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Western Australian Naturalists' Club

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THE WESTERNAUSTRALIAN NATURALIST

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No. 3

A CHECKLIST OF THE VASCULAR FLORA OF THE PORONGURUP NATIONAL PARK, WESTERN AUSTRALIA

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ABSTRACT

The Porongurup National Park contains a flora of at least 822 species of vascular plant. Of these 709 are natives and 113 are weeds. A feature of the range is the number of wet temperate species, including one of the dominant trees (Karri-*Eucalyptus diversicolor*) at their inland margins. There are 10 taxa endemic to the range and brief notes are given on their biology.

INTRODUCTION

The Porongurup National Park (Reserve 18978)is found approximately 35 kilometres north-east of Albany and encompasses within an area of 2,511 hectares the bulk of the Porongurup Range. This granite range rises to a maximum height of 670 metres at Devil's Slide and runs in an east-west direction.

There have been two previous lists of vascular plants prepared for the ranges.

The first list was compiled by members of the Botany Department, University of Western Australia from student field camps and granite rock studies (Smith, 1962) and listed 221 species (Botany Department, 1970). The second by Abbott (1982) listed the flora of the Range itself, above 300 metres and listed 368 species.

The current list is based on these previous lists and extensive field survey of the endemics of the Range mainly undertaken in 1986 and 1987.

The major vegetation formations listed for the Range by Beard (1976) are Jarrah (Eucalyptus marginata) and Marri (Eucalyptus calophylla) tall to low forest to low woodland which occurs on lower slopes and poorer sandy, duplex or lateritic soils. In this vegetation community a diverse range of shrubs and herbs form the understorey. Karri (E. diversicolor) tall forest centred on the creek lines and lower slopes of the range. This forest has a variable understorey of tall shrubs of Acacia urophylla, Trymalium floribundum, Hibbertia serrata, Pimelea sylvestris and vines such as Clematis pubescens and Kennedia coccinea.

Rising above the Karri forest are the bare granite domes of the range, these granite areas contain moss fields, with their associated herbfields (Smith, 1962). Along the rock rills and in depressions where deeper soils are found are shrublands of Brachysema subcordatum. Acacia heteroclita and Agonis linearifolia over sedges of Lepidosperma gladiatum and herbs such as Stypandra glauca. Between this community and the Karri forest are low woodlands of Bullich (Eucalyptus megacarpa) of Yate (Eucalyptus cornuta) often with a similar understorey to the rills.

There are also number of minor communities which Beard did not map separately, including small areas of Mallee heath dominated by *Eucalyptus tetragona* or *Eucalyptus* decipiens. Another small community Melaleuca preissiana low woodland over Pericalymma ellipticum shrubland wetland on the western Margin of the Park, contains numerous wetland species only recorded from this area and is thus listed separately in Appendix 1. Current records of the vascular flora present inside the boundaries of the national Park are given in Appendix I. These records are listed under the major vegetation types of Jarrah, Karri, granite slopes, but also includes the western swamp.

Despite it's small size and limited range of habitat's the flora of the park is rich, being composed of over 822 (709 natives and 113 weeds)taxa of vascular plants. Of these 10 are Ferns and Fern allies, 222 are Monocotyledons and 590 are Dicotyledons.

There has been a long history of disturbance in the Park from grazing. timber cutting, partial clearing, roads for stock transportation and settlements (Burchell, undated) which has resulted in the introduction of many alien plants and created the disturbed areas for their establishment. Of the 113 taxa of weeds in the park, the major weeds are along creek lines are Blackberries (Rubus species), Forget Me Nots (Myosotis sylvatica). In areas of past disturbance Dolichos Pea (Dolichos lignosus), Silky Wattle (Acacia dealbata), Taylorina (Psoralea pinnata). Potentially very serious weeds (Arum Lily and Watsonia) of these areas are present in the park. As illustrated by Taylor (1990) annual grasses are a major threat to the granite rock communities. Control of these weeds is discussed in the recent draft management plan (Herford et al, 1997).

The largest families are the Cyperaceae (31 natives, 2 weeds), Orchidaceae (57 natives, 1 weed), Poaceae (17 natives, 17 weeds), Asteraceae (38 natives, 16 weeds, Epacridaceae (31 natives), Mimosaceae (21), Myrtaceae (44), Papilionaceae (47 natives, 11 weeds) and the Proteaceae (52 natives).

GEOGRAPHICALLY SIGNIFICANT RECORDS

Because of the granitic soils and run-off from the range there are a number of species at the inland margins of their ranges. These taxa include:

Adiantium aethiopicum, Carex appressa, Dampiera hederacea, Darwinia citriodora, Eucalyptus diversicolor, Gonocarpus diffusus, Hakea falcata, Hibbertia serrata, Hydrocotyle plebeja, Isolepis inundata, Lysinema lasiantha, Ozothamnus ramosus, Persoonia elliptica, Picris angustifolia, Rorippa dictyosperma, Scaevola auriculata, Senecio ramosissimus, Trachymene anisocarpa, Thryptomene saxicola and Xanthorrhoeagracilis.

While most plants of the park are normal components of the Jarrah, Karri and granite rocks in the higher rainfall areas of southern Western Australia. Many of the normal important components of the Karri forest are absent, notably Karri Wattle (Acacia pentadenia), Karri Oak (Chorilaena quercifolia) and Lasiopetalum floribundum.

Only one species appears to be at its south-western margin in the park, this is *Calectasia grandiflora*.

ENDEMICS OF THE RANGE AND THEIR BIOLOGY

There are 5 species (Brachysema subcordatum, Billardiera granulata, Hibbertia bracteosa, Villarsia calthifolia and Villarsia marchantii) and 5 subspecies/ varieties.(Acacia drammondii ssp. elegans (Porungurup variant, R.J. Cummings 938), Acacia heteroclita ssp. valida, Apium prostratum ssp. "phillipii", Conospermum caeruleum ssp. adpressum and Stylidium corymbosum var proliferum) endemic to the Range. Brief notes are presented on their distribution and biology. Acacia drummondii ssp. elegans (Porongurup variant, R.J. Cummings 938). This low shrub is found on lateritic and loam soils in Jarrah forest of the western half of the range. Killed by fire and occurs abundantly after fires. This taxon like Conospermum caeruleum ssp. adpressum probably occurred outside the range before clearing.

Acacia heteroclita ssp. valida. This large spreading shrub occurs between Yalperungup and Twin Peaks around the base of the granite rock sheets or along rock rills. Killed by fire, regenerates from seed.

Apium prostratum ssp. phillipii ms An erect perennial herb from a tuberous rootstock. Confined to creeklines in Bullich or Karri forest near the base or below the granite slopes. Pollination and response to fire unknown.

Brachysema subcordatum This is a suckering shrub, confined to rills, often dominating this vegetation between Yalperungup and Castle Rock. Pollinated by birds Adult plants are killed by fire, massive seedling regeneration occurs after fires. First flowering occurs 2 –3 years after the fire.

Billardiera granulata A slender vine to 5 metres. Killed by fire, occurring in abundance after fires often dominating the shrub layer in burnt Bullich stands for 5–10 years after fire. Pollinated by solitary bees. Occurs from Yalperungup to Castle Rock in Bullich or Yate woodlands, on rock rills and occasionally along creek lines in the Karri forest.

Conospermum cuendeum ssp. adpressum. A tufted slender small shrub found only in one area of heath/shrubland on coarse sands. Probably extended beyond the park on this soil/vegetation type before clearing. Pollinated by solitary bees. Adult plants killed by fire, very susceptible to *Phytophthora cinnamomii* (dieback disease).

Hibbertia bracteosa. Unlike most Hibbertias which are low woody shrubs, this species is a spreading rhizomatous herbaceous sub-shrub. Flowering in late spring, it occurs from Yalperungup to Nancy's Peak. Pollinated by native bees and syrphid flies. Killed by fire regenerates prolifically from seed. A large number of plants died during the severe drought summers of 1986/87, however, populations have regenerated from seed, flowering in 18 months from seed.

Stylidium corymbosum var proliferum. A spreading stilt rooted perennial herb in moss swards on granite slopes between Nancy's Peak and Yalperungup. Killed by fire. Pollination unknown. Collections that may be this taxon have recently been collected from Mount Manypeaks.

Villarsia calthifolia. Unlike most other species which are aquatics, the following species, a short lived perennial herb from a tuberous rootstock, does not occur in water but is the only terrestial member of the genus. Confined to shady areas on granite slopes and rock rills, occasionally under Bullich woodland between Yalperungup and Castle Rock. Killed by fire, regenerating prolifically from seed after fires. Seedlings rarely noted otherwise. Plants can flower the spring after sowing in cultivation but normally flowering occurs the next spring in the wild.

Villarsia marchantii. Like the previous species, a short lived perennial herb from a tuberous rootstock, it, however, is normally found along creeklines in the Karri forest between Castle Rock and Gibraltar Rock. At Devils Slide it does occur marginally sympatrically with V. calthifolia where a creek commences on the upper slopes in a rock rill. Here there is a large hybrid zone present between the two species. Killed by fire, regenerating prolifically from seed.

Most of the endemic taxa (Brachysema Billardiera granulata, subcordatum, Hibbertia bracteosa, Villarsia calthifolia. Villarsia marchantii. Acacia heteroclita ssp. valida and Stylidium corymbosum var proliferum) are confined to the massive granite rocks above the forest cover. They are largely found in the western section of the park where these exposures are largest. Interestingly although they grow in relatively fire free environments. most are killed by fire and often only prolifically regenerate after sporadic summer fires penetrate the rock rills and moss swards where they grow.

DISCUSSION

Porongurup National Park despite its small size is of considerable conservation significance. It contains a rich flora of over 822 taxa of vascular plants of which 709 are native. Currently 10 taxa are endemic to the Range. Another major feature of the isolated granite range is that it harbours at least 26 vascular plant taxa at their inland margins, usually disjunct from the coast around Albany or Denmark.

The major forest tree Karri (*Eucalyptus diversicolor*) is one of these taxa. The tree is genetically distinct in this isolated area (Coates and Sokolowski, 1989) and the understorey is floristically simpler than in the main forest block extending from West Cape Howe to Manjimup. This suggests that, as noted by Churchill (1968) the Karri, and associated taxa have been isolated here for over 5,000 years as Karri contracted to it's current range. Other taxa at their margins may also be genetically distinct and deserve study.

The continued conservation of this island of specific and genetic diversity is the future challenge.

REFERENCES

ABBOTT, I. 1982. The Vascular Flora of the Porongurup Range, South-Western Australia. Western Australian Herbarium Research Notes 7: 1–16.

ANON 1970, unpublished. Botany Field Camp Notes, ? compiled by G.G. Smith and A.M. Baird, 30 pages.

BEARD, J.S. 1979. The Vegetation of the Albany and Mount Barker Areas. VegetationSurvey of Western Australia. Vegmap Publications, Fraser Road, Applecross.

BURCHELL, A. (undated) Porongurup, Western Australia, History and Tour Guide. Porongurup Promotions Association.

CHURCHILL, D.M. 1968. The

Distribution and Prehistory of Eucalyptus diversicolor F. Muell., E. marginata Donn ex Sm., and E. calophylla R.Br. in Relation to Rainfall. *Australian Journal of Botany* 16: 125– 131.

COATES, D.J. and SOKOLOWSKI, R.E. 1989. Geographic Patterns of Genetic Diversity in Karri (Eucalyptus diversicolor F.Muell.). Australian Journal of Botany 37: 145–156.

HERFORD, I., GILLEN, K., LLOYD, M., HINE, C. MCCAW, L. and KEIGHERY, G.J. 1997. Stirling Ranges and Porongurup National Parks, Draft Management Plan. CALM.

SMITH, G.G. 1962. The Flora of the Granite Rocks of the Porongurup Range, South Western Australia. *Journal Royal Society of Western Australia* 45: 18–23.

TAYLOR, J. 1990. Australias South West and Our Future. Kangaroo Press.

Appendix 1: Porongurup National Park Flora List

Key: * indicates a naturalised alien species; ms indicates a manuscript name, not yet formally published; GKII314 indicatyes a voucher collection held in PERTH Herbarium; (Habitat Code: GR – Granite, SW – Swamp, JA – Jarrah, KA – Karri)

Taxon Name	GR	SW	JA	KA	
Adiantaceae					
Adiantum aethiopicum				+	
Anogramma leptophylla	+				
Cheilanthes austrotenuifolia	+	+	+	+	
Aizoaceae					
Carpobrotus modestus	+				
Alliaceae					
* Allium triquetrum				+	
* Nothoscordum gracile				+	
Amaryllidaceae					
 * Amaryllis belladonna 				+	
Anthericaceae					
Agrostocrinum scabrum	+		+		
Arthropodium capillipes			+		

					-
E	orya sphaerocephala	+			
C	laesia micrantha			+	
C	Caesia occidentalis			+	
C	Chamaescilla corymbosa var. corymbosa	+		+	
Jo	olinsonia acaulis		+		
Jo	ohnsonia teretifolia			+	
Ĺ	axmannia sessiliflora subsp. australis			+	
S	owerbaea laxiflora			÷	
T	hysanotus manglesianus			, T	
T	hystotus multiflorus			1	
Ť	hysanotus maranonii			T	
Ť	hysanocus paceisonii			Ť	
Ť	risoruma eletior			+	
T				+	
	ncoryne numius			+	
Apia	iceae				
A	actinotus glomeratus			+	
A	pium prostratum subsp. phillipii ms			+	
C	'entella asiatica			+	
D	aucus glochidiatus	+		+	+
H	lomalosciadium homalocarpum	+			
H	lydrocotyle alata	+			
Н	vdrocotyle blepharocarpa	+			
Н	vdrocotyle callicarpa			+	
Н	vdrocotyle diantha	+		'	
Н	vdrocotyle hirta	т			
н	vdrocotyle pleben				+
 LI	vdrocotyle crutellifer				+
DI		+			
- F1 Di	at ysace compressa		+	+	
ri c	atysace pendula		+		
	choenolaena tenulor			+	
11	rachymene anisocarpa	+			
T	rachymene pilosa	+		+	
X	anthosia pusilla			+	
X	anthosia rotundifolia var. rotundifolia			+	+
X	anthosia singuliflora		+		
Arace	eae				
* Za	antedeschia aethiopica			+	+
Asph	odelaceae				
Bu	ulbine semibarbata	+			
Asple	eniaceae	•			
A	splenium aethiopicum	+			
A	solenium flabellifolium	+			
Aster	aceae	+			
* 1.	retothees calendule				
n-	netocneta calendula	+		+	
tor * C	active prove and believe	+			
* 0	autuus pychocephaius	+			+
^ Ce	entaurea melitensis	+			+
Ce	entipeda cunninghamii				+

12	axon Name	GR	sw	JA	KA	
*	Cirsium vulgare			-		
*	Conyza albida			Ī		
*	Conyza bonariensis	+		Ţ	+	
*	Cotula bipinnata	· +		т		
	Cotula cotuloides	· +				
*	Cotula turbinata			т.		
	Craspedia variabilis	- -				
*	Crepis capillaris				+	
	Gnaphalium gymnocephalum	+				
	Gnaphalium sp. GJK 10095				+	
	Gnaphalium sphaencum			+	•	
	Gnephosis drummondii	+	+	•		
	Helichrysum macranthum	+			+	
	Hyalosperma cotula	+			•	
	Hyalosperma pusillum	+				
*	Hypochaeris glabra			+	+	
	lxiolaena viscosa			+		
	Lagenifera huegelii			+	+	
	Millotia myosotidifolia	+				
	Millotia tenuifolia	+		+		
	Olearia ciliata			+		
	Oleana paucidentata	+				
	Ozothamnus ramosus				+	
	Picris angustifolia	+		+	+	
	Picris sp(GK10964)				+	
	Pithocarpa corymbulosa			+		
	Podolepis gracilis			+		
	Podolepis lessonii	+				
	Podotheca angustifolia		+			
*	Pseudognaphalium luteo-album			+		
	Pterochaeta paniculata			+		
	Quinetia urvillei	+				
	Rutidosis multiflora	+				
	Senecio glomeratus	~ +		+		
	Senecio hispidulus	+			+	
	Senecio minimus var. minimus	+				
	Senecio quadridentatus			+		
	Senecio ramosissimus				+	
*	Sigesbeckia orientalis				+	
	Siloxerus humifusus			+	+	
*	Soliva pterosperma	+				
*	Sonchus asper				+	
	Sonchus hydrophilus		+			
*	Sonchus oleraceus	+		+	+	
	Trichocline spathulata		+	+		
*	Vellercophyton dealbatum			+		
	Vittadinia australasica			+		
	Waitzia nitida			+		

_							
	Waitzia suaveolens				+		
Bc	praginaceae						
*	Myosotis sylvatica					+	
Br	assicaceae						
*	Lepidium bonariense		+				
	L pseudo-tasmanicum		+				
	Rorippa dictyosperma					+	
Ca	mpanulaceae						
	Wahlenbergia gracilenta		+		+		
	Wahlenbergia littoricola				+	+	
	Wahlenbergia multicaulis		+				
Ca	ryophyllaceae						
×	Cerastium glomeratum		+		+	+	
×	Moenchia erecta		+				
*	Petrohagia velutina				+		
*	Polycarpon tetraphyllum		+		+	+	
*	Sagina apetala		·		'	, 	
*	Silene gallica		+			т	
*	Spergularia rubra		_				
×	Stellaria media		т ⊥				
Ca	suarinaceae		+		+	+	
cu	Allocasuarina fraseriana						
	Allocasuarina humilie				+		
Ce	ntrolenidaceae				+		
a	Aphelia cuperoides						
	Aphelia drummondii		+		+		
	Apholia putons		+				
	Centrolopic aristota				+		
	Contrologis drummondiana		+		+		
	Centrolopis diuminonulana		+				
	Centrolepis glabra		+				
	Centrolepis polygyna		+		+		
Ch	controlepis sengosa		+		+		
Ch	Chemomodium annettia						
<u></u>					+		
Ch	Islaceae						
Cal	Hypencum gramineum		+				
CO.	Icnicaceae Bourdeau l'anna						
	Burchardia congesta				+		
	Burchardia multiflora		+				
0	Wumbea dioica		+				
Cor	nvolvulaceae						
~	Dichondra repens				+	+	
Cra	ssulaceae						
1	Crassula colorata var. colorata	-	+ •	+ -	+	+	
	Crassula colorata var. tuberculata	-	F -	+			
* (Crassula decumbens	-	F				
* (Crassula natans	-	F				
(Crassula pedicellosa	-	F				

 Taxon Name	GR	SW	JA	KA	
Crassula peduncularis	+	+			
Crassula sieberiana subsp. tetramera	+			+	
Cuscutaceae					
* Cuscuta epithymum		+			
Cyperaceae					
Baumea juncea		+			
Carex inversa				+	
Carex appressa	+				
Cyathochaeta avenacea			+		
* Cyperus tenellus	+		+		
Evandra aristata		+			
Gahnia trifida			+		
Isolepis congrua	+		+		
lsolepis cyperoides	+			+	
lsolepis inundata	+		+		
lsolepis marginata	+				
lsolepis nodosa			+		
lsolepis oldfieldiana	+		+		
* Isolepis prolifera				+	
lsolepis stellata			+	+	
Lepidosperma angustatum			+		
Lepidospenna effusum		+		+	
Lepidospenna gladiatum			+		
Lepidosperma tenue			+		
Lepidosperma tetraquetrum				+	
Mesomelaena graciliceps			+		
Mesomelaena pseudostygia			+		
Mesomelaena tetragona			+		
Schoenus caespititius			+	+	
Schoenus curvifolius			+		
Schoenus humilis	+		+		
Schoenus lanatus			+		
Schoenus minutulus	+				
Schoenus subbulbosus	-		+		
Schoenus subflavus			+		
Tetraria capillaris			+		
Tetraria octandra	+		+		
Tricostularia neesii	+		+		
Dasypogonaceae					
Calectasia cyanea			+		
Calectasia grandiflora			+		
Chamaexeros serra		+	+		
Dasypogon bromeliifolius			+		
Kingia australis			+		
Lomandra caespitosa			+		
Lomandra micrantha			+		
Lomandra nigricans			+		
Lomandra pauciflora	+			+	

Lomandra preissii			+		
Lomandra purpurea			+		
Lomandra sericea			+		
Lomandra suaveolens			+		
Dennstaedtiaceae					
Pteridium esculentum		+	+	+	
Dilleniaceae					
Hibbertia amplexicaulis			+		
Hibbertia bracteosa			+		
Hibbertia commutata			+		
Hibbertia cunninghamii			+		
Hibbertia gracilipes			+		
Hibbertia lineata			+		
Hibbertia microphylla			+		
Hibbertia pulchra			+		
Hibbertia serrata				1	
Droseraceae					
Drosera barbigera		-	+		
Drosera envithrorbiza		т	Ť		
Drosen glanduligara			+		
Drosora Issiantha	+		+		
Drosen magnetha			+		
Drosera macrantna	+		+		
Drosera menziesii suosp. menziesii	+	+	+		
Drosera pallida			+		
Drosera pulchella			+		
Drosera stolonifera	+		+		
Drosera subhirtella subsp. subhirtella	+		+		
Epacridaceae					
Andersonia caerulea			+		
Andersonia micrantha			+		
Andersonia sprengelioides	+				
Astroloma aff. humifusum Porongorups			+		
Astroloma baxteri			+		
Astroloma ciliatum			+		
Astroloma drummondii			+		
Astroloma pallidum			+		
Leucopogon australis			+		
Leucopogon capitellatus			+		
Leucopogon carinatus	+				
Leucopogon cymbiformis			+		
Leucopogon distans var. distans			÷		
Leucopogon gibbosus					
Leucopogon glabellus			-		
Leucopogon gracillimus			T		
Leucopogon obovatus			+		
Leucopogon oppositifolius	*		+	+	
Leucoporton ovvedrus			+		
Leucoporon pondulus		+	+		
reactored pendulus			+	+	

	Leucopogon pogonocalyx		+		
	Leucopogon propinquus	+			
	Leucopogon racemulosus		+		
	Leucopogon unilateralis		+		
	Leucopogon verticillatus		+	+	
	Lysinema ciliatum		+		
	Lysinema lasianthum	+			
	Needhamiella pumilio		+		
	Oligarrhena micrantha		+		
	Sphenotoma capitatum		+		
	Styphelia tenuiflora		+		
Εt	uphorbiaceae				
	Phyllanthus calycinus		+		
	Poranthera microphylla		+		
	Ricinocarpos glaucus		, +		
Ft	Imanaceae		т		
*	Fumaria capreolata			+	
¥	Fumaria muralis		1	т	
G	entianaceae		Ŧ		
*	Centaurium erythraea				
	Sebaea ovata		Ŧ	+	
G	eraniaceae	+			
*	Etodium cicutarium				
*	Geranium molle		+	+	
	Geranium retrorsum			+	
	Geranium solanderi	+			
	Pelargonium australe	+			
G	oodeniaceae	+			
0	Dompier alata				
	Dampier diversifolio		+		
	Dampiera bederacea		+	+	
	Dampier fasiculata			+	
	Dampien iunes		+		
	Dampiera juncea		+		
	Dampiera lavandulacea		+		
	Dampiera incents	+	+	+	
	Candenia sacculata		+		
	Goodenia Caerulea		+		
	Goodenia leptoclada		+		
	Goodenia micrantna	+			
	Goodenia pulchella		+		
	Goodenia scapigera		+		
	Lechenaultia formosa		+		
	Scaevola auriculata	w	+		
	Scaevola calliptera		+		
	Scaevola lanceolata		+		
	Scaevola striata	+	+	+	
	velleia trinervis	+			
H	aemodoraceae				

Taxon Name	GR SW	JA KA	
Anigozanthos bicolor subsp decrescens		+	
Conostylis serulata		+	
Conostylis setigera		+	
Haemodorum discolor		+	
Haemodorum mniculatum		+	
Haemodorum simpley		т	
Haemodorum smrsiflorum	T ,		
Haemodor un spiest un	Ŧ		
Triboponthes oustralis		+	
Tribonanthes longinetale	+ ,		
Haloragasaa	+		
Concernus diffusus			
Helomais brownii	+	+	
Haddagis Drownii	+	+	
Trithurin culate and			
I nuturia subinersa	+ +		
Hypoxidaceae			
Hypoxis glabella var. glabella		+	
Hypoxis occidentalis	+	+	
Iridaceae			
* Gladiolus angustus	+		
Orthrosanthus laxus var. laxus		+	
Patersonia juncea		+	
Patersonia occidentalis		+	
Patersonia umbrosa var. umbrosa		+	
* Komulea rosea	+	+	
* Watsonia bulbillifera		+ +	
Juncaceae			
* Juncus bufonius	+	+	
* Juncus capitatus	+	+	
Juncus holoschoenus		+ +	
Juncus meianthus		+	
Juncus pallidus		+	
Juncus pauciflorus		+ +	
Juncus subsecundus		+ +	
Luzula meridionalis		+	
Juncaginaceae			
Triglochin centrocarpum	+		
Triglochin lineare	+		
Lamiaceae			
Hemiandra pungens var. pungens		+	
Hemigenia incana		+	
* Mentha pulegium		+	
* Prunella vulgans		+	
Lauraceae			
Cassytha glabella	+	+	
Cassytha micrantha	+		
Cassytha pomiformis		+	
Cassytha racemosa		+	

Lentibulariaceae					
Polypompholyx multifida	+				
Polypomphylx tenella	+				
Utricularia menziesii	+				
Linaceae					
Linum marginale			+		
* Linum trigynum			+		
Lindsaeaceae					
Lindsaea linearis		+	ц		
Lobeliaceae		'			
Isotoma hypocrateriformis			Т		
Lobelia alata var alata			т 	-	
Lobelia gibbosa			т	т 	
Lobelia rhombifolia				т	
Loganiaceae			т		
Logania camponulata					
l ogania serpullifolia suben serpullifolia			+		
Mitrasacme paradova			+		
I oranthaceae	+		+		
Amvena miquelii					
Nutrio floribur de			+		
Lycopodiageo			+		
Dhulloglommer day					
Malyagas		+			
Side hereiter i					
Sida nookenana	+			+	
Menyanthaceae					
Villarsia calthifolia	+			+	
Villarsia marchantii				+	
Villarsia parnassifolia			+		
Mimosaceae					
Acacia applanata			+		
Acacia baxteri			+		
Acacia biflora			+		
Acacia browniana var. intermedia			+		
Acacia cochlearis	+		+		
Acacia crispula			+		
Acacia dealbata warr			+	+	
Acacia drummondii ssp elegans					
(Porongurups variant)	+		+	+	
Acacia enervia			+		
Acacia extensa		+			
Acacia heteroclita subsp. valida ms	+				
Acacia leioderma			+		
Acacia luteola			+		
Acacia myrtifolia		+	+	+	
Acacia pulchella		+	+		
Acacia saligna		+	+		
Acacia spectabilis ms			+		
· · · · · · · · · · · · · · · · · · ·					

Acacia subcaerulea			+		
Acacia urophylla				+	
Acacia willdenowiana		+			
Parasenanthes Jophantha	+	•		+	
Myoporaceae					
Myoportup tetrandrum				т.	
Myrtaceae				т	
Agonic hypericifelie					
Agonis linearifolia			+		
Agonis incaritona	+			+	
Agonis parviceps			+		
Astartea rascicularis			+		
Beautortia anisandra		+	+		
Beaufortia empetrifolia			+		
Beaufortia heterophylla			+		
Beaufortia micrantha			+		
Beaufortia sparsa		+			
Corymbia calophylla			+	+	
Calothamnus gracilis		+			
Calothamnus lehmannii			+		
Calothamnus quadrifidus			+		
Calytrix asperula			+		
Calytrix similis			+		
Darwinia citriodora			+		
Darwinia ocderoides					
Darvinia vestita			т - т	т.	
Fucalizatus corputa			т	т	
Eucalyptus connitia	+				
Eucalyptus dicipieris			+		
Eucarypius urveisicolor				+	
Eucalyptus marginata			+		
Eucalyptus megacarpa	+				
Eucalyptus tetragona		+			
Homalospermum firmum		+			
Hypocalymma cordifolium		+			
Kunzea micrantha subsp. oligomera			+		
Kunzea preissiana			+		
Kunzea recurva			+		
Kunzea sulphurea		+			
Leptospermum spinescens		+	+		
Melaleuca blaeriifolia	+				
Melaleuca densa	+		+		
Melaleuca depauperata			+		
Melaleuca incana subsp tenella		+			
Melaleuca preissiana			+		
Melaleuca scabra			т Т		
Melaleuca suberosa			T		
Melaleuca subfalcata		+	+		
Melaleuca thymoides			+		
Periorlummo allinticum			+		
rencarymina empticum		+			

	Thryptomene saxicola	+			
	Verticordia densiflora		+		
	Verticordia sieberi var. Iomara				
0	lacaceae		т		
	Olax phyllanthi				
0	nagraceae		+	+	
Č	Epilobium billardianonum subsp. sin structure				
	Epilobium birtigerum			+	
റ	nhioglossaceaa			+	
0	Ophioglossum lusitaniaum				
0	rchidaceaa	+			
0	Caladania broumii				
	Caladonia asimaiana		+		
	Caladenia d'Isc.		+		
	Caladenia dilatata		+		
	Caladenia ensata		+		
	Caladenia flava	+ +	+		
	Caladenia heberleana		+		
	Caladenia huegelii		+		
	Caladenia latifolia		+		
	Caladenia lobata		+		
	Caladenia longicauda ssp. eminens		+		
	Caladenia longiclavata		+		
	Caladenia macrostylis		÷.		
	Caladenia menziesii	+			
	Caladenia nana subsp nana	+ +	1		
	Caladenia plicata	Ŧ	- T		
	Caladenia rentans		+		
	Caladenia reptans		+		
	Corrybos tocuration	+	+		
	Cruptostulia quata			+	
	Curtostulis huogalii	+	+		
	Division and the function		+	+	
	Diuris amplissima		+		
	Diuris laevis		+		
	Diuris laxiflora		+		
	Diuris longifolia	+	+		
	Diuris setacea	+	+		
	Drakaea glyptodon		+		
	Drakaea livida		+		
	Elythranthera brunonis		+	+	
	Elythranthera emarginata		+		
	Eriochilus dilatatus		+		
	Eriochilus scaber subsp. scaber		+		
	Leporella fimbriata		+		
	Lyperanthus nigricans	*	+	+	
	Lyperanthus serratus				
	Microtis alba		т _		
	Microtis media		T		
×	Monadenia bracteata	- -	+		
	Monaucina Diacteata	+ +	+		

	Paracaleana nigrita			+		
	Praecoxanthus aphyllus			+		
	Prasophyllum brownii			+		
	Prasophyllum elatum			+		
	Prasophyllum fimbria			+		
	Prasophyllum hians			+		
	Prasophyllum oyale			+		
	Prasophyllum parvifolium			÷.		
	Prasophyllum regium			4		
	Pterostylis aff nana	+				
	Pterostylis barbata	т				
	Pterostylis papa	+		т		
	Prorostylis rocurvo	+				
	Ptorostylis licturva			+		
	The large item as maining			+		
	Thelymitra comicina			+		
	Thelymitra chnita			+		
	Thelymitra flexuosa			+		
	Thelymitra fuscolutea			+		
	Thelymitra mucida			+		
	Thelymitra nuda			+	+	
	Thelymitra pauciflora	+			+	
0	robanchaceae					
*	Orobanche minor		+	+	+	
0	xalidaceae					
*	Oxalis caprina				+	
	Oxalis perennans	+		+	+	
*	Oxalis pes-caprae				+	
×	Oxalis purpurea				÷.	
*	Oxalis violacea					
Pa	pilionaceae				т	
	Bossiaga linonhylla					
	Rossinga ornata			+		
	Recipeo prostormiceo			+		
	Prochuseria conference		+	+		
	Brachyserna serie condetana			+		
	Galliata alum 1		+		+	
	Callistachys lanceolata			+	+	
	Chorizema aciculare			+		
	Chorizema carinatum			+		
	Chorizema cordatum			+		
	Chorizema diversifolium			+		
	Chorizema nanum			+	+	
	Chorizema rhombeum			+		
*	Cytisus proliferus				+	
	Daviesa incrassata ssp. reversifolia			+		
	Daviesia cordata			+		
	Daviesia decurrens			+		
	Daviesia flexuosa			+		
	Daviesia horrida			+		

Taxon Name	GR	SW	JA	KA	
* Dipogon lignosus			+		
Eutaxia densifolia			+		
Eutaxia obovata	+				
Gastrolobium stenophyllum		+			
Gompholobium amplexicaule			+		
Gompholobium confertum			+		
Compholobium knightianum			+		
Compholobium marginatum			+		
Gompholobium ovatum	+		+		
Compholobium polymorphum			+		
Gompholobium preissii		+	+		
Gompholobium scabrum		+	+	•	
Hardenbergia comptoniana	+		+		
Hovea chorizemifolia			+		
Hovea elliptica			+	+	
Hovea trisperma			+		
lsotropis cuneifolia			+		
Jacksonia condensata				+	
Jacksonia spinosa			+		
Kennedia coccinea	+		+		
Kennedia microphylla			+		
Kennedia prostrata			+		
 * Lablab purpureus 				+	
Latrobea hirtella		+	+		
* Lotus suaveolens			+	+	
Mirbelia dilatata				+	
 * Ornithopus compressus 	+			+	
 * Ornithopus pinnatus 	+			+	
 * Psoralea pinnata 			+		
Pultenaea obcordata			+		
Pultenaea reticulata		+	+		
Pultenaea strobilifera		+	+		
Sphaerolobium linophyllum			+		
Sphaerolobium medium		+			
Sphaerolobium nudiflorum			+		
* Trifolium campestre			+	+	
* Trifolium cernuum	+			+	
 Trifolium dubium 	+	+			
* Trifolium subterraneum	+		+		
Viminaria juncea			+	+	
Philydraceae					
Philydrella pygmaca			+		
Phormiaceae					
Dianella brevicaulis		+	+		
Dianella revoluta var. revoluta			+		
Stypandra glauca	+				
Pittosporaceae					
Billardiera floribunda			+		

	Billardiera granulata	+			+	
	Billardiera variifolia			+		
	Sollya heterophylla	+		+	+	
Pl	antaginaceae					
	Plantago debilis	+			+	
*	Plantago lanceolata	+		+	+	
Po	baccae			•	·	
	Agrostis ?avenacea GIK11314	+				
	Agrostis avenacea	+				
*	Aira carvophyllea	T 				
*	Aira cupaniana					
	Amphipoton amphipotonoide	+	+	Ŧ		
	Amphipogon turbingtus				+	
*	Ampripogon turbinatus			+		
*	Antrioxanunum odoratum				+	
X	Avena barbata	+				
-74°	Briza maxima	+				
*	Brizaminor	+		+	+	
*	Bromus diandrus	+	+			
*	Bromus hordeaceus subsp. hordeaceus			+		
	Danthonia caespitosa	+		+		
	Deyeuxia drummondii	+				
	Deyeuxia quadriseta	+				
	Dichelachne crinita			+		
*	Holcus lanatus	+	+	+		
¥	Hordeum leponnum		÷	+		
*	Lolium rigidum					
	Microlaena stinoides	Ŧ		- -		
	Neurochne alongeuroidea			+		
*	Postpolum dilatatum			+		
*	Pos appus			+		
	Pos de une en d'ana	+		+		
	Poi drummondiana			+		
	Poa poirormis	+				
	Poaserpentum		+	+		
*	Schismus barbatus	+				
*	Sporobolus indicus	+				
	Stipa compressa	+		+		
	Stipa semibarbata			+		
	Stipa trichophylla				+	
	Tetrarrhena laevis			+		
×	Vulpia bromoides					
*	Vulpia invuros			T		
Po	lygalaceae			+		
	Comesperma calumera					
	Comesportine vignet im			+		
Pol	viganacona		+	+		
*	Dumov acotocalla	•				
*	Numex acclosella	+		+	+	
D	Rumex conglomeratus				+	
ro	runacaceae					

Taxon Name	GR	SW	JA	KA	
Calandrinia calyptrata	+				
Calandrinia granulifera	+				
Primulaceae					
 * Anagallis arvensis var. arvensis 	+				
 * Anagallis arvensis var. caerulea 	+		+	+	
Proteaceae					
Acidonia microcarpa		+			
Adenanthos apiculatus		+	+		
Banksia attenuata			+		
Banksia gardneri var. gardneri			+		
Banksia grandis			+		
Banksia littoralis			+		
Banksia sphaerocarpa var. sphaerocarpa			+		
Conospermum caeruleum ssp. adpressum			+		
Conospermum caeruleum ssp. caeruleum			+		
Conospermum capitatum subsp velutinum			+		
Concspermum multispicatum			+		
Dryandra armata			+		
Dryandra conferta			+		
Dryandra formosa			+		
Dryandra nervosa		+	+		
Dryandra nivea			+		
Dryandra seneciifolia			+		
Franklandia fucifolia			+		
Grevillea brownii			+		
Grevillea depauperata			+		
Grevillea diversifolia subsp. subtersericata			+		
Grevillea fasciculata			+		
Grevillea pulchella			+		
Grevillea trifida			+		
Hakea amplexicaulis			+		
Hakea corymbosa			+		
Hakea falcata			+		
Hakea florida			+		
Hakea prostrata			+		
Hakea ruscifolia			+		
Hakea trifurcata			+		
Hakea undulata			+		
Hakea varia			+		
Isopogon attenuatus			+		
Isopogon formosus			+		
Isopogon longifolius			+		
Isopogon polycephalus			+		
Isopogon sphaerocephalus			+		
Persoonia elliptica			+		
Petrophile acicularis		+			
Petrophile divaricata			+		
Petrophile diversifolia			+		
recoprine arreion one					

					_
Petrophile longifolia			+		
Petrophile rigida		+	+		
Petrophile serruriae			+		
Petrophile teretifolia			+		
Stirlingia simplex		+			
Stirlingia tenuifolia		+	+		
Synaphaea favosa					
Synaphaea petiolaris subsp. petiolaris					
Synaphaeu periorans subsp. periorans					
Synaphea reticulata			T		
Ranunculaceae			т		
Clematic pubecene					
Ranunculus colonorum			+	+	
Rectionaceae	+			+	
A parthria gracilis					
Anarthna gracins		+	+		
Anarthnia humins	+	+	+		
Anarthnia laevis		+			
Anarthna proluera			+		
Harperia laterifiora			+		
Hypolaena exsulca			+		
Lepidobolus chaetocephalus			+		
Leptocarpus tenax		+			
Lepyrodia drummondiana			+		
Lepyrodia hennaphrodita	+		+		
Lepyrodia monoica		+		+	
Loxocarya fasciculata		+	+		
Loxocarya pubescens		+	+		
Lyginia barbata		+			
Restio laxus			+		
Restio tremulus		+			
Rhamnaceae					
Cryptandra arbutiflora		+			
Spyridium spadiceum	+	·		+	
Trymalium floribundum var triflorum				+	
Trymalium ledifolium var. rosmannifolium			+		
Rosaceae					
* Acaena echinata			+	+	
* Prunus cerasifera				÷.	
* Rosa canina			-		
* Rost moschatum			т	+	
* Rubus ulmifolius				- T	
Rubiaceae	+		+	+	
* Calium divarientum					
* Calium murple			+	+	
Opercularia aniciflore	+				
Opercularia bispidula			+		
Opereularia inspirinta	+			+	
Opercularia vaginata			+		
Opercularia volubilis	+			+	

Taxon Name	GR	SW	JA	KA	
Rutaceae					
Boronia crenulata	+		+	+	
Boronia heterophylla		+			
Boronia molloyae				+	
Boronia ramosa subsp. anethifolia			+		
Boronia spathulata			+		
Crowea angustifolia var. angustifolia			+		
Phebalium anceps		+			
Santalaceae					
Leptomeria pauciflora			+		
Leptomeria squarrulosa			+		
Sapindaceae					
Dodonaea ceratocarpa	+				
Scrophulariaceae					
* Bellardia trixago	+		+	+	
Gratiola peruviana			+		
* Parentucellia latifolia	+				
* Parentucellia viscosa	+		+	+	
* Verbascum virgatum				+	
* Veronica arvensis			+	+	
Veronica calvcina			+		
Veronica plebeia			+		
Selaginellaceae					
Selaginella gracillima	+				
Solanaceae					
* Solanum nigrum	+		+	+	
Stackhousiaceae					
Stackhousia pubescens			+		
Stackhousia scoparia			+		
Tripterococcus brunonis			+		
Sterculiaceae					
Rulingia corvlifolia	+				
Rulingia craurophylla			+		
Rulingia grandiflora			+		
Rulingia platycalyx				+	
Thomasia foliosa			+		
Thomasia paniculata			+		
Thomasia purpurea			+		
Thomasia tenuivesta				+	
Stylidiaceae					
Levenbookia dubia	+				
Levenbookia pusilla	+		+		
Stylidium adnatum			+	+	
Stylidium amoenum			+		
Stylidium breviscapum			+		
Stylidium brunonianum subsp. minor			+		
Stylidium calcaratum	+		+		
Stylidium corymbosum var proliferum	+				

Stylidium crassifolium			+		
Stylidium guttatum	+				
Stylidium junceum subsp. brevius		+			
Stylidium petiolare	+	+			
Stylidium repens var. repens			+		
Stylidium spathulatum subsp. spathulatum			+		
Stylidium spinulosum subsp. spinulosum		+	+		
Thymelaeaceae					
Pimelea angustifolia		+			
Pimelea ciliata subsp. ciliata			+		
Pimelca hispida		+			
Pimelea imbricata var. imbricata	+				
Pimelea lehmanniana subsp. lehmanniana			+		
Pimelea longiflora subsp. longiflora		+	+		
Pimelea rosea			+		
Pimelea suaveolens var. suaveolens	+				
Pimelea sulphurea			+	+	
Tremandraceae					
Tetratheca affinis			+		
Tetratheca nuda			+		
Tremandra diffusa	+		+		
Tremandra stelligera			+		
Ulmaceae					
* Ulmus procera				+	
* Poplus alba				+	
Valerianaceae					
* Centranthus ruber				+	
Violaceae					
Hybanthus floribundus subsp. floribundus			+		
Xanthorrhoeaceae					
Xanthorrhoea gracilis	+		+		
Xanthorrhoea platyphylla		+	+		

A STUDY OF THE LAUGHING TURTLE-DOVE STREPTOPELIA SENEGALENSIS IN PERTH, WESTERN AUSTRALIA

By R.H. STRANGER 28/76 East street, Maylands, W.A.,6051

INTRODUCTION

The Laughing Turtle-Dove Streptopelia senegalensis was introduced to Western Australia from the South Perth Zoological Gardens in 1898 and there were additional introductions in the following years (Serventy and Whittell 1976; Storr and Johnstone 1988).

Preliminary studies of the dove were made by Sedgwick (1958,1965,1976). Heshows that it extended its range from the metropolitan area of Perth far into the country and discusses some ecological factors.

Since then it has continued to sustain itself in Perth's metropolitan suburbs and has extended its range congruently with Perth's expansion. At the same time it has extended its marginal range 500km into the South-West and 800km north to North-West Cape (Blakers et al. 1984). The same authors predict that it may spread into the pastoral areas. However it avoids the block of Jarrah Eucalyptus marginata forest to the east and south-east of Perth except where the forest has been opened up and settled. This is similar to the present range of several native.species : Nankeen Kestrel Falco cenchroides, Black-shouldered Kite Elanus axillaris, Magpie-lark Grallina cyanoleuca, Willie Wagtail Rhipidura leucophrys, Richard's Pipit Anthus novaeseelandiae, Grey Butcherbird Cracticus torquata and Australian Magpie Gymnorhina tibicen.

The House Sparrow Passer domesticus, Tree Sparrow Passer montanus, Starling Sturnis vulgaris and Common Myna Acridotheres trista do not occur in Perth. A few native seed-eaters do but they are largely arboreal species such as : Australian Ringneck Barnardius zonarius, Short-billed Black Cockatoo Calyptorhynchus latirostris and Little Corella Cacatua sanguinea, and they do not compete for food with the Laughing Turtle-Dove.

The dove's main ecological competition comes from the introduced Spotted Turtle-Dove Streptopelia chinensis, which is also well established but less numerous. The Domestic Pigeon *Columba livia* is mostly feral but largely avoids the housing areas that support both the turtle-doves.

Outside suburbia the Laughing Turtle-Dove may be in contact and compete with the native Peaceful and Diamond Doves Geopelia striata and G. cuneata. Marginally their respective ranges already overlap (Blakers *et al.* 1984). However the Laughing Turtle-Dove is primarily an inhabitant of cities, towns and settlements so that competition between the doves maybe fairly limited. Since 1956 the distribution of the Crested Pigeon Ocyphaps lophotes has overlapped that of the Laughing TurtleDove in Perth (Serventy and Whittell 1976) Since both are drawn to human habitations they could compete with one another.

Still, it is worth noting and recording the behaviour and ecology of the Laughing Turtle-Dove in Perth and trapping and banding of the species in Perth and further observations since Sedgwick (1958, 1965, 1976) allow me to present this further study.

TRAPPING

A variety of seed-baited drop door and automatic, funnel-entry traps were used, and because continuous trapping led to trap shyness, I found it best to free-feed for short periods, before setting the traps again. This still allows the observation of colour banded birds. Cats can be a problem with unattended traps and especial care in hot weather was necessary.

The only injuries were the loss of feathers and mild abrasions to the forehead and under-shoulder. Many birds had unnatural moults ie. tufts of body feathers and or quills torn out or regrowing, due to normal hazards and predation.

BANDING DATA

The Jersey Street Station.

This station operated intermittently between December 1960 and April 1965. Of 221 birds trapped, banded and released there 48 (22%) were retrapped 91 times, which is an average of 1.9 retraps per bird retrapped. Twelve birds (5.4%) were recovered away from the station (see Table 1).

The Salvado Road Station.

This station operated continuously between September 1960 and December 1961. Of 148 birds trapped, banded and released there 46 (31%) were retrapped 103 times, which is an average of 2.2 retraps per bird retrapped. Fourteen birds (9.5%) were recovered away from the station (Table 1).

The Caporn Street Station.

This station operated intermittently between August 1959 and April 1965. Of 605 birds trapped, banded and released there 197 (33%) were retrapped 356 times, which is an average of 1.8 retraps per bird retrapped. Twenty-nine birds (4.7%) were recovered away from the station (Table 1).

 Table 1. Number of individual Laughing Turtle-Doves trapped at each of the three trapping stations and the number of recaptures. Dates for trapping stations are listed in text under Banding Data.

Trapping Station	No of Individuals Trapped	No. of Individuals Retrapped	No. of Times Retrapped	No. of Recoveries
Jersey Street Xii/60 – iv/65	221	48	91	12
Salvado Road Ix/60 – xii/61	148	46	103	14
Caporn Street Viii/59 –iv/65	605	127	356	29
Total	974	291	550	55

Of 974 birds trapped, banded and released at the three stations 291 (30%) were retrapped 550 times, which is an average of 1.9 retraps per bird retrapped. Fifty-five birds (5.6%) were recovered away from the stations (Table 1).

SEDENTARY NATURE AND HOMING ABILITY

The sedentary nature of the adults in Perth was revealed by Stranger (1968). Of 57 adult recoveries away from the banding stations 39 (68%) were recovered within 0.4km of their banding places, 46 (81%) were recovered within 0.8km, 52 (91%) were recovered within 1.6km, 54 (95%) were recovered within 3.2km and 57 (100%) were within 10km. The juveniles did not differ greatly.

Also, though the Salvado Road and Jersey Street stations were only 0.5km apart, none of the Salvado Road birds were trapped or seen at or recovered near the Jersey Street station, and vice versa. This would seem to indicate that the birds only feed at or near their banding places.

Homing experiments (Stranger 1968) showed that adults transported up to 160km from their banding places had the urge and ability to return home through strange and unknown country i.e. the forest and wheatbelt east of Perth.

A juvenile bird which was trapped, banded and released at the Salvado Road station was retrapped there four times in the next six months. It was then exhibited for one week in a wildlife show in central Perth, 5km from Wembley, and was released there afterwards. One and a half years later it was trapped at the Caporn Street station, 5km from Perth, and subsequently homed to that station from distances of 100km and 160km.

EXTENSION OF RANGE

It is probable that the juveniles are primarily responsible for extending the species' range in W.A. (Blakers et al. 1984) but Morris et al. (1994) observed two adults arrive (and perish ?) on Bernier Island, 40km west of Carnarvon. But the situation probably parallels that of the Collared Turtle-Dove Streptopelia decaocto in which the adults are also very sedentary and the juveniles disperse extensively (Derek Goodwin pers. comm.). However my data does not support this for the juvenile Laughing Turtle-Doves in Perth, for the majority were recovered in the vicinity of their banding places and at distances similar to those of the adults.

RACE AND PLUMAGE

Derek Goodwin judged that specimens collected in Perth in 1965 could be matched with specimens from East Africa, south of the Sahara. This is the nominate race *Streptopelia senegalensis senegalensis* (Serventy and Whittell 1976; Storr and Johnstone 1988).

However Derek Goodwin (pers. comm.) now judges that all the Laughing Turtle-Doves on mainland Africa south of the Sahara are best considered as *S.s.senegalensis* and the specimens collected in Perth are inseparable from those of Africa.

In Perth the richness of the plumage varies considerably and the sexual differences may be masked by it. The colours of the soft parts also vary considerably. A small number of birds had a melanistic tone to the plumage, it varying from brown to dark brown. This may be dietary induced melanism (Derek Goodwin pers. comm.). One bird had very distinct whitish eyebrows

A female bird which was hand-reared and kept in captivity begun egg-laying at 7.5 months of age (C.A. Nicholls pers. comm.) and at that age the bird's breast was fully spotted, the spots having established themselves at random on the breast. This latter is my observation and conclusion too.

STATISTICS

Some measurements are given in Table 2.

FOOD

In Perth the Laughing Turtle-Dove prefers small seeds such as pannicum and white millet but readily eats wheat and will even eat such large seeds as maize. In Egypt Derek Goodwin (pers. comm.) observed first-hand that the species fed on small wild seeds but that numbers of the birds scavenged maple peas and maize from around the Army pigeon lofts. Goodwin (1970) states that "much of the natural food consists of very small seeds of various wild plants".

Goodwin (1978) says that the Laughing Turtle-Dove is a common bird in African villages where it usually feeds partly on grains, usually various millets, spilled by Man. Blakers *et al.* (1984) state that it will feed on crops of small grain.

Thus the species is well suited to take advantage of the seeds from Perth's flora, both native and exotic, and the gardens of the houses and public places are extensively and intensely foraged over. One dead bird found by the roadside in Wilson in the early 1970s had in its crop 134 grains of wheat, 20 portions of wheat, several very small "poppy seeds" and two other seeds. A bird trapped at the Caporn Street station had its crop filled with pannicum seed. It was weighed upon capture and held in a small cage overnight. When weighed next morning it was 13gm lighter (118gm - 105gm)]. a weight loss of 11%.

The species will strip unripe seeds from the Winter Grass *Poa annua* and forages extensively over Perth's lawns, the

	Sample No	Range (cm)	Average (cm)
Body Length	101	23.0 - 27.5	25.5
Tail Length	71	9.8 - 12.5	11.3
Wing Length Wing Span Culmen Tarsus MT & C	164	12.0 - 14.5 35.5 - 42.5 1.3 -1.6 1.9 - 2.5 2.3 - 2.8	13.4
Weight (gm)	94	81 gm- 118 gm	101.5 gm.
			0

Table 2. Measurements of some of the adult Laughing Turtle-doves trapped.

The measurements shown in Table 2 were taken from live birds. Allowance was made for quill wear, which can be substantial (0.5 cm - 0.75 cm). The wing span data is a best fit measurement.

Generally the lower weights were recorded from birds which had no seed visible in their crops, and the birds with the higher weights had at least some seed in their crops (see Food).

latter of which has also been observed in Cairo, Egypt, by Derek Goodwin (1978). Most Perth lawns are either couch or buffalo grasses, are regularly mowed and the seeds from nearby plants find their way onto them.

The dove also feeds on seeds which are released from their fruits by vehicular traffic, such as happens on roadways and parking lots, and Goodwin (1978) has also observed this type of foraging in the Collared Turtle-Dove in England. I have also seen it in the Peaceful Dove at Townsville, Queensland.

The Laughing Turtle-Dove will eat mill offings such as bran and the various mashes fed to poultry, both in commercial and domestic situations. It learns to eat wet bread and will scavenge for scraps and breadcrumbs at bakeries, shopping centres, outdoor dining tables and beer gardens.

It will also range onto oceanic beaches where it will forage, presumably, for the seeds of plants such as the Strand Daisy *Arctotheca nivea*, as does the Spotted Turtle-Dove (Stranger 1969).

ECOLOGICAL COMPETITION

The introduced Spotted Turtle-Dove competes for food and situations with the Laughing Turtle-Dove but though the former is well established it is less common. Another factor is that the Spotted Turtle-Dove largely confines itself to the more mature gardens with their abundant shelter and denser foliages, which are in the older suburbs. In Perth Goodwin (1978) has made this assessment too. The Laughing Turtle-Dove however will range into areas with sparser vegetation, such as the newer housing areas and industrial installations. In Perth Goodwin (1978) independently made this assessment too and notes that though it seems to be a bird of arid areas, it needs some source of water nearby (Goodwin 1970).

The Laughing Turtle-Dove can occupy areas with either dense or sparse vegetation and it will rest in very exposed situations such as on dead and leafless branches and power lines.

The two species will feed together where food is plentiful but the Spotted Turtle-Dove, being the larger of the two, will bully the Laughing Turtle-Dove and chase it away from food. Overall it seems that competition from the former does not limit the latter much. It does seem however that the former has an advantage over the latter and selects and occupies those habitats and areas that it wants to, and that in Perth the Laughing Turtle-Dove simply occupies the remaining habitat, though the two species range together.

In the early 1960s C.A.Nicholls set up a bird hospital in Dalkeith and the ratio of Spotted Turtle-Doves to Laughing Turtle-Doves presented to her then was 1:20. Twenty-five years later, in the mid-1980s, the ratio had changed to 3:20. This is due to the vegetation of the inner, and older, suburbs of Perth becoming more mature with denser foliages, these areas now providing the Spotted Turtle-Dove with additional suitable habitat.So the Spotted Turtle-Dove is becoming more abundant at the expense of the Laughing Turtle-Dove.

The introduced Domestic Pigeon, which is fairly common in Perth's metropolitan area, also competes with the Laughing Turtle-Dove - and the Spotted Turtle-Dove – for food such as wheat and that found in the public gardens. The three species can also be seen feeding near each other in parks and gardens but the Domestic Pigeon rarely ranges into the gardens of the housing areas and does not threaten the survival of the two turtle-doves in Perth. Being the largest however it will bully the turtle-doves and chase them away from food.

MORTALITY

Motorised vehicles cause some death and injury to the Laughing Turtle-Dove in Perth because the birds feed on the roads, verges and footpaths, and fly low over them. The Domestic Cat preys extensively on it and C.A.Nicholls (pers. comm.) estimates that two-thirds of the doves presented to her bird hospital had been mauled to some degree by cats. It is probable though that of the deaths and injuries ascribed to cats some had first been injured or killed in other ways e.g. by a motor vehicle.

It is also possible that some doves die after eating food which has been poisoned by sprays and dusts in domestic gardens. Such an incident occurred on a poultry farm where I was working in 1958. The area had been sprayed to eradicate the Argentine Ant and several dead Laughing Turtle-Doves and a few Spotted Turtle-Doves were found around the farm the following day and during the next week.

Predation by hawks takes place but there are few records. Calderwood (1954) observed predation by a Swamp Harrier Circus approximans and both C.A.Nicholls and myself have independently witnessed predation by the Brown Goshawk Accipiter fasciatus. I have also witnessed attempted predation by the Little Falcon Falco longipennis but though the falcon struck the dove it did not maim or kill it and the dove flew away strongly, even if with a few less feathers.

At Dalkeith C.A.Nicholls (pers.comm.)

has often seen the introduced Brown Kookaburra *Dacelo gigas* prey on this dove's nestlings and it was in fact a regular occurrence. Mueller (1991) observed predation of this dove's nestlings by the Grey Bucher-bird.

Eggs and nestlings thrown out of nests and "fledgling" juveniles which seem to have left the nest prematurely are common in Perth, and the situation is mostly due to very strong winds, many of the nests being simple rafts built in unsafe situations.

LONGEVITY

The oldest birds recovered by the public were of the following banded ages: 7 years 8 months, 6 years 8 months, 5 years 6 months, 4 years, 3 years 8 months, 3 years 5 months, 3 years 3 months (two birds), 3 years 2 months (two birds) and 3 years (two birds). As all the birds were in adult plumage when banded their real ages would be six months greater.

BREEDING

Storr and Johnstone (1988) define the breeding season of this dove locally as July to March, but nestlings were presented to C.A.Nicholls' bird hospital throughout the year. Numbers were at a peak in spring, a lesser peak in autumn and at a minimum during the cold and wetmonths of winter.

Goodwin (1970) states that the species will nest in and on buildings and it will nest in artificial situations locally. Birds may even nest in exposed situations such as the cross arms of power poles and the ledges of buildings. A few nests were within one and one-half metres of the ground.

A female bird that was hand reared (see

Race and Plumage) and kept in captivity begun egg-laying at 7.5 months of age and by the time it died at 7.5 years of age it had laid 120 eggs: 17 per year. However each egg was removed from it when laid (C.A.Nicholls pers. comm).

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REFERENCES

BLAKERS, M., DAV1ES, S.J.J.F., & REILLY, P.N. 1984. The Atlas of Australian Birds, Royal Australasian Ornithologists Union, Melbourne University Press.

CALDERWOOD, D. 1954. Swamp Harrier preying on the Senegal Dove. W.A.Nat. 4:p145.

GOODWIN, D. 1970. Pigeons and Doves of the World. Publication 663. Trustees of the British Museum [Natural History], London, pp143–144.

GOODWIN, D. 1978. Birds of Man's World. British Museum [Natural History], Cornell University Press, London.

MORRIS, K., SPELDEWINDE, P. & ORELL, P. 1994. A new bird record for Bernier Island, Shark Bay. W.A. Nat. 19:p351.

MUELLER, O. 1991. Nest predation by the Grey Butcher-bird. W.A. Nat: 18:p235.

SEDGWICK, E.H. 1958. The introduced turtledoves in Western Australia. *W.A.*.*Nat*. 6:p22.

SEDGWICK, E.H. 1958. The introduced turtle-doves in Western Australia – 2. W.A. Nat. 6:p112.

SEDGWICK, E.H. 1965. Supplementary notes on the introduced turtle-doves in Western Australia. W.A. Nat. 9:p153.

SEDGWICK, E.H. 1976. Supplementary notes on turtle-doves, *Streptopelia*, in Western Australia. W.A. Nat. 13:p173.

SERVENTY, D.L., & WHITTELL, H.M. 1976. Birds of Western Australia, University of W.A. Press, Perth, W.A.

STORR, G.M. & JOHNSTONE, R.E. 1988. Birds of the Swan Coastal Plain and adjacent seas and islands. *Rec. West. Aust. Mus.* Suppl. No 28.

STRANGER, R.H. 1961. Homing performances by Senegal Doves. *W.A. Nat.* 7:p190.

STRANGER, R.H. 1968. A study of homing performance in the Senegal Dove. W.A. Nat. 11:p4.

STRANGER, R.H. 1969. Indian Doves feeding on the beach at Mandurah. W.A. Nat. 11:p66.

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FOOD OF THE FOREST RED-TAILED BLACK COCKATOO CALYPTORHYNCHUS BANKSII NASO IN SOUTH-WEST WESTERN AUSTRALIA

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ABSTRACT

The principal foods of the Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso in south Western Australia are the seeds of Marri Corymbia calophylla and Jarrah Eucalyptus marginata. Of these, Marri is the most important especially during the breeding season in October-February. Other less important foods in northern forests include Snottygobble Persoonia longifolia, Common Sheoak Allocasuarina fraseriana, Blackbutt Eucalyptus patens and in southern forests, Albany Blackbutt E. staeri and Karri E. diversicolor. Although some Marri and Jarrah seed is available all year, the flowering and subsequent fruiting of both species varies between years on about a 4-6 year cycle. Preliminary results from this study suggest that variations in the extent of flowering and nutting may determine the numbers of birds which attempt to breed.

INTRODUCTION

Red-tailed Black Cockatoo The Calyptorhynchus banksii is widely distributed within Australia. Five subspecies are currently recognised three of which occur in Western Australia (Figure 1) namely: C. b. macrorhynchus occurring throughout the Kimberley; C. b. samueli found in the arid and semiarid northern and north-eastern interior (i.e. Pilbara, Gascoyne, northern Wheatbelt and Goldfields); and C. b. naso inhabiting the south-western humid and sub-humid zones (mainly the tall eucalypt forests). Ford (1980) and Johnstone and Storr (1998).

The Kimberley subspecies macrorhynchus is generally common occurring in pairs and family parties and small flocks in forests and woodlands. Its range and status have not altered greatly in the Kimberley since European settlement. The mid-western subspecies samueli has greatly expanded its range south into the northern wheatbelt in the past 60 years. Whereas it was originally confined to northern watercourses including the Murchison, Irwin and Lockier Rivers, it is now most numerous in the northern and north-eastern wheatbelt especially the Eurardy, East Yuna, Three Springs / Perenjori,



Figure I. Distribution of Red-tailed Black Cockatoo in Western Australia.

Jibberding and Trayning / Mukinbudin districts, occurring in pairs, small flocks and occasionally large flocks up to 500. The introduced South African weed the Double-gee *Emex australis* has become a major food source for *samueli* in the wheatbelt. This together with the provision of watering points for livestock has enabled *samueli* to increase in numbers and spread south into what was previously unsuitable habitat.

Conversely the arboreal forest inhabiting subspecies *naso* has experienced a severe decline since European colonisation. Formerly it occurred north to Dandaragan (where there were once large stands of Marri); west to near Gingin (casually). Guildford (resident in colonial times but now rare or absent), Mundijong, Coolup, Lake McLarty and Goodale Sanctuary (16 km SW of Pinjarra) (presumably visitors from adjacent Darling Scarp), Wokalup, Big Brook (23 km west of Nannup), formerly to Vasse River, and Margaret River; and east to Mt Helena (formerly to Toodyay), Christmas Tree Well, North Bannister (formerly to Wandering). Mt Saddleback, formerly to the Kojonup district (where now only casual), Rocky Gully and upper King River (Figure 2). This forest cockatoo was formerly common throughout this historic range but is now rare to uncommon and



Figure 2. Distribution of C. b. naso in south-western Australia (showing present and former ranges).

Table 1. Moi food.	athly re	cords (1996	ó to eary 19	99) with 1	number o	f feeding	observatio	ons (obs) ai	nd total n	umber of	birds rec	orded fee	ling on eacl	-
	Jan. Obs. No	Feb. Obs. No	March Obs. No	April Obs. No	May Obs. No	June Obs. No	July Obs. No	Aug. Obs. No	Sept. Obs. No	Oct. Obs. No	Nov. Obs. No	Dec. Obs. No	Total Obs. Birds	
Marri	15 178	11 124	6 52	77 77	3 10	5 42	12 119	6 28	4	7 7R	6 120	14 113	0.0	1
Jarrah	5 66	7 54	5 63	6 65	8 134	18 75	6 60	3 11	6 53	- + -	8 35	11 83	CIT 78	
Blackbutt	I I	I	I I	1	I I	6.14	4 18	1	1	1 10	 	, c	13 81	
Allocasuarina	3 31	2 6	I I	1	1 8	1	- 1	1	1	. 1	-	5 I 1 I	5 10	
Snottygobble											-		2	
(Persoonia)	I I	I I	1	2 7	T T	8 15	2 9	I I	1	I I	1 J	1	12 31	
Spotted Gum	T T	I I	2 36	1 1	I I	1	ı I	1	1	1	1	1	1 C	
Banksia grandis	I I	I I	ı I	ı ı	2 2	i I	T T	I I	1	I I	1	1 I	1 C 2 C	
Cape Lilac Melia azederach	l L	I I	I I	ı I	l I	1	I I	1 9	I I	1	I I	I I	6	

patchily distributed within its current range that has become markedly reduced through clearing for agriculture. It occurs mainly in pairs or small family groups (3–5) and occasionally large flocks up to 200 have been recorded.

It is perhaps noteworthy that although this large cockatoo is one of the most conspicuous birds in the southern forests its fundamental biology is still poorly understood. Most of the information concerning the diet is anecdotal Storr (1991), Abbott (1998), Johnstone and Storr (1998). Since 1996 we have been studying the distribution, status, conservation and breeding biology of *naso* in south-western forests. The aim of this paper is to identify its main foods and feeding techniques.

MATERIALS AND METHODS

The cockatoos were studied at two main sites namely Bungendore Park (including Wungong Brook) and Jarrahdale (including the Serpentine area). Visits were also made to other areas in the south-west including Collie, Albany, Denmark, Manjimup, Nannup and Margaret River to gather information on distribution, status, diet and breeding etc. The vegetation at the two main study sites at Bungendore Park and Jarrahdale is similar being predominantly Jarrah Eucalyptus marginata and Marri Corymbia callophylla with an understorey of Bull Banksia Banksia grandis, Snottygobble Persoonia longifolia, Allocasuarina fraseriana and Dryandra spp. Both sites also contain scattered stands of Blackbutt Eucalyptus patens and Wandoo Eucalyptus wandoo.

Fieldwork was conducted mostly on a weekly basis commencing in 1996 and continuing to early 1999. Flocks were located in the study sites usually in late afternoon or early morning and, once
located, we recorded the locality, time, number of birds and flock composition, habitat and behaviour including feeding behaviour. The estimated total population in the Bungendore area is 70 birds and at Jarrahdale 100 birds. A total of 219 feeding observations were made in the main study sites (each



observation ranging from several birds to the majority of the flock) (see Table 1). Food trees were noted, food samples including discarded nuts were collected and in some cases photographed.

RESULTS

FOOD AND FOOD AVAILABILITY

The principal food in both study sites was Marri and Jarrah (see Table 1) comprising almost 90% of the diet. We made 96 observations with a total of 960 birds feeding on Marri and 87 observations with a total of 712 birds feeding on Jarrah. Other less important foods include Eucalyptus patens, Allocasuarina and Persoonia. There were two observations of two birds feeding on dead Banksia grandis, two observations with a total of 36 birds feeding on the seeds of the introduced Spotted Gum Eucalyptus maculata and one observation of 9 birds feeding on the seeds of the introduced Cape Lilac Melia azederach. All food was taken from the tree canopy with the Persoonia and Banksia being small understorey trees.

Birds were recorded feeding on Marri throughout the year (see Tables 1 and 2), however there was a strong seasonal shift between March and June from Marri to Jarrah and other foods. Flower and subsequent fruit production of both Marri and Jarrah varies between years on about a four to five year cycle (see tree ecology below and Table 2). Preliminary results indicate that the extent of flowering and nut production may determine the numbers of nesting birds in the subsequent breeding season. Although some seed of Marri and Jarrah is available all year, the cockatoos are extremely selective with respect to which trees they feed in and there may be large differences in seed quality, nutrient value, seed size and seed fill.

They are methodical feeders returning each day to the same tree until the food supply is exhausted. It was frequently noted that adjacent trees of the same species were untouched throughout this feeding activity, even after the 'favoured' tree was depleted. It is also noteworthy that Marri provides both a much larger seed and a heavier seed crop when compared to Jarrah and other foods. For example Marri nuts contain approx 5-6 times the seed mass compared to Jarrah. The seed weight in Marri is 0.113g v Jarrah 0.020g; seed length Marri 12.9 mm v Jarrah 4.5 mm; and seed width in Marri 7.2 mm v 3.0 mm (Abbott 1984). Additionally fewer Marri nuts contain no seed than is the case of larrah. Thus the work effort needed to open a Marri nut is justified. The abundances of the various foods and feeding location, technique and timing highlighted the importance of Marri and the birds' knowledge of their territory.

FEEDING TECHNIQUES

The method of feeding on Marri and Jarrah was distinctive and of use in plotting the occurrence of these cockatoos after they have fed in an area. A bird either nips off a nut within range of one position or nips off a branch (up to 300 mm long and 9 mm thick) with several nuts and then, while still holding the branch breaks off individual nuts. In either case it extracts and husks the seed from the nut with its bill. Leaves and other small stems are often also nipped off to allow easier access to nuts. On finishing, the branch is dropped to the ground. The ground beneath the tree becomes littered with chewed nuts, leaves and small branches with up to 70% of the ground beneath the canopy covered in nuts and leaves. Attention is often drawn to a feeding

party by the sound of hard nuts being cracked open and the continual stream of debris falling to the ground. When feeding in the outer foliage birds often pulled thin branches together for more secure footing and one female was seen to wedge herself into a fork with a spray of nuts in windy conditions.

Marri

Usually a bird bites off a tough woody nut and transfers it to the foot, almost invariably the left foot (but some birds are right footed). Marri nuts are large, thick and woody with measurements ranging from 25–45mm long and 20 x 40mm in width and birds will feed on green to hardened ripe nuts. The Marri nuts are opened in a number of ways (Figures 3 and 4) with individuals using one of the following techniques:

- 1. Holding the nut by the pedicel and chopping their way into the bowl (or hypanthium) from the rim.
- 2. Holding the rim of the nut and chopping in at the base of the hypanthium
- 3. Holding the nut at the rim or base and chopping in at the centre and rotating the nut in the foot anticlockwise.

Depending on the individual skill of the bird it takes about one-two minutes (0.38 - 2.45 minutes) to extract and husk the seed from a Marri nut. One adult male extracted seeds from five green nuts in 3.12 minutes. On one occasion an adult female was also observed taking (grabbing) opened nuts from her mate feeding alongside, taking them from his foot just as the seeds were exposed.

Jarrah

Jarrah nuts are held firmly in the foot or

manoeuvred in the bill (Figure 5) and the seed capsule is split open by the bill and the seeds extracted and husked at a rate of 2–5 nuts per minute (see Figure 6). One adult extracted seeds from 30 nuts in 8.20 minutes. In some cases however only half the seeds from each nut are extracted.

Allocasuarina

Allocasuarina cones are held in the foot, split down the centre with the bill, then rotated with the foot in order to extract and husk the seeds. Times recorded to extract and husk the seeds from Allocasuarina cones range from 30–36 seconds. The seeds of Allocasuarina are retained in the mature cones for only I– 2 months (January-February) and after this time very little seed remains for the cockatoos to harvest.

The fruits of the Snottygobble (*Persoonia*) are split down the centre and the tiny seed extracted. Birds feed very slowly on Snottygobble at the rate of about 2 fruits per minute and not all fruits are eaten. Often adults spending time pruning the outer branches as well as feeding. Spotted gum nuts are handled the same way as jarrah nuts.

Cape Lilac fruits are sometimes held in the foot but mostly sliced in half and seeds extracted with just the bill and tongue.

DAILY ACTIVITY PATTERNS

In both study areas the flocks spend the night roosting in tall straight trunked isolated stands of Jarrah-Marri-Blackbutt growing in a road side verge, edge of a paddock or at the edge of a forest block. The birds usually leave their night roosts at sunrise (ca. 05:00 Western Standard time) split into smaller family groups and move into adjacent forest. Our study flocks (with



Figure 3. Discarded green Marri nuts from one tree showing range of opening methods.



Figure 4. Discarded Marri nuts eaten by naso showing both base (top row) and rim (bottom rows) opening methods.



Figure 5. Female C. b. naso with Jarrah nut in bill.



Figure 6. Discarded Jarrah nuts eaten by naso.

some banded birds) were usually located within 1–4 km of the roost. After a short period of preening and sometimes basking in morning sunlight they began feeding, usually in Marri or Jarrah trees.

Feeding continued for up to 10-12 hours sometimes with short breaks to move to another tree, preen or clean the bill. Bill cleaning involves wiping the bill on dead branches or chewing into dead wood especially Jarrah and Banksia. At around 16:00 to 17:00 hrs birds would stop feeding, begin bill cleaning and preening, become more vocal and move off in small groups to drink at water in tree hollows, creeks. puddles, dams and troughs. Overall they have a preference for drinking at tree hollows and appear quite uncomfortable on the ground. On dark, the birds would return to the roost area.

This behaviour was repeated each day unless there was a marked change in the weather especially with heavy rain and strong winds. Under these conditions birds foraged less and remained more subdued in their behaviour. When breeding the female leaves the nest hollow once or twice a day to be fed by the male (by pump regurgitation). It takes immatures over a year to develop the skills necessary to extract seeds from Marri nuts and during this period they are constantly attended by both parent birds. Young birds must also learn which trees produce nuts with seed in order not to waste effort on seedless nuts.

ECOLOGY OF MARRI AND JARRAH

The flowering and subsequent nutting of Marri and Jarrah varies significantly from one year to the next. Marri flowers heavily on a five year cycle (P. Mawson pers. comm.). Buds are initiated in August or September, mature by January when flowering commences, develop

into nuts in March-December and the seeds dehisce from mature nuts in January-February of the third year. Overall taking about 17 months between initiation of buds and the shedding of seeds. At the end of this cycle trees which produce a heavy flowering and crop of nuts, are in poor condition with reduced leaves in the canopy and few new leaves. The resources used in producing such large flowers and nuts are so great that the tree requires another three years to recover enough to repeat the process. In any one year only about 20-50 percent of the trees produce a large nut crop. It is also noteworthy that a small proportion of Marri trees produce only male flowers and seedless fruits (Carr et al. 1981).

In Jarrah, flowering occurs every 4–6 years (Abbott and Loneragan 1986). Buds are initiated in December-January each year and if conditions are favourable they are retained and develop further, flowering between September and December. These flowers develop into nuts during the next year and mature in September. Seed is shed three months later in December-March taking overall 24–27 months from bud initiation to shedding seed.

CONCLUSIONS

Habitat destruction has clearly caused the Forest Red-tailed Black Cockatoos marked decline in south-western Australia. The extensive clearing of the Jarrah-Marri and Wandoo forest and woodland, largely for agriculture, has led to a loss of over one third of its original range. Land clearing has slowed greatly in recent years. Cockatoos are however long-lived and it is not clear whether this factor is masking a continuing decline in their overall populations. The birds are currently only patchily distributed throughout the southwestern forests. Judging from this study the cockatoos are relatively sedentary and could be extremely vulnerable to habitat loss and fragmentation. The two limiting factors in the birds' survival are food and suitable nest hollows. At present it would appear that the food supply in both study sites is adequate, however quality as well as quantity may be crucial (especially in breeding season). In this context further study is required as to why some trees are extensively cropped whilst others apparently at a similar stage are ignored. The cockatoos are highly dependent for food (and nest hollows) on Marri and to a lesser extent on Jarrah (R. Johnstone, unpublished data). Observations of flock movements, diet changes and breeding times appears to be coincident with the heavy nutting cycle of the Marri so food may be a limiting factor in breeding times. Breeding was only recorded in both study sites in October-December of 1995 and 1997 when both areas had a heavy Marri nut crop. It is also noteworthy that even in these two breeding years only some 10% of the flock in both study areas attempted (or appeared capable) of breeding. Further research into the breeding biology of this subspecies is in progress.

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REFERENCES

ABBOTT, I. 1984. Emergence, early survival, and growth of seedlings of six tree species in Mediterranean forest of Western Australia. Forest Ecology and Management 9, 51–66.

ABBOTT, I. 1998. Conservation of the forest red-tailed black cockatoo, a hollow-dependent species, in the eucalypt forest of Western Australia. *Forest Ecology and Management* 109, 175–185.

ABBOTT, I. and LONERAGAN, O., 1986. Ecology of Jarrah (*Eucalyptus marginata*) in the northern Jarrah forest of Western Australia. Bulletin No. 1 Department of Conservation and Land Management Perth, Western Australia.

CARR, S.G.M., CARR, D.J. and ROSS, F.L. 1981. Male flowers in eucalypts. Australian Journal of Botany 19: 73–83.

FORD, J. 1980. Morphological and ecological divergence and convergence in insolated populations of the redtailed black-cockatoo. *Emu* 80, 103–120.

JOHNSTONE, R.E. and STORR, G.M. 1998. Handbook of Western Australian Birds, Vol. 1. Non-passerines (Emu to Dollarbird), Western Australian Museum, Perth.

STORR, G.M. 1991. Birds of the Southwest Division of Western Australia. *Rec. West. Aust. Mus.* Suppl. **35**: 84–85.

THE VERTEBRATE FAUNA OF BENNETT BROOK AND SUCCESS HILL RESERVE, CAVERSHAM

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INTRODUCTION

Recent work especially that by the Western Australian Museum has illustrated the significance of urban bushland remnants to the survival of vertebrate fauna of the Perth region (How and Dell 1989, 1993, 1994, How *et al.* 1996, Harvey *et al.* 1997 and Cooper 1995). There is a relationship between size of remnant bushland and the number of species surviving with reserves as small as 4 ha having been shown to be important for faunal assemblages (Turpin 1990, 1991). However many species persist on even smaller reserves (Cooper 1995).

This study was initiated by the Success Hill Action Group (Inc.) to determine the vertebrate fauna of the small remnant of native bushland at Success Hill and the adjacent and contiguous Bennett Brook area northwards to Benara Road, in Caversham (Figure I).

STUDY AREA

Success Hill Reserve (Figure I) is vested with the Bassendean Town Council and occupies an elevated area overlooking the Swan River. It is bounded by the Swan River to the east and housing to the west. The area has been isolated by roads to the west for many decades but is contiguous with the riverine woodlands of Bennett Brook to the north. The study area is located at the interface of the Bassendean Dune System and the Pinjarra Plain (Keighery 1996) and consequently the soils are a mixture of sands and clayey silts. In the past, clay has been mined in several places.

Success Hill Reserve is situated on the Bassendean Dune System. It is a remnant Banksia woodland consisting of Candlestick Banksia, Banksia attenuata and Firewood Banksia, B. menziesii with an overstorey of Jarrah, Eucalyptus marginata. There is a shrub and heath understorey. The Swan River has a fringing forest of Flooded Gum, E. rudis, Paperbark, Melaleuca rhaphiophylla and She-oak, Casuarina obesa. This riverine forest extends, patchily, along the entire length of Bennett Brook. Additionally, the Paperbark has extensive woodlands associated with the swamp system on the eastern side of Bennett Brook. These vegetation types are described by Keighery (1996).

Much of the shrub vegetation along Bennett Brook has been modified or eliminated by various land use practices especially cattle and horse grazing.

SAMPLING SITES AND METHODS

This study aimed to record the vertebrate assemblage of each vegetation type in the Success Hill Reserve and nearby parts of the Bennett Brook area. In order to obtain



Figure 1. Aerial photograph of the Success Hill/Bennett Brook area showing locations of vertebrate trapping sites (marked 1 and 2) and the fish shampling sites marked (A, B, C, D, E).

an assessment of the seasonal faunal assemblage it was decided to undertake sampling surveys at several times of the year. Accordingly, surveys were undertaken to examine the fauna during September and November 1994, January, February, March, April, May, July, October and November 1995.

Terrestrial vertebrate sampling sites were established in January 1995 when nine 20 litre buckets, placed 10 metres apart, were used as pitfall traps. A seven metre long flywire fence standing 30 cm high was placed vertically over each trap when they were opened and operational. Two sites were chosen for intensive sampling, one on Success Hill and one on the slopes below Pyrton (Figure I).

These two sites were chosen to represent the range of habitats available in the elevated dry sandy areas. The lowland sites close to Bennett Brook were not chosen for intensive sampling as pitfall traps cannot be located in areas that become waterlogged during winter rains.

The traps were opened and examined on seven consecutive days during February, March, July, October and November 1995. Traps were closed and sealed and the flywire fence removed between trapping periods. Traps were examined daily and all reptiles, amphibians and mammals were identified, measured, and released.

Extensive searches were also made of the entire area to record reptiles and amphibians. In particular all surface rubbish and timber, bark and leaf litter was turned over and examined to reveal hidden species. Nocturnal surveys were undertaken with headtorches on three occasions to reveal species which are only active at night.

Frogs were sampled during favourable weather conditions throughout the year

and fish were sampled on two occasions at set sample sites (Figure 1) along the lower reaches of Bennett Brook in autumn and the beginning of winter. Afternoon and evening surveys were also conducted on four occasions to record calling frogs. All surface fresh water was examined with nets for the presence of tadpoles.

Birds were recorded opportunistically whilst checking the fenced pitlines and during all other reptile and frog surveys.

A search was carried out of relevant literature to find distributional records of vertebrates from the region. In particular we used How and Dell (1993) for mammals, Bush *et al.* (1995) and How and Dell (1993, 1994) for reptiles, Storr and Johnstone (1988) and How and Dell (1993) for birds, Tyler *et al.* (1994) for amphibians, and Sarti and Allen (1978) for freshwater fish. Museum databases were also searched for additional mammal and reptile data.

RESULTS

MAMMALS

During these surveys the only mammal trapped was the introduced House Mouse, Mus musculus. Numerous signs of House Mice were recorded throughout the area where old nests and burrows were located under various large items of rubbish. Both Success Hill Reserve and the Bennett Brook area are used by domestic cats and dogs. Rabbits, Oryctolagus cuniculus, were widespread but not abundant in the area. Signs of Foxes, Vulpes vulpes, were widespread in the area. A fox den had the remains of Swamphens, Black Ducks, Ring-necked Parrots, Dusky Moorhens and freshwater crustaceans, indicating the wide range of previtems taken.

Table 1. Frogs and Reptiles sampled syste SuccessHill . SH, Success Hill; PY, Pyrton Main Swamp.	matical 1; SO, S	lly by trapp heoak: BB,	ing and obs Bennett Br	erved opj ook; SS, S	ortunisti mall Swa	cally in e mps; SA,	ach of the Samphir	e habitats e area; Ol	at Benne B, Old Br	tt Brook/ idge, MS,
Species	Syste SH	matic PY	HS	Ъ	HS	Opport BB	unistic SS	SA	OB	WS
AMPHIBIANS Slender Tree Frog Litoria adelaidensis Motorbike Frog 1_moorei		××				×	×			
Quacking Frog Crinia georgiana Glauert's Froglet C. glauerti	×	×	××	××	××	×	××		××	×
Squelching Froglet Č insignifera Moaning Frog Heleioporus eyrei Banjo Frog Limnodynastes dorxalis	××	××		×	×	×	× ×		×	:×
REPTILES Swamp Skink Bassima trilineata Wall Skink Cryptoblepharus plagiocephalus Striped Skink Ctenotus fallens Limestone Skink C australis Two-toed Skink Hemiergis quadrilineata Elegant Lerista Lerista elegans	×× ×	× ×	×	×	*	×	×	***	××	×
Worm Lerista L. praepedita Grey's Skink Menetia greyi Flecked Morethia Morethia obscura	××		×	×	××	×	×	×	×	
Gould's Monitor Varanus gouldi Tiger Snake Notechis scutatus Dugite Pseudonaja affinis Long-necked Tortoise Chelodina oblonga				×	××	× ×	× ×	××	× ×	×

The Quenda or Southern Brown Bandicoot, Isoodon obesulus, was recorded. Characteristic feeding diggings were located around the edges of the inundated areas after the heavy rains during the winter of 1995. These animals were presumably forced out of their habitat along Bennett Brook and the Swan River. Two dead Quendas were also located on Benara Road near the junction of Bennett Brook at the northern end of the study area during heavy rain.

Although not sighted in the study area several Common Brush possums, *Trichosurus vulpecula* were reported in the Flooded Gums, *Eucalyptus rudis* along the banks of the Swan River just downstream of our study area (K. Pearson, pers. comm). It is likely that Water Rats, *Hydromys chrysogaster* occur in the lower reaches of the Bennett Brook as there are old museum records from nearby localities including Belmont Park, as well as unspecified localities on the Swan River.

No other species of terrestrial mammal was recorded during this survey although introduced Black Rats, *Rattus rattus* are likely to be widespread in the area. Historically, seven species of native terrestrial mammals (Kitchener and Vicker 1981) are known from the Bassendean Sand System but most of these are now locally extinct in the region (How and Dell 1993).

One species of bat was heard calling in the area during nocturnal surveys This was the White-striped Mastiff Bat, *Nyctinomus australis*, which is the only local bat whose echolocation sounds can be heard by the human ear. A search of the literature, especially Strahan (1995) and the Museum database indicates that as many as nine other bat species were originally known from the region but How and Dell (1993) suggest that many may no longer be found in the region.

AMPHIBIANS

Seven species of amphibians were recorded during these surveys. They are listed on Table I together with habitat types in which they were recorded. Each species is also briefly discussed below.

Slender Tree Frog Litoria adelaidensis

At Bennett Brook, it breeds in early spring in the bullrush swamps at the base of the hill below Pyrton. Calling males were abundant in these swamps between August and October. The egg masses were attached to the rush stems just below the surface of the water. Tadpoles were present in late spring and summer. When not breeding they tend to disperse widely and can be found throughout Bennett Brook and the adjacent Melaleuca swamps and were trapped in February mainly in the Bracken Fern on the slopes below Pyrton.

Motorbike Frog Litoria moorei

Only one Motorbike Frog was trapped in the Bracken Ferns below Pyrton during thissurvey.

Quacking Frog Crinia georgiana

Many individuals were captured in the pit traps both on Success Hill and below Pyrton. They were captured in all sampling periods.

This frog breeds in shallow seepages along the entire western side of Bennett Brook northwards from the base of Success Hill. The large eggs are laid from mid-winter and were found throughout the shallow seepage areas.

Glauert's Froglet Crinia glauerti

This frog is common along Bennett

Brook especially in the bulrush swamps and the seasonally inundated areas that occurred in the winter of 1995. This frog bred in large numbers in all the freshwater areas that remained after these heavy rains.

Squelching Froglet Crinia insignifera

This is the commonest frog in the area and was present throughout the Melaleuca swamps. It bred in large numbers in the inundated areas after the heavy winter rains in 1995. The eggs are laid in water in the same manner as Glauert's Froglet.

Moaning Frog Heleioporus eyrei

Only 3 individuals were trapped in the Success Hill and Pyrton areas. Although not recorded breeding on this survey, they probably breed around the margins of the seepage areas.

Banjo Frog Limnodynastes dorsalis

They were captured at both Success Hill and below Pyrton and calling males were heard in the Melaleuca swamp in winter and spring.

Most of the frog species recorded in the study area have widespread distributions in suitable habitat on the Coastal Plain. One species, the Quacking Frog, is mainly a Darling Range species with populations extending onto the Coastal Plain on alluvial soils associated with stream zones. One additional species, the Turtle Frog, Myobatrachus gouldii, is known from the Bassendean Dune System (How & Dell 1993) and may occur at Success Hill.

REPTILES

Thirteen species of reptiles were recorded during these surveys. They are discussed below and listed on Table 1 together with habitat types in which they were recorded.

SwampSkink Bassiana trilineata.

Several individuals were located in winter under rubbish around the margins of the inundated areas at the base of the slopes above the old bridge.

Wall Skink Cryptoblepharus plagiocephalus.

This species is widespread in the area and found on many trees including Paperbark, Melaleuca rhaphiophylla, Swamp Sheoak, Casuarina obesa, Flooded Gum, Eucalyptus rudis. It occupies crevices and gaps among peeling bark.

Striped Skink Ctenotus fallens

This fast-running, diurnal species is widespread throughout Success Hill and the slopes northwards to Pyrton.

Limestone Skink Ctenotus australis

It is scarce in the area and only two individuals were trapped at Success Hill.

Two-toed Skink Hemiergis quadrilineata Only one individual was trapped in May on the slopes below Pyrton.

Elegant Lerista Lerista elegans

This tiny lizard is widespread in the area and was trapped on Success Hill and located among leaf litter under the flooded gums along Bennett Brook.

Worm Lerista Lerista praepedita

This elongated, burrowing lizard is probably rare in the area as only one was trapped on Success Hill.

Grey's Skink Menetia greyii

They live among fallen leaves and are widespread and probably the most abundant lizard in the area.

Flecked Morethia Morethia obscura

This lizard is scarce in the area as only one was sighted among the she-oaks near the brickworks on the eastern side of Bennett Brook.

Gould's Monitor Varanusgouldii

Only one subadult was sighted under the remains of an old car on the slopes below Pyrton after the fire in January 1995.

Tiger Snake Notechis scutatus

Tiger snakes are scarce but widespread in the area especially around the Melaleuca swamps and the seasonally inundated areas.

Dugite Pseudonaja affinis

It is widespread in the area and several were observed during the survey.

Long-necked Tortoise Chelodina oblonga

This tortoise is common throughout the fresh water swamps along Bennett Brook and also occasionally occurs in the brook itself. When the peripheral waters evaporate in summer, some individuals aestivate in the drying mud to emerge with the following winter rains. Adult females leave the water to lay their eggs in dry sandbanks particularly along the western side of Bennett Brook.

Another 31 species of reptiles are known from the Bassendean Dune System (How & Dell 1993) but are unlikely to be present in the study area as suitable habitat does not occur.

FISH

Five species of native and two introduced fish species were recorded in Bennett Brook during these surveys. Each species is listed below together with comments on their status at Bennett Brook.

Western Minnow Galaxias occidentalis

These small eel-like fish were often seen swimming close to the surface against the current in the fastest running parts of Bennett Brook. They are relatively common in Bennett Brook in the upper parts of the study area, downstream at least to the old bridge. This is a common endemic species in the southwest extending from the Moore River to the east of Albany (Allen 1982).

Mosquito Fish Gambusia holbrooki

This is an exotic species which is extremely abundant in Bennett Brook and the extensive Melaleuca Swamps, even in the shallow weedy seasonal wetlands around the margins. Populations fluctuate markedly in Bennett Brook as this is a very fecund species which produces up to 375 live young up to six times during the year (Cadwallader and Backhouse 1983). It is regarded as a pest on native species and in some cases its effect on the native fish fauna has been profound (Allen 1982). In eastern Australia it also has an impact on amphibian populations by predating on tadpoles (Webb & Joss 1997).

Nightfish Bostockia porosa

This nocturnal species prefers running water and was found in the upper reaches of Bennett Brook downstream to the old bridge. During the day time it is very hard to find as it secretes itself away among stones or vegetation at the bottom of the stream. This is an endemic species found in coastal streams, lakes and ponds from the Moore River to Albany (Allen 1982).

Western Pygmy Perch Edelia vittata

This small fish was found throughout the length of Bennett Brook downstream to where the freshwater meets the tidal waters of the Swan River. It was found among water weeds and vegetation debris This is an endemic species found in coastal streams, lakes and ponds from the Moore River to Hopetoun (Allen 1982).

Swan River Goby Pseudogobius olorum

This small species is abundant in the Swan River and was found in the lower reaches of Bennett Brook. This fish is a slow swimming species and was hard to locate as it spends most of its time resting among submerged vegetation. This species is commonly found in streams and estuaries of the South-west (Allen 1982).

Long Thin Goby Favonigobius lateralis

This larger fish was found in the same sites as the Swan River Goby.

Golden Carp Cyprinus auratus

Only two juveniles of this exotic species were found in the middle sections of Bennett Brook. It feeds on insects, crustaceans, molluscs and aquatic vegetation (Allen 1982). The seasonal nature of Bennett Brook suggests that it is unlikely to become abundant and therefore not likely to become a major problem here.

BIRDS

Seventy-eight species of birds were

recorded during this survey. They are listed in Table 2. Not surprisingly, most species are associated with the extensive swamp system on the eastern side of Bennett Brook. Wooded wetlands such as these are now relatively scarce on the eastern side of the Swan Coastal Plain. Accordingly, this swampland is a significant feeding and roosting area for many species of bird especially herons, cormorants and ducks.

Table 2 also includes a number of small insectivorous landbirds such as thornbills, fairy-wrens, scrub-wrens and Grey Fantails which require natural vegetation for their survival. Each of the species in this group have declined markedly on the Swan Coastal Plain as a result of habitat fragmentation (How and Dell, 1993). The corridor of mature trees along Bennett Brook provides an important linkage between the riverine corridor of the Swan River and conservation reserves, especially Ellen Brook to the north.

CONSERVATION SIGNIFICANCE

The study area has been recognised as having important conservation significance and is recommended for conservation in Perth's Bushplan (Government of Western Australia 1998) as the largest and most diverse relatively intact lagoonal system on the Swan-Canning River Estuary and is one of a very limited number of bushland areas on the Swan Estuary in providing habitat for fauna as well as linkages between different bushland areas

The study area has five species of native fish all of which have declined on the Swan Coastal Plain. The frog fauna which includes seven species is moderately rich for a coastal plain wetland. The area has a rich lizard fauna with nine species of skink lizards. The most significant species is the Swamp Skink which is now rarely recorded on Swan Coastal Plain bushlands (How and Dell, 1994).

The conservation significance of the area for birds has been highlighted above. The swamplands support a large number of waterbirds and the riverine forest is an important transit corridor linking the Swan River with conservation reserves to the north.

MANAGEMENT CONSIDERATIONS

The Success Hill/Bennett Brook area needs specific management planning and practices to protect the multiple objectives of conservation (both wildlife and flora) and human recreation and aesthetic values. In particular, the damaging processes of fire, environmental weeds, feral animals, grazing animals and human disturbance need addressing. Some need immediate attention eg. wildfire control and others need longer term considerations as disturbance processes increase with time.

Fire has both short-term as well as longterm effects on native fauna. These were summarised in a symposium organised by the Urban Bushland Council in 1995, and highlighted in a paper by Dell and How (1995). They indicated that vertebrate as well as invertebrate animals were inimically affected by fire. In particular, habitat specific, dietary specialist, sedentary species were worst affected. Some species disappeared completely after fire and others were slow to recolonise burnt areas from unburnt patches

The severe wildfire of January 1995 had a devastating effect on native fauna at Success Hill. Many slow moving, aboveground reptile species such as Bobtails, legless lizards and some skinks were killed outright by the fire. Others which occupied burrows emerged after the fire to face considerably increased predator pressure because their protective cover had been removed.

A large number of exotic grasses and other plants occur in the Success Hill/ Bennett Brook area and all contribute to changes to native plant and animal communities, displace sensitive native species, reduce regeneration of native species, disposess native animals of habitat or food resources, increase flammability of native vegetation and result in more frequent and increased fire intensity. They also affect the soil surface and change natural water and nutrient cycles.

Non-native species of vertebrates such as foxes, cats, rabbits and Golden Carp compete for resources against native species and a number of them predate on native fauna. Rabbit overgrazing can result in soil erosion, weed invasion and the loss of native plant species. Foxes and cats prey upon ground animals and can_seriously affect the population of the Quenda. They also destroy nests of ground-nesting birds or those that nest close to the ground.

Native vegetation is easily damaged by human trampling. This also causes increased erosion and spread of weeds. Fertiliser and chemical use (herbicide and pesticide) should be discouraged in adjacent areas to reduce their effects in Bennett Brook as these affect water quality and the consequent survival of native fish and frogs.

ACKNOWLEDGEMENTS

We would like to thank the Success Hill Action Group (Inc.) for organising the grant from the 1994/95 National Landcare Programme, One Million Table 2. List of birds recorded at Success Hill/Bennett Brook during surveys in 1994-1995 + = species which have colonised the area through natural expansion

* = species which have been introduced by man

ANATIDAE

Black Swan Cygnus atratus Australian Shelduck Tadorna tadornoides Pacific Black Duck Anas superciliosa Grey Teal Anas gracilis Australian Wood Duck Chenonetta jubata Blue-billed Duck Oxyura australis Musk Duck Biziura lobata

PODICIPEDIDAE Australasian Grebe Tachybaptus novaehollandiae

ANHINGIDAE Darter Anhinga melanogaster

PHALACROCORACIDAE Little Black Cormorant Phalacrocorax sulcirostris Great Cormorant Phalacrocorax carbo Little Pied Cormorant Phalacrocorax melanoleucos

PELECANIDAE Australian Pelican Pelecanus conspicillatus

ARDEIDAE

White-necked Heron Ardea pacifica White-faced Heron Ardea novaehollandiae Great Egret Egretia alba Rufous Night Heron Nycticorax caledonicus

THRESKIORNITHIDAE +Sacred Ibis Threskiornis aethiopicus +Straw-necked Ibis Threskiornis spinicollis +Yellow-billed Spoonbill Platalea flavipes

ACCIPITRIDAE Black-shouldered Kite Elanus caeruleus Whistling Kite Haliastur sphenurus Brown Goshawk Accipiter fasciatus

FALCONIDAE Peregrine falcon Falco peregrinus Australian Kestrel Falco cenchroides

RALLIDAE Dusky Moorhen Gallinula tenebrosa Purple Swamphen Porphyrio porphyrio Eurasian Coot Fulica atra Buff-banded Rail Gallirallus philippensis Spotless Crake Porzana tabuensis CHARADRIIDAE Black-fronted Dotterel Charadrius melanops

COLUMBIDAE

*Spotted Turtle-Dove Streptopelia chinensis *Laughing Turtle-Dove Streptopelia senegalensis *Domestic Pigeon Columba livia

PSITTACIDAE

*Rainbow Lorikeet Trichoglossus haematodus Australian Ringneck Platycercus zonarius Red-capped Parrot Platycercus spurius Carnaby's Cockatoo Calyptorhynchus latirostris
+Galah Cacatua roseicapilla
*Corella Cacatua 500.

CUCULIDAE

Pallid Cuckoo Cuculus pallidus Fan-tailed Cuckoo Cacomantis flabelliformis Shining Bronze Cuckoo Chrysococcyx lucidus

HALCYONIDAE *Laughing Kookaburra Dacelo novaeguineae Sacred Kingfisher Todiramphus sanctus

MEROPIDAE Rainbow Bee-cater Merops ornatus

MALURIDAE Splendid Fairy-wren Malunus splendens

PARDALOTIDAE Spotted Pardalote Pardalotus punctatus Striated Pardalote Pardalotus striatus

ACANTHIZIDAE Western Gerygone Gerygone fusca Weebill Smicornis brevirostris Broad-tailed Thornbill Acanthiza apicalis Yellow-rumped Thornbill Acanthiza chrysorrhoa White-browed Scrubwren Sericornis frontalis

MELIPHAGIDAE Brown Honeyeater Lichmera indistincta

Table 2. (continued)

Singing Honeyeater Meliphaga virescens White-cheeked Honeyeater Phylidonyris nigra Tawny-crowned Honeyeater Phylidonyris melanops New Holland Honeyeater Phylidonyris novaehollandiae Western Spinebill Acanthorhynchus superciliosus Western Little Wattlebird Anthochaera himilata Red Wattlebird Anthochaera carunculata White-fronted Chat Epthianura albifrons PACHYCEPHALIDAE Rufous Whistler Pachycephala rufiventris DICRURIDAE Grey Fantail Rhipidura fuliginosa Willy Wagtail Rhipidura leucophrys Magpie-lark Grallina cyanoleuca

CAMPEPHAGIDAE Black-faced Cuckoo-shrike Coracina novaehollandiae CRACTICIDAE Grey Butcherbird Cracticus torquatus Australian Magpie Cracticus tibicen

CORVIDAE Australian Raven Corvus coronoides

HIRUNDINIDAE Welcome Swallow Hirundo neoxena Tree Martin Hirundo nigricans

ZOSTEROPIDAE Grey-breasted White-eye Zosterops lateralis

SYLVIIDAE Clamorous Reed-Warbler Acrocephalus stentoreus

Little Grassbird Megalurus gramineus

DICAEIDAE Mistletoebird Dicaeum hirundinaceum

MOTACILLIDAE Richard's Pipit Anthus novaeseelandiae

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REFERENCES

ALLEN, G.R. 1982. A Field Guide to Inland Fishes of Western Australia. W.A. Museum. Perth.

BUSH, B., MARYAN, B., BROWNE-COOPER, R. and ROBINSON, D. 1995. Reptiles and Frogs of the Perth Region. University of Western Australia Press.

CADWALLADER, P.L. and BACKHOUSE, G.N. 1983. A Guide to the Freshwater Fish of Victoria. Government Printer. Melbourne.

COOPER, N.K. 1995. Vertebrate Fauna of an Isolated Bushland Reserve (No 18325) in Inner Perth. Western Australian Naturalist. 20: 21-28.

DELL, J. and HOW, R.A. 1995. Faunal Responses to Fire in Urban Bushland. pp. 35-41 In: Burning our Bushland. Proceedings of a Conference about Fire and Urban Bushland. Urban Bushland Council (W.A.).

GOVERNMENT OF WESTERN AUSTRALIA 1998. Perth's Bushplan Volume Two Part B. Department of Environmental Protection Perth.

HARVEY, M.S., DELL, J. HOW, R.A., & WALDOCK, J.M. 1997 Ground Fauna of Bushland Remnants on the Ridge Hill Shelf and Pinjarra Plain Landforms, *Perth.* Report to the Australian Heritage Commission. NEP Grant N95/ 49.56 pp.

HOW, R.A. & DELL, J. 1989. Vertebrate Fauna of Bold Park. Western Australian Naturalist. 18: 122-131.

HOW, R.A. & DELL, J. 1993. Vertebrate Fauna of the Perth Metropolitan Region: Consequences of a Modified Environment. pp 28-47. In: M. Hipkins (ed) Urban Bush Management. Australian Institute of Urban Studies, Perth.

HOW, R.A. and DELL, J. 1994. The Zoogeographic Significance of Urban Bushland Remnants to Reptiles in the Perth region, Western Australia. *Pacific Conservation Biology*. 1: 132-140.

HOW, R.A., HARVEY, M.S., DELL, J. and WALDOCK, J.M. 1996. Ground Fauna of Urban Bushland Remnants in Perth. Report to the Australian Heritage Commission. NEP Grant N93/04.

KEIGHERY, BJ. 1996. A Description of Remnant Vegetation of Bennett Brook (System Six Area M41). Report prepared for the Department of Environmental Protection, Perth, Western Australia.

SARTI, N. and ALLEN, G. 1978. Freshwater Fishes of the Northern Swan Coastal Plain. Pp. 204-220, In : R.A. How (ed), Faunal Studies of the Northern Swan Coastal Plain: a consideration of Past and Future changes. W.A. Museum. Perth.

STORR, G.M. and JOHNSTONE, R.E.

1988. Birds of the Swan Coastal Plain. Records of the Western Australian Museum. Supplement 28.

STORR, G.M., HAROLD, G. and BARRON, G. 1978. Amphibians and Reptiles of the Northern Swan Coastal Plain. Pp. 173-203. In: R.A. How (ed), Faunal Studies of the Northern Swan Coastal Plain: a Consideration of Past and Future Changes. W.A. Museum, Perth.

STORR, G.M., SMITH, L.A. and JOHNSTONE, R.E. 1981. Lizards of Western Australian. I. Skinks. Western Australian Museum, Perth.

STRAHAN, R. 1995. The Mammals of Australia. The Australian Museum/ Reed Books, Sydney.

TURPIN, M.C. 1990. Ecological Appraisal of an Isolated Banksia Woodland Reserve No. 3694 South of the Swan River, Perth. Western Australian Naturalist, 18: 131-138.

TURPIN, M.C. 1991. Additions to the Fauna of Reserve 3694, Victoria Park. Western Australian Naturalist, 18: 168-169.

TYLER, M.J., SMITH, L.A. and JOHNSTONE, R.E. 1994. Frogs of Western Australia. Western Australian Museum, Perth.

WEBB, C. and JOSS, J. 1997. Does Predation by the Fish Gambusia holbrooki (Atheriniformes: Poeciliidae) Contribute to Declining Frog Populations. Australian Zoologist, 30: 316-324.

WILLDAMPIA, A NEW GENERIC NAME FOR STURT PEA

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ABSTRACT

The legume known as Sturt Pea (or Sturt's Desert Pea), which has been placed in both *Clianthus* and *Swainsona*, is considered to belong to a distinct, monotypic genus which is described under the name *Willdampia* and a new specific combination made accordingly.

INTRODUCTION

The ephemeral or biennial legume known as Sturt Pea or Sturt's Desert Pea (floral emblem of South Australia) was long known under the name Clianthus formosus (G.Don) Ford & Vickery, although it was accepted widely that it was misplaced in that genus, the type species of which is native to New Zealand, Sturt Pea differs from Clianthus s. str. in its short inflorescence, welldeveloped calyx lobes, long, narrow bilocular cylindrical legume. indumentum, large stipules and ephemeral prostrate habit (Thompson, 1990). In 1990, J. Thompson, completing a revision of the genus Swainsona, decided that C. formosus was more appropriately placed in that genus and made the formal combination (Thompson, 1990). She gave minimal justification for her decision, stating only that 'it is closely related to S. beasleyana F.Muell. from which it differs in its larger usually red (not purple) flowers, acute keel and longer fruit'. Her revision of the genus (Thompson, 1993) gave no further reason for the transfer. 1 believe that her analysis has ignored the very distinctive corolla of this plant which is easily distinguished from all other taxa of Swainsona by the orientation of the standard and keel, by its large size and typically red petals with a prominent black 'boss' on the standard. The standard and keel petals of Sturt Pea diverge at an anle of c. 180° and the 'boss' is prominently convex, in contrast to Swainsona in which they diverge at 70-90° and the eye is concave. In the Cape Range peninsula of north-western Western Australia the 'boss' is dark red. Elsewhere, occasional plants have pinkish or white shades, but these are atypical. The corolla of Sturt Pea is 90-120 mm long; the largest corolla otherwise in Swainsona is 30 mm long (S. maccullochiana F.Muell.). All species of Swainsona have corollas that are various shades of pink, mauve or purple, sometimes with yellow parts, and some show considerable change from a creamish colour in bud to the purple open flower. The legume of Sturt Pea, 40–90 mm long, is also larger than that of most other species of Swainsona, most of which are below 30 mm, the longest being 65 mm in S. *murrayana* Wawra. Accordingly the species is here placed in a new, monotypic genus.

Willdampia A.S.George, gen. nov.

Herbae ephemerae, interdum biennes. Folia pinnata, stipulis prominentibus. Inflorescentia axillaris, racemus floribus usque ad 6 in pedunculo robusto recto. rhachide contracto; flores bracteis prominentibus latis subtenti. Calyx in hypanthio insertum, bracteolis 2 longis. Corollae vexillum ab carina ad angulum c. 180º divergens; petala coccinea, ad basin vexilli nigra et nitens, raro rubra vel alba; vexillum rectum, ad basin convexum, in ungue decrescenti, 4-6 cm longum; alae in ungue gracili auriculato, ad apicem acutum angustatae: carina 5-6 cm longa. pendens, ad apicem acutum decrescens. ungue breve auriuculato. Stamina brevia et longa alternantia, 9 coalita, 1 libera. Pistillum gracile in stipite prominente; ovanium angustum ovulis multis stylus decrescens, glaber; stigma parva. Legumen cylindricum ad anguste ellipsoidale, aliquantum inflatum, in rostro recto angustatum, suturo profunde impresso, secus suturum primum dehiscens, deinde laterum alterum. Semina multa, discoidea, pallida.

Typus: Willdampia formosa (G.Don) A.S.George, comb nov.

Basionym: Donia formosa G.Don, Gen. Hist. Dichlamydeous Plants 2: 468 (1832); Clianthus formosus (G.Don) Ford et Vickery, Contr. New South Wales Natl Herb. 1: 302 (1950); Swainsona formosa (G.Don) Thompson, Telopea 4: 4 (1990). Typus: Curlew River [Ashburton R., W.A.], 20 Feb. 1818, P.P.King; holo: BM n.v., fide J.Thompson, Telopea 5: 469 (1993). For further synonymy and discussion of nomenclature, see Ford & Vickery (1950) and Perry, Wilson & Greuter (1992).

Ephemeral or sometimes biennial herbs. Leaves pinnate; stipules prominent. Inflorescence axillary, a raceme of up to 6 flowers on a robust erect peduncle, the rachis contracted; flowers subtended by prominent broad bracts. Calyx surmounting a hypanthium with 2 long bracteoles. Standard of corolla diverging from keel at an angle of c. 180°; petals usually scarlet with a shining black (sometimes deep red) boss near the base of the standard, rarely pink to almost white; standard erect on a tapered claw, 4-6 cm long with a prominent raised boss; wings on a slender claw with auricles, narrowed to an acute tip; keel 5-6 cm long, descending, long-tapering, acute. on a short claw with basal auricles. Stamens alternately short and long, 9 fused and 1 free. Pistil slender: stipe prominent; ovary narrow, with many ovules; style tapered to a small. glabrous stigma. Legume cylindrical to narrowly ellipsoidal and tapering to a slender straight beak, 40-90 mm long, somewhat inflated, the suture deeply impressed; dehiscing along the suture, later also along the opposite side. Seed numerous, disc-like, pale,

Distribution Widespread through arid Western Australia from North-West Cape S to Kalgoorlie and E through the western desert and Nullarbor Plain to inland South Australia and western New South Wales as well as the southern Darling Downs; occasional in far-southern Northern Territory.

Etymology The generic name is formed from the family and given names of the first European collector of this plant, William Dampier, who, until now, has been acknowledged nomenclaturally only in a synonym of the species. Among his many activities Dampier was a privateer and hence might find a little wry humour in seeing his name slightly corrupted. The Dedication in his 'Voyage to New Holland' (1703) is signed 'Will. Dampier'. He collected the plant in September 1699 on 'Rosemary Island' (the present-day East Lewis Island) in what is now known as the Dampier Archipelago off the northwestern coast of Western Australia. A photograph of his collection was given in George (1971).

The type locality No previous writer has discussed the type locality of Willdampia formosa. It was collected on the first of Phillip Parker King's voyages surveying the Australian coast. Although most botanising on these voyages was undertaken by Allan Cunningham, King himself has been cited as the collector of this plant. In his journal (King, 1827), he gave a detailed account of their exploration of what he called the Curlew River on 20 February 1818 but did not mention the flora except 'a species of eucalyptus' and mangroves. The Curlew is now known as the Ashburton River. King and his party 'ascended it in a boat for four miles'. For two miles they rowed past mangroves, but Beyond this the banks were low and sandy'. They landed but found an and country with poor, mostly sandy soil and 'large patches of salt incrustations'. It was probably in this area that they found Sturt Pea. The date of collection is interesting since Sturt Pea usually flowers in winter and early spring. In contrast to the terrestrial environment, they found the river abounding in fish (but of a 'nauseous taste'), and pelicans and curlews were very numerous (hence the name given to the river). But 'the most numerous and annoying of the inhabitants of this part were the flies, from their constantly creeping into the eyes, nostrils, and mouth, particularly during our meals; and it required some little trouble to partake of our repast without also conveying with it several of these troublesome insects.'

REFERENCES

DAMPIER, W. 1703. A Voyage to New Holland. James Knapton, London.

DON, G. 1832. A General History of the Dichlamydeous Plants, Vol 2. J.G. & F.Rivington *et al.*, London.

FORD, N. & VICKERY, J.W. 1950. The correct name of Sturt's Desert Pea, *Clianthus formosus* (G.Don) comb. nov. *Contr. Natl Herb. New South Wales* 1: 302–303.

GEORGE, A.S. 1971. The plants seen and collected in north-western Australia by William Dampier. W. Australian Nat. 11: 173–178.

KING, P.P. 1827. Narrative of a Survey of the Intertropical and Western Coasts of Australia performed between the years 1818 and 1822 1: 30–31. John Murray, London; Australiana Facsimile editions No. 30, Libraries Board of South Australia, 1969.

PERRY, G., WILSON, P.G. & GREUTER, W. 1992. Two proposals to amend Art. 57. *Taxon* 41: 605–606.

THOMPSON, J. 1990. New species and combinations in the genus *Swainsona*. *Telopea* 4: 1–5.

THOMPSON, J. 1993. A revision of the genus Swainsona (Fabaceae). Telopea 5: 427–581.

TWO RECENT RECORDS OF SOUTHERN ELEPHANT SEAL (MIROUNGALEONINA) BIRTHS IN WESTERN AUSTRALIA.

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ABSTRACT

Southern Elephant Seals (*Mirounga leonina* L) are infrequent visitors to the Australian mainland and the birth of pups at such locations is a rare event. This paper describes the first two recorded births in Western Australia and reviews the seven others from mainland Australia recorded in historic times.

INTRODUCTION

The Southern Elephant Seal (*Mirounga leonina* L.) has a cirmcumpolar distribution centred on sub-antarctic islands of the Southern Ocean and is an infrequent visitor to Australian coastal waters. Up until the early 1800s there were colonies on King Island and New Year Island in Bass Strait (Micco 1971), although Peron did not expressly mention the presence of pups. These colonies were eliminated by sealers, and since then only seven births from Tasmania and the Australian mainland have been recorded (Table I).

This paper describes two more births, both from Western Australia, the first such breeding records for this State.

Record No.1

On 15 October 1996 local fishermen reported seeing a large pinniped swimming in the shallows at Wylie Bay (33[•] 52'S., 121[•] 53'E.), 5km east of Esperance, Western Australia. The animal was identified as an adult female *M. konina.* It was next seen hauled out on beach-washed seaweed on the sandy beach at Wylie Bay early on 16 October with a new born pup, later that afternoon found dead. This carcase was recovered and is now lodged in the Western Australian Museum (WAM *M48667).

The cow remained at Wylie Bay for another two days before leaving the beach. An adult of similar size (presumably the same animal) was then sighted around the Esperance harbour during the next 4-5 days.

Record No. 2

On 12 November 1996 a tourist reported seeing a large pinniped and what appeared to be a pup on a sandy beach, leading up to high sandstone cliffs at the northern end of Epineux Bay (26' 20'S., 113' 18'E.), 24km southeast of Steep Point, Western Australia. This location is on a very remote part of the west coast, but a local resident was able to provide photographs to assist with the identification of the animals. Examination of the photographs confirmed that the animals were an adult female *M. leonina* and a pup of only a few days of age.

Frequent checks were made of the cow and pup during the next five weeks. The pup grew rapidly and had weaned and completed its first moult by 13 December (age approx. 34 days), when both the cow and pup went to sea.

DISCUSSION

These two records are the only known breeding records from Western Australia in historic times. The birth date for the pup from Wylie Bay falls within the range of birth dates (early Sept. – late Oct.) recorded for *M. leonina* at Macquarie Island (Carrick *et al.* 1962). The birth date at Epineux Bay was slightly later, but not the latest date recorded for a birth along the Australian coastline (see Table I).

The time between the approximate birth date and departure to sea for the Epineux Bay pup (*ca.* 34 days) is considerably shorter than the normal 9– 10 weeks recorded for this species. They are usually weaned at three weeks, then moult before leaving the beach at 9–10 weeks of age. However, this was of a similar duration to that recorded by Tyson (1977) for a pup born near Diana's Basin, Tasmania in 1975 (25 days).

The presence of *M. leonina* at these latitudes is unusual, although an adult male was recorded farther north at Tulki Bay (22' 02'S., 113' 54'E.), Ningaloo in 1995. Including the two records

Birth Date	Location	Reference	Fate of pup to weaning
Nov. 1958	Strahan, Tas. (42'09'S., 145'19'E.)	Davies (1963)	Died
Late 1968	Near Golden Beach, Vic. (38'13'S., 147'24'E.)	Warneke (1995)	?
9 Oct. 1975	Diana's Basin, Tasmania (41°23'S., 148°17'E.)	Tyson (1977)	Survived
12 Jan. 1977	Maatsuyker Is, Tas. (43'39'S, 146'17'E.)	Pemberton and Skira (1989)	?
Oct. 1986	Wright Bay, SA (37'03'S, 139'45'F)	Robinson and Dennis (1988)	?
9 Oct. 1988	Maatsuyker Is, Tas. (43'39'S 146'17'F)	Pemberton and Skira (1989)	?
Sept. 1994	Mouth of Elliot River, Vic. (38'46'S 143'40'E)	Warneke (1995)	?
15 Oct. 1996	Wylie Bay, WA (33°52'S 121°53'F)	This paper	Died
12 Nov. 1996	Epineux Bay, WA (26'20'S., 113'18'E.)	This paper	Survived

Table 1. Published records of births of *Mirounga leonina* in Australia during historical times. (?= fate unkown).

presented here, a total of six adult M. leonina (five female, one male) have been recorded along the Western Australian coastline during the penod 1980–1996 (Mawson and Coughran unpubl.).

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REFERENCES

CARRICK, R., CSORDAS, S.E. and INGHAM, S.E. 1962. Studies on the Southern Elephant Seal, *Mirounga leonina* (L.), IV. Breeding and development. CSIRO Wildl. Res. 7: 161–97.

DAVIES, J.L. 1963. The Whales and Seals of Tasmania. (Tasmanian Museum and Art Gallery: Hobart).

MICCO, H.M. 1971. King Island and the sealing trade 1802. A translation of

Chapters XXII and XXIII of the narrative by Francois Peron published in the official account of the voyage of discovery to the southern lands undertaken in the Corvettes *Le Geographe*, *Le Naturaliste* and the schooner *Casuarina*, during the years 1800 to 1804, under the command of Captain Nicholas Baudin. *Roebuck Soc. Publ.* No. 3, pp 51.

PEMBERTON, D. and SKIRA, I.J. 1989. Elephant seals in Tasmania. Victorian Naturalist 106: 202-4.

ROBINSON, A.C. and DENNIS, T.E. 1988. The status and management of seal populations in South Australia. pp. 87–104. In: Marine mammals of Australasia: field biology and captive management. Ed. Augee, M.L. Royal Zoological Society of NSW, Sydney.

TYSON, R.M. 1977. Birth of an Elephant Seal on Tasmania's east coast. *Victorian Naturalist* 94: 212–3.

WARNEKE, R.M. 1995. Family Phocidae. In: Mammals of Victoria; Distribution, ecology and conservation. ed. P.W. Menkhorst. Oxford University Press and Dept. Conservation and Natural Resources, Melbourne.

AN ANNOTATED LIST OF WALMAJARI AND MANGALA NAMES FOR NATURAL FEATURES, PLANTS AND ANIMALS IN THE GREAT SANDY DESERT, WESTERN AUSTRALIA

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INTRODUCTION

The Great Sandy Desert of Australia lies in the northern part of Western Australia between Latitudes 17 and 23' S and Longitudes 120' and 129' E and has been inhabited for at least ten thousand years (Jones 1987) by Aborigines. During July 1996, the Discovery '96 Expedition (Hewitt 1997) visited the area, accompanied by some of the Aborigines who had been born there. The expedition operated from base camp Pegasus, (Figure 1) for 14 days, with field trips to surrounding areas including day visits to Pikarungu (Joanna Spring), Kirriny (Gring Spring), and extended trips to Kurriji pa Yajula (DragonTree and Elizabeth Soaks). This paper documents as much of the knowledge and features important to survival in the desert as we could obtain during the two weeks in the field. The Aboriginal names for theese features, plants and animals are given in the Mangala and Walmajari languages, scientific even when absolute identification of the organisms was not possible, often because parts critical for identification, flowers or fruits, were not available during the visit.

METHODS

The peoples originally occupying these areas spoke Kaarjari, Mangala, and

Walmajari (Figure I). At the request of the Kimberley Land Council, who are currently negotiating native title claims on behalf of these peoples, no boundaries to these language areas are shown on Figure 1. The Kaarjari speakers occupied land extending inland from the coast, overlapping with the western portion of the land occupied by the Mangala speakers. People speaking Walmajari lived farther east again, overlapping the Mangala range. Most of the people speaking these languages now live at the communities of Bidyadanga (formerly La Grange mission), Looma and other communities in and around Fitzroy Crossing, making occasional visits to their tribal lands. The information was gathered mainly with the help of three people. Kurrupa, Gail Smiler, and Mervyn Nampukarti. Kurrupa's people were the Walmajari; he lived as a hunter gatherer until his mid teens when he came out of the desert. Gail is also a Walmajari and she has extensive knowledge in these areas. Mervyn was brought up in the desert and his people are the Mangala; he also brought his teenage daughter Gemma, to show her the country. The presence of the linguist, Eirlys Richards, who is familiar with the languages and their spelling, was of great assistance to us. Details of the expedition, its itinerary and its other activities are given in the report of the expedition (Hewitt 1997).





KNOWLEDGE LIST

The following are descriptions and Walmajari/Mangala names for some of the plants, animals, skills and other features of life in the Great Sandy Desert shared with us by Gail, Kurrupa and Mervyn. Instances where many names were applicable suggests heightened importance, as the item may have been utilised in many ways or been used in particular phases.

Features and Activities

Fire – The making of fire was an important survival skill for food preparation and also many other processes such as implement and weapon manufacture. Two different types of wood were used, Yarun (*Eucalyptus terminalis*) and Kulparn (*Acacia tumida*), one held in the hands and the other, softer one, on the ground to be rubbed by the first. This was done firmly and vigorously while blowing, and administering sawdust and small amounts of spinifex. When heat, air and fuel were sufficient a flame developed.

Jilji (Walmajari). The dune tops or ridges.

Julu (Walmajari). A stand of Yarun trees clumped fairly closely together on a mound of soil such as those seen around false Discovery Well. Mound dimensions were approximately 7m in diameter and Im high.

Karlaka (Walmajari) – The term used for honey. This was produced by native bees, which used hollows in trees as a hive site. When bees were found the tree was tapped or knocked from the hollow entrance downwards with a stick or tomahawk. A change in sound indicated where the hive was. A scarf like cut was then made in the tree and the honey was removed.

Kurrkuminti (Walmajari) – A type of hollow in a sandhill, which was often used as a camp site, especially in cooler weather.

Parpara (Walmajari). The wide swales (lower ground) between the dunes.

Pikarungu – (Mangala) – Joanna Springs.

Purntarrpurntarr or bundar bundar – (Walmajari). An area of vegetation which indicated a waterhole.

Kurriji pa Yajula – Dragon Tree Soak and Elizabeth Soak, (Mangala) – said as one. (Elizabeth soak was not a gazetted name. Ian Bull named it after his mother when he "found" it in 1981.). The site is an A class Conservation Reserve.

Wujuwuju (Walmajari). The narrow swales (lower ground) between the dunes.

Great Sandy Desert Plants

Jalirr (Walmajari) – bush onion. Cyperus bulbosus. Also known as Ngarijijarti, Jurnta. Also WupaWupa (Orbaorba) and Wirrparn (Wirpun) in Walmadjari and Mangala. This bulb was from a small clumped grass with little tubers, very onion like in form. It was cooked on hot coals covered in not very hot ashes, rubbed to remove skin and tasted like peanut.

Jalngu (Walmajari) – spinifex. This soft grass was woven into a ring forming a pad and used to help balance water carried on one's head.

Janiya (Walmajari) – wild pear. *Persoonia falcata.* The fruit could be eaten.

Jijoo or Wirtuka (Walmajari) – Ipomea species – bush potato. The presence of this species was an indicator of nearby water. It grew to about Im high. The tap root was somewhat like a sweet potato, and was dug out, cooked and eaten. Young ones were best. The dark berries were not eaten.

Jitartu (Mangala) – soft spinifex. This was used for conserving water on long trips; tufts of it were placed in the vessel containing water to minimise spillage. It was also dipped into the water and sucked for drinking.

Junyju (Walmajari) – Eucalypt species. The leaves of this tree were used as a whistle.

Jurntijartu or jurntini or majapurti (Walmajari) - puffball fungus -Pisolithus tinctorious. Also known as Majapurti by people from Wangkatjunka. The inner parts of these fungi were eaten when they were still moist, either raw or on the fire. They made the tongue go black. They were apparently still in season in July/August, though most seemed dry. The dry powdery parts of the fungi were used as a type of talcum powder, such as for rashes at the top of the legs.

Karrpukarrajarti (Walmajari) – tuft grass species – Xerochloa barbata. When preparing the seeds for consumption they were first yandied (a process of sifting and sorting done with a variety of swirling and shaking actions in an open elongated wooden dish) and then wet ground and cooked.

Kirli or Jili (Walmajari). Low vine-like prickle bush near waterholes. Usually near 'jila' – permanent waterholes.

Kulparn (Walmajari) – Acacia tumida. The seeds were cooked and eaten like a vegetable. Select pieces of wood from this plant were also used to start a fire by rubbing with wood from the yarun. This plant also sometimes housed an edible grub, or larvae, in the tap root. Small piles of fine sawdust were looked for around the wood at the base of the tree, which indicated the presence of a

1

grub. The main tap root was then exposed and the grub was located. It had a nutty taste.

Kurlulungkurr (Walmajari) – Tinaspora smilacina. This strong creeper climber with red berries was used for making a sandal footwear.

Kurrangany (Walmajari) – shrub. Small bush with purple pea shaped flower. Warts on leaves indicated water nearby.

Marral Marral (Walmajari) – Erythrophleum chlorostachys. Honey was sucked from the flowers of this tree. It flowered in the summertime, in the rainy season.

Marnta (Walmajari) – Sap/gum. Cum from Coolabah and Desert Walnut. This gum was chewed for a snack, and was also sourced from another species of *Acacia* called Pinkalyi (Walmadjari) or Minta (Mangala).

Ngarakarra (Walmajari) – Gyrostemon tepperi. This plant was used by placing it on a fire to smoke babies so as to make them strong and ward off illnesses.

Ngarlka (Walmajari) – see Turtujarti.

Ngujarna (Walmajari) – tuft grass species. This small grass had red seeds which were used for making flour.

Parntal (Mangala) – Desert Walnut – Owenia reticulata. See Turtujarti.

Turtujarti (Walmajari) – Desert Walnut – Owenia reticulata. The nuts from this tree were called Ngarlka (Nulgu), and were gathered from where they have fallen on the ground. The nuts lie on the ground for a long time and may become powdery inside as a result of termites; these were no good (Mirily). Good nuts (Makaly) were collected, sorted by banging on the knee and then shaken near the ear to listen (or feel?) for a looseness or rattle. This was difficult to detect for the unskilled. A bed of coals was prepared and the nuts were cooked by covering them with the coals and stirring occasionally. The nuts "talked" while they were cooking, a slight popping sound, and when this stopped they were cooked. They were removed from the fire and cooled by covering with sand for a short while, then individually cracked open. About half these nuts were cast aside. After cooking, the broken nut inside was eaten. The unripe nuts were called Karraparra, and the flower was called Wurupu

Wirajarti or Rawarawa (Walmajari) – Hakea subora. The creamy coloured flowers were sucked for honey.

Witulurra (Walmajari) – shrub. Waxy red star shaped flowers, roots like potatoes which were eaten.

Yarun (Walmajari) - Eucalyptus terminalis. Found on dunes and ridges. Galls caused by parasitic insects formed nut-like growths called tartaku (duddugo). These were about 25mm in diameter and were edible. The nut-like growth was picked off the tree and cracked open; the inside layer, which looks and tastes similar to coconut, was eaten as was the larvae inside. A natural indentation hole (an eye) at the bottom meant it was good, as did being heavy. Sometimes these nuts had holes bored in their sides which indicated that they were no good. This was where the insect had matured and left the gall. The flower was called Kurrulpiyan.

Great Sandy Desert Animals

Jajalpi (Walmajari) – Mulgara – *Dasycercus cristicauda*. Also known as Minyiparnta.

Lumpurru (Walmajari) – King Brown Snake – Pseudechis australis.

Mantararrararrararra (Walmajari and

Mangala) – Marsupial Mole – Notoryctes typhlops.

Mingajurra (Walmajari) – Golden Bandicoot – Isoodon auratus. This species was no longer present. It also was known in Walmajari as Walkarraja, Miningarna, Mulyajuka, Jurungu.

Mirtuluju (Walmajari) – Bilby – Macrotis lagotis.

Ngarlngarl (Walmajari) – Northern Quoll – Dasyurus hallucatus. This species was no longer present. Also known in Walmajari as Parrjita.

Ngujamili (Walmajari) – Youngson's Dunnart – Sminthopsis youngsoni. Though not a highly sought after food, these were sometimes cooked over an open fire. Also known in Walmajari as Warlungintinginti or Warlukarpirnjuwal.

Nyulkulku (Walmajari) – Cat – Felis catus.

Pinkirrjarti (Walmajari) – Australian Bustard – Ardeotis australis.

Raltartu or Majirri (Walmajari) – Hare wallaby species no longer present.

Waltaki (Walmajari) – Fox – Vulpes vulpes.

Warlu Ngintinginti (Mangala) – see Ngujamili.

Wilika (Walmajari) - Spinifex Hopping Mouse - Notomys alexis. Known as Kanpirriny by Mangala people.

Wirinkuma (Walmajari) – Northern Brushtail Possum – Trichosurus arnhemensis. Also known as tart or wayurta. It ate flowers of bloodwood called ngaak.

Wirlka (Walmajari) – Goulds' Sand Goanna – Varanus gouldii. Flushed from hiding and hit over the head with a stick. The goanna was then gutted by a small incision near the neck and cooked on hot coals.

The abundance of food sources in the Great Sandy Deasert varied from season to season, both for animals and plants. Of the plant species recorded and collected on the expedition, 10 species were found which were previously unlisted in the area by the Western Australian Herbarium. These include Grevillea erythroclada, Hakea subora, Heliotropium epacridium, Ptilotus polystachyus, Panicum whitei, Paspalidium vaginatum, Plectrachne melvillei, an Ipomea species, Eucalyptus terminalis, and a fungus of the Pisolithus genus. The specimen of the Ipomea species, usually only found near water, was found in a very large natural hollow in a dune. This hollow, or kurrkuminti, was perhaps 70m long, 35m wide, 10m deep and about 250m N/E of Kirriny Spring. Kurrkumintis were known to be favourite camp sites, offering shelter from the prevalent easterly wind (Lowe and Pike 1990).

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REFERENCES

HEWITT, D. 1997. The Report of the Discovery '96 Expedition to the Great Sandy Desert. Perth.

JONES, R. 1987. Pleistocene life in the dead heart of Australia. *Nature*, 328:666.

LOWE, P. and PIKE, J. 1990. Jilji – Life in the Great Sandy Desert. Magabala Books, Broome, Western Australia.

NEW LOCALITIES FOR THE WESTERN PYGMY POSSUM, CERCARTETUS CONCINNUS, IN THE GREAT VICTORIA DESERT

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Pygmy possums are small marsupials which eat insects and nectar (Wakefield 1963: Smith 1983). Known localities of Western Pygmy Possums, Cercartetus concinnus, in Western Australia are restricted to the southwest, extending inland to the Kalgoorlie region (Figure 1). Wakefield (1963) rejected Glauert's (1933) Sandstone locality (29'59'S. 119'18'E) which is well east of recorded inland localities because no specimens were available. During long-term pitfall trapping programs at Queen Victoria Springs (30'14'S, 123'41'E) and Yamarna Station (28'14'S, 123'36'E), we captured a number of Western Pygmy Possums. These sites lay well east and north-east of the previous known distribution of the species.

At the Queen Victoria Spring site, C. concinnus were captured over a period of four years between 1987-1991. The site was trapped for five days each year in autumn (March or April), spring (September or October) and summer (December). Additional trapping occurred in June 1987 and January 1989. Three types of pitfalls were used; 160 mm diameter PVC pipe (March 1987 to September 1988) and 250 mm PVC tubes and plastic buckets. Total trapnights for this four year period was 13006. Some of the trapping site was burnt with experimental fires in September 1988, January 1989 and October 1990 to examine the responses of small mammals and reptiles to fires.

Of the ten individuals captured; one was caught in September 1987 (lodged at the Western Australian Museum, registration number M 44158), one in March 1988, three in September 1988. one in September 1989, one in October 1990 and three in September 1991. This trapping result indicates a strong trend for C. concinnus to be caught in spring months when there were abundant flowering shrubs (particularly Hakea francisiana and Grevillea juncifolia) and abundant insect life. The sex ratio of captures was not significantly different from parity (six females and four males) and all individuals captured were adults, ranging in weight from 9.0 to 16.8 g (mean 13.3 g). One female captured on 18 September, 1989 was carrying four pouch young. All possums were marked with ear tags and released; two recaptures occurred the night after their initial capture, but there were no



Figure I. Museum locality records of the Western Pygmy Possum, Cercartetus concinnus, in Western Australia

recaptures between trapping periods. This, and the fact that most captures occurred during September and October, suggests that C. concinnus is a transient in this habitat, either dispersing through it in search of preferred habitat or visiting the area on a nomadic basis in search of food resources or perhaps mates.

A female C. concinnus was captured at Yamarna on 13 October 1998. This specimen was collected on a spinifex plain with only a few small scattered shrubs, none of which could have produced a substantial supply of nectar. Many *Grevillea* and *Hakea* plants were flowering profusely approximately 500 m from the pitfall line. Pit traps at this

site were 20 litre buckets (5,850 trap nights). This specimen weighed 13.0 g and may have been dispersing to a more suitable habitat, or may have been a permanent resident there. It was lodged in the mammal collection of the Australian Museum Western (registration number M 44119). Three years earlier, a few other C. concinnus were captured but released on Yamarna at a separate but similar pitfall line (20 litre buckets, 6.852 trap nights) 4 km northeast of this location (28'12', 123'35').

The fact that several Western Pygmy Possums were captured both at QVS and at Yamarna (over 3 years and at sites 4 km apart) suggests that viable
populations must exist around both of these areas. Grant and Temple-Smith (1987) stated that this species can go into torpor for periods of up to 11 days. Supplies of nectar and pollen at QVS and Yamarna would seem to be lacking for periods longer than this, indicating that Cercartetus concinnus must rely on insects as their main food during such periods. They probably also employ short-term torpor to deal with unfavourable weather conditions as individuals removed from traps after cool nights were typically tightly coiled into a ball and took a minute or so to rouse from this "torpid" state.

These two new locations are east (200 km) and northeast (about 350 km) of the closest previously known records in WA. Yamarna is well into the Great Victoria Desert, while Queen Victoria Spring lies on its south-western edge. Populations of Western Pygmy Possums may occur in other areas of the Great Victoria Desert but as little other intensive trapping has been done there, evidence of their occurrence or absence in other areas is not available. Further study is needed, but is likely to be difficult given the trapping effort required. At both sites while large numbers of some species of mammals were captured we also recorded only very few Mulgara, Dasycercus cristicauda, which are also apparently at very low densities or difficult to capture. Very little data on faunal composition are available from much of central Australia and geographic distributions of many species are based on short-term or opportunistic trapping which often fails to detect species at low densities or with strong seasonal activity patterns. Survey work to document terrestrial vertebrate assemblages in central Australia should aim to sample both seasonal and between year variations.

ACKNOWLEDGEMENTS

We are grateful to Norah Cooper for confirming the identity of specimens and preparing Figure 1 and to many volunteers and CALM staff, particularly Janet Gardener and Dan Grace, for providing assistance in installing and checking pitfall traps. The comments of two anonymous reviewers improved the manuscript.

REFERENCES

GLAUERT, L. 1933. The distribution of marsupials of Western Australia. J. Roy. Soc. W. A. 19: 17-32.

GRANT, T. R. and TEMPLE-SMITH, P. D.1987. Observations on torpor in the small marsupial *Dromociops australis* (Marsupialia: Microbiotheriidae) from southern Chile. pp. 257-271 in *Possums and Opossums: Studies on Evolution*. Vol I. ed. by M. Archer. Surrey Beatty & Sons, Pty. Ltd., Chipping Norton, NSW.

SMITH, M. J. 1983. Western Pigmy Possum. pp. 162-163 in *The Complete Book of Australian Mammals*. ed. by R. Strahan. Angus & Robertson, Sydney.

WAKEFIELD, N. A. 1963. The Australian Pigmy Possum. Victorian Naturalist 80: 99-116.

FROM FIELD AND STUDY

Laughing Turtle-Dove feeds on seeds of Isolepis oldfieldiana – The Laughing Turtle-Dove Streptopelia senegalensis normally occurs on the Maylands mudflats in ones and twos, the birds roaming around and paying special attention to areas where the grassland has been burnt. In January 1985 a large patch of Isolepis oldfieldiana was bumt and some 100 doves fed over it for three weeks. This is one of the few records of this dove feeding on seeds of native plants.

– R.H. STRANGER, 28/76 East Street, Maylands 6051.

Reed Warbler nests in Pampas Grass – The Reed Warbler Acrocephalus stentoreus is intimately tied to the rushes of freshwater swamps and streams, and it is popularly believed that it never leaves them. However in my experience the Reed Warbler does occasionally leave the rushes and in *Birds of Western Australia* (Serventy and Whittell, 1976) the authors cite the Reed Warbler as having nested in *Melaleuca*.

In March 1985 I found a nest of this species in the south quarry of the Maylands peninsula. It was attached to two leaves of a Pampas Grass Cortaderia selloaria, the plant having been left high and dry when the water level fell during summer. A bed of sedge was half a metre away but there was no Typha or Juncus nearby.

– R.H. STRANGER, 28/76 East Street, Maylands 6051.

Dugite eats Tiger Snake – On 9 April 1997 at West Beach in Fitzgerald River National Park in low coastal heath I observed two smakes writhing on the ground. Closer inspection revealed that a Dugite, Pseudonaja affinis was in the early stages of subduing a Tiger Snake, Notechis scutatus and attempting to swallow it. The Dugite had three coils around the Tiger Snake which it also used as support against which to manœuvre while swallowing the Tiger Snake's head. This was the most difficult and time consuming part of the process. Once the head was swallowed the Tiger Snake was guite subdued and the Dugite drew it out lengthwise and swallowed it much more readily. The entire process took one hour. The Dugite was approximately 1.5m long and the Tiger Snake approximately 60 cm. The entire sequence was recorded on colour print film.

– ANDREW CHAPMAN, PO Box 264, Ravensthorpe WA 6346.

Frost damage to vegetation – Between 15-23 July 1997 well below average temperatures were recorded in southern WA due to cloudless skies, light northerly daytime winds and very still nights. At Carracarrup 19km south of Ravensthorpe 1 recorded 8 consecutive frosts: daily minimum temperatures were always zero or below, including a minimum ground temperature of minus 6 C. In early August some vegetation. particularly growing in river or creek valleys began to exhibit signs of frost damage; leaves were 'browned-off' similar in appearance to herbicide application. This applied in particular to Acacia rostellifera where it grew without any overstorey, the leaves were often entirely 'browned'. Acacia cyclops shrubs to 1.5m growing along creeklines without overstorey were killed by this frost. In the West River valley Eucalyptus tetragona where it was low growing only i.e. <1.5m had the distal and marginal portions of leaves 'browned'. Taller plants were

unaffected. I examined leaves of these species to eliminate the possibility of insect damage but could find no evidence of this. Other plants similarly affected were Labichea lanceolata, seedlings of Eucalyptus occidentalis and to a minor extent Acacia acuminata. Muir (1985), Western Australian Naturalist 16: p213, has also recorded possible frost damage to vegetation in nearby Fitzgerald River National Park including damage to Acacia rostellifera and another species of eucalypt.

– ANDREW CHAPMAN, PO Box 264, Ravensthorpe WA 6346.



CLUB NEWS

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General Meetings and Branch Meetings are held at various venues in Nedlands, Kalamunda, Rockingham and Padbury.

The Retired and Leisured Group meets on alternate Wednesdays at 10a.m.

Excursions and field days are planned from time to time and will be advertised in the Club's monthly newsletter "The Naturalist News".

THE WESTERN AUSTRALIAN NATURALIST

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