, bettong, chuditch, koala, numbat, quenda, quokka, quoll, tammar, woylie and wombat — no doubt because they are more apposite than the clumsy terms native bear, marsupial mouse, native cat and kangaroo rat.

Recently I collected together some 250 names used by Aborigines to refer to just over 100 plant species in south-western Australia, and systematized their spelling. Certainly, these names (on photographs opposite) look odd at first glance, but most are short (2-3 syllables) and, after a little practise, roll off the tongue easily.

The list has been derived on the basis of a sympathetic reading of the available evidence on names,

* now known as *Eucalyptus camaldulensis*

but with an eye to practicality in common use. The spelling system adopted is again phonetic.

Consonants are sounded as in English, except that 'ng' sounds as in ring. Vowels are sounded as follows: a as in father, e as in met, i as in bib, o as in low, and u as in put. These conventions are generally neglected. For example, most people mispronounce numbat as numb-bat, instead of noom-bart.

Most of the names gathered refer to tree species occurring between Perth and Albany. Aboriginal names of most other plant species have either not been recorded or, when they were, insufficient description was provided (so that it is now not possible to attach the current scientific name to the Aboriginal word).

Several of the Aboriginal words listed would be suitable common names for plant species. Examples are balga, djiriji, gulli, gulurto, mutyal, twotta and willarac. This would extend a firmly established practice of using Aboriginal names, e.g. jarrah, marri, morrel, wandoo, tuart, karri and mallet.

Where no Aboriginal name has been recorded and no well established English common name is available, it would seem easier and more precise to learn and use the scientific name (Latin binomial).

It is stressed that this is a provisional list and constructive, documented suggestions for modifications or extension are invited.

References

1. Pearce, R.H. and Barbetti, M. 1981. A 38 000-year-old archaeological site at Upper Swan, Western Australia **Archaeology in Oceania** Vol 16 No 3, 173-8.
2. Flood, J. 1983. **'Archaeology of the Dreamtime'.** Collins, Sydney. 288 pp.
3. David Ward, Forests Department of Western Australia, personal communication.

Eucalyptus macrocarpa Mudelka

Callitris preissii Maro (Rottnest Island Pine)

Banksia grandis Pulgarla (Bull Banksia)

Hakea victoria Dalyongurd (Royal Hakea)

Eucalyptus salmonophloia Wurak (Salmon Gum)

Hakea laurina Kodjet (pin cushion)

Eucalyptus erythrocorys Ilyari

Anigozanthos manglesii *Kurulbrang* (Kangaroo Paw)

Latin name	Recommended Aboriginal Name (tentative phonetic rendering)
Acacia acuminata	Mangard
A. lasiocalyx	Wilyurwur
A. lasiocarpa	Padjang
A. microbotrya	Kalyang
A. saligna	Kudjong
Agonis flexuosa	Wonil
A. juniperina	Wodi
Allocasuarina fraserana	Kondil
A. huegeliana	Kwowl
Anigozanthos manglesii	Kurulbrang
A. viridis	Kurulbardang
Astroloma serratifolium	Kondrung
Banksia attenuata	Piara
B. grandis	Pulgarla
B. littoralis	Pungura
Beaufortia squarrosa	Puno
Billardiera lehmanniana	Kurup
Bossiaea aquifolium	Nedik
Callistemon phoeniceus	Dubarda
Callitris preissii	Maro
Calothamnus quadrifidus	Kwowdjard
C. sanguineus	Pindak
Carpobrotus virescens	Kolboko
Casuarina obesa	Kuli
Chorizema cordatum	Karlya
Daviesia divaricata	Marno
Dioscorea hastifolia	Wararn
Dodonaea attenuata	Warning
Dryandra carduacea	Pingurl
D. nivea	Pudjarn
D. sessilis	Pudjak
Eucalyptus angulosa	Kwararl
E. astringens	Malard
E. calophylla	Mari
E. celastroides	Mired
E. cornuta	Yeid
E. diversicolor	Kari
E. doratoxylon	Keidjngund
E. erythrocorys	Ilyari
E. eudesmioides	Marlarli
E. falcata	Dulyumuk
E. flocktoniae	Merid
E. gardneri	Kwoakol
E. gomphocephala	Duart
E. guilfoylei *E. jacksonii*	Dingul Dingul
E. longicornis	Moril
E. loxophleba	Dwoda
E. macrandra	Dwed
E. macrocarpa	Mudelka
E. marginata	Djara
E. megacarpa	Pulidj
E. occidentalis	Moidj
E. patens	Dwuda
E. platypus	Murd
E. rudis	Kulurda
E. salmonophloia	Wurak
E. tetragona	Dalyeruk
E. transcontinentalis	Pungul
E. wandoo	Wondu
E. woodwardii	Gunguru
Exocarpos sparteus	Djuk
Gastrolobium laytonii	Prilya
Haemodorum paniculatum *H. spicatum*	Mardja
Hakea laurina	Kodjet
H. oleifolia	Dungyn
H. preissii	Dandjin
H. recurva	Djarnokmurd
H. victoria	Dalyongurd
Helipterum manglesii	Ngyamingyaming
Hovea pungens	Puyenak
Hypocalymma angustifolium	Kudjid
Jacksonia sericea	Waldjumi
J. sternbergiana	Kapur
Kingia australis	Pulonok
Kunzea ericifolia	Pondil
Lambertia inermis	Djidiok
Lepidosperma gladiatum	Kerbin
Macrozamia riedlei	Djiridji
Melaleuca elliptica	Ngow
M. nesophila	Mindiyed
M. sheathiana	Buri
M. uncinata	Kwidjard
Nuytsia floribunda	Mudja
Oxylobium lanceolatum	Wonidj
O. parviflorum	Dilya
Patersonia occidentalis	Koma
Platysace cirrosa	Karna
P. maxwellii	Karno
Podocarpus drouyniana	Kula
Pteridium aquilinum	Mundangurnang
Ptilotus manglesii	Mulamula
Santalum acuminatum	Warnga
S. murrayanum	Kulya
S. spicatum	Wilarak
Synaphea polymorpha	Pinda
Typha domingensis	Djandjid
Xanthorrhoea gracilis	Mimidi
X. preissii	Palga
Xylomelum occidentale	Djandjin
Verticordia nitens	Kodjeningara
Viminaria juncea	Koweda

Nuytsia floribunda Mudja (Christmas Tree)

Pteridium aquilinum Mundangurnang (Bracken)

Hovea pungens Puyenak (Devils Pins)