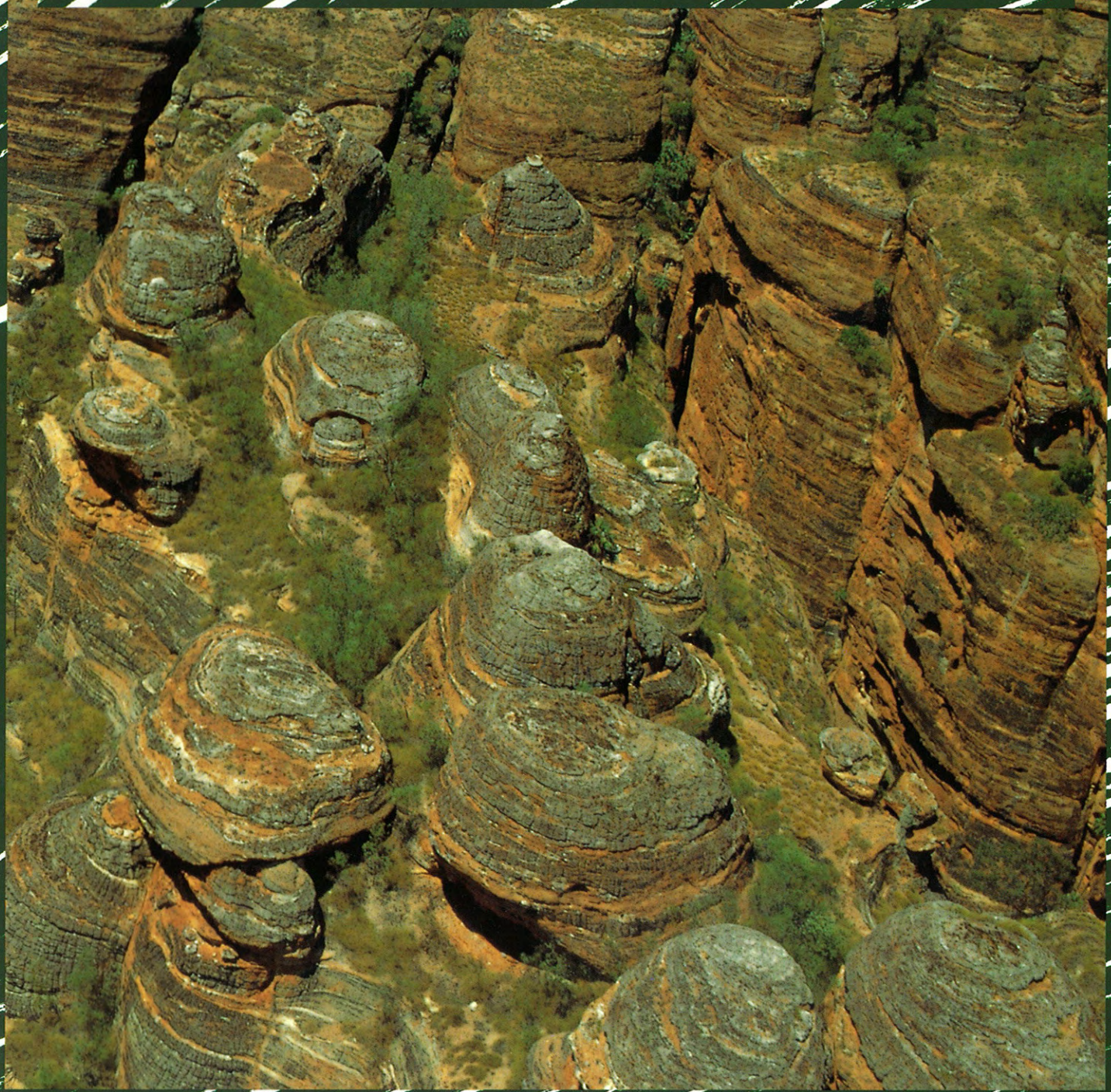
A SURVEY OF THE WILDLIFE AND VEGETATION OF

PURNULULU

(BUNGLE BUNGLE) NATIONAL PARK AND ADJACENT AREA



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Australian National Parks and Wildlife Service

A Survey of the Wildlife and Vegetation of Purnululu (Bungle Bungle) National Park and Adjacent Area

Edited by J.C.Z. Woirnarski
CSIRO Division of Wildlife and Ecology
PMB 44, Winnellie, N.T. 0820

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Preface

In spite of the widespread familiarity of the spectacular beehive domes of Purnululu (Bungle Bungle) National Park from television and magazines, the area has remained poorly known biologically. This study represents a major step towards rectifying that situation.

The study also contributes to knowledge of an important biogeographical gap. The area between the Daly River of the Northern Territory and the east Kimberley is one of the three major regions which are extremely poorly known in northern Australia - the other two being Arnhem Land and the Queensland Gulf Country.

The need for biological surveys in these areas is urgent if the most appropriate use and management of the land is to occur. In this context, Purnululu National Park and environs is located in a strategic position. It lies between the well-studied parts of the wet-dry tropics and the arid zone.

The perspective is provided by the earlier studies of our valued colleagues, primarily from the W.A. Department of Conservation and Land Management, the W.A. Museum, the W.A. Herbarium, the Conservation Commission of the N.T. and the CSIRO Division of Wildlife and Ecology. As always, we stand upon their shoulders to see a little further.

R.W. BRAITHWAITE
Chief Investigator.
CSIRO Division of Wildlife and Ecology
PMB 44, Winnellie, N.R. 0820

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Summary

This report presents results of 10 weeks of biological survey of Purnululu National Park, Purnululu Conservation Reserve and adjacent areas during 1989. We list 616 plant, 149 bird, 81 reptile, 41 mammal, 15 fish and 12 frog species from this area. Notable plants include 12 species new to the Kimberley and two species not otherwise recorded from Western Australia. A number of undetermined specimens may also represent new species. Notable animals include the Grey Falcon, Gouldian Finch, Desert Mouse, Large-footed Mouse-eared Bat, Northern Nail-tail Wallaby, Rock Ringtail Possum, Ningbing Antechinus, the skink *Egernia slateri*, and undescribed species of gecko *Gehyra* sp.nov., skink *Lerista* sp.nov. and turtle *Chelodina* sp.nov.

The fauna includes widespread tropical (Torresian) and desert (Eyrean) elements. The species composition is more similar to that of the northern Kimberley and 'Top End' than that of nearby arid areas (e.g. Edgar Ranges, Great Sandy Desert). Many Torresian species reach their local (southern) range limits in the Bungle Bungle area, particularly in lowland and riparian land systems (along the Ord River and Osmand Creek, and in wet gorges). Eighteen animal species recorded in the Bungle Bungle area are known from either no other or only one other reserve in north-western Australia (based on lists from 29 reserves and national parks from Hamersley Ranges and Ruddall River through the Kimberley and Top End to Lawn Hill in north-western Queensland).

The land of the Bungle Bungle area has been severely degraded over the last 100 years, because of high densities of livestock and feral stock. Lowland and riparian areas are more badly affected than are the rocky upland areas. Two bird species, the Purple-crowned Fairy-wren and White-browed Robin, have probably become extinct in the Bungle Bungle area. We were unable to define precisely the current status of many medium-sized mammals, though several species have clearly declined or recently become extinct in this area (e.g. Bilby, Northern Quoll). The abundance and diversity of small mammals is currently very low in degraded habitats, and in more degraded areas within particular habitats. There is insufficient historical information to determine whether reptile, frog and fish species have undergone change in status. Seventeen exotic weed species (2.8 per cent of the flora) were recorded from the Bungle Bungle area. They are particularly prevalent in the Nelson frontage and Antrim lowlands land systems, and several species constitute substantial management problems. Feral stock (particularly donkey and cattle) remain present in some of the Bungle Bungle area, and continue to pose environmental threats. Other feral species include cat, horse, pig, camel and water buffalo.

Chapter 1

Introduction to Biological Survey of the Bungle Bungle Area

by
John Woinarski

BACKGROUND

The Bungle Bungle Range is a sandstone outlier in the south-east Kimberley (Fig. 1). In recognition of its outstanding scenery, its significance for Aboriginal culture and the botanical value of the massif and adjacent area, the Western Australian government reserved the massif and its surrounds as Purnululu (Bungle Bungle) National Park (208 723 ha) and Purnululu Conservation Reserve (110 602 ha) in 1986 (Fig. 2). Difference in status between the two areas arises from the prior presence of mining leases within the Conservation Reserve area. The Conservation Reserve will be included in the National Park when these leases have expired (Colreavy *et al.* 1989). Together, they form the only large conservation reserve in the south-east Kimberley, and one of only three (with Prince Regent River Reserve and Drysdale National Park) large reserves in the Kimberley proper.

In considering proposals for the National Park, and subsequently in preparation of a management plan for the Park and Conservation Reserve, it was recognized that no detailed information on the wildlife of the area was available (Anon 1986; Colreavy *et al.* 1989). Such knowledge was considered important to assess the conservation significance of the area, to guide management policies, to assist in the interpretation of the Park for tourists and to provide perspective on biogeographic patterns of the Kimberley in general. This report presents information to this end, and is based on two periods of detailed surveys of wildlife and plants of the Bungle Bungle area during 1989. The area considered includes the National Park, Conservation Reserve and portions of the adjacent Texas Downs, Osmand Valley, Mabel Downs and Sophie Downs Stations considered for possible extensions to the Park (Fig. 2). Together, these three categories of land are referred to generally as the Bungle Bungle area in this report.

LOCATION

The Park lies about 160 km south of Kununurra, 50 km south-east of Turkey Creek in the Shire of Halls Creek. The Park, Conservation Reserve and the rest of the area surveyed lie within the one degree block defined by 17 to 18 S and 128 to 129 E. To the north it is bounded by Osmand Valley Station and Texas Downs, to the west by Mabel Downs and Sophie Downs, by Alice Downs in the south-west corner, and by the Ord River Regeneration Reserve (including in part the former Turner and Ord River Stations) to the south and east. The Northern Territory border lies about 50 km to the east.

Access to the Park is by the four-wheel-drive Spring Creek track (*c.* 50 km) running off the Great Northern Highway about 50 km south of Turkey Creek. A previous access via Osmand Valley Station has been closed to the public for about three years.

Place names for locations in the Bungle Bungle area which are listed in the text are shown in Figure 2. Some colloquial names used by ranger staff are given in quotation marks. The use of such names may be discontinued in the near future. Throughout we use the name Osmand (rather than Osmond) to refer to the Range, Valley, Plateau and Station.

CLIMATE

Slatyer (1970) presents a detailed description of climate in the general region of the Ord and Victoria River basins, and this description is based mainly on that report. Purnululu lies near the southern (inland) border of the wet-dry tropics. Rainfall at Turkey Creek and at Limbunya Station (*c.* 140 km east of the study area) probably approximates the wettest and driest portions of the study area (Table 1). The 500-700 mm average annual rainfall occurs mainly (*c.* 85per cent) in the four-month (December to March) wet season. Typical of the wet-dry tropics (Taylor and Tulloch 1985), variability in rainfall between years is pronounced (Robinson 1971). Particularly notable were extensive periods of below-average rainfall between 1927 and 1936, and between 1947 and 1958 (Robinson 1971).

The evaporation rate is very high (greater than 2000 m per year) and run-off is rapid, resulting in little permanent water in the area. The effectiveness of the rainfall has declined fundamentally over the last century because of deterioration of soils and loss of vegetation (Robinson 1971; Aldrick *et al.* 1978). Extreme rainfall events are likely to further exacerbate erosion (Aldrick *et al.* 1978; de Salis 1982).

Mean maximum temperatures during the dry season average between 30 and 35°C and rise at the approach of the wet season to about 40°C in November and December.

LANDSCAPE

Descriptions of geology, geomorphology and soil of the general region are provided by Traves (1955, 1970 a and b), Dow and Gemuts (1967, 1969), Paterson (1970), Stewart (1970), Robinson (1971) and Aldrick *et al.* (1978). Anon (1986) and Colreavy *et al.* (1989) summarize more specific information for the Bungle Bungle area.

To the north and west of the Bungle Bungle massif, there is a narrow zone of ancient (to Archaean, 2500 million years before present) igneous, metamorphic and sedimentary rocks (the Halls Creek Mobile Zone), with complex geological history of intense faulting, folding and deformation. This rugged and undulating terrain is covered by greywacke, phyllite, conglomerate, limestone and dolomite rocks, with some granite intrusions. Slightly younger (Proterozoic, 1500 million years ago) conglomerate and quartz sandstones form the plateau of the Osmand Range to the north of the study area. There is a narrow band of basalts between the Halls Creek Mobile Zone and the Hardman Basin to its south-east.

Almost all of the National Park lies within the Hardman Basin province. This basin, which extends south and east into the Northern Territory, has an underlying layer of basalts of the Antrim Plateau Volcanics with some Cambrian (500 million years ago) limestone, shale, marl and siltstones superimposed. During the Devonian (370 million years ago), Elder sandstone was deposited, and in eroded form persists today as the Bungle Bungle massif or smaller remnants to the south and east (e.g. Dixon, Hardman and White Mountain Ranges). Gradual erosion of this soft sandstone produced the broad sandplains surrounding the central massif. The massif itself is composed of a series of characteristic domes. The lack of scree slopes and boulders reduces the complexity of this range for animal habitat.

Except for the sandplains of the Ord River valley, the Bungle Bungle area is of high relief. Elevation varies from 180 m to 720 m above sea level. Substantial areas of the Osmand Plateau are above 600 m. The highest point of the Bungle Bungle massif is 640 m.

The soils of the region are highly variable, and for convenience are described below in association with land system units.

LAND SYSTEMS

The variety of geological features underlie a pronounced range of land forms in the Park region. For the general region, these were described as a series of named land systems by Stewart *et al.* (1970), Robinson (1971) and Aldrick *et al.* (1978). A more detailed description and mapping of land system units in the Bungle Bungle area was given by de Salis (1982), and subsequently by Anon. (1986). This description is summarized here:

ANTRIM: Rugged uplands (Au), Lowlands (Al).
Occurring in the area as a narrow band on the north-west edge of the Hardman Basin. Basaltic; rough stony hills, with skeletal lithosol soils on hills and juvenile cracking clays on the narrow plains. The hills support *Eucalyptus* open woodland over spinifex, plains have *Eucalyptus* open forest or woodland over tussock grasses, and stream lines support *Terminalia platyphylla* open forest. The lowland areas suffer extensive sheet and gully erosion, but the uplands remain in good condition.

BUCHANAN: Uplands (Bu), Sand Plain (Bp), Frontage (Bf).
Occupying much of the Bungle Bungle area, this land system is based on Elder sandstone, and consequently has deep red and yellow sands or earths, with fine white sands on frontage river plains. Vegetation consists of *Acacia* and *Grevillea* shrublands over spinifex in the uplands, *Eucalyptus* woodlands over *Acacia* and spinifex on sandplains, and a range of species along riparian margins. There is little degradation in this land system.

DOCKRELL: Rugged Uplands (Do).
This land system occurs along the far western edge of the Bungle Bungle area. It consists of folded hills, with sedimentary and metamorphic Archaen rocks and skeletal gravelly lithosol soils. Hills support *Eucalyptus* open woodland over spinifex, and have undergone little degradation. This system was not sampled during this survey.

ELDER: Uplands (Eu), Cuestas (El), Lower Slopes(Ep).
This land system includes much of the Bungle Bungle area, including the massif itself. It is based on Elder sandstone, with exposed rock or sandy lithosols on upland and cuesta units, and sandy to friable calcareous soils on lower slopes. A *Eucalyptus* low open woodland with scattered *Grevillea* and *Acacia* and understorey of spinifex occurs in the upland and cuesta units. The lower slopes support an open woodland of various *Eucalyptus, Acacia* and *Terminalia* species over tussock grasses. The lower slopes have undergone moderate erosion, the cuestas and uplands remain in good condition. The lower slope unit was not sampled in this survey.

HEADLEY: Upper Slopes (Hu), Lower Slopes (Hl).
This system occupies only a little of the Bungle Bungle area, mostly in the south-west adjacent to the Dixon Range. Headley limestone characterizes this system, evident as a series of exposed ridges and cuestas. Soils are skeletal stony calcareous lithosols and loams. Isolated *Ficus platypoda* form a distinctive plant community on outcrops. Lower slopes support woodlands over spinifex or hummock grasses. Upper slopes remain in good

condition, but there has been some erosion of lower slopes. The upper slope unit was not sampled during this survey.

NELSON: Cuestas (Nc), Cuesta Backslopes (Nb), Cracking Clay Plains (Ns), Interfluve Upper Slopes (Nu), Interfluve Lower Slopes (Nl), Frontage (Nf), Low Rises (Nr).
This diverse land system is restricted mainly to the valley of the Ord River along the south and east of the Bungle Bungle area. Its geological composition is calcareous limestone and shales. The cuestas, backslopes and lower rises have skeletal, calcareous soils, bearing open woodland over spinifex, tussock grasses and the introduced *Aerva*. Degradation has been moderate. The cracking clay unit is a black soil plain carrying open woodland of *Lysiphyllum* over tussock grasslands, and remains in reasonably good condition. The upper and lower slope units have grey-brown calcareous desert loam and clay soils, and support a low open woodland of a range of woody species over introduced grass species. These units are extensively degraded. The frontage unit has alluvial sands, silts and loam soils, and supports a narrow riparian strip of open forest dominated by *E. camaldulensis* and/or *Melaleuca leucadendra*, the adjacent levees include also *E. papuana*, the understorey is very heterogeneous but includes substantial cover of introduced species. This unit is severely eroded and degraded. The Cuesta, Cuesta Backslopes and Interfluve Upper Slope units were not sampled in this survey, and the Interfluve Lower Slope unit was sampled by only one quadrat.

WICKHAM: Rugged Uplands (Wk).
This system dominates the north and west of the Bungle Bungle area, covering most of the Osmand Ranges. It should probably be divided into distinct units, as it includes a very variable range of land forms and vegetation. It is based on mostly Proterozoic shales, siltstones, sandstone, conglomerates and dolomites. It consists of rugged plateaux, ridges and cuestas, split by narrow gorges. Soils are variable: dark clays in river valleys, duplex on mid slopes and stony lithosols or exposed rock in uplands. The rocky ranges support *Eucalyptus* open woodlands over spinifex. The more sheltered creek lines support a dense riparian vegetation, including *Melaleuca leucadendra*, with pockets of rain forest species. The rocky ranges remain in good condition, the lowland areas support very high densities of cattle and feral stock (especially donkeys) and are suffering extensive degradation.

ABORIGINAL HISTORY

Aboriginal use of, and association with, the Bungle Bungle area has been long-standing. Much of their traditional activity was centred on the river systems and permanent pools, especially those of the Ord River. The Bungle Bungle massif and surrounding ranges are rich in sites of enduring cultural significance (Kirkby and Williams 1984).

The Aboriginal population declined, and traditional activities were disrupted, following pastoral expansion at the end of the last century. Available food resources declined or were eliminated during the degradation of land associated with grazing (Colreavy *et al.* 1989). Presumably, the reduced role of Aborigines in managing the land over this period was associated with substantial changes in fire regime.

Ongoing links with the Purnululu area were formalized with the creation in 1986 of the Purnululu Aboriginal Corporation which represented the traditional custodians during planning for the establishment of the National Park (Coombs *et al.* 1989). Current management plans provide for permanently inhabited outstations within the Park (one outstation is currently established), Aboriginal rangers, traditional hunting and gathering, and a high priority assigned to the protection of important Aboriginal sites (Anon. 1986; Colreavy *et al.* 1989).

EXPLOITATIVE HISTORY

The first European exploration of the Bungle Bungle area was by Alexander Forrest between 1876 and 1879. His favourable reports of the area led rapidly to the establishment of leaseholds (1880s) and rapid stocking of cattle, especially along the Ord River valley (Bolton 1953; Auty 1964; Perry 1970b). The cattle industry was boosted with the nearby market provided by the Halls Creek gold-rush from the 1880s to the mid 1890s (Stewart 1970a). Stocking rates quickly increased (Perry 1970b), assisted by live cattle export from Wyndham and, from 1918, the establishment of an abbatoir there.

Within forty years most of the more productive land along the Ord River was severely degraded and eroding (Medcalf 1944; de Salis 1982), with massive dust-storms providing conspicuous evidence of poor land management and overstocking (Riddett 1988). Little conservation action was taken until it was realized that continuing soil erosion would lead to massive siltation of the proposed Ord River Dam (Lake Argyle). Arising from this concern, 8960 km^2 of the Ord River catchment (including most of the present Park, and all of Ord River and Turner Stations, and parts of Flora Valley, Elvire Downs and Ruby Plains) was resumed in 1967 as the Ord River Regeneration Reserve, with control vested in the Minister for Agriculture. Rehabilitation measures by the Department of Agriculture included the removal of livestock, mustering and shooting of feral stock (mostly donkeys), fencing and strip contour cultivation and seeding with exotic pioneer species (especially *Cenchrus* spp. and kapok-bush, *Aerva javanica*). The erosion status of this land was surveyed in 1981 by de Salis (1982). There was little restorative work undertaken on degraded lands in the National Park and Conservation Reserve until 1985.

The degradation caused by the pastoral industry has led to extensive loss of soils, change in composition of understorey species (notably the proliferation of *Heteropogon contortus*: Forbes and Kenneally 1986), destruction of much riparian vegetation (e.g. *Typhus* reedbeds around the Ord: Anon. 1986), elimination of many of the herbs and other plants traditionally used as food by the local Aboriginal people (Colreavy *et al.* 1989; Coombs *et al.* 1989) and massive siltation of rivers and waterholes (R. Wallaby in Anon. 1986). These changes have probably been associated with the local extinction of numerous animal species, with the medium-sized mammals being most vulnerable (McKenzie 1981a; Burbidge and McKenzie 1989). Such radical changes in the animal species composition must remain partly conjectural, as the pre-pastoral fauna was never described.

Disturbance and erosion has been very uneven in the Bungle Bungle area, with the water systems and lowland plains adjacent to the Ord River bearing the brunt of livestock pressure (Riddett 1988). The friable soils of these areas proved erosion-prone. The rugged uplands, with their difficult access, relative unpalatibility of their grasses and distance from water, have fared much better.

There has been no substantial mining in the Bungle Bungle area. Limited exploration activity has occurred around the periphery of the National Park, and exploration leases are current in the Conservation Reserve. Some of this exploration has further developed a track network in the Conservation Reserve. Our observations in the south-west of the Conservation Reserve indicated that in some cases exploration tracks had been sited without regard to erosion risks, and there had been little attempt made to rehabilitate disturbances associated with exploration activities. The Bungle Bungle massif itself is not considered highly prospective (Anon. 1986).

TOURISM

The Bungle Bungle massif is now a major focus for tourism in the Kimberley region, with visitor numbers escalating dramatically over the last five years (Barrington Partners 1986; Colreavy *et al.* 1989). Numbers are expected to continue increasing, and an airstrip is under construction near Bellburn Creek campsite. The Department of Conservation and Land Management has restrained tourist pressure by (i) encouraging visits by scenic flight from Kununurra or Halls Creek, (ii) keeping the access track at four-wheel-drive standard, (iii) restricting campsites to two locations, (iv) prohibiting campfires, and (v) limiting access, chiefly to Piccaninny and Cathedral Gorges and Echidna Chasm. Nonetheless, tourist impact has led to some proliferation of tracks and to severe localized degradation where tracks have been inappropriately aligned. Tourist pressure may be expected to increase, with a range of tourist developments being proposed for the Park and surrounding area (e.g. Barrington Partners 1986). The impact and management of visitors will remain a formidable management consideration.

PREVIOUS BIOLOGICAL INFORMATION

There is an extraordinary dearth of information on the fauna of the Bungle Bungle area. It was missed by the extensive collecting expeditions which worked in the Kimberley region over the last 40 years (e.g. Hall 1974; Kitchener and Vicker 1981).

The birds have been best served, with the published list of long-term ranger Mr Bob Taylor (in Colreavy *et al.* 1989) including 115 species from the National Park, and another smaller list based on a short visit (Muir 1983). The bird fauna of the Ord River Station was described by Kilgour in 1904, and this provides an important historical perspective for possible changes in faunal composition. Records from the Bungle Bungle area were also included in the Atlas of Australian Birds (Blakers *et al.* 1984).

Muir (1983) also lists six mammal species identified from bones collected near Bungle Bungle Outcamp. Anon. (1986), McGonigal (1989) and Colreavy *et al.* (1989) give anecdotal records for a few other mammal species, although the identification of some of these is unconfirmed. There is no published information on the reptiles and amphibians of the area, although the Western Australian Museum has undertaken limited collecting of the herpetofauna of the Ord River valley (Smith[1] personal communication).

In contrast, the vegetation of the Bungle Bungle area was described in detail by Forbes and Kenneally (1986), its conservation significance reported by Forbes and Kenneally (1985) and ethnobotanical value given by Rose (1985) and Scarlett (1985). Forbes and Kenneally (1986) provide an extensive annotated list of plant species.

LAYOUT

This report is presented as a series of sections linked by a common introduction, methods and discussion. All references are listed together in the final section. Tables and Figures for individual sections are presented together at the end of the section in which they are cited.

[1] L. Smith - Western Australian Museum, Perth

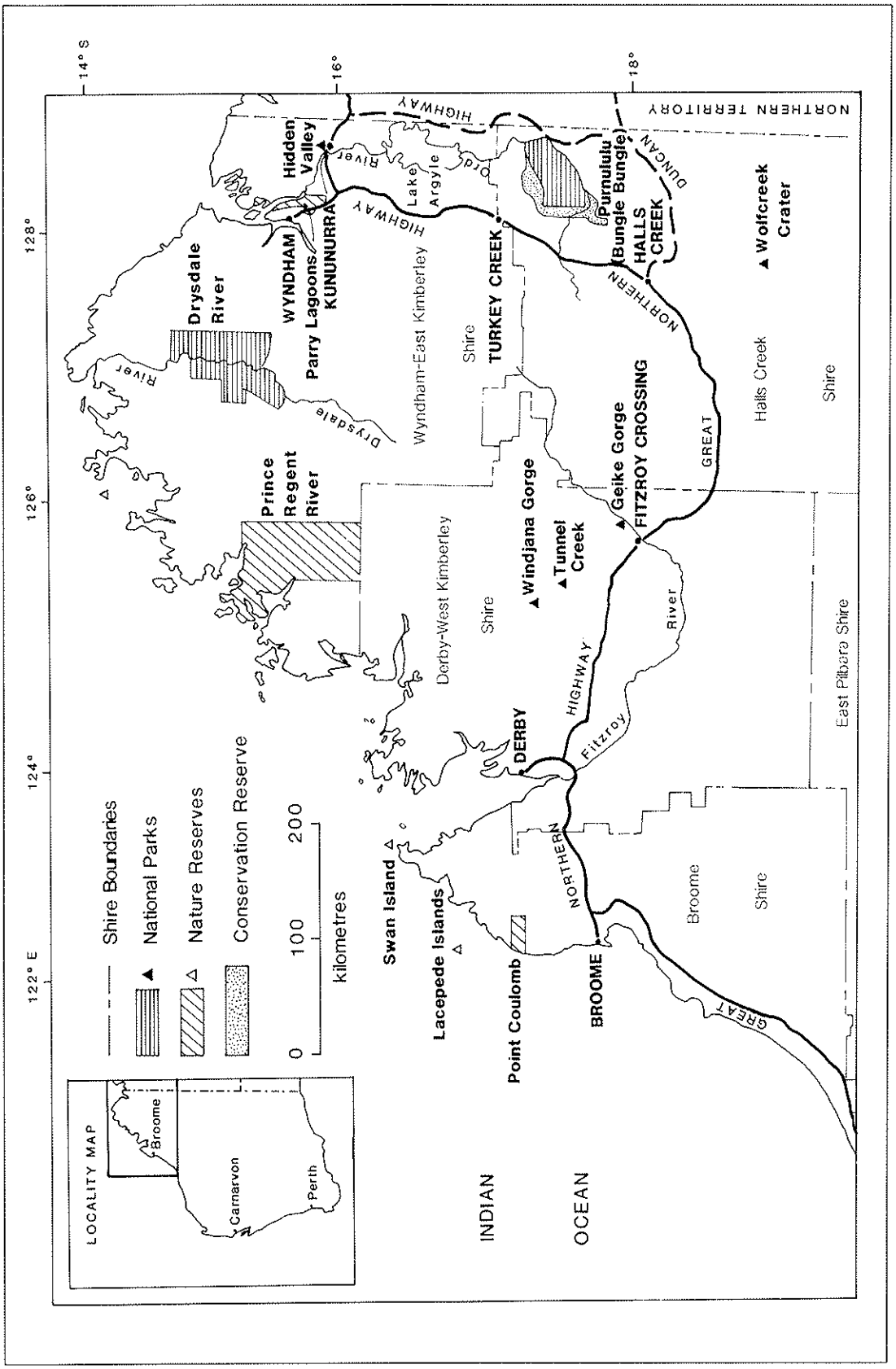

Figure 1

Location of the Bungle Bungle area.

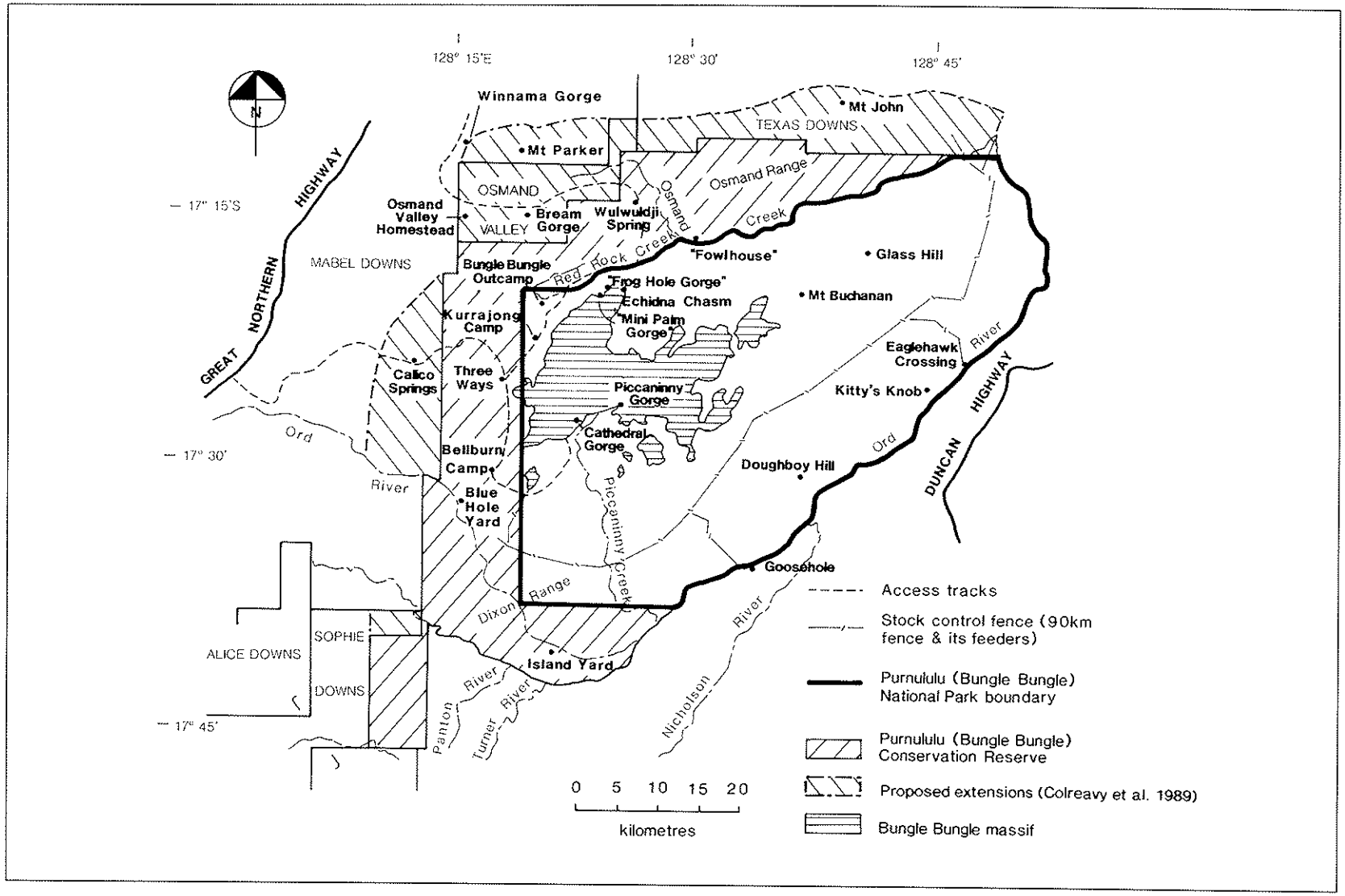

Figure 2

The Bungle Bungle area showing place names mentioned in text.

Table 1

Average rainfall figures (mm) for Turkey Creek (records over 60 years) and Limbunya (records over 44 years).

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Year*
Turkey Creek	170	168	102	26	11	7	6	2	4	18	54	113	681
Limbunya	144	144	79	16	8	5	5	2	2	19	38	91	553

Chapter 2

Methods for Biological Survey of the Bungle Bungle Area

by
John Woinarski, Richard Braithwaite, Karina Menkhorst and Nick Gambold

OUTLINE

The methodology that we employed was based on that used during our wildlife study of Stage III of Kakadu National Park (Woinarski *et al.* 1989a). Representative sites were surveyed intensively for all vertebrates over a period of six days. Marked quadrats were used in order to assess abundance and relate vertebrate records to detailed environmental information.

SITE SELECTION AND SURVEY PERIOD

We selected 10 sites on the basis of (i) geographic spread throughout the Bungle Bungle area (including the Conservation Reserve and areas in Osmand Valley and Texas Downs Stations), (ii) representation of major habitats and land systems, (iii) accessibility, and (iv) avoidance of Aboriginal sacred sites. The location of the sites selected is given in Figure 3, and further details of sites are in Table 2. Seven sites were surveyed between 13 June and 30 July 1989 ('dry season') and three sites between 21 November and 10 December 1989 ('wet season'). Both survey periods were notable for their lack of rainfall, to the extent that conditions in the 'wet season' survey were probably more typical of the late dry season.

A further seven days field work preceded the survey of our last three sites. During this period, we made more extensive searches of Winnama Gorge, Wulwuldji Springs, Turkey Creek (near Osmand Valley Station), Three-ways, Echidna Chasm and 'Frog Hole' Gorge. Mammal traps and mist-nets for bats were set at these sites for periods of one to two nights.

ANIMAL SAMPLING

At every survey site we established three transects, all of 900 m length (Fig. 4). For every transect, we marked five equally spaced core quadrats of 80 m x 20 m, making a total of 150 quadrats for the whole survey. These were the areas used for trapping of small mammals, reptiles and amphibians and for censuses of reptiles and amphibians. The core quadrats were nested inside larger (100 m x 100 m) quadrats marked for bird censuses and observations of larger mammals. In every core quadrat we placed 20 mammal traps (16 small Elliott, 3 large Elliott and 1 cage (20 mm x 20 mm x 56 mm)) and three pitfall traps (28 cm diameter x 36 cm depth), arranged as in Figure 5. These were all set for a period of four successive days and nights. Every pitfall trap had 8 m of 25 cm high driftline fence. Elliott traps were baited with a mixture of peanut butter and oats. Cage traps were baited with figs or apples and jam. All traps were checked in early morning and late afternoon. Elliott traps were rebaited every afternoon.

We searched quadrats systematically for reptiles and amphibians (three censuses per quadrat during daylight and two censuses per quadrat at night, every census for 5 minutes) and birds (eight instantaneous censuses per quadrat during daylight and two at night with numbers of each species present within quadrats recorded at every census). Larger mammals were recorded incidentally during these censuses, or their presence inferred from tracks, scats or other signs.

At every survey site, we set three harp traps (Tidemann and Woodside 1978) over four nights to sample bats. Additionally, we used mist-nets for variable periods on at least three nights per site.

Abundance measures were assigned for every species in every quadrat, by tallying the number of individuals caught and the total number recorded in all censuses for that quadrat. We assigned an abundance value of 0.1 to animal species known to be present in quadrats by tracks or other signs or recorded in incidental observations but neither trapped nor recorded in that quadrat during censuses.

For every survey site, we also recorded incidental observations, of animals seen or heard in the general area encompassed by the end points of all transects, or within about 2 km of the campsite. Scats or pellets of dogs, cats, owls and pythons were collected and hairs or bones in them examined and identified.

Fishes and other aquatic vertebrates were not surveyed systematically by this study, but incidental observations were noted and sampling was undertaken opportunistically. For fishes, methods used for such sampling included cast nets, hook and line, and scoop netting with spotlights at night.

Voucher specimens of mammal, reptile, fish and amphibian species were retained and deposited at the Western Australian Museum.

HABITAT DESCRIPTION AND VEGETATION SAMPLING

We completed a proforma of habitat variables for every quadrat. We measured basal area of every woody plant species present, number and height of termitaria, litter depth and presence of feral animals and their signs. We estimated rock cover, rock size, canopy height, canopy cover, distance to permanent water and cover of life forms in the categories trees >8 m, trees 2-8 m, shrubs >2 m, shrubs <2 m, palms, chenopods, cycads, tussock grasses, spinifex, sedges, forbs, ferns and vines. We recorded topographic position, whether the site had been burnt recently, diameter at breast height frequency distribution, rock type and plant species flowering and fruiting. Soil was assessed for gravel content and texture. Vegetation structure was described using Specht's (1970) classification, land system units described according to the description and/or map of de Salis (1982) and habitat type categorized according to the description of Forbes and Kenneally (1986). Within every quadrat, we marked five plots of 2 m x 2 m, and within these all plant species less than 1m in height with cover of at least 10 per cent were identified and scored for canopy cover. The number of plant species occurring in every plot was recorded by category (woody plants, tussock grasses, hummock grasses, sedges, forbs and ferns). For every plot we also estimated total cover, grass height and grass cover. Surrounding these plots was a 5 m x 5 m plot inside which all plants >1 m and <8 m were identified and scored for canopy cover.

Complete plant species lists were compiled for every quadrat. Duplicate voucher specimens were collected and lodged with the Northern Territory and Western Australia Herbaria.

PERSONNEL

The field team was based on a core of three persons. Primary responsibilities were:

Nick Gambold:
reptiles, amphibians.

Karina Menkhorst:
vegetation and habitat description, bats.

John Woinarski:
birds, small mammals (excluding bats), fish.

Field work was assisted at various times by Dick Braithwaite, Ian Cowie, Garry Cook, Gus Wanganeen, Pip Masters, Pavel Zborowski, Bert Herold, Kay Dyson, Lynn Lowe, Therese Patterson, Glenn and Robyn Colledge, and the very obliging CALM staff of the region: Paul Butters, Gordon Carrington, Chris Done, Dave Milne, Neil McGinty, Mark Pittavino, Alex Rogers, Bob Taylor and Jim Wolfenden.

ANALYSIS

Values for all environmental variables, plant species presence, basal area and cover, and animal species abundance for all quadrats were stored and manipulated using the program DECODA (formerly ECOPAK: Minchin 1986). This large data set was analysed using the multivariate classification TWINSPAN (Hill 1979a) which forms groups of quadrats of similar species composition. This classification was based on the presence of plant species in quadrats.

The distribution of animal species by quadrats was analysed separately by relating to survey sites, land units (the groups recognized by de Salis 1982) and to floristic groups. Animal species were also classified into groups based on their similarity of distribution across quadrats. Results are presented as ordered two-way tables.

A degradation measure was calculated for every quadrat, as the sum of four separate indices of disturbance: percentage of introduced plant species (0 = 0 per cent, 1 = 1-5 per cent, 2 = 6-10 per cent, 3 = 11-25 per cent, 4 = 26-50 per cent, 5 = >50 per cent), percentage of introduced plant cover (0 = 0 per cent, 1 = 1-5 per cent, 2 = 6-10 per cent, 3 = 11-25 per cent, 4 = 26-50 per cent, 5 = >50 per cent), number of scats of feral stock (0 = 0, 1 = 1-5, 2 = 6-10, 3 = >10) and erosion score (0 = no erosion, 1 = some bare ground, 2 = up to 50 per cent bare ground, some gullying, 3 = >50 per cent bare ground and/or extensive gullying). For all those floristic groups and all those land systems that were sampled by at least ten quadrats and which had a range of at least three units in this degradation score, we examined for relationships between degradation and animal distribution and abundance by correlating degradation score with the abundance of vertebrate species.

Species lists for the Bungle Bungle area were compared with other available lists for north-western Australia (Table 3; Fig. 6). Firstly, the similarity between the Bungle Bungle lists (separately for mammals, birds, reptiles and frogs) and lists for other areas was calculated, using the formula

$$200w/(a+b)$$

where w = the number of species found in both the Bungle Bungle area and the other area, a = the number of species known for the Bungle Bungle area, and b = the number of species known from the other area. A value of 100 indicates that the Bungle Bungle list is identical to that of the area compared, a value of 0 indicates that no species are shared between the Bungle Bungle area and the other area compared. Results are presented in a network diagram linking sites to the Bungle Bungle area by lines whose thickness varies according to the similarity in species composition. For every surveyed area, the number of species whose distribution is predominantly Eyrean (desert), Torresian (tropical) or widespread (restricted to neither Eyrean nor Torresian) is also shown on these network diagrams.

These species lists were analysed further to examine biogeographical trends across north-western Australia, using the ordination procedure DCA (Hill 1979b) and TWINSPAN classification. Results are presented as scatter graphs of sites on the first two axes of the ordination. In the space defined by these axes, areas with similar species composition are clustered close to each other, and directional change in species composition is reflected in the position of sites along these axes. In most cases the first axis is by far the most important gradient. The relative importance of the second axis is measured by the ratio of its eigenvalue to that of the first axis. These analyses of species lists at various sites are confounded to an extent by varying survey intensity (duration, censusing during different seasons), size, methodology and habitat heterogeneity. Results from Stage III of Kakadu provide a direct comparison, as this survey used the same personnel, methodology and sampling intensity (Woinarski *et al.* 1989a).

This report can be read without the need to understand these analytic techniques. They simply provide reasonably objective means for compressing a large body of sites-by-species data into a, hopefully, comprehensive summary. The data are receptive to more detailed statistical enquiry yet, but this report is probably an inappropriate vehicle for such fine-scale analysis.

PRESENTATION OF SPECIES LISTS

For mammals, birds, reptiles, frogs and fish, we present annotated lists of species recorded from the Bungle Bungle area. For mammals, birds, reptiles and frogs, we list the study sites where these were recorded, the land system unit in which the average abundance per quadrat is greatest (descibed for convenience as 'Preferred') and also the floristic group in which this abundance is greatest.

Information from the few previous sources is incorporated where relevant. We also describe a regional context for these species, by reference to previous surveys in the Kimberley area (especially those of the nearby Ord River area (Kitchener 1978) and Argyle areas (Dames and Moore 1982), and overviews of the Kimberley fauna (e.g. Storr 1980).

In some cases these regional references suggest the likely occurrence within the Bungle Bungle area of species not recorded by us. Such species are listed where appropriate in either the annotated species list (where denoted by square brackets) or in a section for additional species following that list. These species are not included in analyses or in biogeographic comparisons.

For a few animal and several plant species, identifications remain tentative subject to more detailed taxonomic study. Several species recorded here have not yet been taxonomically described.

Preliminary results from our first survey period (June-July 1989) were given in a progress report to CALM (Woinarski *et al.* 1989b). This present report supersedes that progress report. We note that more detailed taxonomic study or further information has changed the identification of some species listed in that earlier report. These changes are: *Egernia striata* should be *Egernia slateri*, *Lerista bipes* should be *Lerista greeri*, *Ctenotus* sp. should be *Ctenotus decaneurus* (although possibly an aberrant specimen), *Peradorcas concinna* should be *Petrogale brachyotis*, *Pseudomys nanus* includes both *P. nanus* and *P. desertor*, and *Sminthopsis youngsoni* should be included with *S. macroura*.

Nomenclature and taxonomic authority used follow standard texts as given at the beginning of our annotated species lists. We introduce one common name, Kimberley Mouse for *Pseudomys laborifex*, the only mammal recorded here without an established vernacular name. This name aptly describes its distribution, is consistent with geographic descriptors for other species in this genus (e.g. Alice Springs Mouse *P. fieldi*, Shark Bay Mouse *P. praeconis*, Hastings River Mouse *P. oralis* and Pilliga Mouse *P. pilligaensis*), and recognizes the lack of distinctive physical features of this species.

Table 2

Location of survey sites. Abbreviations for status: NP = National Park, CR = Conservation Reserve, TDS = Texas Downs Station, OVS = Osmand Valley Station.

Site No.	*Area*	*Status*	*Dates visited*	*Lat(s) Long(E) Grid Reference*
1	Bull Creek	NP	14-18 June	17°19' 128°27' 4563-424845
2	Osmand Spring	NP,CR	19-24 June	17°16' 128°31' 4663-495893
3	Goosehole Breakaway	NP	28 June-2 July	17°34' 128°31' 4662-490568
4	Piccaninny Massif	NP	3-7 July	17°26' 128°24' 4563-365725
5	Blue Holes	CR	11-15 July	17°33' 128°15' 4562-208587
6	Turner	CR	16-21 July	17°44' 128°09' 4562-118394
7	Mt. John	TDS	25-30 July	17°10' 128°44' 4663-723013
8	Bream Gorge	OVS	21-27 Nov	17°15' 128°18' 4563-258933
9	Kitty's Knob	NP	30 Nov-5 Dec	17°25' 128°46' 4663-764730
10	Cathedral Gorge	NP	5-10 Dec	17°29' 128°22' 4563-340662

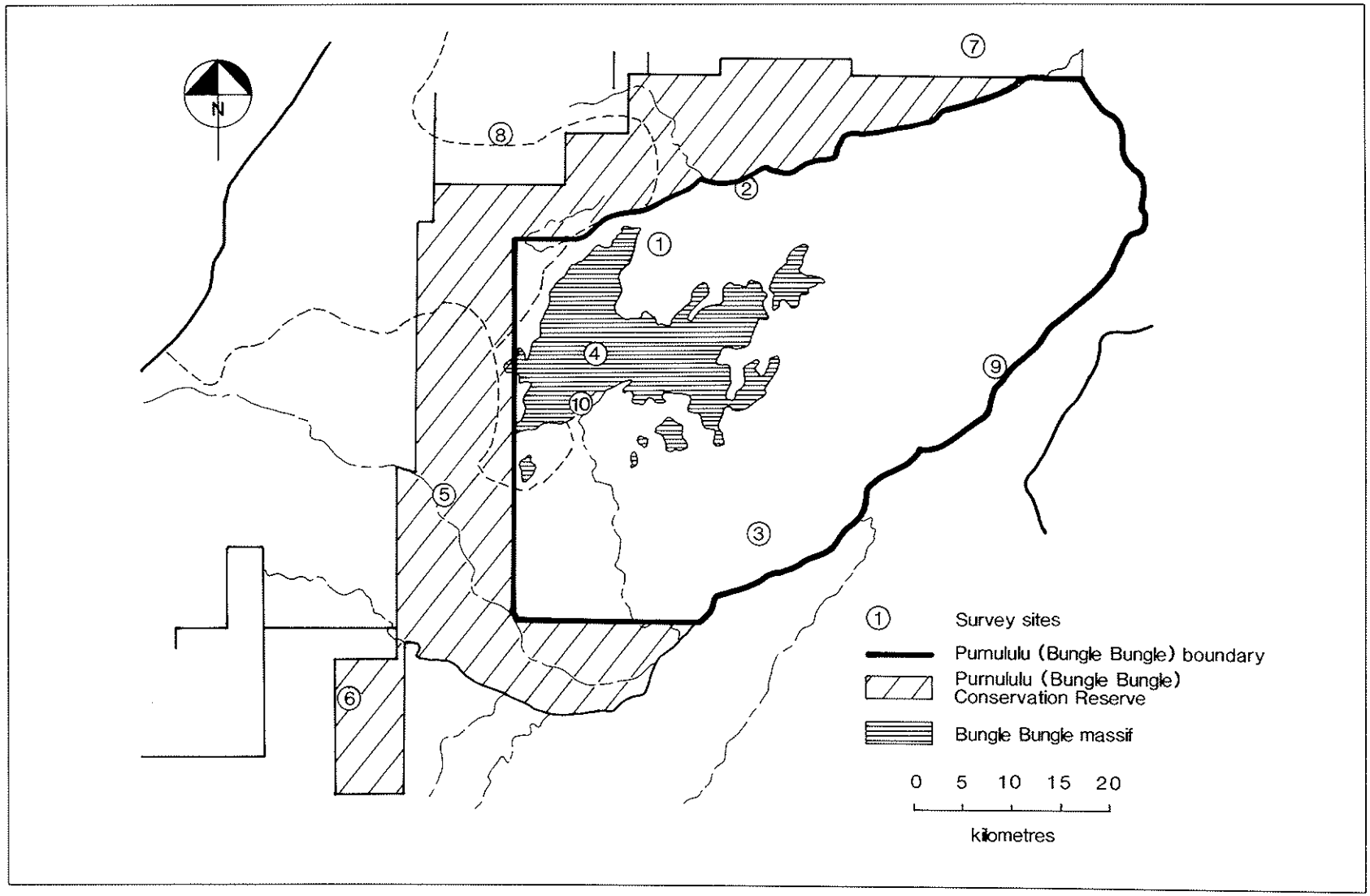

Figure 3

Location of the ten study sites. For further details see Table 2.

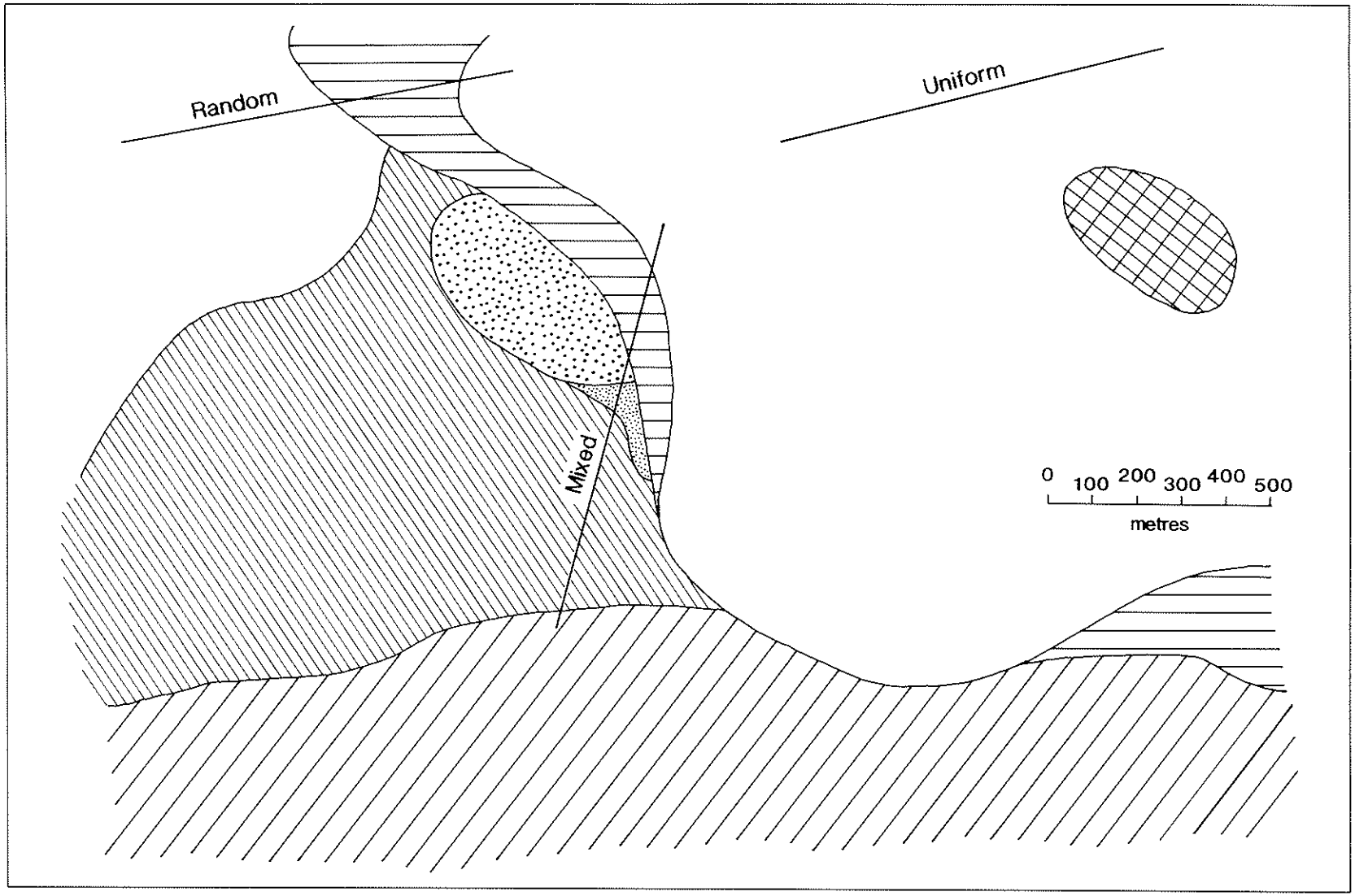

Figure 4

Schematic representation of placement of the three transects at one study site. Vegetation types present are illustrated by different symbols.

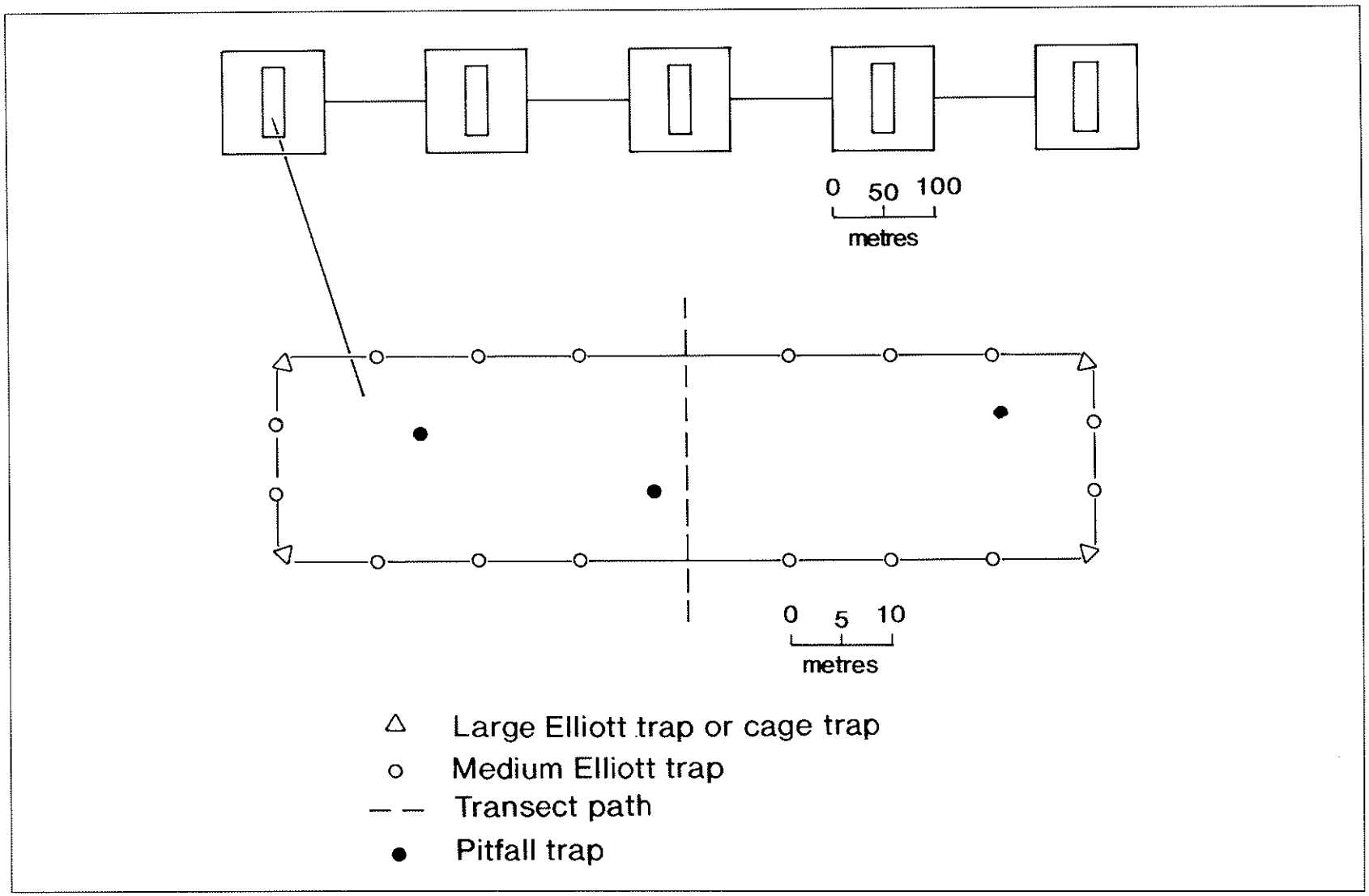

Figure 5

Layout of quadrats and traps along one transect.

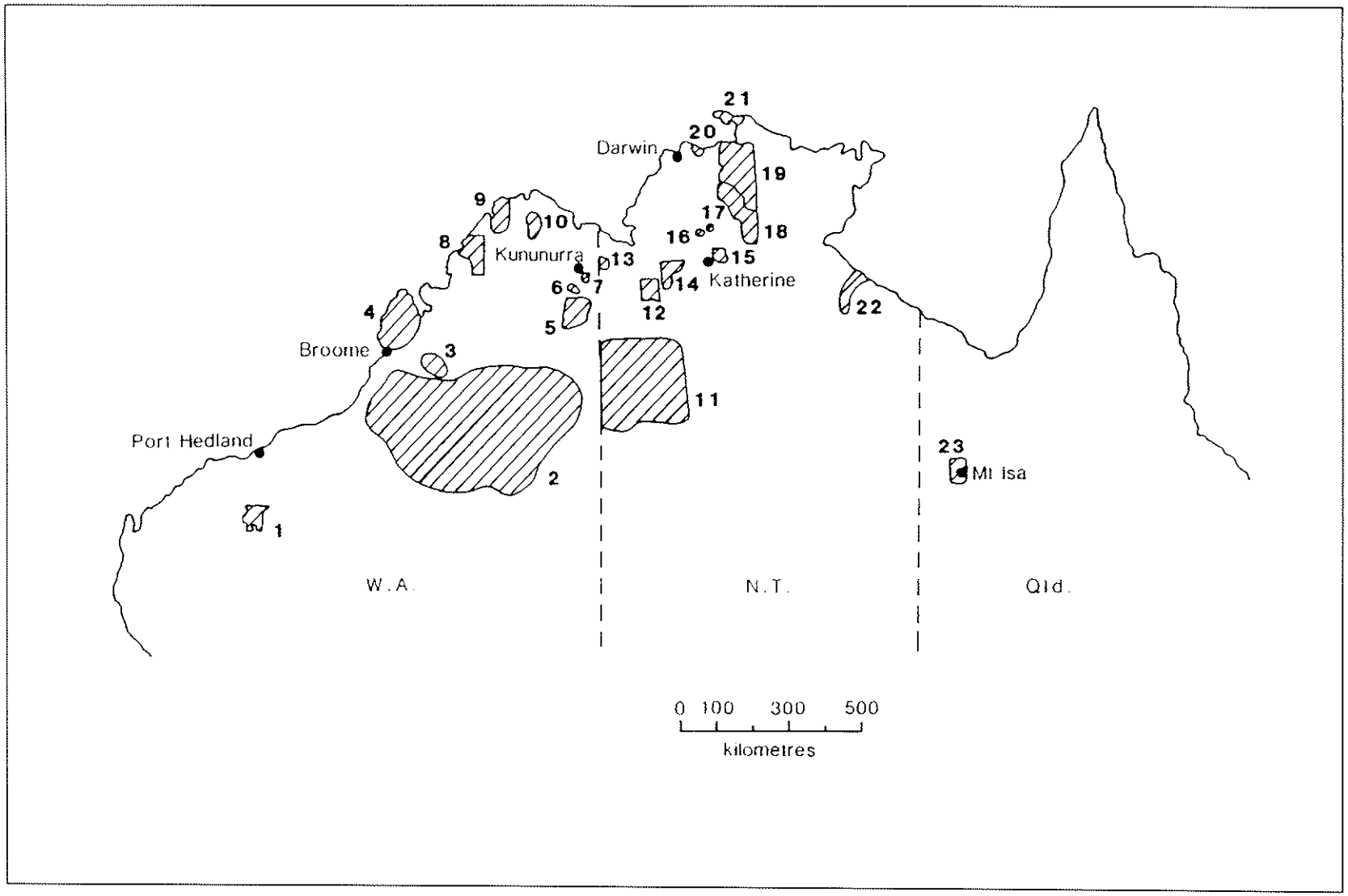

Figure 6

Location and Site Nos of surveyed areas ▨ across north-western Australia. For further details see Table 3.

Table 3

Sites of biological surveys and species lists used in biogeographic comparisons of Bungle Bungle fauna. Site No. as in Figure 6. No. of survey years is number of calendar years in which observations were made. Survey months: DJF = December - February, MAM = March - May, JJA = June - August, SON = September - November. Survey area = approximate size of survey area: * <10 km², ** = 10 -100 km², *** = 100 -1000 km², **** = 1000 -10 000 km², ***** = 10 000 - 100 000 km ², ****** = >100 000 km². Fauna considered is the information used in biogeographic comparisons: M = mammals, B = birds, R = reptiles, F = frogs. Survey effort = approximate No. of person days: * = <100, ** = 100 - 250, *** = 250 - 500, **** = 500 - 1000, ***** = > 1000.

		RAINFALL (mm)	SURVEY YEARS (NO.)	SURVEY MONTHS *DJF*	*MAM*	*JJA*	*SON*	SURVEY AREA	FAUNA *M*	*B*	*R*	*F*	SURVEY EFFORT	SOURCE
1.	Hamersley Range	330	1(4)	?	X	?	?	****	X	X	X	X	**	Muir (1883)
2.	Great Sandy Desert	200-400	4		X	X		******	X	X	X	X	****	Burbidge and McKenzie (1983)
3.	Edgar Ranges	500	3			X	X	*****	X	X	X	X	**	McKenzie (1981a)
4.	Dampier Peninsula	550	3		X	X	X	*****	X	X	X	X	***	McKenzie (1983)
5.	Pumululu	600	1	X		X	X	****	X	X	X	X	**	This report
6.	Argyle	630	2	X	X		X	***	X	X	X	X	*	Dames and Moore (1982)
7.	Ord	650	3	X			X	***	X				***	Kitchener (1978)
8.	Prince Regent River	1300	1			X	X	****	X	X	X	X	**	Miles and Burbidge (1975)
9.	Mitchell Plateau	1600	2		X		X	****	X	X	X	X	***	W.A. Museum (1981)
10.	Drysdale River	1100	1			X		****	X	X	X		**	Kabay and Burbidge (1977)
11.	Tanami	200-400	9		X	X	X	******	X	X	X	X	****	Gibson (1986)
12.	Victoria River Downs	550	2	X	X	X	X	****		X			*	Boekel (1980)
13.	Keep River	700	?	?	?	?	?	***		X			?*	McKean (1986) - CCNT file notes
14.	Gregory	700	?	?	?	?	?	****		x			?**	CCNT file notes
15.	Katherine Gorge (Nitmiluk)	1000	?	X	X	X	X	****	X	X	X	X	***	CCNT file notes
16.	Umbrawara Gorge	1100	?	X	X	X	X	*	X	X	X	X	**	CCNT file notes
17.	Pine Creek	1150	1		X		X	**	X	X	X	X	*	Schulz and Menkhorst (1984)
18.	Kakadu Stage III	1200	2	X	X		X	****	X	X	X	X	**	Woinarski *et al.* (1989a)
19.	Kakadu Stages I & II	1300	4	X	X	X	X	*****	X	X	X	X	*****	Braithwaite (1985); - ANPWS file notes
20.	Howards Peninsula	1650	1		X			***		X			**	Woinarski *et al.* (1988)
21.	Cobourg Peninsula	1700	4	X	X	X	X	****	X	X	X	X	****	Frith and Calaby (1974)
22.	Lower MacArthur	1000	4	X	X	X	X	****	X	X	X		***	CSIRO (1976)
23.	Mt. Isa	380	24	X	X	X	X	****		X			?***	Horton (1975)

Chapter 3

Flora of the Bungle Bungle area

by
Karina Menkhorst and Ian Cowie

VEGETATION DESCRIPTIONS OF FLORISTIC GROUPS IDENTIFIED FOR THE BUNGLE BUNGLE AREA

These floristic groups are defined from analysis of data collected in the 150 quadrats. For labelling, they are identified by the dominant species of tree, shrub and grass layers.

Each of our floristic groups is related to the groupings recognized by Forbes and Kenneally (1986).

1. Livistona sp. Open Forest - *Acacia holosericea - Germania truncatiglumis.*

Site 8

No. of quadrats: 5

Sheltered sandstone gorges of the Osmand Valley with permanent to semi-permanent watercourses support closed to open forest. The canopy height is 14-20 m with the dominant tree species being *Livistona* sp., *Melaleuca Leucadendra, Syzygium angophoroides* and *Euodia elleryana.* The shrub layer is variable, ranging from poorly developed to dense, with *Acacia holosericea, A. tumida, Melastoma polyanthum, Grevillea agrifolia, Leptospermum parviflorum* and *Bossiaea bossiaeoides* being characteristic. The ground layer varies with substrate. The rocky stream bed has occasional tussocks of *Germania truncatiglumis, Arundinella nepalensis* and *Cymbopogon procerus.* The sedge *Fimbristylis pauciflora is* common. The sandy banks are covered with well developed hummocks of *Triodia microstachya.*

The sheltered seepage areas of the sandstone cliffs support a variety of ferns including *Nephrolepis arida, Lygodium microphyllum* and *Dicranopteris linearis.* The clubmoss *Lycopodium cernuum is* restricted to the damp sands of these incised gullies, along with the herbs *Eriocaulon setaceum, Utricularia caerula* and *Drosera* sp. The vines *Marsdenia cinerascens* and *Tylophora flexuosa* are occasional.

This community is restricted to the Wickham Land System and is comparable to Forbes and Kenneally 1.4 (sheltered gullies of streams in Osmand Valley and surrounds).

2. Eucalyptus ptychocarpa Forest - *Pandanus spiralis - Heteropogon contortus.*

Sites 7, 8

No. of quadrats: 5

This community occurs on flats and depressions associated with Osmand Creek on soils ranging from sand to loam. The canopy height is 10-18 m and the dominant tree species are *Eucalyptus ptychocarpa* and *Melaleuca leucadendra* with occasional *Timonius timon, Nauclea orientalis* and *Brachychiton diversifolius. Pandanus spiralis* forms a lower tree layer.

In the Osmand Valley these sites typically support an understorey of *Cycas pruinosa* with a grass layer of *Arundinella nepalensis, Heteropogon contortus* and *Germania truncatiglumis.* Wetter sites occurring downstream on Texas Downs Station have an understorey of *Acacia holosericea, Distichostemon hispidus* and *Fleuggea virosa* with a ground layer of *Cyclosorus interruptus, Fuirena ciliaris* and *Triodia microstachya.* Sedges are characteristic of the ground layer, with *Cyperus polystachyos, Fuirena umbellata, Schoenoplectus mucronatus* and *Scleria rugosa* recorded only in this community.

Adjacent permanent pools supported several rarely recorded species including the aquatic herbs *Aponogeton elongatus* and *Nymphaea violoceae*, the fern *Ceratopteris thalictroides* and *Pandanus aquaticus.*

This community is restricted to the Wickham Land System and is referred to by Forbes and Kenneally as 2.1 (low-lying plains adjacent to semi-permanent streams of the Osmand Valley) and 1.2 (permanent and semi-permanent streams of Osmand Valley and surrounds).

3. Melaleuca leucadendra/Eucalyptus camaldulensis Open Forest - *Aerva javanica - Aristida* spp.

Sites 5, 9

No. of quadrats: 4

This community occurs in the Nelson and Antrim Land Systems of the Ord River valley where the alluvial sands of the river levee support an open forest with a canopy height of 10-20 m. *Melaleuca leucadendra* and *Eucalyptus*

camaldulensis dominate with scattered *Terminalia platyphylla, Lophostemon grandiflorus, Ficus racemigera* and *Lysiphyllum cunninghamii. Terminalia bursarina* occurs as a dominant of low woodlands on the rocky floodplains.

The shrub layer is sparse and characterized by *Acacia farnesiana. Syzygium eucalyptoides* occurs as a small tree only in this community. The understorey comprises a rich assemblage of annual grasses, forbs and exotic species which colonize the alluvial sands after each flood. *Aerva javanica is* a colonizer species that occurs frequently. Grasses include *Aristida* spp., *Cenchrus* spp., *Cynodon dactylon, Digitaria bicornis, Enneapogon purpurascens* and *Heteropogon contortus.* Common forbs include *Cleome viscosa, Indigofera linifolia* and *Portulaca* sp. Species recorded only from this community include the grasses *Xerochloa laniflora, Sorghum laxiflorum* and *Chloris inflata* and the forbs *Bergia trimera, Sida acuta, Cardiospermum halicacabum, Trianthema triquetra* and *Tribulus terrestris.*

Forbes and Kenneally describe a similar community, 1.3 (Ord River at Blue Holes).

4. Melaleuca leucadendra Open Forest - *Acacia eriopoda - Aristida hygrometrica.*

Sites 2, 7, 8

No. of quadrats: 18

The Osmand Creek flows through a broad valley in the Wickham and Antrim Land Systems forming a complex of permanent and ephemeral watercourses. The alluvial sands of the permanent watercourses support a band of open forest with a canopy height of 16 - 20 m, dominated by *Melaleuca leucadendra* with occasional *Eucalyptus camaldulensis* and *Terminalia platyphylla.* Ephemeral watercourses and river levees are more open with a woodland of *Eucalyptus papuana, E. confertiflora* and *Lysiphyllum cunninghamii.* The shrub layer is sparse and characterized by *Acacia eriopoda, A. holosericea, A. tumida* and *Flueggea virosa.* The grassy understorey is dominated by *Aristida* spp., *Heteropogon contortus* and *Cenchrus ciliaris.* Subshrubs such as *Sida* spp., *Crotalaria* spp., *Hibiscus* spp. and *Waltheria indica* and the herbs *Euphorbia* spp., *Portulaca* sp. and *Ipomea* sp. occur frequently.

This community recorded the highest number of plant species per quadrat, (mean 39.7), including many exotic species such as *Datura inoxia, Parkinsonia aculeata, Calotropis procera, Cenchrus echinatus, Citrullus lanatus* and *Euphorbia hirta.*

Comparable to Forbes and Kenneally 2.2 (stream frontage).

5. Lysiphyllum cunninghamii Woodland - *Carissa lanceolata - Heteropogon contortus.*

Sites 6, 7, 8

No. of quadrats: 12

Drainage lines on plains and lower slopes of the Wickham Land System support woodlands with a canopy height of 8-12 m and dominated by *Lysiphyllum cunninghamii, Lophostemon grandiflorus, Eucalyptus chlorophylla* and *Melaleuca viridiflora.* The shrub layer is characterized by *Carissa lanceolata, Atalaya hemiglauca* and *Acacia holosericea.* The tussock grasses *Heteropogon contortus, Eulalia fulva, Chrysopogon* sp. and *Eriachne festucacea* dominate the ground layer.

This community is associated with ephemeral watercourses and is heavily used by feral animals. Many sites are degraded. Forbes and Kenneally describe a similar community 1.1 (ephemeral streams on plains and broad valleys).

6. Lysiphyllum cunninghamii Low Woodland - *Acacia holosericea - Cenchrus ciliaris.*

Sites 3, 9

No. of quadrats: 13

This community occurs on the Nelson Land System on plains and river levees of the Ord River valley and is subject to severe degradation and erosion. Soils vary between loamy sand and sandy clay loams. *Lysiphyllum cunninghamii, Eucalyptus opaca* and *E. pruinosa* characterize the tree layer with a canopy height of 6-10 m, *Grevillea striata* and *Hakea arborescens* occur occasionally. Favourable sites on river levees occasionally support a forest of *Eucalyptus microtheca* with a canopy height of 18 m.

The shrub layer is generally poorly developed, although *Acacia farnesiana* can form dense thickets on heavier soils. The ground layer is dominated by the tussock grasses *Cenchrus ciliaris, Chrysopogon fallax, Bothriochloa ewartiana* and *Astrebla squarrosa.* Forbs are more frequent than in surrounding hummock grass communities and include *Corchorus* spp., *Heliotropium* sp., *Ptilotus* spp. and *Trianthema pilosa.* Termitaria are common.

Forbes and Kenneally describe a similar community, 3.4 (calcareous red earths).

7. Acacia farnesiana Open Shrubland - *Aerva javanica - Aristida* spp.

Sites 3, 5

No. of quadrats: 8

This community occurs in the Nelson and Antrim Land Systems of the Ord River valley. The fine clays and clay loams of these plains are severely eroded in places. The tree layer is virtually absent and a sparse tall shrub layer dominated by *Acacia farnesiana*, a species characteristic of disturbed areas, forms the canopy. Tussock grasses such as *Aristida holathera*, *A. inaequiglumis*, *Cenchrus ciliaris*, *C. echinatus*, *Enneapogon purpurascens*, *Chrysopogon* sp. and *Sporobolus australasicus* dominate the ground layer. There is a high density of forbs, the most common being *Sida* spp., *Cleome viscosa*, *Boerhavia* sp., *Crotalaria medicaginea*, *Heliotropium* sp., *Phyllanthus maderaspatensis* and *Rhynchosia minima*. The numerous annual grasses, forbs and increaser species such as the chenopod *Salsola kali* are all indicators of degradation. The original composition of these plains prior to the introduction of cattle and donkeys is uncertain. This community is comparable to Forbes and Kenneally 3.3 (black-soil plains).

8. Eucalyptus collina Woodland - *Acacia stipuligera* - *Triodia spicata.*

Sites 1, 10

No. of quadrats: 7

The sandplains surrounding the Bungle Bungle massif support a woodland of *Eucalyptus collina* with a canopy height of 12-16 m. There is a well-developed shrub layer dominated by *Acacia stipuligera*, *Grevillea refracta* and *Jacksonia odontoclada*. The ground layer is characterized by a hummock grass not previously recorded in the Kimberley, *Triodia spicata*. Tussock grasses such as *Aristida holathera*, *Eriachne obtusa* and *E. ciliata* occur occasionally between clumps of hummock grass.

This community occurs on the Buchanan Land System. It is included in Forbes and Kenneally 3.2 (sand plains surrounding Bungle Bungle massif).

9. Eucalyptus collina Woodland - *Acacia tumida* - *Plectrachne pungens.*

Site 1

No. of quadrats: 11

Woodlands of *Eucalyptus collina* with occasional *E.* aff. *papuana* occur on the sandy loams of the Buchanan plains and frontages. Ephemeral watercourses have a narrow band of *E. camaldulensis* lining their banks. Shrubs and small trees include *Acacia tumida*, *Corchorus sidioides*, *Tephrosia phaeosperma*, *Cassia venusta* and *Grevillea miniata*. The hummock grass *Plectrachne pungens* dominates the understorey, with *Triodia procera* occurring less frequently. Tussock grasses such as *Aristida holathera* and *Chrysopogon* sp. occur occasionally between clumps. *Indigofera linifolia is* the dominant forb with *Ammannia auriculata*, *Bonamia linearis*, *Crotalaria incana*, *Indigofera hirsuta* and *Tribulopis angustifolia* recorded only in this community.

This community is included in Forbes and Kenneally 3.2 (sandplains surrounding Bungle Bungle massif).

10. Eucalyptus brevifolia Open Woodland - *Cassia venusta* - *Plectrachne pungens.*

Sites 1, 2, 3

No. of quadrats: 11

This community occurs on sandstone breakaways in the Elder and Buchanan Land Systems. *Eucalyptus brevifolia* is the dominant tree with a canopy height of 8-14 m, *E. camaldulensis* and *Ventilago viminalis* occur occasionally in drainage lines. *Cassia venusta*, *Gossypium australe* and *Acacia eripoda* characterize the shrub layer. The ground layer is dominated by the hummock grasses *Plectrachne pungens* and *Triodia inutilis* with the tussock grasses *Aristida hygrometrica*, *Eriachne obtusa*, *Eragrostis* spp. and *Chrysopogon* spp., and the forb *Ptilotus fusiformis* occurring frequently. A new species of *Tephrosia* was collected on the sandstone breakaway at site 3 and the two forbs previously unrecorded in the Kimberley, *Ptilotus schwartzii* and *Streptoglossa decurrens*, were recorded only in this community.

Forbes and Kenneally did not describe this community.

11. Hakea arborescens Low Woodland - *Dodonaea polyzyga* - *Triodia wiseana.*

Site 6

No. of quadrats: 5

This community is restricted to limestone outcrops where the canopy height is typically low and sparse but on favourable sites may form low closed forests. Dominant trees are *Hakea arborescens*, *Eucalyptus opaca*, *Lysiphyllum cunninghamii*, *Santalum lanceolatum* and *Atalaya hemiglauca*, with occasional trees of *Celtis philippinensis*, *Premna acuminata* and *Vitex glabrata.*

The shrub layer is well developed and *Dodonaea polyzyga*, *Acacia acradenia* and *Carissa lanceolata* dominate. Large hummocks of *Triodia wiseana* occur on unburnt sites, often tangled with the vine *Cassytha capillaris.*

This community occurs on the Headley Land System and is comparable to Forbes and Kenneally 4.3 (limestone outcrops).

12. Eucalyptus opaca Low Open Woodland - *Grevillea pyramidalis - Triodia pungens.*

Sites 3, 5, 6, 7, 9

No. of quadrats: 14

A low open woodland dominated by *Eucalyptus opaca* and *Lysiphyllum cunninghamii* with a canopy height of 5-9 m occurs on rocky undulating plains and lower slopes in the Antrim, Nelson and Wickham Land Systems.

Scattered small trees, mainly *Grevillea pyramidalis* and shrubs, principally *Acacia acradenia, Aerva javanica, Carissa lanceolata* and *Dodonaea polyzyga,* form the middle layer. The hummock grasses, *Triodia pungens* and *Triodia intermedia,* dominate the understorey. Soils are typically skeletal sandy clay loams. Forbes and Kenneally describe a similar community 3.1 (interfluves and undulating plains).

13. Eucalyptus brevifolia Low Open Woodland - *Acacia retivenia - Triodia intermedia.*

Sites 6

No. of quadrats: 5

This community is associated with sandstone hills and slopes of the Antrim Uplands. Soils are skeletal sandy clay loams. A sparse low tree layer of *Eucalyptus brevifolia* with a canopy height of 3-6 m occurs over a shrub layer of *Acacia retivenia, A. lycopodifolia, Cochlospermum fraseri, Gossypium australe* and *Terminalia canescens.* The ground layer is dominated by the hummock grass *Triodia intermedia* with occasional *Triodia pungens.* The sedge *Bulbostylus barbata* and the annual grass *Sporobolus australasicus* occur commonly in the bare ground between hummocks.

This community had the lowest number of plant species per quadrat (mean 10.4) recorded for the survey. Forbes and Kenneally record a similar community 4.1 (rocky slopes) occurring on the Antrim, Dockrell and Wickham Land Systems.

14. *Eucalyptus cliftoniana* Low Woodland - *Cajanus* sp. - *Plectrachne pungens.*

Site 7

No. of quadrats: 6

A low woodland dominated by *Eucalyptus cliftoniana* occurs on the dissected sandstone slopes of the Osmand Range in the Wickham Land System. The canopy height is 5-10 m. E *collina* and *Owenia vernucosa* occur occasionally. There is a well-developed shrub layer dominated by *Cajanus* sp., *Acacia gonocarpa, A. lycopodifolia, Corchorus sidioides, Grevillea refracta, Heliotropium epacrideum, Hibiscus leptoclada* and *Cochlospermum fraseri.* Hummock grasses dominate the understorey, mainly *Plectrachne pungens* with isolated hummocks of *Triodia procera.* The tussock grass *Eriachne ciliata* and the sedge *Cyperus* aff. *sexflorus* occur frequently on bare ground between hummocks. The shrub *Paratephrosia lanata* was recorded only in this community. No introduced species were recorded.

Forbes and Kenneally did not record this community.

15. Eucalyptus aspera Low Woodland - *Acacia eripoda - Triodia microstachya.*

Sites 4, 10

No. of quadrats: 3

A distinct community occurs in the gorges of the Bungle Bungle massif. The tree layer is sparse with a canopy height of 4-8 m and is characterized by *Eucalyptus aspera* and *E. brachyandra. Acacia eriopoda* can form a tall shrub layer while the sparse undershrubs include *Calytrix exstipulata, Brucea javanica, Sarcostemma australe* and *Santalum lanceolatum.*

The precipitous gorge walls support *Ficus leucotricha, Grevillea psilantha* (type locality), *Pandorea* aff. *doratoxylon, Eriachne mucronata* and *Plectrachne* sp. nov. New species of *Lindernia* and *Steodia* are restricted to these sandstone walls. The sandy banks of the ephemeral watercourses support large hummocks of *Triodia microstachya.* The fern *Cheilanthes brownii* occurs in crevices. Several species of vine occur in these sheltered gorges including *Tylophora flexuosa, Tinospora smilacina* and *Stehania japonica.*

Permanent water can be found in rockholes in some gorges. The damp loamy sands surrounding these pools support a community of sedges, grasses and forbs not found in drier sites. Of particular interest is the daisy *Erigeron ambiguus,* a new record for Western Australia. Other species include the sedge *Cyperus holoschoenus,* the grass *Elytrophorous spicatus, Byblis liniflora, Eriocaulon cinereum, Centrolepis banksii* and *Monochoria cyanea.*

Forbes and Kenneally describe similar communities as 1.7 (chasm and cliffs) and 1.5 (ephemeral streams on the Bungle Bungle plateau).

16. *Eucalyptus cliftoniana* Low Open Woodland - *Acacia* spp. - *Triodia spicata.*

Sites 4, 10

No. of quadrats: 16

This community occurs predominantly on sandy loams of the Elder uplands of the Bungle Bungle massif. The tree layer is low and sparse, with a canopy height of 4-8 m, and dominated by *Eucalyptus cliftoniana* with occasional *E. collina*. *E. dichromophloia* occurs on rocky slopes and *E. cupularis* is restricted to the sandy ephemeral watercourses of this community. The shrub layer is well-developed, particularly along drainage lines and includes *Acacia gonocarpa, A. stipuligera, A. tumida, A. lycopodifolia, Grevillea miniata, G. refracta* and *Jacksonia odontoclada*. *Triodia spicata* forms a dense ground layer with *Triodia microstachya* forming large hummocks on the sandy banks of ephemeral water courses. The tussock grass *Eriachne ciliata* occurs frequently in the bare ground between hummock grass clumps.

The only records of *Acacia* aff. *hippuroides, Cyperus zollingeri, Mirbelia viminalis* and *Tacca leontopetaloides* occurred here. This community recorded the highest percentage cover of shrubs and hummock grasses and no introduced plants were detected.

This community is described as 5.1 (Bungle Bungle plateau) by Forbes and Kenneally.

17. Acacia spp. Tall Shrubland - *Triodia spicata.*

Site 10

No. of quadrats: 7

The Buchanan Uplands at Piccaninny Gorge support a community of *Acacia* tall shrubland with a canopy height of 3-4 m. This community occurs on sandy soils on plains at the base of the Bungle Bungle massif. The tree layer is generally absent but occasional *Eucalyptus cliftoniana* may occur. Tall shrubs include *Acacia eriopoda, A. tumida* and *Grevillea byrnesii* with *A. stipuligera, A. gonocarpa* and *Jacksonia odontoclada* forming a lower shrub layer. *Triodia spicata* characterizes the ground layer with occasional *T. microstachya, Plectrachne pungens* and *Aristida hygrometrica.*

This community is described in part by Forbes and Kenneally 3.2 (sandplains surrounding Bungle Bungle massif).

ANNOTATED PLANT CHECKLIST

The following annotated list contains all the taxa identified so far. It covers 616 species in which there are 17 ferns and fern allies, 1 gymnosperm and 598 flowering plants (157 monocotyledons and 441 dicotyledons). The monocotyledons are from 69 genera in 17 families, and the dicotyledons from 197 genera in 75 families. This list adds 244 species of vascular plants to the known flora of the Bungle Bungle area.

Genera and species are arranged alphabetically within families which follow Cronquist (1981). Species collected during this survey are followed by collection numbers. Intials refer to the collectors : KM (K.A.Menkhorst) and IDC (I.D.Cowie). These specimens are housed at either the Western Australian or Northern Territory Herbaria.

SR denotes a sight record only.

* indicates species reported in Bungle Bungle area by Forbes and Kenneally (1986).

# indicates introduced species.

+ indicates a record from Northern Territory Herbarium collection. These have been checked for correct identification and their herbarium numbers are given.

(F&K.....) indicates an additional locality recorded by Forbes and Kenneally (1986).

(FoK) refers to Flora of the Kimberley (Kenneally 1989).

(FoCA) refers to Flora of Central Australia (Jessop 1981).

PTERIDOPHYTA (Ferns and Fern Allies.)

BLECHNACEAE

* *Blechnum orientale* L. KM 728
Tufted rhizomic fern to 0.7 m. high. Only recorded from Winnama Gorge. In moist overhangs at base of cliff among closed forest.

GLEICHENIACEAE

* *Dicranopteris linearis* (Burm.f.) L.Underw. KM 853
Scrambling fern. In shaded seepage areas of sandstone cliffs in Bream Gorge. (F&K Piccaninny Gorge.)

HEMIONITIDACEAE

* *Taenitis pinnata* (J.Sm.) Holtt. KM 832
Rhizomic slender fern to 0.8 m. Restricted to sandstone walls in chasms of Bungle Bungle massif.

LINDSAEACEAE

* *Lindsaea ensifolia* Sw. KM 851
Rhizomatic wiry fern to 0.5 m. At base of sandstone cliff at Winnama Gorge. (F&K Piccaninny Gorge.)

LYCOPODIACEAE

Lycopodium cernuum L. KM 753
Wiry erect fern, much branched with drooping tips. In damp loam between sandstone boulders at Bream Gorge.

MARSILEACEAE

* *Marsilea mutica* Mett.
Stoloniferous fern with floating and emergent leaves. (F&K Red Rock Creek.)

Marsilea sp. SR
Erect fern beside stagnant waterhole, Blue Hole.

OLEANDRACEAE

Nephrolepis arida D.L.Jones KM 869
Rhizomatic, scaly fern. On sheltered sandstone cliff at Bream Gorge.

* *Nephrolepis hirsutula* (Forster) C.Presl. KM 707
Rhizomatic fern to 1 m. On sheltered sandstone cliff at Winnama Gorge.

PARKERIACEAE

* *Ceratopteris thalictroides* (L.) Brongn. KM 601
Emergent aquatic. In stagnant pools near Mt. John and at Winnama Gorge. (F&K Osmand Valley.)

PSILOTACEAE

* *Psilotum nudum* (L.) P.Beauv. KM 729
Rhizomatic, branched fern with linear leafless stems. On sheltered sandstone wall at Winnama Gorge. (F&K Piccaninny Gorge.)

SCHIZAEACEAE

* *Lygodium microphyllum* (Cav.) R.Br. KM 708
Delicate climbing maidenhair fern. Ascending shrubs on sandstone cliffs among closed forest at Winnama Gorge and Bream Gorge. (F&K Piccaninny Gorge.)

SINOPTERIDACEAE

* *Cheilanthes brownii* (Desv.) Domin. KM 597; IDC 848
Tufted fern, short rhizome, fronds woolly. Common in sandstone crevices associated with the Bungle Bungle massif, occasional on surrounding sandplains.

Cheilanthes hirsuta (Poiret) Mett.
Identified after publication of Forbes and Kenneally (1986).

* *Cheilanthes pumilio* (R.Br.) F.Muell.
Tufted fern from short rhizome. (F&K Bungle Bungle massif and Red Rock Creek.)

* *Cheilanthes tenuifolia* (Burm.f.) Sw.
Dark, finely dissected fern to 0.3 m. (F&K Piccaninny Gorge.)

* *Cheilanthes* sp.
Tufted fern. (F&K Bungle Bungle Plateau.)

THELYPTERIDACEAE

* *Cyclosorus interruptus* (Willd) H.Ito KM 689, 852
Rhizomatic coarse fern to 1 m. In wet loamy soils beneath closed forest at Wulwuldji Spring and near Mt. John.

SPERMATOPHYTA

GYMNOSPERMAE

CYCADACEAE

* *Cycas pruinosa* Maconochie KM 746
Palm-like plant to 3 m, taller ones branched. Leaves blue-green. In sandy soils of seasonally wet areas in Osmand Valley and on sandstone hillsides of Osmand Plateau. Ripe fruits eaten only after grinding, leaching and baking (Scarlett 1985).

ANGIOSPERMAE

MONOCOTYLEDONAE

APONOGETONACEAE

* *Aponogeton elongatus* F.Muell. ex Benth. KM 460, 622
Aquatic with floating leaves and emergent inflorescences, flowers yellow. In permanent pools on Bungle Bungle Plateau and near Mt. John. (F&K ephemeral pools Piccaninny Gorge.)

ARACEAE

* *Colocasia esculenta* (L.) Schott. KM 706
Semi-aquatic with erect fleshy stems to 1 m. In organic soils of permanent watercourses beneath riparian closed forest at Winnama Gorge and Osmand Valley. Populations sterile at time of survey. Stem tubers eaten after cooking (Scarlett 1985).

ARECACEAE

* *Livistona* sp.
Palm 2 m high, leaves grey-green. (F&K Wulwuldji.)

Livistona sp. KM 678, 838
Palm to 10 m; trunk thick at base, with persistent leafbases, smooth and ringed above; inflorescence yellow, branched; fruit ripening black. Dominant in sandy soil of Bream Gorge, and in swampy loam at base of Wickham Land system outlier in southern Conservation Reserve (site 6). Probably the same species referred to above.

* *Livistona* sp. 'Victoria River' *sensu* D.Jones (1984) KM 779
Palm to 20 m, trunk grey with prominent leaf scars; leaves grey-green; fruits spherical, ripening purple. In chasms and on cliffs of Bungle Bungle massif. Apical bud and upper stem eaten when cooked (Scarlett 1985).

BURMANNIACEAE

Burmannia juncea Sol. ex R.Br. KM 756
Erect herb to 0.2 m, winged fruit mauve. In wet sand beside permanent watercourse, Bream Gorge.

CENTROLEPIDACEAE

Centrolepis banksii (R.Br.) Roemer & Schultes KM 482
In moist sandy soil beside permanent waterhole of Bungle Bungle Plateau.

COMMELINACEAE

Murdannia sp. IDC 814
Erect herb to 0.5 m. On sandplains with *Eucalyptus collina* woodland at Bull Creek.

CYPERACEAE

* *Bulbostylis barbata* (Rottb.) C.B.Clarke KM 549; IDC 941
Tufted small sedge. Common on rocky hillsides in skeletal soils between *Triodia* hummocks. (F&K Piccaninny Gorge.)

* *Cyperus breviculmis* R.Br. IDC 856
Annual sedge, growing on moist sandy bank of ephemeral watercourses at Bull Creek and Osmand Creek. (F&K Piccaninny Gorge.)

* *Cyperus conicus* (R.Br.) Boeckler IDC 817, 845, 929
Perennial sedge. Moist sandy bank of ephemeral watercourses, occasional in Osmand Creek and tributaries. (F&K Piccaninny Gorge.)

* *Cyperus cunninghamii* (C.B.Clarke) C.Gardner KM 538, 540; IDC 860
Tufted resinous sedge. Associated with rocky subtrates on Bungle Bungle Plateau, Goosehole breakaway and ephemeral creeks surrounding the massif.

* *Cyperus cuspidatus* Kunth
(F&K Piccaninny Gorge.)

* *Cyperus eleusinoides* Kunth
Rhizomatous sedge. (F&K Osmand Valley.)

* *Cyperus flaccidus* R.Br. vel aff.
(F&K Picaninny Gorge.)

Cyperus haspan L. KM 872
Erect sedge. In damp sand beside stagnant pool, Bream Gorge.

* *Cyperus holoschoenus* R.Br. KM 550; IDC 863, 928
Perennial sedge to 1 m. In moist sand of drainage lines on Bungle Bungle Plateau and surrounding sandplains.

* *Cyperus microcephalus* R.Br. KM 545; IDC 861
Perennial sedge. In rocky ephemeral watercourses at Bull Creek and Site 6. (F&K Piccaninny Gorge, Winnama Gorge.)

* *Cyperus polystachyos* Rottb. KM 541, 717
Tufted sedge. In damp sand beside permanent watercourse under closed forest near Mt. John and at Winnama Gorge.

* *Cyperus pulchellus* R.Br. KM 539
On Bungle Bungle Plateau. (F&K Piccaninny Gorge.)

Cyperus aff. *sexflorus* R.Br. KM 593
Sedge in dissected sandstone near Mt. John.

* *Cyperus sporobolus* R.Br.
Erect sedge to 0.3 m. (F&K Winnama Gorge.)

* *Cyperus squarrosus* L.
(F&K Piccaninny Gorge.)

* *Cyperus vaginatus* R.Br. KM 542, 543, 546; IDC 948
Robust perennial sedge to 1 m. Common in damp sandy soils of major creeks. Stems used to clean wax from ears (Scarlett 1985).

Cyperus zollingeri Steudel KM 559
Annual sedge with fibrous roots. In moist sand of sandstone gorge, Bungle Bungle Plateau.

* *Eleocharis atropurpurea* Kunth
(F&K Piccaninny Gorge.)

Eleocharis geniculata (L.) Roemer & Schultes KM 547
Annual sedge. Ephemeral sandy watercourse beneath *Melaleuca leucadendra* forest, Osmand Creek.

Eleocharis sp. A (FoK) KM 871
Perennial sedge. In permanent pool, Bream Gorge.

* *Fimbristylis cinnamometorum* (M.Vahl) Kunth
Tufted sedge. (F&K Winnama Gorge.)

* *Fimbristylis depauperata* R.Br.
(F&K Piccaninny Gorge.)

* *Fimbristylis littoralis* Gaudich. IDC 865
Annual sedge. In moist sandy bank of ephemeral watercourse, Bull Creek. (F&K Piccaninny Gorge.)

* *Fimbristylis microcarya* F.Muell.
(F&K Piccaninny Gorge.)

* *Fimbristylis neilsonii* F.Muell. KM 571; IDC 905
Annual sedge. In sandy ephemeral watercourses of Bungle Bungle sandplain and Goosehole breakaway.

* *Fimbristylis nuda* Boeckler
(F&K Piccaninny Gorge.)

Fimbristylis oxystachya F.Muell. KM 572
In sandy soils of *Eucalyptus brevifolia* open woodland, Goosehole breakaway.

Fimbristylis ? pauciflora R.Br. KM 768
Perennial sedge to 0.3 m, forming dense circular clumps in moist sand beside permanent watercourse, Bream Gorge.

* *Fimbristylis rhyticarya* F.Muell.
Recorded by Forbes and Kenneally as *F. acuminata*.(F&K Piccaninny Gorge.)

* *Fimbristylis sphaerocephala* Benth.
(F&K Winnama Gorge.)

* *Fimbristylis tetragona* R.Br.
Tufted sedge to 0.5 m. (F&K Osmand Valley.)

Fimbristylis sp. KM 574
Glabrous perennial sedge. On sandy bank beside permanent watercourse beneath riparian forest near Mt. John.

* *Fimbristylis* sp. KM 767
Glabrous perennial sedge. In moist sandy loam beside permanent water course, Bream Gorge.

* *Fuirena ciliaris* (L.) Roxb. KM 554, 555; IDC 855
Annual sedge to 0.3 m. In loamy soils of permanent springs near Mt. John and at Site 6. (F&K Piccaninny Gorge.)

* *Fuirena umbellata* Rottb. KM 551
Perennial broad leaved sedge to 1 m. In swampy loam beneath riparian forest, near Mt. John. (F&K Osmand Valley.)

* *Lipocarpha microcephala* (R.Br.) Kunth
Annual sedge to 0.2 m. (F&K Winnama Gorge.)

* *Rhynchospora affinis* W.Fitzg.
(F&K Piccaninny Gorge.)

Rhynchospora sp. KM 548
Annual sedge 4 cm high. In sandy soil beneath *Acacia* shrubland on Bungle Bungle Plateau.

* *Schoenoplectus lateriflorus* (J.Gmelin) Lye
Tufted sedge. (F&K ephemeral stream.)

* *Schoenoplectus mucronatus* (L.) Palla ex Kerner KM 552
Perennial sedge with robust triangular stems. In damp soil beside permanent watercourse beneath riparian forest, near Mt. John. (F&K Osmand Valley.)

* *Scleria brownii* Kunth IDC 796
Perennial sedge to 0.5 m, nut white. In *Eucalyptus collina* woodlands of Bungle Bungle sandplains. (F&K Winnama Gorge.)

Scleria rugosa R.Br. KM 570
Annual sedge to 0.3 m. In wet loam beside permanent watercourse, near Mt. John.

ERIOCAULACEAE

* *Eriocaulon cinereum* R.Br. KM 564
Rosetted herb with white flowers. In moist loamy sand in sandstone gullies of Bungle Bungle Plateau. (F&K Red Rock Creek.)

Eriocaulon setaceum L. KM 752
Aquatic herb with emergent inflorescence. Only recorded in permanent pools at Bream Gorge.

* *Eriocaulon* sp. B (FoK) KM 704
Rosetted herb with white flowers. In shallow water of permanent pool, Winnama Gorge. Forbes and Kenneally collection *Eriocaulon* sp. EAC 194 refers to this species.

HAEMODORACEAE

Haemodorum ensifolium F.Muell. KM 800
Perennial herb to 0.5 m, leathery strap-like leaves, root red-orange. In loamy sand beneath *Eucalyptus ptychocarpa* woodland at Bream Gorge.

LILIACEAE

Corynotheca micrantha (Lindley) Druce SR
Divaricately branched herb to 0.3 m. Occasional on sandplains surrounding Bungle Bungle massif.

NAJADACEAE

* *Najas tenuifolia* R.Br.
Aquatic herb. (F&K Winnama Gorge.)

ORCHIDACEAE

* *Cymbidium canaliculatum* R.Br. SR
Epiphytic orchid with thick fleshy stems. Occasional on *Eucalyptus* spp.

PANDANACEAE

Pandanus aquaticus F Muell. KM 667, 783
Palm-like tree to 3 m., narrow wedge-shaped fruits in globular heads. On bank of permanent watercourse near Mt. John and at Wulwuldji Spring.

* *Pandanus spiralis* R.Br. KM 781
Palm-like tree to 10 m, with prominent leaf scars on trunk. Associated with permanent watercourses in Osmand Valley and tributaries. Includes species previously named *P. integer* (F&K Winnama Gorge.) Fruits roasted and kernels eaten (Scarlett 1985).

PHILYDRACEAE

* *Philydrum lanuginosum* Gaertner KM 553, 751
Reed-like perennial herb with yellow flowers. Occasional in shallow permanent pools at Mt. John and Bream Gorge. (F&K Winnama Gorge.)

POACEAE

Aristida capillifolia Henrard KM 485, 565, 769; IDC 849
Tufted perennial grass to 0.3 m. Typically found in sandstone crevices of Bungle Bungle massif and Osmand plateau, occasional on associated sandplains.

Aristida contorta F.Muell. KM 448, 638
Annual grass to 0.2 m. Occasional on dry stony hills and plains.

* *Aristida holathera* Domin IDC 775, 862, 901
Loosely tufted perennial grass to 0.5m. Widespread, most abundant on river levees and sand plains. Previously named *A. browniana.*

Aristida inaequiglumis Domin IDC 774, 816
Loosely tufted perennial grass to 1 m. old leaves curling at base of tussock. Widespread, abundant on river levees and sandplains.

Aristida hygrometrica R.Br. IDC 772, 815
Loosely tufted perennial to 0.5 m. Widespread.

* *Arundinella nepalensis* Trin. KM 557, 568
Robust perennial to 1.5 m. In sand beside watercourses.

Astrebla squarrosa C.Hubb. KM 876
Dense leafy perennial grass to 1.5 m. Locally dominant on cracking clay soils near Kitty's Knob.

Bothriochloa bladhii (Retz.) S.T.Blake IDC 952
Densely tufted perennial grass to 1 m. In sandy ephemeral watercourse, Osmand Creek.

Bothriochloa ewartiana (Domin) C.Hubb. KM 879; IDC 765
Perennial grass to 1 m, foliage bluish. On breakaway at Red Rock Creek and near Kitty's Knob.

Brachiaria holosericea (R.Br.) Hughes IDC 821
Slender hairy annual to 0.3 m. In sandy soil beside ephemeral watercourse, Bull Creek.

* *Brachiaria piligera* (F.Muell. ex Benth.) Hughes (F&K Piccaninny Gorge.)

Brachiaria pubigera (Roemer & Schultes) S.T.Blake IDC 777
Annual grass to 0.3 m. On sand levees beneath *Lysiphyllum cunninghamii* woodland, Osmand Creek.

Brachyachne convergens (F.Muell) Stapf KM 575; IDC 761
Annual grass to 0.2 m. On alluvial flats and ephemeral watercourses.

\# *Cenchrus biflorus* Roxb. IDC 937
Annual grass. On levee beneath *Lysiphyllum cunninghamii* woodland, Osmand Creek.

*# *Cenchrus ciliaris* L. KM 809
Perennial grass to 0.3 m. Colonizer of scalds associated with major river systems.

\# *Cenchrus echinatus* SR
Annual grass to 0.3 m, spikelets very prickly. Colonizer of scalds associated with major river systems.

\# *Cenchrus setigerus* Vahl KM 877
Perennial grass forming dense clumps. In heavy soils with *Eucalyptus pruinosa* woodland near Kitty's Knob.

\# *Chloris inflata* Link KM 579
In sandy soil beside stagnant pools, Blue Holes. Previously named *C. barbata.*

Chloris pectinata Benth. KM 914
Annual grass to 0.3 m. In sandy loam of drainage line through low rocky hills at Goosehole breakaway.

\+ *Chloris scariosa* (F.Muell.) Lazarides D0015471
Ord River Station. Probably occurs within the Park in the Ord River Valley.

Chrysopogon fallax S.T.Blake IDC 766
Robust tussock-forming perennial grass to 1.3 m, with fibrous, silky butt. Widespread, typically on floodplains, levees, and alluvial slopes.

Chrysopogon pallidus (R.Br.) Trin. ex Steudel KM 580, 586; IDC 825
Robust tussock-forming perennial grass to 1 m, with fibrous, silky butt. Widespread.

* *Cymbopogon bombycinus* (R.Br.) Domin KM 419
Tufted perennial grass to 1 m, crushed leaves with strong citrus scent. Widespread.

* *Cymbopogon procerus* (R.Br.) Domin
Perennial grass to 1.5 m, crushed leaves with citrus scent. Widespread, typically on rocky substrates.

Dactyloctenium radulans (R.Br.) Beauv. IDC 951
Prostrate annual grass to 0.2 m. In sandy riverbeds of major watercourses.

Dichanthium fecundum S.T.Blake KM 556; IDC 950
Tufted, leafy perennial to 1 m. In sandy drainage lines and watercourses.

* *Digitaria bicornis* (Lam.) Roemer & Schultes IDC 852
Annual grass to 0.3 m. Widespread on river levees and alluvial flats.

Digitaria brownii (Roemer & Schultes) Hughes IDC 818
Annual grass. In sandy loam beside ephemeral watercourse, Bull Creek.

Digitaria papposa (R.Br.) Beauv. IDC 926
Annual grass, mature spikelets woolly. On sandy bank of ephemeral watercourse, Bull Creek.

Dimeria ornithopoda Trin. KM 503
Slender annual grass to 0.3m. In damp organic loam beside permanent watercourse near Mt. John.

*#*Echinochloa colona* (L.)
Prostrate annual grass to 0.3 m. On creek banks and levees.

* *Echinochloa* sp.
(F&K Piccaninny Gorge.)

Ectrosia agrostoides Benth. KM 561
In damp loamy sand of sandstone gully on Bungle Bungle Plateau.

Ectrosia leporina R.Br. KM 590
Slender perennial grass to 0.2 m. On sandy bank of ephemeral watercourse, Piccaninny Gorge.

* *Ectrosia scabrida* C.E.Hubb.
(F&K Piccaninny Gorge.)

* *Elytrophorus spicatus* (Willd.) A.Camus KM 563; IDC 857
Slender annual grass to 0.2 m, spikelets crowded in globular clusters. In damp sands beside ephemeral pools.

Enneapogon pallidus (R.Br.) Beauv. IDC 946
Perennial grass to 0.4 m. On levee beneath *Lysiphyllum* woodland, Osmand Creek.

Enneapogon polyphyllus (Domin.) N.Burb. IDC 767
Annual grass to 0.4 m, leaves covered with soft hairs. On levee beside Red Rock Creek.

Enneapogon purpurascens (R.Br.) Beauv. KM 587; IDC 768, 841, 935
Annual grass to 0.3 m, inflorescence compact, purplish. Widespread on alluvial flats and river levees.

Enteropogon ramosus B.Simon KM 878
In heavy soils with *Eucalyptus pruinosa* low woodland, Kitty's Knob.

* *Eragrostis cumingii* Steudel KM 573, 581, 584, 585; IDC 851, 927
Slender annual grass to 0.3 m. On sandy banks of ephemeral watercourses.

Eragrostis desertorum Domin KM 569
Tufted perennial grass to 0.3 m. On sandy soils near breakaways fringing the Ord Valley.

Eragrostis eriopoda Benth. IDC 809
Perennial grass to 0.6 m, pubescent at base. On sandplains surrounding Bungle Bungle massif.

* *Eragrostis japonica* (Thunb.) Trin.
Tufted purplish annual to 0.2 m. (F&K ephemeral creeks.)

* *Eragrostis speciosa* (Roemer & Schultes) Steudel KM 583; IDC 824, 854
Slender perennial grass to 0.5 m. On sandy banks of ephemeral watercourses.

* *Eragrostis tenellula* (Kunth) Steudel KM 567, 577, 582, 588; IDC 853
Perennial grass to 0.6 m. In sandy ephemeral watercourses.

* *Eragrostis* sp. nov.
(F&K Bungle Bungle gorge.)

* *Eriachne ciliata* R.Br. KM 558
Delicate annual grass to 0.3 m. Widespread, typically on rocky or skeletal soils.

Eriachne festucacea F.Muell. KM 502
Robust tufted perennial grass to 1 m. On sandy banks of watercourses.

Eriachne mucronata R.Br. KM 822; IDC 850
Dense compact perennial grass forming pendulous clumps in crevices of Bungle Bungle massif.

* *Eriachne obtusa* R.Br. IDC 770, 812
Perennial grass to 0.4 m. Widespread.

* *Eriachne* sp. nov. aff. *tenuiculmis* W.Hartley
(F&K Bungle Bungle gorge.)

* *Eulalia aurea* (Bory) Kunth IDC 942, 943
Dense perennial grass to 1.5 m. Occasional dominant on creek banks and levees. Previously named *E.fulva.*

Germania truncatiglumis (F.Muell. ex Benth.) Chaianan KM 566, 873
In moist soils beside permanent watercourses in the Osmand Valley.

* *Heteropogon contortus* (L.) P.Beauv. ex Roemer & Schultes SR
Tufted perennial with reddish leaves and tangled seeds. Widespread in river valleys and on plains.

\+ *Iseilema macratherum* Domin A0010763
Ord River Station. Probably occurs in Park on plains of Ord River valley.

* *Iseilema* sp. affin. *macratherum* Domin
Tufted reddish annual. (F&K Winnama Gorge.)

Iseilema vaginiflorum Domin IDC 760
Tufted annual grass to 0.3 m. On sandy bank of Bull Creek.

Micraira sp. KM 932
'Resurrection' grass to 4 cm., leaves in whorls. On Bungle Bungle Plateau.

* *Mnesithea rottboellioides* (R.Br.) Koning & Sosef SR
Erect glabrous grass to 1.5 m. On banks of watercourses, Osmand Valley. Previously named *Coelorhachis rottboellioides.*

* *Ophiuros exaltatus* (L.) Kuntze
Cane-like perennial to 2 m. (F&K sheltered creek banks and low-lying plains.)

* *Panicum decompositum* R.Br.
Tufted annual to 0.3 m. (F&K Winnama Gorge.)

* *Panicum mindanaense* Merr.
(F&K Piccaninny gorge.)

Panicum trachyrhachis Benth. KM 576
In moist sand beside stagnant pools, Blue Holes.

Paraneurachne muelleri (Hack.) S.T.Blake KM 589
On rocky breakaway north of Goosehole Yard, *Eucalyptus brevifolia* low open woodland.

* *Paspalidium clementii* (Domin) C.E.Hubb.
Low, almost cushion-forming annual. (F&K Winnama Gorge.)

* *Paspalidium rarum* (R.Br.) Hughes
(F&K Piccaninny Gorge.)

* *Perotis rara* R.Br. IDC 822
Slender annual grass to 0.3 m. Widespread on sandy soils.

* *Phragmites karka* (Retz.) Trin. ex Steudel SR
Robust perennial grass to 2 m, leaves broad, inflorescence plume-like. On sandy bank of permanent pool, Blue Holes; and in *Colocasia esculenta* swamp at Wulwuldji Spring. Stems used to make 'bamboo' spears (Scarlett 1985).

* *Plectrachne bynoei* C.E.Hubb.
Hummock grass. (F&K scree and boulder slopes of Bungle Bungle massif.)

* *Plectrachne pungens* (R.Br.) C.E.Hubb. KM 637, 773; IDC 779
Hummock grass to 1 m, with feathery inflorescence. Widespread.

* *Plectrachne* sp.
(F&K Picaninny Gorge.)

Plectrachne sp. nov. KM 479, 644, 758, 821; IDC 934, 833
Hummock grass to 0.3 m, in crevices of sandstone cliffs on Bungle Bungle massif and Osmand Plateau.

* *Schizachyrium fragile* (R.Br.) A.Camus IDC 800
Slender reddish annual grass to 0.4 m. In sandy soils of drainage lines and ephemeral watercourses.

* *Schizachyrium pseudeulalia* (Hosowaka) S.T.Blake
(F&K Piccaninny Gorge.)

* *Sehima nervosum* (Rottler.) Stapf. IDC 771
Tufted perennial grass to 1 m. On rocky breakaway beside Red Rock Creek. (F&K Winnama Gorge.)

Setaria apiculata (Scribner & Merrill) Schumann IDC 828
Tufted annual grass to 0.3 m, inflorescence with stiff bristles. Occasional in sandy soils.

Setaria dielsii R.Herm. KM 875
Slender weak-stemmed decumbent annual grass. On levee of Ord River beneath *Eucalyptus microtheca* forest.

Sorghum laxiflorum Bailey KM 578
In sandy soil beside stagnant pool, Blue Holes.

Sorghum stipoideum (Ewart & J.W. White) C. Gardner & C Hubb. IDC 762
Annual grass to 1.5 m. Osmand Valley.

Sporobolus australasicus Domin KM 414
Small annual grass to 0.2 m, leaves broad, spikelets minute. Widespread, common on degraded plains of Ord River valley, and occasional in bare ground between hummock grasses.

* *Themeda triandra* Forsskal SR
Tufted, leafy perennial grass to 0.6 m. Rare on river levees. Previously named *T. australis.*

Triodia intermedia Cheel KM 642
Hummock grass forming small clumps, spikelets winged. Dominant on rocky hillsides with *Eucalyptus brevifolia.*

Triodia inutilis N.Burb. KM 442, 640; IDC 830, 836, 837
Hummock grass. Occasional on sandstone breakaways and Bungle Bungle Plateau.

* *Triodia microstachya* R.Br. KM 457, 641, 874
Viscid hummock grass, spikelets maroon. Abundant in sandstone gorges of Bungle Bungle massif and Osmand Plateau; occasional in drainage lines throughout Park.

* *Triodia procera* R.Br. IDC 778
Resinous hummock grass. Occasional in *Plectrachne pungens* hummock grasslands on sandplains and sandstone slopes. Leaves used for steaming treatment of colds and as fish poison. Resin used as adhesive (Scarlett 1985).

Triodia pungens R.Br. KM 915
Hummock grass forming loose clumps, resinous. Dominant on rocky hills with low open woodlands of *Eucalyptus brevifolia* and *E. opaca.*

Triodia spicata N.Burb. IDC 786
Non-resinous hummock grass with sessile spikelets. Dominant on Bungle Bungle Plateau and surrounding sandplains.

Triodia stenostachya Domin KM 909
Hummock grass. On sandstone platform beside permanent watercourse, near Mt. John.

Triodia wiseana C. Gardner KM 643
Glaucous hummock grass. Dominant on limestone ridge in south of Conservation Reserve (Site 6).

* *Tripogon loliiformis* (F.Muell.) C.E.Hubb.
Annual grass to 0.2 m. Common on sandy soils between hummock grass clumps on Bungle Bungle Plateau and surrounding sandplains.

* *Whiteochloa capillipes* (Benth.) Lazarides
(F&K Piccaninny Gorge.)

* *Whiteochloa cymbiformis* (Hughes) B.K.Simon IDC 813
Tall annual grass to 1.5 m. Occasional on sandplains surrounding Bungle Bungle massif.

Xerochloa laniflora Benth. KM 916
Annual grass to 0.3 m, large spikelets. In moist sand beside stagnant pools, Blue Holes.

* *Yakirra australiensis* (Domin) Lazarides & R.Webster IDC 797
Annual grass to 0.2 m. On sandplains surrounding Bungle Bungle massif.

Yakirra majuscula (F.Muell. ex Benth.) Lazarides & R. Webster IDC 799
Annual grass. On sandplain at Bull Creek.

* *Yakirra muelleri* (Hughes) Lazarides & R.Webster
(F&K Piccaninny Gorge.)

PONTEDERIACEAE

* *Monochoria cyanea* (F.Muell.) F.Muell. KM 870
Annual aquatic herb, long-petioled leaves, flowers blue. On edge of drying pool, Cathedral Gorge.

TACCACEAE

* *Tacca leontopetaloides* (L.) Kuntze SR
Stemless herb to 1 m, annual growth from perennial underground tuber. Rare in sandstone gorges of Bungle Bungle massif.

DICOTYLEDONAE

ACANTHACEAE

* *Dicliptera armata* F.Muell. KM 444, 880
Herb to 0.4 m, stems with prominent spiny involucral bracts. Occasional in sheltered gorges of Bungle Bungle massif and sandstone breakaways. Previously named *D. glabra.* (F&K Winnama Gorge.)

* *Hypoestes floribunda* R.Br. SR
Erect herb to 0.5 m, flowers pink, fruits papery. On sand bank in Bream Gorge; on rocky hillside at Winnama Gorge.

* *Nelsonia campestris* R.Br. KM 430; IDC 843
Trailing woolly herb, flowers white. In sandy soils beside epemeral and permanent watercourses.

Rostellularia adscendens (R.Br.) R.M.Barker KM 919
Erect pubescent herb to 0.2 m. On limestone outcrop at Site 6.

AIZOACEAE

* *Trianthema pilosa* F.Muell. IDC 807
Prostrate herb, dense woolly inflorescences, flowers white. Common in drainage lines on sandplains and in seasonally wet areas.

Trianthema triquetra Willd. KM 889
Prostrate herb. On light clay soil in *Eucalyptus pruinosa* low open woodland, Blue Holes.

AMARANTHACEAE

Achyranthes aspera L. IDC 773
Annual herb to 0.6 m, flowers green, fruit pungent. Occasional on degraded river levees and flats.

*#*Aerva javanica* (Burm.f.) Juss. ex Schultes KM 418
Shrub to 1 m, leaves glaucous, flowers cream, woolly. Common on degraded plains along Ord River. Deliberately introduced for Ord River Regeneration program.

Alternanthera angustifolia R.Br. KM 402, 887
Prostrate annual herb. In sandy soils of river levees and major watercourses.

* *Alternanthera denticulata* R.Br.
Shrub to 0.3 m. (F&K rocky outcrops.)

Alternanthera nodiflora R Br. KM 886
Prostrate annual herb, flowers in dense clusters encircling stem. Occasional in heavier soils on Ord River plains.

* *Amaranthus* ? *cuspidifolia* Domin
(F&K Piccaninny Gorge.)

Amaranthus interruptus R.Br. IDC 933
Prostrate annual herb. On river levee with *Lysiphyllum* woodland, Osmand Creek.

Amaranthus pallidiflorus F.Muell. KM 397, 888; IDC 875, 922
Erect or decumbent annual herb, bracts membranous. On river levees and in sandy soils on rocky hillsides.

Gomphrena brachystylis F.Muell. KM 885
Open annual herb to 0.3 m, woolly. In sandy soils on sandstone hillsides.

* *Gomphrena canescens* R.Br. KM 446
Open annual herb to 0.3 m, flowers pink. In sandy soils on sandstone hillsides.

Gomphrena cunninghamii (Moq.) Druce KM 404
Erect annual herb, stems reddish, flowers fading to white. On stream levee with *Lysiphyllum* woodland.

* *Ptilotus capitatus* (F.Muell.) C.Gardner KM 890
Erect perennial herb to 0.6 m, stems reddish, tepals straw-coloured. Occasional on rocky hillsides.

* *Ptilotus corymbosus* R.Br.
Erect herb, flowers white and purple. (F&K stream levee.)

Ptilotus exaltatus Nees KM 434; IDC 915
Erect subshrub to 0.8 m, flowers purple. Occasional on plains.

Ptilotus fusiformis (R.Br.) Poiret KM 778; IDC 819
Open erect herb to 0.5 m, flowers green. In drainage lines on sandplains and rocky slopes.

Ptilotus polystachyus (Gaudich.) F.Muell. KM 429
Erect herb to 0.6 m, flowers cream. In sandy soil at base of Goosehole breakaway.

Ptilotus schwartzii F.Muell. ex Tate KM 441
Open erect herb, flowers white and pink. In sandy loam with *Eucalyptus brevifolia* low open woodland, Goosehole breakaway.

Ptilotus spicatus F.Muell. ex Benth. KM 410, 496
Annual herb to 0.3 m, stems reddish, flowers white and purple. In sandy loams on flats and lower slopes.

ANACARDIACEAE

* *Buchanania obovata* Engl. KM 764
Small tree to 6 m; rough, grey bark; edible green plum-like fruits. On river levees and flats.

APIACEAE

Platysace sp. KM 860
Slender tree 3 m tall with broadly dividing branches. On sandy bank beside permanent watercourse in Bream Gorge.

APOCYNACEAE

* *Alstonia actinophylla* (Cunn.) K.Schumann KM 670
Tree to 8 m; bark grey, deeply fissured; leaves in whorls; copious white sap. On scree and boulder slopes of Bungle Bungle massif.

Alstonia spectabilis R.Br. KM 913
Scrambling shrub 2 m tall. In loamy sand beside permanent watercourse, Osmand Creek.

* *Carissa lanceolata* R.Br. SR
Dense rounded shrub to 2 m, spinose, milky latex in stems. On levees and plains. Fruit eaten raw (Scarlett 1985).

ASCLEPIADACEAE

*#*Calotropis procera* (Aiton) W.T.Aiton KM 854
Shrub or small tree to 4 m; bark pale; large, rounded leaves; flowers white and purple; copious white sap. On degraded plains and levees of major river systems, forming dense thickets at Kitty's Knob.

* *Cynanchum pedunculatum* R.Br. KM 784
Climber with copious white sap and cream flowers. In sandstone gorges of Osmand Valley.

\+ *Cynanchum puberulum* F.Muell. ex Benth. A0060867
Ord River Station. Probably occurs in Park on plains of Ord River valley.

Gymnema geminatum R.Br. KM 824
Shrub with arching branches, flower yellow. On sand bank in sheltered gorges of Bungle Bungle massif and Osmand Plateau.

Gymnema stenophyllum A. Gray SR
In sandy soil below sandstone ridge, Goosehole breakaway.

* *Marsdenia cinerascens* R.Br. SR
Twiner, flowers pink. On sand bank beside permanent watercourse, Bream Gorge. (F&K Piccaninny Gorge.)

* *Marsdenia velutina* R.Br. KM 730
Climber with velutinous leaves. On rocky hillside of Winnama Gorge. (F&K gorge of Bungle Bungle massif.)

* *Sarcostemma australe* R.Br. SR
Leafless succulent climber forming clumps; stems contain copious milky sap; flowers cream. Rare on rocky slopes of Bungle Bungle massif and limestone outcrops.

* *Tylophora flexuosa* R.Br. KM 761, 845
Climber. On sand banks of gorges in Bungle Bungle massif and Osmand Plateau. Recorded by Forbes and Kenneally as *Tylophora* sp.

ASTERACEAE

\# *Acanthospermum hispidum* DC. KM 629
In loamy sand of ephemeral watercourse, Osmand Creek.

Bidens ? *bipinnata* L. IDC 936
Annual herb, fruits with two rigid barbed awns. In loamy sand of ephemeral watercourse, Osmand Creek.

Blumea diffusa R.Br. ex Benth.
Identified after publication of Forbes and Kenneally (1986).

* *Blumea pungens* W.Fitzg. KM 696
Viscid shrub to 1.5 m, inflorescence yellow. On sandstone wall beside spring, Osmand Plateau. (F&K gorge of Bungle Bungle massif.)

\+ *Blumea saxatilis* Zoll. & Moritzi D0032199
Piccaninny Gorge.

* *Blumea* sp. nov.
Sticky, aromatic herb. (F&K Winnama Gorge.)

* *Chrysogonum trichodesmoides* (F.Muell.) F.Muell.
Erect herb. (F&K limestone ridge.)

* *Epaltes australis* Less. KM 912
Erect herb. Submerged in permanent waterhole on Bungle Bungle massif. Recorded by Forbes and Kenneally as *Centipeda* sp. (F&K Piccaninny Gorge.)

Erigeron ambiguus F.Muell. KM 463
Erect herb to 0.2 m, inflorescence mauve. On sand bank of ephemeral watercourse on Bungle Bungle Plateau. Forbes and Kenneally collection *Asteraceae* sp. SJF 2634 refers to this species.

Pterocaulon globuliflorus W.Fitzg. KM 484; IDC 874
Erect, pubescent herb, aromatic, flowerheads white and mauve. In sand at base of sandstone cliff on Bungle Bungle Plateau and surrounding sandplains.

* *Pterocaulon niveum* Cabrera KM 600
Erect herb, dense white tomentome, flowerheads purple. On top of Mt. John. (F&K Bungle Bungle massif.)

* *Pterocaulon serrulatum* (Montr.) Guill. KM 844; IDC 840
Erect herb, flowerheads white. On rocky slopes.

* *Pterocaulon sphacelatum* (Labill.) F.Muell. KM 405, 413, 422, 795
Aromatic, erect, bushy herb to 0.7 m; flowerheads purple fading to white. On river levees and broad plains.

* *Pterocaulon verbascifolium* F.Muell.
Shrub to 1 m. (F&K on levees and terraces.)

\+ *Streptoglossa bubakii* (Domin) Dunlop D0001007
Ord River Station. Possibly occurs in Park on plains of Ord River valley.

Streptoglossa decurrens (DC.) Dunlop KM 596
Strongly aromatic herb; leaves cauline. On sandstone slope, Goosehole breakaway.

Streptoglossa odora (F.Muell.) Dunlop KM 606
Strongly aromatic herb, inflorescence mauve. On clay soils with *Eucalyptus pruinosa* low open woodland, Ord River plains.

* *Vernonia cinerea* Less. KM 716
Erect herb, leaves pale green, inflorescence white. In boulders beside permanent watercourse, Winnama Gorge. (F&K Wulwuldji.)

* *Wedelia verbesinoides* F.Muell. ex Benth.
Aromatic semi-shrub. (F&K limestone outcrop.) Tea made from leaves used medicinally (Scarlett 1985).

BIGNONIACEAE

* *Dolichandrone heterophylla* (R.Br.) F.Muell. IDC 902
Shrub or tree to 4 m, leaves crowded on branchlets. Occasional on plains and breakaways in Ord River valley. (F&K sandplains surrounding Bungle Bungle massif.) Infusion of bark and leaves used for washing sores (Scarlett 1985).

* *Pandorea* aff. *doratoxylon* (J.Black) J.Black KM 461
Pendulous shrub with long flexible branches; flowers cream with purple markings in throat. On precipitous walls and chasm floors of Bungle Bungle massif.

BIXACEAE

* *Cochlospermum fraseri* Planchon KM 674
Small tree to 3 m, deciduous, flowers yellow, oblong fruit splitting to reveal seeds embedded in white fibres. Common on rocky hillsides. Roots eaten after cooking in ashes. Frayed sticks used to extract bush honey (Scarlett 1985).

BOMBACACEAE

Adansonia gregorii F.Muell. SR
Bottle-shaped tree to 15m; smooth, grey bark; furry gourd-like fruit. Occurs uncommonly on river levees and lower slopes of major river systems. Fruits eaten (Scarlett 1985).

BORAGINACEAE

Ehretia saligna R.Br. KM 867
Small tree to 4 m, leaves pendulous. Occasional on river levees and limestone outcrops.

* *Heliotropium diversifolium* F.Muell. ex Benth.
Rigid shrub to 0.3 m. (F&K Winnama Gorge.)

Heliotropium epacrideum F.Muell. ex Benth. KM 594
Open shrub to 1 m, leaves at ends of branchlets, flowers white. Only recorded from *Eucalyptus cliftoniana* open woodland on dissected sandstone slope, near Mt. John.

* *Heliotropium* sp.
Subshrub, flowers cream. (F&K Piccaninny Gorge.)

* *Heliotropium* sp.
Subshrub, flowers white. (F&K Piccaninny Gorge.)

Heliotropium sp. KM 417, 627
Dense low shrub to 0.3 m, flowers white. On degraded plains at Goosehole Yard and Blue Holes.

Heliotropium sp. KM 595, 780, 828, 831
Open shrub to 1 m, bark pale brown, flowers white. In gorges of Bungle Bungle massif and on surrounding sandplains.

* *Trichodesma zeylanicum* (Burm.f.) R.Br. KM 408, 423
Perennial herb to 2 m; stems and leaves grey, with bristly hairs; flowers blue. On river levees, plains and lower slopes.

Trichodesma sp. A (FoCA) KM 805
Perennial herb to 0.8 m, flowers white. In hummock grassland at Kitty's Knob.

BYBLIDACEAE

* *Byblis liniflora* Salisb. KM 462
Insectivorous annual herb, leaves glandular, flowers mauve. On sandy banks of ephemeral watercourses associated with Bungle Bungle massif.

CAESALPINIACEAE

Cassia notabilis F.Muell. KM 868
Spreading, flat-topped shrub to 2 m; fruit shiny brown with raised darker ridges. On river levees and plains.

* *Cassia venusta* F.Muell. KM 684
Softly hairy shrub to 1.5 m, flowers yellow. Widespread, on sand plains, river levees and rocky slopes.

* *Lysiphyllum cunninghamii* (Benth.) de Wit KM 797
Tree to 6 m; dark grey, fissured bark; greyish, butterfly-like leaves; flowers red. Dominant on river levees and lowland plains. Ashes used in preparation of yams (Scarlett 1985).

*#*Parkinsonia aculeata* L. KM 801
Spreading tree to 6 m; bark green; leaves long, narrow with minute leaflets on both edges; flowers yellow. Occasional on river levee of Osmand Creek, dominant on banks of Ord River at Kitty's Knob.

* *Petalostylis cassioides* (F.Muell.) D.E.Symon KM 477, 755
Open shrub to 3 m; bark smooth, orange; flowers yellow. In drainage lines on Bungle Bungle Plateau, and gorges of Osmand Plateau.

Senna artemisiodes (F.Muell.) Randell SR
Shrub to 1.5 m, leaves blue-green, flowers yellow. On limestone ridges and sandstone breakaways. Previously named *Cassia oligophylla.*

Senna cladophylla (W.Fitzg). Randell KM 632, 750
Shrub to 0.8 m, flowers yellow. In sandy soils of gorges and lower slopes, Osmand Plateau and Osmand Range. Previously named *Cassia cladophylla.*

Senna costata (Bailey & C.White) Randell KM 432
Shrub to 2 m; fruit curved, yellow when mature; seeds glossy black. In sandy soil below Goosehole breakaway. Previously named *Cassia costata.*

+ *Senna occidentalis* (L.) Link D0013207
Ord River Station. Possibly occurs in Park on black soil plains of Ord River valley.

Senna oligoclada (F. Muell.) Randell KM 918; IDC 802
Open shrub to 2 m, flowers yellow. On sand plains surrounding massif and river levees of major watercourses. Previously named *Cassia oligoclada.*

Senna planitiicola (Domin) Randell KM 619, 630
Shrub to 1 m, fruit cylindrical when mature. On river levees of major watercourses.

CAMPANULACEAE

* *Lobelia quadrangularis* R.Br. KM 412
Prostrate herb with blue flowers on erect stems. In damp sandy loam beneath riparian forest, Osmand Creek. Leaves dried and chewed with ashes (Scarlett 1985).

CAPPARACEAE

* *Capparis lasiantha* R.Br. ex DC. KM 603, 610
Robust climber or shrub with recurved spines. On river levees and lowland plains of major watercourses.

* *Capparis sepiaria* L.
Climber. (F&K Red Rock Creek.) Fruits eaten raw (Scarlett 1985).

* *Capparis umbonata* Lindley KM 863
Small tree with drooping narrow leaves. Rare, on rocky outcrops and clay flats. Fruits eaten raw (Scarlett 1985).

* *Cleome cleomoides* (F.Muell.) Iltis
Shrub to 0.4 m, flowers yellow. (F&K Piccaninny Gorge.)

* *Cleome viscosa* L. KM 608
Sticky, aromatic, annual herb to 0.5 m; flowers yellow; fruits narrow, cylindrical. Widespread.

CARYOPHYLLACEAE

Polycarpaea corymbosa (L.) Lam.
Identified after publication of Forbes and Kenneally (1986).

Polycarpaea diversifolia Domin IDC 769
Annual herb with reddish stems and white flowers. Occasional on river levees and flats.

* *Polycarpaea involucrata* F.Muell. KM 453; IDC 836\2
Low herb with reddish stems. On sandstone platforms associated with Bungle Bungle massif.

* *Polycarpaea longiflora* F.Muell. IDC 866
Annual herb, flowers pink. On sandplain surrounding Bungle Bungle massif.

* *Polycarpaea* sp.
Herb to 0.1 m with reddish stems. (F&K Winnama Gorge.)

CHENOPODIACEAE

Dysphania plantaginella F.Muell. KM 810
Erect herb to 0.2 m with greenish inflorescence. In alluvial sand of Ord River at Kitty's Knob.

Salsola kali L. KM 416; IDC 923
Dense rounded shrub to 1 m; stems and leaves succulent, becoming brittle and spiny with age; fruits thin and membranous. On river levees and lowland plains, common on degraded flats in Ord River valley.

CHRYSOBALANACEAE

Parinari nonda F.Muell. ex Benth. KM 861
Tree to 6 m; bark grey, deeply fissured; branchlets pendulous; leaves much paler beneath. One tree recorded on sandplain surrounding Bungle Bungle massif.

COMBRETACEAE

* *Terminalia arostata* Ewart & O.B.Davies SR
Tree to 10 m; bark grey, deeply fissured; branches long and weeping. On lowland plains and lower slopes of Ord River valley. Kernels of fruit eaten raw and leaves used for steaming treatment of colds (Scarlett 1985).

* *Terminalia bursarina* F.Muell. KM 428, 497
Tree to 10 m; typically bent by floodwaters; bark brown, hard, deeply fissured; flowers cream. In rocky beds of major watercourses. Edible gum (Scarlett 1985).

* *Terminalia canescens* (DC.) Radkl. KM 665, 683
Small tree to 4 m; leaves silvery with silky hairs; fruit dry, pale brown. Common on rocky slopes, occasional on river levees. Edible gum (Scarlett 1985).

* *Terminalia carpentariae* C.White KM 743
Tree to 6 m; bark grey, flaky; flowers cream; fruit fleshy, green. On rocky hillside, Winnama Gorge.

* *Terminalia platyphylla* F.Muell. SR
Tree to 20 m with dark, fissured bark. Codominant in riparian forest along larger watercourses. Edible gum (Scarlett 1985).

* *Terminalia volucris* R.Br. ex Benth. KM 719
Tree to 6 m; deciduous; flowers cream with strong sweet smell; fruits two-winged. In coarse sand at base of rocky slope, Winnama Gorge. (F&K Osmand Valley.) Edible gum and fine wood shavings used for body decoration (Scarlett 1985).

CONVOLVULACEAE

* *Bonamia linearis* (R.Br.) H.Hallier KM 634, 926; IDC 789
Scandent perennial herb, flowers white. In *Eucalyptus collina* woodland on sandplain surrounding Bungle Bungle massif.

Bonamia media (R.Br.) Hallier f. KM 633
Prostrate hairy herb. On rocky hillside at Blue Holes.

Bonamia pannosa (R.Br.) Hallier f. KM 620; IDC 867, 910
Trailing, densely hairy herb; flowers blue. In sandy soils on sand plains surrounding Bungle Bungle massif and on sandstone hillsides.

Evolvulus alsinoides L. KM 920, 921
Small hairy perennial herb, flowers blue. Common on rocky slopes.

Ipomoea eriocarpa R.Br. KM 631
Climber. In loamy sand beside permanent watercourse, Osmand Creek.

Ipomoea muelleri Benth. KM 439
Pubescent trailer with deltoid leaves. In sandy drainage line at Goosehole breakaway.

* *Ipomoea polymorpha* Roemer & Schultes KM 927
Decumbent herb, flowers purple. In alluvial sand, Blue Holes. (F&K Piccaninny Gorge.)

* *Jacquemontia browniana* Ooststr. KM 647
Erect shrub to 0.5 m. In loamy sand beside ephemeral watercourse at Site 6. (F&K Giliwal.)

Merremia sp. KM 922
Robust climber in *Eucalyptus pruinosa* low woodland at Kitty's Knob.

Merremia sp. IDC 823
Trailing vine, leaves green and maroon, flowers mauve. In ephemeral watercourse on *Eucalyptus collina* sandplain surrounding Bungle Bungle massif.

Operculina aequisepala (Domin) R.W.Johnson KM 409
Robust annual twiner, seeds enclosed in translucent papery bladder. In loamy sand beside permanent watercourse, Osmand Creek.

* *Operculina brownii* Ooststr.
Trailing perennial to 2 m. (F&K basalt outcrop.)

Polymeria ambigua R.Br. KM 447
Herb with trailing stems. On sandplain above Goosehole breakaway.

Polymeria angusta F.Muell. KM 646, 648
Trailing pubescent herb. In loamy sand of ephemeral watercourses and lower slopes.

* *Polymeria* sp.
Tangled herb trailing to 0.5 m. (F&K Piccaninny Gorge.)

Xenostegia tridentata (L.) Austin & Staples KM 438
Dense creeper, flowers pale yellow. In drainage line of Goosehole breakaway.

CUCURBITACEAE

Citrullus colocynthis (L.) Schrader KM 808
Decumbent trailing herb, flowers pale yellow, melon-like fruit green and white. In alluvial sand of Ord River at Kitty's Knob.

*# *Citrullus lanatus* (Thunb.) Matsumura & Nakai KM 628
Decumbent annual herb, melon-like fruit green mottled white. On sand plain beside ephemeral creek, Osmand Creek. (F&K Red Rock Creek.)

Luffa graveolens Roxb. KM 908
Climber with fibrous fruit. In riparian forest beside permanent watercourse, near Mt. John.

Mukia maderaspatana (L.) M.Roemer KM 437
Climber; leaves triangular; fruit globular, green. In sandy soil among dissected sandstone, Goosehole breakaway.

* *Trichosanthes cucumerina* L.
Climber, flowers white, fruit orange. (F&K Piccaninny Gorge.)

ELATINACEAE

* *Bergia pedicellaris* (F.Muell.) Benth.
Annual herb, flowers pink. (F&K in sands along ephemeral watercourse.)

Bergia trimera Fischer & C.Meyer KM 609
Prostrate annual herb. In loamy sand beside permanent watercourse, Blue Holes.

ERYTHROXYLACEAE

Erythroxylum ellipticum R.Br.
Fruits eaten raw (Scarlett 1985).

EUPHORBIACEAE

Antidesma ghaesembilla Gaertner
Fruits eaten raw (Scarlett 1985).

Breynia cernua (Poiret) Muell. Arg. KM 671
Small tree to 3 m; bark grey, fissured; small black fruit. On sand bank in Cathedral Gorge.

Breynia rhynchocarpa Benth. KM 712, 859
Multi-stemmed shrub to 3 m with arching branches; bark grey, flaky; fruit ripening dark purple. On exposed sandstone cliff at Winnama Gorge, and on sand bank beneath closed forest in Bream Gorge.

* *Bridelia tomentosa* Blume IDC 939
Spreading shrub to 3 m. On rocky outcrop beside Osmand Creek. (F&K gorge in Bungle Bungle massif, Winnama Gorge.)

* *Euphorbia coghlanii* Bailey KM 1008
Sprawling subshrub with copious milky latex, flowers white. On sandplain surrounding Bungle Bungle massif and sandstone breakaways.

Euphorbia drummondii Bolss KM 933
Prostrate herb with reddish stems. On disturbed eroded plan of Ord River valley.

*#*Euphorbia hirta* L. KM 599
Prostrate herb with reddish leaves. Common on stream levees.

* *Euphorbia* aff. *micradenia* (Boiss.) Hassall
Semi-shrub to 0.6 m. Previously named *Chamaesyce* aff. *micradenia*. (F&K Winnama Gorge.)

Euphorbia schultzii Benth. KM 691, 1005; IDC 913
Low annual herb, leaves with reddish margin. In sandy soils of lowland plains and lower slopes.

* *Euphorbia tannensis* Sprengel KM 598
Shrub to 1 m, leaves narrow and inconspicuous, copious milky latex in stems. On sand bank in Piccaninny Gorge.

* *Euphorbia* aff. *tannensis* Sprengel
Shrub to 1.5 m. (F&K Winnama Gorge.)

* *Euphorbia wheeleri* Baillon
Semi-shrub to 0.4 m. (F&K black-soil stream levee.)

* *Euphorbia* sp.
Low herb, leaves purplish and green. Previously named *Chamaesyce* sp. (F&K Osmand Range.)

* *Flueggea virosa* (Roxb. ex Willd.) Voigt IDC 940
Spreading shrub to 3 m. Widespread on river levees and rocky slopes. Previously named *Securinega melanthesoides*. Fruits eaten raw (Scarlett 1985).

Leptopus decaisnei (Benth.) H.Pojark KM 612
Much branched shrub to 1 m. In alluvial sand of major watercourses.

* *Mallotus nesophilus* Muell.Arg. KM 740, 782
Small tree to 4 m; rounded hairy leaves much paler beneath; fruits round, yellow. In sandstone gorges and riparian forests of Osmand Valley and Winnama Gorge. (F&K gorges of Bungle Bungle massif.) Fruits eaten raw (Scarlett 1985).

Petalostigma quadriloculare F.Muell. KM 865
Low shrub to 1 m, leaves silvery hairy beneath, segmented fruits orange. In *Eucalyptus brevifolia* open woodland on rocky slope above Winnama Gorge. Recorded by Forbes and Kenneally as *P. nummularium.*

* *Phyllanthus ciccoides* Muell. Arg.
Small tree to 4 m. (F&K Osmand Range.)

Phyllanthus maderaspatensis L. KM 934, 1007
Erect herb to 0.3 m. In sandy soils along watercourses and on lower slopes.

Phyllanthus simplex Retz. KM 420, 1006
Erect herb to 0.2 m. On limestone outcrops and drainage lines through lower slopes. First record for Western Australia.

* *Phyllanthus virgatus* G.Forster
Sprawling subshrub. (F&K sandplain at base of Bungle Bungle massif and Piccaninny Gorge.)

Sebastiania chamaelea (L.) Muell.Arg. KM 934, 935
Spreading herb on low rocky slope at Bream Gorge.

FABACEAE

Abrus precatorius L. KM 790
Slender perennial vine; deciduous; fruit woody, enclosing bright red, black-spotted seeds. On river levee at Wulwuldji.

Aeschynomene indica L. IDC 944
Erect annual herb to 1 m, fruit breaking into squarish segments. In dry claypan, Osmand Creek.

Bossiaea bossiaeoides (Cunn. ex Benth.) Court KM 757
Leafless shrub with broadly winged blue-green branches, flowers yellow. In alluvial sand, Bream Gorge.

Cajanus crassicaulis Maesen KM 786
Open shrub to 2 m, dense white tomentum, flowers yellow. On limestone hillsides in the Osmand Valley.

* *Cajanus pubescens* (Ewart & Morrison) Maesen
Open shrub to 0.7 m, flowers yellow. Previously named *Atylosia pubescens.* (F&K Osmand Valley.)

* *Cajanus reticulata* (Dryander) F.Muell.
Open shrub to 2 m, flowers yellow. Previously named *Atylosia reticulata.* (F&K Bungle Bungle massif surrounds and rocky slopes.)

Cajanus sp. KM 645, 654, 745, 814; IDC 783
Sticky shrub to 3 m, leaves trifoliate, flowers yellow. On sandstone slopes and sandplains associated with Osmand Valley, and on sandplains surrounding Bungle Bungle massif. Dominant on sand sheet on eastern side of Bungle Bungle massif after hot burn in previous year.

* *Canavalia papuana* Merr. & Perry KM 732
Vigorous climber with woody twisted fruits. On sandbank at Winnama Gorge. (F&K riparian fringe of ephemeral streams.) Pods baked and eaten (Scarlett 1985).

Crotalaria crispata (F.Muell.) Benth. KM 435, 636; IDC 781
Annual or short-lived perennial herb, flowers yellow, fruits inflated. On sandplain surrounding Bungle Bungle massif and at Goosehole breakaway.

* *Crotalaria cunninghamii* R.Br. KM 816
Open shrub to 2 m; leaves grey, felty, trifoliate; flowers green. In sandy soils along Osmand Creek and tributaries; on sandplain surrounding Bungle Bungle massif.

Crotalaria medicaginea Lam. KM 607; IDC 906
Annual pubescent herb to 0.5 m; leaves trifoliate, small; flowers yellow; fruit swollen, squarish. In sandy soils beside watercourses and on rocky slopes.

* *Crotalaria montana* Roth
Semi-shrub to 0.5 m, flowers yellow. Previously named *Crotalaria linifolia.* (F&K Winnama Gorge.)

* *Crotalaria novae-hollandiae* DC. KM 399
Subshrub to 1 m, leaves unifoliate, flowers yellow. In sandy soils along Osmand Creek and tributaries.

Crotalaria retusa L. KM 614; IDC 930
Subshrub to 1 m, flowers yellow, fruit inflated. In sandy soils along watercourses and drainage lines.

* *Crotalaria verrucosa* L. KM 841
Erect herb to 0.3 m, flowers blue. In sandy loam beside Osmand Creek.

* *Desmodium filiforme* Zoll. & Moritzi IDC 908
Sprawling herb to 0.5 m with ariculated pods. In sandy soils beside Osmand Creek and in drainage lines on sandplain surrounding Bungle Bungle massif.

* *Erythrina vespertilio* Benth.
Rare tree to 6 m. (F&K Blackfellows Creek on Texas Downs Station.) Wood used to make woomeras (Scarlett 1985).

Glycine arenaria Tindale KM 635; IDC 798
Perennial twining herb, leaves grey, flowers cream to green, fruits borne underground as well as above. On sandplain surrounding Bungle Bungle massif.

Glycine tomentella sens. lat. Hayata KM 652, 825; IDC 842
Trailing herb with mauve flowers. On sandstone breakaways and gorges of Bungle Bungle massif.

* *Indigofera colutea* (Burm.f.) Merr. KM 400; IDC 792
Annual herb, flowers red, fruit viscid. In sandy soils on river levees and flats, on rocky lower slopes and on sandplain surrounding Bungle Bungle massif.

Indigofera hirsuta L. KM 440; IDC 780
Annual herb to 0.5 m, leaves hairy, flowers red. On sandy bank of ephemeral watercourse at Bull Creek, and in drainage line of Goosehole breakaway.

Indigofera linifolia (L.f.)Retz. KM 613; IDC 763
Annual herb with small red flowers and white globular fruit. Widespread on river levees and rocky lower slopes.

Indigofera linnaei Ali KM 911
Spreading subshrub, leaflets small, flowers pink. In *Lysiphyllum* woodland beside Osmand Creek.

* *Indigofera monophylla* DC.
Semi-shrub to 0.7 m. (F&K Piccaninny Gorge.)

* *Jacksonia odontoclada* F.Muell. ex Benth. KM 478, 826; IDC 803
Intricately branched shrub to 2 m, leaves reduced to scales, sepals red-brown, flowers orange. On Bungle Bungle Plateau and surrounding sandplain.

* *Jacksonia thesioides* (Cunn.) Benth. KM 467; IDC 876
Open shrub to 3 m, branchlets silvery pubescent, flowers yellow. In drainage lines and ephemeral watercourses on Bungle Bungle Plateau and surrounding sandplains.

Lotus australis Andrews KM 653
Spreading subshrub to 1 m, flowers mauve. In coarse gravelly sand of ephemeral watercourse at Site 6.

* *Mirbelia viminalis* (Cunn.) C.Gardner KM 492
Intricately branched shrub to 1.5 m, leaves spiny, flowers yellow. In *Eucalyptus cliftoniana* woodland on Bungle Bungle Plateau. (F&K Winnama Gorge.)

* *Nomismia rhomboidea* (F.Muell. ex Benth.) Pedley KM 738; IDC 798\2
Trailing, pubescent herb with broad trifoliate leaves and yellow flowers. On sandplains, river levees and lower slopes. Previously named *Rhynchosia rhomboidea*. Whole plant used as fish poison (Scarlett 1985).

Paratephrosia lanata (Benth.) Domin KM 616
Erect open shrub with few branches to 2 m, flowers orange. On dissected sandstone hillside near Mt. John.

* *Plagiocarpus axillaris* Benth. KM 694
Rounded shrub with erect branches to 1 m, stems orange with dense white hairs. On sandstone hillside at Bream Gorge. (F&K Winnama Gorge.)

* *Psoralea badocana* (Blanco) Blanco
Spreading shrub to 1 m, white-grey felty leaves, flowers pale magenta. (F&K riparian forest Red Rock Creek.)

* *Psoralea martinii* F.Muell.
Erect shrub to 1 m, flowers mauve. (F&K rocky scree under *Eucalyptus brevifolia*.)

Rhynchosia minima (L.) DC. KM 415
Trailing herb, leaves suborbicular. On river levees and plains.

* *Sesbania cannabina* (Retz.) Poiret KM 427, 456, 495
Shrub to 2 m, bark green, flowers yellow with red striations. In alluvial sand beside watercourses including on Bungle Bungle Plateau.

* *Sesbania formosa* (F.Muell.) N.Burb.
Tree to 10 m; bark pale, corky; flowers large, white. In riparian forest along Osmand Creek and tributaries, and Ord River. Wood used to make woomeras (Scarlett 1985).

+ *Sesbania simpliciuscula* F.Muell. ex Benth. A0010759
Ord River Station. Possibly occurs in Park on plains of Ord River valley.

* *Templetonia hookeri* (F.Muell.) Benth. KM 470, 615
Slender shrub to 2 m with smooth orange-brown bark; leaves terete, flowers pale yellow. In sandy drainage lines of Osmand Range and Bungle Bungle Plateau.

Tephrosia leptoclada Benth. IDC 907
Annual herb to 0.3 m, flowers blue. On sandplain surrounding Bungle Bungle massif and rocky hills.

Tephrosia phaeosperma F.Muell. ex Benth. IDC 785, 898
Erect open shrub to 2 m; leaves silvery grey; flowers mauve. On sandy soils of drainage lines, river levees and sandstone lower slopes.

Tephrosia purpurea (L.) Pers. KM 930, 931
Slender open subshrub to 0.5 m, flowers pink. On limestone outcrops and rocky lower slopes.

* *Tephrosia remotiflora* F.Muell. ex Benth.
Slender, spreading subshrub with magenta-pink flowers. (F&K Wulwuldji.)

* *Tephrosia rosea* F.Muell. ex Benth. KM 650, 775
Open shrub to 2 m, leaves silvery-green, flowers purple. On sandstone slopes and drainage lines.

Tephrosia simplicifolia F.Muell. ex Benth. IDC 805
Erect subshrub to 0.7 m, flowers orange. On sandplains surrounding Bungle Bungle massif.

Tephrosia supina Domin KM 929
Pubescent subshrub to 0.5 m. On degraded clay flat at Blue Holes and Goosehole Yard.

* *Tephrosia uniovulata* F.Muell.
Shrub to 1 m, leaves ovate, velutinous, flowers pink. (F&K Piccaninny Gorge.)

* *Tephrosia virens* Pedley KM 651; IDC 810
Open, slender shrub to 1.5 m; flowers orange. In sandy soils on river levees and sandstone lower slopes.

Tephrosia sp. KM 443
Erect subshrub to 1 m, leaves densely hairy, flowers orange. In dissected sandstone with *Eucalyptus brevifolia* low open woodland at Goosehole breakaway.

Tephrosia sp. IDC 839
Erect shrub to 1 m, bark white, furrowed. On steep rocky slope with *Triodia inutilis* at Bull Creek.

* *Vigna lanceolata* Benth.
Trailing herb with slender stems. (F&K Red Rock Creek.) Roots eaten after cooking in ashes (Scarlett 1985).

* *Zornia nervata* Mohl. IDC 811, 909
Spreading herb with paired leaflets, flowers orange. On sandy soils surrounding Bungle Bungle massif and on river levee of Osmand Creek.

GOODENIACEAE

* *Dampiera conospermoides* W.Fitzg. KM 474; IDC 847
Open shrub to 1 m, leaves much paler beneath, flowers small, purple. On Bungle Bungle plateau and asociated gorges and outliers.

* *Goodenia heterochila* F.Muell. KM 917; IDC 912
Trailing herb to 0.2 m. On rocky lower slopes.

* *Goodenia scaevolina* F.Muell. KM 472; IDC 920
Erect shrub to 1 m; viscid, smelly leaves and stems; flowers purple. On Bungle Bungle plateau and associated gorges and outliers.

Goodenia sp. KM 431; IDC 801
Erect pubescent herb to 0.1 m, flowers yellow. In loamy sand of ephemeral watercourses.

Goodenia sp. KM 459
Slender erect herb to 0.1 m, flowers yellow. On sandy bank of ephemeral watercourse on Bungle Bungle Plateau.

Scaevola browniana carolin R.Br. KM 827, 928; IDC 872
Erect shrub to 1 m, leaves pubescent, flowers blue. On sandplain surrounding Bungle Bungle massif and on sandstone slopes near Mt. John.

Scaevola macrostachya Benth.
Identified after publication of Forbes and Kenneally (1986).

HALORAGACEAE

* *Gonocarpus leptothecus* (F.Muell.) Orchard KM 848
Subshrub to 0.5 m with stiff hairs. In alluvial sand beside permanent watercourse at Bream Gorge. (F&K Winnama Gorge, Piccaninny Gorge.)

HERNANDIACEAE

* *Gyrocarpus americanus* Jacq. SR
Deciduous tree with stout golden-white trunk, broad heart-shaped leaves, fruits winged capsules. Occasional on breakaways in Ord River valley, common along Spring Creek Track. (F&K Turkey Creek, Bungle Bungle massif.) Wood used to make 'coolimans' (Scarlett 1985).

LAMIACEAE

* *Coleus scutellarioides* Benth.
Herb to 0.3 m with square stem and opposite leaves, flowers mauve. (F&K Osmand Valley.)

Epimeredi salviifolius (R.Br.) Rothm. KM 907
Spindly open shrub to 1.5 m, flowers mauve with white spots. On limestone hillside at Wulwuldji.

LAURACEAE

* *Cassytha capillaris* Meissner KM 910
Leafless parasitic climber, twining and attaching by small suckers to other plants, stems glabrous. On Bungle Bungle Plateau and surrounding sandplains, limestone outcrops and rocky hills.

* *Cassytha filiformis* L. KM 471
Leafless parasitic climber, twining and attaching by small suckers to other plants, stems hairy. On Bungle Bungle Plateau and associated gorges, in drainage line at base of Wickham outlier at Site 6.

LENTIBULARIACEAE

\+ *Utricularia aurea* Lour. D0019109
Ord River Station. Possibly occurs in Park.

Utricularia caerulea L. KM 747
Delicate erect herb to 0.1 m, flowers purple with yellow spot in throat. In moist loam beside permanent watercourse at Bream Gorge.

* *Utricularia chrysantha* R.Br.
Herb to 5 cm. (F&K Osmand Creek.)

LOGANIACEAE

* *Mitrasacme nudicaulis* Reinw. ex Blume
Herb to 0.2 m, flowers white. Recorded by Forbes and Kenneally as *M. elata*. (F&K Winnama Gorge.)

* *Mitrasacme* sp. A (FoK)
Herb to 0.1 m. Recorded by Forbes and Kenneally as *M. pygmaea* (F&K Bungle Bungle massif.)

LORANTHACEAE

* *Amyema benthamii* (Blakely) Danser
Hemi-parasite on *Lysiphyllum cunninghamii*. (F&K Turkey Creek above junction with Winnama Springs Creek.)

* *Amyema bifurcatum* (Benth.) Tieghem
Hemi-parasite on *Eucalyptus dichromophloia*. (F&K south of Bungle Bungle Outcamp.)

Amyema ? sanguineum (F.Muell.) Danser KM 817
Hemi-parasite on *Eucalyptus brachyandra*, flowers pink. Cathedral Gorge.

Amyema villiflorum (Domin) Barlow KM 891
Hemi-parasite on *Terminalia bursarina*. Blue Holes.

* *Deacaisnina petiolata* (Barlow) Barlow KM 723
Hemi-parasite on *Buchanania obovata*, leaves glaucous, flowers orange with green reflexed tips. Winnama Gorge. (F&K sandplain north of Bungle Bungle massif.)

* *Lysiana spathulata* (Blakely) Barlow
Hemi-parasite on *Acacia stipuligera*, flowers scarlet with yellow-green reflexed tips. (F&K sandplain north of Bungle Bungle massif, Winnama Gorge.)

* *Lysiana subfalcata* (Hook.) Barlow KM 655, 656, 657
Hemi-parasite on *Atalaya hemiglauca* and *Acacia* spp., flowers red with yellow-green tips. Common on river levees and flats.

LYTHRACEAE

Ammannia baccifera L. KM 902, 904
Erect reddish herb to 0.3 m. In moist sandy loam beside permanent watercourse at Blue Holes and near Mt. John.

* *Ammannia multiflora* Roxb. KM 903, IDC 864
Erect herb to 0.3 m, leaves dilated at base, capsule globular. On sand bank beside permanent watercourse near Mt. John. (F&K Winnama Gorge, Piccaninny Gorge.)

* *Rotala diandra* (F.Muell.) Koehne KM 483
Erect herb to 0.1 m in moist sand beside pool on Bungle Bungle Plateau. (F&K Piccaninny Gorge, Red Rock Creek.)

* *Rotala mexicana* Cham. & Schldl.
Semi-aquatic succulent herb. (F&K Winnama Spring, Piccaninny Gorge.)

MALVACEAE

Abutilon andrewsianum W.Fitzg. IDC 932
Erect open shrub, heart-shaped pubescent leaves, flowers yellow. On creek levees.

Abutilon leucopetalum (F.Muell.) F.Muell. ex Benth. IDC 938
Erect shrub to 1 m, heart-shaped pubescent leaves, flowers white. On creek levees.

Abutilon otocarpum F.Muell. KM 906
Low shrub to 0.4 m, orbicular velvety leaves. On creek levees and low rises.

* *Gossypium australe* F.Muell. KM 660; IDC 945
Shrub to 1.5 m, dull-green pubescent leaves, fruit with several hairy seeds. Widespread on sandplains, river levees and rocky hillsides.

Herissantia crispa (L.) Briz. IDC 931
Slender herb to 0.4 m, flowers yellow, fruit inflated. On creek levee with *Lysiphyllum* woodland, Osmand Valley.

Herissantia sp. KM 662, 421
Erect slender shrub to 0.6 m, flowers yellow. On rocky hills with *Eucalyptus brevifolia* low open woodland and on broad plains with *Calotropis procera* shrubland in Ord River valley.

* *Hibiscus leptocladus* Benth. KM 690; IDC 787, 871
Open spreading shrub to 1.5 m, flowers mauve with maroon blotch at base. Widespread on sandplains and rocky hillsides.

* *Hibiscus meraukensis* Hochr. IDC 914
Erect open shrub to 1 m, lower leaves palmately lobed, flower white with red basal spot. On river levees and in ephemeral watercourses through rocky hillsides and gorges.

Hibiscus panduriformis Burman f. KM 893
Shrub to 1.5 m, leaves discolorous, capsule with dense golden hairs. On *Terminalia platyphylla* woodland on river levee, Osmand Creek.

Hibiscus pentaphyllus F.Muell. KM 905
Subshrub to 0.5 m, leaves deeply divided. In loamy sand beside permanent watercourse, Osmand Creek.

* *Hibiscus setulosus* F.Muell. KM 894
Subshrub to 0.5 m densely covered with fine yellow bristles. On rocky hillside with *Eucalyptus brevifolia* low open woodland at Winnama Gorge, and in alluvial sand at Bream Gorge.

Hibiscus sp. KM 765
Open shrub to 3 m, sandpaper-like leaves, flowers pink with maroon blotch in base. In alluvial sand at Bream Gorge.

* *Hibiscus* sp. nov.
Shrub to 1 m. (F&K Osmand Valley.)

* *Hibiscus* sp. nov. 'Middle Springs'
Open shrub to 2 m, flowers pink with maroon blotch at base. (F&K Winnama Gorge.)

Malvastrum americanum (L.) Torrey KM 661
Erect herb to 0.5 m in loamy sand beside permanent watercourse, Osmand Creek.

Sida acuta Burman f. KM 663
Erect herb in loamy sand of watercourse at Blue Holes.

Sida fibulifera Lindley KM 411, 897, 898
Subshrub to 0.5 m, flowers yellow. On degraded plains and river levees.

* *Sida rohlenae* Domin KM 901; IDC 776
Erect subshrub to 1 m, leaves grey-green, seeds awned. On creek banks and levees. (F&K Piccaninny Gorge.)

* *Sida* ? *spinosa* L.
(F&K Piccaninny Gorge.)

Sida sp. *'virgata'* Hook. (FoCA) KM 445, 659, 895, 896, 899, 900; IDC 859
Spindly open shrub to 2 m with rusty stellate hairs, flowers yellow. In sandy soils beside ephemeral watercourses and on dissected sandstone hillsides.

Sida sp. nov KM 819; IDC 903
Open shrub to 1 m, leaves broad, flowers yellow. On sand bank at Cathedral Gorge, and in alluvial sand of ephemeral watercourse at Bull Creek.

MELASTOMATACEAE

Melastoma polyanthum Blume KM 705
Shrub to 2.5 m, leaves with 3-5 prominent veins, large showy mauve flowers. On banks of permanent watercourses beneath closed forest at Winnama Gorge, Bream Gorge and near Mt. John.

MELIACEAE

* *Melia azedarach* L. KM 673, 744
Tree to 4 m, leaves crowded at ends of branches, flowers white and mauve. In rocky gullies at Winnama Gorge and Site 6. (F&K Djimbitjba.)

* *Owenia vernicosa* F.Muell. KM 664
Tree to 6 m, pinnate leaves crowded at ends of branches, pendulous clusters of reddish fruits. On dissected sandstone hillside near Mt. John and on rocky hillside at Winnama Gorge.

MENISPERMACEAE

* *Stephania japonica* (Thunb.) Miers KM 672, 760
Climber with round leaves, flowers small and cream. In sandy gorges of Bungle Bungle massif.

* *Tinospora smilacina* Benth. KM 770; IDC 846
Vigorous climber, flowers green, fruit orange. Widespread.

MENYANTHACEAE

* *Nymphoides indica* (L.) Kuntze
Aquatic herb with floating leaves. (F&K Red Rock Creek.)

MIMOSACEAE

* *Acacia acradenia* F.Muell. KM 426, 763; IDC 806
Shrub to 3 m; bark smooth, grey; phyllodes thick; flowers in spike. Widespread. Edible gum (Scarlett 1985).

Acacia ampliceps Maslin KM 525
Small tree to 4 m, dense crown, flowers globular and pale yellow. On bank of rocky ephemeral creek at Site 6.

* *Acacia coriacea* DC.
Low tree with hard black bark. (F&K Red Rock Creek.) Wood used to make boomerangs, axe handles and fighting sticks (Scarlett 1985).

* *Acacia cowleana* Tate
Shrub to 1 m. (F&K stony slope.)

* *Acacia dunnii* (Maiden) Turrill
Glaucous shrub to 4 m. (F&K Winnama Gorge.)

* *Acacia eriopoda* Maiden & Blakely KM 699
Shrub or tree to 5 m; bark grey , stringy; phyllodes linear. Dominant in sandy drainage lines associated with Bungle Bungle massif and occasional on banks of major watercourses.

* *Acacia farnesiana* (L.) Willd. KM 425, 500
Spreading spiny shrub to 3 m, bark smooth with prominent lenticels, flowers globular and golden. Forming thickets on river levees and flats of major watercourses. Wood used to make boomerangs and fighting sticks (Scarlett 1985).

* *Acacia gonocarpa* F.Muell. KM 476, 527, 700, 774
Rounded shrub to 3 m; bark grey, smooth; flower spikes yellow; woody fruits prominently ridged. In sandy loams with *Eucalyptus collina* and *E. cliftoniana* woodlands on Bungle Bungle Plateau and surrounding sandplains; and on dissected sandstone hillside near Mt. John.

* *Acacia hemignosta* F.Muell. SR
Tree to 5 m with pendulous branchlets, bark rough and flaky, leaves bluish-green. On river levees and low rocky slopes.

Acacia hemsleyi Maiden IDC 949
Shrub to small tree to 4 m, bark rough and grey, cylindrical yellow flowers. On river levee of Osmand Creek.

Acacia aff. *hippuroides* Heward ex Benth. KM 475; IDC 924
Slender shrub to 1.5 m; smooth grey bark; flowers large, golden; young fruit viscid. Rare on Bungle Bungle massif and associated outliers.

* *Acacia holosericea* Cunn. ex Don KM 401, 524, 804
Small tree or shrub to 4 m, grey smooth bark, large silvery-grey phyllodes, fruit in ball-like clusters. Widespread on river levees, plains and drainage lines through low hills. Green fruits used as fish poison (Scarlett 1985).

* *Acacia laccata* Pedley
Shrub to 2 m. (F&K Bungle Bungle Plateau.)

* *Acacia* ? *leptophleba* F.Muell.
Shrub to 2 m. (F&K Winnama Gorge.)

* *Acacia lycopodifolia* Cunn. ex Hook. KM 452, 517, 520, 523, 526, 529, 793
Low spreading shrub to 1 m; narrow leaves arranged in whorls; flowers globular, yellow; fruit viscid. Common on rocky hillsides.

* *Acacia lysiphloia* F.Muell. KM 433
Rounded shrub to 3 m with 'Minnie-Ritchie' bark, flowers yellow, fruits viscid. On sandplains surrounding Bungle Bungle massif.

* *Acacia monticola* J.Black KM 762
Small tree to 4 m with reddish 'Minnie Ritchie' bark, flowers yellow, fruits brown and viscid. In drainage lines on Bungle Bungle massif and gorges of Osmand Plateau.

* *Acacia orthocarpa* F.Muell. KM 722
Open shrub to 1 m; phyllodes erect, slightly curved; flowers in yellow spikes. At Winnama Gorge.

* *Acacia pellita* O.Schwarz
Shrub to 7 m. (F&K Winnama Gorge, Wulwuldji.)

Acacia perryi Pedley KM 720, 835
Open shrub to 1.5 m; bark reddish-brown with prominent lenticels and leaf-scars; phyllodes whorled, grey-green; flowers golden; fruit viscid. On rocky hillside with *Eucalyptus brevifolia* open woodland above Winnama Gorge.

* *Acacia platycarpa* F.Muell. IDC 804
Shrub to 4 m, branches white, broad curved phyllodes, pale globular flowers. On sandplain surrounding Bungle Bungle massif and on river levees. Fruits baked and eaten (Scarlett 1985).

* *Acacia plectocarpa* Cunn. ex Benth. KM 518, 736; IDC 962
Slender tree to 6 m; fibrous grey bark; phyllodes rich shiny green; fruit shiny, sticky and wrinkled. On river levees and in gorges of Osmand Plateau.

* *Acacia retivenia* F.Muell. KM 521
Open shrub to 3 m, bark smooth and grey, large globular flowerheads. On sandstone hillside at Site 6.

Acacia aff. *retivenia* KM 490, 806
Open shrub to 4 m, branchlets pubescent, flowerheads large. On Bungle Bungle plateau and sandstone breakaways along Ord River valley.

* *Acacia stipuligera* F.Muell. KM 489, 771; IDC 808, 873
Shrub to 3 m, broad-triangular stipules at base of phyllodes, flowers in golden spikes. On Bungle Bungle Plateau and surrounding sandplains, can form dense thickets.

* *Acacia translucens* Cunn. ex Hook.
Low shrub to 0.5 m. (F&K Winnama Gorge.)

* *Acacia tumida* F.Muell. ex Benth. KM 491, 836; IDC 795
Shrub or small tree to 4 m, stems and leaves glaucous, flowers in yellow spikes, fruits wrinkled and brown. Widespread on river levees, sandplains, flats and in drainage lines on Bungle Bungle Plateau. Edible gum, green fruits used as fish poison, stems used to make spears and pegs of woomeras (Scarlett 1985).

* *Acacia* sp. subseries Lycopodiifoliae
Open shrub to 1.5 m. (F&K quartzite outcrop and sandstone scree slopes.)

Acacia sp. subgenus *Acacia*, section Bipinnatae KM 697
Tree to 6 m; bark grey-yellow, deeply fissured; bi-pinnate leaves; flat woody fruits. On limestone hillsides in Osmand Valley.

Dichrostachys spicata (F.Muell.) Domin KM 451, 519
Spiny shrub to 3 m, branches smooth and cream, flowers in a yellow and mauve spike. On river levees and broad plains.

Neptunia dimorphantha Domin KM 403
Prostrate herb with bi-pinnate leaves and oval, flat fruits. On river levees and flats.

MOLLUGINACEAE

* *Glinus oppositifolius* (L.) DC. KM 823
Trailing herb, flowers white, fruit green. In sandy ephemeral watercourse, Cathedral Gorge.

MORACEAE

* *Ficus coronulata* F.Muell. KM 812
Multi-stemmed tree to 6 m with drooping branches, narrow pendulous leaves and round green fruit. Subdominant in riparian forests along major watercourses. Fruits eaten raw (Scarlett 1985).

* *Ficus leucotricha* Miq. KM 742
Small tree with smooth grey bark and hairy yellow fruits. On rock faces in sandstone gorges of Bungle Bungle massif and Osmand Plateau.

* *Ficus opposita* Miq. KM 677
Small tree to 4 m; bark dark, deeply fissured; sandpaper-like leaves; fruits small and green. In drainage lines of sandstone breakaways, on limestone outcrops and in riparian forest. Fruits eaten raw (Scarlett 1985).

* *Ficus platypoda* (Miq.) Cunn. ex. Miq.
Small spreading tree to 4 m with aerial and clinging roots; bark smooth and pale grey. On sandstone cliffs and breakaways. Fruits eaten raw (Scarlett 1985).

* *Ficus racemosa* L. KM 703
Large spreading tree to 10 m; trunk buttressed at base; large clusters of fruits borne on trunk and main branches. On banks of major watercourses. Fruits eaten raw (Scarlett 1985).

* *Ficus tinctoria* G.Forster KM 785
Spindly tree with smooth pale grey bark, fruit orange. On sandstone cliff at Wulwuldji. (F&K alluvium by creek.)

* *Ficus virens* Aiton
Tree with aerial roots, bark smooth, light grey. Beside permanent watercourse in Bream Gorge. (F&K Mawundungi.) Fruits eaten raw (Scarlett 1985).

MYOPORACEAE

Eremophila longifolia (R.Br.) F.Muell. KM 449
Shrub to 3 m with drooping branches and narrow pendulous leaves. In *Acacia farnesiana* shrubland on broad plain above Ord River at Goosehole Yard.

* *Myoporum acuminatum* R.Br.
Shrub to 2 m, flowers white and mauve, fruits maroon. (F&K boulder slopes of Bungle Bungle massif.)

MYRTACEAE

* *Calytrix achaeta* F.Muell. KM 458, 892; IDC 835, 858
Dense shrub to 1.5 m with cream flowers. In gorges of Bungle Bungle massif and sandstone breakaways fringing Ord River valley.

* *Calytrix brownii* (Schauer) L.A.Craven
Shrub to 1.5 m with white flowers. Previously named *C. brachychaeta*. (F&K Winnama Gorge.)

* *Calytrix exstipulata* DC. KM 466, 469, 857; IDC 919
Shrub to 1.5 m with bright pink flowers. Common on sandstone substrates.

* *Eucalyptus aspera* F.Muell. KM 487, 511, 741
Tree to 8 m with smooth grey bark and sessile opposite grey-green leaves. Along watercourses of sandstone plateaux and breakaways.

* *Eucalyptus brachyandra* F.Muell. IDC 877
Straggly crooked tree to 5 m; bark grey and fibrous on trunk, smooth and cream on branches. On boulder slopes of Bungle Bungle massif and sandstone gorges.

* *Eucalyptus brevifolia* F.Muell. KM 509
Small tree to 5 m, bark smooth and white, branchlets yellow, leaves grey-green. Dominant on rocky slopes and skeletal soils. Leaves used in earth oven, wood used for firewood (Scarlett 1985).

* *Eucalyptus* sp. aff. *brevifolia* F.Muell. 'Silvery'
Tree to 5 m with smooth white bark and silvery shoots. (F&K Turkey Creek catchment.)

* *Eucalyptus* sp. aff. *brevifolia* F.Muell. 'Grey-green'
Tree to 5 m with smooth white bark and large fruits. (F&K on rocky slope.)

* *Eucalyptus camaldulensis* Dehn. IDC 826, 827, 869
Tree to 10 m with white smooth bark. Subdominant on sandy banks of major watercourses. Leaves used as fish poison, for lining earth ovens and in steaming treatment for colds. Wood prized as firewood (Scarlett 1985).

Eucalyptus clavigera Cunn. ex Schauer KM 513
Tree to 8 m, bark grey and tessellated on lower trunk, smooth and white above; leaves glabrous. On sandy bank beside ephemeral watercourse, Osmand Creek.

Eucalyptus chlorophylla Brooker & Done KM 512, 798
Tree to 10 m with thick, wavy bark persistent to smallest branches. Subdominant on flats and drainage lines in Osmand Valley and at Site 6.

* *Eucalyptus cliftoniana* W.Fitzg. ex Maiden KM 516, 759; IDC 838
Tree to 10 m with thick tessellated golden-brown bark and woody globular fruits. Dominant on Bungle Bungle Plateau and Osmand Range .

* *Eucalyptus collina* W.Fitzg. KM 455, 772
Tree to 10 m, bark white with scaly orange-brown patches on trunk, new growth silvery. Dominant on sandplains surrounding Bungle Bungle massif; codominant on sandstone slopes and breakaways.

* *Eucalyptus confertiflora* F.Muell. KM 692
Tree to 15 m with spreading crown; bark grey and tessellated on lower trunk, smooth and white above; leaves hairy. Common on river levees and flats. Firewood (Scarlett 1985).

* *Eucalyptus cupularis* C.Gardner KM 454, 830
Tree to 5 m with spreading crown; bark smooth, white, powdery; leaves pendulous. In sand banks beside ephemeral watercourses on Bungle Bungle Plateau and at base of massif. (F&K Osmand Range.)

* *Eucalyptus* aff. *dichromophloia* F.Muell. KM 468
Tree to 10 m, bark white with darker flakes, new growth yellow-green. On rocky slopes. Firewood, ash mixed with bush tobacco, *Nicotiana benthamiana* (Scarlett 1985).

* *Eucalyptus herbertiana* Maiden
Crooked tree to 6 m. (F&K Bungle Bungle Plateau.)

Eucalyptus microtheca F.Muell. KM 807
Tree to 16 m; bark brown and fissured on trunk, smooth and cream on branches; leaves pendulous. Dominant on banks of Ord River at Kitty's Knob. This species typically has fibrous bark throughout; partially smooth-barked specimens may be an unnamed species.

Eucalyptus opaca D.Carr & S.Carr KM 510, 840
Tree to 8 m with spreading crown; bark grey-orange, thick on trunk, smooth and cream on branches. On rocky hillsides and plains.

* *Eucalyptus* aff. *papuana* F.Muell. KM 693
Tree to 10 m with smooth white bark, pendulous branchlets and narrow leaves. On river levees and flats along major watercourses.

* *Eucalyptus* sp. aff. *papuana* F.Muell. KM 514, 515, 813; IDC 784
Tree to 8 m with smooth white bark and large leaves. Occasional on low rocky hills and sandplains surrounding Bungle Bungle massif.

* *Eucalyptus pruinosa* Schauer KM 499, 803
Small tree to 6 m with rough fibrous bark and stalkless bluish leaves. Dominant on clayey flats and poorly drained depressions, ocassional on low rocky hills. Firewood (Scarlett 1985).

* *Eucalyptus* sp. aff. *pruinosa* Schauer
Tree to 6 m with pruinose, silver-blue leaves. (F&K clay-loam plain and calcareous red earths.)

* *Eucalyptus ptychocarpa* F.Muell. KM 834
Tree to 8 m with spreading branches and rough fibrous bark. On low-lying plains along Osmand Valley and tributaries.

* *Eucalyptus* sp. aff. *terminalis* F.Muell.
Tree to 10 m, bark tessellated below, smooth above. (F&K west of Bungle Bungle massif.)

* *Eucalyptus* sp. nov. 'Box'
Tree to 8 m, bark fibrous. (F&K alluvium and sandstone scree.)

* *Leptospermum parviflorum* Valeton KM 668, 748
Tree to 8 m with reddish-brown peeling bark and pendulous branchlets. Common on sandy banks of permanent watercourse at Bream Gorge and occasional in Piccaninny Gorge.

* *Lophostemon grandiflorus* (Benth.) Peter G. Wilson & J.T. Waterhouse KM 711
Tree to 10 m; bark rough, hard, dark; flowers cream. Dominant along ephemeral watercourses of low rocky hills and plains. Firewood, bark used for artefacts (Scarlett 1985).

Melaleuca acacioides F.Muell.
Recorded by Scarlett (1985).

* *Melaleuca leucadendra* (L.) L. KM 504, 505, 506, 788
Tree to 20 m with white papery bark, pendulous branchlets and cream flowers. Dominant to codominant along major watercourses. Leaves used for steaming treatment of colds. Bark used to make shelters, blankets and for wrapping food (Scarlett 1985).

* *Melaleuca nervosa* (Lindley) E.Cheel KM 508; IDC 878
Small tree to 5 m with grey papery bark and green flowers. In poorly-drained depressions along Osmand Valley and at Site 6.

Melaleuca viridiflora Sol. ex Gaertner KM 507, 522
Slender tree to 6 m with cream papery bark and broad dark green leaves. In moist drainage line at Site 6 and on sand bank in Piccaninny Gorge.

* *Syzygium angophoroides* (F.Muell.) B.Hyland KM 702
Tree to 10 m with papery or fissured reddish bark and cream flowers. Subdominant in closed forests of Osmand Valley and Winnama Gorge.

* *Syzygium eucalyptoides* (F.Muell.) B.Hyland KM 494
Spreading tree to 8 m with pendulous leaves drooping to ground and white flowers. In riparian forest at Blue Holes.

NYCTAGINACEAE

* *Boerhavia paludosa* (Domin) Miekle
Tangled herb to 1.3 m. (F&K Winnama Gorge, Piccaninny Gorge.)

Boerhavia sp. KM 406, 884; IDC 793
Prostrate annual herb, flowers mauve, fruit sticky. In sandy soils on river levees and plains.

NYMPHEACEAE

Nymphaea violacea Lehm. KM 602
Perennial aquatic herb with floating roundish leaves and emergent purple flowers. In permanent pool near Mt. John.

OLEACEAE

Jasminum didymum Forster f. KM 680, 855
Multi-stemmed shrub to 2 m, bark grey, fruit black. On limestone ridges.

* *Jasminum molle* R.Br.
Semi-shrub to 0.5 m. On bank of drainage line through sandstone breakaway at Kitty's Knob. (F&K Red Rock Creek.) Fruits eaten raw (Scarlett 1985).

ONAGRACEAE

* *Ludwigia octovalvis* (Jacq.) Raven KM 626, 669
Open shrub to 2 m with yellow flowers and tubular red and green fruit. In moist sand beside major watercourses.

* *Ludwigia perennis* L. KM 605; IDC 916
Annual herb to 0.6 m. In sandy ephemeral watercourses.

OPILIACEAE

* *Opilia amentacea* Roxb.
Scandent shrub to 4 m. (F&K Giliwal.) Fruits eaten raw (Scarlett 1985).

PASSIFLORACEAE

*#*Passiflora foetida* L. KM 847
Sprawling climber to 4 m with round orange fruits. In riparian forest along major watercourses.

PEDALIACEAE

Josephinia eugeniae F.Muell. KM 424
Prostrate herb with mauve flowers. In sandy clay loam of broad plains above Ord River at Gooschole Yard.

* *Josephinia* sp. nov.
Subshrub to 0.5 m, flowers mauve. (F&K Winnama Gorge.)

PITTOSPORACEAE

* *Citriobatus spinescens* (F.Muell.) Druce KM 727, 792
Multi-stemmed shrub to 3 m, branchlets spine-tipped, fruits pale yellow. On rocky slopes adjacent to permanent watercourses at Winnama Gorge and Wulwuldji.

POLYGALACEAE

* *Comesperma secundum* Banks ex DC. KM 464
Open slender shrub to 1 m, bark smooth and brown, branchlets pruinose, leaves blue-green. On Bungle Bungle Plateau. Recorded by Forbes and Kenneally as *Comesperma* sp. nov.

* *Polygala linarifolia* Willd.
Annual herb. Previously named *P. chinensis*. (F&K Piccaninny Gorge.)

Polygala sp. IDC 904
Erect herb to 0.3 m with linear leaves and blue flowers. In alluvial sand of ephemeral watercourse at Bull Creek.

POLYGONACEAE

* *Persicaria barbatum* (L.) H.Hara KM 789
Erect herb to 1 m with cream flowers. In damp loam beside permanent watercourse at Wulwuldji. Previously named *Polygonum barbatum.*

PORTULACACEAE

* *Calandrinia* sp.
Sprawling succulent herb, flowers pink. (F&K Piccaninny Gorge.)

* *Portulaca* ? *intraterranea* J.Black
Herb to 0.1 m. (F&K Winnama Gorge.)

Portulaca pilosa L. KM 624
Prostrate annual herb with reddish stems and yellow flowers. In sandy soils along watercourses, flats and lower slopes.

* *Portulaca* ? *pilosa* L.
Succulent herb to 0.1 m, flowers pinkish-yellow. (F&K Piccaninny Gorge.)

* *Portulaca* sp.
Succulent dwarf herb, flowers orange. (F&K Piccaninny Gorge.)

PROTEACEAE

* *Grevillea agrifolia* Cunn. ex R.Br. KM 749
Shrub to 4 m with dark rough bark, toothed bluish-green leaves and cream flowers. In sandy soil beside watercourses in Osmand Valley.

Grevillea byrnesii KM 534, 535, 837; IDC 918
Slender shrub to 4 m, toothed leaves, flowers red. On Bungle Bungle Plateau and surrounding sandplains.

Grevillea dimidiata KM 532
Tree to 6 m; bark black, rough; leaves thick, wavy. On rocky hills at Blue Holes.

Grevillea mimosoides R.Br. KM 787
Tree to 8m; bark thick, corky; leaves clustered at ends of branchlets; fruits coated with brown caustic sticky substance. Occasional on river levees.

* *Grevillea miniata* W.Fitzg. KM 488; IDC 788
Slender erect shrub to 4 m, toothed felty grey-green leaves, flowers orange. Common on Bungle Bungle Plateau and surrounding sandplain. Stems used to make spears and pegs of woomeras (Scarlett 1985).

* *Grevillea psilantha* McGillivray KM 473, 536, 818
Low shrub to 1 m, leaves silvery-green, flowers cream. On precipitous walls of Piccaninny and Cathedral Gorges.

Grevillea pteridifolia Knight
Stems used for making spears, ash from bark used on hair (Scarlett 1985).

* *Grevillea pyramidalis* Cunn. ex R.Br. KM 531, 533
Small tree to 4 m with rough, dark bark and cream flowers. On low rocky hills and elevated plains. Wood used for boomerangs (Scarlett 1985).

* *Grevillea refracta* R.Br. KM 537; IDC 782, 900
Slender shrub to 4 m, silvery-green divided leaves, reddish-yellow to orange flowers. On Bungle Bungle Plateau and surrounding sandplains and in sandstone gorges of Osmand Valley and Winnama Gorge.

Grevillea striata R.Br. KM 802
Small tree to 5 m; bark hard, dark, furrowed; strap-like, silvery-green leaves; flowers cream. In *Lysiphyllum cunninghamii* woodland on plain above Ord River at Kitty's Knob.

Grevillea wickhamii Meissner KM 530, 856
Slender shrub to 3 m, toothed leaves, flowers red. On Bungle Bungle Plateau and low rocky hills.

* *Grevillea* sp. aff. *wickhamii* Meissner KM 465; IDC 925
Slender tree to 4 m, toothed leaves, flowers red with black perianth lobes. On Bungle Bungle Plateau and surrounding sandplain.

* *Hakea arborescens* R.Br. KM 682; IDC 917
Gnarled tree to 4 m with black, deeply fissured bark and cream flowers. Common on sandstone breakaways, limestone ridges and flats. Wood used for boomerangs, fighting clubs (Scarlett, 1985).

Hakea suberea S.Moore KM 923
Gnarled tree to 5 m with deeply fissured bark and long needle-like leaves. On plain above Ord River at Kitty's Knob and on rocky hills in Osmand Valley.

* *Persoonia falcata* R.Br. SR
Small tree to 4 m, bark brown and flaky, flowers yellow. On river levees and sandplains surrounding Bungle Bungle massif. Fruits eaten raw (Scarlett 1985).

* *Stenocarpus* sp. A (FoK)
Refers to species named *S. salignus* by Forbes and Kenneally. (F&K Piccaninny Gorge.)

RHAMNACEAE

* *Ventilago viminalis* Hook. SR
Small tree to 4 m; bark dark, fissured; leaves narrow, pendulous. Beside ephemeral watercourse at Goosehole breakaway. (F&K Bungle Bungle Outcamp.) Wood used for boomerangs (Scarlett 1985).

* *Ziziphus quadrilocularis* F.Muell. KM 701
Open shrub to 2 m with paired spines at leaf bases. In coarse sand beside permanent watercourse at Winnama Gorge. Includes Forbes and Kenneally *Z. oenoplia*. Edible 'skin' on baked fruit (Scarlett 1985).

RHIZOPHORACEAE

* *Carallia brachiata* (Lour.) Merr. KM 862
Tree to 6 m with horizontal branches and pale corky bark. In riparian closed forest at Winnama Gorge. (F&K Osmand Valley.)

RUBIACEAE

* *Canthium attenuatum* R.Br. ex Benth.
Tree to 6 m with grey-black fissured bark. (F&K Bungle Bungle Outcamp.)

* *Gardenia pyriformis* Cunn. ex Benth.
Tree to 4 m with flaky mottled yellow bark. (F&K Bungle Bungle massif, Winnama Gorge.)

Gardenia sp. KM 731, 864
Small tree to 5 m, soft flaky yellow-brown bark, flowers white and sweet smelling. At base of Bungle Bungle massif and on rocky slope at Winnama Gorge.

Hedyotis sp. KM 846
Erect annual herb to 0.2 m. On sand plains surrounding Bungle Bungle massif and in associated gorges.

* *Hedyotis crouchiana* (F.Muell.) F.Muell.
Spreading herb to 0.1 m. Previously named *Oldenlandia crouchiana*. (F&K Piccaninny Gorge.)

* *Hedyotis galioides* (F.Muell.) F.Muell.
Diffuse herb to 0.5 m. Previously named *Oldenlandia galioides*. (F&K Piccaninny Gorge.)

* *Hedyotis mitrasacmoides* (F.Muell.) F.Muell.
Delicate erect herb to 0.3 m. Previously named *Oldenlandia mitrasacmoides*. (F&K Piccaninny Gorge.)

* *Nauclea orientalis* (L.) L. SR
Tree to 15 m, bark pale, dense crown of large glossy leaves. In riparian closed forest near Wulwuldji and near Mt. John. Fruits eaten raw (Scarlett, 1985).

* *Pavetta brownii* Bremek. KM 737
Shrub 2 m with peeling brown bark and white flowers. On sandstone slope at Winnama Gorge. (F&K Osmand Valley, Piccaninny Gorge.)

* *Timonius timon* (Sprengel) Merr. KM 710
Tree to 6 m, bark grey, tubular white flowers, round green fruits. In riparian forest of Osmand Valley, Winnama Gorge and near Mt. John. Wood used for boomerangs and woomeras (Scarlett 1985).

RUTACEAE

* *Boronia ? pauciflora* W.Fitzg.
Low shrub to 0.5 m, flowers pink. (F&K Winnama Gorge.)

* *Euodia elleryana* F.Muell. KM 733, 794
Tree to 15 m; bark yellow, corky; glossy trifoliate leaves. In riparian forest beside permanent watercourses in Osmand Valley, Winnama Gorge and near Mt. John.

SANTALACEAE

Exocarpos latifolius R.Br. KM 791
Multi-stemmed shrub to 4 m; bark dark, hard, rough; broad glossy leaves; fruit with swollen fleshy receptacle. On river levee at Wulwuldji Spring.

* *Santalum lanceolatum* R.Br. KM 436, 675, 681; IDC 829
Pendulous shrub to 3 m, leaves glaucous, flowers cream. Widespread in drainage lines on sandplains and low rocky hills, on limestone ridges, river levees and on Bungle Bungle Plateau. Leaves used in steaming treatment of colds (Scarlett 1985).

SAPINDACEAE

* *Atalaya hemiglauca* (F.Muell.) F.Muell. ex Benth. KM 714
Small tree to 10 m, bark pale grey, bluish-grey pinnate leaves, winged papery fruits. On river levees, drainage lines on low rocky hills and limestone ridges. Wood used for fighting sticks (Scarlett 1985).

Cardiospermum halicacabum L. KM 604
Prostrate herb to 1 m, inflated three-winged fruits. In sandy bed of Ord River at Blue Holes.

* *Distichostemon hispidulus* (Endl.) Baillon KM 493, 688; IDC 921
Spindly shrub to 2 m, hairy prominently winged fruits. In drainage lines on Bungle Bungle Plateau, on sandstone slope near Mt. John, in gorges of Osmand Valley and at base of sandstone hill at Site 6.

Dodonaea coriacea (Ewart & Davies) McGillivray KM 676
Shrub to 1.5 m, toothed wedge-shaped leaves, three-winged fruits. On sandstone slope at Goosehole breakaway.

* *Dodonaea lanceolata* F.Muell. KM 724
Shrub to 2 m, bark peeling in orange strips, three-winged fruits. In alluvial sand beside permanent watercourse at Winnama Gorge and on top of Mt. John. (F&K slopes of Bungle Bungle massif.)

* *Dodonaea polyzyga* F.Muell. KM 450, 685
Shrub to 2 m with viscid stems, leaves and fruit; bark peeling in reddish strips. On rocky hills and limestone outcrops. Implement made from dried stems used for shaping spearheads (Scarlett 1985).

* *Dodonaea viscosa* Jacq. KM 739
Slender shrub to 2 m, leaves very shiny green, papery three-winged fruits. On sandstone slopes at Winnama Gorge and gorges in Osmand Valley. (F&K slopes of Bungle Bungle massif.)

SAPOTACEAE

* *Planchonella arnhemica* (F.Muell. ex Benth.) Royen
Tree to 8 m with dark grey corky bark. (F&K at base of Bungle Bungle massif.)

SCROPHULARIACEAE

Bacopa floribunda (R.Br.) Wettst.
Identified after publication of Forbes and Kenneally (1986).

* *Buchnera ramosissima* R.Br.
Subshrub to 0.8 m, flowers mauve. (F&K Piccaninny Gorge.)

Limnophila fragrans (Forster f.) Seemann KM 621
Trailing herb, flowers white. In moist soil beside permanent watercourse near Mt.John.

Lindernia sp. nov. KM 480, 820
Cascading herb , flowers mauve with darker streaks and white throat. On sandstone walls of Bungle Bungle massif.

* *Stemodia grossa* Benth.
Low soft herb to 0.2 m, flowers purple. (F&K south-west of Bungle Bungle Outcamp, Tickalara Track.)

* *Stemodia lythrifolia* F.Muell. ex Benth. KM 649, 725; IDC 844
Erect aromatic herb to 0.3 m with square stems and mauve flowers. In drainage lines of sandstone slopes and breakaways and on Bungle Bungle massif.

* *Stemodia viscosa* Roxb. KM 776
Erect aromatic sticky herb to 0.3 m, flowers mauve. In rocky ephemeral watercourse, Red Rock Creek. (F&K Bungle Bungle massif.)

* *Stemodia* sp.
Clumped pendulous herb, flowers mauve. (F&K Piccaninny Gorge.)

Stemodia sp. KM 623
Dense pendulous, viscid, aromatic herb with purple flowers. On cliff walls of Bungle Bungle massif at Piccaninny Gorge.

SIMARUBACEAE

* *Brucea javanica* (L.) Merr. KM 718, 754
Open shrub to 2 m, leaves clustered at ends of branchlets, small green flowers on long erect terminal racemes. In sandstone gorges of Osmand Valley and Bungle Bungle massif.

SOLANACEAE

\# *Datura inoxia* Miller KM 407
Hairy low shrub with large white flowers and round spiny fruits on curved stem. In alluvial sand of Osmand Creek.

* *Nicotiana benthamiana* Domin KM 849, 850
Erect herb to 0.3 m with thin odorous leaves and white flowers. In sheltered sandstone overhang at Piccaninny Gorge. (F&K limestone at Red Rock Creek.) Bush tobacco, dried leaves chewed with ash (Scarlett 1985).

Solanum carduiforme F.Muell.
Identified after publication of Forbes and Kenneally (1986).

Solanum dioicum W.Fitzg. KM 925
Small shrub to 0.5 m with dense golden tomentum and spines on stems and main leaf veins, flowers mauve. Occasional on rocky lower slopes.

* *Solanum* sp. aff. *dioicum* W.Fitzg
Low shrub to 0.6 m. (F&K Winnama Gorge.).

* *Solanum echinatum* R.Br. KM 498
Very spiny subshrub to 0.5 m, flowers mauve. On degraded clay flat at Blue Holes. (F&K Osmand Valley.) Fruits eaten raw (Scarlett 1985).

* *Solanum lucani* F.Muell.
Prickly low semi-shrub to 0.2 m. (F&K Wulwuldji, Winnama Gorge, Piccaninny Gorge.)

Solanum sp. F.Muell. KM 829
Open spiny shrub to 1 m, leaves dissected, flowers purple. In gorges and associated outliers of Bungle Bungle massif.

* *Solanum quadriloculatum* F.Muell.
Low shrub. (F&K Winnama Gorge.)

STACKHOUSIACEAE

* *Stackhousia intermedia* Bailey
Herb to 0.3 m. (F&K Winnama Gorge.)

STERCULIACEAE

* *Brachychiton diversifolius* R.Br. KM 666
Tree to 10 m with dark, fissured bark, pendulous branchlets and green flowers with maroon streaks. On river levees of major watercourses. Green pods edible when baked, frayed sticks used for spooning out bush honey (Scarlett 1985).

* *Brachychiton viscidulus* (W.Fitzg.) Guymer KM 734, 833
Deciduous tree to 5 m, bark rough and dark, flowers red. On rocky hillsides in Osmand Valley and Winnama Gorge. (F&K slopes of Bungle Bungle massif.) Green pods edible when baked (Scarlett 1985).

Melhania oblongifolia F.Muell. KM 396, 618, 686, 796
Erect greyish shrub to 0.3 m with yellow flowers. On river levees and lower slopes.

Melhania sp. KM 924
Erect subshrub to 0.3 m. On limestone outcrop at Site 6.

Melochia pyramidata L. KM 611
Spindly erect shrub with reddish stems and inflated fruit. On river levees of major watercourses.

Melochia sp. KM 766
Low spreading shrub to 0.5m, flowers pink. In sandy ephemeral watercourse at Bream Gorge.

Waltheria indica L. KM 815; IDC 790, 791
Erect hairy subshrub to 0.5 m, flowers yellow. Widespread in sandy soils.

STYLIDIACEAE

* *Stylidium muscicola* F.Muell.
Flowers deep pink. (F&K Piccaninny Gorge.)

* *Stylidium schizanthum* F.Muell.
Small pink ephemeral. (F&K Winnama Gorge.)

TILIACEAE

Corchorus aestuans L. KM 881
Annual herb on cracking clay plain at Kitty's Knob.

Corchorus fascicularis KM 882
Annual herb on cracking clay plain at Kitty's Knob.

Corchorus olitorius L. KM 883
Annual herb on cracking clay plain at Kitty's Knob.

* *Corchorus sidoides* F.Muell. KM 658, 687; IDC 764, 899
Erect open shrub to 1 m, leaves grey-green, flowers yellow. Widespread on river levees, limestone outcrops, sandstone breakaways and broad plains.

Corchorus tridens L. KM 395
Prostrate annual herb with cylindrical fruits splitting into three parts, flowers yellow. On plains adjacent to major watercourses.

* *Grewia polygama* Roxb. KM 866
Open shrub with cream flowers. On river levee at Bream Gorge. (F&K Wulwuldji.) Fruits eaten raw (Scarlett 1985).

Triumfetta aff. *appendiculata* F.Muell. IDC 947
Perennial shrub to 1 m. In *Eucalyptus papuana* woodland on river levee of Osmand Creek.

* *Triumfetta glaucescens* (R.Br.) Benth.
Slender shrub to 0.5 m. (F&K slope of Bungle Bungle massif.)

* *Triumfetta plumigera* F.Muell. KM 799, 842
Erect spindly semi-shrub to 0.5 m. On sandstone slopes.

Triumfetta sp. KM 839, 843
Open shrub to 1.5 m, flowers yellow. On river levees and rocky lower slopes.

* *Triumfetta* sp. IDC 879
Open densely hairy shrub to 1.5 m, flowers yellow, fruit round with soft spines. Widespread on drainage lines and watercourses. Recorded by Forbes and Kenneally as *T. appendiculata.*

ULMACEAE

* *Celtis philippinensis* Blanco KM 679, 858
Small tree to 5 m with dense compact canopy; bark grey, smooth; leaves toothed; flowers pale yellow. On limestone outcrops.

* *Trema tomentosa* (Roxb.) Hara KM 398, 698, 709
Small tree to 3 m, bark brown, toothed leaves and clusters of small black fruits. In riparian forest along Osmand Creek and tributaries and Winnama Gorge.

VERBENACEAE

* *Clerodendrum floribundum* R.Br. IDC 868
Small tree to 3 m, furrowed pale bark, reddish new shoots and leaf stalks. On river levees in Osmand Valley and on sandplains surrounding Bungle Bungle massif.

* *Clerodendrum tomentosum* (Vent.) R.Br. KM 713
Slender tree to 2 m, bark grey and fissured, ripe fruits purple. In sandstone gorges of Osmand Valley, Bungle Bungle massif and Winnama Gorge.

* *Premna acuminata* R.Br.
Small tree to 3 m, bark grey, broad leaves with pointy tip. On limestone outcrops. Stems used to make fire sticks (Scarlett 1985).

* *Vitex glabrata* R.Br. KM 715
Small tree to 5 m, bark grey and fissured, flowers cream and mauve. In sandstone gorges of Osmand Valley, Bungle Bungle massif and Winnama Gorge. Fruits eaten raw (Scarlett 1985).

VIOLACEAE

* *Hybanthus aurantiacus* (F.Muell. ex Benth.) F.Muell. KM 617; IDC 794, 911
Erect shrub to 1 m, toothed leaves, flowers orange. Widespread on river levees, limestone outcrops, low rocky hills and sandplains.

ZYGOPHYLLACEAE

* *Tribulopis angustifolia* R.Br. IDC 820
Prostrate herb with yellow flowers. In sandy ephemeral watercourse at Bull Creek. Recorded by Forbes and Kenneally as *Tribulopis* sp. (F&K Piccaninny Gorge.)

Tribulopis pentandra R.Br. KM 777
Prostrate herb with reddish stems and yellow flowers. In rocky ephemeral watercourse at Red Rock Creek.

Tribulus terrestris L. KM 625
Prostrate herb with orange stems and yellow flowers. In sandy ephemeral watercourse at Blue Holes.

DISCUSSION

Comparison of floristic classification with that of Forbes and Kenneally (1986)

We classified the vegetation of the Bungle Bungle area into seventeen communities defined on floristics. Many of these are directly comparable to those of Forbes and Kenneally (1986). We have no direct comparison for Forbes and Kenneally's community 1.6 (ephemeral streams draining scree and boulder slopes and gorges of the Bungle Bungle massif) or 4.2 (scree and boulder slopes of the Bungle Bungle massif) although parts of these may be found in our groups 15 and 16. We have differentiated the sandplain vegetation (Forbes and Kenneally unit 3.2) into three separate groups (8, 9, 17).

Both the Osmand Plateau and Osmand Ranges require further investigation. Forbes and Kenneally give a brief description of the community 5.2 (Osmand Plateau and surrounds), however, no collections were made. The vegetation of the Osmand Plateau (not visited by us) may be comparable to our group 14 describing the Osmand Ranges to the east.

Biogeographic comparisons

Bowman *et al.* (1988) used the survey results of Forbes and Kenneally (1986) in their examination of the regional floristic similarity of Gregory National Park. They calculated similarity between the Bungle Bungle area and Gregory as 37 per cent (based on an index using number of species in common/the lower species tally of the two areas considered), although a recalculation using their data showed that this should have been 43 per cent. Including the data from our survey, the similarity is higher (47 per cent), and approaches the highest recorded by Bowman *et al.*, that of 53 per cent between Keep River and Gregory.

This suggests that there is a distinct component of the flora of the East Kimberley-Victoria River region, and hence that sites in this region have relatively low floristic similarity with that of the higher rainfall Top End (Litchfield, Katherine Gorge and Alligator River Region). Further analysis to examine the biogeographic affinities of the Bungle Bungle flora is desirable, but will require a thorough matching of the nomenclature used in Kimberley surveys and Northern Territory surveys. The interpretation of such comparisons is limited by differences in survey methodology and thoroughness (e.g. collecting in the wet season).

We also compared the floristic richness found in our survey of the Bungle Bungle area with that of other surveyed areas in north-western Australia (Prince Regent River, Drysdale River, Mitchell Plateau, Dampier Peninsula, 'Darwin and Gulf Districts', Victoria River Districts and Kakadu, Keep River, Katherine Gorge and Litchfield National Parks) using data presented in Lazarides *et al.* (1988) and Bowman *et al.* (1988). Species tallies are presented against area on a log-log scale in Figure 7, which also shows the regression line calculated by Lazarides *et al.* (1988). The Bungle Bungle flora is marginally richer than expected based on survey area, suggesting either an unusually thorough survey, or a flora which is relatively rich in comparison with other sites in monsoonal Australia. There is a weak trend for sites with higher rainfall to have greater species richness (correlation between rainfall and departure from regression line: $r = 0.37$, $p > 0.05$), and the Bungle Bungle area is the only relatively dry (mean annual rainfall <1000 mm) site having more plant species than expected, based on the regression equation of Lazarides *et al.* (1988). In terms of the sites available for comparison in north-western Australia, the Bungle Bungle area has a floristic richness slightly greater than expected based on area, and this richness is especially unusual given the relatively low rainfall.

We speculate that the occurrence of mesic habitats in the chasms and gorges, in an otherwise dry environment, contributes to this richness.

Wet Season Collecting

Further collecting during the mid to late wet season would substantially increase our understanding of the flora, as many plants are only fertile during this period and ephemeral species are most easily detected then.

We did not collect during the wet season although Forbes and Kenneally record some ephemeral species collected by Marion Blackwell in early April 1985.

Gymnosperms and Pteridophytes

Gymnosperms make up a very small proportion of the flora of the Bungle Bungle area as has been reported for the Kimberley and Cape York (Clarkson and Kenneally 1988).

Ferns and fern allies represent 2.8 per cent of the native vascular species recorded in the Bungle Bungle area (2.7 per cent for the Kimberley). At the family level ferns form a larger segment of the flora, representing 11.4 per cent of the families in the Bungle Bungle area (12.8 per cent of the Kimberley).

The richness of the pteridophyte flora is surprising in an area with an annual rainfall of 600 mm and highlights the importance of the moist sheltered environments provided by the Osmand Valley and associated gorges and the chasms of the Bungle Bungle massif. Many of these pteridophytes are at their inland limit.

Invasive Alien Species

Despite areas of invasion by alien species the Bungle Bungle area has a low overall occurrence of weeds. Seventeen species of invasive alien species representing 10 families were recorded in the Bungle Bungle area (Table 4). This represents 2.8 per cent of the total flora, compared with 10.5 per cent for Western Australia, 4.8 per cent for the Kimberley (Clarkson and Kenneally 1988), 5.2 per cent for the Northern Territory (Bowman *et al.* 1988) and 5.8 per cent for Kakadu (Cowie and Werner 1987).

The figure derived by us is in the lower part of the range for overseas continental reserves dominated by tropical savannas and dry woodlands (2.6 per cent to 8.8 per cent) (Macdonald and Frame 1988; Usher 1988) and lower than for reserves of arid vegetation (4.0 per cent to 9.2 per cent) (Loope *et al.* 1988).

Low figures for introduced species in Australia's tropics are considered by Clarkson and Kenneally (1988) to reflect the sparse settlement and land use patterns based on grazing of native pastures with minimal clearing. This is also true for the Bungle Bungle area.

In any area, the numbers of invasive alien species in a family is generally proportional to the global size of the family, with the exception of the Orchidaceae (Specht 1981; Williamson and Brown 1986; Esler and Astridge 1987). The three families Poaceae, Fabaceae and Asteraceae are often dominant in the invasive alien floras of tropical and other areas (Specht 1981; Cowie and Werner 1987; Clarkson and Kenneally 1988). These patterns do not hold completely for the Bungle Bungle area. Although the Poaceae accounts for 35 per cent of exotic species, no introduced species of Fabaceae were detected and only one species (6 per cent) of the family Asteraceae was recorded. In common with Kakadu, the Malvaceae contributed more alien species than the Asteraceae.

A notable introduced species is *Datura inoxia*, not previously recorded in the Kimberley.

Of the invasive alien species in the Park, the perennial shrubs *Parkinsonia aculeata* and *Calotropis procera* appear the most significant from a conservation perspective. These species occur in dense stands on the banks of the Ord River and appear to have the potential to invade other riparian areas in the Park (e.g. Osmand Creek, Red Rock Creek). There is also a risk that invasive species occurring elsewhere in northern Australia may be inadvertently introduced to the Park by tourists. The most important of these include *Acacia nilotica*, *Cryptostegia grandiflora* (rubber vine), *Mimosa pigra*, *Parthenium hysterophorus*, *Tamarix aphylla* (tamarisk) and *Xanthium pungens* (noogoora burr) (Swarbrick 1983; Loope *et al.* 1988). Many of these species also favour riparian habitats.

Species with burrs, such as the annual grasses *Cenchrus biflorus* and *Cenchrus echinatus* and the native herb *Tribulus terrestris*, have the potential to infest campgrounds, to the detriment of Park visitors. These species can cause painful punctures of the skin and can puncture camping equipment (Holm *et al.* 1977).

Within the Bungle Bungle area, sandstone habitats and rocky hills remain relatively pristine with little disturbance by feral stock or invasion of introduced plant species. The major watercourses and associated plains suffer the greatest degradation and it is here that the introduced plant species are most prevalent.

Distribution of notable species and conservation value

For convenience here we divide the Bungle Bungle area into eight broad environments.

1. Bungle Bungle massif

This unit is of high conservation value. Occurring in the sheltered habitats of the chasms and gorges are a number of rare or restricted species, new records for Western Australia, undescribed species and records of biogeographical significance.

Eyrean elements such as *Acacia* spp. and *Grevillea* spp. dominate the exposed Plateau while relicts of a wetter climate occur in the sheltered gorges. The rugged terrain and inaccessibility to feral stock has resulted in little degradation and the absence of exotic plant species.

Notable species include:

The fern *Taenitis pinnata* recorded by Forbes and Kenneally as a new record for Western Australia, otherwise known only from north-eastern Queensland. The undescribed palm *Livistona* sp. 'Victoria River' a species restricted to chasm floors and walls of the massif.

A collection of the resurrection grass *Micaira* sp. from the sandstone plateau of the massif extends the known range of this interesting genus. It has a disjunct distribution including the northern Kimberley, the Darwin region of the Northern Territory, and Queensland. Its presence on the Bungle Bungle Plateau significantly extends its range inland.

The daisy *Erigeron ambiguus* collected from ephemeral watercourses on the Bungle Bungle Plateau is a new record for Western Australia. It is known from the Barkly and Darwin regions of the Northern Territory.

The second collection of *Blumea pungens* was made from a gorge of the Bungle Bungle massif by Forbes and Kenneally. Our survey discovered a third locality for this rare species on the Osmand Plateau.

The chasm walls of the massif support a number of species not known from any other habitat, including *Grevillea psilantha, Lindernia* sp. nov. and *Stemodia* sp. nov. *Plectrachne* sp. nov. occurs both here and on sandstone substrates of the Osmand Plateau.

2. Sandplains surrounding the Bungle Bungle massif

An extensive broad plain surrounds the Bungle Bungle massif. Its vegetation ranges from *Eucalyptus collina* woodlands to *Acacia* tall shrublands (floristic groups 8,9,17). The shrub layer is dominated by Eyrean elements including *Acacia* spp. *Grevillea* sp. and the Fabaceae family. The distinctive shrub *Jacksonia odontoclada* was first recorded from Western Australia by Forbes and Kenneally's survey. *Grevillea byrnesii*, which also occurs on the Bungle Bungle Plateau, is a new record for Western Australia. The hummock grass *Triodia spicata* occurs as large pungent clumps in fire protected areas of the massif and surrounding sandplains. This species has not previously been recorded for the Kimberley and represents the northern range limit of this desert species.

3. Sandstone breakaways

Rugged breakaways occur to the south of the massif on the lower slopes of the Elder Land System. These abrupt rocky slopes form the boundary between the Buchanan sandplains and the Nelson Land Units of the Ord River valley. Several desert species not previously recorded in the Kimberley occur here: the grass *Paraneurachne muelleri*, and the forbs *Ptilotus schwartzii* and *Streptoglossa decurrens*.

4. Osmand Valley and associated gorges

The permanent and semi-permanent watercourses associated with the Osmand Valley support closed forests. These represent the most south-easterly occurrence of such forest in Western Australia. The best example of this vegetation occurs in Winnama Gorge. Trees such as *Euodia elleryana, Syzygium angophoroides, Carallia brachiata* and *Ficus* spp. form a closed canopy over permanent watercourses. The understorey is characterized by sedges and ferns, many of them at their most south-easterly limit. Notable species include:

The sedge *Cyperus polystachyos*, recorded by Forbes and Kenneally as a new record for Western Australia;

The fern *Nephrolepis arida*, the second collection from the Kimberley;

The shrub *Breynia rhynchocarpa*, restricted to these sheltered gorges and not previously recorded in Western Australia. It is known to occur in the Darwin region of the Northern Territory;

The broader valley of the Osmand Creek itself supports tall forests of *Melaleuca leucadendra*. Populations of *Colocasia esculenta* are considered a valuable genetic resource (Forbes and Kenneally 1986). This species is widely distributed throughout the humid tropics but in the Kimberley it is restricted to a few localities. The introduced species *Datura inoxia*, found only in alluvial sand of the Osmand Creek, had not previously been recorded in the Kimberley;

The forb *Polycarpaea diversifolia* is also new for the Kimberley.

5. Osmand Ranges and Plateau

Our study describes one community (floristic group 14) from the Osmand Ranges, a low woodland of *Eucalyptus cliftoniana*. The shrub *Cajanus* sp. recorded here and on the sandplains surrounding the Bungle Bungle massif may be an undescribed species.

The Osmand Range has sheltered gorges supporting closed forest and in one such site we recorded the waterlily *Nymphaea violacea, Pandanus aquaticus*, the aquatic forb *Aponogeton elongatus*, and the fern *Ceratopteris thalictroides*. All these species are at their inland range limit.

The presence of feral pigs in the tributary of Osmand Creek near Mt. John poses a significant threat to these vulnerable sites.

6. Limestone outcrops

Limestone outcrops occur on the northern side of Osmand Valley, the western side of the Bungle Bungle massif and in the south part of the Conservation Reserve. These outcrops support a low closed forest on favourable sites. An unidentified *Acacia* occurs on limestone in the Osmand Valley along with the rare shrub *Cajanus crassicaulis.*

7. Rocky hills

Rugged hills occur with a range of rocky substrates throughout the Bungle Bungle area. Their floristic diversity is generally low. There is little degradation from erosion or introduction of exotic species. The hummock grass *Triodia inutilis* represents a new record for the Kimberley; it is known from the Victoria River and Barkly districts in the Northern Territory. *Eucalyptus opaca* forms low open woodlands on these undulating hills. This species has not previously been recorded in the Kimberley but is probably the same species as Forbes and Kenneally's *'Eucalyptus* aff. *terminalis.'*

8. Ord River Valley

The Ord River valley is the most degraded environment in the Bungle Bungle area. The fine clays produce spectacular sheet and gully erosion when overgrazing results in loss of vegetation. Much of this area is included in the Ord River Regeneration Reserve and exotic species such as *Aerva javanica* and *Cenchrus* spp. have been used to stabilize the soils. The banks are characterized in many places by large stands of the introduced shrubs *Parkinsonia aculeata* and *Calotropis procera.*

The plains of the Ord River valley are characterized by a high occurrence of annual grasses, increaser species and forbs which indicate a history of degradation and overgrazing. Perennial grasses such as *Astrebla squarrosa* are rarely seen and only *Chrysopogon fallax,* a species reasonably tolerant of overgrazing, could be described as commonly occurring, although only as scattered tussocks.

The riparian forest fringing the Ord River is significant though floristically depauperate compared with that of Osmand Valley. Our only records of *Eucalyptus microtheca* and *Syzygium eucalyptoides* occurred in this forest while *Grevillea striata* was found only on the adjacent plains.

The subshrubs *Abutilon leucopetalum* and *Tephrosia supina,* and the forb *Polymeria angusta* have not previously been recorded for the Kimberley.

The removal of much of the feral stock on these plains has reduced the grazing pressure, however, areas already bare of vegetation will continue to erode unless the soil can be stabilized.

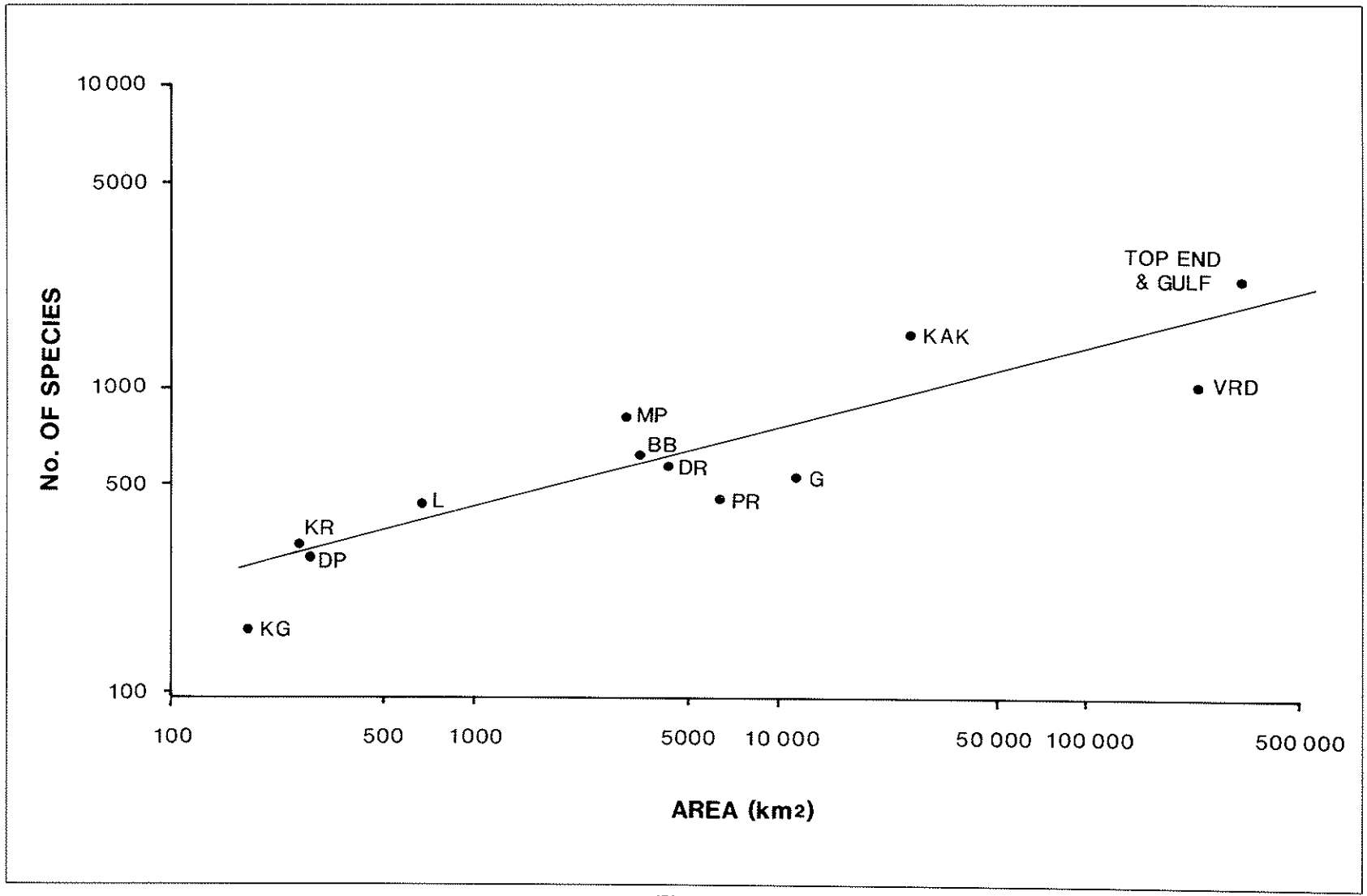

Figure 7

Regression of number of plant species against survey area for locations in north-western Australia (from Lazarides *et al.* (1988, with further data from Bowman *et al.* 1988). The line is that from Lazarides *et al.* Abbreviations: KG = Katherine Gorge, KR = Keep River, DP = Dampier Peninsula, L = Litchfield, MP = Mitchell Plateau, BB = Bungle Bungle, DR = Drysdale River, PR = Prince Regent River, G = Gregory, KAK = Kakadu, VRD = Victoria River District.

Table 4

Introduced plant species recorded in the Bungle Bungle area. Floristic groups (see pp 16-20) in which they are recorded are listed in order of decreasing frequency of occurrence in quadrats.

Species	*Floristic Group*
POACEAE	
Cenchrus biflorus	4
Cenchrus ciliaris	6, 7, 4, 12
Cenchrus echinatus	7, 4, 10
Cenchrus setigerus	6, 3
Chloris inflata	3
Echinochloa colona	4, 6, 7
AMARANTHACEAE	
Aerva javanica	7, 6, 4, 11, 12, 10, 5
ASCLEPIADACEAE	
Calotropis procera	7, 4, 6
ASTERACEAE	
Acanthospermum hispidum	4
CAESALPINIACEAE	
Parkinsonia aculeata	4, 7
CUCURBITACEAE	
Citrullus colocynthis	6
Citrullus lanatus	6, 4
EUPHORBIACEAE	
Euphorbia hirta	4, 2, 7, 5
MALVACEAE	
Malvastrum americanum	4
Sida acuta	7
PASSIFLORACEAE	
Passiflora foetida	2, 4, 7, 6
SOLANACEAE	
Datura inoxia	4

Chapter 4

Mammals of the Bungle Bungle Area

by
John Woinarski, Karina Menkhorst, Nick Gambold and Richard Braithwaite.

ANNOTATED SPECIES LIST

Nomenclature and order follow Strahan (1988).

'A' indicates species recorded from Argyle (Dames and Moore 1982).

'O' indicates species recorded from the Ord River survey (Kitchener 1978).

# indicates introduced species.

The survey sites where we recorded the species are given in parentheses after the scientific name. The land unit and floristic group in which the highest mean abundance was recorded is listed, except for those species where this mean maximum abundance was less than 0.1 animals per quadrat (see Tables 5 and 6).

Species not definitely recorded from the Bungle Bungle area are enclosed in square brackets.

Measurements for bats caught during the survey are listed in Table 7.

All specimens retained are now housed in the Western Australian Museum.

O. ECHIDNA *Tachyglossus aculeatus.*
(3,6,7,8).
Common and widespread throughout the Bungle Bungle area, including the Osmand Valley, though presence was more often detected by scats than by sightings of animals.

[NORTHERN QUOLL *Dasyurus hallucatus.*]
Not recorded during this survey. Nick Gambold observed a quoll on two nights in November 1986, near Piccaninny Gorge. McGonigal (1989) noted anecdotally that quolls were found in the Bungle Bungle area. Local Aborigines knew this species from the Park area, though they could not confirm its continued presence.

NINGBING ANTECHINUS *Pseudantechinus ningbing.*
(8,10).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E.aspera* low woodland-*Acacia-Triodia.*
1 trapped, 1 specimen.
One animal collected in Cathedral Gorge, one seen also in Bream Gorge, and may be widespread but in low numbers throughout the sandstone ranges.

OA. STRIPE-FACED DUNNART *Sminthopsis macroura.*
(1,3,5,9).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *E.brevifolia* open woodland-*Cassia-Plectrachne.*
6 trapped, 5 specimens.
Uncommon, mostly in sandplains with spinifex, but also recorded on cracking clays.

OA. LONG-TAILED PLANIGALE *Planigale ingrami.*
COMMON PLANIGALE *Planigale maculata.*
(1,4,6,7,8,10).
Preferred land unit: Antrim rugged uplands.
Preferred floristic group: *E.brevifolia* low open woodland-*Acacia-Triodia.*
19 trapped, 14 specimens.
Planigales were reasonably common on both rocky ridges with spinifex and loamy clay soils with tussock grasses. Apparently mature male specimens varied in weight from 3 g to 9.7 g, and exhibited a range of pelage colours. All specimens have been identified (N. Cooper and D. Kitchener, Westerm Australian Museum) as *P. maculata*, in contrast to the usual identification of planigales in the Kimberley as *P. ingrami* (e.g. Kitchener 1978; Dames and Moore 1982). *P.maculata* was not recorded from the east Kimberley by McKenzie (1981a).

[BILBY *Macrotis lagotis.*]
Not definitely recorded during this survey. A burrow unit thought to be of this species was found on a sandplain near a rocky breakaway just north of Goosehole (site 3), but had been abandoned for probably two to five years. Known by Raymond Wallaby for the Bungle Bungle area, though he was not able to confirm its continued presence.

ROCK RINGTAIL POSSUM *Pseudocheirus dahli.*
(4,8).
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
One animal and scats seen at Bream Gorge and occasional scats on the plateau of the Bungle Bungle massif. Probably widespread in gorges and rock outcrops, but at very low density. This species has not hitherto been recorded in the east Kimberley (McKenzie 1981a).

[SPECTACLED HARE-WALLABY *Lagorchestes conspicillatus.*]
Not definitely recorded. We noted a runway unit and heard a small macropod in very dense old spinifex on a low limestone ridge at site 6, but were unable to secure a specimen or locate any more substantial signs. A hare-wallaby was thought to once occur in the Park area by Raymond Wallaby.

OA. NORTHERN NAIL-TAIL WALLABY *Onychogalea unguifera.* (3,5,9).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Melaleuca* low open woodland-*Acacia-Aerva.*
Common on blacksoil plains and tussock grasslands near the Ord River.

OA. SHORT-EARED ROCK-WALLABY *Petrogale brachyotis.*
(6,8,10).
Patchily common on massif (e.g. 'Frog Hole' Gorge, 'Mini Palm' Gorge), Osmand Range (e.g. near 'Fowlhouse') and ranges in the south of the Park (site 6). No specimen was secured, so identification is based on detailed sight records (vouched by Mr. Norm McKenzie).

OA. AGILE (SANDY) WALLABY *Macropus agilis.*
(6).
We did not see this common Kimberley species in the survey area. It is mentioned as occurring in the Bungle Bungle area in the CALM Park brochure (one of only two animal species listed) and 'thought to occur in the park' by Colreavy *et al.* (1989). Our closest sight record was near the Negri (about 20 km north of the north-east corner of the Park). A dingo scat collected at site 6 contained hairs of this species.

OA. COMMON WALLAROO (EURO) *Macropus robustus.*
(3,4,5,6,7,8,10).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
Common in most habitats of the Park, other than the degraded blacksoil of the Ord River plains.

O. LITTLE RED FLYING-FOX *Pteropus scapulatus.*
(7).
Uncommon in the Park during our survey but may be seasonally common. One individual was observed by spotlight on a tributary of Osmand Creek near Mt. John and several mummified remains were found caught on barbed wire of the ninety kilometre fence. A large colony of approximately 10 000 individuals occurred in closed riparian forest at Winnama Gorge during November.

O. DUSKY HORSESHOE-BAT *Hipposideros ater.*
(6).
3 trapped, 3 specimens.
Uncommon, recorded only from the south of the Conservation Reserve at Site 6. This species uses warm humid caves and possibly also occurs in Osmand Valley.

OA. COMMON SHEATHTAIL-BAT *Taphozous georgianus.*
(4,6,10).
13 trapped, 3 specimens.
Common in sandstone caves in the Bungle Bungle massif, Osmand Valley and ranges in the south of the Park.

0. YELLOW-BELLIED SHEATHTAIL-BAT *Taphozous flaviventris.*
(9).
Uncommon, several individuals were observed by spotlight over broad plains at Kitty's Knob. This species is probably more widespread in the Park, however, its foraging strategy of flying fast above the tree canopy makes it difficult to collect.

A. NORTHERN MASTIFF-BAT *Chaerophon jobensis.*
(8).
2 trapped.
Uncommon, recorded only from Bream Gorge where a pregnant female was mist-netted at an open waterhole in November.

BECCARI'S MASTIFF-BAT *Mormopterus beccarii.*
(8).
4 trapped.
Uncommon, recorded only from an open waterhole at Bream Gorge.

LESSER LONG-EARED BAT *Nyctophilus geoffroyi.*
(7,8,9).
11 trapped, 2 specimens.
This bat was widespread and reasonably common. It was trapped most frequently in riparian forests. Females with enlarged nipples and juveniles were both recorded in late November.

NORTH QUEENSLAND LONG-EARED BAT *Nyctophilus bifax.*
(8,9)
3 trapped, 2 specimens.
Uncommon but probably widespread, this species was trapped at open waterholes fringed by riparian forest at Bream Gorge and on the Ord River at Kitty's Knob. Females collected in late November had enlarged nipples. This species has not been recorded before in the east Kimberley (McKenzie 1981a).

O. ARNHEM LAND LONG-EARED BAT *Nyctophilus arnhemensis.*
(2,5,6,8,9).
21 trapped, 4 specimens.
Common in riparian vegetation ranging from closed forests to dense *Acacia* shrublands. Females with enlarged nipples were recorded in late November.

COMMON BENT-WING BAT *Miniopterus schreibersii.*
(1,4,5,6,8,10).
26 trapped, 3 specimens.
Common in sandstone habitats, especially the Bungle Bungle massif, where it roosts in caves. Males with descended testes were collected in mid-July and pregnant females in late November.

O. GOULD'S WATTLED BAT *Chalinolobus gouldii.*
(1,2,5,6,7,8,9,10)
16 trapped, 5 specimens.
Common, most frequently trapped on the edge of riparian forests. Males with descended testes were collected in June and July, females with enlarged nipples in early December.

LARGE-FOOTED MOUSE-EARED BAT *Myotis adversus.*
(10).
3 trapped, 3 specimens.
Rare. One specimen was mist-netted over a permanent creek fringed by closed forest in Winnama Gorge. Two individuals were caught in Cathedral Gorge. One male with descended testes was recorded in early December. This species was not recorded for the east Kimberley by McKenzie (1981a).

O. LITTLE BROAD-NOSED BAT *Scotorepens greyi.*
LITTLE NORTHERN BROAD-NOSED BAT *Scotorepens sanborni.*
(1,5,6,8,9,10)
114 trapped, 5 specimens.
These two taxa were not separated in the field. We collected one specimen of *S.greyi* and four of *S.sanborni.* Abundant in a wide variety of habitats throughout the Park. Males with descended testes were recorded in June and July, pregnant females in early December. *S.sanborni* was not recorded for the east Kimberley by McKenzie (1981a).

O. LITTLE CAVE BAT *Eptesicus caurinus.*
(1,4,5,6,8,10).
121 trapped, 16 specimens.
Most commonly trapped on the sandplains surrounding the Bungle Bungle massif, this species is widespread and abundant in the Park. It was observed roosting in caves and fissures in rock walls. Males with descended testes were collected throughout the survey period, females with enlarged nipples in late November and juveniles in early December.

WATER-RAT *Hydromys chrysogaster.*
(7).
Recorded only in large pools of the Mt. John tributary of the Osmand Creek.

OA. COMMON ROCK-RAT *Zyzomys argurus.*
(4,6,7,8,9,10).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E.cliftoniana* low woodland-*Cajanus-Plectrachne.*
167 trapped, 7 specimens.
Patchily very common in gorges and rocky ranges of the massif (e.g. 'Frog Hole' Gorge, plateau), Osmand Range (e.g. Winnama Gorge, Bream Gorge, Mt. John site), and scattered rocky hills in the south-west of the Park.

OA. WESTERN CHESTNUT MOUSE *Pseudomys nanus.*
(1,2,9).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E.collina* woodland-*Acacia-Triodia.*
26 trapped, 3 specimens.
Patchily common, especially on plains with sandy soils supporting woodlands and dense shrub or tussock grass cover.

DESERT MOUSE *Pseudomys desertor.*
(4,6,10).
Preferred land unit: Elder uplands.
Preferred floristic group: *E.brevifolia* low open woodland-*Acacia-Triodia.*
11 trapped, 4 specimens.
Patchily common, especially on gravelly sandy loam soils, with extensive rock cover, dense spinifex and low open tree layer. Also trapped in dense old spinifex just south of Three-ways. This species has not been recorded in the east Kimberley before (McKenzie 1981a).

OA. DELICATE MOUSE *Pseudomys delicatulus.*
(1,2,3,5,8,9).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E.collina* woodland-*Acacia-Triodia.*
25 trapped, 7 specimens.
Patchily common, especially on alluvial sands and deep sand plains, with relatively tall woodlands and dense cover of tussock grasses or spinifex.

A. KIMBERLEY MOUSE *Pseudomys laborifex.*
(6,8).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Lysiphyllum* woodland-*Carissa-Heteropogon*, *E.brevifolia* low open woodland-*Acacia-Triodia.*
4 trapped, 4 specimens.

Uncommon, recorded in slopes and gullies on sandy loam soils with extensive cover of gravel, stones or rocks and with low open woodlands above relatively dense spinifex or tussock grasses.

OA. SHORT-TAILED MOUSE *Leggadina forresti.*
(8).
Preferred floristic group: *Lysiphyllum* woodland-*Carissa-Heteropogon.*
1 trapped, 1 specimen.
Although quite common at Argyle and Ord, especially in tussock grasslands, only one was recorded in this survey. Bone fragments attributable to this species were recorded by Muir (1983) from limestone near the Bungle Bungle outcamp.

PALE FIELD-RAT *Rattus tunneyi.*
(8).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
33 trapped, 6 specimens.
Common in wet gorges, springs and dense riparian vegetation of the Osmand Valley (e.g. Bream Gorge, Winnama Gorge, Wulwuldji Spring); not recorded in the drier gorges of the massif, nor in fringing vegetation of the Ord River. The Osmand Valley may be the local southern range limit for this now mainly Torresian species. Bone fragments of this species were recorded by Muir (1983) from limestone near the Bungle Bungle outcamp. This species has been recorded rarely before from the east Kimberley (McKenzie 1981a), and Burbidge and McKenzie (1989) consider it to be declining there.

OA. DINGO *Canis familiaris dingo.*
(1,2,3,5,6,10).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E.brevifolia* open woodland-*Cassia-Plectrachne.*
Reasonably common and widespread, occurring throughout the Park other than the plateau of the massif.

#OA. FERAL CAT *Felis catus.*
(1,2,3,8,10).
Uncommon but widespread. Specimens are occasionally trapped and removed by rangers around Kurrajong camp.

#OA. HORSE *Equus caballus.*
(6,8).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Lysiphyllum* woodland-*Carissa-Heteropogon.*
Uncommon in the National Park, at least partly because of recent culling. Reasonably common in the Osmand Valley, and present also in the south-west of the Park.

#OA. DONKEY *Equus asinus.*
(1,2,3,5,6,7,8,9,10).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *Hakea* low woodland-*Dodonea-Triodia.*
Still reasonably common and widespread in the Park; extremely common in Osmand Valley Station and the south-west of the Conservation Reserve. Culling, especially in the Park area, has reduced numbers substantially over the last five years. Nonetheless, donkeys are still responsible for pronounced environmental degradation, especially in the Osmand Valley.

FERAL PIG *Sus scrofa.*
(7).
Uncommon and patchily distributed. Recorded in this survey from dense riparian vegetation of Winnama Gorge and the Mt. John tributary of the Osmand Creek. Reported also in the south-east of the Park (between the Ninety-Kilometre fence and Ord River Station). Apparently these populations are recent invaders from escaped Turkey Creek stock. Any increase in the population or range of this species may lead to serious damage of the limited dense riparian vegetation (e.g. the taro swamps of the Osmand Valley).

#A. ONE-HUMPED CAMEL *Camelus dromedarius.*
Not recorded during this survey, but a small population is known from the Park area - a group of 4 or 5 individuals was reported from between Three-ways and Bellburn Creek in December 1985 (Bob Taylor) and odd individuals have been reported since along the Ninety-Kilometre fence.

#OA. FERAL CATTLE *Bos taurus.*
(1,2,3,5,6,7,8,9).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E.opaca* low open woodland-*Grevillea-Triodia.*
Still reasonably common and widespread throughout the Park (except for the more rugged Bungle Bungle massif and other ranges), although much of the population has been culled over the last 5 years. A relatively high stocking rate of cattle in the Osmand Valley Station continues to contribute to environmental degradation.

#. FERAL WATER BUFFALO *Bubalus bubalis.*
Not recorded during this survey, though odd individuals have been reported from the Ord and Osmand units by Paul Novelly and local rangers, including one individual shot during 1989.

Notable species

Like many other medium-sized mammals, the Northern Quoll and Bilby have suffered drastic reductions in range and population size over the last century (McKenzie 1981a; Burbidge and McKenzie 1990). Custodians of the Bungle Bungle area regarded both species as formerly occurring in the region, though they had seen neither for some years. Relatively recent signs of Bilbies and sightings of Quolls (see Annotated Species List) suggest that both species were present within the last five years. However, we found no evidence for the continued survival of either species in our intensive surveys. For the Quoll, extensive areas of apparently suitable habitat persist in reasonable condition in rocky areas of the Bungle Bungle massif, Osmand Plateau and the south-west of the Conservation Reserve. For the Bilby, most of the previously suitable habitat is now degraded. These two species are probably on the brink of local extinction in the Park, if they have not already totally disappeared.

The Ningbing Antechinus was described only recently (Kitchener 1988) from sandstone outcrops and limestone ridges in the Kimberley, and its ecology remains poorly known.

The Rock Ringtail Possum has a patchy distribution in sandstone outcrops from Arnhem Land to the west Kimberley, and it is generally regarded as rare (e.g. Sawle 1988).

The Northern Nail-tail Wallaby has a wide distribution in savanna woodlands of the northern semi-arid reserve from Queensland to Western Australia, but is generally uncommon within this range. Purnululu National Park is one of the few conservation reserves or national parks where it occurs in reasonable numbers.

The Kimberley Mouse (*Pseudomys laborifex*) was described recently (Kitchener and Humphreys 1986) from Mitchell Plateau, and has since been shown to have a reasonably wide distribution in the Kimberley region, though it characteristically occurs at very low densities. Its ecological requirements remain poorly known.

The occurrence of the Desert Mouse (*Pseudomys desertor*) in the Bungle Bungle area is particularly noteworthy, as it extends the known range considerably (from the Great Sandy Desert and Tanami: Burbidge and McKenzie 1983; Gibson 1986), and it overlaps the distribution of its close relative the Western Chestnut Mouse. Little is known of the ecology of the Desert Mouse, but it has apparently undergone a dramatic reduction in range over the last century (Strahan 1988). All our records for this species were from on or adjacent to the Bungle Bungle massif or on rugged stony hills with spinifex in the south-west of the Conservation Reserve, and these relatively inaccessible areas may have escaped the massive environmental degradation of the surrounding lowlands. This stony habitat is dissimilar to habitats previously reported for this species (Finlayson 1941; Gibson 1986).

The Large-footed Mouse-eared Bat (*Myotis adversus*) occurs in a broad coastal belt from South Australia, along the east coast of Australia to the Kimberley in the west. Strahan (1988) regards this species as comparatively rare over its limited range. The distribution of *Myotis* in Australia is limited by the aridity and lack of permanent bodies of freshwater over much of the continent. Western Australian Museum records of this species are restricted to the northern Kimberley (Kitchener and Vicker 1981). *Myotis* uses its large feet to rake the surface of water to catch aquatic insects which make up the majority of its diet. The occurrence of this species in the Park is particularly notable both for its distance from the coast and its comparative aridity. One specimen was mist-netted over a permanent watercourse fringed by closed forest at Winnama Gorge, however, the other two individuals were trapped in an ephemeral watercourse of the Bungle Bungle massif. All watercourses of the Bungle Bungle massif are ephemeral and small pools of water occurring in rocky basins are relatively rare. The presence of *Myotis* in the Park represents both an inland range extension and an extension of its previously known habitat.

Six species recorded in this survey have not been recorded in the east Kimberley before (Kitchener 1978; McKenzie 1981a; Dames and Moore 1982): *Planigale maculata, Pseudocheirus dahli, Nyctophilus bifax, Scotorepens sanborni, Myotis adversus and Pseudomys desertor.*

Additional species

Five bat species known from the Ord River (Kitchener 1978) and/or Argyle (Dames and Moore 1982) areas were not recorded in this survey of the Bungle Bungle area: Black Flying-Fox *Pteropus alecto*, Ghost Bat (*Macroderma gigas*, Orange Horseshoe Bat (*Rhinonicteris aurantius*, Hoary Bat (*Chalinolobus nigrogriseus*) and Little Northern Mastiff-bat (*Mormopterus loriae*). The Black Flying-Fox is a partly nomadic species and may at times follow the fruiting or flowering of plants along watercourses into the Bungle Bungle area. The Ghost Bat and Orange Horseshoe Bat are cave-dwelling species and regarded as rare or declining (Churchill *et al.* 1988; Jolly 1988; Churchill and Helman 1990). Although we visited many caves in the Bungle Bungle massif and Osmand Valley, many others proved inaccessible and may well be inhabited by these species. The Hoary Bat is a common species across northern Australia and its absence from our survey is surprising.

We did not record the House Mouse (*Mus musculus*) during this survey, although it is known from around homesteads and pastures in the Ord River area (Kitchener 1978) and much of the Kimberley (e.g. McKenzie 1981a, 1983). The Long-haired Rat (*Rattus villosissimus*), which has a mainly inland distribution, has been recorded from recent skeletal material in the Ord River area (Kitchener 1978) and may occur in the Bungle Bungle area during outbreaks.

The Scaly-tailed Possum (*Wyulda squamicaudata*) was described from an animal from Violet Valley Aboriginal Reserve near Turkey Creek, though the provenance of this specimen is perhaps dubious as it appears now to be restricted to higher rainfall areas of near coastal north Kimberley (Strahan 1988).

Red Kangaroos *(Macropus rufus)* have been reported from just south of Ord River Station (Hadden[2] personal communication), and may occasionally occur on sandy plains in the south of the Park and Conservation Reserve.

The Antilopine Wallaroo (*Macropus antilopinus*) is known from the east Kimberley as far south as the Negri (Parker 1973), a record omitted by McKenzie (1981a). It may well occur in the taller open forests of Texas Downs and the north of the National Park.

Bandicoots were known from the Bungle Bungle area (Wallaby[3] personal communication; Colreavy *et al.* 1989), but their continued presence is uncertain. Either or both Golden Bandicoot (*Isoodon auratus*) and Northern Brown Bandicoot (*Isoodon macrourus*) could have occurred in the area. These species have declined or disappeared from much of northern Australia over the last century (McKenzie 1981a), at least partly because of the effects of the grazing industry (Kitchener 1978).

The arboreal Brush-tailed Phascogale (*Phascogale tapoatafa*), Sugar Glider (*Petaurus breviceps*) and Northern Brushtail Possum (*Trichosurus arnhemensis*) may also be present in the taller open forests of the Bungle Bungle area, particularly of the Osmand Valley, or have existed there until recent times. These species have apparently disappeared from the south-west Kimberley over the last century (McKenzie 1981a).

Patterns within the Bungle Bungles

The number of species of mammal recorded per site varied from eight to 21 (Table 8). The richest sites were those adjacent to the massif or other rocky ranges (Bream Gorge, the south-west of the Conservation Reserve, and Piccaninny Gorge). The plateau of the massif (site 4) had relatively few species. Bream Gorge had the most species which were restricted to only one site.

The diversity of mammal species varied widely between land units (Table 9). Headley lower slopes, Wickham uplands, Antrim uplands and Elder cuestas had the highest average number of native mammal species per quadrat. The lowland units Nelson low rises and Antrim lowlands had few mammal species per quadrat, and Nelson low slopes and frontages had no native mammal species, although few quadrats in these units were sampled.

Mammal species with a predominantly Eyrean distribution were restricted mostly to Antrim, Buchanan and Elder land units. Introduced species were most abundant and diverse in Nelson, Headley and Wickham units.

The upland land units - Elder uplands, Buchanan uplands and Wickham uplands - and Buchanan frontage had a distinctive mammal fauna including Desert Mouse, Common Planigale, Ningbing Antechinus, Common Rock-rat, Kimberley Mouse, Rock Ringtail Possum and Short-eared Rock Wallaby (Table 5). Lush vegetation along watercourses and gorges of the Wickham unit also contained Feral Pig and Pale Field-Rat. Euros were also relatively abundant in these upland units, but occurred also in the lower slopes of Headley, Antrim and Elder units. Feral donkeys and cattle were distributed throughout most land units, though were comparitively rare in the upland units. The Delicate Mouse and Western Chestnut Mouse were most abundant in the Buchanan sandplains. The Northern Nail-tail Wallaby was most abundant on Nelson cracking clay plains, but occurred also on tussock grasslands of Nelson low rises and on lower slopes of the Antrim and Elder units.

Mammal species diversity also varied substantially between floristic groups (Table 10). Floristic groups *Livistona* open forest-*Acacia-Germania, E. ptychocarpa* forest-*Pandanus-Heteropogon, Lysiphyllum* woodland-*Carissa-Heteropogon* and *Hakea* low woodland-*Dodonea-Triodia* had the most mammal species per quadrat: groups *E. cliftoniana* low open woodland-*Acacia-Triodia, E. collina* woodland-*Acacia-Triodia* and *E. collina* woodland-*Acacia-Plectrachne* had the fewest. Introduced species were especially abundant and diverse in floristic groups *E. ptychocarpa* forest-*Pandanus-Heteropogon, Lysiphyllum* woodland-*Carissa-Heteropogon, E. opaca* low open woodland-*Grevillea-Triodia, Hakea* low woodland-*Dodonea-Triodia, Lysiphyllum* low woodland-*Acacia-Cenchrus* and *Melaleuca* low open woodland-*Acacia-Aerva*. Eyrean species were most diverse in floristic groups *E. brevifolia* low open woodland-*Acacia-Triodia, E. brevifolia* open woodland-*Cassia-Plectrachne, E. cliftoniana* low open woodland-*Acacia-Triodia* and

[2] D. Hadden - Western Australian Department of Agriculture, Ord River Station

[3] R. Wallaby - Pumululu Aboriginal Corporation

Acacia spp. tall shrubland-*Triodia*, but were absent from most floristic groups. The highest numbers of Torresian mammal species were in floristic groups *Livistona* open forest-*Acacia-Germania, E. brevifolia* low open woodland-*Acacia-Triodia, E. aspera* low woodland-*Acacia-Triodia* and *E. cliftoniana* low woodland-*Cajanus-Plectrachne*.

The distribution of mammal species across floristic groups (Table 6) largely recapitulated the distribution across land units (Table 5).

The occurrence of four species of *Pseudomys* (and the closely related *Leggadina*) in one area is unusual. The two smaller species (Delicate Mouse and Kimberley Mouse) and the two larger species (Western Chestnut Mouse and Desert Mouse) appear to be segregated by habitat (Table 11). The Desert Mouse and Kimberley Mouse occurred in low woodlands or shrublands with extensive spinifex, rock and gravel cover. The Western Chestnut Mouse and Delicate Mouse preferred open forest or woodland flats with sandy soil, relatively abundant tussock grass and little cover of rocks or gravel.

Biogeographic patterns

Thirty-four native mammal species and seven introduced mammal species are now known from the Bungle Bungle area. This is a rich assemblage, being surpassed by only Mitchell Plateau, Kakadu Stages I and II, and Kakadu Stage III of the 16 other regional surveys available in north-western Australia (Fig. 8). Torresian species and species with relatively widespread distributions dominate the mammal fauna, with only two native species (Desert Mouse and Stripe-faced Dunnart) having a principally Eyrean distribution.

The mammal fauna of the Bungle Bungle area is most similar to that of the Ord River region, Drysdale and Stage III of Kakadu (Fig. 8). It has little similarity with the mammal faunas of the Great Sandy Desert, Tanami, Hamersley and three Top End areas where the survey was least detailed - Umbrawara, Katherine Gorge and Coburg Peninsula. Indeed, survey procedure (trapping techniques and effort, especially for bats) has a gross influence on the composition and comprehensiveness of any mammal species list.

Ordination of the available mammal species lists shows the dominant influence of the rainfall gradient (Fig. 9). The four sites with lowest rainfall - Tanami, Great Sandy Desert, Hamersley and Edgar Ranges - are clearly segregated from all other sites. The mammal species composition undergoes its most substantial change with the rainfall drop from the Bungle Bungle area (c 600 mm) to the Edgar Ranges (c 500 mm). Within the higher rainfall sites, the Bungle Bungle area is grouped with Argyle, Ord and Drysdale. The second axis of the ordination loosely separates Kimberley sites from those of the Top End, although the positions of Katherine Gorge and Dampier Peninsula are anomalous.

As foreshadowed by McKenzie (1981a), the fauna of the east Kimberley region has very strong affinities with that of the Phanerozoic south-west Kimberley, matching in part the similarity between these two areas in climate, topography and geological history. Re-analysing his data to include our records from the Bungle Bungle area, and using the similarity index we describe earlier, the extant south-west Kimberley fauna is more similar to that of the geographically distant east Kimberley (S.I.=72.7) than to the adjacent north Kimberley (68.0) or Sandy Deserts (53.8). Both the south-west Kimberley and the Bungle Bungle area occupy transition zones between the Torresian and Eyrean biogeographic regions, although both contain more Torresian mammal species.

Related to the change in mammal species composition along this moisture gradient, the Bungle Bungle area marks an approximate inland (southern) local range limit for several Torresian species: Pale Field Rat (although this species had a much more extensive distribution in the recent past), Ningbing Antechinus, Short-eared Rock-wallaby, Rock Ringtail Possum, Agile Wallaby, Dusky Horseshoe Bat, Common Bent-wing Bat, Large-footed Mouse-eared Bat, North Queensland Long-eared Bat, Arnhem Land Long-eared Bat, Common Rock-Rat and Kimberley Mouse. The occurrence of the Desert Mouse also represents a northern range limit for this inland species.

The overall trapping success for small mammals was low (1.4 per cent per trapnight for Elliott and cage traps, and 2.8 per cent per pitfall trapnight), compared with other surveyed areas in north-western Australia (e.g. Great Sandy Desert (Burbidge and McKenzie 1983) 0.8 per cent for Elliotts and 69.4 per cent for pitfalls; Tanami (Gibson 1986) 3.9 per cent for Elliotts and 35.8 per cent for pitfalls; Mitchell Plateau (Bradley *et al.* 1987) 3.1 per cent for Elliotts and cage-traps). This low abundance of small mammals was particularly marked for the more degraded land units: Antrim lower slopes (0 and 1.2 per cent), Nelson low rises (0 and 0 per cent), Nelson lower slopes (0 and 0 per cent), Nelson frontages (0 and 0 per cent), Headley lower slopes (1.0 and 0 per cent), Buchanan uplands (0.2 and 0 per cent) and Buchanan frontage (0.5 and 1.1 per cent). Trapping success for small mammals was better in Wickham (6.1 and 1.0 per cent), Elder cuestas (0 and 4.2 per cent), Buchanan sandplains (1.8 and 11.3 per cent), Antrim uplands (1.9 and 6.9 per cent) and Elder uplands (1.8 and 2.1 per cent). The mean number of small mammals caught per quadrat was significantly correlated with degradation score across land units ($r = 0.60$, $p < 0.05$, $N = 13$): small mammals become increasingly rare in more degraded land units.

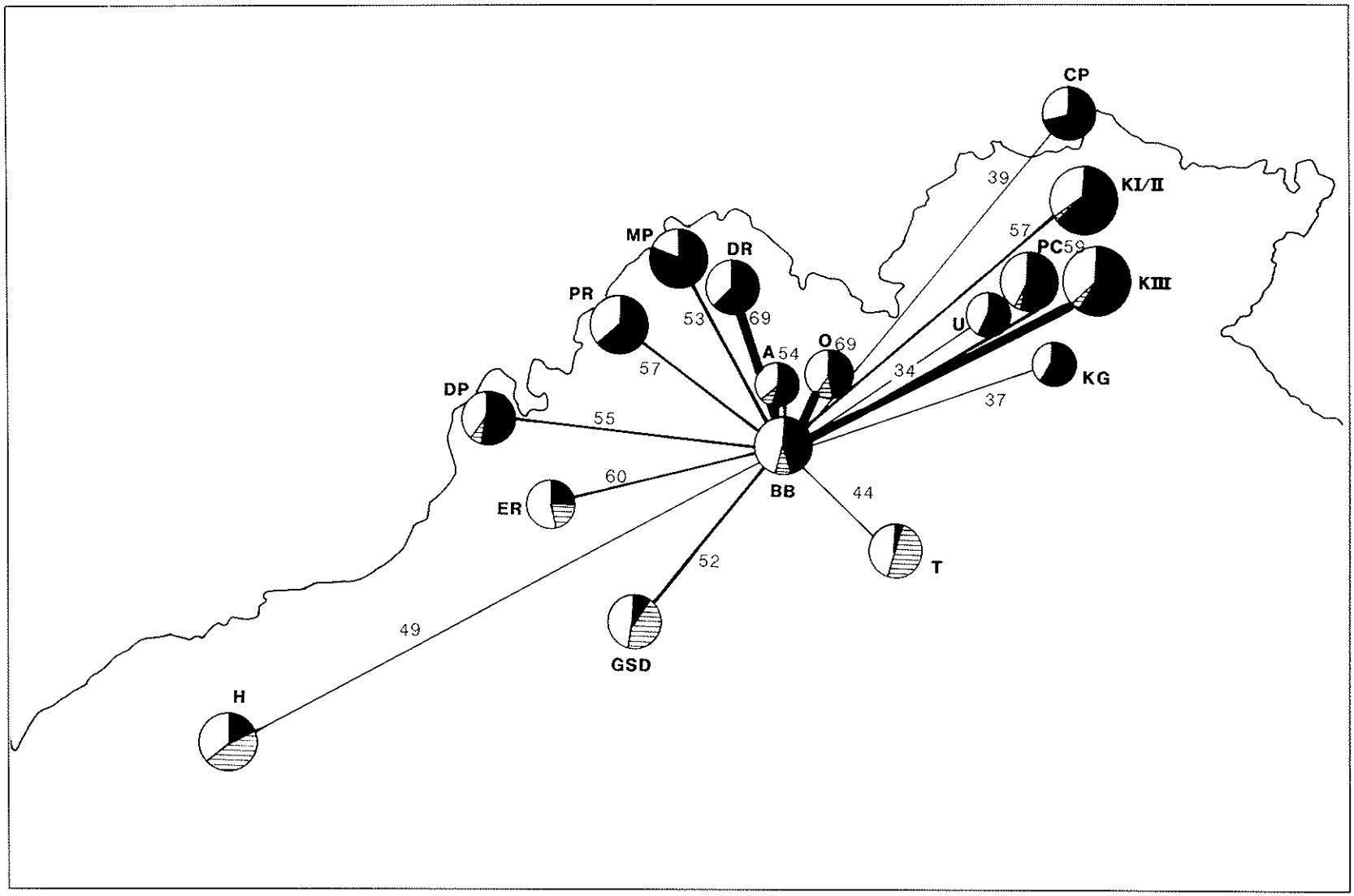

Figure 8

Network diagram showing similarity of the native mammal fauna of the Bungle Bungle area to other surveyed regions of north-western Australia. Similarity values are given and represented by the thickness of connecting lines. The proportion of Torresian species recorded is represented by black, of Eyrean species by horizontal lines, and widespread species are unshaded. The size of the circle is proportional to the number of species recorded: H (Hamersley) = 33; DP (Dampier Peninsula) = 29; ER (Edgar Range) = 24; GSD (Great Sandy Desert) = 29; PR (Prince Regent River) = 34; MP (Mitchell Plateau) = 39; DR (Drysdale) = 28; BB (Bungle Bungle) = 34; A (Argyle) = 15; O (Ord) = 25; T (Tanami) = 30; U (Umbrawara) = 14; KG (Katherine Gorge) = 16; PC (Pine Creek) = 32; KIII (Stage III of Kakadu) = 55; KI/II (Stages I & II of Kakadu) = 58; CP (Cobourg Peninsula) = 27.

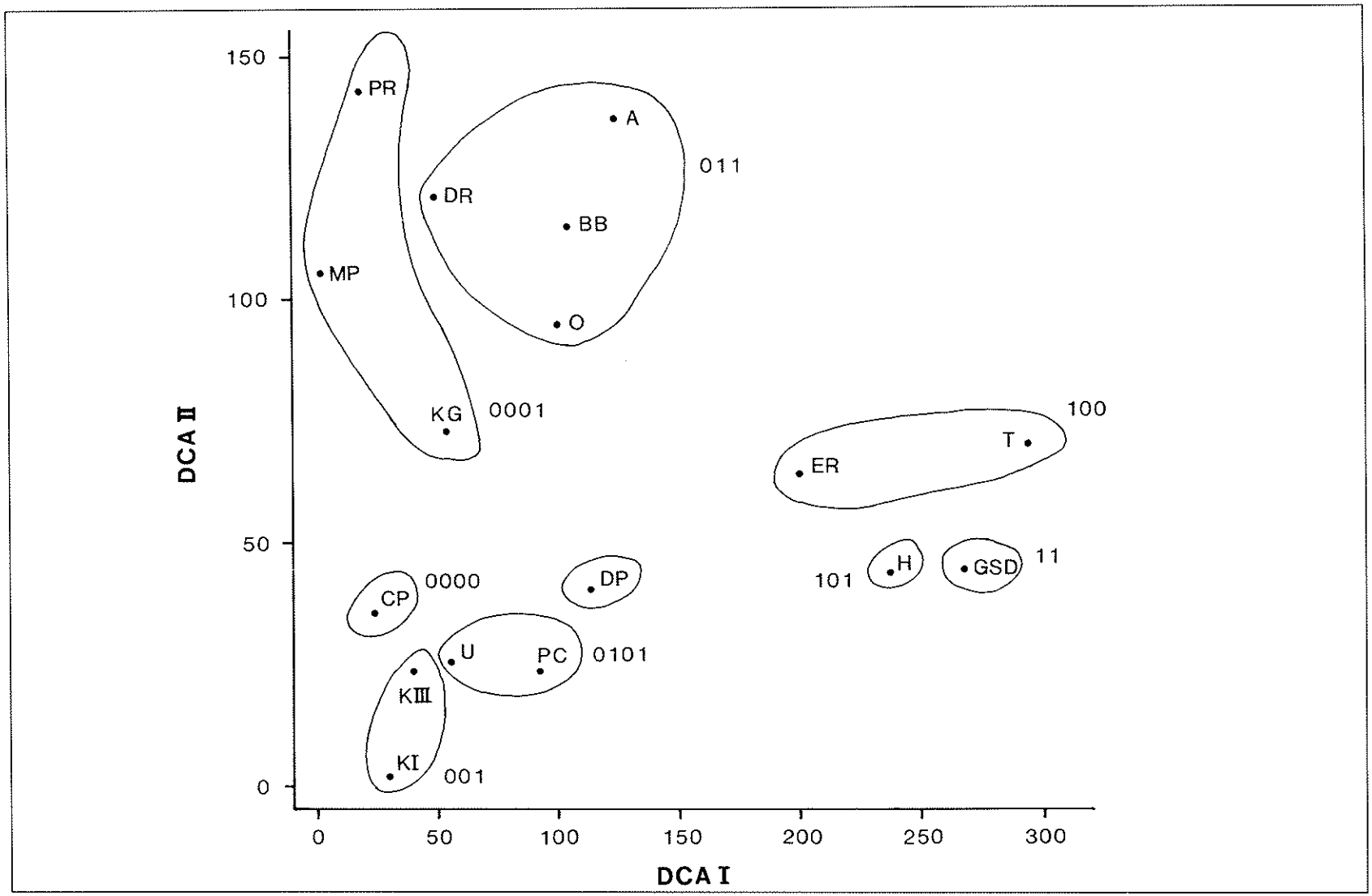

Figure 9

Ordination of the native mammal faunas of 17 areas surveyed in north-western Australia. Lines enclosing points represent TWINSPAN groups. Symbols as for Figure 8. Eigenvalues for DCA 1 0.48, for DCA 2 0.13.

Table 5

Distribution of mammal species across land systems [a]. Values in body of table are average abundance per quadrat. Asterisks denote proportion of quadrats per unit in which the species was recorded: *>25%, **>50%, ***>75%.

SPECIES	LAND SYSTEM												
	Eu	*Bf*	*Bu*	*Au*	*Bp*	*Hl*	*Ns*	*Al*	*El*	*Nr*	*Wk*	*Nl*	*Nf*
Pseudantechinus ningbing	.14												
Pseudomys desertor	.38	.14	.14	.17									
Planigale maculata	.25	.14		.42*	.29						.11		
Zyzomys argurus	1.00*	.29*		1.33		.80**	.25*				2.40**		
Macropus robustus	.09*	.03*	.09***	.08**		.10***		.01	.09***				
Equus asinus			.04*	.05*	.06	1.28***	.10***	.03*		.10***	.19**	.10***	.10***
Bos taurus				.03*		.10***	.10***	.35	.02	.06**	.05**	.10***	.10***
Sminthopsis macroura				.08	.06		.25*	.05	.20				
Pseudomys delicatulus				.13	1.00*			.10	.30				
Pseudomys nanus					1.47*		.25*						
Canis familiaris						.08***		.02	.22*				
Onychogalea unguifera							.05*	.01	.01	.03*			
Felis cattus								.01	.03*	.02			
Pseudomys laborifex			.08								.09		
Tachyglossus aculeatus									.01		.02		
Leggadina forresti											.03		
Rattus tunneyi											.54		
Equus caballus											.15		
Sus scrofa											.01		
Petrogale brachyotis											.01		
Pseudocheirus dahli											.03		

[a] Land systems: Eu = Elder uplands, Bf = Buchanan frontage, Bu = Buchanan uplands, Au = Antrim rugged uplands, Bp = Buchanan Sandplain, Hl = Headley lower slopes, Ns = Nelson cracking clay plains, Al = Antrim lowlands, El = Elder cuestas, Nr = Nelson low rises, Wk = Wikham rugged uplands, Nl = Nelson interfluve lower slopes, Nf = Nelson frontage

Table 6

Distribution of mammal species across floristic groups [a]. Values in body of table are average abundance per quadrat. Asterisks denote proportion of quadrats per group in which the species was recorded: *>25%, **>50%, ***>75%.

SPECIES	FLORISTIC GROUP																
	1	*14*	*13*	*2*	*5*	*11*	*16*	*15*	*17*	*12*	*4*	*7*	*6*	*10*	*8*	*9*	*3*
Rattus tunneyi	3.0**			0.4	0.2												
Pseudocheirus dahli	0.2																
Petrogale brachyotis	p				p												
Zyzomys argurus	4.8***	6.8***	3.2*	0.6*	1.0*	0.8**	0.9*	1.3***		0.1	0.1		0.1				
Planigale maculata	0.2	0.2	1.0**				0.2			0.1					0.3*	0.5*	
Tachyglossus aculeatus	p	p*		p	p									p			
Macropus robustus	0.8***	0.1***	0.1**	0.1**		0.4***	0.1***	0.1*	0.1***	0.1**	0.1**	0.1	p		0.1**		p
Equus asinus		p		p*	0.5***	1.3***			p*	0.1***	p*	0.1***	0.1***				0.1 p*
Pseudomys desertor			0.4*				0.4		0.3*								
Pseudomys laborifex			0.2		0.2					0.1							
Equus caballus				p	0.4*												
Bos taurus				0.1**	0.1**	0.1**				0.6**	p*	p	0.1***	p			p
Sus scrofa				p*							p						
Leggadina forresti					0.1												
Canis familiaris						0.1***				p	p	p	p	0.2*			
Parantechinus ningbing								0.3*									
Onychogalea unguifera										p		0.1**	p*				
Pseudomys delicatulus										0.1	0.1			0.5*	1.1*	0.5*	
Sminthopsis macroura										0.1			0.1	0.2	0.1		
Felis catus											p	p	p	p			
Pseudomys nanus													0.1	0.2	1.9*	0.9*	

[a] Descriptions of floristic groups: 1 = *Livistona - Acacia - Germania*, 14 = *E. cliftoniana - Cajanus - Plectrachne*, 13 = *E. brevifolia - Acacia - Triodia*, 2 = *E. ptychocarpa - Pandanus - Heteropogon*, 5 = *Lysiphyllum - Carissa - Heteropogon*, 11 = *Hakea - Dodonea - Triodia*, 16 = *E. cliftoniana - Acacia - Triodia*, 15 = *E. aspera - Acacia - Triodia*, 17 = *Acacia-Triodia*, 12 = *E.opaca - Grevillea - Triodia*, 4 = *Melaleuca - Acacia - Aristida*, 7 = *Acacia - Aerva - Aristida*, 6 = *Lysiphyllum - Acacia - Cenchrus*, 10 = *E. brevifolia - Cassia - Plectrachne*, 8 = *E. collina - Acacia - Triodia*, 9 = *E. collina - Acacia -Plectrachne*, 3 = *E. camaldulensis/Melaleuca - Aerva - Aristida*.

Table 7

Forearm measurements (mm) of bat species trapped during the survey; giving mean (number measured; range).

Species	*Female*	*Male*
Hipposideros ater	36.4(2;36.2-36.6)	37.4 (1)
Taphozous georgianus	65.2(2;64.6-65.7)	65.5 (1)
Chaeropon jobensis	50.5(1)	- -
Mormopteris beccarii	37.8(2;37.4-38.2)	37.0(2;36.7-37.2)
Nyctophilus geoffroyi	35.2(5;32.8-37.4)	34.2(4;33.3-35.0)
Nyctophilus bifax	41.2(3;40.5-41.6)	- -
Nyctophilus arnhemensis	39.0(10;37.7-41.0)	37.6(10;36.0-39.2)
Miniopteris schreibersii	44.0(4;43.3-44.8)	44.5(7;43.6-45.6)
Chalinolobus gouldii	38.8(4;37.4-39.5)	37.5(11;35.4-39.4)
Myotis adversus	38.8 (1)	38.0(2;37.5-38.5)
Scotorepens greyii/sanborni	31.1(63;28.5-33.5)	30.8(38;27.1-32.8)
Eptesicus caurinus	30.4(56;28.0-33.2)	29.3(62;27.4-30.9)

Table 8

The number of mammal species recorded per study site, and the number of these recorded from only one site (i.e. restricted species). Introduced species are included in parentheses.

Site	*No. mammal species*	*No. restricted species*	
1	12 (3)	0	
2	8 (3)	0	
3	9 (3)	0	
4	8 (0)	0	
5	12 (2)	0	
6	18 (3)	1	*Hipposideros ater*
7	11 (3)	2	*Sus scrofa, Hydromys chrysogaster*
8	21 (3)	4	*Leggadina forresti, Rattus tunneyi, Chaerophon jobensis, Mormopterus beccarii*
9	12 (2)	0	
10	15 (2)	2	*Pseudantechinus ningbing, Myotis adversus*

Table 9

Average number of mammal species per quadrat for the land systems surveyed.

LAND SYSTEM		SYMBOL	NO. QUADRATS	NO. MAMMAL SPP.	NO. NATIVE MAMMAL SPP.		
					Total	*Torresian*	*Eyrean*
ANTRIM	rugged uplands	Au	12	2.42	1.67	0.67 (40.1%)	0.25 (15.0%)
ANTRIM	lowlands	Al	21	1.10	0.52	0.24 (46.2%)	0.05 (9.6%)
BUCHANAN	uplands	Bu	7	1.43	1.00	0	0.14 (14.0%)
BUCHANAN	sandplain	Bp	17	1.24	1.18	0.71 (60.2%)	0.06 (5.1%)
BUCHANAN	frontage	Bf	7	1.00	1.00	0.57 (57.0%)	0.14 (14.0%)
ELDER	uplands	Eu	16	1.13	1.13	0.63 (55.8%)	0.19 (16.8%)
ELDER	cuestas	El	10	2.40	1.90	0.30 (15.8%)	0.20 (10.5%)
HEADLEY	lower slopes	Hl	5	4.40	2.40	0.60 (25.0%)	0
NELSON	cracking clay plains	Ns	4	3.25	1.25	0.75 (60.0%)	0.25 (20.0%)
NELSON	interfluve lower slopes	Nl	1	2.00	0	0	0
NELSON	frontage	Nf	3	2.00	0	0	0
NELSON	low rises	Nr	12	2.08	0.33	0.33 (100%)	0
WICKHAM	rugged uplands	Wk	35	3.54	2.20	0.89 (40.5%)	0

Table 10

Average number of mammal species per quadrat for the floristic groups.

FLORISTIC GROUP	NO. MAMMAL SPP.	NO. NATIVE MAMMAL SPP.		
		Total	*Torresian*	*Eyrean*
1. *Livistona - Acacia holosericea - Germania*	3.6	3.6	1.6 (44%)	0
2. *E. ptychocarpa - Pandanus - Heteropogon*	3.4	1.6	0.4 (25%)	0
3. *E. camaldulensis / Melaleuca - Aerva - Aristida*	1.0	0.3	0	0
4. *Melaleuca leucadendra - Acacia eriopoda - Aristida*	1.2	0.4	0.2 (39%)	0
5. *Lysiphyllum - Carissa - Heteropogon*	3.9	2.0	0.8 (38%)	0
6. *Lysiphyllum - Acacia holosericea - Cenchrus*	2.5	0.6	0.3 (50%)	0.1 (13%)
7. *Acacia farnesiana - Aerva - Aristida*	2.4	1.0	0.8 (80%)	0
8. *E. collina - Acacia stipuligera - Triodia spicata*	1.1	1.1	0.6 (50%)	0.1 (12%)
9. *E. collina - Acacia tumida - Plectrachne pungens*	1.2	1.1	0.8 (75%)	0
10. *E. brevifolia - Cassia - Plectrachne pungens*	2.0	1.6	0.3 (16%)	0.2 (11%)
11. *Hakea arborescens - Dodonea - Triodia wiseana*	4.4	2.4	0.6 (25%)	0
12. *E. opaca - Grevillea pyramidalis - Triodia pungens*	2.6	1.2	0.4 (36%)	0.1 (12%)
13. *E. brevifolia - Acacia retivenia - Triodia intermedia*	2.6	2.6	1.4 (54%)	0.4 (15%)
14. *E. cliftoniana - Cajanus - Plectrachne pungens*	2.7	2.5	1.2 (47%)	0
15. *E. aspera - Acacia eriopoda - Triodia microstachya*	2.3	2.3	1.3 (57%)	0
16. *E. cliftoniana - Acacia spp - Triodia spicata*	1.0	1.0	0.5 (50%)	0.2 (20%)
17. *Acacia spp - Triodia spicata*	1.4	1.0	0	0.3 (29%)

Table 11

Environmental variables of quadrats where six small mammals were captured.

		SPECIES					
		Pseudomys delicatulus	*Pseudomys laborifex*	*Pseudomys nanus*	*Pseudomys desertor*	*Sminthopsis macroura*	*Planigale maculata*
NO. OF QUADRATS		*13*	*4*	*8*	*7*	*6*	*14*
% Rock cover:	: mean (s.d.)	9.2 (22.0)	78.8 (25.9)	4.4 (10.5)	68.6 (40.5)	33.3 (45.9)	58.9 (40.7)
	range	0 - 80	40 - 95	0 - 30	0 - 95	0 - 95	0 - 95
% Tree cover (>8m)	: mean (s.d.)	9.6 (7.2)	1.3 (2.5)	7.5 (4.6)	0	5.0 (4.5)	4.3 (6.8)
	range	0 - 30	0 - 5	0 - 15		0 - 10	0 - 20
% Tree cover (2-8m)	: mean (s.d.)	3.8 (4.9)	7.5 (8.7)	2.5 (3.4)	3.6 (2.4)	3.2 (3.7)	3.0 (3.1)
	range	0 - 15	0 - 20	0 - 10	0 - 5	1 - 10	0 - 10
% Shrub cover (>2m)	: mean (s.d.)	7.0 (9.4)	1.5 (2.4)	14.4 (11.5)	8.7 (6.0)	6.0 (7.9)	6.3 (8.7)
	range	0 - 30	0 - 5	0 - 30	1 - 20	0 - 20	0 - 30
% Shrub cover (<2m)	: mean (s.d.)	4.2 (3.2)	9.0 (8.2)	7.0 (3.5)	10.9 (7.1)	3.2 (3.7)	6.9 (5.2)
	range	1 - 10	1 - 20	1 - 10	1 - 20	1 - 10	1 - 20
% Tussock grass cover	: mean (s.d.)	16.3 (16.6)	13.3 (24.5)	19.0 (20.9)	1 (-)	14.5 (14.6)	2.1 (2.7)
	range	1 - 60	1 - 50	1 - 60	1	1 - 40	0 - 10
% Spinifex cover	: mean (s.d.)	24.6 (16.6)	40.0 (21.6)	32.5 (15.8)	66.4 (14.9)	35.0 (12.2)	42.1 (20.1)
	range	0 - 50	10 - 60	0 - 50	40 - 85	20 - 50	0 - 70
% Gravel cover	: mean (s.d.)	1.7 (6.1)	24.8 (26.8)	0.3 (0.7)	3.9 (24.9)	15.0 (24.3)	28.8 (29.1)
	range	0 - 22	0 - 56	0 - 2	0 - 61	0 - 56	0 - 70
No. plant spp/quadrat	: mean (s.d.)	28.1 (8.1)	17.8 (8.8)	24.5 (7.5)	15.9 (10.6)	29.0 (11.8)	19.9 (8.8)
	range	15 - 45	7 - 25	15 - 34	7 - 31	18 - 44	7 - 33
Soil texture (no. quadrats)							
sand		-	-	-	-	1	1
loamy sand		7	-	-	1	1	1
clayey sand		-	-	-	1	-	-
sandy loam		6	1	5	3	2	7
light sandy clay loam		-	2	-	1	-	3
sandy clay loam		-	1	1	1	2	2
Land form (no. quadrats)							
ridge		-	-	-	-	-	2
slope		1	2	-	2	1	4
flat		11	-	8	4	2	5
gully		1	2	-	1	3	3
Vegetation formation (no. quadrats)							
open forest		1	-	-	-	-	1
woodland		7	-	4	-	2	3
open woodland		3	-	3	-	1	1
low woodland		1	1	1	-	1	-
low open woodland		1	2	-	5	2	6
tall shrubland		-	-	-	1	-	2
shrubland		-	1	-	1	-	1

Chapter 5

Birds of the Bungle Bungle Area

by
John Woinarski

ANNOTATED SPECIES LIST

Species names and order follow Blakers *et al.* (1984).

* indicates species previously recorded in the Bungle Bungle National Park by Bob Taylor (Colreavy *et al.* 1989).

'A' indicates species recorded from Argyle (Dames and Moore 1982).

'R' indicates species recorded in Blakers *et al.* (1984) from the one degree block (17 to 18 S, 128 to 129 E) mostly comprising the Bungle Bungle area.

The survey sites where we recorded species are given in brackets after the scientific name. The land unit and floristic group in which the highest mean abundance was recorded is listed, except where this maximum mean abundance was less than 0.1 animals per quadrat (see Tables 12 and 13).

Two additional species recorded by J R Ford in April 1986 are listed.

Species not definitely recorded from the Bungle Bungle area are listed in square brackets.

Comments on the wider distribution of species within the Kimberley region are from Storr (1980).

*A EMU *Dromaius novaehollandiae.*
(1,9).
In low density throughout the Bungle Bungle area, except for the massif. Storr: Widespread but generally scarce in the Kimberley.

* HOARY-HEADED GREBE *Poliocephalus poliocephalus.*
Not recorded during this survey. Bob Taylor recorded this species in pools of Red Rock Creek near Echidna Chasm just after the end of the wet season of 1986. Storr: Status uncertain, perhaps a rare winter visitor to the south of the Kimberley Division.

[AUSTRALASIAN GREBE *Tachybaptus novaehollandiae.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Moderately common in southern and eastern flatlands, especially about the lower and middle courses of major streams (Fitzroy, Ord and Sturt).]

*AR AUSTRALIAN PELICAN *Pelecanus conspicillatus.*
(9).
Several flocks (5 to 15 birds) recorded along the Ord River (e.g. near Kitty's Knob). Storr: moderately common in open freshwater throughout the Kimberley.

*R DARTER *Anhinga melanogaster.*
(5,7).
Preferred land unit: Wickham rugged uplands.
Recorded on most larger pools of the Ord River and Osmand Creek. Storr: Moderately common in eastern and southern flatlands, scarce or uncommon further north.

R LITTLE BLACK CORMORANT *Phalacrocorax sulcirostris.*
(5,7,9).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Common in small groups on pools of the Ord River and Osmand Creek. Storr: Moderately common in southern and eastern flatlands, especially about the lower courses of major streams, scarce in hilly north Kimberley.

*R LITTLE PIED CORMORANT *Phalacrocorax melanoleucos.*
(7,9).
Common in small groups on pools of the Ord River. Storr: Common on Lake Argyle, scarce to moderately common elsewhere.

*AR PACIFIC HERON *Ardea pacifica.*
(5,6,7).
Solitary birds seen around pools of Ord River and tributaries of the Panton. Storr: Moderately common in southern and eastern flatlands, scarce or uncommon in hilly north Kimberley.

*AR WHITE-FACED HERON *Ardea novaehollandiae.*
(2).
Solitary birds seen around pools on the Ord River and Osmand Creek. Storr: Moderately common in southern and eastern flatlands, scarce or uncommon in hilly north Kimberley.

[CATTLE EGRET *Ardeola ibis.*
Recorded by Storr at Old Lissadell.] Breeding lower Ord, Lake Kununurra (Jaensch 1988).

*R GREAT EGRET *Egretta alba.*
(5,9).
Solitary birds seen around pools of Ord River. Storr: Very common at Lake Argyle, moderately common elsewhere in southern and eastern flatlands and locally on coasts, uncommon in hilly north Kimberley.

LITTLE EGRET *Egretta garzetta.*
(9).
Solitary birds seen around pools of Ord River near Kitty's Knob. Storr: Moderately common in north-east and locally on coasts, uncommon elsewhere.

*AR RUFOUS NIGHT HERON *Nycticorax caledonicus.*
(5,6,7,9).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Reasonably common around pools of Ord River and Osmand Creek, especially in areas with dense riparian vegetation. Storr: Very common in eastern and southern flatlands about lower and middle courses of larger streams, uncommon in hilly north Kimberley.

* BLACK BITTERN *Dupetor flavicollis.*
(5,7).
Reasonably common around springs (e.g. Wulwuldji) and pools of Ord River and Osmand Creek, where dense riparian vegetation persists. Storr: uncommon to moderately common.

*AR BLACK-NECKED STORK (JABIRU) *Xenorhynchus asiaticus.*
(2,9).
Solitary birds about pools of Ord River and Osmand Creek. Storr: Moderately common on lower courses of larger rivers and locally on coast, but generally uncommon.

[GLOSSY IBIS *Plegadis falcinellus.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Nomadic, locally and seasonally common but generally uncommon in freshwater swamps and pools, about the lower Ord River (upstream to Argyle Downs).]

[R SACRED IBIS *Threskiornis aethiopica.*
Storr: Nomadic, locally common but generally uncommon to moderately common throughout the Kimberley.]

[A STRAW-NECKED IBIS *Threskiornis spinicollis.*
Recorded on farm dam near Lissadell homestead (Dames and Moore 1982). Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Kilgour (1904) recorded it in flocks of 'tens of thousands' at Ord River Station in 1903. Storr: Common to moderately common in southern and eastern flatlands, scarce in hilly north Kimberley.]

[ROYAL SPOONBILL *Platalea regia.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Moderately common in eastern and southern flatlands, about the lower courses of major streams; scarce elsewhere.]

[YELLOW-BILLED SPOONBILL *Platalea flavipes.*
Blakers *et al.* (1984) record it from the one degree blocks to the immediate south, north, east and west of the Bungle Bungle area. Storr: Uncommon to moderately common about the lower and middle Fitzroy and Sturt Creek; scarce elsewhere, in freshwater lagoons, river-pools and large station dams.]

[R MAGPIE GOOSE *Anseranas semipalmata.*
Storr: Formerly very common but now only moderately common in north-eastern flatlands, formerly common but now uncommon in south-western flatlands, scarce elsewhere; ordinarily south to the middle Ord River (Old Lissadell).]

[A PLUMED WHISTLING-DUCK *Dendrocygna arcuata.*
Recorded at Smoke Creek in the Argyle survey (Dames and Moore 1982). Blakers *et al.* (1984) record it from the one degree blocks immediately to the south, east and north of the Bungle Bungle area. Storr: Locally and seasonally very common (but generally only moderately common) in southern and eastern flatlands.]

BLACK SWAN *Cygnus atratus*
Recorded at Island Yard on the Ord River by Alex Rogers. Storr: Not recorded in the Kimberley until recently (first listed record 1944), but becoming an increasingly frequent visitor.

* RADJAH SHELDUCK (BURDEKIN DUCK) *Tadorna radjah.*
(5,9).
Several pairs observed on pools of the Ord River. Kilgour (1904) noted that in 1903 on the Ord River near Ord River station 'wherever there is a fair-sized hole in the river, one is sure to find a pair'. Storr: Formerly moderately common, now becoming uncommon in the north-east, no records from the south Kimberley since 1897; south to Old Lissadell.

A PACIFIC BLACK DUCK *Anas superciliosa.*
(9).
One small flock observed on pool of Ord River near Kitty's Knob. Storr: Moderately common in southern flatlands, uncommon to moderately common in north-eastern flatlands, scarce in hilly north Kimberley.

GREY TEAL *Anas gibberifrons.*
Solitary bird on pool of Ord River near Eagle Hawk Crossing (November 1989). Storr: Uncommon to common in southern flatlands, uncommon to moderately common in north-eastern flatlands (about the Ord River upstream to Old Lissadell), rare in north Kimberley.

[HARDHEAD (WHITE-EYED DUCK) *Aythya australis.*
Blakers *et al.* (1984) record it from the one degree blocks to the immediate south and north of the Bungle Bungle area. Storr: Locally and seasonally common, but generally scarce, in southern and eastern freshwater lagoons and claypans.]

AR BLACK-SHOULDERED KITE *Elanus notatus.*
One bird observed at Echidna Chasm on 12 July 1989 (Paton[4] personal communication). Single bird recorded during Argyle survey. Storr: Status uncertain, but probably a non-breeding visitor.

PACIFIC BAZA (CRESTED HAWK) *Aviceda subcristata.*
(7).
Pair observed in dense riparian vegetation along a tributary of the Osmand Creek (c. 5 km east of Mt. John); also seen at Wulwuldji Spring by N. Gambold and K. Menkhorst (November 1986). Storr: Status uncertain, but clearly rare.

*AR BLACK KITE (FORK-TAILED KITE) *Milvus migrans.*
(2,3).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *Melaleuca* woodland-*Acacia-Aristida.*
Widespread but at low density throughout Park area. Storr: Locally very common (in settled areas), but generally common to moderately common; scarce in unsettled country.

A SQUARE-TAILED KITE *Lophoictinia isura.*
(6).
Single bird seen in south-west of Park. Storr: Moderately common near-west and north-east coast of Dampier Land, scarce to uncommon elsewhere; south to the lower Negri.

*A BLACK-BREASTED BUZZARD *Hamirostra melanosternon.*
(2,3,4,9).
Widespread but at low density throughout Park, usually singly or in pairs. Storr: Moderately common in arid and semi-arid south and east, scarce or uncommon in subhumid north-west.

*AR WHISTLING KITE *Haliastur sphenurus.*
(1,2,5,6).
Preferred land unit: Antrim lowlands.
Widespread but uncommon throughout Park. Storr: Very common in southern and eastern flatlands in vicinity of water, moderately common in hilly north Kimberley.

*AR BROWN GOSHAWK *Accipiter fasciatus.*
(2,7,8,9).
Preferred land unit: Nelson frontage.
Moderately common, especially in taller forests. Nest with young at Kurrajong Camp (November). Storr: Uncommon to moderately common, migratory.

*A COLLARED SPARROWHAWK *Accipiter cirrhocephalus.*
(2,5,6,9).
Preferred land unit: Headley lower slopes.
Uncommon, mostly in denser riparian forests, especially about waterholes. Storr: Uncommon to moderately common.

* GREY GOSHAWK *Accipiter novaehollandiae.*
(2).
Two individuals in dense riparian forest along Osmand Creek. Storr: Scarce to uncommon, extending south along the Ord River to the lower Behn.

R WHITE-BELLIED SEA-EAGLE *Haliaeetus leucogaster.*
(2,5,7,9).
Preferred land unit: Antrim lowlands.
Single birds around waterholes of Ord River and Osmand Creek. Storr: Moderately common on tidal waters; scarce on freshwaters, ascending the Ord River to Lake Argyle.

[4] J. B. Paton - (private individual) Adelaide

*AR WEDGE-TAILED EAGLE *Aquila audax.*
(3,5,6,7).
Widespread but at low density. Storr: Moderately common in pastoral country; uncommon in subhumid north-west, scarce in sandy deserts.

* LITTLE EAGLE *Hieraaetus morphnoides.*
(3).
Single bird seen at Goosehole. Storr: Uncommon to scarce in lightly wooded country, especially grassy plains about the lower and middle courses of the Fitzroy and Ord Rivers.

*A SPOTTED HARRIER *Circus assimilis.*
(9).
Single bird observed in grassland near Kitty's Knob. Recorded in 1987, 1988 and 1989 by Bob Taylor around Kurrajong, Fowlhouse and the new Three-ways. Storr: Moderately common in southern arid and semi-arid flatlands, uncommon in north-eastern flatlands, scarce in hilly north Kimberley.

[MARSH HARRIER *Circus aeruginosus.*
Blakers *et al.* (1984) record it from the one degree blocks to the immediate south and north of the Bungle Bungle area. Storr: Non-breeding visitor to the greater part of the Kimberley; uncommon about the lower Ord River (upstream to Kununurra).]

A PEREGRINE FALCON *Falco peregrinus.*
(1,4,9,10).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera* low woodland-*Acacia-Triodia.*
Reasonably common throughout, especially about the massif. Storr: Uncommon in hilly north-west Kimberley, scarce elsewhere.

*A AUSTRALIAN HOBBY (LITTLE FALCON) *Falco longipennis.*
(2,3,5).
Preferred land unit: Elder cuestas.
Widespread but uncommon. Storr: Moderately common (at least in winter) in southern flatlands, uncommon in north-east flatlands, scarce in hilly north Kimberley.

* GREY FALCON *Falco hypoleucos.*
(1,6,7).
Preferred land unit: Headley lower slopes.
Widespread, at low density. Recorded also at Piccaninny Gorge by J. B. Paton (11 July 1989). Storr: Scarce in the south-west, rare elsewhere.

*AR BROWN FALCON *Falco berigora.*
(1,2,3,5,6,7).
Preferred land units: Wickham rugged uplands, Antrim lowlands, Elder cuestas, Nelson low rises.
Common and widespread. Storr: Generally common on lightly wooded plains.

*A AUSTRALIAN KESTREL *Falco cenchroides.*
(2,4,5).
Widespread but at low numbers, over grasslands and open woodlands. Storr: Uncommon to moderately common resident and moderately common to very common autumn-winter visitor in south and east; uncommon winter visitor in hilly north Kimberley.

*A BROWN QUAIL *Coturnix australis.*
(1,3,9).
Preferred land unit: Elder cuestas.
Preferred floristic groups: *E. brevifolia* open woodland-*Cassia-Plectrachne; E. collina* woodland-*Acacia-Triodia.*
Locally common, in both spinifex and tussock grasslands (e.g. at Kurrajong Camp). Storr: Common in long grass of subhumid and semi-arid zones.

AR LITTLE BUTTON-QUAIL *Turnix velox.*
(3,6,10).
Preferred land units: Elder cuestas, Buchanan sandplain.
Reasonably common in both spinifex and tussock grasslands. Storr: Highly nomadic; very common in good seasons on arid southern plains, but generally uncommon to moderately common.

A RED-CHESTED BUTTON-QUAIL *Turnix pyrrhothorax.*
(9).
Preferred land unit: Nelson cracking clay plains.
Several birds in spinifex and tussock grasslands at Kitty's Knob. One bird caught by hand when spotlighting. At Argyle, three birds were observed on black-soil plains. Storr: Status uncertain, perhaps a drought refugee from interior of eastern Australia. About a dozen records from the Kimberley region.

CHESTNUT-BACKED BUTTON QUAIL *Turnix castanota.*
One individual recorded by J R Ford 5 km west of Park boundary on Calico Springs track, April 1986.

[BLACK-TAILED NATIVE-HEN *Gallinula ventralis.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Uncommon visitor to freshwater swamps in south and east flatlands; about the lower and middle courses of the Ord River.]

[PURPLE SWAMPHEN *Porphyrio porphyrio.*
Storr: Common in north-eastern flatlands about the lower and middle Ord River; upstream to Lissadell.]

[EURASIAN COOT *Fulica atra.*
Blakers *et al.* (1984) recorded it from the one degree blocks immediately to the north, south and west of the Bungle Bungle area. Storr: Scarce to moderately common in southern and eastern flatlands in freshwater lagoons and river pools.]

AR BROLGA *Grus rubicundus.*
(7,9).
Preferred land unit: Nelson interfluve lower slopes.
Single birds and pairs in pools and grassland along the Ord River and Osmand Creek. Storr: Common in well-watered north-eastern and southern flatlands; uncommon to moderately common in hilly country and on south-western coastal plains.

*AR AUSTRALIAN BUSTARD *Ardeotis australis.*
(3,6,9).
Preferred land units: Nelson cracking clay plains, Nelson interfluve lower slopes.
Reasonably common and widespread, especially in tussock grasslands. Storr: Nomadic; uncommon to very common on southern plains; less numerous in semi-arid and subhumid zones.

* BUSH THICK-KNEE (SOUTHERN STONE-CURLEW) *Burhinus magnirostris.*
(2).
We recorded only two birds, in open woodland over tussock grassland near Red Rock. Muir (1983) heard birds on the Ord River and at the Bungle Bungle massif. Storr: Uncommon to moderately common in subhumid and semi-arid zones, and near coast in arid zone; scarce or absent in arid interior.

AR MASKED LAPWING (SPUR-WINGED PLOVER) *Vanellus miles.*
(9).
In small groups near pools and in short grasslands along Ord River. Storr: Moderately common in north-eastern and southern flatlands, rare in hilly north Kimberley.

[RED-KNEED DOTTEREL *Erythrogonys cinctus.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Uncommon in north-eastern flatlands (about the lower and middle Ord River); south-eastern and south-western flatlands.]

*AR BLACK-FRONTED PLOVER *Charadrius melanops.*
(1,2,3,5,6,9,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis-Melaleuca* open forest-*Aerva-Aristida.*
Common in small groups on shingle beaches around pools in all watercourses. Storr: Common in well-watered eastern and southern flatlands; generally scarce or absent in hilly north Kimberley, except on floodplains of large rivers where moderately common.

A BLACK-WINGED STILT *Himantopus himantopus.*
(9).
Three birds on pool of Ord River at Eagle Hawk Crossing (November 1989). At Argyle, four birds recorded at Smoke Creek (Dames and Moore 1982). Storr: Nomadic; common on north-eastern and south-eastern flatlands (including the Ord River south to Old Lissadell).

[A WOOD SANDPIPER *Tringa glareola.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. At Argyle several birds were recorded around ephemeral pools. Storr: Uncommon visitor in north-eastern flatlands (about lower and middle Ord River upstream to Argyle Lagoon) and south-western flatlands; scarce elsewhere.]

COMMON SANDPIPER *Tringa hypoleucos.*
(9).
Single birds at two isolated pools on the Ord River near Kitty's Knob. Storr: Moderately common visitor to greater part of Kimberley.

[GREENSHANK *Tringa nebularia.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Moderately common on north-eastern flatlands (the Ord River south to Old Lissadell), south-western flatlands and coasts.]

[ORIENTAL PRATINCOLE *Glareola maldivarum.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Kilgour (1904) reported large flocks on the plains of Ord River Station during the wet season. Storr: Common visitor to the greater part of the Kimberley.]

A AUSTRALIAN PRATINCOLE *Stiltia isabella.*
The manager of Ord River Station (Don Haddon) recorded many birds in flocks on black-soil plains of the Station and the Park near Eagle Hawk Crossing (October 1989). Storr: Nomadic; uncommon to common in well-watered southern and north-eastern flatlands, absent or scarce in hilly north Kimberley.

[WHISKERED TERN *Chlidonias hybrida.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Nomadic; during and after the wet season a common visitor to freshwater swamps in south-western flatlands and north-eastern flatlands (about the lower and middle Ord); in the dry season retreating to permanent freshwaters (e.g. lagoons and river-pools on and near the Ord River).]

*AR PEACEFUL DOVE *Geopelia placida.*
(1,2,3,5,6,7,8,9,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *Melaleuca* woodland-*Acacia-Aristida.*
Very common throughout the Park, especially in tussock grasslands with forest or woodland overstorey. Storr: Moderately common to very common over most of the Kimberley.

*AR DIAMOND DOVE *Geopelia cuneata.*
(3,5,6,9,10).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *E. brevifolia* open woodland-*Cassia-Plectrachne.*
Common throughout the Park, especially in spinifex and degraded tussock grasslands with relatively open woodland overstorey. Storr: Common in arid zone, moderately common in semi-arid zone, generally uncommon in subhumid zone.

*A BAR-SHOULDERED DOVE *Geopelia humeralis.*
(2,3,5,7,9).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Common in riparian forests and dense shrublands throughout the Park. Storr: Common on coastal plains, common to moderately common along the largest rivers (e.g. lower and middle Ord), but uncommon, scarce or absent in much of the interior.

* COMMON BRONZEWING *Phaps chalcoptera.*
(1,2,3,6,9).
Preferred land unit: Headley lower slopes.
Moderately common and widespread, favouring *Acacia* thickets. Storr: Moderately common in north-western subhumid zone, uncommon elsewhere.

[FLOCK BRONZEWING *Phaps histrionica.*
Storr: Common on open black-soil plains, occurring in the greater part of the Kimberley.]

*AR CRESTED PIGEON *Ocyphaps lophotes.*
(1,2,3,5,8,9).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. brevifolia* open woodland-*Cassia-Plectrachne.*
Common in open woodlands over tussock grasslands throughout the Park. Storr: Common in arid zone and parts of semi-arid zone, scarce elsewhere.

*R WHITE-QUILLED ROCK-PIGEON *Petrophassa albipennis.*
(1,4,7,10).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera* low woodland-*Acacia-Triodia.*
Reasonably common about rocky ranges throughout. Storr: Common in hilly north and central Kimberley; south to Lake Argyle.

*AR SPINIFEX PIGEON *Petrophassa plumifera.*
(1,3,5,6,7,9,10).
Preferred land unit: Buchanan uplands.
Preferred floristic group: *Acacia farnesiana* open shrubland-*Aerva-Aristida.*
Common in spinifex throughout the Park. Storr: Common in arid zone; uncommon to moderately common in semi-arid zone.

*AR RED-TAILED BLACK-COCKATOO *Calyptorhynchus magnificus.*
(2,7,8,9).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Reasonably common in taller forests, especially where *Eucalyptus ptychocarpa* is abundant. Storr: Generally common throughout most of the Kimberley.

*AR GALAH *Cacatua roseicapilla.*
Uncommon, occurring in small flocks in woodland areas (e.g. at Kurrajong Camp). Bob Taylor has recorded it in small numbers from Fowlhouse, Osmand Creek and the Ninety Kilometre fence in 1987, 1988 and 1989. Storr: Common in well-watered parts of arid zone and in pastoral country in semi-arid, scarce elsewhere.

*AR LITTLE CORELLA *Cacatua sanguinea.*
(2,3,5,7,9).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*

Common and widespread, with large flocks (to 200 birds) drinking at isolated waterholes on the Ord River in November. Storr: Very common in flatlands about larger watercourses in arid and semi-arid zones, uncommon in subhumid zone.

*AR SULPHUR-CRESTED COCKATOO *Cacatua galerita.*
(1,2,3,5,6,7,8,9).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis-Melaleuca* open forest-*Aerva-Aristida.*
Widespread and reasonably common, especially in taller riparian forests. Storr: Uncommon, mainly in the subhumid and semi-arid zones.

*AR RED-COLLARED LORIKEET *Trichoglossus rubritorquis.*
(1,2,9).
Preferred land unit: Buchanan sandplain.
Uncommon and restricted mainly to tall and dense riparian forests. Storr: Nomadic; common in subhumid zone and wetter half of semi-arid zone, scarce elsewhere.

*AR VARIED LORIKEET *Psitteuteles versicolor.*
(3,5,8,9).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *Melaleuca* low open woodland-*Acacia-Aerva.*
Uncommon, restricted mainly to relatively tall open forests. Storr: Nomadic; common in wetter half of subhumid zone, moderately common in subhumid zone and drier half of semi-arid zone, scarce to moderately common elsewhere.

*AR RED-WINGED PARROT *Aprosmictus erythropterus.*
(1,2,3,5,6,7,8,9).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Common in small groups, especially in relatively tall forests by watercourses. Storr: Moderately common to common, particularly in subhumid zone.

*AR COCKATIEL *Nymphicus hollandicus.*
(1,2,3,5,6,9).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina* woodland-*Acacia-Plectrachne.*
Reasonably common throughout the Park, usually in small groups. Storr: Nomadic; scarce to common in arid and semi-arid zones.

*AR BUDGERIGAR *Melopsittacus undulatus.*
(1,2,3,5,9).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. brevifolia* open woodland-*Cassia-Plectrachne.*
Common, especially in open woodland over spinifex. Storr: Nomadic, common in arid and semi-arid zones, irregular in subhumid zone.

*AR NORTHERN ROSELLA *Platycercus venustus.*
(1,2,3,5,6,8).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. collina* woodland-*Acacia-Plectrachne.*
Reasonably common and widespread, mostly in open forests. Storr: Locally common in subhumid and semi-arid zones; south to Texas Downs and Lake Argyle.

*A PALLID CUCKOO *Cuculus pallidus.*
(3,6,7,9).
Preferred land unit: Nelson cracking clay plains.
Widespread in low numbers, mostly in open forests. Storr: Nonbreeding visitor throughout the Kimberley.

R BRUSH CUCKOO *Cuculus variolosus.*
(9).
Preferred land unit: Nelson frontage.
Occasional birds in taller forests (e.g. near Osmand Valley Homestead), in wet season survey only. Storr: Uncommon, mainly in subhumid and semi-arid zones.

[A BLACK-EARED CUCKOO *Chrysococcyx osculans.*
At Argyle, single birds in low woodland. Storr: Nonbreeding visitor; uncommon in arid and semi-arid zones, scarce in subhumid zone.]

HORSFIELD'S BRONZE-CUCKOO *Chrysococcyx basalis.*
(3,5,6,9,10).
Preferred land unit: Nelson cracking clay plains.
Uncommon but widespread in woodlands and open forests. Storr: Moderately common in south-eastern and semi-arid zones, scarce in subhumid.

COMMON KOEL *Eudynamis scolopacea.*
(9).
Preferred land unit: Nelson frontage.
Uncommon, only recorded in wet season survey in tall riparian and open forest near the Ord River. Storr: Moderately common in subhumid zone, uncommon in semi-arid zone; south to Lake Argyle.

* CHANNEL-BILLED CUCKOO *Scythrops novaehollandiae.*
(2,8).
Preferred land unit: Wickham rugged uplands.
Uncommon, solitary or in pairs in tall riparian forests and gorges (e.g. Winnama Gorge). Storr: Uncommon visitor to semi-arid zone, rare in subhumid zone.

*A PHEASANT COUCAL *Centropus phasianus.*
(2,7).
Uncommon, solitary or in pairs in tussock grasslands. Storr: Moderately common in subhumid zone, uncommon in semi-arid, scarce in arid; south to Texas Downs.

*AR SOUTHERN BOOBOOK *Ninox novaeseelandiae.*
(3,4,5,7,8,10).
Preferred land units: Wickham rugged uplands, Elder uplands, Elder cuestas.
Common and widespread, frequently found sheltering in caves and crevices of the massif. Storr: Common in most of the Kimberley.

*A BARKING OWL *Ninox connivens.*
(2,7).
Preferred land unit: Wickham rugged uplands.
Uncommon, we recorded it only in the Osmand valley, although Muir (1983) heard it on the Ord River near Spring Creek. Storr: Common in most of the Kimberley.

A BARN OWL *Tyto alba.*
(3,9).
Preferred land units: Nelson frontage, Nelson low rises, Nelson interfluve lower slopes.
Common on black-soil plains and open tussock grasslands. Storr: Uncommon, occurring as a winter visitor through most of the Kimberley.

*A TAWNY FROGMOUTH *Podargus strigoides.*
(1,3,5,6,8,10).
Preferred land unit: Wickham rugged uplands.
Reasonably common throughout Park. Storr: Common, occurring through most of the Kimberley.

A AUSTRALIAN OWLET-NIGHTJAR *Aegotheles cristatus.*
(1,6,9).
Preferred land unit: Nelson frontage.
Uncommon but widespread, occurring in most wooded habitats. Storr: Moderately common through most of the Kimberley.

*A SPOTTED NIGHTJAR *Caprimulgus guttatus.*
(1,3,5,6,7,8).
Preferred land unit: Headley lower slopes.
Common and widespread especially in spinifex covered hills. Storr: Uncommon resident and moderately common winter visitor, occurring through most of the Kimberley.

[FORK-TAILED SWIFT *Apus pacificus.*
Blakers *et al.* (1984) record it from the one degree blocks immediately to the south and north of the Bungle Bungle area. Storr: Common visitor.]

AZURE KINGFISHER *Ceyx azurea.*
(2,5,7).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Reasonably common along pools of the Ord River and Osmand Creek, especially where there is dense riparian vegetation. Storr: Uncommon in subhumid zone, scarce in semi-arid zone; south to the middle Ord (Brook Creek).

*AR BLUE-WINGED KOOKABURRA *Dacelo leachii.*
(1,2,6,7,8,9).
Preferred land units: Wickham rugged uplands, Antrim lowlands.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Widespread and reasonably common in taller forests, especially in relatively dense riparian vegetation. Storr: Moderately common, in most of the Kimberley.

*AR RED-BACKED KINGFISHER *Halcyon pyrrhopygia.*
(2,3,5,6,7,8,10).
Preferred land unit: Antrim rugged uplands.
Reasonably common and widespread in most vegetation types. Storr: Common in arid and semi-arid zones, scarce in subhumid zones.

*A SACRED KINGFISHER *Halcyon sancta.*
(8,9,10).
Preferred land unit: Nelson frontage.
Preferred floristic group: *Lysiphyllum* low woodland-*Acacia-Cenchrus.*
Reasonably common and widespread, wet season survey only. Storr: Migrant, occurring through most of the Kimberley.

*AR RAINBOW BEE-EATER *Merops ornatus.*
(1,2,3,4,5,6,7,8,9,10).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *Acacia* spp. tall shrubland-*Triodia.*
Common and widespread throughout the Park. Storr: Very common winter visitor and passage migrant; in summer, moderately common in arid and semi-arid zones but scarce in subhumid zone.

*A DOLLARBIRD *Eurystomus orientalis.*
(8,9).
Preferred land units: Wickham rugged uplands, Nelson frontage.
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
Uncommon, solitary or in small groups, especially around taller riparian forests; only recorded during wet season. Storr: Breeding visitor, moderately common in most of the Kimberley.

*A SINGING BUSHLARK *Mirafra javanica.*
(8,9).
Preferred land units: Nelson cracking clay plains, Nelson interfluve lower slopes.
Preferred floristic group: *Lysiphyllum* low woodland-*Acacia-Cenchrus.*
Common in tussock grasslands, especially on black soil and eroded plains. Storr: Very common in arid zone on black-soil plains; common on alluvial and other grassy plains of arid and semi-arid, patchily distributed and generally uncommon in the subhumid zone.

*A TREE MARTIN *Cecropis nigricans.*
(5,9).
Uncommon, in small flocks (2 to 5 birds) in open forests and around waterholes. Storr: Nonbreeding visitor, very common in dry season near coast, scarce to moderately common elsewhere.

*AR FAIRY MARTIN *Cecropis ariel.*
(3,9,10).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina* woodland-*Acacia-Triodia.*
Moderately common and widespread. Nests are common on the massif. Storr: Nomadic, locally common but generally uncommon, occurring through most of the Kimberley.

*AR RICHARD'S PIPIT *Anthus novaeseelandiae.*
(5).
Uncommon, restricted mainly to degraded tussock grasslands. Storr: Locally common in arid zone, but generally uncommon to moderately common; absent to uncommon in semi-arid zone.

*AR BLACK-FACED CUCKOO-SHRIKE *Coracina novaehollandiae.*
(1,2,3,4,5,6,7,8,9,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Common and widespread, occurring in all vegetation types. Storr: Common through most of the Kimberley.

*AR WHITE-BELLIED CUCKOO-SHRIKE *Coracina papuensis.*
(1,2,3,5,6,7,8).
Preferred land unit: Wickham rugged uplands.
Preferred floristic groups: *Livistona* open forest-*Acacia-Germania; Lysiphyllum* woodland-*Carissa-Heteropogon.*
Common and widespread, especially in relatively tall forests. Storr: Common in subhumid zone, uncommon in arid and semi-arid zone; south to Texas Downs and the Behn.

*AR GROUND CUCKOO-SHRIKE *Coracina maxima.*
(3).
Uncommon, singly or in pairs, in tussock grasslands and degraded areas. Storr: Locally common or moderately common in arid zone, but generally uncommon.

*AR WHITE-WINGED TRILLER *Lalage sueurii.*
(1,2,3,5,6,7,9,10).
Preferred land unit: Antrim rugged uplands.
Preferred floristic group: *Acacia farnesiana* open shrubland-*Aerva-Aristida.*
Common and widespread, occurring in all habitats. In large flocks at flowering *Grevilleas* on massif in July. Storr: Common to very common in arid and semi-arid zones, uncommon to moderately common in subhumid zone.

R RED-CAPPED ROBIN *Petroica goodenovii.*
(6).
One bird seen in open woodland. Storr: Non-breeding winter visitor. Uncommon to moderately common in pindan of western arid zone, scarce elsewhere; north to Christmas Creek and Old Billiluna.

[HOODED ROBIN *Melanodryas cucullata.*
Blakers *et al.* (1984) recorded it from the one degree blocks to the immediate north and east of the Bungle Bungle area. Storr: Uncommon, in northern interior, south-western and south-eastern.]

A JACKY WINTER *Microeca leucophaea.*
(2).
Preferred land unit: Buchanan sandplain.
Recorded only in *Lysiphyllum* woodland adjacent to the Osmand, where it was quite common. Storr: Common in open forests and woodlands of the semi-arid zone and in pindan of the western arid zone, scarce to uncommon in the rest of the arid zone and in the subhumid zone.

[WHITE-BROWED ROBIN *Poecilodryas superciliosa.*
Kilgour (1904) reported this species as common along the riverbanks of the Ord River near Ord River Station around 1903. It now appears to be absent in this area (Smith and Johnstone 1977). Storr: In dense riparian vegetation, formerly common but now scarce on the Fitzroy and Ord River (upstream to Brook Creek), common on Drysdale, uncommon in subhumid zone.]

*AR RUFOUS WHISTLER *Pachycephala rufiventris.*
(2,3,5,6,7,8,9,10).
Preferred land unit: Nelson frontage.
Preferred floristic group: *Melaleuca* woodland-*Acacia-Aristida.*
Widespread and common in all areas of woodland and forest. Storr: Common throughout the Kimberley, excluding sandy deserts.

* SANDSTONE SHRIKE-THRUSH *Colluricincla woodwardi.*
(1,3,4,6,7,10).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera* low woodland-*Acacia-Triodia.* Widespread and reasonably common in all rocky habitats. Storr: Common to moderately common in subhumid and semi-arid zones.

CRESTED BELLBIRD *Oreoica gutturalis.*
Not recorded in this survey. J. R. Ford heard at least one calling in 'wattle scrub about watercourses' about 5 km west of Three-Ways in April 1986.

*AR GREY SHRIKE-THRUSH *Colluricincla harmonica.*
(1,2,3,5,6,7,9,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Widespread and common in all areas of woodland and forest. Storr: Uncommon to moderately common throughout most of the Kimberley.

*R LEADEN FLYCATCHER *Myiagra rubecula.*
(7,8).
Preferred land unit: Wickham rugged uplands.
Preferred floristic groups: *Livistona* open forest-*Acacia-Germania; E.ptychocarpa* forest-*Pandanus-Heteropogon.*
Uncommon, restricted mainly to tall riparian forests. Storr: Common in subhumid zone, uncommon to moderately common in wetter half of semi-arid zone, scarce in driest part of range.

*AR RESTLESS FLYCATCHER *Myiagra inquieta.*
(2,5,6,7,8,9,10).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Common and widespread, occurring through all habitats. Storr: Moderately common in most of the Kimberley.

* GREY FANTAIL *Rhipidura fuliginosa.*
Not recorded in this survey, but Bob Taylor has recorded it in every year from 1986 to 1989 in riparian areas (e.g. Wulwuldji Springs, 'Frog Hollow', Osmand Range and 'Fowlhouse'). One collected by J. R. Ford at base of massif, April 1986. Storr: Uncommon winter visitor, scattered records.

*AR NORTHERN FANTAIL *Rhipidura rufiventris.*
(2,5,7,8).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Reasonably common, though restricted mostly to denser riparian vegetation. Storr: Common and widespread in the subhumid zone, locally moderately common in the wetter half of the semi-arid zone.

*AR WILLIE WAGTAIL *Rhipidura leucophrys.*
(1,2,3,5,6,7,8,9,10).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Common and widespread occurring through all vegetation types. Storr: Uncommon to moderately common in subhumid zone, common in semi-arid, scarce in arid zone.

*AR GREY-CROWNED BABBLER *Pomatostomus temporalis.*
(2,3,5,6,9,10).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. brevifolia* open woodland-*Cassia-Plectrachne.*
Common and widespread, especially in dense scrub, woodland and open forest areas. Storr: Common in semi-arid and arid areas, uncommon in subhumid zone.

* SPINIFEXBIRD *Eremiornis carteri.*
(3,6).
Preferred land unit: Nelson low rises.
Uncommon, restricted to spinifex grasslands. We recorded it also in spinifex on stony hills on the Spring Creek Track about 8 km west of Three-ways. Storr: Moderately common in arid southern interior, north to the Hardman Range.

GOLDEN-HEADED CISTICOLA *Cisticola exilis.*
(9).
Preferred land unit: Nelson cracking clay plains.
Recorded only in tussock grasslands on black-soil plains adjacent to the Ord River, though relatively common there. Storr: Common in subhumid zone, uncommon to moderately common in semi-arid zone, scarce in arid zone; south to Ord River Station.

*A RUFOUS SONGLARK *Cinclorhamphus mathewsi.*
(2,9).
Preferred land unit: Nelson cracking clay plains.
Uncommon, in tussock grasslands with or without tree layer. Storr: Uncommon to moderately common in arid and semi-arid zones, scarce in subhumid zone.

[PURPLE-CROWNED FAIRY-WREN *Malurus coronatus.*
Kilgour (1904) reported it 'almost wherever there is water' around Ord River Station in 1903. Storr: Formerly the greater part of the Kimberley; south to the upper Ord (Ord River Station), where now it is apparently extinct (Smith and Johnstone 1977).]

* VARIEGATED FAIRY-WREN *Malurus lamberti.*
(4,6,7,10).
Preferred land units: Wickham rugged uplands, Buchanan uplands.
Preferred floristic group: *Lysiphyllum* woodland-*Carissa-Heteropogon.*

Reasonably common and widespread, especially in spinifex about sandstone ranges. Storr: Moderately common in subhumid and semi-arid zones.

*AR RED-BACKED FAIRY-WREN *Malurus melanocephalus.*
(1,3,5,6,8,9,10).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Lysiphyllum* low woodland-*Acacia-Cenchrus.*
Common and widespread in tussock grasslands and spinifex. Storr: Common in subhumid and semi-arid zones, uncommon and patchily distributed in arid zones.

*AR WEEBILL *Smicrornis brevirostris.*
(2,3,5,6,7,8,9,10).
Preferred land unit: Antrim rugged uplands.
Preferred floristic group: *Lysiphyllum* woodland-*Carissa-Heteropogon.*
Common and widespread in most forest and woodland habitats. Storr: Moderately common throughout most of the Kimberley.

*A VARIED SITTELLA *Daphoenositta chrysoptera.*
(1,2,6,9).
Preferred land unit: Nelson frontage.
Preferred floristic group: *Hakea* low woodland-*Acacia-Cenchrus.*
Reasonably common and widespread in most open forest and woodland habitats. Storr: Uncommon to moderately common in most of the Kimberley.

*AR BLACK-TAILED TREECREEPER *Climacteris melanura.*
(1,2,3,5,6,9).
Preferred land unit: Antrim rugged uplands.
Preferred floristic group: *E. collina* woodland-*Acacia-Triodia.*
Common and widespread in most woodland and open forest habitats. Storr: Common in semi-arid interior, uncommon in Dampier Land and arid zone, scarce in north-west and humid zone.

*AR SILVER-CROWNED FRIARBIRD *Philemon argenticeps.*
(1,2,4,6,7,8).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
Reasonably common and widespread, mostly in taller open forests. Storr: Common in subhumid zone; south to Lake Argyle; uncommon to moderately common in semi-arid zone.

*AR LITTLE FRIARBIRD *Philemon citreogularis.*
(1,2,3,4,5,6,7,8,9,10).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. collina* woodland-*Acacia-Triodia.*
Common and widespread in all woodland and open forest habitats. Storr: Common to very common in semi-arid zone, generally uncommon in arid zone, scarce in subhumid zone.

[R BLUE-FACED HONEYEATER *Entomyzon cyanotis.*
Storr: Locally common but generally uncommon and patchily distributed; in subhumid zone and wetter half of semi-arid zone, south to Lake Argyle.]

*AR YELLOW-THROATED MINER *Manorina flavigula.*
(1,3,4,5,7,8,9,10).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina* woodland-*Acacia-Plectrachne.*
Common and widespread in taller open forests. Storr: Moderately common to common in arid and semi-arid zones.

*AR SINGING HONEYEATER *Lichenostomus virescens.*
(3,4,5,7,9).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Lysiphyllum* low woodland-*Acacia-Cenchrus.*
Reasonably common and widespread, especially in *Lysiphyllum* woodlands. Storr: Moderately common to very common in arid zone, uncommon and patchy in semi-arid, scarce or absent in subhumid zone.

*AR WHITE-GAPED HONEYEATER *Lichenostomus unicolor.*
(2,5,7,8,9).
Preferred land unit: Nelson frontage.
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
Reasonably common in denser riparian forests, springs and well-vegetated gorges. Storr: Locally common in subhumid zone and denser vegetation of semi-arid zone.

R GREY-HEADED HONEYEATER *Lichenostomus keartlandi.*
(1).
Only one pair seen, in flowering *Grevillea* in gorge of Bull Creek. Storr: Uncommon to moderately common in arid southern interior.

*AR GREY-FRONTED HONEYEATER (YELLOW-FRONTED HONEYEATER) *Lichenostomus plumulus.*
(1,3,4,6,7,8,9,10).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. collina* woodland-*Acacia-Triodia.*
Very common in most woodland vegetation throughout Park. Storr: Moderately common in arid and semi-arid interior.

*AR YELLOW-TINTED HONEYEATER *Lichenostomus flavescens.*
(2,5,6,7,8,9).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.* Patchily common, especially in riparian *Eucalyptus camaldulensis* forests. Storr: Moderately common to very common, over most of the Kimberley.

*AR BLACK-CHINNED HONEYEATER (GOLDEN-BACKED HONEYEATER) *Melithreptus gularis.*
(1,3,5,6,7,9).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Reasonably common and widespread. Storr: Nomadic, uncommon to moderately common in arid and semi-arid zones, scarce visitor to subhumid zone.

*AR WHITE-THROATED HONEYEATER *Melithreptus albogularis.*
(2,7,8,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
Reasonably common and widespread, especially in denser and taller forests. Storr: Moderately common; in subhumid and semi-arid zones.

*AR BROWN HONEYEATER *Lichmera indistincta.*
(1,2,4,5,6,7,8,9,10).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Very common in all woodland and open forest habitats. Storr: Very common throughout most of the Kimberley.

A BAR-BREASTED HONEYEATER *Ramsayornis fasciatus.*
(7).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Uncommon, recorded only in paperbark forests of Osmand Creek area. Storr: Moderately common in subhumid and semi-arid zones; south to Lake Argyle.

*AR RUFOUS-THROATED HONEYEATER *Conopophila rufogularis.*
(4,5,7,8,9).
Preferred land unit: Nelson frontage.
Preferred floristic group; *Lysiphyllum* low woodland-*Acacia-Cenchrus.*
Moderately common, especially in *Lysiphyllum* woodlands, but large flocks collecting around flowering trees in many other habitats. Storr: Moderately common to common in subhumid zones, uncommon and patchy in arid zone.

*AR BANDED HONEYEATER *Certhionyx pectoralis.*
(9).
Preferred land unit: Nelson frontage. Uncommon, occurring at low density in woodlands and open forests. Bob Taylor has observed it breeding in all years from 1986 to 1989, at Bellburn Creek, Kurrajong and the northern gorges. Storr: Nomadic, locally common in semi-arid zone but generally uncommon, scarce in subhumid zone.

*AR MISTLETOEBIRD *Dicaeum hirundinaceum.*
(1,2,3,4,5,6,7,8,9,10).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera* low woodland-*Acacia-Triodia.*
Very common and widespread, in all woodlands and open forests. Storr: Common in subhumid zone, moderately common in semi-arid and arid zones.

AR RED-BROWED PARDALOTE *Pardalotus rubricatus.*
(1,3,5,6,9,10).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. brevifolia* open woodland-*Cassia-Plectrachne.*
Common and widespread, especially in relatively tall riparian open forests. Storr: Common in arid and semi-arid zones.

*AR STRIATED PARDALOTE *Pardalotus striatus.*
(1,2,3,4,5,6,7,8).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *Melaleuca* woodland-*Acacia-Aristida.*
Common and widespread in all woodlands and open forests. More abundant in dry season. Storr: Common through most of the Kimberley.

* PAINTED FIRETAIL *Emblema picta.*
(3,5,6,8,10).
Preferred land unit: Nelson low rises.
Preferred floristic group: *Acacia farnesiana* open shrubland-*Aerva-Aristida.*
Common and widespread in spinifex. Storr: Locally common in hilly arid interior, but generally uncommon, scarce and patchy in hilly semi-arid country.

*A CRIMSON FINCH *Neochmia phaeton.*
(7,9).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Melaleuca* woodland-*Acacia-Aristida.*
Locally abundant (e.g. Wulwuldji Spring) in dense pandanus. Storr: Locally common but generally uncommon to moderately common and patchy in subhumid and semi-arid zones; south to Lake Argyle and the Negri.

*AR ZEBRA FINCH *Poephila guttata.*
(3,5,6,9,10).
Preferred land unit: Nelson low rises.
Preferred floristic group: *Acacia farnesiana* open shrubland-*Aerva-Aristida.*
Widespread and common, especially in tussock grasslands. Storr: Very common in arid zone, moderately common in drier half of semi-arid zone.

*AR DOUBLE-BARRED FINCH *Poephila bichenovii.*
(2,5,6,7,8,9,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Reasonably common and widespread, especially in wetter areas with dense shrub layer. Storr: Generally common in semi-arid zone and along the lower and middle Ord River drainage, uncommon to moderately common in subhumid zone.

*AR MASKED FINCH *Poephila personata.*
(5,6,9).
Preferred land unit: Antrim rugged uplands.
Uncommon. Occurring in open forests and woodlands above tussock grass, usually solitary or in small groups. Storr: Uncommon, south to Lake Argyle and the Negri.

*AR LONG-TAILED FINCH *Poephila acuticauda.*
(1,2,3,5,6,8,10).
Preferred land units: Al, Antrim rugged uplands.
Preferred floristic group: *Lysiphyllum* woodland-*Carissa-Heteropogon.*
Common and widespread, especially in open forests and woodlands above tussock grasslands. Storr: Moderately common throughout most of the Kimberley.

*A PICTORELLA MANNIKIN *Lonchura pectoralis.*
(1,3,9).
Preferred land unit: Nelson cracking clay plains.
Uncommon and patchily distributed, mostly in tussock grasslands. J. B. Paton recorded it also from Kurrajong Camp (10-12 July 1989). Storr: Nomadic, uncommon to moderately common (least plentiful in upper Ord River drainage), mainly semi-arid and arid interior.

[CHESTNUT-BREASTED MANNIKIN *Lonchura castaneothorax.*
Storr: Nomadic, locally common but generally uncommon, in northern and north-western Kimberley. It became established in the north-eastern flatlands (the Ord River upstream to Old Lissadell) between 1910 and 1960.]

A GOULDIAN FINCH *Erythrura gouldiae.*
One juvenile reported drinking at bird bath at Bellburn Creek, early dry season 1989 (Alex Rogers). Storr: Scarce to moderately common in subhumid and semi-arid zones.

*AR OLIVE-BACKED ORIOLE *Oriolus sagittatus.*
(2,7,8).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa* forest-*Pandanus-Heteropogon.*
Uncommon, mostly in riparian open forests, especially where figs occur. Storr: Nomadic, uncommon to moderately common in subhumid and semi-arid zones, scarce in arid zone.

*AR GREAT BOWERBIRD *Chlamydera nuchalis.*
(1,2,4,5,6,7,8,9,10).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona* open forest-*Acacia-Germania.*
Common and widespread in all open forest and woodland habitats. Storr: Common throughout most of the Kimberley.

*AR AUSTRALIAN MAGPIE-LARK *Grallina cyanoleuca.*
(1,2,3,5,7,8,9).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Common and widespread, especially in open forests over tussock grasslands, particularly in recently burnt areas. Storr: Very common in well-watered parts of arid and semi-arid zones, moderately common in dry season in subhumid zone.

WHITE-BREASTED WOOD-SWALLOW *Artamus leucorhynchus.*
(2,5,9).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. camaldulensis/Melaleuca* open forest-*Aerva-Aristida.*
Uncommon, near waterholes on Ord River and Osmand Creek. Storr: Scarce to uncommon and patchily distributed over greater part of the Kimberley.

* MASKED WOOD-SWALLOW *Artamus personatus.*
(4,5).
Preferred land unit: Eu.
Preferred floristic group: *E. cliftoniana* low open woodland-*Acacia-Triodia.*
Very common in large flocks about flowering *Grevillea* on massif in July 1989. Uncommon elsewhere. Storr: Highly nomadic, moderately common to very common in dry season in arid and semi-arid zones.

*A WHITE-BROWED WOOD-SWALLOW *Artamus superciliosis.*
(4).
Preferred land unit: Eu.
Occasional birds associated with the large flocks of Masked Wood-swallows around flowering *Grevillea* on Bungle Bungle massif in July 1989. Storr: Rare visitor, only recorded in west Kimberley.

*AR BLACK-FACED WOOD-SWALLOW *Artamus cinereus.*
(1,2,3,5,6,7,8,9,10).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Lysiphyllum* low woodland-*Acacia-Cenchrus.*
Very common and widespread, in small groups, in all habitats. Storr: Very common in arid zone and drier half of semi-arid zone, scarce to moderately common elsewhere.

*AR LITTLE WOOD-SWALLOW *Artamus minor.*
(1,2,3,4,5,7,8,9,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *E. collina* woodland-*Acacia-Triodia.*
Reasonably common and widespread, especially in open woodlands on stony hills. Storr: Locally common in hilly parts of the semi-arid zone, but generally uncommon.

* GREY BUTCHERBIRD *Cracticus torquatus.*
(7).
Only two birds recorded, in open forest near Mt. John, though Muir (1983) recorded this species from the massif and between the massif and Ord River Station. Storr: Moderately common in dense vegetation in subhumid zone and wetter half of semi-arid zone south to Mt. King, with unconfirmed reports from Argyle Downs.

*AR PIED BUTCHERBIRD *Cracticus nigrogularis.*
(1,2,3,4,5,6,7,8,9,10).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. collina* woodland-*Acacia-Plectrachne.*
Very common and widespread in all open forest and woodland habitats. Storr: Common throughout most of the Kimberley.

*AR AUSTRALIAN MAGPIE *Gymnorhina tibicen.*
(1,3,5,8,9).
Preferred land unit: Buchanan sandplain.
Uncommon, in small numbers in open forests and woodlands with a relatively open tussock grass understorey. Storr: Locally moderately common, but generally uncommon in hilly semi-arid and arid interior.

A LITTLE CROW *Corvus bennetti.*
(1,3,6,7).
Preferred land unit: Elder cuestas.
Uncommon, mostly in degraded open woodland country around the Ord River and spinifex woodlands in the south of the Park. Storr: Moderately common in arid zone.

*AR TORRESIAN CROW *Corvus orru.*
(1,2,4,5,7,8,9,10).
Preferred land unit: Antrim lowlands.
Preferred floristic group: *Melaleuca* woodland-*Acacia-Aristida.* Common and widespread in most woodland and open forest habitats. Storr: Common in more populated parts of arid and semi-arid, uncommon in subhumid zone.

Notable species

Two species recorded in the Bungle Bungle area are included in the most recent comprehensive list of 'rare, endangered and extinct' birds of Australia (Brouwer and Garnett 1990).

The Grey Falcon is considered rare throughout the continent. We recorded this species at three study sites (Bull Creek, near Turner Station and Mt. John), incidentally at Bellburn Creek and near Calico Springs, and J.B. Paton also recorded it during our survey period at Piccaninny Gorge. These records suggest a reasonably large population in the Bungle Bungle area, although population sizes and distribution may fluctuate widely depending on continental weather conditions (Blakers *et al.* 1984).

The Gouldian Finch is suffering a rapid decline throughout most of its known range (tropical savanna woodlands from the Kimberley to Queensland) and is now regarded as endangered (Tidemann *et al.* in press). The Bungle Bungle area would lie at the southern (inland) edge of its range, although this species may make substantial nomadic postbreeding movements. Its presence in the study area is based on only one record of one individual, and the Bungle Bungle area probably has little conservation significance for this species.

Two species, Purple-crowned Fairy-wren and White-browed Robin, formerly known from riverside vegetation of the Ord River in the Bungle Bungle area (Kilgour 1904) are now presumed extinct there (Smith and Johnstone 1977), and are undergoing substantial reductions elsewhere (Storr 1980). The loss or decline of these species is probably attributable to the degradation of riparian (especially pandanus) habitats by stock (Smith and Johnstone 1977; Rowley 1988).

Additional species

Included in the annotated species list are several water birds not yet definitely recorded from the Bungle Bungle area, but which most probably do occur there at least seasonally. Their absence is at least partly owing to limited surveying in the Ord River and Osmand Creek systems.

Nomadism is a feature of many bird species of semi-arid northern Australia (Davies 1986), and the Bungle Bungle bird fauna probably includes a substantial number of such species. As a consequence of the relatively unpredictable and transitory nature of such visits, we recorded few of these nomads (although our records of Red-chested Button-quail, Red-capped Robin, Masked Wood-swallow and White-browed Wood-swallow fit this pattern). Other semi-arid or arid visitors would probably include Flock Bronzewing, Brown Songlark (*Cinclorhampus mathewsi*), Black-eared Cuckoo, Crimson Chat (*Ephthianura tricolor*), Black Honeyeater (*Certhionyx niger*), Pied Honeyeater (*Certhionyx variegatus*) and Black Falcon (*Falco subniger*) (e.g. Storr 1981). Flocks of the migratory Fork-tailed Swift and Oriental Pratincole would also be expected over the Bungle Bungle area during the wet season.

Other than these groups of nomadic species, this survey is probably comprehensive. Some species not recorded merit comment. The Hooded Robin (*Melanodryas cucullata*) may occur in low densities in woodlands or *Acacia* thickets, but its distribution is characteristically patchy in northern Australia (Storr 1977, 1980; Ford 1978). The White-throated Gerygone (*Gerygone olivacea*) may also be present in low numbers in relatively tall *Eucalyptus* open forest, though it too has a characteristically patchy distribution. We recorded no Grass-wrens (*Amytornis* spp.) despite extensive searches in apparently suitable habitat (spinifex among boulders).

Distributional patterns within the Bungle Bungle area

The number of bird species recorded at the 10 study sites is listed in Table 14. The two sites on the Ord River, at Kitty's Knob (site 9) and Blue Holes (site 5), were richest in species. This is in part owing to the wide range of habitats at these sites, including pools suitable for waterbirds. Site 4 (on the plateau of the Bungle Bungle massif) had by far the fewest species.

Twenty-five species were recorded at only one site (Table 14), with 12 of these recorded only at site 9.

There is wide variation in bird species diversity between land units (Table 15). Nelson frontage and Antrim lowlands have the highest diversity. The uplands of Elder and Buchanan land units have fewest species.

The proportion of Torresian to Eyrean species also varies substantially between land units. The northern gorges of Wickham land unit and the riverside Antrim lowlands, Nelson frontage and Buchanan frontage support relatively many Torresian species. Eyrean species comprise a relatively higher proportion of Elder cuestas and Nelson low rises.

The distribution of bird species across land units is given in Table 12. A group of, mainly Torresian, species is largely restricted to the Wickham, Antrim lowlands and Nelson frontage land units. Examples of these species include Rufous Night Heron, Dollarbird, Leaden Flycatcher, Northern Fantail, White-gaped Honeyeater and Crimson Finch. Twenty species occurred most abundantly in the Nelson frontage unit, 20 in Antrim lowlands and 17 in Wickham. Another group of species is also most abundant in these land units, but occurs also across a broad range of land units (e.g. Double-barred Finch, Great Bowerbird, Peaceful Dove, Restless Flycatcher, Torresian Crow).

A third group of species occurs almost ubiquitously across the land units studied. Such widespread species include Rainbow Bee-eater, Willie Wagtail, Little Friarbird, Australian Magpie-lark, Black-faced Wood-swallow and Black-faced Cuckoo-shrike.

A small group of species also has widespread distribution but with reduced abundance in the Wickham, Antrim lowlands and Nelson frontages: examples include Grey-fronted Honeyeater, Red-browed Pardalote and Spinifex Pigeon.

The relatively tall *Eucalyptus* open forests of Buchanan frontage and Buchanan sandplains are preferred habitat for Pied Butcherbird, Northern Rosella and Yellow-throated Miner.

The black-soil plains of the Nelson cracking clay unit support a distinctive bird fauna including Singing Honeyeater, Singing Bushlark, Australian Bustard and Golden-headed Cisticola. Eleven species are most abundant in this land unit, with some of these species occurring almost as abundantly in the Nelson low rises unit.

A small group of species is restricted mostly to the sandstone spinifex of Elder uplands, Buchanan frontage

and Buchanan uplands. Characteristic of this group are Variegated Fairy-wren, Peregrine Falcon, Sandstone Shrike-thrush and White-quilled Rock Pigeon.

Bird species typically occurred across several land units. No common species (found with an average abundance of greater than 1 per quadrat in at least one land unit) was restricted to only one land unit.

As with land units, there is wide variation between floristic groups in their bird species diversity (Table 16). Highest diversity, with between 15 and 20 species per quadrat, was in the groups *E. ptychocarpa* forest-*Pandanus-Heteropogon, Melaleuca* woodland-*Acacia-Aristida, Hakea* low woodland-*Dodonea-Triodia, Lysiphyllum* low woodland-*Acacia-Cenchrus* and *Melaleuca* low open woodland-*Acacia-Aerva.* The group *E. brevifolia* low open woodland-*Acacia-Triodia* was relatively depauperate, averaging fewer than five bird species per quadrat.

There is a high proportion of Torresian species in all floristic groups where native tussock grasses dominate the understorey: *Livistona* open forest-*Acacia-Germania, E. ptychocarpa* forest-*Pandanus-Heteropogon, Lysiphyllum* woodland-*Carissa-Heteropogon* and *Melaleuca* woodland-*Acacia-Aristida.* Eyrean species make up a relatively high proportion of the species occurring in *E. brevifolia* low open woodland-*Acacia-Triodia* and *E. brevifolia* open woodland-*Cassia-Plectrachne.*

The distributional patterns of birds across floristic groups (Table 13) is broadly similar to that for land units (Table 12). The relatively tall and dense vegetation of floristic groups *Livistona* open forest-*Acacia-Germania, E. ptychocarpa* forest-*Pandanus-Heteropogon* and *Melaleuca* woodland-*Acacia-Aristida* supports high densities of many Torresian species, such as Dollarbird, Silver-crowned Friarbird, Bar-shouldered Dove, Northern Fantail, Bar-breasted Honeyeater and Crimson Finch. In the low woodland group dominated by *E. aspera-Acacia-Triodia,* and associated with sandstone outcrops, the White-quilled Rock-pigeon, Sandstone Shrike-thrush and Peregrine Falcon were relatively abundant. The tussock grasslands and low woodlands of floristic group *Lysiphyllum-Acacia-Cenchrus* were favoured by Rufous-throated Honeyeater, Singing Bushlark, Red-backed Fairy-wren, Singing Honeyeater and Black-faced Wood-swallow. Tall woodlands of *E. collina-Acacia-Plectrachne* contained highest densities of Northern Rosella, Pied Butcherbird, Cockatiel and Yellow-throated Miner. No bird species occurred at their highest density in the low woodland floristic groups dominated by *E. brevifolia-Acacia-Triodia, E. opaca-Grevillea pyramidalis-Triodia* or *E. cliftoniana-Cajanus-Plectrachne.*

Biogeographic patterns

The total of 149 species now known from the Bungle Bungle area is moderate compared with 21 other surveyed areas across north-western Australia (Fig. 10), although only two (Mitchell Plateau and Dampier Peninsula) of the eight other Western Australian sites have higher bird species totals. The Bungle Bungle list notably contains few waterbirds, a consequence of both the restricted area and variety of waterbodies and the relative lack of survey effort around these.

The bird species composition of the Bungle Bungle area is very similar to that recorded for nearby semi-arid areas, notably Argyle, Keep River, Victoria River Downs and, slightly less so, Drysdale, Gregory, Katherine Gorge, Pine Creek, Edgar Ranges and Kakadu Stage III (Fig. 10). Its bird fauna is more similar to distant semi-arid areas (Mt. Isa, Lower MacArthur) than to relatively close coastal humid areas (Mitchell Plateau) or relatively close arid areas (Great Sandy Desert, Tanami). Indeed, 141 of the 149 bird species of the Bungle Bungle area were also recorded in the Lower MacArthur region, more than 1000 km distant.

The Bungle Bungle landbird fauna has a substantially higher component of Torresian (35 per cent) than Eyrean (16 per cent) species, with just under half of the species having relatively ubiquitous distributions. This composition is similar to that of Argyle, Dampier Peninsula and Victoria River Downs. Eyrean species contribute a much higher proportion to the bird fauna of Edgar Ranges and, especially, Great Sandy Desert and Tanami. In higher rainfall areas of the Kimberley, there are fewer Eyrean species (e.g. Mitchell Plateau 5 per cent, Prince Regent 2 per cent, Drysdale 6 per cent), and the bird fauna of these areas, and high rainfall areas of the Top End, is predominantly Torresian.

This gradation of bird species composition with rainfall gradient is evident in the ordination of bird species lists from across north-western Australia (Fig. 11). The five most arid sites - Hamersley, Edgar Ranges, Great Sandy Desert, Tanami and Mt. Isa - cluster at one end of the gradient. The Bungle Bungle area is included in a group of sites - Victoria River Downs, Argyle, Gregory, Keep River and Drysdale - in a zone with some monsoonal influences but with substantial semi-arid vegetation. Sites with slightly higher rainfall - Katherine Gorge, Pine Creek and Umbrawara - form a related group. Longitude has little influence on the bird species composition of sites in this comparison: for example, on their bird species composition, the Lower MacArthur and Dampier Peninsula form one group, and Mitchell Plateau and Kakadu another.

Related to this change in bird species composition along the rainfall gradient, several species characteristic of coastal or higher rainfall areas reach their local southern (inland) range limits in the Bungle Bungle area. These include a few species with rain forest affinities (Woinarski 1988) whose occurrence in the Bungle Bungle area is restricted largely to pockets of relatively dense riparian vegetation (e.g. Wulwuldji Springs, Bream Gorge). Examples of such species include Pacific Baza, Common Koel, Black Bittern, Bar-shouldered Dove, Bar-breasted Honeyeater, Crimson Finch and Northern Fantail. Nonetheless this is a very small component of the Kimberley rain forest avifauna, and the absence in the Bungle Bungle area of species such as Green-backed Gerygone, Yellow Oriole, Varied Triller, Little Shrike-thrush and Torresian Imperial-Pigeon is notable. Such species are probably absent because of the isolation, small size and floristic impoverishment of the denser forest vegetation of the gorges and springs of the Bungle Bungle area (Johnston and Burbidge 1991).

Another group of bird species reaching their inland range limits around the Bungle Bungle area is that characteristic of relatively tall *Eucalyptus* open forests. Such species include Northern Rosella, Silver-crowned Friarbird, Grey Butcherbird, Leaden Flycatcher, White-bellied Cuckoo-shrike and Masked Finch.

The White-bellied Sea-eagle and Radjah Shelduck may also extend no further upstream in the Ord River system than pools around Blue Holes, although their occurrence may vary substantially depending on the regional distribution of water.

Inland species for which the Bungle Bungle area forms an approximate northern limit include Red-capped Robin, Spinifex Bird, Grey-headed Honeyeater and Red-chested Button-quail. The Spinifex Bird is probably resident in the Park, but the other three species are more nomadic, visiting the Bungle Bungle area in response to particularly favourable or unfavourable conditions in their more usual arid or semi-arid range

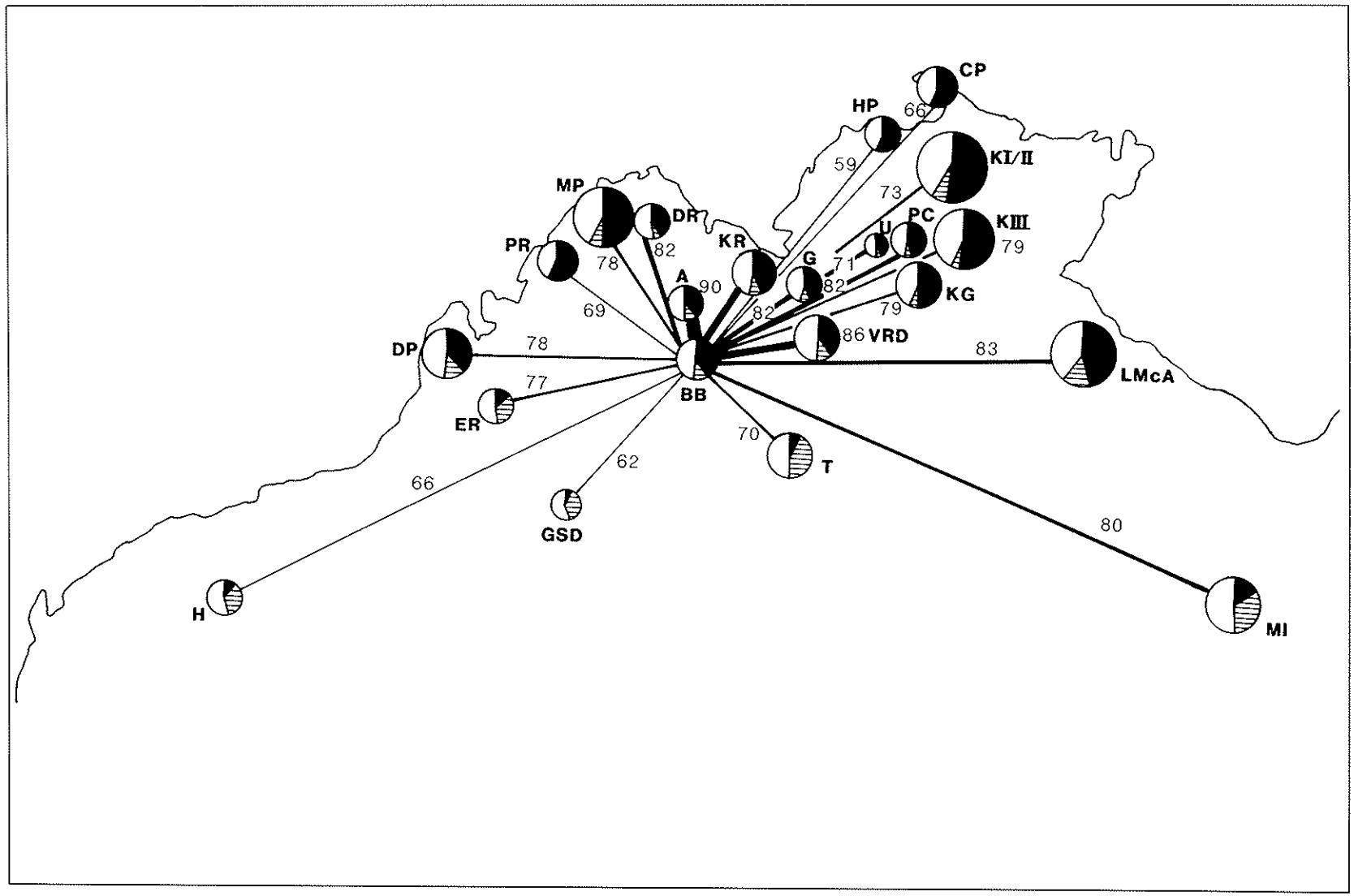

Figure 10

Network diagram showing similarity of the land bird fauna of the Bungle Bungle area with other surveyed regions of north-western Australia. Conventions as for Figure 8. Number of species recorded: H (Hamersley) = 106; DP (Dampier Peninsula) = 138; ER (Edgar Ranges) = 105; GSD (Great Sandy Desert) = 95; PR (Prince Regent River) = 117; MP (Mitchell Plateau) = 151;; DR (Drysdale) = 109; BB (Bungle Bungle) = 125; A (Argyle) = 103; KR (Keep River) = 124; T (Tanami) = 125; VRD (Victoria River Downs) = 128; G (Gregory) = 106; U (Umbrawara) = 89; KG (Katherine Gorge) = 129; KIII (Kakadu Stage III) = 155; KI/II (Kakadu Stages I & II) = 184; HP (Howards Peninsula) = 102; CP (Cobourg Peninsula) = 114; LMcA (Lower MacArthur) = 161; MI (Mt. Isa) = 143.

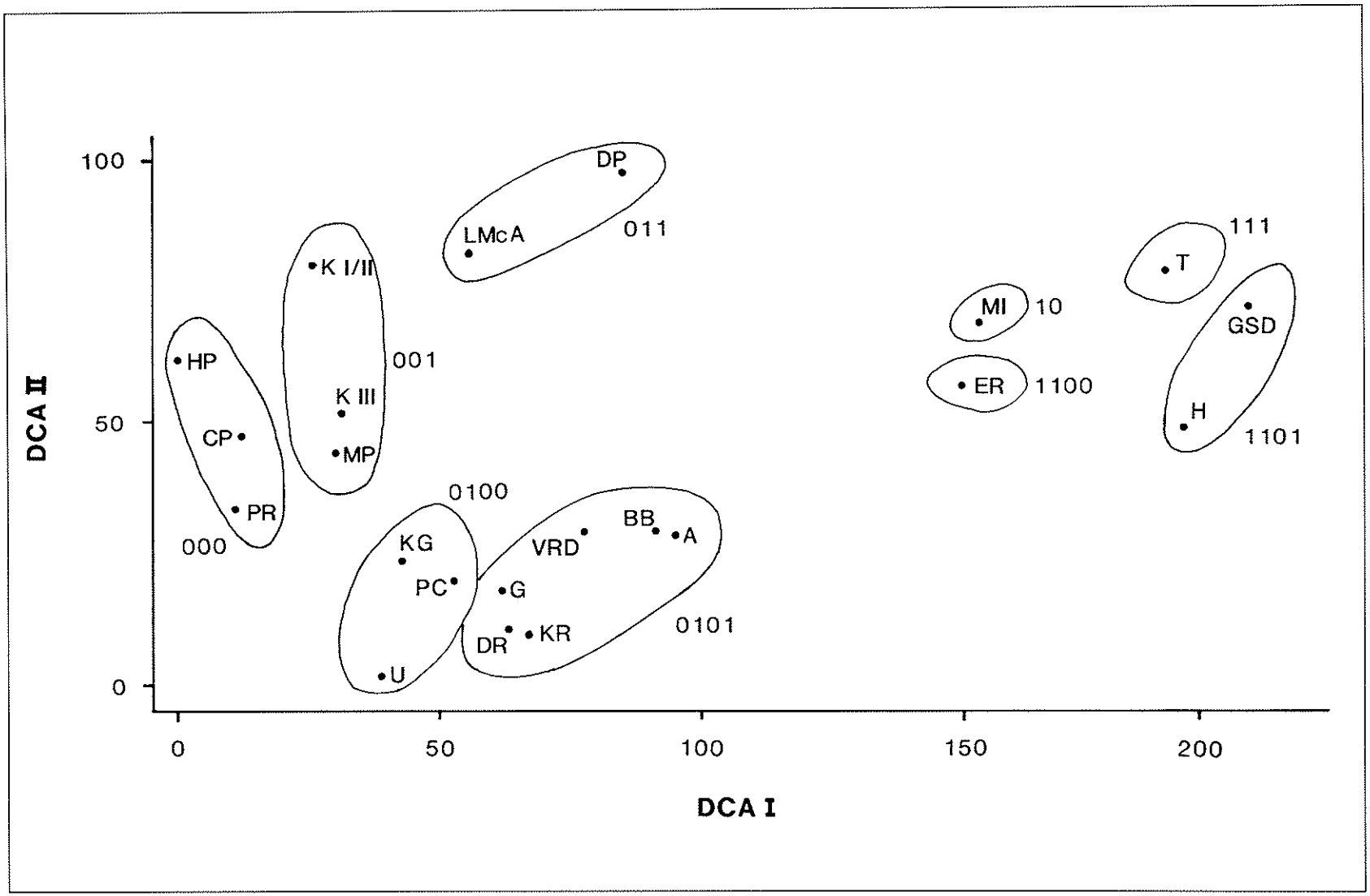

Figure 11

Ordination of the land bird fauna of 22 areas surveyed in north-western Australia. Lines enclosing points represent TWINSPAN groups. Symbols as for Figure 10. Eigenvalues for DCA 1 0.27, for DCA 2 0.07.

Table 12

Distribution of bird species across land system units [a]. Values in body of table are mean abundance per quadrat. Species are included only if they have a mean abundance of >0.1 per quadrat in at least one land system unit. p indicates mean abundance of <0.5. Asterisks denote the proportion of quadrats in which the species was recorded: *>25%, **>50%, ***>75%.

	LAND SYSTEM												
	Wk.	*Al.*	*Nf.*	*Au.*	*Hl.*	*Bp.*	*Bf.*	*Bu.*	*El.*	*Eu.*	*Nr.*	*Ns.*	*Nl.*
Barking Owl	p												
Darter	p	p											
White-bellied Sea-eagle	p	p											
Red-tailed Black Cockatoo	0.6												
Tawny Frogmouth	p												
Channel-billed Cuckoo	p												
Leaden Flycatcher	p*												
Bar-breasted Honeyeater	p												
Sulphur-crested Cockatoo	p	0.8*											
Northern Fantail	0.9*	p											
Azure Kingfisher		p											
Rufous Night-heron	p	p	0.7**										
Brown Goshawk	p	p	p*										
Little Black Cormorant		p	p*										
Black-fronted Plover		p											
Bar-Shouldered Dove	2.1	3.1**	0.7*										
Dollarbird	p		p*										
White-gaped Honeyeater	1.0*	p	4.3**										
Crimson Finch	1.8		1.7*										
Brush Cuckoo			0.7**										
Common Koel			p*										
Banded Honeyeater			0.7*										
Blue-winged Kookaburra	p	p			p								
White-throated Honeyeater	0.6*	1.2*				p							
Olive-backed Oriole	0.6*	0.5				p							
Yellow-tinted Honeyeater	0.7	9.7**	2.3**	p	1.2								
Long-tailed Finch	0.5	1.0*		1.0		0.5	p						
Brown Falcon	p	p							p		p		
Silver-crowned Friarbird	1.1**	p				p	2.9*						
Double-barred Finch	4.6*	6.8**	2.0**	p	3.6**		1.4*	1.1*					
Great Bowerbird	1.0*	p	0.7*		p*	p	p*	p*		p			
Whistling Kite		p		p									
Black Kite		0.5							p				
Red-collared Lorikeet		p				p							
Red-winged Parrot	0.8*	0.6			1.4**	p	p				p		
White-bellied Cuckoo-shrike	0.5*			p		p			p				
Collared Sparrowhawk		p			p								
Grey Shrike-thrush	0.5	1.0*	p*	p	0.8**	p			p				
Little Corella		p							p				

Table 12 *(cont.)*

	LAND SYSTEM												
	Wk.	*Al.*	*Nf.*	*Au.*	*Hl.*	*Bp.*	*Bf.*	*Bu.*	*El.*	*Eu.*	*Nr.*	*Ns.*	*Nl.*
Australian Magpie		p				p							
Jacky Winter		p				p							
Sacred Kingfisher	p		2.7***								p		
Varied Lorikeet	p	0.5							p				
Spotted Nightjar	p			p	p*	0.7					p		
Fairy Martin						O.7							
Masked Finch				p									
Grey Falcon					p								
Australian Owlet-nightjar	p		p*		p						p		
Peaceful Dove	3.7**	10.0***	9.0***	1.0*	4.0***	1.7*	0.6*	0.9*	0.8*		1.3*	4.8*	
Restless Flycatcher	p	1.7**	3.0***	0.8*	p	p					p		
Striated Pardalote	1.4*	3.4**		0.6	p*	1.1*	5.4*		p	0.5*			
Brown Honeyeater	14.1**	11.3***	53.3***	4.0**	22.6***	6.3*	17.4***	p	p	20.3***	p	4.0	
Mistletoebird	1.7**	2.2**	p*	p	0.6*	p*	2.3**	1.9***	p	1.3**	0.8*	0.5*	
Torresian Crow	p*	1.7*	p*	p		p	0.6*			p			
Rufous Whistler	1.1*	2.9***	3.3***	p	2.8***	0.8*		p	1.0*		0.8*	0.8	
Rainbow Bee-eater	0.8*	0.9*	1.3**	0.7*		0.5*	1.7**	1.6***	p	p*	p*	p	
Willie Wagtail	p*	2.2***	2.7***	0.6*	1.4***	p			1.0**		1.8*	p	
Little Friarbird	1.7*	2.6***	27.7**	0.6	1.4***	6.5***	12.1**	0.7**	0.6*	2.1*	p	1.3**	
Northern Rosella	p	0.8		p	p	3.3**	4.7**		1.0*				
Crested Pigeon	p	0.5*		0.5		p	2.0*		0.6*		p		
Weebill	3.5**	2.1*	1.0*	4.2**	1.4*	1.1			p		0.5	0.5	
Pied Butcherbird	0.8*	1.3**	0.7**	0.8*		2.9***	3.3**	p	1.5**	0.8*	0.8*	p	
Black-faced Cuckoo-shrike	p	1.0*	p*	p	0.8**	p		p*	p	p	p	0.5	
Black-chinned Honeyeater	p	p	p*	p	0.6	p	p*		1.7**		p		
Australian Magpie-lark	p	1.7**	1.0**	p		p	0.9*		1.8**		0.5*	p	1.0*
Little Wood-swallow	p	0.9*		0.7		0.7			0.5	p			
White-winged Triller	p	1.5*		3.5*	p	p			p*	p	1.1**	p	
Grey-crowned Babbler	0.7	1.9*	0.7*	p	2.2*	p			5.5**		1.4*	3.0**	2.0***
White-breated Wood-swallow		0.5										p	
Australian Hobby		p							p				
Varied Sittella			1.0*		0.8*	p	p				p	0.5	
Grey-fronted Honeyeater	1.8*			1.5	6.6***	5.4**	2.3**	2.6***	6.5***	1.8*	0.9	3.8	
Red-browed Pardalote	p	p	p*		0.6**	p	p*	p*	1.1**		p		
Emu						p					p		
Cockatiel		0.6	0.7*	p		1.4	0.7*		0.5		1.1*		
Budgerigar		1.0*	5.3*	0.8		1.0	1.6*		12.2***		5.9*	0.8*	
Black-tailed Treecreeper		p		1.2		0.5			0.7*		p		
Yellow-throated Miner	p	1.0	0.7*	p		10.1**	8.9**		2.0**	p	0.8*	2.5*	
Little Crow									p		p		
Painted Firetail				0.6	p	0.5					2.1*		
Little Button-quail						p			p				

Table 12 *(cont.)*

	LAND SYSTEM												
	Wk.	*Al.*	*Nf.*	*Au.*	*Hl.*	*Bp.*	*Bf.*	*Bu.*	*El.*	*Eu.*	*Nr.*	*Ns.*	*Nl.*
Brown Quail						p	p		0.7	p		p	
Red-backed Kingfisher				p		p			p		p		
Common Bronzewing		p			p		p	p		p			
Southern Boobook	p								p	p			
Variegated Fairy-wren	0.6							0.6*		p			
Peregrine Falcon			p*				p*			p			
Sandstone Shrike-thrush						p	0.7*	p*	p	p			
White-browed Wood-swallow										p			
Masked Wood-swallow				2.0						24.8***			
White-quilled Rock-pigeon	p						1.1*	0.6*		p			
Diamond Dove		0.7	5.3**	p	1.2**	1.0*		p	12.3***		5.8***	13.5***	11.0***
Spinifex Pigeon	p	0.6		0.8*	p	p		1.7**	0.6*	p	1.4	1.5	
Barn Owl			p*								p		1.0***
Pallid Cuckoo	p								p*		p	0.8	
Horsfield Bronze-cuckoo				p	p			p*	p*		p	0.5	
Spinifex Bird	p										p		
Red-backed Fairy-wren	p	p	5.7*	1.9	0.6		1.7*	1.4*	1.3*	p	5.0*	16.5***	4.0***
Black-faced Wood-swallow	p	1.9*	2.7*	4.3**	0.6*	0.5		0.6*	3.1**		6.9***	12.5***	2.0***
Rufous-throated Honeyeater	p		52.7***	p						p	2.3**	8.0**	
Zebra Finch		p		1.7	p	p	0.9*		10.5**		14.7*	1.8*	
Singing Bushlark			0.7*								p	3.0**	18.0***
Singing Honeyeater	p		p*	p							1.7*	5.3*	
Pictorella Mannikin												1.0*	
Rufous Songlark			0.3*									1.0	
Australian Bustard											p	0.5*	1.0***
Red-chested Button-quail												0.8*	
Golden-headed Cisticola												1.3	
Brolga													1.0***

(a) Land systems: Eu = Elder uplands, Bf = Buchanan frontage, Bu = Buchanan uplands, Au = Antrim rugged uplands, Bp = Buchanan Sandplain, Hl = Headley lower slopes, Ns = Nelson cracking clay plains, Al = Antrim lowlands, El = Elder cuestas, Nr = Nelson low rises, Wk = Wikham rugged uplands, Nl = Nelson interfluve lower slopes, Nf = Nelson frontage

Table 13

Distribution of bird species across floristic groups [3]. Values in body of table are average abundance per quadrat.
Asterisks denote the proportion of quadrats per group in which the species was recorded: *>25%, **>50%, ***>75%.

	2	*1*	*4*	*3*	*5*	*11*	*16*	*12*	*6*	*7*	*10*	*8*	*9*	*14*	*17*	*15*	*13*
Darter	p*			p													
Little Black Cormorant				0.5*													
Brown Goshawk		p*	p	p													
Black-fronted Plover				1.8*													
Rufous Night-heron	p		p	1.0*	P				P								
Bar-shouldered Dove	6.8**		4.2**	4.8*	0.8				P								
Red-tailed Black Cockatoo	2.2*	P	P		P												
Sulphur-crested Cockatoo	1.0**	P*	0.5*	2.3**	P												
White-breasted Wood-swallow			P	1.0					P								
Channel-billed Cuckoo		P*															
Azure Kingfisher			P	0.5*													
Blue-winged Kookaburra	1.2*		P		P*	P											
Little Corella				1.3*						P							
Dollarbird		1.4**	P	P	P												
Leaden Flycatcher	0.6**	0.6*	P		P												
Northern Fantail	2.8***	2.0**	P*	0.5*	P												
White-gaped Honeyeater	1.6***	2.0**	0.7*	0.8*	0.9				0.8								
White-throated Honeyeater	1.6**	2.0**	1.7*		P									P			
Bar-breasted Honeyeater	4.0*		0.5		P												
Crimson Finch	2.6*		2.7	1.3													
Olive-backed Oriole	1.2**		1.1*		0.7*												
Silver-crowned Friarbird	1.8***	2.0**	0.6*		0.5*						0.8	0.6	1.1	1.0*			
Yellow-tinted Honeyeater			8.6**	15.8***	0.8*	1.2		P	0.5	P							
Double-barred Finch	7.2***	1.2*	10.3***	13.0**	2.2*	3.6**			P	P					2.0*	1.3*	
Great Bowerbird	1.4***	1.8**	p	1.0*	0.8*	p*	p	p			p	p*		p	p*	0.7*	
Black Kite			0.6								p						
Red-winged Parrot	2.0**	p	0.6*	1.8*	0.9*	1.4**			p			p	p				
White-bellied Cuckoo-shrike		0.8*	0.6*	0.5	0.8*			p	p		p	p					
Grey Shrike-thrush	0.6*		1.0*	2.0*	0.8*	0.8**		p	p		p	p*					

Table 13 *(cont.)*

	2	*1*	*4*	*3*	*5*	*11*	*16*	*12*	*6*	*7*	*10*	*8*	*9*	*14*	*17*	*15*	*13*
Peaceful Dove	4.8***	p	14.2***	6.5***	3.5**	4.0***		1.4*	4.1**	p	1.3*	0.9*	0.5*	p	1.1*	p*	
Restless Flycatcher	p		1.5**	3.3***	p*	p		0.6*	0.5*	p		p					
Striated Pardalote	1.6*	p	5.6***	2.8**	0.5*	p*	p*	0.6*			1.3*	p	3.4**				
Brown Honeyeater	39.8***	1.2*	13.6***	22.0***	11.2***	22.6***	18.7***	3.6**	13.4*	8.6*	2.7	8.6*	11.8**	1.3***	p	6.0***	
Mistletoebird	3.0***	1.4**	3.9***	1.0*	p*	0.6*	1.1**	p*	1.0**		p*	p*	p*	0.5*	2.3***	4.0***	
Torresian Crow	0.8*	p	1.9**	1.5***	0.5*		p	p				p	p	p		1.0**	
Sacred Kingfisher	p		p	0.5	p				0.6								
Rufous Whistler	3.2***		4.0***	0.8**	1.0**	2.8***	p	p	1.6**	p	1.1*	0.7*					
Long-tailed Finch			1.2*	0.5	1.5*			0.6		0.6		0.7*	p				
Varied Lorikeet	0.6		p	1.8	p					p	p						
Spotted Nightjar	p				p	p*		p	p								p*
Rainbow Bee-eater	0.8	1.8**	1.0*	1.5**	0.5*		0.6*	0.6*	p	1.0**	p	0.7*	p		2.3***	2.0**	p
Willie Wagtail	p		1.8**	4.3***	0.6*	1.4***		0.5*	1.9**	1.1**	1.0**	p*		p*			
Little Friarbird	3.0***	p	3.1**	4.0***	1.0*	1.4***	1.6*	0.9*	6.8*	1.5*	3.0**	12.3***	7.7***	p*	0.7**	0.7*	
Northern Rosella			0.9*		1.1*	p		p			1.7**	2.3**	5.8**				
Crested Pigeon			0.5*		0.8			0.6	p		1.3*	p	0.8*				
Weebill	1.2*	1.6	1.3*		6.5***	1.4*		5.8**	0.7	1.1*	1.6*			2.2***			1.4*
Pied Butcherbird	p		1.6**		0.6*		0.8*	0.9*	0.9**	p	2.0**	2.3**	4.1***	2.5***	0.3*	0.7**	
Black-faced Cuckoo-shrike		p	0.7*	1.8**	p	0.8**	p	p*	p	p	p	p*		0.5*	p*		
Tawny Frogmouth					p*						p						
Varied Sittella			p			0.8*			0.6				p				
Black-chinned Honeyeater	P			1.5**	P	0.6		P	0.6*		1.3**	P	P				
Rufous-throated Honeyeater	p		0.6	2.0	p		p	0.6	15.5***					p			
Australian Magpie-lark			0.9*	2.0**	p			p	0.7**	1.5**	1.9**		0.6*				
Little Wood-swallow			p	0.5	0.8		p	1.0*	p	1.0	p	1.7**					
White-winged Triller			0.6*	0.8		p	p	1.5*	0.6*	5.9**	p*	0.7*					p
Grey-crowned Babbler			1.2*	3.0*	2.0	2.2*	p	p	2.4**	3.0*	4.6**						
Grey-fronted Honeyeater		p			5.2**	6.6***	2.3*	p	2.0	1.1	4.9**	11.1***	1.3		2.9***	2.3**	
Red-browed Pardalote				p		0.6**	p	p	0.5*		1.0**	p	p				
Diamond Dove				2.0**		1.2**	p	0.8	10.5***	1.5**	10.8**	2.0**			p		
Spinifex Pigeon						p		1.4*	0.5	2.1**	0.5	p*	0.7		1.7**		1.2**
Pallid Cuckoo					p				p		p*						
Horsfield Bronze-cuckoo						p		p	p		p				p*		

Table 13 *(cont.)*

	2	*1*	*4*	*3*	*5*	*11*	*16*	*12*	*6*	*7*	*10*	*8*	*9*	*14*	*17*	*15*	*13*
Singing Bushlark								p	2.5*								
Fairy Martin												1.7*					
Red-backed Fairy-wren					0.6	0.6		4.1*	7.3**	3.3	0.6*		1.5*		1.4*		
Singing Honeyeater			p						2.7**	1.0*							
Black-faced Wood-swallow			0.8	3.0*	p	0.6*		2.4***	7.8**	7.1***	2.8**	1.3*			0.6*		3.2***
Zebra Finch						p		2.9	0.7	20.3***	9.5*	p			p	1.3*	
Painted Firetail						p	p	0.9		2.4*		0.7*			p		p
Brown Quail									p		0.6	0.6	p*				
Red-backed Kingfisher								p	p	p	p	p*					
Spinifex Bird					p					0.5*							
Australian Bustard									p*								
Emu										p			p*	p			
Cockatiel								0.5	p	2.5**	0.5		2.6**				
Budgerigar			0.6	1.3*				0.7*	6.9**	0.8	11.6***	1.3*	1.2*				
Black-tailed Treecreeper								0.9	p	0.9	0.5*	1.1*	p				0.6
Yellow-throated Miner				1.3	0.5*			p	1.8*	2.6*	1.5**	6.6**	17.0***				
Common Bronzewing			p			p						p	p*				
Southern Boobook	p	p					p				p			p*			
Variegated Fairy-wren					1.5*		p							p	0.6*		
Peregrine Falcon				p							p		p			0.7**	
Sandstone Shrike-thrush							p				p	p			p*	1.7***	
Masked Wood-swallow							24.6*	0.9		1.5						0.7*	
White-quilled Rock-Pigeon							p						p		0.9*	2.0**	

(a) Description of floristic groups: 2 = *E. ptychocarpa - Pandanus - Heteropogon*, 1 = *Livistona - Acacia - Germania*, 4 = *Melaleuca - Acacia - Aristida*, 3 = *E. camaldulensis/Melaleuca - Aerva - Aristida*, 5 = 11 *Lysiphyllum - Carissa - Heteropogon*, 11 = *Hakea - Dodonea - Triodia*, 16 = *E. cliftoniana - Acacia - Trioda*, 12 = *E. opaca - Grevillea - Triodia*, 6 = *Lysiphyllum - Acacia - Cenchrus*, 7 = *Acacia - Aerva - Aristida*, 10 = *E. brevifolia - Cassia - Plectrachne*, 8 = *E. collina - Acacia - Triodia*, 9 = *E. collina - Acacia - Plectrachne*, 14 = *E. cliftoniana - Cajanus - Plectrachne*, 17 = *Acacia - Triodia*, 15 = *E. aspera - Acacia - Triodia*, 13 = *E. brevifolia - Acacia - Triodia*.

Table 14

The number of bird species recorded per study site, and the number of these recorded for only one site.

SITE	NO. BIRD SPP.	NO. RESTRICTED SPP.	
1	52	1	Grey-headed Honeyeater
2	65	3	White-faced Heron, Grey Goshawk, Jacky Winter
3	63	2	Little Eagle, Ground Cuckoo-shrike
4	25	1	White-browed Wood-swallow
5	73	1	Richard's Pipit
6	61	2	Square-tailed Kite, Red-capped Robin
7	67	3	Pacific Baza, Bar-breasted Honeyeater, Grey Butcherbird
8	49	0	
9	89	12	Little Egret, Pacific Black Duck, Spotted Harrier, Masked Plover, Brush Cuckoo, Golden-headed Cisticola, Banded Honeyeater, Red-chested Button-quail, Common Sandpiper, Common Koel, Black-headed Stilt, Australian Pelican
10	42	0	

Table 15

Average number of bird species per quadrat for the land systems surveyed.

LAND SYSTEM		SYMBOL	NO. QUADRATS	NO. BIRD SPECIES		
				Total	*Torresian*	*Eyrean*
ANTRIM	rugged uplands	Au	12	10.0	2.3 (22.5%)	1.7 (16.7%)
ANTRIM	lowlands	Al	21	19.3	7.2 (37.5%)	1.1 (5.7%)
BUCHANAN	uplands	Bu	7	7.7	2.3 (29.7%)	1.6 (2.1%)
BUCHANAN	sandplain	Bp	17	10.8	3.1 (28.8%)	1.9 (17.6%)
BUCHANAN	frontage	Bf	7	12.0	4.0 (33.3%)	2.1 (17.5%)
ELDER	uplands	Eu	16	6.7	1.6 (24.4%)	0.6 (9.0%)
ELDER	cuestas	El	10	15.4	2.6 (16.9%)	3.7 (24.0%)
HEADLEY	lower slopes	Hl	5	15.2	4.2 (27.6%)	2.4 (15.8%)
NELSON	cracking clay plains	Ns	4	15.3	4.3 (27.9%)	2.5 (16.3%)
NELSON	interfluve lower slopes	Nl	1	9.0	2.0 (22.2%)	0 (0%)
NELSON	frontage	Nf	3	23.0	8.0 (34.8%)	1.3 (5.7%)
NELSON	low rises	Nr	12	12.9	1.8 (13.5%)	3.4 (26.4%)
WICKHAM	rugged uplands	Wk	35	13.4	6.1 (45.8%)	0.5 (3.7%)

Table 16

Average number of bird species per quadrat for the floristic groups.

FLORISTIC GROUP	NO. OF BIRD SPECIES		
	Total	*Torresian*	*Eyrean*
1. *Livistona - Acacia holosericea - Germania*	9.6	4.0 (42%)	0.2 (2%)
2. *E. ptychocarpa - Pandanus - Heteropogon*	18.8	10.8 (57%)	0
3. *E. camaldulensis / Melaleuca - Aerva - Aristida*	26.3	11.0 (42%)	0.8 (3%)
4. *Melaleuca leucadendra - Acacia eriopoda - Aristida*	19.9	8.8 (44%)	0.5 (3%)
5. *Lysiphyllum - Carissa - Heteropogon*	14.4	6.1 (42%)	1.0 (7%)
6. *Lysiphyllum - Acacia holosericea - Cenchrus*	16.6	3.8 (23%)	2.5 (15%)
7. *Acacia farnesiana - Aerva - Aristida*	13.9	2.0 (14%)	4.3 (31%)
8. *E. collina - Acacia stipuligera - Triodia spicata*	13.1	3.9 (30%)	2.3 (18%)
9. *E. collina - Acacia tumida - Plectrachne pungens*	9.7	3.2 (33%)	1.8 (19%)
10. *E. brevifolia - Cassia - Plectrachne pungens*	14.5	2.6 (18%)	3.3 (23%)
11. *Hakea arborescens - Dodonea - Triodia wiseana*	15.2	4.2 (28%)	2.4 (16%)
12. *E. opaca - Grevillea pyramidalis - Triodia pungens*	11.1	2.7 (24%)	1.6 (14%)
13. *E. brevifolia - Acacia retivenia - Triodia intermedia*	3.6	0	1.4 (39%)
14. *E. cliftoniana - Cajanus - Plectrachne pungens*	7.2	2.3 (32%)	0
15. *E. aspera - Acacia eriopoda - Triodia microstachya*	9.3	3.3 (36%)	1.0 (11%)
16. *E. cliftoniana - Acacia spp - Triodia spicata*	6.5	1.3 (20%)	0.8 (12%)
17. *Acacia spp - Triodia spicata*	8.4	2.7 (32%)	1.7 (20%)

Chapter 6

Herpetofauna of the Bungle Bungle Area

by
Nick Gambold

ANNOTATED SPECIES LIST

Nomenclature follows Storr *et al.* (1981, 1983, 1986, 1990) for reptiles and Tyler *et al.* (1984) for amphibians.

For Australian distribution: T = tropical northern Australia (Torresian zone), D = primarily desert (Eyrean zone), K = restricted to the Kimberley, C = continent-wide distribution.

The survey sites where species were recorded by CSIRO are listed after the scientific name. Numbers in brackets refer to the number of individuals (if any) recorded in quadrats for those sites.

The number of specimens collected is given after survey sites; all specimens are lodged in the Western Australian Museum with prefix R103...

Amphibia

FAMILY Leptodactylidae. Ground Frogs.

ORNATE BURROWING FROG *Limnodynastes ornatus* (Gray). T
1(3), 2(1), 4(1), 8(4), 9(4), 10(2).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca-Aerva-Aristida.*
5 specimens.
Abundant in many habitats, particularly fluvial sands. Occurs on the Bungle Bungle plateau.

Ranidella bilingua (Martin, Tyler & Davies). T
2(5), 4(26), 5(2), 6(10), 7(31), 8(3).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
7 specimens.
Locally common, confined to permanently moist habitats associated with springs, soaks and plunge pools.

Uperoleia borealis Tyler, Martin & Davies. K
4(30), 10(56).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
10 specimens.
Locally abundant around plunge pools and ephemeral creeks of the massif.

FAMILY Hylidae. Tree Frogs.

Cyclorana australis (Gray). T
10(4).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
2 specimens.
Common, large numbers observed at temporary pools in ephemeral creeks running off the south-west face of the massif following heavy rain in Novemeber 1986.

Cyclorana longipes Tyler & Martin. T
Not recorded during this survey, but I recorded one specimen at Piccaninny Creek in November 1986.

GREEN TREE FROG *Litoria caerulea* (White). T
8(1), 10(2).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
1 specimen.
Recorded co-occurring with *Litoria splendida* in rocky gorges. Also in woodlands and artificial structures within the Park.

COPLAND'S ROCK FROG *Litoria coplandi* (Tyler). T
1(4), 4(19), 5(9), 6(2), 7(13), 8(4), 10(10).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
6 specimens.
Abundant in watercourses throughout sandstone.

Litoria meiriana (Tyler). T
4(127), 10(1).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
Conspicuous and diurnal, often co-occurring with *L. coplandi* in pools in rocky gorges. Seasonally variable in abundance.

ROTH'S TREE FROG *Litoria rothii* (de Vis). T
5.
Recorded incidentally at Winnama Gorge and at Blue Holes.

DESERT TREE FROG *Litoria rubella* (Gray). C
1, 5.
1 specimen.
Probably common and widespread following rain.

Litoria splendida Tyler, Martin & Davies. K
8(7), 10(6).
Preferred land unit: Buchanan frontage. Preferred floristic group: *E. aspera-Acacia-Triodia.*
1 specimen.
Found commonly in sandstone gorges of the Osmand Valley and Bungle Bungle massif, often forming aggregations in caves and crevices.

Litoria wotjulumensis (Copland). T
6(3), 7(1), 8(10), 10.
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
5 specimens.
Moderately common, associated with tussock grass fringing watercourses.

Reptilia

FAMILY Crocodylidae. Crocodiles.

FRESHWATER CROCODILE *Crocodylus johnstoni* Krefft. T
2(2), 5(2), 7(10), 9.
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
Common in pools of the Ord River and Osmand Creek units. 56 were counted in one pool at Blue Holes.

FAMILY Chelidae. Turtles.

Chelodina sp. nov. T
7(3), 8(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
1 specimen.
A large snake-necked turtle associated with sandstone watercourses. Also known from the north Kimberley and Northern Territory (Kennett[5] personal communication).

Emydura australis (Gray). K
7(6), 9.
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
1 specimen.
Common short-necked turtle (with red temporal streak) throughout the major waterways of the area. Recorded also at Wulwuldji Spring.

FAMILY Gekkonidae. Geckoes.

CLAWLESS GECKO *Crenadactylus ocellatus* (Gray). D
8(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Lysiphyllum-Carissa-Heteropogon.*
1 specimen.
Recorded on cycads and from burning spinifex on sandstone. Specimen is of the subspecies *C. ocellatus rostralis.*

SPINY-TAILED GECKO *Diplodactylus ciliaris* Boulenger. T,D
10(1).
Preferred land unit: Buchanan uplands.
Preferred floristic group: *Acacia-Triodia.*
1 specimen.
Uncommon, although possibly underestimated because of cryptic arboreal habits. Specimen is of the subspecies *D. ciliaris ciliaris.*

FAT-TAILED GECKO *Diplodactylus conspicillatus* Lucas & Frost. D 9(3).
Preferred land unit: Nelson low rises.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
3 specimens.
On sandstone breakaway. All specimens gravid with two near term eggs (late November).

Diplodactylus stenodactylus Boulenger. T,D
1(4), 5(1), 8(6), 9(2), 10(1).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina-Acacia-Plectrachne.*
7 specimens.
Common, especially on deep sands.

NORTHERN DTELLA *Gehyra australis* Gray. T
1(2), 2(5), 3(2), 5(1), 6(1), 7(3), 8(6), 9(6).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
14 specimens.
Common and widespread other than on massif. Mostly recorded from beneath loose bark of eucalypts, also common in *Lysiphyllum* woodlands. Two distinct forms noted during this survey.

[5] R. Kennett - Conservation Commission of the Northern Territory, Darwin.

Gehyra nana Storr. T
1(1), 3(6), 4(9), 5(1), 6(9), 7(2), 8(2), 9(13).
Preferred land unit: Nelson low rises.
Preferred floristic group: *E. cliftoniana-Cajanus-Plectrachne.*
9 specimens.
Common on sandstone and limestone throughout the Park.

PILBARA DTELLA *Gehyra pilbara* Mitchell. D
3(4), 9(16).
Preferred land unit: Nelson low rises.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
6 specimens.
Commonly recorded on termite mounds associated with sandstone cuestas and breakaways.

Gehyra sp.nov. K
1, 4(2), 7(2), 10.
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. cliftoniana-Cajanus-Plectrachne.*
16 specimens.
A large saxicoline Dtella superficially resembling *Pseudothecadactylus*, found in deep cool gorges and caves of the Bungle Bungle massif, Osmand Ranges and 'Keep River Sandstone' (King[6] personal communicaiton).

BYNOE'S GECKO *Heteronotia binoei* (Gray). C
1(3), 2(17), 3(7), 5(8), 6(4), 7(8), 8(1), 9(13).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *E. camaldulensis/Melaleuca-Aerva-Aristida.*
14 specimens.
Ubiquitous, except on the massif. Often encountered in burrows and on termite mounds.

CAVE GECKO *Heteronotia planiceps* Storr. T
1, 4(1), 6(2), 7(2), 8(3).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *Livistona-Acacia-Germania.*
12 specimens.
A common saxicoline gecko of sandstone, basalt and limestone environments. Some specimens were difficult to distinguish from *H. spelea* morphologically.

MARBLED VELVET GECKO *Oedura marmorata* Gray. T,D
4(1).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. cliftoniana-Acacia-Triodia.*
1 specimen.
Scarce - single specimen on sandstone from the top of the massif.

Oedura rhombifer Gray. T,D
6(1).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *Hakea-Dodonea-Triodia.*
1 specimen.
Scarce - single juvenile specimen pit-trapped on a limestone ridge, with dense spinifex understorey.

BEAKED GECKO *Rhynchoedura ornata* (Gunther). D
2(1), 3(1), 9(4), 10(1).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca-Aerva-Aristida.*
6 specimens.
Moderately common. In late November females were gravid with two near-term eggs.

FAMILY Pygopodidae. Pygopodids (Legless Lizards).

Delma borea Kluge. T,D
4(1), 5(1), 6(2), 7(1), 8(2), 10(3).
Preferred land unit: Buchanan uplands.
Preferred floristic group: *E. clftoniana-Cajanus-Plectrachne.*
13 specimens.
Commonly pit-trapped or found within spinifex.

Delma nasuta Kluge. D
4(3), 8(1).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
1 specimen.
Common only on the Bungle Bungle Plateau where it inhabited dense spinifex.

Delma tincta de Vis. T,D
8(1), 9(1).
Preferred land unit: Nelson frontage.
Preferred floristic group: *Livistona-Acacia-Germania.*
12 specimens.
Uncommon, generally occurring in more arid environments than *D. borea.* Damaged specimen from site 8 was not positively identified.

BURTON'S SNAKE-LIZARD *Lialis burtonis* Gray. C
9(2), 10(3).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca-Aerva-Aristida.*
Only recorded during the 'wet season' survey, when it was moderately common.

[6] M. King - Northern Territory Museum of Arts and Services, Darwin.

HOODED SCALY-FOOT *Pygopus nigriceps* (Fischer). C
1.
1 specimen.
Scarce - a single specimen active at night among spinifex on red sand plain. Specimen is of the subspecies *P. nigriceps schraderi.*

FAMILY Agamidae. Dragons.

FRILL-NECKED LIZARD *Chlamydosaurus kingi* Gray.] T
Not recorded during this survey, but sightings reported from Island Yard on the Ord River (Rogers and Butters[7] personal communication).

RING-TAILED DRAGON *Ctenophorus caudicinctus* (Gunther). T
3(4), 5(2), 7(2), 9(2), 10(2).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. brevifolia-Cassia-Plectrachne.*
4 specimens.
Moderately common in sandstone habitats, including low breakaways in the Ord River valley. Specimens are of the subspecies *C. caudicinctus macropus.*

MILITARY DRAGON *Ctenophorus isolepis* (Fischer). D
1(18), 3(7), 10(42).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina-Acacia-Triodia.*
3 specimens.
Common and conspicuous on deep red sands surrounding much of the massif. Specimens are of the subspecies *C. isolepis isolepis.*

Diporiphora arnhemica Storr. T
5(9), 8(1).
Preferred land unit: Antrim rugged uplands.
Preferred floristic group: *E. opaca-Grevillea-Triodia.*
4 specimens.
Locally common. All records from open spinifex on stony rises.

Diporiphora lalliae Storr. D
3(1), 6(2), 9(13).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
4 specimens.
Locally common, particularly in scattered open shrubs over tussock grasslands.

Diporiphora magna Storr. T
1(3), 3(3), 10(2).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. collina-Acacia-Triodia.*
5 specimens.
A small dragon moderately common on sandplains of the Buchanan and Elder systems.

Gemmatophora gilberti (Gray). T,D
2(10), 5(8), 6, 7(18), 8(2), 9(5). Preferred land unit: Nelson frontage.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
6 specimens.
Common in riparian habitats other than those directly adjacent to the massif. Specimens are of the subspecies *G. gilberti gilberti.*

Pogona minor (Sternfeld). T,D
10.
A bearded dragon skull, probably this species, was collected from underneath a raptor roost in a sandstone outlier. This species is uncommon throughout the Kimberley.

FAMILY Varanidae. Monitors (Goannas).

RIDGE-TAILED MONITOR *Varanus acanthurus* Boulenger. T,D
3(1), 4(5), 6(2).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. cliftoniana-Acacia-Triodia.*
2 specimens.
Very numerous among sandstone boulders on top of massif. Also common in most other rocky habitats in the Bungle Bungle area.

Varanus glauerti Mertens. T
8(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
4 specimens.
All specimens from gorges in the Osmand and Bungle Bungle ranges. In congregations around persistent waterholes in 'wet season' survey.

LONG-TAILED ROCK MONITOR *Varanus glebopalma* Mitchell. T
7(2), 8, 10.
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. cliftoniana-Cajanus-Plectrachne.*
Inconspicuous, but probably common in sandstone habitats throughout the Park.

[7] A. Rogers and P. Butters - Department of Conservation and Land Management, Kununurra, W.A.

SAND GOANNA *Varanus gouldii* (Gray). T,D
10(8).
Preferred land unit: Buchanan uplands.
Preferred floristic group: *Acacia-Triodia.*
2 specimens.
The distinctive diggings of this species were common in all quadrats on red sand. Two adult specimens from spinifex on sandplain.

Varanus kingorum Storr. K
6(1).
Preferred land unit: Antrim rugged uplands.
Preferred floristic group: *E. brevifolia-Acacia-Triodia.*
1 specimen.
Scarce, one female pit-trapped on shattered, hard sandstone ridge in July was gravid with two well-formed eggs.

MERTEN'S WATER MONITOR *Varanus mertensi* Glauert. T
4(1), 5(1), 7(2), 8(5).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
Common in permanent pools of the Osmand Creek and gorges of the Bungle Bungle massif. One specimen was captured in a dry creek bed on top of the massif. Gravid females and neonates observed in November and December.

MITCHELL'S WATER MONITOR *Varanus mitchelli* Mertens. T
2(1), 7(2), 8(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
1 specimen.
Common along Osmand Creek and associated gorges.

NORTHERN SAND GOANNA *Varanus panoptes* Storr. T
3(2), 9(3), 10(2).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
Reasonably abundant, especially near watercourses.

BLACK-HEADED GOANNA *Varanus tristis* Schlegel. C
5(2), 8(3), 9(1), 10(1).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Livistona-Acacia-Germania.*
2 specimens.
Moderately common, recorded under bark and in hollow limbs of eucalypts. Also caught in Elliott traps. Specimens are of the subspecies *V. tristis tristis.*

FAMILY Scincidae. Skinks.

Carlia amax Storr. T
4(6), 6(2), 8(7).
Preferred land unit: Elder uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
7 specimens.
Common on the harder sandstones of the Osmand Ranges and on the plateau of the Bungle Bungle massif, but absent from the fragile conglomerates of the massif's perimeter.

Carlia munda de Vis. T
7(9), 8(2).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
2 specimens.
Isolated populations occurring on heavy cracking clays, rain forest patches and *Melaleuca* swamps.

Carlia triacantha (Mitchell). T,D
9(2).
Preferred land unit: Nelson low rises.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
1 specimen.
Scarce, very limited distribution within the Park: only recorded from spinifex and tussock grass on stony soils.

Cryptoblepharus megastictus Storr. T
4(1), 7(4), 8(4), 10(3).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
2 specimens.
Moderately common on sandstone of the Osmand Ranges and Bungle Bungle massif.

Cryptoblepharus plagiocephalus (Cocteau). C
1(2), 2(2), 6(3), 8(3), 9(2).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
4 specimens.
Moderately common in most woodland and open forest habitats.

Ctenotus decaneurus Storr. T
1(1), 8(1).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina-Acacia-Plectrachne.*
2 specimens.
One specimen was collected from an extensive sandplain (where sympatric with *C. piankai*), but normally on shaley substrates.

Ctenotus inornatus Storr. T.
Ctenotus saxatilis (Gray). D.
1(12), 2(1), 3(4), 4(21), 5(4), 6(4), 7(5), 8(3), 9(16), 10(92).
Preferred land unit: Buchanan uplands.
Preferred floristic group: *Acacia-Triodia.*
39 specimens.
Very abundant and widespread. These taxa were not differentiated as their morphological patterns appear to intergrade extensively in this area.

SOLDIER SKINK *Ctenotus militaris* Storr. K
9(14).
Preferred land unit: Nelson low rises. Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
4 specimens.
Locally abundant on sandstone breakaways and cracking clays adjacent to the Ord River at Kitty's Knob.

OCELLATED SKINK *Ctenotus pantherinus* Peters. T
3(3), 5(10), 6(6), 7(3), 8(5), 9(1).
Preferred land unit: Antrim rugged uplands.
Preferred floristic group: *E. brevifolia-Acacia-Triodia.*
8 specimens.
Common in most spinifex habitats, except those on the massif. Specimens are of the subspecies *C. pantherinus calx.*

Ctenotus piankai Storr. D
1(5), 3(4), 5(1), 10(9).
Preferred land unit: Buchanan uplands.
Preferred floristic group: *Acacia-Triodia.*
6 specimens.
Reasonably common on red sands with spinifex.

Ctenotus tantillus Storr. K
1(1).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina-Acacia-Plectrachne.*
1 specimen.
Scarce, the Park may represent its local southern range limit. Pit-trapped on sandplain with *Eucalyptus collina* woodland.

Egernia slateri Storr. D
4(5).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. cliftoniana-Acacia-Triodia.*
3 specimens.
Confined to the plateau of the Bungle Bungle massif, where numerous and colonial. Their conspicuous burrows (often with multiple openings) were placed at the base of spinifex clumps on shallow sandy soils. Specimens are of the subspecies *E. slateri slateri,* which also occurs in the south of the Northern Territory.

BROAD-BANDED SAND-SWIMMER *Eremiascincus richardsonii* (Gray). D
5(1), 9(1).
Preferred land unit: Nelson frontage.
Preferred floristic group: *Acacia-Aerva-Aristida.*
1 specimen.
Two were pit-trapped on silty soils of levee banks of the Ord River. Vegetation and impact of feral animals were very different at these sites.

Sphenomorphus isolepis (Boulenger). T
8(3).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
2 specimens.
Recorded from sheltered gullies supporting closed forests in the Osmand Valley (Winnama Gorge, Bream Gorge).

Lerista aericeps (Storr). D
1(2).
Preferred land unit: Buchanan sandplain.
Preferred floristic group: *E. collina-Acacia-Triodia.*
2 specimens.
Both raked from sandy soil beneath logs in *Eucalyptus collina* open woodland over spinifex. Previously known in Western Australia from only one specimen collected about 100 km south of the Park at Gordon Downs. Specimens are of the subspecies *L. aericeps taeniata.*

Lerista borealis Storr. K
2(1), 8(4).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
1 specimen.
Collected from sandy or loamy substrates. This species is typically associated with more humid habitats than for the other *Lerista* species recorded.

Lerista greeri Storr. K
1(26), 2(5), 3(3), 9(21), 10(21).
Preferred land unit: Nelson frontage.
Preferred floristic group: *E. camaldulensis/Melaleuca-Aerva-Aristida.*
45 specimens.
Abundant in sandy soils throughout the Park. Gravid females collected in November and December. There was great variation in colour and dorsal pattern of specimens collected.

Lerista sp. nov.
10(2).
Preferred land unit: Buchanan frontage.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
1 specimen.

Pit-trapped and observed in fluvial sands with dense *Triodia microstachya*. Distinguished from the closely related *Lerista desertorum* by lack of lateral stripe and nasals in contact.

Menetia greyii Gray. C
2(3), 6(4), 8(1), 9(7).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *Hakea-Dodonea-Triodia.*
8 specimens.
Moderately common, being most often recorded in dense leaf litter or beneath spinifex.

Menetia maini Storr. T,D
8(1), 9(8).
Preferred land unit: Nelson low rises.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
6 specimens.
Locally common, sympatric with *M. greyii* at some sites and with similar micro-habitat.

FIRE-TAILED SKINK *Morethia ruficauda* (Lucas & Frost). T,D
1(1), 2(6), 3(1), 4(3), 7(4), 8(7), 9(1), 10(3).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
5 specimens.
Widespread in many habitats, particularly riparian and sandstone environments.

Notoscincus wotjulum (Broom). T
2(3), 8(5).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Melaleuca-Acacia-Aristida.*
6 specimens.
Locally common, mainly associated with riparian habitats.

Omolepida branchialis (Gunther). D
1(2), 3(7), 10(1).
Preferred land unit: Nelson low rises.
Preferred floristic group: *Acacia-Aerva-Aristida.*
3 specimens.
Common, sheltering under spinifex. One specimen observed swallowing large *Ctenotus saxatilis.*

Proablepharus reginae (Glauert). D
10(3).
Preferred land unit: Buchanan uplands.
Preferred floristic group: *Acacia-Triodia.*
1 specimen.
Restricted, active among spinifex on a stony substrate. This species has a very patchy distribution across arid Western Australia.

Probalepharus tenuis (Broom). T
3(2), 5(3), 6(3), 8(1), 9(3), 10(1).
Preferred land unit: Headley lower slopes.
Preferred floristic group: *Hakea-Dodonea-Triodia.*
6 specimens.
Common in debris beneath spinifex.

CENTRALIAN BLUE-TONGUE *Tiliqua multifasciata* Sternfield. D
10(6).
Preferred land unit: Buchanan uplands. Preferred floristic group: *Acacia-Triodia.*
Only encountered at one site, though probably widespread throughout Park. Activity seasonal.

NORTHERN BLUE-TONGUE *Tiliqua scincoides* White. T
7(1), 8(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. cliftoniana-Cajanus-Plectrachne.*
1 specimen.
Recorded from dissected sandstone habitats, where it was reasonably common. Specimen is of the subspecies *T. scincoides intermedia.*

FAMILY Typhlopidae. Blind Snakes.

Ramphotyphlops guentheri (Peters). T
7(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. opaca-Grevillea-Triodia.*
1 specimen.
Pit-trapped on compact shaley substrate.

FAMILY Boidae. Pythons.

BLACK-HEADED PYTHON *Aspidites melanocephalus* (Krefft). T,D
9(1).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
One record from heavy cracking clay with dense tussock grass and *Acacia farnesiana.*

CHILDREN'S PYTHON *Morelia childreni* Gray. T
5(1), 9(2).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
2 specimens.
Locally common on heavy cracking clays adjacent to the Ord River, also recorded from the northern face of the massif.

OLIVE PYTHON *Morelia olivaceus* Gray. T
8(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
Common in sheltered gullies of the Osmand valley (e.g. Winnama Gorge, Bream Gorge), apparently absent from the Bungle Bungle massif.

CARPET PYTHON *Morelia spilota* (Lacepede). T 8.
Sloughed skin found at Bream Gorge was almost certainly from this species. Carpet Pythons are recorded rarely from the Kimberley region.

FAMILY Colubridae. Colubrid snakes.

BROWN TREE SNAKE *Boiga fusca* (Merrem). T
8(2).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
Common in the sheltered gullies of the Osmand Valley (e.g. Winnama Gorge, Bream Gorge); not recorded from the Bungle Bungle massif.

COMMON TREE SNAKE *Dendrolaphus punctulatus* (Gray). T
4(1), 8(1).
Preferred land unit: Elder uplands.
Preferred floristic group: *E. aspera-Acacia-Triodia.*
Common in the sheltered gullies of the Osmand valley and gorges of the Bungle Bungle massif.

FAMILY Elapidae. Elapid snakes.

NORTHERN DEATH ADDER *Acanthophis praelongus* Ramsay. T
Only one record during this survey, adjacent to the western face of the massif (Herold[8] personal communication). Rangers provided numerous other records from close to the massif (A. Rogers personal communication).

BLACK WHIP SNAKE *Demansia atra* (Macleay). T
7(1).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *E. ptychocarpa-Pandanus-Heteropogon.*
Recorded in *Eucalyptus ptychocarpa* forest adjacent to creek of sandstone gorge.

OLIVE WHIP SNAKE *Demansia olivacea* (Gray). T
6(2).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Lysiphyllum-Carissa-Heteropogon.*
2 specimens.
Caught in hard sandstone range in the south-east of the Conservation Reserve. It probably also occurs in similar habitat in the Osmand Range.

MOON SNAKE *Furina ornata* (Gray). T,D
7(1), 9(1).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *Lysiphyllum-Acacia-Cenchrus.*
3 specimens.
Recorded from a wide range of habitats, including gorges in the Bungle Bungle massif.

[KING BROWN SNAKE *Pseudechis australis* (Gray).]
C
Not recorded during this survey, but reported from cracking clays in the east of the Park near Ord River Station (D. Haddon personal communication) and near Piccaninny Gorge (Johnston[9] personal communication) in April 1989.

RINGED BROWN SNAKE *Pseudonaja modesta* (Gunther). D
3(1), 10(1).
Preferred land unit: Elder cuestas.
Preferred floristic group: *E. brevifolia-Cassia-Plectrachne.*
2 specimens.
Gravid female (with 9 well-formed eggs) from red soils of the Ord River basin in July, and specimen from creek bed in Piccaninny Gorge.

LITTLE SPOTTED SNAKE *Rhinoplocephalus punctatus* Boulenger. T,D
1(2), 2(2), 3(1), 5(1), 9(1), 10(1).
Preferred land unit: Nelson cracking clay plains.
Preferred floristic group: *E. collina-Acacia-Plectrachne.*
4 specimens.
Common in a wide variety of habitats throughout the Park.

NORTHERN SHOVEL-NOSED SNAKE *Vermicella roperi* (Kinghorn). T
8(4).
Preferred land unit: Wickham rugged uplands.
Preferred floristic group: *Livistona-Acacia-Germania.*
1 specimen.
Locally common in riparian vegetation at Bream Gorge.

[8] B. Herold - (private individual) Darwin

[9] F. Johnston - (private individual) Darwin

Notable species

The fossorial skink *Lerista* sp.nov. is known from a single specimen pit-trapped on a sand drift in Cathedral Gorge. This species is the most northerly member of the *Lerista desertorum* group and will be formally described by the Western Australian Museum in the near future.

Two specimens of the burrowing skink *Lerista aericeps taeniata* may represent a new species record for Western Australia (Greer[10] personal communication.), although one previous record, of *'Lerista orientalis'*, from Gordon Downs may actually be of this taxon.

The nocturnal burrowing skink *Egernia slateri slateri*, colonies of which were discovered on the plateau of the Bungle Bungle massif, is a new record for Western Australia, with a range extension of over 900 km. The nearest known populations are of the same subspecies (L.Smith personal communication) and occur on the alluvial plains of the Finke, Palmer and Todd Rivers in central Australia. The specimens from the Bungle Bungle area lack the dark pigmentation normally characteristic of this species.

Another skink with its local northern range limit within the Park is *Proablepharus reginae*. It is distributed patchily over much of arid Western Australia and adjacent parts of South Australia and the Northern Territory. Wilson and Knowles (1988) consider it to be common only on Barrow Island.

Seldom recorded in the Kimberley region, the Carpet Python (*Morelia spilota variegata*) was provisionally identified during this survey from a sloughed skin found at Bream Gorge in the Osmand valley. The dense riparian vegetation at this site could be suitable habitat for this snake. The previous most southerly record from the Kimberley is at Wyndham, several hundred kilometres to the north (Smith 1981).

A skull and mandible from a small bearded dragon (probably *Pogona minor mitchelli*) was found at an owl roost near Cathedral Gorge. Although seldom recorded from the eastern Kimberley, it is known from nearby Bedford Downs (Wilson and Knowles 1988) and El Questro (personal observation) Stations.

A large saxicoline Dtella (*Gehyra* sp.nov.) was found mostly in deep cool recesses of the Bungle Bungle massif and appears to be ecologically and morphologically distinct from the related *Gehyra australis*. The taxonomic status of these specimens is now being considered by Max King (N.T. Museum).

Possibly a second undescribed Dtella, similar in appearance to *'Gehyra* sp.1' from Lissadell pictured in Wilson and Knowles (1988) as Figure 170, was recorded in this survey in riparian habitats and adjacent areas of *Lysiphyllum* woodland. In the field they were not distinguished from *G. australis*, and they are combined in analyses here.

Although not yet formally described, the Snake-necked Turtle (*Chelodina* sp.nov.) is known to occur in drainage units of sandstone plateaux from the Kimberley to western Arnhem Land (R.Kennett personal communcation).

Additional species

The present herpetospecies list for the Bungle Bungle area is undoubtedly incomplete, particularly for snakes and frogs. This is supported by the high number of species (33 per cent) first recorded in the last third of the survey period.

There are few records from other sources adjacent to the Bungle Bungle area. Dames and Moore (1982) recorded 12 species from the Argyle area (about 50 km to the north) that we did not record in this survey and which may be present in the Bungle Bungle area. These are the Northern Spade-footed Frog (*Notaden melanoscaphus*), the frogs *Limnodynastes depressus* and *Litoria pallida* (listed as *Litoria* cf. *latopalmata*), Northern Knob-tailed Gecko (*Nephrurus asper*), the gecko *Diplodactylus taeniatus*, Central Netted Dragon (*Ctenophorus inermis*), the dragon *Diporiphora bennetti*, Storr's Monitor *(Varanus storri)*, Spotted Tree Monitor (*Varanus scalaris*), the skink *Ctenotus schomburgkii*, and the blind snakes *Ramphotyphlops ligatus* and *R. unguirostris*. Of this group, the rare frog *Limnodynastes depressus* is noteworthy as much of its known range was inundated in the construction of Lake Argyle (Tyler *et al.* 1984). No remaining populations are known from conservation reserves.

There are records from the Western Australian Museum from the vicinity of the Ord River. These include the following species not recorded during our survey: the frogs *Limnodynastes convexiusculus, Litoria inermis, Litoria nasuta, Litoria pallida, Megistolotis lignarius*, the dragon *Tympanocryptis lineata*, the skink *Egernia douglasi*, Northern Small-eyed Snake (*Cryptophis pallidiceps*), Keelback Snake (*Amphiesma mairii*), Western Brown Snake (*Pseudonaja nuchalis*) and the blind snake *Ramphotyphlops diversus*. All of these species may be distributed along the Ord River valley as far upstream as the Purnululu National Park.

[10] A. Greer - Australian Museum, Sydney

Two further species of snake may occur on black-soil plains of the Ord River valley within the National Park. Both the Eastern Brown Snake (*Pseudonaja textilis*) and Ord River Snake (*Denisonia ordensis*) have been recorded from this habitat at Gordon Downs, 90 km south of the Park (Horner[11] personal communication).

Distributional patterns within the Bungle Bungle area

The number of reptile and frog species recorded per site varied from 16 at site 2 on Osmand Creek to 42 at Bream Gorge (Table 17). Many species were recorded only from either Bream Gorge or the Cathedral Gorge/Buchanan sandplain site 10.

On average, twice as many species were recorded during the second survey period (mean of 38.3 per site) as during the first survey period (19.1 per site). This suggests that many species were inactive during the initial sampling period, probably because of relatively low temperatures (especially at night) and lack of rain.

The distribution of reptile and frog taxa in the Bungle Bungle area is closely associated with land units and, less closely, with floristic groups (Tables 18 and 19).

There is considerable variation in reptile species diversity between land unit (Table 20). Nelson frontage, Nelson low rises, Buchanan uplands and Nelson cracking clay plains had the highest number of reptile species per quadrat. The least diverse were Nelson lower slopes, Antrim uplands and lowlands, and Headley lower slopes.

Torresian species dominated in Wickham, and most Nelson and Antrim units. A total of 51 reptile species were recorded in the Wickham unit, of which eleven were not recorded in other units. This community (including the Olive Python, Carpet Python, Black Whip Snake, Brown Tree Snake, the skink *Sphenomorphus isolepis* and the turtle *Chelodina* sp.nov.) is typical of the north-eastern Kimberley, with many Torresian species reaching their local southern range limits in the humid gullies and gorges of the Osmand Range. Some mesic species persist along the major water courses of the Park which flow through the Antrim lowland and Nelson frontage land units. These species include the Freshwater Crocodile, Short-necked Turtle, Mitchell's Water Monitor and the fossorial skink *Lerista borealis*. The riparian influence is also marked by the abundance of nine other species, of which the Beaked Gecko and the Broad-banded Sand-swimmer are interesting examples for their affinity with alluvial soils in the north of their range.

Eyrean species were relatively more diverse in Buchanan units and Elder cuestas. Of the nineteen species which reached their highest abundance in the Buchanan land units, over 50 per cent are predominantly Eyrean species (e.g. Military Dragon, Centralian Blue-tongue, the skink *Ctenotus piankai* and three *Lerista* species).

Adjoining the Buchanan sandplains are the Elder upland sandstones which form the Bungle Bungle massif. Few species are shared between these two environments. The seasonally dry chasms of the massif support a community characterized by the Common Tree Snake, Merten's Water Monitor, Glauert's Monitor and the frogs *Litoria splendida* and *Ranidella bilingua*. This assemblage generally persists on the topographically isolated plateau, though here the Desert Skink is present and *Lerista* species were notably absent.

Along the northern and western valley of the Ord River, low sandstone cuestas (breakaways), cracking clay plains and footslopes of the Nelson land unit form a complex environment. Herpetospecies here are diverse, with a notable abundance of snakes. Characteristic lizards include the Soldier Skink, Pilbara Dtella, Ring-tailed Dragon and the skink *Carlia triacantha*.

A group of species occurred widely throughout the Bungle Bungle area, being present in most land units. Such species included the Northern Dtella, Bynoe's Gecko, Fire-tailed Skink, *Lerista greeri*, *Ctenotus saxatilis*, *Cryptoblepharus plagiocephalus* and the Ornate Burrowing Frog.

The mean number of reptile species per quadrat varied from a low of 1.2 in the floristic group *E. brevifolia* low open woodland-*Acacia-Triodia* to a high of 6.2 in *Lysiphyllum* low woodland-*Acacia-Cenchrus* (Table 21). Torresian species were especially abundant in the taller forest of *Livistona-Acacia-Germania* and *E. ptychocarpa-Pandanus-Heteropogon* groups. Eyrean species were absent from these floristic groups, but outnumbered Torresian species in *E. brevifolia* open woodland-*Cassia-Plectrachne*, *E. collina* woodland-*Acacia-Triodia*, *E. collina* woodland-*Acacia-Plectrachne* and *Acacia* spp. tall shrubland-*Triodia* groups.

[11] P. Horner - Northern Territory Museum of Arts and Sciences, Darwin

Biogeographic patterns

The Bungle Bungle area encompasses a broad environmental gradient from the subhumid to semi-arid environments of north-western Australia. The taxonomic composition and species richness of the area's reptile fauna reflect these influences, and includes a distinctive mixture of Torresian (40 per cent) and Eyrean (25 per cent) species. The frog fauna is a less diverse subset of Kimberley species, although the lack of ground hylids and burrowing species recorded may be a consequence of the dry period during which the survey took place.

Eighty-one species of reptiles and twelve species of amphibians are known to occur in the Bungle Bungle area, representing thirteen families and 48 genera. Compared with other surveyed areas of north-western Australia, only Kakadu National Park and the Hamersley Range have greater species richness (Figs 12 and 13). Within the Bungle Bungle area, genera that were well-represented include *Varanus*, with nine species, *Ctenotus*, with seven species, and *Gehyra*, with between four and six species.

The reptile species composition of the Bungle Bungle area is most similar to those of Argyle, and the relatively distant Lower MacArthur, Katherine Gorge and Kakadu Stage III (Fig. 14). The strong latitudinal trend evident broadly follows the rainfall gradient, and suggests that moisture availability is a major factor affecting the distribution of reptile species in north-western Australia.

In contrast, the frog fauna of the Bungle Bungle area was most similar to that of the Kimberley in general, and as such reflects a high degree of regional endemism (Fig. 15).

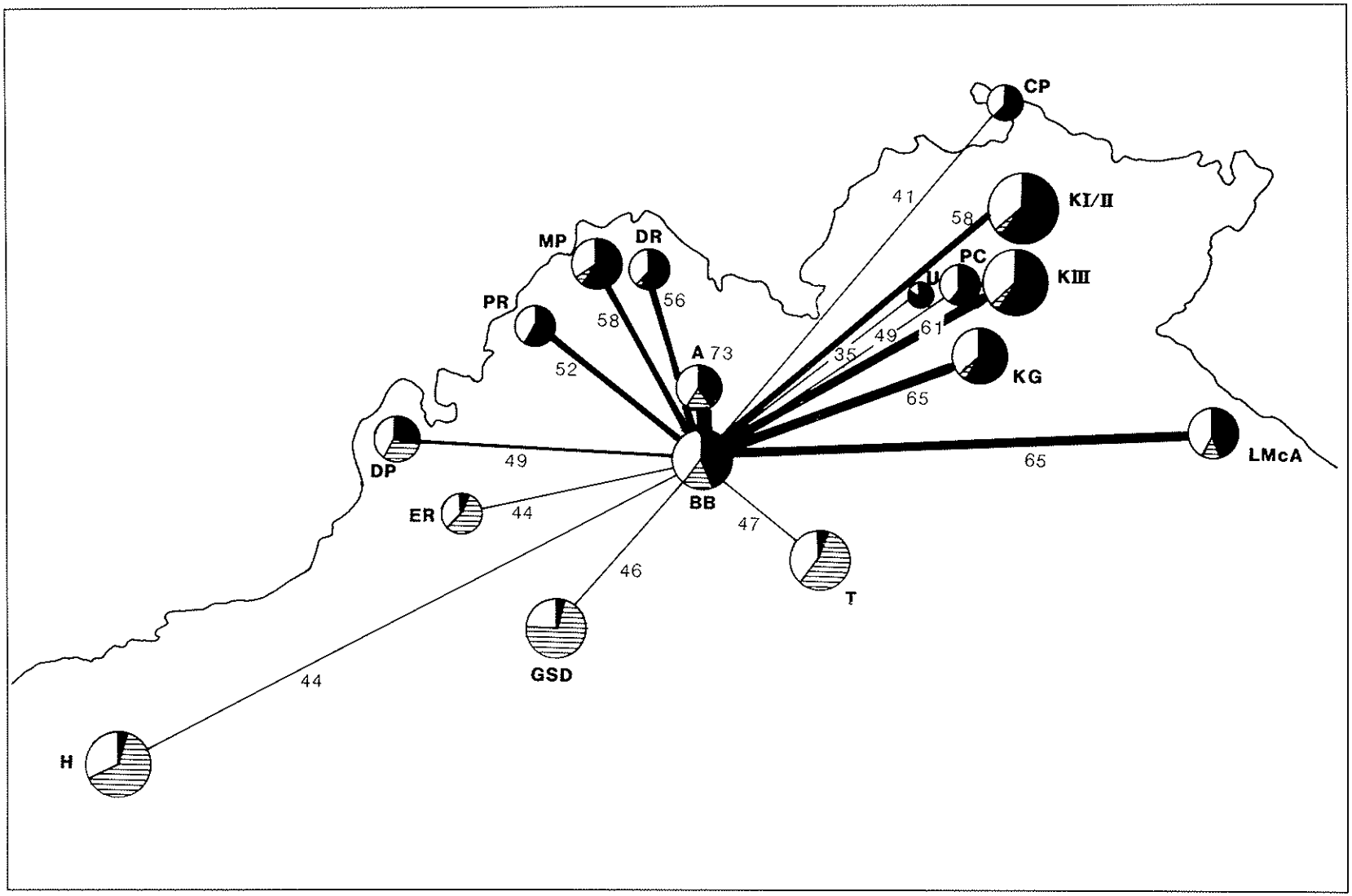

Figure 12

Network diagram showing similarity of the terrestrial reptile fauna of the Bungle Bungle area with other surveyed regions of north-western Australia. Conventions as for Figure 8. Number of species recorded: H (Hamersley) = 84; DP (Dampier Peninsula) = 55; ER (Edgar Ranges) = 49; GSD (Great Sandy Desert) = 78; PR (Prince Regent River) = 48; MP (Mitchell Plateau) = 63; DR (Drysdale) = 42; BB (Bungle Bungle) = 79; A (Argyle) = 59; T (Tanami) = 77; U (Umdrawara) = 25; KG (Katherine Gorge) = 73; PC (Pine Creek) = 40; KIII (Kakadu Stage III) = 86; KI/II (Kakadu Stages I & II) = 93; CP (Cobourg Peninsula) = 38; LMcA (Lower MacArthur) = 60.

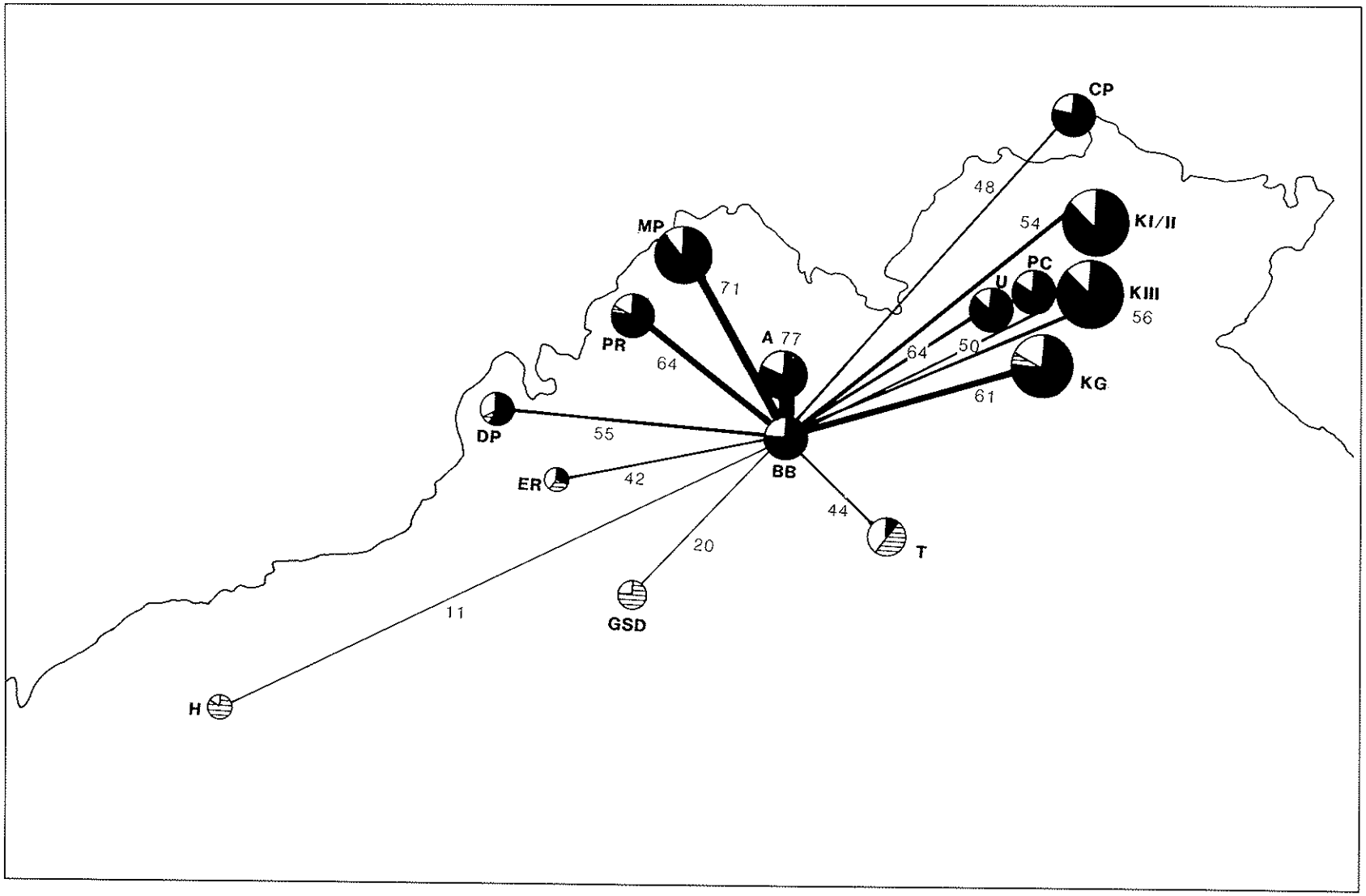

Figure 13

Network diagram showing similarity of the frog fauna of the Bungle Bungle area with other surveyed regions of north-western Australia. Conventions as for Figure 8. Number of species recorded: H (Hamersley) = 6; DP (Dampier Peninsula) = 10; ER (Edgar Ranges) = 7; GSD (Great Sandy Desert) = 8; PR (Prince Regent River) = 13; MP (Mitchell Plateau) = 19; A (Argyle) = 14; BB (Bungle Bungle) = 12; T (Tanami) = 11; U (Umbrawara) = 13; KG (Katherine Gorge) = 21; PC (Pine Creek) = 12; KIII (Kakadu Stage III) = 24; KI/II (Kakadu Stages I & II) = 25; CP (Cobourg Peninsula) = 13.

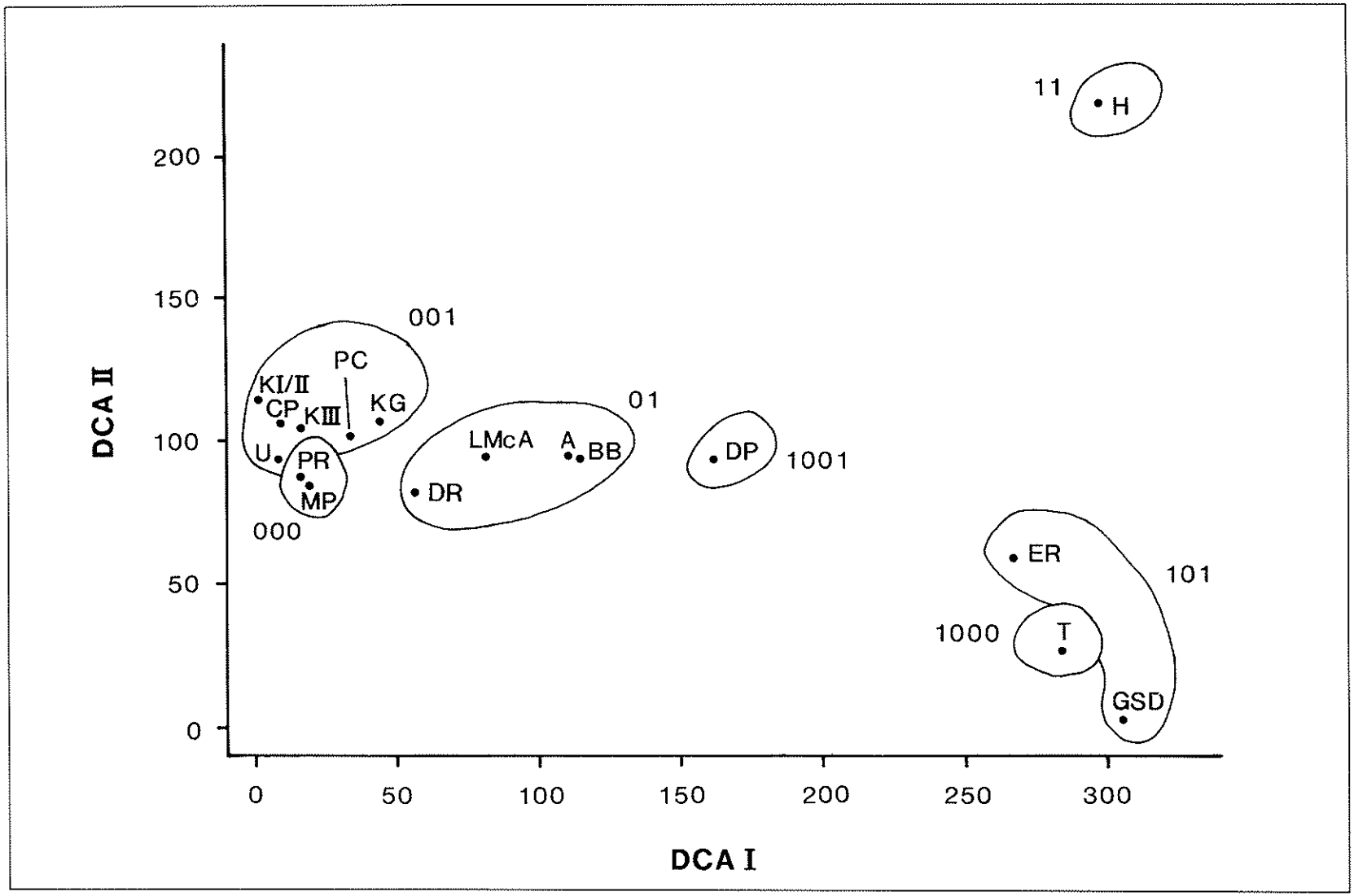

Figure 14

Ordination of the terrestrial reptile fauna of 17 areas surveyed in north-western Australia. Lines enclosing points represent TWINSPAN groups. Symbols as for Figure 12. Eigenvalues for DCA 1 0.57, for DCA 2 0.33.

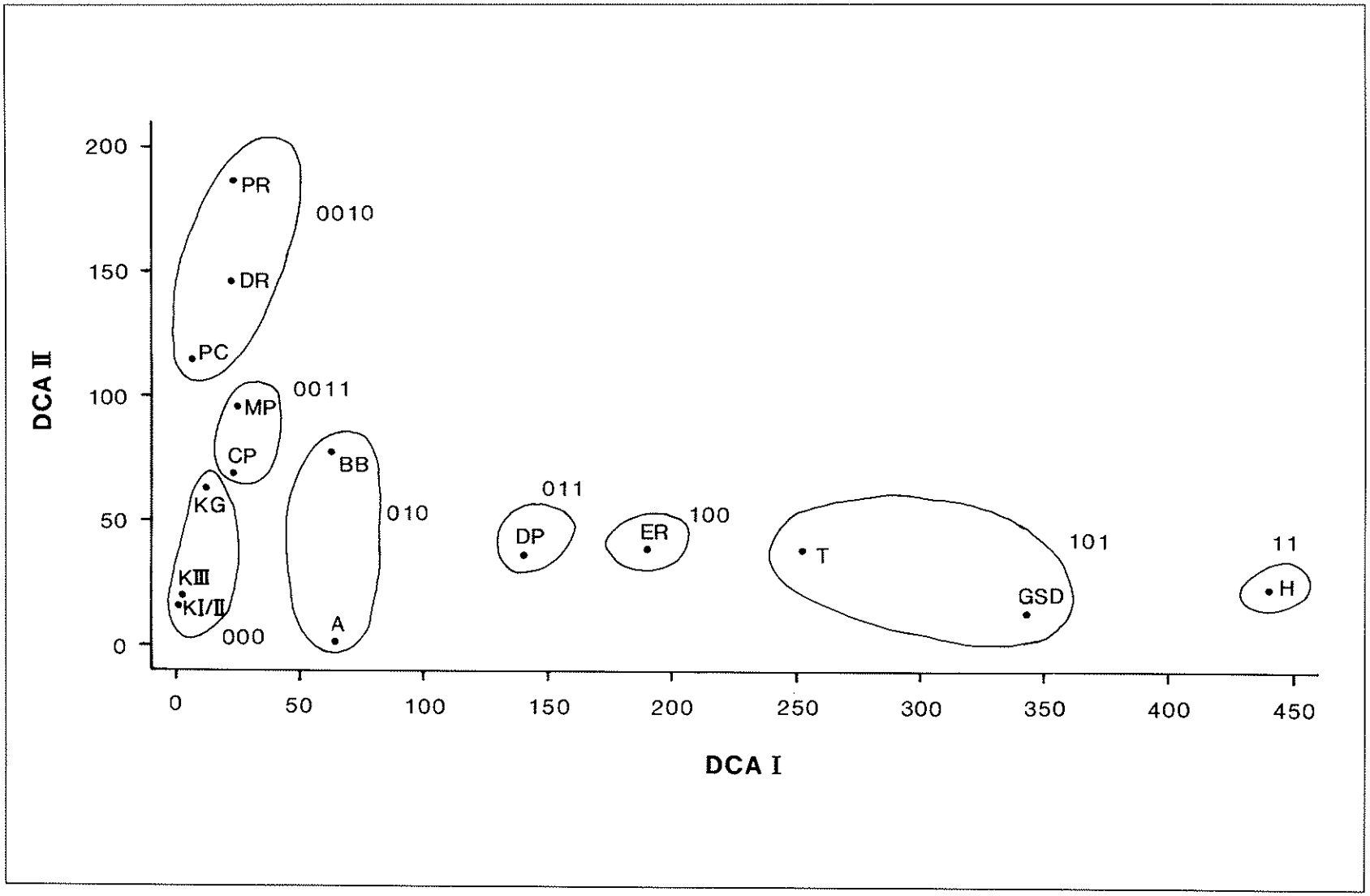

Figure 15

Ordination of the frog fauna of 15 areas surveyed in north-western Australia. Lines enclosing points represent TWINSPAN groups. Symbols as for Figure 13. Eigenvalues for DCA 1 0.72, for DCA 2 0.15.

Table 17

The number of herpetospecies recorded per study site and the number of these recorded for only one site.

SITE	NO. REPTILE SPP.	NO. FROG SPP.		NO. RESTRICTED SPP.
1	15	3	3	*Pygopus nigriceps, Lerista aericeps, Ctenotus tantillus*
2	14	2	0	
3	19	0	0	
4	13	5	2	*Oedura marmorata, Egernia slateri*
5	16	2	1	*Litoria rothii*
6	16	3	3	*Oedura rhombifer, Demansia olivacea, Varanus kingorum*
7	23	3	2	*Ramphotyphlops guentheri, Demansia atra*
8	36	6	7	*Crenadactylus ocellatus, Sphenomorphus isolepis, Varanus glauerti, Morelia, Morelia spilota, Boiga fusca, Vermicella roperi*
9	34	2	4	*Diplodactylus conspicillatus, Carlia triacantha, Ctenotus militaris, Aspidites melanocephalus*
10	28	9	8	*Cyclorana australis, Cyclorana longipes, Diplodactylus ciliaris, Pogona minor, Varanus gouldii, Tiliqua multifasciata, reginae, Lerista* sp. nov.

Table 18

Distribution of herpetospecies across land units [a]. Values in the body of the table are average abundance per quadrat. Bold type denotes highest value for each species.

SPECIES	LAND UNITS												
	Wk	*Eu*	*Au*	*Al*	*Hl*	*Ns*	*Nf*	*Nr*	*Bu*	*Bf*	*Bp*	*El*	*Nl*
Varanus glauerte	**0.03**												
Emydura australis	**0.17**												
Chelodina sp. nov.	**0.11**												
Ramphotyphlops guentheri	**0.03**												
Crenadactylus ocellatus	**0.03**												
Vermicella roperi	**0.11**												
Sphenomorphus isolepis	**0.09**												
Gehyra sp. nov.	**0.06**												
Tiliqua scincoides	**0.06**												
Varanus glebopalma	**0.09**												
Morelia olivaceus	**0.03**												
Demansia atra	**0.03**												
Demansia olivacea	**0.06**												
Boiga fusca	**0.06**												
Litoria wotjulumensis	**0.40**												
Varanus mertensi	**0.20**												
Varanus mitchelli	**0.09**			0.05									
Crocodylus johnstoni	**0.29**			0.19									
Lerista borealis	**0.11**			0.05							0.06		
Notoscincus wotjulum	**0.14**			**0.14**									
Morethia ruficauda	**0.31**	0.18	0.29				0.08		0.29	0.12	0.10		
Egernia slateri		**0.31**											
Oedura marmorata		**0.06**											
Dendrolaphis punctulatus	0.03	**0.06**											
Ranidella bilingua	1.26	**1.62**	0.17	0.24									
Delma nasuta	0.03	**0.19**											
Carlia amax	0.23	**0.38**			0.20								
Litoria coplandi	0.54	**1.25**	0.08	0.38				0.71	1.14				
Litoria meiriana		**7.94**								0.14			
Varanus acanthurus	0.03	**0.31**			0.20							0.10	
Varanus kingorum			**0.08**										
Diporiphora arnhemica	0.03		**0.75**										
Ctenotus pantherinus	0.29		**1.08**	0.10				0.25					0.10
Oedura rhombifer					**0.20**								
Heteronotia planiceps	0.14	0.06			**0.20**								
Menetia greyii	0.06			0.14	**0.60**	0.50	0.33	0.33					
Proablepharus tenuis	0.06		0.25		**0.40**	0.25		0.33	0.14				
Cryptoblephurus plagiocephalus	0.17	0.06		0.10	**0.40**		0.33	0.08					
Rhinoplocephalus punctatus				0.14		**0.25**		0.08					
Furina ornata	0.03					**0.25**		0.08					
Aspidites melanocephalus						**0.25**							
Morelia childreni				0.05		**0.25**		0.08					

Table 18 *(cont.)*

SPECIES	LAND UNITS												
	Wk	*Eu*	*Au*	*Al*	*Hl*	*Ns*	*Nf*	*Nr*	*Bu*	*Bf*	*Bp*	*El*	*Nl*
Varanus tristis	0.09		0.17			**0.50**			0.14				
Diporiphora lalliae	0.03		0.08			**1.25**	0.67	0.58					
Heteronotia binoei	0.26	0.06	0.17	1.01	0.80	**1.50**	1.00	0.83		0.29			
Carlia munda	0.31					0.75	0.33						
Limnodynastes ornatus	0.11	0.06		0.05			**1.33**		0.29	0.43			
Delma tincta	0.03						**0.33**						
Gehyra australis	0.26		0.08	0.24		0.50	**1.00**	0.08		0.14	0.06	0.20	
Lialis burtonis							**0.33**	0.08	0.29		0.06		
Gemmatophora gilberti	**0.57**		0.50	0.57			**1.33**	0.08					
Varanus panoptes						0.25	0.33			0.29		0.20	
Rynchoedura ornata				0.05			**0.33**	0.33			0.06		
Eremiascincus richardsoni				0.05			**0.33**						
Lerista greeri				0.24			**6.33**	0.75	1.14	1.14	1.82	0.30	
Gehyra nana	0.14	0.63	0.58					**1.17**				0.50	
Menetia maini	0.03					0.25		**0.58**					
Ctenotus militaris								**0.67**					0.60
Gehyra pilbara								**1.33**				0.40	
Diplodactylus conspicillatus								**0.25**					
Carlia triacantha								**0.17**					
Omolepida branchialis			0.08					**0.58**		0.29	0.06		
Ctenotus inornatus/saxatilis	0.29	1.50	0.33	0.10		1.00	0.33	1.17	**6.14**	4.71	1.65	0.10	
Delma borea	0.14		0.08						**0.29**				
Diplodactylus ciliaris									**0.14**				
Varanus gouldii									**0.71**		0.18		
Tiliqua multifasciata									**0.43**		0.18		
Ctenotus piankai			0.08						**0.86**	0.14	0.35	0.40	
Proablepharus reginae									**0.43**				
Cyclorana australis										**0.57**			
Litoria caerulea	0.03									**0.14**			
Litoria rubella										**0.14**			
Cryptoblepharus megastictus	0.23	0.06								**0.43**			
Uperoleia borealis		1.88								**4.29**			
Litoria splendida										**0.86**			
Lerista sp. nov.										**0.29**			
Lerista aericeps											**0.12**		
Diplodactylus stenodactylus	0.17			0.05				0.17			**0.29**		
Ctenophorus isolepis									0.71	0.14	**3.18**		
Ctenotus decaneurus	0.03										**0.06**		
Ctenotus tantillus											**0.06**		
Ctenophorus caudicinctus	0.06			0.10				0.17	0.29			**0.40**	
Diporiphora magna									0.14		0.24	**0.30**	
Pseudonaja modesta												**0.10**	

(a) Land systems: Eu = Elder uplands, Bf = Buchanan frontage, Bu = Buchanan uplands, Au = Antrim rugged uplands, Bp = Buchanan Sandplain, Hl = Headley lower slopes, Ns = Nelson cracking clay plains, Al = Antrim lowlands, El = Elder cuestas, Nr = Nelson low rises, Wk = Wikham rugged uplands, Nl = Nelson interfluve lower slopes, Nf = Nelson frontage

Table 19

Distribution of herpetospecies across floristic groups. Values in the body of the table are average abundance per quadrat. Bold type denotes highest value for each species.

	FLORISTIC GROUPS																
SPECIES	*1*	*2*	*14*	*4*	*12*	*16*	*15*	*13*	*5*	*3*	*9*	*6*	*7*	*17*	*10*	*8*	*11*
Sphenomorphus isolepis	**0.60**																
Boiga fusca	**0.40**																
Morelia olivaceus	**0.20**																
Varanus mitchelli	**0.20**			0.06													
Varanus mertensi	**1.00**	0.40				0.06											
Varanus tristis	**0.20**			0.06	0.14	0.06			0.08			0.15					
Carlia amax	**1.20**					0.38			0.17								0.20
Delma tincta	**0.20**											0.08					
Varanus glauerti	**0.20**																
Vermicella roperi	**0.20**			0.06					0.17								
Heteronotia planiceps	**0.40**		0.33			0.06			0.08								0.20
Lerista borealis	**0.40**	0.20		0.06					0.08								
Demansia atra		0.20															
Chelodina sp. nov.	0.20	**0.60**															
Emydura australis		**1.00**		0.06													
Crocodylus johnstoni		**1.00**		0.30						0.05							
Ranidella bilingua	0.60	**2.80**		0.83	0.14	1.25	2.00		1.42								
Morethia ruficauda	0.20	**0.80**	0.33	0.44		0.19	0.33		0.17		0.09	0.08			0.09	0.29	
Gehyra australis	0.20	**0.40**		0.39	0.07				0.33	0.25	0.18	0.39				0.18	
Litoria wotjulumensis	0.80	**1.40**							0.25								
Carlia munda		**2.00**							0.08			0.31					
Cryptoblephurus plagiocephalus		**0.60**		0.17					0.17		0.09	0.15					0.40
Gemmatophora gilberti		**1.60**		0.889	0.43				0.33	1.25		0.15					
Gehyra sp. nov.			**0.33**														
Tiliqua scincoides			**0.17**						0.08								
Varanus glebopalma			**0.33**						0.08								
Delma borea	0.20		**0.25**		0.14	0.13								0.14		0.14	
Notoscincus wotjulum				**0.44**													
Ramphotyphlops guentheri					**0.07**												
Diporiphora arnhemica					**0.64**				0.08								
Oedura marmorata						**0.06**											
Egernia slateri						**0.31**											
Varanus acanthurus						**0.31**			0.08						0.09		0.20
Lerista sp. nov.							**0.67**										
Cryptoblephurus megastictus	0.80		0.67			0.06	**1.00**										
Dendrolaphis punctulatus	0.20						**0.33**										
Litoria meiriana						3.56	**23.67**										
Delma nasuta						0.13	**0.33**		0.08								

Table 19 *(cont.)*

SPECIES	FLORISTIC GROUPS																
	1	*2*	*14*	*4*	*12*	*16*	*15*	*13*	*5*	*3*	*9*	*6*	*7*	*17*	*10*	*8*	*11*
Litoria caerulea							**0.33**		0.08								
Uperoleia borealis						1.13	**13.33**							0.29			
Litoria splendida							**1.33**							0.29			
Cyclorana australis							**0.67**							0.29			
Litoria coplandi	0.80	0.60			0.14	0.56	**4.67**		1.00	1.75	0.09			0.86	0.27		
Varanus panoptes							**0.67**			0.25		0.07			0.18		
Varanus kingorum								**0.22**									
Ctenotus pantherinus				0.06	0.93			**1.00**	0.50			0.08	0.25		0.09		
Crenadactylus ocellatus									**0.08**								
Demansia olivacea									**0.17**								
Limnodynastes ornatus	0.40			0.17		0.06				**0.75**		0.08		0.29	0.27		
Lialis burtonis					0.07	0.06				**0.25**				0.14		0.14	
Rynchoedura ornata				0.06						**0.25**		0.23	0.13			0.14	
Lerista greeri				0.28						**2.25**	1.91	1.54		1.14	0.55	2.00	
Heteronotia binoei		0.20		1.33	0.36				0.08	**1.50**	0.18	0.92	0.63		0.09		0.80
Ctenotus decaneurus									0.08		**0.09**						
Ctenotus tantillus											**0.09**						
Rhynoplocephalus punctatus				0.11	0.07	0.06					**0.18**	0.08	0.13				
Diplodactylus stenodactylus				0.17					0.25		**0.36**	0.15	0.13			0.14	
Aspidites melanocephalus												**0.08**					
Diplodactylus conspicillatus												**0.23**					
Carlia triacantha					0.07							**0.08**					
Furina ornata					0.07							**0.08**					
Morelia childreni					0.07							**0.15**					
Ctenotus militaris					0.07							**1.00**					
Diporiphora lalliae					0.21			0.20				**0.85**	0.13				
Menetia maini									0.08			**0.62**					
Gehyra nana			0.33		0.43	0.56			0.80		0.09	**0.85**			0.46		
Gehyra pilbara												**1.23**			0.36		
Eremiascincus richardsonii												0.08	**0.13**				
Omolepida branchialis					0.07		0.33				0.09		**0.88**		0.09		
Diplodactylus ciliaris														**0.14**			
Proablephurus reginae														**0.43**			
Ctenotus inornatus/saxatilis			0.50	0.11	1.00	1.88	6.33		0.42		0.73	0.54	0.38	**6.86**	0.46	2.71	
Ctenotus piankai					0.07	0.06					0.27			**0.86**	0.36	0.43	
Varanus gouldii						0.06								**0.57**		0.43	
Tiliqua multifasciata						0.06								**0.43**		0.29	
Ctenophorus caudicinctus			0.33		0.07					0.25		0.15		0.29	**0.36**		

Table 19 *(cont.)*

SPECIES	FLORISTIC GROUPS																
	1	*2*	*14*	*4*	*12*	*16*	*15*	*13*	*5*	*3*	*9*	*6*	*7*	*17*	*10*	*8*	*11*
Pseudonaja modesta															**0.09**		
Litoria rubella															**0.09**		
Ctenophorus isolepis											0.55	0.15		0.71	0.55	**6.00**	
Lerista aericeps											0.09					**0.14**	
Diporiphora magna											0.09			0.14	0.27	**0.43**	
Proablepharus tenuis				0.06	0.29				0.08			0.23	0.13	0.14			**0.40**
Oedura rhombifer																	**0.20**
Menetia greyii				0.07					0.17			0.54					**0.60**

[a] Description of floristic groups: 1 = *Livistona-Acacia-Germania*, 2 = *E. ptychocarpa-Pandanus-Heteropogon*, 14 = *E. cliftoniana-Cajanus-Plectrachne*, 4 = *Melaleuca-Acacia-Aristida*, 12 = *E. opaca-Grevillea-Triodia*, 16 = *E. cliftoniana-Acacia-Triodia*, 15 = *E. aspera-Acacia-Triodia*, 13 = *E. brevifolia-Acacia-Triodia*, 5 = *Lysiphyllum-Carissa-Heteropogon*, 3 = *E. camaldulensis/Melaleuca-Aerva-Aristida*, 9 = *E. collina-Acacia-Plectrachne*, 6 = *Lysiphyllum-Acacia-Cenchrus*, 7 = *Acacia-Aerva-Aristida*, 17 = *Acacia-Triodia*, 10 = *E. brevifolia- Cassia-Plectrachne*, 8 = *E. collina-Acacia-Triodia*, 11 = *Hakea-Dodonea-Triodia*.

Table 20

Average number of reptile species per quadrat for the land systems surveyed.

LAND SYSTEM		SYMBOL	NO. REPTILE SPECIES		
			Total	*Torresian*	*Eyrean*
ANTRIM	rugged uplands	Au	2.8	1.8 (62%)	0.8 (27%)
ANTRIM	lowlands	Al	2.7	1.0 (35%)	0.3 (12%)
BUCHANAN	uplands	Bu	5.4	1.3 (24%)	2.0 (37%)
BUCHANAN	sandplain	Bp	3.2	0.9 (29%)	1.5 (47%)
BUCHANAN	frontage	Bf	2.9	0.9 (30%)	1.1 (40%)
ELDER	uplands	Eu	2.9	1.8 (62%)	0.4 (15%)
ELDER	cuestas	El	3.1	0.8 (26%)	1.5 (48%)
HEADLEY	lower slopes	Hl	2.6	0.6 (23%)	0
NELSON	cracking clay plains	Ns	4.5	1.5 (33%)	0.5 (11%)
NELSON	interfluve lower slopes	Nl	1.0	1.0 (100%)	0
NELSON	frontage	Nf	6.7	2.3 (35%)	2.0 (30%)
NELSON	low rises	Nr	5.8	1.9 (33%)	2.1 (36%)
WICKHAM	rugged uplands	Wk	4.0	2.4 (60%)	0.3 (7%)

Table 21

Average number of reptile species per quadrat for the floristic groups.

	FLORISTIC GROUP	NO. OF REPTILE SPECIES		
		Total	*Torresian*	*Eyrean*
1.	*Livistona - Acacia holosericea - Germania*	5.4	4.4 (81%)	0
2.	*E. ptychocarpa - Pandanus - Heteropogon*	4.8	3.6 (75%)	0
3.	*E. camaldulensis / Melaleuca - Aerva - Aristida*	3.5	1.3 (37%)	0.5 (14%)
4.	*Melaleuca leucadendra - Acacia eriopoda - Aristida* 3	.4	1.4 (40%)	0.3 (10%)
5.	*Lysiphyllum - Carissa - Heteropogon*	3.7	1.7 (46%)	0.5 (14%)
6.	*Lysiphyllum - Acacia holosericea - Cenchrus*	6.2	1.9 (31%)	1.9 (31%)
7.	*Acacia farnesiana - Aerva - Aristida*	2.1	0.5 (24%)	1.0 (48%)
8.	*E. collina - Acacia stipuligera - Triodia spicata*	4.0	1.0 (25%)	2.0 (50%)
9.	*E. collina - Acacia tumida - Plectrachne pungens*	3.0	1.0 (33%)	1.2 (39%)
10.	*E. brevifolia - Cassia - Plectrachne pungens*	3.0	0.8 (27%)	1.5 (48%)
11.	*Hakea arborescens - Dodonea - Triodia wiseana*	2.6	0.6 (23%)	0
12.	*E. opaca - Grevillea pyramidalis - Triodia pungens*	3.6	2.0 (56%)	0.8 (22%)
13.	*E. brevifolia - Acacia retivenia - Triodia intermedia*	1.2	0.6 (50%)	0.6 (50%)
14.	*E. cliftoniana - Cajanus - Plectrachne pungens*	3.0	2.0 (67%)	0
15.	*E. aspera - Acacia eriopoda - Triodia microstachya*	3.3	1.7 (50%)	1.0 (30%)
16.	*E. cliftoniana - Acacia spp - Triodia spicata*	3.1	1.7 (54%)	0.5 (16%)
17.	*Acacia spp - Triodia spicata*	4.9	1.3 (27%)	2.0 (41%)

Chapter 7

Fish of the Bungle Bungle Area

by
John Woinarski

ANNOTATED SPECIES LIST

Nomenclature, order and comments on wider distribution are from Allen (1982) or Merrick and Schmida (1984).

FRESHWATER HERRING (BONY BREAM) *Nematolosa erebi.*
4 specimens.
Common in large pools of the Ord River and Osmand Creek.
Allen: Known from throughout the Kimberley and Pilbara regions. Usually found in slow-flowing water or large rocky pools.

FORK-TAILED (BLUE) CATFISH *Arius graeffei.*
3 specimens.
Reasonably common in larger pools of the Ord River and Osmand Creek.
Allen: Common in the major river systems of the Kimberley.

COMMON EEL-TAILED CATFISH *Neosilurus hyrtlii.*
5 specimens.
Common throughout the Ord River and Osmand Creek systems, including springs, small flowing creeks and large isolated pools.
Allen: Widespread throughout the Pilbara and Kimberley regions; found in a variety of habitats.

WESTERN RAINBOWFISH *Melanotaenia splendida.*
8 specimens.
Very common throughout the Ord River and Osmand Creek systems, in almost all springs, small flowing creeks and large isolated pools.
Allen: Ranges widely in northern and eastern Australia, perhaps the most abundant inland species of northern waters.

RETICULATED GLASSFISH *Ambassis macleayi.*
In small numbers at Blue Holes on the Ord River.
Allen: Known in Western Australia only from the Ord and Carson River systems (distributed also in Northern Territory, Queensland and New Guinea).

GIANT GLASSFISH *Parambassis gulliveri.*
2 specimen.
Common at Blue Holes on the Ord River.
Allen: Known in Western Australia only from the Ord River system, but occurring also in Northern Territory, Queensland and New Guinea.

BARRED GRUNTER *Amniatoba percoides.*
7 specimens.
Very common throughout the Ord River and Osmand Creek systems, mostly in larger pools.
Allen: Throughout the Kimberley and Pilbara region, also in Northern Territory and Queensland.

SOOTY GRUNTER (BLACK BREAM) *Hephaestus jenkinsi.*
2 specimens.
Very common throughout the Ord River and Osmand Creek systems, especially in relatively deep pools and springs.
Allen: Throughout the Kimberley in large watercourses, also in Northern Territory.

SPANGLED PERCH *Leiopetherapon unicolor.*
2 specimens.
Very common throughout the Ord River and Osmand Creek systems, in pools, springs and flowing creeks.
Allen: Throughout the Kimberley and Pilbara regions, one of the most widespread inland species.

SEVEN-SPOT ARCHERFISH *Toxotes chatareus.*
4 specimens.
Common in the Ord River and Osmand Creek systems, particularly in large deep pools flanked by dense vegetation.
Allen: Common throughout far northern Australia.

GUDGEON *Mogurnda* sp.
3 specimens.
Common at Wulwuldji Springs. Status elsewhere uncertain. Probably Purple-spotted Gudgeon *(Mogurnda mogurnda).*
Allen: Throughout the Kimberley, also across northern Australia and New Guinea, in clear, slow-flowing streams.

GIANT GUDGEON (SLEEPY COD) *Oxyeleotris herwerdenii.*
SLEEPER GUDGEON (SLEEPY COD) *Oxyeleotris lineolatus.*
3 specimens.
Common in the Ord River and Osmand Creek systems, particularly in large isolated pools. Both species are probably present, but no definite identification to hand yet. Allen: Throughout the Kimberley, also across northern Australia and New Guinea.

GOLDEN GOBY *Glossogobius aureus.*
4 specimens.
Recorded from large pools on sand on the Ord River at Kitty's Knob and on the Osmand Creek.

TAILED SOLE *Aseraggodes klunzingeri.*
4 specimens.
Recorded from one large pool on the Ord River near Kitty's Knob. Allen: Primarily a marine fish, sometimes entering fresh waters. Known from lower to middle reaches of the Ord, Victoria and Alligator Rivers systems.

COMMENTS

The fish fauna of the Bungle Bungle area is generally unspectacular in terms of the diversity of species and the geographic distribution of species recorded. All species except the Tailed Sole are known to be common in the Ord River system, and most are widespread species in the Kimberley and across northern Australia.

Nonetheless it is remarkable that in this semi-arid region almost every water body has a high diversity and density of fish, with several species (e.g. Western Rainbowfish, Barred Grunter and Spangled Perch) being virtually ubiquitous. The 15 species recorded in this survey constitute about 5 per cent of the vertebrate fauna known from the Bungle Bungle, a component which should not be neglected in consideration of that fauna.

Several additional fish species may be expected to occur in the Bungle Bungle region, especially during the wet season, when the Ord River is in flow. Those most likely are Sailfin Glassfish (*Ambassis agrammus*) (the common glassfish of the Kimberley, widely distributed in slow-flowing streams, lakes and billabongs), Rendahl's Catfish (*Copidoglanis rendahli*) (known from the Ord River system), Butler's Grunter (*Syncomistes butleri*) (known from rocky pools of the Ord River), the Mullet (*Liza diadema*), the Strawman (*Quirichthys stramineus*) (common in Lake Argyle), Freshwater Long-Tom (*Strongylura krefftii*) (which is widespread in the larger rivers of the Kimberley, and may occur hundreds of kilometres upstream), Mouth Almighty (*Glossamia aprion*) (known from the south and east Kimberley, occurring especially in weedy areas along the edges of streams and in billabongs) and Carp Gudgeon (*Hypseleotris compressa*) (widely distributed in the Kimberley). Further sampling of the Ord River at this time should establish the status of these species in the Bungle Bungle area.

The fish fauna may not have escaped totally the consequences of land degradation associated with almost a century of grazing. Small isolated pools have been trampled or been consumed by stock, erosion has led to massive build-up of silt in the main river systems and the consequent shrinking of large pools (Anon. 1986), riparian vegetation has been removed or replaced with alien species, and changes in run-off and interception rates may have shortened the vital period when water is put in to the system during the wet season.

Chapter 8

Discussion and Recommendations of Biological Survey of the Bungle Bungle Area

by
John Woinarski, Richard Braithwaite, Nick Gambold and Karina Menkhorst.

OVERVIEW OF THE FAUNA

We list a total of 298 vertebrates (149 bird, 81 reptile, 41 mammal, 15 fish and 12 frog species) from the Purnululu National Park, Conservation Reserve and adjacent area. This fauna comprises a mixture of widespread species, species typical of the tropical north (Torresian) and a minority of species characteristic of arid Australia (Eyrean). The affinity of the fauna is with the higher rainfall areas of the Kimberley, rather than with the Great Sandy Desert or Tanami to the near south (and south-east). The mammal fauna in particular bears close resemblance to that of the south-west Kimberley (McKenzie 1981a). The Bungle Bungle fauna is also very similar to the wildlife of medium-rainfall (c 600-1200 mm) areas of northern Australia (e.g. Katherine Gorge, Kakadu Stage III, Pine Creek, Gregory, Keep River, Lower MacArthur), illustrating the relative uniformity of the Torresian fauna across an extensive longitudinal arc (Woinarski *et al.* 1989a). In addition to this broad suite of widespread species, several species found in the Bungle Bungle area have a distribution which is restricted to the Kimberley-Keep region: the gecko *Gehyra* sp.nov., Ningbing Antechinus, Kimberley Mouse, White-quilled Rock-Pigeon, the frogs *Litoria splendida* and *Uperoleia borealis*, the monitor *Varanus kingorum* and the skinks *Ctenotus militaris*, *Ctenotus tantillus*, *Lerista borealis* and *Lerista greeri*.

Species are distributed very unevenly within the Bungle Bungle area. Torresian species occur mostly in the relatively tall and dense riparian vegetation of the main water courses and in the more sheltered gorges. These areas represent the local southern (inland) limit for many such species (e.g. Bar-breasted Honeyeater, Pale Field-Rat, Large-footed Mouse-eared Bat, Common Koel, Olive Python). Rocky ranges with spinifex - e.g. Osmand Range, Bungle Bungle massif, Turner area - have a very different fauna including some notable species whose range is otherwise largely confined to the arid centre: Desert Mouse and the skink *Egernia slateri*. Other rock-dwelling species include the Common Rock-Rat, Rock Ringtail Possum, Short-eared Rock Wallaby, White-quilled Rock-Pigeon, Variegated Fairy-wren, Sandstone Shrike-thrush, Copland's Rock Frog, the monitors *Varanus glauerti*, *Varanus kingorum* and *Varanus acanthurus* and the skink *Cryptoblepharus megastictus*. Another distinctive group of species occurs on the black-soil plains of the Ord River basin: these include the Northern Nailtail Wallaby, Rufous-throated Honeyeater, Rufous Songlark, Golden-headed Cisticola, Australian Bustard and Singing Bushlark. The extensive sandplains surrounding the massif characteristically contain Sand Goanna, Delicate Mouse, Western Chestnut Mouse, Stripe-faced Dunnart and the skink *Lerista greeri*. Yellow-throated Miners, Northern Rosellas and Pied Butcherbirds are abundant where these sandplains carry taller woodlands.

OVERVIEW OF THE FLORA

We list 619 vascular plant species from the Bungle Bungle area, an increase of 244 species from that previously known. Based on a regional comparison relating species tallies to survey area, this number is marginally higher than expected, especially so given the relatively low rainfall of the Bungle Bungle area. The flora is closely related to that reported for the Gregory National Park of north-western Northern Territory, although we have not compared it directly with other surveyed sites in the Kimberley.

The number of weed species recorded from the Bungle Bungle area is relatively low (17 species, or 2.8 per cent of the flora), though several of these species now present serious problems. The abundance of weeds is highest on lowland and river frontage areas. Additional species are likely to colonize in association with increased visitor numbers and ongoing land degradation.

We list 35 notable species, including several probable new species, new records for Western Australia, new records for the Kimberley and species at the limits of their known range.

Based on floristic records from the 150 quadrats, we classify the vegetation of the Bungle Bungle area into 17 floristic groups. These groups are mostly closely related to the vegetation communities described by Forbes and Kenneally (1986).

The Osmand Plateau and Osmand Range have not been adequately surveyed for plants, and there has been insufficient collecting during the wet season.

DEGRADATION, AND THE STATUS OF THE FAUNA

By far the greatest problem that the wildlife of the Bungle Bungle area has faced historically is the degradation of the environment caused by overgrazing by domestic and feral stock. Ongoing degradation through the continued presence of feral donkeys and cattle, and the residual consequences of former overgrazing will be the major management concern affecting wildlife of the area for the next few decades.

Over the last century, high densities of cattle and feral stock (especially during periods of below average rainfall: Robinson 1971) have led to changes in the composition of native grasslands, reduction or extermination of some plant species, loss of vegetative cover, change in run-off and water-holding capacity of the soil, extensive and very severe erosion, siltation of waterholes and destruction of waterside vegetation, especially reedbeds and dense stands of *Pandanus* (e.g. Robinson 1971; Forbes and Kenneally 1986; Colreavy *et al.* 1989; Coombs *et al.* 1989). With the development of grazing leases, the diaspora of Aboriginal custodians has been accompanied by a change in traditional fire regimes. Elsewhere in Australia, these environmental modifications have been associated with substantial losses of mammals (e.g. Frith 1973; Kitchener 1978; Burbidge and McKenzie 1989; Morton 1990).

There were no fauna collections of consequence from the east Kimberley before this century. Lacking historical information on the wildlife of the Bungle Bungle area, it is now difficult to describe how this environmental degradation has affected the wildlife. Two bird species, Purple-crowned Fairy-wren and White-browed Robin, have probably disappeared from the pandanus fringes of the upper Ord River (as elsewhere: Smith and Johnstone 1977; Rowley 1988). Based on information from Aboriginal custodians, it is probable that several medium-sized mammals have also disappeared or declined substantially - Bilby, Northern Quoll, and possibly Spectacled Hare-wallaby, Golden Bandicoot and Northern Brown Bandicoot. The large macropods - Agile Wallaby and Common Wallaroo - also may have become rarer. There is no evidence to describe historic changes in status for reptile, frog, fish or small mammal species.

Relationships between the present degradation levels and the distribution and abundance of animal species show complex patterns (Table 22). These relationships are confounded by underlying patterns in the distribution of animals: the open forests and riparian areas of plains and valleys generally support higher diversities of birds, reptiles and frogs than do the low very open woodlands of the rocky ranges. They also have been subjected to much more grazing pressure and consequent degradation, and hence positive associations between degradation and animal species diversity might be expected at this level. Indeed, the more degraded habitats do have more bird species, but notably support fewer native mammal species than do less degraded habitats. Small mammals are also less abundant in the degraded land units. There were no significant correlations across land systems between mean degradation score and the diversities of reptiles, frogs or plants.

Within any given habitat, there is little relationship between the distribution of animal species and the current level of degradation (Table 23), and correlations are not consistent across different habitats. For most of the habitats considered there is a weak tendency for bird species diversity to be higher in the more degraded quadrats, though this is significant only for the Wickham land system. This significant correlation is probably owing to the heterogeneity of the Wickham system, with riparian areas supporting more bird species and also having more grazing pressure than upland parts of the Wickham system. In contrast, native mammals show the opposite trend for Wickham, possibly because of the relatively high diversity of rock-dwelling mammals in upland areas. Native mammals were positively associated with degradation for the floristic group *Eucalyptus brevifolia* low open woodland-*Acacia retivenia-Triodia intermedia*, although the meaningfulness of this correlation is limited by the very low range of degradation scores for quadrats in this habitat.

Many individual bird species occurred more abundantly in degraded quadrats of particular habitats (Table 24). These were mostly granivorous species (e.g. Diamond Dove, Peaceful Dove, Crested Pigeon, Zebra Finch). Only two reptile and one mammal species showed such significant positive associations with disturbance in any habitat. In contrast, more reptile and mammal species, but fewer bird species, were significantly rarer in degraded quadrats for particular habitats. Illustrative of the lack of generality in these patterns, several species showed significant positive correlations with degradation in one habitat but significant negative correlations in another habitat (e.g. Pied Butcherbird, Spinifex Pigeon, Northern Nailtail Wallaby, Crested Pigeon).

The most notable feature of these relationships with disturbance is the lack of clear pattern between existing levels of degradation and the current distribution for most species and for most vertebrate groups. This may be owing to a number of possible causes:

i) those species which were most sensitive to degradation have already been eliminated;

ii) current levels of degradation have very little impact on the distribution of animals;

iii) species may have already responded to the erosion-control procedures implemented in the last decade;

iv) in line with our contractural brief, we did not sample extremely degraded areas, and the range of degradation that we did examine may have been below a threshold where the distribution of animal species was affected.

To an extent, these alternatives may be examined by careful monitoring of experimental restoration and untreated plots. Large-scale restoration work would provide a critical opportunity for examining how native animal species are affected by environmental degradation, and show to what extent land restoration can contribute to the recovery of the indigineous animal community.

The removal of feral stock and the rehabilitation of degraded land is the critical management requirement for ensuring the conservation significance of Purnululu National Park, Conservation Reserve and adjacent land. The banks of the Ord River, the levee plains of Antrim lowlands between Osmand Range and Osmand Creek, and plains on Osmand Valley Station (notably an area about 2-3 km south of Mt. Parker) have suffered massive erosion and loss of vegetation cover (de Salis 1982; personal observation). The Western Australian Department of Agriculture has conducted seasonal shoots of feral stock in the Bungle Bungle area in collaboration with the Department of Conservation and Land Management (CALM). Elimination of feral donkeys is extremely expensive (Choquenot 1988), because of their very high reproductive rates and attainable densities and their ability to subsist on low quality food resources (Freeland and Choquenot 1990). These factors also determine a very rapid recovery following incomplete extermination. This problem requires the goodwill and close co-operation of station managers, CALM and the Department of Agriculture.

Feral pigs also have a high potential for profoundly affecting environmental quality. Pigs currently occur at low density along the Osmand Creek system, and have been reported further south towards the Ord River, within the National Park. These are apparently recent colonizers from escaped Turkey Creek stock (Novelly[12] personal communication). The elimination of feral pigs when they are at high density is an extremely difficult management problem (Hone 1983; Bayliss and Yeomans 1989), and determined efforts to eliminate the current low population would be cost-effective in the long term.

Feral cats occur extensively, but apparently at low densities in the Bungle Bungle area, and feed on native small mammals, reptiles and ground-nesting birds. Their control is presently incorporated into the management duties of ranger staff, though may require more systematic concentration to be effective.

The elimination of feral stock may take many years, or even prove impossible (e.g. Ridpath and Waithman 1988; Bayliss and Yeomans 1989). In the meantime, methods aimed at controlling their damage should be implemented. De Salis (1982) lists the most vulnerable land systems as Antrim lowlands, Elder lower slopes, Headley lower slopes and cracking clays and Nelson frontage, cuestas, cuesta backslopes, upper and lower slopes and low rises. The vegetation being most degraded is that fringing the river systems, soaks, gorges and springs. Most notably, the pandanus thickets along sections of the Ord River have been extremely degraded by cattle trampling, erosion and the spread of exotic plants (e.g. *Cenchrus* spp., *Parkinsonia*). The riverside vegetation on the southern and south-eastern border of the Park (along the Ord River) should be protected from cattle by adequate fencing. This exclusion would also serve to protect vulnerable areas of the Elder lower slopes and Nelson frontage, low rises and cuesta land systems. We note that the present alignment of an electric fence to exclude cattle lies well to the north of the Ord River, thereby offering no protection to these land systems and vegetation. In terms of the conservation of natural values, this fence is currently in the wrong place. To achieve this aim it should be aligned along the southern bank of the Ord River. Alternatively, along the north bank of the Ord River substantial areas of riparian vegetation still in reasonable condition should be fenced off to exclude feral stock.

Rehabilitation of badly degraded land along the Ord River valley has been attempted by the Department of Agriculture, and monitored in a series of experimental plots (de Salis 1982; Colreavy *et al.* 1989). Although some success has been claimed (e.g. Anon. 1986), Coombs *et al.* (1989) note that the Ord River Regeneration Reserve has shown little evidence of successful regeneration. There appears to have been no treatment of the badly degraded areas of the northern section of the Conservation Reserve, Osmand Valley Station or the southern part of Texas Downs Station (personal observation).

Our survey was not designed to enquire into rehabilitation, but we note with disquiet the use of exotic pioneer species (*Aerva* and *Cenchrus*) for soil stabilization. In incidental observations we noted little colonization by native plant species of areas sown with these exotic species. Although our data provide no usable evidence on the suitability to native animals of exotic pastures *vis-a-vis* regeneration by native grasses, it would be parsimonious to presume that most native granivorous animal species are better adapted to exploiting seeds of native species than those of introduced species.

[12] Paul Novelly - Western Australian Department of Agriculture, Kununurra

The use of, or at least experimentation with, native pioneer grasses should be regarded as mandatory for restoration within a National Park. In this context, we note that Robinson (1971) doubted the wisdom of using introduced strong perennial grasses (e.g. *Cenchrus*) for rehabilitation, suggesting instead the natives *Enneapogon* and *Eragrostis falcata* for restoration work in the Hardman Basin. We recommend much more extensive experimentation using native plant species for the rehabilitation of all degraded areas in the National Park, Conservation Reserve and adjacent areas. Although rehabilitation measures must be taken urgently, experimentation into rehabilitation should be considered also over a long enough period to incorporate the influence of burning regime and over many years of rainfall variability. Experimentation should involve a considered design which includes the range of susceptible land units, topography, vegetation, visitor use, fire regimes and present erosional condition. If conducted properly, experimentation in the Bungle Bungle area could be used as a springboard for the restoration of the very extensive degradation across the Kimberley and north-west Northern Territory.

The rehabilitation procedure used to date, and any variations used in the future, provide an excellent opportunity to experimentally test the factors involved in the effects of degradation (and recovery with rehabilitation) for native animal species. Such monitoring should be integral to the vegetation rehabilitation trials and practices. We note, however, that over the long-term some reintroductions of medium-sized mammals may be desirable.

In attempting to restore an intact natural environment to this conservation area, the control of exotic weed species will pose a formidable problem. The woody weeds *Calotropis procera* and *Parkinsonia aculeata* have aggressively colonized degraded flats and riparian areas, and these, in particular, require continued urgent management attention. Although the diversity of exotic plants in the Bungle Bungle area is generally low, this invasion by exotic plant species is very variable, ranging from less than 0.5 per cent of the plant species in quadrats for the Buchanan frontage, Buchanan sandplains and Elder upland units, to 7.1 per cent in Nelson lower slopes, 7.3 per cent in Nelson low rises, 11.6 per cent in Antrim lowlands and a disquieting 13.6 per cent in Nelson frontage. With the continued presence of feral stock and an increase in tourist numbers, additional weed species may be expected to colonize the Bungle Bungle area.

CONSERVATION SIGNIFICANCE

Few species of the Bungle Bungle fauna are recognized as rare or endangered on a national scale. The most notable species that we recorded were Grey Falcon, Desert Mouse, the skinks *Egernia slateri* and *Lerista* sp.nov. and the gecko *Gehyra* sp.nov.

Although generally rare, the Grey Falcon has a very wide range across semi-arid Australia and may be at least partly nomadic (Blakers *et al.* 1984). It would be desirable to monitor their numbers and residential status in the Park area.

The Desert Mouse has an unusual distribution in central Australia without any apparent environmental determinants (S.Morton[13] personal communication), and is regarded as rare and declining (Strahan 1988). The Bungle Bungle population represents the most northerly and high rainfall area known to be occupied by this species. It appears to be reasonably widespread and abundant in the Bungle Bungle area, especially in relatively old spinifex on gravel or rock substrates. Further trapping in such habitat would define more precisely their distribution and abundance, and could determine suitable fire regimes to be implemented for their conservation.

The presence of *Egernia slateri* on the Bungle Bungle massif represents a very disjunct population of a species whose range is otherwise restricted to central Australia. Again, fire regimes which would be most suitable for this species have not been defined, and further trapping would be desirable in order to determine its precise distribution and abundance.

The distribution of an undescribed *Lerista* is not yet sufficiently known to determine the significance of Bungle Bungle National Park for its conservation, though it is possible that the Bungle Bungle area may comprise its total range.

The new species of *Gehyra* is thought to occur also in Keep River National Park and around Kununurra (M.King personal communication). Within the Bungle Bungle area, this species is abundant in caves, crevices and exfoliating rocks.

The greatest frustration of this survey was in the very limited information gathered on medium-sized mammals. We remain unsure of the continued presence within the Park area of the Bilby, Spectacled Hare-wallaby and Northern Quoll, and we gathered no evidence for Northern Brushtail Possum, Golden Bandicoot or Northern Brown Bandicoot, all of which may have been expected. These species are of considerable conservation significance because of their widespread decline in recent times (McKenzie 1981a; Burbidge and McKenzie 1989). Further attempts to detect these species (possibly using low-flying helicopter survey in sandy areas: Burbidge and Pearson 1989) are warranted. If located, populations may require protection from grazing and the local implementation of suitable burning regimes.

[13] S. Morton - CSIRO Wildlife and Ecology, Alice Springs

For all the native terrestrial vertebrates recorded from the Bungle Bungle area, we examined for presence in the other National Parks and Conservation Reserves throughout north-western Australia (using published surveys and file notes from Hamersley, Ruddall River, Point Coulomb, Windjana Gorge, Prince Regent , Drysdale River, Parry Lagoons, Hidden Valley, Keep River, Berry Springs, Holmes Jungle, Litchfield, Gregory, Howard Springs, Mary River, Fogg Dam, Douglas Hot Springs, Butterfly Gorge, Umbrawara Gorge, Coburg, Kakadu, Katherine Gorge, Katherine Low Level, Cutta Cutta Caves, Mataranka Pool, Connells Lagoon, Lawn Hill, and Camooweal Caves). For nine species, the Bungle Bungle area is the only conservation area in which they have been recorded in north-western Australia. Nine other species have been recorded from the Bungle Bungle area and only one other of these reserves (Table 25). It is for the conservation of these 18 species that Purnululu National Park may be critically important. This should be qualified by the presence of at least some of these species in conservation reserves outside north-western Australia, and the incompleteness of many species lists from reserves in north-western Australia.

HUMAN IMPACT

Direct human impact was not considered specially in this survey. This impact falls into three classes:

i) hunting by custodians,
ii) intensive pressure on particular areas by tourists, and
iii) a very large number of scenic low-level flights over the Bungle Bungle area.

At present, most hunting by outstation residents is for feral stock. If feral stock are eliminated or reduced to very low density, the demand for fresh meat may be transferred to the larger macropods and, possibly, Bustard. There has been no research on the consequences of traditional hunting with modern weapons in any area of northern Australia. The expanding number of cases of traditional owners or custodians living within National Parks (e.g. Kakadu, Gurig, Nitmiluk) may be expected to result in some conflict in Park conservation aims. It would be desirable to monitor density, removal rates and reproductive status of macropods if these become a major food item of custodians. Common Wallaroos enjoy a better conservation status (in terms of abundance and representation in National Parks) than do Northern Nailtail Wallabies, and any hunting should be restricted mainly to them. We note that custodians have expressed concern about the perceived low numbers of macropods in the Park area, and in response to this they are not currently hunting these species.

Tourists may make some impact on localized areas of high use, by frightening away shy species, possibly interfering with nests and picking or trampling rare plant species (especially in the sheltered gorges). Such impact is likely to be very minor and restricted. Access tracks and tourist infrastructure (e.g. airstrip) may lead to erosion, spread of weeds and occasional roadkills of small vertebrates, but again impacts on wildlife would be limited and localized. Camp fires are currently prohibited throughout the Park. This policy is probably justified at designated campgrounds, as the availability of timber is limited. The few studies elsewhere in Australia (e.g. Rolls 1989; Laidlaw and Wilson 1989) suggest that the rapid depletion of standing and fallen timber around sites of intensive camping is associated with a local decline in the animal species using this resource. The provision of timber from outside the Park is probably no solution because of expense and the possibility of introducing unwanted species to the Park area. Where camping is to be permitted beyond designated intensive-use campsites (e.g. for overnight bushwalks) there is no compelling biological reason (other than possible escape to wildfire) for prohibition of campfires.

Intensive camping is currently restricted to two sites, and the area open to visitors is also tightly controlled. In general, the conservation value of most sites that we visited would not be jeapordized by well-controlled tourist use. Qualifying this, there are areas which we consider unsuitable for intensive use by tourists. These include the relatively lush gorges and springs of the Osmand Valley (Winnama, Bream and Wulwuldji) which contain unusual vegetation which may be vulnerable to trampling if visited by excessive numbers of tourists (Forbes and Kenneally 1986); the larger pools of the Ord River and Osmand Creek (e.g. Blue Holes, Island Yard) which provide critical foci for many wildlife species in the late dry season, such that human disturbance then would be undesirable; and the plateau of the massif whose isolation and difficult access has allowed the persistence of several species more characteristic of central Australia. Additionally, most caves in the Bungle Bungle area are inaccessible or nearly so, but for the few which can be reached by tourists, some controls may be required in order to ensure that disturbance of their bats is minimized.

Domestic cats and dogs (owned either by tourists or custodians) should continue to be prohibited from the National Park and Conservation Reserve, because if these wander or become feral they may place high predation pressure on native species.

There is no information available on the effects of low-flying aircraft on native animals. We would presume that most animals of the Bungle Bungles are now habituated to this disturbance.

Any consideration for more tourist development and infrastructure in the Park should be preceded by an environmental impact assessment including examination for the presence of the notable species we document in this report.

VALUE OF CONSERVATION RESERVE AND POSSIBLE EXTENSIONS

We sampled five sites in the National Park, two sites in the Conservation Reserve, one site on the border of the two zones and two sites on adjacent pastoral leases, Texas Downs and Osmand Valley (Table 2). The two sites on pastoral leases averaged more native animal species (105) than those on the Conservation Reserve (98 species) or the National Park (91 species).

Twelve animal species were found at the pastoral lease sites but are not known from the National Park or Conservation Reserve: Bar-breasted Honeyeater, Eastern Water Rat, Northern Mastiff-bat, Beccari's Mastiff-bat, Black Whip Snake, Olive Python, Carpet Snake, Brown Tree Snake, the gecko *Crenadactylus ocellatus*, the skink *Eulamprus isolepis* and the snake *Vermicella roperi*. A further five species were recorded at our pastoral lease sites but at no other of our intensive survey sites (although we recorded them incidentally, or they are known from other sources, within the National Park and/or Conservation Reserve): Pacific Baza, Grey Butcherbird, Short-tailed Mouse, Pale Field-Rat and the monitor *Varanus glauerti*.

Extension of the National Park to include Osmand Valley Station and the southern part of Texas Downs would therefore increase the number of terrestrial vertebrate species known from the National Park and Conservation Reserve by between 4 and 5 per cent, including many Torresian species at the local southern limit of their range. It would also place in a reserve one species (*Crenadactylus ocellatus*) known from no other conservation reserve or National Park in north-western Australia. It would greatly increase the representation of the distinctive Wickham land system of hard sandstone ranges, deeply-incised gorges and lush riparian vegetation. Management by CALM of these areas would increase the protection of the dense riparian vegetation flanking Osmand Creek, its tributaries (e.g. Mt. John Creek), springs and gorges. We did not survey the small areas of Mabel Downs and Sophie Downs suggested for possible expansion of the National Park.

Eight species were recorded at sites in the Conservation Reserve but at no other sites: Richard's Pipit, Square-tailed Kite, Red-capped Robin, Olive Whip Snake, Dusky Horseshoe Bat, *Litoria rothi*, *Oedura rhombifer* and *Varanus kingorum*. Relative to the National Park, the Conservation Reserve includes much more of the Wickham, Dockrell and Antrim uplands land systems, and their inclusion clearly would add to the representativeness of the Park.

FIRE REGIMES

Both in the tropical north (e.g. Braithwaite and Estbergs 1985; Press 1987; Braithwaite 1987; Noske 1988; Woinarski 1990) and arid and semi-arid areas (e.g. Bolton and Latz 1978; Suijdendorp 1981; Kimber 1982; Burbidge 1985; Caughley 1985; Woinarski 1989) fire regime is an important determinant of vegetation pattern, and consequently of the distribution and abundance of animal species. By manipulating fire periods, intensities and size, the habitat suitability can be controlled for particular target species, and ecological diversity can be maximized.

Our survey was not aimed at defining suitable fire regimes, but some information was collected incidentally. Most notably, our records for the Desert Mouse were mostly from relatively old and dense spinifex, and this species may be favoured by reasonably long (10-20 years) intervals between fires. In many other areas of Australia, a range of animal species has been shown to be particularly associated with old spinifex (e.g. Mather 1979; Coventry and Dixon 1984; Noske 1988).

In contrast, in the tropical north, annual burning early in the dry season is favoured by many species of bird (Woinarski 1990) and some reptiles (Braithwaite 1987). In this environment, mammals, other reptiles and bird show a great array of preferred fire regimes, including some species which prefer long periods without fire (e.g. Kerle 1985; Braithwaite 1987).

In seeking some compromise to these various ecological demands, managers of national parks in the northern part of Australia have implemented a system of mosaic burning (Press 1987, 1988), consciously mimicking the broad pattern traditionally produced by Aborigines (Lewis 1985; Hallam 1985). Carefully considered (and long-term) experimental manipulation of fire regimes, and the detailed monitoring and chronicling of fire history (using LANDSAT) have been critical elements in the development and continuation of this strategy. Ecological monitoring of this management system is also recognized as essential to providing feedback into its sucess and failures.

The arid area has a conspicuously different climate and vegetation to the tropical north, with consequent marked differences in fire behaviour and vegetation responses. But as with the tropical north, in arid areas controlled mosaic burning has been identified as critical for some mammals (e.g. Bolton and Latz 1978; Pearson 1989), and recent changes in fire regime have been implicated in the decline of many mammals (e.g. Burbidge *et al.* 1988).

The Bungle Bungle area lies between the tropical and arid zones and includes elements of the climate, plants and animals of both in a complicated mix. Accordingly, it is unrealistic to extrapolate to the Bungle Bungle area the fire effects and preferred burning regimes from either tropical or arid examples. In the absence of fire response data from the south-east Kimberley, the most prudent management plan for the immediate future would be to ensure the availability of as wide a range of successional ages of vegetation as possible, through the carefully considered implementation of mosaic burning.

To identify the optimal design of an imposed fire regime for the Bungle Bungle area, it is crucial that experimental areas be established and be subjected to a variety of fire treatments. Vegetation and animal responses to these regimes should be monitored over a period of at least ten years. Further research into the relationships between fire regime and the distribution of animal species in the Bungle Bungle area is also desirable, especially for notable species.

As a further aid toward the establishment of a fire policy for the Bungle Bungle area, it is important to determine the fire regime traditionally used by Aborigines of the area, and to document, if possible, the reasons why such burning practices were used. In Kakadu National Park, Aborigines living within the Park are intimately associated with the management fires.

It should be implicit that the management of the Park requires the careful collection of fire history maps (preferably using LANDSAT imagery), and that the development and implementation of a fire regime for the Park area requires such sustained and accurate mapping. Over the last few years, the foundation for such a fire history map has been established for the Bungle Bungle area (Done[14] personal communication).

INTERPRETATION

Tourists to the Bungle Bungle area are drawn by the beauty and unusual nature of the massif. In contrast, most of the rich fauna is inconspicuous and/or uncommon. This is so especially for mammals and reptiles, and many visitors may be disappointed at failing to encounter wildlife in this remote natural area. Sensible interpretation will at least inform such visitors of what animals do occur, may give them ideas of where and when to look for particular species, and help them identify those that they may see. Such well-informed tourists may contribute records of additional species and/or locations of particular notable species, useful in the ongoing description and management of the Park's fauna.

[14] C. Done -Department of Conservation and Land Management, Kununurra, W.A.

REGIONAL PERSPECTIVE

Throughout this report we have focused on the Bungle Bungle area as defined in the Introduction (National Park, Conservation Reserve and immediate surrounds). Conservation of the south-east Kimberley will not be served solely by the simple reservation of this defined area. For example, not all plants and animals of the south-east Kimberley occur within the Purnululu National Park. But also, the condition of land in the region surrounding the Bungle Bungle area may influence the viability of populations within the National Park. This is most evident for nomadic species (such as the Masked Wood-swallow, Grey Falcon, Rufous-throated Honeyeater and Cockatiel) which depend on tracking seasonally shifting areas of resource abundance. No matter how well managed the National Park area is, such species will decline in it if the surrounding area is degraded. A conservation strategy for pastoral land in the Kimberley region is required.

INFORMATION SYSTEM

The management of a large and popular National Park with considerable conservation significance is a formidable task, made even more difficult by the requirements to develop and monitor extensive rehabilitation and burning strategies. The careful planning and integration of much information which must form the framework for this management would be greatly aided by the use of some form of geographic information system (GIS). We have consciously tried to present our data in a form which is amenable to inclusion in such a system. The use of some form of GIS is implicit in many of the recommendations that we now offer.

RECOMMENDATIONS

More detailed arguments or comments relating to these recommendations are given in the preceding discussion. We caution that it is hubris to pretend that an initial survey of wildlife and vegetation should provide recommendations for wide-ranging aspects of the management of an area as large and diverse as Purnululu National Park, Conservation Reserve and adjacent pastoral leases.

We assign three levels of priority to these recommendations: urgent, very high and high. We don't attempt to cost any of these proposals, nor comment on their degree of difficulty. In some cases these recommendations complement those identified in the Draft Management Plan (Colreavy *et al.* 1989). Some items in this recommendation list are contingent on or connected with others and form an overall plan for the wise conservation of the Bungle Bungle area's vegetation and wildlife.

A. Synthesis of Management Priorities, Information and Planning

A1. Establish a GIS

A1.1. Introduce a geographic information system for the storage of data on wildlife distribution, vegetation, degradation, fire history, tourist access, Aboriginal sites, and experimental plots. This database would then be used for management planning, prediction and information retrieval.

Priority: Very high.

Justification: Integration and storage of large amounts of information; considered management planning.

B. Land Degradation

B1. Control of feral animals

B1.1. Continue the systematic shooting of feral donkeys and cattle in the National Park, Conservation Reserve and adjacent area, until eradication is achieved (in collaboration with Department of Agriculture/Agriculture Protection Board).

Priority: Urgent.

Justification: Unacceptable levels of land degradation, especially in Osmand Valley Station, the Osmand Valley section of the Conservation Reserve and the banks of the Ord River.

B1.2. Eradicate the population of feral pigs.

Priority: Urgent.

Justification: Threat posed to riparian vegetation if pig numbers increase.

B1.3. Eradicate the small populations of camels and water buffalo.

Priority: High.

Justification: Alien species, damage to control fences.

B1.4. Trap and remove feral cats.

Priority: High.

Justification: Alien species, predation pressure on wildlife.

B1.5. Continue prohibition of domestic dogs and cats.

Priority: High.

Justification: Predation pressure on wildlife.

B1.6. Construct exclosure fences around vulnerable areas, explicitly Wulwuldji Springs, sections of the northern bank of the Ord River (especially where dense *Pandanus* vegetation or reedbeds persist), Winnama Gorge, 'Fowlhouse' and the area around the junction of the Ord River and Osmand Creek.

Priority: Urgent.

Justification: Unacceptably high levels of damage by feral livestock to key conservation areas.

B2. Density of stock on adjacent pastoral leases

B2.1. Scrutinize covenants governing Osmand Valley and Texas Downs pastoral leases. In consultation with leaseholders and the Department of Agriculture, stock levels should be reduced and rehabilitation measures implemented for degraded land.

Priority: Urgent.

Justification: Devaluation of the conservation significance of these areas.

B3. Rehabilitation

B3.1. Accelerate program to rehabilitate badly-degraded areas (e.g. Ord River basin, Osmand Valley in the Conservation Reserve, Osmand Valley Station). Long-term systematic and carefully monitored experimentation, using native species as pioneers, is mandatory. Rehabilitation measures should be well documented such that Purnululu is capable of providing an example for the restoration of degraded lands in the East Kimberley.

Priority: Urgent.

Justification: Loss of conservation value.

B3.2. Methodical monitoring of recovery of animal (especially small mammal and reptile) populations should accompany vegetation rehabilitation trials and also large-scale rehabilitation implementation.

Priority: Very high.

Justification: Ideal opportunity to examine the response of native animals to degradation and vegetation restoration. The recovery of the former animal community should be a primary aim of any land rehabilitation procedure.

B3.3. Consider the collaboration of custodians in the collection and cultivation of native plant species for possible use in restoration.

Priority: High.

Justification: Integrate custodians in the care of the land, use available knowledge and interest.

B4. Remove exotic plants

B4.1. Assess and monitor the current distribution and abundance of exotic plants in the Bungle Bungle area. Particular problem species should be eradicated, especially those which are now in relatively controllable numbers but which have the potential for substantial increase (e.g. *Parkinsonia, Calotropis*). The Antrim lowland and Nelson frontage land systems have the most exotic species.

Priority: Very high.

Justification: Restoring intact natural systems; averting threats for substantial expansion.

B4.2. Continue to look out for additional exotic species, and plan for possible changes in vehicular access should additional species of weeds begin to use the roads of the Bungle Bungle area as colonizing routes.

Priority: High.

Justification: Proactive plan to reduce the threat of rapidly increasing weed species.

C. Wildlife Studies and Monitoring

C1. Notable species

C1.1. Gather information on numbers, distribution and residential status of the Grey Falcon in the Bungle Bungle area.

Priority: High.

Justification: Rare species.

C1.2. Further survey the distribution, habitat requirements and status of the Desert Mouse in the Bungle Bungle area, especially relating to any association with fire regime.

Priority: Very high.

Justification: Rare species, isolated population.

C1.3. Further survey the distribution, habitat requirements and status of the two skinks *Egernia slateri* and *Lerista* sp.nov., especially relating to any association with fire regime. In this area, *Egernia slateri* is currently known only from the plateau of the Bungle Bungle massif. *Lerista* sp.nov. is known only from the sandy floor of Cathedral Gorge.

Priority: Very high.

Justification: Rare species, isolated population, poorly known distribution.

C1.4. Search the dense riparian vegetation (especially *Pandanus*) along the Ord River and Osmand Creek for the Purple-crowned Fairy-wren and White-browed Robin, formerly common in the area but now presumed extinct. If found, populations should be carefully protected. If not found, reintroduction may be desirable if vegetation has recovered sufficiently and can continue to be protected.

Priority: Very high.

Justification: Rare species, restoration of intact natural systems.

C1.5. Continue searches for medium-sized mammals (especially Northern Quoll, Bilby, Spectacled Hare-wallaby, Golden Bandicoot and Northern Brown Bandicoot), preferably in collaboration with custodians. If found, the distribution, habitat requirements, population status and association with fire regime should be defined. Any populations found should be carefully managed.

Priority: Urgent.

Justification: Restoration of intact natural systems, conservation of rare and declining mammal species.

C1.6. Consider the reintroduction of mammal species presumed to have declined or become extinct in this area. If land degradation can be reversed and fire managed sympathetically, such reintroductions may succeed here, especially because of the absence of foxes and rabbits.

Priority: High.

Justification: Restoration of intact natural system; providing sanctuary for species which are threatened across their entire range.

C2. Inventory

C2.1. Continue to update species lists by coordinating observations of tourists and ranger staff.

Priority: High.

Justification: Increased knowledge of natural resources, possible detection of trends in changing abundance.

C2.2. Search in wet season for frogs, snakes and water birds (all possibly under-sampled in this survey).

Priority: High.

Justification: Increased knowledge of natural resources.

D. Vegetation

D1. Additional collecting

D1.1. Survey of plants during the wet season.

Priority: High.

Justification: Almost no collecting has occurred during the wet season, the only period in which many annuals are conspicuous and in which fertile specimens can be collected.

D1.2. Survey vegetation of the Osmand Plateau.

Priority: High.

Justification: Not surveyed in detail by either this survey or by Forbes and Kenneally (1986), and may harbour species of biogeographic interest.

D2. Horticulture

D2.1. Collect seeds to examine suitability of a range of local plant species for propagation for possible use in rehabilitation (see also B3.3). Also, the cultivation of some of the very restricted plants occurring in the sheltered gorges *may* provide some conservation security for these species.

Priority: High.

Justification: Use in restoration and conservation.

E. Fire Regime

E1. Experimental trials

E1.1. Establish long-term, carefully monitored experimental trials to examine the effects of different burning regimes on native plants and animals.

Priority: Urgent.

Justification: Management to increase biological diversity, and to manipulate habitat suitability for particular species.

E2. Traditional burning practice

E2.1. Consult with custodians about their memories of traditional burning regimes, their aims and results.

Priority: High.

Justification: Restoration of natural systems, using available experience and expertise.

E3. Protect long-unburnt patches

E3.1. The Desert Mouse, at least, appears to favour areas with long intervals between fires. A reasonable proportion of such old spinifex country should be adequately protected.

Priority: High.

Justification: Protection of rare species.

E4. Establish a considered fire strategy

E4.1. Based on the above points and on other criteria (e.g. protection of tourists, protection of rehabilitation plots, more general legislation relating to burning), prepare and implement a systematic policy governing fire regime in the Park area. The optimum policy is most likely to be one which uses a mosaic of burning to maintain a wide range of vegetation ages and types.

Priority: Urgent.

Justification: Sound and deliberate management practice, protection of rare species.

E4.2. Maintain a detailed fire history map of the Park and adjacent area, and link this with a GIS (Recommendation A1.1).

Priority: Very high.

Justification: Requirement for considered management, and conservation of rare species.

F. Tourism

F1. Interpretation

F1.1. Provide a digest of some of the information in this report in a form attractive to tourists, such that they can appreciate the wildlife and vegetation values of the Bungle Bungle area.

Priority: High.

Justification: Visitor appreciation of the Park.

F1.2. Establish and coordinate a wildlife database from interested and informed tourists and ranger staff (= C2.1.).

Priority: High.

Justification: Visitor appreciation of the Park, updating and accumulating information on Park resources.

F1.3. Encourage the establishment of nature tours and bush tucker tours, in collaboration with custodians.

Priority: High.

Justification: Visitor appreciation of Park; accumulating information on Park resources; providing commercial opportunities for custodians.

F2. Development of infrastructure

F2.1. Any development involving substantial buildings, clearing of native vegetation or use of waterbodies, should be preceded by environmental assessment, particularly by consideration of the presence of the plant and animal species identified as notable in this report.

Priority: Very high.

Justification: Protection of rare species.

F3. Campfires

F3.1. Campfires should not be permitted at sites of intensive use (e.g. designated camp grounds), as is current policy.

Priority: Very high.

Justification: Local loss of critical resources for some animal species.

F4. General

We can provide little information on other tourist-related management problems, such as increased visitor numbers, better access, low-level scenic flights, camp-fires for dispersed camping and accessibility to additional areas. We note comments on some of these matters in the Discussion.

G. Extensions

G1. Addition of Osmand Valley Station and southern part of Texas Downs

G1.1. We support the incorporation of these areas into Purnululu National Park, although we note that land degradation is continuing (?and accelerating) on these pastoral leases.

Priority: Urgent.

Justification: Outstanding natural values, which largely complement those of the existing National Park.

H. Surrounding Land

H1. Develop a conservation strategy for all lands in the east Kimberley

H1.1. In association with other interested groups (e.g. local councils, pastoralists, Aboriginal organizations, tourist operators, conservationists, and mining companies) develop a conservation strategy for pastoral land, Aboriginal reserves and conservation areas in order to best protect the conservation values of all land in the east Kimberley.

Priority: Very high.

Justification: Conservation reserves alone will not provide sufficient protection for the survival of wildlife and vegetation in this region. Many sites with high conservation value occur in areas where there is currently little protection or appreciation of those values.

Table 22

Relationships between mean degradation score and number of species of plants and animals across floristic groups. Significance of correlation coefficients : *p<0.05, ** p<0.01

	FLORISTIC GROUP	DEGRADATION	MEAN NO. NATIVE SPP.				
			Plants	*Mammals*	*Birds*	*Reptiles*	*Frogs*
1.	*Livistona - Acacia holosericea - Germania*	0	30.2	3.6	9.6	5.4	1.4
2.	*E. ptychocarpa - Pandanus - Heteropogon*	3.2	29.8	1.6	18.8	4.8	1.0
3.	*E. camaldulensis / Melaleuca - Aerva - Aristida*	8.3	34.3	0.3	26.3	3.5	0.5
4.	*Melaleuca leucadendra - Acacia eriopoda - Aristida*	4.4	35.6	0.4	19.9	3.4	0.3
5.	*Lysiphyllum - Carissa - Heteropogon*	3.2	23.0	2.0	14.4	3.7	0.6
6.	*Lysiphyllum - Acacia holosericea - Cenchrus*	3.6	21.1	0.6	16.6	6.2	0.1
7.	*Acacia farnesiana - Aerva - Aristida*	9.3	22.8	1.0	13.9	2.1	0
8.	*E. collina - Acacia stipuligera - Triodia spicata*	0.1	16.0	1.1	13.1	4.0	0
9.	*E. collina - Acacia tumida - Plectrachne pungens*	0	28.6	1.1	9.7	3.0	0.1
10.	*E. brevifolia - Cassia - Plectrachne pungens*	1.6	35.1	1.6	14.5	3.0	0.3
11.	*Hakea arborescens - Dodonea - Triodia wiseana*	3.0	22.8	2.4	15.2	2.6	0
12.	*E. opaca - Grevillea pyramidalis - Triodia pungens*	2.4	20.3	1.2	11.1	3.6	0.2
13.	*E. brevifolia - Acacia retivenia - Triodia intermedia*	0.8	10.4	2.6	3.6	1.2	0
14.	*E. cliftoniana - Cajanus - Plectrachne pungens*	0	21.0	2.5	7.2	3.0	0
15.	*E. aspera - Acacia eriopoda - Triodia microstachya*	0.3	30.3	2.3	9.3	3.3	4.0
16.	*E. cliftoniana - Acacia spp - Triodia spicata*	0.1	20.4	1.0	6.5	3.1	0.3
17.	*Acacia spp - Triodia spicata*	1.7	14.9	1.0	8.4	4.9	1.0
	Correlation coefficient with degradation:		.27	-.51*	.71 **	-.09	-.21

Table 23

Correlation coefficients between degradation scores and number of animal species, within individual land systems and within individual floristic groups. Significance levels: *p<0.05, **p<0.01

	No. quadrats	*Disturbance range*	*All spp.*	*Birds*	*Native Mammals*	*Reptiles*
LAND SYSTEMS						
Al	21	2-11	.27	.27	.26	-.17
Au	12	0-12	.32	.53	-.54	-.19
Nr	12	1-9	-.04	.09	.58*	-.19
Wk	35	0-6	.65**	.69**	-.55**	.08
FLORISTIC GROUPS						
4	18	2-11	.42	.49	.03	.07
5	12	1-6	.38	.43	-.41	-.05
6	13	1-8	.26	.22	-.44	.27
10	11	0-3	.04	.23	.69*	-.46
12	14	1-5	.07	.04	.23	.11

Table 24

Significant correlations between the abundance of animal species and degradation score, within individual land systems and within individual floristic groups. Number in parentheses after species name is number of quadrats in which recorded for a given land system or floristic group. Significance levels: *p<0.05, **p<0.01

	NO. QUADRATS	DISTURBANCE RANGE	NEGATIVE	POSITIVE
LAND SYSTEM				
Al	21	2-11	-.51* Pied Butcherbird (12)	.53* Spinifex Pigeon (3)
				.42* Diamond Dove (4)
Au	12	0-12		.84** Budgerigar (3)
Nr	12	1-9	-.55* *Ctenotus militaris* (5)	.62* Spinifex Bird (3)
				.62* *Omolepida branchialis* (3)
				.60* Peregrine Falcon (5)
				.59* Zebra Finch (6)
				.58* Northern Nailtail Wallaby (4)
Wk	35	0-6	-.59** Common Rock-rat (21)	.60** Peaceful Dove (19)
			-.45** White-quilled Rock-pigeon (5)	.46** Bar-shouldered Dove (7)
			-.42** *Cryptoblephurus megastictus* (4)	.45** *Heteronotia binoei* (5)
			-.33* Pale Field-rat (7)	.42* Double-barred Finch (17)
				.36* Crested Pigeon (3)
				.35* Long-tailed Finch (5)
FLORISTIC GROUP				
4. *Melaleuca-Acacia-Aristida*				
	18	2-11		.79** Kite (4)
				.68** Torresian Crow (10)
				.57* Australian Magpie-lark (8)
5. *Lysiphyllum-Carissa-Heteropogon*				
	12	1-6	-.57* *Ctenotus inornatus* (4)	.86** Pied Butcherbird (6)
6. *Lysiphyllum-AcaciaCenchrus*				
	13	1-8	-.56* Northern Nailtail Wallaby (3)	.65* Sacred Kingfisher (3)
10. *E. brevifolia-Cassia -Plectrachne*				
	11	0-3	-.69* *Lerista greeri* (3)	.62* Diamond Dove (8)
			-.60* Crested Pigeon (4)	.62* Zebra Finch (4)
12. *E. opaca-Grevillea-Triodia*	14	1-5	-.51* Spinifex Pigeon (5)	.62* Painted Firetail (3)
				.57* Zebra Finch (3)

Table 25

List of native terrestrial vertebrates found in the Bungle Bungle area but known from fewer than two other national parks or conservation reserves in north-western Australia (see text for names of 28 other reserves considered).

SPECIES	OTHER RESERVES	COMMENT
Scotorepens sanborni	-	
Pseudomys desertor	-	
Ctenotus piankai	-	
Ommolepida branchialis	-	
Lerista aericeps	-	
Lerista greeri	-	
Varanus kingorum	-	
Egernia slateri	-	
Lerista sp. nov.	-	
Eremiascincus richardsoni	Hamersley	
Proablepharus reginae	Hamersley	
Pseudonaja modesta	Hamersley	
Diporiphora lalliae	Connell's Lagoon	
Ctenotus militaris	Hidden Valley	
Crenodactylus ocellatus	Geikie Gorge	
Uperoleia borealis	Keep River	
Lerista borealis	Gregory	
Chelodina sp. nov.	Kakadu	

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