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Forestry
IN
WESTERN AUSTRALIA

CHAPTER III

**THE FOREST FORMATIONS OF
WESTERN AUSTRALIA**

THE JARRAH FOREST
THE KARRI FOREST
THE TUART FOREST
THE WANDOO WOODLAND
THE MALLETS AND OTHER
TANNIN TREES
FORESTS AND WOODLANDS OF
THE ARID AND SEMI-ARID INLAND

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CHAPTER III

THE FOREST FORMATIONS OF WESTERN AUSTRALIA

The Jarrah Forest

Jarrah (*Eucalyptus marginata*) is the principal timber tree of Western Australia. Because of its resemblance to the well known Honduras timber "mahogany" it also was given that name by early settlers. It was recognised, however, that as the timber had so many fine qualities peculiar to itself, it warranted a distinctive name of its own and from about 1860 onwards it became universally known by its aboriginal name—"Jarrah".

Description of the Forest

Jarrah is a large tree, attaining under optimum conditions, a height of 100 feet (30 m) to 130 feet (40 m), with a straight bole of up to 50 feet (15 m) or 60 feet (18 m), and a diameter of 6 feet (2 m).

The bark is persistent, reddish-grey, stringy, flat and flakey, with small fissures running vertically. This bark renders jarrah distinct from other South-Western trees, except from Albany blackbutt (*Euc. staeri*), and red tingle (*Euc. jacksonii*), which trees also have fairly stringy barks, although less tough than that of jarrah.

The jarrah formation is a high forest with a small admixture of marri (*Euc. calophylla*) and blackbutt (*Euc. patens*); flooded gum (*Euc. rudis*) and bullich (*Euc. megacarpa*) occur in the gullies and flats. The understorey consists mainly of scattered sheoak (*Casuarina fraseriana*), bull banksia (*Banksia grandis*), and to a lesser extent, emu bush (*Persoonia spp.*). Below this understorey, blackboy (*Xanthorrhoea preissii* and *X. gracilis*) and zamia palm (*Macrozamia reidlei*) occur with grass trees (*Kingia australis*) on the poorer sandy types. The ground is covered with a wealth of shrubs and woody plants.

Although it lacks the aesthetic qualities of other forests, the jarrah formation is noted for its remarkable purity and the value and utility of the timber it produces. The prime belt has by far the least admixture of other species than any other Eucalypt forest in Australia of equivalent area, and it is considered to be one of the finest hardwood stands in the world.

Distribution

Jarrah was originally found scattered throughout the south-west of the State over some 13 million acres (5.3 million ha.) of country within the 25 in. (635 mm) to 50 in. (1270 mm) rainfall belt. The prime forest of some 4 million acres (1.6 million ha.) however, stretches from Chidlow's Well in the north, following the Darling Range to the extreme south of the State finishing just north of Albany. Most of this is now State Forest. The species is closely associated with soils of lateritic origin and the best existing forest areas occur on the lateritic gravels of the Darling Range where the rainfall exceeds 45 inches (1143 mm). However, jarrah attains its greatest size in the red loam soils of the deeply dissected river valleys. Most of these areas have been cleared of jarrah forest for other uses.



Plate 16
Mature jarrah forest near Dwellingup

Distribution is limited to the east and to the north by low rainfall and the species becomes progressively smaller as the rainfall decreases. Eastwards it gives way to wandoo (*E. wandoo*), powder-bark wandoo (*E. accedens*) and York gum (*E. loxophleba*). On the coastal strip west of the Darling Range it occurs in rather open formation as a tree of low height and poor form. Here it is associated with tuart (*E. gomphocephala*) which replaces the jarrah completely on the limestone ridges. In the extreme south of its range it is replaced by karri (*E. diversicolor*) and marri on the better soils, while on the southern plains it is a small, crooked tree and takes on a mallee form in the harsher environments.

Timber

Jarrah timber is dense, hard but fairly easily worked, of a red colour darkening with age to a rich brown with a beautiful grain, and takes a fine polish. It will be readily realised that there are few purposes for which jarrah cannot be used, when in addition to beauty of colour and grain, its strength, durability and an amazing resistance to fire are considered. Some trees possess a remarkable fiddleback figure referred to in the trade as "curly jarrah". For beauty of appearance as a furniture wood it has few rivals.

Weight per cubic foot (green)	73 lb. (1168 kg/m ³)
At 12 per cent moisture	54 lb. (864 kg/m ³)
Transverse strength	16,200 lb. per sq. in. (1,139,000 gm. per sq. cm.)
Tensile strength	15,500 lb. per sq. in. (1,090,000 gm. per sq. cm.)

Uses

In Western Australia jarrah is a veritable all-purpose timber. Despite its beauty as a furniture wood, it is used as a utility timber because of its strength, durability and availability. In the form of piles, stringers and decking it has been employed to such an extent that there is scarcely a wharf, pier or jetty in Western Australia which does not contain a high percentage of jarrah.

It is eminently satisfactory as a building timber, being used in the sawn state for stumps, joists, weatherboards, plates, studs, rafters, laths and shingles, while flooring, lining, frames, doors, windows, interior trim mantelpieces and other furnishings testify to the beauty and suitability of the dressed timber for high grade purposes. In large buildings jarrah makes excellent beams, columns and rafters, while as dados, panelling, partitioning, stair railing, counters and similar furnishings, it adds to the beauty of the interior. The pleasing figure of jarrah makes it eminently suitable for veneers and small quantities are now being used for this purpose.

Waste timber is universally used in the South-West as firewood, and jarrah forms the chief firewood supply of Perth.

The timber is quite durable and when used for posts or sleepers in contact with the ground it gives a long life of valuable service. The average life of jarrah sleepers in Australia is 20-35 years, depending on the locality in which they are used. Jarrah sleepers are readily accepted in many overseas countries and they contribute to a valuable export trade. In the London Underground they are still in use after 50 years of service.

Prior to the development of concrete and bitumen road surfaces, its durable nature permitted many famous thoroughfares throughout the world to be paved with jarrah blocks. Jarrah timbering employed in the first houses constructed in the Colony is still sound today and the post-and-rail fences erected by the early settlers are often still standing.

Flowering and Seeding

New fruiting buds appear in the axils of the leaves of the new summer growth in the December to March period, and if retained, they flower in the following November and December. From this flowering, the fruits mature to shed their seed in the following summer, two years after first formation of the bud.

Seed years, however, are not regular and heavy seeding occurs only once every four to six years. Scattered individuals can be found in seed every year, but in a general seeding, some 25 to 50 per cent of the stand will carry a heavy crop.

A marked crown degradation is noticeable during a heavy seeding. Copious flower bud formation is at the expense of the normal crop of leaf buds and when older leaves are shed the trees are left with extremely thin crowns. These normally rejuvenate during the summer after seeding.

The seed is black and three sided, and a little over an eighth of an inch in length. There are about 4,000 to the ounce (140 to the gram.) pure, or 1,000 with chaff.

Seed fall is brought about by the opening of the capsules in the hot dry weather of mid-summer. Dispersal distance is usually taken as the ground distance equivalent to the height of the tree.

Regeneration

Germination occurs in the cool, moist conditions of late May and June. Although many thousands of seedlings may appear on each acre at this time of the year, losses due to insects, fungi, and drought reduces the numbers by up to 95 per cent in the first year after germination. Mortality among the survivors continues for a number of years and a very small proportion of seedlings live to reach tree size.

A swelling forms at the base of the stem of the young seedlings. This swelling develops downwards as the seedling ages and forms a hardy, woody subterranean lump called the lignotuber. The leafy shoots of this plant grow very slowly in length but rapidly multiply in number to form a small bush. At the same time a large, deeply penetrating tap root is formed. This bushy form of jarrah becomes almost completely indestructible and is immune to fire. If the leafy shoots are burnt off, more arise from dormant buds on the lignotuber. If these shoots are not burnt off periodically they become moribund and the development of the plant is severely retarded. The jarrah bush appears to be quite incapable of developing into a sapling with a single upright stem until the lignotuber attains a diameter of about four inches, or until the shoots of the bush reach about two and a half feet in length and exceed six or seven in number. The period the plant takes to reach this stage varies considerably. Jarrah seedlings planted into ploughed soil where there is no competition will form a sapling shoot at from three to six years of age. Under normal forest conditions the period may extend to 15 years or more and on harsh, low quality forest sites this period of consolidation may exceed half a century.

Once a single leading shoot appears, it grows rapidly for the first few years, after which height growth slowly declines. A five-year old sapling shoot is likely to attain a height of 20 feet (6 m) or more, and at age 10 it will reach 30 feet (9 m) on a good site. For the first few years the sapling shoot is green and fleshy but by the time it is 5-8 years old thick bark is forming and it can withstand mild fires.

The impetus for the bushy plant to produce a dynamic sapling shoot arises from a reduction in competition. In the virgin forest this comes from the death of a large tree. Bushy plants, previously shaded by the tree, respond to the increased growing space available by forming sapling shoots. In managed forest similar conditions are created by the cutting of large trees for timber production.



Plate 17

An unthinned jarrah pole stand, 48 years old

Fire in the Forest

No account of the jarrah forest would be complete without some mention of fire. The whole forest community, including animals, plants and jarrah itself has developed in an environment which is subject to frequent burning. Botanically the jarrah forest community would be classed as a *fire-climax*, meaning that the plant species represented have reached a stable equilibrium with site conditions, and *particularly with fire*. Research workers have found sound evidence that the forest has been associated with fire for at least 7,000 years. The vast majority of plants in the forest, including wildflowers and jarrah itself, have certain adaptations that protect them from fire. In some cases fire is essential for their continued existence. Some instances of these adaptations can be cited.

The seed pods of some *Hakeas* and *Grevilleas* can only be opened and the seed released by the high temperatures of a fire. Nearly all the wattles (*Acacia spp.*) need treatment with temperatures around that of boiling water before they will germinate. A very high proportion of the plants in the jarrah forest have subterranean wood-stocks (or sheathed shoots in the case of plants of the lily family) from which new shoots are formed after a fire.

The Forests Department has learned by bitter experience the consequences of excluding fire from the forest, and the resultant build-up of leaf litter and dead plants. A succession of severe and uncontrollable wildfires in the period 1948-1950 followed 15 years of protection from fire.

We have then, a situation where the forest community needs fire for its continued health and existence. This is achieved by rotational burning over the forest floor every 3-5 years with carefully controlled fires in mild weather conditions. Rotational controlled burning nowadays replaces the lightning fires and aboriginal hunting fires of the pre-settlement era of the State.

Silvicultural Cutting for Regeneration

When sawmilling operations are about to commence on any specific area, an advance controlled burn is run through the area in cool weather to reduce the accumulated inflammable debris.

Next comes the operation of treemarking. Trees which are to be felled for sawmilling are marked by a forest officer. He blazes the tree to be felled and in a nick cut at the base, brands it with his treemarkers brand. This allows for the removal of mature or less vigorous elements of the old crop; and in the openings left by these trees the regrowth will become established.

The young, vigorously growing trees of the crop are retained in the forest to provide the mill logs of the future and the treemarker is careful to mark the old trees so that they will fall in the direction which will cause the least damage to those which remain.

Following the logging operation, tops (crowns) of felled trees are lopped flat and debris cleared away from the butts of good piles and poles. Finally, this debris is burnt in spring or autumn when minimum damage will occur to the remaining stand.

Full protection from fire must be afforded for a period of years until the openings have been satisfactorily stocked with young regrowth of sufficient height to permit the reduction of the fire hazard by prescribed light burning without incurring damage to the crowns. This period of complete fire protection may be from 8 to 10 years, by which time a total height well in excess of 20 feet (6 m) should have been attained.

Growth Rates

Although the growth rate of jarrah cannot compare with that of karri, it is nevertheless impressive when the harsh and impoverished conditions it grows under are taken into account. The average yield of sawlogs from the whole jarrah forest is in the region of 15 cubic feet per acre ($1.05 m^3/ha$) each year. There is a large difference in the rate of growth of the species between the relatively poor northern and eastern sectors of the forest and the prime forest area on the western edge of the Darling Range. In the former the trees may grow well under half an inch in girth ($13 mm$) each year and the annual timber yield per acre may be as low as five cubic feet ($0.14 m^3$). The prime forests of the high rainfall area produce more than 10 times this timber yield and individual tree growth may exceed three-quarters of an inch ($19 mm$) in girth a year.

The productivity of the jarrah forest is rapidly improving under the careful management regimes now practised. Protection from severe fires alone has resulted in a marked increase in production, and further gains can be expected from the large scale thinning operations of the last few years.

Other Trees of the Jarrah Forest

MARRI (*Eucalyptus calophylla*)

Introduction

Marri, a large and shapely tree, is the most widely distributed eucalypt in the south-west of Western Australia. The early settlers knew the tree as red-gum, no doubt because of the prevalence of a red gum or kino in the wood. The kino was often used as a tanning material. However, to avoid confusing the tree with the better known River Red Gum (*Euc. camaldulensis*), the native name of Marri was substituted for red gum some 50 years ago.

The tree is well known to the apiarist and farmer. In suitable seasons it gives a copious supply of nectar, usually flowering in the summer months of February and March. For the farmer its shapely form, dense crown and large white flowers make it an attractive and valuable shade tree.

The name calophylla signifies beautiful leaf, while children know the fruits as "hockey nuts".

Habit and Distribution

Marri has been recorded as growing near Port Gregory, some 40 miles ($64 km$) north of Geraldton; near Tinkurri, 30 miles ($48 km$) east of Narrogin and as far as Cape Riche on the south coast. In the marginal areas, the tree is usually stunted.

In the prime jarrah forest, mature marri trees grow to over 100 feet ($30 m$) in height, with 40 to 50 feet (12 to $15 m$) of bole and diameters at breast height of four feet ($1.2 m$) or more. In the wetter karri regions they frequently attain heights in excess of 150 feet ($46 m$) with a correspondingly greater bole length.

The largest tree recorded grows about two miles ($3.2 km$) west of Pemberton in a farmer's paddock, and has a height of 201 feet ($61 m$), a bole of 71 feet ($22 m$), a girth at breast height of 20 feet 10 inches ($6 m$) and a merchantable log volume of 1,215 cubic feet ($34 m^3$). A second large tree occurs some 20 miles ($32 km$) south-west of Collie with the corresponding measurements of 178 feet ($54 m$), 98 feet ($30 m$), 18 feet 10 inches ($5.4 m$) and 1,295 cubic feet ($37 m^3$).

Marri usually occurs in mixture with jarrah or karri and is not often seen in pure formation, although small pure stands do occur south of the Blackwood where the species reaches its best development. (See Plate 14.)

Growing in forests yielding high quality clear timber of jarrah and karri, marri until recently has been by-passed in logging. However, it is now coming into wider use following appreciation of its good properties.

Timber Properties

Marri is in the C.S.I.R.O. Strength Group B and the Durability Class 3.

In mature trees the heartwood is light brown and the sapwood varies in width from $\frac{1}{2}$ to $1\frac{1}{2}$ inches (13 to 38 mm). The grain is slightly interlocked and the wood is non-fissile, with a uniform medium coarse texture.

It is easily worked, but the prevalence of gum veins and the occasional loose ring has, in the past, inhibited its use as a saw timber. Nevertheless, it is stronger than jarrah, seasons with much less shrinkage than jarrah and karri and takes paint well. It is not difficult to nail and does not tend to split as much as some of the lighter eucalypts. One sawmill is now cutting only marri and producing mainly scantling.

It steam bends satisfactorily. Although better than karri, the timber is not as durable in the ground as jarrah.

Marri is of particular interest because it shows little decay or fibre breakdown, even in the heart of the tree. In wood-chip and pulp mills, this will enable the species to be chipped as a whole tree operation, avoiding costly segregation of faulty material. In this respect marri is unique among the hardwoods of Australia available for this purpose.

General Uses

Marri has adequate strength and durability for use as piles, sills and beams in bridge construction and it is satisfactory for marine piling where the hazard from marine borers is of low intensity. Preservative treatment makes marri suitable for use as poles, and a considerable number are now in use with the Postmaster General's Department. Experimental lots of sleepers have been used by the West Australian Government Railways, and they are also in use in New Zealand.

The timber is being used successfully for handles, shafts and oars, and for bats and other sporting goods. In the sawmilling areas it has been used quite extensively in cottage construction for framing, weatherboards, flooring and tile battens, and it is coming into more general use in this field in Perth. It is being used for the framing of flush panel doors and in select quality it would be excellent for furniture construction. It has also been found to make satisfactory fruit and beer cases.

W.A. BLACKBUTT (*Eucalyptus patens*)

Habit

Blackbutt is a tree which may attain a height of up to 150 feet (46 m), with a bole length of 40 to 50 feet (12 to 15 m), and a diameter, breast high, up to 6 feet (1.8 m). The bark is persistent, hard, fibrous, deeply fissured, and dark-grey in colour with an almost corky appearance.

In the forest, however, the bark on the lower portion of the trunk is usually blackened by fire, hence the name "blackbutt".

There are several other tree-species of lesser importance in Western Australia, especially on the Goldfields, known in their respective districts as "blackbutt". This indicates why a tree may need something more than its common or local name to distinguish it. (The trade name for the timber is Yarri.)

People unfamiliar with our forest trees sometimes experience some difficulty in distinguishing blackbutt from jarrah. The leaves, however, are smaller than those of jarrah and of a bluish-green colour. The fruits are somewhat smaller than the jarrah fruits, but the rim which forms the top margin of the fruit is quite narrow, and the ovary is slightly sunk and flatter.

Distribution

W.A. Blackbutt is not plentiful, but it is found in tree form in small patches in the gullies and pockets of alluvial soils throughout the prime jarrah forest region, and occurring with jarrah in some parts of the karri forest. A shrubby form is found as far east as Esperance, but is rare.

Timber and Uses

The timber is about the same weight and strength as jarrah, but of a pale yellow colour. It is almost identical in quality with jarrah and serves as a durable general purpose timber. The oak-like colour and hardness of the wood make it an excellent flooring and panelling timber. When available it is acceptable locally as a sleeper in the same class as jarrah.

SHEOAK (*Casuarina fraseriana*)

This tree grows to a height of 40 to 50 feet (12 to 15 m), with a bole 10 to 15 feet (3.0 to 4.5 m), and a diameter of 2 feet 6 inches (0.75 m). The bark is persistent, greyish and deeply channelled longitudinally.

The fruits of the sheoak are known as "cones". These, in the case of *Casuarina fraseriana*, are almost globular, about an inch in diameter, slightly flattened on top, and the valves, or openings which emit the seeds, are a light brown inside and open widely.

The wood is sound with broad medullary rays, which show up well and make the timber particularly beautiful when cut "on the quarter". It takes a good polish and is durable in service, and therefore makes an excellent cabinet wood. It splits well and was used almost exclusively in the early days of the Colony for roofing shingles. A shingle taken from one of the first houses to be erected in Perth (after 83 years' use) was found to be in a splendid state of preservation.

Sheoak has proved to be a first class cooperage timber and was formerly in high demand as a timber for keg and cask construction due to its relatively slight degree of shrinkage.

MINOR SPECIES

Two other species merit a mention due to their very attractive timbers. Both are relatively small trees, irregularly distributed throughout the forest. The timbers, therefore, are available only in small quantities.

Native Pear (*Xylomelum occidentale*) is a small tree attaining a height of 20 to 25 feet (6.0 to 7.6 m) with a short bole, and a diameter of up to 12 inches (30 cm). The bark is persistent, grey or almost black and lightly fissured.

Native pear is to be found growing all along the sandplain country, between the Darling Range and the sea coast.

The tree yields a most ornamental dark brown wood, with a beautiful figure. It is light, and makes up into a very fine furniture wood. Finished with a wax surface it resembles moire silk. The tree being small, of poor form and frequently damaged by fire, the timber is never obtainable in large size or in commercial quantity.

River Banksia (*Banksia verticillata*) is a tree which reaches a height of 50 to 60 feet (15 to 18 m) with a bole of 15 to 20 feet (4.5 to 6.1 m), and a diameter of 2 feet 6 inches (0.76 m). The bark which is persistent, grey and completely fissured longitudinally, shows red when it is cut. The tree occurs along the larger rivers and streams in the South-West, and is rarely found growing far away from running water.

The timber is light-coloured with a particularly beautiful grain. The medullary rays are wide, so that when cut on the quarter it shows a beautiful oaklike figure much prized in furniture work. It is the lightest of the timbers of the State.

The Karri Forest

Karri is the Aboriginal name for the State's tallest trees and together with Mountain Ash and Alpine Ash of Victoria and Tasmania is credited with being one of the three tallest hardwood trees in the world. Its botanical name is *Eucalyptus diversicolor*, the specific name "diversicolor" referring to the difference in the shade of green between the upper and lower surfaces of the leaf. On days when the wind is strong enough to overturn leaves from their natural hanging position, the paler under surface contrasts strongly with the deeper green of the upper surface of the leaf.

Description of the Forest

Prime stands of karri constitute some of the most magnificent hardwood forests in the world. Long, straight boles, as much as 120 feet (37 m) to 160 feet (49 m) to the first limb, tower skywards supporting wide spreading crowns 60 feet (18 m) or more in diameter and total heights of 200 to 250 feet (61 to 76 m) are common. The tallest karri (measured in 1939) reached 286 feet (90 m) and had a butt girth of 24 feet (7.3 m)—truly a masterpiece of natural engineering combining symmetry and beauty with great strength and economy of material. The largest girth yet recorded is 40 feet 2 inches (12 m) at breast height.

The bark is smooth and greyish-white when old. However, in late summer this old bark splits and sheds in irregular patches exposing the new, fresh salmon-yellow bark beneath, so giving the stems a mottled appearance. Following severe fires, bark shed may be greater than normal resulting in stands of trees having uniform salmon-yellow bark. As the months pass, however, the colour gradually reverts to the original greyish-white.

Seen in the slanting rays of the morning sun, which illuminates the long, smooth straight boles against the bright green mass of the undergrowth, the karri forest presents a beautiful sight not readily forgotten. Care has been taken to reserve extensive areas in the virgin state, not only for reasons of conservation and recreation, but also to provide reference points for scientific ecological studies.



Plate 18
Virgin karri forest

Distribution

The karri forest occurs in the extreme south-west of the State in localities receiving a rainfall in excess of 40 in. (1016 mm) per annum. The main belt of forest lies south of a line drawn from Nannup in the north-west, through Manjimup to the Frankland River in the south-east, thence in a belt of decreasing width through to Denmark and Torbay, near Albany. Its western limit is a line south from Nannup, separated from the coast by a belt of coastal sand-dune country, varying in width from 2 to 10 miles (3 to 16 km).

A number of outliers from the main belt occur, the largest of which are:—

- (1) A narrow coastal belt of some 75,000 acres (30,000 ha) on the strip of limestone soils between Karridale and Forest Grove.
- (2) A patch of a few hundred acres on the northern slopes of the Porongorups, approximately 12 miles (19 km) east-south-east of Mt. Barker.

Within these distribution limits of nearly one million acres, the main commercial forest of about 300,000 acres (120,000 ha) spreads through the river systems. Of this, 170,000 acres (69,000 ha) are in pure stands, and 130,000 acres (51,000 ha) in mixture with marri, or more rarely, in mixture with jarrah or the Tingles (*Euc. jacksonii* and *Euc. guilfoylei*). Of the remaining 700,000 acres (280,000 ha) about 80 to 85 per cent is occupied by jarrah-marri forest, and the rest by wide, poorly drained flats carrying no native tree growth of commercial value.

Within its range, the actual distribution of karri is determined mainly by soil type.

Soils of the Karri Forest

Karri soils generally are acidic in reaction, with textures varying from fine sands to sandy loams derived from underlying granite gneiss. Such soils are of low nutritive value and have been proved deficient in trace elements such as zinc, copper, and cobalt.

The Timber and Its Uses

The timber of karri varies in colour from pale pink to reddish-brown and deep red and although closely resembling jarrah in appearance, is generally lighter in colour. A common test to distinguish between jarrah and karri is to burn a splinter of sound truewood—avoid sapwood and brittle heart. Jarrah burns to black charcoal, but with karri the red-hot coal continues to glow until a true white ash is produced.

The timber of karri is hard, stiff and tough, and considerably stronger than Douglas Fir and English Oak. It has exceptionally good bending properties.

Weight per cubic foot (green)	72 lb./cu. ft. (1200 kg/m ³)
At 12 per cent moisture	57 lb./cu. ft. (912 kg/m ³)
C.S.I.R.O. strength group rating	B

Karri is rated as durability class 3 by the Division of Forest Products, C.S.I.R.O.

The uses of karri wood material are numerous. The strength and stiffness of the timber, combined with the extraordinary long, clean lengths which may be obtained, render it unsurpassable for superstructural work. It is possible to secure karri in larger sections and longer lengths than any other known hardwood. In beams, rafters, tile battens, columns, roof trusses, warehouse floor joists, and other members where strength is the essential factor, it gives satisfaction. It may be mentioned that, in one of the mills in the karri forest, the roof was carried by two trusses with a common tie beam consisting of a piece of 12 in. x 12 in. (30 cm by 30 cm) karri,

80 ft. (24 m) in length. In many instances karri has replaced oregon for scaffolding planks, where its greater strength has more than offset the increase in weight. In bridge construction it is used for half caps and decking. The timber is highly prized for transmission line crossarms, and is also used in coach, waggon and motor body building.

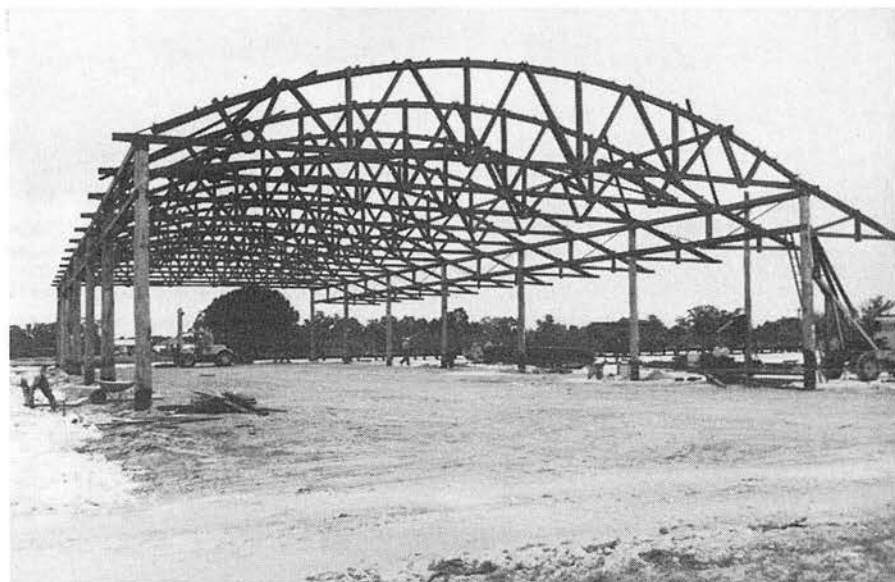


Plate 19

Thirteen karri bowstring trusses were used in the construction of this sawmill near Welshpool. The carved sections are of laminated construction and each truss spans 18.9 m with a 3.7 m cantilever. The round posts are jarrah.

In the gold mines of Western Australia, karri is used for many purposes, while large quantities have been exported to Johannesburg where its use is particularly favoured in gold mines as cage guides or "sliding" beams. Reports show that, under conditions of heavy wear, it has a much longer life for this purpose than pitch pine and other timbers previously used.

Large quantities of karri have been used for many years by the Postmaster General's Department for telephone crossarms, and these have given good service. With the setting up of a 1,000 pounds per square inch ($70,300 \text{ gr./cm}^2$) pressure impregnation plant at Pemberton, crossarms are now being treated with 3 per cent pentachlorophenol in oil, and give excellent service. Since its inception not one failure of a crossarm in service has been reported. The hazard from termite and fungus attack in a crossarm is low, but the oil impregnation is worthwhile in reducing the weather checking that can occur in a hot, dry climate. Treated karri crossarms are now used throughout Western Australia and are exported to other States.

In 1944 the plywood industry was established in Western Australia using selected karri logs. Although used initially for all classes of plywood, especially 3-ply, the main use of karri veneer today is for multi-ply waterproof sheets. This type of product is in great demand for concrete form work, because of its great strength and resistance to wear. Karri plywood is also used for truck flooring, and any requirement where strength is an important factor.

Karri has become increasingly popular as a flooring timber, with regular exports of the finished product to the eastern States of Australia, Darwin, the United Kingdom, New Zealand and Greece.

A recent addition to the export market is its use as slats for refrigeration rail-cars in the United States of America. This commodity is usually supplied by the Philippines and South America.

Until partially replaced by cartons, fruit cases were produced annually to carry the apple crop to England. Karri has also been used for wine vat and cask manufacture and for wood pipes and flumes. The last section of karri pipe in the Goldfields Water Supply Scheme pipeline was removed in early 1971—still in good condition.

Karri is on Lloyd's list of shipbuilding timbers and, before the days of steamships, vessels built wholly of this timber were constructed in Western Australia. At Hamelin Harbour, from which the produce of the early Karridale sawmills was exported, quite a fleet of large lighters built entirely of karri was employed. In shipbuilding in later times, the wood had been used largely for keelsons, and the long lengths obtainable are regarded by shipbuilders as an added advantage for this work.

Despite difficulties encountered in gluing, karri shows promise for use in long span laminated beams.

Recent trials have indicated that round karri poles can be successfully impregnated with creosote by "Boultonizing", a process which displaces the green sap with preservative without requiring the pole to be dried beforehand. Previously, drying of poles has been accompanied by excessive checking. Should artificial durability be imparted to karri poles free of excessive checking, then the ready availability of long transmission poles, 55 feet and more in length, from thinnings in even-aged regrowth stands, promises to solve a serious problem of supply of this commodity for the State.

As early as 1923 paper was produced from a mixture of 70 per cent karri and 30 per cent imported sulphite pulp. In recent years trials have indicated that satisfactory pulp can be produced from karri, particularly from young thinnings, and also from sawmill waste.

The sap is strongly acid and readily corrodes iron in exposed positions. When nailed green, galvanised iron nails should be used.

When in full flower, the karri forest is one of the most prolific honey yielders known, contributing about 25 per cent of all table honey produced in W.A. From 400 to 600 lb. (181 to 272 kg) of the finest quality honey may be harvested from each hive.

The Protective and Recreational Functions of the Forest

Apart from its more obvious value as a wood producer, the karri forest, even more than adjacent forest communities, has the capacity to trap and regulate the heavy concentrated winter rainfall. Streams of fresh water, free of contamination by silt or salt, flow the year round. In a dry country such as Australia, fresh water, suitably stored, is of vital importance for domestic, industrial and rural usage. It will not be long before all such streams are utilised for these purposes. It is noteworthy that streams which originate further inland from the forest belt, yet flow through it (e.g., Warren, Frankland, Kent Rivers), have become progressively more salty with agricultural development in the upper reaches, whereas those confined to forest catchments (Donnelly, Barlee, Treen) have maintained their freshness.

Being the only temperate eucalypt rain forest in W.A. it is logical that it be used for recreation, not only during the hot summer months, but also in springtime when the ground flora bursts into flower. Many thousands of visitors annually appreciate

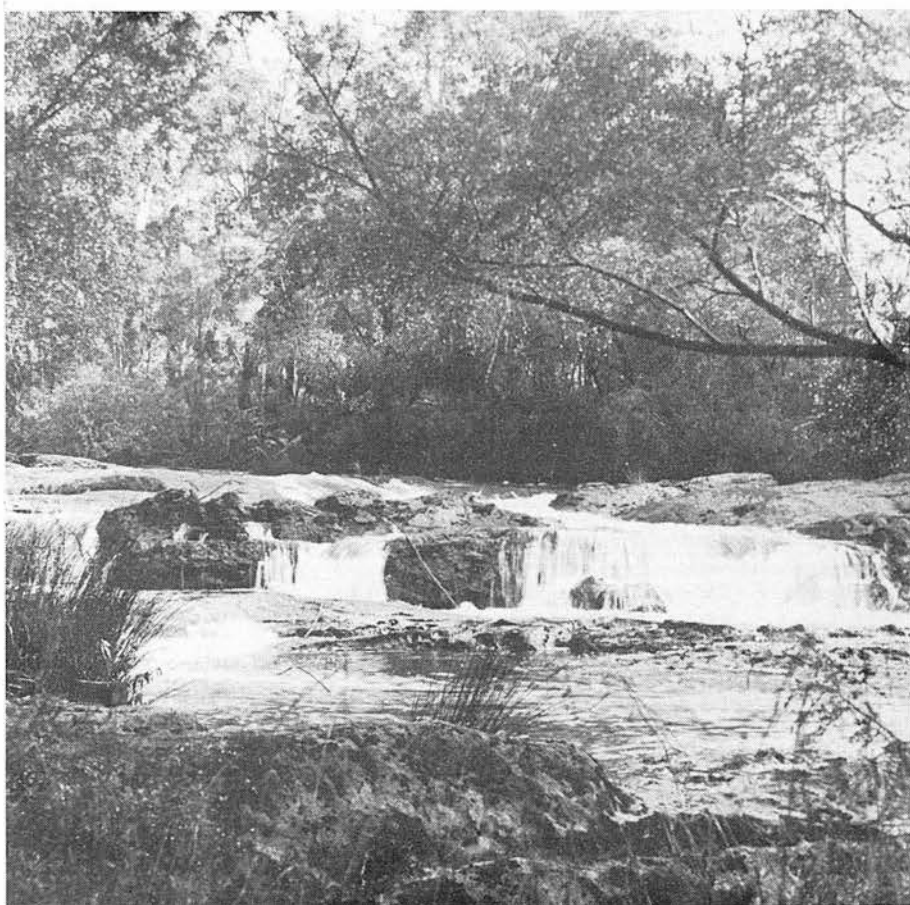


Plate 20

"The Cascades", a favourite tourist spot near Pemberton, is typical of scenes to be found along the permanent freshwater streams which arise in nearby State forest

the cool green gullies, and fish for native marron and introduced trout in the streams. Birdlife is prolific and kangaroos, emus and brush wallabies are often seen.

The Forests Department in the past has provided a number of tourist facilities, either independently, under Treasury grant, or in conjunction with the Pemberton National Parks Board. These include development of access and provision of picnic spots in the karri forest, such as the Rainbow Trail, the Cascades, One-Tree Bridge and developments in the Beedelup, Warren and Pemberton National Parks.

Departmental lookouts such as Gloucester Tree and Diamond Tree attract a high volume of tourist attention and Gloucester Tree is manned for part of the tourist season, outside the normal fire season, for the benefit of tourists.

Flowering and Seeding Habits

Unlike jarrah and marri, which have a reserve lignotuberous stage between seedling and sapling, karri must rely upon its seedlings to develop directly into tree form.

Hence its natural regenerative process relies wholly on seedfall, detailed knowledge of which is essential for silvicultural operations.

The normal seed cycle from bud initiation to mature seedfall takes 4 to 5 years. Flowering takes place in mid-cycle at 2½ years from bud initiation. With minor exceptions all trees progress through the cycle in unison. Hence seed is available in the forest only at the end of each 4 to 5 year cycle. It follows that regeneration operations utilising natural seedfall can only take place at periodic intervals, usually for two years out of every five. Bumper seed crops seldom follow one another, but usually occur once a decade.

Seed Supplies

Dominant trees are the best seed source for the 120,000 seeds per acre (49,000 *ha*) required for adequate natural regeneration. Sampling shows that seed is dispersed indiscriminately with equal amounts being distributed under the crowns and out to a distance equal to half the tree height; about half this number reaches distances equal to the total tree height.

Seed collection for artificial regeneration is done in association with trade cutting, following the testing of sample capsules for high quality seed of above average yield. About one ton of green capsules yields 11 lb. of pure seed (5 *kg to one metric ton*), averaging 330,000 per pound (150,000 *per kilogram*). The seed constitutes only about one-sixth of the material extracted from the capsules, and the balance is worthless chaff.

Natural Regeneration

In order to prepare a clean seed-bed, burning is carried out at a time when the seed supply—as determined by sampling and testing—is adequate for karri regeneration. Burning before the seed is ripe encourages the weeds to establish first, and burning after seedfall incinerates the seed on the ground. Burning helps to ripen the seed in the capsules and promotes seed-shed; it also removes competing scrub and stimulates the early development of karri seedlings.

The seed germinates after the opening rains in autumn and early winter. Leaf mould, litter and ground vegetation hinder establishment of the seedlings, but the bare mineral soil exposed by the controlled burning becomes carpeted with seedlings.

In cutover stands of karri, three dominant trees per two acres will provide the 120,000 seeds per acre (49,000 *ha*) required for satisfactory regeneration. From this seed shed between 500 and 3,000 seedlings per acre (200 and 1200/*ha*) are established.

The effect of the ashbed resulting from the burn is quite remarkable in ensuring the absolute dominance of karri over the weeds. At the centre of a two-year-old ashbed, karri seedlings may be 10 to 12 feet (3 to 4 *m*) in height, compared with 1 to 2 feet (0.3 to 0.7 *m*) in height off the ashbed. Vigorous sapling stands can then completely dominate the site and attain 80 to 90 feet (24 to 27 *m*) height growth in 20 years.

Artificial Regeneration

Proven methods of artificial regeneration have been adopted by the Forests Department, so that areas not satisfactorily stocked with natural regeneration may now be restored to full productivity.

Seed is very sensitive to site influences and direct seeding to date has proved unreliable and expensive. Broadcast seeding requires four to eight times as much seed as spot seeding and sixty times as much as for the production of nursery plants.



Plate 21

A 40-year-old stand of karri regrowth resulting from clear-cutting and regeneration treatment

Transplanting suitably-sized natural regeneration (15 in.) (38 cm) or of open-rooted nursery plants (6 to 8 in.) (15 to 20 cm) gives more certain establishment than does seeding. A handful of equal amounts of nitrogen and phosphate fertiliser next to the planting hole has the effect of producing more rapid, and uniform growth in transplanted seedlings than in naturally regenerated seedlings. The shoots of karri seedlings which have been transplanted without fertiliser die back for two-thirds of their height after planting; development is retarded in the early stages and restricted subsequently by weed growth, and the leading side shoots are commonly forked and malformed. On the other hand, karri seedlings fertilised at the time of transplanting produce vigorous leading shoots and a rush of height growth which quickly dominates the competing ground vegetation.

Silviculture

Karri thins itself moderately well, naturally. The dominant saplings race ahead in height growth, develop larger crowns and overcome their neighbours in the struggle for light, space, and soil nutrients.

The initial establishment of 120,000 or more seedlings per acre (49,000 ha) would, under natural conditions of height growth and fire, be reduced to 1,000 (400) trees at 10 years and 500 (200) at 20 years. Roughly half of these would by this time be dominated.

Except on an experimental scale, no artificial thinning treatments have been carried out in the karri forest. This practice would prove uneconomic at the present stage. Should a pulp industry develop, a large amount of raw material could become available in the form of thinnings from stands 10 to 30 years of age.

The oldest stands resulting from Departmental regeneration work date from 1929, but valuable information has been obtained from areas of natural regeneration at Karridale, now aged 70 to 80 years, and also from old farm properties, one of which dates back to 1872.

Measurements of sample plots laid down in these areas indicate that karri will produce from 75 to 150 cubic feet of wood per acre per annum (5 to 10 m³/ha) on favourable sites.

Judicious use of controlled fire in sapling stands does not appear to have any adverse effect on tree growth. The critical bark thickness to insulate the cambium from the radiant heat of fire is 0.4 to 0.7 in. (10 to 18 mm). This critical point usually occurs where the stem is at least three inches in diameter. Vigorous dominants develop a thick fire-resistant bark near the butt and can survive all but the hottest fires.

Regeneration Systems Employed

The earlier regrowth stands from 1929 to 1938 were produced under a clear-felling system in which marketable timber was felled with no attempt to preserve smaller immature trees. Many of these were smashed in felling operations. Karri trees were ringbarked, and the understorey scrub felled, and the whole burnt by a fierce fire in a good seed year. A dense and uniform crop of seedling regeneration came from seed provided by non-marketable karri trees left in the stand. These latter were subsequently ringbarked to save the growing stock from competition.

In 1938 this method was replaced by a silvicultural operation known as the Selection System, a modified form of treemarking under which the over-mature and mature karri trees were removed for sawlogs under the direction of a forest officer, with the aim of retaining undamaged the maximum number of immature trees. Standard treemarking was introduced into the karri forest about 1949. Under this system the

forest officer marks the trees to be removed, and also indicates the direction in which they are to be felled in order to avoid damage to growing stock. (See Plate 58.)

Since 1968 the system has changed again, reverting to a clear-felling system which produces an even aged stand similar to those produced from 1929-1938. The main objection to the earlier clear-felling was the unavoidable waste of smaller immature trees. Over the past decade a market for smaller scantling sizes, boards, etc., has enabled the utilization of a greater proportion of these smaller trees previously wasted. The manifest advantages of a clear-felling system are: simplified management and protection, more efficient extraction, and less complex regeneration procedures. The main difference between the present clear-felling system and the initial one is that great care is now taken to retain the biggest and best trees as seed trees and not rely on unmarketable trees as previously. Once regeneration is established seed trees are removed.

Other Important Species of the Karri Forest

On the south coast, in the vicinity of Walpole, is a small pocket of country which has the mildest climate of the whole State. Within its confines are a number of eucalypts deserving of special note—the Tingles and Red-flowered Gum. These are all endemic, *i.e.*, they are native to this area and nowhere else.

RED TINGLE (*Eucalypt jacksonii*)

Red Tingle is one of the world's big trees. Though not as tall as karri, it attains larger girths, often being heavily buttressed. Diameters of 15 feet (4.6 m) at 5 feet (1.5 m) from the ground are found, and one tree measured 66 feet (20 m) in circumference at the base. Heights rise to 230 feet (70 m), but are more commonly 180 feet (55 m).

The bark is persistent, grey-brown in colour, and longitudinally fissured in the "stringybark" fashion. Except for its size, red tingle closely resembles jarrah in general external appearance. However, the heavy undergrowth and denser crowns are more typical of the moister karri type forest.

Distribution

The total occurrence is no more than 15,000 acres (6,000 ha) and is bounded by the Kent River to the east, the Deep River to the west, and to the north by a line approximately 10 miles from the coast. Annual rainfall is 50 inches (1270 mm) or more; summer rainfall is 12 to 14 inches (305 to 356 mm), distinctly higher than elsewhere in the south-west. It commonly occurs in mixed stands with karri, marri and yellow tingle, but pure stands of limited extent are found.

Timber

The timber is red-brown in colour and closely resembles jarrah, but is lighter in weight. Limited supply has prevented its wider use for general framing and structural purposes. Some fine examples of its use in furniture and panelling exist. Used as a sleeper, it has a service life of 20 years under South-West conditions. It suffers from "collapse" if not carefully seasoned.

The importance of conserving this rare species is more important than promoting its utilization. All the best stands are now either in State Forest or National Park.

YELLOW TINGLE (*E. guilfoylei*)

In size, form, and general appearance of bark and bole, yellow tingle and jarrah are very similar. Both resemble red tingle also, except that the latter is taller and more massive. Yellow tingle attains a height of 80 to 120 feet (24 to 36 m) and a diameter at breast height of three to four feet. Apart from the yellow colour of its wood, the most obvious characteristic used to distinguish the tree from red tingle is the flat, strap-like peduncle of its fruit. Jarrah fruit are bigger and shaped differently from either red or yellow tingle.

Distribution

Yellow and red tingle occur together, but the yellow extends considerably further to the west, north and east.

Timber

The timber is yellow in colour, hard, dense and durable. Having a wider occurrence than red tingle, availability is better. In limited numbers it is accepted as a sleeper with jarrah, and is considered of equal durability and utility. It does not suffer from "collapse" during seasoning.

For some years the existence of another Tingle having characteristics of both red and yellow tingle has been known. Although its form and appearance closely resembles red tingle, the wood is yellow, and its distribution is more that of yellow tingle. The buds and fruit are different from both, as is the glaucous nature of its juvenile foliage. Recent investigations suggest that sufficient differences exist for it to be named a third Tingle species.

RED-FLOWERED GUM (*Eucalyptus ficifolia*)

The brilliant vermilion stamens of this tree have made it famous and it is widely planted as an ornamental in Australia and overseas. Its natural occurrence is confined to the same south coast pocket as the tingles. However, it does not intermingle with them, but grows on coarse sandy soils in several small patches; one in sight of the coast near Peaceful Bay, and others twelve to sixteen miles inland directly to the north. The first recorded sighting of *E. ficifolia* was further west at Broke Inlet. However, it has not been seen there since.

Considerable variation in flower colour is found: vermilion, crimson, orange and pink. Trees of outstanding colour have been identified and tagged in the field. Seeds have been collected from each tree, raised in the nursery and planted out in orchard form in a safe area within State Forest. The survival of this irreplaceable genetic material is thus favoured.

In Western Australia cultivated specimens are prone to attack by fungal canker, which also affects marri but less severely. It is hoped that resistant strains may eventually be found.

Eucalyptus ficifolia and *Eucalyptus calophylla* (Marri) are both bloodwoods and are closely related. However, *E. ficifolia* has smaller more rigid leaves, a characteristic umbrageous shorter form, coloured flowers, and slightly different fruits.

W.A. PEPPERMINT (*Agonis flexuosa*)

Peppermint is a common understorey tree along the banks of streams and in damp, sandy situations throughout the karri forest and further north, particularly in

association with tuart. Though the timber makes fine panelling and has good strength qualities, irregular form limits its usage. Its umbrageous, sometimes weeping habit, the pleasing appearance of its light green foliage, its peppermint scent, and the clean carpet of leaf litter formed beneath the crowns, create an ideal environment for summer campers. The trees are commonly left standing singly and in groups for stock shelter, and have been planted extensively as street trees, particularly in the Perth Metropolitan area.

WARREN RIVER CEDAR (*Agonis juniperina*)

Warren River Cedar is confined to the higher rainfall karri area. It commonly occurs in permanently damp situations alongside streams and surrounding swamps, often in association with peppermint and river banksia.

The wood is light brown to yellow in colour, has good strength and working properties, and has been used for handles and boat building. However, limited availability and the vulnerability of the standing tree to attack by a large borer have restricted its use.

The Tuart Forest

Description of the Forest

Tuart (*Eucalyptus gomphocephala*) occurs in an open formation which particularly over the southern portion of its range, approaches typical savannah forest conditions. The undergrowth is scanty, consisting chiefly of trailing legumes such as *Hardenbergia*, *Kennedyia* and *Hovea*, but there is, however a well developed understorey of small trees which afford shade. The ground covering consists of grasses and herbs which dry off in the summer. This forest is the only forest formation in the southern portion of the State which has a ground covering partially of grass, a factor typical of savannah formations generally.

Peppermint (*Agonis flexuosa*), attaining heights of up to 30 feet (9 m) is the principal understorey species in the south, while *Banksia menziesii*, *Banksia grandis*, *Banksia attenuata*, *Casuarina fraseriana*, black wattle and spearwood (*Kunzea evicifolia*) predominate in the north.

The tuart normally grows in a pure stand, but can nevertheless be found associating with other eucalypts, particularly towards the outskirts of the stand. Marri is a common species throughout the entire range of the forest, and jarrah occurs in patches but never attains any great size. Flooded gum (*Euc. rudis*) and yate (*Euc. cornuta*) are also found on the swampy flats in the south.

Tuart, the principal species of the formation, attains heights of up to 120 feet (36 m). It is more umbrageous than jarrah, but the trunk is usually not as straight. Bark is persistent, rough, light grey in colour—a bark typical of the "Box" group of eucalypts more common to the Eastern States.

Distribution

Tuart is confined to limestone formations which stretch in scattered lines from Lake Pinjar southward along the coast as far as Sabina River, some three miles east of Busselton. Curiously enough, it is not found elsewhere in the State, although limestone occurs all round the coastline.

The tuart belt is separated from the seaboard by an extensive system of sand dunes, and from the Darling Range (which runs parallel to and at an average distance of 20 miles from the coast) by the lateritic foothills which claim the jarrah as their principal tree. This belt is some 150 miles (240 km) in length and 5 to 10 miles (8 to 16 km) in width.

Rainfall throughout is approximately 30 inches (762 mm) per annum, but, the prime area of forest is found towards the southern limits where the rainfall increases to about 40 inches (1016 mm).

The best tuart is to be found between Capel and the Sabina River. Over 6,000 acres (2400 ha) of tuart country in this locality has been reserved as a State Forest.

Soils

Tuart is only found on limestone outcrops and the yellow to brown sands associated with them on this coastal tract.

Timber and Uses

The timber is a pale yellow in colour, very hard and dense with a strong interlocked grain—a characteristic which makes it ideal for use where strains or abrasions are encountered. For this reason it is largely employed in the construction of railway wagons, and formerly it was used extensively for the pins supporting telegraph insulators. The timber is reasonably termite resistant and even stronger than that of the wandoo and makes a very attractive floor.

The area of prime tuart forest is of very limited extent, and the timber growing in State Forests is reserved for Government requirements.

Weight per cubic foot (green)	78 lb. (1250 kg/m ³)
At 12 per cent moisture	64 lb. (1025 kg/m ³)
Transverse strength	17,900 lb. per sq. in. (1,258,000 gr/cm ²)
Tensile strength	16,500 lb. per sq. in. (1,160,000 gr/cm ²)

Flowering and Seeding

A general seed year occurs only at intervals of from five to eight years. Buds form in March to April, flowers the following March to April, and seeds the next year in the same month. Dispersal is very good, but seed is often retained another year. A fire assists in obtaining a general seedfall.

Regeneration

The establishment of seedlings is a haphazard process of which the story is only partly known. Very little regeneration is found in the tuart forest and has not been apparent for many years.

Seedlings generally die before they reach any appreciable size, and those that survive do so on an ashbed where a heavy pile of debris or a log has been burnt. Limited research indicates that the story is more complicated than this.

Nursery stock planted on sites where they are free from competition from established trees have developed quite satisfactorily.

Only one small sawmill is in operation in the tuart forest. It is controlled by the Forests Department, regulating the cutting of this valuable timber to the rate of growth. The small area of good tuart forest has been declared State Forest and is now under fire protection and silvicultural treatment.

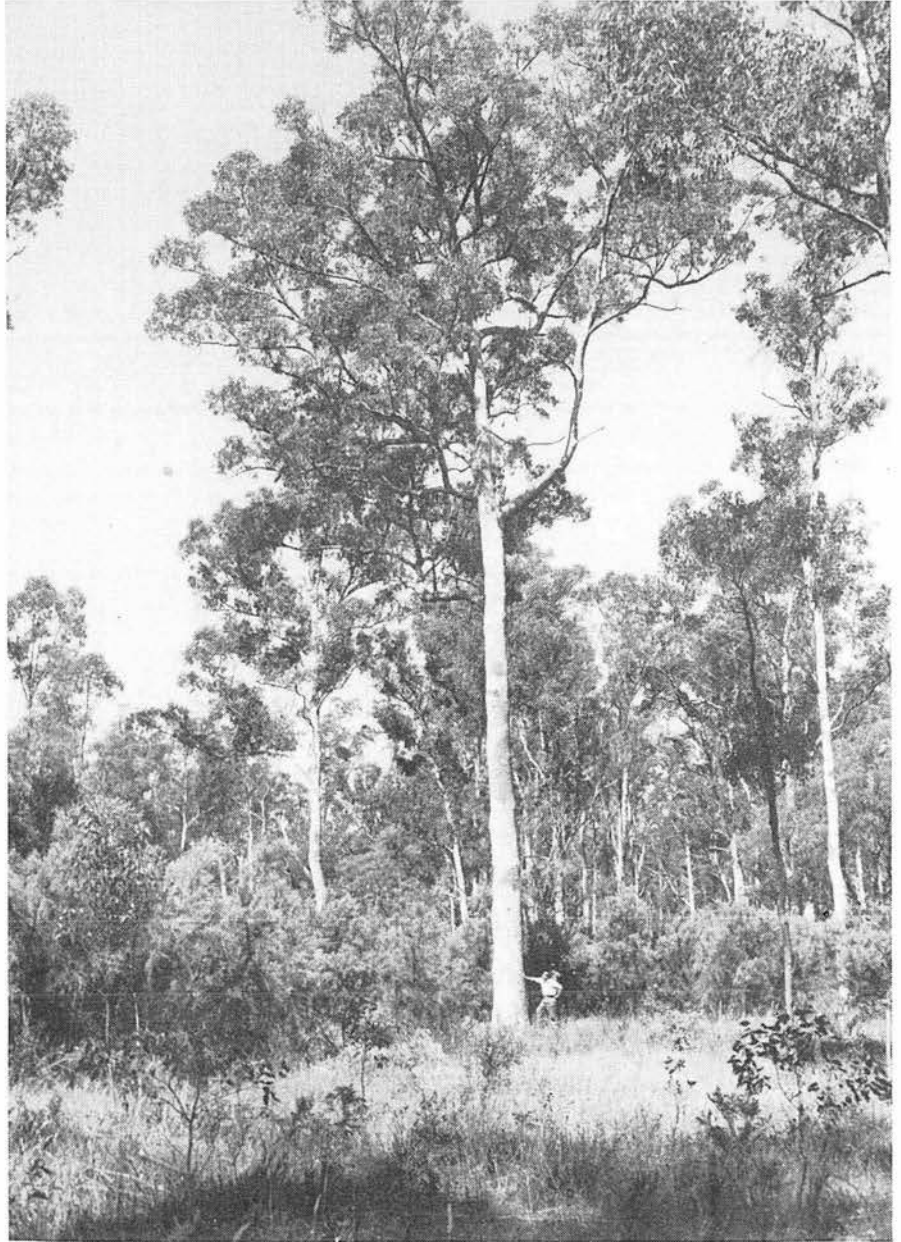


Plate 22

Cut-over tuart forest near Ludlow

YATE (*Eucalyptus cornuta*)

Yate grows to a height of 50 to 70 feet (15-21 m) with a bole of 25 to 35 feet (7.6 m-10.7 m), and a diameter of three feet (0.9 m).

The bark is persistent, dark, rough, and of dirty, untidy appearance on the trunk; it peels off the branches, often hanging down in strips, leaving the branches white like those of karri. It occurs at Busselton, Donnelly River coast, Lake Muir, and in the Mount Barker district.

The timber is light-coloured and of exceptional strength; probably the strongest timber in the world—the results of one test for tensile strength and breaking load was 17½ tons per square inch, which is 3½ tons less than that usually specified for wrought iron of ordinary quality.

Weight per cubic foot (green)	79 lb. (1264 kg/m ³)
At 12 per cent moisture	71 lb. (1136 kg/m ³)
Transverse strength	21,500 lb. per sq. in. (1,512,000 gr/cm ²)
Tensile strength	24,200 lb. per sq. in. (1,702,000 gr/cm ²)

Yate was used generally for wheelwright work, but now the supply of this timber is practically negligible.

The Wandoo Woodland

Description of the Woodland

Wandoo (*Eucalyptus wandoo*; syn. *redunca* var. *elata*) is a smooth barked tree which often grows to a height of 100 feet (30 m) with a bole length of 30 to 40 feet (9-12 m) and a breast height diameter of 4 feet (1.2 m). Under forest conditions, however, the height is generally between 70 and 80 feet (21 and 24 m) with a 20 to 25 foot (6 to 8 m) bole and a breast height diameter of 2 to 3 feet (0.6 to 0.9 m).

The bark is smooth, yellowish-white in colour with purple-grey patches of more persistent bark. On a mature tree the bark is about 1 inch in thickness and decorticates in patches.

The tree closely resembles *Eucalyptus accedens* (Powderbark Wandoo) both in appearance and silvicultural characteristics, and often the two species are found growing in mixture. A point of distinction is that the bark of mature trees of *Eucalyptus accedens* bears a fine, white powder which may be rubbed off with the hands. Furthermore, the operculum or bud cap of the wandoo is long and tapering, while that of the powder bark is blunt. In the young stages the two species may be readily separated by the differences in juvenile leaves.

Another tree which closely resembles wandoo is the recently named *Eucalyptus laeliae*. This new species was earlier confused with powderbark wandoo but differs from it in that the buds and fruits are much smaller and, in particular, the startling white bark persists to the smallest branches. Furthermore it occurs in small pure stands only on laterite-free soils in drainage lines of the Darling Range. The specific name refers to "Laelia", one of the vestal virgins, and is obviously related to the virgin whiteness of the bark.

Unlike the jarrah, karri and tuart formations, the wandoo forest does not present a uniform woodland. Rather does it form a series of associations in which the tree takes a leading part. It does not grow in close formation but in an open savannah woodland or sclerophyll woodland in which there is wide spacing between the trees. Within these areas wandoo occurs both as a pure stand and in mixture with jarrah, marri or powderbark wandoo.



Karri trees, particularly after bark-shed in late summer, form one of the world's most magnificent and scenically beautiful hardwood forests. .



Red-flowered gum (*E. ficifolia*).





Mottlecah (*E. macrocarpa*).



Illyarrie (*E. erythrocorys*).



Throughout the range of wandoo, york gum (*Euc. loxophleba*) is found in association, but not as a mixture with it, the separation of site being determined mainly by soil factors. In the centre and to the east of its range wandoo associates with the mallots (*Euc. astringens*, *Euc. gardneri*, *Euc. falcata*). Yate (*Euc. cornuta*) and swamp yate (*Euc. occidentalis*) occur in association with wandoo towards the limit of its range where its quality is poor. Flooded gum (*Euc. rudis*) is also found with wandoo along some gullies.

Distribution

Wandoo is a native of the south-west of Western Australia and is generally found between the 15 and 20 inch (381 and 508 mm) rainfall limits. It extends as far north as Mt. Lesuer (Jurien Bay) where it occurs in small pure stands, but reaches its maximum development in the vicinity of Bindoon from whence it deviates to form two areas, one on either side of the Darling Range.

Wandoo on the western side of the range is not extensive and exists mainly as odd clumps of trees along the foothills of the scarp.

On the east of the Darling Range it encroaches well into the jarrah forest along the gullies.

The prime wandoo woodland occurs from Bindoon to Boddington, either in broad gullies or on low ridges. Extending south from Boddington, the quality of the stands fall off until it reaches the southern limit in the Stirling Ranges.

The eastern limit of the species extends from Hyden northwards and eastwards almost to Bullabulling where it occurs in mallee form.

Soils of the Wandoo Woodland

The surface layers of typical wandoo soil are dark brown loamy sands or sandy loams containing some gravel. Occasionally in the bottom of a valley the texture of the surface soil becomes a clayey loam. Usually clay occurs at a shallow depth in wandoo soils, varying from six inches to almost four feet, depending on the slope of the land.

Surface drainage in wandoo soils is fair only, and down the profile the drainage can be poor.

Timber

Wandoo timber is light brown to light yellowish brown in colour. It is fairly close-textured with a wavy or interlocked grain, with which some figure may be associated. It is one of the heaviest eucalypts and one of the most durable of Australian hardwoods. It is very hard, exceedingly strong and stiff, and very tough. With hand tools, it is somewhat heavy to work, but it performs satisfactorily in machining.

Weight per cubic foot (green)	80 lb. (1281 kg/m ³)
At 12 per cent moisture	68 lb. (1089 kg/m ³)
Transverse strength	16,100 lb. per sq. in. (1,132,000 gr/cm ²)
Tensile strength	16,500 lb. per sq. in. (1,160,000 gr/cm ²)

Uses

Wandoo is best suited for purposes where strength and durability are of importance. It is used in considerable quantities for sleepers, being recognised as one of Australia's best sleeper timbers. It is a first class structural timber and used in the construction of



Plate 23

Open wandoo woodland east of Mundaring

bridges and wharves for beams, girders, joists and storey posts. For railway purposes it is used for truck under-frames and has proved eminently satisfactory for top planks in truck sidings where it is subject to heavy service conditions. In earlier days it was highly prized by the wheel-wright trade for naves, shafts, cogs, spokes and felloes.

It is particularly suitable for flooring subject to heavy wear and in building construction where durability, strength, or hard wearing qualities are desired.

A remarkable quality of this timber is that, when used in conjunction with steel, there is no chemical action between the wood and the metal. Bolts have been taken from under-frames of trucks after 20 years' use and found to be quite as clean as when put there, while the auger marks were still visible in the holes.

The wood and bark of wandoo contain a high percentage of usable tans which are extracted by digesting the chipped material in large vats. A wide range of commercial tan products are derived from the extract liquor.

The wandoo areas form an important part of the honey industry in W.A. due to the heavy nectar production in seed years. Wandoo honey is a light coloured highly palatable product which has a big internal demand from honey connoisseurs. In addition, the winter flowering habit of wandoo north of Bindoon is a valuable supply for the off-season sustenance of apiaries.

Silviculture

The formation of the bud, fruit and seed of wandoo follows a similar pattern to jarrah.

For an average season, new leaf growth begins in January and reaches a maximum during February. In conjunction with leaf formation, new flower buds form in the axils of the leaves. Many of these buds do not mature further.

Twelve months later during February when the buds have fully developed, flowering occurs. These flowers set and require a further twelve months after flowering for the seed present in the capsules to ripen. The fruit capsules do not remain on the tree for long after ripening.

From the first formation of the bud it requires two years to obtain the ripe seed which is generally shed while the fruit is still held on the crown. After a ground fire a heavy fall of seed will result.

Wandoo has a periodicity of general seed years which is about once in every three years. Flowering throughout the forest does occur every year, but to a limited extent.

Present observations indicate that under natural conditions wandoo seed will only germinate satisfactorily on an ash bed.

As with jarrah, the aerial shoot from the germinating seed of wandoo does not grow immediately to form one erect stem. Several shoots develop to assume a low bushy habit and the plant enters into a resting period during which the ligno-tuber increases in diameter. Approximately ten years after germination, the ligno-tuber which has grown to about three inches in diameter, puts forth one single vigorous shoot from the bushy advance growth to assume dominance and develop into a sapling.

Following germination, a light fire does little damage to regeneration due to the establishment of the vigorous ligno-tuber below ground level. Intensive fires, however, may be the cause of lack of advance growth under virgin wandoo forest. In areas where there have been severe fires, a marked effect on the soundness of the timber in mature trees is apparent. Wandoo burnt at the butt, or with a dry side, is usually not suitable for milling.



Plate 24

York Gum (*Eucalyptus toxophleba*) near Brookton. Background trees on the river bank are Hooded gum, (*E. radix*).

Other Trees of the Wandoo Woodland

YORK GUM (*Eucalyptus loxophleba*)

York gum may grow to a height of 40 to 60 feet (12 to 18 m) with length of bole of 10 to 15 feet (3.0 to 4.6 m), and a diameter of 18 to 24 inches (46 to 61 cm).

The bark is rough, persistent and varies from a light to a dark-grey in colour. The inside of the bark is reddish. Branches are more spreading than is the case with most eucalypts.

The wood is yellow-brown in colour, dense, hard, heavy, with an interlocked grain very suitable as a mallet, nave or maul timber. It may be worked to exhibit a beautiful figure.

Weight per cubic foot (green)	77 lb. (1234 kg/m ³)
At 12 per cent moisture	67 lb. (1073 kg/m ³)
Transverse strength	14,500 lb. per sq. in. (1,019,000 gr/cm ²)
Tensile strength	13,000 lb. per sq. in. (914,000 gr/cm ²)

York gum grows in open or savannah forests in the 20 inch (508 mm) rainfall belt and is most common around Bolgart, Toodyay, Northam, York and from Narrogin to Broomehill. Its presence is regarded by farmers as an indication of good agricultural soil for wheat growing, and also good grazing country for sheep.

FLAT-TOPPED YATE (*Eucalyptus occidentalis*)

Flat-topped yate is a tree which may attain a height of about 70 feet (21 m) with a trunk of up to 20 inches (51 cm) in diameter and a rough, grey, flaky-fibrous bark covering the whole of the trunk and the lower parts of the main branches. The branches have a smooth yellowish-grey bark and are usually wide spreading giving the crown of the tree a typically broad and flat appearance, hence the name of "flat-topped" yate.

The timber is pale in colour, hard, and somewhat straight-grained, something like that of yate but inferior in strength and durability.

The bark contains a relatively high percentage of tannin, but as yet the tree has not been economically exploited for tan bark, nor is it considered likely to be so in the future.

Sometimes called swamp yate, it occurs in poorly drained areas such as alluvial flats and the margin of swamps and lakes in the Wagin, Dumbleyung, Katanning and Cranbrook districts. From here it extends almost to the south coast and eastwards to Esperance and beyond.

RASPBERRY JAM (*Acacia acuminata*)

Jam occurs as a small tree 15 to 25 feet (4.6 to 7.6 m) in height with a short bole up to 12 inches (30 cm) in diameter.

The wood is heavy and very durable; in the agricultural areas jam posts have a service life of 40 years. The grain, like its Victorian sister, the blackwood, is very beautiful and is much prized for cabinet work. The jam tree is regarded by farmers as an indication of good wheat-growing and sheep-raising land, and is therefore being rapidly destroyed in the course of clearing operations.

The name "raspberry jam" arises from the strong scent, resembling that of pressed raspberries, which is characteristic of the wood.



Plate 25

Raspberry Jam (*Acacia acuminata*) trees in a reserve near Williams

The Mallets and other Tannin Trees

Tannins are a valuable commodity which have the ability to convert hides to leather, making them resistant to exposure to air, moisture, temperature change and bacterial attack. They are also useful as a basic ingredient of ink, as an astringent in medicine, and as a dispersant to control the viscosity of mud in oil-well drilling.

In recent years, synthetic materials have largely replaced leather for many of its traditional uses. Nevertheless, the demand for natural tanning materials continues but on a very much reduced scale.

The tannins of the State occur in the following forms—

- (a) In the bark—e.g. Brown mallet (*Eucalyptus astringens*)
- (b) In the kino (or so-called gum), as in Marri (*Eucalyptus calophylla*).
- (c) In the wood, as in Wandoo (*Eucalyptus wandoo*).

Of these the best known are brown mallet bark and the wood of wandoo (already described).

The Mallets

In Western Australia the common name "mallet" is applied to four species of eucalypts:—

- Eucalyptus astringens*—Brown mallet.
- Eucalyptus gardneri*—Blue mallet.
- Eucalyptus falcata*—White mallet.
- Eucalyptus spathulata*—Swamp mallet.

All produce bark with a high tannin content, brown mallet being of most economic importance and swamp mallet, which is of limited extent, the least important.

Description of the Mallet Areas

The mallets are smooth-barked trees, the brown and blue (refers to leaf colour) having bronze-coloured bark when freshly exposed in mid-summer. The colour gradually changes to dark-grey as the year progresses. White mallet has a light-grey to pale bronze bark. Bark thickness near the base varies from one-quarter inch (6 mm) on young trees to over $\frac{1}{2}$ inch (13 mm) on large isolated trees. However, bark on the limbs seldom exceeds one-quarter inch (6 mm) in thickness.

The growth habits of the mallets vary considerably, ranging from typical tree form to mallee form. As trees, they have more-or-less straight boles, 6 feet to 20 feet (1.8 m to 6.1 m) long, while total heights attained are: brown, 60 feet (18 m); white, 35 feet (11 m); blue, 30 feet (9 m); and swamp mallet, 30 feet (9 m).

Brown mallet reaches the greatest size. Large trees are seldom seen these days but trees 70 feet (21 m) in height, two feet six inches (76 cm) breast height diameter with a bole of 20-30 feet (6-9 m) were not uncommon in the natural state.

Mallet regenerates prolifically after a fire and forms dense groups of regrowth. Similar dense groups occur under plantation conditions. Unless these are thinned, growth stagnation occurs which results in delayed production of bark of economic value. Given ample space, the mallets under favourable conditions develop into attractive ornamental trees.

The mallets are all extremely fire-tender but managed to survive for untold centuries in areas subject to periodic heavy fires. When they regenerate after a fire they are commonly associated with a dense growth of poison plants. After some 12 to 20 years these plants die and disintegrate leaving a comparatively clean floor which will not

readily carry a fire except under severe weather conditions. With the increase in fire frequency associated with settlement, mallet groups were generally not able to remain unburnt until the clean floor stage was reached and many of them were destroyed.

Distribution

The four species occur between York and Mt. Barker, on the Great Southern Railway, and south-eastwards to Ravensthorpe.

To the east of the 25 inch (635 mm) isohyet, the jarrah forest gives place to wandoo woodland and further east the wandoo gradually merges into the low rainfall temperate woodlands of salmon gum and morrell, with belts of mallee and heath. In these two latter woodland types, mallet occurs in colonies ranging in area from one to 200 acres (81 ha).

Brown, blue and white mallet attain their best development on well-drained, elevated land on the laterite breakaways and on the scree below them, occasionally extending for some distance into the more level adjacent country of the new plateau.

Brown mallet predominates in the western portion of the range, but proceeding eastwards the proportion of white mallet increases until it becomes the major species. These two species may occur in pure formation, in mixture, or in association with other species such as *Euc. redunca* and *Euc. accedens*. Blue mallet is a minor species occurring with white and brown mallet but seldom forms the predominant species of the mixture.

Swamp mallet occurs on loams in low-lying situations. It attains its best form in the southern wheat belt between Katanning and Ongerup.

Utilization

The economic importance of mallet arises from the tannin which occurs in the bark, particularly that of brown mallet which is recognised as one of the richest natural tanning materials in the world and has been used in the manufacture of leather for over 60 years. This bark, which contains from 40 to 57 per cent tannin, is stripped from the tree during the winter and spring months, i.e. from May to November. After air-drying it is chipped into small pieces about one inch in length and in this form is used for making tan "liquor" in the leather industry.

Brown mallet timber has been tested and found to be almost as tough as American hickory and has a higher static strength than that species; on the other hand it is stiffer and considerably heavier than hickory. Mallet should make a satisfactory substitute for hickory for all but the most exacting purposes. It has been used on a semi-commercial scale for the manufacture of tool handles, and only the lack of adequate supplies of mature trees has prevented a more widespread use for this purpose. This dense timber has a very low shrinkage and no difficulty is experienced in air drying. The wood is very hard, it machines well and appears to bend very well when steamed.

In recent years brown mallet has, on occasions, been used as a mining timber in sizes from 3 inch (7.6 cm) crown diameter upwards.

There is no quantitative data for the other mallets, but like brown mallet they are excellent fuels and are used as a farm timber in their respective localities.

The history of the tan bark industry in this State is one of destructive exploitation. Beginning early in the present century, an export market of 138 tons (140 metric tons) in 1903 rose to 20,700 tons (21,030 metric tons) in 1905. A rapid decline of production followed as mature mallet trees were destroyed by stripping, by fire, or by removal during the clearing of land for agriculture.

The economic importance of the bark resulted in the Department establishing 19,000 acres (7,689 ha) of brown mallet plantation between 1927 and 1960. Unfortun-



Plate 26

A plantation of brown mallet (*Eucalyptus astringens*) at Dryandra north-west of Narrogin. Mixed wandoo and powderbark wandoo may be seen to the right of the road.

ately, the market has declined to the extent that the last effective commercial bark stripping for tannin occurred in 1969 and the industry would need an increase both of demand and price to become viable again.

Silviculture

With the exception of the mallee forms, all species of mallet are fire tender and do not coppice. However, the trees commence to bear fertile seeds at about six to eight years and regeneration is generally copious following a fire, but sparse, even after trade cutting, if the area is unburnt.

The procedure followed in the artificial regeneration of brown mallet was to remove all marketable timber from an area, clear-fell the remainder and, after it had dried, burn in late summer. Sowing was carried out as soon as possible after burning to take advantage of the early winter rains. Small spots about 12 in. (30 cm) in diameter at about 6 ft. (1.8 m) intervals were lightly cultivated with small hand hoes and a pinch of seed dropped on each (about $\frac{1}{2}$ lb. (227 gr) of seed per acre was used). The seed was then lightly covered and compacted by light pressure from the planter's foot.

Best results were obtained when the intensity of the heat from the fire was sufficient to kill scrub and weed growth and to partly sterilise the soil. In addition, the mineral salts in the ash made available by the fire may have been a contributing factor. The success of planting was affected to some extent by the season and the intensity of the fire, but mainly by the suitability of the site, as indicated by the original vegetation.

Owing to the use of impure brown mallet seed, both blue and white mallet appeared in minor proportions in the plantations showing that they can be established in the same manner as brown mallet.

Trials have shown that white mallet will succeed on laterite sites considered too poor for brown mallet. On the better sites the latter is undoubtedly the most desirable species, with a potentially high yield of quality tans.

All species have for several years been regularly raised under nursery conditions in various forms of containers—principally earthenware flower pots, but also in tubes and in metal or wooden trays $4\frac{1}{2}$ in. (11.4 cm) in depth, allowing 5 sq. in. (32 sq. cm) per plant. Their production has presented no serious difficulty except under the more humid conditions near the coast. Nursery stock of brown mallet planted on well prepared sites in Western and South Australia and Victoria have attained heights of nine feet and over in three years.

However, trees established by direct sowing in plantations where they are subject to competition from established vegetation are slower in their development and sites are considered of first quality when annual height increment is 18 inches or more. The rate of growth of the edge trees—the roots of which have access to cleared and cultivated firebreak strips—is considerably greater than that of trees less favourably situated within the compartment.

Other Tannin Trees

Tannins in the Bark: Three other trees provide tan bark of fair quality but inferior to the brown, blue and white mallots. They are:—

Flat-topped Yate — *Eucalyptus occidentalis*.

Dundas Mahogany — *Eucalyptus brockwayi*.

Dundas Blackbutt — *Eucalyptus dundasii*.

The last named two occur in the Norseman district.

Marri Kino or Gum: Investigation proceeded for a number of years into the suitability of marri kino as a source of tanning materials. As yet this kino has not been used commercially because of difficulties involving its insolubility and colour, but it has been definitely established that the extracts from it are very suitable for tanning heavy leather.

Wandoo Wood Extract: Both the wood—and bark—of wandoo and powderbark wandoo contain a high percentage of usable tans which are extracted by digesting the chipped material in large vats. A large plant has been operating at Toodyay for some years providing extract for the local market and for export.

The districts in which wandoo occurs are being rapidly developed for agriculture and much of the timber utilized by the factory would otherwise have been destroyed.

Forests and Woodlands of the semi-arid and arid regions of W.A.

Distribution

These forests, or woodlands, cover a region roughly rectangular in shape, bounded on the north by the 25° parallel of latitude and on the east by the 125° meridian of longitude. The south western boundary is the 20 in. (508 mm) isohyet and the southern boundary (from a point about 70 miles (113 km) east of Albany) is the south coast.

The region falls naturally into two distinct zones, the boundary between which approximates to about the 9 in. (229 mm) isohyet. The southern zone is characterised by Eucalypt woodland and the northern by Acacia (Mulga) bush. To the east at about the 8 in. (203 mm) isohyet the eucalypt zone meets the Nullabor Plain.

The Eucalypt Zone

This is spread over an area of approximately 156,000 square miles (404,000 sq. km). Over one quarter of this, in the higher rainfall (western and southern) portions of the zone, has been cleared for agriculture.

A large proportion (probably two thirds) of the balance is naturally treeless.

Whilst this zone forms one broad climatic type, a number of sub-zones can be recognised, viz:—

(1) 15-20 in. (381-508 mm) Annual Rainfall.

The principal species are wandoo, york gum and the mallets (already described under their respective sections). This is a mixed farming zone and has been mostly cleared for agriculture.

An easterly extension of this zone which forms a narrow strip of some six million acres in extent adjoins the south coast and extends eastwards to about 120 miles (193 km) beyond Esperance. This extension consists largely of sandplain and mallee and is at present being rapidly developed for agricultural purposes.

(2) 11-15 in. (279-381 mm) Annual Rainfall.

Principal species are Salmon Gum (*Euc. salmonophloia*), Gimlet (*Euc. salubris*), and Morrel (*Euc. longicornis*). Other less common species in this region are Salt River Gum (*Euc. sargentii*), Merrit (*Euc. flocktoniae*), and Swamp Mallet (*Euc. spathulata*). The sub-zone coincides with what is now the wheatbelt and only fragments of the original forest remain. Some mining timber and firewood for the pumping stations on the Goldfields pipeline were obtained from the forests of the wheatbelt but generally the original trees were felled and burnt in the process of agricultural development.

(3) Below 11 in. (279 mm) Annual Rainfall.

This sub-zone lies to the east of the agricultural areas and extends thence eastwards for a distance of nearly three hundred miles. Its northern limit is about fifty miles (80 km) north of Kalgoorlie and its southern limit some sixty miles (96 km) south of Norseman.

A wide range of species occur and include—Morrel, Merrit, Salmon Gum, Gimlet, Silver Gimlet (*Euc. campaspe*), Goldfields Blackbutt (*Euc. le souefii*), Boongul (*Euc. transcontinentalis*), Coral-flowered Gum, (*Euc. torquata*), Dundas Mahogany (*Euc. brockwayi*) and Dundas Blackbutt (*Euc. dundasii*).

Salmon Gum, Morrel and Dundas Mahogany attain heights of seventy feet or more but the other species vary in height from thirty to about fifty feet (9-15 m).

This inland woodland played an important part in the State's development by providing fuel and mining timber in enormous quantities for the goldmining industry. For approximately 40 years mining operations on the Golden Mile depended solely on wood fuel for their power. During the 1930's a change was initiated with the introduction of oil fuel on two mines and this trend continued until about 1960 when wood fuel was entirely displaced by oil on all mines. It is estimated that the total firewood consumed by the goldmining industry since its inception is of the order of thirty million tons (30.5 million metric tons).

In addition to the principal woodland types described, there are associated with them the following non-forest areas which occur throughout the whole eucalypt zone:—

- (a) Mallee—Mallee is a term used in describing a considerable number of the eucalypts which have the common characteristics of large persistent rootstock and a number of stems. They attain various heights up to 30 feet (9 m), depending on the species and the locality. A limited amount of small-dimension firewood is obtained from this forest, while the "mallee root" is particularly prized for domestic firewood. Pure mallee always occurs on sandy loams, but isolated patches intrude into other forests types and into the sand plains. A number of species which occur as trees under one set of conditions take mallee form under less favourable conditions.
- (b) Sandplain (Scrub Plain)—This formation carries no timber of economic value and is a sub-type in which the eucalypts do not predominate. The chief genera represented are *Acacia*, *Grevillea*, *Hakea* and *Casuarina*.
- (c) In addition to the above, there are several sub-types of no economic importance, e.g. lake country consisting of actual lakes and treeless flats adjacent to them, and low hills of wind-blown sand bordering the lakes.

The Mulga Zone

In this zone the eucalypts, although still represented, form only a minor part of the bush which is an almost pure *Acacia* association. The acacias have vertical leaf-like phyllodes of a blue-grey hue and the general appearance of the mulga is drab and dull. The most outstanding species are:

Mulga (narrow, medium and broad leafed forms)	<i>Acacia aneura</i>
Hop bush mulga	<i>Acacia craspedocarpa</i>
Bowgada	<i>Acacia linophylla</i>
Curara	<i>Acacia tetragonaphylla</i>
Minerichi	<i>Acacia grasbyi</i>
Sugar brother	<i>Acacia brachystachya</i>

Associated with the acacias are a number of minor genera; viz., hakeas, eremophilas, cassias, brachychiton, etc.

At intervals of many miles, large watercourses occur throughout the mulga zone and in the beds and on the banks of these there are strips of River Gum (*Eucalyptus camaldulensis*). This tree has played quite a considerable part in the development of the mining industry in the northern goldfields, but it is not sufficiently plentiful or of good enough quality to supply the requirements of the mines after they have passed through the early stages of development.

Silviculture of the Inland Woodlands

Eucalypt Woodland: The recent history of the goldfields woodlands has been one of exploitation. Trade cutting was followed by natural regeneration, in parts heavy, elsewhere meagre, but seldom absent. The forester's part has been to protect this second growth from indiscriminate cutting, at least until such time as it is sufficiently mature to provide seed for a third crop. Owing to the sparse nature of the ground cover, extensive fires do not occur and hence fire protection is not necessary.

Cutting has been practically on a clear felling basis, the only trees excluded from the operations of licensees being those of under five inches (12.7 cm) diameter at six inches (15.2 cm) from the ground. Actually, scattered over-mature trees unfit for mill

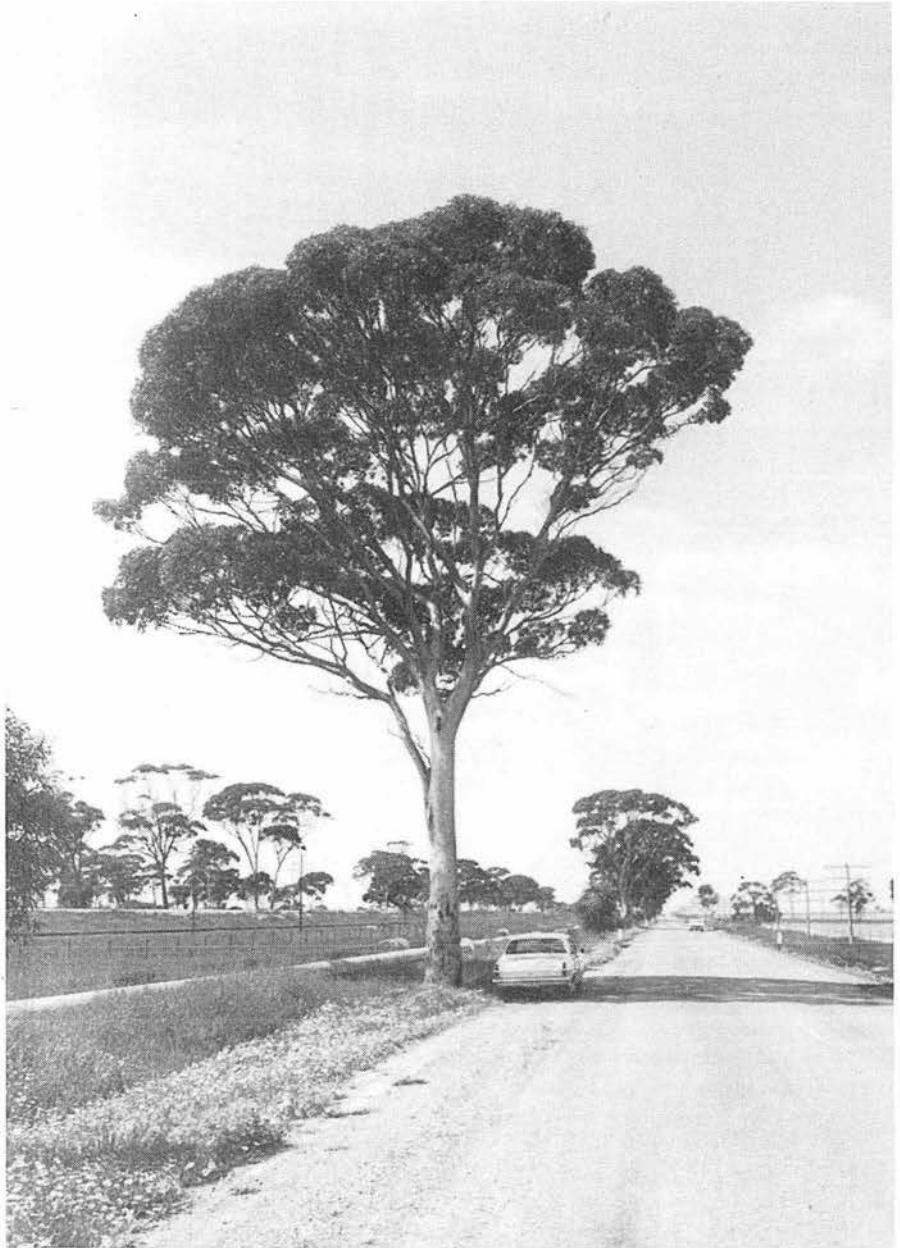


Plate 27

Salmon Gum (*Eucalyptus salmonophloia*) bordering the Great Eastern Highway and railway reserve west of Cunderdin.

logs and too tough to split for firewood were left and these assisted, to a limited extent, in providing seed for the second crop. Much of the seed, however, came from the trees which had been felled and many of the seedlings became established either among the leaves of the parent or in slight depressions—particularly in the wheel ruts made by drays etc.

The Goldfields' eucalypts are seldom without seed—seed usually remaining in the tree for two summers after maturing; hence it is not unusual to find on one tree two crops of ripe seed. The older seed vessels usually open while the third crop is ripening. A limited proportion (seldom more than 10 per cent) of the stumps left after the trade cutting, coppice, but coppicing is confined almost entirely to stumps which are favourably situated to receive additional moisture or are protected by tall shrubs of the understorey. During particularly dry seasons both seedlings and coppice growth may be absent.

Mulga Bush: Further problems arise in dealing with the mulga bush. The understorey is sparse and if too much of the cover is removed, wind erosion is liable to occur, and because growth rates are very slow—on trees of 3 inch (7.6 cm) diameter it is less than 1/5th of an inch (5 mm) in girth per annum—restocking is a very slow process. The majority of the acacias in the association possess marked value as top feed for stock, while the timber—being fungus and termite resistant—is eminently suitable for fencing and other requirements on the sheep stations. The Forests Department, therefore, is called upon here to safeguard and reconcile the conflicting claims of the miner, the firewood cutter and the pastoralist.

In order to safeguard mulga stands, firewood cutters are required to confine their cutting to the denser patches and leave at least seven living trees over four feet (1.2 m) in height per square chain on the areas cut over.

The Principal Goldfields Trees

SALMON GUM (*Eucalyptus salmonophloia*)

In the forest or woodland areas of what is now the wheatbelt, salmon gum trees of 80 to 100 feet (24 to 30 m) in height with boles of 40 feet (12 m) and 2½ to 3 feet (0.8 to 0.9 m) in diameter once occurred. In more easterly forests now remaining, trees of these dimensions are seldom, if ever, seen.

The crown is umbrella-shaped and somewhat thin-foliaged, but the burnished or lacquered appearance of the leaves is a feature possessed by few other trees. The bark is smooth throughout and rather thick and friable. The gleaming salmon-coloured bark and bright shining leaves make it the most conspicuous tree in the savannah forest.

The wood is deep red when freshly cut, reddish brown when dry and exceedingly dense and strong. It has been used extensively for mining and farming purposes.

Weight per cubic foot (green)	70 lb. (1,121 kg/m ³).
At 12 per cent moisture	66 lb. (1,057 kg/m ³).
Transverse strength	20,100 lb. per sq. in. (1,413,000 gr/cm ²)
Tensile strength	19,200 lb. per sq. in. (1,350,000 gr/cm ²)

The tree usually occurs in pure stands forming open woodland formations on red loamy or light clay soils but is sometimes mixed with gimlet, morrel and other species.

THE GIMLETS

The gimlets are small trees with a maximum height of 40 ft. (12 m). The bark is smooth, thin and reddish-brown in colour and the trunk, especially in young trees, is fluted or spirally twisted. This longitudinally-twisted characteristic of the stem is responsible for the vernacular name of the tree.

Gimlet (*Eucalyptus salubris*) is the best known of the gimlets, occurring over a wide range which includes the greater part of the wheatbelt (where it is now rare), the Eastern and Dundas goldfields and for many miles eastwards from Kalgoorlie.

It occurs in pure formation—usually on heavy clay loams in low lying areas—but is also found associated with salmon gum over more extensive areas. The salmon gum—gimlet association was regarded as an indication of the best agricultural land and little of it now remains uncleared throughout the wheatbelt.

Silver Gimlet or Silver-topped Gimlet (*Eucalyptus campaspe*) has a more restricted range. Starting near Coolgardie it extends eastwards to Kalgoorlie and at least one hundred miles beyond and also south to the Eyre Highway. It receives its name from the blue-green leaves and the silvery-powdered twigs and capsules. However, there are many specimens which show characteristics intermediate between the two species.

A somewhat similar tree (*Euc. annulata*) which occurs in the south-eastern wheatbelt and thence eastward to Norseman is also known in the districts where it occurs as "gimlet".

The timber of common gimlet is hard and tough and has been used extensively in the round (as poles) for building and mining purposes. The silver gimlet, although useful in very small sizes for firing sticks in the mines, soon develops a hollow trunk as it grows larger and is thus of limited use even as firewood. The two gimlets as well as *Euc. annulata* are all quite suitable for planting in parks, gardens and streets but they require good loam soil and it is inadvisable to endeavour to grow them in poor soil.

RED MORREL (*Eucalyptus longicornis*)

Both Red Morrel and Black Morrel (*Eucalyptus melanoxylon*) are well-known trees of the wheatbelt. The former is larger and more widely distributed and may attain heights of up to 90 feet (27 m) in the wheatbelt but somewhat less further east. It occurs throughout the whole of the wheatbelt and its eastern fringes as far as the goldfields. On the other hand black morrel occurs in a more restricted area from Westonia to Bullabulling. Although somewhat similar in appearance, the two can be distinguished fairly easily. The wood of the red morrel is red, the under-bark pink and the bark on the upper branches reddish-grey. The wood of the black morrel is dark brown, the under-bark yellow and the bark on the upper branches silver-grey with darker patches.

The bark on the trunk of both species is rough, grey in colour and persistent for almost the whole length of the bole. Both trees grow in a belt of country having an annual rainfall ranging between 10 and 12 inches (25-30 cm).

The following are the physical characteristics of red morrel:—

Weight per cubic foot (green)	73 lb. (1,169 kg/m ³)
At 12 per cent moisture	64 lb. (1,025 kg/m ³)
Transverse strength	16,900 lb. per sq. in. (1,188,000 gr/cm ²)
Tensile strength	18,000 lb. per sq. in. (1,266,000 gr/cm ²)

Red morrel is used both as a mining timber and for firewood; black morrel is suitable for firewood only.

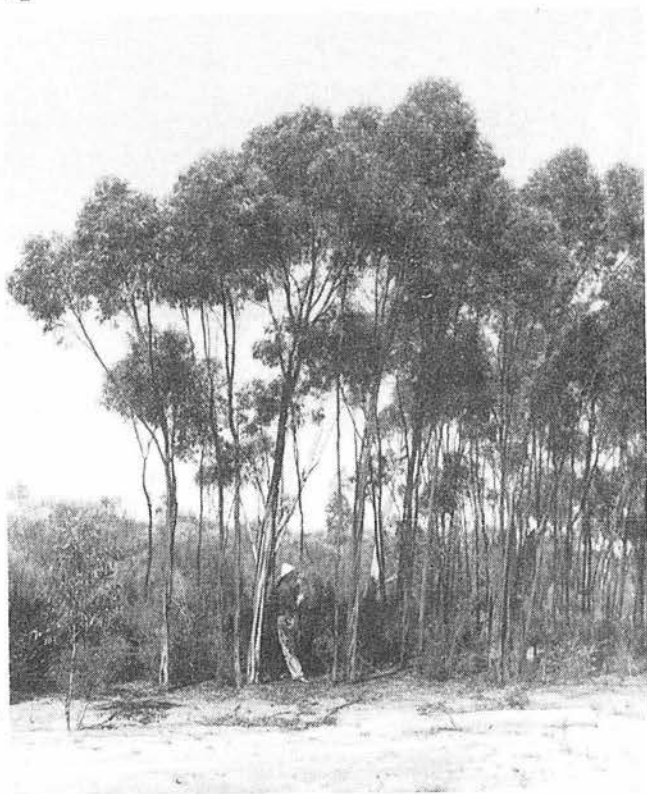


Plate 28A

Young gimlet (*Eucalyptus salubris*) north of Westonia.



Plate 28B

Below. Mature gimlet in a paddock near Kellerberrin. Note the heavy, almost 'corkscrew' fluting of the stem and main branches—hence the name 'gimlet'.

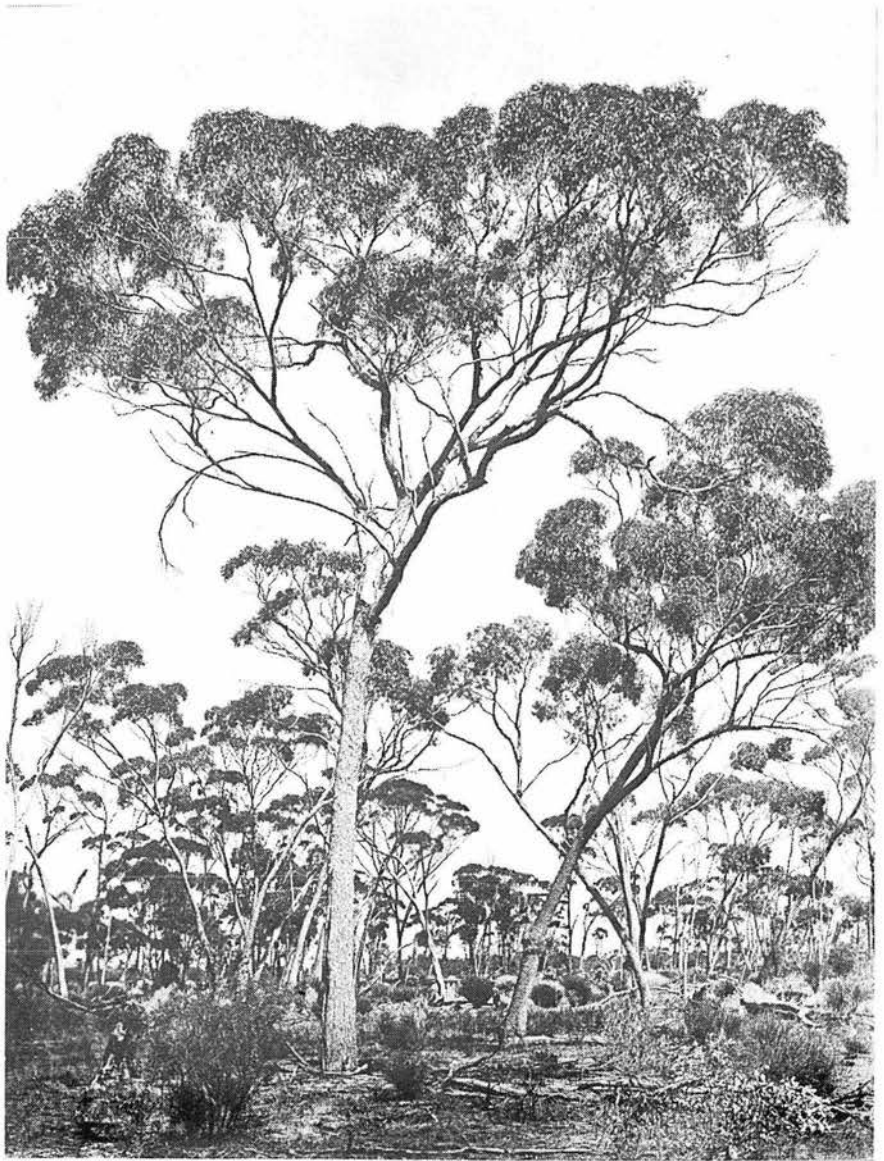


Plate 29

Morrel (*Eucalyptus longicornis*) showing the open nature of dry area woodlands

DUNDAS MAHOGANY (*Eucalyptus brockwayi*)

This tree is indigenous to the Norseman district where it grows to a height of up to 80 feet (24 m), and has a broad crown of lustrous green foliage and a smooth-barked trunk up to 2½ feet (76 cm) in diameter.

Resembling the salmon gum in general appearance, the tree may be distinguished in the field by a paler-coloured bark and deeper green crown. The bark when cut is blood red and sticky to the touch.

Dundas mahogany commonly occurs in the Norseman district, growing on the greenstone formation of the area. Its associates are salmon gum, morrel, merrit and Dundas blackbutt.

Eucalyptus brockwayi is very suitable for planting as a shade tree in agricultural areas.

GOLDFIELDS BLACKBUTT (*Eucalyptus le souefii*)

Eucalyptus le souefii forms a tree of 30 feet to 40 feet (9 to 12 m) in height. This tree has a dark-brown flaky bark for two feet to six feet (0.6 to 1.8 m) in height at the base of the trunk, which is otherwise smooth and greyish-brown in colour. This dark bark at the base of the trunk is responsible for the tree's common name.

Blackbutt timber is light brown and very dense. It is used in small sizes as mining timber—chiefly as “pass logs”—but since it becomes hollow as it approaches maturity the larger trees are usually suitable only for firewood. It has quite a wide range, extending from some 50 miles (80 km) north of Kalgoorlie to some 50 miles (80 km) south of Norseman and from Coolgardie eastwards for about 150 miles (241 km).

Two other Goldfields' species (*Euc. clelandii* and *Euc. stricklandii*), which have dark rough bark on the lower portion of the trunk, are also known locally as “blackbutt”.

BOONGUL (*Eucalyptus transcontinentalis*)

Bongul reaches its best development on the Goldfields where it attains heights of 30 to 50 feet (9 to 15 m) and has a smooth white bark and rather spreading crown. The bluish green leaves lack the sheen of salmon gum and in spring the tree produces heavy crops of nectar-bearing blossom, light yellow in colour. In recent years apiarists have periodically moved their bees from the coast to feed on the nectar produced by this and other Goldfield trees.

The wood is reddish in colour, fairly tough and in the past was used by natives for making spears.

Euc. transcontinentalis also occurs in the wheatbelt and in all southern States of Australia except Tasmania. However, in these places it is a mallee with a rough bark.

CORAL-FLOWERED GUM (*Eucalyptus torquata*)

Coral-flowered gum occurs as a small tree of 20 to 25 feet (6.0 to 7.6 m) with widely spreading branches and dull, dark grey-green leaves. The bark is persistent, dark grey or almost black, longitudinally fissured and friable.

Inflorescences are produced in abundance. The striking red and yellow buds are followed by attractive pink blossoms. Under natural conditions flowering is confined mainly to the spring months, but under cultivated conditions a greatly extended flowering period may occur.

Buds and fruits are quite unique in form, in that both the base of the capsule and the operculum are distinctly ribbed, while the latter terminates in a beak some half inch (12.7 mm) in length. (See Plate 10.)

The distribution of the species extends from the Eastern to the Dundas Goldfields and its occurrence is almost invariably on rising ground, in gravelly soil.

KURRAJONG (*Brachychiton gregorii*)

Kurrajong grows to 25 feet (7.6 m) in height with a thick, straight trunk and widely spreading dense branches. The bark is rough and persistent, and light grey in colour. The wood is spongy and the cambium ring yields a strong fibre.

Kurrajong is an excellent shade tree, being very densely branched. The leaves are divided into finger-like segments, and the flowers are greenish red and broadly bell-shaped. The species occurs freely throughout the Goldfields, particularly in the "mulga" area. Initial growth rate is very slow.

Stock are very partial to its foliage, so that it needs protection until it has attained a considerable size.

GOLDFIELDS PINE (*Callitris glauca*)

This native conifer may attain a height of 30 feet (9 m) with more or less spreading branches which give it a cedar-like appearance. The leaves are bluish-green, the bark almost black and fibrous. This tree is very much like its sister the Rottneest pine (*Callitris robusta*), and occurs on the margins of salt lakes. Its timber is resistant to termite attack, which makes it valuable as a fence-post timber.

SANDALWOOD (*Santalum spicatum*)

At the present time this species may be found growing as a small tree to a height of 12 to 16 feet (3.7 to 4.9 m) with a diameter of six to eight inches (15 to 20 cm). Before it had been so extensively exploited, specimens reaching a height of 25 feet (7.6 m) with a diameter up to 12 inches (30 cm) were common in the areas of better rainfall which are now cleared and cultivated for the production of wheat crops.

In the early days of the State the habitat of sandalwood extended as far west as Northam. In those days, the tree played an important part in the development of Western Australia. It always commanded ready money by reason of its value as an article of export to China, where it is highly prized and used for ceremonial purposes. The tree has now practically ceased to exist in the wheatbelt and present supplies are often hauled 100 miles (161 km) or more to the railway lines running to goldmining centres of the interior.

The wood is light-yellow in colour, and the heartwood is strongly aromatic. It is this latter property which led to its extensive use by the Chinese in the manufacture of "Joss Sticks" for burning in religious ceremonies. In addition, sandalwood is popular for fancy and carved woodwork, and the making of trinket boxes and a host of other small articles.

Sandalwood oil obtained from this species is of fine quality and valued for use in soaps, perfumes and for medical purposes.

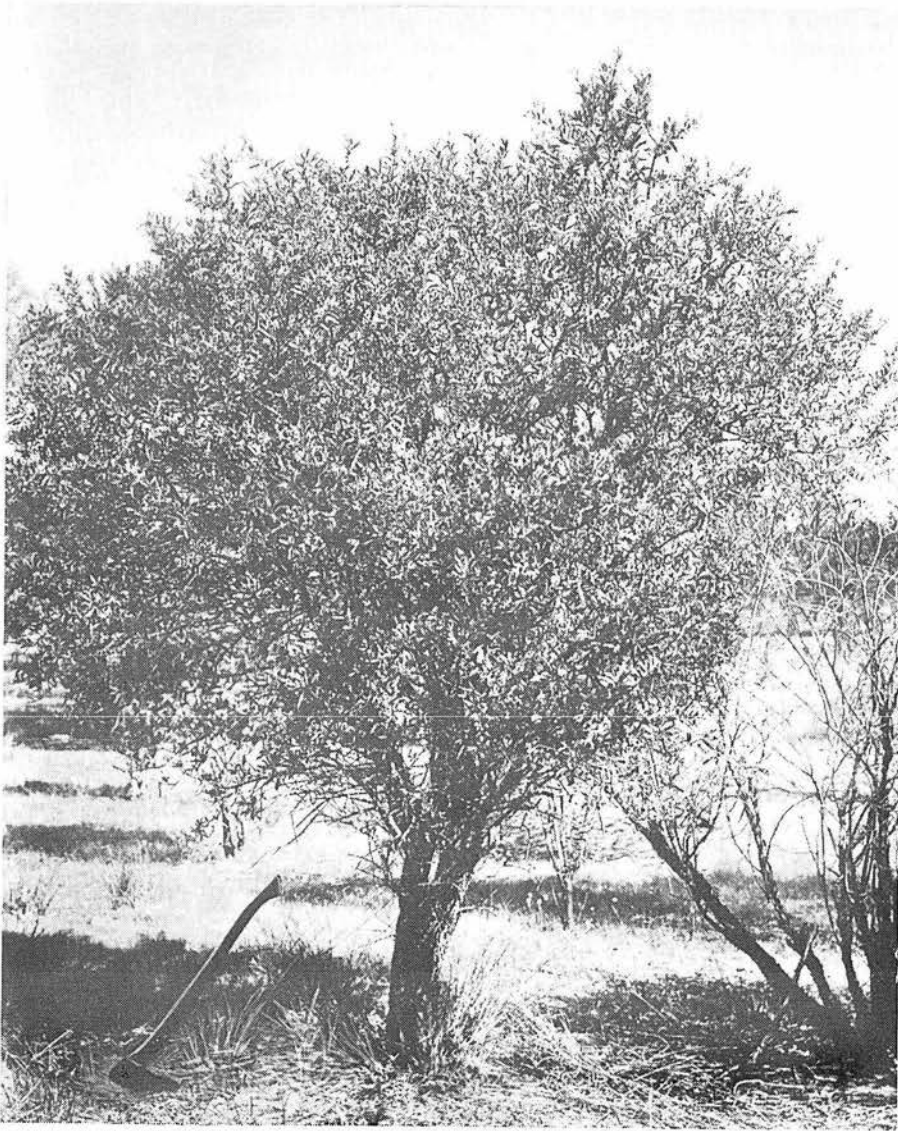


Plate 30
Sandalwood (*Santalum spicatum*)

Eucalypts—A Simplified Key to 17 W.A. Trees

Identification of eucalypts is often not a simple task and a single characteristic is rarely sufficient for the purpose.

Over 600 species and variations have been named. Many different eucalyptus species have similar characteristics, and even the identifying characteristics on one particular tree or trees of the same species can vary greatly; e.g., *E. loxophleba* (York Gum) in the key.

A positive identification can generally result only from the careful consideration of a number of features possessed by an individual tree. The most helpful of these are the general size and form; the nature of the bark on the trunk and branches; the adult leaf characters, including venation and oil dots; juvenile leaf forms; flower colour type and size, shape and structure of buds and fruits. Where naturally occurring plants are concerned, the geographical location and habitat can be of great assistance in their identification as many species are strictly limited in their distribution.

Example for using simplified key:

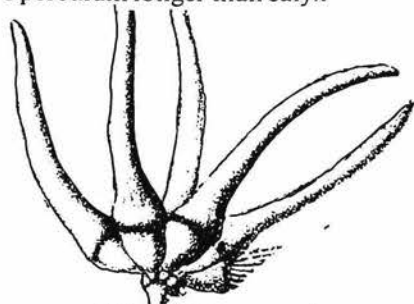
Assuming we have a tree with a smooth, greyish-white bark, large fruits and exsert valves.

Under the major heading "Bark smooth", the specimen fits into the colour of bark category *greyish-white*. The large fruit and exsert valves would then place the specimen into the first of the next two categories, which means that it is *E. megacarpa*, or Bullich.

Explanatory Notes

Eucalypt buds consist of the *operculum* which protects the developing stamens and which is eventually shed as these mature; and the *calyx* which develops into the fruit.

Operculum longer than calyx



YATE (*E. cornuta*)

Operculum shorter than calyx



MARRI (*E. calophylla*)

When the seeds are ripe, the valves in the fruit open and the seeds are released. The valves may either be *exsert* or *enclosed*.

Exsert valves



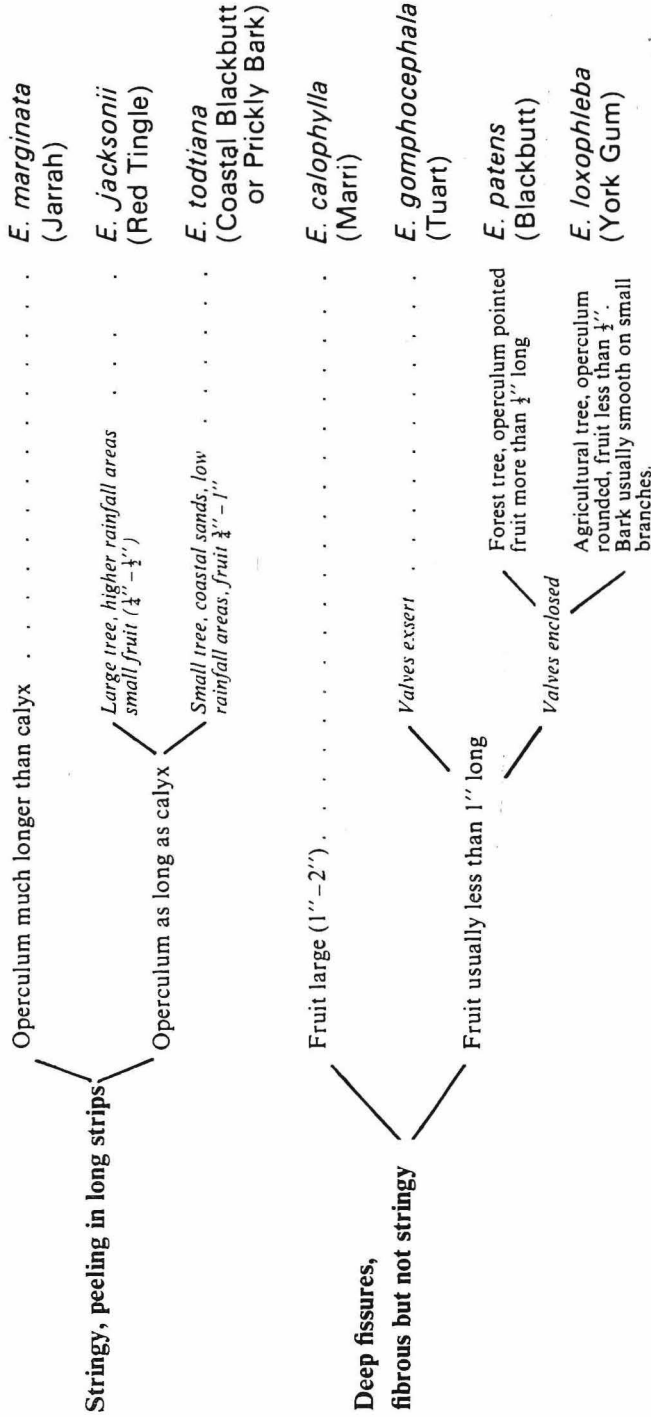
BROWN MALLET (*E. astringens*)

Enclosed valves

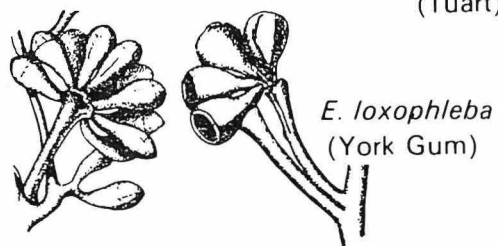
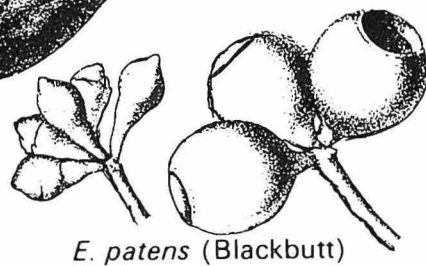
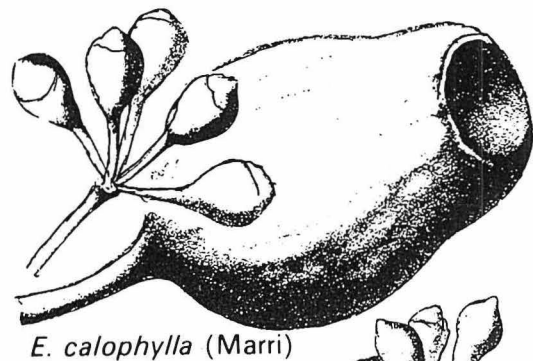
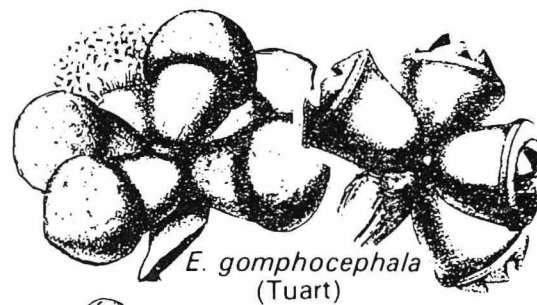
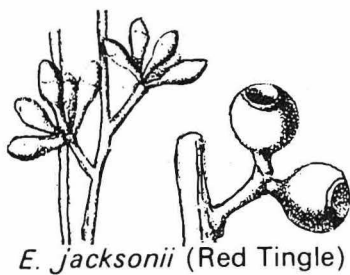
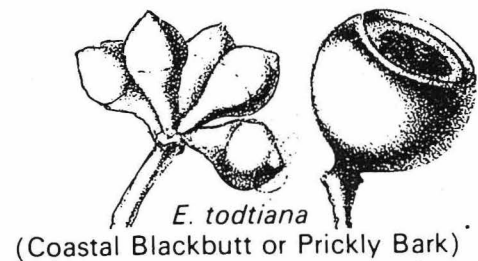
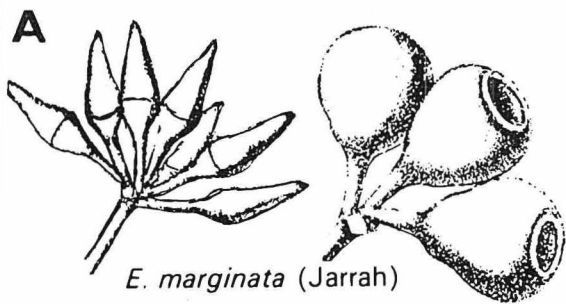


JARRAH (*E. marginata*)

A BARK THICK, ROUGH AND PERSISTENT

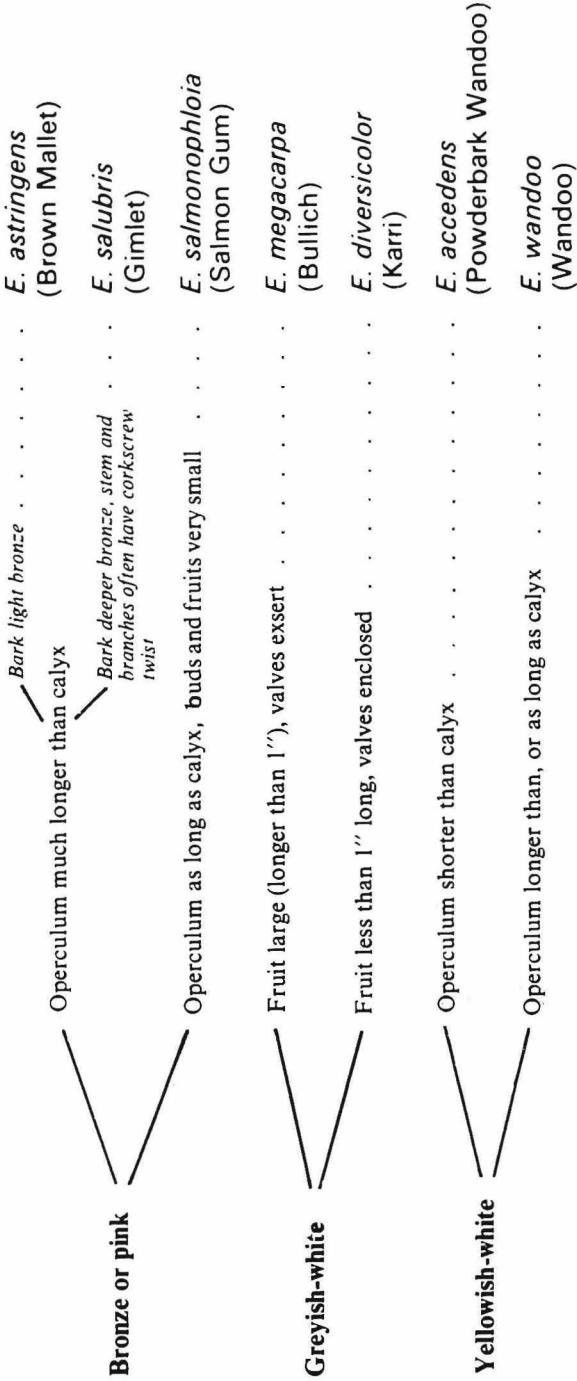


ALL ILLUSTRATIONS OF BUDS AND FRUITS ARE DRAWN TO ACTUAL SIZE



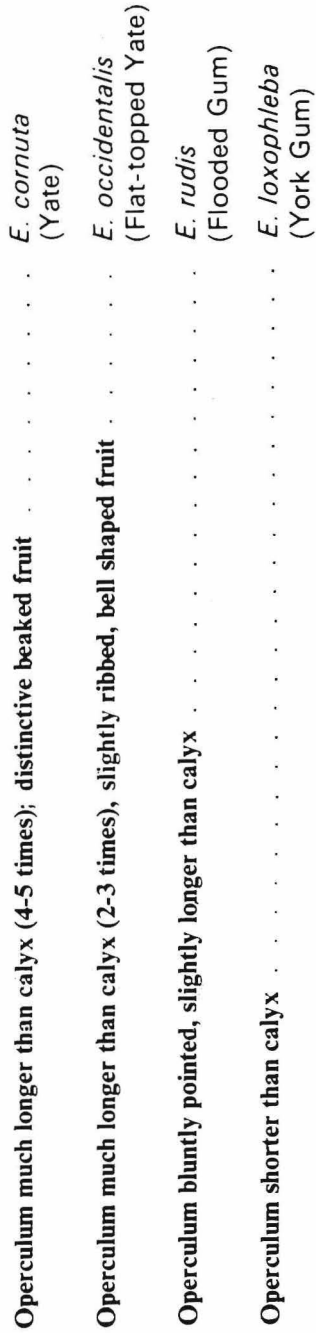
BARK SMOOTH

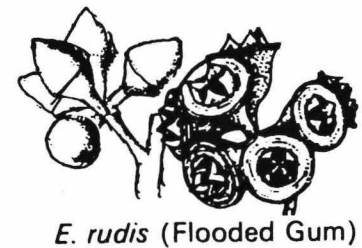
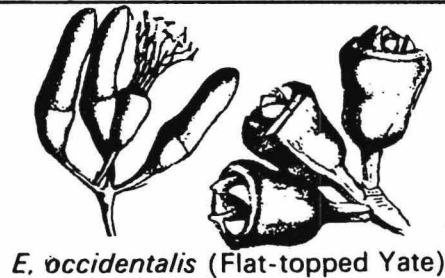
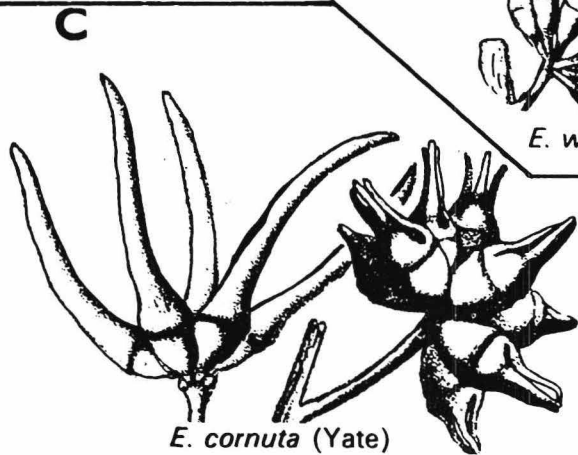
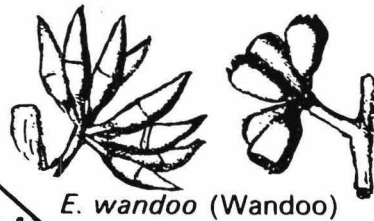
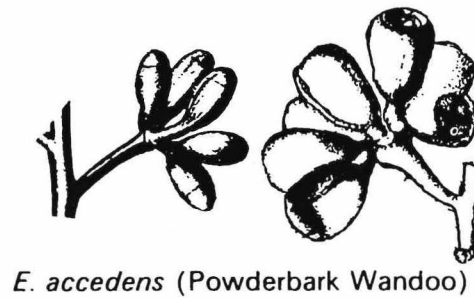
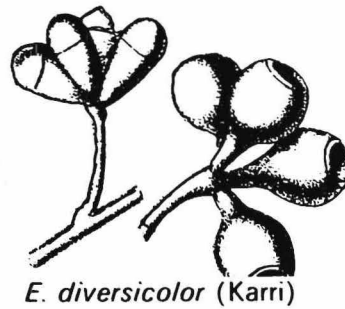
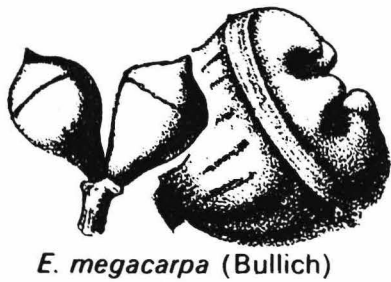
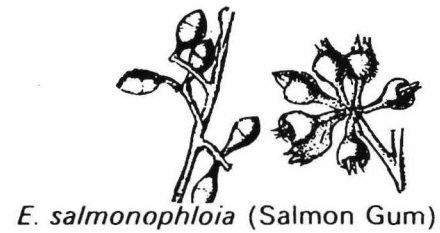
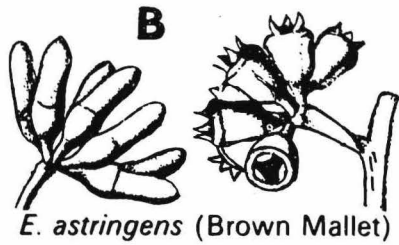
B



BARK ROUGH ON TRUNK, SMOOTH ON LARGER BRANCHES

C





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