INTERNATIONAL ASSOCIATION

FOR

VEGETATION SCIENCE

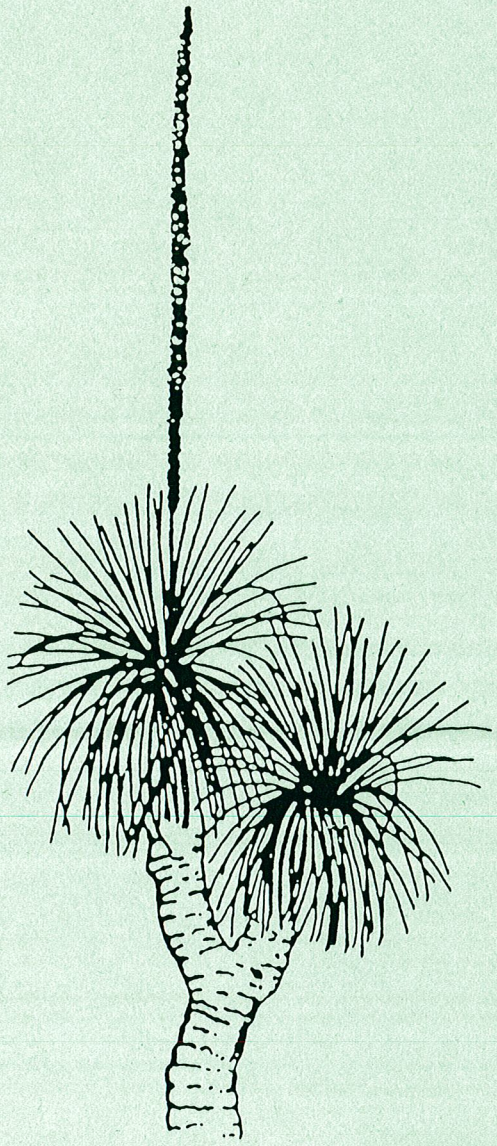
GUIDE

TO THE

EXCURSION IN

WESTERN AUSTRALIA

1990



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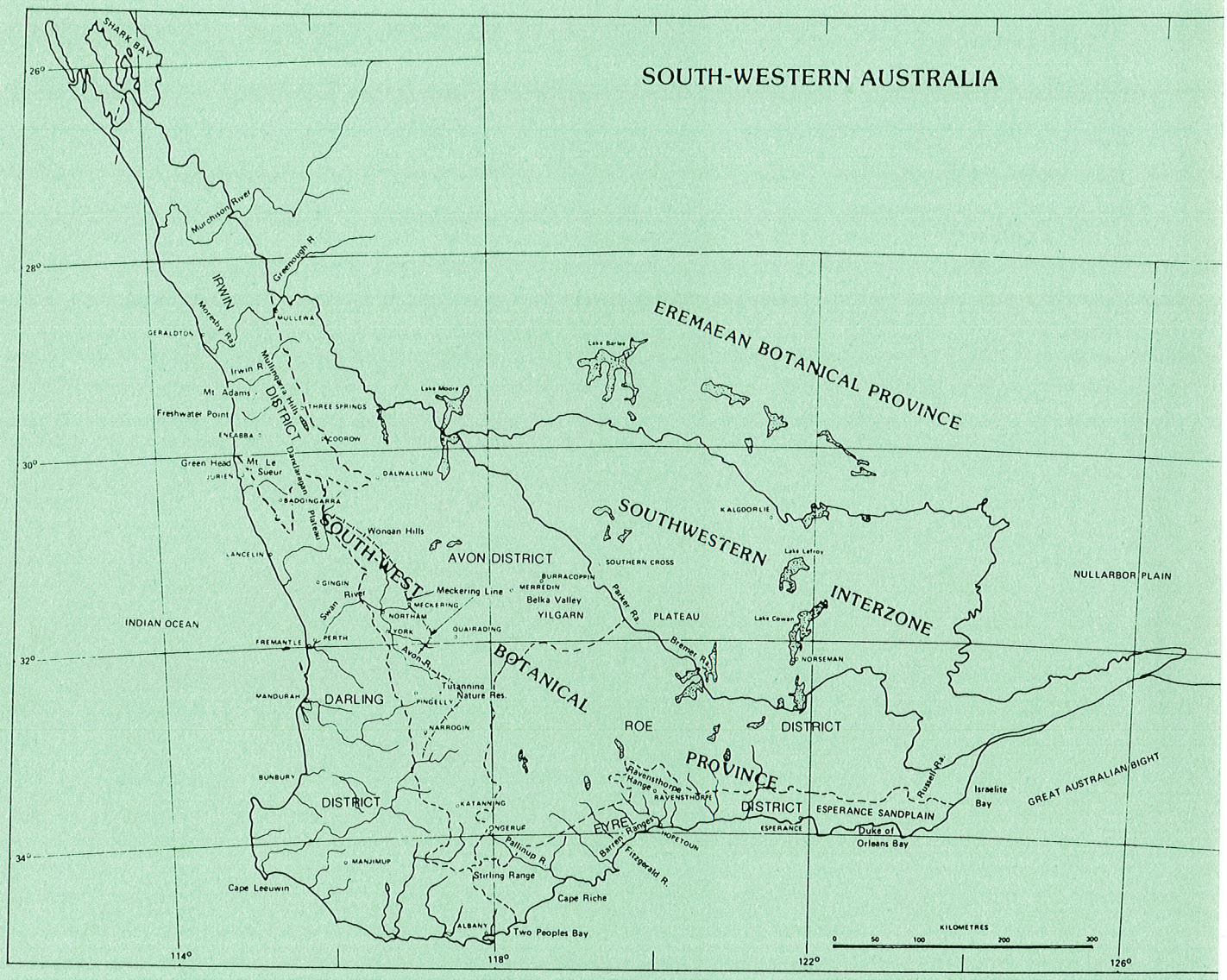

Fig.1 South-western Australia, showing division into phytogeographic provinces and districts, the boundaries determined by vegetation mapping. From Pate & Beard, 1984.

PART I - ITINERARY

INTRODUCTORY NOTE.

The IAVS Tour this year marks an important new development as it will be the first time that a body of vegetation scientists schooled in European phytosociology will visit the State. Although the vegetation of Western Australia has received considerable study and has been mapped overall at various scales, hitherto phytosociological methods have been very little applied. Until the recent work by Sandro & Erika Pignatti in the course of several visits, there had been only one phytosociological study in the Braun-Blanquet tradition, published by Bridgewater & Zammit 1979 (Phytosociolgy of S.W. Australian limestone heaths. Phytocoenologia 6:327-43). Sandro has contributed data from a number of his relevés which were recorded along the tour route, and these appear in Part 2 of this Guide. We understand that Sandro plans a general publication at a later date.

The Vegetation Survey of Western Australia which effected the mapping of the State was established in 1964 and concluded in 1981. Its aims, objects and methods are decribed in detail in the first publication by the Survey (Beard & Webb 1974). It was considered that physiognomic methods were more appropriate for an initial, broad-scale study of a very large unknown region (2 500 000 km^2). There would simply not have been time to have recorded the number of relevés required in a phytosociological approach. Secondly, the British school of plant ecology is less interested in the definition of an ecosystem than in knowing how it works. We therefore attach much importance to soil and landscape studies, as we hope to show you in the course of this tour. None the less floristics are of course important too, and in vegetation mapping it was laid down at the outset (Beard & Webb 1974) that the basic unit would be the plant association, a floristic grouping, "the largest possible group with consistent dominants, either of the same or closely allied species". The term Alliance which is often used in Australia means a group of associations which are distinct but floristically related to one another. The term Formation is used for a grouping of associations and alliances on the basis of a common physiognomy (structure and life form). The formation is therefore a physiognomic unit. Units mapped in the Survey have been primarily formations, but associations and alliances were distinguished if the scale of the map and its resolution permitted. Our approach was that once the general nature of the vegetation had been ascertained and mapped, then would be the time to fill out the detail with floristic studies of more limited areas.

This has already been done by a number of authors using methods analogous to those of European phytosociology. J.J.Havel (1968,1975) made a study of the understory communities first in the Banksia woodlands of the Swan Coastal Plain, later in the jarrah (Eucalyptus marginata) forest, relating them to soil type and topographic position. Details are given in Part 3 of this Guide.

B.G.Muir (1976-8) undertook the botanical component of a biological survey of some Nature Reserves in the Wheatbelt and Mallee Regions, based on detailed recording of plots similar to relevés. From these he distinguished associations and gave details of floristic composition. Several of these reserves will be visited on the tour, and summaries of Muir's work are given in Part 3. A study of the karri (Eucalyptus diversicolor) forest with a list of its floristic composition was published by W.M.McArthur and A.L.Clifton in 1975. J.S.Beard studied the vegetation of the Stirling Range with definition of plant associations in 1979, and I.Abbott did the same for the Porongurup Range in 1982. It must not be thought therefore that the absence of phytosociological studies in W.A. implies that we are in ignorance of the floristics of our vegetation. It is merely that different methods have been applied. For the areas to be visited by the tour, and for which Sandro Pignatti has provided his data, it is interesting to see that the communities which he recognises are the same as those previously distinguished, though disguised under different nomenclature and terminology.

It has been remarked above that our approach attaches much importance to soil and landscape studies. For each community we must ascertain the conditions of climate, topography, soil, etc. of which it is the expression, and study its relation to other communities. It has been found that the key to understanding the vegetation of southwestern Australia is the catenary sequence, of which an example is given in Fig.2 below.

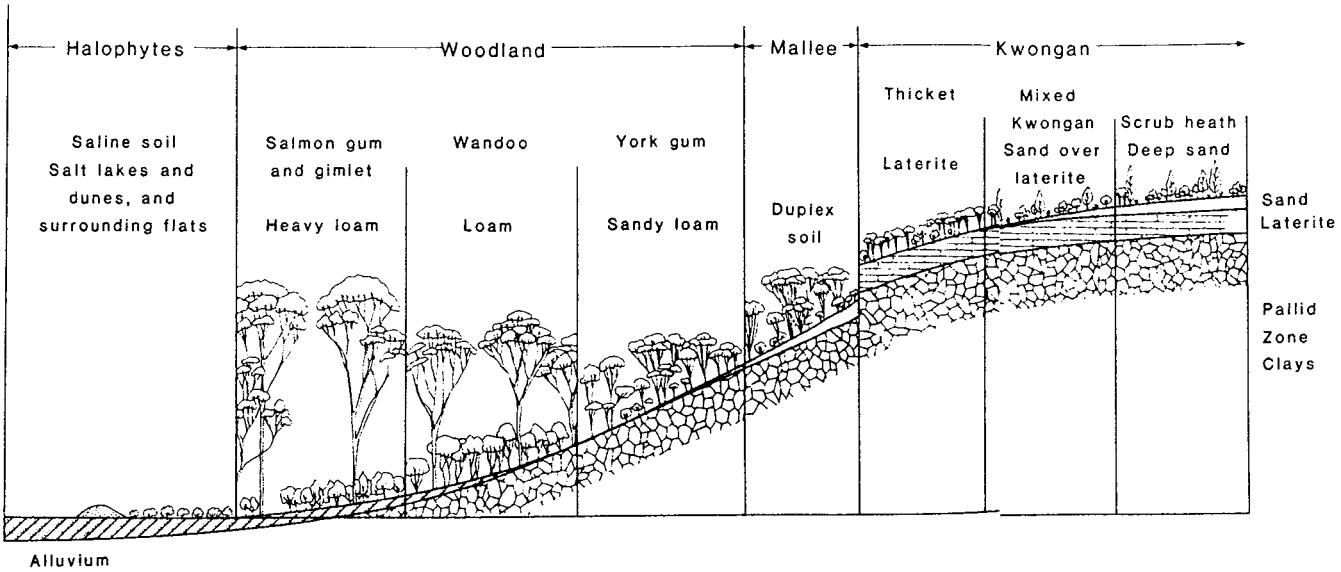

Fig.2 Idealised catenary sequence for the Wheatbelt Region.
The pallid zone consists of leached, kaolinised material derived from deep weathering of granite.
Salmon gum = Eucalyptus salmonophloia. Gimlet = E.salubris
Wandoo = E.wandoo York gum = E.loxophleba
Kwongan is an aboriginal term for the Western Australian sandplain and its vegetation; it equates with maquis, chaparral and fynbos in mediterranean-type vegetation. It is primary and not a degradation community.
Mallee is a term for eucalypt shrubland, 2-5m tall; the eucalypts have numerous thin stems arising from a massive rootstock.

The continental plateau is an extremely old land surface. It was first observed by Milne (1936) in East Africa that catenary systems of soils are characteristic of such old landscapes. If we imagine a chain (catena = chain) strung from one hilltop to another across a valley, we shall find a sequence of soil types arranged like links in the chain down the slope and up again the other side in reverse order. A particular soil type is always linked to its position on the slope.

In Fig.2 there is a typical section of the landscape beginning in the valley bottom with saline loam at the margin of a salt lake. The section passes gradually up slope through red loam soils becoming more sandy until a duplex profile with sand over clay is attained. Above this we arrive at the duricrusted upland covered with laterite and sand, in this example with a small scarp called a breakaway to mark the transition. This feature is not always present. On the highest part of the landscape there is a "sandplain", an expanse of sand derived from decay of laterite. Sandplains may be many kilometres wide, and typically carry a kwongan vegetation whereas the valley soils carry eucalypt woodland.

Climate exerts the primary determining influence on vegetation. Within each climatic zone, soil type exerts the second degree of influence. Therefore for each soil type there is a corresponding vegetation type, and as we have catenary sequences of soils, so we can distinguish catenary sequences of plant communities. In Fig.2 the catena embraces two types of woodland, one of mallee and two types of kwongan. Elsewhere on the plateau the basic soil catena is the same but with different rainfall the sequence of vegetation types will be different.

ECOLOGICAL FACTORS.

General Description: (This section was written By Sandro Pignatti and gives his impressions of Western Australia).

Western Australia is the western portion of the continent, with a surface area of ca. 2.5 million km^2, and 1.5 million population, 2/3 of them living in the Perth metropolitan area. In comparison the DBR has 0.25 million km^2 and 62 million population - everybody can easily calculate the difference in population density!

It belongs to the Commonwealth of Australia, a federation of 7 states. Separated from the other states by a huge desert area, W.Australia is largely autonomous, and sometimes promotes itself to a distinct geographical unit called Westralia, but most West Australians call their country simply "WA", pronounced dable-yu:ei - not easily understood by foreigners! For Europeans in the first impact with WA two aspects are amazing: "a country where space is absolutely not a problem" and "a tradition of hospitality unthinkable in more congested parts of the world". For botanists there is also a third aspect: "forget all you have learnt on the Old World flora: here it is completely useless". The aim of the IAVS Excursion is to fill, at least in minimal part, this gap.

Western Australia is basically divided into 3 botanical provinces; the tropical area in the north, a desertic area in the centre, and a mediterranean area in the southwestern corner. The IAVS Excursion of 1990 visits essentially the South-West Province but will briefly enter the Eremaean or desert Province (see Fig.1)

Geologically, the greater part of the South-West Province belongs to the Western Shield, an extensive region underlain by Precambrian rocks which has remained essentially stable during Phanerozoic time, i.e. in the past 570 million years. Tablelands and sandplains prevail in the landscape, and the only mountain system is the Stirling Range in the south with a maximum height of 1072m.

Rivers are few and in general relatively small, not reaching far inland from the coast. The interior is occupied by relics of ancient drainage systems which are now disorganised into chains of salt lakes.

The climate of the South-West is of the mediterranean type, i.e. warm temperate with yearly average temperatures of 15°-18°C, rainfall with a winter maximum, 1500mm in the southwest declining towards the northeast to 300mm at the boundary of the South-West Province and to 200mm in the Eremaea. Beard (1981) classified climatic zones according to the length of the dry season following Bagnouls & Gaussen (1957), as:

Moderate mediterranean (Mesomediterranéen)	3-4 dry months
Dry mediterranean (Thermomediterranéen)	5-6 dry months
Extra-dry medit.(Xerothermomediterranéen)	7-8 dry months

Natural Regions:
The map Fig.1 shows the boundary of the South-West Province as it has been fixed from vegetation mapping by Beard, and the intermediate area or Southwestern Interzone between it and the Eremaean Province. The tour will be in the Eremaea on the two nights spent at the sheep stations Thundelarra and Bimbijy (north of Lake Moore on map), and the completely different character of the Eremaean vegetation with its Acacia low woodland will be seen. The South-West Province is divided phytogeographically into 5 "Botanical Districts", each of which is a natural ecological region with a distinctive character.
The Darling District is the South-West Forest Region. This has a relatively high rainfall (600-1500mm) and was originally covered over 50% by forests of Eucalyptus marginata, E.calophylla and E.diversicolor, the rest mainly by other low forests and woodland. Kwongan is confined to small patches on coastal dunes.
The Irwin District is the Northern Sandplains Region. It has a lower rainfall, 300-600mm, and predominantly sandy soils derived from Phanerozoic rocks. Kwongan is therefore the principal formation and originally covered 70% of the region. Woodlands covered only 2%, mainly on valley soils.
The Avon District is the Wheatbelt Region, the principal agricultural region of WA with 18 million hectares under cultivation for wheat in rotation with sheep on artificial pasture. 93% of the region has been cleared for farming. Originally the vegetation was organised according to the catena shown in Fig.2.
The Roe District is the Mallee Region, south-east of the Wheatbelt. Owing to lower rainfall woodland is confined to patches in the valley bottoms, and most of the catena is occupied by the mallee formation. Kwongan occupies some sandplain areas on summits.
The Eyre District, the Esperance Plains Region of the south-east, is mainly covered by kwongan and mallee.

DAILY ITINERARY. Bus No.2, southbound from Perth.

DAY 1. Sept.11th 1990. Perth to Pemberton, 400km

8.30am 00km We leave Paradise Riverview Hotel, East Perth, and travel into the forest country of the south, first visiting the jarrah *(Eucalyptus marginata)* forest where we shall see the forest itself, bauxite mining operations and restoration of mined sites. Accompanied by a guide from Alcoa of Australia Ltd we travel south to Jarrahdale.

9.30 45km. Arrive at Jarrahdale, a centre for both mining and forestry in the jarrah forest. A programme will be arranged by Alcoa who are our hosts for the morning. Detailed information on the jarrah forest will be found in Part 3 of this book, p.109

12.00 75km. Lunch at Langford Park by courtesy of Alcoa.

1 pm Leave Langford Park. We now have over 300 km to travel to our night's destination and have therefore little opportunity for further stops. Our route is south to Pinjarra, then towards the coast to Mandurah, where we cross the outlet of the Peel Inlet, one of the large estuary systems of the west coast.. Just south of the bridge there is a salt flat on the left with the halophytes *Halosarcia halocnemoides* and *Sarcocornia*, and the salt-tolerant tree *Casuarina obesa* at the edge

Further down, the bus will turn off along a scenic drive following the shore of the Peel Inlet. Fringing communities will be seen of *Juncus*, *Melaleuca*, *Viminaria*, *Casuarina obesa* and *Eucalyptus rudis*. On returning to the main road we traverse weathered dunes under eucalypt woodland. All down this coastal strip where there is natural vegetation we shall see woodland dominated by *Eucalyptus gomphocephala* (tuart) and *E.marginata* (jarrah) with smaller trees of *Agonis flexuosa & Banksia grandis*. Other conspicuous plants are *Acacia pulchella*, *A.saligna*, *Clematis pubescens*, *Hardenbergia comptoniana*, *Hibbertia hypericoides*, *Jacksonia thesioides*, *Logania vaginalis*,*Xanthorrhoea*.

3 pm 217km. After a long drive we shall see the Leschenault Inlet on our right and the town of Bunbury in the distance. Here we shall break the journey (toilets available) and if time permits visit the small relict population of the mangrove *Avicennia marina* 600km further south than other mangroves on this coast. It is probably a survivor from the climatic optimum 10-6,000 years BP. Fringing vegetation of *Sarcocornia*, reed beds and salt-water couch grass.

After leaving Bunbury the route traverses the coastal plain which has been mainly cleared but has relics of original vegetation. Forest and woodland of *Eucalyptus marginata* and *E.calophylla* was formerly widespread, with paperbarks*(Melaleuca rhaphiophylla)* in the more swampy places. Occasional sand ridges will be seen, marking old shore lines, and these carry Banksia woodland. On leaving the coastal plain we enter a dissected region of the interior plateau with lateritic soils where a ferruginous duricrust caps the higher ground while yellow and red loam soils occur on the slopes and lower ground. The latter have mostly been cleared for farming, leaving the original forest, now managed as State Forest, on the duricrust.

We pass through the towns of Donnybrook (fruit growing), Bridgetown (private forestry with pine plantations) and Manjimup (important forestry centre). At Manjimup we enter the karri forest, where karri *(Eucalyptus diversicolor,* is the commonest species on certain soils. We shall spend the day in the karri forest tomorrow. Eventually we pass through the small timber town of Pemberton and 18km further on reach the Karri Valley Resort where we are to spend the night.
6.30pm 400km. Reach Karri Valley.

Day2, Sept.12th Around Pemberton District in the karri forest. 156 km.

8.30am 00km. Depart on foot for circuit of Beedelup Lake, 1½ hours gentle walk. This passes entirely through karri forest where the guides will identify plants in flower. The route passes the Beedelup Falls, site of one Pignatti's relevés, see Part 2, page 51. Part 3, page 106 has a general account of the karri forest.
10am 00km. Depart by coach for tour of the district, taking the Vasse Highway towards Pemberton. In the first 2km we pass through the "Karri Valley" in Beedelup National Park, a fine example of the virgin forest.
10.10 09km. Turn right on Old Vasse Road to traverse Warren National Park.
10.15 14km Stop 1. Photo stop and discussion. This Park protects some of the finest virgin stands of karri. The dominant understory plant here is *Acacia urophylla* and *Oxylobium lanceolatum* will be seen. Along the route, observe (1) a notice commemorating the artist Marianne North, (2) notice about jarrah dieback disease and quarantine. Depart 10.30am

We continue to the Pemberton-Northcliffe Road, turn R, and pass through the Brockman National Park.
10.40am 22km. Stop 2. Stunted jarrah on sandplain. A small sandplain occurs at this point on high ground, similar to sand-plains which will be seen later in the tour. Typically, the vegetation of sandplains is kwongan, but owing to the high rainfall here we have poor woodland. The sand is highly leached, bleached white, and is winter-wet as it overlies clay. Jarrah is adaptable enough to grow on this stratum but not karri. Shrubs include *Acacia browniana*, *A.extensa*, *A.myrtifolia*, *Agonis parviceps*, *Andersonia caerulea*, *Persoonia longifolia* and *Pimelea hispida*. Herbaceous species include *Anigosanthos flavida* and numerous Restionaceae (*Anarthria* spp.,*Evandra aristata*) and Cyperaceae (*Gahnia*, *Lepidosperma*). Depart 11am
11.15am 35km. Pass through Pemberton.
11.20am 39km. Stop 3. Arrive at Gloucester Tree. Toilets available. Ramble round nature trail in karri forest.

The Gloucester Tree, which may be climbed by visitors, was originally used as a forest fire lookout. Owing to the difficulty of constructing look-out towers of sufficient height in such a forest, outstanding trees on high points were selected and turned into lookouts by being climbed, laddered, lopped and having a cabin built on the top which was manned during the fire season. Aircraft surveillance is now used instead.

The nature trail shows us the understory of the karri forest, containing many soft-leaved plants and others of less marked sclerophylly than is normal in Western Australia. Conspicuous plants are as follows, likely to be in flower: *Acacia urophylla*, *Chorizema quercifolium*, *Hibbertia cuneiformis* *Hovea elliptica*, *Opercularia ?volubilis*. Others not in flower include *Albizia lophantha*, *Casuarina decussata*, *Clematis pubescens*, *Eragrostis curvula*, *Macrozamia riedlei*, *Persoonia longifolia*, *Pteridium aquilinum*, *Stylidium rhynchangium*, *Trymalium spathulatum*. Depart 11.40

11.45am 41km. Stop 4. We return to Pemberton and visit the Fine Woodcraft Shop where there are many interesting examples of local crafts and materials. 30 mins. Depart 12.15

We then take the Rainbow Trail, which winds scenically through the forest past artificial lakes.

12.30pm 50km. Stop 5, Lunch. We take our lunch at the picnic area overlooking the Big Brook Dam in the forest.

1 hour, depart 1.30

The afternoon's programme will be arranged by the Dept. of Conservation and Land Management to visit logging and regeneration in the karri forest. Both the jarrah and karri forests are important economic resources. In the past century it was the practice for settlers to cut out the forest and convert it to farmland but fortunately for the forest a large part of the forest area is agriculturally intractable. In the present century the remaining forests have been dedicated as State Forests and placed under management. Felling is regulated according to quotas, and the forest is regenerated after logging. The karri forest is worked under the Uniform System as it is called in Europe. Defined areas are clear-felled annually, normally leaving seed-trees for regeneration. The coupe is burnt causing liberation of the seed, and copious regeneration follows the next rainy season. Karri is self-thinning, so that expensive weeding and thinning operations are unnecessary.

The karri forest consists of two species of trees, *E.diversicolor* and *E.calophylla*. Karri is a good saw timber but *E.calophylla* cannot be sawn owing to inherent defects. This species is therefore utilised to make wood-chips for export to Japan, as it would not be feasible to exploit one without the other. Waste karri from defective logs and sawmill waste is also chipped. The utilisation of the forest is therefore quite efficient.

It may be a surprise to visitors from Europe, where exploitation of the forests under management is regarded as normal, to learn that there is a strong movement in Australia under the banner of conservation dedicated to closing all native forests to production. Already half the forest area in Western Australia has been taken out of production which of course results in economic loss. Not only is the value of the timber wasted, but money must be spent on forest protection without revenue to balance it.

Europeans may also be interested to observe that no problems are caused here by industrial pollution.

We return to the Karri Valley Resort for a second night.

Day 3, Sept.13th. Pemberton to Porongurup, 324 km.
Today we travel down to the south coast, eastward along it, and inland once more to the Karribank Lodge at the foot of the Porongurup Range. The first 148 km of the route are through almost unbroken forest where we see the full extent of the mosaics of karri and jarrah forest and reed swamps. At Walpole we emerge into the sparsely populated coastal strip and after seeing more giant trees we have our lunch on the beach in the William Bay National Park and inspect coastal vegetation. In the afternoon we proceed mainly through jarrah forest to the township of Mt.Barker and on to the Porongurup where we hope to have time for a ramble in the Range.
For today, see Pignatti's relevés nos.16,17,18 in Part 2, pp. 48-50.
8.30am 00km Leave Karri Valley Resort towards Pemberton.
12km Pass through Treen Brook State Forest where (without stopping) we inspect a young regenerated karri crop.
52km Pass through small timber town of Northcliffe.
80km Meet Southwestern Highway at Shannon and turn R.
9.45am 90km. Stop 1. Examine Casuarina low forest. This formation appears in the coastal belt on deposits of bleached white sand, usually pure *Casuarina fraseriana*, sometimes with *Eucalyptus marginata* or *E.staeri*. 15 mins, depart 10am.
10.15am 115km.Stop 2, at junction of Beardmore Road to inspect swamp land with reeds and scrub jarrah.The swamps consist principally of dense Cyperaceae and Restionaceae with woody plants present in various communities. One phase, probaly perenially wet, has scattered paperbark trees (*Melaleuca cuticularis*) and small teatree (*M.densa*), another has clumps of jarrah mallee (*Eucalyptus marginata*) or of scattered shrubs (*Beaufortia sparsa*, *Callistemon speciosus*) or blackboys (*Xanthorrhoea preissii*). There is also a "heath swamp" association on sandy, probably seasonally wet, ground in which the reeds are mixed with *Adenanthos obovatus*, *Acacia myrtifolia*, *Agonis flexuosa*,*A.juniperina*, *A.marginata*, *Andersonia caerulea*, *Beaufortia sparsa*, *Boronia ?spathulata*, *Callistemon speciosus*, *Cosmelia rubra*, *Grevillea brevicuspis*, *Kunzea ericifolia*, *Leucopogon ?revolutus*, *Oxylobium lanceolatum*, *Pultenaea reticulata*. Many of these shrubs are very showy in flower, especially *Beaufortia sparsa* which is summer-flowering. Among interesting smaller plants in these swamps is the pitcher plant(insectivorous) *Cephalotus follicularis*. Among the reeds *Leptocarpus tenax* seems to be generally dominant; others are *Evandra aristata*, *Mesomelaena tetragona and Restio tremulus*.
150km. Walpole. We emerge from the forest and make a brief stop at a viewpoint overlooking the coast.
159km. Turn off left for the Valley of the Giants.
11.30 165km. Stop 3 in parking area among giant Tingle trees (*Eucalyptus jacksonii*). This species and another,*E.guilfoylei*, associate with or replace karri in this part of the south coast forest which has the highest rainfall, about 1500mm per annum. Together with some other restricted species it seems probable that they are survivors from a period of more abundant rainfall.
Depart 11.50

We return to the coastal highway, turn east and at 208km turn off again south into William Bay National Park.
12.45 211km. Stop 4. Lunch stop in parking area or on beach. Toilets. Swimming if weather favorable. Examine coastal vegetation.

1.45pm 215km. Circuit to Mad Fish Bay and back,4 km. Dune and coastal vegetation. Most of the vegetation is developed on a mantle of recently consolidated sand which is little weathered, poor in nutrients. When burnt it does not regenerate rapidly. The climax appears to be low woodland of *Agonis flexuosa* but this is only seen locally due to fire which reduces the trees to a sort of mallee form scattered in kwongan-type heath plants. The heath becomes dominant on slopes facing the sea due to the action of wind and spray. Some interesting examples of dwarfing can be seen for example in *Banksia grandis* normally a forest tree but here reduced to 1m tall. Close to the sea *Scaevola crassifolia*, *S.nitida*, *Olearia axillaris*and *Senecio elegans* form thickets. Further inland the shrubland includes *Acacia decipiens*, *A.?divergens*, *Adenanthos cuneatus*, *A.sericeus*, *Andersonia simplex*, *Anigozanthos flavidus*, *Anthocercis viscosa*, *Casuarina humilis*, *Dryandra sessilis*, *Hakea elliptica*, *H.oleifolia*, *H.prostrata*, *Hibbertia cuneiformis*, *Jacksonia horrida*, *Leucopogon parviflorus*, *Lysinema ciliatum*, *Melaleuca acerosa*, *Olax phyllanthi*, *Pimelea clavata*, *Senecio lautus*, *Spyridium globulosum* and there is a large reed *Loxocaria flexuosa*. After fire *Pimelea rosea* can be abundant and showy in flower. 30 mins., Depart 2.15

We return to the main road and pass through the town of Denmark, then turning inland for Mount Barker. The route lies mainly through poor quality jarrah forest with occasional reed and paperbark swamps. 2 stops will be made.

4pm 292 km. Pass through Mt. Barker.

4.15 314km. Arr. Porongurup. The bus will proceed straight to Bolganup in the Porongurup Range. Toilets available on way in at Bolganup Dam. The party will have two hours here for a ramble up the Wansborough Walk, continuing if desired up the rock slopes to the summit of the Devil's Slide, 670m. The range is formed of a series of granite domes 12km long and 3km wide. It is the most massive granite outcrop in the State. The summits are in many cases quite bare or covered with lichens, herbaceous plants and scattered shrubs. Lower down a belt of *Eucalyptus cornuta* and *E.megacarpa* leads into extensive karri forest on the lower slopes. Karri here is an outlier, 100km east of its main range. Five species are known to be endemic to the Range, *Brachysema subcordatum*, *Billardiera granulata*, *Hibbertia bracteosa*, *Apium aff. prostratum* and *Villarsia calthifolia*.

Some of Pignatti's releves were taken here, see Part 2, page 47, and there is a general account of the National Park in part 3, page 104.

6.15 pm. 324 km. We arrive at Karribank Lodge for the night.

Day 4. Sept.14th. Porongurup to Katanning, 234 km.
We spend most of today in the Stirling Range National Park, and continue in the afternoon to our night's stop at Katanning.

8.30 am 00km. Leave Karribank Lodge. After travelling along the foot of the Porongurup Range we meet the main road from Albany and turn north. Another 5km, and we cross the forest boundary to enter the Kalgan Plains, the extremity of the heath-covered Esperance Plains which extend east from here all along the south coast. The Kalgan Plains have been largely cleared for farming in recent years but we shall see the original vegetation in the National Park.

The Stirling Range, coming into view in front, is a highly eroded remnant of sedimentary rocks of Proterozoic age dated at >1340 m.y. The highest peak is Bluff Knoll, 1073m. The rocks consist of sandstone at the base overlain by phyllite and muddy sandstone, and are up 910m thick.

Several of the Pignatti's relevés were taken in the Stirling Range and will be found in Part 2,p41-3.An account of the vegetation was given by Beard in "The Vegetation of the Albany & Mt.Barker Areas" 1979, but will superseded by a new work bv Greg Keighery which is not yet ready for publication. Some extracts from Beard's work are given in Part 3,p94-7and we have been promised a supplementary note by Greg Keighery to be issued at the time of the Excursion.

9 am 34km. Enter Stirling Range National Park.

35km. Stop 1 on sandplain. The vegetation of the south-coast sandplains in classed as "mallee-heath" as it comprises a heath layer overtopped by scattered small mallee eucalypts. *Eucalyptus tetragona* is the most characteristic species and is conspicuous with its glaucous leaves. Other mallees at this stop are *E.angulosa*, *E.pachylomaand E.anceps*. Conspicuous shrubs at this stop are *Acacia drummondii*, *Baeckea schollerifolia*, *Andersonia caerulea*, *Banksia gardneri*, *Calectasia cyanea*, *Casuarina humilis*, *C.thuyoides*, *Chorizema glycinifolium*, *Dryandra armata*, *D.brownii*, *Exocarpos sp.*, *Hakea corymbosa*, *H.trifurcata*, *Hibbertia sp.*, *Leucopogon cucullatus*, *Lysinema ciliatum*, *Melaleuca suberosa*, *Petrophile squamata*, *Xanthorrhoea platyphylla*. The ground layer is mainly of the sedge *Mesomelaena pseudostygia*. 20 mins, depart 9.20

9.30am 41 km. Stop 2 at the Gold Holes picnic area to view woodland in the Park. A small amount of alluvial gold was discovered and worked here. Trees on the deep valley soil are *Eucalyptus calophylla* and *E.cornuta*. On more shallow soil opposite there is *E.wandoo* which has a sparse understory mainly of *Templetonia retusa* also *Acacia drummondii*, *A.cyclops*, *Dryandra sessilis*, *Hakea trifurcata* and *Leucopogon revolutus*. There is also a patch of *Banksia attenuata* low woodland on bleached sand on the west side above the Gold Holes, which merges behind into *E.marginata* low woodland. Shrubs present are *Boronia racemosa*, *Isotropis cuneiformis*, *Jacksonia furcellata*, *Leucopogon revolutus Lhotskya ericifolia*, *Pimelea hispida*. 20 mins. depart 9.50

10.15am 60km. Stop 3 in parking area at foot of Bluff Knoll. Toilets available. 2 hours will be allowed for a ramble up the access track, the more energetic ones perhaps making for the summit. With some effort it may be possible to view the interesting thicket formation at the higher levels.

The ascent begins in low woodland of *E.marginata* and *E.calophylla* with an understory of *Acacia drummondii*, *Dryandra sessilis*, *D.plumosa*, *Hakea trifurcata*, *Isopogon baxteri*, *leucopogon revolutus*, *Lysinema ciliatum*, *Xanthorrhoea platyphylla*. As the woodland declines in height the trees take on the stature of mallee without change of species. Higher still the high-level flora begins to come in, e.g. *Andersonia echinocephala*, *Banksia solandri*, *Beaufortia orbifolia*, *Dryandra formosa*, *D.serra*, *Isopogon latifolius*, *Oxylobium atropurpureum*, *Sphenotoma dracophylloides*. Many of these plants are spectacular in flower. The dense thicket formation gives a strong similarity to the South African *fynbos*.

12.30pm 60km. Lunch at Bluff Knoll. 1 hour, depart 1.30
64km. Stop 4 in sandplain before reaching main road. This consists of mallee-heath similar to that seen at Stop 1, with *E.tetragona*, *E.angulosa*, *E.buprestium and E.marginata* Shrubs not seen at Stop 1 will include *Cryptandra sp.*, *Dryandra sessilis*, *Gastrolobium spinosum*, *Hakea nitida*, *Isopogon formosus*, *Lambertia inermis*, *Synaphea polymorpha*.
There is a thicket of tall *Leptospemum erubescens* behind the picnic ground. 20 mins, depart 2 pm.
2 pm. Resume journey by the Stirling Range scenic drive, which skirts the prominent peak Toolbrunup and leads on to the group of Gog, Magog and Talyuberlup in the centre of the Park. Zonation of vegetation according to slope will be observed.
2.30pm. 94km.Stop 5. Talyuberlup picnic area. A brief stop will be made here to see some localised species, e.g. *Eucalyptus talyuberlup* (formerly *E.macrocera)*,an undescribed *Acacia* and *Darwinia wittwerorum*. 20 mins. depart 2.50
3 pm ±98km. Stop 6. Photo stop at viewpoint south of Gog. 5 minutes.
3.15pm 112. Stop 7. Mondurup parking area. The lower mountains in this part of the Park receive less rainfall, with some species changes. 15 minutes, depart 3.30
3.40pm.118 Stop 8. Red Gum Springs. A waterhole here was used by travellers and sandalwood cutters in the last century. Good stands of *Banksia coccinea* and *Hakea cucullata* are found here and may be seen in flower. 15 mins. depart 3.55
4 pm. 124 Stop 9. Photo stop on the last hill before leaving the Park, where there is a panorama of the peaks of the Range to the east and of the sandplain and salt lakes north of the Range.

From here we have to drive through to Katanning for our night's stop. The road proceeds to Cranbrook, passing Hamilla and Sukey Hills which continue the geological formation of the Stirling Range. We then turn north and at Pootenup we pass through a salt lake complex. The intermittent lakes, normally dry, are surrounded by *Halosarcia*, then *Melaleuca* and *Lawrencia*. Each lake has a lunette or complex of lunettes on the ESE on which there is *Acacia acuminata*, *Eucalyptus wandoo*, *E.occidentalis* and paperbarks. Between the lakes woodland is formed by *Acacia acuminata & E.loxophleba*, an association which we shall see much of further inland.

Around Tambellup there is a depositional sand-plain with a heath cover. After passing through Broome Hill, *E.gardneri* becomes plentiful.
5.30 pm 234km. Arrive Jumbuk Motel, Katanning.

Day 5. Sept.15th. Katanning to Lake Grace, 203 km.

We now set off to the north-east into the drier country of the wheatbelt where a change in the landscape will be observed. We shall see woodlands, mallee and heath. Lakes will be salt, at first permananent, then intermittent.

8.30am 00km. Leave Katanning for Dumbleyung.
8.45 16km. Stop 1, at typical "mallet ridge". Laterite is now only seen as a capping on isolated ridges. The typical tree on such sites is *Eucalyptus astringens* with *E.wandoo* and *E.longicornis*,and usually little or no understory.Depart 9 am.

30 km from Katanning we pass the remains of a kwongan area along the road, with *Leptospermum erubescens*.

33 km, we encounter our first salmon gum tree,*Eucalyptus salmonophloia*. The undershrub is *Templetonia aculeata*.

37 km, we cross a laterite ridge, now too dry for tree eucalypts so that the vegetation is kwongan with *Dryandra armata* dominant and the mallee *Eucalyptus ?decurva*. Other shrubs are *Acacia lasiocalyx*, *Gastrolobium tricuspidatum*, *G.spinosum*, *Hakea gilbertii*, *Isopogon divaricatus*.

9.30 am 48km. Stop 2. Salt flats on the Coblinine River. In the wheatbelt, rivers become intermittent and saline. Two species of samphire (*Halosarcia*) form the ground cover with *Pelargonium havlasae* and *Avena* . Trees and shrubs have suffered from increase in salinity since land clearing and many are dead. These include *Melaleuca cuticularis*, *M.lateriflora*, *M.uncinata* and the taller *Casuarina obesa*. 15 mins. Depart 9.45

9.50 am 49km. Stop 3. Sandhills with Banksia low woodland. A sand quarry shows the profile of the deep, structureless aeolian material. Trees are *Banksia attenuata*, *B.prionotes*, *Acacia acuminata*, *Casuarina huegeliana*, *Eucalyptus loxophleba*. Shrubs include *Acacia stenoptera*, *Eremaea pauciflora*, *Exocarpos sparteus*, *Gyrostemon subnudus*, *Hakea corymbosa*, *H.prostrata*, *Jacksonia furcellata* and the reed *Lepidobolus chaetocephalus*.

We continue the route, passing through the town of Dumbleyung, where we turn left.

10.30 am 66km. Stop 4, at lookout point over Lake Dumbleyung. This lake is salt but permanent, an unusual combination. Until Lake Argyle was filled by the Ord River Dam, in the Kimberley, this was the largest body of permanent water in Western Australia. Sir Donald Campbell broke the World Water Speed Record here on Dec.31st.,1964. The lake level varies very considerably with rainfall cycles and has no normal outlet, overflowing only rarely. At low levels, sandbanks with tree stumps are exposed.

We resume our route, passing back through Dumbleyung and and heading in a general northerly direction for the Dongolocking group of reserves.

12 noon. 113km. Stop 5, in Dongolocking Nature Reserve. LUNCH. Lunch will be taken in open country. No toilets.

There are no Pignatti relevés for this area, but an account of the district with details of the vegetation of the Reserve is given in Part 3, page 89-93

The vegetation at the lunch stop is woodland of *E.wandoo* with an understory of *Oxylobium parviflorum* and *Acacia pulchella*. This opens out to kwongan in which the principal species are *Banksia sphaerocarpa*, *Calothamnus quadrifidus*, *Calytrix brachyphylla*, *Casuarina microstachya*, *Comesperma scoparium*, *Dryandra armata*, *D.cirsioides*, *Eucalyptus eremophila* *Hakea lehmannii*, *H.aff.marginata*, *Isopogon drummondii*, *Leptospermum erubescens*, *Leucopogon ?dielsianus*, *Melaleuca subtrigona*, *M.uncinata*, *Petrophile squamata*, *Xanthorrhoea reflexa*. The sedges *Caustis dioica* and *Mesomelaena stygia* are ground plants.

1.30pm. 124km. Stop 6, for further inspection of vegetation types in the Dongolocking Reserve. The stop is on a small laterite plateau, the soil sand over pisolitic ironstone. Two formations are present, mallee on ironstone, kwongan on sand.

Mallees are *Eucalyptus oleosa*, *E.sheathiana*, *E.decipiens*, *E.falcata*. *Dryandra nobilis*, *D.cirsioides* and *D.sessilis* form a dense understory to the mallee.

Kwongan includes *Adenanthos cygnorum*, *Beaufortia incana*, *Calothamnus sanguineus*, *Chloanthes coccinea*, *Darwinia vestita*, *Hakea baxteri*, *Hibbertia sp.*, *Isopogon divergens*, *Lambertia inermis*, *Lysinema ciliatum*, *Melaleuca sp.*, *Pimelea ferruginea*, *P.silvestris*, *Grocarpus squamuligerus*, *Xantnorrhoea reflexa*.

After resuming the journey we pass through extensive flat country originally under woodland of *Eucalyptus loxophleba* and *E.salmonophloia*. 30 mins. Depart 2 pm.

3 pm. ±173km. Stop 7, near Kukerin, for inspection of mallee formation on calcareous soil. Mallee species are *E.gracilis*, *E.redunca*, *E.sheathiana*. There is very little understory here, a few *Daviesia acanthoclona* and *Templetonia aculeata*, with *Microcybe pauciflora*, *Phebalium tuberculatum*, *Wilsonia ?humilis*. ½km further on there is a thick understory containing *Bossiaea sp.*, *Chamaelaucium ciliatum*, *Guichenotia sp.*, *Melaleuca uncinata*, *Santalum acuminatum*. 15 mins. Depart 3.15

3.30 pm 184km. Stop 8, Tarin Rock Reserve. 30 mins, Dep.4 pm.

The Reserve here preserves an extensive remnant of kwongan on sandplain. The kwongan contains scattered small mallee, *Eucalyptus albida*, which only occurs in kwongan; *Grevillea hookeriana*, a pioneer species abundant after fire, and the compass bush *Casuarina pinaster* which leans over to the south. Other species at the stop are *Adenanthos argyreus*, *Banksia sphaerocarpa*, *Boronia caerulea*, *Casuarina humilis*, *Daviesia acanthoclona*, *D.uniflora*, *Dryandra aff. cirsioides*, *Grevillea armigera*, *G.pilulifera*, *Hakea glabella*, *H.incrassata*, *Isopogon drummondii*, *Jacksonia sp.*, *Olax benthamiana*, *Synaphea polymorpha*.

2 km further on we shall see *Grevillea insignis and Hakea multilineata* by the road side.

After another 15 km an extensive view of the salt lakes opens up (Lake Grace North & South). The first gimlet trees appear (*Eucalyptus salubris*) and thickets of *Casuarina campestris* on laterite. Photo stop on request.

4.25 pm. 201km. Stop 9, salt flats of Lake Grace. After crossing the lake by the causeway we stop to examine the adjacent salt flats. Salt-tolerant eucalypts, *E.gracilis and E.kondininensis* are seen on the lunette with Chenopodiaceae, e.g. *Enchylaena tomentosa* and *Threlkeldia*. *Atriplex vesicaria* is dominant on the flats with *Disphyma crassifolium* and *Frankenia* sp. The lake itself is bordered by *Halosarcia* and *Lawrencia*.

30 mins. Depart 4.55

5 pm. 203 km. Arrive at Lake Grace township for the night's stop.

Day 6. Sept.16th. Lake Grace to Hyden, 180 km.

Today we enter the Mallee Region, in which the vegetation is mainly mallee with some drier woodlands and kwongan. Some of the Pignatti relevés apply here, see Part 2, page 40. Fairly extensive research has been done on the two Nature Reserves at Bendering which we are to visit, and some data are given in Part 3, page 82-88.

8.30 am. 00km. Leave Lake Grace on the Kulin road.

The country is very gently undulating with mallee and woodland alongside the road. A number of granite outcrops will be observed.

9.30 am. 58km. Stop 1, Jilakin Rock. An especially prominent granite dome here affords a recreational area and overlooks a small salt lake. The site is of interest for the occurrence of a small population of jarrah, *Eucalyptus marginata*, an outlier 120 km east of any others. The site receives extra moisture as run-off from the rock, a factor interpreted as having preserved the population since jarrah was more widespread during the climatic optimum 6,000-10,000 years B.P. Also growing at the foot of the rock are *Eucalyptus loxophleba*, and *Acacia saligna*, *Casuarina huegeliana*.

The opportunity will be taken to examine the rock and the plants growing on it in crevices and patches of soil. A number of species are confined to this habitat and we shall see *Stypandra grandiflora*, called "blind grass" because it causes blindness in sheep if eaten; and the floriferous shrub *Kunzea pulchella* which makes a good garden subject. Other plants are *Casuarina huegeliana*, *Diplolaena microcephala*, *Dodonaea viscosa*, the reed *Spartochloa* and the sandalwood *Santalum spicatum*. Clumps of *Borya nitida* form a grass-like cover in parts. This is a "resurrection plant", capable of drying up completely during drought and appearing dead, but recovering when rain falls.

On resuming our journey we pass through the township of Kondinin, type locality for *Eucalyptus kondininensis*, and head north for Bendering where we turn east to examine the Bendering Reserves which have been the subject of a biological survey. Conveniently, the road runs along the west,south and east sides of the West Bendering Nature Reserve, enabling inspection from the bus. There is first woodland of *Eucalyptus salmonophloia* and *E.salubris*, then mallee, then Casuarina thicket containing *Casuarina acutivalvis* and *Callitris preissii*on the laterite at the top of the rise, then down into mallee (note topographic sequence). Along the south side of the Reserve we shall see mallee with scattered trees of *E.salmonophloia and E.loxophleba*. After turning north along the east side, we again see mallee and woodland , and come eventually to an extensive granite outcrop.

11.30 am. 122km. Stop 2, at cross-roads. A laterite quarry shows a profile of the duricrust. It carries a thicket of *Casuarina campestris* with a limited number of associated species, e.g. *Acacia /multispicata*, *Calothamnus quadrifidus*, *Dryandra sp. Grevillea armigera*, *G.eriostachya var. excelsior*, *Hibbertia spicata*, *Melaleuca uncinata and M.undulata*.

Around the granite rock outcrops we see the run-off community of *Acacia lasiocalyx*, *Dodonaea viscosa*, *Leptospermum erubescens* and the sedge *Lepidosperma viscidulum*.

The run-off community merges into mallee - *E.eremophila* - with scattered trees of *E.loxophleba* and undershrubs of *Casuarina acutivalvis*, *Astroloma epacridis*, *Comesperma scoparium*, *Hakea invaginata*, *Verticordia acerosa*,*V.picta*30 mins. Dep.12 noon

We resume the road east towards the main Bendering Nature Reserve of earlier work now renamed the North Karlgarin Nature Reserve, and turn south for 1km along the boundary.
12.10pm 129km. Stop 3. *Eucalyptus burracoppinensis* community.
A feature of this area is the occurrence of the small mallee *Eucalyptus burracoppinensis* in kwongan. It sems to favour sandy loam soil. The kwongan at the stop is essentially Casuarina thicket with a mixture of *Casuarina acutivalvis*, *C.campestris & C.corniculata*and *Acacia sp.*, *Santalum acuminatum* (Quandong). There is only a sparse understory including *Boronia crenulata*, *Persoonia sp.*, *& Phebalium tuberculatum*.
12.30pm 130km. Stop 4, LUNCH. Woodland, no toilets.

We return to the main road and stop for lunch in a grove of mallet trees, *E.falcata & E.gardneri*. These are small, non-lignotuberous, seed-regenerating eucalypts, which are common in the Mallee Region. After fire, resprouting species form mallee but non-sprouting species must regenerate from seed and form groves of marlocks. Understory shrubs here are *Beyeria leschenaultii*, *Callitris roei*, *Casuarina acutivalvis*, *Dodonaea bursariifolia*, *Isopogon aff.buxifolius*, *Hakea sp.* *Leptomeria sp.*, *Phebalium tuberculatum*, *Olearia muelleri*.

The mallee formation immediately to the east down the slope consists of *E.eremophila*, *E.flocktoniae*, *E.loxophleba*. The understory is mainly of *Melaleuca uncinata & M.undulata*.

1¼ hours, depart 1.45

1.50 pm. 132km. Stop 5, for kwongan in the Reserve.

The kwongan takes the form of scrub-heath, a more mixed and open community where sand predominates over ironstone gravel in the soil. The patchy nature of the community will be observed illustrating the highly mosaic character of kwongan. The following are likely to be in flower: *Adenanthos argyrea*, *Boronia ternata*, *Chamaelaucium megalopetalum*, *Grevillea hookeriana*, *Isopogon buxifolius*, *Lysinema ciliatum*, *Mirbelia sp.* *Pimelea sulphurea*, *Psammomoya choretroides*, *Synaphea polymorpha*.

20 mins., Depart 2.10

2.30pm. 148km. Stop 6, Deep-weathered profile.

An exposure will be seen at the roadside of the deep-weathered soil profile. A massive lateritic carapace overlies a mottled zone which merges down into a pallid zone of white kaolinised material. The deep weathering is thought to be of early Tertiary age, the lateritisation Oligocene/Miocene. The water storage potential for tree growth can be appreciated.

A few small *Callitris canescens* occur on the summit.
3.30 pm. 172km. Arrive at Hyden. Pass through town.
3.35 pm. 175km. Stop 7. Visit Wave Rock.

This rock,while basically the same as Jilakin Rock visited this morning, is a major tourist attraction due to the wave formation on the north side, which we shall see. The rock above is rather bare of plants but the run-off community can be seen as before at the foot. The rock also serves as a catchment for the town's water supply which is impounded by a small dam.
5 pm. 178 km. We return to Hyden, to the hotel for the night.

Day 7. Sept. 17th. Hyden to Merredin, 215 km.

We continue our journey northward, leaving the Mallee Region and entering the Wheatbelt Region for a night stop at Merredin.

8.30 am 00km. Leave Hyden Hotel going north on the Narembeen road.

04km. Salt lakes with dead shrubs due to salinization.

10km. Pass point where our route came in yesterday.

8.50 am 24km. Stop 1. As ground rises just beyond a cross roads, there is kwongan on the right, on yellow sandy soil, a mixed scrub-heath assemblage more interesting than the dense Casuarina thickets. It becomes taller higher up the slope.

30 mins. Depart 9.20

30km. Fork in road, keep right.

38km. Turn right at sign reading M C Sweeney.

40km. Turn right, signposted Anderson Rocks.

This is reserve 2357, a kwongan-covered slope rising up to the Anderson Rocks to the south.

9.35 am 41km. Stop 2. The soil becomes more sandy near the foot of the rock, and the Casuarina thicket changes to scrub-heath with numerous *Banksia elderiana*. The stop will be made to examine the kwongan, and the more adventurous may climb the rock behind which affords a view of the country, though there are not many plants up there. 30 mins. Depart 10.05

47km. We return to the main road and turn north.

57km. Pass Mt.Walker grain terminal. Farms here are too far out to be near the railway. Wheat is collected here and taken out by road transport.

59km. X-roads, turn east.

61,65 km. Granite outcrops L.

71km. Optional photostop. Photogenic salmon gums.

11 am. 82km. Stop 3 the abandoned Holleton town site and mining area. This greenstone outcrop like others is mineralised and gold was mined here from 1925 to 1942. Unlike others the mine has not been reopened. Some historical details are given on a commemorative tablet and an old mine shaft can be seen. The low-lying country here is part of a "greenstone belt". The granite of the plateau is periodically interrupted by belts of infolded metamorphic rocks of Archaean age, generally dated at ±2400 million years. These consist mainly of altered basalt called amphibolite, popularly greenstone, some more siliceous rocks known as whitestones, and banded ironstone. Their importance is that they are mineralised and contain the gold, nickel, copper etc. mined in Western Australia. The harder members of these rocks resist erosion and form hills. Here at Holleton the rocks have weathered readily to form deep soils, giving us a profile of relatively luxuriant eucalypt woodlands with both broombush and saltbush understories. (Broombush = shrubs, typically *Melaleuca* and *Eremophila spp.*, Saltbush = *Atriplex*). Blackbutt trees, *Eucalyptus clelandii*, which are an indicator species for greenstone, are to be seen here. The several species of blackbutt including *E.le souefii* and *E.corrugata* with dark persistent bark on the base of the trunk, are very common further east around Kalgoorlie in the principal gold-mining area. Other trees at Holleton are *E.salmonophloia*, *E.salubris* and *E.longicornis*.

30 mins. Depart 11.30

We retrace our steps for 5km and turn NW along the line of a former rabbit-proof fence, now abandoned. At one time several of these fences were built in an attempt to stop the spread of rabbits from the east - in which they failed.

11.40am. 88km. Stop 4 at a steep slope marking the boundary of the greenstone belt, woodland at the bottom, kwongan at the top. We stop to examine this change in soils and vegetation, then continue NW. 30 mins. Depart 12.20

12.30 95km. Stop 5, LUNCH. Meet the opposite tour party and exchange leaders. You will now be taken over by John Beard and Pauline Fairall. 1 hour. Depart 1.30

2.10pm. 130km.Stop 6. Cairn Rock Nature Reserve No.9754, again reported on by B.G.Muir, see Part 3, pp 79-81. We shall stop in Casuarina thicket, see list of species under *C.corniculata* heath. The energetic may walk up to the granite rock if they wish. 30 mins. Depart 2.30

3 pm. 150km. Stop 7. We encounter a sandplain, deep sand, where we stop to examine the more open, species-rich scrub-heath type of kwongan. The following may be observed here: *Acacia rossei*, *Adenanthos argyrea*,*Banksia laevigata ssp.fusco-lutea*, *Boronia sp. Burtonia hendersonii*, *Casuarina acutivalvis*, *Chamaelaucium megapetalum*, *C.pauciflorum*, *Dryandra pteridifolia*, *Grevillea hookeriana*, *G.pritzelii*, *Isopogon scabriusculus*, *Leptomeria preissiana*, *Melaleuca pungens*, *Petrophile aff. ericifolia*, *Pityrodia lepidota*. 20 mins. Depart 3.20

3.35 174km. Stop 8 to examine mallee. We shall have to make shift to identify the species: mallees are always difficult. The most likely species here are *E.redunca*, *E.loxophleba*, *E.sheathiana*.

15 mins. Depart 3.50

4.10 191km.Stop 9, Reserve no.18198. This is another Reserve examined by B.G.Muir, whose sketch map and report are reproduced in Part 3, pp 77-78. The reserve contains woodland of *E.salubris* and *E.salmonophloia*with a broombush understory, further on *Acacia-Casuarina* thicketwith dominants *A.signata* and *Casuarina corniculata*. There are minor patches of mallee, mixed kwongan (called the *Acacia-Hakea* heath), and kwongan with *Ecdeiocolea* understory. 20 mins. Depart 4.30

194km. Burracoppin, type locality for *Eucalyptus burracoppinensis*. We meet the Great Eastern Highway and turn W.

5 pm. 215km. Arrive Merredin for the night. This is one of the largest towns in the Wheatbelt Region, being on the transcontinental road and railway, and a centre for the grain industry. The West Australian Wheatbelt, devoted to production of wheat in rotation with sheep on artifical pasture, is one of the world's great grain-growing areas with 18 million hectares under cultivation, about a quarter of which is sown to wheat annually. We depend heavily on exports and rely on the continued inability of China and the Soviet Union to feed themselves!

DAY 8. Sept.18th. Merredin to Bimbijy, 318 km.

Our route lies north today, heading for a decisive change in the vegetation when late in the afternoon, having left the farming area behind, we cross the boundary between the South-West and Eremaean Provinces, and enter the arid zone. Owing to the sparse population we encounter difficulties in catering and accommodation. At 5.30 pm we are due to reach Mouroubra Station ("Station" means a sheep ranch) where the owners Mr & Mrs Arthur Heale will give us an evening meal. As they have no suitable accommodation we later have to board the bus again and travel another 40 km to Bimbijy Station where they have quarters but cannot feed us. The caretaker has promised to have a camp fire burning and the lights on. We shall sleep in the quarters provided for itinerant sheep-shearers' teams which are basic but adequate. Sleeping bags and blankets will be provided.

8.30am. 00km. Depart Merredin heading north.
40km. Nungarin. Turn right for Lake Brown.
9.30 ±60km. Stop 1, at Lake Brown picnic area. There is a granite rock here overlooking the lake. On the rock the saxicole species *Kunzea pulchella* may be seen in flower. Trees bordering the lake are *Eucalyptus salmonophloia*, *Callitris glaucophylla*, *Pittosporum phylliraeoides*. 30 mins. Depart 10am
10.30. 7km. Stop 2, not a botanical stop this time but at the historic Mangowine Homestead built by early settlers 100 years ago. There are some exhibits showing the life of those times. We shall have a conducted tour and morning tea.
1 hour. Depart 11.30

We continue 25km to the town of Mukinbudin and then 35km to Bencubbin. We make our next stop 4km before Bencubbin.
12.30 137km. Stop 3, in bush adjacent to town. Lunch, and various vegetation types to inspect:-

1). Flat granite rock, shallow soil. On the rock outcrop *Borya nitida*, *Stackhousia huegelii*, *Stypandra glauca*. Peripheral shrubs are *Acacia neurophylla*, *Calothamnus asper*, *Calytrix brevifolia*, *Casuarina campestris*, *Dodonaea boroniifolia*, *D.filifolia*, *Thryptomene australis*, *Verticordia preissii*. This grades into *Casuarina campestris* thicket.

2). On shallow, winter-wet soil, *Melaleuca uncinata-Ecdeiocolea monostachya* community. Associated plants are *Alyxia buxifolia*, *Baeckea grandibracteata*, *Eremophila drummondii*, *E.oppositifolia*, *Melaleuca acuminata*, *Waitzia acuminata*.

3). On yellow sandy soil over laterite, *Acacia-Casuarina* thicket. *Acacia merrallii*, *A.neurophylla*, *Casuarina acutivalvis*, *Hakea subsulcata*, *Phebalium tuberculatum*, *Scaevola spinescens*, *Thryptomene appressa*.

4). On red loam soil, eucalypt woodland. Dominants are *Eucalyptus transcontinentalis*, *E.salmonophloia*, *E.salubris*. The understory consists in part of *Atriplex* and *Maireana carnosa* which are halophytes, described as a saltbush understory, but in general is a "broombush" understory of sclerophyll shrubs, typically *Eremophila* spp., *E.drummondii & E.oppositifolia*. Other species are *Acacia spp.*, *Olearia muelleri*, *Santalum acuminatum*, *Scaevola spinescens*.

1½ hours including lunch. Depart 2 pm.

We pass through Bencubbin and turn north for Beacon.

185km. Beacon. Turn west.
208km. Cleary. Turn north. All this time we are passing through cleared farm land, with little natural vegetation remaining.
235km. At this point, however, we come to the end of the last farm. With declining rainfall, there has to be an arbitrary cut-off point where cultivation ceases. We enter undisturbed bush.
3.45pm.245km. Stop 4. Mixed kwongan and thicket on sandplain, dominated by Acacia and Casuarina. This still typical wheatbelt vegetation and will be found similar to so much kwongan seen further south. 15 mins. Depart 4 pm.
4.05pm.246km. Stop 5. At the end of the same sandplain, the soil becomes a very deep sand and the thicket changes to an almost pure stand of *Acacia resinomarginea*. There are few associated species. This community is very typical of deep sand soils in the north-eastern wheatbelt. It has a greater biomass than the mixed Acacia-Casuarina thicket of more shallow soils. 15 mins. Depart 4.20.
4.25pm.251km. Stop 6. *Eucalyptus salubris*, *Acacia ramulosa* and a ground layer of samphire, *Sclerostegia disarticulata*. Still southern vegetation. 15 mins. Depart 4.40.
257km. Cross the rabbit-proof fence. This one is still maintained, not to exclude rabbits, but to prevent emus from migrating down into the farming area. In this case it works! Here we could be said to enter the Eremaean Province.
5.10pm.275km. Stop 7. The vegetation has now completely changed. The eucalypt woodland is replaced by a lower and more open woodland of mulga (*Acacia aneura*) and cypress pine (*Callitris glaucophylla*). The mulga formation is more or less continuous across the whole southern half of the Eremaean Province in W.A. covering nearly 500,000 km^2. The cypress pines are only common along the southern border. A full description of the mulga formation will be found in Part 3, pp.67-70. 15 mins. Depart 5.25
5.30pm.278km. Arrive Mouroubra Station for the evening meal. 1½ hours. Depart 7 pm.
8 pm. 318km. Arrive Bimbijy Station for the night. The 40km to be travelled are on an earth road through the bush, with nine gates to open and a salt lake to cross. In dry weather we should have no problem.

DAY 9. Sept.19th. Bimbijy to Thundelarra, 246 km.
How did you sleep? Breakfast will be served at 7.30 in the open air at the Station, for an 8.30 departure. Today we continue northward through the mulga country (Part 3, p67-70) to reach another Station tonight, called Thundelarra, which is much less basic and regularly equipped for visitors, so that it should be much more comfortable.
8.30am. 00km. Leave Bimbijy and retrace our route of last night, so that we can now see in daylight what we missed. After a few km we cross a salt lake and climb a bluff the other side which affords a view - optional photo-stop. At this point you will se Mouroubra's shearers' quarters and appreciate why we did not stay there!

40km. Repass Mouroubra Station and turn north.
9.45am. 52km. Stop 1. Small salt lakes; plants include an unusual halophytic member of the Proteaceae, *Grevillea sarissa*: *Acacia coolgardiensis*, *A.erinacea*, *Maireana carnosa*, *Sclerolaena eurotioides*. 15 mins. Depart 10am.
10.20am. 71km. Stop 2. Mulga and cypress pines. This is much the same as Stop 7 of yesterday, which may emphasise the monotony of the mulga country where the community is virtually unchanged over long distances. Note the structure of the mulga - scattered low trees, even more scattered shrubs mainly of *Cassia* and *Eremophila*, and a ground layer of annuals, mainly Compositae (Asteraceae). Actually the ground layer is variable. If there is summer rain it encourages annual grasses such as *Monachather (Danthonia)*, *Eragrostis and Eriachne spp.*, but if there is winter rain it encourages forbs. The composites include typically *Cephalipterum drummondii* (in two colour forms, white and yellow), *Helipterum craspedioides*, *H.splendidum*, *Myriocephalus guerinae*, *Podolepis auriculata*, *Schoenia cassiniana*, *Velleia rosea*. Belonging to other families are *Brunonia australis*, *Clianthus formosus*, *Erodium cygnorum*, *Goodenia* and *Ptilotus* spp. Rainfall here is extremely unreliable and we have to hope for a good season to give us a show of flowers. If we are unlucky there may be nothing. 20 mins. Depart 10.40

10.55am 84km. Stop 3 on high ground overlooking Lake Moore. We shall walk down to the edge of the lake. Vegetation, which is affected by salt, consists of scattered *Hakea preissii* and *Acacia murrayana* with the halophyte *Maireana pyramidata* and the annual grasses *Aristida arenaria* and *Stipa trichophylla*. Other plants include two species of *Cassia*, *Solanum lasiophyllum* and the annual *Helipterum splendidum*. 30 mins. Depart 11.25
11.55 114km. We reach the Great Northern Highway at Paynes Find, a former gold-mining area, now an industrial desert. Toilets at road-house. Turn west on highway.
12 noon.118km. Stop 4. to examine mallee and spinifex community. In the mulga country sandplains are less common due to the greater erosion of the country, but where they occur the vegetation consists of spinifex grass (*Triodia* or *Plectrachne*) with scattered mallee eucalypts and other shrubs. A small patch of sand here enables us to see an example. The sclerophylly so dominant in Australian vegetation has produced a sclerophyll desert grass believed to be a unique life-form. The spinifex here is *Triodia scariosa*, the mallee *Eucalyptus plenissima*. A few small shrubs occur such as *Halgania viscosa*. 20 mins. Depart 12.20

We return to Paynes Find and head north but turn left in 4km.
12.35pm. 131km. Stop 5. Granite rock outcrop with the succulent shrub *Calycopeplus ephedroides*. 15 mins. Depart12.50.
1 pm. 139km. Stop 6, for lunch at roadside. The mulga still contains cypress pines, and also eucalypts (*E.oleosa*) + *Acacia ligulata*, *Cassia chatelaineana*, *C.phyllodinea*, *Eremophila subfloccosa*, *Grevillea obliquistigma*, *Olearia pimelioides*, *Pimelea microcephala*, *Santalum acuminatum*, *Scaevola spinescens*. 1 hour, Depart 2 pm.

2.05pm. 146km. Stop 7, in mulga but with some varied associates. The cypress pines and eucalypts have now dropped out but we see a large tree *Grevillea, G.eriostachya; Bursaria spinosa, Acacia murrayana* and other Acacias, *Eremophila* sp.,*Melaleuca uncinata, Thryptomene mucronulata.* 20 mins. Depart 2.25
2.40pm. 153km. Stop 8, in a good typical pure stand of mulga. *Acacia aneura* is often the sole tree species in good stands on plains, but is polymorphic and has several different forms. Mistletoe (*Amyema*) can be seen on the trees. Typically there are scattered smaller shrubs of *Cassia* and *Eremophila* spp. What we see as a ground layer depends on the season this year. 20 mins. Depart 3 pm.
3.45pm. 196km. Pass Thundelarra Station. We are to spend the night here, but having time in hand will go north for 20km for a further stop in the mulga, returning later.
4.10pm. 225km. Stop 9 at a scenic spot in breakaway country. Erosion of the landscape by cutting away of the lateritic duricrust and the weathered "pallid zone" beneath it leaves scarped remnants. The vegetation is much the same as we saw before except that salt-tolerant plants often appear at the foot of breakaways. 30 mins. Depart 4.40
5 pm. 246km. Arrive at Thundelarra Station for the night. This "Station" is a working sheep ranch of 160,000 hectares, where they take visitors as an additional enterprise. The quarters built to house itinerant shearing teams have been improved and modernised, and will be found quite comfortable. After dinner the proprietor, Mr.Jack Morrissey, will give a talk on station life and range management.

An account of the mulga country in this Region is given in Part 3, page 67.

Day 10. Sept. 20th. Thundelarra to Wubin, 196 km.

Today our route has to turn west, towards the coast. We are only travelling across a small corner of this huge country but time does not permit us to go further inland. Even if we did, the vegetation north-east of here is exactly the same for at least 500 km! We have made a transect of the South-West Province along the rainfall gradient, and the contrast between the karri forest and the mulga is quite extreme.

On the way today we shall re-enter the South-West Province and change back to kwongan and eucalypt woodlands, finally also to farmland.
8.30am. 00km. We leave Thundelarra and at first retrace our route of yesterday heading south.
11km. Photo stop. A windmill, a dry lake, a sheep pen, typical of station country. 5 mins.
8.50am. 22km. Stop 1. Acacia scrub on hills with associated species. *A.quadrimarginea* is normally dominant on rocky ridges with *A.tetragonophylla, A.grasbyi, Thryptomeme australis* and *Santalum spicatum* (sandalwood). Smaller bushes are *Eremophila fraseri* and the annuals *Ptilotus helipteroides.*
The hills here indicate another greenstone belt, an outcrop of mafic rocks (gabbro, dolerite, basalt) which in this case have been more resistant to weathering than the granite country rock. Signs of gold-mining can be seen here and there near the road.
30 mins. Depart 9.20

26km. Turn right on road to Wubin and leave the hills for lower, salty country.

39km. Photo stop; grid, borehole and tank. 5 mins. 9.55am. 52km. Stop 2, to inspect salt flat. Halophytes here include the shrub *Eremophila miniata* and smaller plants *Atriplex inflata*, *A.vesicaria*, *Disphyma crassifolium*, *Maireana georgei*, *M.pyramidata*, *Gunniopsis quadrifida*.

30 mins. Depart 10.25

10.35am. 59km. Stop 3, Acacia vegetation, but this will be the last sign of *Acacia aneura* itself as it drops out here. Other Acacias remain dominant for some distance and include *A.ramulosa* mainly, with *A.grasbyi and A.eremaea*.
If it is a good season and we are lucky, we may expect a display of annuals.

30 mins. Depart 1.05

70km. Reach the Great Northern Highway, a sealed road, and turn right. Pass Mt.Singleton,a basalt mountain.
11.34am. 78km. Stop 4. Scattered trees of Casuarina, large shrubs of Acacia and annuals. The Acacias seen here include *A.ramulosa* mainly, with *A.acuminata*, *A.eremaea*, *A.murrayana*, *A.sclerosperma*. The annuals include mainly *Cephalipterum drummondii* (in two colour forms, white and yellow),*Helipterum craspedioides*, *H.splendidum*, *Myriocephalus guerinae*, *Podolepis auriculata*, *Schoenia cassiniana* and *Velleia rosea*.

30 mins. Depart 12.05

88km. A change in vegetation here indicates the boundary between the Eremaean and South-West Provinces. The Acacia vegetation gives way to kwongan and eucalypt woodland.
12.30pm. 105km. Stop 5. We turn off the main road into Mount Gibson Station and we shall take our lunch break, and see their experiments with farming emus (*Dromaius novae-hollandiae*). A company appropriately named Dromaius Enterprises Ltd hopes to develop a trade in emu products. 1 hour. Depart 1.30

After lunch we retrace our route 6 km to the east and turn off to the left on the Perenjori road.
1.45pm.112km.Stop 6. We turn off the main road for 1km to visit a burnt area in an early stage of regeneration. Kwongan in the interior features a number of pioneer species after fire, which do not appear nearer the coast. This is due probably to more plentiful nutrients. These include the tree *Codonocarpus cotinifolius* (native poplar). Other plants are *Cyanostegia angustifolia*, *Dampiera wellsiana*, *Duboisia hopwoodii*, *Glischrocaryon aureum*, *Keraudrenia integrifolia*, *Lachnostachys verbascifolia*, *Mirbelia depressa*, *Pityrodia terminalis*, *Prostanthera eckersleyana*.
It will be observed that these have soft, tomentose leaves; they are not sclerophyll plants. They grow rapidly and flower copiously for a few years until replaced by the regenerating thicket.

45 mins. Depart 2.30

114km. Return to highway and turn right.
2.45pm. 134km. Stop 7 at turn-off to Mt.Gibson mine. The particular interest here is the Wreath Leschenaultia, *Lechenaultia macrantha*. Otherwise, this is again kwongan but recovering from fire. Few pioneer plants remain except along the road side, e.g. *Pityrodia terminalis* and *Glischrocaryon flavescens*. *Grevillea paradoxa*, one of the few Proteaceae in this type of kwongan, is to be seen, also *Baeckea behrii*, *Dodonaea microzyga*, *Eriostemon deserti*, *Wehlia aurea*.

20 mins. Depart 3.05

3.15pm. 142km. Stop 8, to examine kwongan on sandplain. We have returned to the conditions of the Wheatbelt, and have kwongan consisting of typical Acacia-Casuarina thicket on a soil of sand on laterite. As we approach the coast, this will change. The dominants at this site are *Acacia beauverdiana* and *Casuarina acutivalvis*, with *Grevillea brachystachya*, *Hakea minyma*, *H.recurva*, *Melaleuca filifolia*. Smaller shrubs are *Hibbertia exasperata*, *H.pungens*, *Keraudrenia integrifolia*, *Phebalium tuberculatum*, *Thryptomene maisonneuvii*, *Wrixonia prostantheroides*. Herbaceous: *Dampiera wellsiana*. 30 mins to 3.45

3.55pm. 150km. Stop 9. Woodland of *E.salmonophloia*, *E.gracilis*, *Acacia acuminata* and *A.longispinea*. The ground layer is of saltbush, *Atriplex vesicaria* with the grass *Stipa trichophylla*. An old watering place with a well here gives an opportunity to examine a soil profile. 20 mins. Depart 4.15

160km. Cross a grid, and re-enter farming country.

4.30pm. 164km. Stop 10, at a salt flat, edge of lake Goorly, part of the extensive Lake Moore system. Halophytes include *Acacia jibberdingensis*, *Disphyma crassifolium*, *Gunniopsis quadrifida*, *Maireana carnosa*, *M.georgei* . Note that in Australia succulent plants occur freely in saline and other high pH soils but not elsewhere. The Australian desert is more or less devoid of succulents. 20 mins. Depart 4.50

5.15pm. 196km. Arrive at Wubin Hotel for the night. This is a very small town, with one small hotel, but should be comfortable.

DAY 11. Sept. 21st. Wubin to Jurien, 192 km.

Our route is due west today, completing the journey to the coast. For the first 100 km we remain on the granite plateau, with country similar to that of the Wheatbelt, farmed in the same way, the original vegetation kwongan and eucalypt woodlands. Just before lunch, however, we shall cross the geological boundary onto the sedimentary rocks of the Perth Basin which are predominantly arenaceous, producing sandy and lateritic soils. Kwongan then becomes dominant in the landscape while mallee and woodland are restricted to mere pockets.

8.30am. 00km. Leave Wubin by the highway going south. There is quite a lot of kwongan vegetation left along the roadside and between the road and the railway.

8.40am. 12km. Stop 1. Nugadong. There is a reserve here, originally for railway purposes, which preserves some interesting kwongan. There is the usual thicket dominated by *Casuarina acutivalvis* which includes *Acacia cochlocarpa*, *A.fragilis*, *Calytrix depressa*, *Daviesia juncea*, *Grevillea rudis*, *Hakea falcata*, *Isopogon teretifolius*, *Petrophile conifera*, *P.megalostegia*, *Melaleuca conothamnoides*, *M.cordata*, *Verticordia picta*, *V.roei*.

In addition there is a community of mallee (2 spp.) over a ground layer of the reed *Ecdeiocolea monostachya* which has the same aspect as the mallee and spinifex community at Paynes Find, though the two are ecologically quite different. In this case the site seems to be winter-wet, with impeded drainage.

20 mins. Depart 9 am.

9.20am. 33km. Stop 2. A granite outcrop gives us an area of coarse shallow soil with *Eucalyptus loxophleba*(York gum). Shrubs include *Acacia lasiocalyx*, *Baeckea crispiflora*, *Calytrix sp. Casuarina campestris*, *Melaleuca steedmannii*, *M.uncinata*, *Solanum lasiophyllum*, *Thryptomene tuberculata*. Among ground plants the reed *Ecdeiocolea monostachya*, and ephemerals *Schoenia cassiniana*, *Stackhousia ?huegelii*. *Borya nitida* grows on granite slabs. 20 mins. Depart9.20

9.30am. 40km. Stop 3, just before X-roads of Wubin and Pierce roads, for kwongan on sandplain. With the gradual increase in rainfall towards the coast, the nature of kwongan changes. The dense Casuarina thickets are now restricted to massive ironstone ridges, while on sand the kwongan becomes more open and species-rich, classified physiognomically as scrub-heath. At this site, it belongs floristically to the "Banksia-Xylomelum alliance" which is widespread on deeper sands throughout the northern coastal region, characterised by presence of sundry *Banksia* spp. and *Xylomelum angustifolium*. More details are given under Stop 6 this morning, see Part 3, pp65. 20 mins. Depart 9.50

10 am. 53km. Stop 4. Drainage is as usual ponded in chains of salt lakes surrounded by halophytic vegetation. The small lake here is surrounded by *Eucalyptus salmonophloia* (salmon gum) with a ground layer of *Atriplex* (saltbush). We shall visit the lake margin below where we see the mallee *E.transcontinentalis* and *Daviesia nematophylla*, *Eremophila drummondii* and *Olearia calcarea*. 20 mins. Depart 10.20

10.30 61km. Stop 5, salt flat with the salt-tolerant *Casuarina obesa* . 10 mins. Depart 10.40

10.45 64km. Stop 6, Gunyidi Nature Reserve,"Bryant Park". There is a sandplain here with some interesting kwongan, and down the side road there used to be a small freshwater lake (now dry) which was a popular recreational area for the district. A species list is given in Part 3, pp.65. 30 mins. Dep. 11.15

78km. Meet Geraldton Highway, turn R, then L after 3km. In the next few km we pass over a hill and descend to a low-lying area of salty flats marking the line of an ancient river. This is also the geological boundary. Vegetation of this valley is described in Part 3, bottom of p .

12 noon 101km. Stop 7, LUNCH, at junction of Carger Road. On the south side of the road is the Watheroo National Park. The soil here is a deep yellow sand, carrying the *Banksia-Xylomelum* alliance characterised by the presence of *Actinostrobus arenarius*, *Banksia* spp., *Grevillea leucopteris*, *Pileanthus peduncularis* and *Xylomelum angustifolium*. The Banksias here are *B.burdettii* and *B.prionotes*. Other local species are *Adenanthos stictus* and *Eucalyptus pyriformis* Not all of these character species will be seen at Stop 7, but may be observed along the road. Smaller shrubs present at Stop 7 include *Chamaelaucium drummondii*, *Hakea circumalata*, *Lachnostachys eriobotrya*, *Mirbelia spinosa*, *Verticordia grandiflora*.

A recent fire here gives an opportunity to observe the fire ecology, and to see which species regenerate from seed and which by resprouting. 1 hour. Depart 1 pm.

We are now in dissected, rolling, sandstone country, the soils entirely sandy, with laterite at variable depth.

1.20pm. 117km. Stop 8. A pit for the extraction of laterite road metal affords an opportunity to examine this material and the kwongan upon it. Like the vegetation of sandy soil, this has also changed since the interior, is now shorter, more mixed, even more sclerophyllous, dominated by *Dryandra* and *Hakea* spp. Under higher rainfall, the kwongan becomes more species-rich but of lower biomass. 20 mins. Depart 1.40
2 pm. 135km. Stop 9 We come to some more broken country, the Herschel Ra. Heavier soils in this more hilly area bring in woodland of *E.wandoo* with some *E.loxophleba*, and an understory of *Acacia saligna*, *A.microbotrya* and *Casuarina campestris*. A mallee community is peripheral to the woodland. *E.eudesmioides* and *E.drummondii* appear as emergents to 4m tall in dense *Dryandra cirsioides* and *D.kippistiana* of 2m.15 mins. Depart 2.15
2.25 140km. Stop 10. The kwongan here, on sand over laterite, is quite low except for scattered small trees of *Nuytsia floribunda*. (Loranthaceae). Being a root parasite, this tree owes its superiority to robbing other plants. Other species to be seen here include: *Banksia sp.*, *Conostylis angustifolia*, *Dryandra tridentata*, *Eucalyptus tetragona*, *Gastrolobium bidens*, *Grevillea integrifolia*, *G.shuttleworthiana*, *Lambertia inermis*, *Melaleuca trichophylla*, *Ricinocarpus glaucus*, *Verticordia drummondii*, *Xanthorrhoea drummondii*, *Xylomelum angustifolium*.
20 mins. Depart 2.45
147km. Meet Brand Highway, turn north.
3 pm. 150km. We pull off the road into a parking area at junction of road to Jurien. Stop 11. The trees along the valley are *Eucalyptus accedens*. The cycad *Macrozamia riedlei* is not uncommon, some with trunks of 1½m. 15 mins. Depart 3.15
3.30pm. 165km. Stop 12. Wandoo woodland on a patch of heavy soil. The undergrowth is typically sparse in these woodlands, a few prickly *Acacia*, *Daviesia*, *Oxylobium*. A patch of open heath outside the clump of trees is much richer. 15 mins. Depart 3.45
4.05pm. 181km. Stop 13. We cross the hills known as the Gairdner Range and descend to the coastal plain. A further slight rise brings us to the coastal limestone, consolidated former dunes of calcareous sand thrown up by the sea. At the foot of the rise tall shrubs of *Scholtzia parviflora* and *Daviesia divaricata* should be in flower. 10 mins for photo stop if this is so. Depart 4.15
4.20 ±183km. Stop 14. Kwongan on the coastal limestone is specifically distinct from that on sandstone, although no different physiognomically. The limestone weathers to a superficial sandy soil. 30 mins. Depart 4.50
5 pm. 192km. Arrive at the motel in the coastal town of Jurien for two nights - tomorrow also.

DAY 12. Sept.22nd. Jurien District, 192 km.

We spend the day in the district here and return to the same hotel tonight. We shall defer till tomorrow examination of the strand vegetation here, and proceed 30 km inland where we shall transfer to 4-WD vehicles for a circuit of the proposed Mt. Lesueur National Park. Mt.Lesueur is a mesa visible inland east of Jurien. Both these French names were given by the Baudin expedition in 1801. The French did not actually land here but named features from the sea.

DAY 12.
8.30am 00km. Leave Jurien Motel by the inland road.
9 am. 32km. Stop 1.

We proceed inland by the main road and turn north on Banovich Road for 5km as far as the bus can go, and transfer to 4-wheel drive to go round the tracks of the Lesueur area. The particular interest here is that it is very varied country containing as a result a greater range of both species and plant communities than usual. See account in Part 3, page 62. The hilly country is due to faulting and uplift locally of the sedimentary rocks of the Perth Basin. The range so formed was eroded into a smooth whaleback shape which was duricrusted, i.e. capped by laterite. Later erosion has breached the laterite crust which can be seen capping mesas such as Mt. Lesueur itself, and younger less leached soils were formed on the exposed slopes. Variation in the underlying rocks led to variety in these soil types. Vegetation is always expressive of soil, thus we have also a variety of plant communities. Several stops will be made.

Stop 2. Kwongan is the principal formation throughout owing to the generally sandy nature of the underlying rocks, with woodland restricted to the heavier soils, and mallee intermediate. At this site the main interest is *Hakea megalosperma*, a local endemic species.

Stop 3. We have an example of mallee here, eucalypts which do not form trees but consist of clumps of thin stems rising from a common rootstock. Fire has much to do with the creation of this growth-form. A special interest here is that the mallee is *Eucalyptus marginata* (jarrah) which you will see as a large forest tree at the southern end of this tour. It is a highly plastic species and appears as mallee at the extreme end of its range both here and in the south-east in the Stirling Range. The steeper west-facing slope here has dense stands of the local endemic *Hakea neurophylla*. Across the small gully the vegetation changes abruptly to *Eucalyptus wandoo* woodland.

Stop 4. *E.wandoo* woodland. The Lesueur Fault here provides a magnificent vista to the west. The converging breakaways through which the Cockleshell Gully winds can be seen about 5km away. The highest point on the NW horizon is Mt.Peron. At least three parrots, Carnaby's Cockatoo, the White Corella and Galah all nest in hollows of the wandoo trees.

Stop 5. Here we stop on the watershed between the heavily dissected catchment of the Cockleshell Gully to the west and the gently undulating branch of the Coomallo Creek to the east. Immediately in front we have kwongan dominated by the endemic *Hakea neurophylla*. Beyond the gully it contains a local rare *Banksia*, *B.tricuspis*, and the mallee *Eucalyptus drummondii*. Soil here is very shallow over sandstone. To the north are extensive areas of wandoo woodlands.

On the way back to the bus we shall see the following and will stop if time permits.

Drainage lines. In the valleys, sand tends to be deeper, bringing in the Banksias seen yesterday (*B.attenuata*, *B.menziesii*) and *Eucalyptus todtiana*. Permanently wet ground supports paperbark trees (*Melaleuca preissiana*) with the sedge *Baumea preissii*. Intermittently wet ground supports kwongan with *Verticordia densiflora*, *Calothamnus quadrifidus* and *Hakea varia*. Yet another community which is thought to represent winter-wet sites is kwongan with a ground layer of the Restionaceous reed *Ecdeiocolea monostachya*.

12.30pm 32km. Return to the bus for field lunch. 1 hour.
Depart 1.30

We return towards Jurien, at 56km turn south, and at 72km turn west towards the fishing village of Cervantes.
2 pm. 76km. Stop 6 to examine kwongan on coastal limestone. This a short, very mixed kwongan of distinctive composition. Species noted include *Acacia lasiocarpa*, *A.spathulifolia*, *Banksia leptophylla*, *Conospermum stoechadis*, *Conostylis setigera*, *Dryandra sessilis*, *Hakea costata*, *H.trifurcata*, *Hibbertia hypericoides*, *H.subvaginata*, *Lechenaultia linarioides*, *Sphaerolobium grandiflorum*, *Stackhousia sp.* See description in Part 3, p.61. 30 mins. Depart 2.30
It will be noticed that the kwongan here has been burnt in recent years and is full of dead sticks. Regeneration occurs directly without a stage of pioneer plants except possibly for the abundance of *Acacia spathulifolia* in the usual role of a legume to restore nitrogen levels. Nearer the coast there will be sheets of colour from this species where the kwongan has been burnt and is still very short except for isolated *Nuytsia* trees which have survived the fire.

93km. Cervantes. Turn south. The rather bad road here traverses younger, less consolidated dunes which have only been deposited in the last few thousand years since the post-glacial rise in sea level. These carry distinctive plant communities.
2.50pm. 110km. Stop 7. Arrive at Nambung National Park for a visit to The Pinnacles "Desert", one of the State's chief tourist attractions. A separate leaflet on the National Park is provided which explains the origin of the spectacular pinnacles. As the bus cannot negotiate the driving track around the pinnacles area, it will be necessary to go round on foot. We allow 1 hour, Depart 3.50
4 pm. Stop 8. On the way back to Cervantes we turn off left to Kangaroo Point (2km) to examine the strand vegetation. Sandro Pignatti gives an excellent account of these coastal communities in Part 2,pp.34, relevé no.3. Species and communities seen are dealt with in these notes below under tomorrow morning's visit to the beach at Jurien.
30 mins. Depart 4.30

We now retrace our route for the return to Jurien.
5.15pm. 190km. Return to the Jurien Motel for the night.

DAY 13. Sept. 23rd. Jurien to Perth, 262 km.
8.30am 00km. Leave Jurien Hotel.
8.35 3.5km. Stop 1. We turn up Seaward Road until the beach is reached, and examine strand vegetation. Sandro Pignatti gives an excellent account of the communities here in Part 2, page 34 , relevé no.3. The principal strand plants at the point examined are *Arctotheca populifolia*, *Atriplex isatidea*, *Cakile maritima*, *Carpobrotus edulis*, *Tetragonia decumbens*, *Trachyandra*. On the first stabilised dune behind, we see *Acanthocarpus preissii*, *Anthocercis littorea*, *Helichrysum cordatum*,*Olearia axillaris*.
15 mins. Depart 8.50

8.55 5km. Stop 2. On way back we examine the vegetation of an older stabilised dune. The climax here is a thicket of *Acacia rostellifera* with some *Melaleuca*, *M.huegelii* or *M.cardiophylla*and *Casuarina lehmanniana* . When burnt this reverts to a seral stage with low plants of *Acacia lasiocarpa*, *Melaleuca acerosa*, *Scaevola dielsii*,*S.crassifolia*. Depart 9.15

We now leave for Perth by the inland road, at 21km turn south, and at 37km repass the Cervantes turn-off.

10.15am. 64km. Stop 3, in the Badgingarra National Park 1km before reaching the Brand Highway, on a lateritic hilltop.

Pignatti relevés no.4 apply here, Part 2, page37, also the description in Part 3, page 58-60.

After World War II, advances in agricultural technology, especially in the use of trace elements for poor soils, led to the development of the whole coastal belt north of Perth, previously an uninhabited waste. Farming problems still exist however, and much land has been abandoned again. A number of abandoned farms here was combined to form a National Park to preserve examples of original native kwongan communities. We see three principal types. Along the roadside we pass the *Banksia* type, which occupies the deepest sandy soil and is dominated by the same Banksias as in the Moore River National Park, but here reduced to shrubs by the lower rainfall. At Stop 4 we see the second, the *Hakea obliqua* type, and here the *Xanthorrhoea* type. This is rising ground with little surface sand, and laterite exposed. As a result the kwongan is short and more sclerophyllous than ever. "Blackboys", *Xanthorrhoea drummondii*, are conspicuous, though spp. of *Dryandra* and *Hakea* may be said to be dominant. Poisonous legumes of the genera *Gastrolobium*, *Sphaerolobium*, *Oxylobium* are a feature of these lateritic sites. The following species are present. Shrubs: *Astroloma xerophyllum*, *Calothamnus sanguineus*, *C.torulosus*, *Conospermum acerosum*, *C.huegelii*, *Conothamnus trinervis*, *Daviesia divaricata*, *D.pedunculata*, *D.quadrilatera*, *Dryandra carlinoides*, *D.nivea*, *D.sessilis*, *D.shuttleworthiana*, *Gastrolobium spinosum*, *Grevillea synapheae*, *Hakea conchifolia*, *H.costata*, *Lambertia inermis*, *Lasiopetalum ogilvieanum*, *Lechenaultia biloba*, *Nemcia capitata*, *Petrophile macrostachya*, *P.serruriae*, *Sphaerolobium macranthum*, *Thomasia grandiflora*. Herbaceous : *Anigozanthos humilis*, *Blancoa canescens*, *Johnsonia pubescens*, *Macropidia fuliginosa*.

20 mins. Depart 10.35

65km. Turn south on the Brand Highway.

10.45 70km. Stop 4. *Hakea obliqua* type kwongan.

Hakea obliqua is taken as the character species in a community on sand of moderate depth overlying laterite. The small ericoid shrubs of kwongan form a lower layer beneath scattered taller shrubs up to 2m. The *Hakea* is the most conspicuous, with species of *Adenanthos*, *Banksia*, *Calothamnus*.

At Stop 4 we are likely to see:

Shrubs: *Adenanthos cygnorum*, *Astroloma xerophyllum*, *Banksia attenuata*, *B.menziesii*, *Calothamnus sanguineus*, *Casuarina humilis*, *Conospermum acerosum*, *Daviesia divaricata*, *D.quadrilatera*, *Eremaea ?fimbriata*, *Hakea obliqua*, *Jacksonia floribunda*, *Lysinema ciliatum*, *Stirlingia latifolia*.

Herbaceous:*Conostylis crassinervia*, *Drosera pallida*, *D.macrantha*, *Johnsonia pubescens*. 20 mins. Depart 11.05

The nature trail shows us the understory of the karri forest, containing many soft-leaved plants and others of less marked sclerophylly than is normal in Western Australia. Conspicuous plants are as follows, likely to be in flower: *Acacia urophylla*, *Chorizema quercifolium*, *Hibbertia cuneiformis* *Hovea elliptica*, *Opercularia ?volubilis*. Others not in flower include *Albizia lophantha*, *Casuarina decussata*, *Clematis pubescens*, *Eragrostis curvula*, *Macrozamia riedlei*, *Persoonia longifolia*, *Pteridium aquilinum*, *Stylidium rhynchangium*, *Trymalium spathulatum*. Depart 11.40

11.45am 41km.Stop 4. We return to Pemberton and visit the Fine Woodcraft Shop where there are many interesting examples of local crafts and materials. 30 mins.Depart 12.15

We then take the Rainbow Trail, which winds scenically through the forest past artificial lakes.

12.30pm 50km. Stop 5, Lunch. We take our lunch at the picnic area overlooking the Big Brook Dam in the forest.

1 hour, depart 1.30

The afternoon's programme will be arranged by the Dept. of Conservation and Land Management to visit logging and regeneration in the karri forest. Both the jarrah and karri forests are important economic resources. In the past century it was the practice for settlers to cut out the forest and convert it to farmland but fortunately for the forest a large part of the forest area is agriculturally intractable. In the present century the remaining forests have been dedicated as State Forests and placed under management. Felling is regulated according to quotas, and the forest is regenerated after logging. The karri forest is worked under the Uniform System as it is called in Europe. Defined areas are clear-felled annually, normally leaving seed-trees for regeneration. The coupe is burnt causing liberation of the seed, and copious regeneration follows the next rainy season. Karri is self-thinning, so that expensive weeding and thinning operations are unnecessary.

The karri forest consists of two species of trees, *E.diversicolor* and *E.calophylla*. Karri is a good saw timber but *E.calophylla* cannot be sawn owing to inherent defects. This species is therefore utilised to make wood-chips for export to Japan, as it would not be feasible to exploit one without the other. Waste karri from defective logs and sawmill waste is also chipped. The utilisation of the forest is therefore quite efficient.

It may be a surprise to visitors from Europe, where exploitation of the forests under management is regarded as normal, to learn that there is a strong movement in Australia under the banner of conservation dedicated to closing all native forests to production. Already half the forest area in Western Australia has been taken out of production which of course results in economic loss. Not only is the value of the timber wasted, but money must be spent on forest protection without revenue to balance it.

Europeans may also be interested to observe that no problems are caused here by industrial pollution.

We return to the Karri Valley Resort for a second night.

PART 2.

PHYTOSOCIOLOGICAL DATA

BY

SANDRO & ERIKA PIGNATTI

In collaboration with J.S.Beard & G.Keighery

CONTENTS

1) Sept. 11 and 23.: MOORE RIVER NATIONAL PARK

The vegetation is mainly composed of kwongan communities with arborescent species of Banksia, Eucalyptus and Nuytsia. In the North these species reach hardly 4-5 m height, mostly growing in scattered groups of individuals, but in the South they progressively develop in a open woodland with a distinct tree layer 8-12 m tall. In the Moore River area the kwongan vegetation is represented by the widespread Daviesia incrassata - Adenanthos cygnorum community, which is replaced more and more to the South up to the surroundings of Perth by the Banksia menziesii - Banksia attenuata woodland. Along the river the Eucalyptus rudis - Melaleuca rhaphiophylla association occurs, a completely distinct forest community.

The Daviesia incrassata - Adenanthos cygnorum association is relatively polymorphic and according to fire history arborescent species can be present or absent; the mean composition (6 rel.) is as follows:

Treelets and higher shrubs

(1)	Adenanthos cygnorum	V	Nuytsia floribunda	V
	Eucalyptus todtiana	III	Xanthorrhoea preissii	III
	Eucalyptus calophylla	II		

Shrubs (low or prostrate)

Hibbertia hypericoides	V	Banksia attenuata	IV
Conostephium pendulum	IV	Conospermum stoechadis	IV
Allocasuarina humilis	IV	Petrophile linearis	IV
Stirlingia latifolia	IV	Eremaea pauciflora cfr.	III
Verticordia monadelpha	III	Jacksonia furcellata	III
Andersonia coerulea	III	Calytrix strigosa	III
Jacksonia incrassata	III	Calothamnus sanguineus	III
Hakea trifurcata	III	Synaphea petiolaris	III
Melaleuca scabra	II	Hibbertia subvaginata	II
Petrophile serruriae	II	Leucopogon striatus	II
Dryandra nivea	II	Leucopogon oldfieldii	II
Lechenaultia floribunda	II	Isopogon dubius	II
Hakea costata	II	Petrophile synaphea	II
Baeckea grandiflora	II	Hibbertia huegelii	II
Dryandra tenuifolia	II		

Herbs

Drosera menziesii	V	Lyginia barbata	V
Loxocarya flexuosa	V	Burchardia umbellata	V
Amphipogon turbinatus	IV	Patersonia occidentalis	IV
Stylidium crossocephalum	IV	Dampiera linearis	IV
Ursinia anthemoides	IV	Mesomelaena stygia	IV
Anigozanthos humilis	III	Schoenus clandestinus	III
Conostylis teretifolia	III	Bossiaea eriocarpa	III
Eriostemon spicatus	III	Lomandra sp.	III
Drosera bulbosa	III	Caustis dioica	III
Stylidium brunonianum	III	Gompholobium tomentosum	III

Stylidium repens	II	Thelymitra sp.	II
Schoenus curvifolius	II	Conostylis serrulata	II
Xanthosia huegelii	II	Cassytha glabella	II
Calectasia cyanea	II	Mitrasacme paradoxa	II
Comesperma nudiusculum	II	Macropidia fuliginosa	II
Sowerbaea laxiflora	II	Scaevola paludosa	II
Opercularia vaginata	II	Boronia ramosa	II
Hyalospermum cotula	II	Thysanotus manglesianus	II
Tortella sp.	II		

(69 species with presence 1 should be added).

The Eucalyptus rudis-Melaleuca rhaphiophylla association covers as a closed forest community the areas along river banks. The soil is composed of recent clayey sediments and is very humid, in many places with freshwater springs or swamps: Under such conditions forests are mostly characterized by a massive invasion of weeds of mediterranean and south african origin so that a phytosociological analysis appears impossible. The Moore River area on the contrary bears a quite natural vegetation and weeds are reduced to a reasonable presence. Two rel. have been carried out (5.X.1989):

	a	b	
higher trees (18-25 m)			
cover %	40	10	
Eucalyptus rudis	2.1	1.1	(2)
Melaleuca rhaphiophylla	1.1		
lower trees (5-15 m)			
cover %	40	80	
Melaleuca rhaphiophylla	2.1	4.1	
Paraseriathes lophantha	1.1	+	
Stylobasium australe	+		
Eucalyptus marginata	+		
Banksia attenuata		+	
shrubs			
cover %	<1	<1	
Eucalyptus rudis	+	+	
Acacia sp.	+		
Melaleuca sp.	+		
herbs			
cover %	98	80	
Pteridium esculentum	3.2	1.1	
Juncus sp.	1.2	3.2	
Microtus unifolia	1.2	+	
Pentapeltis peltigera	1.3	1.2	
Lagenifera huegelii	1.2	1.1	
Lepidosperma tetraquetrum	1.2		
Juncus pallidus	1.2		
Caladenia latifolia	+		

Ranunculus colonorum	+	
Samolus repens	+	
sporadic and weeds	7	2

This is one of the very few remnants of a quite natural riverine forest community which is completely different as to floristic composition from the Eucalyptus forests (E. marginata, E. diversicolor etc.) of well drained soils.

2) Sept. 11. and 22.: JURIEN - MT. LESUEUR
Two major landscape units can be recognized: the **coastal plain**, mainly calcareous, and the markedly acid **plateau and hilly area**. The differences are quite large so that Beard (1981) considers both as distinct vegetation systems, belonging to different botanical subdistricts.

The coastal plain
Rocky coasts consist of limestone cliffs up to 20-30 m high exposed to wave action and with deposition of salt. In more protected situations large systems of recent dunes are developed. Parallel to the coast, but in a certain distance, there are humid depressions among dunes. The substrate is mainly rich in limestone and neutro-basic, only in the most elevated places the continental quartz sand is prevalent and substrates are acid.

The vegetation of coastal dunes appears little different from the situation observed on the beaches near Perth and Bunbury and seems representative of the general conditions of the western coast of the continent. The zonation of plant communities is summarized by the following scheme:

beach	Tetragonia decumbens - community
young dunes	Spinifex longifolius - Scaevola crassifolia community
old dunes	Spyridium globulosum - community
depressions	Acacia lasiocarpa - Melaleuca acerosa community

The Tetragonia association is at the foot of dunes on substrates slightly enriched in salt and nitrates (Spühlsaum), the correponding conditions in Europe are occupied by associations of the Cakiletalia or Atriplicetalia. Cakile maritima is present as a naturalized therophyte in this community. Other species are relatively rare; a facies with dominance of Atriplex cinerea sometimes occurs.

The Spinifex - Scaevola association is the West Australian counterpart of the European and Mediterranean Ammophiletum. The first of the character-species is in general a pioneer, whereas

Scaevola has the tendence to occupy older dunes; other frequent species are Olearia axillaris, Isolepis nodosa (aspect of Holoschoenus!), Rhagodia baccata, Myoporum insulare and Senecio lautus and some naturalized like Tetragonia, Trachyandra divarica, Carpobrotus edulis, Bromus diandrus. In the southern coast from Cape Naturaliste to Albany this association is replaced by a similar Spinifex hirsutus community.

The Spyridium globulosum community has a typical aspect of maquis; Spyridium is the dominant sclerophyllous shrub with habit of Rhamnus alaternus or Quercus ilex. Some species of the dunes (Senecio lautus, Rhagodia baccata, Acacia cyclops, Hemigenia pungens, Myoporum insulare, Scaevola crassifolia) occur together with kwongan elements (Allocasuarina humilis, Conostylis racemosa, Leucopogon sp. pl.). The ecology of this association can be compared with the conditions of a mediterranean Crucianelletum but the structure is completely different, with a well developed shrub layer of 1-2 m height.

The environment of humid depressions resembles that of the mediterranean Schoenetum but with a different vegetation rich on sclerophyllous woody plants. Dominant species are the following shrubs: Acacia lasiocarpa, Melaleuca acerosa, M. huegelii, Leucopogon parviflorus, Pimelea ferruginea, Hemigenia pungens, or slender fruticose (Comesperma virgatum, Gompholobium tomentosum). Herbs are well represented, both graminoids (Lepidosperma angustatum, Loxocarya flexuosa, Poa drummondiana and the Schoenus-like Mesomelaena stygia) as well as dicotyledons (Opercularia vaginata, Stylidium junceum).

The vegetation of maritime cliffs is a parallel to the mediterranean Crithmo-Staticion and, like this, relatively rare. At least three associations have been identified:

	(a)	(b)	(c)	
Number of rel.	6	8	5	
Ch.-sp. of the Samolus ass.				
Samolus repens	6			(3)
Ch.-sp. of the Frankenia ass.				
Frankenia pauciflora	1	7		
Nitraria billardieri		2		
Ch.-sp. of the Westringia ass.				
Westringia dampieri	3		5	
Halophytes				
Senecio lautus	1	6	4	
Atriplex cinerea		6		
Scaevola crassifolia			5	
Parapholis incurva	1	4		
Sarcocornia blackiana	1	3		
Carpobrotus virescens	1	3		

Suaeda australis		4	4
Rhagodia baccata		4	
Mesembryanthemum crystallinum		3	
Widespread species			
Templetonia retusa	3		3
Acanthocarpus preissii	4		5
Conostylis racemosa			5
Poa drummondiana			5
Hardenbergia comptoniana			4

In conclusion, the coastal vegetation had a high diversity and features which appear remarkably parallel with the coastal vegetation of the northern hemisphere and in particular of the mediterranean.

The plateau and hilly area

The vegetation of the more elevated portions of the Jurien and Mt. Lesueur area presents a very good example of **kwongan** as a zonal vegetation or climax-complex. The relatively dry climate and the arid substrate give negative conditions for the development of a forest vegetation and in fact tall trees can grow only in gullys where the water table is relatively superficial, but on well drained soils trees are completely lacking. The kwongan on the contrary is developed in an optimal condition, species-rich and very polymorphic. In general it is composed of sclerophyllous shrubs and treelets 1-2 m high but sometimes is reduced to a low kwongan or, on the contrary, can develop to a low (2-5 m high) woodland. At least 4 communities have been recognized:

(a) - **Dryandra sessilis - Hakea lissocarpha** kwongan community after fire

(b) - **Banksia attenuata - Jacksonia floribunda** kwongan community of the sandplains

(c) - **Dryandra shuttleworthiana - Xanthorrhoea drummondii** kwongan community on lateritic duricrust

(d) - **Banksia menziesii - Banksia prionotes** low woodland.

	(a)	(b)	(c)	(d)
Number of rel.	7	12	6	12
Character-species of ass. (a)				
Hakea lissocarpha	V		I	
Jacksonia furcellata	V	II		II
Banksia micrantha	V	I		II
Hybanthus floribundus	IV			
Labichea cassioides	III			
Differential species of ass. (a)				
Dryandra sessilis	V	I		I
Gompholobium tomentosum	V	I		III
Comesperma confertum	III			
Ricinocarpus glaucus	III		I	I
Tersonia brevipes	III	I		
Sowerbea laxiflora	III	I		
Character-species of ass. (b)				
Jacksonia floribunda		IV	II	
Differential species of ass. (b)				
Gompholobium knightianum	I	V	II	
Mesomelaena tetragona	I	V	I	
Schoenus curvifolius	I	IV		II
Stirlingia latifolia	I	III	I	IV
Character-species of ass. (c)				
Dryandra shuttleworthiana		I	V	II
Hakea conchifolia		I	IV	
Hibbertia montana		I	IV	
Lambertia multiflora		I	IV	
Hypocalymma pendulum			IV	
Daviesia decurrens		I	III	
Differential species of ass. (c)				
Xanthorrhoea drummondii				
Calectasia cyanea	II	I	V	
Conostylis androstemma		I	III	II
Tripterococcus brunonis	I		III	II
Xanthosia tomentosa			III	
Tetratheca confertifolia			III	
Daviesia epiphylla			III	
Labichea punctata			III	
Patersonia lanata			III	
Dryandra armata			II	
Kingia australis	I	II	I	
Character-species of ass. (d)				
Banksia menziesii				V
Eucalyptus todtiana				IV
Differential-species of ass. (d)				
Banksia prionotes	I	I		V
Macrozamia riedlei				IV
Scholtzia involucrata				II

(4)

Regional indicators				
Petrophile media	III	III	V	II
Xanthosia huegelii	III	III	III	IV
Conostylis teretifolia	III	IV	IV	III
Petrophile macrostachya	III	IV	III	IV
Hibbertia pachyrrhiza	III	III	III	II
Daviesia quadrilatera	III	III	I	II
Stackhousia huegelii	III	II	II	II
Scaevola paludosa	III	III	II	I
Hibbertia huegelii	I	III	III	II
Pimelea suaveolens	II	III	II	II
Adenanthos cygnorum	I	III	I	IV
Conostylis racemosa	V	III		III
Conospermum triplinervium		IV	II	III
Darwinia sanguinea		III	IV	II
Conostylis canescens	III	I		II
Hakea flabellifolia		III	I	I
Baeckea grandiflora		III	IV	
Ch.-sp. of northern sandplains				
Stylidium repens	III	V	III	II
Scaevola canescens	V	III	V	III
Calothamnus sanguineus	II	III	V	II
Anigozanthos humilis	IV	IV	II	IV
Stylidium crossocephalum	III	IV	I	IV
Patersonia occidentalis	III	III	III	III
Calothamnus quadrifidus	III	II	IV	II
Daviesia nudiflora	II	II	IV	II
Eremaea beaufortioides	II	III	I	II
Synaphea spinulosa	I	I	I	I
Ecdeiocolea monostachya		III	I	III
Acacia lasiocarpa	III	II		III
Conostylis aurea		II	I	III
Drosera leucoblasta		II	I	I
Petrophile seminuda	III	II	IV	
Phymatocarpus porphyrocephalus		II	II	I
Petrophile linearis		II		III
Stirlingia simplex		I	I	
Hakea costata	II	I		II
Lechenaultia linearioides	III		I	

Ch.-sp. of order & class				
Hibbertia hypericoides	III	V	V	V
Allocasuarina humilis	V	III	V	IV
Mesomelaena stygia	III	V	III	IV
Lepidosperma angustatum	III	IV	V	II
Melaleuca scabra	V	III	I	III
Loxocarya flexuosa	V	II	III	III
Caustis dioica	III	V	II	III
Dryandra nivea	IV	IV	IV	III
Conospermum stoechadis	IV	III	I	III
Opercularia vaginata	II	II	IV	III
Eriostemon spicatum	V	III	I	III
Stylidium brunonianum	II	III	II	IV
Dampiera linearis	II	II	I	II
Conostephium pendulum	I	III	II	III
Macropidia fuliginosa	II	IV	II	II
Banksia attenuata	IV		V	IV
Nuytsia floribunda	III		II	V
Dasypogon bromeliifolius	I	I	II	
Widespread species				
Burchardia umbellata	III	V	V	V
Drosera stolonifera	II	IV	V	IV
Thysanotus manglesianus	III	IV	III	V
Drosera erythrorrhiza	III	IV	II	IV
Anigozanthos manglesii	I	I		I

For a better understanding of the species groups indicated in the table it must be pointed out that "regional indicators" are species occurring in the kwongan vegetation only in the Jurien - Mt. Lesueur area; "northern kwongan" indicates a syntaxon (probably an alliance) including all kwongan vegetation-types north of Perth. Widespread species are companions. In principle only species occurring in more than one table and with presence II-V have been recorded, in the general data there are ca. 100 more species with low presence.

3) 16-17-18 Sept.: HYDEN to LAKE GRACE
Vegetation is classified in at least 4 communities, which can be interpreted as a climax-complex:

a) a **Mesomelaena-Dryandra** kwongan community: includes many widespread kwongan species but also a large number of local endemics; frequent dominance of decorative Verticordia species; on the top of hills where a thin sand layer covers the laterite;

b) Allocasuarina - **thicket**: very dense, mostly 3-6 m high (in particular conditions up to 10 m high); develops over gently sloping sites on laterite;

c) **mallee** - with Eucalyptus redunca, E. uncinata, E. eremophila and other species, mostly 5-6 m high, at the base of hills on clay soil;

d) open **Eucalyptus salmonophloia woodland** near the bottom of valleys: soil is clayey and more humid than in c), sometimes with tendence to salinity - passage to salt lakes often surrounded by a belt of dead eucalypts.

The composition of a) and b) can be sketched on the basis of 4+4 rel. of year 1985; for the other associations, which have the main flowering in winter, phytosociological rel. are presently not available.

	a	b
number of rel.	4	4
ch.-species of (a)		
Mesomelaena stygia	4	1
Laxmannia palacea	4	1
Neurachne alopecuroides	4	1
(6) Dryandra cirsioides	3	1
Petrophile ericifolia	3	1
Xanthorrhoea nana	3	1
Persoonia tortifolia	3	1
Synaphea petiolaris	3	1
Dryandra pteridifolia	3	1
Grevillea hookeriana	3	
Dampiera incana	3	
Chamaelaucium megapetalum	3	
Lepidosperma gracile	3	
Melaleuca scabra	3	
Hakea incrassata	3	
Hakea lissocarpha	2	
Hakea corymbosa	1	
ch.-species of (b)		

Allocasuarina campestris	1	4
Allocasuarina acutivalvis	1	2
Allocasuarina corniculata		2
Acacia acuminata		2
Brachysema daviesioides		1
Widespread		
Verticordia roei	4	3
Verticordia chrysantha	4	2
Melaleuca cordata	3	3
Verticordia picta	3	2
Lyginia barbata	3	2
Calytrix brachyphylla	2	2

In this area there are some granite outcrops with a very special vegetation. At the Jilakin Rock and Wave Rock an interesting community of the small xerophytic fern Pleurosurus rutifolius occurs (a parallel to Asplenietea communities of the Northern hemisphere).

4) Sept. 14 and 20.: STIRLING WEST

The principal lowland vegetation is composed of the Dryandra concinna - Xanthorrhoea platyphylla association. This is a community with dominant evergreen shrubs mostly 3-15 dm high and frequent treelets 2-4 m high; sometimes in more favourable environments this vegetation develops to an open woodland with scattered trees Eucalyptus marginata, E. calophylla), or, mostly as a result of fire, is reduced to a heath with dominance of Proteaceae, Myrtaceae and Restionaceae mainly not over 5 dm high. Soils are mostly lateritic, but about 6 km east of the Mondurup Pass there is a large sandflat with dominance of arborescent Banksias.

In the Stirlings there are no permanent rivers but only creeks with water during the rainy season; the lowest part of valleys are sometimes moister and there forests of Eucalyptus marginata, E. wandoo and E. redunca occur.

Average composition of the Dryandra concinna - Xanthorrhoea platyphylla community (15 rel.)

Treelets and higher shrubs				
Xanthorrhoea platyphylla	V	Hakea varia	IV	(7
Agonis spathulata	IV	Hakea ambigua	IV	
Hakea cucullata	III	Hakea prostrata	III	
Eucalyptus marginata	III	Eucalyptus tetragona	III	
Kingia australis	II	Dryandra armata	II	
Regelia inops	II	Beaufortia squarrosa	II	
Agonis hypericifolia	II			
Shrubs (low or prostrate)				
Synaphea petiolaris	V	Allocasuarina humilis	V	
Calothamnus gracilis	V	Dryandra nivea	IV	

Dryandra concinna	IV	Dryandra drummondii	IV
Astroloma pallidum	IV	Lysinema ciliatum	IV
Isopogon teretifolius	IV	Agonis spathulata	IV
Darwinia vestita	IV	Banksia gardneri	IV
Petrophile serruriae	IV	Spaerolobium macranthum	III
Melaleuca thymoides	III	Calytrix cfr.simplex	III
Banksia sphaerocarpa	III	Leucopogon gibbosus	III
Allocasuarina thuyoides	III	Petrophile divaricata	III
Conostephium pendulum	II	Isopogon divergens	II
Hibbertia subvaginata	II	Comesperma confertum	II
Allocasuarina acutivalvis	II	Petrophile linearis	II
Hakea corymbosa	II	Kunzea recurva	II
Grevillea uniflora	II	Astroloma epacridis	II
Stirlingia latifolia	II	Dryandra pteridifolia	II
Verticordia picta	II	Hakea baxteri	II
Sphenotoma capitatum	II	Jacksonia furcellata	II
Agonis floribunda	II	Pimelea suaveolens	II
Isopogon latifolius	II	Adenanthos obovatus	I
		Tetratheca cfr. hispidissima	III

Herbs

Mesomelaena stygia	V	Anarthria laevis	V
Hibbertia uncinata	IV	Neurachne alopecuroides	IV
Loxocarya fasciculata	IV	Anarthria prolyfera	IV
Gompholobium knightianum	III	Conostylis setigera	III
Drosera neesii	III	Stylidium brunonianum	III
Patersonia umbrosa	III	Dampiera linearis	III
Loxocarya cinerea	III	Mesomelaena tetragona	III
Conostylis aculeata	III	Caustis dioica	II
Cassytha melantha	II	Drosera cfr. bulbosa	II
Drosera stolonifera	II	Burchardia umbellata	II
Xanthosia rotundifolia	II	Stylidium repens	II
Drosera scorpioides	II	Lepidosperma angustatum	II
Johnsonia teretifolia	II	Elythranthera brunonis	II

(ca. 70 species with presence I and many other sporadic species should be added).

This association is widespread through the Stirling Range from the plain to the foothills where it covers most of the surface, often in alternation with patches of mallee (mainly Eucalyptus marginata and E. tetragona). There are several aspects related to altitude, humidity of the soil and consequences of fire.

Despite the relatively abundant rainfall, the environmental conditions in the lowland belt of the Stirlings are characterized by high aridity and the development of a forest under natural conditions is impossible (with exception of some moister soils in valleys). In the vegetation belt between 200 and 500 m altitude the Dryandra concinna - Xanthorrhoea platyphylla community consequently can be considered as a climax, sometimes reaching 600-700 m. Under optimal conditions this climax is given by an open woodland with scattered eucalypts eventually reaching 10-12 m, but through the action of fire vegetation is mostly reduced to the combination of shrubs and black boys: in both cases

differences are mainly in the dominance and not in the floristic composition. If it would be possible to avoid fire for longer periods, probably this association would evolve to a condition of dominance of treelets and erect shrubs, but without forming a continuous tree layer and the species present would remain more or less the same.

All vegetation types occurring in the Stirlings are composed mainly of perennial (and mostly woody) species; annuals are very few and often of exotic origin. The only vegetation rich in therophytes is in winter wet depressions, as pioneer on sandy soils, with Centrolepidaceae, Juncus bufonius, Callitriche, Mitrasacme, Levenhookia, in conditions resembling those of the european Nanocyperion, whereas therophyte communities with Velleia trinervis have analogy to the Tuberarietea, and in fact include some mediterranean weeds (Hypochoeris glabra, Galium parisiense, Briza maxima, Aira sp.).

The woodlands include some nemoral species in the shrub layer:

Trymalium floribundum (8)
Thomasia brachystachys
Thomasia laxiflora
Bossiaea linophylla
Hibbertia cunninghamii
Aotus ericoides
Hovea elliptica
Pimelea sylvestris
Eutaxia virgata
Pteridium esculentum
Empodisma gracillimum

5) Sept. 14 and 20: STIRLING EAST: BLUFF KNOLL

The Bluff Knoll (m 1056) is the highest peak in the Southwest Botanical province and the second highest in W.Australia (after Mt. Meharry m 1226 far in the North and with semiarid climate); it is the only point in W.Australia where a clear altitudinal zonation with different vegetation belts occur. The local flora is highly diversified, extremely rich in endemics and often with species of amazing beauty.

The climate is relatively cold and at the top of Bluff Knoll in winter sometimes a very thin cover of snow can occur; the action of wind is very strong, chiefly on the northern slopes; near the top during the cold season morning temperatures under the freezing point are frequent.

Around the parking area a dense formation of low woodland - mallee belonging to a montane aspect of the Dryandra concinna-Xanthorrhoea platyphylla community. From here it is possible to observe on the slopes at 600-800 m altitude the mallee-heath and at higher altitudes the montane thicket. In the valleys there is in general more water available and open woodlands with Eucalyptus marginata, E. calophylla and sometimes E. wandoo

occur; near a temporary creek and a small waterfall even a small closed community of Eucalyptus marginata with several forest species.

The general zonation along the altitudinal gradient is as follows:

altitude		
> 1000 m	thicket	Andersonia axilliflora - And. echinocephala ass.
850-1000 m	thicket	Kunzea montana - Andersonia echinocephala ass.
700-900 m	mallee-heath	Oxylobium atropurpureum - Hakea varia ass.
500-700 m	low woodland--mallee	Dryandra concinna - Xanthorrhoea platyphylla ass.
< 500	low woodland	Dryandra concinna - Xanth. platyphylla ass.

The Oxylobium atropurpureum - Hakea varia community - Appears mostly in the form of a very dense shrub community 2-4 m high. Among the dominants are some species with conspicuous flowers, e. g. Oxylobium atropurpureum with deep red corolla, Dryandra formosa with large orange heads and Isopogon latifolius similar to a gigantic Centaurea.

Slopes of the Bluff Knoll (25.X.1985), alt. 750 m, 5o North, 300mq:

mallee, 3-4 m high, cover 20 %

(9)

1.2 Eucalyptus marginata	1.2 Eucalyptus calophylla

treelets 2-3 m high, cover under 1 %

+ Xanthorrhoea platyphylla	+ Kingia australis

shrubs 5-20 dm forming a dense thicket, cover 80 %

2.2 Eucalyptus marginata	2.2 Hakea trifurcata
1.2 Eucalyptus calophylla	1.2 Eucalyptus sp.
1.1 Oxylobium atropurpureum	1.1 Dryandra formosa
1.1 Burtonia scabra	+ Isopogon latifolius
+ Leucopogon australis	+ Leucopogon sp.
+ Petrophile serruriae	+ Banksia meisneri
+ Agonis spathulata	+ Grevillea brownii
+ Boronia crenulata	+ Beaufortia ?orbifolia
+ Banksia baxteri	+ Hibbertia subvaginata
+ Conostephium pendulum	+ Hypocalymma phillipsii

+ Dryandra falcata

herbs, 1-5 dm high, cover 10 %

1.2 Anarthria humilis	1.3 Anarthria prolyfera
+ Loxocarya flexuosa	+ Lechenaultia tubiflora
+ Opercularia vaginata	+ Stylidium brunonis

The Kunzea montana - Andersonia echinocephala community - The vegetation of the upper portion of higher mountains (mainly the group of Bluff Knoll and Toolbrunup) is composed of large thicket formations. The Kunzea - Andersonia community is widespread on the slopes, where it forms a nearly impenetrable thicket of spiny shrubs; only in the highest part of the Bluff Knoll this community is replaced by the Andersonia - Andersonia community and forms of nival vegetation (see below). In general the Kunzea - Andersonia community develops on relatively stable slopes where the substrate is rich on stones and with good drainage; in valleys or on humid screes sometimes shrubby species become rare and Anarthria scabra develops dense populations.

Mt. Mondurup (21.X.1989), alt. 847 m, 2o Sud, 100 mq.

shrubs 5-15 dm, 100 % cover

3.3 Oxylobium atropurpureum	1.1 Xanthorrhoea platyphylla (1
1.1 Andersonia echinocephala	1.1 Kunzea montana
1.1 Banksia solandri	1.1 Hakea varia
1.1 Isopogon latifolius	1.1 Adenanthos filifolius
1.1 Hakea ambigua	1.1 Leucopogon atherolepis
+ Darwinia macrostegia	+ Beaufortia ?orbifolia
+ Boronia crenulata	+ Agonis floribunda
+ Leucopogon unilateralis	+ Amperea ericoides
+ Kingia australis	+ Petrophile media

herbs 2-5 dm, 20 % cover

1.1 Xanthosia candida	+ Stylidium brunonianum
+ Scaevola canescens	+ Empodisma gracillimum

(6 sporadic species with low presence).

The Andersonia axilliflora - And. echinocephala community - This association is limited to the upper parts of Bluff Knoll and exclusive to this mountain; many of the species listed in the following rel. are endemics of the Stirlings or even of the Bluff Knoll itself (e.g. Andersonia axilliflora and Darwinia collina) so that this association represents one of the most important points of interest for the biogeography of this region.

Near the top of Bluff Knoll (25.X.1985), alt. 1070 m, 5o Sud, 500 mq:

shrubs 5-15 dm, cover 90 %

2.3 Kunzea montana	1.1 Andersonia axilliflora (11)
1.1 Banksia brownii	1.1 Adenanthos filifolius
1.1 Isopogon latifolius	1.1 Banksia solandri
1.1 Sphenotoma drummondii	+ Leucopogon atherolepis

+	Darwinia collina	+	Calothamnus cfr. gracilis
+	Andersonia echinocephala	+	Hakea varia
+	Agonis parviceps	+	Agonis spathulata
+	Astroloma cfr.pallidum	+	Grevillea brownii
(+)	Hakea ambigua	(+)	Acacia drummondii

herbs, 1-5 dm high, cover 50 %

2.2	Anarthria prolifera	1.1	Loxocarya flexuosa
+	Cassytha pubescens	+	Xanthosia rotundifolia
+	Platysace compressa	+	Dicranum sp.

Nival vegetation

In the top of higher mountains (Bluff Knoll, Toolbrunup, Mt. Trio) there are some rocky places where ecological conditions are particularly severe. Rocks are compact and vascular plants can grow only on crevices or screes. Low temperatures in the night as well as full illumination in the day and action of wind often provoke stress conditions. At least 2 associations are limited to such environments: the Asplenium flabellifolium community on vertical rocks (ecological conditions are analogous to those of Asplenietea rupestris of the northern hemisphere) and the Drosera stolonifera - Platysace compressa community on more or less flat surfaces.

Toolbrunup, alt. 1050 m (24.IX.1987):

a) Asplenium flabellifolium ass. on vertical rocks, 90o West, 3 % cover, 4 mq

b) Drosera-Platysace ass. on fissures of humid rocks, 5o-15o West, 70 % cover, 3 mq; in the rel. an undetermined species of Poaceae (1.2). ?Deyeauxia quadriseta.

		a	b
	Asplenium flabellifolium	1.2	
(12)	Drosera stolonifera v.montana		+
	Platysace compressa	+	+
	Helichrysum macranthum	+	+
	Kunzea montana	+	
	Chamaescilla corymbosa fo.		+
	Campylopus sp.		3.5

6) Sept. 13 and 21.: PORONGURUP

From 300 to 500 m altitude the Porongurup Range is covered by a continuous karri (Eucalyptus diversicolor) forest.

A rel. in the luxuriant forest was carried out at 13.X.1989:

altitude m	350
aspect	N
slope in o	5
surface mq	1500

A1: 35-60 m high, diam. XX cm, cover 60 %		
Eucalyptus diversicolor	3.1	(13)
Eucalyptus calophylla	1.1	
A2: 8-25 m high, cover 20 %		
Eucalyptus diversicolor	1.1	
Paraserianthes lophantha	+	
B: 1-8 m high, cover 90 %		
Trymalium floribundum	4.5	
Mirbelia dilatata	+	
Acacia urophylla	+	
Oxylobium lanceolatum	+	
Leucopogon sp.	+	
Crowea angustifolia	+.2	
Acacia drummondiana	(+)	
Acacia sp.	(+)	
Hovea elliptica	(+)	
Hibbertia amplexicaulis	(+)	
C: 2-20 dm, cover 30 %		
Poa drummondiana	2.2	
Pteridium esculentum	1.1	
Opercularia apiciflora	+.2	
Dichondra repens	+.2	
Ranunculus colonorum	+	
Stylidium rhynchocarpum	+	
Stackhousia sp.	+	
Tremandra diffusa	+	
D: cover <1 %		
Clematis pubescens	+	
Chorizema ilicifolium	+	
Hardenbergia comptoniana	(+)	
Sollya heterophylla	(+)	

In the compact karri belt no others dependent associations are present. On the bare rocks there are interesting examples of the Campylopus-Polypompholyx association (see **21**) and of a chasmophytic community with Asplenium praemorsum, Asplenium flabellifolium, Cheilanthes austrotenuifolia, Pelargonium

australe, Helichrysum macranthum and the spectacular Hibbertia bracteosa.

Approaching the Porongurup Range from the North the road crosses a jarrah (Eucalyptus marginata) forest as an inferior vegetation belt corresponding to drier conditions and on laterite soil with following main features:

(15) A1: 15-25 m, cover 60 % - Eucalyptus marginata (dom.), E. calophylla

A2: 2-8 m, cover 15 % - Xanthorrhoea preissii, Kingia australis, Banksia grandis

B: 5-30 dm, cover 50 % - Bossiaea linophylla, Sphenotoma capitatum, Astroloma microcalyx, Hakea ruscifolia, Dryandra nivea, Leucopogon verticillatus, Agonis hypericifolia, A. parviceps, Mirbelia dilatata, Daviesia cordata

C: 2-12 dm, cover 800 % - Anarthria prolifera, Loxocarya cinerea, Dampiera linearis, Xanthosia rotundifolia, Hibbertia racemosa, Platytheca galioides

D: cover <1 % - Kennedia coccinea, Billardiera variifolia, Chorizema diversifolium

(14 rare species should be added)

7) Sept. 13 and 21.: WALPOLE AND THE SOUTH COAST

The southernmost region in W.Australia is the coast near Denmark and Walpole, which was settled relatively late and remains rich in primeval landscapes, much of them preserved as National Parks.

Karri forest

The composition of the karri-tingle forest is shown with the following rel. (Valley of the Giants, 11.X.1989):

altitude	70 m
aspect	W
slope	5
surface sq.m	300

(16)

A1: 30-45 m high, cover 60 %	
Eucalyptus jacksonii	3.1
Eucalyptus diversicolor	2.1
A2: 5-15 m high, cover 70 %	
Acacia pentadenia	3.2
Chorilaena quercifolia	(+)
B: 5-30 dm; cover 60 %	
Leucopogon verticillatus	2.2
Pimelea clavata	2.2
Thomasia quercifolia	1.1
Crowea angustifolia	+

Hibbertia cfr. montana	+
Acacia urophylla	(+)
C: 3-20 dm; cover 30 %	
Anarthria scabra	2.1
Pteridium esculentum	+
Opercularia volubilis	+
Tremandra stelligera	+
D: cover 10 %	
Cassytha racemosa	1.1
Chorizema ilicifolium	1.1
Billardiera variifolia	+
Dampiera hederacea	+

(and 3 rare or unidentified species).

Coastal dunes
The general structure resembles the Spinifex longifolius - Scaevola crassifolia communuty of the West coast but many differences are evident: another Spinifex species appears as a vicariant, Scaevola is relatively rare, many introduced species appear (Cakile, Carpobrotus, Arctotheca, Anthericum (etc.).

average composition of 6 rel.:

Spinifex hirsutus	V	(17)
Cakile maritima	V	
Carpobrotus edulis	V	
Isolepis nodosa	IV	
Arctotheca populifolia	IV	
Calocephalus brownii	III	
Tetragonia decumbens	III	
Arctites (Sonchus) megalocarpa	III	
Olearia rudis	II	
Cakile maritima ssp. aegyptiaca	II	
Trachyandra divaricata	II	
Pelargonium capitatum	II	
Euphorbia paralias	II	
Scaevola crassifolia	I	
Calystegia soldanella cfr.	I	
Rhagodia baccata	I	
Senecio lautus	I	
Olearia axillaris	I	
Atriplex isatidea	I	

(5 rare species should be added)

Maritime cliffs
On rocky coasts a regular zonation appears; the best examples are in the district from Cape Naturaliste to Augusta and Leeuwin, but with some variations the same communities can be observed along more than 200 miles of coast as far as Denmark, Albany and the Manypeaks area. The only really halophytic association (although

in a reduced grade) is the Boronia alata community; others are littoral, but rich in species of the mainland; units b-c-d are probably facies of a unique association; the Eucalyptus calophylla is a tall woodland of humid plains.

At least 6 communities can be recognized:

a) **Boronia alata** ass. on exposed cliffs

b) **Spyridium globulosum - Acacia littorea** ass. on protected sites in xeric conditions

c) **Spyridium globulosum - Agonis flexuosa** ass. on protected sites in humid conditions

d) **Spyridium - Agonis** facies of **Dryandra sessilis**, like (c) but probably as a consequence of fire

e) **Melaleuca lanceolata** low woodland in wet depressions

f) **Eucalyptus calophylla** tall woodland (mainland)

(18)

	a	b	c	d	e	f
number of rel.	7	4	4	3	3	1
Boronia alata	7					
Spyridium globulosum	4	4	4	3	3	1
Agonis flexuosa (shrub)		1	4	3	2	1
Dryandra sessilis			1	3		
Melaleuca lanceolata					3	
Eucalyptus calophylla						1
Agonis flexuosa (arborescent)						1
Shrubs						
Hibbertia cuneifolia	4	3	4	3	2	1
Templetonia retusa	3	1	1	1	1	1
Olearia axillaris	7	4	3	3	2	
Scaevola crassifolia	7	1	2	3	1	
Acacia littorea	7	4	4	2	2	
Rhagodia baccata	6	3	2		2	1
Pimelea ferruginea	6	1	2	3	1	
Leucopogon parviflorus	6	2	1	2	2	
Exocarpos sparteus	3	3	1		1	
Acanthocarpus preissii	4	1		1	1	
Diplolaena grandiflora	3	2			2	
Herbs						
Lepidosperma gladiatum	4	2	2	1	1	

Conostylis serrulata	3	2	1	3	2	
Phyllanthus calycinus	1	2	1	3		1
Dichondra repens		1			2	1
Vines						
Hardenbergia comptoniana	1	1	4	2	1	1
Cassytha racemosa	2	4	1	2	1	
Clematis aristata	1	2	3	1	1	
Sollya heterophylla		1	1	1	1	

(only frequent species are recorded)

8) Sept. 12 - 22: PEMBERTON DISTRICT

Forests
The climax vegetation of the Pemberton - Warren area is the karri (Eucalyptus diversicolor) forest which covers largely extended areas mainly on red soils. The karri forest is composed of trees 40-50 m high (in exceptional cases even 70 m and more) and represents the ecosystem with the highest complexity (as to spatial development, stratification, structure and biomass) in the state; floristic composition on the contrary is uniform and species diversity relatively low; the karri forest is limited to areas with the highest rainfall values.

The structure of the forest is quite complex:

A1) a superior tree layer of Eucalyptus diversicolor and E. calophylla (in the southern portion near the coast also E. jacksoni, E. guilfoylei) 30-70 m high; the cover of this layer is mostly discontinuous and inferior layers are not completely shadowed, a striking difference in comparison to the reduced illumination in the dense eurasiatic temperate or tropical forests

A2) an inferior tree layer mainly of Casuarina decussata 10-25 m high

B1) tall shrubs dominated by Trymalium floribundum, reaching 10 m and more, sometimes arborescent (e.g. Persoonia, Podocarpus, Agonis, Acacia urophylla) as a transition to A2

B2) small shrubs

C) herbs, sometimes very tall (Gahnia, Lepidosperma up to 2-3 m)

D) a rich occurrence of vines, more than in any other association in W. Australia.

Mean composition of 10 rel.:

A1: superior tree layer 30-70 m high, cover 40-70 %		
Eucalyptus diversicolor	V	(20)
Eucalyptus calophylla	III	

Eucalyptus jacksonii	II
Eucalyptus guilfoylei	I

A2/B1: inferior tree layer and erect shrubs 5-20 m high, cover 40-95 %

Trymalium floribundum	V
Casuarina decussata	IV
Leucopogon verticillatus	IV
Hovea elliptica	IV
Crowea angustifolia	IV
Acacia urophylla	III
Chorilaena quercifolia	III
Acacia pentadenia	III
Podocarpus drouynianus	II
Agonis flexuosa	II
Persoonia longifolia	II
Pimelea clavata	I
Acacia cfr. divergens	I
Oxylobium lanceolatum	I

B2: Shrubs and treelets 1-3 m high, cover 10-60 %

Hibbertia cuneiformis	III
Macrozamia riedlei	III
Pimelea floribunda	II
Hibbertia montana	II
Thomasia quercifolia	II
Thomasia cfr. solanacea	I
Boronia gracilipes	I
Acacia cfr. pulchella	I
Mirbelia dilatata	I
Acacia drummondiana	I

C: Herbs 2-20 dm high, cover 5-60 %

Pteridium esculentum	V
Opercularia volubilis	V
Stylidium rhynchocarpum	III
Poa drummondiana	III
Tremandra stelligera	III
Anarthria scabra	III
Baumea juncea	III
Empodisma gracillimum	I
Hibbertia grossulariaefolia	I
Ranunculus colonorum	I

D: vines, cover 1-20 %

Hardenbergia comptoniana	IV
Dampiera hederacea	IV
Clematis pubescens	IV
Billardiera variifolia	III
Chorizema ilicifolia	III
Cassytha racemosa	II
Sollya heterophylla	I
Kennedya sp.	I
Chorizema sp.	I

(50 species with low presence should be added).

The flora of the karri forest, although not particularly rich, is highly specialized and most species appear exclusive to this community, i.e. good character species in the sense used for the european vegetation; only few extend into the jarrah forest communities. Trymalium floribundum is very polymorphic. Approaching the southern coast other tall eucalypts (E. guilfoylei, E. jacksonii) appear in the upper tree layer and probably differentiate a vicariant community.

Pastures
Are widespread around the villages and towns; the vegetation is mostly composed of weeds of european origin. In the local flora herbs suitable as fodder for cattle and sheep are apparently nonexistent.

Swamps
In humid places communities of "sedges" (mostly Cyperaceae and Restionaceae) are widespread; hygrophilous communities with Dasypogon bromeliaefolius, Agonis parviceps and several species ofSchoenus, Leptocarpus, Baumea, Gahnia occur. This vegetation is insufficiently known.

Granite outcrops
An impressive feature of the landscape is gigantic granite outcrops emerging (mostly for only a few meters) from the surrounding vegetation; the biggest are near Muirillup but such outcrops are widespread and can be found easily e.g. along the Shannon river. Around and over such outcrops there are places with seepage of extremely oligotrophic water where several hygrophilous associations occur.

In general a zonation with at least 3 steps can be observed:

1) Extremely wet ----------> **Campylopus-Polypompholyx** ass.

2) Wet ----------> **Campylopus-Aphelia** ass.

3) Moist ----------> **Borya scirpoidea** ass.

4) Humid ----------> belt of **Myrtaceae / Restionaceae**

The **Campylopus bicolor - Aphelia cyperoides** and the **Campylopus bicolor-Polypompholyx multifida** associations consist of a compact layer of mosses, sometimes with character of peat bog, and scattered annuals with dominance of Centrolepidaceae. The habitat resembles that of some mediterranean Isoetetalia and Montio-Cardaminetea associations and - as a further analogy - both associations are rich in rare species of small dimensions. The Campylopus-Aphelia ass. is very polymorphic; in its more widespread form appears as in column (a); column (b) is a Drosera variant; column (c) represents the Campylopus - Polypompholyx association.

	a	b	c
number of rel.	9	3	7
dominant			
(21) Campylopus bicolor	V	2	V
ch.-sp. ass. (a)			
Aphelia cyperoides	V		
Cyperus tenellus	IV		I
Hydrocotyle callicarpa	III	1	
Drosera glanduligera	III		
ch.-sp. ass. (b)			
Drosera stolonifera fo.	II	3	
Stylidium calcaratum		2	
ch.-sp. ass. (c)			
Polypompholyx multifida			IV
Phylloglossum drummondii			I
Aphelia brizula			I
ch.-sp. of higher syntaxa			
Centrolepis aristata	III	2	III
Hydrocotyle alata	III		II
Mitrasacme paradoxa	II		II
Polypompholyx tenella	II	1	I
Tribonanthes uniflora	II		I
Cheilanthes austrotenuifolia	II		I
Chamaescilla corymbosa fo.		1	IV
Velleia trinervis		1	II
Philydrella pygmaea		2	I
Levenhookia pusilla	I		I
Isolepis cyperoides	I		
Triglochin calcitrapa			I
Stylidium pulchellum			I

Borya is a genus of the Liliaceae complex (now belonging to Anthericaceae) with small species 1-2 dm high; the general aspect is herbaceous, similar to the european Trichophorum, but most species have highly sclerophyllous leaves and bracts, are growing in dense tufts and acutely spiny. In the granite outcrops Borya species are gregarious and dominant in monotonous associations:

(22)

Borya scirpoidea at Muirillup Rock
Borya constricta at Sullivan Rock
Borya sphaerocephala at Sullivan Rock and Pony Hill

Few species join this vegetation: Drosera stolonifera, D. gigantea, Stylidium calcaratum, Thelymitra sp.pl., Hydrocotyle callicarpa. In comparison to the communities of annual Centrolepidaceae, Borya associations form a more mature stage and occupy a less wet niche.

PART 3

SUPPLEMENTARY DATA FOR LOCALITIES

by

J.S.Beard & B.G.Muir

CONTENTS

Note: Where material has been reproduced from earlier work, some botanical names may have been changed since publication.

MOORE RIVER NATIONAL PARK

The Moore River National Park forms part of the sandy Swan Coastal Plain and is principally vegetated with Banksia Low Woodland, a formation which occurs throughout the Coastal Plain varying from south to north as the rainfall decreases. The following account is reproduced from Beard, "The Vegetation of the Moora and Hill River Areas" 1979.

The country is a flat plain with low ridges of bleached sand alternating with swampy flats underlain by a calcareous hardpan. Banksia low woodland forms the general cover on the better-drained soil with trees 4.5 to 6m in height, at times only 3m. A type of heath covers the swampy areas. Rarely, there are Teatree, Paperbark and Banksia swamps, and some small salt lakes in the south.

Composition of the Banksia Low Woodland was listed at three sites as shown in Table III. Site 1 was 1 km south of the Hill River, Site 2 26 km further south and Site 3 near Reagan's Ford 1 km up the Mogumber road from the highway. There is considerable consistency in the overstory but rather less in the understory. Site 2 had a poorer composition generally and was weak in herbaceous components. This formation is the habitat of *Eucalyptus todtiana* but there appear to be no other exclusive species.

The heath of swampy patches varies locally. Sometimes it is similar to that of flats on the coast with *Acacia lasiocarpa* and *Melaleuca acerosa* dominant, more often *Banksia sphaerocarpa* is very abundant or *Calytrix aurea, C.flavescens, Verticordia densiflora* and *V.drummondii* may dominate whole patches and provide brilliant colour displays in early summer. *Frankenia* and samphire appear in salty patches. The whole is a mosaic requiring further study. Other characteristic species are *Beaufortia squarrosa, Byblis gigantea, Kingia australis* and *Viminaria denudata*.

Deep swamps are tree-covered, associations noted being *Melaleuca rhaphiophylla* and *Banksia littoralis* with an understory of *Hypocalymma angustifolium*, or *Casuarina obesa*, or *Eucalyptus rudis* with *Acacia rostellifera* and *Melaleuca thyoides*, or thickets of *Melaleuca thyoides, Viminaria denudata* and *Hakea varia* with *Leptocarpus* sp. densely in open spaces.

SPECIES COMPOSITION OF BANKSIA LOW WOODLAND

SPECIES	SITES 1	2	3
Trees :			
Banksia attenuata	X	x	x
Banksia ilicifolia	x		x
Banksia menziesii	x	x	x
Eucalyptus todtiana	x	x	x
Nuytsia floribunda			x
Cycad, Blackboy :			
Macrozamia riedlei	x		x
Xanthorrhoea preissii	x	x	x
Shrubs :			
Acacia pulchella var.	x		
Adenanthos cygnorum		x	x
Banksia sphaerocarpa		x	
Calectasia cyanea		x	x
Calothamnus sanguineus	x		
Casuarina humilis	x		x
Casuarina microstachya			x
Conospermum incurvum			x
Conospermum stoechadis	x		
Conostephium pendulum			x
Cryptandra pungens	x		x
Dasypogon bromeliifolius		x	
Daviesia sp.		x	
Dryandra nivea	x	x	
Eremaea fimbriata	x	x	x
Eremaea pauciflora	x		
Eriostemon sp.			x
Hakea prostrata		x	
Hakea ruscifolia	x		
Hakea sp.		x	
Hibbertia sp.	x	x	x

SPECIES	SITES 1	2	3
Hybanthus calycinus	x		
Jacksonia furcellata	x		x
Leptosperum spinescens			x
Leucopogon sp.			x
Lysinema ciliatum	x	x	
Petrophile linearis	x		x
Petrophile macrostachya	x		
Petrophile rigida			x
Persoonia sp.			x
Stirlingia latifolia		x	x
Synaphea sp.			x
Verticordia sp.			x
Herbaceous :			
Anigozanthos humilis	x	x	x
Anigozanthos manglesii	x		
Anigozanthos pulcherrima	x		
Blancoa canescens	x		x
Burchardia umbellata	x		x
Conostylis aculeata	x	x	x
Conostylis setigera	x		x
Dampiera linearis			x
Drosera spp.	x		
Johnsonia pubescens	x		
Macarthuria australis	x		
Patersonia sp.	x		x
Sowerbaea laxiflora	x		
Cyperaceae spp.	x	x	x
Restionaceae spp.	x	x	x

THE NORTHERN SANDPLAINS REGION

Irwin Botanical District

THE BADGINGARRA NATIONAL PARK

Reproduced from Beard, "The Vegetation of the Moora & Hill River Areas" 1979

The catena comprises heath in which blackboys are a conspicuous element on laterite, usually on summits and upper slopes, scrub heath on sand on middle slopes, Banksia low woodland on deep sand in valley bottoms and Eucalypt woodland along major drainage.

HEATH

The heath consists of a dense, rich assemblage of low shrubs, mostly very sclerophyllous and pungent, with scattered blackboys *Xanthorrhoea reflexa* as emergent taller plants and scattered small herbaceous plants as a ground layer featuring Cyperaceae and Restionaceae. Blackboys may reach 2 m tall, the low shrub layer is usually less than 1 m. Species of *Dryandra* and *Hakea* may be said to be dominant.

Two lists of species composition were made, the first 3 Km west of the highway on the continuation of Strathmore Road and in the Badgingarra National Park, soil sand over laterite.

Blackboys : *Xanthorrhoea reflexa.*

Shrubs : *Calothamnus torulosus, Casuarina humilis, Conospermum sericeum, C.stoechadis, Dasypogon bromeliifolius, Daviesia* sp. *Dryandra shuttleworthiana, Eremaea fimbriata* var. *brevifolia, Hakea conchifolia, H.flabellifolia, H.prostrata, H.ruscifolia, Hibbertia* sp., *Hovea stricta, Hypocalymma tetrapterum, Isopogon scabriusculus, Jacksonia floribunda, Labichea punctata, Lambertia inermis, Leptospermum spinosum, Leucopogon* sp., *Melaleuca scabra, M.*sp., *Stirlingia latifolia, Synaphea petiolaris.*

Herbaceous and Ground Plants : *Banksia* (prostrate species), *Burchardia umbellata, Calectasia cyanea, Conostylis aculeata, C.setosa, Dryandra nana, Johnsonia pubescens, Macropidia fuliginosa, Restionaceae, Cyperaceae.*

The second site enumerated was 29 Km inland from Jurien Bay along the main road east : soil sandy with ironstone nodules at the surface.

Blackboys : *Xanthorrhoea reflexa*

SPECIES COMPOSITION OF HAKEA OBLIQUA SCRUB-HEATH

SPECIES	SITES 1	2	3
Andersonia heterophylla	x		x
Anigozanthos humilis			x
Adenanthos cygnorum	x	x	x
Banksia attenuata	x	x	x
Banksia candolleana	x	x	x
Banksia menziesii			x
Banksia violacea	x		x
Beaufortia heterophylla		x	
Blancoa canescens			x
Burchardia umbellata			x
Calectasia cyanea			x
Calothamnus sanguineus	x	x	
Calytrix empetroides		x	
Casuarina humilis	x	x	
Conospermum incurvum		x	x
C.stoechadis	x	x	x
C.triplinervium	x		
Conostephium pendulum	x		x
Conostylis aculeata	x		x
C.setosa	x		
Dasypogon bromeliifolius	x		x
Daviesia quadrilatera	x		x
Dryandra acuneata		x	
D.aff.armata		x	
D.kippistiana		x	
D.nana	x		
D.shuttleworthiana	x		
Eremaea fimbriata		x	x
Eriostemon spicatus	x		
Grevillea sp. (small white)	x		
G.shuttleworthiana			x
Hakea bicostata		x	
H.conchifolia		x	

SPECIES	SITES 1	2	3
Hakea corymbosa			x
H.flabellifolia	x		
H.gilbertii		x	
H.incrassata		x	
H.obliqua	x	x	x
H.ruscifolia		x	
Hibbertia hypericoides	x	x	x
Isopogon scabriusculus	x		
Isopogon sp.		x	
Jacksonia floribunda	x		x
Lasiopetalum drummondii	x		
Lambertia inermis	x		
L.hirsuta			x
Leucopogon polymorphus	x		x
Leucopogon sp. 7855.	x		
Lechenaultia?floribunda			x
Lomandra hastilis		x	
Lysinema ciliatum		x	x
Melaleuca aff.scabra	x		
Nuytsia floribunda		x	x
Patersonia	x		
Petrophile ericifolia		x	
P.linearis	x		x
P.media		x	
P.megalostegia		x	x
Stirlingia latifolia	x		x
Strangea cynanchicarpa	x		
Synaphea petiolaris	x	x	
Verticordia grandiflora	x		x
V.grandis	x		x
V.ovalifolia	x		
Xanthorrhoea reflexa	x		

Shrubs : *Banksia violacea, Calothamnus torulosus, Daviesia* sp. *Dryandra bipinnatifida, D.?pulchella, Gastrolobium pauciflorum, Grevillea synapheae, Hakea auriculata, H.conchifolia, H.incrassata, Hibbertia pungens, Hovea stricta, Hypocalymma tetrapterum, Isopogon scabriusculus, Labichea punctata, Lambertia inermis, Lysinema ciliatum, Melaleuca* sp., *Petrophile linearis, P.serruriae, Synaphea petiolaris, Tetratheca* sp., *Verticordia grandiflora.*

Herbaceous and ground plants : *Calectasia cyanea, Haemodorum* sp.

Other species noted elsewhere for this community include mallees *Eucalyptus tetragona* and *E.macrocarpa, Gastrolobium spinosum* and *Lechenaultia biloba.*

SCRUB-HEATH

In the scrub-heath the blackboys are virtually absent and are replaced by an open stratum of tall shrubs reaching some 2m in height, principally Proteaceae. *Hakea obliqua* is particularly common and conspicuous, and is taken as the character species. Species lists were made at 3 sites and have been combined into Table II where a total of 69 appear. Site 1 was 13 Km north of Strathmore Road junction on the Brand Highway in the Badgingarra National Park, Site 2 on the Marchagee road 16 Km east of the Brand Highway and Site 3 on the Jurien Bay road 4 Km west of the Brand Highway. In addition to the species listed the rare mallees *Eucalyptus johnsoniana, E.lane-poolei* and *E.pendens* are occasionally seen in this community.

BANKSIA LOW WOODLAND

This is essentially of the same composition as that in the Bassendean System (see later) but the trees are usually very stunted, often barely 3 m tall. Principal species are *Banksia attenuata, B.menziesii, B.prionotes, Eucalyptus todtiana* and *Nuytsia floribunda* among the trees with associated shrubs of the *Hakea obliqua* association. *Lachnostachys albicans* and *Verreauxia reinwardtii* are soft shrubs perhaps typical of this community.

EUCALYPT WOODLAND

A strip of woodland lines the Hill River and some tributaries on alluvial soil or heavier soil developed in situ after stripping of the sand and laterite, and occurs also along the Mullering, Minyulo and Caren Caren Brooks descending from the Dandaragan Plateau. The woodland is of variable height, width and consistency. *Eucalyptus calophylla, E.wandoo, E.loxophleba, E.accedens* and *E.rudis* may all be present, singly or in mixture.

JURIEN AREA - THE COASTAL LIMESTONE

Reproduced from Beard, "The Vegetation of the Moora & Hill River Areas", 1979.

THE JURIEN SYSTEM

The Jurien System occupies the older coastal limestone.

The plant cover is a mosaic in which scrub-heath is the dominant member with *Banksia prionotes* as character species among the taller shrubs and *Dryandra sessilis* and *Calothamnus quadrifidus* as dominants in the lower heath layer. The mosaic includes patches of *Acacia spathulata* heath on shallow soil (?), of *Banksia* low woodland on deep white sand and of stunted *Eucalyptus gomphocephala* in depressions.

Composition of the Scrub-heath was recorded as follows :

Large shrubs and small trees > 1m :

Banksia attenuata, B.menziesii, B.prionotes
Nuytsia floribunda
Xanthorrhoea preissii

Smaller shrubs < 1m :

Acacia spathulata, Astroloma pallida, Banksia sphaerocarpa, Calothamnus quadrifidus, Casuarina humilis, Chamaelaucium uncinatum, Conospermum stoechadis, Daviesia divaricata, Dianella revoluta, Diplolaena microcephala, Diplopeltis huegelii, Dryandra sessilis, Eremaea pauciflora, Eriostemon spicatus, Hakea bicostata, H.prostrata, H.trifurcata, Hibbertia hypericoides, Hybanthus calycinus, Jacksonia sp., *Lechenaultia linarioides, Leucopogon tenuis, Olearia axillaris* (after disturbance), *Olearia rudis, Petrophile trifida, P.serruriae, Pityrodia bartlingii, Ricinocarpus glaucus, Scaevola canescens, Synaphea* sp.

Herbaceous :

Anigozanthos humilis.

The *Acacia spathulata* heath was not listed. This species becomes dominant in a low heath without taller shrubs.

Banksia low woodland contains *Banksia attenuata, B.menziesii, Eucalyptus todtiana* and *Nuytsia* as dominants but does not have the same associated flora as in the Bassendean System (see Beard 1979b).

Small patches of *Eucalyptus gomphocephala* low woodland occur here and there in depressions and are outliers from the principal habitat of this species further south.

There are considerable areas of unvegetated drift sand in the System, one of which has exposed the Pinnacles in the Nambung National Park. Recolonisation of exposed subsoil on the windward side of the Pinnacles is proceeding by *Dryandra sessilis, Scaevola crassifolia, Acacia cuneata, Hibbertia cuneiformis, Conostylis candicans, Olearis axillaris* and at a later stage *Acacia cyclopis* and *Hemiandra pungens.*

LESUEUR PROPOSED NATIONAL PARK

In the absence of suitable previously published work, this account has been specially written for the Excursion Guide by J.S.Beard. A comprehensive publication on the area is said to be in preparation by the Environmental Protection Authority but was not available at the time these notes were written.

The French expedition of 1801 to the West Australian coast under Capt. Hamelin put into Jurien Bay but did not go ashore. From the sea they named local features after members of the expedition, including Jurien itself, and some prominent mesas further inland, Mt.Lesueur (313m), Mt.Michaud and Mt.Peron. These belong to a hilly tract now known as the Gairdner Range. The hills owe their origin to block faulting in the Perth Basin when they were upthrust. Subsequently the upland was worn down into a smooth whaleback form and (probably in the middle Tertiary) was coated with a lateritic duricrust. Later still the duricrust was breached by erosion leaving remnants which can be seen today capping mesaform residuals whose summits conform to the original whaleback contours. On the slopes below younger soils have developed, and on an unusual range of parent materials because of the Cretaceous block-faulting. The Gairdner Range is therefore unusually varied topographically compared with other landscapes in the Perth Basin, and contains an unusual series of soil types. The vegetation is therefore unusually varied also and the flora is a very rich one. The unusual number of available habitats may not entirely account for this diversity, and it may be that the area has served as a refugium in the past, perhaps most recently during the severe arid phase of the last Ice Age 20,000 to 15,000 years BP. The vegetation of the area in general is kwongan, with eucalypt woodlands occurring on heavier, younger soils in the valleys. The kwongan itself is quite varied and numerous associations could probably be distinguished.

A detailed floristic study was published by Griffin & Hopkins (The Flora and Vegetation of Mt.Lesueur, Western Australia. Journ.Roy.Soc.W.Aust. 67:45-58, 1985) covering the plateau and slopes of Mt.Lesueur itself. This was a true phytosociological study based on enumeration of numerous quadrats and releves, but being confined to the summit plateau and upper slopes is only partially informative for the whole area of the proposed National Park. Dissected country east of Mt.Lesueur which will be visited by the Excursion is more varied and in many ways more interesting. The data of these authors are however generally applicable to kwongan communities on sand and laterite in the area.

On the summit plateau Griffin & Hopkins reported that the kwongan comprised three distinct strata. As is usual and indeed diagnostic in kwongan there is a universal low shrub stratum <1m tall, ranging from 30 to 90 cm in height. Larger shrub species included *Calothamnus sanguineus*, *Daviesia aff.striata*, *D.longifolia*, *Dryandra armata*, *Hakea megalosperma* and *Lambertia multiflora*. The grass trees *Kingia australis* and *Xanthorrhoea drummondii* were conspicuous in the low shrub layer, frequently emerged from it and reached 1.5m in height. Amongst the more abundant low shrubs and herbs 20-50 cm tall were *Actinostrobus acuminatus*, *Astroloma sp.*,*Banksia micrantha* *Conothamnus trinervis*, *Darwinia helichrysoides*, *Dryandra nivea*, *Grevillea synaphea*, *Hakes conchifolia*, *H.incrassata*, *Hibberia acerosa*, *Hypocalymma*

xanthopetalum, *Isopogon asper*, *Lysinema ciliatum*, *Macropidia fuliginosa*, *Melaleuca aff.megacephala*, *Petrophile striata*, *Sphaerolobium macranthum* and *Synaphea petiolaris*.

On about 30% of the surface of the plateau a stratum of taller shrubs 1-2m tall was present, dense and forming thickets. *Dryandra sessilis* was dominant with occasional *Hakea trifurcata* and *H.undulata* but malle-form eucalypts also occurred locally. These comprised *Eucalyptus marginata* and two previously unknown species which were later described as *E.suberea* and *E.lateritica*. *E.marginata* is well known as jarrah, a forest tree of the south-west, which occurs here only as a mallee at the limit of its range. It does the same in the Stirling Range at the opposite end of its own range, and is a very plastic species adopting as it does all sizes from mallee to giant tree. These thickets on the plateau were more common where laterite blocks appeared on the surface.

In addition an even taller stratum of large shrubs or small trees up to 3.5m tall was present on about 25% of the plateau surface, comprising *Banksia tricuspis and Nuytsia floribunda*. The former is a local endemic species of this area. In occasional pockets of deeper sandy soil, arenophilous species appeared such as *Adenanthos cygnorum*, *Bossiaea eriocarpa*, *Hakea ruscifolia* and *Lomandra hastilis*.

Structurally, the vegetation of the slopes of Mt.Lesueur was essentially the same as that on the plateau but there were species changes. *Hakea megalosperma* was absent and *Banksia micrantha* much less abundant. However the slopes supported a great number of species which were either absent or rare on the plateau. For example, *Hakea neurophylla* was abundant on the higher north-eastern slopes, *Casuarina humilis*, *Daviesia decurrens*, *Eremaea violacea*, *Leucopogon plumiflorus* and *Melaleuca trichophylla* were abundant on the southern, western and northern slopes, and *Gastrolobium spinosum* and *Petrophile chrysantha* were abundant on the lower eastern slopes, but all were poorly represented on the plateau top. *Cryptandra arbutifolia*, *Hakea auriculata*, *Labichea punctata*, *Neurachne alopecuroidea*, *Petrophile chrysantha* and *Pultenaea ericifolia* were prominent on the slopes but not located on the plateau top.

287 vascular plant species were recorded from Mt.Lesueur. For kwongan, this is not a particularly high number. The number of rare and localised species however appears to be high - at least in the present state of our knowledge where other kwongan communities have not been as intensively studies. Three species have been gazetted as rare under the provisions of the law on Wildlife Conservation: *Banksia tricuspis*, *Hakea megalosperma*, *Urocarpus phebalioides*. 23 species in all, while not confirned to Mt.Lesueur, have restricted distributions. 26 of the species found in the survey have distributions for which Mt.Lesueur represents an outlying or extreme northern occurrence, including *Eucalyptus marginata* as a typical example.

Other communities, which will be seen in the dissected country east of Mt.Lesueur include:
Banksia woodland and low woodland. This appears on deep sand, usually in the valleys, and is essentially the same as the Banksia community listed for the Badgingarra National Park. *Banksia attenuata*, *B.menziesii* and *Eucalyptus todtiana* are the principal dominants.

Eucalypt woodland. On heavier soils, i.e. containing more clay, eucalypt tree formations appear. The commonest species is *E.wandoo* (with white bark) on heavy clay, often with *E.accedens* (powderbark wandoo). On sandy clays the rough-barked species *E.calophylla* (marri) and *E.marginata* (jarrah) appear. These woodlands have sclerophyll shrub understories.
Mallee. Limited areas dominated by *Eucalyptus drummondii* and *E.marginata* growing in a mallee form occur on soils intermediate between those of kwongan and woodland. The understory is of kwongan type.
Kwongan. Various different kwongan communities can be distinguished, such as:

a). Community with *Banksia tricuspis*, similar to that enumerated on Mt.Lesueur

b). Communities with conspicuous *Hakea neurophylla* or *H.megalosperma* or *H.trifurcata* or *Petrophile seminuda* or *Isopogon dubius*.

c). Shrubland of *Calothamnus quadrifidus* with a ground layer of the reed *Ecdeiocolea monostachya* or of the small shrub *Verticordia densiflora* on poorly drained, winter-wet sites.

d). Low woodland of *Melaleuca preissiana* with the sedge *Baumea preissii* on drainage lines, or thickets of *Melaleuca platycalyx*.

THE NORTHERN SANDPLAINS REGION
Irwin Botanical District.

The interior portion of this Region which is traversed by the tour between Jurien and Wubin belongs to the Marchagee System. The following details are taken from Beard, "The Vegetation of the Moora and Hill River Areas" 1979.

THE MARCHAGEE SYSTEM

The vegetation in the Marchagee System consists almost entirely of scrub-heath on yellow sandplain and sand ridges but there are limited areas of Casuarina thicket on ridges of Proterozoic rocks, of Eucalypt woodlands on red loam soils, and of woodland, mallee and halophytes in depressions. The sandplains lie at the southern end of a chain of yellow sandplains stretching north to beyond the Murchison River and having broadly the same vegetation which may be termed the *Banksia-Xylomelum* alliance from the consistent conspicuous genera. In the Marchagee System the alliance is represented by a distinct association with a number of characteristic species. A detailed description and list of species was given by Beard (1976a) from a site 28 Km west of Winchester. In the Moora - Hill River area the same assemblage was observed throughout the sandplains. The following species list was made in the Gunyidi Recreation Reserve No. 21783 "Bryant Park".

Acacia juncea, Acacia sp., *Actinostrobus arenarius, Adenanthos sticta, Anigozanthos humilis, Banksia attenuata, B.prionotes, Casuarina acutivalvis, C.campestris, Calytrix angulata, C.?strigosa, Conospermum stoechadis, Conostylis aculeata, Dryandra* sp., *Eremaea pauciflora, Eucalyptus pyriformis, Gompholobium tomentosum, Grevillea amplexans, G.eriostachya, G.integrifolia, G.leucopteris, Hakea falcata, H.obliqua, H.scoparia, H.trifurcata, Hibbertia hypericoides, Isopogon divergens, Jacksonia floribunda, J.hakeoides, Leptospermum erubescens, Loudonia roei, Melaleuca cordata, Persoonia saundersiana, Petrophile ericifolia, P.seminuda, P.trifida, Pileanthus peduncularis, Pimelea lehmaniana, Santalum acuminatum, Synaphea petiolaris, Thryptomene tuberculata, Verreauia reinwardtii, Verticordia grandis, V.picta, V.polycephala, V.* sp. inedit., *Xylomelum angustifolium,* and Restionaceae in tussocks.

The *Banksia-Xylomelum* alliance is characterised by the presence of *Actinostrobus arenarius, Banksia* spp., *Grevillea leucopteris, Pileanthus peduncularis* and *Xylomelum augustifolium*. In the Marchagee System the local association is further characterised by *Adenanthos sticta, Banksia burdettii* and *Eucalyptus pyriformis*. *B.burdettii* was not recorded at Gunyidi but is common west of the railway along the Marchagee - Jurien Bay road where it was also noted that *Eremaea fimbriata* replaced *E.pauciflora* forming a dense layer about 90 cm tall. If unburnt the larger species in this association - *Actinostrobus, Banksia, Eucalyptus, Xylomelum* - become trees of 6-8m in height but due to frequent fires this mature structure is rarely attained.

Valleys crossing the sandplain have become choked with sand. Unfortunately owing to land clearing it is now difficult to determine whether the vegetation was of any distinctive character. There are numerous small lakes and pans surrounded by sandhills, usually fresh like the one in the Gunyidi Recreation Reserve and bordered by *Eucalyptus rudis* and *Melaleuca* spp. One small salt pan seen was surrounded by a few large *E.camaldulensis* with *Atriplex* ground layer, and another by *Casuarina obesa*. Secondary stands of *Actinostrobus* are often very common in cleared valleys and it may be that the original community was similar to one extant in Flora Reserve A2736 at Marlingette Well west of Dalwallinu which comprises scattered *Actinostrobus* 3m, open *Acacia* sp. 2 m and a ground layer of *Ecdeiocolea monostachya* looking like a grassland and concealing numerous small ericoid shrubs.

On Precambrian ridges thickets of *Casuarina campestris* appear with *Eucalyptus eudesmioides, Grevillea petrophiloides* and *Santalum acunuinatum*. Woodlands of *E.loxophleba* and *E.salmonophloia* occur in patches on red soils where the sandplain is not continuous. In the depression along the line of the Darling Fault where there are drainage channels running south from Lakes Eganu and Pinjarrega, *Eucalyptus camaldulensis* and *Casuarina obesa* with some samphire appear along the channels bordered by small *E.loxophleba* with *Plectrachne danthonioides* and a *Jacksonia*. Mallee of *E.foecunda* grows in thickets of *Melaleuca uncinata* in pans, or in depressions over an understory of *Ecdeiocolea monostachya*.

1 THE EREMAEAN BOTANICAL PROVINCE

MURCHISON REGION (Austin Botanical District)

These pages are reproduced from Beard, "The Vegetation of the Murchison Region", 1976, University of West.Aust.Press.

The Austin Botanical District is that part of the Eremaean Botanical Province which lies on the granite, gneiss and included metamorphics of the Yilgarn Block. Its boundaries to the west, north and east are geologically determined and coincide in a general and approximate manner with the boundaries of the Yilgarn Block. The southern boundary, being also the provincial boundary, is climatically determined. The district thus possesses a characteristic geological structure; its geological history has given it a characteristic physiography; its particular position on the Western Australian plateau gives it a characteristic climate: and these three factors in conjunction have given it characteristic soils. All these factors of the environment have been described in previous sections. Particular attention is drawn to the details of climate, especially rainfall distribution.

The Austin Botanical District is essentially the mulga region of Western Australia. *Acacia aneura*—mulga—is dominant or contributes significantly to the biomass in the most extensive communities. Mulga does not extend further to the west since climate and soils in the Carnarvon Basin do not favour it. It extends to the north into the Ashburton Botanical District, where it is widely developed, but geology, topography and soils differ. It extends also to the east onto different geology, topography and soils in the Great Victoria Desert but its occurrence is limited by the unfavourable substrata. The climate throughout that area is favourable to it, and if the Yilgarn Block had extended further in that direction, there is no doubt that it would have been covered with mulga. Conditions within the Austin District favour mulga more generally than in any other part of Western Australia. (See Plate 5.)

Acacia aneura grows in the form of a tree with a single erect trunk on the more favourable soils and then forms low woodland. On less favourable sites it takes the form of a shrub, and such areas have been mapped as scrub. The low woodland may be continuous (a_1Li) or interrupted by bare patches (a_1Lp). *A. aneura* is at its best on plains with a red loam soil overlying a siliceous hardpan. In its shrub form it extends to hills with other soil types. It tends to be absent or only sparingly present on sandplains and on heavy alkaline and saline soils. Height and density of the mulga are both greater in the south than in the north, and throughout mortality is a very noticeable feature, which will be discussed.

Structure consists of an open low tree or tall-shrub layer > 3m, a sparse low-shrub layer of 1-2m and a ground layer of ephemeral herbs which may be a closed one in a favourable season. In an unfavourable season this layer may not be present at all. There are also sparse perennial and annual grasses.

The more important component species in the mulga low woodland formation are as follows:

Small trees or large shrubs > 3m: *Acacia aneura* (very abundant: all other spp. rare or localized), *A. coriacea, A. grasbyi, A. kempeana, A. ligulata, A. linophylla, A. pruinocarpa, A. ramulosa, A. sclerosperma, A. tetragonophylla, A. victoriae, Bursaria spinosa, Hakea suberea, Plectronia latifolia.*

Scattered *Eucalyptus kingsmillii, E. lucasii* and *E. oleosa* in a tall mallee form may be present in some areas.

Undershrubs 1-2m: *Acacia craspedocarpa, Cassia desolata, C. leurssenii, C. sturtii, Dodonaea microzyga, Eremophila angustifolia, E. clarkei, E. dielsiana, E. duttonii, E. exilifolia, E. foliosissima, E. fraseri, E. georgei, E. gilesii, E. granitica, E. latrobei, E. leucophylla, E. mackinlayi, E. macmillaniana, E. oppositifolia, E. platycalyx, E. punicea, E. spathulata, E. spectabilis, E. viscida, Grevillea deflexa, Halgania preissiana, Ptilotus obovatus, P. rotundifolius, Sida calyxhymenia, Solanum lasiophyllum.*
Perennial herb: *Ptilotus drummondii.*

Perennial grasses: *Danthonia bipartita, Eragrostis lanipes, E. eriopoda, Eriachne helmsii, E. mucronata.*

Annual grasses: *Artistida arenaria, Eragrostis dielsii, Eriachne pulchella.*

Ephemeral herbs: *Angianthus burkittii, Brachycome ciliocarpa, Brunonia australis, Calotis multicaulis, Cephalipterum drummondii, Clianthus formosus, Erodium cygnorum, Goodenia concinna, G. hirsuta, Haloragis odontocarpa, Helipterum charsleyae, H. craspedioides, H. floribundum, H. splendidum, H. venustum, Myriocephalus guerinae, Peplidium muelleri, Podolepis auriculata, P. kendallii, Ptilotus aervoides, P. alopecuroideus, P. exaltatus, P. helipteroides, P. macrocephalus, Schoenia cassiniana, Swainsona beasleyana, S. villosa, Symphiobasis* sp., *Velleia rosea, Waitzia aurea, W. citrina.*

Greater detail can be obtained from Davies (1970) who listed 216 species, nearly all of them components of the mulga alliance.

Acacia pruinocarpa is the largest tree, reaching about 8m in height: it is absent from the Barlee and Yalgoo Sub-regions. *A. aneura, Bursaria* and *Hakea* reach 5-6m, other species 3-5m. *Acacia coriacea* is mainly on drainage, *A. grasbyi* in creek beds or on granite, *A. ramulosa* on sand, *A. sclerosperma* on calcrete and *A. victoriae* on salty flats.

Acacia craspedocarpa is a common undershrub but mainly in the Wiluna Sub-region. The commonest undershrubs are the *Cassia* species, *Eremophila fraseri* and *E. foliosissima,* which are normally present in good stands of mulga. *E. fraseri* seems to indicate stony ground, and *E. foliosissima* deep loam.

The perennial grasses are normally confined to patches of sandy soil, known as 'wanderrie country', in which the sand tends to occur in low, raised banks. *Acacia aneura* associates with *A. linophylla* on these, and the grasses are frequently so dense as almost to form a closed stratum. The normal mulga association occurs between the banks. Annual grasses are favoured by summer

rains and forbs by winter rains. The writer's field-work of 1973 was done in an excellent season for forbs of which there is a substantial list in consequence. Grasses were little in evidence and the list is taken from Mabbut *et al.* (1963). The display of colour from the flowers in this country in a favourable season is very striking. Given plentiful winter rains, by August the ground is covered with a carpet of flowers which may be continuous for hundreds of kilometres. White and yellow colours predominate with lesser pink, mauve and blue. Red and orange are absent except in *Clianthus formosus*. The commonest forbs are *Cephalipterum* (which has two colour forms, white and yellow), *Erodium, Goodenia rosea, Haloragis, Helipterum* spp., *Myriocephalus, Podolepis auriculata, Ptilotus alopecuroideus, P. helipteroides* and *Schoenia*.

Optimum conditions for mulga are found on plains which have a deep red loam soil overlying siliceous hardpan. Here mulga adopts a tree form in relatively-tall, dense stands which have tended to remain longest in good condition. On other sites both further up slope and further down slope towards the rivers, mulga was originally less tall and dense and has deteriorated more since the introduction of grazing. On stony plains and stony pediments in many parts of the region nearly all the mulga is dead, and in some cases the death took place so long ago that the trees have rotted and disappeared. Under these conditions the understory species of *Cassia* and *Eremophila* become larger and more numerous, also secondary species of *Acacia* such as *A. victoriae* and *A. tetragonophylla*.

The problem of the death and regeneration of mulga is discussed at the end of this section.

Opening of the mulga in this way is different from the condition of irregular and patchy growth mapped as a_1Lp. This is found on plains, where there has been strong development of the red-brown hardpan, which is later brought to the surface by erosion, resulting in the exposure of indurated pavements. These are treeless, so that the woodland is interrupted by frequent open patches, or in extreme cases is reduced to groves following sand-filled depressions and channels in the hardpan. The indurated pavements are frequently bare except for rare shrubs, grasses and ephemerals in season, many of which adopt a prostrate or ground-hugging habit. A typical description of a portion of such country, near Cunyu woolshed north of Wiluna, reads:

> Level plains with *A. aneura* and *A. pruinocarpa,* very irregular with large bare areas, or sparsely wooded, or mulga dead and regenerating alternating with good areas. The bare patches are covered with ground-hugging *Calandrinia,* composites and other prostrate plants, and a very short grass of purple colour, *Eragrostis pergracilis. Eremophila latrobei* is sometimes sparingly present and the following small herbs were recorded: *Calandrinia creethae, Chthonocephalus* sp., *Heliotropium heteranthum, Trianthema oxycalyptra.* [Author's field notes 1973]

Hills on granite and gneiss are normally covered with mulga in a shrub form, height 2-3m. *Acacia aneura* is associated with *A. quadrimarginea, A. ramulosa* and *A. grasbyi* and has understories as before of *Cassia* and *Eremophila* shrubs, and ephemerals.

Granite outcrops and abrupt rocky ranges of resistant Archaean rocks tend to be similar to the granite hills, but as there are local features, these will be dealt with under the sub-regions.

Sandplains cover remnants of the earlier Tertiary land surface throughout the region, especially in the Wiluna, Byro and Barlee Sub-regions. On these, *Acacia aneura* while generally still present is a minor element. The vegetation of the sandplains varies in response to climate more widely than that of any other landscape in the region and must, therefore, also be dealt with on a sub-regional basis. Frequently the sandplains are bounded by laterite scarps or breakaways, which generally carry shrubby *Acacia aneura, A. grasbyi* and *A. quadrimarginea,* but sometimes also trees of *Callitris columellaris* and *Eucalyptus carnei.* It is common to find an open area at the foot of the breakaway formed of white gritty clay leached from the pallid zone, on which there are small *Frankenia* or *Arthrocnemum* and other halophytes.

Down slope from the plains of optimum mulga growth the landscape units become more alkaline, often floored with calcrete deposit, or saline if there is not active drainage. In the first stage, which may be characterized as mulga with salty openings, the mulga low woodland is interrupted by patches of scrub of *Acacia sclerosperma, A. tetragonophylla, A. victoriae* and *Hakea preissii.* This scrub in turn is interrupted by openings bare of trees and large shrubs, carrying scattered *Maireana pyramidata* and *M. triptera* surrounded peripherally by *Eremophila pterocarpa* or *Melaleuca uncinata.* With increasing salinity samphire (*Arthrocnemum*) replaces the *Maireanae.* All such country tends to be badly eaten out and reduced to patches of mulga in open bare areas containing nothing but *Eremophila pterocarpa* and prostrate ephemerals.

Calcrete has been widely deposited along drainage lines past and present, and in many cases valleys are floored with sheets of it. Later erosion may convert the material into raised benches. Scrub of *Acacia sclerosperma* with *Pittosporum phillyraeoides* and *Grevillea nematophylla* is characteristic and there is a form of *Acacia aneura* with horizontal branching habit (Plate 7) which occurs in some areas. The ephemerals *Helipterum sterilescens* and *H. humboldtianum* are also characteristic. Both are silver-tomentose with white and yellow flowers respectively. Other species include the grass *Enneapogon caerulescens* and the succulent *Bassia, Calandrinia* and *Zygophyllum* spp.

Towards the rivers, where there is active drainage, scattered trees of *Eucalyptus camaldulensis* and *Casuarina obesa* appear in the mulga, and they also line the drainage channels. Locally *Eucalyptus camaldulensis* may form woodland on flood plains, in claypans and on calcrete areas. Some of these areas are large enough to be mapped.

Where drainage is disorganized, salinity of the lower plains increases further, with the formation of extensive salt flats vegetated with small halophytes such as *Atriplex, Maireana* and *Frankenia.* Sometimes scattered acacias persist. In the most extreme cases playa lakes have formed with beds of bare mud and salt crystals or with samphire colonies. Some of these lakes have accumulated gypsum which carries a particular group of plant species. The features of these lakes are described under the sub-regions in which they occur.

WHEATBELT REGION

Reserve No. 24534

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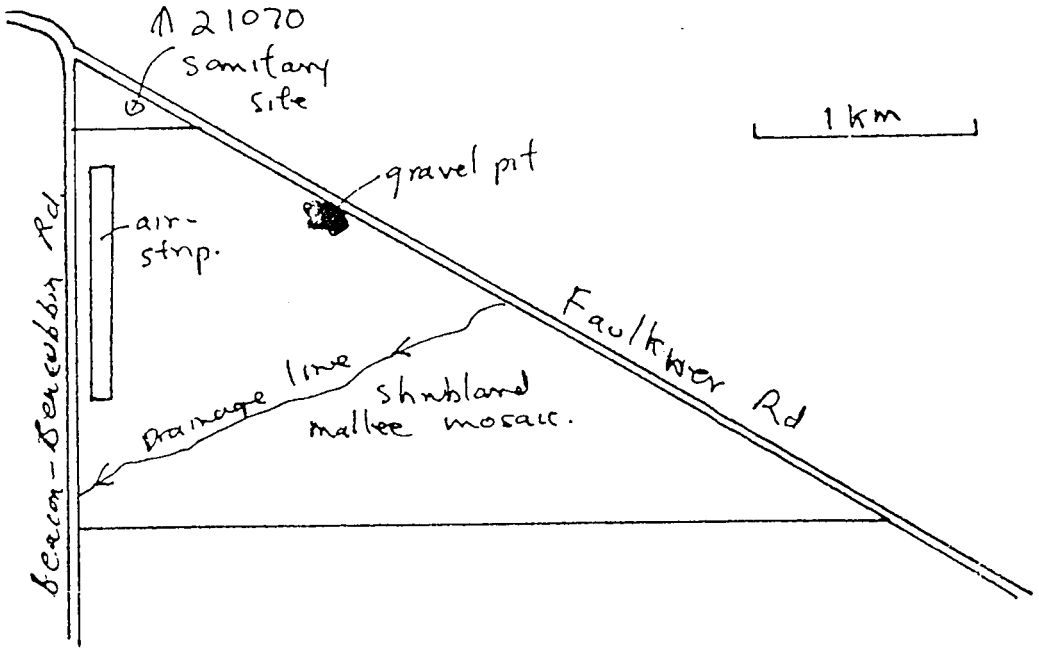


The reserve has a mosaic of mallee and shrubland.

Mallee component.

Eucalyptus ovularis shrub mallee, 4-7m tall, 10-30% cover over *Acacia ?fragilis* 2-3 m tall, 2-10% cover over *A.mackeyana* 1 m, 2-10% cover. Other plant species recorded were *A.colletioides*, *A.hemiteles*, *Borya nitida*, *Daviesia nematophylla*, *Dianella revoluta*, *Eremophila clarkei*, *Exocarpos sparteus*, *Melaleuca hamulosa*, *Olearia muelleri*, *Ptilotus exaltatus*, *Sclerolaena diacantha*. Soil yellowish brown, fine sandy loam. Well drained.

Shrubland component.

Casuarina campestris and *Acacia stereophylla* shrubs, 2-3m tall, 30-70% cover over *Ecdeiocolea monostachya*, 0.5m tall, 30-70%cover. Also recorded were *Acacia sp.*, *Borya nitida*, *Dianella revoluta*, *Eucalyptus redunca*, *Grevillea yorkrakinensis*, *Lepidosperma gracile*, *Melaleuca uncinata*, *Platysace effusa*. Soil yellowish brown sandy loam. Well drained.

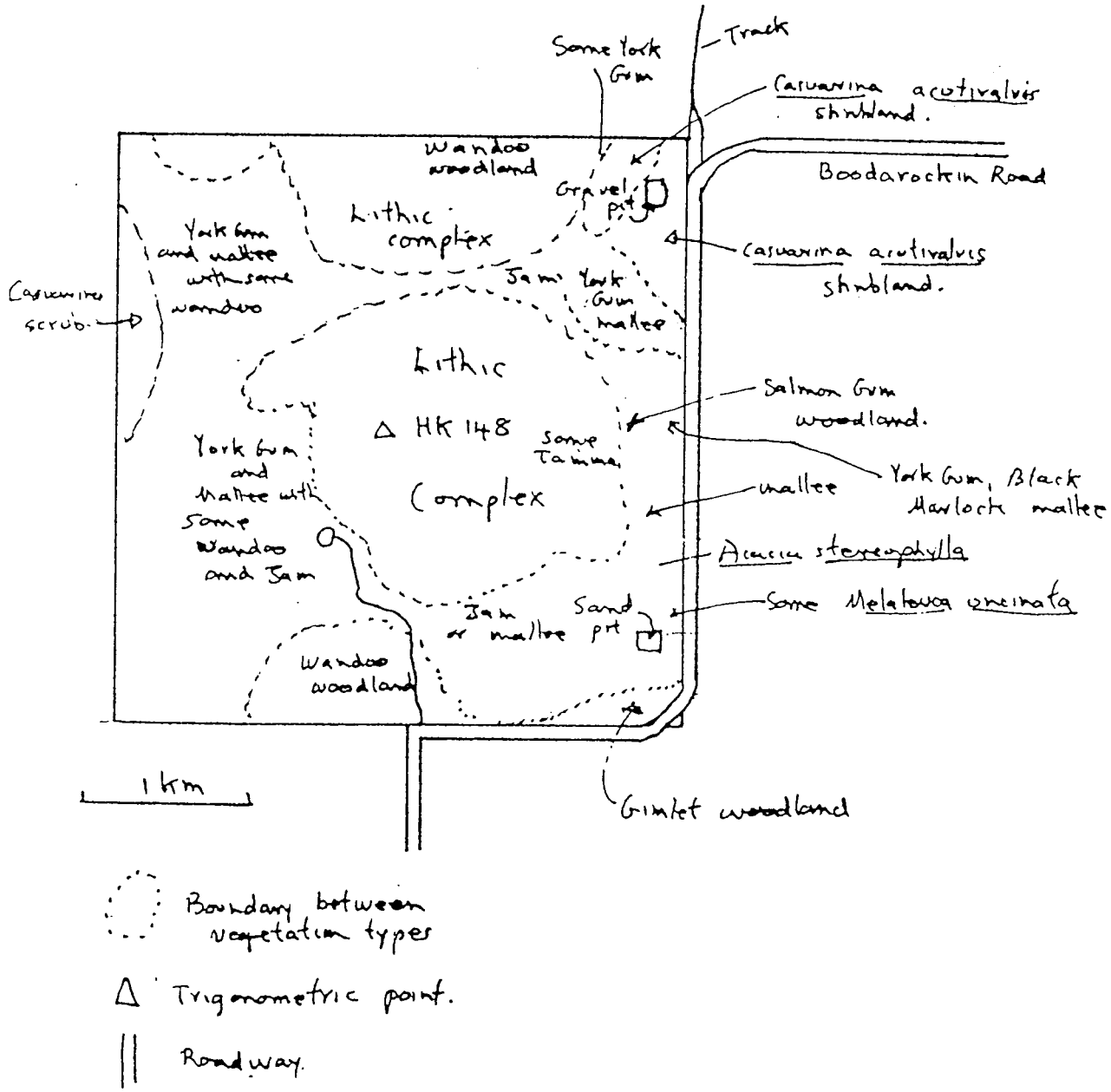
Casuarina acutivalvis is common in the ecotone between the mosaics. A creek running into the reserve on the NE side has *Acacia acuminata*, *Eremophila decipiens*, *Lomandra effusa*, *Melaleuca eleutherostachya*, *M.hamulosa* and *Ptilotus obovatus*.

WHEATBELT REGION

SANDFORD ROCKS NATURE RESERVE

These pages are reproduced from an unpublished report to the Department of Fisheries and Wildlife by B.C.Muir,1978.

The Reserve has an area of 806 ha. Most of it is a complex mosaic of granite outcrop and tumbled boulders with surrounding flat areas carrying woodlands or shrublands



Reserve 1432

Jam woodland

Acacia acuminata trees, 3.5-5m tall, 30-70% canopy cover over Melaleuca uncinata shrubs, 1.5-2.5 m tall, 2-10% cover over Amphipogon debilis and Waitzia acuminata grasses and herbs, 20 cm tall, 2-10% canopy cover. No other species recorded. Soil pinkish grey, gritty, loam. Moderately well drained.

Gimlet woodland

Eucalyptus salubris trees, 8-11 m tall, 30-70% cover over mixed shrubs, 1 m tall, 2-10% cover. Other species recorded were: Acacia colletioides, A. affin. daviesioides, A. erinacea, A. graffiana, A. ligustrina, A. merrallii, Bassia diacantha, Daviesia nematophylla, Eremophila decipiens, E. drummondii, Eucalyptus salmonophloia, Exocarpus aphyllus, Melaleuca hamulosa, Olearia muelleri, Ptilotus exaltatus, Scaevola spinescens, Stipa elegantissima, Wilsonia humilis. Soil red, sandy clay; poorly drained.

Wandoo woodland

Mature woodlands with Eucalyptus wandoo trees 14-18 m tall, 2-10% cover over grassy annual understory. Scattered Eucalyptus salmonophloia present as well as Acacia microbotrya, Dampiera juncea, Dianella revoluta, Grevillea paniculata, Lomandra effusa and Santalum spicatum. Immature stands 8-12 m tall and 10-30% cover with mean trunk diameter of 15 cm. Scattered shrubs present. Species recorded were: Acacia acuminata, A. graffiana, Baeckea sp., Borya nitida, Dianella revoluta, Enneapogon caerulescens, Eucalyptus loxophleba, Grevillea paniculata, Lepidosperma tenue, Melaleuca laxiflora and Olearia revoluta. There are some marginal clumps of Melaleuca hamulosa and M. ? pauperiflora. Soil pinkish grey, sandy clay loam. Poorly drained.

York Gum woodland

Eucalyptus loxophleba trees and tree mallee, 4-7 m tall, 10-30% cover over mixed shrubs, 1 m tall, 2-10% cover. Also recorded were: Acacia acuminata, A. erinacea, A. graffiana, Alyxia buxifolia, Carpobrotus edulis, Daviesia nematophylla, Dianella revoluta, Dodonaea inequifolia, Eremophila drummondii, Rhagodia nutans, Santalum spicatum, Scaevola spinescens, Solanum lasiophyllum, S. nummularium. Soil is pinkish grey, sandy clay. Poorly drained. Where the York Gum woodland overlaps with marginal lithic complex Calycopeplus helmsii, Cheilanthes tenuifolia, Isotoma petraea, Keraudrenia hermanniaefolia, Muhlenbeckia adpressa, and Ptilotus exaltatus penetrate into the woodland.

Black Marlock mallee

Eucalyptus redunca shrub mallee, 5-7 m tall, 2-10% cover over Acacia acuminata trees 2-3.5 m tall and Melaleuca acuminata shrubs 2-3.5 m tall, 2-10% cover over annual grasses 70-100% cover. Some areas with Acacia stereophylla penetrating from adjacent shrublands. Soil light reddish brown, loam.

On areas of heavier soil the association was E. redunca shrub mallee 4-5 m tall, 2-10% cover over mixed shrubs 0.5 m tall, 2-10% cover over Borya nitida 10 cm tall, 10-30% cover. Other species recorded were: Acacia graffiana, Amphipogon debilis, Baeckea affin. crispiflora, Bertya cunninghami, Cassytha glabella, Casuarina compestris, Daviesia nematophylla, Dodonaea caespitosa, Ecdeiocolea monostachya, Eucalyptus wandoo, Grevillea paradoxa, G. yorkrakinensis, Hibbertia pungens, Lepidosperma sp. Lomandra glauca collina, Melaleuca laxiflora, M.platycalyx, Santalum acuminatum, Schoenus sp., Spartochloa scirpoidea. Soil pinkish grey, sandy clay, poorly drained.

Tamma shrubland

Casuarina campestris shrubs, 1.5-2.5 m tall, 10-30% canopy cover (overall 2-10% but some clumping) over Ecdeiocolea monostachya sedges 0.5 m tall, 30-70% cover. Also recorded were: Acacia dielsii. A. sessilispica, A. stereophylla, A. sp., Borya nitida, Cryptandra myriantha, Eriostemon tomentellus, Eucalyptus rigidula, Grevillea yorkrakinensis, Hakea falcata, Harperia lateriflora, Melaleuca oldfieldii, Platysa e effusa, Santalum acuminatum.

In some areas Acacia stereophylla is a cod minant and the density increases to 70-100%. Concurrently the understory density dropped to 2-10% cover. In these areas were Acacia bidentata, Amphipogon debilis, Cryptandra myriantha, Eucalyptus redunca, Grevillea apiciloba, G. paradoxa, G. yorkrakinensis, Hibbertia verrucosa, Lepidosperma drummondii, Lyginea barbata, Phebalium tuberculosum, Schoenus sp., Spyridium complicatum. Soil in both areas is reddish yellow, fine sandy loam, well drained and ca 40% laterite in the sparser areas and moderately drained and ca 60% laterite in the denser areas with Acacia.

Acacia stereophylla shrubland

A. stereophylla shrubs, 1.5-3 m tall, 30-70% cover over Baeckea muricata, B. sp. and Thryptomene affin. australis and Calothamnus gilesii shrubs, 1-2 m tall, 30-70% cover. Other species, recorded were: Acacia neurophylla, Amphipogon debilis, Cassytha glabella, Casuarina acutivalvis, Dianella revoluta, Ecdeioidea monostachya, Eucalyptus leptopoda, Grevillea excelsior, Hakea coriacea, Melaleuca oldfieldii, Phebalium tuberculosum, Schoenus affin. globifer. Soil brownish yellow fine sandy clay loam with ca 60% latente. Moderately drained.

Casuarina acutivalvis shrubland

C. acutivalvis shrubs 3-5 m tall, 30-70% cover over understory as for Acacia stereophylla shrubland but 10-30% cover. All species were the same except Dianella revoluta, Ecdeiocolea monostachya and Grevillea excelsior were absent in this association.

Lithic complex

Large pavements and rounded outcrops of granite gneiss with Parmelia and other lichens, and Grimmea moss. Soil pockets of variable depth with heathy or shrubland formations and runoff areas and surrounding flats with shrublands or woodland.

A species list and distribution is set out below.

	Tumbled boulders	Shallow soil pockets	Deep soil pockets	Runoff areas	Marginal flats
Acacia dentifera	X	X			
A. fauntleroyi			X		
A. lasiocalyx			X	X	X
A. sessilispica			X		
Alyxia buxifolia				X	X
Amphipogon caricinus	X				
A. debilis			X		X
Baeckea sp.			X		
Borya nitida		X	X		
Brachysema daviesioides					X
Calothamnus asper		X	X	X	X
Calycopeplus helmsii	X	X	X	X	X
Casuarina campestris		X	X	X	
C. huegeliana			X	X	X
Chamaexeros fimbriata					X
Cheilanthes tenuifolia	X	X	X	X	
Comesperma scoparia					X
Dodonaea attenuata			X	X	X
D. inequifolia			X		
Eucalyptus kruseana			X		
Grevillea paniculata	X	X	X		
Hakea decurva			x		x
Hibbertia affin. glomerosa		X	X	X	
Isotoma petraea	X	X	X	X	
Juncus affin. pallidus				X	

Keraudrenia integrifolia	X				
Kunzea pulchella		X			
Leptospermum erubescens			X	X	X
Lepidosperma drummondii	X	X	X	X	
L. gracile	X	X		X	
Melaleuca hamulosa				X	X
M. preissiana			X	X	
Muhlenbeckia adpressa	X			X	
Persoonia striata					X
Pleurosaurus rutifolius	X				
Prostanthera sp. 1.					X
Ptilotus obovatus	X				X
Santalum spicatum			X		X
Solanum nummularium	X		X		
Stypandra imbricata	X	X	X	X	
Thryptomene australis			X	X	X

WHEATBELT REGION

Burracoppin Reserve No.18198

202 ha.

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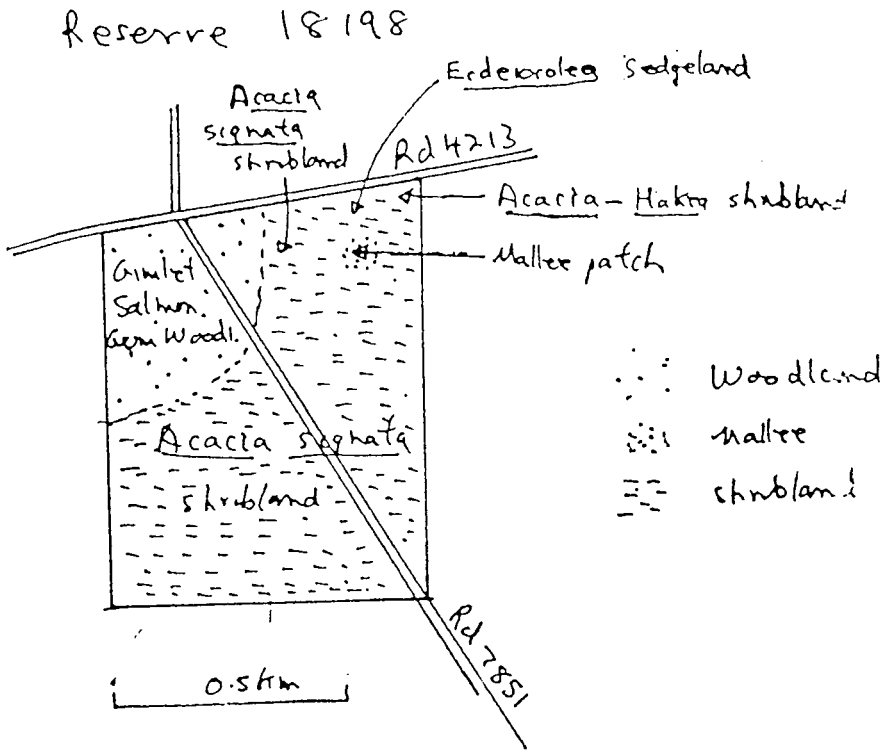

VEGETATION DETAILS RESERVE 18198

Gimlet-Salmon Gum woodland

Eucalyptus salubris and E. salmonophloia trees, mature, 16-24 m tall, 2-10% canopy cover over mixed shrubs (no particular dominant) mature, 1 m tall, 2-10% canopy cover. Other species recorded were: Acacia graffiana, Bassia diacantha, B. forrestiana, Eremophila drummondii, Grevillea acuaria, Olearia muelleri, Santalum acuminatum, Stipa elegantissima, Templetonia sulcata. Soil light reddish brown, fine sandy clay loam. Poorly drained.

Mallee patch

Eucalyptus redunca shrub mallee, mature, 4-7 m tall, 10-30% canopy cover. No understory in the centre of the stand, but the margins have Melaleuca uncinata shrubs, mature, 1.5-2.5 m tall, 30-70% canopy cover. The central area has only Dianella revoluta, Olearia revoluta, Patersonia sp. and Phebalium filifolium present. Margins have these species and also Acacia signata, Beyeria leschenaultii, Ecdeiocolea monostachya, Hibbertia affin. aurea, Lepidosperma drummondii, Patersonia sp., Persoonia striata, Phebalium tuberculosum and Platysace effusa. Soil light brownish grey, loam. Poorly drained.

Acacia signata shrubland

Acacia signata shrubs, mature, stratum 3-4 m tall, 70-100% canopy cover. No understory but the following species were present: Baeckea crispiflora, Casuarina corniculata, Eucalyptus drummondii, Hakea multilineata, Melaleuca cordata, Phebalium sp., Schoenus sp., Stipa elegantissima. Soil yellow, light sandy clay loam with ca 70% laterite. Well drained.

Acacia-Hakea heath

Acacia signata, Hakea falcata shrubs, immature, stratum 0.5-2 m tall, 30-70% canopy cover over Ecdeiocolea monostachya and mixed shrubs, mature, stratum 1 m tall, 30-70% canopy cover. Numerous other species were present. Acacia dielsii, A. signata, Beaufortia macrantha, Borya nitida, Casuarina acutivalvis, Choretrum pritzellii, Grevillea ?pritzellii, Hakea falcata, Harperia lateriflora, Lepidosperma drummondii, Leucopogon hamulosus, Melaleuca cordata, M. platycalyx, M. scabra, M. uncinata, Persoonia coriacea, P. striata, Santalum acuminatum, Schoenus sp. Soil yellow, sandy loam with ca 5% laterite. Well drained.

Ecdeiocolea sedgeland

Ecdeiocolea monostachya sedges, mature, stratum 0.4 m tall, 30-70% canopy cover. Also present were: Acacia dielsii, A. signata, Baeckea crispiflora, B. ?floribunda, Chamaexeros fimbriata, Eriostemon sp. B, Eucalyptus drummondii, Grevillea hookerana, G. paradoxa, Harperia lateriflora, Lepidosperma tenue, Lygenia tenax, Melaleuca cordata, Phebalium filifolia, P. tuberculosum, Philotheca drummondita, Platysace effusa, Schoenus sp. Soil brownish yellow, clayey sand with ca 30% laterite. Well drained.

WHEATBELT REGION

CAIRN ROCK NATURE RESERVE No.9754

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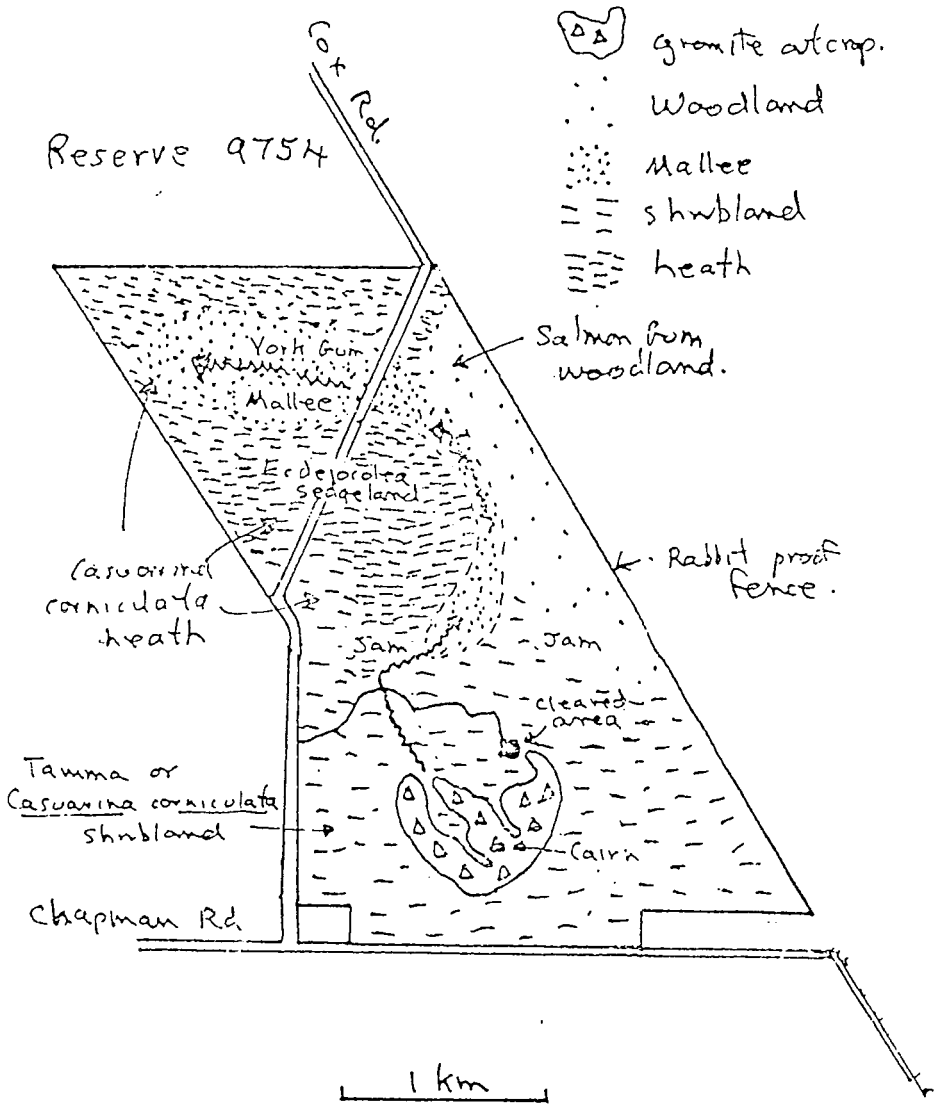


VEGETATION DETAILS RESERVE 9754

Salmon Gum woodland

Eucalyptus salmonophloia trees, mature, 16-22 m tall, ca 2% canopy cover over Eucalyptus loxophleba trees, mature, 4-9 m tall, 10-30% canopy cover (but patchily distributed) over Lomandra effusa herbs, mature, 0.5 m tall, 2-10% canopy cover. Other plant species recorded were: Acacia acuminata, A. colletioides, A. graffiana, A. merrallii, Borya nitida, Dianella revoluta, Melaleuca eleutherostachya, Podolepis capillaris, Santalum acuminatum. Soil pink, light sandy clay loam. Poorly drained.

Jam woodland

Acacia acuminata trees, mature, stratum 4-7 m tall, 10-30% canopy cover (but patchily distributed). No understory present except scattered plants of: Lepidosperma gracile, Lomandra effusa, Santalum spicatum, Stipa elegantissima. Soil light red, light clay. Poorly drained.

York Gum Tree Mallee

Eucalyptus loxophleba tree mallee, mature to senescent, stratum 4-9 m tall, 30-70% canopy cover. Understory absent except for scattered plants of: Acacia acuminata, Borya nitida, Casuarina campestris, Santalum acuminatum, Spartochloa scirpoidea and Stipa elegantissima. Soil light brownish grey, sandy clay. Poorly drained.

Casuarina corniculata heath.

Casuarina corniculata shrubs, mature, stratum 1.5-2 m tall, 30-70% canopy cover over Ecdeiocolea monostachya sedge, mature, stratum 0.5 m tall, 2-10% canopy cover. Scattered Eucalyptus drummondii and Hakea multilineata shrubs emergent to 5 m tall. Also recorded were: Astroloma serratifolium, Baeckea crispiflora, B. sp., Bertya cunninghami, Cassytha glabella, Chamaexeros serra, Cyperaceae gen. 1., Grevillea ?didymobotrya, G. paradoxa, Hakea falcata, Lepidosperma drummondii, Melaleuca oldfiel Phebalium tuberculosum, Platysace effusa, ?Schoenus sp. Soil yellowish brown, fine sandy loam with ca 10% gravel. Moderately drained.

Ecdeiocolea sedgeland.

Ecdeiocolea monostachya sedge and some shrubs, mature, stratum 0.5 m tall, 70-100% canopy cover. Other plant species recorded were: Acacia dielsii, A. filifolia, Baeckea crispiflora, Borya nitida, Casuarina campestris, Cryptandra myriantha, C. sp. 11, Grevillea didymobotrya, G. paradoxa, Hakea subsulcata, Leucopogon hamulosus, Melaleuca oldfieldii, M. pungens, M. uncinata, Platysace effusa, Schoenus sp. Soil yellowish brown, fine sandy loam with ca 60% gravel. Poorly drained.

Granite outcrop.

The granite outcrop on Reserve 9754 has a great diversity of altitudinal variation, drainage characteristics and depth of soil. This has resulted in a great variety of herb, shrub and tree stands. The variation is so great over short distances that the only classification possible was the broad categories of: bare rock surface; cracks, boulder heaps and shallow soils; and deep soil pockets.
Bare rock surface: the areas of bare rock had abundant growth of lichens and mosses. The commonest species were Parmelia spp. lichens and Grimmea sp. moss.

Cracks, boulder heaps and shallow soils: scattered shrubs growing opportunistically. Species included Acacia acuminata, A. saligna, Alyxia buxifolia, Cheilanthes tenuifolia, Dodonaea attenuata var. linearis, Kennedia prostrata, Kunzea pulchella, Lepidosperma scabrum, Leptospermum erubescens, Muhlenbeckia adpressa, Pittosporum phylliraeoides, Pleurosorus rutifolius, Santalum spicatum, Spartochloa scirpoidea, Stackhousia viminea, Verticordia drummondii.
Deep soil pockets: three types were most common.

1. Thryptomene australis shrubs, 1-1.5 m tall, 70-100% canopy cover. Other species recorded were: Acacia acuminata, A. dentifera, A. saligna, Cheilanthes tenuifolia, Dodonaea attenuata var. linearis, Lepidosperma scabrum, Leptospermum erubescens, Melaleuca macronycha, Muhlenbeckia adpressa, Prostanthera sp. 1, Spartochloa scirpoidea, Stypandra imbricata.

2. Leptospermum erubescens shrubs, 1-4 m tall, varying from 2-30% canopy cover. Species as for type 1 above.

3. Casuarina huegeliana trees, 3-9 m tall 10-30% canopy cover. Often occurs as a stand with type 2 (Leptospermum erubescens) as an understory.

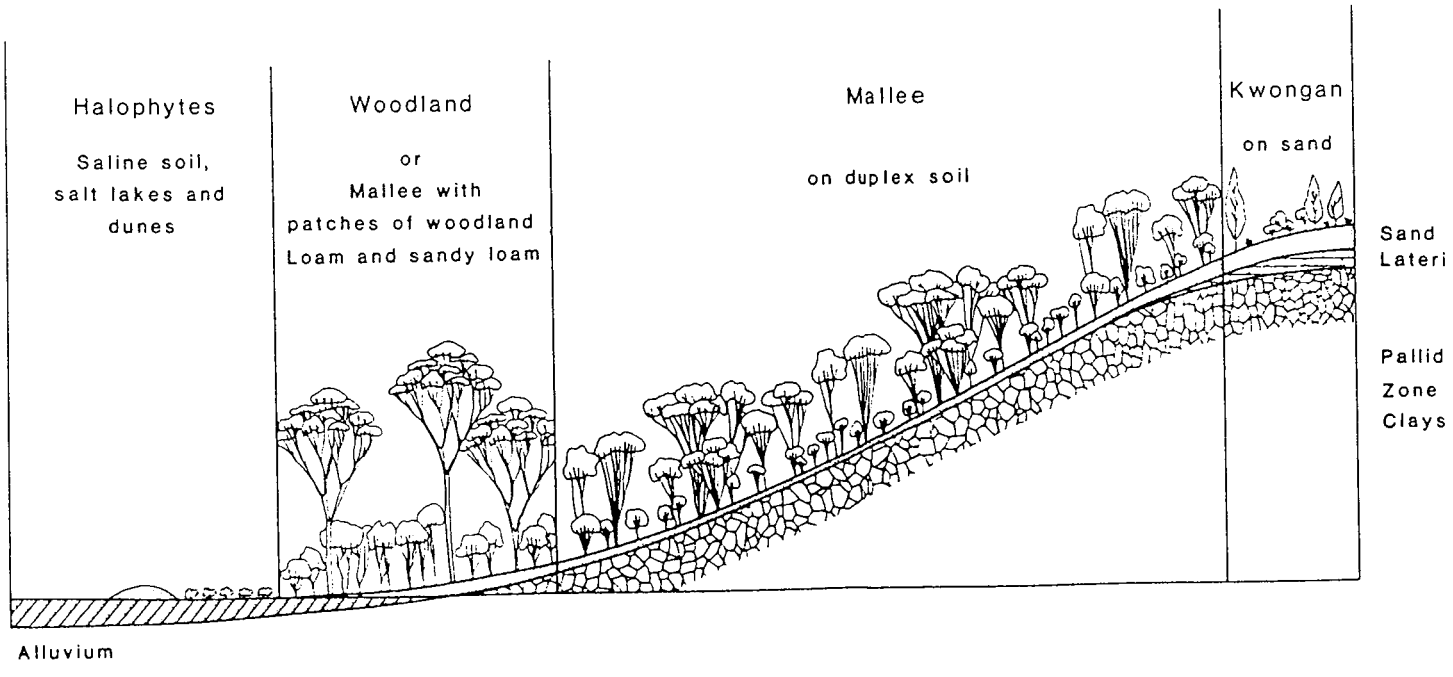
THE MALLEE REGION

Reproduced from Beard, "The Vegetation of the Corrigin Area" 1980

ROE BOTANICAL DISTRICT

THE HYDEN SYSTEM

The Hyden System which occupies the eastern third of the Corrigin sheet south of South Kumminin is a very extensive one, occupying fully half of the adjoining Hyden Sheet to the east and a like proportion of the Newdegate sheet (Beard 1972a,c). It is one of the largest components of the Roe District. The landscape is very gently undulating with wide flat valleys and long gentle slopes rising to broad interfluves. The latter are capped as elsewhere by residual laterite and sand of the prior land surface, but these deposits have seldom any definite margins such as breakaways. Perhaps due to the gentle slopes soils are very variable and the highly mosaic character exhibited by the vegetation of the Wheatbelt becomes even more pronounced. The plant cover varies in structure and composition every few yards. Mapping is complicated by this and even more by the frequent fires which take place and eliminate or obscure the vegetation patterns seen in aerial photography. It is usually only possible to map accurately those categories which give pronounced photo-patterns, e.g. rock outcrops, woodland relative to shrublands, salt flats and lakes. Types of shrubland may be difficult or impossible to distinguish from one another. However on a broad scale it is possible to say that there is a characteristic catena in the Hyden System comprising Kwongan (heath and thicket) on sandplains, mallee on the slopes covering the bulk of the area, mallee with patches of woodland on upper valley soils, woodland on lower valley soils, and in saline areas a mosaic of woodland, shrubland and samphire.



Two large reserves to the east of Bendering (Nos. 25681 and 20388) and one on the southern margin of the map (29857) were included in the W.A. Museum's Biological Survey of the Wheatbelt and were examined in considerable detail (Muir 1976, 1977a&b), providing a valuable sample of the higher-lying communities in the System. Three other reserves were examined later by Muir (1978-79), one by George and Hnatiuk (unpub.), others by the writer in the course of field traverses. The two Bendering Reserves 20388 and 25681 are only 7 km apart and basically similar. 25681 is more varied and contains medium-height woodlands which are barely represented in 20388. The two reserves may for practical purposes be treated together. The structure, dominance and other principal features of the communities recognized will be dealt with first, followed by a general discussion of floristics.

WOODLAND

Medium-height woodlands of *E.loxophleba* and *A.acuminata*, *E.loxophleba* and *E.salmonophloia*, *E.wandoo* and *E.salubris* occur in 25681, of *E.salmonophloia* and *E.salubris* in 20388. Height and density are variable and some stands were less than 10 m tall at the sampling point, bringing them into the low woodland class. However, heights of up to 12-15 m are common, with *E.salmonophloia* capable of reaching 22 m. Canopy cover may be as little as 2% or as high as 70%. Lower layers tend to vary with species. *E.loxophleba* usually has a small tree layer of *Acacia acuminata* and *Santalum spicatum* 2-5 m and a ground layer of sedges with annual grass and forbs in winter. *E.wandoo* covers scattered shrubs, mainly *Gastrolobium crassifolium*. *E.salmonophloia* and *E.salubris* commonly have a scattered tall shrub layer of *Melaleuca* spp., or in some cases here of mallee, with scattered smaller shrubs especially *Acacia erinacea* and *Templetonia sulcata*, the ground layer being of *Borya nitida* and *Wilsonia humilis*.

LOW WOODLAND

Muir (1977) did not distinguish woodland from low woodland but it is considered important in the mallee region to distinguish woodlands as comprised in the previous section which occur elsewhere in the wheatbelt from the stands of smaller trees or "marlocks" which replace them in the mallee. For example, *Eucalyptus astringens* (Brown Mallet) which occurs on laterite plateaux and breakaways further west is replaced by *E.falcata* (White Mallet) and *E.gardneri* (Blue Mallet) in that habitat. There are small occurrences of *E.astringens* in 25621 but it is below the breakaway and no longer on laterite. *E.annulata* replaces *E.salubris* on very heavy clay. Other

marlocks (e.g. *E.diptera, E.platypus, E.spathulata)* not found here play similar roles elsewhere in the mallee region. Marlocks are tender to fire and regenerate from seed, forming even-aged stands of single-stemmed trees (Beard 1967). The principal low woodland association found here is of *E.falcata* and *E.gardneri* on laterite. Height is usually about 6-8 m and the cover fairly heavy, 30-70%. Examples of old stands up to 16 m tall were found, and these were more sparse. *E.redunca* and *E.flocktoniae* may at times be significant associates, other casual spp. recorded were *E.burracoppinensis,* (only an under-shrub), *F.foecunda, E.incrassata* and *E.pileata.* Stands of *E.astringens* 8-10 m and 30-70% occur as previously noted; *Callitris canescens* was recorded twice, once on laterite and once on granite, 3-5 m tall. All these stands have shrub understories similar to that of mallee.

MALLEE

Mallee is very widespread in both reserves. Muir (1977) distinguished seven associations in 25681 and 16 in 20338 but it is not clear whether these represent chance combinations encountered at sampling points or are genuine communities related to soil characteristics. Mallee proper is distinguished from *Eucalyptus burracoppinensis* communities which are treated below under mallee-heath. The following species form mallee in the two reserves : *Eucalyptus annulata, E.calycogona, E.celastroides, E.cylindriflora, E.eremophila, E.falcata, E.foecunda, E.gardneri, E.incrassata, E.loxophleba, E.pileata, E.redunca, E.sheathiana, E.transcontinentalis.* True mallees, as distinct from marlocks occurring with them, are coppicing species which resprout from a rootstock after fire and are thus multi-stemmed. Classification as mallee is based on this characteristic, and Muir (1977) distinguished both tree mallee and shrub mallee on the basis of number of stems. Height is variable, probably related in most cases to age of the stand. A very old *E.redunca* of 16 m was measured. No doubt if fire could be eliminated the climax would be low woodland. Most mallee stands are about 3-5m tall with canopy cover in the range 10-30%. There is normally a dense understory of sclerophyll shrubs 1-2 m in height.

MALLEE HEATH

Seven associations dominated by *E.burracoppinensis* occur in 20338 : they are absent from 25681 though the species does occur there individually. The illustration Plate 4 in Muir (1977a) shows "a typical *Eucalyptus burracoppinensis* mallee association on Bendering Reserve. Numerous clumps of *E.burracoppinensis* are scattered over a heath-like understory of many species

of shrubs. Occasional *Grevillea eriostachya* or *Hakea coriacea* stand above the mallee stratum at this location." In comparison with other mallees, *E.burracoppinensis* is of spreading, straggly growth. Its occurrence in heathland produces a formation comparable with that dominated by *E.tetragona* on coastal sandplains of the south-east, which has been termed mallee-heath by Beard (1967, 1972c, 1973b). Muir (1977a) recognised the aberrant character of *E.burracoppinensis* communities, noting that ten species of mallee found in 20338 did not associate with *E.burracoppinensis*. Five others did but occurred rarely, whereas they were common in other mallee associations. *E.burracoppinensis* can occur occasionally in other mallee as well as in Kwongan associations. Muir however was unable to find any very positive differences in soil profiles to distinguish *E.burracoppinensis* sites from others. These associations are found only on gradational acid soils but other mallee associations can also so occur, as well as on uniform and neutral soils. Although *E.burracoppinensis* associations appear to be related to shrublands and heaths as much as to mallee, these all occurred on uniform profiles, usually neutral in reaction. *E.burracoppinensis* soils were more yellow in colour than other mallee soils. Muir suggested that there may be some differences in soil chemistry which require further examination.

The upper layer in the mallee-heath varies from 1 to 5 m in height with an extreme of 6-8m. Cover is variable, the classes 2-10%, 10-30% and 30-70% all being recorded. The lower heath layer may be any height up to 1m, and density from 10 to 100%.

SHRUBLANDS

Shrublands of Muir exceed 2 m in height : lower shrublands are classified as heath. In 25681 the shrublands are all thickets mostly dominated by *Casuarina acutivalvis* and/or *C.campestris*, but in two examples by *Acacia signata* and in one by *Melaleuca uncinata*. These are normally 2-3 m tall with 70-100% canopy cover. An understory is formed by numerous species but relatively sparse. In 20388 the same *Casuarina* thickets are common, also *Acacia* thickets but with *A.acuminata* dominant and a *Melaleuca* thicket with *M.lateriflora* and *M.acuminata*, along a watercourse. In addition numerous examples were listed which are structurally scrub-heath, that is there is an open upper stratum of large shrubs 2-4 m tall and a denser lower layer of smaller shrubs. In every case *Casuarina acutivalvis* is dominant together with taller elements of the shrubland flora and the lower layer is formed by much the same species as in the thickets, growing more abundantly. This community corresponds closely to the "mixed Kwongan" recognised by Beard (1980a&b) in various vegetation

systems in the Avon District. The various thicket associations have also been previously encountered. Individual component species may vary locally due to climatic differences but the dominants are usually the same and it is evident that certain floristic alliances can be traced.

HEATH

Heath formations are so classified if height does not reach 2 m but in many cases they appear to be similar in other respects to shrubland formations. Stratification is the same but less tall and the dominants may be the same especially *Casuarina acutivalvis*. In other cases there is no such similarity. The structure of scrub-heath is general, i.e. an upper open layer of large shrubs not exceeding 2 m and a lower closed layer of smaller shrubs. Mixed species mainly Proteaceae make up the upper layer without distinct patterns, except that *Dryandra cirsioides* may be conspicuous where laterite is present. In still other cases only a low heath layer is present, without distinctive dominants. No definite or consistent soil characteristics were found to explain the differences between heath and shrubland except the apparently contradictory feature that heath soils tend to have a higher clay content, contrary to the general impression that heath soils should be sandy. Height differences do not appear to be related to age since most examples were recorded as mature and ages from 10 to 19 years were inferred.

ROCK OUTCROPS

Outcrop areas tend to carry very complex mosaics of several associations. In 25681 at location 5.6 bare granite rock with moss *(Grimmea* sp.) and lichens (mostly *Parmelia* spp.) has developed shallow layers of soil supporting *Borya nitida* herbs and some shrubs, notably *Leptospermum erubescens, Dodonaea attenuata* and *Hibbertia enervia*. Where soil is deeper low woodland of *Acacia lasiocalyx* or thickets of *Casuarina campestris* form a mosaic. *Acacia acuminata* low woodland frequently surrounds outcrops or forms the cover between expanses of granite pavement. All of these may contain scattered *E.loxophleba* trees.

BREAKAWAYS

In 25681, location 6.1, the platform above the breakaways is covered by *Casuarina campestris* thicket and also the scree area except for a portion where a laterite scarp 1-2 m high is present, and here the scree has *Eucalyptus astringens* low woodland. Breakaways in 20338 on the other hand, figured in Plate 8 of Muir (1977a) are much more pronounced features, higher and steeper. No special vegetation is found on the platform. The scarp and the scree are virtually bare of vegetation. The outwash zone at the foot is sparsely vegetated with *Callitris canescens* trees up to 5 m tall interspersed with shrubs such as *Melaleuca undulata* and *Grevillea huegelii*.

Flora list for the Bendering and West Bendering Reserves,

from Muir (1977a&b).

	Woodland	Low Woodland	Mallee	Mallee-heath	Thicket & Scrub-heath	Heath
SHRUBS						
Acacia acanthoclada		x	x		x	
A.acuaria					x	x
A.acuminata	x	x	x	x	x	x
A.aff.andrewsii			x			
A.assimilis			x		x	x
A.aff. bidentata			x			
A.brachyclada	x					
A.celastrifolia		x				
A.deflexa						x
A.densiflora			x			
A.dermatophylla	x					
A.desertorum		x	x	x		x
A.dielsii		x	x			x
A.erinacea	x		x			
A.fragilis			x			
A.graffiana	x		x			
A.jacksonioides					x	
A.lasiocalyx		x	x		x	x
A.mackayana			x			
A.merrallii	x		x			
A.microbotrya	x					
A.multispicata	x	x	x			x
A.myrtifolia		x				
A.pulchella		x	x			x
A.sclerophylla		x	x			
A.sedifolia					x	
A.signata				x	x	
A.sulcata	x		x	x	x	x
A.aff.tamminensis			x			
Actinostrobus arenarius			x			
Adenanthos argyrea			x	x	x	x
Alyxia buxifolia			x			
Astartea heteranthera		x	x	x		
Astroloma epacridis	x					
A.serratifolium		x	x	x	x	x
Baeckea sp.			x			
B.aff.muricata			x			
Banksia sphaerocarpa				x	x	x
Beaufortia bracteosa				x	x	x
B.micrantha						x
B.orbifolia			x			
Bertya cunninghamii		x	x	x	x	
Beyeria leschenaultii		x	x		x	
Boronia capitata						x
B.ternata		x		x	x	
Brachyloma concolor		x	x		x	
Callistemon phoeniceus			x			x
Callitris canescens		x	x		x	x
C.preissii		x	x			
C.roei		x	x			
C.verrucosa			x			x
Calothamnus asper						x
C.aff.gilesii					x	x
C.quadrifidus			x		x	x
Calycopeplus glomeratus				x		
Calytrix brachyphylla		x	x		x	x
C.empetroides				x		x
C.fraseri	x	x	x		x	x
Casuarina acutivalvis		x	x	x	x	x
C.campestris	x	x	x		x	x
C.corniculata			x		x	
C.aff.huegeliana		x				
C.humilis						x
C.microstachya						x
Chamaelaucium sp.				x	x	
C.megapetalum						x

	Woodland	Low Woodland	Mallee	Mallee-heath	Thicket & Scrub-heath	Heath
Choretrum glomeratum		x	x			x
C.pritzelii			x		x	x
Chorizema ericifolium						x
Coleanthera myrtoides		x				
Comesperma volubile					x	
Conospermum amoenum			x		x	
C.stoechadis						x
Cryptandra miliaris			x			x
C.parvifolia			x			
C.polyclada			x			x
C.pungens						x
C.tomentosa		x	x			
C. sp.			x			
Daviesia acanthoclona		x	x	x	x	
D.aphylla				x		x
D.brevifolia	x				x	x
D.cardiophylla					x	x
D.colletioides			x		x	x
D.aff.decurva						x
D.aff.preissii						x
D.teretifolia	x					
D.uniflora				x		
Dicrastyles sp.			x			
Dodonaea amblyophylla	x					
D.bursariifolia		x	x			
D.caespitosa	x					
Dryandra aff. cirsioides		x	x	x	x	x
D.ferruginea			x	x	x	x
D. sp. A.						x
D. sp. B.						x
Eremaea pauciflora		x	x			x
Eremophila saundersiana			x			
E.aff.brevifolia	x					
E.woolsiana	x					
E.sp.						x
Eriostemon aff. gardneri						x
Eucalyptus annulata			x			
E.astringens		x				
E.burracoppinensis		x	x	x	x	x
E.calycogona	x		x			
E.celastroides			x			
E.cylindriflora			x		x	
E.eremophila	x		x	x		
E.falcata		x	x			
E.foecunda		x	x	x	x	x
E.flocktoniae	x	x				
E.gardneri		x	x		x	
E.incrassata		x	x			x
E.loxophleba	x		x		x	
E.ovularis	x					
E.pileata		x	x	x		x
E.redunca		x	x		x	x
E.salmonophloia	x				x	
E.sheathiana			x			
E.transcontinentalis			x			x
E.wandoo	x					
Exocarpos aphyllus	x	x	x		x	
Gastrolobium crassifolium	x	x	x			
G.hookeri						x
G.spinosum		x	x	x	x	x
G.trilobum			x			
Goodenia helmsii			x			x
G.pinifolia		x	x	x	x	x
G.scapigera		x				x
Grevillea aff. acuaria	x					
G.asteriscosa		x				
G.eriostachya				x		x

	Woodland	Low Woodland	Mallee	Mallee-heath	Thicket & Scrub-heath	Heath
G.ericoides			x			x
G.aff.filifolia					x	
G.hookerana		x	x	x	x	x
G.huegelii	x	x	x			
G.integrifolia			x	x		x
G.pritzelii						x
Hakea adnata	x	x	x	x		x
H.ambigua			x			x
H.baxteri						x
H.coriacea				x		
H.corymbosa			x			x
H.crassifolia			x			x
H.falcata			x	x	x	x
H.incrassata			x			x
H.lehmanniana					x	x
H.lissocarpha		x	x			x
H.multilineata		x	x	x	x	x
H.scoparia		x	x	x	x	x
H.aff.sulcata		x				
H.subsulcata		x	x			x
Halgania sp.	x					
Hemigenia diplanthera						x
Hibbertia enervia		x			x	
H.lineata				x		
H.pungens						x
H.stricta				x	x	x
H.uncinata					x	
H.verrucosa		x	x			
Hypocalymma puniceum			x	x		
Isopogon polycephalus		x	x	x	x	x
I.scabriusculus				x	x	x
I.teretifolius						x
Jacksonia aff.racemosa		x	x	x	x	
Lasiopetalum indutum			x			
Lechenaultia biloba			x			x
Leptomeria sp.						x
Leptospermum erubescens	x	x	x	x	x	x
Leucopogon blepharolepis			x		x	x
L.crassifolius				x	x	x
L.dielsianus			x		x	x
L.hamulosus			x			x
L.minutifolius			x			
L.phyllostachys					x	x
Lhotzkya violacea	x					
Lysinema ciliatum					x	x
Melaleuca acuminata	x	x	x		x	x
M.adnata	x	x	x			
M.cardiophylla			x		x	x
M.cordata		x	x	x	x	x
M.aff.cuticularis		x	x	x		
M.aff.densa			x			
M.eleutherostachya	x	x	x		x	
M.fulgens					x	
M.hamulosa	x	x	x		x	
M.lateriflora	x		x		x	
M.lateritia			x			x
M.laxiflora	x	x	x		x	x
M.pauperiflora	x					x
M.platycalyx			x			x
M.pungens		x		x	x	x
M.radula			x			
M.scabra	x	x	x			
M.seriata						x
M.spathulata			x	x	x	x
M.spicigera		x	x		x	x
M.subtrigona			x		x	x
M.uncinata	x	x	x	x	x	x
M.undulata			x			
Micromyrtus imbricata			x	x	x	x
M.aff.racemosa					x	
Olearia aff. adenolasia	x					
O.muelleri	x		x		x	
O.revoluta	x		x			

	Woodland	Low Woodland	Mallee	Mallee-heath	Thicket & Scrub-heath	Heath
Oxylobium sp.					x	
Persoonia coriacea		x		x	x	x
P.aff.saundersiana		x			x	
P.striata			x	x	x	
P.teretifolia						x
Petrophile conifera					x	x
P.divaricata				x	x	
P.ericifolia		x	x	x	x	x
P.seminuda			x	x	x	x
P.shuttleworthiana					x	x
P.squamata					x	x
Phebalium ambiguum				x		
P.filifolium		x			x	
P.tuberculosum		x	x		x	
P.verrucosum		x	x	x	x	
Philotheca drummondita						x
Pimelea nervosa			x			
P.sylvestris		x	x	x		x
Pityrodea axillaris					x	x
Platysace effusa					x	
P.maxwellii		x	x		x	x
Rhagodia preissii	x					
R. sp.	x					
Santalum acuminatum	x	x	x	x	x	x
S.spicatum	x		x			x
Synaphea petiolaris				x		x
S.polymorpha					x	x
Templetonia sulcata	x		x			
Thryptomene australis			x		x	
T.aff.prolifera		x				
Thomasia tenuivesta	x					
Verticordia brownii					x	x
V.chrysantha				x		x
V.picta						x
V.plumosa						x
V.roei						x
V.serrata					x	x
Westringia cephalantha		x				
W.sp.		x	x		x	
Xanthorrhoea nana			x			x
HERBACEOUS						
Borya nitida	x		x		x	x
Dampiera eriocephala			x		x	x
D.aff.juncea						x
D.sacculata			x			
D.tomentosa					x	
Dianella revoluta	x	x				
Glischrocaryon flavescens		x	x			x
Harperia lateriflora		x			x	x
Inula graveolens				x		
Laxmannia sp.					x	
Lepidosperma brunonianum					x	x
L.drummondii	x	x	x	x	x	x
L.effusum					x	x
L.gracile		x	x	x		x
L.aff.tenue	x					
L.tuberculatum			x			
Lobelia heterophylla						x
Loxocarya fasciculata						x
L.sp.		x	x			
Lomandra effusa	x					
Mesomelaena uncinata						x
Podolepis capillaris	x					
Ptilotus sp.			x			
Spartochloa scirpoidea	x		x		x	x
Stylidium repens	x		x		x	
Schoenus brevifolius					x	
S.compressus				x		
Stackhousia pubescens						x
Waitzia acuminata	x					
Wilsonia humilis	x		x			

THE DUMBLEYUNG DISTRICT

AND THE DONGOLOCKING GROUP OF RESERVES

Reproduced from Beard, "The Vegetation of the Dumbleyung Area" 1980

THE DUMBLEYUNG SYSTEM

This System occupies the central portion of the map sheet including the town and lake of Dumbleyung. It lies east of the Wagin System and receives a lower rainfall. The southern limit is at Lake Coyrecup and the eastern boundary is drawn on entering country where mallee is predominant. The country is gently undulating with scattered residual laterite cappings. These are more frequent in the north. Salt flats and lakes occupy the principal valleys, sometimes with associated sand deposits. An extensive tongue of sandplain north-east of Coomelberrup Lake is most likely an aeolian deposit as its shape and WNW-ESE orientation suggests. The general catena in the System is of *Dryandra*-dominated heath on laterite residuals, woodland and low woodland of the "mallets" *Eucalyptus astringens, E.falcata* and *E.gardneri* on degraded laterites and laterite wash, woodland of *E.loxophleba, E.longicornis, E.salmonophloia* and *E.wandoo* on the undulating country generally with frequent small patches of mallee, teatree and samphire on salt flats, scrub-heath and low woodland on low-level sandplains.

Detailed information is available from the study of the Dongolocking group of reserves Nos. 19082, 19083, 19085, 19096 and 20070 by the W.A. Museum (Muir 1978) which contain all principal formations in the System except those of salt flats and low level sandplains. Distribution of formations in the reserves was given as follows :

Woodland	60% of area
Mallee	6
Shrubland	2.6
Heath	30
Lithic complex	0.9
Breakaway complex	0.5

The reserves occupy relatively high ground and were originally set aside for the preservation of stands of mallet in the days when these were a valuable resource for tanbark, but as this industry had declined they were transferred to Conservation of Flora and Fauna in 1972. Further west, mallet occurs on breakaways and lateritic summits. Under the lower rainfall here as in the Tutanning Reserve (Beard 1980) summits are abandoned to heath and the mallets occur mainly on laterite wash, topographically below the breakaways. A detailed vegetation map of the reserves and some adjacent uncleared land is given in Muir (1978). Details follow.

HEATH

Heath is defined as closed to dense shrubland less than 2m tall. 10 types of "heath" were recognised by Muir in addition to the one discussed above but this variation is hardly surprising since the substrates vary from hard, compact laterite without soil in the ordinary sense through brown sandy loam to grey and white sands. It is perhaps more surprising that there is largely a common heath flora throughout, with response to soil differences expressed in changes in dominance, which in itself amounts to ringing the changes among a limited number of species. *Dryandra cirsioides* is a dominant in five of the ten associations and is characteristic of dense laterite substrates but occurs also on sandy loam and sand. *Banksia sphaerocarpa* is associated with sandy loam, *Casuarina humilis* and *Leptospermum erubescens* with bleached sand.

In most cases two strata of shrubs can be distinguished, usually 0.5 and 1.0 m tall respectively, but in one sample only the taller layer and in another the shorter was present. Odd trees or mallees may sometimes be present as emergents. A summarised list of the heath flora from Muir's samples is as follows.

Scattered trees (rare) : *Banksia attenuata, Casuarina huegeliana, Eucalyptus astringens, E.gardneri, E.incrassata, E.wandoo, Nuytsia floribunda.*

Shrubs : *Acacia cuneata, A.pulchella, Adenanthos argyrea, A.cygnorum, A.flavidiflora, Andersonia caerulea, Astartea heteranthera, Astroloma compactum, A.serratifolium, Baeckea grandibracteata, Banksia sphaerocarpa, Beaufortia bracteosa, B.incana, B.micrantha, Calothamnus planifolius, C.preissii, C. aff. villosus, Calytrix brachyphylla, C.fraseri, C.stipulosa, Casuarina humilis, C.microstachya, Chamaelaucium ciliatum, C.megalopetalum, Choretrum glomeratum, Cryptandra miliaris, Daviesia aff. acanthoclona, D.brevifolia, D.cardiophylla, D. aff. preissii, D.rhombifolia, D.variophylla, Dodonaea divaricata, Dryandra cirsioides, D.nobilis, D.nivea, D.sessilis, Dryandra* 2 spp. unidentified, *Eremaea pauciflora, Gastrolobium hookeri, G.laytonii, G.tricuspidatum, G.trilobum, Goodenia pinifolia, Grevillea* aff. *uncinulata, Hakea adnata, H.ambigua, H.baxteri, H.corymbosa, H.crassifolia, H.falcata,*

H.ferruginea, H.gilbertii, H.incrassata, H.lehmanniana, H.prostrata, H.trifurcata, Hibbertia enervia, Hypocalymma angustifolium, Isopogon drummondii, I.teretifolius, Lambertia ilicifolia, Leptospermum erubescens, Leucopogon dielsianus, L.hamulosus, L.minutifolius, L.phyllostachys, Lysinema ciliatum, Melaleuca conferta, M.pungens, M.seriata, M. aff. *subtrigona, Microcorys lenticularis, Micromyrtus imbricata, Olax benthamiana, Persoonia striata, Petrophile conifera, P.ericifolia, P.seminuda, P.squamata, P.stricta, Spyridium complicatum, Stirlingia latifolia, Verticordia brownii, Xanthorrhoea reflexa.*

Herbaceous : *Borya nitida, Conostylis breviscapa, C.* aff. *setigera, Dampiera* sp., *D.spicigera, D.* aff. *juncea, Harperia lateriflora, Lepidosperma gracile, L.pubisquameum, Loxocarya* sp., *L.fasciculata, Lyginea tenax, Mesomelaena uncinata, Neurachne* sp., Poaceae 2 spp., Restionaceae sp., *Schoenus brevifolius, S.compressus, S.curvifolius, S.* aff. *globifer, S.* 2 spp. unidentified, *Stipa hemipogon, Stylidium repens, Waitzia paniculata.*

The total of 120 species listed is very large. This flora is remarkable for the large number of species in *Calothamnus, Daviesia, Dryandra* and *Hakea*, and the small number in *Grevillea, Melaleuca* and *Verticordia*.

SHRUBLANDS

In Muir's terminology shrublands are distinguished from heath in exceeding 2 m in height. It was possible to recognise three strata instead of two, the uppermost 2 to 4 m in height. Soil is given as light grey sand which is probably deeper than in the heaths, the differences in stature and species composition being a response to this. *Lambertia inermis,* notoriously a deep sand species, is dominant in all four samples, with *Dryandra sessilis* or *D.cuneata*. With the small number of samples, with only two being enumerated in detail, 57 species were recorded, 18 of them not in the heath. These 18 were :

Acacia stenoptera, A.varia, Banksia baueri, Billardiera variifolia, Calytrix cephalantha, Cassytha sp., *Daviesia pachyphylla, Dodonaea amblyophylla, Dryandra cuneata, Eucalyptus foecunda, Gastrolobium spinosum, Hakea ruscifolia, Hibbertia verrucosa, Lambertia inermis, Lepidosperma tenue, Leucopogon* aff. *ozothamnoides, Melaleuca lateritia, Restio sphacelatus.*

MALLEE

Six species of mallee are present to dominate this formation which is only poorly represented in the reserves. These are *Eucalyptus albida, E.eremophila, E.foecunda, E.incrassata, E.redunca* and *E.transcontinentalis.* Of these *E.eremophila* is the most important and the most consistently present, followed by *E.redunca.* The mallets *E.falcata* and *E.gardneri* are also frequent but are not true mallees being single-stemmed non-coppicing species. The mallee unless immature is from 2 to 6 m in height forming an upper layer of variable density from 10% to 70% cover over shrub layers similar to those of the heath in both structure and composition with *Dryandra cirsioides, Gastrolobium* spp., *Leptospermum erubescens, Melaleuca pungens* and *M.uncinata* among the most conspicuous species. Mallee soils contain more clay than heath soils and are generally described as sandy clay of a light colour.

86 species were recorded for the mallee, 60 (70%) of which occur also in heath and shrubland. 50% of the heath species enter the mallee.

WOODLAND

As previously noted, there are two distinct types of woodland, mallet which occurs on lateritic wash and the other species York gum, salmon gum, morrell and wandoo which grow on soils derived from pallid zone clays. The mallets here are the brown mallet *Eucalyptus astringens,* the white mallet *E.falcata* (also present in its form var. *ecostata*), and the blue mallet *E.gardneri.* This is an intermediate zone where the three intermingle. *E.astringens* occurs principally further west and is a medium-height tree (10-30 m) while the other two occur mainly further east where they are small trees or marlocks under 10 m. The height of mallet stands here is variable, from 6 to 20 m. They tend to be fairly dense with 30-70% cover and are thus technically forest or low forest rather than woodland, and have little understory. The three mallet species associate variously with one, two or three species apparently randomly present. *E.longicornis* was present also in one sample. Relatively few associated species of smaller plants, only 23, were recorded owing to the sparseness of the understory. These were :

Shrubs : *Astroloma prostratum, Beaufortia bracteosa, Daviesia colletioides, Dodonaea bursariifolia, Dryandra cirsioides, D.drummondii, D.ferruginea, D.* sp., *Gastrolobium crassifolium, Hakea multilineata, H.nitida, Hibbertia recurvifolia, Melaleuca uncinata, Platysace maxwellii, Santalum acuminatum, Spyridium denticuliferum, Westringia cephalantha.*

Herbaceous : *Aira caryophylla, Lepidosperma angustatum, L.drummondii, L.gracile, L.tenue, Stipa hemipogon.*

Most of the other woodlands in the reserves are of *Eucalyptus wandoo* as may be expected in this high ground of lateritic ridges since wandoo soils normally occupy the upper part of the catena. However there is one enumerated sample of an *E.loxophleba* (York gum) stand and one of mixed *E.salmonophloia-E.longicornis* (salmon gum and morrell).

Wandoo, sometimes with morrell, are from 10 to 18 m in height and very variable density from 2% to 70% canopy cover. A 2-4 m layer of small trees of *Acacia acuminata* and *Casuarina huegeliana* is sometimes present. Scattered shrubs notably of *Gastrolobium crassifolium, Leptospermum erubescens* and *Melaleuca uncinata* are normally present and the ground is covered by *Borya nitida*, sedges and Restionaceae. Only four of the locations sampled were fully enumerated and these give the following list of 35 associated species :

Trees :	*Acacia acuminata, Casuarina huegeliana.*
Shrubs :	*Acacia lasiocarpa* var. *sedifolia, A.microbotrya, A.pulchella, Astroloma compactum, A.pallidum, A.serratifolium, A.* sp., *Daviesia brevifolia, Dryandra fraseri, D.nivea, D.sessilis, Gastrolobium crassifolium, Hakea lissocarpha, Hibbertia enervia, Hypocalymma puniceum, Leptospermum erubescens, Melaleuca* aff. *subtrigona, M.uncinata.*
Herbaceous :	*Angianthus pusillus, Borya nitida, Dampiera spicigera, Laxmannia* sp., *Lepidosperma brunonianum, L.gracile, L.scabrum, L.tenue, L.tuberculatum, Lomandra effusa, Loxocarya* sp., Poaceae. sp., *Stipa hemipogon, Waitzia acuminata.*
Climber :	*Billardiera variifolia.*

In the example of *E.salmonophloia-E.longicornis* woodland the trees are 14 to 20 m tall, 30 - 70% canopy cover. An understory of scattered shrubs and grasses is present but constitutes much less than 2%. *Acacia erinacea, A.microbotrya, Dodonaea* aff. *attenuata, Lomandra effusa,* Poaceae sp. and *Rhagodia preissii* were recorded. The only *E.loxophleba* sample is mixed with *E.wandoo* and has a small tree layer of *A.acuminata* and *C.huegeliana* and a ground layer of *Borya* and sedges. The wandoo are 14-20 m tall, the York gum only 8 - 10 m. No shrubs were recorded and the only ground plants were *Borya nitida, Lomandra effusa* and *Loxocarya* sp.

THE ESPERANCE PLAINS REGION

Reproduced from Beard,"The Vegetation of the Albany & Mt.Barker Areas, 1980.

EYRE BOTANICAL DISTRICT

Named originally by Diels after John Eyre who came through from Adelaide on the first land-based exploration in 1841, the Eyre District stretches from the Stirling Range and Mount Manypeaks as far as the Bight. It is the coastal sector of the mallee region where due to prolonged leaching of the soil over millions of years the plains consist only of poor sands unable to support more vegetation than heath with an open upper layer of stunted mallee - characterised as mallee-heath. True mallee is restricted to hills and valleys, while woodland is almost non-existent. This is a seeming anomaly as the coastal sector of course receives more rain than the better wooded country further inland, but it is explained by the poverty of the soil.

Six vegetation systems are represented.

QUALUP SYSTEM (Beard 1972)

The Qualup System is the most widespread and characteristic, covering the sandy gravelly plains north and south of the Stirling Range and extending east to the Phillips River beyond which it is continued by the very similar Esperance System to Cape Arid and Israelite Bay. South of the Stirlings the Qualup gives way to the Cape Riche System with a change in vegetation which cannot now after land clearing be exactly traced by means of aerial photo patterns and an arbitrary line has been drawn.

The principal formation is mallee-heath in which the conspicuous tallerack (*Eucalyptus tetragona*) is taken as the character species, growing on plains of sand overlying clay often with ironstone gravel. On deep sand the formation changes to scrub-heath in which mainly Protaeceous shrubs, e.g. *Lambertia inermis*, largely replace mallee. Mallee itself occurs on the lunettes of lakes. There is limited woodland along creeks coming down from the Stirling Range and along the Kalgan River. The plains are dotted with numerous salt lakes and pans or simply swampy depressions which contain *E.decipiens* mallee if sandy, *E.occidentalis* woodland if loamy.

In mallee-heath there is an open upper layer of tall shrubs capable of reaching perhaps 3.5m in height. These consist mainly of *Eucalyptus* but other shrubs, usually Proteaceae, may be present.

There is a lower layer, closed and about 50 cm tall when mature, of small shrubs which have typically small "ericoid" leaves. Profile diagrams illustrating the structure of *E.tetragona* mallee-heath were given by Beard (1972).

The character-species *E.tetragona* is conspicuous for its straggly growth and large very glaucous leaves. The stems are twisted and rambling, and form very open clumps.

A species list was made from various localities.

Small trees (rare):

Nuytsia floribunda

Grass trees :

Xanthorrhoea gracilis

Mallee :

Eucalyptus angulosa, E.buprestium, E.decipiens, E.decurva, E.flocktoniae, E.marginata, E.pachyloma, E.preissiana, E.redunca, E.tetragona, E.uncinata.

Other tall shrubs :

Acacia saligna, Agonis spathulata, Banksia sphaerocarpa, Beaufortia schaueri, Calothamnus sp., *Casuarina humilis, Dryandra falcata, D.proteoides, D.sessilis, Gastrolobium spinosum, Grevillea brownii, G.fasciculata, Hakea corymbosa H.pandanicarpa, H.prostrata, H.trifurcata, H.undulata, Isopogon buxifolius, I.formosus, I.longifolius, I.teretifolius, Kunzea preissiana, Lambertia ericifolia, L.inermis, L.uniflora, Melaleuca pungens, M.scabra, Petrophile ericifolia, P.serruriae, P.squamata, Regelia inops.*

Smaller shrubs :

Astroloma serratifolium, Banksia petiolaris, B.repens, Calectasia cyanea, Calytrix brachyphylla, Chorizema aciculare, Conospermum floribundum, Darwinia diosmoides, Daviesia incrassata, D.obtusifolia, Dryandra nivea, D.pteridifolia, Gompholobium burtonioides, Hibbertia cf. *recurvifolia, Kunzea* sp.aff. *recurva, Leschenaultia formosa, Leucopogon bracteolaris, Lysinema ciliatum, Stirlingia latifolia, Synaphaea spinulosa, Verticordia chrysantha, V.habrantha.*

Herbaceous :

Anigosanthos humilis, Conostylis villosa, Lomandra hastilis, Patersonia occidentalis, Stackhousia pubescens, Restionaceae spp.

Hamilla Hill, an outlying portion of the Stirling Range National Park at the western end and formed of the same quarzite as the Range, is covered by this mallee-heath with scattered wandoo trees. On Sukey Hill closer to Cranbrook the mallee-heath covers the north slope again with scattered wandoo and *E.decipiens*. Wandoo woodland covers the south slope.

On deep sand there is a radical change as follows, to the scrub-heath formation which may be seen on the plains south of Bluff Knoll, and in the Camel lake area north of the Range.

Tall shrubs :

E.decipiens replaces the other mallees and is subordinate to other large shrubs, notably *Adenanthos cuneatus, Banksia attenuata, B.baxteri, B.coccinea, Isopogon attenuatus, Lambertia inermis, Leptospermum erubescens, Melaleuca polygaloides. Nuytsia floribunda, Petrophile rigida.*

Smaller shrubs :

Actinodium cunninghamii, Burtonia scabra, Bossiaea linophylla, Conospermum amoenum, Daviesia incrassata, Hibbertia cf.*lineata, Leucopogon polymorphum, Pimelea modesta, Platytheca* sp., *Stirlingia latifolia, Verticordia habrantha.*

Herbaceous :

Anigozanthos humilis, Anarthria scabra.

Lambertia inermis becomes very abundant and is the commonest and most conspicuous shrub. *Hakea corymbosa* is common. Large open patches tend to occur with the dwarf Banksias and Dryandras *(B.petiolaris, B.prostrata, B.repens, D.nivea, D.pterifidolia)* and small ericoid shrubs *(Lysinema, Verticordia)*.

In damp sandy areas the mallee returns in the shape of *E.angulosa, E.falcata, E.tetragona* and *E.uncinata. Melaleuca exarata* is conspicuous among the ground plants.

E.decipiens may occur as an understory species to *E.occidentalis* woodland in hollows or be peripheral to it. Other mallees notably *E.lehmannii, E.falcata, E.preissiana* and *E.buprestium* may similarly occur fringing patches of woodland.

The principal occurrence of mallee in the system is on the curving, parallel sand ridges known as lunettes on the south-east side of Lake Quarderwardup and its adjacent salt lakes. Principal species are *Eucalyptus angulosa, E.decipiens* and *E.tetragona* associated with *Banksia media, Beaufortia squarrosa, Callitris roei, Hakea corymbosa, H.laurina, Lambertia inermis* and *Nuytsia floribunda.*

Strips of jarrah-marri woodland are found along streams descending from the Stirling Range and pure stands of marri occur round the southeastern salt lakes in the National Park, e.g. at Kojaneerup Spring. In the valleys of the Pallinup and Kalgan Rivers there are woodlands of York gum and yate as in the Chidnup System, and more or less circular patches of yate growing in hollows dot the plains.

STIRLING RANGE SYSTEM

This system is associated with the Range of that name and covers the slopes, peaks and valleys. Surrounding plains and pediments are included in the Qualup System where their vegetation is *E.tetragona* mallee-heath or mixed scrub-heath.

Principal control of vegetation is by topography and soil. Owing to the mountainous nature of the Range, topography exerts a very strong influence, and the relationships of the various units can be explained in terms of a catena. Both geology and soils are also related to positions in this catena. The rocks forming the Stirling Range are of sedimentary origin, consisting of quartz sandstone at the base, overlain by phyllite and muddy sandstone. As the beds are mostly fairly flat-lying this sequence exists throughout and there is an absence of the lithological diversity which is marked in the Barren Ranges further east and has created ecological niches favourable to local endemic species there. Broadly, the thicket of the mountain tops is associated with phyllite and the mallee-heath of the lower slopes with quartz sandstone. Woodland in the valleys is associated with colluvium brought down from the mountains, forming relatively young, undeveloped soils. Although these may contain quantities of laterite, it is in the form of transported nodules. On the other hand the *Eucalyptus tetragona* mallee-heath of the surrounding plains and pediments, (Qualup System), while it is also developed partly on colluvium, has a highly weathered soil profile dating probably from the Early and Middle Tertiary.

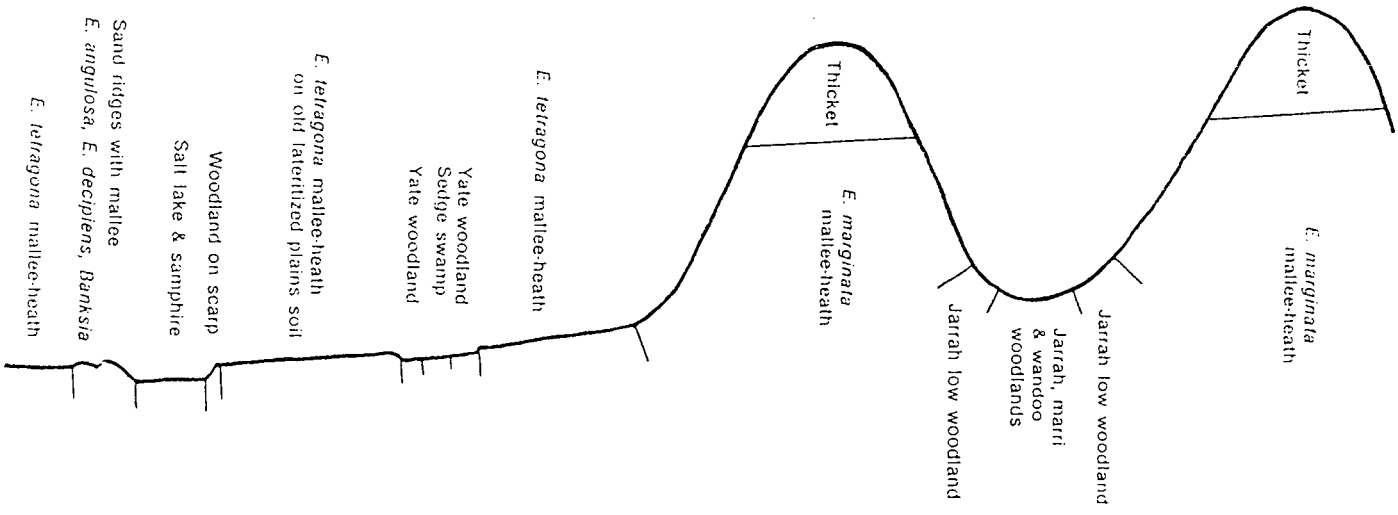


Diagram showing topographic relationship of vegetation units in Stirling Range

WOODLAND

Woodland and Open Woodland are found in many of the valleys. They have not been separated in mapping owing to the restricted areas occupied and the prevalence of intergrading situations. Density varies from near-forest along the creeks north of Isongerup and Ellen Peak to very open woodland along the Young River. Tree heights of *E.marginata* and *E.calophylla* were estimated at 10-15m in Chester Pass. Some *E.wandoo* were measured at 17-18m in the Magog picnic area, and 20-26m at White Gum Flat, but most woodlands grade upslope into Low Woodland of 5-10m.

Species forming woodland in the Park are (in order of abundance): *E.marginata, E.calophylla, E.wandoo, E.occidentalis, E.rudis, E.cornuta* and *Acacia* sp. inedit..*E.marginata* is normally associated with lesser numbers of *E.calophylla* and sometimes also with *E.wandoo* which may occur pure or with *E.calophylla* or with *E.occidentalis*. *E.marginata* is found on sandy and laterite soils, *E.wandoo* on heavier red and yellow soils while *E.calophylla* is intermediate. *E.occidentalis* favours swampy heavy grey soils, sometimes with *E.rudis*. *E.cornuta* may occur as a tree on creek banks, e.g. along the Mabinup Creek north of Toolbrunup. It occurs also as a mallee e.g. at the north foot of Bluff Knoll, on the col between Magog and Talyuberlup, and on the northeast face of Magog. An unknown Acacia tree froms woodland in gullies on Toolbrunup and Mt. Hassell. Patches of *E.marginata-E.calophylla* woodland may occur high in the mountains as on the slopes of Magog and in gullies on the south slopes from Bluff Knoll to Ellen Peak.

Understories are variable, according to soil. In stands of *E.marginata* and *E.calophylla* wattles are normally conspicuous, e.g. *Acacia drummondii, A.pulchella, A.myrtifolia*. Other species noted include *Banksia grandis, Conospermum amoenum, Dryandra formosa, D.cirsioides, Hakea ambigua, H.cucullata, Leucopogon unilateralis, Mirbelia dilatata, Xanthorrhoea gracilis*. Banksias may often be conspicuous in sandy places, e.g. *B.attenuata, B.baxteri, B.coccinea* and also *Hakea varia*. Woodland patches at high altitude have mountain thicket species as understory plants, e.g. *Dryandra formosa, Isopogon latifolius, Oxylobium atropurpureum*.

A stand of *E.wandoo* was examined at the Magog Picnic area. The trees are solely of *E.wandoo* except for *E.cornuta* on creek banks. Mallees *E.angulosa, E.decurva* and *E.tetragona* occur as understory on upper slopes. Other understory plants noted included :

Shrubs :

Bossiaea linophylla (abundant and conspicuous), *Calytrix brachyphylla, Casuarina humilis, Chamaelaucium ciliatum, Gastrolobium* sp., *Hakea corymbosa, H.varia, Leptospermum erubescens, Leucopogon polymorphus, Oxylobium velutinum, Phyllanthus calycinus, Pseudanthus virgatus.*

Climbers :

Clematis pubescens, Sollya heterophylla.

Herbaceous :

Caladenia flava, Drosera sp., *Dianella revoluta, Waitzia citrina.*

Reeds :

Lepidosperma leptostachyum

At a higher level, on the eastern slopes of Talyuberlup, *E.wandoo* is mixed with mallee of *E.cornuta, E.lehmannii* and *E.occidentalis* together with *Acacia* sp. inedit., *A.ferocior, Calothamnus* sp. aff. *gracilis, Dryandra cirsioides, Hakea* sp., *Leucopogon unilateralis, L.parviflorus, Melaleuca acerosa, M.depauperata, Oxylobium bilobum* var. *angustifolium, Sollya heterophylla.*

Woodlands formed of or containing *E.occidentalis* commonly have somewhat sparse understories. Mixed *E.occidentalis* and *E.wandoo* at the Chester Pass caravan park have scattered *Billardiera, Calytrix tenuifolia, Chorizema aciculare* and clumps of the sedge *Gahnia ancistrophylla*. Elsewhere in Chester Pass, mixed *E.occidentalis* and *E.rudis* have little but *Acacia saligna* beneath. In Pillenorup Swamp the understory species are *Beaufortia sparsa* and *Leptomeria* sp.

LOW WOODLAND

Low woodland occurs on lower slopes above the Woodland if present or may occupy the whole valley. As with Woodland, Low Woodland mapped includes Open Low Woodland. There seems to be no floristic difference, the two intergrade with one another and with woodland downslope, mallee-heath up slope. Almost all low woodland in the Park is of *E.marginata-E.calophylla* but three other associations have been observed in a minor role. *E.megacarpa* and *Casuarina huegeliana* occur together on parts of Ellen Peak and perhaps represent the true climax in fire-protected places. *E.macrocera* and *C.huegeliana* were observed in a similar situation on The Abbey. *E.decipiens* is dominant with *E. marginata* in some valleys south of Gog, and forms stands in very sandy soil along the Young River associated with *Banksia attenuata* and *Lambertia inermis.*

Trees in Low Woodland are from 5 to 10m in height. In *E.marginata* stands they are commonly much distorted by frequent burning.

A species list was made along the track to Magog :

Low trees :

E.calophylla, E.marginata, Banksia attenuata, B.grandis, Nuytsia floribunda.

Tall shrubs :

Agonis parviceps, Banksia coccinea, B.sphaerocarpa, Beaufortia heterophylla, Calothamnus sp., *Casuarina humilis, C.trichodon, Dryandra concinna, Hakea baxteri, H.corymbosa, H.cucullata, H.trifurcata, H.varia, Isopogon baxteri, I.cuneatus, I.dubius, Kingia australis, Kunzea recurva* var.*recurva, Lambertia ericifolia, Leucopogon parviflorus, Melaleuca acerosa, M.polygaliodes, Petrophile divaricata, P.serruriae, Sphenotoma* sp.aff. *dracophylloides Xanthorrhoea gracilis.*

Small shrubs :

Adenanthos apiculatus, Andersonia simplex, Astroloma serratifolium, Baeckea sp., *Banksia petiolaris, Burtonia scabra, Daviesia incrassata, Dillwynia cinerascens, Dryandra nivea, D.pteridifolia, Eucalyptus doratoxylon, Grevillea pulchella, Latrobea hirtella, Leucopogon carinatus, Lysinema ciliatum, Petrophile longifolia, Platytheca juniperina, Pultenaea verruculosa, Stirlingia latifolia, Synaphaea spinulosa, Restionaceae* spp. (see list under Mallee-heath).

MALLEE-HEATH

Mallee-heath is the most widespread formation in the Range, covering all the mountain slopes except for the upper parts of the principal peaks where there is a thicket formation described later. *Eucalyptus marginata* now in mallee form is the principal species. This *E.marginata* association is characteristic of the mountain slopes but does also descend to the pediments on the south side of the Range east of Chester Pass where it forms a patchy mixture with the type of scrub heath described in the Qualup System, the two alternating according to the depth of the sandy topsoil.

A species list for the *E.marginata* mallee-heath was made along the Stirling Range Drive east of Mt. Hassell, as follows :

Small trees (rare) :

Nuytsia floribunda

Grass trees to 3m :

Kingia australis, Xanthorrhoea gracilis.

Mallee :

Eucalyptus calophylla, E.doratoxylon, E.marginata

Other tall shrubs :

Banksia grandis, Hakea baxteri, H.cucullata, H.pandanicarpa, Lambertia ericifolia, L.uniflora.

Smaller shrubs :

Banksia petiolaris, B.sphaerocarpa, Beaufortia heterophylla, Boronia crenulata, Burtonia villosa, Casuarina humilis, Conospermum dorrienii, Darwinia diosmifolia, Dryandra nivea, D.proteoides, Isopogon cuneatus, I.dubius, Lysinema ciliatum, Melaleuca polygaloides, Petrophile divaricata, Platytheca galioides, Sphaerolobium macranthum, Sphenotoma dracophylloides, Synaphaea ?favosa, Xanthosia rotundifolia.

Herbaceous plants :

Conostylis villosa, Dampiera sp., *Diuris longifolia, Drosera* spp., *Johnsonia lupulina*

Restionaceae :

Anarthria gracilis, Caustis dioica, Lepidosperma viscidum, Mesomelaena stygia, M.tetragona, Restio sp. inedit.

The list of Restionaceae is derived from another area at the foot of The Abbey, south side.

THICKET

A formation of closed tall shrubs or thicket, occurs at the upper levels on all the principal peaks in the Range. As with other shrubland formations, structure varies with the time elapsed since the last burn since all top growth is normally killed by fire. As the thicket regenerates it grows taller until a maximum is reached which might be of the order of 3m but would vary according to soil depth, exposure and other factors. Adjacent shrubs grow to approximately the same height so that an even canopy is produced. The stand is dense and difficult to penetrate. Composition was examined on seven of the peaks with consistent results shown in the Table. The north slope of Bluff Knoll and the summit are separated, making eight sites listed since the composition on the plateau shows some special features.

The Table shows first a group of 15 species which occur consistently on at least four of the seven peaks. It is probable that they do occur throughout but were overlooked in some cases. Several of these flower very conspicuously in spring, notably *Dryandra formosa, Isopogon latifolius* and *Oxylobium atropurpureum* which normally put on a most magnificent show in October. In this respect together with the prominence of Proteaceae and the general physiognomy, the thicket more closely resembles the *fynbos* formation of the South African mountains than any other in Western Australia.

TABLE

COMPOSITION OF THICKET ON SEVEN PEAKS IN THE STIRLING RANGE.

	Mondurup	Magog	Tabyuberlup	The Abbey	Toolbrunup	North slope BLUFF KNOLL	Summit plateau	Ellen Peak
Acacia drummondii	x	x	x	x	x		x	
Andersonia echinocephala	x	x	x				x	x
Banksia solandri	x	x	x	x	x	x		x
Beaufortia decussata	x	x	x		x	x	x	x
Boronia crenulata	x		x		x	x	x	
Calothamnus sp.aff. *gracilis* (JSB 7622)	x			x	x		x	x
Dryandra formosa	x	x	x	x	x	x		x
Hakea ? florida (JSB 7449)	x	x	x	x	x		x	x
Hypocalymma myrtifolium	x	x	x	x	x	x		
Isopogon latifolius	x	x	x	x	x	x	x	x
Kunzea recurva var. *montana*	x	x	x	x	x		x	x
Leucopogon unilateralis		x	x	x	x			
Oxylobium atropurpureum	x	x	x	x	x	x		x
*Sphenotoma*sp.aff.*dracophylloides* (JSB 7436)	x	x	x		x	x	x	x
Xanthorrhoea gracilis	x		x	x	x	x	x	
Adenanthos filifolia	x	x					x	
Andersonia axilliflora						x	x	x
Banksia quercifolia		x		x		x	x	
Burtonia villosa						x		x
Casuarina trichodon	x		x			x		
Dryandra concinna			x		x	x		
Eucalyptus calophylla	x		x					
Eucalyptus marginata		x	x		x			
Eucalyptus megacarpa				x		x		x
Eucalyptus sp.inedit. (JSB 7624)	x							
Hakea ambigua	x		x		x			
Leucopogon atherolepis	x		x					
Petrophile heterophylla			x					x
Platytheca juniperina			x		x			

There is a second group of 13 species which were recorded less consistently and apparently are not of general occurrence. This group includes the mallee eucalypts which are generally speaking not an important element in the thicket formation, except on Mondurup where it seems drier and more open than elsewhere. Not only are mallees dominant on Mondurup but the principal species, collected as JSB 7624, appears to be an unknown local endemic. It resembles both *E.marginata* and *E.preissiana* of which the latter is also present on the mountain. Except for this one case, species recorded only once at the seven sites were omitted from the Table.

The Bluff Knoll plateau is in essential respects similar to the thicket elsewhere. *Banksia brownii* replaces *B.solandri*, *Dryandra mucronulata* replaces *D.formosa* while *Xanthorrhoea* is only locally present. *Hypocalymma myrtifolium*, *Leucopogon unilateralis* and *Oxylobium atropurpureum* have not been recorded. Other species present on the plateau but not apparently in the thicket on other peaks are *Agonis spathulata*, *Andersonia axilliflora*, *Astartea fascicularis*, *Beaufortia anisandra*, *Darwinia collina*, *Lambertia uniflora*, *Lepidosperma longitudinale* and *Leucopon gnaphalioides*.

Other minor communities of mountain vegetation include mats formed by fleshy rosette-plants on rock slabs, e.g. *Andersonia sprengelioides*, *Monotoca oligarrhenoides* and *Sphenotoma drummondii*. Rock screes on Toolbrunup carry a few scattered plants of *Helichrysum* sp. aff. *bracteatum*, *Hibbertia argentea* and *Sphenotoma drummondii*. The scree is bordered in places by thickets of *Trymalium spathulatum*.

NOTES ON THE FLORA

Owing to the diversity of habitats the flora of the Stirling Range has long been recognised for its richness. Erickson, George, Marchant and Morcombe (1973) estimated the flora at over 550 species. A checklist of the flowering plants (Hussey 1977) produced a total of 544. Only the most conspicuous species or those of ecological importance have been mentioned in this account of the vegetation.

It has also long been recognised that a high proportion of the flora of the Range is endemic to it, that is to say, is found only there and nowhere else, but in the present state of our knowledge it is difficult to be precise about this. The 1977 checklist of the flora does not indicate endemic species and it would require an exhaustive check of the material in the State Herbarium to obtain the information. It is obvious that the Stirlings, being the only substantial mountain range in the South-west of Western Australia, comprise a series of unique habitats in which unique species are likely to be harboured, but the situation differs materially from that in the Barren Ranges further east.

THE PORONGURUP RANGE

This account is mainly taken from a paper by Ian Abbott 1982, "The Vascular Flora of the Porongurup Range, South-western Australia" in W.A.Herbarium Research Notes 7:1-16

The Porongurup Range rises to a maximum altitude of 655m from a plain between Albany and the Stirling Ranges. It is formed of a huge granite batholith of Proterozoic age, about 1100 million years old, which is exposed in a chain of granite bosses 12 km long and 3 km wide. It is the most massive granite outcrop in the whole State. Most of the domes have bare summits where the rock is smooth and thinly covered with lichens or mats of moss, or is irregularly covered with boulders and pockets of soil in which scattered plants can take root. The bare domes rise from an encircling mass of karri (Eucalyptus diversicolor) tall forest whose enormous trees reaching 60m in height form a striking contrast with the scrubby rocks above. In this locality karri only occurs on the slopes of this range and is an outlier from the main area of karri forest 100km to the west. This disjunction is merely due to the lack of suitable karri soil, as the Porongurup lies within the zone of mesomediterranean climate with a short dry season. Karri loam has formed from decomposition of the granite, and further factor favouring karri probably is the additional moisture shed into the forest by run-off from the rocks above.

On the pediments of the Range the soil becomes more highly leached and lateritised, and the forest cover changes to medium-height trees of jarrah (E.marginata) and marri (E.c .ophylla). On the north-western flank of the Range the laterite crust is very massive and the jarrah are reduced to low trees of 10m or less in height. Along the southern flank of the Range there is a lateritic soil with a surface layer of bleached sand which carries only kwongan.

Climate

There is no temperature recording station at the Range, but temperatures are probably slightly more equable than at nearby Mt. Barker (mean daily maxima in January and July = 27.4 and 14.8°C respectively; mean daily minima in same months = 13.3 and 6.5°C).

Rainfall data for Porongurup Village on the north side of the Range, just below the 300 m contour, are as follows:

	J	F	M	A	M	J	J	A	S	O	N	D	Y
Mean rainfall (mm)	31	33	46	64	98	102	107	93	92	94	54	34	848
Median rainfall (mm)	19	28	43	58	84	93	97	96	96	80	48	32	838
Mean No. raindays	7	8	10	13	16	18	20	17	17	16	11	8	160

These data are for the period 1914-1978 where records are available (usually 29-33 years). They show that about two-thirds of the annual rainfall falls between May and October inclusive. The Porongurup Range is also one of the few places in Western Australia where snow occasionally falls.

It seems very likely that the southern (windward) side of the Range would receive over 900 mm because of an orographic effect; this is evidenced by higher quality jarrah forest on the southern slopes relative to that of the northern slope.

Vegetation

Four vegetation units are recognizable: tall open forest (estimated area 1700 ha); open forest, including small areas of open-scrub, formerly continuous with the chief vegetation type surrounding the Range; a lithic complex of mossland, herbland and fernland (total area about 250 ha); and pasture. These units have been mapped by Abbott (1981).

Tall open forest has *Eucalyptus diversicolor* (karri) as dominant and *E. calophylla* (marri) as subdominant. This unit is restricted to deep, red loams. The understorey vegetation may be low and sparse (often dominated by *Pteridium aquilinum*) or dense and tall (dominated by *Albizia lophantha*, *Acacia urophylla* or *Trymalium spathulatum*). These differences may reflect variation in soil depth, effective moisture, and fire history.

Open forest consists of jarrah and marri, and occurs on laterite soils and freely-draining sands. Understorey is rarely dense. The main understorey species are *Bossiaea linophylla*, *Xanthorrhoea preissii*, *Hibbertia* spp., *Acacia leioderma*, *Agonis hypericifolia*, *A. parviceps*, *Myoporum tetrandrum* and *Leucopogon revolutus*. At lower levels near the 300 m contour, where drainage is impeded, open forest becomes open-scrub, dominated by *Astartea fascicularis*, *Kunzea recurva*, *Banksia littoralis*, *Melaleuca preissiana*, *Agonis hypericifolia* and *A. parviceps*.

Lithic complex refers to the vegetation present on shallow soils associated with rock exposures. These are covered with mosses, lichens, *Cheilanthes tenuifolia* and *Thryptomene saxicola* where soils are shallow. In valleys or where soil is deeper, *Eucalyptus megacarpa* and *E. cornuta* occur with dense thickets dominated by *Agonis linearifolia*, *Acacia heteroclita* and *Hakea varia*.

Pasture, sown to subclover, with many other non-native plant species present, now virtually encircles the Porongurup Range.

Species richness

The number of plant species recorded in the three major vegetational units was as follows: karri forest, 85; jarrah forest, 255; granitic rocks, 119 (Appendix 1). This confirms Drummond's observation (recorded above) that fewer plant species are found on granitic rocks than in jarrah forest, though this should not be surprising given the relatively small extent of exposures of granitic rocks. The number of species found only in one of the three major vegetation types was: karri forest, 21; Jarrah forest, 163; granitic rocks, 55. The flora of granitic rocks has a greater similarity with that of jarrah forest (.19, using Sorensen's coefficient) than with karri forest (.08).
The above figures relate to the flora as known at the time of Abbott's paper in 1982, with a total of 368 species. More work since that time has raised the number to 499 spp., according to a recent check-list by Greg Keighery.

Endemic species

Five species are endemic to the Range - *Brachysema subcordatum*, *Billardiera granulata*, *Hibbertia bracteosa*, *Apium aff. prostratum* and *Villarsia calthifolia*, which largely occur on the open granite slopes above the forest.

Karri Forest Subregion

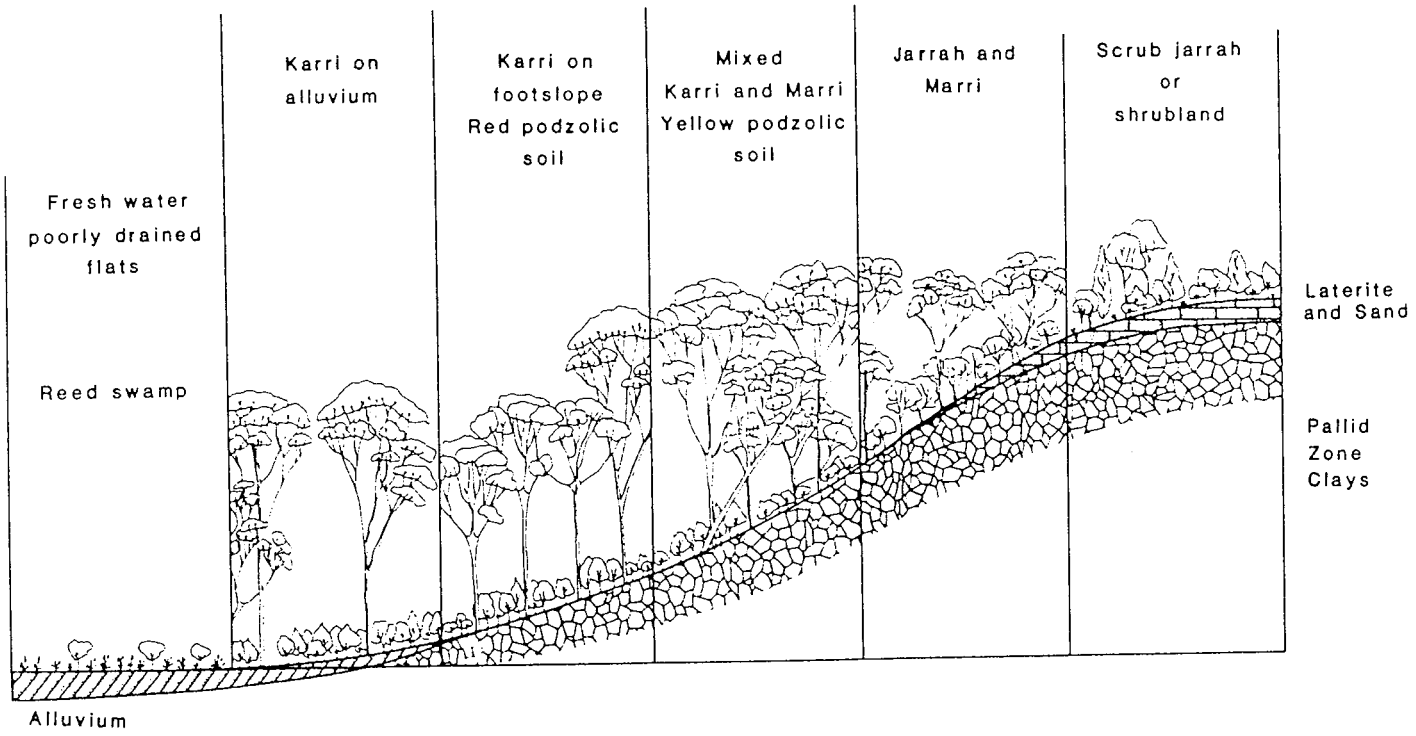
WARREN BOTANICAL SUBDISTRICT

(Reproduced from Beard, "The Plant Life of Western Australia" 1990)

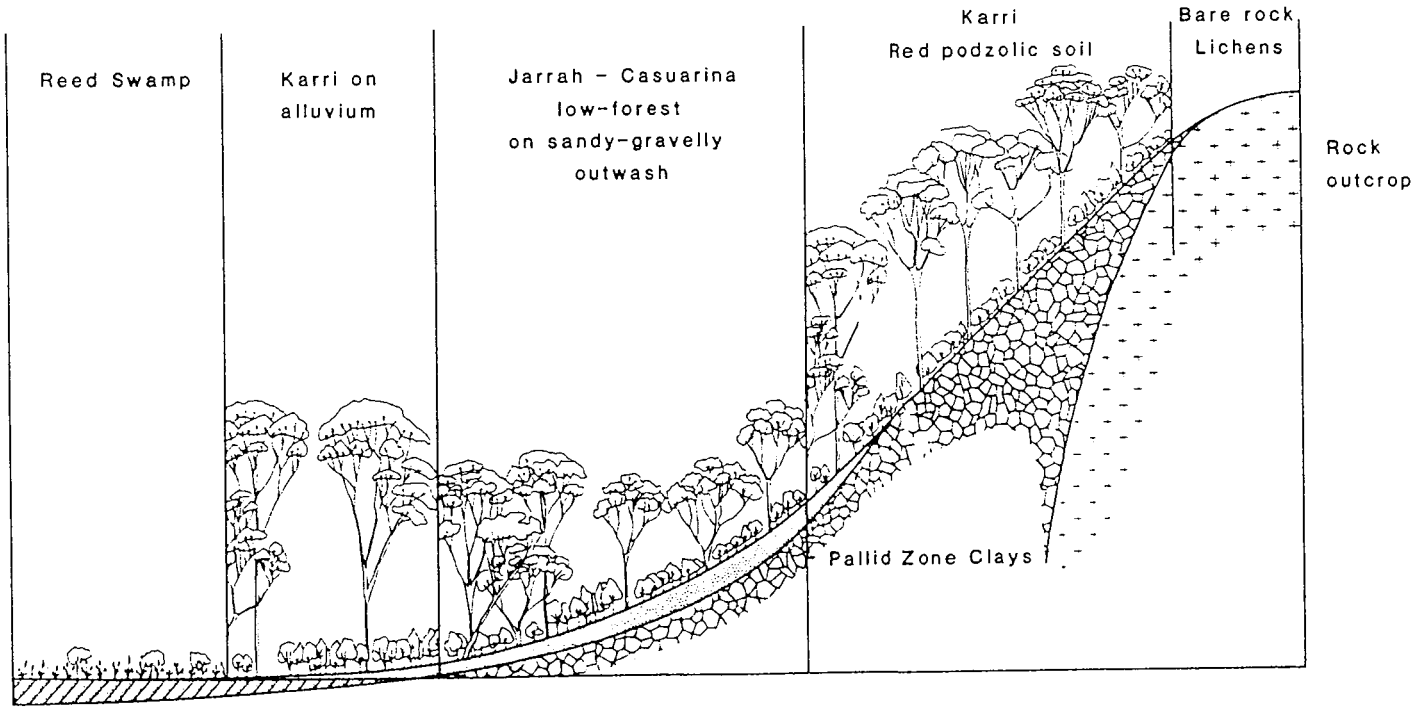
Although the vegetation of this subregion reaches its climax in the magnificent karri forest, which gives its character to the whole region, karri *(Eucalyptus diversicolor)* is by no means universal and in fact has a very patchy distribution. The reason is that forest trees of such size and luxuriance can only grow on the most favourable soils, called 'karri loams'. In Chapter 2 we have seen that types of soil occur linked in catenary sequences, and karri loams only occupy a portion of the catena. Karri forest country has been subject to clearing for agriculture only to a minor extent, fortunately for the forest, because the soils are agriculturally unproductive. They have a very good physical structure, which favours tree growth, but have been shown to require additions of phosphorus and zinc to support productivity under cultivation[1].

Typical karri soil has a reddish-brown loam or sandy loam surface horizon changing gradually to red clay at about 50 cm depth. Other soils in the area unfavourable to karri are more leached, often expressed by paler colour, and may be more sandy or contain ironstone gravel. Poor internal drainage and waterlogging are also unfavourable factors. Because of these limitations, karri has a central node of abundance between the Donnelly and Shannon Rivers in an east-west direction, and from behind the coastal dunes inland for some 50 km. The Donnelly River approximately marks the line of the Darling Fault. West of it the geological formation changes to sedimentary rocks, and resulting soils are unfavourable to karri which is absent from the Blackwood Plateau but reappears in small patches in the hilly area of Margaret River-Augusta. Most of these patches are on old, highly weathered coastal dunes, some are on alluvium or on young soils along creeks. A large patch at Karridale was logged at the turn of the century and converted to farmland, except for a portion of Boranup which regenerated successfully and has recently been made into a national park. Karri occurs occasionally along the south coast on the dune systems, provided the soil is old and highly weathered, but many of these patches are actually of *Eucalyptus cornuta* (yate) which looks similar. East of the Shannon the concentration of karri declines rapidly. Much of the country is swampy and covered with reeds and paperbarks. Here the karri is joined by the two tingles, yellow tingle *(Eucalyptus guilfoylei)* mainly inland from Broke Inlet, and red tingle *(E. jacksonii)* in the Walpole area. These are also giant trees, distinguished by their rough bark, having a very restricted distribution. It seems probable that these are relict species, formerly more widespread when climate was more favourable. Similarly, red-flowering gum *(E. ficifolia)* has a restricted habitat on the south coast on dune sands. Going eastward, karri remains common on the hills around Denmark and Torbay, but the flatter country is unfavourable to it, and only small patches are seen. However karri reappears in the Porongurup Range, adding much beauty to the national park; and there are two patches on a plain further east to the north of Mt Manypeaks. All these outliers are within the proper climatic zone for karri but restricted by the lack of suitable soil. The distribution of karri and karri loams in the landscape is shown diagrammatically in Fig. 3.12. Catena A applies in the central node from the Donnelly River to Walpole while Catena B applies to the country east of Walpole. The diagrams are not literal representations from measured profiles but show a typical arrangement in each case. The segments of the profile are not to scale and may not occur precisely in this manner on every slope. In Catena A the sequence begins with reed swamp in the bottomland or alternatively paperbark low forest, or there may be a creek lined with Warren River cedar *(Agonis juniperina)*. As the soil becomes better drained, karri appears, often towering up at the edge of the swamp, and persists up slope until on middle to upper slopes it becomes mixed with marri *(E. calophylla)*. On upper slopes if the soil becomes more sandy, or laterite appears, karri drops out and jarrah *(E. marginata)* becomes co-dominant with marri. On summits where the soil may be leached sand overlying clay and is poorly drained the jarrah declines to open stands of short crooked trees, giving way in extreme cases to shrubland of *Pultenaea reticulata*.

Catena B is to be seen east of Walpole where karri occurs either on alluvium or on red loam surrounding a granite outcrop but typically not on the lower and middle slopes where sandy and lateritic soils are found. These carry jarrah forest or jarrah-casuarina *(C. fraseriana)*, or in extreme cases on leached white sand, casuarina low forest. *Eucalyptus megacarpa* appears between the karri forest and the rock outcrop. This catena is particularly well developed in the Porongurup National Park.



Catena A, showing the distribution of vegetation and soil types in the central portion of the Warren sub-district, from the Donnelly River to Walpole.



Catena B, showing the organisation of the country east of Walpole in the Warren sub-district. This diagram applies also to the Porongurup Range.

Karri forms tall forest with a general canopy level of about 70 m. Below this at about 10 m is a scattered layer of *Agonis flexuosa, Casuarina decussata* and banksia and at about 3 m a continuous stratum of soft-leaved plants such as *Trymalium spathulatum, Chorilaena quercifolia, Hovea elliptica* and *Acacia* spp. The lack of sclerophylly in the understorey of the karri forest is one of its most striking features. The ground cover consists of many shrubs and creepers and a very light cover of the grass *Tetrarrhena laevis* together with some mosses, liverworts and occasional epiphytic ferns.

A list of the karri forest flora below is taken mainly from McArthur and Clifton, Table 4.[1]

Canopy trees *Eucalyptus diversicolor, E. calophylla, E. marginata.*

Trees 10–30 m *Casuarina decussata, Eucalyptus megacarpa.*

Small trees < 10 m *Agonis flexuosa, Banksia grandis, B. verticillata, Persoonia longifolia.*

Tall shrubs 2-3 m *Acacia pentadenia, Paraserianthes (Albizia) lophantha, Bossiaea aquifolium, Chorilaena quercifolia, Pimelea clavata, Trymalium floribundum.*

Small shrubs 1-2 m *Acacia browniana, A. divergens, A. myrtifolia, A. pulchella, A. urophylla, Bossiaea linophylla, B. ornata, Chorizema ilicifolium, Crowea angustifolia, Hakea amplexicaulis, Hibbertia amplexicaulis, H. grossulariifolia, H. cuneiformis, H. serrata, Hovea elliptica, Hypocalymma cordifolium, Leucopogon capitellatus, L. propinquus, L. verticillatus, Phyllanthus calycinus, Podocarpus drouynianus, Sphaerolobium medium, Thomasia quercifolia, T. triloba, Tremandra stelligera, Xanthosia* spp.

Cycad, to 2 m *Macrozamia riedlei.*

Grass tree, to 3 m *Xanthorrhoea preissii.*

Herbaceous *Anigozanthos flavidus, Dampiera hederacea, D. linearis, Lepidosperma longitudinale, Lomandra* spp., *Opercularia hispidula, Orthrosanthus laxus, Patersonia umbrosa, Pteridium esculentum, Scaevola auriculata, S. striata.*

Creepers *Cassytha glabella, Clematis pubescens, Chorizema diversifolium, Hardenbergia comptoniana, Kennedia coccinea.*

Other vegetation besides karri in this region includes principally the jarrah forest which replaces karri forest on the poorer soils and originally probably covered about half as much area as karri. To avoid duplication the jarrah forest will be dealt with in the next section under the Southern Jarrah Forest Region. Other communities cover relatively minor areas. Jarrah is a very variable and plastic species in both habitat and form. It grows on a wide range of sandy and lateritic soil types and ranges in height from a giant tree in association with the karri forest to a mallee in the Stirling Range with a suite of intermediate forms in forest, low forest and low woodland. As low woodland it occurs in Catena A on poorly drained sands on watersheds, and in association with *Banksia* spp. on sand ridges in swamps. As low forest it may occur on low ground and sandy soil in Catena B.

The paperbark tree *Melaleuca rhaphiophylla* forms a low forest in deep swamps, either completely covering the swamp or occurring as a ring round the edge. There is an understorey of rushes. Another paperbark, *M. preissiana*, appears as a small tree, scattered or in small groups, covering large areas of open flats of leached sand subject to seasonal flooding. The swamp banksia, *B. littoralis*, stunted jarrah, and *Nuytsia floribunda* may also be present, and blackboys *(Xanthorrhoea preissii)*. The ground layer consists of heathy shrubs, merging into reed swamp in wetter parts. Reed swamps occur principally close to the coast where drainage has been obstructed by the coastal dune systems.

The swamps consist principally of dense Cyperaceae and Restionaceae with woody plants present in various communities. One phase, probably perennially wet, has scattered paperbark trees *(Melaleuca preissiana)* and small teatree *(M. densa)*, another has clumps of jarrah mallee *(Eucalyptus marginata)* or of scattered shrubs *(Beaufortia sparsa, Callistemon speciosus)* or blackboys *(Xanthorrhoea preissii)*. There is also a 'heath swamp' association on sandy, probably seasonally wet ground, in which the reeds are mixed with *Adenanthos obovatus, Acacia myrtifolia, Agonis flexuosa, A. juniperina, A. marginata, Andersonia caerulea, Beaufortia sparsa, Boronia spathulata, Callistemon speciosus, Cosmelia rubra, Grevillea brevicuspis, Kunzea ericifolia, Leucopogon obovatus, Oxylobium lanceolatum, Pultenaea reticulata.* Many of these shrubs are very showy in flower, especially *Beaufortia sparsa* which is summer flowering. Among interesting smaller plants in these swamps is the pitcher-plant *Cephalotus follicularis*. Among the reeds *Leptocarpus tenax* seems to be generally dominant: others identified are *Anarthria prolifera, A. scabra, Evandra aristata, Lepidosperma persecans, Leptocarpus scariosus, Lyginia barbata, Mesomelaena tetragona* and *Restio tremulus.*

JARRAH FOREST

This account of the Jarrah Forest is reproduced from Beard, "The Vegetation of the Perth Area", Vegmap Publications 1979.

JARRAH FOREST

The jarrah forest is one of the only two forest formations in Western Australia and is composed of trees averaging 25 to 30m tall in the western sector, about 4m less in the easten (Havel 1975). Williams (1945) recorded a stem density of 125 to 150 per hectare. Today nearly all stands have been logged so that many or most of the largest trees have gone and been replaced by a larger number of younger stems. Whereas the virgin forest originally contained mainly large mature trees (see illustration) most stands now contain smaller immature trees. In addition many stands have been thinned by dieback disease caused by *Phytophthora cinnamomi*. Jarrah *(E.marginata)* is the principal dominant tree, normally accompanied by marri *(E.calophylla)* in proportions varying from 50% downwards, and by *E.patens*, *E.wandoo* and *E.accedens* on some sites. There is frequently a lower layer of small trees of 10-15m, *Banksia grandis*, *Casuarina fraserana* and *Persoonia longifolia*, and a ground layer of sclerophyll shrubs 1-2m tall and averaging 185 individuals to the hectare (Havel 1975). In Appendix 5 of Havel 1975 (1) he gave a list of 130 principal indicator species, mainly shrubs, which comprise the most important components of the understory. Their grouping into understory communities is dealt with later under minor catenas.

It is an apparent anomaly that the jarrah forest is the tallest and densest formation in the catena, yet grows on the inhospitable laterite duricrust of the plateau. However Doley (1967) and Kimber (1974) showed that the root system of jarrah penetrates the duricrust into the deep-weathered zone beneath as deep as 16m, tapping reserves of moisture during summer and allowing growth to continue throughout the year. Soils of the scarp and valleys where the deep-weathered zone has been stripped off actually provide much less water storage than the plateau.

MARRI-WANDOO WOODLAND

The sites mentioned in the previous sentence above carry a lower and more open formation which was intensively studied by Williams (1932) at Darlington. Tree height is 20-25m, and density approx. 100 stems per ha. The two trees marri *(E.calophylla)* and wandoo *(E.wandoo)* constitute the woodland with occasionally *E.laeliae* on granite outcrops. *Nuytsia*

floribunda occurs as a smaller tree. The grass tree *Xanthorrhoea preissii* is common and conspicuous with 600 to 1000 plants per ha. *Macrozamia riedlei* is less common. Tall shrubs (1.2 to 1.5m) include *Daviesia horrida, Dryandra sessilis, Hakea cristata* and *H.trifurcata*. Small shrubs of 45 to 60 cm typically include *Acacia pulchella, Dryandra nivea, Hibbertia hypericoides* and *H.montana*. A full list of 54 component understory shrubs was given in column A of Table 4 of Williams (1932).

Williams in this and his later study (1945) found that while the two tree species intermingled, *E.calophylla* occurred principally on granite and *E.wandoo* on the numerous epidiorite (dolerite) dykes. This correlation with lithology should not be taken too literally as both species occur widely on other rock types. It merely shows a preference of *E.calophylla* for more sandy and of *E.wandoo* for more clayey soils as observed e.g. by Beard (1979a) in the Gairdner Range on Jurassic rocks.

RIVERAIN WOODLAND

Eucalyptus rudis forms narrow strips of woodland along the streams, frequently with *Melaleuca rhaphiophylla*. The latter forms dense groves along the shores of the Chittering and Needonga Lakes.

ROCK OUTCROPS

In the wetter western sector these may often have no special vegetation other than lichens on the rocks which are interspersed with jarrah and marri trees. Elsewhere the rocks are more open; characteristic species are lichens, tussocks of *Borya nitida*, shrubs *Grevillea bipinnatifida, Hakea elliptica, H.undulata*, small trees *Casuarina huegeliana* and *Eucalyptus laeliae*.

MINOR CATENAS

The minor catenas occur within the jarrah forest and were worked out by Havel (1975) applying the methods of his study of the Swan Coastal Plain (1968) to determine "site-vegetation types". 320 plots were enumerated and subjected to mathematical analysis which showed that although the ground vegetation was a continuum subject to unending variation, 20 site types could be segregated and characterised by a suite of indicator species (Table II). A 21st, Type G, applying to granite outcrops which were not included in the study plots, was added later. 11 of these types occur mainly in the wetter western sector and 11 mainly in the drier eastern sector, 2 of them being common to both (Types G and R). Types A, B and C occur in swampy bottom lands, G and R on or in association with

PRINCIPAL INDICATOR SPECIES

FOR THE SITE-VEGETATION TYPES OF HAVEL (1975).

PLANT SPECIES	SITE-VEGETATION TYPES																			
	A	B	C	D	E	F	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Acacia alata	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acacia extensa	-	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-	○	-	-
Acacia browniana	-	-	-	-	-	-	○	-	-	-	-	●	-	-	●	-	-	-	-	○
Acacia urophylla	-	-	-	-	-	-	-	-	-	-	○	-	○	-	○	○	-	-	-	-
Adenanthos barbigerus	-	-	-	-	-	-	-	○	-	-	-	●	-	○	●	-	-	-	-	-
Adenanthos obovatus	○	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agonis linearifolia	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Astartea fascicularis	●	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baeckea camphorosmae	-	-	-	○	●	-	○	○	-	○	-	-	-	-	-	-	-	-	●	-
Banksia attenuata	-	-	-	-	-	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-
Banksia grandis	-	-	-	-	-	-	-	-	-	-	●	●	-	-	○	○	-	-	-	-
Banksia littoralis	●	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bossiaea aquifolium	-	-	-	-	-	-	-	-	-	-	○	-	○	-	○	○	-	-	-	-
Casuarina fraserana	-	-	-	-	-	-	-	○	-	-	○	●	-	-	○	-	-	-	-	-
Casuarina humilis	-	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-
Caustis dioica	-	○	-	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choriaema ilicifolium	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-	○	○	-	-	-
Clematis pubescens	-	-	-	-	-	-	-	-	-	-	-	-	●	-	-	●	○	-	-	-
Conospermum stoechadis	-	●	-	-	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-
Dampiera alata	-	-	○	◉	●	-	-	-	-	○	-	-	-	-	-	-	-	○	●	-
Dasypogon bromeliaefolius	○	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daviesia pectinata	-	○	-	-	○	-	●	●	-	-	-	○	-	-	○	-	-	-	-	-
Diplolaena drummondii	-	-	-	-	-	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-
Dilwynia cinerascens	-	-	-	-	○	-	-	-	-	○	-	-	○	-	-	-	-	-	-	-
Eucalyptus calophylla	○	●	-	●	○	-	-	○	-	○	●	○	●	●	○	●	●	●	-	○
Eucalyptus marginata	-	●	-	○	●	●	●	●	-	○	●	●	○	●	●	●	-	○	-	●
Eucalyptus megacarpa	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus patens	●	-	○	○	-	-	-	-	○	○	-	-	●	-	-	○	●	●	-	-
Eucalyptus wandoo	-	-	-	-	-	-	-	-	●	●	-	-	-	-	-	-	-	-	●	-
Gastrolobium calycinum	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-	-	-	○	○
Grevillea diversifolia	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grevillea wilsonii	-	-	-	-	○	-	-	●	-	-	-	●	-	-	-	-	-	-	-	-
Hakea cyclocarpa	-	-	-	-	-	-	○	○	-	-	-	-	-	-	○	-	-	-	-	-
Hakea ceratophylla	◉	-	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hakea lissocarpha	-	-	-	○	○	-	-	-	●	●	-	-	●	●	○	○	○	●	●	●
Hakea muscifolia	-	-	-	-	○	●	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Hakea varia	◉	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hibbertia lineata	-	-	-	-	-	-	-	-	●	-	-	-	○	-	-	-	-	-	●	-
Hibbertia polystachya	-	●	-	-	-	○	-	◉	-	-	-	-	-	-	-	-	-	-	-	-
Hovea chorizemifolia	-	-	-	-	-	-	-	-	-	-	○	●	○	-	●	●	-	-	-	-
Hypocalymma angustifolium	●	○	○	●	●	-	○	-	●	●	-	-	○	●	-	-	○	●	-	-
Isopogon dubius	-	-	-	-	-	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Kennedia coccinea	-	-	-	-	-	-	-	-	-	-	○	-	○	-	-	○	-	-	-	-
Kingia australis	-	-	-	○	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lasjopetalum floribundum	-	-	-	-	-	-	○	-	-	-	-	○	-	-	●	●	-	-	-	○
Lepidosperma angustatum	○	●	●	●	●	-	●	○	-	-	●	●	○	○	○	-	-	●	○	○
Lepidosperma tetraquetrum	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptocarpus scariosus	◉	●	●	◉	●	○	-	○	-	-	-	-	-	-	-	-	-	○	○	-
Leptomeria cunninghamii	-	-	-	-	-	-	-	-	-	○	-	○	-	○	●	○	-	-	-	○
Leptospermum ellipticum	●	-	-	●	○	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-
Leucopogon capitellatus	-	-	-	-	-	-	-	-	-	-	-	-	○	●	●	○	-	-	-	●
Leucopogon oxycedrus	-	-	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-	-	-
Leucopogon cordatus	-	●	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leucopogon propinquus	-	-	-	-	-	-	-	-	-	-	○	-	○	●	○	○	-	-	-	●
Leucopogon verticillatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	○	●	-	-	-	-
Lyginia tenax	-	●	-	-	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-
Macrotamia riedlei	-	-	-	-	-	-	-	-	○	◉	-	-	●	●	●	●	●	-	-	●
Melaleuca preissiana	◉	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mesomelaena tetragona	●	●	●	●	●	○	●	●	-	-	-	-	-	-	-	-	-	●	○	-
Nuytsia floribunda	-	-	-	-	-	○	-	○	-	-	-	-	-	-	-	-	-	-	-	-
Patersonia occidentalis	-	●	-	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-	○	-
Patersonia rudis	-	-	-	-	○	-	●	○	-	○	-	●	-	○	○	-	-	-	-	●
Persoonia longifolia	-	-	-	-	-	-	-	-	-	-	-	●	-	-	○	-	-	-	-	-
Phyllanthus calycinus	-	-	-	-	-	-	-	-	-	○	-	-	●	●	●	○	-	-	-	○
Pteridium esculentum	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-	●	●	-	-	-
Sphaerolobium medium	-	○	-	-	○	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Stirlingia latifolia	-	-	-	-	-	●	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Styphelia tenuiflora	-	-	-	-	-	-	●	○	-	-	-	●	-	○	○	-	-	-	-	●
Synaphea petiolaris	○	○	-	○	●	-	○	-	-	-	-	-	-	-	-	-	-	●	-	-
Trymalium ledifolium	-	-	-	-	-	-	○	-	-	-	-	○	-	●	-	-	-	-	-	○
Trymalium spathulatum	-	-	-	-	-	-	-	-	-	-	-	-	●	-	-	-	-	-	-	-

● Species should be present.
○ Species should be present, but absence not critical.
- Species generally absent.

granite outcrops. These last five types have recognizable photo-patterns and can be mapped by photogrammetric methods. The larger granite outcrops are shown on the vegetation map. The swampy bottomlands are very narrow but could have been readily shown also if the map had been published in colour. An idea of their extent can be gained from the geological map. The other 16 types could only be mapped laboriously by ground survey.

Details of the site-vegetation types are given below first for the wetter western sector and secondly for the drier eastern sector. To save space the indicator species for each type have been summarised in Table II. In the wetter western sector, Types T, S and P are found on the highest ground, T being on richer soil; S and P are similar but sufficiently different, P occupying the sandier middle and lower slopes below S. R is on gravelly slopes, Q and U are similar and on rich loams. D and W are similar, C in swampy bottoms generally below them. E may be found between B and H or M, W is normally situated between P or S and C, and is rather similar to D except for somewhat heavier soil texture. The gross variation in the tree layer is from *E.marginata-E.calophylla* forest on uplands, downslope to mixture with *E.patens* on valley loams, and to *E.patens* with *E.megacarpa* and *Agonis linearifolia* in swampy bottomlands.

Type S - Massive gravels with sandy loam matrix on the highest ground, i.e. slopes, ridges and plateaux. *E.marginata* with some *E.calophylla* and second story of *Banksia grandis*, *Persoonia longifolia* and *Casuarina fraserana*.

Type T - Upper slopes and ridges as in Type S, soil less sandy. Trees as in Type S without *Casuarina*.

Type P - Sandy gravels on mid and lower slopes, adjoining Types S and T. Trees as in Type S.

Type R - Lower and middle slopes of valleys with superficial wash of gravel and kaolinitic clay, often close to granite outcrops. *E.marginata* and *E.calophylla*, no small tree layer.

Type Q - Lower and middle slopes with good brown loam soil. *E.patens* with some *E.calophylla* and *E.marginata*, small tree layer of canopy spp. only.

Type U - Fertile loams on slopes of main river valleys. *E.patens* and *E.calophylla*, small tree layer of canopy spp. only.

Type E - Gravelly sands, transitional between swamps (C) and gravelly slopes (P & R). *E.marginata*, some *E.calophylla*, few *Banksia grandis*.

Type W - Winter-wet sandy loams on lower slopes and valley floors. Equal mixture of *E.marginata*, *E.calophylla*, *E.patens*.

Type D - Seasonally waterlogged sandy loams with hardpan on lower slopes and valley floors. *E.marginata* and *E.calophylla*, some *E.patens*.

Type C - Moist to wet sandy loams along creeks and swamp margins. Mainly *E.patens* with *E.megacarpa*, *E.calophylla*, *E.marginata*, occasionally *E.rudis*, *Banksia littoralis*.

In the drier eastern sector not only climate but geomorphology is also different so that it is difficult to compare individual types. There is a catena from gravel uplands to sandy bottomlands Z-H-F/J-B/A, and one from gravel uplands to loam flats Z-M-L-Y-A.

The gross variation in the tree layer is from *E.marginata-E.calophylla* forest on uplands continuing all the way down slope on sands finally changing to *Melaleuca* and *Banksia* on sand flats, or merging into *E.wandoo* and *E.patens* on loam slopes, pure *E.wandoo* on valley floors.

Type Z - Sandy loams with heavy gravel on upper slopes and uplands. *E.marginata* with some *E.calophylla*, second story largely missing.

Type H - Gravelly sands on lower and middle slopes. *E.marginata*, little *E.calophylla* some *Banksia grandis* and *Casuarina fraserana*.

Type F - Grey sand on lower slopes and broad upland depressions. *E.marginata* sole tree.

Type J - Leached sands on lower slopes and broad upland depressions. *E.marginata*, *E.calophylla* with *E.patens* at the moist and *Banksia attenuata* at the dry end of the range.

Type M - Gravelly loams on valley slopes. *E.wandoo* with occ. *E.patens* at lower levels and *E.marginata* at upper. No second story.

Type L - Fertile loams on lower slopes. *E.wandoo* with *E.patens*. No second story.

Type Y - Pale hard-setting loams on valley floors and lower slopes. *E.wandoo* virtually sole tree.

Type B - Winter-wet leached acid grey sands in upland depressions. *E.marginata*, *E.calophylla*, scattered understory of *Banksia grandis*.

Type A - Winter-waterlogged leached acid sands over hardpan in broad heads of valleys. Scattered *Melaleuca preissiana*, *Banksia littoralis*, *E.calophylla*, *E.patens*, or largely treeless.