Forestry

IN

WESTERN AUSTRALIA

CHAPTER II

THE FOREST ENVIRONMENT

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CHAPTER II

THE FOREST ENVIRONMENT

Forest Botany

A Description of a Tree

A tree may be defined as a woody, erect growth having three readily distinguishable sections: the roots, the bole (stem or trunk) and the crown. The crown is supported by a single stem so that the height of the plant, when mature, exceeds 15 feet. This definition separates the tree from all other members of the plant kingdom in which it stands as the highest evolved form.

THE SECTIONS OF A TREE

The Root System

The roots constitute the underground portion of the tree and have two main functions: to support the stem and crown in their upright habit, and perhaps more important, to absorb from the soil the water and minerals required for plant nutrition.

Root types vary considerably from species to species and from tree to tree. They are governed mainly by two factors—(1) the particular nature of the species concerned, and (2) the soil type or rooting medium in which it is growing. Some trees possess an inherent capacity to send a tap root deep down into the soil. Other species favour shallow rooting and penetrate more in a lateral than in a vertical direction. Deep, well-drained soils favour tap root development, while shallow or waterlogged soils lead to a more lateral spread of the roots.

The nutrients in the soil water, when absorbed, are passed up, *via* the bole, to the crown to be converted into the food materials necessary to sustain life and growth.

Water absorption is carried out by the young fine rootlets and root hairs, the only part of the root system which has this property. These small absorbing ends have a short life and, once they have completed their work, break up and are replaced by the new rootlets formed at the growing tips. A layer of protective bark develops around the older non-absorbing roots, and they serve the dual role as a soil anchorage medium and as a pipeline to pass the root solutions taken up at the tips back to the stem and then up into the trunk.

Most root systems are extensively branched to permit the fine feeding rootlets to completely ramify through the soil in the search for water and mineral nutrients.

The Bole

The bole of the tree also carries out a twofold role in the life of the tree. It serves as a support to thrust the crown up and out into the light, and constitutes a conducting medium by means of which root solutions are passed up into the crown. The stem also allows the plant foods produced in the crown to return downwards to the other living parts of the tree.

All tree stems are woody and capable of radial growth. This allows the tree to grow in girth at the same time as it increases in height and width of crown. A sheath of bark completely encases the bole, protecting the vital conducting and growth tissues from external damage.

The size of a tree's bole depends to a large extent on its particular type, but it is also a reflection of the fertility of the site occupied by the tree. Karri has a bole length often exceeding 100 feet (*30 m*), while the woodland wandoo is normally found with a bole of approximately 25 feet (*8 m*). York gum and flooded gum are species which usually have very short boles.

Since the bole of the tree supplies the saw logs of commerce, this is the section with which foresters are primarily concerned. Trees in their young stages are often closely spaced to influence height growth and branch shed, forming a long, clean bole. Once maximum height is attained, however, the trees are thinned out. This allows the remaining trees more space for crown and root development and leads to more rapid increase in diameter growth.

WOOD

The body of a tree is made up of small cells composed of cellulose, the building material of plants. These cells are usually relatively short-lived and are rapidly replaced in function by new, younger cells put down for growth and expansion purposes. In the heartwood of the tree trunk, the majority of the cells have completed their living function and serve purely as mechanical support for the living parts. To facilitate this role, the cell wall normally undergoes chemical change and thickening, forming a much stronger unit.

A cross-section of a tree (Plate 4) shows the following well-defined features in succession from the outside to the centre:—

1. Bark, which may be divided into—
   (a) the outer, corky dead part that varies greatly in thickness with different species and with age of trees, and
   (b) the thin, inner living part.
2. Wood which in merchantable trees of most species is clearly differentiated into sapwood aind heartwood.
3. The pith, indicated by a small central core, darker in colour, which represents primary growth formed when woody stems or branches elongate.

Growth Rings

In the growing season the tree adds a layer of wood on the outside of that previously formed. If growth is interrupted annually by cold weather or dry seasons, the character of the cells at the end of each year's growth and the beginning of the next is sufficiently different to define sharply the annual layers or growth rings. (Plate 4). Consequently the age of such a tree may be determined by counting the number of annual growth rings at its base. In parts of the Tropics, where the growing season extends throughout the year, no well-defined annual growth layers are formed and it

is impossible, with any degree of accuracy, to tell the age of such trees. In eucalypts also it is generally difficult to determine the growth rings.

Sapwood and Heartwood

Sapwood contains living cells and plays an active part in the life processes of the tree. It is located next to the cambium and is the part of the tree that conducts the sap from the roots to the crown; it is also used for the storage of food. The sapwood layer may vary in thickness and commonly ranges from half to two inches. As a rule, the more vigorously growing trees of a species have wider sapwood layers.

As the tree grows the old sapwood is replaced by new rings and these old cells are altered to form heartwood. In the cavities of the heartwood various materials are deposited which frequently give a much darker colour to this wood. These infiltrations or materials deposited also make timber cut from it more durable when used in exposed conditions.

Medullary Rays

Another feature of wood which is particularly important in determining the "figure" of many woods are the medullary rays. These rays are observed on the cross-section as discontinuous radial lines. They vary in length and thickness with different species and serve, in the living tree, as a means of moving food radially across the wood tissues and as a food storage and waste depository area. Silky Oak, Banksia, Sheoak, and Oak, are some trees whose pronounced medullary rays produce a figure in wood highly valued for ornamental work.

The Tree Crown

The leaves of the crown form the factory area of the tree and the processes of food production, transpiration and respiration are all functions of the leaves. Seed for reproducing the species is also formed in the crown.

HOW A TREE LIVES AND GROWS

Tree Nutrition

Plants are the sustenance of all life on earth, for they alone are able to produce from simple, naturally occurring substances, the complex organic foods necessary for the life of organic cells. This process depends entirely on the action of sunlight on the green colouring matter (chlorophyll) of the leaves and is called photosynthesis. Animals require organic materials already formed and obtain them in solid food derived directly from plants or from other animals which have in turn fed on plants.

The basic elements required for food synthesis are drawn from two sources: the air and the soil. In all, nine elements—carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur—are required by all plants in fairly large quantities. These elements are referred to as the major elements of plant nutrition. Other elements such as boron, cobalt, chlorine, copper, iron, manganese, molybdenum and zinc are called the minor elements and are known to be essential for at least some plants, but are required in much smaller amounts. Of these elements, carbon in the form of carbon dioxide is taken from the atmosphere and all others are derived from the soil, in the form of mineral solutions in water.

Respiration

All plants breathe and respiration is just as necessary for plant life as it is for animal life. Plant respiration is also identical with animal respiration; oxygen is utilized and carbon dioxide is expelled. The energy required for this process is derived from some of the food materials supplied by photosynthesis.

The tree breathes through the leaves, the stomata providing the necessary communication between the plant and the atmosphere. Within the leaves small spaces between the cells serve as a channelway, connecting with the stomata. Each cell is therefore indirectly in contact with the atmosphere permitting the exchange of gases required in respiration.

A tree in which the energy built up in photosynthesis just balances that used in respiration will stay alive but will not grow. To encourage growth, conditions which favour maximum photosynthesis must be satisfied.

Respiration and photosynthesis then are two very different processes, both necessary for the life of the plant. Briefly, their differences may be listed as follows:—

Respiration

(1) Respiration is a continuous process, which functions night and day throughout the life of the plant.

(2) Respiration is necessary and common to all living cells, independent of their location or function.

(3) Respiration takes in oxygen from the atmosphere and expels carbon dioxide.

(4) Respiration uses up energy and plant food.

Photosynthesis

(1) Photosythesis occurs only in the presence of sunlight.

(2) Photosynthesis requires chlorophyll and thus only occurs in green cells.

(3) Photosynthesis uses carbon dioxide and water vapour and produces oxygen as a by-product.

(4) Photosynthesis provides food and the energy necessary for plant growth.

Reproduction

Nature makes plentiful provision for the preservation of the species and all trees, when they come to maturity, bear flowers. Within the flowers pollination occurs and in time they develop into fruit with seeds which fall to the ground and germinate to form new trees.

Jarrah flowers develop one year after the buds are first seen and are pollinated during the summer months. Twelve months after pollination, the fruit contains mature seeds. In the hot months of the summer the valves of the ripe fruit open while still attached to the tree and the seeds are allowed to drop to the forest floor. During their travel from the height of the crown to the floor, air currents may disperse the light seeds some distance from the mother tree. Many trees, such as the pines, have evolved wings on the seeds to allow for widespread dispersal once launched from the height of the tree.

On the forest floor the seed germinates when conditions of temperature, light and moisture are favourable to the establishment of the young seedling. Of the thousands upon thousands of seeds which germinate on every acre of forest soil, however, only a few survive competition from weeds, neighbouring trees and the long dry summer to eventually become a mature tree.

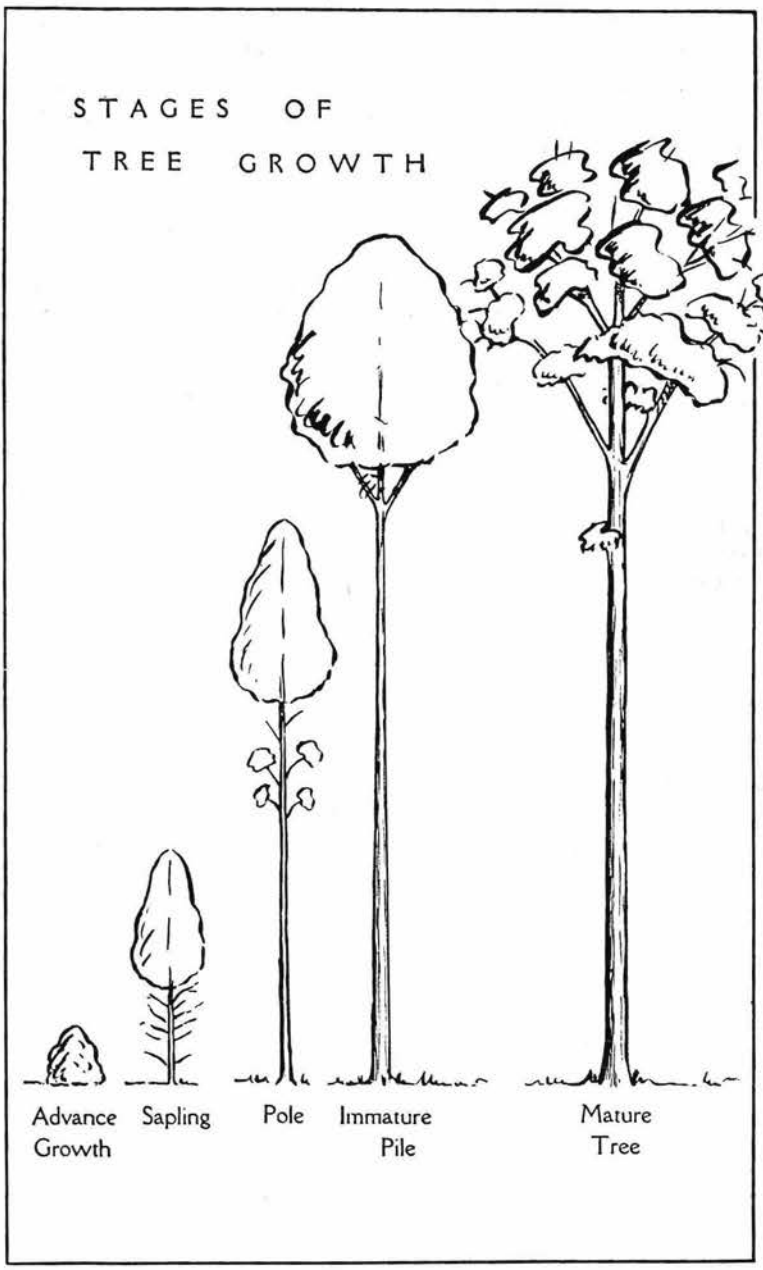


Plate 8

Illustrative stages showing the development of bole and crown throughout the life of a jarrah tree. From the small bushy advance growth stage to that of the mature tree required for sawmilling, a period of 150 years may elapse

The forester is largely concerned with providing the most suitable conditions for seed formation, seed shed, germination and successful establishment of the young seedlings to obtain adequate stocking throughout the forest area.

Besides reproduction by means of seed, many trees, like jarrah, are able to regenerate by shoots (coppice) which arise from the stump after the mother tree has been felled, or by suckers from the roots as with elms and figs.

Growth

Tree growth is carried out at three main growing regions. The root tips which grow generally downwards into the soil. The shoot tips which grow upwards. The third growing region of a tree is called the cambium, and is concerned with the growth in diameter of all woody parts of the tree. The cambium consists of a single layer of cells completely ensheathing the woody section of the tree, and is located immediately beneath the bark. From the cambium, cells are formed in two directions: new wood cells are formed on the inside, and new bark cells on the outside.

A tree grows by the formation of new cells rather than by the extension of existing cells. A tree grows in height by adding new cells upwards on top of the existing tip. A nail placed at the base of a tree will not move upwards as the tree grows, as is often believed; it will remain at the same distance from the ground throughout the life of the tree.

The Vegetation of W.A.

For over a century, in fact from the time when Dampier visited these shores, the unique flora of Western Australia has claimed the attention of botanists throughout the world. Only in South Africa and in South America do we find the native species so rich in vegetative and floristic forms.

The distribution of vegetation types in Western Australia is determined mainly by climate and to a lesser extent by soil type.

Climatically, three broad vegetation regions may be separated. These are a Northern Province, an area in the North and North-West of the State which receives a summer rainfall, a South-Western Province receiving a consistent reliable winter rainfall and a Central Province, a buffer region between the Northern and South-Western Provinces which receives an indefinite rainfall in either summer or winter.

The South-Western Province covers vegetative types which are typically Australian in character, a type familiar to most Southern Australians. The Northern Province, however, as well as containing an Australian flora, has some tropical species of Indo-Malayan origin. Eucalypts are present, so are Grevilleas, Hakeas and Banksias, yet in certain areas, particularly those of high rainfall and along the watercourses, tropical species are abundant.

In the Central Province grow species common to the South-Western Province, some species common to the Northern Province and also a definite characteristic scrub and steppe type vegetation of its own. Mulga bush is typical of a large section of this Province.

Within these Provinces, vegetative formations are separated both by local climatic and by soil factors. The accompanying vegetation map of the State (*Plate 9*) separates the following vegetative types:—

A.—Sclerophyllous Types (undergrowth of harsh leaved shrubs).

(1) Low rainfall tropical woodlands. Eucalypts are the dominant species.

(7), (8) and (9) Low rainfall temperate forests and woodlands with belts of sand heath and mallee. Eucalypts are the dominant species. This includes the salmon gum, wandoo, mallet and morrel woodlands. Type (8) is mainly sandplain.

(10) Sclerophyllous forest. Eucalypts are the dominant species. This type is the jarrah forest, including marri and blackbutt. It is one of the finest hardwood areas in the world.

(11) Temperate eucalpyt rain forest. Eucalypts are the dominant species. This type is the valuable and highly productive karri forest.

B.—Savannah Types. (Undergrowth herbaceous, principally grasses.)

(2) Savannah forest and woodlands. Eucalypts are the dominant species. Along the rivers, relatively dense forests of tropical species thrive.

(13) Savannah forest. Eucalypts are the dominant species. This is the coastal tuart formation.

(3) and (4) Savannah. In these areas are expanses of grassland, mainly of *Triodia* and *Themedia* species.

(5) Mulga bush.

C.—Treeless Regions

(6) Saltbush plain. The Nullarbor Plain.

(12) Desert with Spinifex and belts of low shrub.

The better known commercial forests of jarrah, karri and associated species are confined to that small fraction (2% of the total area) of the State which receives a reliable winter rainfall of 25 in. (*635 mm*) or better per annum, with wandoo extending eastward as open forest to areas of 20 in. (*508 mm*) rainfall.

Beyond the 20 in. (*508 mm*) rainfall limit, which lies some 50 miles (*80 km*) east of Perth, occurs the inland forest of open sclerophyllous woodland. Much of this land, down to 11 in. (*279 mm*) rainfall areas, has been cleared for agricultural purposes, forming the main wheat growing area of the State. Further east, in the Eastern Goldfields area, the open eucalypt forest has supplied valuable fuel and mining timber for the mining and grazing industries carried on within its precincts.

Northern and central areas are not a commercial proposition as far as the timber industry is concerned, but the local woodlands have played a major part in supplying timber and fuel used in the development of the country for grazing and mining purposes.

Western Australian Trees

The number and variety of native Western Australian trees is great, the eucalypts alone exceeding one hundred species. Only a few, however, are of commercial importance and the significance of the remainder is often overlooked. The prominence of the first half dozen species of importance in the timber trade is widely recognised for they produce timber of a quality highly regarded throughout the world. These species jarrah (*Euc. marginata*), karri (*Euc. diversicolor*), tuart (*Euc. gomphocephala*), wandoo (*Euc. wandoo*), marri (*Euc. calophylla*), blackbutt (*Euc. patens*) and red tingle (*Euc. jacksonii*) have played an important role in the development of the State, both from the point of view of supplying local timber requirements and in permitting a valuable export trade.

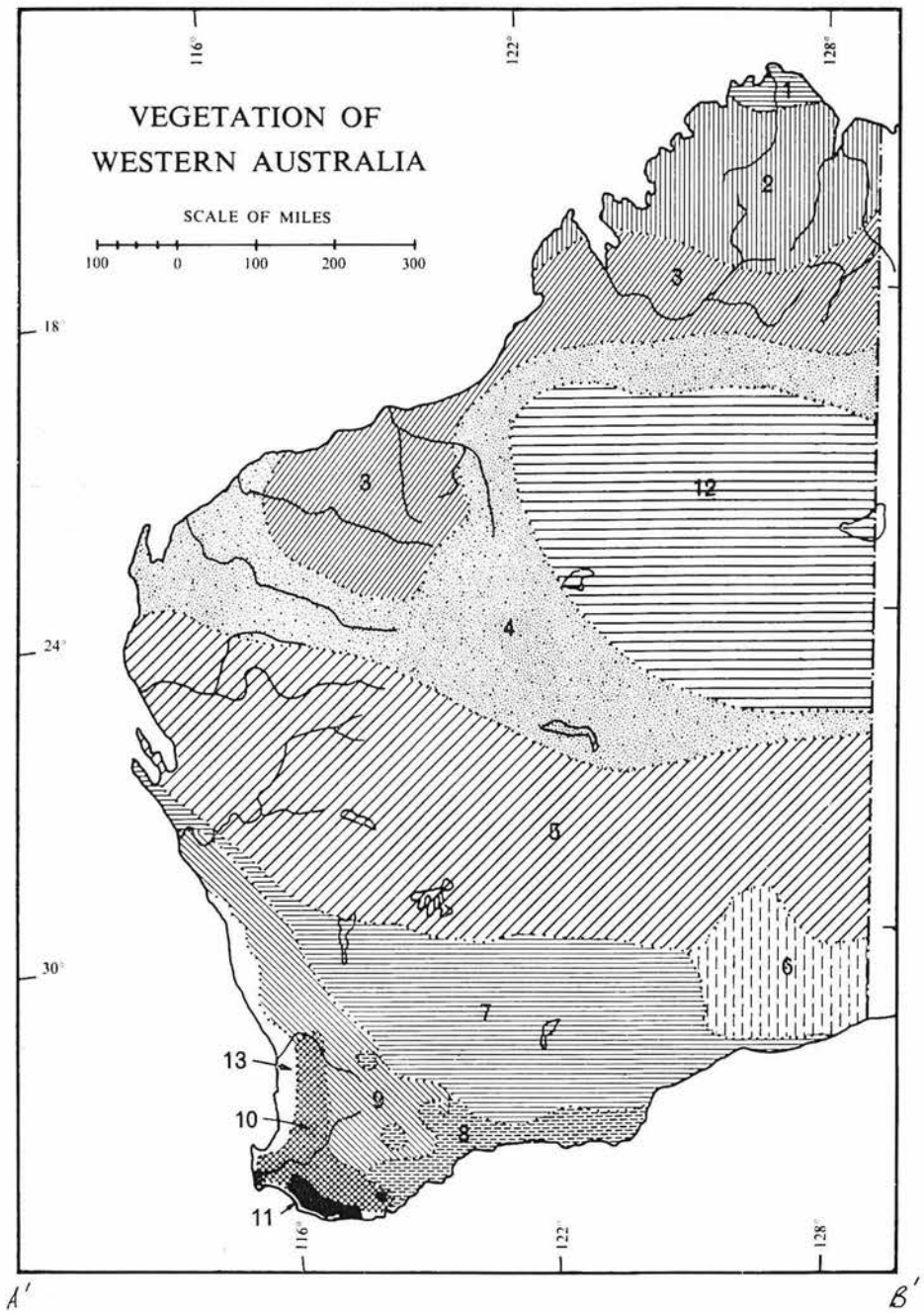


Plate 9

Map of W.A. showing vegetative formations. For description see text.
—"*By Courtesy of Royal Society of W.A.*"

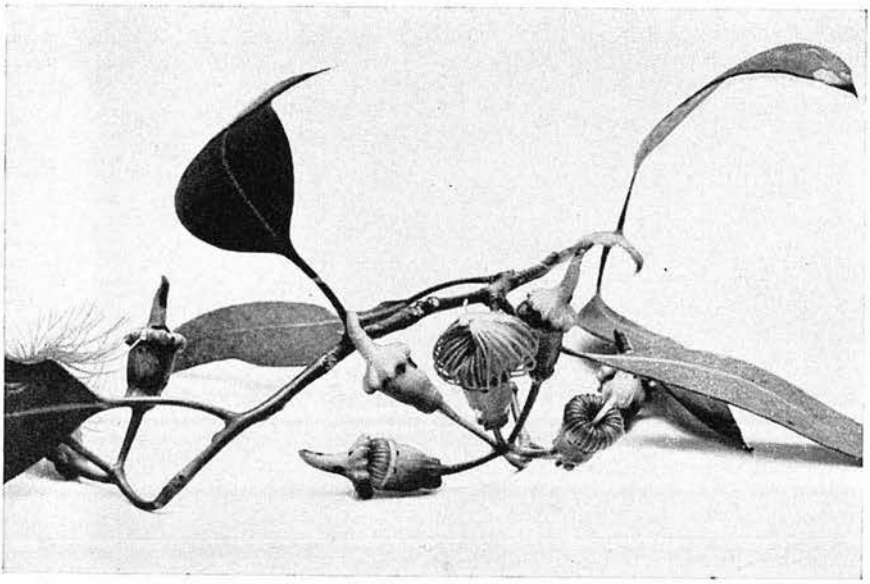


Plate 10

Coral-flowered Gum (*Eucalyptus torquata*

In recent years, the minor Western Australian trees have received considerable attention. Such species as salmon gum (*Euc. salmonophloia*), the mallets (*Euc. astringens, Euc. gardneri,* etc.), morrel (*Euc. longicornis*), gimlet (*Euc. salubris*), coral-flowered gum (*Euc. torquata*) and others, typical of semi-arid to arid regions of the State are unique, in that they can attain a tree form in such low rainfall areas. Overseas attention has focused on these species with a view to afforestation in the drier regions of these countries, since usually no such comparable growth exists in semi-arid regions outside Australia. Many other of our minor species such as red-flowered gum (*Euc. ficifolia*), coral-flowered gum and fuchsia mallee (*Euc. forrestiana*), due to colour and diversity of blossoms, fruits, buds and leaves, are much sought after for ornamental planting.

The great majority of important trees of the State are of the evergreen, hardwood type and belong to the genus Eucalyptus. Natural softwoods are rare and confined almost exclusively to the genus Callitris, and are of no commercial value. Examples of such conifers are the Rottnest Island pine (*Callitris robusta*) and the Goldfields pine (*Callitris glauca*). Pine plantations observed in the metropolitan area and rural centres consist of exotic pines, that is, pine species introduced from other lands and not native to this State. These plantations are composed principally of *Pinus radiata,* a pine from the Monterey region of California, and *Pinus pinaster,* a species native to Mediterranean regions such as Portugal, Spain, Italy and France.

The value of tree growth in the Northern parts of the State is not generally appreciated by Southerners. Though not commercially important, these trees have proved invaluable in supplying local wood requirements for heating, fencing and building. Coolibah (*Euc. microtheca*), river red gum (*Euc. camaldulensis*) and several others are highly valued by the limited population of these outback areas.

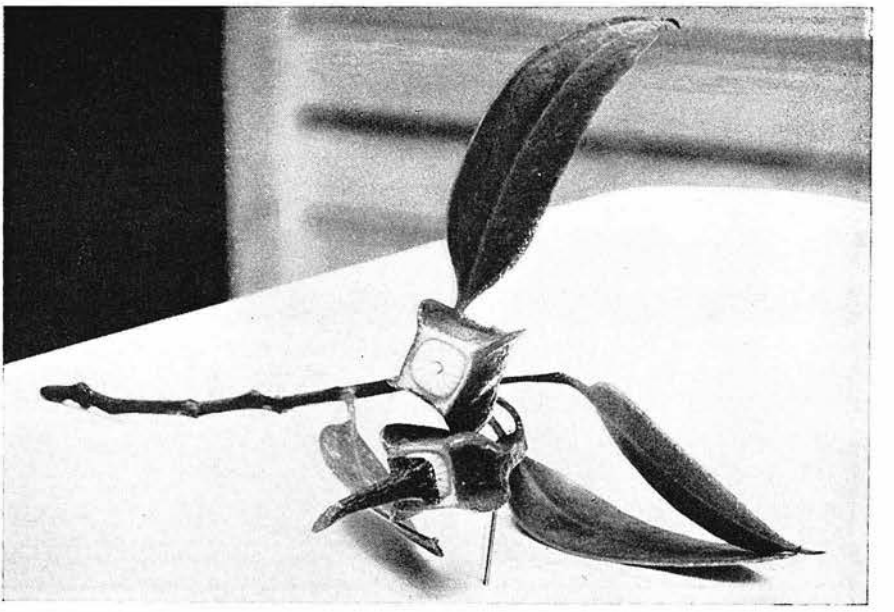


Plate 11

Fuchsia Mallee (*Eucalyptus forrestiana*)

The following list includes the principal trees of the southern portion of the State:—

Trees of the Humid and Sub-Humid Zones

Bullich	*Eucalyptus megacarpa*
Flooded Gum	„ *rudis*
Jarrah	„ *marginata*
Karri	„ *diversicolor*
Marri	„ *calophylla*
Red-flowered Gum	„ *ficifolia*
Tingle, red	„ *jacksonii*
Tingle, yellow	„ *guilfoylei*
Tuart	„ *gomphocephala*
W.A. Blackbutt	„ *patens*
Wandoo	„ *wandoo (syn. redunca var. elata)*
Yate	„ *cornuta*
Bull Banksia	*Banksia grandis*
Karri Oak	*Casuarina decussata*
Menzies Banksia	*Banksia menziesii*
Native Pear	*Xylomelum occidentale*
River Banksia	*Banksia verticillata*
Rottnest Island Pine	*Callistris robusta*
Sheoak	*Casuarina fraseriana*
W.A. Peppermint	*Agonis flexuosa*
Warren River Cedar	*Agonis juniperina*

Trees of the Semi-Arid and Arid Zones

Blackbutt, Dundas	*Eucalyptus dundasii*
Blackbutt, Goldfields	„ *le souefii*
Blackbutt, yellow-flowered	„ *stricklandii*
Boongul	„ *transcontinentalis*
Coral-flowered Gum	„ *torquata*
Dundas Mahogany	„ *brockwayi*
Gimlet and Silver Gimlet	„ *salubris, Euc. campaspe*
Mallet, brown, white, etc.	„ *astringens, Euc. falcata,* etc.
Merrit	„ *flocktoniae*
Morrel, red	„ *longicornis*
Salmon Gum	„ *salmonophloia*
Swamp or Flat-topped Yate	„ *occidentalis*
York Gum	„ *loxophleba*
Goldfields Pine	*Callitris glauca*
Kurrajong	*Brachychiton gregorii*
Raspberry Jam	*Acacia acuminata*
Sandalwood	*Santalum spicatum*

This list includes the commonly known species. Appendix I provides a more complete list of the Eucalypts of Western Australia.

Characteristics of the Genus Eucalyptus

The Eucalyptus derives its name from two Greek words which may be translated as "well covered"—a name applied to the little cap which protects the unopened flower, and one which aptly describes what is perhaps the leading feature of the genus. The most noticeable feature about a eucalyptus flower is the absence of both sepals and petals, and the presence of the bud cap or operculum which protects the stamens. The operculum usually falls off entirely as the flower expands, but sometimes remains hinged onto the calyx after the flower opens. These characteristics, together with the presence of the inferior ovary and the conspicuous stamens of indefinite number, serve to distinguish the genus *Eucalyptus* from all other flowering plants. The *Eucalyptus* is closely allied to the genus *Angophora,* which is found only in the Eastern States, in which there are petals which soon fall after expansion, and small but distinct calyx teeth. The calyx, although generally without lobes or teeth at all, has, in a few instances, small teeth, four in number, which are situated at or near the top of the calyx, and which appear to be the rudiments of sepals. The operculum takes the place of petals as regards their protective functions, but the filaments are the most conspicuous part of the flower, and being attractive, serve as petals in this respect. If, as is generally supposed, the Angophores are the ancestors of the Eucalypts, the operculum may have, at one time consisted of free petals. In some species of *Eucalyptus,* the operculum is double—the outer one falling off before the inner.

Eucalypts are all evergreen trees or shrubs, with the exception of one tropical tree which is deciduous, and another from the same latitude which is partially deciduous. They have simple leaves which usually have leaf stalks. The leaves are generally of a lance or egg shape. The venation consists of a midrib connected by fine secondary veins with a vein which runs close to the margin of the leaf (intra-marginal).

With few exceptions, the bracts and bracteoles so characteristic of other flowering shrubs and trees are absent from *Eucalyptus,* and, when present, are either rudimentary or fall before the flowering period.

The Eucalypt Fruit

Eucalypt flowers differ from those of most other plants in that they have no obvious petals.

When flowering, the attractiveness of the blossom is derived from the numerous, conspicuous and often brightly coloured stamens.

The petals in the eucalyptus flower are replaced by the bud cap which protects the miniature stamens, dropping off when they mature.

The following illustrations show the method of fruiting and flowering of three different West Australian eucalypts.

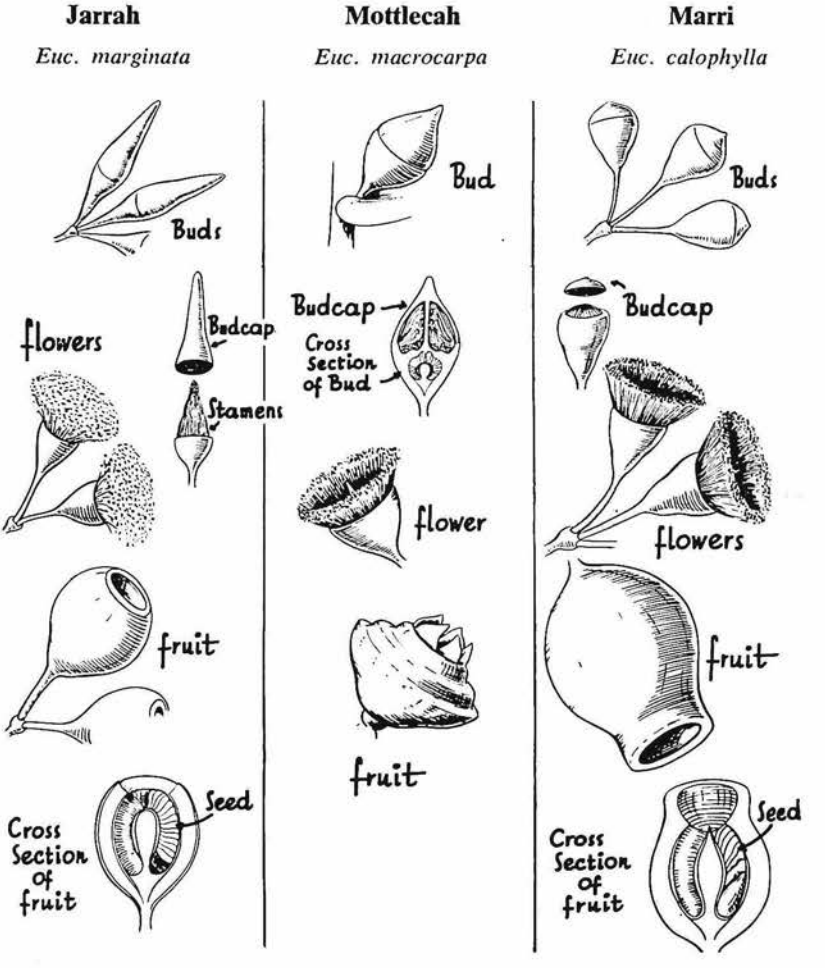


Plate 12

The flowering forms of three common W.A. eucalypts

P. KIMBER

Brown Thornbill (*Acanthiza pusilla*) at nest with young Fan-tailed Cuckoo (*Cacomantis pyrrhophanus*).

Bottom left: Rufous Tree-creepers (*Climacteris rufa*) at nest.

Bottom right: Rainbow Bird (*Merops ornatus*) at nest.

P. KIMBER

P. KIMBER

Yellow-tailed Thornbill or Tom Tit (*Acanthiza chrysorrhoa*).

P. KIMBER

Splendid Wren (*Malurus splendens*) beside nest.

P. KIMBER

Yellow Robin (*Eopsaltria griseogularis*) with young in nest.

P. KIMBER

Purple-crowned Lorikeet (*Glossopsitta porphyrocephala*).

Red-winged Wren (*Malurus elegans*).

Numbat or Banded Anteater (*Myrmecobius fasciatus*).

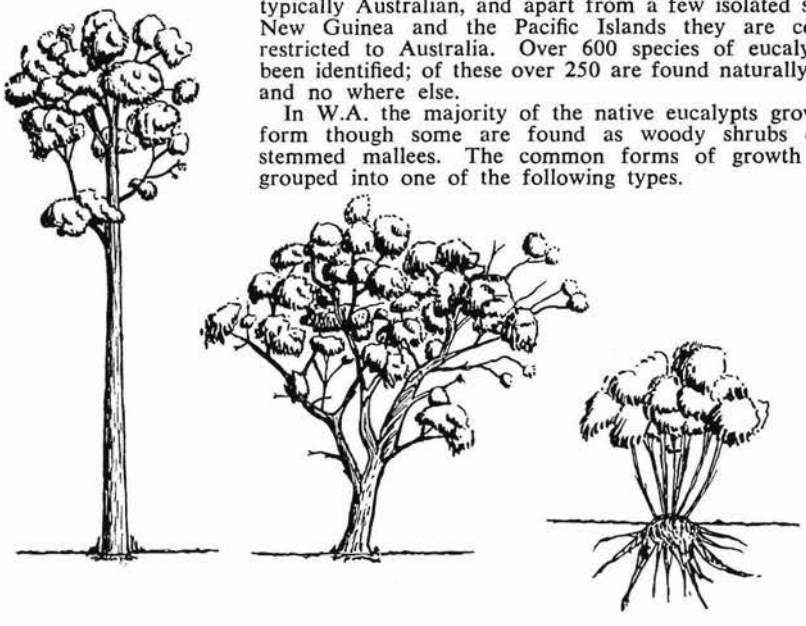
Short-nosed Bandicoot (*Isoodon obesulus*).

Eucalypts are divided, as regards their habit, into Trees, Shrubs, Mallees and Marlocks. Trees are distinctive in habit, in that they possess a well defined trunk. Shrubs branch from the base, or close to the base; Mallees have a bulbous rootstock, either subterranean or half above the soil, from which arise stems (usualy four to eight in number) which are all about the same height. Typical mallees have a large woody stock. Marlocks, which may be called "sand plain mallees" have a smaller reduced stock, or become true shrubs. It is often difficult to distinguish between a marlock and a shrub, as intermediate forms occur, which may be one or the other. Trees and mallees, on the other hand, are quite distinctive forms of vegetation.

The Tree Form of the Eucalypts

The eucalypts are a family of woody plants which are typically Australian, and apart from a few isolated species in New Guinea and the Pacific Islands they are completely restricted to Australia. Over 600 species of eucalypts have been identified; of these over 250 are found naturally in W.A. and no where else.

In W.A. the majority of the native eucalypts grow in tree form though some are found as woody shrubs or many stemmed mallees. The common forms of growth may be grouped into one of the following types.



Long tapering bole with small crown. This type is characteristic of Karri, Jarrah and Blackbutt, the principal commercial timber producing species. Height growth is usually over 100 ft.

Short stocky bole with wide spreading shady crown. Height under 80 ft. This tree is characteristic of York Gum, Wandoo and Flooded Gum, found in farming areas.

Maximum height approximately 30 ft. Several stems arise from a single rootstock below ground. Mallees are typical of sand plains and many arid area species. Mottlecah is an example.

Plate 13

Three common habits of the eucalypts

The Forest

During the course of time the word "Forest" has altered in meaning as the social life of people has changed. The word, originally applied in feudal times to areas of land over which the King claimed exclusive rights of the chase, now refers to a wooded area or a collection of woods of large extent. To be precise, the F.A.O. has recently published the following definition for forests:—

> "Lands bearing vegetative associations dominated by trees of any size capable of producing timber or other forests products or of exercising an influence on the climate or on the water regime."

This is a very broad definition which, in Western Australia, includes not only the important jarrah, karri and tuart areas, but also the semi-arid and arid area woodlands in which wandoo, salmon gum, morrel, gimlet and mallet are prominent. It can be seen, therefore, that within the scope of the word "Forest" there are many forms.

Forests are primarily of two kinds, natural forests and artificial or planted forests. Jarrah and karri are examples of natural forests. The pine plantations around the Metropolitan Area and South-West are artificial forests.

Natural forests may be considered as managed or unmanaged, according to their treatment by man. An unmanaged forest is one which has received no attention from man except to regard it as a storehouse of timber to be cut down and carried away.

Plate 14

Virgin marri forest south of Pemberton

The managed forest, however, is one in which man has done much to control the utilization of the trees and to ensure their replacement and to maintain the forest as a vigorous producing unit.

The Distribution of Forests

Forest distribution throughout the world is determined by variations in climatic and soil conditions.

The commercial forests of this State occur principally in areas receiving a rainfall greater than 25 inches (*635 mm*) per annum in which the winter fall is reliable. Within this broad area of the South-West different forest types occur, according to the different requirements of their main species. The jarrah forest favours the well-drained lateritic soils of the Darling Scarp; tuart occurs only on the coastal plain limestone fringe, while karri requires particular soils of granitic origin in the cooler and better watered far-South.

Afforestation, or the creation of artificial forests (or plantations), is concerned with the planting of forests of a desired type on treeless areas, or to replace uneconomical tree growth on areas with suitable climate and soil.

The Composition of Forests

The forest is a community consisting of several component parts. Under forest conditions these components—vegetation, soil, animals, insects and birds—do not exist as separate entities. They live in an environment in which each is dependent on the others. Trees cannot grow satisfactorily unless certain soil and climatic factors are present, nor can they continue to reproduce and thrive unless animals, insects and birds are available to aid the process and maintain soil fertility.

The relationship which exists between the many individuals of the forest is intricate and usually varies from one type of forest to the next, for no two forests may be regarded as identical in all respects. It is necessary to understand the basic relationships which exist between the tree and its habitat, and this study of Forest Ecology is essential for successful forestry.

The Trees of the Forest

The trees in the forest form an entity within which they are mutually dependent but at the same time in competition with one another. Each requires a minimum allotment of light, space and soil nutrients for sustenance and growth; these factors varying with species and also with the age or stage of development of the particular tree. Some trees are light demanders in that they require plenty of light and space to mature and produce millable logs. The eucalypts are of this class. Jarrah seedlings will only develop to form a tree provided they are permitted a space in the forest canopy which allows ample light and area for development. Vigorous young jarrah saplings are rarely found growing in the shade or in close proximity to mature trees.

Other types of trees develop better under shade and are called shade tolerant. The English beech is the classical example of this. The sheoak and *Banksia grandis* provide the best examples of shade tolerant trees, which are not common in Western Australia.

Competition between trees for space, light and soil nutrients gives to the forest a distinctive structure in which the crowns of different species form successive layers or storeys. These canopy or crown levels are more distinctive in certain types of forest, the tropical rain forest in particular. In the jarrah forest, a reasonable example of these storied vegetation layers may often be found. Mature jarrah crowns form the upper

storey which may be generally divided into three separate regions, the top level of dominant trees, the general level of co-dominant trees and the lower level of dominated and younger tree crowns. Underneath this general canopy level is the understorey of suppressed trees, saplings, sheoaks and banksia. The lowest limit, or stratum, is classed as the ground flora and embraces the smaller shrubs, herbs and prostrate forms growing close to the ground.

This storied arrangement of the different types of vegetative growth has characteristics which are stable for a particular type of forest and is an aspect of importance to the forester when considering treatment methods most advantageous to tree growth.

The Forest Soil

The forest soil is second in importance only to climate as a factor determining the existence of forests. It often determines the nature and extent of the forests within a climatic zone and, in this State in particular, soil types may be broadly correlated with the forest types.

The soil provides a root anchorage for the trees and is a reservoir of the mineral nutrients necessary for the production of plant foods. It is not the inanimate and static medium it appears to the casual observer, but in reality, teems with a soil flora and fauna of its own. These organisms, most of them microscopic, play a very important part in aerating the soil and in making soil nutrients available for uptake by the plant roots. They are responsible for the breakdown of forest litter and its incorporation in the soil as humus.

Litter breakdown is a gradual transition in which the organic matter of plant debris is altered in composition and returned to the soil. Plant nutrients are released during the transformation and changed to a state available to the plant roots. By this process, the material built up by plants is never wasted but returned to the soil and again made available to the vegetation to sustain life and permit growth.

Under natural conditions there is a balance between the nutrients returned to the soil by litter decomposition and those utilized by the forest. Natural forest soils, in contrast to soils subjected to agricultural cropping, maintain their fertility under continued use.

When managing forests it is of prime importance that the nutrient balance be maintained, in the interests of soil fertility and sustained tree growth.

Managed and Unmanaged Forests

Possibly the idea of the cultivated forest is not entirely clear. One may ask just what advantages has a managed forest over a virgin forest if the latter is able to provide trees in perpetuity, maintain a stable composition and the soil fertility. It is not always realised that the virgin forest is not the most economical forest from man's point of view. Virgin forests have no normal succession of trees of all ages, but by virtue of their great age, usually contain a majority of overmature trees. Such trees lose more wood by internal decay each year than they are capable of putting on in their condition of poor vigour. Their large crowns overtop and suppress young trees and prevent germination of seed on the forest floor.

Managed forests, on the other hand, aim to have the optimum number of vigorously growing trees per acre. Once a tree slackens off in increment, it is removed to make way for more vigorous young ones coming on. All age classes of trees are represented in the forest so that as trees are cut for milling, others are available to produce a future final crop with a minimum lapse of time. Spacing between the trees is also controlled to permit an adequate area for growth of each member and the minimum of

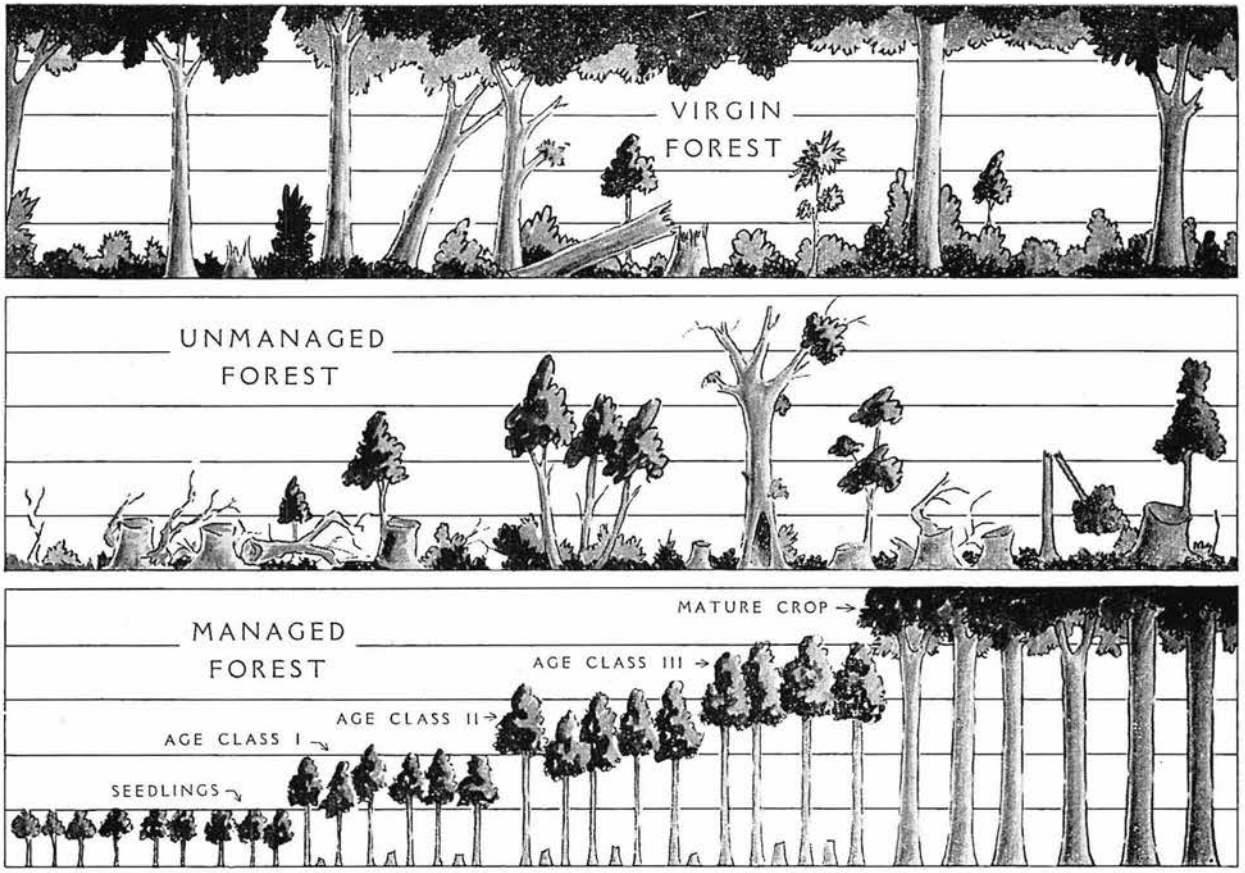


PLATE 15

Diagrammatic representation of a forest under management.
Virgin forest—mature to over-mature trees; very little regeneration present and frequent insect, fungi and fire damage.
Unmanaged forest—All good mill timber has been removed with subsequent damage to remaining stems. No provision for regeneration.
Managed forest—A regular succession of all age classes represented to provide regular timber crops in perpetuity.

competition from neighbours. Managed forests, therefore, are cultivated to produce the maximum amount of desirable produce while guaranteeing that there is always a crop ready to replace the one that is removed for utilization."

The Animals and Birds of the Forest (See also pages 41 - 45)

The forests of a country provide food and shelter for the many native birds and animals which have evolved to become a permanent part of the forest community. In Western Australia, this native fauna, completely at home in the virgin hardwood formations, has offered very few problems to foresters. Birds, by virtue of their feeding habits, are generally regarded as beneficial since they play a considerable part in keeping the insect population (usually a source of damage to timber) down to a minimum. As many as 83 birds have been recorded in and around the Dwellingup jarrah forest.

Introduced animals such as rabbits, sheep, cattle and goats, however, often cause considerable damage to the balanced state of a forest formation. These animals, by feeding on young shoots and trampling the soil, have the effect of reducing the regeneration potential of the forest. Over-grazing can eventually reduce forested lands to deserts.

Plantations of exotic species to which the natural fauna is not adapted, are often extensively damaged by animals and birds. The Black Cockatoo which damages growing tips and seeds in feeding from pine cones imposes a problem of control which has not yet been solved. Rabbits also cause extensive damage to pine nurseries and newly planted-out seedlings in some areas of the State.

Native animals and birds in natural forests, however, must be considered as a part of the forest complex to which, under normal conditions, they cause no great damage.

Insects and Fungi (See also Forest Pathology)

Insects and fungi are found in all forest formations. These, too, are part of the forest complex which must be considered by the forester. To all appearances a minor part of the complex, insects and fungi nevertheless play an important role in the forest. They can represent a source of damage to growing timber that is second only to fire.

However, not all insects and fungi are harmful. Some insects are pollinators and necessary for the reproduction of many plants growing in the forest, and soil insects and fungi are necessary for litter breakdown and humus formation.

Many fungi grow in association with tree and plant roots constituting mycorrhiza which is essential to the growth of such plants. This association of the lowly fungus with the highest forms of plant life is a remarkable example of symbiosis, or a mutually-advantageous relationship between two living organisms. Each of the participants in the union give and take some substance from the other. In the case of many trees, vigorous growth is not possible without this association with a certain type of fungus.

Pines in Western Australia require a mycorrhizal association and until this was realised, and the necessary fungi introduced, all attempts at pine nursery establishments resulted in failure. Little is known of the possibility of the W.A. eucalypts having mycorrhiza, but recent work seems to indicate a strong possibility in the case of jarrah.

The Forest Area

Of the total land area of 34,000 million acres (*13,770 million ha*), the world has 10,000 million acres (*4,000 million ha*) of forested land. This is separated as follows:—

Total forest area	10,000 million acres (*4,000 million ha*)
Accessible forest	5,000 million acres (*2,000 million ha*)
Forest being utilized	2,500 million acres (*1,000 million ha*)
Forest area under sound management	1,000 million acres (*400 million ha*)

It is estimated that a further area of 4,000 million acres (*1.6 million ha*) *of the* earth's original forest has been already destroyed by man's activity. This 30 per cent depletion of the original area provides a grave warning of what could be the fate of the present forests unless they are placed under wise and careful management.

As a result of a wise and far-thinking forest policy, Australia is fortunate in having substantial areas dedicated as State Forests or Timber Reserves to ensure the perpetual retention of our forest capital. Additional areas are retained by the Government under less secure tenure for the practice of forestry on a temporary basis. Table 3 below sets out in detail the areas reserved for forestry in Australia.

TABLE 3

Forest Reserves as at March 31, 1969
(Thousands of Acres)
(*Thousands of Hectares*)

State or Territory	Production Reserves (*a*)	Protection Reserves (*b*)	All Other Reserves	Total Area All Reserves
New South Wales	8,407	20	1,038	9,465
	3,402	*8*	*420*	*3,830*
Victoria	5,669	499	151	6,319
	2,294	*202*	*61*	*2,557*
Queensland	*8,927*	2,343	—	11,270
	3,613	*948*		*4,561*
South Australia	272	21	—	293
	110	*8*	—	*119*
Western Australia (*c*)	4,775	116	—	4,891
	1,932	*47*	—	*1,979*
Tasmania	4,537	234	—	4,771
	1,836	*95*	—	*1,931*
Australian Capital Territory	30	110	—	140
	12	*45*	—	*57*
Northern Territory	11	1,478	—	1,489
	4	*598*	—	*602*
Total	32,628	4,821	1,189	38,638
	13,204	*1,951*	*481*	*15,636*

— Nil or negligible

(*a*) Land reserved for production of timber for commercial purposes.

(*b*) Land reserved principally for protection of other natural resources (e.g. parks, scenic areas, hills and water catchments).

(*c*) South-West zone only. There are a further 1,689,000 acres (*684,000 ha*) in the Eastern Goldfields region reserved for mining timber, firewood and sandalwood requirements.

Included in the above areas dedicated to forestry are many plantations of native and introduced species. These are mainly softwoods of the Pinus species, but do include native softwoods such as hoop pine and kauri pine. Private enterprise is becoming increasingly attracted by the growing world demand for timber, particularly in the form of manufactured products such as paper pulp, plywood and particle board, and has already established a significant acreage of private forests in Australia.

Table 4 shows the area of plantations as at 31st March, 1969. Since that date there has been another planting in the winter rainfall areas and the total area of coniferous plus broadleafed plantations was in excess of 1 million acres by the close of 1969. A ceremony to mark the planting of the millionth acre was held in Perth in October, 1969, on the occasion of the 7th All Australian Timber Congress.

TABLE 4

Area of Plantations, coniferous and Broadleaved, as at 31 March 1969
(Acres)
(*Hectares*)

State or Territory	Coniferous						Govt. plus private	Broad-leaved (*c*)
	Government-owned			Private property (*b*)				
	P. radiata	Other species	Total	*P. radiata*	Other species	Total		
New South Wales	127,440	23,284	150,724	11,095	16,889	27,984	178,708	21,070
	51,613	*9,430*	*61,043*	*4,493*	*6,840*	*11,333*	*72,377*	*8,533*
Victoria	77,803	8,917	86,720	118,759	917	119,676	206,396	9,330
	31,510	*3,611*	*35,121*	*48,097*	*371*	*48,468*	*83,590*	*3,779*
Queensland	3,712	141,347	145,059	842	34,802	35,644	180,703	5,178
	1,504	*57,246*	*58,750*	*341*	*14,095*	*14,436*	*73,185*	*2,097*
South Australia	142,988	14,107	157,095	39,502	16	39,518	196,613	3,437
	57,910	*5,713*	*63,623*	*15,998*	*6*	*16,004*	*79,628*	*1,392*
Western Australia (*a*)	23,763	35,009	58,772	2,073	188	2,261	61,033	19,111
	9,624	*14,179*	*23,803*	*840*	*76*	*916*	*24,718*	*7,740*
Tasmania	35,338	424	35,762	14,764	3	14,767	50,529	809
	14,311	*172*	*14,483*	*5,979*	*1*	*5,980*	*20,464*	*328*
Australian Capital Territory	27,053	2,238	29,291	—	—	—	29,291	—
	10,957	*906*	*11,863*	—	—	—	*11,863*	—
Northern Territory	—	2,965	2,965	—	50	50	3,015	65
	—	*1,201*	*1,201*	—	*21*	*21*	*1,221*	*26*
Total	438,097	228,291	666,388	187,035	52,865	239,900	906,288	59,000
	177,429	*92,458*	*269,987*	*75,749*	*21,410*	*97,159*	*367,046*	*23,895*

— Nil or negligible.
(*a*) South-west zone only. Broadleaved plantations are mallet (*E. astringens*).
(*b*) Includes some preliminary figures.
(*c*) State-owned only.

Birds of the South-West Forests

(By C. F. H. Jenkins, M.A.)*

Anyone who has spent a few hours bird hunting in our south-west jarrah and karri areas will know that high, dense forests are not the best places to get a large tally of either bird species or individuals. In fact, many observers have commented upon the almost cathedral-like stillness which often pervades the densest forests. It is in the small clearings and along the forest streams that most of the birds will be found because of the varied habitat and food supply.

* Chief, Biological Services Division, Department of Agriculture, W.A.

At least four species of parrots are present in most areas of the south-west, and three are to be found nowhere else in Australia.

The Western Rosella (*Platycercus icterotis*) with its scarlet breast and yellow cheeks has close relatives in other States, but the Red-capped Parrot or Western Australian King Parrot (*Purpureicephalus spurius*) is quite unique. The rich purple underparts and the red markings on the head and beneath the tail make it one of our most handsome species. This bird has evolved in association with the south-west marri forests for the beak has a particularly long upper mandible which easily extracts the seed from the large woody "gum nuts". Unfortunately, the Western Rosella and the King Parrot have developed a taste for cultivated fruits and are regarded as pests by orchardists.

The parrots are the noisiest birds in the forest, and by far the rowdiest of all are the White-tailed Black Cockatoos (*Calyptorynchus baundini*). They occur only in south-west Australia and are rather irregular in their movements, touring the country in large screeching parties which feed on gum blossoms, nuts and insects, as well as apples and pine cones. The powerful bill of the cockatoo is well adapted for tearing the bark from the forest trees and removing the various insect borers which sometimes cause considerable damage, particularly to eucalypts and wattles. But, unfortunately, the bill is equally useful for shredding up pine cones and seed production is sometimes seriously affected.

Another noisy and irregular visitor to the forests is the Purple-crowned Lorrikeet (*Glossopsitta porphyrocephalus*). The call of the lorrikeet is always welcomed by the beekeeper as a sign that nectar-bearing flowers are about, and it is also probable that the birds help in the cross-pollination of the flowers as they move from one cluster of blooms to another.

The commonest parrot in Western Australia is the Twentyeight or Port Lincoln Parrot (*Barnardius zonarius*). The birds vary considerably in size and colour, according to the locality, and the call note also varies.

The forest birds of the south-west are large and predominantly green in colour, with a yellow collar and some red feathers at the base of the bill. The call can easily be syllabised as "twentyeight".

The wheatbelt birds are smaller and show increasing yellow on the underparts as one goes north. The call bears little resemblance to the "twentyeight" of the forest birds.

Amongst the smaller dwellers in the forest trees are the pardalotes or diamond birds, the western warblers, the thornbills or tits, and the sittellas or tree-runners. These are all insects eaters, but each species has its own particular method of seeking its prey.

The Yellow-rumped Thornbill or Tomtit (*Acanthiza chrysorrhoa*) is easily recognised by the canary-yellow patch above the base of the tail. This bird often feeds in small parties both on the ground and in the lower branches of the trees. Its duller relative, the Broadtailed Thornbill (*A. apicalis*), has a striped breast, a cocked-up tail and a rather persistent chatter. It feeds mainly amongst the twigs and leaves, often well above the ground.

The tiny Red-tipped Pardalote or Diamond Bird (*Pardalotus substriatus*) is much more often heard than seen, for in the springtime it keeps up a continuous call of "two two" as it climbs through the highest twigs, picking scale-like psyllids or lerps from the leaves.

Another tiny bird which is seldom seen, but whose activities affect many forest trees is the Flower Pecker or Mistletoe Bird (*Dicaeum hirundinaceum*). The male

is one of our most brilliantly coloured species with its steely black upper parts and bright red throat, breast and rump. The birds feed mainly on mistletoe berries and are instrumental in spreading seeds of the parasite from tree to tree.

The Western Warbler (*Gerygone fusca*) is a very small but active bird known to many children as the Sleepy Twit, because of its high-pitched, rather hesitant whistle. The Warbler often flutters at the end of a bough picking insects from the outer leaves and showing a characteristic white band near the end of its tail.

The Black-capped Sittella or Tree-runner *(Neositta pileata)* is a close relative of the European Nuthatch. It is an attractively coloured bird with a black head and an orange wing patch. The most outstanding feature is the relatively long bill, which turns distinctly upwards. The sittellas often hunt in small noisy parties and run spirally down the tree trunk using the upturned bill to probe every crack and crevice for hidden insects.

The Rufous Tree-creeper (*Climacteris rufa*) is another inhabitant of the thick forest areas. It is reddish brown in colour, rather larger than the Black-capped Sittella and has a characteristic highpitched call. It also runs spirally around the tree trunks looking for insects, but whereas the sittellas, as we have seen, usually work downwards, the tree-creepers usually work upwards, and so check cracks and hiding places which may have been missed on the downward run.

Amongst the most beautiful birds of the forest country are the robins and wrens. The Scarlet Robin *(Petroica multicolor)* with its brilliant red breast and white forehead is known to most people, but the more shy Western Yellow Robin (*Eopsaltria griseogularis)* is often overlooked. The canary-yellow of the underparts makes the bird easy to identify and its habit of clinging to the side of a large tree trunk is also characteristic.

Two wrens of the south-west forests are the Banded Blue Wren (*Malurus splendens)* and the Red-backed Wren *(Malurus elegans)*. Both like plenty of bushy cover and often nest in the tea-tree thickets which line the banks of forest streams.

Honeyeaters are amongst the most characteristic and specialised of Australian birds, and they are well represented in the forests. The long curved bill and brush tipped tongue are a special adaptation to assist birds in taking nectar and insects from native flowers. In some instances, the birds repay their hosts by carrying pollen from one bloom to another.

The largest and noisiest honeyeaters seen in the south-west are the wattle birds. The Red Wattle-bird (*Anthochaera carunculata*), so called because of the red fleshy wattle on the side of the head, is about the size of a small dove and has a hoarse coughing note. In company with the Little Wattle-bird (*A. chrysoptera*) is a frequent visitor to flowering plants, particularly banksias.

The smaller honeyeaters include the Brown Honeyeater *(Lichmera indistincta)*, which can be distinguished by its relatively long curved beak, small size, dull plumage and almost canary-like song. The Singing Honeyeater *(Meliphaga virescens)* which is rather larger, is greenish in colour, with a dark stripe through the eye. This species is common in suburban gardens. The New Holland Honeyeater (*Phylidonyris novae-hollandiae)* frequents the flowering eucalypts and banksias. It is frequently recognised by its black plumage, white face marks and yellow wing patches. A common species in the high tree tops, but one which is seldom seen at close quarters is the White-naped Honeyeater (*Melithreptus lunatus*). It may be distinguished from other common species by its small size and the conspicuous white crescent on the back of the neck.

Most of the honeyeaters mentioned may at times visit kangaroo paws and assist in cross-pollination.

The Western Magpie (*Gymnohina dorsalis*), the Squeaker (*Strepera versicolor*) and the Grey Butcher Bird *(Cracticus torquatus)* are widespread in the south-west, although the Magpie was scarce in the heavy forest regions prior to the general clearing for agriculture.

The Squeaker or Bell Magpie is about the size of a crow, but dark grey in colour with a light mark on the wings, which is quite conspicuous as the bird flies. The loud ringing calls of the Squeaker may be heard both in the forest and in more open country.

The Grey Butcher Bird is one of Australia's finest songsters and, unlike many other local birds, it calls strongly both in the spring and the autumn.

The Butcher Bird feeds on insects, lizards and small birds and often wedges its food under loose bark or into the fork of a tree, for later attention.

A comparative newcomer to the south-west forest is the Kookaburra *(Dacelo gigas)*. Although most people regard the Kookaburra as a native, it was introduced from the Eastern States about the turn of the century. Liberations from the Zoological Gardens were made over several years and the birds quickly colonised the southern portions of the State.

Two species of doves, the Senegal Turtle Dove (*Streptopelia senegalensis*) and the larger Spotted Turtle Dove (*S. chinensis*) were also released about the same time as the Kookaburra, but although they spread to many country towns, they have shown little inclination to penetrate the forests.

Native Mammals of the South-West Forests

(By C. F. H. Jenkins M.A.)*

Most of our native mammals are nocturnal and so the existence of many species in a particular district may be overlooked unless dead bodies are seen on the roadside or specimens are brought home by the family cat.

EGG-LAYING MAMMALS OR MONOTREMES

Australia is famous for containing the only egg-laying mammals still surviving on the earth, and one of these is found in Western Australia. The Platypus is confined to the rivers of eastern Australia, but the Australian Spiny Anteater or Echidna *(Tachyglossus aculeatus)* is found all over the Commonwealth and is still moderately plentiful in the south-west of this State.

MARSUPIALS

The Western Grey Kangaroo (*Macropus fuliginosus*), recently shown to be a distinct species from the Grey Kangaroo of Victoria and New South Wales (*M. giganteus*), is still abundant in many areas of the south-west. The smaller brush Wallaby (*Wallabia irma*) is also widespread in the forest regions, but has disappeared from many of its former haunts.

The Quokka (*Setonix brachyurus*) has suffered severely in recent years, and although it was hunted for sport in the 1930's along many of the river thickets of the south-west, it is now very rare on the mainland, with its main strongholds on Rottnest Island and Bald Island.

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* Chief, Biological Services Division, Department of Agriculture, W.A.

Two other wallabies, the Woilie or Brush-tailed Rat-Kangaroo (*Bettongia penicillata*) and the Tammar (*Thylogale eugenii*) have also declined in numbers in recent years. They both figured in the skin and hide trade in the 1930's, but now they survive in scattered areas only. Fortunately, the wandoo (white gum) woodlands of the Great Southern still support a reasonable number.

The Brush-tailed Possum (*Trichosurus vulpecula*) is still plentiful in many areas, but the nest building Western Ring-tailed Possum (*Pseudocheirus occidentalis*) with its white tipped tail, is a rarity.

Several species of bandicoots were once common in various parts of south-western Australia, but the Dalgite or Rabbit-eared Bandicoot (*Macrotis lagotis*) has disappeared and only the Short-nosed Bandicoot or Quenda (*Isoodon obesulus*) is common. The presence of this nocturnal feeder may be deduced from the conical diggings which may appear in the bush and even in home gardens, as the animals search for insects. The dark brown fur is coarse and bristly, and was never exploited by the "trade".

One of our most interesting mammals is the so-called Banded Ant-eater or Numbat (*Myrmecobius fasciatus*). It has reddish fur with several white bands across the back and rump. The name ant-eater refers to the fact that the creature feeds mainly upon termites or white ants which it unearths with its powerful claws. Although a true marsupial, the numbat lacks a well developed pouch, and the young are merely protected by tufts of long hairs as they cling to the mother. This animal is most commonly met within wandoo country around Pingelly, Narrogin and Kojonup.

The Chuditch or Western Native Cat (*Dasyurus geoffroii*) was once very common throughout the south-west and still persists in many timbered areas. It feeds upon insects, birds and other small creatures and used to rob the henroosts of the early settlers. As in other members of the marsupial cat family, the pouch is represented by two flaps of skin which afford but scanty protection to the naked young.

The tree climbing wambengers or native squirrels are still present in many areas, but because of their nocturnal habits they are seldom seen.

The Brush-tailed Wambenger (*Phascogale tapoatafa*) feeds upon various small creatures including birds, and like the larger native cat, it once caused trouble by robbing farm henroosts.

The so-called marsupial mice include two charming species—the Pigmy Possum (*Cercatetus concinnus*) which feeds mainly upon insects, and the Honey Mouse (*Tarsipes spenserae*) which takes insects and nectar from bush flowers. Both species are active mainly at night, but only too often they fall victim to the domestic cat.

RODENTS

A number of native rats and mice occur in Western Australia but the best known is probably the Western Water-Rat (*Hydromys fuliginosus*). It is found in most of our south-west streams, but because of its retiring habits, it is seldom seen.

It is a true rodent, but can be distinguished from the introduced rat, which may also frequent bush streams, by its much greater size, thick fur (once used commercially) and the fully furred white-tipped tail. In the early days the Water-Rat often used to rob the henroost, but its native food consists of gilgies and other water life.

Forest Conservation

For nearly 80 years the forests of Western Australia were exploited for their timber without any serious effort being made for replacement of the resource. Fortunately a small group of enlightened, far-sighted citizens realised that the resource was

not in fact "inexhaustible" and objected strongly to "mining" of the forest. It was through their efforts that the Forests Act, which aims at the conservation and regeneration of our native forests, was passed in 1918 and gazetted early in 1919.

Since the passing of the Act, conservation as practised by the Department, has not been the narrow concept of preservation, but rather the planned use and management of land, water, and their associated resources, for the provision of optimum social and economic returns.

The first step taken by the Department was the acquisition of prime forest for dedication as permanent State Forest. This was followed by measures to control exploitation so that only the forest increment was removed. Regeneration of cut-over areas then ensured that our forest resource would be with us in perpetuity.

Protection of the forest from fire was obviously necessary and an efficient fire control organisation has been developed. Not only are State Forests and timber reserves protected but a further two million acres of other Crown land and private property are given indirect protection, due either to their strategic significance in relation to State Forest or to their forest value.

Forest maps produced from aerial photographs, are of considerable value to Departmental research officers, C.S.I.R.O. and University staff, and amateur conservation groups studying ecology. In fact, these maps are the most suitable available basis for conservation studies in the high rainfall areas of the State. More recently, ecological site surveys linking vegetation with climate, topography and soil, provide a ready-made reference system for intensive studies of fauna and flora.

The Department has undertaken a number of major projects, some of which are, or were, not revenue producing. These include:—

Sand dune reclamation on areas along the South coast.

The establishment and maintenance of 56 arboreta scattered throughout the wheatbelt and the raising of tree seedlings for supply to farmers, Local Government authorities and other Government departments for shade, shelterbelt and ornamental purposes.

The protection of Dryandra Forest north-west of Narrogin, not only for timber requirements, but also as a habitat for the indigenous fauna, of which some species are quite rare.

The Native Flora Protection Act is administered by the Department and the Conservator is Chairman of the recently formed "Committee for Conservation of Road Verges".

Department officers have played and continue to play an active role on various bodies which are concerned with the conservation of natural resources. Some of these are:—

Western Australian Wild Life Authority

Reserves Advisory Council

Water Purity Advisory Committee

Soil Conservation Advisory Committee

Water Research Foundation of Australia.

Unfortunately the forest environment is seriously prejudiced by the over-riding powers of the Mining Act. However, following an enquiry into this Act early in 1970, firm recommendations were made by the Committee of Inquiry, which, if implemented, will provide valuable assistance in safe-guarding the forests in the future.

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