

PART III

THE DRYSDALE RIVER NATIONAL PARK ENVIRONMENT

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INTRODUCTION

This section of the report provides a composite picture of the physical environment both of the park as a whole and of the collection sites. As well, the major floristic elements in the vegetation communities at the collection sites are documented. A vegetation map, described in Part IV, delineates the vegetation communities of the park while Part V itemises the flora found at the various localities.

CLIMATE

Köppen (1936) described the North Kimberley as tropical savannah with a distinct dry season between June and September during which very little, if any, rain falls. Though the Bureau of Meteorology (Anon. 1975) has updated Slatyer's (1960) climatic description of the North Kimberley Region, meteorological data for the Park itself are very limited. Theda Station 11 km east of the Park (14°30'S, 126°44'E) has recorded rainfall between 1965 and 1974, while Carson River Station, 20 km north-west of the Park (14°30'S, 126°43'E) has records from 1970 to 1973.

Rainfall figures for the two stations are tabulated in Table 1.

District was below average especially for the last three months preceding the survey—May, June and July 1975—and this was reflected in the flow patterns of the creeks and rivers. On 27 July the Drysdale River at Drysdale Crossing was flowing while by 24 August it had dried up at this point. In the Park itself the Drysdale River was still flowing at sites A1, B2 and C5. On 1 August Morgan Falls had a very small flow of water which had ceased by 16 August. The Carson River had dried up into isolated pools by 31 July. However, in the Park all creeks which drained sandstone country were reported by team members to be still flowing slightly. One of the features of the rainfall in the North Kimberley, where cyclones and thunderstorms are common, is the occurrence of sudden downpours which can cause local flooding during the 'wet'.

As daily temperature and humidity data are not collected in the inland area of the northern part of the North Kimberley, no information is available concerning these parameters for the Park. However, Slatyer (1960) says that, though the conditions (temperature and humidity) on the coast (e.g. at Derby) are less extreme than those experienced inland (e.g. at Gibb River), the differences are of a "rather small order and do not change the general picture". Table 2 tabulates the mean monthly

TABLE 1

COMMONWEALTH BUREAU OF METEOROLOGY RAINFALL FIGURES FOR NORTH KIMBERLEY

Location	Years	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Theda	1965-74	261	263	196	35	33	0	0	6	1	54	84	132	1 072
Carson River	1970-73	137	296	354	75	0	0	0	0	0	21	70	236	1 189

Mean Monthly and Annual Rainfall (mm)

In comparison with the data for the Prince Regent River Reserve (Miles *et al.* 1975), the figures support the contention of Slatyer (1960) that there is a north west-south east decrease in both the amount and intensity of rainfall in the Kimberley, as well as in the number of wet days per year. Thus, while the Drysdale River National Park (DRNP) is north-east of the Prince Regent River Nature Reserve (PRRNR) it is sufficiently inland from the coast for its yearly rainfall to be slightly less than that for the PRRNR. Three-quarters of the PRRNR lies within the 1200 and 1400 mm mean annual rainfall isohyets with the remaining southern quarter having a mean annual rainfall of between 1000 mm and 1200 mm. The DRNP on the other hand straddles the 1000 mm isohyet (Anon. 1975). Heavy dews occur in the Park area during the dry period (Morgan 1955). On several occasions substantial dews were recorded at Old Doongan and at the collection sites during the survey.

The Bureau of Meteorology reported (Anon. 1974/1975) that the 1974/75 rainfall for the North Kimberley

maximum and minimum temperatures for Kalumburu (45 km north of the Park, on the coast) and Mitchell Plateau (180 km west, inland from the coast). It also lists the 9 a.m. and 3 p.m. mean monthly relative humidity for both stations. Mitchell Plateau would tend to reflect the climatic conditions of DRNP while Kalumburu would mirror the wetter parts of PRRNR. Morgan (1955), during his survey of the area, recorded that, from May to August, maximum temperatures of up to 30°C followed by minima between 2°C and 7°C were experienced. On one occasion during June a low of -3°C was recorded. By the end of August maximum temperatures were approaching 38°C and by the end of September 40°C.

GEOLOGY AND PHYSIOGRAPHY

The geology of the area in which DRNP is located has been examined by both Derrick (1968) who discussed the geology of the Ashton area and Gellatly and Sofoulis (1969) who carried out a similar study in the Drysdale and Londonderry areas: the former study includes the southern part of the Park while the northern half of the Park is included in the latter paper.

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TABLE 2
AVERAGE MONTHLY MAXIMUM AND MINIMUM TEMPERATURES (°C)

Station	Period	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Kalumburu	30 year average	33.9	33.5	34.0	34.3	32.8	31.9	31.9	33.6	35.7	37.2	37.7	36.4	34.4
		24.6	24.5	32.9	21.3	17.8	14.9	13.4	15.1	18.4	22.2	24.5	25.0	20.5
Mitchell Plateau	1970-74	33.6	32.6	32.4	32.4	31.6	30.0	30.6	33.2	35.1	36.7	36.1	33.3	33.4
		22.3	22.0	21.3	18.6	12.8	10.8	8.3	12.1	16.6	20.0	21.5	22.5	17.4

AVERAGE MONTHLY 9 a.m. AND 3 p.m. RELATIVE HUMIDITY (%)														
Station	Period	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Kalumburu	30 year average	71	74	70	60	48	43	38	37	41	45	50	61	53
		62	66	60	47	39	33	28	28	35	42	47	54	48
Mitchell Plateau	1970-74	70	74	70	59	39	36	31	38	40	44	52	66	52
		57	63	57	45	30	28	22	27	34	40	43	55	42

Geologically, the Park is an eastward continuation of a geological series that runs north/south, slopes east/west and has its older western boundary in the PRRNR. Together these series form part of the physiographic Kimberley Plateau Province of Wright (1964) which overlies the Western Shield. Three of the sub-provinces are represented in the Park; the Prince Regent Plateau, Gibb Hills and Karunjie Plateau.

On the western edge of the Park, in the section isolated by a stock route, part of the Prince Regent Plateau is represented. Unlike the PRRNR where this plateau constitutes the main physiographic unit, in the DRNP it occupies only a small area. It consists of the very old (Proterozoic) sedimentary King Leopold Sandstones. The area is extremely rugged, very dissected with faults and features numerous gorges and waterfalls—Worriga Gorge and Morgan Falls being examples.

The Gibb Hills subprovince also occupies part of the western isolated section of the Park and lies to the east of the Prince Regent Plateau. Thus, like the Plateau, this subprovince is only slightly represented in the Park. Geologically it is formed by the sub-aerial extrusion of the basaltic Carson Volcanics over the King Leopold Sandstones. The part of the volcanics which are found in the Park form an area in which mesas and terraces are common due to the differences in the weathering pattern of the interbedded sandstones and volcanics. The area is less rugged than the previous sub-province and is characterised by undulating rocky plains and rounded hills capped by tertiary laterite e.g. Gattenhof and Goodirrie Hills.

The Karunjie Plateau represents the major physiographic subprovince within the Park. It is characterised by the shallowly dipping or horizontal rocks of the Warton Sandstones, Elgee Siltstones and Pentecost Sandstones. Due to variation in the erosive character of the various rock strata, cuestas, mesas and erosional escarpments are common.

The Warton Sandstones are deposited conformably over the volcanics and occupy the western edge of the main Park. The lower beds form the Carson Escarpment whose formation is due to the erosion of the volcanics at their junction with the more resistant sandstones. The upper beds have gentle dip slopes which are represented as sand-covered plains through which little of the bedrock outcrops.

The Elgee Siltstones are poorly represented due to their erosion from the more resistant surrounding sandstones.

They are generally calcareous and are prominent on scarps and at the bottom of valleys. Within the Park they occur at the base of the Ashton Range.

The Pentecost Sandstones conformably overlie the siltstone and occupy the remaining half of the Park. They consist of three members. From west to east they are the Lower, Middle and Upper Pentecosts. The sandstones form cuestas and scarps which range from well defined high features in the lower members to less defined and sand-covered plains in the upper members. The Lower occur on top of the Ashton Range and to the west of the Drysdale River; the Middle dominate most of the Park; and the Upper, which are very eroded and so are poorly represented, occur in the south-east quarter of the Park.

The above geological formations present in the sub-provinces belong to the Kimberley Stratigraphic Group. Also within the Karunjie Plateau subprovince is the Bastion Group and the Hart Dolerites.

The Bastion Group conformably overlies the previously mentioned strata of the Kimberley Group and in the Park is represented by the Mendena Formation. This formation occurs in the south-east corner of the Park as small low mesas rising out of the flat plains. These mesas, the Pseudomys Hills, have a siltstone base and are capped by quartz sandstone.

The Hart Dolerite intrudes into the sequence of both Groups. However, only in the King Leopold Sandstones at the base of Worriga Gorge is this dolerite exposed within the Park.

Folding and faulting occurred after this intrusion and were followed by a period of unconformity during which erosion of all groups occurred. During the Tertiary a laterite surface developed which tilted slightly northward, after which the current drainage system was developed. This eroded through the laterite to the Precambrian strata producing the present superimposed river system. The laterite is presently represented as remnants, capping some mesas. Very few of these occur in the Park and those that do are found mainly over the King Leopolds and the Carson Volcanics.

The Cainozoic soils overlie flat mature land surfaces and are developed as extensive tracts over the Warton Sandstones, Carson Volcanics and the Pentecosts. They are yellow where they overlie sandstone and red brown to grey where they overlie the volcanics. Colluvium occurs on scree slopes at the bottom of the sandstone scarps.

TABLE 3

A SUMMARY OF PLANT COMMUNITIES FOUND IN THE DRYSDALE RIVER NATIONAL PARK

(after Specht, Roe and Boughton, 1974)

The site of each community is noted by C5a, A2f, etc. (See below)

CONSERVATION AREA

Drysdale River National Park
Co. Wyndham, East Kimberley
Lat. 14° 56' S
Long. 126° 52' E
Area: 424 342 ha
R.I.:A

PLANT COMMUNITIES

Tall closed-forest

- (1) *Melaleuca leucadendron*, *Carallia brachiata*,
Metrosideros eucalyptoides. C5a

Closed-forest

- (1) Semi-deciduous mesophyll vine forest.
Diospyros nitens, *D. ferrea*, *Cassine melanocarpa*,
Canarium australianum, *Ficus racemosa*, *Carallia*
brachiata, *Albizia lebbek*, *Timonius timon*. C1i
- (2) *Eucalyptus miniata*, *E. tetradonta*. A2f
- (3) *Melaleuca leucadendron*, *Pandanus* sp. B2a, B2c,
B3d, B3f, C2e

Low closed-forest

- (1) *Canarium australianum*, *Pouteria sericea*, *Vitex*
glabrata, *Alphitonia excelsa*, *Randia cochinchin-*
ensis, *Ficus platypoda*, *Diospyros nitens*. B1b
- (2) *Syzygium suborbiculare*, *Carallia brachiata*, *Alphi-*
tonia excelsa, *Glycosmis pentaphylla*. C4d
- (3) *Melaleuca virens*, *Cassine melanocarpa*, *Planchon-*
ella pohlmanniana, *Alphitonia excelsa*. C5b

Open-forest

- (1) *Eucalyptus miniata*, *E. apodophylla*, *Erythrophleum*
chlorostachys. C4f

Low open-forest

- (1) Semi-deciduous microphyll vine thicket.
Alphitonia excelsa, *Pouteria sericea*, *Bombax*
ceiba var. *leiocarpum*, *Planchonella arnhemica*,
Micromelum minutum. C1f
- (2) *Eucalyptus latifolia*, *E. miniata*, *E. nesophila*, *E.*
polycarpa, *E. tetradonta*. A1d
- (3) *Banksia dentata*, *Pandanus spiralis*, *Eucalyptus*
ptychocarpa. A1f
- (4) *Eucalyptus bleeseri*, *E. latifolia*, *E. miniata*, *E.*
oligantha, *E. tetradonta*. A4a
- (5) *Melaleuca viridiflora*, *Eucalyptus apodophylla*, *E.*
ptychocarpa. A4c
- (6) *Melaleuca viridiflora*, *Eucalyptus ptychocarpa*
Banksia dentata, *Terminalia grandiflora*, *Eugenia*
bleeseri. C4b
- (7) *Celtis philippensis*, *Cassine melanocarpa*, *Ficus*
platypoda, *Dolichandrone heterophylla*, *Vitex glab-*
rata, *Gardenia megasperma*, *Bombax ceiba* var.
leiocarpum, *Gyrocarpus americanus*. C4c
- (8) *Eucalyptus miniata*, *E. tetradonta*. C1a
- (9) *Eucalyptus tectifera*, *E. grandifolia*, *E. aff. leuco-*
phloia. C2g

Woodland

- (1) *Eucalyptus tectifera*, *E. latifolia*, *E. foelscheana*.
B1c

- (2) *Melaleuca viridiflora*, *Eucalyptus apodophylla*,
Nauclea coadnata, *Pandanus spiralis*, *Terminalia*
grandifolia, *T. platyphylla*. B1d
- (3) *Eucalyptus miniata*, *E. tetradonta*, *E. ? latifolia*.
A2h, B4b
- (4) *Eucalyptus bleeseri*, *E. zygophylla*, *Erythrophleum*
chlorostachys, *Brachychiton* sp. A2b
- (5) *Eucalyptus miniata*, *E. bleeseri*. B3k
- (6) *Eucalyptus bleeseri*, *E. tetradonta*, *E. confertiflora*.
C3d

Low woodland

- (1) *Eucalyptus latifolia*, *E. miniata*, *E. nesophila*, *E.*
polycarpa, *E. tetradonta*. A1d
- (2) *Eucalyptus bleeseri*, *E. latifolia*, *E. miniata*, *E.*
oligantha, *E. tetradonta*. A4a
- (3) *Eucalyptus* aff. *leucophloia*, *E. sp.* (bloodwood),
Owenia vernicosa, *Buchanania obovata*. B1a, C4a
- (4) *Eucalyptus* aff. *leucophloia*, *E. miniata*, *E. herb-*
ertiana, *Owenia vernicosa*, *Acacia kelleri*. B4a
- (5) *Eucalyptus latifolia*, *E. tectifera*, *Erythrophleum*
chlorostachys, *Cochlospermum fraseri*, *Buchanania*
obovata. C4c
- (6) *Eucalyptus jensenii*, *E. zygophylla*, *E. tetradonta*,
Callitris intratropica, *Erythrophleum chlorostachys*.
A3b
- (7) *Eucalyptus tectifera*, *E. foelscheana*, *Hakea arbor-*
escens, *Grevillea mimosoides*. C2e, C4g
- (8) *Eucalyptus perplexa*, *E. spp.* (bloodwoods), *Cal-*
litris intratropica. A4e
- (9) *Eucalyptus miniata*, *E. tetradonta*. C1a
- (10) *Eucalyptus tectifera*. C1d
- (11) *Melaleuca viridiflora*. C5b

Open-woodland

- (1) *Melaleuca leucadendron*, *Sesbania formosa*,
Nauclea coadnata, *Pandanus aquaticus*. C1e
- (2) *Eucalyptus polycarpa*, *E. miniata*, *E. bleeseri*. B2d
- (3) *Eucalyptus miniata*, *E. tetradonta*. A3c
- (4) *Eucalyptus miniata*, *E. bleeseri*. B3k
- (5) *Eucalyptus bleeseri*, *E. tetradonta*, *E. confertiflora*.
C3d

Low open-woodland

- (1) *Eucalyptus latifolia*, *E. miniata*, *E. nesophila*, *E.*
polycarpa, *E. tetradonta*. A1d
- (2) *Pandanus spiralis*, *Grevillea pteridifolia*, *Melaleuca*
viridiflora, *Banksia dentata*. A1g
- (3) *Eucalyptus bleeseri*, *E. latifolia*, *E. miniata*, *E.*
oligantha, *E. tetradonta*. A4a
- (4) *Melaleuca? viridiflora*, *Eucalyptus apodophylla*, *E.*
latifolia, *Grevillea pteridifolia*. A4b
- (5) *Eucalyptus tectifera*, *E. latifolia*, *E. foelscheana*.
B1c
- (6) *Planchonella arnhemica*, *Ficus virens*, *Ficus leuco-*
tricha, *F. platypoda*, *Denhamia obscura*. C3c
- (7) *Eucalyptus miniata*, *E. tetradonta*. A3e
- (8) *Eucalyptus tetradonta*, *E. confertiflora*, *E. latifolia*,
Callitris intratropica, *Terminalia latipes*. A4d

TABLE 3—continued

Open-scrub	Tall open-shrubland
(1) <i>Acacia plectocarpa</i> , <i>A. kelleri</i> , <i>Grevillea agrifolia</i> , <i>G. pteridifolia</i> . C4e	(1) <i>Eugenia eucalyptoides</i> , <i>Calytrix brachychaeta</i> , <i>Buchanania obovata</i> . C1e
(2) <i>Xanthostemon paradoxus</i> , <i>Ficus platypoda</i> , <i>Cannarium australium</i> , <i>Stenocarpus cunninghamii</i> , <i>Gardenia pantonii</i> . B4e	Low open-shrubland
Tall shrubland	(1) <i>Acacia brevifolia</i> , <i>A. translucens</i> , <i>Bossiaea bos-siaeoides</i> , <i>Burtonia subulata</i> , <i>Mirbelia viminialis</i> , <i>Triumfetta plumigera</i> . A2a
(1) <i>Acacia holosericea</i> , <i>A. tumida</i> , <i>A. sericata</i> , <i>A. kelleri</i> , <i>Grevillea pteridifolia</i> . A1b	Closed-herbland
(2) <i>Melaleuca argentea</i> , <i>Terminalia bursarina</i> , <i>Pouteria sericea</i> , <i>Calytrix brachychaeta</i> , <i>Grevillea agrifolia</i> , <i>Xanthostemon paradoxus</i> . A1c	(A) Closed-grassland
(3) <i>Eugenia eucalyptoides</i> , <i>Terminalia bursarina</i> , <i>Barringtonia acutangula</i> , <i>Calytrix brachychaeta</i> . B4c	(1) <i>Heteropogon contortus</i> , <i>Elytrophorus spicatus</i> , <i>Eragrostis</i> spp. A4b
	(2) <i>Ectrosia</i> sp., <i>Eragrostis</i> sp. C4b
	(3) <i>Themeda australis</i> , <i>Setaria surgens</i> , <i>Cymbopogon bombycinus</i> , <i>C. procerus</i> , <i>Eriachne sulcata</i> , <i>Triodia</i> sp. A3a, A3f
	(4) <i>Cymbopogon procerus</i> , <i>Triodia pungens</i> . B3i

The other type of soil—the ferruginous/lateritic soils—occur less frequently than the former and are located in isolated pockets in the centre of the Park on the glauconitic Middle Pentecosts. Finally, Quarternary alluvium is confined to beds of rivers and creeks. In places, such as A1 on the Drysdale River where the river has eroded down to bedrock through the small flood plain deposits, the latter are left as upraised terraces.

The Park is drained mainly by the Drysdale River, with the Carson River draining the extreme western edge and the separated section, the Berkeley River the south-eastern section and the King George River the north-east part.

DESCRIPTION OF SITES

The principal vegetation formations around each site are described in terms of geology, structure and floristics. The formations have been classified according to Specht (1970). Assessment of structure and dominance was qualitative, but correlated well with the aerial photo interpretation of Smith (Part IV of this bulletin). In contrast to the Prince Regent River expedition, provision was made for us to visit all sites. While this allowed better assessment of the whole area, it reduced the time at each site to a maximum of three days, so that floristic sampling was less thorough. The formations are coded (A1a, A1b, etc.) to facilitate cross-referencing in later Parts of the bulletin.

The plant communities of the Park are summarised in Table 3, in more detail than was available when the table in Specht *et al.* (1974) was prepared. It should be noted that several areas included in the table and in the ensuing descriptions are not at present part of the Park but are recommended for addition to it. They are Forest Creek (C5), Galaxy Swamp, and some sections of the Stock Route at B1 and C4. The site at which each community was recorded is given in the table.

No attempt has been made to estimate the area covered by each community. Broadly speaking, much of the Park is covered by low open-forest, low woodland and low open-woodland, the upper stratum sometimes being tall enough to bring it into the categories of open-forest, woodland and open-woodland. Various *Eucalyptus* species tend to dominate these formations, but there is admixture of other genera. The understorey is usually dominated by grasses with scattered shrubs, but the latter sometimes predominate. The structure and floristics

appear to vary according to the geology and ground water availability.

The presence of water on or close to the surface makes an immediate and striking impact on the vegetation. This can be seen in the fringing formations along creeks and rivers: they are usually narrow and quite different from adjacent drier areas.

Three formations deserve special comment. One is the low closed-forest (sometimes low open-forest) which occurs on suitable rocky sandstone screes in gullies, especially along the Carson Escarpment (B1, C4) and along Forest Creek (C5). It is akin to the semi-deciduous microphyll vine thicket recorded in the Prince Regent River Reserve (Miles *et al.* 1975) but, probably due to the lower rainfall, is less diverse floristically and contains fewer vines. Other areas are known to occur around the Mitchell Plateau, on the far north coast and on some offshore Kimberley islands. However they are usually small pockets of a few hectares or less, and it is important that as many be preserved as possible. A number of species are known in W.A. only from this formation, e.g. the Rutaceous species *Glycosmis pentaphylla* and *Micromelum minutum*. Typically Australian genera such as *Eucalyptus*, *Calytrix* and *Grevillea* are lacking, the floristic affinity being rather with Indo-Malaysia.

The second unusual formation is a pocket of closed-forest covering 1 to 2 ha in Worriga Gorge (C1). There are robust lianes with stems up to 10 cm thick, and the formation can be classified as semi-deciduous mesophyll vine forest, the first time it has been recorded in W.A. Floristic composition is similar to that of the low closed-forest mentioned above with the addition of four or five species of lianes which have not as yet been identified.

Similarly, the record of tall closed-forest along Forest Creek (C5) is the first of this formation in the Kimberley. Again, it is small, about 1 ha, and is floristically poor, but it is impressive and in marked contrast to the surrounding areas. One of the tree species has not yet been identified, while another (*Metrosideros eucalyptoides*) is known in W.A. from only one other locality near the Mitchell Plateau.

A1 Mogurnda Creek (Figures 1, 2)

The campsite was located on the west bank of the Drysdale River in 15°02'S, 126°55'E where the altitude above sea level is approximately 230 m. The geological formation is Lower Pentecost Sandstone (Pkpl). The river

here forms a pool about 2 km long, 150 m wide and up to 5 m deep. A freshwater creek, Mogurnda Creek, enters the Drysdale just downstream from the camp.

- (a) The west bank is sandy alluvium (Qa) and is fringed with Silver Cadjeput (*Melaleuca argentea*) and River Pandanus (*Pandanus aquaticus*), with some Freshwater Mangrove (*Barringtonia acutangula*), and scattered herbs and grasses. Aquatic plants include *Nymphaea gigantea*, *Nymphoides hydrocharoides* and *Vallisneria spiralis*.
- (b) Behind the fringing vegetation a steep sandy bank carries a tall shrubland of the wattles *Acacia holosericea*, *A. tumida*, *A. sericata* and *A. kelleri* with some *Grevillea pteridifolia* and an occasional emergent River Gum (*Eucalyptus camaldulensis*). The spinifex *Plectrachne pungens* is common. The east bank of the river is mostly rocky but supports a similar fringing vegetation.
- (c) Both upstream and downstream from the long pool the river in late winter forms a series of broken pools and small rapids over a rocky bed. The vegetation is chiefly a tall shrubland of *Melaleuca argentea*, *Terminalia bursarina*, *Pouteria sericea*, *Calytrix brachychaeta*, *Grevillea agrifolia* and *Xanthostemon paradoxus*. Near the water are some dense stands of *Pandanus aquaticus*. There are areas of bare rock and sand.
- (d) Away from the river the land is gently undulating except for a prominent sandstone ridge to the south east of the camp. The soil is either sandy or rocky. The vegetation is low woodland, occasionally low open-forest or low open-woodland. The trees are dominated by *Eucalyptus* species, especially *E. latifolia*, *E. miniata*, *E. nesophila*, *E. polycarpa* and *E. tetradonta*. Other trees are *Brachychiton diversifolium*, *Buchanania* sp., *Callitris intratropica*, *Denhamia obscura*, *Erythrophleum chlorostachys*, *Gardenia* sp., *Owenia vernicosa*, *Petalostigma pubescens*, *Planchonella arnhemica* and *Terminalia* sp. A rather sparse shrub layer includes *Bossiaea bossiaeooides*, *Distichostemon hispidulus*, *Grevillea refracta*, *Jacksonia argentea*, *Triumfetta* spp. and *Verticordia cunninghamii*. The ground flora at this dry season is dominated by grasses, especially ephemeral *Sorghum* in sand and the spinifex *Plectrachne bynoei* in rocky areas.
- (e) Mogurnda Creek enters the Drysdale just below the campsite. Slowly flowing in the dry season, it is lined with Cadjeput (*Melaleuca leucadendron*) and River Gums (*Eucalyptus camaldulensis*) near the river, and higher up with *Pandanus spiralis*, *Eucalyptus ptychocarpa* and *Grevillea pteridifolia*. The sandy banks are mostly covered with grasses, while numerous herbs occur in the bed and in pools. Aquatic species are *Blyxa echinosperma*, *Eriocaulon setaceum*, *Limnophila chinensis*, *Triglochin pterocarpa* and *Utricularia exoleta*. Marsh plants include *Phylidrum lanuginosum*, *Ludwigia suffruticosa*, *Xyris complanata* and *Scirpus mucronatus*.
- (f) About 400 m up Mogurnda Creek and on its north side is a swamp supporting a low open-forest of *Banksia dentata*, *Pandanus spiralis* and *Eucalyptus ptychocarpa* with emergent *E. apodophylla*. There is a dense understorey chiefly of grasses.
- (g) Another small swampy flat lies between the Drysdale River and the sandstone ridge beyond the east bank of the river. Here there is a low open-woodland of



Figure 1—View east across the Drysdale River at AI. Sandy bank in foreground with *Grevillea agrifolia* (left) and *Acacia tumida* (right). *Melaleuca argentea* and *Pandanus aquaticus* on water's edge. Low open-woodland beyond farther bank.



Figure 2—Mogurnda Creek (AI). Trees include *Pandanus spiralis*, *Grevillea pteridifolia*, *Melaleuca leucadendron* and *Eucalyptus ptychocarpa*. Dense grasses along banks and *Phylidrum lanuginosum* in pools.

Pandanus spiralis, *Grevillea pteridifolia*, *Melaleuca viridiflora* and *Banksia dentata*, again with a low but dense ground cover of grasses and herbs.

- (h) West of the camp a billabong occupies a flood channel of the river. The bottom is partly rocky, partly mud, with steep sandy banks. A few tall *Eucalyptus camaldulensis* line the banks together with low shrubs of *Barringtonia acutangula*. The sandy banks are densely covered with grasses including *Arundinella nepalensis* and *Vetiveria pauciflora*. Many aquatic and marsh plants occur in and around the water.

They include *Nymphaea gigantea*, *Nymphoides indica*, *N. hydrocharoides*, *Marsilea* ? *mutica*, *Caldesia oligococca*, *Dysophylla verticillata*, *Utricularia* sp., *Pseudoraphis abortiva*, *Eriocaulon quinquangulare* and *Limnophila* sp.

A2 Boiga Falls (Figures 3, 4, 5)

The A2 campsite (15°08'S, 127°06'E) was situated at an altitude of 400 m on top of Boiga Falls within a run-off depression on Tadarida Scarp. The falls (which were dry at the time of visiting) form the headwaters of Lorikeet Creek which drains into Tadarida Creek, this in turn flowing to the Drysdale River.

- (a) The plateau above the scarp consists mainly of rocky, sandy soils (Czs) with some massive outcrops of Upper Pentecost Sandstone (Pkp). The depression on the scarp where the campsite was situated supports a low open-shrubland of *Acacia brevifolia*, *A. translucens*, *Bossiaea bossiaeooides*, *Burtonia subulata*, *Mirbelia viminalis* and *Triumfetta plumigera* with *Cochlospermum fraseri* as an occasional emergent. Scattered spinifex (*Triodia* sp.), *Solanum* sp., *Phyllanthus* sp., *Petalostigma quadriloculare*, *Gonocarpus leptothecus*, and a woolly species of fern (*Cheilanthes vellea*) form the main ground cover.
- (b) On either side of the depression on sandy (Czs) soils *Eucalyptus bleeseri* and *E. zygophylla* form a woodland to low open-woodland. Beneath the tree layer

Erythrophleum chlorostachys and *Brachychiton* sp. form sub-dominants along with *Acacia translucens* and *Petalostigma pubescens*. Spinifex (*Triodia* sp.), is the main ground cover particularly around rocky outcrops, although on sandy, open areas *Cymbopogon procerus* also occurs.

- (c) The edge of the sandstone cliff forms almost a sheer drop over Boiga Falls but is flanked by well-formed scree slopes of Upper Pentecost Sandstone (Pkp) leading in from the valleys on either side. The cliff edge supports a dense stand of mixed species. These include *Owenia vernicosa*, *Terminalia latipes*, *Ficus platypoda*, *Grevillea agrifolia*, *Gardenia* sp., and *Exocarpos latifolius*.
- (d) The Upper Pentecost scree slopes consist of massive sandstone boulders. The vegetation of the scree is similar to that of the cliff edge but includes species such as *Planchonella arnhemica*, *Acacia humifusa*, *Callitris intratropica*, *Eucalyptus clavigera*, *Buchanania obovata* with the grasses *Cymbopogon procerus* and *Coelorhachis rottboellioides* commonly occurring.
- (e) Below Boiga Falls there is a massive sandstone (Pkp) scree which is a seasonal water course. At the base of the cliff is a seepage area. This damp environment (particularly on shaded rock ledges) supports *Ficus virens* (growing from rock crevices), the ferns *Lindsaea ensifolia* and *L. ? orbifolia* and the ephemeral trigger-plant, *Stylidium muscicola*. On the exposed rock



Figure 3—View west from the edge of Boiga Falls (A2) over the low eucalypt woodland through which runs Lorikeet Creek.



Figure 4—Boiga Falls (A2). A massive sandstone cliff face, dry at the time of our visit. The plateau above the falls supports a low open-woodland to low open-shrubland. A dense stand of trees and shrubs occurs on the rock ledges below the cliff face



Figure 5—Lorikeet Creek (A2). Restricted to a series of remnant pools at the time of our visit. The banks support a dense growth of fern (*Blechnum orientale*) and *Osbeckia australiana*.

ledges at the base of the cliff, trees and tall shrubs such as *Alstonia actinophylla*, *Fenzlia phebaloides* and *Canarium ? australianum* occur.

- (f) The valley below Boiga Falls narrows and the sand over sandstone (Pkp_m) supports a closed-forest of *Eucalyptus miniata* and *E. tetradonta* through which flows (in the wet) Lorikeet Creek. At the time of our visit Lorikeet Creek was restricted to a series of remnant pools with a dense growth of fern (*Blechnum orientale*) and *Osbeckia australiana* covering the creek banks.
- (g) Further downstream the valley widens out into what would be a seasonal swamp flat after the wet as evidenced by the dense stand of grasses (mainly *Cymbopogon procerus* and *Sclerandrium truncatiglume*) and ephemeral herbs (*Stylidium pachyrrhizum*, *Drosera* spp.) most of which had dried off. Along the creek bank small clumps of *Eucalyptus houseana*, *Pandanus spiralis* var. *convexus* and *Melaleuca viridiflora* occur as common emergents on the swamp flat. The remnant pools support few aquatics, *Eriocaulon setaceum* being the most common. On the sandy creek bank *Philydrum lanuginosum*, *Xyris complanata*, *Dicliptera glabra*, *Thysanotus chinensis* and *Borreria ? australiana* are common herbs.
- (h) The valley eventually widens out into a broad plain of Middle Pentecost Sandstone (Pkp_m), supporting a low woodland of *Eucalyptus miniata* and *E. tetradonta*.

A3 Pseudomys Hills (Figures 6, 7, 8)

The A3 campsite (15°17'S, 127°12'E) was situated on sandy soils (Czs) derived from Upper Pentecost Sandstone (Pkp_u) near the headwaters of the Forrest River and adjacent to the Pseudomys Hills. The Pseudomys Hills rise 40 m from the surrounding plain and consist of banded layers of siltstone and sandstone, forming mesas. This series of mesas constitutes the only Mendena Formation (Ptm) in the Park.

- (a) The campsite was under a small clump of eucalypts (*Eucalyptus microtheca* and *E. grandifolia*) on the edge of a closed grassland (*Themeda australis*, *Setaria surgens*, *Cymbopogon bombycinus*, *Eriachne* sp., *Triodia* sp.) forming part of the watershed from Pseudomys Hills to the headwaters of the Forrest River. Tree and shrub emergents are scattered and comprise species such as *Dolichandrone filiformis*, *D. heterophylla*, *Erythrophleum chlorostachys*, *Terminalia canescens*, *Sterculia viscidula*, *Cochlospermum fraseri* and *Acacia translucens*.
- (b) On either side of the watershed a low woodland of *Eucalyptus jensenii*, *E. zygophylla* and *E. tetradonta* occurs. Associated with the woodlands are stands of *Callitris intratropica* and *Erythrophleum chlorostachys*. Where the sandstone (Pkp_u) outcrops a scattered shrub layer of *Calytrix conferta*, *Bossiaea bossiaeoidea* and *Petalostigma pubescens* occurs with the grasses *Cymbopogon procerus*, *Triodia* sp. and *Themeda australis* forming the main ground cover.
- (c) The Pseudomys Hills lie to the north of the campsite. The plateau on top of the mesa consists of broken sandstone boulders whereas the scree slopes are covered in large boulders of siltstone. The tops of the mesas support an open-woodland of *Eucalyptus miniata* and *E. tetradonta* with grasses forming a dense ground cover. Occasionally along the ridges and scree slopes, clumps of *Callitris intratropica*, *Gardenia* sp. and *Eucalyptus perfoliata* are present.



Figure 6—Pseudomys Hills (A3). View south from the edge of the mesa overlooking the closed-grassland surrounded by low eucalypt woodland.



Figure 7—Pseudomys Hills (A3). The plateau on top of the mesa supports an open-woodland of *Eucalyptus miniata* and *E. tetradonta* with a dense grass ground cover.



Figure 8—Pseudomys Hills (A3). Siltstone scree slopes of the mesa showing a dense belt of *Melaleuca minutifolia*.

- (d) The siltstone scree slopes are covered in hummock grass (*Triodia* sp.) and Kangaroo Grass (*Themeda australis*) with low shrubs of *Bossiaea bossiaeoidea* and *Verticordia cunninghamii*. Fringing the scree slopes is a dense belt of *Melaleuca minutifolia* which becomes mixed with *Melaleuca viridiflora*, *Cochlospermum fraseri* and *Calytrix conferta* as it descends the watershed.

- (e) Toward the headwaters of the Forrest River sandy soils (Czs) support a low open-woodland of *Eucalyptus miniata* and *E. tetradonta*.
- (f) Fringing the banks of Forrest River is a closed grassland (*Eriachne sulcata*, *Themeda australis*, *Cymbopogon procerus*) with *Pandanus* sp. *Eucalyptus houseana*, *E. latifolia*, *E. apodophylla*, *Melaleuca viridiflora* and clumps of *Grevillea viscidula* lining the banks or occurring as emergents. The area of grassland near the creek was still quite damp, the mud supporting many ephemeral species such as *Mitrasacme* spp., *Stylidium* spp., *Byblis liniflora*, *Thysanotus chinensis*, *Utricularia* spp. and *Xyris* spp. The boundary between wet and dry areas was clearly defined, the ephemeral species being replaced by hardier perennial species such as *Evolvulus alsinoides*, *Buchnera ramosissima*, *Hypericum gramineum* and *Stemodia caerulea*.
- (g) The remnant pools of the river contain many aquatics such as *Nymphaea indica*, *Nymphaea gigantea* and *Eriocaulon setaceum*. *Philydrum lanuginosum* forms dense stands in the shallow pools.

A4 Dromaius Creek (Figure 9)

The A4 locality lies in 15°16'S, 126°43'E on the plain between the southern end of the Ashton Range and Dromaius Creek. The Creek meanders northwards across the plain and eventually reaches the Drysdale River. In the dry season the creek becomes a series of pools. The altitude on the plain is about 310 m and on top of the range about 400 m.

- (a) The plain consists of alluvial soils derived from sandstone (Czs) and the principal vegetation formations are low open-forest, low woodland and low open-woodland. *Eucalyptus* species are the dominant trees and include *E. bleeseri*, *E. latifolia*, *E. miniata*, *E. oligantha* and *E. tetradonta*. Other trees are *Acacia aulacocarpa*, *Brachychiton diversifolium*, *Callitris intratropica*, *Erythrophleum chlorostachys*, *Grevillea pteridifolia*, *Pandanus spiralis*, *Petalostigma pubescens* and *Terminalia grandiflora*. An open shrub layer includes such species as *Acacia translucens*, *Bossiaea bossiaeoides*, *Burtonia subulata*, *Hakea arborescens*, *Planchonia australis* and *Verticordia cunninghamii*. There is a moderately dense cover of grasses and herbs such as *Plectrachne pungens*, ephemeral *Sorghum*, *Eriachne obtusa*, *Helichrysum apiculatum*, *Blumea integrifolia*, *Platyzoma microphyllum*, *Mitrasacme* spp. and *Polycarphaea staminodina*.
- (b) Among the low open-forest and low woodland are pockets of closed grassland on fine clay which is probably waterlogged in the wet season, and there is an extensive such area about 2 km south of the campsite. The grasses include *Heteropogon contortus*, *Elytrophorus spicatus* and *Eragrostis* spp., while typical herbs are *Xyris complanata*, *Byblis liniflora*, *Thysanotus chinensis*, *Buchnera linearis* and *Stackhousia viminea*. There are open thickets, sometimes forming low open-woodland, consisting chiefly of *Melaleuca* ? *viridiflora*, *Eucalyptus apodophylla*, *E. latifolia* and *Grevillea pteridifolia*.
- (c) Along Dromaius Creek is a fringing low open-forest or woodland dominated by *Melaleuca viridiflora*, *Eucalyptus apodophylla*, *E. ptychocarpa* and *Pandanus* sp. Grasses form a dense understorey, consisting especially of *Coelorrhachis rottboellioides*. A few aquatics are present in the pools, e.g. *Nymphaea*

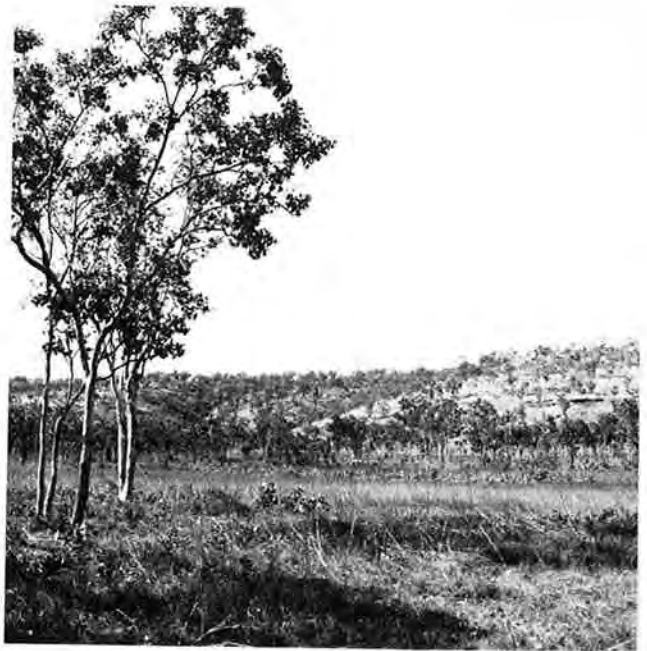


Figure 9—Alluvial plain at A4, with the Ashton Range beyond. Low open-forest and closed-grassland on plain, tall open-shrubland on scarp.

gigantea, *Nymphoides hydrocharoides*, *N. indica*, *Linnophila chinensis*, *Utricularia* sp. and *Eriocaulon setaceum*.

- (d) The western scarp of the Ashton Range consists of Elgee Siltstone (Pke) and near A4 rises almost 100 m above the plain. The scarp is rocky and scree-like and supports low open-woodland and tall open-shrubland over grassland. The trees and shrubs include *Eucalyptus tetradonta*, *E. confertiflora*, *E. latifolia*, *Callitris intratropica*, *Cochlospermum fraseri*, *Acacia plectocarpa*, *Terminalia latipes*, *Buchanania* sp. and *Gardenia* sp. Ephemeral *Sorghum* is the dominant grass.
- (e) The top of the range is plateau-like and consists of Lower Pentecost Sandstone (Pkpl). Here there is a low woodland and low open-forest (in places woodland) over grassland. *Eucalyptus* species are dominant and include *E. perplexa* and three bloodwoods as yet unidentified. *Callitris intratropica* is present but appears much reduced by fire. A rather sparse shrub layer includes *Distichostemon hispidulus*, *Grevillea agrifolia*, *Hibbertia lepidota* and *Mirbelia viminialis*.

B1 Orchid Creek (Figures 10, 11, 12, Colour plates 7, 8)

This locality is in 14°49'S, 126°49'E, where Orchid Creek leaves the Carson Escarpment and winds across the plain to the Carson River. Near the head of the deep gully (Glider Gorge) cut by the creek into the Escarpment is Dulcis Falls, a waterfall about 50 m high above which the creek dries up in the dry season. Seepages give rise to a number of pools in the gully and along the creek. The Carson Escarpment here is a rampart about 120 m high, in places sheer cliffs, in others with small bluffs and steep screes below. The height above sea level is about 240 m atop the Escarpment, 120 m on the plain below. To the west, the Carson River is a prominent watercourse winding northward across basaltic plains with frequent rocky outcrops in its bed. At the time of our visit it was a series of pools with slight flow between them.

(a) On the Warton Sandstone (Pkw) plateau in very rocky soil the vegetation is low woodland and tall shrubland grading to low open-forest away from the Escarpment. *Eucalyptus* sp. aff. *leucophloia* is a common tree, an undetermined bloodwood less so. Other trees are *Owenia vernicosa*, *Buchanania obovata*, *Planchonia australis*, *Gardenia* sp. and *Xanthostemon paradoxus*, while along the rocky edge of the plateau are found *Callitris intratropica* and *Ficus* sp. The understorey consists of *Sorghum* and *Triodia* with an open shrub layer of such species as *Strychnos lucida*, *Santalum lanceolatum*, *Acacia* spp., *Fenzlia pheba-lioides* and *Homalocalyx ericaeus*. About 1 km north of Glider Gorge is a population of an un-described *Eucalyptus* allied to *E. alba*.



Figure 10—Aerial view of the Carson Escarpment and Glider Gorge at B1. Low woodland on plateau and below escarpment. Low closed-forest in gullies. Orchid Creek runs out of the Gorge.



Figure 11—Low closed-forest in Glider Gorge (B1). Note rocky floor, climbers and cliff behind.



Figure 12—View south along the Carson River near B1, with *Pandanus aquaticus* and *Melaleuca leucadendron*, etc. *Eriachne festucacea* on basaltic rocks in foreground. Carson Escarpment in distance.

(b) On the very rocky soils of the screes and gullies of the Escarpment the formation varies, perhaps according to available ground water, from low closed-forest through low open-forest to low woodland. No species are dominant in the closed-forest, but representative trees are *Canarium australianum*, *Pouteria sericea*, *Vitex glabrata*, *Alphitonia excelsa*, *Randia cochinchinensis*, *Ficus platypoda* and *Diospyros nitens*. Along Orchid Creek, in the gully, are *Pandanus spiralis* and *Syzygium suborbiculare*. In seepages on rock ledges occur the ferns *Lindsaea ensifolia* and *Lygodium japonicum*, together with the mat-like grass *Micraria subulifolia*. The epiphytic orchid *Dendrobium dicuphum* is common. Wet crevices of Dulcis Falls support the fern *Nephrolepis hirsutula*, the grasses *Paspalum commersonii* and *Sclerandrium truncatiglume* and the fig *Ficus virens*. In closed areas there is little ground flora, but climbers such as *Tinospora smilacina*, *Flagellaria indica* and *Smilax australis* are present. In more open areas other trees occur, such as *Eucalyptus confertiflora*, *Stenocarpus cunninghamii* and *Atalaya variifolia*, and there is a ground cover chiefly of grasses.

(c) The plain below the Escarpment consists of loamy or rocky Carson Volcanics (Pkc) and is gently undulating. There are low rock outcrops which are quite bare, but otherwise the vegetation is woodland, low woodland and low open-woodland. The dominant trees are usually *Eucalyptus*, especially *E. tectifica*, *E. latifolia* and *E. foelscheana*, but in some areas *Terminalia grandiflora* is dominant. Other trees are *Erythrophleum chlorostachys*, *Sterculia viscidula*, *Planchonia australis*, *Ficus opposita* and *Grevillea mimosoides*. Towards the base of the Escarpment are such species as *Verticordia cunninghamii*, *Grevillea heliosperma* and *Petalostigma pubescens*. A dense ground cover of grasses includes *Sorghum* sp., herbs such as *Platyzoma microphyllum*, *Helichrysum apiculatum* and *Ptilotus exaltatus*.

The epiphytic orchid *Cymbidium canaliculatum* inhabits a few tree forks.

- (d) Woodland and low woodland occur along Orchid Creek where it crosses the plain to the Carson River. The trees include *Melaleuca viridiflora*, *Eucalyptus apodophylla*, *Nauclea coadnata*, *Pandanus spiralis*, *Terminalia grandiflora* and *T. platyphylla*. There is a dense ground cover of grasses, while herbs occur along the creek bed and in pools.



Figure 13—Nymphaea Creek (B2) near its junction with the Drysdale River.

- (e) The Carson River is fringed irregularly with a narrow belt of trees of *Melaleuca leucadendron*, *Ficus coronulata*, *Sesbania formosa*, *Terminalia platyphylla*, *Pandanus aquaticus* and *Barringtonia acutangula*. *Eriachne festucacea* is a common grass in the rocky bed of the river, and *Myriophyllum verrucosum* is common in the pools.

B2 Nymphaea Creek (Figures 13, 14, 15)

The B2 campsite (14°49'S, 126°55'E) was situated near the junction of Nymphaea Creek and the Drysdale River.

- (a) The vegetation of the river banks is a closed-forest of Cadjeputs (*Melaleuca leucadendron*, *M. argentea*) with Screw-Pine (*Pandanus* sp.), River Gum (*Eucalyptus camaldulensis*) and *Nauclea coadnata*.
- (b) Nymphaea Creek although only slowly flowing through sandy (Czs) soils at the time of our visit, widens out in many places to form shallow pools or wet, swampy areas. The pools and creek banks are fringed with Cadjeputs (*Melaleuca argentea*, *M. leucadendron*, *M. viridiflora*), Screw-pine (*Pandanus juleensis*), *Jacksonia thesioides*, *Acacia holosericea*,

A. plectocarpa, *A. tumida* and the Freshwater Mangrove, *Barringtonia acutangula*. The shallow pools support aquatics such as *Eriocaulon* spp., *Triglochin procera* and *Nymphaea gigantea*. The swampy fringe areas of the creek form a grassland with species such as *Sclerandrium truncatiglume*, *Ectrosia leporina*, *Eragrostis ? brownii*, *Eriachne festucacea* and *Dimeria ornithopoda* being common. The grassland is rich in herbs such as *Stylidium* spp., *Mitrasacme* spp., *Drosera* spp., *Utricularia* spp., *Byblis liniflora*, *Limnophila chinensis*, *Nelsonia brunelloides*, *Centrolepis exserta*, *Blumea tenella*, *Philydrum lanuginosum*, *Hemiarrhena plantaginea*, *Xyris* spp., and *Buchnera linearis*.

- (c) Further up Nymphaea Creek a large swamp (Czs soils) supports a closed-forest of Cadjeput (*Melaleuca leucadendron*). Associated with this are Screw-pine (*Pandanus* sp.), *Melaleuca viridiflora*, *Eucalyptus ptychocarpa*, *Banksia dentata* and *Grevillea pteridifolia*. Areas of closed-grassland are commonly interspersed with the closed-forest but do not support the ephemeral species as in B2 b, although the grass species are the same.
- (d) On either side of Nymphaea Creek the sand over sandstone (Czs) supports an open-woodland of eucalypts (*Eucalyptus polycarpa*, *E. miniata*, *E. bleeseri*) with patches of *Callitris intratropica*, *Buchanania obovata*, *Acacia brevifolia*, *A. dunnii*, *Calytrix achaeta*, and *Petalostigma pubescens* occurring where the sandstone outcrops.



Figure 14—Nymphaea Creek (B2). Edge of the closed Cadjeput (*Melaleuca leucadendron*) forest with grassland in the foreground.



Figure 15—Patches of *Callitris intratropica* in the sandstone within areas of open eucalypt woodland. Near Nymphaea Creek (B2).

- (e) Downstream from the campsite the Drysdale River has braided its bed and numerous levees and inter-levee pools occur. The levee banks support dense stands of Cadjeputs (*Melaleuca* spp.) and *Pandanus* sp. while the grasses *Vetiveria pauciflora*, *Digitaria longiflora* and *Sclerandrium truncatiglume* are common, extending from the river bank to the open-woodland.
- (f) At B2 the Drysdale River flows through a gap in the Ashton Range, and across the river, opposite the campsite, Elgee siltstones (Pk1) are exposed in the scree slopes of the steep-sided hills. These hills consist of Lower Pentecost Sandstones (Pkpl). The main tree species are *Eucalyptus tetrodonta*, *E. bleeseri*, *E. confertiflora*, *Cochlospermum fraseri*, *Persoonia falcata*, *Planchonella arnhemica*, *Terminalia canescens*, *Xanthostemon paradoxus*, *Owenia vernicosa*, *Erythrophleum chlorostachys*, *Stenocarpus cuminghamii*, *Callitris intratropica* and *Gardenia* sp. Shrub species such as *Distichostemon hispidulus*, the fern *Platyzoma microphyllum* and the hummock grass (*Triodia* sp.) are common on the slopes.

B3 Cracticus Falls (Figures 16, 17, Colour plate 11)

The B3 campsite (14°47'S, 127°05'E) was established at the base of Cracticus Falls on Johnson Creek in Petrogale Gorge.

- (a) The floor of the gorge above Cracticus Falls consists of Lower Pentecost Sandstone (Pkpl) and at the time



Figure 16—Petrogale Gorge (B3). The plunge pool at the base of Cracticus Falls fed by Johnson Creek. The vegetation of the southern gorge wall and the main sandstone plateau can be seen in the distance.

of our visit, contained large, shallow, residual pools. In most places the dried bed of Johnson Creek has been worn smooth but in other areas the floor is littered with large sandstone boulders undercut from the gorge wall. Because of the seasonal rush of water, permanent vegetation in the creek bed is scarce and is restricted to Cadjeputs (*Melaleuca leucadendron*, *M. argentea*, *M. viridiflora*), River Gum (*Eucalyptus camaldulensis*), *Eugenia eucalyptoides* and the Freshwater Mangrove (*Barringtonia acutangula*).

- (b) In the remnant pools numerous aquatics such as *Eriocaulon* spp., *Valisneria spiralis*, *Nymphoides* spp., *Myriophyllum trachycarpum*, *Utricularia exoleta* and *Nymphaea gigantea* are common. The wet alluvial sand banks (Qa) and sand-filled crevices within the sandstone creek bed support herbs such as *Ludwigia suffruticosa*, *Polygonum attenuatum* and *Goodenia lamprosperma* while on the mud are *Limnophila fragrans* and *Microcarpaea minima*.
- (c) On the rock ledges immediately above the creek bed *Ficus leucotricha* var. *megacarpa*, *Hibiscus* sp., *Distichostemon hispidulus* and the hummock grass *Plectrachne bynoei* occur.



Figure 17—Petrogale Gorge (B3). Dense closed-forest of Cadjeputs (*Melaleuca argentea* and *M. leucadendron*) and *Eugenia eucalyptoides*, on the edge of the plunge pool below Cracticus Falls.

- (d) Below Cracticus Falls the creek descends into a deep plunge pool before flowing on into a narrow gorge. At the edge of the large plunge pool a dense stand of Cadjeputs (*Melaleuca leucadendron*, *M. argentea*) and *Eugenia eucalyptoides* forms a fringing closed-forest. Because of the depth of water the pool is devoid of aquatics.
- (e) The rock ledges and scree slopes surrounding the pool support the Screw-pine (*Pandanus yuleensis*), *Calytrix brachychaeta*, *Planchonella pohlmanniana*, *Clerodendrum tomentosum*, *Acacia kelleri*, *A. dunnii* and the Rock Fig (*Ficus platypoda*).
- (f) Where the creek enters the narrow steep-sided sandstone gorge (cut to about 30 m below the surrounding plateau) a dense closed-forest of Cadjeputs (*Melaleuca leucadendron*, *M. argentea*, *M. viridiflora*) and *Eugenia eucalyptoides* occurs. Where the *Melaleuca leucadendron* emerges above the gorge wall, creepers such as *Passiflora foetida*, *Flagellaria indica*, *Adenia heterophylla* ssp. *australis* and *Smilax australis* are common in its canopy. On the shaded gorge floor, black mud banks and shallow pools support aquatics such as *Blyxa aubertii*, *B. echinosperma*, *Valisneria spiralis* and *Myriophyllum trachycarpum*, while *Xyris*

pauciflora, *Ludwigia suffruticosa* and the grasses *Elytrophorus spicatus* and *Sclerandrum truncatiglume* are common.

- (g) Eastwards up Johnson Creek, following the creek bed, there is a thick band of vegetation on the rugged scree slopes (Pkpl) where the gorge widens out. The vegetation is mainly *Xanthostemon paradoxus*, *Ficus* spp., *Livistona* sp., *Canarium australianum* and *Pouteria sericea*. The creepers *Smilax australis*, *Capparis* spp., are common, as is the Precatory Bean (*Abrus precatorius*).
- (h) Seepage areas along the shaded sandstone (Pkpl) ledges at the base of the cliff wall are characterised by ephemeral species (*Stylidium muscicola*, *Nicotiana benthamiana*) and fern allies (*Cheilanthes* sp., *Selaginella ciliaris*).
- (i) Beside Johnson Creek on the elevated flats there is a large area of sand over sandstone (Pkpl) which is primarily a closed-grassland, the common species being *Cymbopogon procerus* and *Triodia pungens*. Tree and tall shrub emergents such as *Buchanania obovata*, *Terminalia latipes*, *Petalostigma pubescens*, *Grevillea viscidula* and *Sterculia viscidula* occur. Beyond the closed-grassland a massive scree slope rises to the base of a sheer cliff, with the main plateau directly above.
- (j) The vegetation of the scree (Pkpl) is a mixed community of *Livistona* sp., *Erythrophleum chlorostachys*, *Eucalyptus miniata*, *E. clavigera*, *Terminalia latipes* and *Owenia vernicosa*. Shrub species such as *Atylosia cinerea*, *Pachynema junceum* and *Hibbertia lepidota* are common as are the grass species *Cymbopogon procerus* and *Triodia pungens*.
- (k) On the main sandstone plateau (Middle Pentecosts; Pkpm) above Petrogale Gorge, *Livistona* sp., *Stenocarpus cunninghamii*, *Buchanania obovata* are common along the cliff edge. The plateau supports a woodland to open-woodland of eucalypts (*Eucalyptus miniata*, *E. bleeseri*) together with *Terminalia* sp., *Livistona* sp., *Erythrophleum chlorostachys* and *Santalum lanceolatum*.

B4 Solea Falls (Figures 18, 19, Colour plate 3)

Solea Falls lies on the Drysdale River in 14°40'S, 127°00'E. The altitude above the falls is about 120 m. The horseshoe-shaped waterfall, about 30 m high, is spectacular even in the dry season. The plunge pool below is about 150 m long, 100 m wide and 10–15 m deep. Above and below the falls the river bed is strewn with boulders and in places the water during the dry season flows beneath them. On the west side are some loose sand banks. About 1 km south of the falls is a long permanent pool, and into this from the east flow Johnson Creek and Petrophassa Creek. Just west of the falls is a flood channel of the Drysdale with a pool remaining at its lowest point. On either side of the river the country is gently undulating but with a rugged surface. Between Johnson and Petrophassa Creeks is a flat sandy plain. Geologically the area consists of Warton Sandstone (Pkw).

- (a) The vegetation away from the river is mostly low woodland, tall shrubland and tall open-shrubland. In the upper storey there are no dominants and the trees and shrubs include *Eucalyptus* aff. *leucophloia*, *E. miniata*, *E. herbertiana*, *Owenia vernicosa*, *Acacia kelleri*, *A. dumii*, *A. tumida*, *Persoonia falcata*, *Ficus leucotricha*, *Eugenia bleeseri*, *Brachychiton* sp., *Verti-*



Figure 18—View south-east across the B4 site. Tall open-shrubland on sandstone hills in foreground, with the Drysdale River and Solea Falls beyond. Tall trees in right distance are *Melaleuca leucadendron* along Galola Creek.

- cordia cunninghamii*, *Grevillea cunninghamii* and *Xanthostemon paradoxus*. A fan palm (*Livistona loriphyllo*) is frequent in places. There are two viscid spinifexes, *Triodia pungens* and *Plectrachne pungens*.
- (b) On the alluvial sand (Qa) near the river between Petrophassa and Johnson Creeks is a woodland dominated by *Eucalyptus*, especially *E. miniata*, *E. tetrodonta* and *E. ? latifolia*. Smaller trees are *Planchonella arnhemica*, *Buchanania obovata*, *Petalostigma pubescens*, *Grevillea pteridifolia* and *Verticordia cunninghamii*, while *Bossiaea bossiaeoidea* is a common undershrub. Grasses and herbs form a rather dense ground cover.
- (c) Along the Drysdale River is a fringing formation of varying composition. By the long pool south of the falls, *Melaleuca leucadendron* and *M. argentea* are common, with dense stands of *Pandanus aquaticus*. There are some *Eucalyptus camaldulensis*. This formation extends a little way up Johnson Creek. In rocky areas, sometimes with the water flowing "underground", there is a tall shrubland or open-shrubland dominated by *Eugenia eucalyptoides* and *Terminalia bursarina* with some *Barringtonia acutangula* and *Calytrix brachychaeta*. Aquatic plants in the river include *Nymphoides* spp., *Utricularia inflexa* and *Triglochin pterocarpa*.
- (d) Petrophassa Creek is lined with *Melaleuca leucadendron* in its lower course, changing to *M. viridiflora*, *Pandanus spiralis* and *Banksia dentata* higher up. The creek supports quite a rich aquatic and marsh flora, including species of *Blyxa*, *Limnophila*, *Eriocaulon*, *Cyperus*, *Drosera*, *Mitrasacme*, *Xyris*, *Marsilea*, *Stylidium*, *Mimulus* and *Hemiarrhena*.
- (e) Just below Solea Falls on the east side of the Drysdale is a pocket of open-scrub on a boulder scree. The trees and shrubs include *Xanthostemon paradoxus*, *Ficus platypoda*, *Canarium australianum*, *Stenocarpus cunninghamii*, *Gardenia pantoni*, *Owenia vernicosa* and *Clerodendrum tomentosum*.



Figure 19—The Drysdale River above B4. *Melaleuca argentea* and *Pandanus aquaticus* on right bank. *Melaleuca leucadendron* and *Pandanus* on left bank, with *Eucalyptus* woodland beyond.

C1 Morgan Falls (Figures 20, 21, Colour Plates 1, 2)

This site is at Morgan Falls where Palmoondoor Creek falls into Worriga Gorge. It lies in 15°02'S, 126°40'E, and the altitude atop the falls is about 280 m. The creek, flowing from the west, descends 60 m in two massive steps into the gorge where it turns due north. The gorge is spectacular, with vertical sandstone cliffs along its east side and very steep slopes and cliffs along the west side. Opposite Morgan Falls is a smaller waterfall, Christella Falls. Both were reduced to trickles at the time of our visit though the creek bed contained many permanent pools. A southern extension of Worriga Gorge is occupied by a permanent stream, Elasmias Creek. The plateau and gorge consist of King Leopold Sandstone (Pkl) but in the bottom of the gorge are a few outcrops of Hart Dolerite (Pdh). Several remnants of laterite occur on the plateau. Most areas are very rocky.

(a) On the plateau and scree slopes of the gorge the vegetation is mostly low-woodland and low open-forest dominated by *Eucalyptus* species, especially *E. miniata*, *E. tetradonta* and, along the edge of the gorge, *E. aff. leucophloia*. Other trees here include *Callitris intratropica*, *Owenia vernicosa*, *Erythrophleum chlorostachys*, *Petalostigma pubescens*, *Gardenia* sp. and *Sterculia viscidula*. Most of the understorey was burnt by the fire which passed through the area just after the arrival of the survey team. However the following shrubs were recorded: *Bossiaea bossiaeoides*, *Calytrix microphylla*, *C. achaeta*, *Grevillea agrifolia*, *Jacksonia argentea*, *Triumfetta* sp. and *Acacia dunnii*. Ephemeral *Sorghum* is common, as well as the spinifex *Plectrachne bynoei*.

(b) A variable fringing formation occurs along Palmoondoor Creek above Morgan Falls. *Pandanus aquaticus* and *P. ? spiralis* form dense thickets around permanent pools. In more open areas *Calytrix brachychaeta* and *Acacia plectocarpa* are frequent. A few *Melaleuca leucadendron* occur along the creek. Aquatic and marsh plants include *Vallisneria spiralis*,

Nymphoides spp., *Dysophylla verticillata*, *Ebermaiera glauca*, *Eriocaulon* spp., *Utricularia chrysantha* and *Goodenia lamprosperma*.

- (c) Shrubs and small trees inhabit rock crevices around Morgan Falls, e.g. *Ficus virens*, *F. platypoda*, *Calytrix microphylla*, *Stenocarpus cunninghamii*, *Xanthostemon paradoxus* and *Eucalyptus* aff. *leucophloia*. The spinifex *Triodia pungens* is common on dry ledges, while in sheltered crevices *Micraira subulifolia* occurs. Beneath the overhangs of the fall are the ferns *Nephrolepis hirsutula* and *Lygodium microphyllum*.
- (d) Some lower slopes of the gorge consist of basaltic soil which supports a low woodland dominated by *Eucalyptus tectifera*, with a dense ground cover of grasses. There are a few *Erythrina vespertilio*. At the north end of Worriga Gorge is a small perennial tributary, Colochasia Creek, along which is a population of *Colochasia antiquorum* growing in black loam with *Blechnum orientale* and *Cyclosorus interruptus* under *Pandanus* sp.
- (e) The floor of Worriga Gorge is extremely rocky and has many permanent pools. The vegetation is varied. There are fringes of open-woodland with *Melaleuca leucadendron*, *Sesbania formosa* and *Nauclea coadnata* over dense stands of *Pandanus aquaticus*. In drier areas a tall shrubland or tall open-shrubland is dominated by *Eugenia eucalyptoides* with a few *Calytrix brachychaeta* and *Buchanania obovata*. There are small stands of the perennial grasses *Arundinella nepalensis* and *Coelorachis rottboellioides*. *Nymphaea gigantea* and *Nymphoides* spp. are common in the pools.
- (f) Pockets of low open-forest akin to semi-deciduous vine thicket occupy the lowest slopes of the gorge. The trees include *Alphitonia excelsa*, *Pouteria sericea*, *Bombax ceiba*, *Planchonella arnhemica* and *Micromelum minutum*, with the creepers *Abrus precatorius* and *Sarcostemma australe*.
- (g) Several seepages occur on the lower cliffs of the eastern side of the gorge and support lush populations of ferns. They include *Blechnum orientale*,



Figure 20—View east across Worriga Gorge at C1. Low woodland on plateau, open-woodland and open-shrubland in gorge. Christella Falls right-centre.



Figure 21—Semi-deciduous vine forest near Elasmias Creek in Worriga Gorge (C1).

Lygodium microphyllum, *Dicranopteris linearis* and *Lygodium cernuum*. *Melastoma malabathricum* is a common shrub, and several species of *Stylidium* occupy rock ledges. *Eucalyptus ptychocarpa* is sometimes present.

- (h) The vertical sandstone cliffs are almost bare, except for a few shrubs and small trees such as *Eucalyptus brachyandra* and *Ficus leucotricha*.
- (i) Along Elasmias Creek is a small but striking area of closed-forest forming a semi-deciduous mesophyll vine forest of mixed composition. The trees include *Diospyros nitens*, *D. ferrea*, *Cassine melanocarpa*, *Canarium australianum*, *Ficus racemosa*, *F. virens*, *Carallia brachiata*, *Albizia lebbek*, *Timonius timon*, etc. There are robust lianes, as yet unidentified. There is little understorey but a thick leaf litter covers the ground. The fern *Doryopteris concolor* occurs here, dry and dormant at the time of our visit.
- (j) At the edge of the vine forest, Elasmias Creek supports a luxuriant growth of ferns, especially *Stenochlaena palustris*, *Lygodium microphyllum* and *Cyclosorus interruptus*. Ferns are a feature of Worriga Gorge with 13 species recorded, making it the richest single area for them in Western Australia. The records of *Doryopteris* and *Christella dentata* are the first of these genera in the State.

C2 Euro Gorge (Figures 22, 23)

The C2 campsite (15°03'S, 126°44'E) was established at the end of Euro Gorge on Woorakin Creek about 1 km from where the creek enters the Carson River. At this site the gorge is narrow with steep faces, few scree slopes and with large sheets of bare rock exposed on the gorge floor. Woorakin Creek was flowing slowly and shallow pools cut into the King Leopold Sandstone were common at the time of our visit.

- (a) Fringing the creek and pool banks are dense stands of Screw-pine (*Pandanus aquaticus*) and Cadjeput (*Melaleuca leucadendron*) together with *Alphitonia excelsa*, *Santalum lanceolatum*, *Acacia holosericea*,

A. plectocarpa, *A. retinervis*, *Canarium australianum* and *Verticordia cunninghamii*. On the wet sand banks, herbs such as *Osbeckia australiana*, *Bergia pedicularis*, *Ludwigia suffruticosa*, *Crotalaria crassipes* and *Philydrum lanuginosum* are common. The shallow pools support aquatics such as *Blyxa echinosperma*, *Isoetes* sp. and *Nymphoides indica*.

- (b) Further upstream, the gorge narrows and supports a dense stand of Cadjeput (*Melaleuca leucadendron*), some over 30 m tall, Screw-pine (*Pandanus aquaticus*) with the ferns *Lygodium microphyllum* and *Blechnum orientale*. *Smilax australis* and *Passiflora foetida* are common scrambling amongst a dense growth of Sedge (*Scleria* sp.) and climbing up into the tree canopies. A seepage in the sandstone cliff was covered in a dense growth of the scrambling fern *Dicranopteris linearis* with *Lindsaea ensifolia* growing among it.
- (c) The sandstone (Pkl) cliff faces and ledges of the gorge support tall trees (up to 11 m) of *Ficus virens* var. *sublanceolata* (heavily in fruit at the time of our visit) and *Ficus leucotricha* (also in fruit). On the edges of the gorge *Eucalyptus* aff. *leucophloia*, *Buchanania obovata*, *Brachychiton* sp. and *Owenia vernicosa* are common trees.
- (d) Downstream toward the junction with the Carson River, Woorakin Creek widens forming a mosaic of broad deep pools (some 30 m x 70 m and up to 4 m



Figure 22—View east over Carson Volcanics towards Carson River near Euro Gorge (C2) with *Grevillea mimosoides* and *Hakea arborescens* in foreground.



Figure 23—Near Euro Gorge (C2). Dark outcrops of Carson Volcanics supporting a low open-woodland with the grasses *Themeda australis* and *Cymbopogon procerus* forming the main ground cover.

deep) and muddy areas where pools have dried out. The alluvial creek and levee banks support a mixed plant community. Fringing the creek Cadjeputs (*Melaleuca leucadendron* and *M. argentea*) and Screw-pine (*Pandanus spiralis* var. *convexus*) are most common but patches of *Eucalyptus ptychocarpa*, *Banksia dentata*, *Ficus racemosa*, *Brachychiton australe*, *Sterculia viscidula* and *Bombax ceiba* var. *leiocarpum* also occur. In places the banks are covered in a dense growth of Kangaroo Grass (*Themeda australis*) and *Cymbopogon procerus*. The muddy areas are rich in semi-aquatic species such as Nardoo (*Marsilea* sp.), *Limnophila indica*, *Najas tenuifolia*, *Lobelia quadrangularis*, *Rotala diandra* and *Ebermaiera glauca*.

- (e) The banks of the Carson River support a dense closed-forest of Cadjeputs, (*Melaleuca leucadendron*, *M. argentea*) Screw-pine (*Pandanus* sp.), *Terminalia latipes*, *Ficus coronulata*, *Brachychiton australe* and *Eucalyptus ptychocarpa*. It was possible to move through the dense thickets of Screw-pine following feral cattle pads.
- (f) East of the Carson River the dark outcrops of the Carson Volcanics (Pkc) are encountered. These basalt soils support a low woodland to low open-woodland of *Eucalyptus tectifica* and *E. foelscheana* together with *Hakea arborescens*, *Grevillea mimosoides*, *Celtis philippensis*, *Cochlospermum fraseri*, *Terminalia canescens*, *Gardenia* sp., *Brachychiton* sp., *Acacia translucens*, *A. sutherlandii* and *Stemodia viscosa*. The grasses *Themeda australis* and *Heteropogon contortus* formed the main ground cover.
- (g) In contrast to the Carson Volcanics the rugged plateau of King Leopold Sandstone supports a low open-forest of *Eucalyptus tectifica*, *E. grandiflora* and *E. aff. leucophloia* with *Erythrophleum chlorostachys* and *Terminalia latipes* also occurring. On the areas of flat sandstone usually devoid of soil, a scattered shrub layer of *Acacia deltoidea*, *A. stigmatophylla*, *Jacksonia argentea*, *Grevillea agrifolia*, *Hakea arborescens*, *Hibbertia lepidota*, *Phyllanthus* sp. and *Calytrix brachychaeta* is well developed.

C3 Planigale Creek (Figure 24)

The C3 campsite (14°43'S, 126°54'E) was established near a large shallow pool on Planigale Creek about 4.5 km in a direct line from where the creek enters the Drysdale River.

- (a) The creek bed both upstream and downstream of the pool was dry with flat sheets or angular boulders exposed of Warton Sandstone (Pkw). The residual pool contained no aquatics although the bottom was sandy. In many places Cadjeputs (*Melaleuca leucadendron* and *M. argentea*), the Freshwater Mangrove (*Barringtonia acutangula*), *Eugenia eucalyptoides*, *Acacia latifolia*, *A. kelleri* and *Grevillea pteridifolia* grow on the sandy levee banks or in the rock fissures of the creek bed. The grasses *Triodia microstachya* and *Eragrostis* sp. are also common in rock fissures where alluvial sand has been deposited.
- (b) Downstream Planigale Creek forms a series of braided pools again lined with Cadjeputs and the Screw-pine (*Pandanus yuleensis*). These pools contain numerous aquatics such as *Nymphaea gigantea*, *Nymphoides indica*, *Eriocaulon* spp., *Aponogeton elongatus*, *Myriophyllum trachycarpum* and *Limnophila fragrans*. Perennial herbs such as *Philydrum lanuginosum* and *Xyris* spp. are also common.

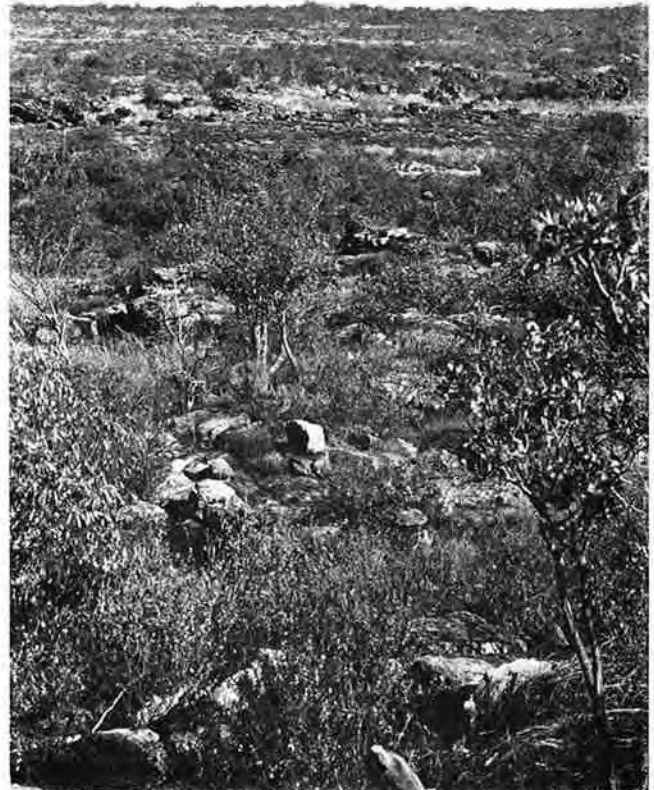


Figure 24—Planigale Creek area (C3). Flat plain dissected by massive sandstone outcrops.

- (c) Away from Planigale Creek the surrounding plain is flat but broken by a series of massive sandstone (Pkw) outcrops. The vegetation of the outcrops is a low open-woodland dominated by tree and shrub species such as *Planchonella arnhemica*, *Ficus virens*, *F. leucotricha*, *F. platypoda*, *Denhamia obscura*, *Acacia dunnii*, *Buchanania obovata*, *Grevillea refracta*, *Pouteria sericea*, and *Atylosia ? cinerea*. The climbers *Smilax australis*, *Flagellaria indica*, *Tinospora smilacina* and *Parsonsia velutina* are common, tangled among the canopies of the trees and straggling across the sandstone boulders. The grass *Micraria* aff. *subulifolia* forms dense mats on the floors of shaded caves.
- (d) The flat areas between the sandstone (Pkw) outcrops support a woodland to open-woodland dominated by *Eucalyptus bleeseri*, *E. tetradonta* and *E. confertiflora*. Other tree and shrub species are *Terminalia latipes*, *Grevillea cunninghamii*, *Santalum lanceolatum*, *Buchanania obovata*, *Stenocarpus cunninghamii*, *Verticordia cunninghamii*, *Plagiocarpus axillaris* and *Calytrix achaeta*. There are dense patches of Kangaroo Grass (*Themeda australis*) and *Cymbopogon procerus* and these open grassy areas become more common as one approaches Planigale Creek.
- (e) The dry, deeply dissected creek beds, tributaries of Planigale Creek, support small stands of *Eucalyptus ptychocarpa*, *E. ? herbertiana*, *E. tetradonta*, *Livistona* sp., and *Acacia dunnii* with *Bossiaea bossiaeoidea*, *Petalostigma pubescens*, *Ricinocarpus* sp., *Glycosmis trifoliata* and *Burtonia subulata* being common shrubs.

C4 Carlia Creek (Figures 25, 26, 27, Colour plate 15)

The C4 campsite was located some 20 km south of B1, again where a small stream (Carlia Creek) leaves the Carson Escarpment, in 15°02'S, 126°49'E. The Escarpment here is mostly a steep scree, but some high cliffs occur about 2 km north of the creek. A deep gully (Coucal Gorge) has been carved by the creek into the scarp. The scarp and plateau consist of Warton Sandstone (Pkw), while the plain below is of loam derived from Carson Volcanics (Pkc) with alluvial outwash along the foot of the Escarpment. To the west the Carson River flows north across the plain, with basalt outcrops in its bed.



Figure 25—View south along the Carson Escarpment at C4. Low woodland on plateau, woodland on plain.



Figure 26—Low open/closed-forest on the Carson Escarpment north of C4. Tree at left is *Gyrocarpus americanus*, that in centre is *Bombax ceiba* in flower.



Figure 27—The Carson River near C4. A large pool with fringing *Pandanus aquaticus*, *Ficus racemosa*, *Tristania ? suaveolens*, *Eucalyptus camaldulensis*, etc.

- (a) On the plateau is a low woodland and tall shrubland grading to open-forest eastwards. Eucalypts are prominent, especially *E. aff. leucophloia*, *E. confertiflora* and two other undetermined bloodwoods. Other frequent trees are *Owenia vernicosa*, *Buchanania obovata*, *Callitris intratropica* and *Petalostigma pubescens*. The principal shrubs are *Acacia* spp., *Verticordia cunninghamii*, *Calytrix* spp., *Bossiaea bossiaeooides*, *Jacksonia ? argentea* and *Boronia lanuginosa*. Spinifex (? *Plectrachne* sp.) and ephemeral *Sorghum* are common grasses.
- (b) About 1 km south of the camp, near the edge of the plateau above the scarp is a seepage area still damp at the time of our visit. It is a small area of closed grassland, with a low open-forest on the slope above. Besides various grasses such as *Eragrostis* and *Ectrosia* there are many herbs in the grassland, e.g. *Stylidium*, *Drosera*, *Utricularia*, *Xyris*, *Ophioglossum*, *Goodenia* and *Mitrasacme*. *Pandanus spiralis* occurs around the margins. The low open-forest is dominated by *Eucalyptus ptychocarpa* and *Melaleuca viridiflora*, with an admixture of *Banksia dentata*, *Terminalia grandiflora* and *Eugenia bleeseri*.
- (c) The screens of the Escarpment carry low woodland with areas of low open (rarely closed)-forest. Trees of the woodland are mostly *Eucalyptus latifolia*, *E. tectifera*, *Acacia* spp., *Erythrophleum chlorostachys*, *Cochlospermum fraseri*, *Terminalia* sp. and *Buchanania obovata*. There are a few shrubs such as *Solanum dioicum* and *Psoralea pustulata* but the understorey consists mainly of grasses including *Sclerandrium truncatiglume* and *Cenchrus elymoides*. The low open-forest is of mixed composition and generally lacks eucalypts. Representative trees are *Celtis philippensis*, *Cassine melanocarpa*, *Ficus platypoda*, *Dolichandrone heterophylla*, *Vitex glabrata* and *Gardenia megasperma*, with *Bombax ceiba* and *Gyrocarpus americanus* as deciduous emergents. There are a few climbers and scrambling shrubs such as *Adenia heterophylla*, *Jasminum didymum* and *Caparis* sp.

- (d) In Coucal Gorge on the Escarpment is a similar but more extensive low open- or closed-forest. The trees found here include *Syzygium suborbiculare*, *Carallia brachiata*, *Alphitonia excelsa*, *Glycosmis pentaphylla* and *Randia cochinchinensis*. *Pandanus* sp. is common along the creek which contains several permanent pools. The ferns *Lindsaea ensifolia* and *Blechnum orientale* grow around these. In more open areas are shrubs such as *Fenzlia phebalioides*, *Boronia lanuginosa* and *Stenocarpus cunninghamii*.
- (e) At the entrance to the gully there is open-scrub dominated by *Acacia* species, especially *A. plectocarpa* and *A. kelleri*, together with *Grevillea agrifolia*, *G. pteridifolia* and a few *Eucalyptus ptychocarpa*. A dense ground cover of grasses includes *Triodia pungens* and *Plectrachne bynoei*.
- (f) In the alluvial soil along the foot of the Escarpment to the north of the gully are open-forest and low open-forest, with little understorey except for a dense ground cover of grasses. The trees include *Eucalyptus miniata*, *E. apodophylla*, *Erthrophleum chlorostachys*, *Ficus opposita*, *Petalostigma pubescens*, *Sterculia viscidula*, *Verticordia cunninghamii*, *Cochlospermum fraseri*, *Terminalia* sp., *Grevillea pteridifolia* and *Pandanus* sp.
- (g) Towards the Carson River in loamy basaltic soil the low woodland is dominated by eucalypts, especially *E. tectifera* and *E. foelscheana*, with admixture of *Hakea arborescens* and *Erythrina vespertilio* and the shrubs *Acacia stigmatophylla*, *A. sutherlandii* and *Grevillea mimosoides*. Grasses again form a dense ground cover.
- (h) The Carson River and nearby tributaries have a narrow fringing formation which includes tall trees such as *Ficus racemosa*, *Tristania ? suaveolens*, *Sesbania formosa*, *Terminalia* sp., *Timonius timon* and *Eucalyptus camaldulensis*. There are dense stands of *Pandanus aquaticus*. The perennial grass *Eriachne festucea* is common in the river bed, and there are small sedges such as *Cyperus* sp. and *Fimbristylis* sp.



Figure 28—View up Dysphania Gorge (C5). Low closed-forest along creek, closed-scrub on left hand slope, low woodland on opposite slope and on hills.



Figure 29—Rugged sandstone hills at C5 with low woodland. Tree at left is *Eucalyptus miniata*, palms are *Livistona loriphylla*. Area burnt 1–2 years before and *Triodia* not yet prominent.

C5 Forest Creek (Figures 28, 29, Colour plate 4)

This campsite was located on Forest Creek, a small tributary of the Drysdale River, in 14°39'S, 126°56'E. The stream is perennial for some distance and issues from two gorges in the low hills south of the river. Forest Creek occupies the eastern gully (Dysphania Gorge) and Schizaea Creek the western (Robin Gully). The hills consist of Warton Sandstone (Pkw) and have an extremely rugged surface of sandstone blocks. The elevation of the campsite is about 100 m above sea level.

- (a) A striking feature of the locality is a narrow belt of tall closed-forest along the creek just before it reaches the river. The trees are *Melaleuca leucadendron*, *Carallia brachiata*, *Metrosideros eucalyptoides* and one as yet undetermined. There is only a layer of leaf litter on the ground.
- (b) In the two gullies where the streams are perennial is a low closed-forest, while closed-scrub occurs on the south-facing slope of Forest Creek. The composition is very mixed. The trees include *Melaleuca virens*, *Cassine melanocarpa*, *Planchonella pohlmanniana*, *Alphitonia excelsa*, *Pandanus* sp., *Eucalyptus ptychocarpa* and *Denhamia obscura*. *Melastoma malabathricum* is common by the creek. The fern *Schizaea digitata* occurs in both gullies. Other ferns in wet areas include *Lycopodium cernuum*, *Lygodium microphyllum*, *Lindsaea ensifolia* and *Dicranopteris linearis*. Aquatic species in the creek are *Blyxa aubertii*, *Aponogeton elongatus* and *Limnophila fragrans*. *Banksia dentata* occurs along Schizaea Creek in its upper reach where it descends over terraces. In the drier closed-scrub along Forest Creek, are small trees such as *Pouteria sericea*, *Planchonia australis*, *Stenocarpus cunninghamii*, *Xanthostemon paradoxus*, *Glycosmis trifoliata*, *Vitex glabrata* and *Rapanea ? porosa*, the last being the first record for the genus in Western Australia. *Sarcostemma australe* and *Flagellaria indica* occur as creepers.
- (c) On the dry, rocky, sandstone hills there is a low woodland, occasionally woodland. Eucalypts are

the dominant trees, especially *E. miniata*, *E. tetrodonta* and *E. herbertiana*. Fan palms (*Livistona* sp.) are very common. Other trees are *Owenia vernicosa* and *Buchanania obovata*, while common shrubs are *Acacia dunnii*, *Bossiaea bossiaeoidea*, and, on the dry north-facing slope of the gully above Forest Creek, *Grevillea cunninghamii*, *Jacksonia argentea* and *Boronia lanuginosa*. A spinifex (? *Plectrachne* sp.) is very common.

- (d) Along the Drysdale River at this locality is a fringing formation dominated by the Cadjeputs *Melaleuca leucadendron* and *M. argentea*.

C5A Galaxy Swamp (Figure 30)

A visit of one hour was made to this swamp which lies to the west of Forest Creek (C5), in approximately 14°37'S, 126°55'E. It is on an almost flat alluvial plain west of the Drysdale River and north of an extensive belt of Warton Sandstone hills. There is an area of permanent water covering about 2 ha surrounded by a swampy area which would be flooded in the wet season.

- (a) In black mud around the permanent water is a dense belt of *Eleocharis* sp. with admixture of *Cyperus holoschoenus*, *Vetiveria pauciflora* and *Oryza australiensis*. *Nymphaea gigantea* occurs in the open water.
- (b) A fringe of low woodland of varying width around the water is dominated by *Melaleuca viridiflora*. The low ground cover beneath it contains ephemeral and perennial herbs such as *Scirpus ? supinus*, *Xyris pauciflora*, *Linnophila* sp., *Nymphoides hydrocharoides*, *Eriachne glauca* and *Stylidium schizanthum*. The soil is clayey, becoming muddy where wet.
- (c) Surrounding the swamp on sand is a low open-forest dominated by Eucalypts including *E. miniata*. Other trees are *Banksia dentata* and *Pandanus spiralis*, while there is a ground storey principally of grass but including a number of herbs such as *Drosera indica*, *Mitrasacme commutata*, *Blumea integrifolia* and *Mimulus linearis*.



Figure 30—Galaxy Swamp (C5A). Cadjeputs are *Melaleuca viridiflora*, grass in foreground is *Vetiveria pauciflora*.

THE EFFECT OF FERAL EUROPEAN CATTLE ON THE VEGETATION

Frequent summer fires as well as the trampling and grazing effect of feral European cattle (*Bos taurus* Linnaeus) appear to be widespread in the Kimberley. Their combined effect on the vegetation and native fauna is yet to be fully ascertained. Damage caused by feral Bali cattle (*Bos javanicus* d'Alton) has also been recorded for the Northern Territory by Frith and Calaby (1974). Feral cattle, both singly and in groups, were encountered at nine of the collecting sites and evidence of their presence recorded at the remainder (McKenzie *et al.*; this bulletin). Many small groups were observed from the air and well-defined pads are often seen.

The cattle favour the fringing formations of rivers, creeks and swamps as is evidenced for example by the severe trampling and grazing effects observed on the grasslands fringing the sandy alluvial flats.

Damage is caused to *Pandanus spiralis* thickets fringing the banks of the Carson River near Woorakin Creek, and eroded areas created by cattle dust-bathing between the woodland and riverine communities are common.

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