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THE BIRDS OF THE NOW NON-EXISTENT CAUSEWAY SALT MARSHES, PERTH, W.A.

By M. K. TARBURTON, Fulton College, Suva, Fiji.

Summary

The Causeway mudflats, a tidal marsh area close to Perth, was destroyed by the combined activities of water skiers, council rubbish men and road builders during the period from December, 1963 to 1969. Before this time the area was an important refuge and feeding area for many waterfowl and waders. A brief description of the communities is followed by an analysis of their birds. Counts of species and individuals on a monthly basis furnish the basis of the study.

INTRODUCTION

The area of study consisted of so-called "wasteland" centred around a tidal backwater 22 km inland along the Swan River. Situated only 3 km from the centre of Perth it was thus cut off from all other areas of bushland thereby eliminating some of those bird species that are shy of man's habitations.

The northern side was bounded by the relatively undisturbed waters of the Swan River; the west by Heirisson Island and the six-laned causeway bridges; the southern border was marked by a stand of Flooded Gum *(Eucalyptus rudis)*, houses and the Great Eastern Highway; the eastern perimeter was formed by a cement factory and the Perth City Council rubbish dump. The area itself comprised six distinct communities.

THE COMMUNITIES

I. Rubbish Dump. To many in authority the rubbish dump was the obvious fulfilment of such a site so close to the city and so prone to the breeding of the salt-water mosquitoes. This community provided conditions suitable only for Silver Gulls *(Larus novaehollandiae)* and the occasional Raven *(Corvus coronoides)*.

II. Rush Beds. Adjacent to the rubbish dump and running north beside the cement factory and south beside the road to the tip was an extensive series of rush beds. These were broken by open patches of mud and a stand of dead paperbarks *(Melaleuca sp.)*.

III. Salt Flats. The third community constituted virtually the rest of the land above the high tide mark. Abnormal highwater levels did however inundate this section. Such tides occurred when excessive rain fell in the catchment area of the Swan River or when a Spring or Neap Tide coincided with a moderate rainfall. Such flooding occurred only two or three times a year but would last for ten or even more days. The main plant equipped to survive over most of this area was the Beaded Glasswort or Samphire *(Salicornia australis)*. However the Marsh Club Rush *(Scirpus maritimus)* and a Glasswort *(Arthrocnemum bideus)* grew in fairly well defined sections of this area. The Glassworts provided three main functions: roosts for the Chats, Pipits and Songlarks; food and protection for numerous insects and camouflage for waterbirds and waders during periods of high tides. This last function was particularly noticeable with the Golden Plovers *(Pluvialis dominica)* which rarely seemed to leave the Causeway area during summer. On the south side some of this zone had been turned into rough pasture presenting patches of introduced grasses and the natural plants. White-faced Herons *(Ardea novaehollandiae)* and White Egrets *(Egretta alba)* were often seen stalking frogs and *Gambusia* amongst the plants and along the drains of this community.

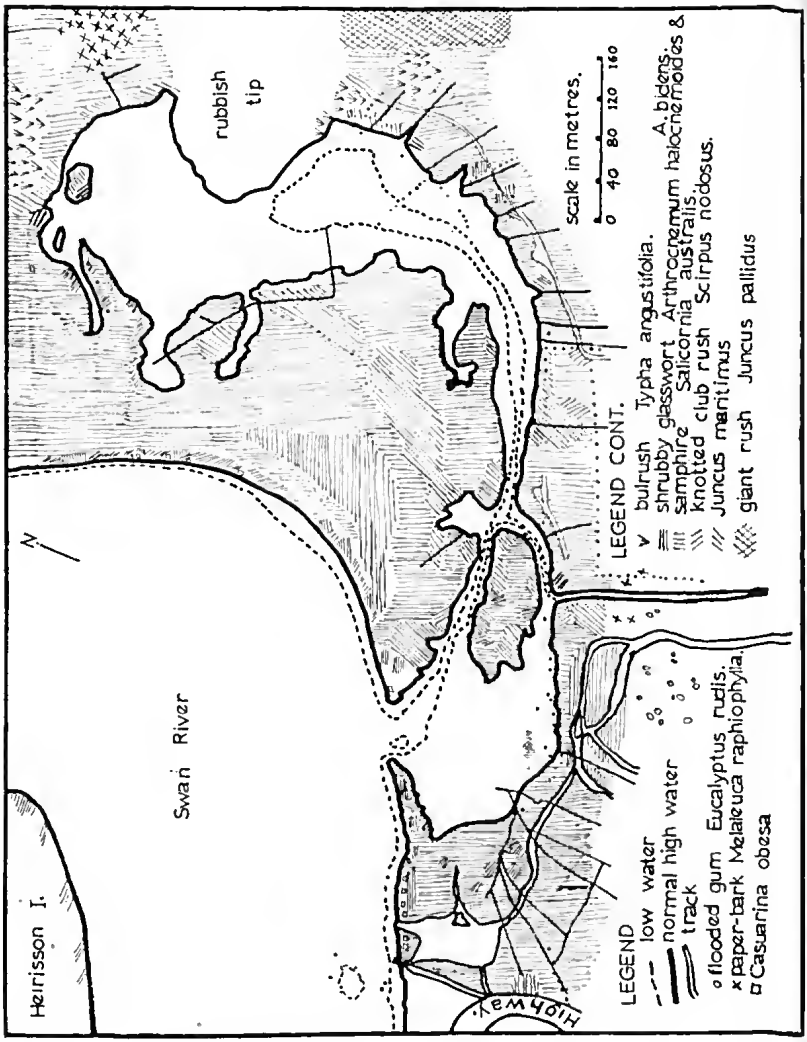

Fig. 1.—The Causeway Salt Marshes as they were in 1961. Dots represent posts, mainly fence posts. Fairly straight lines represent hand-dug drainage channels. The Highway that was built in 1970 passes across the map from the word "Highway" to just above the words "scale in metres". Other plants found in quantities too small to be shown on the map are Pale Goosefoot *(Chenopodium glaucum)*, Seablight *(Suaeda australis)* and *Acacia cyanophylla.*

IV. The largest population of birds occurred in the stretch of mud between low and high tide levels and the small amount of water in the inlet during low tide. In effect the area could only be used by birds during medium or low tides. During medium tides ducks were the most noticeable of the avifauna but waders were often abundant. At times the mud in this area was quite firm and could be walked on—but after it had been under water it usually became very soft and one sunk to one's knees in traversing the area. This would deter observers from working this area for regular study.

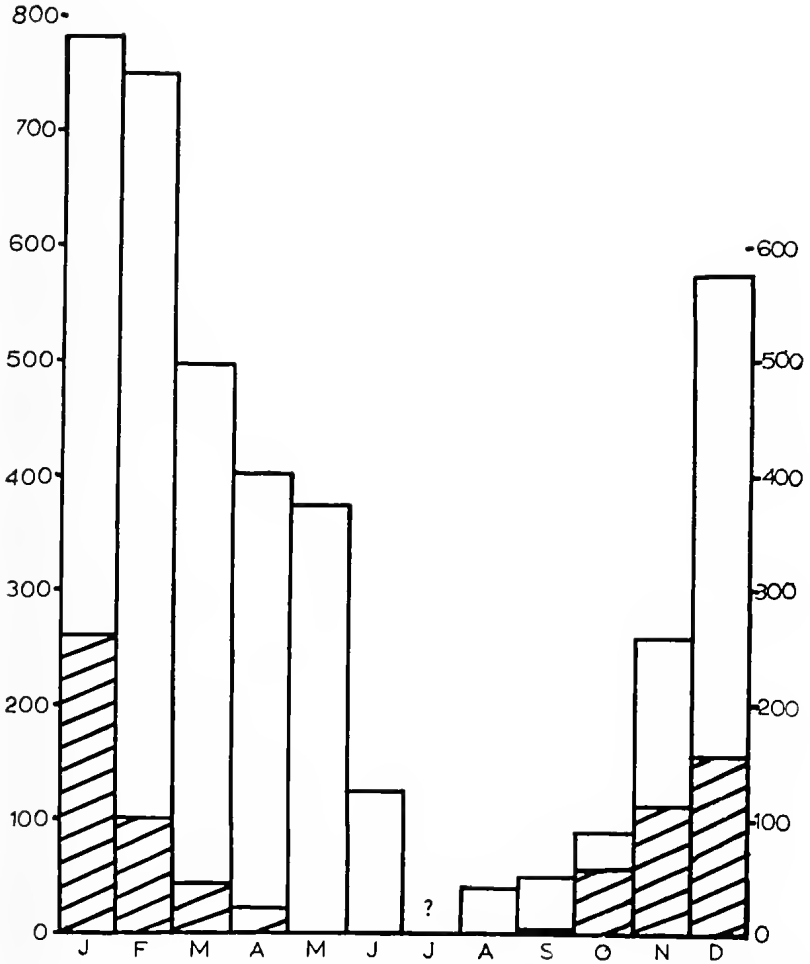

Fig. 2.—Column graph showing monthly means of the number of individual birds in all communities, 1961-65 inclusive. The shaded component shows the proportion and number of migratory waders.

The mud contained many polychaete worms which anglers periodically collected. Small crustacea were also evident. There were no mud whelks as found on other more solid tidal flats of the Swan River Estuary.

V. This is the sandy beach of the river shore. It is composed of coarse sand and broken shell but in places gives way to mud. The beach zone was and still is bordered by the Shore Rush *(Juncus maritimus)*. The birds that made use of this area were the terns, cormorants, gulls and sometimes Red-capped Dotterels. Sheoaks *(Casuarina obesa)* and the Shrubby Glasswort *(Arthrocnemum halocnemoides)* also provided shelter for some of these birds along the flood formed levee banks.

VI. In the open waters of the river brown algae grew in the deeper parts and here could be found such fauna as Mullet, Blowfish, Gobbleguts, Pipe-fish, Cobbler and School Prawns. The birds that used this area were Cormorants, Pelicans and Coots.

THE DESTRUCTION OF THE COMMUNITIES

The rubbish dump had for some years been slowly encroaching on the rush beds and mud flats. As shown in Figure 1 the dump covered quite a large area by 1961.

The year 1964 saw a marked decrease in the Cormorant and Grebe populations in the river because of the first continued use of the river, immediately above the causeway, by power boats and skiers. This activity commenced in December 1962. The Coots also seemed to be detrimentally affected. They were present in strength in 1962, but only two appeared in the 1963-64 season.

Although the boat club used a ski jump, large modifications to the physical aspects of the environment did not commence until a large fleet of trucks started covering a strip of mud in order to re-route the Great Eastern Highway. They carted the initial sand from where the State Government offices now stand near Kings Park. This was dumped at depths of 6 to 8 feet over the salt marshes in line with the new highway route.

After this the dumping of filling and rubbish accelerated until the whole area was completely altered, a great loss to the bird fauna of the Swan River.

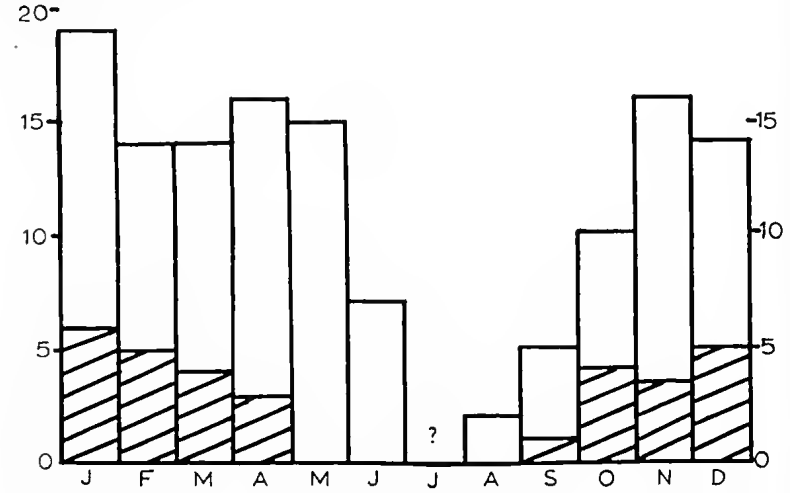

Fig. 3.—Column graph showing monthly means for the number of species present at the Causeway during 1961-1965 inclusive. The shaded component represents the proportion and number made up by migratory waders.

SYSTEMATIC LIST OF SPECIES

Hoary-headed Grebe, *Podiceps poliocephalus*.—Quite often present. The most seen was 15 on 29 April 1962. The area was too tidal for it to breed.

Australian Pelican, *Pelecanus conspicillatus*.—Three to 8 often seen "sailing" in the river or fishing in the backwaters for the schools of fish that occurred there. At times groups of up to 30 (24 December 1961) were seen spiralling in the air currents to great heights.

Black Cormorant, *Phalacrocorax carbo*.—Common but not abundant and rarely seen after the ski club took occupation of the river in December 1963.

Little Black Cormorant, *Phalacrocorax sulcirostris*,—Common but not abundant, except on 9 May 1963 when 70 were seen flying downstream.

Pied Cormorant, *Phalacrocorax varius*.—The least common of the

cormorants and seen only during summer months—apparently liking only salt water.

Little Pied Cormorant, *Phalacrocorax melanoleucos.*—Present mainly during the summer months.

White Egret, *Egretta alba.*—One to 6 often seen in Communities IV and V until the middle of 1963.

White-faced Heron, *Ardea novaehollandiae.*—Nearly always present throughout the year in Communities II, III and IV. The most seen were 31 on 18 February 1965.

White-necked Heron, *Ardea pacifica.*—One only seen, 10 February 1963.

Straw-necked Ibis, *Threskiornis spinicollis.*—Up to 6 were seen in December 1961 and could have constituted a portion of the birds which move down the western edge of the Darling Scarp to the Pinjarra breeding area in the summer.

Black Swan, *Cygnus atratus.*—The numbers started falling off during 1963. Birds were most abundant from April to June. For 1962 these were the only months they were seen. Sometimes birds flew in during the day but more often they were heard calling as they flew over nearby Victoria Park during the night.

Mountain Duck, *Tadorna tadornoides.*—One to three were seen at odd times up to February 1963.

Black Duck, *Anas superciliosa.*—These birds often mixed with the Grey Teal on the mud-flats of the inlet but were just as often found on the open waters of the river. Before their decline in 1963-1965 groups of up to 35 were fairly common. They seemed to prefer the protection and easy food provided at city parks such as Queen's Gardens, Hyde Park, Shenton Park Lake and Monger's Lake.

Grey Teal, *Anas gibberifrons.*—An abundant bird making particular use of the mud flats. Although up to 240 were seen the bird was rare during winter and spring when presumably it made use of areas normally dry during summer. The bird showed no signs of decline until after February 1965.

Introduced ducks.—The area often contained a Khaki Campbell or a black and white escapee.

Black-shouldered Kite, *Elanus notatus.*—A single bird seen a number of times in 1962. There were two birds seen in May of the same year.

Swamp Harrier, *Circus approximans.*—A common though brief visitor to the area. If there were no dead birds the individual moved on after half an hour or so.

Brown Falcon, *Falco berigora.*—An occasional visitor.

Nankeen Kestrel, *Falco cenchroides.*—A fairly regular predator in this area.

Little Falcon, *Falco longipennis.*—Two seen on nearby Heirisson Island.

Quail.—A large quail was noticed dead in the *Salicornia* in 1962, but the corpse was missing when I went to collect it.

Western Swamphen, *Porphyrio porphyrio.*—One or two occasionally seen in Community II.

Coot, *Fulica atra.*—The middle of March 1962 saw an influx of birds onto the open water immediately above the southern arch of the causeway. By May some were penetrating the inlet but most dived for the brown weeds of the river. The numbers steadily rose until about 10 June when I counted 180 birds. In the following year two birds were seen—the last my records show.

Banded Plover, *Zonifer tricolor.*—Small groups fly over more often than land in the area. They prefer the grassed areas of Langley Park, Heirisson Island and the old Maylands airport.

Grey Plover, *Pluvialis squatarola.*—Not common, only seen on nine occasions when one to ten individuals were present.

Eastern Golden Plover, *Pluvialis dominica.*—It is interesting that although this plover is much less plentiful in south-western Australia than the Grey Plover (vide Serventy and Whittell) it was more common at

the Causeway. It was seen in groups of 3 to 60 on 31 occasions. Only seen between September and April. Birds were seen in both these months in 1962; the year when I saw quite a few hundred waders leave the Swan River Estuary and fly north over Kings Park on 21 April. Not quite four months later (13 September) some of the 7 Golden Plovers seen at the Causeway were still in breeding plumage. Of course these birds may not have been in the group that left on 21 April. Since the area's habitats have been destroyed I have seen 8 on nearby Heirisson Island (1967).

Black-fronted Dotterel, *Charadrius melanops.*—Two or three seen several times during April and May of 1962.

Red-capped Dotterel, *Charadrius ruficapillus.*—A common bird but I never saw it during winter. Numbers varied between one and 150 on 35 visits, giving a mean count of 35 birds.

Eastern Curlew, *Numenius madagascariensis.*—One or two recorded on 18 occasions between September and March.

Little Whimbrel, *Numenius minutus.*—One seen on 20 December 1964.

Bar-tailed Godwit, *Limosa lapponica.*—Four seen twice during October 1962.

Common Sandpiper, *Tringa hypoleucos.*—One or two seen occasionally—but seen more often on the stone wall around Heirisson Island.

Greenshank, *Tringa nebularia.*—One to four regularly seen. From my observations this bird would seem to leave and return later than the other migratory waders (early May and late October).

Curlew Sandpiper, *Erolia ferruginea.*—This was a fairly common resident of the muddy areas during summer. Numbers varied from one to 75.

Little Stint, *Erolia ruficollis.*—Although the most common of the migratory waders in Australia, the largest number seen in this area at any one time was only 130. There was a mean of 41 over 28 of my visits. This is small when compared with the 4,000 that I have seen at another part of the Swan River.

Sharp-tailed Sandpiper, *Erolia acuminata.*—This was the most common migratory wader at the Causeway. It was present on 27 of my visits with an average of 74 birds and a range of four to 350.

White-headed Stilt, *Himantopus himantopus.*—Groups of one to 40 fairly common.

Avocet, *Recurvirostra novaehollandiae.*—Their numbers reached a peak each summer, 260 were the most birds ever seen. Over 37 trips the mean number observed was 68.

Silver Gull, *Larus novaehollandiae.*—In consequence of the rubbish tip having been started before I commenced this study this species was present in every month of the year; 650 birds was the maximum counted.

Caspian Tern, *Hydroprogne caspia.*—One to 7 birds seen fishing in the river or resting on the sandy beach.

Crested Tern, *Sterna bergii.*—About as common as the Caspian Tern; 9 being the most seen.

Fairy Tern, *Sterna nereis.*—This species was not nearly as common as on other parts of the Swan River. Two only seen twice in 1963.

Welcome Swallow, *Hirundo neoxena.*—Small numbers seen each year during the December to March period.

Australian Tree Martin, *Petrochelidon nigricans.*—More common than the swallow. The only months when it was not seen were October and November.

Australian Pipit, *Anthus novaeseelandiae.*—A common inhabitant of the area; found nesting during August on Heirisson Island.

Brown Songlark, *Cinclorhamphus cruralis.*—Up to 4 were seen during 1962-63 (December, January, June).

Little Grass-bird, *Megalurus gramineus.*—Up to 6 recorded in the Giant-Rush beds of Community II. This area was ideal for rush birds and although I never heard the Reed Warbler I am sure it must have been there in the earlier years.

Blue-and-White Wren, *Malurus leuconotus.*—I have seen up to 6 including at times a fully plumaged male. These sightings were made on

Heirisson Island during 1962-63. This is their southernmost known limit (vide Serventy and Whittell).

White-fronted Chat, *Epthianura albifrons*.—Found only in the warmer months. The range being one to 20 though I have seen 40 on Heirisson Island.

ACKNOWLEDGEMENTS

I would like to acknowledge help given by Dr. D. L. Serventy and Miss C. A. Nicholls in the early stages of bird identification. Also Messrs. A. S. George, T. E. H. Aplin and B. Maslin of the Western Australian Herbarium for help in identification of plants.

BIRDS OF THE GIBB ROCK AREA

By E. H. SEDGWICK

Summary

An annotated list of 89 species identified at Gibb Rock 309 km just south of east of Perth, between 1966 and 1973, with more detailed notes on the effects of progressive farm development on the status of particular species as the originally virgin sandplain-mallee habitat becomes modified.

GENERAL DESCRIPTION OF AREA UNDER CONSIDERATION:

Gibb Rock is 61 kilometres E.S.E. of Narembeen and 32 kilometres N.N.E. of Hyden.

Just south of Gibb Rock is 'Sedgmoor', Location 2672, the property in which the writer is interested. This was acquired and has been developed by Malcolm C. Sedgwick (M.C.S.). It was in a primitive state—typical sandplain-mallee country. A shed was built and clearing commenced in late 1966 and 200 hectares of crop put in in May, 1967. The first dam was put down in 1969, but remained dry until filled by summer rains in February, 1970. At the time of writing, 810 hectares—nearly half of the property—have been cleared and cultivated.

An unusual feature of the farm is a natural soak, almost circular and 1.3 hectares in area. As this soak at times provides almost a hectare of open water, it is probable that the original avifauna included water-frequenting birds of several species which would not have occurred if the soak had not been there.

Landmarks mentioned are: The Humps, 17 kilometres S.S.W., Wave Rock, 29 kilometres in the same direction; Holleton, 27 kilometres N. and Mount Walker, 27 kilometres W.N.W.

NATURAL VEGETATION OF MAIN STUDY AREA:

Vegetation is of the mallee-scrub-plain type. Salmon Gum *(Eucalyptus salmonophloia)* and Wandoo *(Euc. wandoo)* occur very sparingly and there are thickets of Gimlet *(Euc. salubris)*. Mallee forms, occurring mainly in loose, scattered, clumps, are Tall Sandplain Mallee *(Euc. eremophila,* Lerp Mallee *(Euc. incrassata),* Oldfield's Mallee *(Euc. oldfieldi)* and Morrel *(Euc. longicornis)*.

Casuarina acutivalvis, locally known as Wodjil, dominates considerable areas in which mallees do not occur. Shrubs of the Family Myrtaceae form another dominant element.

Other plants occurring in the area are: *Acacia graffiana, A. merrallii, A. multispicata, Exocarpus aphyllus, Grevillea hookeriana, G. sluttleworthiana, Hakea coriacea, H. falcata, H. platysperma, Conesperma volubile, Dryandra (sp.), Astartea heteranthera, Thryptomene kochii, Micromyrtus imbricata, Chamaelaucium megalopetalum, Verticordia acerosa, V. chrysantha, V. insignis, Calytrix ?brachyphylla, Beaufortia micrantha, Mirbelia floribunda, Hibbertia exasperata, Leucopogon woodsii, L. dielsianus, Brachyloma concolor, Eremophila drummondii, Phebalium filifolia, P. tuberculosum var. tuberculosum, Synaphea (sp.), Drummondita hassellii, Pimelea angustifolia, P. sylvestris, Olearia muelleri, Dampiera wellsiana, Leschenaultia formosa, Drosera macrantha, Caladenia cairnsiana, C. roei, C. saccharata, C. filamentosa, Pterostylis vittata.*

This list is not exhaustive, of course. Specimens of plants, in blossom where possible, were collected from the area being cleared, as opportunity offered, in a largely random manner.

OBSERVED ORDER OF APPEARANCE OF FARMLAND SPECIES FOLLOWING CLEARING AT 'SEDGMOOR'

Welcome Swallow	—	March 1967
Australian Bustard	—	March 1967
White-fronted Chat	—	March 1967
Western Magpie	—	March 1967
Banded Plover	—	May 1967
Australian Pipit	—	August 1967
Willy Wagtail	—	August 1967
Hooded Robin	—	May 1968
Stubble Quail	—	December 1968
Australian Dotterel	—	May 1969
Chestnut-breasted Shelduck	—	March 1970
White-faced Heron	—	May 1970
Brown Songlark	—	September 1970

Since 1966 the writer has visited the property at least twice annually, the two principal visits in each year being in May and in late August and early September, so that most of his personal observations are confined to those periods.

ACKNOWLEDGEMENTS

Assistance from the officers of the Western Australian Herbarium who identified specimens of plants taken in the area cleared for cultivation, and from my son, Lindsay Sedgwick, who provided information on the Eucalypts which he had collected in this area, is gratefully acknowledged.

LIST OF SPECIES

Emu, *Dromaius novaehollandiae*.—Single birds and parties of up to twelve have been seen from time to time. A disused nest with two intact eggs and a few egg shells was found in mallee scrub in September 1972.

Little Grebe, *Podiceps novaehollandiae*.—In May 1971 a few birds were present on the large soak on "Sedgmoor" which had been filled by heavy rains in March. As partly submerged tea-tree provided ample cover, the number present could not be determined. The birds were calling frequently. When I revisited the area in August, Little Grebe were present and calling.

Hoary-headed Grebe, *P. poliocephalus*.—In May 1968 one bird was seen on a dam between Narembeen and Mt. Walker. Two birds in breeding plumage were present on a dam at Holleton on September 5, 1971.

White-faced Heron, *Ardea novaehollandiae*.—On August 29, 1968, I encountered one bird by a temporary pool at the foot of Mt. Walker. I first saw herons at "Sedgmoor" on May 18, 1970. These two birds were in flight, but had probably been at the dam put down in 1969, but dry until February 1970.

Chestnut-breasted Shelduck, *Tadorna tadornoides*.—Observed, usually by dams, on the well established farms between Narembeen and Mt. Walker, but not seen at "Sedgmoor" until early 1970 when M.C.S. recorded two at the dam mentioned in the previous note. Two birds were again recorded in May 1972.

Grey Teal, *Anas gibberifrons*.—Noted by a dam on farmland between Narembeen and Mt. Walker on March 27, 1967 and first seen at "Sedgmoor" on May 17, 1971 when I found c. 200 birds on the Soak, which had been filled by cyclonic rains in late March. These birds were easily alarmed and flushed several times while I was working in the vicinity. The following day they were gone, but on May 25 birds were again present. On August 2, only two birds could be seen and these took cover in the partly submerged tea-trees.

Maned Goose, *Chenonetta jubata*.—In 1968, I flushed c. 20 birds from a roadside pool c. 5 kilometres west of "Sedgmoor" and a week later saw three birds by a dam c. 5 kilometres west of Mt. Walker. In

September, I saw three birds in flight c. 10 kilometres south of "Sedgmoor".

Black-shouldered Kite, *Elanus notatus*.—Two birds seen over "Sedgmoor" in September 1967 were probably of this species. M.C.S. identified the species definitely early in 1970 when he observed one hovering over the farmland. Others have been noted between Mt. Walker and Narembeen.

Collared Sparrowhawk, *Accipiter cirrocephalus*.—One bird observed on a heap of roots in the farmyard on August 30, 1968. Almost certainly a eock bird, it appeared quite small in contrast with a Raven perched nearby.

Little Eagle, *Hieraaetus morphnoides*.—A bird seen at a distanee on September 3, 1968 was apparently of this species.

Wedge-tailed Eagle, *Aquila audax*.—M.C.S. reported two rather light coloured birds at "Sedgmoor" on March 1, 1969. On August 30, 1970, I saw one bird over the uncleared part of the property and two days later saw one bird rather persistently pursuing a *Corvus* over one of the sheep paddocks. On August 23, 1969, I flushed one bird from the roadside near the Humps, a rock outcrop between Hyden and Gibb Rock.

Spotted Harrier, *Circus assimilis*.—One was seen on May 16, 1970, flying low over a sheep paddock. On May 17, 1972, one bird was observed in the same area.

Little Falcon, *Falco longipennis*.—One bird noted in a tree 13 kilometres east of Narembeen on May 20, 1967.

Brown Hawk, *F. berigora*.—One bird was noticed on "Sedgmoor" shortly after clearing commenced and by May 1967 had become very confiding, permitting an approach to within five metres. The following May two birds were present and taking a keen interest in farming operations. However by August 1968 neither bird could be located. This pair was replaced early in 1969 by a bird lighter in colour than the original one and much more wary. This, or a similar bird, is still present.

Kestrel, *F. cenchroides*.—These birds occur throughout the general area. I first recorded one on the farm in May 1967 and have since seen individuals occasionally during both May and August visits. The presence of these birds in August is not surprising, but I would not have expected them in this part of the wheatbelt in May.

Mallee-fowl, *Leipoa ocellata*.—In September 1966 we obtained good views of single birds by the roadside near Hyden. None has been seen on the farm, but I have located five nests within, or adjacent to, the boundaries. All were in fair order, but I have no evidence of recent use. M.C.S. has seen a bird of this species ten kilometres to the north-west of the farm on the Gibb Rock road and another bird sixteen kilometres to the south-west.

Stubble Quail, *Coturnix pectoralis*.—This species was first noted on December 29, 1968. While working in the wheat crop we located a walnut-sized chick, still in the down, but active. When pressed, it 'froze' and when touched it closed its eyes. We found a nest in a clump of mallee suckers. This contained the shells of two eggs apparently hatched normally. Since that time birds appear to have been present on cultivated areas, but in fluctuating numbers. In late August 1969 birds were calling both day and night, particularly about the time of the full moon on August 27. Observations since made at the same period indicated no activity in 1970 and 1972 and only daylight activity in 1971.

Little Quail, *Turnix velox*.—A bird seen by vehicle headlight as it moved from a fallow into a shelter belt appeared rather small and could have been of this species. On August 27, 1972, I saw three small quail in an aviary on Mr. Wm. Lang's Gibb Rock property. One bird was larger than the other two, presumably a female. At least one had a distinct white median stripe on the crown. The birds lacked a hind toe. They had been taken locally, from the same nest, in a crop.

Australian Bustard, *Eupodotis australis*.—On March 24, 1967, I noted the remains of a bird apparently killed by poachers at a camp near Gibb

Rock. In May 1968 pairs of birds appeared on "Sedgmoor" and on an adjacent property. Mr. A. Powell, the owner, was anxious to preserve his birds and urged us not to shoot ours! M.C.S. observed that at "Sedgmoor" the birds appeared from the scrub-plain to the south, usually late in the afternoon. In August 1969 two birds were again appearing in the same area. In August 1960, M.C.S. reported two birds on another part of the property and further records were made in the summer of 1970-71. This limited evidence suggests spring-summer occurrences. One was flushed from a sheep paddoek in September 1972. A little previously, thirteen birds had been seen on Mr. Powell's property.

Banded Plover, *Zonifer tricolor.*—Plovers appeared on the farm shortly after the completion of the initial elearing operations. Seven birds were present on newly ploughed land in May 1967. Birds have remained without marked increase in numbers. A nest with four eggs was located on August 21, 1971 and young chicks reeorded on May 24 and 25, 1971. A young bird was noted in early September 1972.

Australian Dotterel, *Peltohyas australis.*—On September 3, 1968, I saw two birds at the roadside six kilometres south of "Sedgmoor" and in the following May M.C.S. reported the species present on cultivated land on the farm. I saw one. Thereafter birds have been seen frequently in flocks of up to twenty and perhaps even more. Mating was observed in May, nests with eggs in February, April, May and June, downy chicks in May, June and September and distraction display in February, May and August, suggesting that breeding occurs from February to September inelusive. It appears possible that breeding is triggered by falls of rain, but further data on this are desirable.

White-headed Stilt, *Himantopus himantopus.*—In late August 1968 we located three birds on salt pans just east of Narembeen.

Southern Stone-Curlew, *Burhinus magnirostris.*—Two calls—not a sequence—whieh I attributed to this species, were heard in the early hours of August 27, 1972, a moon-lit night, Mr. Wm. Lang of Gibb Rock, has heard these birds on two occasions and once encountered two, an adult and a young bird, 16 kilometres to the south. He captured the young bird for examination.

Common Bronzewing, *Phaps chalcoptera.*—In March and May 1967 I saw birds in the vicinity of the farm and, in August, on the farm. Since then we have seen them from time to time, usually on eultivated land adjacent to scrub-plain. Birds have also been seen at the Humps.

Crested Pigeon, *Ocyphaps lophotes.*—Parties of up to at least twelve have been noted throughout the district. The first record for the farm was on September 2, 1969, when two flew from a fallow and perched in the southern boundary fence. It is possible that the birds occur in above average density in the vicinity of the Mount Walker wheat bin.

Purple-erowned Lorikeet, *Glossopsitta porphyrocephala.*—First noted at "Sedgmoor" in March 1967 and recorded in the vicinity from time to time during 1967-68-69.

White-tailed Black Cockatoo, *Calyptorhynchus baudini.*—On September 3, 1969, c. twelve birds flew over the farm.

Red-tailed Blaek Cockatoo, *C. banksi.*—M.C.S. has observed that both species of black coekatoo oecur near Narembeen.

Galah, *Cacatua roseicapilla.*—Galahs are fairly frequent on the established farms in the district. So far only single birds or small flocks have visited "Sedgmoor", the first recorded appearing over the cleared area in August 1967.

Regent Parrot, *Polytelis anthopeplus.*—Our reeords are few—one on May 13, 1967 sixteen kilometres east of Narembeen, onc on or about September 1, 1967 in flight over the cleared portion of the farm and birds were thrice noted in flight over the farm between August 23 and September 2, 1969.

Western Rosella, *Platycercus icterotis.*—Noted twenty-one kilometres east of Narembeen and, one bird, just south of "Sedgmoor".

Port Lincoln Parrot, *Barnardius zonarius.*—Occurs in both developed and undeveloped areas—mainly mallee—but is not particularly frequent.

Mulga Parrot, *Psephotus varius.*—Noted at Mount Walker and in mallee just south of "Sedgmoor".

Elegant Parrot, *Neophema elegans.*—Recorded five kilometres west of Hyden and, sparingly, between Narembeen and Gibb Rock.

Pallid Cuckoo, *Cuculus pallidus.*—Heard and seen in August-September 1967, heard calling in August-September 1968 and seen at Hyden in September 1972. Most records were made where cleared land adjoined bushland.

Fantailed Cuckoo, *Cacomantis pyrrhophanus.*—Noted, calling, in Gibb Rock area in September 1968, May 1969, August 1969, August-September 1970 and May 1971. In August 1970, I noted this species at the Humps also.

Narrow-billed Bronze Cuckoo, *Chrysococcyx basalis.*—Seen and heard in August 1967. Noted calling in September 1968, August 1969, August-September 1970 and August 1971, always in uncleared areas. This species was also recorded at the Humps in August.

Boobook Owl, *Ninox novaeseelandiae.*—M.C.S. reported a bird roosting in the farm shed. Pellets and excreta were present on a truck which had been standing under one of the roof transoms.

Winking Owl, *N. connivens.*—On September 6, 1968 while walking through a stand of gimlet *(Eucalyptus salubris)* and mallee along the northern boundary of the farm, I flushed two birds from, I think, a height of one metre or less. I could not relocate them. One evening, at a later date, I heard calls from the same area.

Barn Owl, *Tyto alba.*—In May 1970, while driving after dark, owls were twice seen on a sub-dividing fence on the farm. In September 1970, a bird was flushed on a neighbour's property. When we returned about thirty minutes later, a bird again rose from a fence post.

Tawny Frogmouth, *Podargus strigoides.*—A bird flushed in the deep dusk from farmland was probably of this species and in August 1971, I flushed two birds from the ground in mallee adjacent to the farm.

Spotted Nightjar, *Eurostopodus guttatus.*—During the evening of August 31, 1968, I heard calls of this species from scrubland adjacent to the farm. On August 30, 1970, I twice flushed a bird from mallee with undergrowth of shrubs. M.C.S., on November 7, 1971, located and photographed a bird sitting on one egg in the same general area.

Rainbow bird, *Merops ornatus.*—In late December 1967 birds were in evidence in and about a patch of native vegetation left in one of the farm paddocks. No further records have been made.

White-backed Swallow, *Cheramoeca leucosternum.*—On September 6, 1966 one bird was seen just west of Hyden, near a sandy excavation. In May 1968, a few were seen, associated with Tree Martins, over "Sedgmoor" and in August 1968 two birds were seen travelling over farmland.

Welcome Swallow, *Hirundo neoxena.*—In March 1967 birds were present in the farm shed and were hawking over adjacent scrub-plain. Since that time birds have been about the shed, usually only one or two at a time. An unsuccessful breeding attempt was made in August-October 1971.

Tree Martin, *Petrochelidon nigricans.*—At dusk on May 26, 1967, a considerable number of birds, almost certainly of this species, drifted across the scrub-plain. In late August 1967, the species was definitely recorded at "Sedgmoor" and in May 1968, individuals were observed with White-backed Swallows, as noted above. Birds have also been seen at the Humps and at Holleton.

Australian Pipit, *Anthus novaeseelandiae.*—In March 1967, birds were noted between Narembeen and Gibb Rock. In August 1967, birds were observed on the farm and by May the following year were well-distributed. Since that time birds have been numerous in the cleared areas. In September 1970, I located a nest with three eggs in a wheat crop.

Black-faced Cuckoo-shrike, *Coracina novaehollandiae*.—Birds noted occasionally, mainly in uncleared areas, and once at the Humps.

Southern Scrub-robin, *Drymodes brunneopygia*.—First noted on September 7, 1966, when I was making my first inspection of the block. Its presence in numbers was confirmed in March 1967. Clearing has driven the species from the farmland, but it is still a frequent species in uncleared areas. M.C.S. located a nest with one egg on September 2, 1967. We have also noted the species at Holleton.

White-browed Babbler, *Pomatostomus superciliosus*.—This is another species noted on the initial visit to "Sedgmoor". Other records have been made since on or near the farm, between Narembeen and Gibb Rock, at the Humps and in *Eucalyptus* forest at Holleton.

Brown Songlark, *Cinclorhamphus cruralis*.—Noted only in September 1970 when a bird appeared in the wheat crop. Its call seemed rather tentative and weak. Later the bird—a cock—was seen perched on a fence post.

Blue-breasted Wren, *Malurus pulcherrimus*.—Located from time to time on uncleared parts of the property and once in a shelter belt of native vegetation. This species was also noted at Holleton. All records have been made during my August-September visits, but this may not be significant.

Western Warbler, *Gerygone fusca*.—Calling at the Humps on August 29, 1970.

Broad-tailed Thornbill, *Acanthiza apicalis*.—This has proved one of the most frequent species in uncleared areas and one which has a tendency to persist while any cover remains. A few remain in the shelter belts. A nest with two eggs was located on August 25, 1969. This species was noted at Holleton.

Chestnut-tailed Thornbill, *A. uropygialis*.—Noted in *Eucalyptus salmonophloia* forest at the Humps, but its presence at Gibb Rock has still to be confirmed.

Yellow-tailed Thornbill, *A. chrysorrhoa*.—This species occurs in forest at the Humps, near Hyden, and on the farmlands east of Narembeen, but has not yet been located at Gibb Rock.

Weebill, *Smicrornis brevirostris*.—Weebills were noted on our initial visit to the farm block. They are encountered consistently wherever eucalypts grow. Weebills are present at Holleton, the Humps, and Wave Rock also.

Shy Ground Wren, *Hylacola cauta*.—This was one of the first species noted, on September 6, 1966. My only other encounter was on September 6, 1970. In both instances the birds were in scrub-plain vegetation and permitted a close approach. Indeed, in the first instance the birds spent some time observing us closely.

Field Wren, *Calamanthus fuliginosus*.—This was almost certainly the most frequent species on the farm. These birds disappear when the land is cleared, but they desert only in the last stages of clearing: while any cover remains, e.g. in areas chained and burned, they persist. Shelter belts provide them with adequate cover. In May 1967 I twice observed birds taking bread from our camp rubbish heap. Usually a bird picked up a beakful and ran to the adjacent scrub.

White-fronted Chat, *Epthianura albifrons*.—These birds appeared on the farmland as soon as cultivation commenced. We recorded them on burned areas, but they appear to favour the cultivated land and have increased in frequency, flocks of c. 20 birds being encountered.

Crimson Chat, *E. tricolor*.—These birds appeared and were recorded by M.C.S. in September 1970. They frequented the roadside along the western boundary of the farm. There were twelve to fifteen birds. They remained until early 1971 and probably disappeared at the onset of the winter rains. They were noted by two neighbours on farm properties to the west as 'strangers' in the area, so it would appear that there were at least three flocks in the vicinity.

Brown Flycatcher, *Microeca leucophoea*.—Not yet sighted, but while working near the northern boundary of the farm on May 27, 1971, I heard a 'peter-peter' call which I attributed to this species.

Red-capped Robin, *Petroica goodenovii*.—First recorded on May 17, 1968—a bird calling on the edge of a clearing. In May 1969 a bird was calling from one of the shelter belts and in May 1972 one was perched on a fence beside a shelter belt. I have recorded the species in salmon gum forest at the Humps.

Hooded Robin, *P. cucullata*.—On May 18, 1968, I encountered a pair of Hooded Robins flitting from heap to heap of stacked roots in a newly cleared paddock. In May 1971, a hen bird was present near the house, frequenting mainly the posts of the farmyard fence, and in May 1972 a cock bird was observed on a fence near the homestead dam.

Western Yellow Robin, *Eopsaltria griseogularis*.—Recorded in mallee adjacent to the farm on three occasions—August 1969, August 1970 and August 1971. The fact that all are August records is probably not significant: work pressures are less in August than in May.

Grey Fantail, *Rhipidura fuliginosa*.—Noted in mallee adjacent to the farm on September 1, 1968 and on May 22, 1969. On August 29, 1970, I encountered the species in forest undergrowth at the Humps.

Willy Wagtail, *R. leucophrys*.—In August 1969, I located two birds in undisturbed mallee just south of the farm and in August 1971, I again located two birds in the same area. Two birds took up residence near the house, which had been occupied since the previous October, at some time prior to May 15, 1971. However, I did not see these in August. There was a pair at the soak, which is surrounded by a belt of mallee. In May 1972, a pair was again present at the house and there appeared to be at least two other pairs on the developed portion of the farm. In August 1970, I recorded the species at the Humps.

Golden Whistler, *Pachycephala pectoralis*.—These birds occur in mallee adjacent to the farm.

Rufous Whistler, *P. rufiventris*.—Recorded in salmon gum forest at the Humps on August 29, 1970.

Western Shrike-Thrush, *Colluricincla rufiventris*.—Noted in mallee on and adjacent to the farm on a number of occasions. It also occurs at the Humps in salmon gum forest.

Crested Bellbird, *Oreoica gutturalis*.—Apparently fairly widespread in scrub plain areas both on and adjacent to the farm. Also recorded at the Humps.

Red-tipped Pardalote, *Pardalotus substriatus*.—Recorded in mallee on a number of occasions during both May and August visits. I have recorded the species at the Humps and at Holleton also.

Brown Honeyeater, *Lichmera indistincta*.—Noted fairly frequently in mallee areas on or adjacent to the farm, but all my records have been made in August-September visits. This may be significant, as at least two species of the mallees frequented are blossoming at that time. Also noted at the Humps on August 29, 1970.

Singing Honeyeater, *Meliphaga virescens*.—These birds are not particularly frequent in this area—they are usually outnumbered by at least three other honeyeaters—the Brown, the Tawny-crowned and the White-eared. They occur mainly in the mallee areas at Gibb Rock, in forest at the Humps and in roadside vegetation between Narembeen and Gibb Rock.

Yellow-plumed Honeyeater, *M. ornata*.—Recorded once, on August 29, 1971 in a few Wandoo *(Eucalyptus wandoo)* trees—the only large trees in a predominantly mallee area.

Purple-gaped Honeyeater, *M. cratitia*.—I located a flock of these birds in mallee adjacent to the farm on May 20, 1970 and re-located them on each subsequent visit until May 1972.

White-eared Honeyeater, *M. leucotis*.—This characteristic mallee species is fairly frequent in mallee on and adjacent to the farm and has been noted on all visits, including May 1972 when, due perhaps to drought conditions, few other birds were observed. This species occurs at Wave Rock also.

Brown-headed Honeyeater, *Melithreptus brevirostris*.—Recorded fairly consistently in mallee areas.

Tawny-crowned Honeyeater, *Gliciphila melanops*.—Frequent and well-distributed in sand-plain areas. On the farm it has shown some tendency to persist in shelter belts and other remnants of native vegetation.

White-fronted Honeyeater. *Phylidonyris albifrons*.—Recorded on only one occasion, on May 20, 1970, in mallee just to the south of the farm.

Dusky Miner, *Manorhina flavigula*.—Not observed at "Sedgmoor", but birds have been observed between Narembeen and Gibb Rock and near the rabbit-proof fence between Gibb Rock and Holleton.

Red Wattle-bird, *Anthochaera carunculata*.—First noted in the "Sedgmoor" area on September 3 1970, but they have not proved to be frequent. At the Humps, in forest, they are much more conspicuous. At Holleton, too, they occur in forest.

Magpie-lark, *Grallina cyanoleuca*.—Birds may be seen at Mt. Walker and I have one record for farmland north of Gibb Rock. M.C.S. saw one bird on the farm shed in April 1972, but it did not remain. A similar visit took place in early September 1972. The species occurs in forest at the Humps.

Black-faced Wood-Swallow, *Artamus cinereus*.—Wood-Swallows occur between Narembeen and Gibb Rock. Birds were first noted on the farm in August 1967. In May 1968 birds were present in an area being cleared and were active during burning operations. There are other more recent records.

Grey Currawong, *Strepera versicolor*.—Noted on our first visit to the farm block in March 1966 and thereafter recorded fairly frequently, singly or in parties of up to six, both on the farm and throughout the district.

Grey Butcher-bird, *Cracticus torquatus*.—First noted on the farm on March 28, 1967, when birds were seen mobbing a (probable) Brown Hawk. More recent records from or adjacent to "Sedgmoor" are mainly for mallee areas.

Pied Butcher-bird, *C. nigrogularis*.—Birds have not yet appeared on the farm, but have been noted in Hyden, at the Humps and at Mt. Walker.

Western Magpie, *Gymnorhina dorsalis*.—In March 1967, six birds were present on the farm frequenting the newly cleared area but, in our absence, entering the shed either for shade or to forage. Eight birds were noted in May 1967. Since that time a flock has occupied a rather large territory comprising at least the cleared area, now 800 hectares. In May 1972, fourteen birds were present and these may comprise two flocks of eight and of six respectively. The birds were at first very wary, but now some at least seem more confiding. Calls differ from those of our coastal birds—a distinct dialect.

Raven. *Corvus coronoides*.—*Corvus* are widely distributed through the area. Birds found dead on the road—three—have all proved to be *C. coronoides*, though some calls heard at "Sedgmoor" have suggested *C. bennetti*, which occurs, no doubt, in this area.

NOTES ON THE HERBACEOUS VEGETATION OF THE EUCLA DISTRICT, W.A.

By B. M. J. HUSSEY, Mercedes College, Perth

INTRODUCTION

A considerable amount of botanical collecting has been done around Eucla, but mostly in the months of June-September. I visited the area in May 1973, when the ground was covered with a prolific growth of ephemerals due to heavy rains some six weeks earlier.

Willis (1959) lists the larger plants of the area and Johnson and Baird (1970) provide annotated descriptions of plants found at Forrest, some 70 miles further inland. However I can find no readily available published information on the herbaceous flora and these short notes are intended to fit into that gap.

Willis (1959) has described the various plant associations of the area in full, but a brief description is necessary here in order to set the scene.

Apart from the Hampton Scarp, an old cliff-line that reaches the coast

at Wilson Bluff just east of Euela, the land is a limestone plateau. Not completely level, however, it is very gently undulating in a series of clay-pans or "dongas" and ridges. From the coast to some 4-5 miles inland the ridges are covered by mallee scrub. The dongas have a flora of grass and herbs.

Northwards the trees thin out very rapidly leaving a few stunted Myall *(Acacia sowdenii)* on the ridges. In this area, both ridges and dongas have a flora of saltbush types, mainly from the family Chenopodiaceae, that have been well described elsewhere. Woodella Rockhole is 6.5 miles along the Reid road from the Euela Motel.

DONGAS IN THE MALLEE AREA

These seemed to be of two types, those with a lot of tussock grass (not identified) and those with little. Possibly, from the feel of the soil, the difference could be related to the amount of water that collects in them. Since the variation is subjective and not measured, the flora of both types will be described together.

The dominant plant was the Twinleaf, *Zygophyllum ovatum*, which was abundant and in full flower, presenting the appearance of a luxuriant rippling green meadow. Scattered among it were a number of other small plants, including *Trisetum pumilum, Auguillaria dioica, Kochia lobiflora, Stenopetalum lineare, Swainsona campestris, Erodium cicutarium, Oxalis corniculata, Euphorbia drummondii, Malva* sp., *Nicotiana goodspeedii, Brachycome ciliaris, Calotis hispidula*, and *Isoetopsis graminiflora.*

RIDGES IN THE MALLEE AREA

These supported relatively few herbs, but there were occasional patches of *Kochia lobiflora* and *Zygophyllum ovatum.*

WOODELLA ROCKHOLE

This is a sink-hole in the limestone found at the lowest part of a donga. It consists of a hole three feet across and four feet deep which contained water that was fresh but green. This lay in the centre of a roughly circular depression whose edges formed areas of shade and dampness where a variety of plants thrived.

Some of the plants were especially luxuriant examples of those already seen, eg. *Zygophyllum ovatum, Euphorbia drummondii, Brachycome ciliaris, Isoetopsis graminifolia.*

Fig. 1.—Woodella Rockhole.

However, a number of plants were found only at this and another rockhole. These were: *Eragrostis dielsii, Triglochin calcitrapa, Phlegmatospermum cochlearinum, Lepidium* sp., *Omphalolappula concava* (also at Wilson Bluff), *Crassula siekerana, Chenopodium album, C. melanocarpum,* and also a *Tetragonia* sp. that had large cabbage-sized leaves covered with shiny globules of transparent stuff making a very squishy "iee-plant".

AMONG SALTBUSH

The only annual was *Zygophyllum ovatum.*

ACKNOWLEDGEMENTS

Thanks are given to the staff of the Western Australian Herbarium, who identified the plants. Thanks also to my companions on the trip who put up very patiently with a lot of extra stops for botanising.

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A MIGRATION OF *VANESSA KERSHAWI* (McCOY) (LEPIDOPTERA: NYMPHALIDAE) IN WESTERN AUSTRALIA

By C. N. SMITHERS, The Australian Museum, Sydney

The period 17 to 23 August, 1973 was spent on a field trip from Perth through Moora, Carnamah, Mingenew, Morawa, Wongan Hills, Northam, Narrogin and Collie and back to Perth. This round trip coincided with a migration of the Painted Lady Butterfly *(Vanessa kershawi* (McCoy) and provided an unusual opportunity to observe its progression. This species is known to be a migrant (Smithers and Peters, 1966; Smithers, 1969) in eastern Australia; there are no published records of movement in Western Australia but migrations of varying extent are probably annual events, Mr. Noel McFarland *(in litt.)* having observed one near Geraldton in August, 1972.

From 11 to 22 August very few butterflies were seen in the Perth area and none were *V. kershawi;* the weather was intermittently suitable for butterfly activity.

On travelling north the first *V. kershawi* were seen 10 km south-east of Coorow where a count gave 6/½ hr./45 metres, all flying in a south-south-west direction. Similar counts, giving approximately comparable densities, were made at several points along the route given above between Coorow and Morawa on 18 August and Morawa and Pithara on 19 August; a few specimens were seen south of Pithara. The weather was windy and overcast along some of the route of the 19 August.

V. kershawi was not seen in the Northam area on 20 August and only an occasional specimen seen from York to Williams on 21 and 22 August. By 23 August, however, the species was common at Wellington Dam and southerly population movements were observed between there and Perth.

These observations indicate that a moving population had reached just south of Coorow by 18 August and that I travelled through it until reaching the Pithara area south of which only a few specimens were encountered. The movement clearly continued until I re-entered it at Wellington Dam on 23 August, by which time *V. kershawi* had populated the whole coastal area by immigration.

At a point 5 km north of Carnamah, where a large stand of mature, flowering *Helichrysum* occurred together with Capeweed *(Arctotheca calendula)* some specimens of *V. kershawi* were seen to be flitting around the plants whilst others were flying straight through the area in typical migratory flight largely ignoring the flowers and not settling on the larval food plants.

Also, a distinct maturity gradient was observed in the host plants, those in the Carnamah area being mature and in flower whereas those

in the Collie-Williams area were much younger. It seems likely that southerly invasion is timed to coincide with the state of growth of host plants.

Western Australia is clearly an area in which detailed studies on the movements of *V. kershawi* could be made; this note is published with the hope that further observations will be made and recorded on migration of this and other species in the State, for which very few insect migration records have been published.

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MECOPTERA AS VECTORS—A NEW RECORD

By G. J. KEIGHERY, University of W.A., Nedlands

The Order Mecoptera, in Australia, consists of some twenty species distributed in eight genera (Bornemissza, 1966, and Riek, 1954). In the adult stage they are slender, slow flying predators of soft bodied insects, e.g. bees, flies (Bornemissza, 1966). The largest and most widespread genus is *Harpobittacus* (fig. 1).

A note of blossom visitation by *Harpobittacus australis* was found in Riek (1970). He states that adults of this species obtain prey and nectar from flowers of a *Leptospermum sp.* at their emergence sites in Eastern Australia. He indicates that later in the season more species may be visited, but no details are given. From personal observations in Western Australia the author doubts that *Harpobittacus* would be likely pollinators of *Leptospermum;* bees, wasps and flies are the major visitors.

Fig. 1.—Adult of *Harpobittacus similis.*

No other records of blossom visitation could be obtained from the scattered Australian (e.g. Hamilton, 1919) or overseas literature (Faegri and Van der Pijl, 1971; Knuth, 1909 and Percival, 1965) on pollination. However, two other records were found in unpublished data. Symmington (1963) noted that *Harpobittacus similis* visits *Calectasia cyanea* R.Br. (Xanthorrhoeaceae). However, the author would consider that these visits are to obtain prey, since larval instars of a lygaeid bug were also found in these flowers, and Anway (1969) noted that *C. cyanea* is autogamous, pollination occurring in the bud stage. Kenneally (1970) has observed *Harpobittacus* sp. visiting flowers of *Diplopeltis huegelii* Endl. (Sapindaceae). These were noted to be obtaining nectar from male flowers.

The author has noted adults of *H. similis* actively foraging in the floral heads of *Podolepis lessonii* (Cass.) Benth. (Asteraceae) at Regans Ford and Jurien Bay. Also adults of this species have been observed systematically visiting the floral heads of *Eryngium pinnatifidum* Bunge (Apiaceae) at Cockleshell Gully (N. of Jurien Bay) and Yanchep. This is shown in fig. 2, a drawing from a kodachrome.

All the animals observed had a dusting of pollen over their heads and proboscises. No insects were found in the flowers, although many species visit these flowers. Nectar was, however, freely available and contact with the stigma was noted in both cases.

These, therefore, would appear to be the first records of members of this order as vectors. Since they are present in vast numbers during spring many small herbs and annuals in flower during this period may utilize these insects as vectors. Especially members of the families Apiaceae and Asteraceae (Composites) which are known to be promiscuously pollinated, e.g. Heywood (1971). More studies are needed to assess the importance of this genus to our native flora.

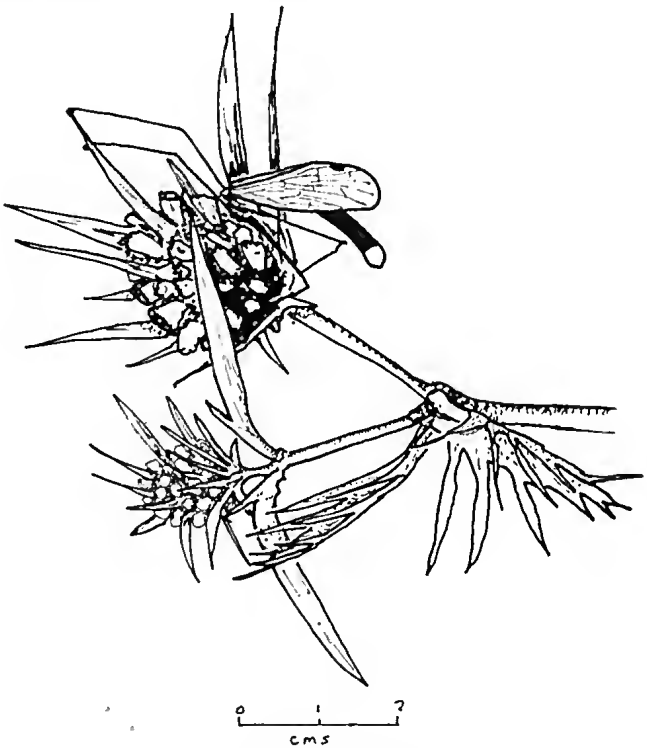

Fig. 2.—Adult *H. similis* foraging in floral head of *Eryngium pinnatifidum*.

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REPORT ON A VISIT TO DIRK HARTOG ISLAND, AUGUST-SEPTEMBER 1973, WITH SOME OBSERVATIONS ON THE FAUNA AND FLORA

By B. A. and A. G. WELLS, Scarborough

INTRODUCTION

Our visit to Dirk Hartog Island arose from a growing interest in the photography of the various Australian wren species. Since there had been little, if any, close up photography of the Pied Wren *(Malurus leucopterus)* which occurs only on Dirk Hartog and Barrow Islands, we chose this species as our special target for 1973.

WORKING AREA

It was initially decided to camp, and work, in the Quoin Bluff South area, thus gaining some benefit from observations made by R.A.O.U. members during their visit to Peron Peninsula in August-September 1972. (N.B. a closely similarly-named feature, Quoin Bluff North, is situated on Dorre Island, to N.E. of Dirk Hartog Island).

We were therefore fortunate in being able to establish our base at the Herald Bay Outcamp, situated midway between the Station homestead to the south and Sandy Point to the north, a total distance of about 35 kilometres, with Quoin Bluff as its focal point. The greater portion of our time was devoted to this area on the east coast, which includes mainly sandy country, with dense thickets of low scrub dominated by *Acacia, Diplolaena* and spinifex. In the vicinity of the Ten Mile Well, the vegetation is more open on flat ground. On the land rising to Quoin Bluff, ground cover consists almost entirely of dense low heath of *Thryptomene* with some *Plectrachne* (one of the species of spinifex common at Dirk Hartog Island).

F. Lawson Whitlock apparently searched this same general area on foot in 1920. When referring to the Australian Bustard, he wrote ". . . I seldom walked from my camp to the homestead (10 miles!) without seeing a young male bird . . ." We felt that today's observer in this kind of terrain, could well be handicapped by the four-wheel-drive vehicle, which may explain perhaps, to some extent, the non-appearance or non-observance in 1973, of some species so well described by this ornithologist over 50 years previously.

FLORA

Wildflowers appeared to be plentiful after a better than average winter rainfall. The following species were in flower and were photographed:

Abutilon oxycarpum F. Muell.
Brachycome latisquamea F. Muell.
Brachycome iberifolia Benth.
Calythrix strigosa A. Cunn.
Diplolaena grandiflora Desf.
Eremophila glabra (R.Br.) Ostf.
Halgania littoralis Gardn.
Jasminum calcareum F. Muell.

Pileanthus linnacis Labill.
Pittosporum phillyraeoides DC.
Pityrodia atriplicina (F. Muell) F. Muell. ex Benth.
Thryptomene baeckaecea F. Muell.
Westringia rigida R.Br.

MAMMALS

No feral cats were encountered although on one occasion fresh paw marks were found on recent tyre tracks some 14 kilometres from the homestead. No wild goats were seen, either during a day visit to the West Coast Mill where they were said to occur, or during a 2-day visit to Cape Inscription. No marsupials were observed; some limestone caves on the east coast were searched for skeletal remains—without success.

Trapping, with small "Elliot" folding live traps, was carried out on behalf of the Fauna Research Branch of the Fisheries and Fauna Department, in six localities in the main working area—360 trap-nights yielded two specimens of the Sandy Island Mouse *(Pseudomys hermannsburgensis)*.

REPTILES

The following reptiles were collected:

Heteronota bynoei (Bynoe's Gecko).
Diplodactylus spinigerus (Soft-spined Gecko).
Lerista praepedita (a burrowing skink).
Demansia psammophis reticulata (Coppertail).
Vermicella bertholdi littoralis (Bandy Bandy).
(Specimens registered W.A. Museum R44234-239).

There were also seen:

Pseudechis australis (Mulga Snake).
Nephrurus laevis occidentalis (Knobtailed Gecko).
Amphibolurus reticulatus (Netted Dragon).

BIRDS

Continuing unsettled weather with light rains extending even into the first week of September, and the early onset of the well known seasonal winds of Shark Bay ("southerly busters") considerably inhibited our prospects of photographing the wren species, even with specialised stalking equipment. Persistent winds confined these small birds to the undergrowth, and no evidence of nesting was observed until almost the last week of our stay.

It was significant that on one of the few warm windless days (September 5) B. A. W. found several nests of the Pied Wren and also parties of Emu Wrens with newly fledged young. This was due to her methodical searching of the sloping ground behind Quoin Bluff where she had established definite territories of at least four pairs. On the next day, when the winds returned, it became necessary to create "natural" windbreaks in order to obtain reasonable conditions for close-up photography of these two species.

In the following notes, all sightings were made and confirmed by both of us—unless otherwise stated. Several species of sea birds and waders were not identified.

Wedge-tailed Shearwater.—On the return journey to the mainland (15 September) in rough sea about 8 kilometres from Dirk Hartog Island, we ran close to a flock of about 100 birds—some resting on the water and others flying often very close to the waves. They were all of entirely dark coloration.

Pelican.—Frequently in groups of up to 15 on various sandy strips exposed by the tide.

Pied Cormorant.—Actively nesting in the large colony at Quoin Bluff containing an estimated 3,000 plus birds. A "raft" of some hundreds was seen on one occasion about 1 kilometre from the colony.

Reef Heron.—One or two birds often seen near each rocky point or reef. All were in the grey phase.

Wedge-tailed Eagle.—One bird seemed to inhabit the area of Ten Mile

Well. According to local information, numbers of these birds have been found after drowning in open tanks at various well sites. The lessee is concerned with this problem and is taking action to protect the species.

Australian Little Eagle.—Apparently not previously recorded on Dirk Hartog Island. We saw one bird, at a distance of 50 metres, standing on its prey (a skink) below the cliffs at Cape Inscription on September 3. Its size, coloration, feathered tarsi, and characteristic profile, left no doubt as to its identity.

White-breasted Sea-Eagle.—The old nest under the cliff at Quoin Bluff, contained two well advanced chicks on August 14. One appeared to be suffering irritation at the vent—it was found next day riddled with brown maggots similar to those infesting dead carrion brought to the nest. On one occasion, a live Pied Cormorant juvenile was seen carried to the nest from the colony below and fed to the juvenile. Pieces of fresh green foliage were also brought to the nest and changed daily. Predation on waders on the beach, south of the bluff was observed. One parent disappeared about the end of August. Some days later a recently drowned Sea-Eagle was extracted by station staff from an open tank at Ten Mile Well. Sea-Eagles appeared to be also inhabiting most of the main headlands on the east coast. On August 14, six birds were seen on the wing together high over Quoin Bluff.

Osprey.—Frequenting most rocky headlands—sometimes in spectacular aerial combat with Sea-Eagles. Old but active nests with eggs were found at four points including one just below the historic posts of Cape Inscription. An old nest on a low "grape" bush on the beach south of Quoin Bluff was occupied at times by two birds simultaneously, but no eggs were laid during the five weeks of our observation. At other times one bird was always close by—seemingly protecting its claim to this nest.

Nankeen Kestrel.—Apparently common throughout the island. Nesting in cliffs on the coast, and in old Little Crows' nests inland. On August 19 a Little Crow's nest in the Garden windmill contained 5 Kestrel eggs. On 30 August these had been replaced by one egg of a Little Crow. Another Little Crow's nest in the small mangrove at the neck of Tetradon Loop contained 5 well advanced Kestrel chicks on September 13.

Australian Bustard.—A party of 5 birds was often seen in our main area. A Bustard with one juvenile about one month old appeared on the track to the West Coast Mill on August 25. According to local information the bird is common on the island.

Pied Oystercatcher and **Black Oystercatcher.**—Both species frequently seen, either in mixed groups or singly. A nest of a Pied Oystercatcher contained 2 eggs on 15 August, and was vacated by September 2; 2 fledglings were on Sandy Point on 13 September. No nests of the Black Oystercatcher were found.

Banded Plover.—Inhabiting the open flat areas. One pair with three juveniles at the Ten Mile Well.

Red-capped Dotterel.—Several pairs feeding on edge of tidal salt pan south of Cape Inscription on 4 September.

Australian Dotterel.—One bird with two juveniles seen south of Quoin Bluff on 9 September.

Grey Plover.—Various sightings on beaches near Quoin Bluff. A flock was seen on the homestead beach on 14 September.

Turnstone.—Flock of eight on beach south of Quoin Bluff on 17 August.

Eastern Curlew.—Single birds seen on several occasions wading in shallows at low tide south of Quoin Bluff. A group of seven seen on 30 August.

Common Sandpiper.—One bird on beach 2 kilometres south of Quoin Bluff on 13 September.

Bar-tailed Godwit.—Flock of up to 10 birds at various times north and south of Quoin Bluff. A flock of 40 birds appeared at Tetradon Loop on 30 August.

White-headed Stilt.—Two adults with three immatures on water-covered saline flat close to beach north of Sandy Point on 4 September.

Southern Stone Curlew.—Frequently heard calling at night from the dense scrubland behind Herald Bay. A. G. W. flushed one bird during the day on 29 August.

Pacific Gull.—Occasional pairs sighted. One pair was seen with an immature bird, on the wing, over Quoin Bluff on 23 August.

Silver Gull.—Nesting in several places but more numerous at Quoin Bluff in association with the Pied Cormorant colony, where juveniles were seen at various stages. Predation on the Pied Cormorant nests was observed.

Caspian Tern and **Crested Tern.**—Both seen occasionally in small numbers. A large flock of about 200 of these two species was resting north of Sandy Point on 2 September. We did not see any nesting.

Common Bronzewing.—Two flushed by B. A. W. from acacia scrub at Herald Bay.

Domestic Pigeon.—One bird appeared daily on the main track near Ten Mile Well. It disappeared after a few weeks and was later recovered by station staff from a nearby well where it had recently drowned. It was noted there was water available in adjacent sheep troughs. The bird bore a leg band ND/PC 72 1039. This was later identified by the Southern Suburbs Pigeon Racing Club as belonging to one of a number of birds released on 4 August 1973 at Carnarvon in a normal Club race to Perth. It had been recorded that strong easterly winds caused a number of the birds to be lost or delayed.

Welcome Swallow.—Common. One pair nesting under our roof in the outcamp.

Australian Pipit.—Common. Nesting throughout August.

Pied Wren.—Fairly common over the whole area. No difficulty was experienced in "calling up" females, but males invariably fled with low flights of increasing distance, assisted by the persistent wind. The spectacular male thus had no difficulty in keeping out of camera range, and many hours were lost in unsuccessful pursuit. Whereas Whitlock found the Variegated Wren to be extremely shy and not so abundant as the Pied Wren, our experience differed.

Nesting at Quoin Bluff appeared to have taken place several weeks later than that in the northern part of the island where Pied Wrens inhabit the dense low Melaleuca heath. According to local information the winter rainfall was much heavier in the north. Nests found by B. A. W. in Quoin Bluff area were not more than half a metre from the ground, two in *Thryptomene* and one in saltbush, the latter being fairly easily seen.

Variegated Wren.—Common in our area and appearing to be more abundant than the Pied Wren. Fledglings were seen early in September. One nest with juveniles was found deep in a dense spreading *Acacia*—another was situated in a small open saltbush. We frequently noted females of this species attempted to draw us away from the nesting area by simulated "feeding chick" noises. This was not observed with other species of wrens.

Southern Emu-Wren.—Parties were seen on several occasions in low *Thryptomene* heath on Quoin Bluff, where *Plectrachne* also occurs. On 27 August at Herald Bay one pair was flushed from a dense *Acacia-Diplolaena-Triodia* thicket. Their behaviour ("rodent run" and broken wing displays) indicated nesting but a careful search failed to find the nest or fledglings. Fledglings were seen during the second week in September in Quoin Bluff area. On 14 August at Quoin Bluff, A. G. W. saw a male Emu-Wren with a clearly defined rufous crown. It differed markedly in this respect from other male Emu-Wrens of the same locality.

Spotted Scrub-Wren.—Common.

Western Grass-Wren.—We were not successful in making a positive identification.

Field Wren.—Seen at various times in vicinity of Quoin Bluff. One bird appeared to be nesting (carrying food) on 9 September.

Red-capped Robin.—On 3 September B. A. W. saw a male Red-capped

Robin on a ridge in the Cape Inscription reserve, where the tallest vegetation was an *Acacia* species.

Crested Bellbird.—Frequently heard calling from various points in the dense scrubland. We were not successful in our search for the bird.

Western Silvereye.—Common in the *Acacia* scrubland.

Singing Honeyeater.—Perhaps the most common bird seen.

Zebra Finch.—Seen in two localities. One pair was apparently nesting in the lower part of an old Little Crow's nest in a mangrove tree at Tetradon Loop. Another pair was seen near a mustering paddock in the Sandy Point area.

Black-faced Wood-Swallow.—Parties of these birds were at various places.

Grey Butcher-bird.—Nearly all pairs were nesting. They were not aggressive like the birds in the Perth suburbs.

Little Crow.—Common. Nesting during August-September usually in the tallest trees and on windmills. One nest was built and occupied on the daylight sensor which activates the Cape Inscription lighthouse. At South Passage Mill 4 eggs were in a nest built in a clump of spinifex at the base of a windmill.

ACKNOWLEDGEMENTS

We were most appreciative of the advice given by Dr. D. L. Serventy —copies of valuable ornithological papers in his possession were of great material help to our project.

The Trustees of the National Photographic Index of Australian Birds, Australian Museum, Sydney, gave assistance under the Bank of New South Wales Grants Scheme.

Sea and land transport, with accommodation on the island, were kindly provided by Sir Thomas Wardle, lessee of Dirk Hartog Island. Sir Thomas's personal interest made our expedition far more comfortable and flexible than our own plan would have allowed.

Notes on the R.A.O.U. observations in 1972 were supplied by Mr. G. C. Chapman, of Glen Forrest.

We were also equipped with a most useful summary of observations made by various ornithologists during the years 1917-1972, and compiled by Dr. S. J. J. F. Davies, C.S.I.R.O., Division of Wildlife Research.

A copy of F. Lawson Whitlock's "Notes on Dirk Hartog Island and Peron Peninsula, Shark Bay, Western Australia", *The Emu*, vol. XX, 1921, was kindly supplied by Dr. Serventy. This was fortuitous, since our base was only 3 kilometres from the Ten Mile Well, where Whitlock was encamped during the period June-September 1920. We were thus able to more appreciate his comments when working in the exact localities about which he wrote.

We were also able to refer to personal notes loaned by Dr. A. A. Burbidge, Fauna Research Branch, Department of Fisheries and Fauna, relating to his visit (with A. S. George and T. Evans) during September 1972.

Mr. George identified the flora mentioned in our report.

PERSONAL COMMENT

We were most favourably impressed with the intention, expressed by Sir Thomas Wardle, to maintain the essential nature of Dirk Hartog Island, and to avoid this being endangered by unrestricted tourism and by other pressures.

As non-professional naturalists, we saw and appreciated much on the island of great interest, in the few sections of natural history with which we are familiar.

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D. L. SERVENTY, "Peron Peninsula" (ms.).

FROM FIELD AND STUDY

Absence of the Pallid Cuckoo at Merredin, 1973.—For the first time, over a period of observing them for 24 years, Pallid Cuckoos *(Cuculus pallidus)* failed to visit the district in the spring of 1973. None were seen by me or by other people who are familiar with this bird.

I kept a close watch each week in their usual haunts and also visited Nungarin and Southern Cross, but no birds were seen or heard calling.

During the previous spring, in 1972, there was an increase in the numbers of Pallid Cuckoos; they usually first appear just before mid-July. There were a small number of cuckoo chicks about my yard, apparently being cared for by Willy Wagtails.

I wonder how general was this absence of Pallid Cuckoos in the south of the State during 1973? May they have found more attractive feeding areas in the north because of the bountiful rains there?

—(Mrs.) M. B. MILLS, Merredin.

Avian-Derived Phosphate from Inland Western Australia.—Several recent collections of minerals from the Gascoyne and Murchison regions have yielded the aluminium phosphate variscite derived from biogenic phosphatisation. The specimens came from the tops of prominent hills at Pyramid Hill (20°42'S, 115°51'E), Yinnietharra Station, and the hematite outcrop at Wilgie Mia (26°56'S, 117°41'E), Weld Range and are considered to be of sub-recent to recent origin.

Both occurrences are of a buff to white, vughy, crystalline to compact variscite encrusting the base rock in layers up to three inches thick and filling crevices for some feet. Simpson (1932) described a much larger deposit at Ninghanboun Hills (29°12'S, 116°27'E) where a serpentinite was altered to phosphate of iron and aluminium. Similar occurrences have been recorded from near Mt. Magnet and Belele Station. Mawson and Cooke (1907) reported several occurrences in South Australia and described the material as 'paratocite', which may be a mixture or a previously described mineral.

Maritime guano deposits are usually derived from the excreta of large flocks of birds but the inland occurrences described here probably indicate the hunting roosts of much smaller populations. The larger deposits described by Simpson and Mawson *et al.*, are not compatible with the present day smaller bird populations.

In the past, the salt lakes and filled swamps near these deposits probably contained plentiful aquatic life and supported considerably larger bird colonies. Similar conclusions have been drawn from the fossil bird discoveries of J. W. Gregory, R. H. Tedford, A. H. Miller and others in Central Australia.

These phosphate deposits may be of some minor significance where they are associated with iron ore deposits. The maximum phosphorus level allowed for iron ore exported to Japan is 0.07%. However, the amount of variscite necessary to affect the large tonnages mined is unlikely to exist in most Western Australian iron ore districts.

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—P. J. BRIDGE, Government Chemical Laboratories, Perth.

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ZONAL FEEDING IN THE BIRDS OF CULEENUP ISLAND, YUNDURUP

By ALLEN KEAST, Queen's University, Kingston, Ontario

Zonal feeding in birds is determined by dividing the trees, shrubs, and ground, into a series of vertical levels and recording the relative amounts of feeding in each. Two alternative but comparable methods are used for the latter, assessing the amounts of *time* spent feeding in each zone by means of a watch, or counting the number of feeding actions (pecks) in each over a measured time interval. Balance is achieved by restricting the observations of any individual bird (I use half a minute) and flock (up to 4 minutes) spreading the observations over different hours of the day, observing a range of individuals, and carrying out the observations in a range of localities (Keast, 1968).

Because most observers are limited in the amount of time they can spend on a project the work is usually concentrated in the breeding season, it being argued that this is the time when there is likely to be the greatest competition for resources and when species feeding differences and separations are hence likely to be most clear cut. There is, of course, no doubt that studies of zonal feeding should be carried out through-out the year or, rather, during the four major seasons. It may change as the spatial distribution of dominant food resources change or when, due to nomadism or migration, the associated combination of species sharing the particular habitat changes. There have, however, been virtually no comparative studies made on a seasonal basis.

That closely related bird species may feed at different "levels", and that this is one of the devices whereby inter-specific competition is reduced has been recognised for some time. The first quantitative study, however, was that of Colquohoun and Morley (1943) on British tits (Paridae). These observers also noted that different species showed some preferences for different kinds of trees, i.e. conifers relative to deciduous. MacArthur (1958), and others, have noted that tree crown feeders may, alternatively, feed tangentially (i.e. working around the outside of the foliage), or radially (i.e. they enter the foliage by way of the branches). My observations indicate that this division is rarely absolute. In South-Western Australia, however, Weebills commonly obtain their insects from the foliage by fluttering around, and clinging to, the outer leaves whereas Broad-tailed Thornbills rarely do this, preferring either to approach the terminal leaves by way of the outer branches and twigs, or alighting amongst the twigs. Generally speaking large birds are radial feeders, their weight necessitating that they work out along the branch and reach into the foliage. Rufous and Golden Whistlers and, of course, Western Shrike-Thrushes, all being to a considerable degree branch feeders, also do this. Black-faced Cuckoo-Shrikes and Grey Fantails, by contrast, do some fluttering at the foliage.

In Table 1 are summarised the results I obtained over a couple of days field observing on Culeenup Island (September 14-15, 1974) in the mixed woodland there. The area is dominated by *Eucalyptus rudis* but there is a rich development of tall saplings and shrubs of all sizes. *Casuarina*, *Melaleuca* and *Kunzea* also provided tree-type feeding opportunities. Eleven categories of feeding level were allowed. Observations were made on the

TABLE 1. ZONAL FEEDING AT CULEENUP ISLAND

	Percentage in each Feeding Zone											
	No. of observations	Air	Foliage	Twigs	Branches Outer	Branches Inner	Trunk Upper	Trunk Lower	Sapl. Foliage	Sapl. Trunk & Branches	Low Shrub	Ground
Broad-tailed Thornbill	229	2	25	10	5	2		5	23	10	18	
Yellow-tailed Thornbill	185		5						40	15		40
Western Warbler	70		56	27	12						5	
Silvereye	440		15	3	6	18	21	13	13		11	
					3% of feeding time on nectar							
Rufous Whistler	72	2	26	16	26	6			16	8		
Golden Whistler	35		10	30	30				30			
Red-tipped Pardalote	135		85	10	5							
Splendid Wren	45				10				45	10	35	
Scarlet Robin	30									20		80
Western Shrike-thrush	110		15		60	15				10		
Grey Fantail	72	60	20	5	5				5	5		
Willie Wagtail	26	55								10		35
Golden Bronze Cuckoo	20		80	20								
Pallid Cuckoo	25					10		10				80
Brown Honeyeater	85	5	25	20	10				40			
					20% of feeding time on nectar							
New Holland Honeyeater*	15	35	65		90% of feeding time on nectar							
Welcome Swallow	35	100										

* Refers to insect-taking activity only. At virtually any time the relatively few birds present could be seen flower-probing.

basis of numbers of feeding actions (pecks), expressed as a percentage. I prefer such a counting method rather than recording time spent feeding in each area, both because it is more precise and because it is faster, on occasions permitting observations to be made simultaneously on members of two species.

A range of clear-cut results emerge from the Table. Apart from obvious knowledge that the Welcome Swallow is exclusively an aerial feeder (above treetop height or over fields and open water), the Red-tipped Pardalote emerges as virtually exclusively an outer foliage feeder (much of its time was spent in the tops of the loftiest trees), the Splendid Wren as a dense thicket and lower sapling feeder (on one occasion a male temporarily fed in branches at 30ft.) The Grey Fantail is an aerial insect feeder (60% of total feeding actions), with half the catches being made on sorties between trees (at or below canopy height), a third on short dashes within the branches or about the twigs, and the remainder within and about saplings. In addition insects were obtained from the foliage by fluttering around, or clinging to, the outer leaves. The two whistlers fed mostly at the middle regions or terminations of the branches, taking up vantage points and from there scrutinising the foliage, branches, and twigs above, below, and on either side. When a suitable prey item was spotted the bird hopped or quickly fluttered to it. On occasions, however, they hopped methodically through the dense outer foliage of trees or worked through the heavy foliage of saplings. They did not feed at heights of less than 6-8 ft. (in places, of course, the Golden Whistler does much feeding at heights of 4-8 ft.). The Western Shrike-Thrush differed from its smaller relatives in the greater amount of branch feeding. Observations on the Scarlet Robin and Pallid Cuckoo were too few to be quantitative. A fair degree of ground-feeding was indicated, however.

The writer was most interested in three species, the two thornbills and the silvereye. In the east, where the arboreal feeding Striated Thornbill and Little Thornbill are present, the Brown Thornbill is a low shrub and sapling feeder; the Yellow-tailed Thornbill largely a ground feeder. It very soon became apparent that here, as elsewhere in the South-West, the Broad-tailed Thornbill, the counterpart of and close relative of the Brown, feeds at all levels and has a marked foliage-gleaning component to the feeding. The Yellow-tailed Thornbill, likewise, has changed feeding habits, over half the feeding being carried out in the branches and foliage of saplings. The Western Silvereye proved to be extremely versatile. It fed virtually everywhere but in the air. There was a marked amount of trunk and branch feeding, with the birds working their way around these, or fluttering and clinging at all angles. Other feeding parties (or the same individuals later) assiduously worked the foliage of 60-80 ft. eucalypts, and saplings. Then a group would drop out of the trees to work over and through small 2-3 ft. high shrubs. From time to time individuals even probed the flowers of *Eucalyptus rudis* alongside the New Holland and Brown Honeyeaters, or, rarely, those of *Hardenbergia comptoniana*, the ground-clinging yellow-flowering *Conostylis aculeatus*, or the blossoms of the wattle, *Acacia cyanophylla*. One could not help speculating that there must have been a correlation between the trunk feeding of silvereyes and the local absence of the trunk-feeding sittellas and treecreepers. Silvereyes are, of course, both insect and berry feeders and, as such, are obviously amongst the most generalised feeders in the bush. I have never before this, however, seen them taking insects from such a wide range of vertical levels. The great versatility displayed in its feeding by this species in part must explain its success and abundance over wide areas.

Nectar feeding is very hard to measure by the methods used here. Even if one were to use the stop-watch method and come up with comparative figures for the *amount of time* spent nectar relative to insect feeding it would not help give a comparative picture of the actual weights of the two foods being consumed, or of the calorific or energetic value being obtained from each. Recher and Abbott (1970), for example, in stressing the relatively low nutritional value of nectar suggest that the

frequency with which meliphagids are observed aerial feeding stems from the need to supplement the diet with animal protein. All meliphagids are, of course, partly nectar-feeding, the amount varying with the species (see Keast and Condon, 1968). The New Holland Honeyeater would seem to be one of the least insectivorous species and, in fact except for once or twice, every time the 3 or 4 individuals on Culeenup Island were seen feeding it was at the flowers of *Eucalyptus rudis*. The much more abundant Brown Honeyeaters, however, only occasionally visited the flowers (which proved to be almost lacking in nectar). Instead these birds spent nearly all their feeding time taking insects from the branches and leaves of the riverside trees and saplings. They mostly worked their way into the leaves along the outer branches but, on a few occasions, fluttered at the outer foliage.

The above brief observations indicate that this method of quantification can be very rewarding for defining the ecological roles of series of cohabiting bird species and giving insight into mechanisms operating to minimise interspecific competition. They can be elaborated by making counts of the relative abundances of the different species (thereby coming up with a measure of the actual "pressure" being exerted by each species on its specific range of food resources). Insectivorous species also differ, of course, in the sizes of prey items taken. Overseas work brings out that there is a broad correlation between prey size and bill size, in birds. A superficial survey of the Australian literature on stomach analyses indicates that this is also true here. It can be inferred, hence, that the different bill sizes of a thornbill, a whistler, and a shrike-thrush "channel" them towards insects of different sizes and that these three are never in competition.

Studies such as the above should be carried out at a range of localities in South-Western Australia, and elsewhere. Culeenup Island, in itself, merits analysis at the height of the breeding season, and at all other times of the year.

APPENDIX—SCIENTIFIC NAMES OF BIRDS DISCUSSED

Pallid Cuckoo—
Cuculus pallidus
Golden Bronze-Cuckoo—
Chrysococcyx plagosus
Welcome Swallow—
Hirundo neoxena
Black-faced Cuckoo-Shrike—
Coracina novaehollandiae
Splendid Blue Wren —
Malurus splendens
Western Warbler—
Gerygone fusca
Weebill—
Smicrornis brevirostris
Striated Thornbill—
Acanthiza lineata
Little Thornbill—
A. nana
Brown Thornbill—
A. pusilla
Broad-tailed Thornbill—
A. apicalis
Yellow-rumped Thornbill—
A. chrysorrhoa
Scarlet Robin—
Petroica multicolor
Grey Fantail—
Rhipidura fuliginosa
Willie Wagtail—
R. leucophrys
Golden Whistler—
Pachycephala pectoralis
Rufous Whistler—
P. rufiventris
Western Shrike-Thrush—
Colluricincla rufiventris
Black-capped Sittella—
Neositta pileata
Rufous Tree-creeper— —
Climacteris rufa
Red-tipped Pardalote—
Pardalotus substriatus
Western Silvereye—
Zosterops gouldi
Brown Honeyeater—
Lichmera indistincta
New Holland Honeyeater—
Phylidonyris novaehollandiae

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"MISS NORTH'S TREE," WARREN NATIONAL PARK

By D. L. SERVENTY and G. G. SMITH, Nedlands

In the article on "Historic Trees," in the *Australian Encyclopaedia,* 1958, vol. 9, p. 31, is listed "Miss North's Tree," a large karri in the Warren National Park, south-west of Pemberton. Mr. B. J. Beggs, Conservator of Forests, has supplied us with some data on the tree, which is situated on high ground on the edge (south side) of the Old Vasse Road which traverses the Warren National Park on the north side of the Warren River. It is slightly over 4 km west of the point where the Old Vasse Road leaves the Northcliffe Road near Warren House, the old Brockman homestead. Mr. Beggs adds that the tree "has a height of 55 metres with a girth measurement of 5.6 metres. At a height of about 12 metres a large burl or 'niggerhead' completely rings the bole. The tree is overmature with decadent crown and has many epicormic limbs for the full length of the bole. There is a weathered plaque at the base of the tree inscribed 'Marianne North Tree'."

The tree is notable because it was painted by Miss Marianne North, the English botanical artist and traveller, when she stayed with her kinsman, Edward Reveley Brockman (1838-1902), at Warren House, near Pemberton, in December 1880 *(Recollections of a Happy Life,* 1892, vol. 2, pp. 164-166). She does not actually mention this particular tree in the book, though she was vastly impressed with the large size of the trees in this magnificent forest, where, on one occasion, "I spent four delightful hours sketching or resting under these gigantic white pillars, which were far more imposing than the trees of Fernshaw" (the Mountain Ash in Victoria).

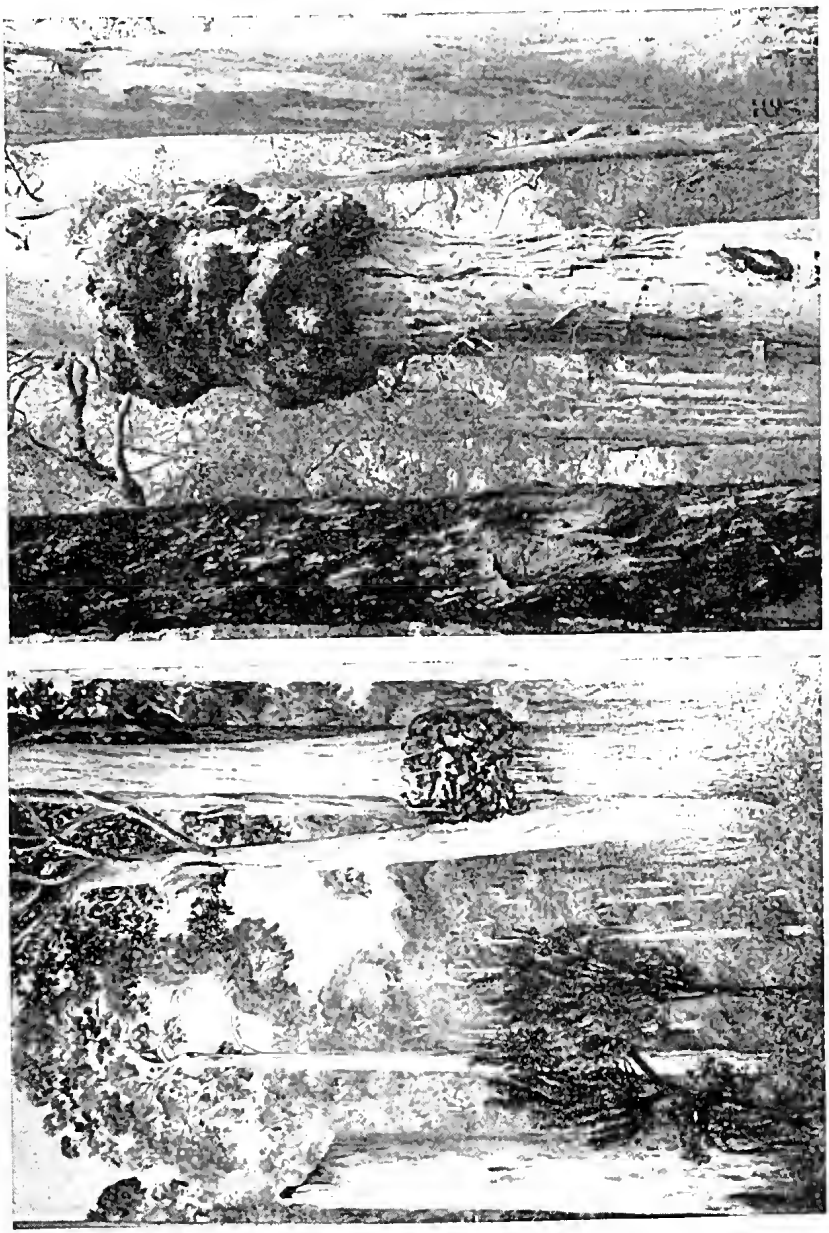
Her painting of the tree hangs in the North Gallery at the Royal Botanic Gardens, Kew, a building she had erected at her own expense to house her considerable collection of botanical paintings. It was opened to the public in 1882. The *Official Guide to the North Gallery,* 6th edn., 1914, p. 121, no. 782, has the following description, by Miss North herself: *"Karri Gums, near the Warren River, West Australia.* Casuarinas and Emus in the foreground. The Karri Gum trees *(Eucalyptus diversicolor,* F. Muell.) are among the tallest trees in the world. Baron Mueller states that he has seen many of them that approached 400 feet in height*. One of those painted has a monstrous ring of warts around the trunk, reminding one of the columns of Milan Cathedral, the trunks being as white and polished as the pillars themselves."

The painting is about 12 x 18 in. In the foreground are casuarinas (which must be *Casuarina decussata*) and emus, on the track or a clearing. There are also braeken, zamia palms and *Leucopogon verticillatus.*

*Actually neither the Karri nor the Mountain Ash *(Eucalyptus regnans)* have been proved to reach this height; the Karri approaches 300 feet, and the tallest known Mountain Ash was 375 feet.

See Fig. 1. Perhaps travelling Western Australians are more familiar with this painting than with the actual tree itself. We ourselves have not yet seen the tree but have viewed the painting on a number of occasions.

Though knowledge of the tree is not widely disseminated among people in Western Australia descendants of E. R. Brockman are familiar with it. Mrs. Julius Brockman, of Busselton, who has ridden past the tree years ago when taking cattle to the coast, informs us that travellers would pass the tree on their way to or from the Vasse, and it would be



a point of conversation. Her own opinion is that it was a favourite landmark and picnic spot for the Brockman family of the Warren. Mr. Brockman says that there used to be a post and rail fence around the tree. This has now vanished. There exists another painting of this tree. It was painted for Edward and Capel Brockman by their brother-in-law, Henry C. Prinsep, and used to hang for years in the drawing room of "Beachgrove", a Brockman home in Ford Road, Busselton, now the residence of Mr. and Mrs. Julius Brockman. The painting, however, is now in the possession of a grand-daughter of the original E. R. Brockman.

One member of the Western Australian Naturalists' Club who has recently been to the tree is Mrs. Helen Wilson of Pingelly who took a photograph of it in November 1971 (Fig. 2). She had seen a reproduction of the painting at the Pemberton Tourist Bureau. There appears to be no substantial difference in the appearance of the tree since it was painted over 90 years ago.

Marianne North (1830-1890) was one of those formidable upper middleclass Englishwomen (Daisy Bates was another) who, because of their social status and personality, successfully travelled alone through little-known parts of the world, often under incredibly primitive conditions, indulging their interests and hobbies. She was a member of a family prominent in English affairs in the 17th and 18th centuries, one member of which, Frederick, Lord North (second Earl of Guilford) was Prime Minister during the American War of Independence. Marianne was descended from Dudley, 4th Lord North, through his youngest son, Roger, the historian and Attorney-General under James II. Her father, Frederick North, was M.P. for Hastings, and in his company she began that lengthy series of journeys, starting in 1865, to Syria and Egypt, and continued after his death to most parts of the world until 1885, to Chile. "She scoured the globe for spectacular plants which she painstakingly recorded in oils in their natural surroundings" (Wilfrid Blunt, *The Art of Botanical Illustration,* 1950).

At the suggestion of Charles Darwin she visited Australia and New Zealand, commencing her Australian tour at Thursday Island in July 1880, and after travelling through Queensland, New South Wales, Victoria, Western Australia and Tasmania (by Cobb & Co. coach, horse drays, train and ship) she left for New Zealand in February 1881. A lively, and on the whole kindly, account of her Australian experiences is given in volume 2 of her autobiographical *Recollections of a Happy Life,* London, 1892. In the fashion of the age she wrote uninhibitedly, sometimes with embarrassing frankness, of her impressions of places, social customs and people—the latter being thinly disguised under their initials. In a second impression of the book some of the more outspoken passages are replaced by more innocuous matter.

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THE BREEDING BURROW OF THE BANDED ANT-EATER OR NUMBAT *(MYRMECOBIUS FASCIATUS)*

By P. CHRISTENSEN, Forests Department, Manjimup

Despite the Numbat's recent elevation to fame as our State's fauna emblem, little work has been done on this interesting marsupial and many aspects of its habits and life history remain relatively unknown.

For example the question of whether or not Numbats dig burrows has not been definitely resolved. Troughton (1967) states, "It is not a burrower", but Calaby (1960) says: "There is anecdotal evidence that the female digs a burrow during the breeding season". He goes on to cite John Gilbert's notebook, published by Whittell (1954). Gilbert records that it breeds "in holes or short burrows". Shortridge (1910) was told by Aborigines that during the breeding season the female makes "a rather shallow perpendicular hole in the ground". Mr. L. Glauert, former Director of the W.A. Museum, wrote in his copy of Wood Jones (1923) (now in the Museum library) that a correspondent, Mr. E. C. Cecil Dival "surprised a Numbat which made for a hole in the ground. It was a burrow about three feet long at the end of which was a nest made of straw and bits of newspaper". Glauert (1935) wrote that another correspondent, Miss E. Wills, found a litter in a burrow. Her dog began barking at a small hole which she dug out. After digging along for about three feet "the tunnel suddenly widened from two inches into a large nesting place about nine inches in diameter, lined all around with fine dead silver grass". In the nest were three young Numbats, and a further one of the same size was found in a nearby log.

Ride (1970) sums up the situation in the following words: "There is good evidence that the female Numbat digs a burrow and on several occasions young have been found in nests at the end of these short breeding burrows".

However since no detailed description of a breeding-burrow seems to have been published the question remains to some extent unresolved.

In view of this it seems appropriate to record in some detail a description of what I am quite convinced was a Numbat's breeding burrow.

On 1st May, 1974 a female Numbat was brought to me by Rod Simmons, an officer of the Forests Department. He had obtained it from a forestry gang who had captured it whilst clearing a track off the Boyup/Cranbrook road. The site is located approximately 8 miles south-east of Heartlea and within the Forests Department's Perup River fauna priority area.

The Numbat had been surprised by them in the morning and had darted into a burrow located close to the track and on the other side of a large jarrah log. They dug out the burrow and located the Numbat in a chamber at the end of a short tunnel. It was a female with four young (approximately 20 mm long) attached firmly to the teats.

The area where the burrow was found is on a ridge. The forest type is predominantly jarrah *(Eucalyptus marginata)* with scattered red gums or marri *(E. calophylla)*. The canopy is between 50 to 70 ft. The area has been logged and a scattered understorey of 15 to 30 ft. jarrah and marri saplings are also present. Other understorey trees present in the area include bull banksia *(Banksia grandis)* and snotty gobble (*Persoonia longifolia)*. The understorey scrub is relatively sparse giving approximately 30 to 40 percent ground cover. The dominant species is *Bossiaea ornata* with other species such as *Hakea lissocarpa, Leucopogon verticillatus* and zamia palms also present. The area was last burnt four years ago.

The soil in which the burrow was located is a very gravelly greyish yellow sand, containing lateritic pebbles varying in size from very small to over one inch in diameter.

Part of the burrow had been dug out during the capture of the

Numbat, but the burrow entrance and part of the tunnel which passed under a log was still intact. From the appearance of the spoil at the entrance to the burrow it was judged to have been dug out no more than a week or two previously.

It was possible to trace the outline of the remainder of the burrow and the nesting chamber and so to reconstruct their dimensions, direction and depth in considerable detail (see Figs. 1 and 2).

Fig 1. — Burrow as viewed from above.

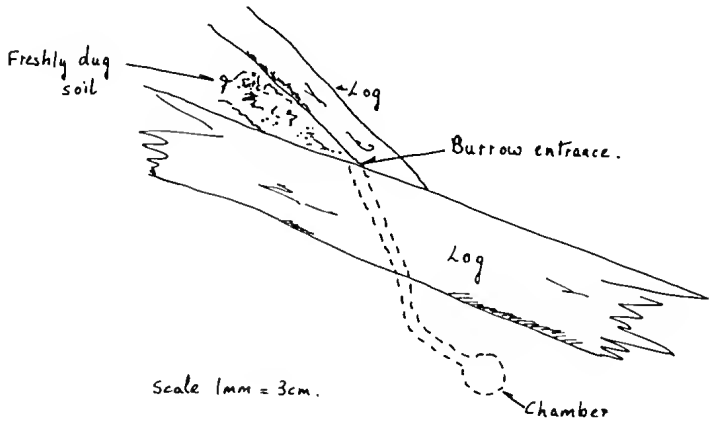
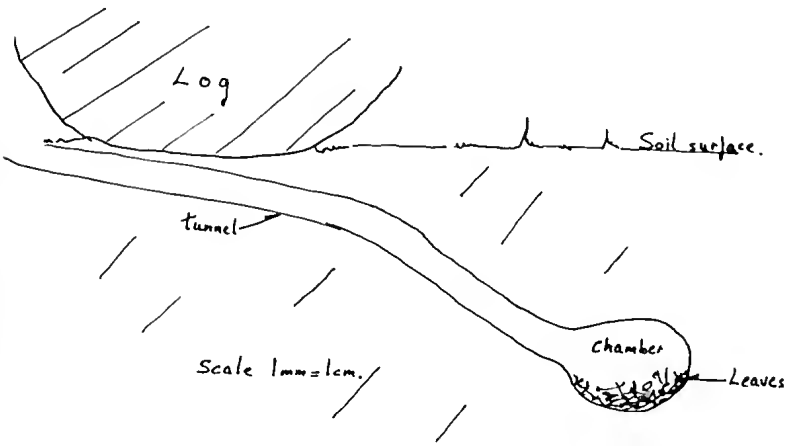


Fig 2. — Burrow as viewed in cross section



The floor of the nesting chamber was lined somewhat sparsely with dry jarrah and marri leaves, apparently obtained in the vicinity of the burrow.

There seems no reason to doubt that this burrow was in fact dug by the Numbat herself. The fact that the dimensions seem to fit the Numbat's size so perfectly, and it was obviously freshly dug, combined

with the fact that the Numbat took refuge in it when disturbed, seems to point to this. It may also be of interest to note that in the short time whilst she remained captive before she was released she exhibited considerable digging skills whilst attempting to escape by digging into the soil in the corner of her cage.

An examination of the location and structure of the burrow also reveals that it is no casual digging. If the diagrams of the burrow's location and structure are examined it is evident that a considerable amount of attention has been given to the siting of the entrance and to the structure of the burrow itself. Any animal attempting to dig it out such as a dog or a fox would find it a difficult, if not impossible task. The entrance is so located as to leave the minimal amount of space for any large animal to dig. The fact that the first 30 inches of the tunnel are close up against the underside of the log would also contribute towards making it difficult to dig out.

The young would have been approximately 1 month old (Calaby, 1960). It appears that the female Numbat may dig a breeding burrow at about this time in preparation for the time when the young become too large for her to carry. The Numbat has no pouch, the young are simply attached to the teats and cling to the long fur on the underside of the mother.

The breeding-burrow, however, as a depositing place for the young fills the gap between when the young are too large for the mother to carry but still too small to accompany her on foraging expeditions.

Another almost identical empty burrow, believed to be a Numbat's, has since been discovered in a similar location. This one was liberally lined with bark from a nearby paperbark, *Melaleuca parviflora*.

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WATERFOWL SEEN AT LAKE CLAREMONT (BUTLER'S SWAMP) IN THE SPRINGS OF 1972 and 1974

By K. EMORY, I. R. LANTZKE*, G. L. LAMBERT and F. OSBORNE, Graylands Teachers College, Mimosa Ave., Graylands, W.A.

In view of the continuing decrease in the quantity and quality of wetlands on the Swan Coastal Plain, summarized by Seddon (1972), and the sensitivity of birds to environmental effects, it would seem desirable to publish periodically lists of birds observed on representative lakes and swamps. In this way the interested public may be able to keep informed of the position. In late 1972, and again in spring 1974 the water birds

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TABLE 1. THE NUMBER OF ADULT WATERFOWL AND THEIR YOUNG (IN PARENTHESES) SEEN AT LAKE CLAREMONT ON THE SPECIFIED DATES.

	1972						1973	1974							
SPECIES Date	7/4	5/9	24/10	24/11	8/12	28/12	8/1	21/9	23/9	24/9	6/10	13/10	20/10	3/11	10/11
Black Duck	18	14	12	20	7*		15 (6)	29 (35)		6 (4)	16 (24)	27 (18)	25 (15)	32 (12)	28 (15)
Pink-eared Duck			1	1	2*	1		4 (3)	2 (1)		4 (2)	2	1	3	1
Blue-billed Duck	2	4	3	2	4			7	5	7	13	39 (2)	34 (2)	36 (5)	37 (5)
White-eyed Duck	4	2	2*	2	5	2	8		2	5	3 (5)	7	3	1	1
Grey Teal	20	14	14	13	3		10	19			18	18	17	17	17
Muscovy Duck								1							
Black Swan	4	6*	4 (3)		1 (3)	4	2 (4)	3 (5)			2	3 (5)	3 (5)	4 (6)	3 (5)
Swamp Hen			5	3	1			1		3	6	8	5	8 (1)	8
Dusky Moor Hen	2	2	1*	6*	2	12	4	1		3	3	3	2	4	7
Coot				4	2			9		13	15	17*	14	10	17
Little Grebe	10 (37)	4	4	6*		8 (5)	3	4	3 (1)	8	20 (1)	15 (5)	34 (7)	7	12 (6)
Hoary Headed Grebe			2									13 (6)		21 (1)	20 (9)
Great Crested Grebe														1	
Pelican						2	1								
Little Bittern										1					
Cormorants									1		1	4	2	5	7
Silver Gull	17	35	40	35	26	5	17	8			7100	7100	750	750	750
Reed Warbler			2							1				+	+

NOTES: 1.
* indicates a nest observed or inferred
+ indicates calls only heard, but no birds seen

2. Observations were made in the mornings (before approx. 9.00 a.m.) except on 23/9/74 when the observation period was 1.30 to 3.00 p.m.
3. The gulls appeared to use the lake mainly when the weather was rough.

on Lake Claremont were systematically observed (Osborne, 1972; Emory, 1972; Lambert, 1974) and the results are presented in Table 1.

DISCUSSION

The physieal geography of Lake Claremont and its history up to 1950 have been deseribed by Evans and Sherlock (1950), but since that time eonsiderable filling of the lake has oeeurred. As a result the area of near permanent water is now redueed to approximately 50 aeres. The margins are now steep man made banks around most of the lake and no longer earry native plants, heing either bare or eovered with introdueed grass (for playing fields). The plants of the wet areas still remaining, do not appear to be as ehanged sinee 1950 as the lake's margins.

The eomposition of the lake's water differs from that of the neighbouring lakes, being from approximately 1½ to 3 times more saline than those of Perry Lakes (exeept the smaller third lake), Herdsman's swamp and Mongers Lake. Values of ehloride ion eoneentrations (in mg/l) in these lakes are given in Table 2.

TABLE 2.—SOME CHLORIDE ION CONCENTRATIONS IN LAKE CLAREMONT AND 4 NEIGHBOURING LAKES BETWEEN 1972 AND JANUARY 1975. CONCENTRATIONS ARE IN MG I (PARTS PER MILLION).

	1972	1973	1974		1975
	April	Deeember	April	August	January
Lake Claremont	2,800	290	570	310	510
Perry Lakes East		200		150	260
Perry Lakes eentral	410	180	410	76	193
Mongers Lake		150	210		
Herdsmans Swamp*		190	110		88

*Herdsman's swamp tigures are for samples taken from a small rather stagnant drain on the north side. They may not be representative of the main water mass.

The very high eoneentration of ehloride ion in Lake Claremont in April 1972 is eonsistent with the low water level noted at that time, when the northern end of the lake was little more than a series of eonneeted puddles. There was also a heavy growth of algae on the lake's surfaee at that time. Growths of algae were not observed in the autumn of 1974.

In considering the bird observations it should be pointed out that, while there is no reason to doubt the eorreetness of all the identifieations, at the eommeneement of their field work the observers were not experieneed bird watehers. Also the aeeuraey of the bird numbers is not high, as eounts were obtained using several positions around the lake, with signifieant elapsed time between eountings, during whieh bird movement eould oeeur.

Within these limitations it appears that despite further filling of the lake between 1972 and 1974 a larger number of water birds frequented the lake in 1974 than in 1972. This eould be due to differenees in the timing of the seasons in the two years, but eould result from the "improved" eondition of the water in autumn 1974 eompared with autumn 1972. Besides the high salinity of the lake in April 1972, the rainfall record for Perth shows the winter rains to have eommeneed late (May: 7 wet days and 31.5 mm rainfall) eompared with 1974 (May: 15 wet days and 200 mm rainfall). In 1973 and 1974 total rainfall was above average, whereas in 1971 and 1972 it was below average.

Therefore it appears that despite the filling of the lake a wide range

of waterfowl spend the late winter and the spring on Lake Claremont and that some continue to breed there, at least when the season is wet. These include the Pink-eared Duck (both years). The nesting of this species on Lake Claremont has been recorded previously (Rook, 1963).

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AN ABANDONED ABORIGINAL CAMP SITE, NEAR PARABURDOO, WESTERN AUSTRALIA

By G. B. WHITFIELD*

ABSTRACT

Stone artefacts at an abandoned aboriginal camp have recently been discovered 17 km south of Paraburdoo. The camp site is in flat terrain and encircles a 6 m high chert-breccia outcrop, the summit of which overlooks the surrounding country for several kilometres. A cave exists in the rock outcrop. Artefacts found include spear points, grind-stones, a hand axe, various types of scrapers, cutting-flakes and microliths.

INTRODUCTION

The author was attraeted to the vicinity of the eamp site by black and white agate in a dry creek bed 17 km south of Paraburdoo.

Paraburdoo is a fairly new 'iron ore' town, situated 980 km north northeast of Perth, and there is a void in the literature about the history and culture of the early aboriginal people of this area (*i.e.* the southern portion of the Hamersley Range Province).

From the agate-bearing creek bed, the only significant topographical feature, in an otherwise flat terrain, is a 6 m high, 23 m long and 12 m wide outcrop of white ehert-breccia 120 m to the west. On approaching this outcrop angular black and grey chert fragments begin to appear in the scree which is mainly white chert-breccia. Many of the black and grey chert fragments, on closer inspection, show deliberate flaking and trimming along one or more margins. At the rock outcrop black and grey chert fragments are abundant and beneath this outcrop there is a cave 4.2 m long, 2.5 m wide and 1.1 m high. The floor of the cave is covered by a deposit of fine sand about 15 cm thick, and the ceiling is smoke-stained.

GEOLOGY

The area of the camp site consists of Reeent colluvium and Lower Proterozoic sediments of the Wyloo Group. The rock types present are banded quartzite and chert (these yielded the black and white agate), dolomitic limestone, chert breccia and calcrete. No outcrops of dolerite or black and grey chert were found. This indicates that the materials

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forming most of the relicts were collected elsewhere and transported to the site.

CAMP SITE

The camp site is in a flat area strewn with cobbles and pebbles of rounded and angular white chert breccia, has no trees and surrounds a 6 m high chert breccia outcrop. The cave beneath this rock outcrop provides the only shade in the area. Water was probably obtained from a creek bed (now dry) 600 m to the west, where tall trees and thick scrub still exist. A map of the camp site is given in Figure 1 and a section through the rock outcrop is presented in Figure 2. No engravings were observed on the rock outcrop.

The boundary of the camp site is vague due to the random and wide scattering of the stone artefacts which may indicate that the site is fairly old. At the site, along with the stone relics, were found a tektite and a devil's dice (composed of limonite pseudomorphing pyrite). Mitchell (1949) suggests that the aboriginal people may have believed that tektites were magic stones possessing magic properties.

ARTEFACTS

Implements found on the camp site are all of stone and consist of chert, quartz or dolerite (Figure 3). The following were recognised; six

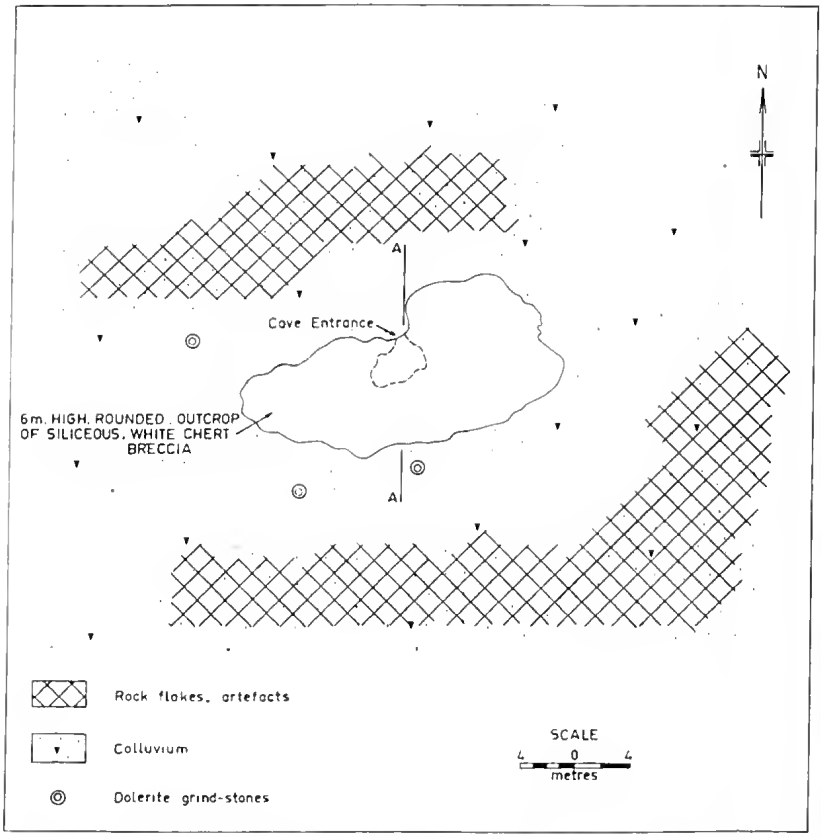

Fig. 1.—Map of camp site, near Paraburdoo, Western Australia. Rock flakes often partly trimmed. Colluvium incorporates prolific white chert breccia scree.

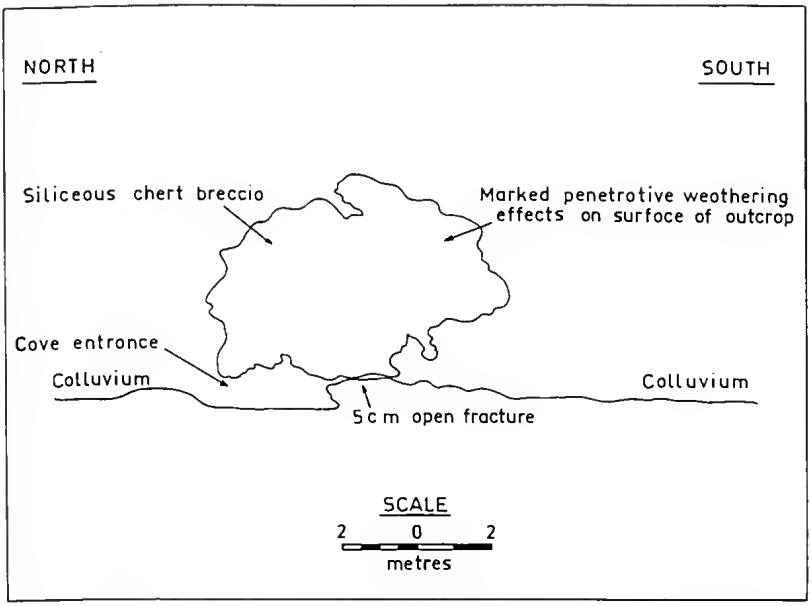

Fig. 2.—Seetion of 6 m high ehert breeeia outerop showing position and shape of eave. Seetion along AA, looking east.

spear points, three grind-stones, two rounded stones used on the grind-stones, one hand axe, nine serapers of various types, two eutting-flakes and four mieroliths.

Spear points

These are made from chert or quartz and range from 37 mm to 63 mm in length.

The blaek or grey chert spear points are leaf-shaped, symmetrieal points, eaeh possessing fine, regular trimming on two eonverging lateral margins and one or two median ridges. The trimming is on both surfaees hence the spear points are of bifaee type.

The quartz spear point has a broken point-tip and is of Pirri-type with delieate trimming on two lateral margins of one surfaee. The outer surfaee has a median ridge that extends from the unmodified butt end to the opposite end where the point-tip has been fractured off. The inner surfaee is flat.

Grind-stones

The grind-stones are slab-like and are eomposed of fresh dolerite. They range from 250 mm to 305 mm in length, 185 mm to 253 mm in width and 27 mm to 74 mm in thiekness. Eaeh has a very smooth, broad, shallow depression on one or two flat surfaces.

Within 3 m of one of the grind-stones were found two rounded stones of dolerite eaeh roughly 90 mm in diameter, with one rather flat, polished area. Presumably, they were used on the grind-stones during the grinding proeess.

Hand axe

This implement, 106 mm long and 110 mm wide, is made of fresh dolerite. It is wedge-shaped and rounded on the proximal margin with the eutting-edge showing bifaeial trimming. The two lateral margins are broad, flat planes produeed by grinding and on one of these surfaees there are two finger grooves. This axe resembles one illustrated by Mulvaney (1969).

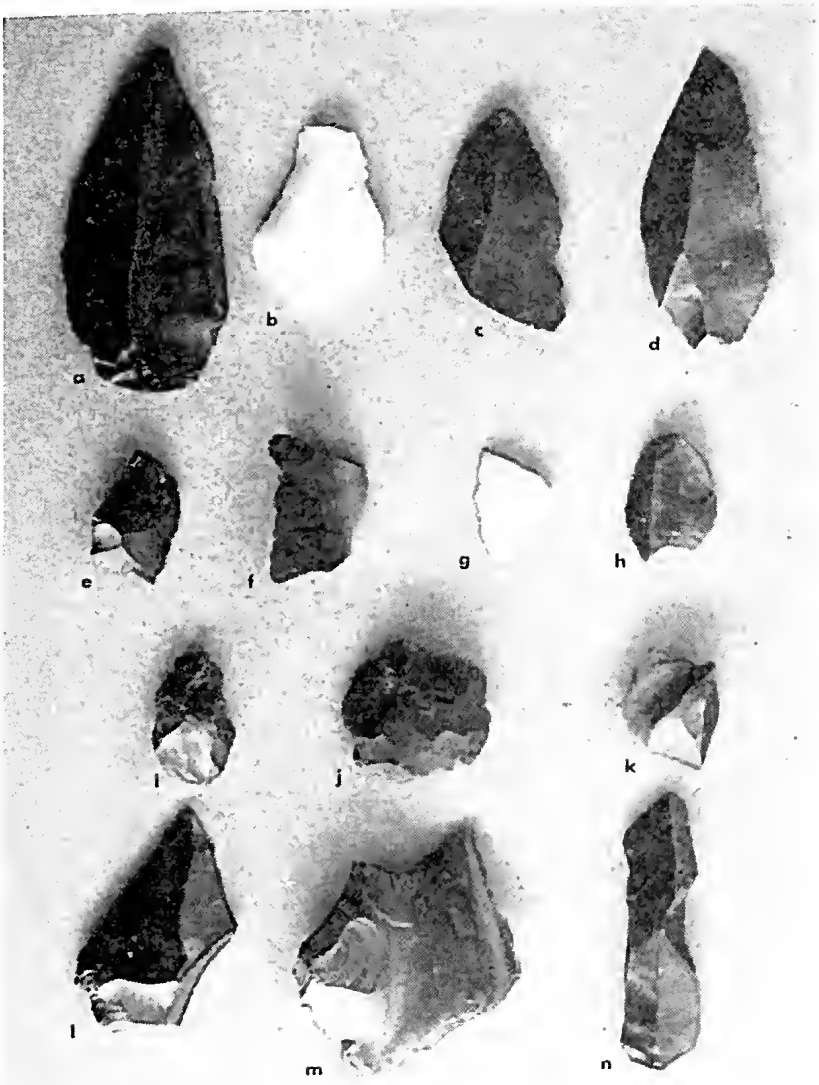

Fig. 3.—Artefacts from the Paraburdoo camp site. (a) biface-type spear point; (b) Pirri-type spear point with broken off point-tip; (c) broken biface-type spear point; (d) bifaee-type spear point; (e) and (f) cutting-flakes; (g) geometrieal mierolith; (h) micro-two-side seraper; (i) micro-semi-discoidal seraper; (j) semi-discoidal seraper; (k) nosed seraper; (l) bimarginal point seraper; (m) eoneave seraper; and (n) one-side seraper. Three fifths natural size.

Scrapers

Scrapers are the most frequent artefacts found at the camping place. They are made of black and grey chert and red jasper and range between 26 mm to 62 mm in length. The scrapers are of differing shapes, some being irregular, and each possesses a working-edge formed by trimming along part or the whole of the margin of a suitable flake.

Six scraper types have been recognised at this locality. Each type depends on the general shape and the number of, and shape or shapes, of the working or scraping-edges. Varieties of scrapers found include two-side and one-end, semi-discoidal, nosed, concave, bimarginal point and one-side scrapers (Figure 3).

Cutting-flakes

These implements belong to the fortuitous cutting-flake tools described by Mitchell (1949). Two cutting-flakes or 'cutters' of black chert were found, each about 20 mm by 30 mm in size. They have sharp cutting-edges with some fine trimming. The shape of each implement is irregular but, with the cutting-edge pointing down, each fits comfortably into one's right hand between thumb and index finger.

Microliths

The types of microliths found include one geometric, a triangle, and three different types of micro-scrapers. The triangle is quartz and measures 25 mm in length and 16 mm in width. Its shape is isosceles and it shows fine trimming on all three margins. This artefact is similar to one drawn in McCarthy (1967).

Types of micro-scrapers found comprise micro-semi-discoidal, micro-two-side and micro-end scrapers. The micro-semi-discoidal scraper consists of black chert, is 32 mm long and has coarse trimming on the complete periphery. Two prominent parallel median ridges are also present. The micro-two-side scraper is made of brownish red chert, is 33 mm long and is elongate. The two lateral edges show fine regular trimming. The micro-end scraper (21 mm long) is made of grey chert and is trapezoid in form with the distal end being distinctly rounded from use. The two lateral margins are thin and show fine trimming. This implement was possibly hafted as the proximal end is relatively thick with a triangular cross-section.

CONCLUSIONS

The camp site was a favoured location for a small aboriginal population and provided shelter, nearby water and game. The summit of the rock outcrop was possibly valued as a strategic point for viewing movements of neighbouring peoples.

ACKNOWLEDGEMENTS

The author acknowledges Mr D. Holder, the discoverer of the camp site and Messrs G. Cobby and D. Holder for assistance in artefact location and identification.

Mr T. Wallis took the photograph forming Figure 3 and Mr M. Groves prepared Figures 1 and 2.

Dr J. Glover read the text.

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OBSERVATIONS ON THE BREEDING OF THE LONG-NECKED TORTOISE, *CHELODINA OBLONGA*

By DIANE NICHOLSON, Wanneroo

In the twelve months prior to October 1973 an area at the northern end of Lake Joondalup was gradually developed as a new housing estate. Roads were laid, including one running parallel to the shoreline of the lake, some half-dozen houses were occupied and several more were under construction.

During the weekend of October 13/14 large numbers of Long-necked Tortoises, *Chelodina oblonga*, were seen to leave the lake and make their way into the bush to lay their eggs. The vegetation of the strip of land between the lake and the road is mainly low shrub, grass and ground-cover plants. A number of the tortoises laid their eggs within this strip, but many crossed the road and entered the denser bush of eucalypt and banksia trees, zamia palms, clumps of low shrubs and grass, in the midst of the housing area. Nothing stopped their compulsive march to find the correct spot in which to dig holes and lay their eggs. My husband and I policed them across the road and over the weekend only one was hit and killed by a car. Several others were removed from builders' sheds after they were heard battering their way around the tin walls, and one, after repeated efforts to dissuade it from trying to get through our carport wall, was carried to the other side of the house where she soon selected a site for her nest.

The process of egg-laying was observed from start to finish. The tortoise excavated a hole with her hind legs, heaping the sand around the rim farthest from her. The hole became more of a shaft, and a slightly larger chamber was dug at the bottom. The depth of the hole varied. Though exact measurements were not taken the average depth appeared to be about 5-6 in., with the shaft approximately 2½-3 in. across, almost vertical to the chamber. The hole completed, the tortoise rested for a short time and then commenced laying her eggs. One hind leg, noticeably the left more often than the right, was left in the shaft, and as each egg was laid the foot pushed it out of the way into the chamber. The eggs were laid at very short intervals, and when the clutch was completed the hole was filled in, again using the hind legs as scoops. Periodically the sand in the shaft was firmed down by the tortoise and when the area was level again she raised herself up on her hind legs and slammed her shell down onto the sand. This action was repeated many times. Then she turned towards the lake and set off on her journey back to the water. It was noticed that even when a hole was dug in the middle of a clump of grass, after the tortoise had finished her work, the untrained eye could detect no disturbance.

The eggs were somewhat cylindrical in shape, without the tapering of one end as in a hen's egg. They were whitish in colour, approximately 3.7 cm long and 2.2 cm in diameter at their widest part. The number in the clutch varied from 2 in the smallest to 15 in the largest, the intervening clutch sizes being 6 (4 nests), 7 (one nest) and 9 eggs (2 nests). In another nest 4 eggs were accidentally dug up when my block was fenced but, unfortunately, they were all damaged. One tortoise went through the whole process of digging a hole and filling it in again without laying a single egg. The reason for this was not apparent.

Because of the development of the area some eggs were laid on building sites. Three such nests were seen to be made where they were destined to be concreted over within a short time, and these eggs I dug up and removed—one clutch of 15, one 9 and the third of 6 eggs. These 30 eggs were placed in a chamber, at the base of a 5½-6 in. shaft, in sand, on my block. Because of the large number of eggs the chamber was made larger than any normally made by tortoises and the shaft was possibly wider too. The little plot was fenced in with roofing tiles and protected with shade

cloth to prevent any predators digging up the eggs. Though the area was in a sunny position the shade cloth would have reduced the sun's heat somewhat. Otherwise the area around this man-made nest was left entirely to nature, no additional water was given by manual watering of the rest of the block.

The weeks went by. On March 17, 1974, in ignorance of the normal incubation period of the eggs of *Chelodina oblonga* (I had not then read the note by Beverley Russ in *W. Aust. Nat.*, 11, 1970: 122), I loosened the sand around the 30 eggs. One egg shell was pierced accidentally and, on examination, found to contain an apparently fully formed tortoise with a small yolk sac about 4 mm in diameter still attached. On June 23, thinking that the eggs were infertile or had been ruined by their transfer, I decided to uncover the remaining 29 eggs. After careful probing, at a depth of about 2½ in., two live hatchlings were found. Then 9 more live ones, together with three which had developed but were decayed in the shell, and 7 unfertilised eggs. The other 8 eggs were unaccounted for. They had either disintegrated or disappeared without trace. All the live 11 hatchlings were in the presumably embryonic position, with the neck curled deep in to the body, and covered in damp sand. Among them were swarms of minute insects.

They were placed in the driveway in the sun. Some within seconds and others within minutes showed signs of life. The neck swung out from the body, the head swayed from side to side and the tiny tortoises commenced walking. They went in different directions and not one, initially, towards the lake. The 11 were placed in a shallow bowl containing water and small rocks. At first they appeared to panic and tried to get out, but within a few moments they all chose to hide under the rocks. At intervals they raised their nostrils above the water to breathe.

On the following morning, June 24, at 7 a.m., 9 of the hatchlings were taken to the lake and released at a point where the water was extremely shallow. All immediately made their way to deeper water and tended to keep as near to the mud bottom as they could. The remaining two were retained as guests of the University kindergarten for a while so that the children could observe them. They did not touch the raw mincemeat fed to them, so they were given bran. The kindergarten teacher was not sure whether anything was eaten. They were kept in a large plastic bowl containing sand and rocks, with a small pond. After four weeks I collected the tortoises and found them highly active.

They were then held in a small container with similar surroundings, and it was noted that one spent most its time in the water while the other preferred to be half-buried in the sand, usually half under a rock. On being fed shredded raw mincemeat the water-baby attacked it voraciously, but consumed only two small pieces. The other one appeared quite disinterested and made its way back to its position under the rock. When in the pond both raised half of their necks out of the water, and breathing movements were visible along the upper portions of the neck. It was also noticed that the eyes blink, but withdrawal movements of the head are only made when a really sudden movement is made near the tortoise. There is no such reaction for a mere slow waving motion of the hand above or near its head.

Of the hatchlings which must have been raised naturally along the lake margin only two have been reported. Inquiries have revealed that one neighbour saw two in his back garden and carried them to the lake. It is certain that some nests were entombed as building work in the area progressed. What the natural survival rate is in normal circumstances is unknown. The young tortoises on my block were removed 252 days after the eggs were laid. Is this a normal time before the emergence of hatchlings, and how much longer would they have remained in the nest if they had been undisturbed? Beverley Russ *(ibid.)*, from eggs laid in November at Bridgetown by the Blackwood River, found that the first had hatched exactly six months later but had not yet emerged from the soil.

Measurements were not taken at the time the tortoises were first removed from the sand, but after 4 weeks they were as follows: Upper shell, 30 mm long, 23 mm at the widest part; neck, 35 mm long, 5 mm at narrowest; head, 10 mm across; legs, 20 mm from the shell to the needle-like toes.

THE FLORA OF HUNT'S DAM RESERVE, MERREDIN

By Mrs. M. B. MILLS, Merredin

Hunt's Dam Reserve is an area of approximately 31-36 hectares (78 acres) of undulating land and large granite rocks. The area is classified as "Recreation" Reserve 29700 which is vested in the Shire of Merredin. It formerly comprised three separate areas. In the north-west was vacant crown land. In the east Reserve 17042 (Avon Location 13196) was a former reserve for "Camping and Utility". The balance of the land was former Reserve 1314 (Avon Location 17657) which was set apart for the purpose of "Water" and vested in the Minister for Water Supply, Sewerage and Drainage.

It is situated north of Merredin township about 3½ miles from the railway station, on Chandler Road.

In recent years a signboard has been erected which reads: Hunt's Dam, originally built in 1866, by Surveyor C. Hunt using convict labour. According to local history Surveyor Hunt and his party pitched camp at the granite rocks and in an unusual breach formed by two large rocks built a wall of earth and stone to form a dam.

Since the days of my childhood Hunt's Dam has been a source of interest to me; many singular species of flora grow there which do not occur in other places in the district.

There are several species of *Acacia* and some of these trees are very large and very old, bent and gnarled, forming grotesque shapes. Lack of rootholds on the edges and clefts in the rocks, high winds and time have caused the trees to grow in this manner.

There is black-barked manna gum, *Acacia microbotrya,* which has delicious gum exuding from the limbs of the trees, *Acacia lasiocalyx* with graceful long fingers of flowers, *Acacia cyanophylla* and *Acacia acuminata.* In May and into springtime these trees carry a heavy covering of yellow blossoms.

In sheltered places near the rocks, the tobacco plant, *Nicotiana rotundifolia,* with small whitish-grey flowers and large cabbage-like leaves can be found, its leaves giving off a strong odour due to sulphur and nicotine in the leaves.

At the base of the rocks near the dam beautiful red bottle brush, *Melaleuca fulgens,* grows as well as the climber, *Muehlenbeckia adpressa,* and "blind grass", *Stypandra imbricata.*

A shrub of *Cassia pleurocarpa* has made its appearance here in the past few years; there is only one shrub, but it is growing very well in rich soil, amongst Acacias.

Sheltering under the ledges of rocks are "snake bushes", *Isotoma petraea,* while on the rocks in pockets of soil hop bushes, *Dodonaea attenuata,* grow with golden brown seed pods and a strong odour coming from the leaves.

Here too, grows the graceful small shrub *Glycyrrhiza acanthocarpa* with pink pea-shaped flowers and long brown seed pods.

In clefts on the rock scarlet flowers of *Kunzea pulchella* may be seen in November.

Further up from the dam and rocks on an incline is a group of

interesting trees. *Pittosporum phillyraeoides* with pale green foliage sweeping to the ground and bearing beautiful orange-red berries which split open revealing small round seeds within, which are held in the pods by a sticky substance. The trees have a peculiar odour, especially the berries, but it is unique and pleasant.

Also on the incline is a greyish-white shrub, *Ricinocarpus velutinus,* which is fairly common in the north-eastern agricultural areas and adjacent pastoral areas, but is near its southern limit in this district; it does not apparently occur anywhere else in this district.

Here too, is *Hakea recurva* and *Grevillea paniculata,* small trees.

On the incline and further afield is thickly covered brown, waving spear grass, *Aristida contorta.*

An uncommon plant which is rare here is *Abutilon oxycarpum* and belongs to the hibiscus family. It is of unusual interest as it occurs otherwise only in the northern and eastern pastoral regions.

Growing in only one area here, sheltered by rocks and boulders, is a small plant, *Helichrysum ambignum,* which is more typical of the drier inland districts; it has a very strong odour when the leaves are crushed, which is very head-clearing if one has hay-fever.

Red-centred mauve *Hibiscus* grows along a water course, but is common throughout the district.

Sandalwood trees, *Santalum spicatum,* grow prolifically on the reserve and bear an abundance of brown-skinned fruit, the kernel of the nut being delicious to eat, raw or cooked.

Casuarina acutivalvis wave and whisper in the wind, tall, straight and graceful with pendulous reddish-brown male flowers and large dark nuts.

There are many different species of grasses here, *Briza maxima, Briza minima,* and a scented grass, *Cymbopogon ambignus,* which is rare here but is a widespread species in the north of the State, but does not extend far south of this district.

On the western and northern flats around the rocks there is a profusion of shrubs and flowers and small trees as follows:

Acacia acuminata
Acacia microbotrya
Acacia lasiocalyx
Acacia cyanophylla
Angianthus tomentosus
Dampiera lavandulacea
Ursinia anthemoides
Waitzia acuminata
Sida calyxhymenia
Trichininm polystachyum
Stackhousia huegelii
Brunonia australis
Helipterum spicatum
Enchylaena sp.
Melaleuca fulgens
Ptilotus spathulatus
Podolepis canescens
Muehlenbeckia adpressa
Podotheca gnaphalioides
Brachycome iberidifolia
Eriachne ovata
Solanum nigrum
Casuarina acutivalvis
Aristida contorta
Hakea recurva
Podolepis lessonii
Santalum spicatum
Alyxia buxifolia
Isotropis juncea
Melaleuca radula
Waitzia aurea
Helichrysum lindleyi (formerly known as *H. roseum*)
Schoenia cassiniana
Calademia filamentosa? var. *denticulata*
Eremophila drummondii
Isotoma hypocrateriformis

Donkey Orchids and small Blue Orchids are dotted about the flat.

Eucalypt trees are scattered about the reserve.

This part of the reserve is not usually frequented by tourists or locals, so it is in its natural state of rugged beauty.

I am grateful to Mr. R. D. Royce, of the Department of Agriculture, South Perth, for identifying the specimens of the species mentioned.

PARALLEL EVOLUTION OF FLORAL STRUCTURES IN *DARWINIA* (MYRTACEAE) and *PIMELEA* (THYMELEACEAE)

By G. J. KEIGHERY, Kings Park & Botanic Garden, West Perth

Darwinia and *Pimelea* are widespread genera throughout temperate Australia, and probably originated in this region. The families to which they belong, however, the Myrtaceae and Thymeleaceae, respectively, are considered only distantly related (Hutchison, 1969 and Takhatjan, 1969),

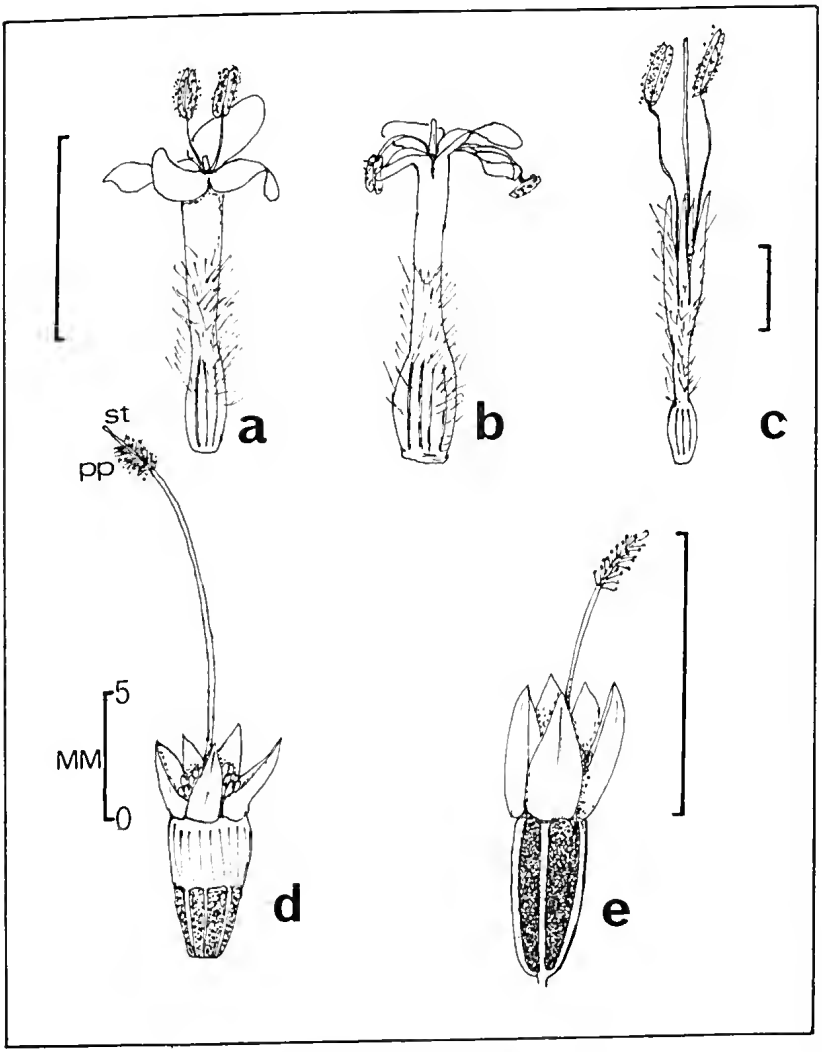

Fig. 1—Single Flowers.

Fig. 1a—*Pimelea rosea*—anther dehiscence.
Fig. 1b—*Pimelea rosea*—stigma receptive.
Fig. 1c—*Pimelea physodes.*
Fig. 1d—*Darwinia macrostegia.*
Fig. 1e—*Darwinia vestita.*
pp—pollen presenter st—stigma

although Cronquist (1968) has placed them in the same order, the Myrtales, but in different sections.

Naturally the basic inflorescence and floral strueture shows this lack of relationship (see Fig 1, a-e and Fig. 2, c and d). The flowers of *Pimelea* have four perianth parts, with four or two anthers per flower, while *Darwinia* has five perianth parts and numerous anthers per flower. Reasons for the divergent inflorescenee organization will be offered later.

Both genera show extreme protandry, but in remarkably different ways. In most speeies of *Pimelea,* the anthers dehisce, then fall, being re-

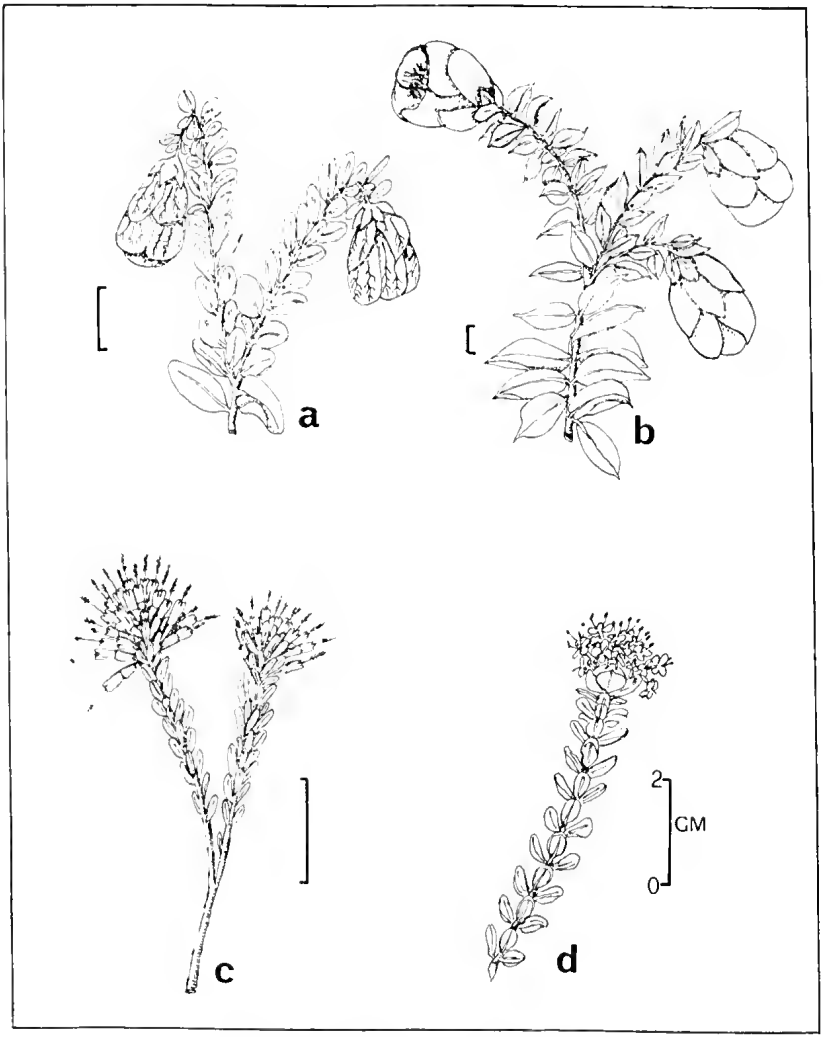

Fig. 2—Infloreseence Morphology.
Fig. 2a—*Darwinia macrostegia.*
Fig. 2b—*Pimelea physodes.*
Fig. 2e—*Darwinia vestita.*
Fig. 2d—*Pimelea rosea.*
(a, b and c from herbarium material)

placed by a receptive stigma (Fig 1, a and b). In *Darwinia,* the anthers dehisce in the bud and extrude their pollen suspended in an oily liquid onto a pollen presenter located near the tip of the style (Fig 1, d and e). As the bud opens the style is extended and the pollen becomes available for dispersal, at a later date the stigma becomes receptive.

Morcombe (1968, 1970) has indicated that butterflies are the probable major vectors of *Pimelea,* and my personal observations fully support his hypothesis (Table 3). The long tubular corolla of *Pimelea* is ideally suited to such a vector, as is the open nature of the inflorescence (Fig 2, d).

Generally, *Darwinia* has been found to be bird pollinated in Eastern Australia, in studies by Brewster (1915) and Briggs (1962, 1964). Briggs (1964) does indicate that some of the smaller species are also visited by insects. Many western species of the genus are also bird pollinated, see Tables 1 and 2. These species generally have large showy bracts surrounding the inflorescence (Fig 2, a: and also illustrations in Gardner, 1968), and a long style to deposit pollen on the visitors' head (Fig 1, d). Most of these species have the pollen presenter situated below the apex where the stigma is located and will not self although all species studied are self fertile (Briggs, 1964). However some species with round floral heads, e.g. *D. nielandia,* have the stigmatic head covered by the pollen presenter and can self. These species apparently form a distinct group in the bird pollinated species.

The other group of species of *Darwinia* in Western Australia have insignificant bracts and small white flowers (Fig 1, c and Fig 2, c) and are pollinated by insects; see Tables 1 and 2. All species in this group are able to effect self pollination.

One species of *Pimelea, P. physodes* Hook, has long caused considerable comment because of its external similarity to *Darwinia macrostegia* (Good, 1956 and Hutchison, 1969). This similarity has been noted as an extremely unusual example of parallel evolution that could not be ex-

TABLE 1.—POLLINATION VECTORS OF *DARWINIA* SPP IN WESTERN AUSTRALIA.

Species	Area	Vectors observed
D. speciosa	Hill River	*Lichmera indistincta* Gliciphila melanops**
D. macrostegia	Slopes of Mt. Toolbrunup	*Acanthorhynchus superciliosus**
D. nieldiana	Eneabba to Jurien Bay Road	*Acanthochaera chrysoptera* Phylidonyris niger**
D. citriodora	Darlington	*Acanthorhynchus superciliosus**
D. thymoides	Chittering	Thinnidae (flower wasps) Native Bees
D. vestita	7 miles west Mt. Barker	Thinnidae (flower wasps) Native Bees
D. diosmoides	Two Peoples Bay	Thinnidae (flower wasps), *Exoneura sp.* (Bee)
D. paucillora	Mullewa	Thinnidae (flower wasps)

*Birds

TABLE 2.—POLLINATION TYPES IN WESTERN AUSTRALIAN *DARWINIAS.*

Large showy bracts-birds	Small bracts-insects	Uncertain
D. pimelioides	*D. thymoides*	*D. acerosa*
D. speciosa	*D. vestita*	*D. oederoides*
D. carnea	*D. repens*	*D. oldfieldii*
D. macrostegia	*D. paucillora*	*D. virescens*
D. hypericilolia	*D. polycephala*	*D. purpurea*
D. helichrysoides	*D. rhadinophylla*	*D. sanguinea*
D. meissneri	*D. diosmoides*	
D. meeboldii	*D. pinifolia*	
D. collina	*D. verticordina*	
D. squarrosa		
D. nieldiana		
D. citriodora		
12 species	9 species	6 species

TABLE 3.—POLLINATION VECTORS OF *PIMELEA*
O, denotes original

Species	Area	Source	Vector*
P. sulphurea	Cockleshell Gully	Original	*Canadalides acastus*
P. sulphurea	Yanchep	O	*Vanessa kershawi* *Vanessa itea*
P. erruginea	Yanchep	O	*Vanessa kershawi* *Vanessa itea* *Taractrocera papyria* *Canadalides hyacinthinus*
P. rosea	Darlington	O	*Vanessa itea* *Vanessa kershawi* *Danaus chryssipus petilia*
P. spectabilis	Mount Chudalup	O	*Heteronympha merope duboulayi*
P. spectabilis	30 miles north Pemberton	O	*Heteronympha merope duboulayi*
P. suaveolens	Darlington		*Vanessa itea*
P. sylvestris	Shannon River	O	unident. butterfly
P. augustifolia	Walpole	O	unident. butterfly
P. sp.	Stirlings	O	*Neolucia agricola*
P. sp.	Stirlings	O	*Heteronympha merope duboulayi*
P. haemostachya	Frazer, Burdekin River, Qld.	Morcombe, 1970	*Anapheis java*
P. physodes	Fitzgerald River Reserve	O	*Gliciphila melanops* (bird)
P. sp.	Black Mountain, Canberra	O	unident. butterfly
P. sp.	Woy Woy, N.S.W.	Rayment, 1935	*Halictus urbanus* Sm. (bee)

*all butterflies unless stated

plained (see Fig 2, b) by usual methods. As noted, however, in Table 1, the author has found this species to be bird pollinated. The radically different flower with its long style and anthers (Fig. 1, c) ensures effective placement and pick-up of pollen with this new vector. The large bracts serve an attractant function as in the bird pollinated species of *Darwinia*.

The range of *P. physodes* borders that of large numbers of bird pollinated *Darwinias* which grow in the Stirling Ranges, where over 20 species of honeyeater are found. It would appear, therefore, that such mimicry must be of adaptive advantage to the species, especially as it flowers during the middle of the year when most honey plants are not in flower (including most species of *Darwinia*). The species thus provides an abundant nectar source for the honeyeaters when few are available.

SUMMARY

The 'parallel' evolution shown by *Pimelea physodes* is shown to be of adaptive value in utilizing a new vector source, not able to be used by other members of the genus. Its occurrence near the greatest concentration of bird pollinated *Darwinia* species of similar morphology suggests a form of mimicry may be operating. This species, because of these adaptations, now forms a distinct group in the genus *Pimelea*.

Further study upon the pollination systems of our species of *Darwinia* is needed to erect an evolutionary sequence of morphological change in this genus.

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SOME FIELD OBSERVATIONS ON *NUYTSIA FLORIBUNDA* (LABILL.) R.BR.

By THOMAS GÖBEL*

INTRODUCTION

All authors describing the aspects and peculiarities of the Western Australian flora mention the monotypic *Nuytsia floribunda* and point to its peculiar appearance; for example in the recent works of Morcombe (1968), Seddon (1972) and Erickson (1973) and others. The authors usually mention the following characteristics:

(1) *Nuytsia* is one of the three genera of the family of Loranthaceae rooting in the ground. The second genus which is also found in Australia, *Atkinsonia,* is also monotypic; the third, *Gaiadendron,* contains a few species in South America.

(2) The abundance and magnificence of its blossoms, blooming from December until the middle of January and especially copious after forest fires.

(3) The arboreseence and size which is unique among the Loranthaceae.

(4) The secondary bend of the boughs related to the development of more than one cambium ring.

(5) The growth of very long root-runners which produce the root-suckers thereby providing for the vegetative propagation of the plant. (Regeneration by means of seeds seems to be exceptional).

Beyond these there are only very few specific studies of *Nuytsia.* Herbert (1918) was the first to find out that it is a root parasite. Diels (1906) doubted its parasitism, because in some cases he could not find any suitable host plants within a considerable distance around the plant. He writes: "It would be—at least for the full-grown state of the tree—a very forced assumption, if one imagined that it takes its nutrition from the roots of those comparatively dwarf shrubs thriving scantily at its feet." Grass, later discovered as a possible host by Herbert, was not even taken into consideration.

Further descriptions of the parasitism of *Nuytsia* are to be found in Ewart's (1930) study: he writes that carrot root crops are parasitized. McKee (1952) found the roots of neighbour plants parasitized. Main (1947) presents a study in which he draws attention to the poor germinative faculty of *Nuytsia* seeds and the difficulties of artificial propagation. Narayana (1955, 1958) worked on the morphology of the blossom and the embryology. Beyond these only a few scattered remarks are to be found

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in literature. Seddon (1972), for example mentions the length of the root-runners and Kuijt (1969) reports that by producing specific enzymes the haustoria can attack even synthetic materials. A telephone cable cut by *Nuytsia* is exhibited in the Western Australian Herbarium.

In spite of its conspicuous appearance and morphological, histological and physiological peculiarities *Nuytsia* has not been studied very much. Therefore it seems appropriate to report on a series of field observations which the author carried out from December 21st to December 27th, 1973. They pertain to the morphology and the leaf position of a one-year-old root-sucker and the shape of the underground stem of a young plant.

THE AREA OF OBSERVATION

The observation area was located 22 km east of Augusta, 2.4 km north of the Scott River. It covers 250 m to the north-south and 100 m to the east-west. This area was chosen because it came closest to the author's idea of a natural habitat of *Nuytsia*. That may be wrong. In any case, it has already become difficult nowadays to find natural habitats of *Nuytsia*. In an area ranging from 64 km north of Geraldton (the most northerly *Nuytsia* observed), across the Swan Coastal Plain and the Darling Range down to Albany in the south, the author happened on only one other extensive habitat. This was on a sandy rise near the Harris River, 8 km east of Treesville, between Collie and Quindanning. However, neither root-suckers nor very old plants were to be found there. The cause for the scarcity of undisturbed habitats is the almost complete agricultural exploitation of the Swan Coastal Plain and the increasingly extensive agricultural and forestry developments in the Darling Range and the area between Bunbury, Augusta and Albany. The search for such habitats was pursued over a period of 16 days. The study area was a flat south-west slope of a sandy rise, apparently the furthest one to the north-west of a series of such, stretching from the observation post to the south and the east. To the west stretched a flat swamp bearing heathy vegetation, while the rise itself was wooded. The trees consisted mainly of Jarrah *(Eucalyptus marginata)* intermixed with a few (5%) Marri *(Eucalyptus calophylla)*. In the second zone of trees *Banksia ilicifolia* was rather frequent whereas *Nuytsia floribunda* was rarer. There was a total lack of brushwood in the observation area. However, a great deal of burnt or dried up shrubbery was found. These and the fresh layer of carbonized remains as well as the great number of one-year-old *Acacia* seedlings pointed to the fact that the area was burnt in 1972. In the herbaceous zone there were loosely spread *Carex* species, beside the *Acacia* seedlings and one-year-old root-suckers of *Nuytsia floribunda*. These root-suckers grow in clusters on areas of 60-140 m^2, sometimes very close together, 10 to 30 specimens on the square metre, mostly, however, 4 to 10. Mosses and lichens were not observed. The soil in the observation area consisted of medium to fine-grained sand. Except for the upper 3 to 5 cm of the soil profile appearing grey to grey-black, there was no differentiation into strata down to a depth of 120 cm. The colour of the soil from 5 to 120 cm varied from a light grey to a faint yellow. The soil was perfectly light without any clay. The moisture did not change with depth. It stayed fresh.

Figure 1 gives a general view of the location with the young *Nuytsia floribunda* in the centre which was dug out a little later.

THE OCCURRENCE OF *NUYTSIA FLORIBUNDA* IN THE OBSERVATION AREA

Two loosely growing clusters of *Nuytsia floribunda* with a few younger plants in between were found in the observation area. Only the northerly cluster had a very old full-grown specimen of 14 m in height. It grew on the edge of an open space in the west that passed into the swamp. In its surroundings 11 younger specimens were found. The second group at the south end of the explored area consisted of 16 younger to middle-aged specimens. The distance between the specimens was 4 to 22 m. The root-suckers which had obviously developed only after the forest fire of

1972 were only rarely found near the older speeimens, exeept for those growing immediately around the base of the trunks. They seemed to prefer the lighter spaees of the stoek.

THE MORPHOLOGY OF A ONE-YEAR-OLD ROOT-SUCKER

A suitable root-sueker was ehosen for examination. If possible it should have grown without a bend in the main stem. The additional sub-shoots ought to be regularly developed on all sides. (If the root-suekers grow elosely together their additional shoots appear to be ehecked by the

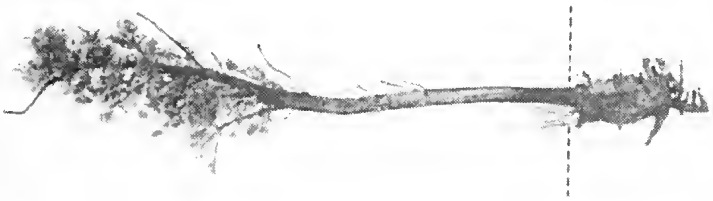

FIG. 2

FIG. 1

Fig. 1.—General view of the observation area with the young *Nuytsia floribunda* (leaning) which was dug out.
Fig. 2.—The *Nuytsia floribunda* dug out as a whole; its dimensions are set out in Table 2, p. 56.

others.) There were 73 leaved nodes counted on the chosen root-sucker, only the two next to the roots had no leaves (lost?). The leaves closest to the ground were visibly broader and shorter than the following ones. They passed continuously into the lanceolate shape by 3 or 4 leaves. The two leaves at the top apparently had not yet stopped growing. They were visibly smaller and of a lighter shade. Past the 73rd leaf on the 75th node towards the top a zone of growth was found with buds and internodes, that had not come to an end with their formation and lengthening. Nodes with buds could be made out by means of a magnifying glass up to the 83rd. Additional shoots were found without exception in the axils of the leaves of nodes 16 to 41. The additional shoots were distributed as follows on the 42nd to 54th nodes:

\+ = with additional shoot — = without additional shoot

nodes:	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
	+	+	—	+	+	—	+	+	—	+	—	+	—	—	+	—	—
			△												△		

first node without add. shoot — last node with add. shoot

Table 1 was included in order to show that the length of the internodes reveals a certain rhythm. In two sequences the 5th internode respectively is lengthened. The two sequences were marked A and B. (In order to mark the different internodes of these sequences they were given the ordinal number of the node below). Thus sequence A consists of the internodes 30, 35, 40, 45, 50, 55, 60, 65, 70, 75 and sequence B of the internodes 27, 32, 37, 42, 47, 52, 57, 62, 67, 72. If one compares the length of the internodes (Table 1) of the two sequences it is obvious that A is dominant towards the top, B towards the root. (The length of the internodes in that sequence begins unsystematically in the lower part). The first systematic lengthening can be observed at internode 14. Then follow 18, 23, 27 and 32. The differences here are 4, 5, 4, 5. The difference remains 5 within sequence B up to the topmost measurable internode (72). One more lengthened internode (68, 73) follows the two topmost internodes (67, 72) immediately. Sequence A starts, yet indistinctly, at internode 30 and after internode 60, it overtakes the length of sequence B.

In order to find out the leaf position of this root-sucker the angle formed by two adjacent central leaf axes and the stem was measured on a number of leaves (accuracy of ± 0.5°), i.e. on the nodes 33 to 52. The result was a median angle of 136°, 54' with a maximum spread of 2.5°. This satisfies quite exactly a leaf position of 8/21, the mathematical equivalent is an angle of 137°, 8', 4". A leaf position of 8/21 of the leaves of dicotyledons seems to be a rare exception. If one takes into consideration that each of the two sequences of lengthened internodes (A and B) correspond to a distichous leaf position, the sequences A and B run along the main stem on approximately opposite sides.

THE MORPHOLOGY OF A ROOT-STOCK OF *NUYTSIA FLORIBUNDA*

In order to understand the morphology of the root-stock of *Nuytsia floribunda*, the root of a younger specimen was dug out. Thus many haustoria could be found. The smallest (youngest?) of the examples in the observation area was chosen. It could be distinguished from all other individuals by the fact that the main stem did not show the bend so typical of later age. The trunk itself was 5.18 m high, the main stem having died away by burning at 4.90 m. It had already been replaced by an additional shoot of equally vertical growth. At its base the trunk (including the bark) had a diameter of 177 mm; at 30 cm above the surface it was 148 mm; at 100 cm, the same, and at 500 cm, 18 mm

TECHNIQUE OF DIGGING

In order to gain a suitable starting-point for the search of haustoria a ditch was dug from the foot of the trunk to the south, 50 cm deep, 50 cm wide and 100 cm long. Two hausoria were found accidentally. After that

TABLE 1

Ord. Number of the node	Height of insertion (mm)	Length of Internodes (mm)	addition shoot yes + no —	length (mm)
1	0	—	—	
2	1	1	—	
3	2	1	—	
4	9	7	—	
5	9	0	—	
6	10	1	—	
7	13	3	—	
8	14	1	—	
9	17	3	—	
10	22	5	—	
11	28	6	—	
12	28	0	—	
13	30	2	—	
14	39	B 9	—	
15	42	3	—	
16	48	6	+	180
17	51	3	+	256
18	61	B 10	+	2
19	65	4	+	99
20	69	4	+	190
21	73	4	+	221
22	75	2	+	252
23	87	B 12	+	190
24	96	9	+	195
25	98	2	+	228
26	99	1	+	267
27	112	B 13	+	237
28	115	3	+	248
29	122	7	+	217
30	130	8	+	228
31	133	3	+	209
32	145	B 12	+	215
33	149	4	+	193
34	154	5	+	213
35	164	A 10	+	225
36	166	2	+	206
37	173	B 7	+	123
38	178	5	+	99
39	184	6	+	104
40	193	A 9	+	138
41	194	1	+	107
42	204	B 10	—	
43	207	3	+	48
44	213	6	+	106
45	223	A 10	—	
46	223	0	+	114
47	233	B 10	+	76
48	238	5	—	
49	245	7	+	106
50	256	A 11	—	
51	257	1	+	101
52	269	B 12	—	
53	272	3	—	
54	281	9	+	38
55	292	A 11	—	
56	298	6	—	
57	309	B 11	—	
58	316	7	—	
59	323	7	—	
60	333	A 10	—	
61	339	6	—	
62	348	B 9	—	
63	355	7	—	
64	362	7	—	
65	372	A 10	—	
66	377	5	—	
67	386	B 9	—	
68	396	10	—	
69	401	5	—	
70	412	A 11	—	
71	417	5	—	
72	425	B 8	—	
73	434	9	—	
74	439	5	—	
75	451	A 12	—	

the remaining wall was dug out from beneath with a small shovel so that the sand from above came crumbling down. Now and then some knocking and scratching with the hand from below was helpful. By this method no finer roots were injured. In this way a circular area, 200 cm in diameter and 50 cm deep was dug out.

DISTRIBUTION OF THE HAUSTORIA

It turned out that haustoria were developed only in the upper 10-12 cm of the soil around very fine roots, mostly of *Carex* sp., in some cases

Fig. 3.—Haustoria of *Nuytsia floribunda*.

of *Eucalyptus* spp. A total of 64 haustoria were found which appeared to be snow-white in colour as described by Herbert (1918) and which surrounded the host-root in a ring. In two cases the haustoria did not connect into a ring. The exterior diameter of the haustoria lay between 2.5 mm and 8 mm. Fig. 3 shows a haustorium of 6 mm in diameter.

The *Nuytsia*-root to which a haustorium belongs, was in every case thinner than 0.5 mm and equally white. All haustoria-bearing *Nuytsia*-roots did not spring from the trunk itself but from the abundant number of root-suckers that sprang from the root-neck of the main trunk 6-10 cm deep in the ground (Fig. 4).

After it had become evident that there would be no further haustoria in the deeper layers, digging into the depth was continued without any special precaution.

THE SHAPE OF THE UNDERGROUND STEM

The underground stem had the shape of a turnip which changed 85 cm below the surface from the vertical to a horizontal tap-root spreading immediately into 4 roots (Fig. 5). Furthermore nine other roots were made out springing horizontally from the turnip-root in a depth of 70-78 cm and rising vertically at some further distance. Table 2 gives the measurements of the turnip-root and the diameters of the roots.

Fig. 2 shows the *Nuytsia floribunda* which was dug out as a whole. A closer look at the surface of the turnip-root shows that it is covered with

TABLE 2.—DIMENSIONS OF THE STUDY TREE

TRUNK and UNDERGROUND STEM			ROOT	
Position	Girth (mm)	diameter (mm)	No.	/ diameter at a distance of 20 cm from the turnip-root (mm)
30 cm above the surface		148	1	60
10 cm above the surface		170	2	52
surface		177	3	104
14 cm below the surface	1,190	379	4	78
30 cm below the surface	1,325	422	5	92
40 cm below the surface	1,475	470	6	84
50 cm below the surface	1,340	433	7	57
60 cm below the surface	122	388	8	28
85 cm below the surface		60	9	32
			10 a	40
			10 b	35
			10 c	26
			10 d	22

ring-shaped bark-folds. These are presumably the cicatrized remains of withered root-runners. That means, however, that the root-runners are periodically replaced by new roots at greater depth. This is supported by the fact the root marked 3 had withered at a distance of 1.10 m from the turnip root. Only very little amount of organic remains was found in front of the still living stump. Another fact speaks in favour of this: root No. 3 with a diameter of 104 mm was the strongest and at the same time the one in the least depth (60 cm).

Fig. 4.—Root-suckers of *Nuytsia floribunda* which spring from the root-neck of the main trunk.

In the end an attempt was made to dig out root No. 6. This plan was given up after 21 m. Table 3 gives the diameters of the root at every metre. Only one branch was found on the total length of that root and that at a distance of 19 m from the foot of the trunk where a root of 22 mm in diameter branched off to the front in an acute angle.

After cutting the part of the trunk above the ground, a colourless gum flowed out, especially intensely in a ring of 1 cm width, measured from the bark to the centre. This flow continued for about 24 hours. The gum coagulated into a sticky substance that stood up like hair over the milk

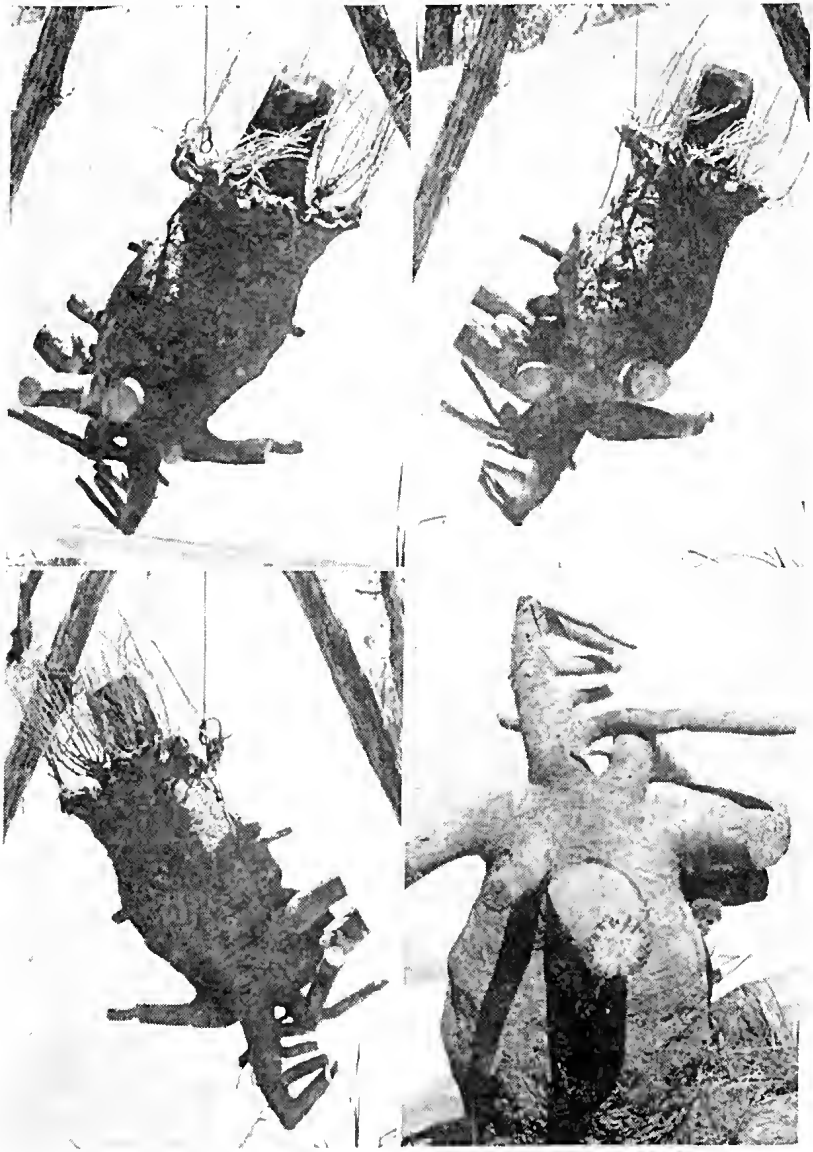

Fig. 5.—Four views of the underground stem of *Nuytsia floribunda*.

TABLE 3

length (m)	diameter (mm)	length (m)	diameter (mm)	length (m)	diameter (mm)
0	89	8	44	15	43
1	64	9	41	16	46
2	59	10	41	17	43
3	50	11	43	18	43
4	47	12	43	19	43
5	46	13	45	20	39
6	44	14	45	21	39
7	42				

tubules. A light-green gum, however, flowed from the turnip-root and took a little longer to coagulate into drops. The zone in the root from which the gum ran was 8 cm wide and lay in the exterior third of the cross-section. The root-runners had the light-green gum flow across the total cross-section.

The existence of such an important storage organ as the turnip-root of that enormous size compared to the above-ground part of the plant, explains perhaps the magnificence of the blossoms of *Nuytsia floribunda* especially after forest fires. Specimens were seen by the author blooming abundantly with yellow flowers and bearing no single leaf capable of assimilation.

The observations described here are single cases and need repetition before the leaf position and the existence of a turnip-root can be taken as an established generalisation. To assess the possible significance of the turnip-root, repeated observations would be desirable.

SUMMARY

Near Augusta in Western Australia a one-year-old rootsucker and an entire young plant of *Nuytsia floribunda* were observed with regard to their morphological characteristics. Two sequences of internodes of the rootsucker, belonging to two approximately opposite distichs of the leaf position, are promoted before all others. The leaf position of this shoot is 18/21. The younger specimen which was dug out with a trunk of 15 cm in diameter, 30 cm above the ground, had a turnip-root of 85 cm length and a maximum diameter of 47 cm. The magnificence of the blossoms of *Nuytsia floribunda* especially after forest fires in the leafless state can possibly be explained by the great nutritive reservoir of the underground turnip-root.

Verifications of these isolated observations are essential.

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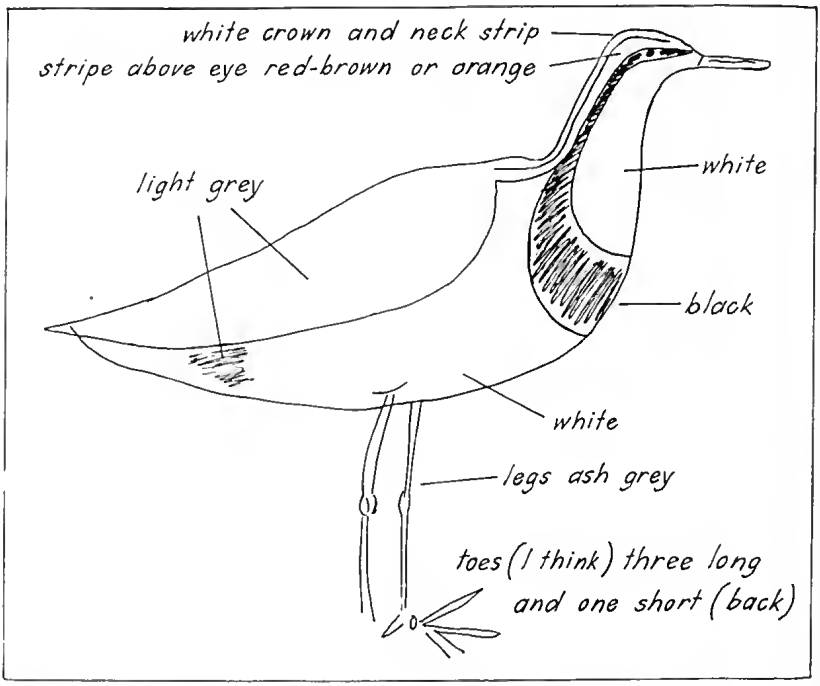
AN OBSERVATION OF THE PHEASANT-TAILED JACANA IN WESTERN AUSTRALIA

By G. M. STORR and R. E. JOHNSTONE,
Western Australian Museum, Perth

Early this year Mr. Joseph A. Smith sought our help in identifying a strange bird he saw on 22 December, 1974 at the north-western iron-mining town of Paraburdoo (23°12'S, 117°40'E).

Mr. Smith wrote, "Here's a mystery for you to solve, nothing like it in Cayley's or Slater's books. Seen feeding in water's edge at sewage pond. Legs long (about 9 or 10 inches) and toes (front) seemed quite long. The black band across its chest 2 inches wide at base and narrowing as it reaches eye. With the brown-coloured stripe on each side of its head down to the shoulder and the white central strip [of crown] and bib and belly it is quite an attractive bird. Height of bird seen next to a Black-tailed Water Hen about 3 inches shorter. When I saw it fly,



Copy of field sketch by Mr. J. A. Smith of the Pheasant-tailed Jacana.

the depth of wings was rather great and the flight similar to that of the Lapwing and other plovers. Bill about one inch long. I have no record of tail length, so assume that it was short. The bird was gone next day."

A rough sketch of the feeding bird, as seen from behind, shows the wing tips crossing each other and extending beyond the tail. A sketch of the bird in profile is reproduced here. In a subsequent letter, Mr Smith told us that the bird was wading in the water (which explains his failure to record details of the feet).

It was soon evident to us that this was no resident Australian bird or regular visitor. We therefore searched the literature for descriptions of moderately large Asian aquatic birds. Only one species fitted Mr. Smith's sketches and description, namely the non-breeding form of the Pheasant-tailed Jacana, *Hydrophasianus chirurgus,* which ranges from Pakistan east through southern China and Malaya to Formosa, the Philippines and Java.

We sent a photocopy of Mr. Smith's letter and sketches to Mr. John Darnell of Goldsworthy for his opinion on the bird. Mr. Darnell, an expert on south-east Asian birds, immediately recognised the bird and telephoned us to confirm our identification.

Meanwhile we had sent similar photocopies to the British Museum (Natural History) for checking directly against specimens of *Hydrophasianus.* On 31 January 1975, Mr. Peter Colston replied, "I have looked at the skins in the collection and it fits and compares very well with a female collected by H. Whistler in February 1936 from the Chanda Dist., Central Prov., India . . . . I have also looked through the waders, i.e. lapwings etc. and Wilson's Phalarope, but none agree."

Great numbers of birds from northern Asia visit Western Australia every summer. Visitors from subtropical and tropical Asia, however, are a very rare category, which hitherto included only the Malay Banded Crake *(Rallina fasciata)* and the Blue-winged Pitta *(Pitta moluccensis).* To these we can now add the Pheasant-tailed Jacana.

According to Hugh Whistler *(Popular Handbook of Indian Birds)* the Pheasant-tailed Jacana is similar to other members of the Jacanidae in favouring waters with floating vegetation, but it is "more ready to frequent open water, and more accustomed to wander to flood water, streams, and similar spots free of weeds." It is therefore not so surprising to find this species in a region that is completely lacking in habitat suitable for its relative, the Australian Lotus-bird.

When breeding the Pheasant-tailed Jacana is a very beautiful bird. It then acquires tail plumes half a metre long, and the body becomes glossy chocolate brown.

FROM FIELD AND STUDY

The Black Tern near Perth.—The Black Tern *(Chlidonias niger)* does not appear to be unquestionably admitted as a member of the Australian avifauna (cf. Serventy *et al., The Handbook of Australian Sea-Birds,* 1971: 206). However I am satisfied I observed an individual resting on a partly submerged post in Lake Joondalup on December 31, 1973.

The bird was in winter plumage and had the following characteristics: A small marsh tern having the forehead, neck and underparts white with a greyish patch on the side of the breast in front of the wing. The bill was black and the legs red. The back and wings were slate grey. The flight was typically buoyant in character. The bird allowed a very close approach but once disturbed it flew off and was not observed to feed.

The species is readily distinguished in its winter plumage from all sea terns by its distinctive "bat-like" flight and greyish black upper parts. The only species with which it could be readily confused is the White-

winged Black Tern *(Chlidonias leucopterus)*. The latter has no dark patch on the side of the breast, a paler rump and tail and brighter reddish legs.

I am well acquainted with this species in winter plumage. I have frequently observed it as an autumn migrant in England—visiting estuaries, brackish and fresh-water lagoons and marshes, especially on the east coast —during its movement southward from its breeding haunts in Northern Europe, e.g. Denmark, Germany, Holland, etc., to its winter quarters in Africa. This little marsh tern was an extremely common winter visitor to Lagos, Nigeria, where I spent two years.

—SYDNEY JACOBS, Nedlands.

Cockatiel in the Wheatbelt.—As a contribution to information on the recent spread, or invasion, of the Cockatiel *(Nymphicus hollandicus)* I offer the following observations. On August 31, 1974 on Mr Roger Forte's farm at Latham I observed 7 birds. In about 30 years of observing the birds in the area Mr Forte had never seen this species before. At Merredin I observed 10 birds on February 6 and 40 birds on February 22, 1975. Mr Paddy Crook, a farmer who is keenly interested in the local wildlife, having lived most of his life in the district (about 40 years) had never seen the Cockatiel previously until this month (February, 1975).

—GREG LINSTEAD, Merredin.

A Recent Breeding Record of *Charadrius melanops* in the Metropolitan Area.—During an excursion to Lake Herdsman on December 1, 1974, two adult Black-fronted Dotterels, *Charadrius melanops*, were observed. I followed them into the corner of a mudflat. One bird was always running away from me, then squatting down, spreading the tail and lowering both wings. The matter became more interesting now and I tried to spot a nest or fledglings. Soon after, only 1 metre away from me, I discovered the young dotterels. Being precocial, the legs were the most conspicuous feature of the half-thumb sized birds. The tarsus measured 26 mm, while the centre toes were 13 mm. Measurements of the beak and wing were 9 mm and 14 mm respectively.

—OTTO MUELLER, Wembley.

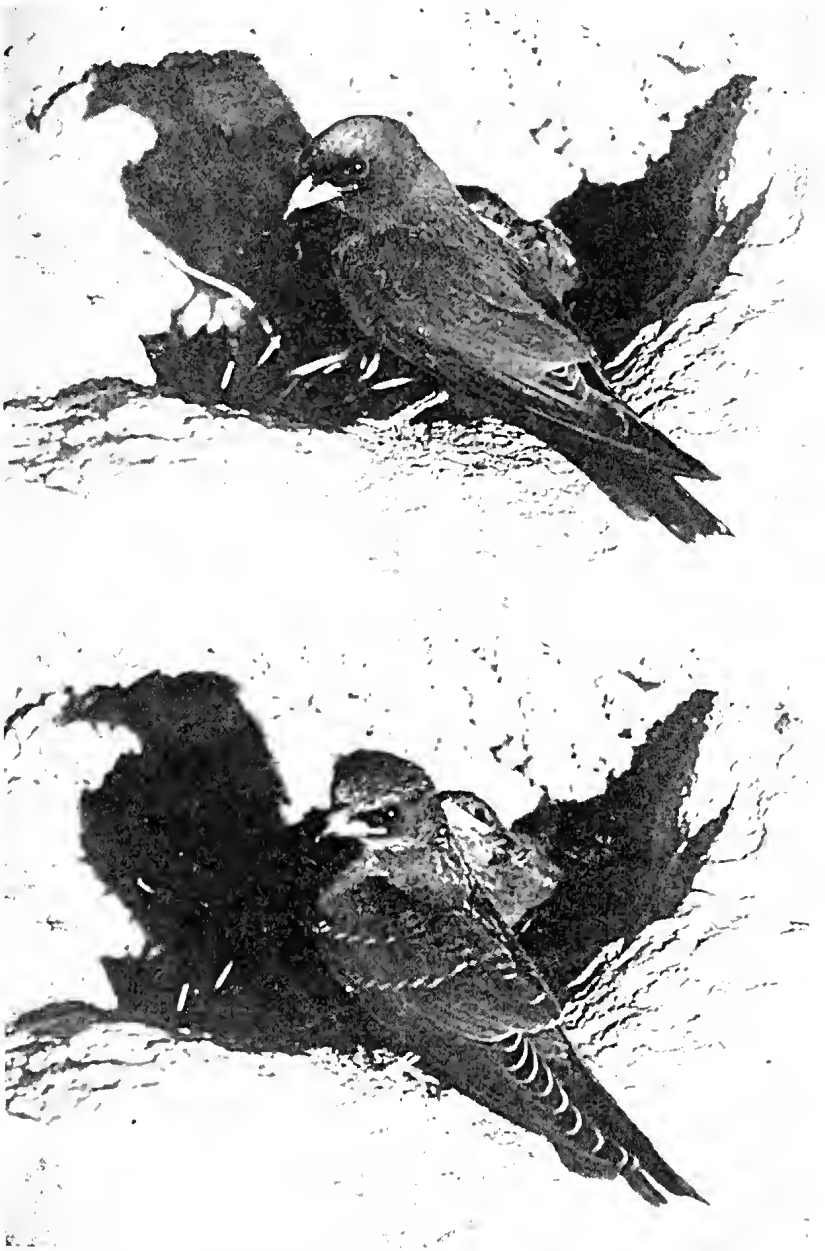
A Further Record of Little Egret, *Egretta garzetta*, in the South West. —On November 27, 1973, at Benger Swamp, I observed a slender egret with black bill, black legs and two plumes extending back horizontally from the nape. This I supposed must be a Little Egret although it did not appear to be obviously smaller than the White Egrets, *Egretta alba* which were frequent though none was close enough to serve as a 'yard-stick'.

I returned to Benger Swamp on December 4, 1973 and spent some time examining egrets which appeared 'under-sized' without conclusive results until I located a typical Little Egret in breeding plumage standing in a group of resting White-faced Herons, *Ardea novaehollandiae*. This bird I viewed in a good light with X 8 binoculars and X 20 telescope at distances down to c. 60 m. Bill, legs and, I think, feet, were black. The bird appeared somewhat smaller than the herons, both resting and in flight. Its rate of wing beat was similar to that of the herons from which it separated when flushed.

It is just possible that there may have been more than one Little Egret present. It seemed to me that the nape plumes of the second bird identified were longer and more tapering than those of the first, and it is by no means certain that all my apparently 'undersized' egrets were one and the same.

—ERIC H. SEDGWICK, Harvey.

Co-operative Nesting Behaviour in Little Wood-Swallow.—On 3 February 1974 I found the nest of a Little Wood-Swallow, *Artamus minor*, in a breakaway on Mileura Station, 93 miles north-west of Cue. The nest contained two downy chicks with eyes still closed. I returned on 16



UPPER: Adult Little Wood-Swallow at nest. LOWER: Juvenile Little Wood-Swallow at same nest after feeding nestlings.

February and photographed the nest, during which time I noticed that besides the two adults who fed the young many times, a third bird in juvenile plumage fed the nestlings four times over a period of two hours. I believe this to be the first record of co-operative nesting behaviour in the Little Wood-Swallow.

—JOHN ESTBERGS, Helena Valley.

Graphium **Butterflies at Koolan Island.**—The butterflies of Koolan Island were recorded by Koch and van Ingen (1957, *W. Aust. Nat.*, 11: 98). A species of papilionid to add to this list is *Graphium eurypylus nyctimus* (Waterhouse and Lyell, 1914). Two specimens were collected by Mr. F. C. van Ingen at Koolan Island, W.A., one on 28 December 1973, the other on 4 January 1974. They are lodged in the Western Australian Museum (W.A.M. Reg. Nos. 74/1082-3).

The distribution of *Graphium eurypylus,* which has some thirteen subspecies, includes India, southern China, southern Japan, south-east Asia, New Guinea and northern and eastern Australia. *G. e. nyctimus* was previously known from Darwin and Groote Eylandt. The only other subspecies in Australia is *G. e. lycaon* which occurs from Cape York to Sydney.

—L. E. KOCH, Western Australian Museum.

Incursion of Painted Finches into the North-Eastern Goldfields.—1973 was a drought breaking year in the north-eastern goldfields and North-eastern Division, with some localities recording double their average rainfall. A trip across the centre, through the Warburton Ranges to Alice Springs in August-September, was through a carpet of vegetation the whole way.

The Painted Finch *(Zonaegintlus pictus)* was noticed at various localities in Western Australia and the Northern Territory, from Gahnda Rock Hole (Yowalga 1: 250,000 map) eastwards, making me familiar with a bird I had not seen before. Thus it was with great interest I observed this bird on three occasions soon after returning to Leonora, and once early in 1974.

Locations and dates of observations are listed below and are occasions where positive identification, by observation through 7x50 binoculars, was made. Maps referred to are Department of National Mapping 1:250,000 series.

Date	*Map*	*Grid Reference*	*Number*
18 September, 1973	Menzies	429365	2 birds
9 October, 1973	Leonora	371412	4 birds
9 October, 1973	Menzies	354403	2 birds
4 February, 1974	Leonora	435417	15 birds

Thus this irruption south and west of the bird's usual range has led to sightings 37 and 50 miles west of Leonora, at Gwalia (2½ miles south of Leonora) and 29 miles ENE of Menzies. No doubt this movement was facilitated by abundant surface water and feed throughout the whole area.

—DON REID, Gwalia.

An Observation of the White Wagtail *(Motacilla alba)* **in Western Australia.**—About May 1971 Messrs. I. Cooke and W. A. Gibb, then of the Waterfowl Research unit of the Department of Fisheries and Fauna, Perth, sought my help in identifying a strange black-and-white passerine bird that they had recently seen in the Katanning district (250 km SE of Perth).

The bird was a little smaller than a White-winged Triller *(Lalage sueurii)* and looked like a miniature Magpielark *(Grallina cyanoleuca).* It was found in Douglas's Swamp, 15 km WNW of Woodanilling. While Cooke and Gibb were describing the bird I made an 'identikit' drawing of it. The forehead, face, throat, lower breast and abdomen were white;

the back of the head and upper breast were black; the wings were black marked with white; and the tail was black except for an outer strip of white extending to the tip.

In our discussion on the identity of the bird, all black-and-white Australian species were considered but finally rejected. Though the identification of the bird seemed insoluble, I retained the 'identikit' drawing.

About two years later, when consulting Smythies' *Birds of Borneo*, the figure of the White Wagtail on plate XXVIa instantly reminded me of the Woodanilling bird. I compared this figure with my drawing and found the two practically identical. I now have no doubt that the bird seen by Cooke and Gibb belonged to one or another of the east Asian subspecies of *Motacilla alba*. All the latter are migratory, most birds spending the northern winter in northeastern India and southern China, a few individuals extending to the Indo-Chinese countries and the Philippines but seldom further south.

—G. M. STORR, Western Australian Museum, Perth.

Additions to the Kalbarri Bird List.—Following the Royal Australasian Ornithologists' Union Camp of 1948 at the mouth of the Murchison River, a list of birds known to occur there was published in *Emu*, 48: 212. Further species—Golden Plover, White-headed Stilt, Little Corella and Variegated Wren—were recorded by K. Buller, *W. Aust. Nat.*, 2: 82 and a referenee to Budgerygahs appears in *W. Aust. Nat.*, 3:37.

I was at Kalbarri from June 18 to 21, 1974 and noted the following species additional to those listed in the sources mentioned above:

Crested Pigeon, *Ocyphaps lophotes*. A flock of at least three birds was flushed between Murchison House Station and the aecess road to Kalbarri.

Bustard, *Eupodotis australis*. This was reported to the R.A.O.U. party by residents, but not sighted. I encountered one bird between the gorge at Z Bend and the access road to Kalbarri.

Redthroat, *Pyrrholaemus brunneus*. One bird was encountered at The Loop. This was perched on a small tree and was singing vigorously. It permitted a close approach and was viewed through binoculars in a good light. In the same area a Black-eared Cuckoo, *Chrysococcyx osculans* was calling. This species favours the Redthroat as a host.

Little Wood-Swallow, *Artamus minor*. This bird was not seen by the R.A.O.U. party, but is mentioned in *Birds of Western Australia*, Serventy and Whittell, as occurring in the Murchison gorges. We saw several in flight at The Loop and encountered several resting on the road to Hawkshead Lookout. One was slow in taking evasive action and was nearly struck by the windscreen of our vehicle. In the Northern Territory, I found Little Wood-Swallows given to sitting on roads, but had not previously seen this practice in Western Australia.

—ERIC. H. SEDGWICK, Harvey.

Birds and the Total Eclipse—Observations from Albany.—Birds are not numerous on Mt. Clarence at Albany even though most of it is covered with quite thick scrub. Before the eclipse began, on June 20, 1974, and during the early stages of it there was no bird song to be heard as is quite usual during the middle of the day. As the light from the sun grew less the slight wind became colder and four or five Yellow-winged Honeyeaters *(Phylidonyris novaehollandiae)* ealled briefly, answering each other, then were silent for a few minutes and a couple called again. Then a family group of Splendid Wrens *(Malurus splendens)* gave a brief twitter just below the brow of the mountain and Kookaburras *(Dacelo gigas)* were heard giving evensong in the distance.

There was no further song during the total eclipse and bird life seemed to resume its normal tenor as the light improved again without

any fuss, other than two Magpies *(Gymnorhina dorsalis)* heard giving a brief morning carol.

However, the Silver Gulls *(Larus novaehollandiae),* which are very numerous and tame in Albany, seem to have had some very unpleasant shocks. They were roosting on roofs and various vantage points not very far from the Senior Primary School in the main street when the light began to go and the air became colder. The leaders apparently decided it was time for roosting and after a great commotion led the flocks down towards the harbour. This decision took some time and darkness caught the two or three flocks some hundreds of metres from the shore line. They all settled on the grass—most on the Parade Street Soccer Ground—and remained there quite silently. When the light increased again the flocks took off and circled the centre of the town about fifty metres in the air for some time. Finally tiring of this the birds settled on buildings again but not on their accustomed perches or buildings. They favoured high ridge caps and had an unmistakeable air of discomposure for the remainder of the day. One must be sympathetic with the seagulls for not only were they unable to reach their sleeping areas before darkness but were not allowed to go to sleep and to cap it all, their usual lunch hour feed of crusts and scraps of food on the school playground did not eventuate. The children all ate lunch in school and naturally crusts went into dustbins.

H. O. WEBSTER, Albany.

Departure Date of the Bridled Tern in Shark Bay.—Serventy *et al. (The Handbook of Australian Sea-Birds,* 1971, p. 228), give the departure date of the migratory Bridled Tern *(Sterna anaethetus)* as late February in the Perth area and April at Green Islets and the Abrolhos Islands. By a mere fluke I was able to determine the exact day and almost the hour when they left Slope Island, Shark Bay this year (1974).

On Sunday, February 24 my wife and I were on the island fishing most of the morning and noticed the terns seemed more agitated than usual, flying to and fro and settling on the rocks for only a few seconds at a time, and calling to each other incessantly. Only a small number seemed to be present so we guessed they were preparing to leave. We left the island at 11.45 a.m. and returned at 2 p.m., intending to take some photographs of the birds with a new 250 mm. lens I had just bought. However, not one bird was in sight and although we drove out there daily for the next week not a tern did we find.

—ROBERT C. MITCHELL, Hastings, N.Z.

Discovery of the Western Whipbird at Hopetoun.—The known distribution of the Western Whipbird, *Psophodes nigrogularis,* in Western Australia has been documented by Serventy and Whittell *(Birds of Western Australia,* 1967). It has been found at Two Peoples Bay and in mallee country around Borden and Gnowangerup and its most easterly location was hitherto 120 kilometres east of Borden near the Fitzgerald River.

On November 6, 1974 whilst visiting Hopetoun with members of the Royal Australasian Ornithologists' Union engaged in compiling a list of birds in the Fitzgerald National Park I heard a Western Whipbird calling near the coast road 3 km east of the town, and on November 9, two birds were observed and the identification confirmed. Subsequently a third bird was heard calling on the road to Ravensthorpe, 32 km from Hopetoun, by Mrs. J. Seabrook and Mrs. J. Clark. The known range is thus extended eastwards by 80 km.

The habitat was dense thickets of Round-leaved Moort, *Eucalyptus platypus,* and in the area close to Hopetoun this was supplemented by low coastal heath. All areas where the birds were found were composed of dense mallee regrowth resulting from fire.

An examination of tape recordings of the songs of these birds and

those of Two Peoples Bay, and comparison with recordings from South Australia shows that there is little regional variation. Such consistency over a distance of some 1,240 km suggests the existence of further colonies of these birds around the little known coastline of the Great Australian Bight.

—F. N. ROBINSON, Helena Valley.

A Third Nesting Station of the Pelican in Peel Inlet.—Pelicans *(Pelecanus conspicillatus)* have in recent years established two nesting stations in Peel Inlet, south of Mandurah—on Creery I. and Nirimba Cay *(W. Aust. Nat.*, 9 (4), 1964: 80-84). Prior to about 1962 the southernmost nesting colony known in Western Australia was Pelican I. in Shark Bay. Now a third nesting station has been discovered in Peel Inlet, on a sand island created as a result of spoil from dredging the Yundurup Canals Scheme. The island came into existence in 1972, and is one mile from the eastern shore of Peel Inlet just south of the Murray River delta at Yundurup. It is known locally as Sand I., White I., or as Joan Watters I.

Naturalists first became aware of the colony on July 7, 1974. Several of us, including Julian Ford, Ron Templeton, Tony Bush and myself, took Professor Charles Sibley, of the Peabody Museum of Natural History, Yale University, on an excursion to Peel Inlet. Noting with the field-glasses an unusually dense concentration of Pelicans on the island we decided to make a closer inspection. To our surprise we found the birds were nesting. There were two groups of nests on the eastern slope of the islet. The more southerly group, evidently a slightly earlier laying, contained 47 nests —one egg in 3 nests; 2 eggs in 41 nests; and 3 eggs in 3 nests. The second group, close by, comprised 41 nests—one egg in 25 nests; 2 eggs in 15 nests, and 3 eggs in one nest. In addition there were 83 eggs scattered above the tide line, not in nests. All were fresh and cold. The Pelicans waddled off their nests as we landed, at 1.15 p.m., but immediately returned to the nests when we embarked in our dinghy at 1.20 p.m.

We were unable to visit the island again until September 8. In the interim, as we were informed by Mrs J. L. Wright and Mr C. G. Dunnet, of Culeenup I., Yundurup, that later in July there had been gales and floodings, during which part of the sand island had been inundated and the eggs washed away.

On September 8 I visited the island, with Dr Wilhelm Meise, of Hamburg. The Pelicans had laid again higher up the crest of the islet. We counted 65 adults but did not make too close an approach as we did not wish to disturb the birds unduly. The incubating birds were all on eggs and no chicks were visible. On September 15 I visited the island with Professor J. A. Keast. There were 33 nests—7 nests each contained 2 eggs; one nest had one egg and one chick; 13 nests had one chick, and 12 nests had 2 chicks. About 36 adult birds were present, very placid and they scarcely moved off as we approached. Most of the chicks were very small, evidently hatched during the week, though one or two were obviously older. On October 1 we (Mr A. G. Mathews, Mrs Geraldine Gregory and I) inspected the island with Messrs Phil Bodeker and D. Tapper of the "Daily News". Most of the young birds, now much more advanced, and covered with white down, crowded into a creche as we approached. About 30 of these young were counted. There were about 30 nests recognisable. In one nest was an egg and chick, 6 nests each contained one chick, one nest had 2 chicks, one had one egg, and one had 2 eggs. The adult birds returned very rapidly to the nesting area as we withdrew.

On October 12 the nesting site was visited by Brian Hutchison, A. G. Mathews, K. Flanagan and W. Meecham. All the chicks were in a creche and 41 were counted. The nests were unoccupied. Two dead chicks were noticed and one addled egg. The individuals in the creche moved off into the water as the visitors approached and were then herded back by the parents when the visitors left. All the chicks were downy but two or three were feathered, with brown backs. None could fly. Food regurgitated by

the young was entirely of shrimps (*Palaemonetes australis*). On the following day, October 13, the island was visited by a Naturalists Club party which also included Dr Frederick Hamerstrom and Dr Florence Hamerstrom, of Wisconsin, and Mrs M. B. Mills.

On October 31 Mr Max Bailey and I encircled the islet and made a census from the boat. The actual nesting site was not occupied but the young (29 individual young were counted) were on a sand bank just off the island and waddled into the sea as we approached. They were in a tight group and could not fly. They were downy, with feathers, and had pale bills. They were accompanied by 12 adults. Off Meeyip I., one of the Yundurup delta islands, 3 Pelicans were seen, one of which was evidently a young bird (smaller, with paler bill); perhaps it was an advanced young from this or one of the other Peel Inlet colonies. On November 5 I counted 32 young birds swimming in a compact group in the water off the sand island. They could not fly. On November 17 Miss V. M. Bristowe, Miss Christine Maggs and I visited the island and counted 28 young birds. They were swimming in a dispersed group, could not fly, and only flapped helplessly when the boat approached, unable to take off. The other four young seen on November 5 may have been elsewhere, as the young we counted swam quite some distance from their home island. There were few adults in the vicinity; only 4 were close by and 2 others flew in, as we watched, and joined the young birds.

—D. L. SERVENTY, Nedlands.

OBITUARY

BRUCE SHIPWAY

Bruce Shipway, Honorary Life Member of the Club, and former President (1948-49), died suddenly in Perth on May 29, 1972. He was born in Sydney, N.S.W., on March 27, 1907. His father, William Charles Shipway, a solicitor, was prominent in Sydney and Lord Howe Island affairs, and his mother was a member of the Hordern family. A brother, Phillip,

Bruce Shipway, 1966.

of the Sydney legal firm of Shipway and Berne, was for long treasurer of the Royal Zoological Society of N.S.W. and its president in 1936.

Mr. Shipway senior was a member of the N.S.W. contingent in the Sudan War of 1885 and after completing his legal course on his return founded the legal firm of Shipway and Berne in 1890. He was M.L.A. for Paddington, chairman of directors of the Kentia Palm Seed and Plant Co-operative Company Ltd. (a Lord Howe Island enterprise), a Taronga Park Trustee and Deputy Grand Master of N.S.W. Freemasons. He died in 1925.

After education at the North Sydney Church of England Grammar School ("Shore") Bruce had the chance of entering the family law firm but a desk job had no appeal. He was a high-spirited youth and for a few years led an adventurous life in Sydney. Competitive motor cycling was his first sport and he provided patrons at the Penrith Speedway with some spectacular displays. The *Daily Guardian Pictorial* in its issue of October 6, 1926, featured a photograph of Bruce riding his Chater Lea in what the paper described as "one of the most remarkable performances ever witnessed on a race track" at the final of the five miles consolation race. With one lap to go he had his back tyre wrenched off on a corner. He did not fall but kept going and was just beaten for second place within 20 yards of the finish. He then became interested in flying and in 1928 trained with the Australian Aero Club. He won the silver cup presented by Sir Charles Wakefield, the Angels Kiss Cup at Mascot and figured in another sensational incident which captured the newspaper headlines. In August 1929 at Penrith he did a parachute jump from the wing of a plane flying at 3,400ft. The rip cord failed to open after the scheduled interval—two seconds—and he struggled with the mechanism with his hands and opened the parachute after 14 seconds, falling some 1,500ft. before the parachute functioned. On another occasion due to engine failure he crashed into the Snowy River in mid-winter. He told his brother, Phillip, that it was either the river or a mountain side! He intended to take up commercial flying but a slight colour blindness prevented it. A hint of later activities was his fascination by the aquarium at Taronga Park Zoo (opened in 1927), whose construction he watched. But he seems to have been conditioned even earlier. He once mentioned that there was an aquarium in the room at home where he was born.

Before World War II, in 1930-32, he and another brother, Ron, engaged in motor transport of stock in the North-West of Western Australia. One run was from Roy Hill to Meekatharra along the "Madman's Track". During this period he noted natural history phenomena which he made use of in later papers (cf. *W. Aust. Nat.*, I, 1947: 47).

He had earlier in Sydney served an apprenticeship in instrument technology and in Perth joined the staff of the Tough Instrument Company. This engineering skill was later applied both in his natural history activities and in his professional career.

When World War II broke out he joined the A.I.F. and became a sergeant in the survey corps. It was then that he became heavily involved in what was to become his life-time interest in natural history—the study of freshwater fishes. He first came to the notice of other naturalists by his re-discovery of Leichhardt's Sawfish. In June 1845 the explorer Ludwig Leichhardt was shown a strange fish, dead, at the edge of a waterhole in the Lynd River in northern Queensland and "I was greatly surprised to find it a sawfish (Pristis), which I thought lived exclusively in salt water" (Leichhardt, *Journal of an Overland Expedition in Australia*, 1847, p. 288). The explorer speculated on the significance of the find. Later travellers also reported sawfishes in the north but no specimens had been studied by ichthyologists until Bruce Shipway in October 1944 was able to examine a specimen from the same river as Leichhardt's, the Lynd. He gave a photograph and description to Gilbert Whitley, the ichthyologist at the Australian Museum, Sydney, who in the *Australian Zoologist*, 11 (1), 1945: 43-45, reported this re-discovery of "Leichhardt's Sawfish", as he termed it, and gave the fish a new name and formal description—*Pristiophorus leich-*

hardti, though some modern workers doubt whether it should be regarded as a separate species. Shipway also saw the fish in the Walsh, Mitchell and Palmer Rivers, and Whitley surmised that it was "obviously a permanent resident of the rivers and not a fortuitous visitor." Besides the sawfish discovery he accumulated material for publication himself, including a series of illustrated papers on the fishes of the Barron River.

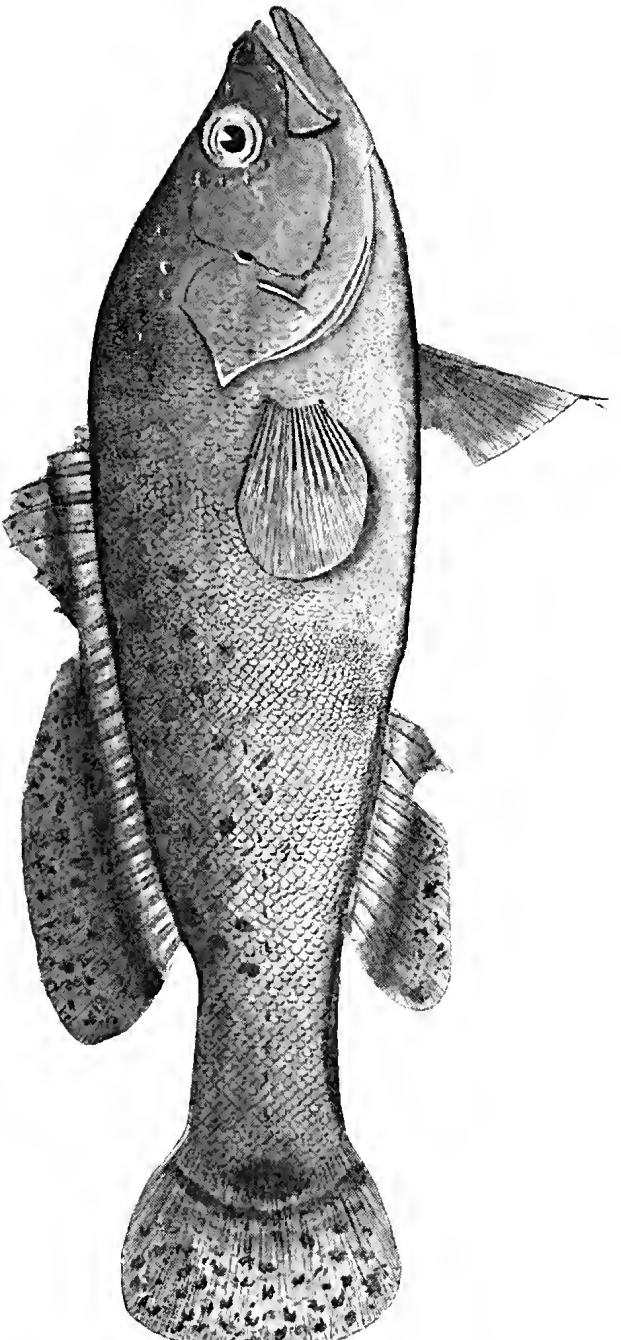
On transfer to Western Australia he was engaged in Army surveys north of Perth, and when peace returned he continued in survey work, this time in the Avon valley on the standard gauge railway project. He resumed association with the W.A. Naturalists' Club which began on his earlier stay in W.A., and henceforth was always linked with its activities. These were mostly concerned with freshwater fishes and other aquatic fauna. He was expert in making and equipping aquariums, and was outstanding in the study of life histories from aquarium observations. His exhibits at the Wild Life Shows in the Perth Town Hall, from 1946 onwards, attracted wide public interest. An early lecture to the Club preceded by many years general concern at stream pollution. At the general meeting in the W.A. Museum in February 1946 he screened a movie film he had made himself of Queensland scenery and wildlife which included a scene showing how a brook teeming with fish and plant growth could be destroyed by a mere trickle of effluent from a nearby camp.

When the CSIRO Division of Fisheries began its sea-going fisheries investigations in this State, with the F.R.V. *Warreen* (Captain C. E. Pedersen) Bruce applied for and was appointed to the post of Technical Officer in December 1946 and he and the writer were together for over three years whilst he remained in the service. He made cruises all around the coast, to Timor, across the Great Australian Bight and to Tasmania. He also participated in land and coastal surveys and mapped the interesting shoreline feature, the 12-mile beach east of Hopetoun which at the time supported a rich fishery on Australian Salmon. In 1948 he participated in the R.A.O.U. camp-out at the Murchison River, discovering and describing a new species of the fish genus *Eleotris,* which Gilbert Whitley later placed in a new genus named after him, *Shipwayia.*

In January 1950 he resigned to become Curator of the trout hatcheries at Pemberton for the Pemberton-Warren Trout Acclimatisation Society. Here, though he was mainly concerned with trout management, as a sideline, at the suggestion of Mr. A. J. Fraser, Director of Fisheries, he investigated the life history of Marron and the ecology of local streams. He prepared a useful pamphlet on pond fish farming, which, however, was never published. He became impressed with the lack of nutrients in the fresh waters and the consequent sparsity of their animal life. He hurt the pride of his employers, who held a pardonably exaggerated view of the productivity of their waters, by paraphrasing Winston Churchill: "Never have I seen so much water with so little in it."

As may be imagined Bruce did not stay long in this post. His inability to suffer fools gladly, and the independence of mind ingrained in him by his early upbringing, meant he often changed jobs. He could not bring himself to be agreeable to anyone for whom he had no respect, even if they were important personages on whom most people fawned. After he left Pemberton in 1952 he decided he had had enough of being in service to others. He achieved independence by acquiring an engineering company, the Burrows Engineering Company, which he re-named the Jay Bee Engineering Company, making it a vigorous and successful enterprise. In 1970 it was re-named the Acme Engineering Company.

Freshwater biology continued, however, to be his private hobby. He was a foundation member of the Aquarium Society of Western Australia in September 1953 and was its president for several years. He held high hopes, after his retirement from business, of continuing research on local fishes on the lines of his paper on the Pigmy Perch (*W. Aust. Nat.,* 2, 1949): 1), beginning with the Nightfish, *Bostockia porosa.* Unfortunately a serious hip injury, caused by a fall on the floor of his factory in August, 1962, incapacitated him and this led indirectly to his premature death following



The Nightfish, *Bostockia porosa*. An adult specimen drawn by Bruce Shipway. Mature specimens range in total length from 90 to 120 mm. The specimen drawn was 110 mm.

a heart attaek and two strokes.

The work on *Bostockia* was not completed. We publish herewith a drawing he had made of the species in connection with the projeet. He had considerable facility for drawing fishes and some of his later papers were exeellently illustrated. A set of his fish drawings is preserved in the club's archives.

In July 1949 he married a fellow Club member, a widow, Mrs. Irene Metcalfe (born Monck), with kindred interests in freshwater natural history, who was associated with him both in his hobbies and business career. In the engineering company she specialised in the administration side whilst Bruce was concerned mainly with the technology. Mrs. Shipway was a foundation council member of the Aquarium Society and was his companion on field trips and associate in aquarium work at home.

Bruce Shipway impressed all his naturalist friends by his zest for life, his enthusiasm for wildlife and particularly freshwater fishes. He was generous to fellow workers and kind and encouraging to all younger naturalists. Personally he was a most kind and eonsiderate man. This was exemplified to an extraordinary degree by the devoted eare he bestowed on his bed-ridden mother, an arthritis invalid of many years. She came to live with him in South Perth and he looked after her until she died in June, 1949.

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—D.L.S.

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THE CITRINE SPIDER: A NEW GENUS OF TRAPDOOR SPIDER (MYGALOMORPHAE: DIPLURIDAE)

By BARBARA YORK MAIN, Zoology Department, University of Western Australia

The Citrine Spider is common and widespread throughout the Wheatbelt. Although known to naturalists for many years and in spite of its attractive and conspicuous colouring it has never been described or scientifically named. The spider occurs in sandy, granite soils throughout the range of the jam and Yorkgum woodlands but is more precisely associated with thickets of teatree *(Melaleuca uncinata)*. The burrows are frequently found in the meadows around granite outcrops, both in the small meadows

Plate 1.—*Teyl luculentus,* female paratype (BYM 56/507). Approximately life size.

Plate 2.—*Teyl luculentus,* male paratype (BYM 56/495). Approximately life size.

of the rock slopes and the apron at the base of rocks. Burrows are not closed by a door but are open like a wolf spider's except during the summer when the entrance is sealed with a soil plug. The burrow descends vertically and turns abruptly at the base. Mature nests may be about 25 cm deep. Nests generally have no silk lining and maintain their shape by virtue of the angularity of the sand grains in which they are excavated.

Like all trapdoor spiders, the Citrine Spider takes several years to mature. Males emerge and wander during late autumn and early winter. Eggs are laid in the female nest during spring and the young disperse the following autumn after the first seasonal rains.

The author first found the spider at Emu Hill (near Narembeen) in 1952. Subsequently hundreds of specimens have been located and the

species appears to range over the whole of the Wheatbelt. One other species (to be described later when male specimens are found) has been collected from the granite rocks northeast of Payne's Find. Another group of related species, believed to be derived from the Citrine Spider, construct doors to the nests. These are to be described elsewhere. For the present the genus and the common species are herewith named and described.

Note on name: the generic name is derived from an Aboriginal word meaning a brightly coloured stone; the specific name refers to the shining yellowish colour.

TEYL gen. nov.

Colour: ♀, carapace, sternum and basal segments of legs and palps a shining (glabrous) yellow, sometimes with the thoracic region of the carapace darker. Metatarsi and tarsi often dark brown. Abdomen brownish, frequently speckled. The whole body and legs very sparsely hairy and the shiny yellow integument occasionally suffused with a greenish tinge. Prominent spines on legs; carapace often with heavy marginal spines. Scopula on tarsi and metatarsi very sparse or absent. Tarsal claws bipectinate.

Carapace broad with rounded sides, caput slightly raised, fovea variable, procurved, straight or recurved. Eyes in compact group on a tubercle. Sternum very broad with small sometimes round sigilla, sub marginal. Labium small and broad with anterior indentation; no spinules. Chelicerae with heavy teeth on inner edge (promargin) and small basal row on outer edge (retromargin). Sometimes a group of stout spines (pseudo-rastellum) on apical angle of chelicerae. Male with no spur on first tibia; scopula present on tarsi.

Distinguishing features: Broad glabrous carapace with variable fovea, broad sternum with small, sometimes round, submarginal sigilla. Male lacks tibial spur.

Teyl luculentus sp. nov.

Holotype: ♀ Locality 14.5 km north of Bruce Rock on Bruce Rock/Merredin Road. 29,viii,1956. Collected by B. Y. Main (BYM 56/499). Deposited in Western Australian Museum.

Colour, body and appendages bright shining yellow in life; abdomen with dark brown, mottled dorsal pattern. Carapace 9.0 mm long, 8.00 mm wide. Fovea recurved. Carapace glabrous and smooth except for stout marginal spines. Eye group 1.4 mm wide and 0.7 mm long, slightly raised. Sternum 4.6 mm long and 4.8 mm wide. Sigilla small, indistinct; posterior ones oval in shape, submarginal; sternum with open pile of long hairs. Labium broad, 0.7 mm long, anteriorly indented. Chelicerae with pseudorastellum of stout bristles. Inner margin of left cheliceral furrow with 8 large teeth and outer margin with 7 small teeth near base; right chelicera with 9 teeth on inner margin, 5 on outer margin.

Legs: Leg formula:

4	1	2	3
2.95	2.84	2.66	2.3

$$= \frac{\text{(leg length}}{\text{carapace length)}}$$

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Palp	4.5	2.5	3.5	—	3.0	13.5
I	7.4	4.0	6.0	5.0	3.2	25.6
II	6.7	3.6	5.7	4.8	3.2	24.0
III	5.5	3.0	4.0	4.7	3.5	20.7
IV	7.5	3.5	6.0	6.6	3.6	26.6

Hairs but no scopula on legs. All segments shining, glazed almost hairless except for femurs. Tarsi without spines. Heavy paired spines on ventral faces of metatarsi I & II. Spines on all faces of metatarsi and tibia, 1 or 2 prolateral spines on patella, a few dorsal spines on femurs; ring of stout spines on coxae and trochanters. Palp tarsus with several ventral spines but lacking the basal pair characteristic of *Chenistonia* and related genera. Abdomen 12.00 mm long. Almost bare except for sparsely scattered, long fine hairs.

Paratype ♂. Locality 13 km south of Merredin on Bruce Rock Road 29.viii.56. Collected by B. Y. Main (BYM 56/495). Deposited in Western Australian Museum.

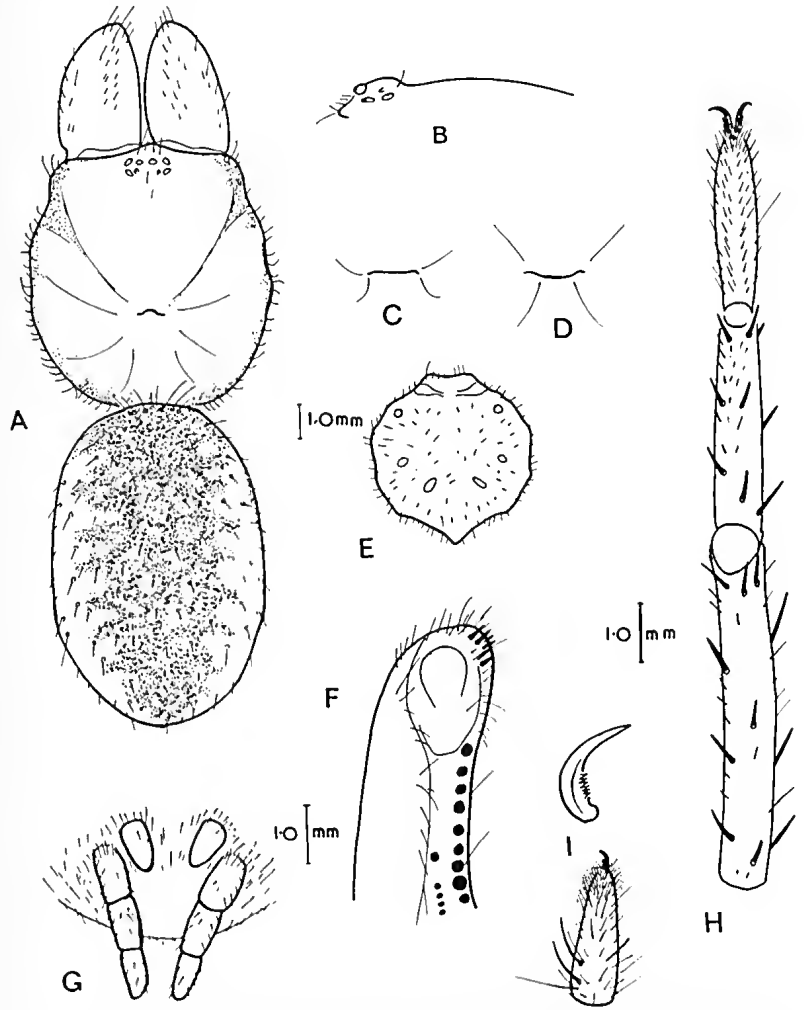

Fig. 1.—*Teyl luculentus*. A, B, E-H, Holotype female (BYM 56/499). A, Carapace and abdomen from above. B, Eye tubercle from side. C, D, Fovea of paratypes (BYM 56/497 and 56/262 respectively). E, Sternum. F, Right chelicera with fang removed to expose position of teeth. G, Spinnerets. H, First right leg, ventral view, spines and hairs. I, Tarsus of right palp; claw enlarged. A, E, same scale. C, D, F, G, H, I, same scale. B, not to scale.

Colour, body and appendages generally yellowish brown; chelicerae dark brown; proximal segments of legs with dark brown smudges, distal segments dark brown; tibia I red and patella reddish brown. Abdomen, dorsally grey-brown with irregular dark brown median mark; ventrally greyish-yellow.

Carapace 6.5 mm long, 5.9 mm wide. Fovea procurved. Sternum broad, shield shaped with round, submarginal sigilla. Heavy spines on metatarsus

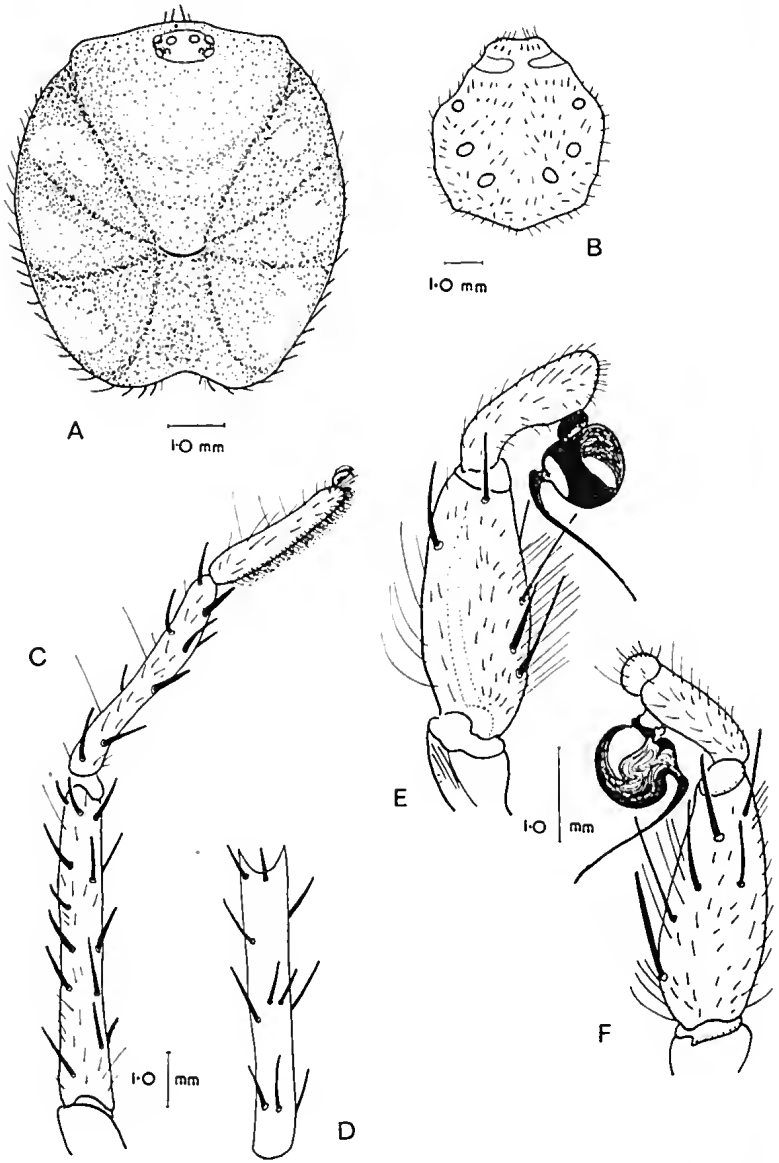

Fig. 2.—*Teyl luculentus,* paratype male (BYM 56/495). A, Carapace. B, Sternum and labium. C, D, First right leg; C, retrolateral view; D, ventral. E, F, Right palp; E, retrolateral view; F, prolateral.

and tibia of first leg. Tarsi with scopula. Palp tibia with 5 long retrolateral spines and 6 prolateral spines; bulb round, stigma curved and finely tapered (see Fig. 2).

Legs: Leg formula:

4	2	1	3
4.66	4.00	3.61	3.5

$$= \frac{\text{(leg length}}{\text{carapace length)}}$$

Total length of legs: I, 25.74 mm; II, 26.34; III, 23.40; IV, 30.64.

Notes on other Paratypes: ♀ ♀

13 km south of Merredin on Merredin/Bruce Rock Road. 29,viii,1956. Collected by B. Y. Main (BYM 56/493). Carapace length, 7.5 mm [W.A. Museum].

Locality data as above (BYM 56/497). [W.A. Museum].

9.5 km from Bruce Rock on Bruce Rock/Doodlakine Road. 29.viii. 1956. Collected by B. Y. Main (BYM 56/502). Carapace length, 8.0 mm. Internal genitalia dissected (see Fig. 3). [W.A. Museum].

As above (BYM 56/505). Carapace length, 7.0 mm. Internal genitalia dissected. [W.A. Museum].

As above (BYM 56/507). Carapace length, 7.6 mm. [W.A. Museum].

14.5 km north of Bungulla at "Fairfields". 16.v.1956. Collected by B. Y. Main (BYM 56/262). Carapace length, 4.2 mm. No pseudo-rastellum. Fine bristles on margin of carapace. Scopula on tarsi of palp and first leg. [W.A. Museum].

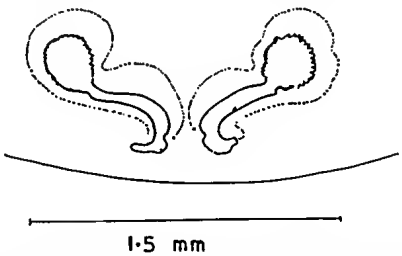

Fig. 3.—*Teyl luculentus*, paratype female (BYM 56/502). Internal genitalia.

Paratype ♂ ♂

12.8 km south of Merredin on Merredin/Bruce Rock Road. 29.viii.1956. Collected by B. Y. Main (BYM 56/496). Specimen collected as penultimate instar and reared to maturity the following autumn. Carapace length, 6.4 mm. [Australian Museum].

14.5 km north of Bungulla at "Fairfields". 15.v.1956. Collected by B. Y. Main (BYM 56/258). Collected as penultimate instar and reared to maturity following autumn. Carapace length, 4.9 mm. [W.A. Museum].

Variability of ♀ ♀. Some specimens observed to be less markedly spinose having soft bristles instead of stout marginal spines on the carapace and basal segments of legs; thin scopula may be present on tarsi; colour varies from bright yellow to greenish. Delineation of fovea varies—straight, procurved or recurved. Pseudo-rastellum on chelicera present or absent.

Variability of ♂ ♂. Size at maturity varies. Number and stoutness of spines on palp tibia varies; number of spines on tibia and metatarsus of first legs also variable.

Additional specimens have been collected from the following localities and are stored in the author's collection, housed at the Zoology Department of the University of Western Australia.

Beverley; Boyagin Rock; Bruce Rock area, 13.5 km and 14.5 km N. on Merredin Rd., and 9.5 km on Doodlakine Rd.; 'Fairfields', 14.5 km N. Bungulla; 'Eboracum', N. Bungulla; Heitman's Scrub, N. Bungulla; Bushfire Rock; Canna; Coolgardie, 25 km S.; Cranbrook; Crossman; Emu Hill (near Narembeen); Goomalling, town reserve, and salt lakes N. of town, and on Bolgart Rd.; Hyden, 8.5 km E., and 22.5 km E. at King Rocks turnoff; Harrismith; Koorarawalyee, 3 km W.; Merredin area, golf course, 6.5 km N., 24 km N., 13 km S.; Mooliaman; Morawa causeway, and 27.0 km W.; Murchison River, at Highway crossing; Northam/Goomalling Rd.; Northampton, 88 km N.; 343 km on Great Northern Highway; Pindabunna; Quindanning, 19 km W.; Quairading; Sandford Rocks (Westonia); Tuttanning Reserve (E. Pingelly); Wongan Hills; Wurarga, 11 km W.; Williams, 21 km S.; Yalgoo; York; Yorkrakine Rock.

ACKNOWLEDGEMENTS

Some of the specimens on which this study is based were collected while the author was in receipt of a University of Western Australia Research Grant (1952-1956 inclusive). The author is also indebted to the following people for specimens: M. J. Littlejohn, W. J. Lane, A. R. Main, H. W. Norris and W. H. Butler. The photographs were taken by A. R. Main.

ADDITIONS TO THE FAUNA OF BARROW ISLAND, W.A.

By W. H. BUTLER, Wanneroo

Subsequent to the publication of my summary of the vertebrate fauna of Barrow Island *(W. Aust. Nat.,* 11 (7), 1970: 149-160), I visited the island on a number of occasions and have added new or further records to the published list. Unless otherwise acknowledged all records were made by me.

MAMMALS

Family DASYURIDAE

Planigale sp. Marsupial Mouse.

This identification was provided by Mr. M. J. Archer (Qld. Museum).

Four specimens were taken by Mr. L. A. Smith and myself in Aug.-Sept. 1973 (Research Grant awarded by Wapet and the Western Australian Wildlife Authority). The animal is slightly smaller than *Antechinus macdonnellensis* which it closely resembles. The first two specimens were taken by hand in limestone eaves (WHB) on the western side of the island. The third was killed during the blasting of a termite mound, and the fourth was taken in a pit trap in 1.5 metre high *Triodia angusta.* This record makes eight species of marsupials on Barrow Island. Although the same collecting techniques had been used by me on Barrow Island for a period of 10 years, this is the first time that this animal was noted. It is possibly undergoing some form of cyclic increase in numbers and it may not be easily found again for a number of years.

Family MACROPODIDAE

Bettongia lesueur. Boodie Rat.

In 1972 an inspection team from the Fisheries and Wildlife Department of W.A. confirmed its occurrence on Boodie Island, the furthest south island in the adjacent chain close to Barrow Island. There appears to be no physical difference between Boodie and Barrow specimens in the field but no specimens have been taken of the former group and identity is based on field observation and pickup skulls.

Family DUGONGIDAE

Dugong dugon. Dugong.

Several individuals were observed at various times on the west coast. One animal found alive on Turtle Bay beach was photographed before returning it to the water: it had severe scars of a shark attack. It is recorded

by Ride (1970) that this animal never leaves the water but it appears that under stress conditions such as shark attack and falling tide a stranding may occur.

Family DELPHINIDAE

Sousa sp. probably *S. plumbea.* A Long-snouted Dolphin.

One specimen of this animal was collected on Barrow Island in June 1964 but positive identification has only just been forthcoming. (All Cetacea collected are in the W.A. Museum and were identified by Mr. J. Bannister).

Steno bredanensis. The Rough-toothed Dolphin.

3 beach casualties were collected in 1971.

Stenella sp.

The skull of a juvenile beach casualty was collected in 1974.

Pseudorca crassidens. False Killer.

A group of some thirty of these animals came ashore in Bandicoot Bay in 1971. Despite massive efforts by workmen and machinery to return them to the deeper water they persisted and perished. Skulls, dentaries and ear bones were collected from the bodies.

Family PHYSETERIDAE

Physeter catodon. Sperm Whale.

Ear bones and teeth were collected in 1972 from five animals beached near Stokes Point in 1970.

REPTILES

A considerable number of new reptile records have been made which are included in a separate paper to be published by Mr. L. A. Smith of the W.A. Museum.

BIRDS

Species new for the island are asterisked.

*Little Grebe *(Podiceps novaehollandiae).* One dead bird on an eastern beach, Aug. 1974.

*Brown Gannet *(Sula leucogaster).* Four birds flying off Wapet Landing, 30 Aug. 1973.

Reef Heron *(Egretta sacra).* A pair nesting in mangroves: 3 chicks, Sept./Oct. 1974. This species usually nests on rocky ledges.

*Black Swan *(Cygnus atratus).* One bird near Bandicoot Bay, 30 Jan. to 3 Feb. 1974.

*Grey Teal *(Anas gibberifrons).* One bird on camp swimming pool—2 Aug. 1974.

*Maned Goose *(Chenonetta jubata).* 2 birds on an ephemeral pool following cyclone 1-3 Jan. 1974. They were being harried by an Osprey.

Osprey *(Pandion haliaetus).* 9 pairs nesting in Aug. 1973. Oldest chicks almost fully feathered. A new-laid egg was seen on 31 Aug. 1973. Other nest contents: 2 with 1 egg, 2 with 1 chick, 3 with 2 chicks, 1 with 3 chicks.

Kestrel *(Falco cenchroides).* Nest and 5 eggs 22 Aug. 1973; first egg hatched Sept. 1973. The male of this pair took a first flight Welcome Swallow fledgling from the ground where it landed after a 20 yard flight. The parent swallows made no attempt to defend or attack the raptor although a Singing Honeyeater which was nesting about 5 metres away made very determined efforts to drive off the intruder.

Bustard *(Eupodotis australis).* 7 birds, north end of island Oct. 1973.

Pied Oyster-catcher *(Haematopus ostralegus).* 4 pairs with discovered young, 2 chicks plus 3 single chicks, Aug.Sept. 1973. All chicks downy.

Grey Plover *(Pluvialis squatarola).* This species is frequent around the island beaches. A most unusual single bird in breeding plumage was photographed at Bandicoot Bay Sept. 1974.

***Golden Plover** *(Pluvialis dominica).* Several seen with large flock of Grey Tattlers, Aug./Sept. 1973. 2 on Donald River mouth Sept. 1974.

***Oriental Dotterel** *(Charadrius veredus).* 2 pairs on airstrip Aug./Sept. 1973. (Specimen taken). 3 pairs on old airstrip Sept. 1974.

Red-capped Dotterel *(Charadrius ruficapillus).* Nesting Aug. 1973. 2 eggs, 3 eggs, chicks running. One nest in middle of Wapet Landing gravel area.

***Bar-tailed Godwit** *(Limosa lapponica).* Frequent but not plentiful at Bandicoot Bay.

***Greenshank** *(Tringa nebularia).* Regular on mudflats, eastern side of island. Mostly twos and threes.

***Grey-tailed Tattler** *(Tringa brevipes).* Large flocks seen Aug. 1973, Sept. 1974. Specimen taken 1973.

***Turnstone** *(Arenaria interpres).* A common beach bird.

Silver Gull *(Larus novaehollandiae).* Camp scraps and rubbish plus the fresh water swimming pool have increased the numbers on Barrow Island. 1964 records show the species was common but not in large numbers. 1974 records show flocks of 200 or more are constant. A new breeding colony has been reported on the north end of Middle Island (W. Foster, WAPET).

Crested Tern *(Sterna bergii).* Fairly common. Recorded by Serventy and Marshall (A Natural History Reconnaissance of Barrow and Montebello Islands 1958, *CSIRO Div. Wildlife Res., Tech. Paper* No. 6, 1964) but omitted from my 1970 paper.

Bar-shouldered Dove *(Geopelia humeralis).* 2 nests on rocks at cave mouth, 2 eggs each. 27 Aug. 1973. Flying young in mangroves Bandicoot Bay 11 Sept. 1974.

***Budgerigah** *(Melopsittacus undulatus).* 3 birds on four consecutive days. 6-9 May 1975. These were observed following a period of constant offshore winds.

***Fork-tailed Swift** *(Apus pacificus).* A dead bird found on a tank top at south end of island, Jan. 1972.

Welcome Swallow *(Hirundo neoxena).* 17 Aug. 1973, 3 juveniles in nest, second brood for year. Aug.-Sept. 1974, nesting: 4 eggs, 4 eggs, 4 eggs, 3 young. 3 young flying on 13 Aug. 1973 (see note under Kestrel).

Spinifex-bird *(Eremiornis carteri).* Flying young being fed, 4 Sept. 1973.

Singing Honeyeater *(Meliphaga virescens).* Nesting Aug.-Sept. 1973: 3 eggs, 2 eggs, 2 eggs, young just flying, fledged young.

***Painted Finch** *(Zonaegintlus pictus).* 2 at Biggada Creek, Nov. 1972; 4 at Donald River, Sept. 1974; 4 at Old Airport waterwell with 9 Zebra Finches *(Taeniopygia castanotis).* Dec. 1974.

INVERTEBRATES

The only published record of island invertebrates is the checklist of termite species by D. H. Perry *(W. Aust. Nat.,* 12 (3), 1972: 52-55).

Incidental collections (mainly arachnids, myriapods and insects) have since been made during various island visits and the resulting material has been passed to the W.A. Museum for identification and study. Lists will be published in due course.

In the meantime mention will only be made of a few molluscs, two land snails, *Rhagada convicta* (Cox) and *Themapura* sp. Two marine gastropods, *Tutufa bubo* and *T. rubeta,* are the first records of the species from Western Australia. *Fragum bannoi* Otuka, a fossil Pleistocene cardiid bivalve, was also collected.

BREEDING SYSTEMS OF THE WESTERN AUSTRALIAN FLORA, I. *TRIGLOCHIN* L. (JUNCAGINACEAE)

By G. J. KEIGHERY, Kings Park & Botanic Garden, West Perth

SUMMARY

Seventeen populations, comprising 10 taxa, of the genus *Triglochin* were analysed for types of breeding system. In all cases the taxa were found to be wind pollinated, self compatible and capable of self pollination. Seeds were dispersed by water for the perennial species, but no special means of dispersal were found in the small annuals.

INTRODUCTION — General

Little is known about the basic biology of most of our native flora. For most species there are no data on any aspect of their life history (e.g. length of life, flowering times, pollination biology, seed dispersal and seedling establishment). It is essential that a substantial amount of such data be accumulated so that an understanding of how our unique flora evolved and now maintains itself will be acquired.

Considering the latter point in more detail; it is well known that many species, members of the genera *Banksia, Macropidia, Lachnostachys* and *Ptilotus,* set only very small amounts of viable seed per plant, even with an abundant supply of pollination vectors. Exploration of the reasons for such seed set patterns may enable one to estimate accurately the number of adult plants needed within an area for replacement by seedlings to occur, and thus plan adequate reserves for these species.

Finally many of the above species are highly desirable subjects for cultivation, and a knowledge of the breeding system of a species is an essential prerequisite to any experimental breeding programme for the production of new cultivars.

This series will, hopefully, add a large amount of new data to our knowledge of the life histories of our flora, which will be of general use to biologists and naturalists interested in the flora of our state.

INTRODUCTION — Specific

Triglochin L. (water ribbons) is a small cosmopolitan genus of approximately 14 species. The extra-Australian species are all perennial herbs inhabiting shallow fresh water environments. These species are grown as fresh water aquaria plants, which is the only known economic use for members of the genus.

Although cosmopolitan, the majority of species (approximately 11 of the 14 known) are restricted to Australia, and chiefly to South-Western Australia, where about 8 species are endemic. These endemic species form a unique group within the genus in that they are annuals, not perennials and are not truly aquatic (habit, Fig. 1A). These species occupy shallow, sandy, winter wet depressions throughout South-Western Australia. They can be easily grown in pots, and have been successfully cultivated. However, they are not attractive subjects for horticultural purposes.

LIFE HISTORY

The annual species germinate in autumn, after the first heavy winter rains, vegetative growth occurs during winter, and flowering in spring. The plants die as the ground dries in early summer, and oversummer as seeds. Willis (1973) states that the "species of *Triglochin* bear fruits with spines, and are animal dispersed", this does not appear true for the native annuals which have no special means of dispersal. The seeds fall off the plant on to the ground, where they lie dormant until next autumn.

The perennials are still totally aquatic, and oversummer either by occupying permanent streams or dying back to their underground tubers (Fig. 1.B). Specimens of *T. procera* var. *duthiae* observed at Darlington in a permanent creek dropped their fruits directly into the water where they

floated away. Specimens of the same variety in an ephemeral pool at Cannington dropped the fruits into the drying mud. Flowering of the perennial species commences in early spring and may extend into January in some permanent pools, e.g. below the Mundaring Weir.

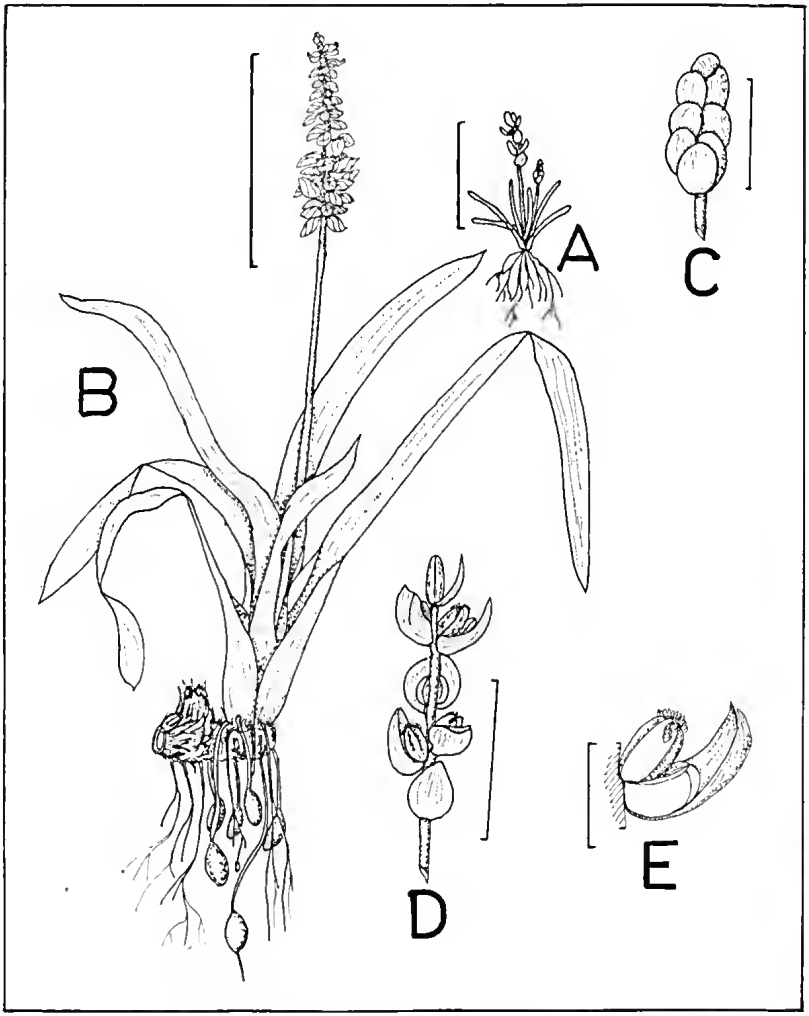

Fig. 1.—A. *Triglochin minutissima;* scale bar 3 cm. B. *T. procera;* scale bar 5 cm. C. *T. minutissima;* scale bar 10 mm, inflorescence, buds. D. *T. minutissima;* scale bar 15 mm, inflorescence, mature. E. *T. minutissima;* scale bar 5 mm, single flower.

POLLINATION SYSTEMS

Extra-Australian species are known to be wind pollinated (Faegri and Van der Pijl, 1971 and Pojar, 1974). All members of the genus bear small inconspicuous green flowers of a very simple construction (Figs. 1, C, D, E). No nectar or other attractants for animal vectors are found in the flower. The pollen which is dry and powdery is dehisced from the anther into a

boat shaped braet below (Fig. 1, E), and is kept there until shaken out by the wind. No inseets were observed visiting any of the 7 taxa observed for several hours at Cannington, although other speeies of plants flowering nearby were attraeting a diverse fauna. Ample pollen dispersal by wind was observed in several eases. The floral morphology and field observations demonstrate that the Australian speeies are also wind pollinated.

BREEDING SYSTEMS

Methods—For the annual speeies two plants per population were seored for eaeh of the open and elosed seed set data eolumns. The average seed set of these plants is presented in eaeh eolumn of Table 1.

For the perennial speeies two infloreseenees, eaeh from a separate plant, were seored and averaged per population for eaeh eolumn in Table 2. Very little variation between plants was noted in both instanees.

Closed seed set was determined either by isolated potted material (annuals) or by plaeing glassine bags over the infloreseenees in the field (perennials).

Initially in *T. minutissima* hand self and eross pollinations were earried out on individual flowers. This method proved unneeessary as shown in the results. Seed set in both hand self and eross pollination were exaetly the same, no differenees being deteeted by this alternate method.

Apomixis—Flower buds of four speeies were emaseulated and bagged to deteet the presenee of apomixis (fruit setting without fertilization).

RESULTS AND INTERPRETATION

Nature of Breeding System—All speeies were found to be highly self eompatible (Tables 1 and 2). There was no signifieant differenee in any speeies between the amount of seed set in the field or by enforeed selfing. All speeies were found eapable of self pollinating (i.e. autogamous) when kept in isolation. This is in aeeord with the observations of Pojar (1974) on *T. maritima* in British Columbia, Canada.

Apomixis—In all four species tested (Table 3) removal of the anthers results in a laek of fruit and seed set. Some fruit development was noted in *T. minutissima*, but no seeds formed. It is probable, therefore, that the speeies are not apomietie, but further studies are needed on the other speeies of the genus.

TIME OF SELFING

Stigma squashes of isolated, reeently opened flowers of the small annuals, just after anther dehiseenee, invariably showed a deposition of pollen had oeeurred on the stigma. In the perennial speeies pollen was not deposited on the stigma during anther dehiseenee but fell from other flowers when wind disturbanee oeeurred. One isolated infloreseenee plaeed in a sealed box did deposit eonsiderable pollen on the plate below its eontainer, so wind is not absolutely neeessary for selfing to oeeur.

DISCUSSION

Open spaees of water are ideal for wind transport of pollen between plants, but this is not true for small enelosed patehes of swampy soil. To sueeessfully oeeupy sueh areas, as annuals, the speeies have enhaneed the ability to self present in the perennial speeies, to ensure adequate seed set.

Seed dispersal has been redueed to a minimum in the annuals, ensuring that the speeies will oeeupy the same favourable area next year.

Finally this breeding system enables several distinet taxa to oeeupy the same site by preeluding the ehanee for hybridization, as the speeies are self pollinated before erossing ean oeeur. This situation has been also found in the genus *Darwinia* by Briggs (1964).

TABLE 1.—SEED SET FOLLOWING SELF AND CROSS POLLINATION OF ANNUAL MEMBERS OF THE GENUS *TRIGLOCHIN*.

Taxa	Area collection originated from	Open seed set/ plant (Field or pots outside)	Closed seed set
T. calcitrapa Hook.	Cannington	1.00	1.00
	Ongerup	1.00	1.00
	Capel	1.00	1.00
	Arrino	1.00	1.00
T. sp. 1 (GJK171) aff. *calcitrapa*	Cannington	1.00	1.00
T. centrocarpa Hook.	Cannington	1.00	1.00
	Tammin	0.95	1.00
	30 km S. Northampton	1.00	1.00
T. sp. 2 (GJK73) aff. *centrocarpa*	Cannington	1.00	1.00
T. mucronata R.Br.	Cannington	0.97	0.95
	10 km N. Esperance	1.00	1.00
T. mucronata R.Br. var nov (GJK204)	Kalbarri	1.00	1.00
T. minutissima F.v.M.	306 mile peg Lake King Road	1.00	1.00
	Cannington	1.00	1.00

TABLE 2.—SEED SET FOLLOWING SELF AND CROSS POLLINATION OF PERENNIAL MEMBERS OF THE GENUS *TRIGLOCHIN*.

Taxa	Area collection originated from	Open seed set/ inflorescence (Field)	Closed Seed Set
T. procera R.Br. var *procera*	Capel	0.91	1.00
T. procera R.Br. var *duthiae*	Cannington	1.00	1.00
T. striata Ruiz and Pov	Moore River	0.92	—
	Busselton	—	0.89

TABLE 3.—TESTS FOR APOMIXIS (ALL FROM CANNINGTON).

Taxa	No. flowers emasculated	Fruit development	Seed Set
T. procera var *duthiae*	6	0	0
T. centrocarpa	5	0	0
T. sp. 1	5	0	0
T. minutissima	10	4	0

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UREA FROM WILGIE MIA CAVE, W.A., AND A NOTE ON THE TYPE LOCALITY OF UREA

By P. J. BRIDGE, Government Chemical Laboratories, Perth

Urea, an organic mineral derived from mammalian urine, is rapidly decomposed under humid and bacterial conditions. However in dry warm areas accumulations of crystalline urea and associated minerals may occur. Several occurrences of urea are known, one from Egypt and the other from Lake Rason, W.A. (Bridge, 1973a).

A further occurrence is in Wilgie Mia Cave (26° 56'S, 117° 41'E) which is developed in a hematite-rich zone of the banded ironstone of the Weld Range. The mining of red ochre over a long period of time by Aborigines and later commercial ochre production has enlarged the cave (Ellis, 1952).

In 1973 M. Thomas, while investigating physiological aspects of the bat *Taphozous georgianus* which occurs with *Eptesicus pumilus* in Wilgie Mia Cave, collected an encrustation of urea and biphosphammite from the hematite wall rock of a small side chamber in the upper part of the cave. Further specimens were collected by the writer in late 1973. The urea occurred in a stalagmitic form approx. 30 cm high on a steep slope. The outer surface of the stalagmite was coated with hematite dust. The crystal mass is friable, cavernous, pale yellow in colour and contains seats composed of mammal hair, bone fragments and insects. The position of the

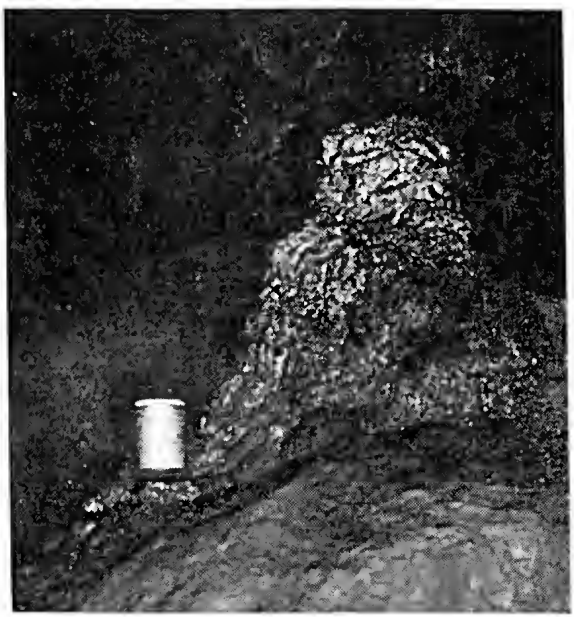

Fig. 1.—Urea Stalagmite (the capsule is 4.5 cm high).

stalagmite and its constituents can only be attributed to bats, confirmed as the Ghost Bat, *Macroderma gigas*, by A. M. Douglas from examination of seats. Feathers, mainly from owls, *Tyto sp.* or *Ninox sp.*, are cemented into the crystal mass. Minerals associated with the urea were aphthitalite $(K,Na)_3Na(SO_4)_2$ and biphosphammite $(NH_4H_2PO_4)$.

The similarity of the Wilgie Mia and Lake Rason samples suggests that the latter occurrence may also be derived from *Macroderma,* thus extending the possible known range of this bat. Further the possible difference in the mineralogy and chemistry of *Macroderma* and insectivorous bat guanos, shown by the high K_2O content of the latter (Bridge, 1973b) strongly indicates a *Macroderma* origin for the Lake Rason guano.

When Bridge (1973a) was published no information on the location of Earles Find could be found. The diaries of F. Hann, now in the Battye Library, Perth, have enabled the locality to be fixed at 129° 18'E, 26° 10'S, in South Australia near the WA-SA-NT border. The locality was visited by Hann on May 28 and 29, 1906 where he reports: "I came on a strange hill just as it was getting dark, got off, saw it was a kind of ironstone, I looked about and saw the hole in the side Earles spoke of. I am sure now I have Earles Find . . . . at the east end it is about 50 feet high, nearly all iron, cave on N side, east end, small hole to go in about 20 feet, can stand up in it." Hann visited Earles Find again on January 15-18, 1907.

His diary makes no mention of bats or having collected any guano samples on either trip to Earles Find. However he reports from a place he named Bats Camp "a good cave here, dozens of bats in it." This was visited on January 18, 1906 and is in the vicinity of Lake McInnes which is approximately 124° 10'E, 28° 22'S. This is some 25 miles NE of Toppin Hill which was considered the urea type locality (Bridge, 1973a).

The problem arising as to the correct type locality for the mineral urea will not be resolved until an examination is made of the possible sites.

Pseudobitumen or dung bitumen, derived from rat droppings and incorporating large amounts of hematite is common on ledges around the entrance to the side chamber containing the urea in Wilgie Mia Cave. An analysis of this material reported by Maitland (1905) showed a high content of K_2O and examination by the author of the water soluble inorganic compounds showed sylvite (KCl) to be the main component with minor syngenite ($K_2Ca(SO_4)_2 \cdot H_2O$), nitre (KNO_3) and aphthitalite. Specimens are preserved in the collections of the W.A. Government Chemical Laboratories, W.A. Museum and British Museum (Natural History).

The author appreciates the co-operation of A. Baynes, R. E. Johnstone and A. M. Douglas of the W.A. Museum and of M. Thomas for supplying the original sample. The help of the South Australian Department of Mines and the State Library of South Australia in supplying old references is also appreciated.

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A MOLLUSCAN INTERMEDIATE HOST TO *FASCIOLA HEPATICA* LINNAEUS FERAL IN SOUTH-WESTERN AUSTRALIA.

By PHILLIP N. CHALMER, Department of Zoology, University of Western Australia and GEORGE W. KENDRICK, Western Australian Museum

In March 1975, a population of the pond snail *Lymnaea (Pseudosuccinea) columella* Say was discovered in the Canning River above the Kent Street Weir at Cannington, a Perth suburb. Specimens collected on this occasion were presented to the Western Australian Museum, where the identification was made. *L. (P.) columella* is a confirmed intermediate host of the Liver Fluke of domestic livestock *Fasciola hepatica* Linnaeus (Pullan, 1970) and is the first such species to be recorded from south-western Australia.

On several occasions from late 1972 into 1974, odd specimens of this then unfamiliar snail were received for identification at the Western Australian Museum. All had been found in local aquaria and a non-Australian identity was suspected. This opinion was subsequently confirmed by Dr. J. B. Burch at the University of Michigan, Ann Arbor, who recognized the specimens as *L. (P.) columella*, an eastern North American species that has been introduced to western North America, Central America, Cuba, Europe and South Africa according to Hubendick (1951) and to New Zealand (Pullan, 1970; Climo and Pullan, 1972). A feral Australian population has recently been discovered at Sydney, New South Wales (Ponder, 1975).

The shell of *L. (P.) columella* is unlike that of any other lymnaeid snail known to occur in Western Australia. It is elongate and succineiform, with a height to width ratio of about 2.2 : 1 (Fig. 1). The largest specimen meas-

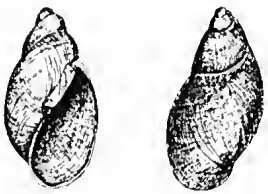

Fig. 1.—Shell of *Lymnaea (Pseudosuccinea) columella Say x 2.*

ured (3 whorls) has a height of 11 mm, width of 5 mm and an apertural height of 7.5 mm. Under magnification, the shell is seen to bear a very fine, close spiral sculpture, most evident on the last whorl. The animal is typically lymnaeid with eyes on the head between two broad flat triangular tentacles; body greyish-brown. The succineid snails, which have a superficially similar shell, have four cylindrical tentacles on the head, the eyes being located on the tips of the upper, larger pair.

The only other lymnaeid snail known to have become established in south-western Australia is *Austropeplea lessoni* (Deshayes), first noted at Coolup in 1941 (Robinson, 1949) and subsequently collected throughout the entire region north to the Northampton district. Its shell is ovate with a short spire and very thin, smooth and transparent whorls; the animal is yellow-brown. *A. lessoni* is native to eastern Australia and New Guinea and appears to have been introduced to Western Australia. The related *A. tomentosa* (Pfeiffer), a confirmed host to *F. hepatica* (Boray and McMichael, 1961), inhabits the northern part of Western Australia but Museum records suggest that it does not extend south of the Gascoyne River System. The European *Lymnaea stagnalis* (Linnaeus) is kept in Perth aquaria but is not known to have become established locally.

The source of the Australian infestations of L. *(P.) columella* is unknown but the circumstantial evidence suggests that the exotic fish trade may have been implicated. What appears to be a parallel situation has arisen

in Florida, U.S.A., where a thiarid snail of the genus *Tarebia,* believed to be a host species of the Oriental Lung Fluke, *Paragonimus westermani,* has become feral following its introduction with aquatic plants from the Philippines (Morrison, 1954). The present local situation suggests that the quarantine procedures, which should control the entry of exotic organisms into Australia, are not fully effective. In our opinion, a national survey of the aquarium molluscs of Australia is overdue in view of the association of some freshwater snails, such as *L. (P.) columella,* with parasitic diseases of man and livestock.

We thank Dr. J. B. Burch, now of the Australian Museum, Sydney, for the identification of specimens and Dr. W. F. Ponder, Australian Museum, for information regarding the New South Wales occurrence of *L. (P.) columella.* The illustration was drawn by Lesley J. Gilchrist.

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SOME ASPECTS OF ABORIGINAL OCCUPATION SITES IN THE PERTH METROPOLITAN AREA.

By B. BLURTON and P. RANDOLPH, Aboriginal Sites Department, W.A. Museum.

When living off the land (before Europeans arrived) Aborigines often camped on the coastal plain. Such places are referred to as occupation sites.

Several sites are known throughout the Midland, Kewdale and Lynwood areas, as well as along the Darling Scarp. (Akerman, 1969; Butler, 1958 and Hallam, 1972, 1973). The general characteristics of these sites are as follows: they are often situated near permanent water sources; on sandy ridges; usually with little or no vegetation where there is evidence of an artefact scatter. Therefore, if you came across a site, you would find artefacts scattered on the ground.

The earliest phase of occupation can tentatively be divided into Inland and Coastal localities. Inland refers to sites on and around the scarp. The artefacts associated with this locality are pebble choppers and steep edge scrapers (including horse-hoof scrapers) often made from dolerite. Some of these artefacts are river washed stones that have been flaked only once, the sharp edge making an adequate cutting tool. Coastal areas start from the foot of the scarp continuing across the sandy coastal plain to the sea. Artefacts found in this area are steep scrapers on flakes and scrapers made from

Fig. 1.—A general view of a site on a sandy ridge with a permanent water course nearby.

Fig. 2.—Grinding stone with grinder and other artefacts scattered nearby.

fossiliferous chert. The source of fossiliferous chert seems to have become unaccessible at about 5,000 years B.P. (before present) and therefore the early phase dates back beyond 5,000 years.

A middle phase is apparent between about 5,000 years and 500 years ago. This is characterised by the use of quartz and a fine green chert modelled into the shape of backed blades, adzes, scrapers and other flakes.

The late phase from 500 years ago up to the time of European contact in the middle 1800's saw another change in the artefact assemblage in the form of 'fabricators'. The assemblage also includes lots of quartz flakes, chips, and waste material. 'Fabricators' are prepared by smashing quartz nodules between two other rocks. The resulting artefacts are effectively flaked from both ends creating two sets of cutting edges which could be used as tools. It is likely that because of their small size 'fabricators' were mounted with gum on wooden implements.

Glasslike material (European bottles, porcelain, etc.) was introduced later, and was often flaked and made into traditional artefacts. The range of artefacts at the Walyunga site includes pieces of pottery, claypipes and bottle glass. This is evidence of European contact which in the years that followed changed the Aboriginal life style till traditional tools of stone were no longer to be found at sites.

In traditional times a camp would almost always be set up near a water source, because there is usually food to be found in association with good water sources. Some of the more permanent sites can be pinpointed because grinding stones have been found on location, indicating that grass and other seeds were probably prepared for eating at the spot. It is probable that some sites were occupied seasonally over long periods, showing evidence of more than one phase of occupation, while others were merely visited on a random basis. An analysis of the artefact material provides an assessment of the past use of the site.

We are grateful to Mrs S. J. Hallam, W.A. University, for much of the information concerning the phases of occupation sites in the metropolitan area.

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PRESENTATION OF INFORMATION IN BIOLOGICAL SURVEYS OF NATIONAL PARKS

By FRANCIS G. SMITH, Director, National Parks Board of Western Australia.

In order that the information obtained from biological surveys of national parks may have some relevance to ecological management, it is essential that it be presented in an appropriate form.

It is suggested that the report of a survey should contain the following appendices:—

1. A map of vegetation types—(Plant Associations/Formations)—at the largest scale practicable. This should follow the criteria of the W.A. Vegetation Survey Committee. (See Vegetation Maps Pemberton/Irwin Inlet 1972, Busselton/Augusta 1973, Collie 1974).

2. For each vegetation type or plant community the following information is required:—

(a) Name of Plant Association—Formation.

(b) Location—include grid reference or latitude and longitude.

(c) Vegetation System (if one has been recognised by earlier work or by the current survey).

(d) Habitat—brief description of topography, climate, soil, rock and other edaphic factors.

(e) Brief description of community with notes on effect of fires, actual or estimated time since last fire. Notes on regeneration.

(f) Floristic Composition (table).
The table of the floristic composition should be presented in order of importance in the community under the following headings:—

Botanical name, author, frequency, height (metres or cm), form, notes:

(i) Frequency, expressed by symbols as follows:—
Abundant (a)
Frequent (f)
Occasional (o)
Rare (r)
Local (l)
Dominant (d)
Co-dominant (cd)

(ii) Form expressed as
Tree (T)
Shrub (S)
Herb (H)

(g) Table of fauna associated with the vegetation type or plant community under the following headings:— Scientific name, common name (if any), frequency.

(h) Notes on any special relationship between fauna and that particular vegetation type or plant community, i.e. nesting, breeding, essential food requirement, cover.

EXAMPLE

Vegetation Type: *Eucalyptus gomphocephala* woodland (B3T)

Location: Yalgorup National Park, between Lake Clifton and Martin Tank. Map Ref. 367938.

Vegetation System: Spearwood System (McArthur & Bettenay, 1960).

Habitat: Low sandy ridge, with aeolionitic limestone 2-4 m below surface. Sand yellow to brown, leached white on surface, free drainage. Rainfall 880 mm mostly winter.

Description: Woodland in which Tuart is dominant, with understorey of trees *Agonis flexuosa* and *Banksia grandis*, tall shrubs *Acacia* spp. and *Jacksonia furcellata*. Low shrub and herb layer sparse. No evidence of Tuart regeneration. At least ten years since last fire. In recently burnt adjacent areas understorey shows rapid rate of recovery.

Floristic Composition:				
Eucalyptus gomphocephala DC.	ad	20-30 m		T
E. calophylla R.Br.	l	20-25 m		T
Agonis flexuosa (Spreng.) Sehau.	f	6-10 m		T
Banksia grandis Willd.	l	3-7 m		T
Jacksonia furcellata (Bonpl.) DC	l	2-3 m		S
Acacia saligna (Labill.) Wendle	o	2-3 m		S
A. pulchella R.Br.	l	-1 m		S
Clematis pubescens Hueg.	o	climber		
Drosera stolonifera Endl.	f	0.2 m		H

Fauna Present:	
Macropus fuliginosus, Western Grey Kangaroo	f
Tarsipes spencerae, Honey Possum	r
Pseudomys albocinereus, Ashy-grey Mouse	o
Tachyglossus aculeatus, Echidna	r
Trachysaurus rugosus, Bobtail	o
Dromaius novaehollandiae, Emu	o

Notes: Both the Grey Kangaroo and the Emu use the woodland as shelter but are not dependent upon it for food. When undisturbed these two species feed even in daylight on nearby areas of open heath, the Grey Kangaroos particularly favour the heath of the secondary coastal dunes.

It is hoped that the information from a biological survey would be rather more comprehensive than that given in the above example, which is only a guide to form.

DIXON ISLAND; AN ABORIGINAL SITE IN DANGER

By KINGSLEY PALMER, Department of Aboriginal Sites, W.A. Museum.

Dixon Island is situated off the north-west coast of Western Australia, not far from the iron ore loading port at Cape Lambert. Visitors to the island have reported numerous signs of Aboriginal habitation, particularly artefact scatters, workshop areas and middens. At present the island is largely ignored, though the access beach at Antonio's Mire is a much used fishing and boating place. It is likely therefore that within a short time of the continued expansion of the area the island will be increasingly used as a tourist and pleasure area.

Perhaps the most salient feature of the island is that it is bounded to the north and west by steep sea cliffs whose precipitous fall into deep waters renders its situation valuable as a harbour in an area of extensive salt marshes and shallow tidal flats. Dixon Island received attention from the Pilbara Study Group (1) and it has been suggested that the island would make an ideal industrial complex and port site.

The island's archaeological potential is threatened on all sides, and action at least in the form of a preliminary survey was essential. Immediate problems were mainly physical ones since access to the island was not easy. Local sources stated that it was possible to walk to the island at low tide, but the proposition did not appear altogether practical. Small boats were also unsuitable since sandbanks, shoals and the poor nature of the access track across the marshes could have caused problems. Finally a canoe was offered, being both light and of shallow draft. While the vessel imposed limitation on baggage the journey to the island was both adventurous and efficient, and not so far removed from the way in which the Aborigines must have been crossing the same stretch of water for generations.

The island is composed geologically of shales and chert of Cleverville Formations belonging to the Archaean period. The rock has been weathered to a rough consistency in places and demonstrates extreme irregularities in stratified forms as a result of subterranean pressures. Where exposed it is consistently dark red and sometimes purple. The associated weathered sand is consequently of a dark red colour. While the greater part of the island is composed of these older rocks, coastal areas are mainly sand dunes, with bands of quaternary limestone and coral deposits still unconsolidated.

The topography of the island can thus be divided into two main sections. The inland areas are of low rolling hills, with isolated outcrops of rock. This higher land terminates in the spectacular sea cliffs to the north west of the island at a height of something over 35 metres. The lower coastal areas are of sand and more recent deposits, being flat and for the most part low lying. The island is then on the whole of regular appearance, and the terrain smooth and uninterrupted by bluffs and outcrops. The rising ground that terminated in the sea cliffs offers some contrast to this relief by presenting bolder, higher ground. The island is approximately five and a half kilometres in length, and from one to two kilometres wide.

The chief vegetation of the island is spinifex. This covers almost all of the high inland areas, and extends to cover the dune areas in places. However, there are quantities of local grasses, which in some places are more prolific than the spinifex. Large areas of the coast to the west and south-east have mangroves and inland areas and coastal alluvial flats have several varieties of shrub—mulgas and acacias, but there were no larger trees.

The island had a prolific kangaroo population. These were Plains Kangaroos, which unmolested, breed freely on the island. There are also goannas and geckoes, pelicans, cormorants and sea eagles. Above all else the island is surrounded by waters containing a rich and varied sea life. The extensive tidal flats contained multitudes of shells, bivalves and gastropods, mainly mangrove creepers. A variety of fish live in the water, as well as turtles, dugongs and bêche-de-mer.

Very little is known of the Aboriginal relationship to the island. Traditionally the island would have been in Ngarluma territory, and it is probable that these were the people who used it. The island does not figure in any of the traditional lore with whieh we are familiar, nor is the place talked of hy the surviving members of the raee. We do know however from the accounts of eontemporary explorers (2) that the Ngarluma people did use primitive rafts. These were eorkwood boughs bound together, and paddled by hand. By analogy with surviving eoastal peoples elsewhere we may eonclude that the Ngarluma would have exploited both fish and shell food from the area. The aeeessibility of Dixon Island would have made it a natural loeation for habitation from time to time, perhaps when there were exeeptionally low tides, or when other food sourees gave out. There is however no evidenee to support the view that the island had eeremonial signifieanee, though knowledge of these people is extremely limited.

We have then an easily aeeessible eoastal island, offering rieh supplies of food, shelter and most probahly seasonal fresh water. Further, supplies of loeal roek were of a fine-grained material whieh broke eleanly, offering a sharp eutting edge ideal for domestie and eultural use. It is hardly surprising therefore that the island offers a number of rieh Aboriginal sites of the habitation and artefaet *genre.*

Eight artefaet/midden sites were found on the island, and these were all loeated in the low eoastal areas, adjaeent to bays or tidal mud flats and mangrove thiekets. The sites along the south-east eoast were loeated on limestone or eoral eonglomerate, interspersed with thiek shrubs in plaees. The soil however was generally sandy and the outlook was usually mangroves or eoastal mud flats. The sites along the north-west were only different in that they were loeated in dunes of a more prominent nature, though in one ease the site was loeated well behind the beaeh on flat alluvial, interspersed with spinifex. Sites varied in their extent, measuring from 30 metres in length along a beaeh line, to something over 200 metres. The depth of the deposit was only tested in one loeation, and was there found to be at least 30 eentimetres, though it was time that arrested the depth of the test pit, not laek of material.

Sites varied mainly in numbers and abundanee of artefaets. The material was from loeal roeks and has been identified as silieified ehert breeeia, fine grained cherty siltstone and banded ehaleedony (3). Artefaets from the loeal green roeks found in some numhers on the north-west of the island were formed from the green granular roeks. They were partieularly attraetive as were those manufactured from translueent ehaleedony with blaek impurities that made an intricate traeework when held up to the light. At only one plaee, near high water mark, was bottle glass diseovered, and this was doubtfully artefaetual. Worked bailer shell was also noted as were fragments of bailer shell, though it is possible that these were a food souree. They may have served both purposes.

By far the greater part of the midden material was composed of bivalves *(Anadara* sp). These littered the ground in great profusion and over extensive areas in some eases. Next were gastropods, mainly mangrove ereepers, found in fewer numbers but with no established pattern as far as loeation was eoneerned. Lastly fragments of bailer shell, trumpet shell and turtle bone were noted, along with erab elaws and other unidentifiable ealeareous material.

The island is thrcatened both by industrial development and by tourism. The island is outstanding for its Aboriginal habitation and midden sites, both for their abundanee and unspoilt eondition as they relate to the island as a whole. The island is also of outstanding natural beauty, offering sea eliffs and seenery rarely found in this section of Western Australia. The wild life and flora are unmolested and worthy of a separate study.

NOTES

(1) The Pilbara Study, Report of the Industrial Development of the Pilbara. Canberra, 1974. 6.5.ff.

(2) The Diary of William Shakespeare Hall, 1861. Copies from the originals by J. H. Clifton, 1928. W.A. Historical Society. Entry for May 15th.

(3) J. Clarke, Conservation Geologist, W.A. Museum; personal communication. March 1975.

The writer wishes to acknowledge with thanks the help and advice of Bill Curry, whose co-operation and forebearance made this preliminary survey possible.

Details of all sites, including maps and photographs are on file with the Registrar of Aboriginal Sites, W.A. Museum.

NESTING OF BANDED STILTS AT LAKE BALLARD

By C. F. H. JENKINS

The Banded Stilt *(Cladorhynchus leucocephalus)* has been known to science for almost 160 years and yet it still remains one of Australia's mystery birds. Each summer flocks of these stilts, or Rottnest Snipe, appear on the Rottnest salt lakes and other waters along the west coast, but during the breeding season the birds disappear inland and for more than a hundred years they managed to conceal their nesting habits from the prying eyes of even the most ardent bird watchers.

The first breakthrough came in the winter of 1930 when eggs, photographs and dead birds taken at Lake Grace were forwarded to the Western Australian Museum by Mrs. B. E. Cannon of Kukerin. A comparison of these eggs with those of the White-headed Stilt *(Himantopus himantopus),* confirmed that the Lake Grace eggs were indeed new to science.

Remarkably enough the next breeding record of this stilt came in December of the same year when eggs were collected at Lake Callabona in the north of South Australia (McGilp and Morgan, 1931). Despite the increased interest aroused by these two nesting records and a watching brief by various naturalists no further breeding activity was recorded until 1945 and 1946—two very wet years—when nesting again took place at Lake Grace, but on both occasions, the eggs were flooded before the chicks could hatch (Serventy & Whittell, 1967).

The latest record of a successful breeding in Western Australia came from Lake Ballard, about eight miles north-west of Menzies, in July 1973.

Police sergeant Alan Middleton reported the occurrence and confirmed it by forwarding newly hatched chicks to the Perth Zoological Gardens where they were successfully reared by the Director, Mr. Tom Spence.

Middleton stated that approximately 13 inches of rain fell at Menzies from May to October and that about 60 breeding pairs occupied samphire flats on the edge of the lake. Brine shrimps, *Parartemia* sp., were said to be present, but not numerous and the birds had access to extensive areas of water about four inches deep.

Unfortunately, various predators were attracted to the area including Aborigines (to whom the chicks are a delicacy), crows, hawks (including Grey Falcons) and foxes. The clutch size, as at the original Lake Grace site, varied from three to four but Middleton estimates that only about 10 per cent of the chicks normally survive.

Middleton also reported that although no nesting colony was actually found, the Banded Stilts certainly bred in the Menzies district in 1963 when numbers of chicks walked through the town.

This recalls a much earlier reference to chicks walking by T. Smith of Kalgoorlie who, writing to the Curator of the Museum, Mr. L. Glauert, referred to "the migration of young 'Rottnest Snipe' which took place from

a large lake some distance from Menzies this spring" (1929). Smith continued: "they must have died by the hundred thousands for a strip of country about 30 miles wide was literally white with dead birds" (Glauert & Jenkins, 1931).

Fortunately several of the stilt chicks received at the zoo in 1973 are still thriving and observations on these and other older birds made by Mr. Spence have revealed some interesting plumage changes.

The characteristic chestnut band has generally been taken as a sign of maturity and white-breasted birds have been regarded as immature. But some of the captive birds have been seen to lose their chestnut feathers and to moult into the white "immature" plumage, suggesting that as with many other waders, the Banded Stilt may have an "eclipse" phase characterised by the loss of the chestnut band. If this is correct then many of the white-breasted birds seen on the coastal plain and at Rottnest (Storr, 1965) during the summer time may not be immature birds, but adults in non-breeding plumage.

Another interesting feature noted by Mr. Spence (pers. comm.) was that when feeding, the very young chicks adopted a side to side or scything action with the bill reminiscent of the Avocet *(Recurvirostra novaehollandiae).* This habit is not noticeable in adult birds.

Although there is no close relationship between flamingos and stilts there are some remarkable similarities in their breeding habits. For instance, as with the Banded Stilt, the breeding habits of the Lesser Flamingo *(Phoeniconaias minor)* of Africa was shrouded in legend and mystery for many years and the true story was not revealed until Leslie Brown (Brown, 1960) flew over large breeding colonies in Lake Natron—one of the alkaline lakes of Tanganyika. He reported large parties of chicks walking many kilometres to the shore and the heavy mortality which accompanied this mass movement.

A major trek of the Lesser Flamingo was also recorded by Hugh Berry when thousands of chicks walked to the nearest source of water after Etosha Pan in South-west Africa dried up in 1971. They travelled 80 km and were fed en route by the parents "who flew ahead to the place where they were going and returned with food for the chicks" (Anon., 1973).

It is worthy of note that although flamingos do not occur naturally in Australia at the present time, fossil remains have been found at Lake Eyre in South Australia, not far from the region in which the Banded Stilts nested in 1930 (Stirton *et al.*, 1961). It is interesting to reflect upon the changing conditions which caused the flamingos to disappear from the scene and the stilts to survive or perhaps take their place.

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OBSERVATIONS ON FLIES OF THE FAMILY MILICHIIDAE CLEANING *ARANEUS* AND *NEPHILA* SPIDERS

By R. P. McMILLAN, Honorary Associate, W.A. Museum

An interesting association between spiders and flies was observed in 1972/1973 at Guildford, Western Australia. The spiders were *Araneus transmarinus* Keyserling, 1865, family Araneidae, sometimes known as "Garden Spiders", and *Nephila* sp., family Araneidae, known as Golden Orb Weavers. The flies were identifed by David McAlpine of the Australian Museum, as belonging to the genus *Desmometopa*, family Milichiidae. No species identification has yet been made.

The observations began at Guildford Grammar School in February 1972, when a number of small flies were seen wandering over the webs of *A. transmarinus*, and congregating on the spiders' prey of bees and cicadas. It was noted that the flies, when moving over the web, used the radial threads for walking and flew over the circular, sticky sections. This seemed to indicate a long familiarity with this type of environment.

The flies were also observed congregating on the spiders, mainly in and around their mouth and anal regions. It was noted that the insects were actually feeding, and at the same time appeared to be acting as cleaners. As a result of feeding on bees the spiders had become wet and sticky around their chelicerae and mouths, this seemed to attract the flies to these places. To "help" the cleaning operation, the spiders spread their chelicerae, thus allowing the flies to feed actively all over the bases, fangs and mouth.

The spiders defaecated at frequent intervals and when this occurred several flies would move and feed at the anal opening. The number of flies in this region were never as great as around the chelicerae and mouth.

In March 1973 two large female Golden Orb Weavers, which one of the students had collected on the coast at Triggs, were released in the school grounds. These spiders soon began trapping cicadas and bees in their webs and feeding on them. The "cleaning" flies immediately arrived and their behaviour was the same as for *A. transmarinus*.

In 1974 I commenced observations at Cottesloe where *A. transmarinus* and the "cleaning" flies have been active.

During the observations none of the spiders made any attempt to get rid of the flies; in fact, they went as far as to actively co-operate with them in making the cleaning easier by opening their chelicerae. This behaviour seems to indicate a long term association.

Bristowe (1941) has interesting examples of intimate associations by small flies on spiders but "the reason for their presence in such an unusual situation" puzzled him. He quotes a case where an observer noted a small fly crawling over the palps and "mouth" of *Nephila maculata*. He also records a sighting of Milichiid flies, *Desmetopa sordida* Fall., sharing a snared hive bee with a spider, probably *Thomisus annulus* Walck. Another fly, *Microphorus crassipes* Macq., family Empididae, has been recorded as feeding on prey trapped in spider webs (Laurence, 1948).

The present observation is, as far as I know, the first of flies actively feeding on material present on living spiders.

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THE AVON: FAUNAL AND OTHER NOTES ON A DYING RIVER IN SOUTH-WESTERN AUSTRALIA

By GEORGE W. KENDRICK, Greenwood.

INTRODUCTION

In the course of general studies on the freshwater molluses of Western Australia, it became apparent that very little information was available, either in museum collections or published records, about the molluse fauna of the Avon River. This was unexpected because the Avon is one of the major rivers of the South-West Region and could have been expected to contribute prominently to any study of the aquatic life of the area. In seeking to account for this discrepancy, evidence has been obtained which suggests that, since the turn of the century, the original aquatic environment and fauna of the Avon have been subjected to a variety of disturbances of increasing severity. These, so far as they affect the molluses, have reached catastrophic proportions and local extinction now seems distinctly possible for some, if not all, of the original fauna. Paradoxically, the environmental changes that have harmed these species have facilitated upstream expansion into the Avon of what appears until recently to have been a wholly estuarine molluse. The reason for these changes seems to lie with the near-complete alienation of land for agriculture in the drainage basin and the absence of any kind of conservation-management policy that would recognize the need to protect the riverine environment and biota.

The inland boundary of the Avon drainage basin is not readily definable, varying according to seasonal fluctuations in the amount and distribution of rainfall. Theoretical maximum boundaries are depicted by Bettenay and Mulcahy (1972: 360, Fig. 1), who recognize a topographically young to mature western part, characterized by a regular, annual discharge to the sea and a larger, topographically old inland part, which contributes to external drainage only irregularly and after periods of exceptional rain. In most years, external discharge is confined to the area westward from the Meckering Line of Mulcahy (1967, 1973). The present study concerns mainly the active, fully fluviatile part of the Avon lying immediately inland from the Darling Range and major tributaries, such as the Dale and Mortlock Rivers, the Talbot and Spencer's Brooks (Fig. 1). Most of this area lies between the 380-508 mm (15-20 inch) isohyets, the 6 wettest months being May to October. River flow is strongly seasonal and usually ceases during summer-autumn.

1. THE AVON MOLLUSCS

Aquatic molluses were recorded from the Avon soon after the establishment of the Swan River Colony. The collector J. A. L. Preiss (see Glauert, 1948) obtained two species, a thiarid snail and a naiad or freshwater mussel while in the York district between 1838-42. His specimens were presented to C. T. Menke, the German conchologist, and recorded (Menke, 1843) under the names *Melania lirata*, new species and *Unio australis* Lamarck respectively. However the names applied by Menke to these particular specimens are no longer recognized. The first was a homonym of *M. lirata* Benson and was replaced by Brot (1862) with the new

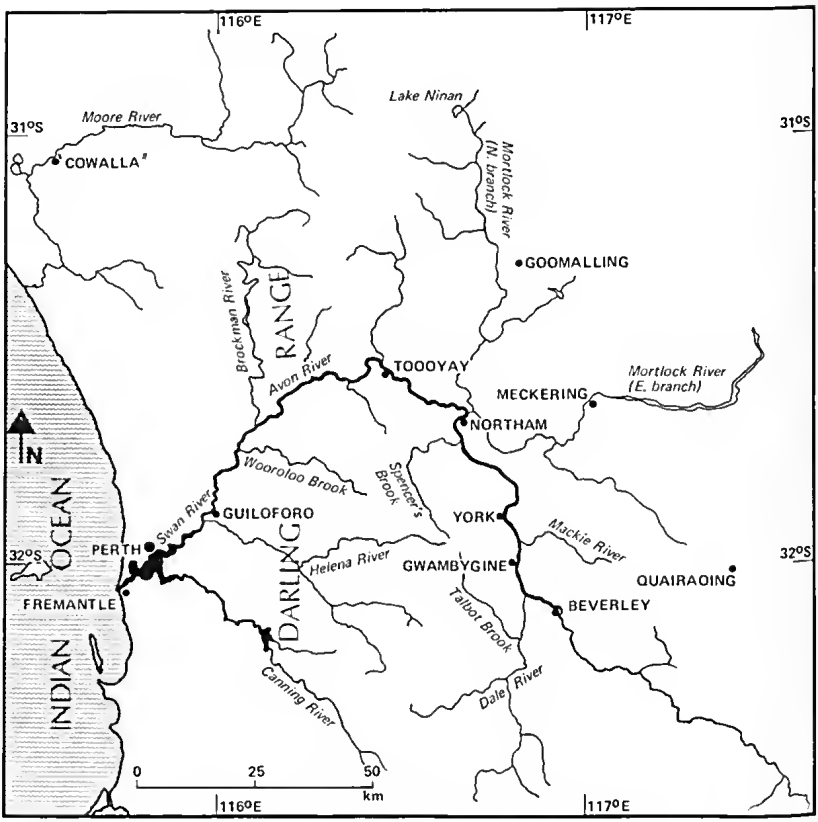


Fig. 1.—Swan-Avon and Moore River systems, south-western Australia, showing principal tributaries.

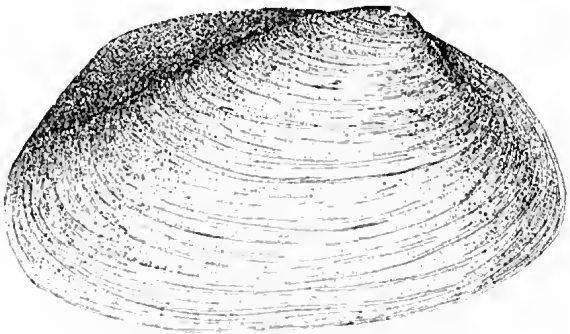
name *Melania incerta*. Latterly, Australian snails of this group have been placed in the genus *Plotiopsis* Brot. Their taxonomy is unsatisfactory (see McMichael, 1967) and the correct name for the Avon specimens is uncertain but I follow Hedley (1916) provisionally, in the use of the name *P. australis* (I. and H. C. Lea, 1850) for Western Australian occurrences. Menke's other name was a misidentification of the species now known as *Westralunio carteri* Iredale (see McMichael and Hiscock, 1958). The present whereabouts of Menke's specimens is unknown; they may be lost (Dance, 1966).

A second early record from the Avon concerns a specimen of *W. carteri* presented to the British Museum (Natural History) by Mrs. J. Gould (McMichael and Hiscock, *ibid.*), which was probably collected by John Gilbert while in the York or Toodyay districts during 1839-1840. Whittell (1954) records that Gilbert's consignments to Gould in the latter year, at the close of his first visit to Western Australia, included three boxes of shells.

These few records from the pioneering days of the last century (with the sole exception of Main, 1968: 58) appear to comprise all that has been published hitherto on the mollusc fauna of the Avon. Recent collecting has revealed the presence of a further 5 species, making a total of 7 species from the river. These 7 are the bivalves *Westralunio carteri* Iredale and *Anticorbula amara* (Laseron), the prosobranch snails *Potamopyrgus* sp.,

Coxiella glabra Macpherson and *Plotiopsis australis* (I. and H. C. Lea) and the pulmonate snails *Physa* sp. and *Physastra* sp. The status of these species, past and present, is discussed separately.

1. *Westralunio carteri* (Fig. 2).



This clam has a large, robust shell up to 8 cm long, with a rounded-oblong outline, a dark brown outer surface and a nacreous interior. The animals are active substrate burrowers and feed on detritus and micro-organisms filtered from internally circulated water. Reproduction in *W. carteri* has not been studied but presumably resembles that in other hyriid species (McMichael and Hiscock, *ibid.*). In these, the sexes are separate and fertilization is internal, the young larvae being discharged from the female as free-swimming glochidia, which must locate and temporarily parasitize a teleost fish. On completion of larval growth, the young clams leave the fish to adopt a burrowing habit in the substrate.

W. carteri is the only naiad to occur in south-western Australia and inhabits (mainly) river pools from the Moore south to about the Kalgan. It is usually a common and conspicuous element of stream faunas. The complete absence of any record of the species from the Avon since the 1840s, either in publications or scientific collections, seemed anomalous, prompting concern for its status there. Regrettably, this concern appears to be well founded for *W. carteri* now seems to have disappeared or become rare at places along the Avon where it used to be common only a few decades ago.

In April 1973, Mr. Brian M. Clifton of "Gwambyginc", between York and Beverley, told me that in his younger days around 1912, *W. carteri* was common in Gwambygine Pool but that a decline became evident during the 1940s, the last specimen being seen there by him around 1950. The freshwater catfish or cobbler, *Tandanus bostocki*, declined similarly, the last at Gwambyginc Pool to his knowledge being caught in the 1950s. This may be significant in view of the reproductive dependence of the naiad on fish.

Mr. James Masters of "Glen Avon", between Northam and Toodyay, informed me (personal communication, April 1973) that *W. carteri* was fairly common in pools there from 1924 to 1930. Large numbers of shells were evident after winter runs of the river until about 1947 but declined noticeably from then until about 1960. A single dead but fresh specimen was noticed at the Glen Avon Pool in 1971 and odd fragments have been seen occasionally since. He concludes *(ibid.)* that "from the rarity of old shells here, the creature exists in extremely small numbers nowadays". Mr. Masters had noted that the Black Bittern, *Dupetor flavicollis*, had apparently disappeared from the river there since 1952 and had ceased to breed locally by about 1948. The preferred diet of this bird comprised naiads and the Jilgie, *Cherax quinquecarinatus*. Over the same period,

Jilgies had deereased greatly in the Avon, though still eommon in adjaeent dams and soaks. This and other ehanges in bird life along the river have been diseussed by Masters and Milhineh (1974).

Similar observations have been provided by Mrs. M. Jefferys of "Spion Kop", Toodyay, who reealled seeing naiads at the West Toodyay bridge and at Redbank Pool near Toodyay around the year 1930, but never sinee then (personal eommunieation, 1971).

In May 1971, several dead shells of *W. carteri* were found in the Avon on both sides of Toodyay by Mr. Dennis F. Pember and students of the Toodyay Junior High Sehool. These speeimens were presented to the Western Australian Museum, to beeome the first representation of the speeies from the Avon in the Museum's eolleetion. Further empty shells have sinee been found by Mr. Pember at another pool below Toodyay. These reeords seem to eonfirm Mr. Masters' appraisal of the present status of the speeies below Northam. No living speeimen has been reported from there for some years and the long term prospeets of whatever population still survives in this traet of the Avon seem at best to be poor.

Apart from Mr. Clifton's reeolleetions of Gwambygine Pool, nothing further is known about *W. carteri* in the Avon above Northam and, with one possible exeeption, extinetion is indieated there and in all loeal tributaries. I have been informed separately by Mrs. N. I. Doneon and Mr. C. Bennett of Beverley that mussels were known by them to oeeur in Spring Pool, beside the Dale River some 16 km SSW from Beverley in 1968 and 1958 respeetively. In April 1973, assisted by Mr. Bennett, I visited Spring Pool but was unable to obtain positive evidenee that *W. carteri* was still present. However the water was fresh and unpolluted and the speeies may well be living there. Subsequently Mrs. Doneon loeated a speeimen of *W. carteri* eolleeted at Spring Pool around 1960; this has been presented to the Western Australian Museum. If extant, the Spring Pool population may be the only survivors of *W. carteri* in the Avon System above Northam. I have oeeasionally found fragments of naiad shells in the Avon near the Wooroloo Brook eonfluenee, but these may be derived from that tributary, where a small population of *W. carteri* oeeurs.

The salinity toleranees of *W. carteri* and its host fishes are unknown but these may now be exeeeded in water along most if not all of the Avon for a signifieant part of eaeh year. Cireumstantial evidenee presented below (Figs 10, 11) suggests that raised salinity has been the prineipal eause of the eatastrophie deeline of the speeies sinee the 1940s.

2. *Anticorbula amara* (Fig. 3).

This is a small, brown, modioliform elam up to about 16 mm long, with a eoneave, slightly twisted ventral margin and a toothless hinge. It lives attaehed by byssal fibres to submerged wood, stones, eoarse sand, ete., and presumably is a filter feeder. It inhabits the estuaries of south-eastern and south-western Australia and in the latter has been found tolerant of seawater (E. P. Hodgkin, personal eommunieation, 1975). There are no wholly marine reeords and, eonsidered as an estuarine speeies, *A. amara* should be regarded as a braekish-water element (Green, 1968). However in Western Australia, this speeies ranges far above the limits of tidal influenee, having been eolleeted in the Avon as far upstream as Gwambygine Pool and in the Moore near "Cowalla".

Mr. Masters *(ibid.)* considers that *A. amara* has become common in the Avon near his property only in recent years, being rare there during the 1930s. It seems not to have been collected by Preiss at York around 1840, though now conspicuously abundant there. The evidence suggests that, since the turn of the century, *A. amara* has extended its range upstream from the Swan Estuary in response to changes in the river environment. Though present in the Swan near the Helena confluence, *A. amara* seems never to have become established in the latter stream, which has remained fresh throughout this period.

Specimens presumably of *A. amara* were collected in the Swan Estuary at Guildford by the Hamburg Expedition in 1905 and are listed by Thiele (1930) under the name *Modiolus (Fluviolanatus) subtortus* (Dunker). Me-Michael (1967) considers *Fluviolanatus* Iredale to be a synonym of *Anticorbula* Dall. The anatomical characters of local specimens are unlike those of the Mytilidae (B. R. Wilson, personal communication, October 1971); their affinities seem to lie with the Lyonsiidae.

3. *Potamopyrgus* sp. (Fig. 4).

x 6

This is a minute snail with a shell up to 4 mm high, dark brown, elongate-conical, with slightly convex, smooth whorls; operculum thin, corneous. Records are from streams in south-western Australia between the Moore and Frankland Rivers, it being found on submerged sticks, bark, stones, etc. In the Avon, *Potamopyrgus* sp. is known only from pools in the Walyunga National Park. These are situated in the Darling Range immediately below the confluence with the comparatively fresh Wooroloo Brook; records date only from 1969. It seems likely that this species once occurred more widely along the Avon and tributaries but positive evidence of this is lacking.

4. *Coxiella glabra* (Fig. 5).

x 3

One of the Salt Lake Snails (Macpherson, 1957), this species has a small, smooth, elevated, light brown shell, usually with a decollate spire and a height of up to 7 mm; occasional non-decollate shells may reach to 11 mm. The operculum is corneous and thick. *C. glabra* inhabits saline to brackish lakes and streams from the Murchison district south into the central wheatbelt. From the Avon River System, it is known only from one sample collected in May 1958 from "a creek bed beside the Goomalling road 8 miles N of Jennacubbine", evidently the north branch of the Mortlock River. It is uncertain whether this record represents a long standing presence in the Mortlock or a recent extension of range from salt lakes in the district, such as Lake Ninan, in which *C. glabra* occurs and which connects with the Mortlock near Wongan Hills (Fig. 1).

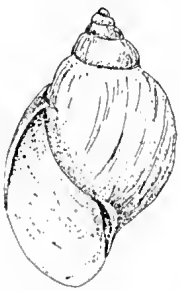
5. *Plotiopsis australis* (Fig. 6).

This is a small to medium sized snail with a shell up to 30 mm high, the spire high, apex decollate, and with shouldered convex whorls, which usually bear both spiral and axial sculpture. The columella is thickened and the aperture roundly cut out at the base. It is coloured yellowish-brown, with or without reddish axial streaks; colours are often concealed beneath a blackish-brown encrustation. The operculum is corneous, thick and dark brown. *P. australis* occurs in river pools generally throughout Western Australia south to the Avon.

Since its discovery at York by Preiss around 1840, *P. australis* has not been recorded again from there or from any further-upstream locality; it has never been noticed by Mr. Clifton at Gwambygine Pool. Mr. Masters informs me *(ibid.)* that it "existed in extremely large numbers in Avon pools in this area (between Northam and Toodyay) until at least 1947 or 1948 and could still be found . . . to at least 1956". So common was it during the 1920s that shells were bagged and fed to the farm poultry. In contrast, present populations along this section of river appear to be scattered and live specimens uncommon. Mr Masters estimates that *P. australis* and *A. amara* have changed inversely in abundance near "Glen Avon" over the past 50 years.

In April 1973, I found numerous shells of *P. australis* in what remained of Burlong Pool, near Northam. All were dead and apparently only recently so; this appears to be the most-upstream record for the species since the time of Preiss. Living *P. australis* are still common in the Avon where it traverses the Darling Range, e.g., near the Wooroloo Brook confluence, and range downstream to Guildford. Elsewhere along the Avon, the species has declined in numbers and contracted downstream similarly to *Westralunio carteri*, though apparently later and to a somewhat lesser degree. The period of greatest decline seems to have been the 1950s.

6. *Physa* sp. (Fig. 7).

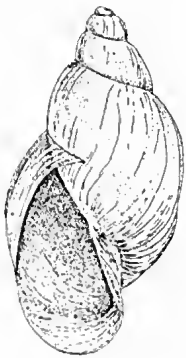


This is an introduced pond snail with a small, ovate, pale-brown shell, up to 14 mm high, sinistrally coiled, with a short, acute spire and smooth,

polished, translucent whorls. There is no opereulum. The shell resembles that of the following species, *Physastra* sp., and reliable separation of the two depends on anatomical characters. The animal of *Physa* sp. has a series of finger-like processes along the mantle margin; seen through the shell, the mantle has a reticulate pattern and the blood is colourless.

This appears to be an introduced species, first recorded from Western Australia at Perth in 1952 (Hubendick, 1955) and now aeclimatized throughout much of the south-west of the State. It was collected from the Burlong railway dam near Northam in 1968 and from the Avon near the Wooroloo Brook confluence in 1969. *Physa* sp. is commonly kept in local aquaria and its acclimatization probably followed release from these. The Physidae were originally Holaretic in distribution and local stocks are probably derived from either Europe or North America.

7. *Physastra* sp. (Fig. 8).



x 3

Like the preceding species, this pond snail has a thin, sinistrally coiled shell but may reach a height of 28 mm. Fresh shells are usually a medium to pale shade of brown and are more opaque than those of *Physa* sp.; there is no opereulum. The mantle margins are smooth, lacking processes and the blood is red. *Physastra* sp. is a common, generally distributed snail in fresh inland waters throughout south-western Australia.

However the only known occurrence from the Avon system above the Darling Range is in Spring Pool near Beverley. This pool, which stands above and beside the main channel of the Dale River, holds fresh water. *Physastra* sp. has recently been collected from the Brockman River at Chittering and there is a sample in the W.A. Museum collection from "a soak near Beverley", presented in 1950. Whether the species was ever generally present along the Avon is uncertain but the evidence of these few peripheral occurrences, together with its general distribution elsewhere within the region, suggests that this was probably so.

8. An ancylid freshwater limpet of minute size, up to 5 mm long and tentatively referred to the "form group" *Ferrissia (Pettancylus) petterdi* (Johnston) after Hubendick (1967) occurs widely in lakes, streams and other water bodies of south-western Australia. There are no known records from the Avon, but this may reflect either the unobtrusive nature of the animal, or insufficient collecting, or a recent decline. Distribution records from the Western Australian Museum collection suggest that *F. (P.) petterdi* either is or was probably part of the Avon fauna and justify its qualified inclusion in this summary.

2. THE CONDITION OF THE AVON

(a) THE AVON AS IT WAS

The first Europeans to sight the Avon River did so in August 1830 near the impending site of York. The weather was wintry and the river in flood. Their leader, Ensign Robert Dale, recorded in his journal (Dale, 1833a) that "The water was discoloured and muddy with a rapid current and

enclosed between banks moderately clothed with trees and shrubs". No other reference was made to water quality. A later report (Dale, 1833b) refers to brackish and salt water pools in the upper reaches of the Avon during October. Pools of varying salinity, from fresh to salt, along the Avon in 1836 are referred to by Bunbury (1930: 28, 32, 43, 50).

The central Avon valley was one of the earliest districts to attract settlers from Perth. The first of these "set out in September 1831 to take possession of their grants. Soon all the river frontages from the present towns of Beverley to Northam were taken up . . ." (Mouritz, 1956: 46). Private land extended "right into the river bed", according to James (1893), a condition that generally prevails to this day. Early reports on the Avon lack chemical data but suggest that, even in the early years of European settlement, water quality varied perceptibly with time and place but this did not prevent its being used extensively by the settlers. Describing the Avon at Toodyay in the 1870s, Hammond (1936: 123) recalled that "The very fine pools of fresh water in the river in the summer time made the whole district suitable for raising stock of all kinds".

In a report to Parliament on water supplies along the Avon, James (1893) found the river water at York to be unsuitable for domestic purposes, particularly when in flood, because of overflow (presumably saline) water from lakes near the river's source; however a western tributary near York was found to have "remarkably pure water". At the Mortlock confluence just below Northam, James noted that the Avon became saline and undrinkable. However water in pools by Mt. Noondening (near "Glen Avon", between Northam and Toodyay) was "fairly good, having a slightly sweet taste, quite suitable for house or stock purposes". Burlong Pool was then "a vast sheet of water fully one third of a mile long. The river at this point has well defined, fairly high banks; this pool is now running full and the water is of excellent quality, quite suitable for domestic purposes, although it carries with it at this date (March 1893) a slight taste".

James quoted a local resident who had known Burlong Pool for 41 years, i.e. since 1852, asserting that it had never been dry in that time "and with ordinary rain was perfectly fresh, pure water as it receives rain from Spencer's Brook (six miles distant) and four other large tributaries, which make the Avon River drinkable at all seasons" *(ibid.)*.

Reports on the working of the Western Australian Government Railways for the years 1892-1902 show clearly the reliance of the Department during those years on water from the Avon River for steam locomotives operating out of Northam. The railway reached Northam in October 1886; initial sources of water are not specified but during the period 1892-1895, the water service at the West Northam locomotive depot was connected by pipe with Burlong Pool, situated about 2 miles (3.2 km) upstream (Report for 1892-1895, pp. 9, 10).

During 1896-1897, the Burlong Railway Dam was constructed on a minor tributary of the Avon, a little west of Burlong Pool and from then until the arrival of the Goldfields Water Scheme at Northam in April 1902, the railway drew on both the dam and pool for boiler water. For periods during the summers of 1896-1897 and 1897-1898, when dams dried up along the Eastern Goldfields line, Burlong Pool appears to have been the principal source of boiler water for locomotives operating east from Northam.

No chemical data from analyses of Burlong Pool water over this period seem to have been preserved but railway boiler water was preferred to carry not more than 430 parts per million (30 grains per gallon) sodium chloride according to Simpson (1928), and could be accepted at no higher than 500 p.p.m. (35 g./g.) if necessary (Mr. H. Groom, personal communication, May 1973). This may indicate an approximate upper level to salt concentration in Burlong Pool water during the 1890s. For domestic and stock purposes, such water would be regarded as fresh.

In August 1894, at a time of acute pressure on the government to provide a reliable water supply for the Eastern Goldfields, a Mr. John

Maher applied to the Minister for Mines for rights to impound and pipe water from the tributaries of the Avon near Northam to Coolgardie. Maher's letter appeared a month later in *The West Australian* of 17th September. An editorial on the following day, predictably cool toward the Maher scheme, referred to the Avon as "the source from which we shall draw the means for providing the many townships along its banks with water for general use. The municipalities have a lien on the waters of the Swan for their municipal wants. Moreover the owners of the fertile lands lying along the banks cherish expectations that by means of its pools irrigation will be made a cheap and simple matter for them". A letter from a Maher supporter published on 29th September advocated a system of dams and weirs on the Avon.

The Southern Cross Herald of 21st September 1894, supporting the Maher scheme, contended that "if the Avon near the Burralong (presumably Burlong) Pool, Northam, is dammed up, an inexhaustible supply of the precious fluid would be procurable". On 28th September, this newspaper published an interview with Maher concerning his "Avon-Coolgardie Water Scheme". Proposals in 1894 to dam the Avon near Toodyay and Northam are discussed by Erickson (1974: 317).

The government adopted a proposal made by C. Y. O'Connor to dam the Helena River to supply the Goldfields and Maher did not proceed with his scheme. However these contemporary records show that towards the turn of the century, the Avon and its western tributaries, especially near Northam, were regarded as acceptable sources of domestic, agricultural and industrial water. In the absence of positive mollusc records from this period, it is safe to assume that the fauna of the Avon was the same as that found by Preiss and Gilbert a half century earlier. *Westralunio carteri* and *Plotiopsis australis* were undoubtedly present in this fauna and probably *Potamopyrgus* sp., *Physastra* sp. and *Ferrissia (Pettancylus) petterdi* were likewise; at this time, *Anticorbula amara* may have been confined to estuarine waters.

(b) THE AVON TURNS SALT

By the turn of the century, signs of deterioration in the condition of the Avon were appearing. Wood (1924) recalled that "about 1897, in the Northam-Toodyay district, I heard it suggested that destruction of the native vegetation turned the water in the creeks salt; and about 1904 I thought that I could see evidence of increase in salinity in the Goomalling Agricultural Area". The connection between the clearing of catchments and salinity increase was also noted by E. S. Hume, Chief Mechanical Engineer, in the *Report on the working of the Government Railways for the year 1908-9.*

From about 1893 to 1910, a steam-powered flour mill operated at Beverley, using boiler water from the Avon. The late Mr. A. Oliver of Beverley, whose father was manager, informed me (personal communication, June 1973) that "salinity was an increasing problem from about 1907 and . . . every few months there would be a shut down of the mill whilst my father and others removed salt encrustations from the boiler".

Upstream from Toodyay, the drainage basin of the Avon has been very extensively cleared for agriculture, probably to a greater extent and for a longer time than any other in Western Australia. Destruction of the original deep-rooted *Eucalyptus-Acacia* woodland and its replacement with shallow-rooted seasonal crops and pastures has raised the water table and greatly increased the salinity of stream discharge, here as elsewhere in south-western Australia (Mulcahy, 1973; Peck and Hurle, 1973). Na^+ and Cl^- are the predominant ions in the groundwater throughout the region. They are believed to have been derived largely from the rain as "cyclic salt" (Weller, 1928; Williams, 1967). Many Avon tributaries, especially the smaller ones, have been entirely cleared of standing vegetation; others have been devegetated through salting following the clearing of the surrounding land. The extension of agriculture eastward from the Meek-

ering Line has increased the frequency of saline lake discharge into rivers including the Avon, thus further raising their salinity load (Mulcahy, 1973).

I have not attempted to establish the proportion of the Avon catchment that has been cleared but present data on some agricultural shires, being representative "Avon country", to indicate the approximate degree to which this has proceeded. Rural land utilization statistics issued by the Bureau of Statistics show that by 1971-72 in the wholly agricultural shires of Goomalling, Cunderdin, Brookton and Quairading (taken together) about 85% of farming land had been cleared. Most of the remainder seems to have been used for stockgrazing and very little of the original woodland would now remain in an unmodified condition. The shires of Toodyay, Northam, York and Beverley retain forested water catchment areas in their western parts and, statistically, have higher proportions of uncleared land than the foregoing. However their agricultural eastern parts appear to have been cleared to a similar extent. Masters and Milhinch (1974) estimate that less than 5% of the area of Northam Shire remains in virgin condition.

By 1932, it appears that salinity in the Avon at Northam had increased considerably over the preceding 30 years. An analysis by the Railway Department in August of that year showed 1,278 p.p.m. (90 gr./gal.) of "salt", a concentration more than double the accepted maximum for locomotive water. By contrast, the streams flowing into Burlong Dam at the same time averaged only 71 p.p.m. (5 gr./gal.) of "salt". Older water

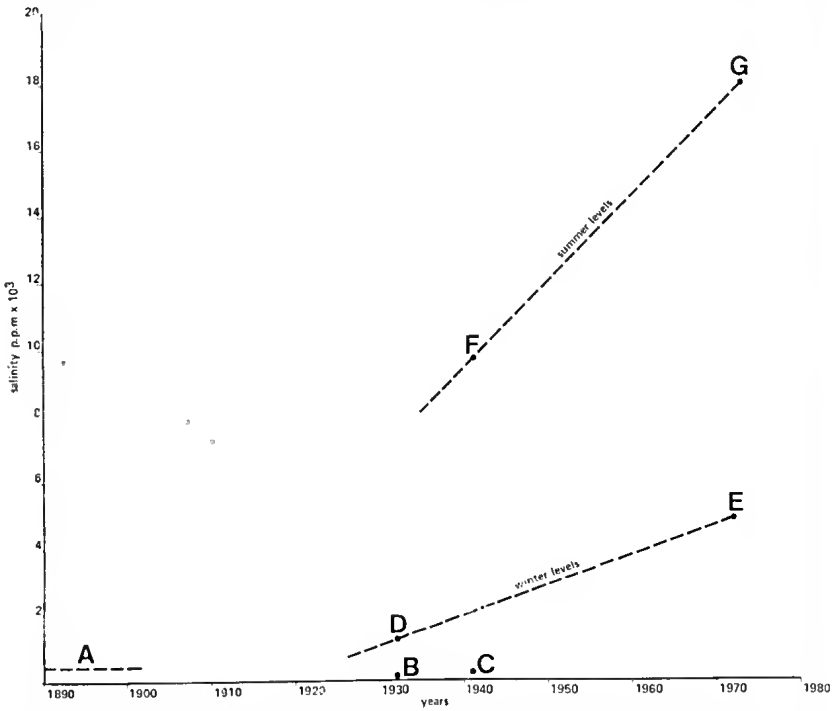


Fig. 9.—Salinity levels (sodium chloride) in the Avon River and Burlong railway dam, Northam, 1890-1973. A maximum acceptable level for locomotive boiler water (Simpson, 1928). B Burlong railway dam, August 1932 (winter). Source W.A.G.R. C Burlong railway dam, January 1941 (summer). Source W.A.G.R. D Burlong Pool, August 1932. Source W.A.G.R. E Avon R. above Mortlock confluence, August 1972 (winter). Source P.W.D. F Burlong Pool, January 1941. Source W.A.G.R. G Avon R. above Mortlock confluence, April 1973 (autumn). Source P.W.D.

drawn from the bottom of the dam carried 162 p.p.m. (11.4 gr./gal.). These tests were repeated by the Department in January 1941; Burlong Pool water then contained 9,734 p.p.m. (685.5 gr./gal.) of "alkaline chlorides" and drew the comment from the analyst that "This water is quite unsuitable even for boiler washout purposes". Again, by contrast, Burlong Dam water sampled a few weeks earlier contained only 256 p.p.m. (18.04 gr /gal.) of "alkaline chlorides" (Mr. H. Groom, personal communication, May 1973).

These data, from Railway Department records, point to rapidly diverging salinity levels over the decade 1932-1941 between Burlong Dam and Burlong Pool. The low concentrations from the dam on these two occasions lend credence to the subjective impressions of James *(ibid.)* on the purity of water from the Avon's western tributaries in the 1890s.

Concentrations of sodium chloride in Avon water at Northam (from a site above the Mortlock confluence and presumably comparable with Burlong Pool water) determined by the Public Works Department for the period November 1971 to May 1973 range from 4,850 p.p.m. (328 gr./gal.) in August 1972 to a maximum of 17,800 p.p.m. (1,254 gr./gal.) in April 1973. A combined graph of the abovementioned salinity data from governmental sources in Fig. 9 suggests the rate and timing of change in the composition of Avon water at Northam since the turn of the century. A substantial transformation had evidently set in by 1941 and a large part of this probably occurred during the preceding decade.

On the timing of these events, some observations of Mr. Masters may provide further evidence. He has noted that from 1935-1944 no major flood from the eastern wheatbelt lake system entered the Avon, the floods of 1939 and 1943 originating in the relatively fresh western watershed. The major floods of 1945 and 1946 were the first occasion for over 10 years, when the wheatbelt lakes overflowed, discharging a large quantity of salt accumulated there in the wake of the post-1920 agricultural development of the region. Hydrologic and other deterioration of the Avon was intensified as a result of these two floods (pers. comm., Dec. 1975).

Mr. Masters has kindly made available some data (Fig. 10) on salinity of river water near his property. He writes: "Water salinities in the major pools between 1930 and 1944, at least between Northam and Toodyay,

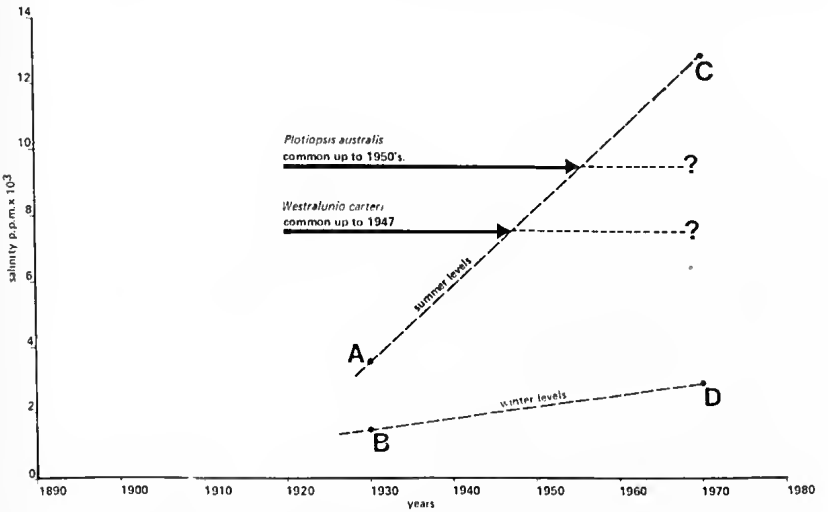


Fig. 10. Approximate range of salinity levels ("total salts") in Glen Avon Pool, between Northam and Toodyay, 1930-1970. A-C dry season levels. B-D wet season levels. Onset of crises affecting 2 species of molluscs shown by arrows.

ranged between about 1420 and 3550 p.p.m. (100 and 250 gr./gal.) total salts during the course of eaeh year. Sinee about 1950, this pool at "Glen Avon", at least, has a range of salinity of about 2,840 p.p.m. (200 gr./gal.) in flood to as high as 12,780 p.p.m. (900 gr./gal.) at the end of a long dry summer, and the higher figure is usually reaehed in years when lakes from the inland wheatbelt have overflowed strongly into the spring months. This year (Mareh 1973), without any inflow from the eastern lake system, the salt eontent at the moment is approximately 6,390 p.p.m. (450 gr./gal.) and this is the usual eharaeteristie of this pool in drier years without runoff from the eastern watershed".

The "Glen Avon" data are similar to those from Northam and indieate a direet eause and effeet relationship between rising salinities and the observed ehanges in aquatie life along the Avon over the past half eentury. There is no evidenee that this inereasing rate of salt diseharge has yet peaked. The eontinued presenee of abundant *Plotiopsis* and *Potamopyrgus* in the lower Avon below Toodyay suggests that fresh water reeeived from tributaries and seepage in the Darling Range provides some proteetion for these speeies in that part of the system. A salinity profile similar to that reported for the Blaekwood River by Morrissey (1974) evidently exists within the Avon.

(e) LIVESTOCK POLLUTION

Contamination of ground and surfaee waters by animal wastes is an aeknowledged pollution hazard in some parts of the world, notably North Ameriea, where intensive livestoek farming is widespread, but has reeeived little attention to date in Australia (Boughton, 1970). The havoe whieh it ean infliet on aquatie life under eertain eonditions is shown by some reeent experienees along the Avon.

Early in February 1971, a tropieal eyelone brought heavy loeal rain to the Toodyay distriet, a good deal of whieh ran quiekly off the dry paddoeks and into the Avon. Mueh organie material, ineluding animal waste, was washed into the pools. About a week later, the press reported that an estimated 1,000 fish, mostly Cobblers, and some Jilgies had been found dead in Redbank Pool. This was attributed to oxygen depletion of the water and presumably eutrophieation (*The West Australian*, 9th February, 1971, p. 5).

A similar sequenee of events, probably in the wake of the same eyelone, was observed by Mr. V. Thorbjornsen of Northam. Here, heavy rain on adjaeent dry paddoeks washed a large quantity of organie material into Burlong Pool so as to virtually blanket the surfaee with a floating mass, mainly sheep manure. The water turned dark and smelly and dead fish appeared along the banks (personal eommunieation, April 1973).

At the beginning of April 1973, aeeompanied by Messrs. A. Oliver and C. Bennett of Beverley, I visited a seetion of the Dale River near Mile and Reserve Pools, SSW of Beverley. No rain had fallen in the distriet for some time but nevertheless a small flow of elean, slightly braekish but potable water was moving through Reserve Pool. This probably originated from springs loeated upstream near Spring Pool. Fish and other fauna were evident in the pool, though no molluses were seen. One week later a thunderstorm brought the first autumn rains to the distriet, with heavy loeal showers.

On a return visit one week after the rain and two weeks after my first visit, I found the same streteh of river grossly polluted. The water was dark brown and smelt strongly of animal waste, evidently sheep manure. Between Reserve and Spring Pools the banks were strewn with dead and apparently dying Nightfish *(Bostockia porosa)* and Pigmy Pereh *(Edelia vittata)*. A Jilgie, without ehelae, presumably as a result of stress, was taken from the water. At Mile Pool, vast numbers of dead and dying shrimps *(Palaemonetes australis)* littered the banks. Others were swimming erratieally on the surfaee at the water's edge, some leaping out to join those on the banks. Presumably this behaviour was in response to the fouled eondition of the water.

These three episodes, involving catastrophic destruction of fauna, point to a second major threat to the biota of the Avon, or that part of it that has been able to tolerate prevailing salinities. The observations cited relate only to small sections of the river system but the ingredients are ubiquitous and it is reasonable to believe that such events now occur regularly along much of the Avon and tributaries during the summer-autumn months. This is the time of year when the fauna would probably be under greatest stress from the effect of raised salinities.

Since the 1830s, the Avon pools have been used for the watering of livestock, particularly in the dry season, and in earlier periods of low stock density and salinity little if any harm would have been done to the aquatic environment and biota. Over the last 30 years, however, since the introduction of subterranean clover and other innovations, the sheep population of the Avon districts has risen about three-fold (Bureau of Statistics data) and no doubt total stock density on the river and adjoining land has increased substantially over this period. No figures are available, but the quantity of animal waste deposited during a dry season in the main and tributary channels and adjacent land must be considerable. The sudden reactivation of this material by summer or autumn rains can lead to crises of deoxygenation and eutrophication in the pools, which are the dry season refuges for the fauna.

The traditional practice of permitting livestock generous access to the pools, channel and banks of the Avon and its tributaries, initiated in a bygone age of low stock densities and relatively fresh water, should now be reappraised in the light of its apparent significant contribution to the advanced degradation of the river environment.

It is conceded that the above comments are largely intuitive and lack the authority that would derive from a series of more representative, controlled observations; however their relevance to the overall problem of the ecologic stability of the Avon is undeniable. The uncertainties that exist in relation to this question only emphasize the fact that no authoritative investigation into the combined effect of increased salinity and animal waste pollution on river biotas has ever been undertaken in Western Australia. Other potential sources of river pollution, less amenable to direct observation, include chemical fertilizers used to excess, weedicides and pesticides, but nothing is known of their presence in the Avon and effects, if any, on the biota.

(d) A RIVER OF SAND

In its mature middle section the bed of the Avon originally comprised alternate deeps and shallows which, in the dry season, took the form of stable, permanent pools separated by dry sandy channels. The latter supported a substantial growth of trees, bushes and other vegetation, notably species of *Casuarina, Melaleuca* and *Eucalyptus*, the roots of which, together with a great quantity of surficial and buried woody debris, served to stabilize the substrate. Though no data are available on which to base precise comparisons, there can be little doubt that the near-total clearing of the catchment has substantially increased the concentration and probably also the volume of surface runoff after rain. These factors have probably intensified the erosion of sediment, particularly from higher land, and contributed significantly to the accumulation of sand in the bed. The continual access of livestock to the banks, channel and tributaries is likely to have aggravated this process.

The Avon towns were initially laid out at a time when the discharge characteristics of the river, unmodified by man, were poorly understood. Old Toodyay, located in close proximity to the Avon, had to be abandoned in favour of the present site following a sequence of floods of growing severity through the 1840s and 50s (Erickson, 1974). Buildings were flooded in Northam as early as 1862, but the example of Old Toodyay, based on recognition of the need to give the river adequate room, seems not to have been followed and the town centre was allowed to develop

with the protection of a levee on flood-prone land. The inevitable crisis arrived in 1955, when much of central Northam was inundated following heavy cyclonic rain. This seems to have been the last occasion on which some relatively inexpensive reorganization of the town to accommodate the river might have been entertained. Regrettably, however, an opposite policy was adopted.

In 1956, the government of the day (the Premier being the Member for Northam) initiated the "Avon River Training Scheme", which sought to improve the river's flood discharge capacity by the mechanical removal of sediment and vegetation from the channel between Toodyay and Brookton. This operation, seemingly of indefinite duration, has been confined to the main channel, that is, the area where the *symptoms* of hydrologic and sedimentologic instability are most concentrated and without regard for those parts of the catchment where the underlying problems of concentrated runoff and erosion are generated. Whatever the reasons, it is evident that the channel substrate has become less rather than more stabilized and this has given rise to public misgivings as to the merits of the scheme.

Over its 20 years of operation, no official evaluation of the "training scheme" has been released but it is clear that one major negative consequence has been the creation of a large body of unstable sand in the channel between York and Toodyay. Some once-permanent pools have been buried by this sand and others partly so, including the once extensive and deep Burlong Pool (see newspaper references, *Daily News* and *West Australian*). Without some new initiative, it seems that the obliteration of most if not all of the pools in the Northam district is only a matter of time. In the past, the pools served as summer refugia for aquatic life. Now not only the fauna but the very existence of the pools, once regarded as among the district's greatest assets, is in jeopardy. Their loss would constitute a further major step in the degradation of the initially fragile riverine environment of the region. If the aim of the "training scheme" was to convert the central Avon into a mere agricultural storm-water drain, then by this narrow engineering premise it could be regarded as a qualified (as yet untested) success, apart from being financially wasteful and unnecessary. But as an operation aimed at river conservation, its effect has been disastrous. The scheme was initiated and pursued without regard for the need for any biological investigation of the Avon and it is probable that part of the biota has now been irrevocably lost as a direct consequence.

The changes to parts of the Avon associated with the "training scheme" are drastic and visibly conspicuous and therefore disturbing to those who knew the river in better times. However it should be realized that these changes are only the most recent episode in a process of accelerating multiple disturbance to the river's ecosystem that has been operating since before the turn of the century.

3. WANTED: A NEW APPROACH

The old Avon, together with the woodlands that sustained it, is gone for ever; agricultural development of the catchment has brought permanent, irreversible changes to the region. The river's present and future need seems to be for an informed, conservation-management policy that will progressively establish a degree of stability and harmony with its man-made environment and at the same time conserve and restore as much as possible of the original riverine flora and fauna. Any further change would need to be of a kind beneficial to the river environment. (Indeed a cynic might argue that little more *could* now be done to harm the river, intentionally or otherwise). Our readiness to see it in such a way should be helped by the realization that the Avon, once an economic and recreational asset, has been transformed into a financial and environmental liability; a stabilized, restored Avon would mean, in time, a better human environment for the district. A new approach is indicated, but in practical terms are there any real alternatives to present practices and policies? There is little

cause for optimism in official and community attitudes; beyond the need to protect the towns from flooding, no aims have been defined, no expectations fostered.

A listing of facile "solutions" to the problems of the Avon is not called for here. Before they could be considered, attitudes and values among all concerned parties would have to be established and clarified, the problems recognized and defined. However I propose to mention briefly some possibly useful ideas on the subject in support of the view that there are alternatives to the present policy of attrition.

Initially, data would need to be gathered on all aspects of the hydrology, sedimentology and biology of the Avon, its tributaries and the catchment generally, including land-use practices in the region. In particular, the system's net rate of salt discharge (Peck and Hurle, 1973) could be assessed, as could the totality of factors that contribute to flooding. Innovations regarding salination and flood control, such as revegetation, could be devised. Soil erosion in the district is currently judged solely on agricultural criteria; whether these are also adequate to protect the Avon from excessive long-term sand accumulation may be relevant. Further implementation of the "training scheme" should be stopped and the effort thus saved diverted into the search for more enlightened and comprehensive policies of river management. At the same time, the Northam levee system should be improved. Flood-prone areas of this and other towns could be proclaimed and all new building in them prohibited, a measure that is at least a century overdue.

In the past, the Avon pools were important for the watering of livestock, but now this is often no longer feasible and in general no longer necessary. Most farms in the district now have access to reticulated water from the Darling Range and with this alternative source available, or potentially so, it may be time to propose the future exclusion of livestock from the river and major tributaries. Studies of the effect of livestock trampling on the sedimentologic stability of channels and banks, as well as the effects of animal waste pollution on aquatic life seem to be desirable. An attempt at a comprehensive biological survey of the Avon could be made and a policy adopted for a regular monitoring of the biota.

In the wheatbelt communities of Western Australia there is now some recognition, even regret, that the region was cleared to excess. With regard to this sentiment and to the conservation needs of the Avon, a case could be made for a study of ways and means whereby a special Avon River Reserve or even National Park could be established, comprising the channel, banks and a generous width of land on both sides. This could comprise both public and privately owned land, the former created by purchase, the latter by voluntary concession; for the loss of productive land in the latter case, compensation borne by the State would be justified. Such a reserve, a long-term project, would need to be fenced to exclude livestock; channel sands could be re-stabilized and pool formation assisted where possible. Native vegetation could be restored. Animal vermin would need to be controlled and noxious and aggressive weeds excluded. The reserve could be extended progressively out from the main channel and along the larger tributaries.

The Avon's problems are complex and regional in scope; their amelioration in ways that would lead to the restoration of the river, rather than its further degradation, would seem to require the combined resources of private individuals and organizations as well as governments at all levels. A managerial body with an overview of the total situation, on which local communities would be directly represented, would be essential for continuity and effective action.

Returning to the real world, there can be few who would be surprised if the future of the Avon turned out to have little or no resemblance to the scenario lightly sketched above. However the central issue of the protection of the integrity of river environments in south-western Australia cannot be concealed much longer, for although the Avon is the most

degraded of our rivers, it is not the only one so affected. There is faunal and other evidence that the Moore has been overtaken by a hydrologic crisis since the 1960s; others, such as the Murray, Collie and Blackwood are becoming increasingly affected by salination. The conflicting interests of water conservation, nature conservation, agriculture, bauxite mining and wood-chipping, aggravated by the spread of die-back disease, will not be easily resolved and constitute a problem of unprecedented magnitude. Recognition that our freshwater faunas are threatened has been late in coming; that their preservation is directly linked with the stability of our water catchments and hence with the future basic needs of urban and rural communities in south-western Australia may yet swing the balance in favour of more effective conservation measures on behalf of our limited freshwater resources. If the example of the Avon serves only to create more concern for the fate of the rivers in the region, its destruction will not have been completely in vain.

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TABLE 1.—SYNOPSIS OF APPARENT OR INFERRED CHANGES IN THE OCCURRENCE AND DISTRIBUTION OF MOLLUSCS IN THE AVON RIVER, 1840-1975.

Species	Past status	Present status
1. *Westralunio carteri*	Originally common and widespread. In pools above York, common up to the 1940s, then in decline; last seen about 1950 in Gwambygine Pool. Between Toodyay and Northam common up to about 1947, in decline to ebout 1960, subsequently rere.	Probably extinct above Northam except for remnant population in Spring Pool, by Dale River. Below Northem rare, perhaps close to extinction. Present but uncommon in Wooroloo Brook, 1971.
2. *Anticorbula amara*	Prior to 1900 probably wholly estuarine. Below Northam rare in the 1920s, increesingly abundant since.	Common in the Swan estuary and abundant upstream to beyond York.
3. *Potamopyrgus* sp.	Unknown; possibly once widespread.	Living near the Wooroloo Brook confluenco since 1969.
4. *Coxiella glabra*	Unknown but may have been originally restricted to saline/brackish lakes in the northern headweters of the drainage basin; present in the Mortlock (North Branch), 1958.	No records since 1958.
5. *Plotiopsis australis*	Originally common and widespread at least upstream to York, but not reported from there since about 1840. Between Northam-Toodyay, common up to the 1950s; subsequently in decline there.	Probably oxtinct from York upstream; recently living in Burlong Pool but now possibly extinct between Northam and York. Uncommon between Northam-Toodyay. Common in Darling Range, notably around Wooroloo Brook confluence and downstream to Guildford.
6. *Physa* sp.	Introduced species.	In Burlong railway dam, 1968; in Avon noar Wooroloo Brook confluenco, 1969.
7. *Physastra* sp.	Unknown but probably once widespread. Collected in 1950 from "soak near Beverley".	In Brockman River and in Spring Pool by Dale River.
8. *Ferrissia (Pettancylus) petterdi*	Unknown; past presenco inferred.	Unknown; recent decline or extinction possible.

NEW BREEDING RECORDS OF THE BANDED STILT IN WESTERN AUSTRALIA

By NICHOLAS KOLICHIS, Osborne Park

C. F. H. Jenkins (1975) has given a brief summary of the remarkable history of diseovery of the nesting habits of the Banded Stilt *(Cladorhynchus leucocephalus)* in inland salt lakes, and of the latest reeord, at Lake Ballard, near Menzies, in 1973.

Some additional early nesting reeords, attempted and aetual, not eited by Mr. Jenkins, may be mentioned.

On November 8, 1960 in the Yalgoo distriet Ivan Carnaby found 40-50 depressions in preparation for nesting by this speeies on an island in Wagga Wagga Lake, but when he and P. J. Fuller (1963) returned on November 26 nesting had been abandoned, presumably beeause the lakes were drying. About 400 Banded Stilts were present on both visits.

On August 11-17, 1971 Mr. W. H. Butler (pers. eomm.) saw a floek of Banded Stilts, adults and young, at a elaypan 30 km south of Durba Spring on the Canning Stoek Route and others at a elaypan 5 km north of Well No. 11. He colleeted an immature speeimen (now in the Amerieun Museum of Natural History, New York). Presumably they had nested nearby, probably at Lake Disappointment. This lake would have been filled by heavy rain in May of that year.

In July 1974 Mr. A. Middleton (pers. eomm.), while a resident at Menzies, saw a large number of ehieks and adult Banded Stilts on the

eastern end of Lake Ballard but he did not see any actual breeding. As reported in Mr. Jenkins's article Mr. Middleton had discovered nesting at this lake in the previous year and had forwarded newly hatched chicks to the South Perth Zoological Gardens.

In September 1975 the Western Australian Museum received fragments of sub-fossilised eggs of the Banded Stilt from the Geological Survey of Western Australia. These had been found partly buried in clay in the Percival Lakes (Lat. 21° 22' S. Long. 124° 44' E). The shells were still pigmented and were evidently of recent age.

Fig. 1.—Nesting islet on Lake Marmion (resembling reversed figure "3").

OBSERVATIONS IN 1975

On April 6-7, 1975, Mr. and Mrs. A. G. Wells saw a flock of about 3,000 adult Banded Stilts at the eastern end of Lake Ballard, and during the nights while camped in this vicinity heard stilts continuously flying overhead until midnight. The water in the lake was about 30 cm deep and appeared to have an abundance of small fish and brine shrimps.

Mr. Wells's information stimulated me to search for breeding colonies. Consequently Mr. J. B. Woods and I chartered a plane on May 26, 1975, and flew over the lakes between Kalgoorlie and Menzies. At Lake Goongarrie, 86 km north of Kalgoorlie, a flock of about 1,000 Banded Stilts were observed feeding in the shallow water but no nesting was found.

At Lake Ballard, a vast sheet of water some 65 km long and 15 km wide, there were literally hundreds of islands varying in shape and size. In shallow water on the north-eastern end, several thousand Banded Stilts were scattered in about 20 groups over an area of approximately 3 km in diameter. As the aircraft approached the birds the adults flew off leaving behind hundreds of large flightless young which huddled closely together. As soon as the aircraft had passed over the adult birds returned to their young. After passing over most of the islands in the lake we located those on which the birds were nesting. These were two sandy islands about 10 metres apart in shallow water about 300 metres from the north-eastern shore of the lake. The smaller of the islands had no vegetation and was completely covered in empty nest scrapes. The other was a flat, wide,

Fig. 2.—Rookery on Lake Marmion.

are-shaped island with some seattered samphire bushes on the northern end, and two-thirds were eovered with nests eontaining one to three eggs. These nests were presumed to have been abandoned beeause the eggs were partly buried in sand and no birds were seen in attendanee. Possibly the reeeding water allowed mammal-predators to eross to the island or the eggs were infertile and abandoned remnants of sueeessful breeding because numerous young birds were on the lake.

At Lake Marmion, we saw Banded Stilts on the water in small groups varying from three young with two adults to about 40 young with six to nine adults and eventually we saw a large eolony of birds leaving an island. As the aireraft flew eloser these birds huddled together in shallow water off the edge of a rookery eonsisting of hundreds of serapes with eggs. The birds returned to their nests as soon as we passed over the area.

The eolony at Lake Marmion was later surveyed from the ground. The nesting colony eould not be seen from the lake shore. On walking to the rookery three flightless young stilts were captured while they were swimming in water 25 em deep. They were white exeept for blaek wings and bill and dark greyish-blaek legs. As the rookery was approaehed we notieed that the smallest ehieks were elosest to the nesting area and the largest ehieks were the furthest from the rookery, about 2 km away. The smaller ehieks were eovered with pure white down, their legs and bill being blaek. While several of the young were swimming they peeked at small blaek ostraeod erustaeeans floating on the surfaee of the water. Brine shrimps, the main food of adults, were not plentiful. One reeently hatehed ehiek was seen to leave its nest and huddle elose to another ehiek in another nest nearby.

RAINFALL

Rain from tropieal eyelone "Trixie" of February 17-24, 1975, filled these lakes. "Trixie" arose in the Coekatoo Island—Yampi Sound area and moved parallel to the eoast before erossing inland just east of Onslow. It then moved southward to just east of Shark Bay and then moved south-eastwards into the Eastern Goldfields as a rain depression. Table 1

gives rainfall data for places in the Eastern Goldfields in the late summer and early autumn of 1975. Usually these centres receive an average monthly rainfall of only 15-30 mm during this period.

TABLE 1.—MONTHLY RAINFALL IN MM

	JAN	FEB	MAR	APR	MAY
Menzies	3	242	3	38	43
Leonora	12	237	26	63	37
Agnew	NIL	333	30	42	57
Sandstone	NIL	292	43	56	41
Cashmere Downs	0.5	299	15	72	27
Diemals	NIL	105	26	100	25
Laverton	NIL	120	(No Report)		

DESCRIPTION OF LOCALITY

Lake Marmion is an ephemeral salt lake 32 km east of Menzies (130 km north of Kalgoorlie). It is about 30 km long by 20 km wide. The nesting island was in the north-western part of the lake, and the nesting colony was on the north-eastern end of the island, about 7 km from the western shore. The island was long, narrow, and shaped like the numeral "3", about 5 km long, 100 m wide and one metre above water, covered sparsely with samphire and short green grass, and with odd low mud spits along the edges. There was open water on the north side and high islands on the south side of this island, the closest island being about 200 m from the rookery. Water about 40 cm deep surrounded the island and the water gradually became shallow towards the lake shore. The bottom of the lake was partly covered with soft mud up to 15 cm deep. The water was very salt.

Fig. 3.—Nest with four eggs, Lake Marmion.

DESCRIPTION OF COLONY AND NESTING

A colony of approximately 2,500 nesting pairs covered an area of about one half a hectare, which was on a bare patch of sandy-clay soil on the island, 70 cm above water. The surface had a thin, dry but fairly hard crust, which, when broken, revealed a soft, fine, light reddish-brown subsoil. Only odd bushes of samphire were scattered over the nesting area. The nests were shallow scrapes in the ground, averaging 15 cm across by 3 cm deep and were placed 30-40 cm apart. There were patches of unused ground throughout the rookery. Eggs were laid on bare ground, except for odd nests with pieces of dry samphire and dry grass as lining. Clutch sizes varied from 1-5; 3 was most common, followed closely by 4; odd clutches of 5 were scattered through the rookery and clutches of 1 and 2 were uncommon. Eggs varied considerably in colour, markings and shape, even within a clutch. The stage of incubation varied from fresh eggs to young recently hatched. Where there were breeding birds only odd nests contained addled eggs, but about 1,000 nests at the southern part of the rookery, where there were no birds, contained addled eggs partly buried in the ground.

MORTALITY AND PREDATION

About 300 small young dead in the rookery, and odd dead young, on the lake and outer shore were found. Three Whistling Eagles *(Haliastur sphenurus)* and several crows were seen flying round the rookery. A mouse was seen leaving a half dead chick with its scalp partly eaten and bleeding. Another 25-30 dead chicks were seen amongst the colony with their heads partly eaten. Only one adult was found dead; it was 200 m from the rookery. Adults were never seen feeding young birds, so possibly the high

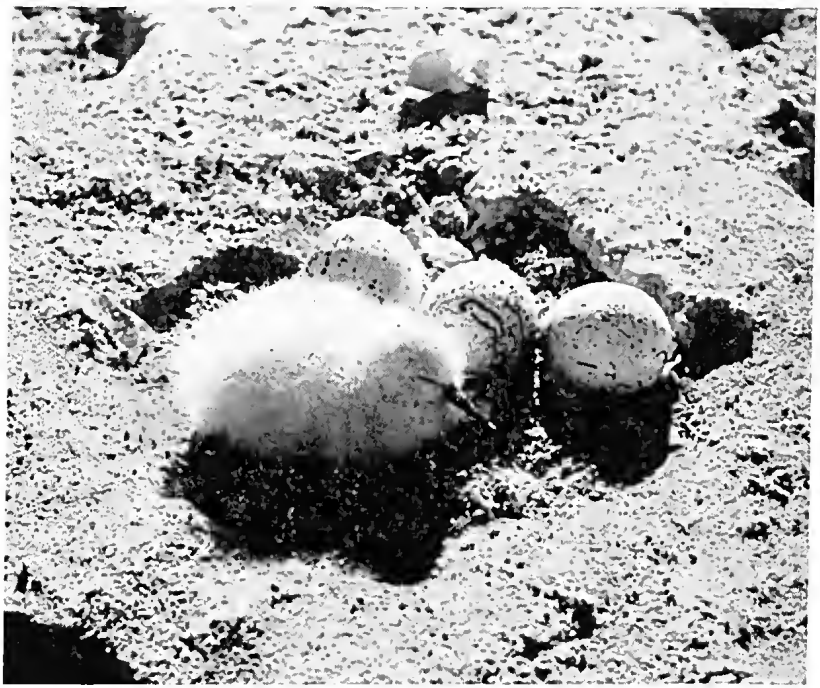

Fig. 4.—Eggs and chick in nest, Lake Marmion.
—Photos N. Kolichis

mortality among young birds was due to starvation and exposure to cold nights.

DISCUSSION AND CONCLUSION

The Banded Stilt has now been found nesting, or attempted nesting, at Lake Grace, Lake King, Wagga Wagga Lake (Yalgoo), Lake Ballard, Lake Marmion, Lake Disappointment (probably) and the Percival Lakes in Western Australia, and Lake Callabonna in South Australia. The Percival Lakes are the northernmost known breeding locality of this species. These are ephemeral lakes which are infrequently filled because very heavy rain is irregular, especially in arid areas. Numerous other inland lakes in the central parts of Australia are also presumably used for breeding if they contain islands and sufficient water and food (cf. Fuller, 1963). Breeding is seldom discovered because these lakes are numerous, large and difficult to survey from the ground, and often inaccessible.

ACKNOWLEDGEMENTS

I wish to extend my thanks to Mr. J. B. Woods (Dowerin), who accompanied me on this trip. I am also grateful to Mr. and Mrs. A. G. Wells who informed me of the presence of these birds. My thanks also go to the Bureau of Meteorology for the information on rainfall in this area. To Mr. J. R. Ford and Dr. G. M. Storr (Western Australian Museum), I am very grateful for help in the preparation of this paper.

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THE NOISY SCRUB-BIRD — FACT AND FICTION

By F. N. ROBINSON and G. T. SMITH

INTRODUCTION

This article has been prompted by the recent publication of incorrect and misleading information on the vocal abilities and habitat of the Noisy Scrub-bird, *Atrichornis clamosus*, (Macdonald, 1973; P. Slater, 1974). Because the general standard of these texts is good, they will be widely used as a source of information and will consequently be considered authoritative. It is therefore essential that in correcting these inaccuracies their genesis is examined in some detail.

The Noisy Scrub-bird was discovered in 1842 at Drakesbrook in the Darling Range. Between then and 1889 it was reported in other parts of the south-west corner of W.A., from Boogidup creek, Augusta, Torbay, Albany (Serventy and Whittell, 1967) and as far north of Albany as Mt. Barker (E. Slater, 1973 and pers. comm.). It was not sighted again until 1961 when H. O. Webster re-discovered it at Two Peoples Bay near Albany (Webster, 1962a). It is therefore important to consider two generations of data, namely that of the 19th century when the bird was widespread and that of the 20th century based on relatively few individuals at one location.

VOCAL BEHAVIOUR

Five observers who had first-hand contact with the bird in the period from 1842 to 1889 have described the territorial song of the male. These are worth quoting. Drummond (1843) ". . . . . and singing sweetly with loud clear notes". Gilbert (in Whittell, 1951) "It . . . . utters its loud notes while on the ground . . . . . When I first heard its extraordinary loud notes, many of which are sweet and melodious . . . . . its notes are so exceedingly loud and shrill, as to produce a ringing sensation in the ears". Masters (in Ramsay, 1866) noted ventriloquial ability, but made no mention of it being a mimic. Webb (1895) "Its note is loud and clear and piercing and sounds something like 'Cheap, Cheap, Cheap, Cheap'. The first note is short, the second, third and fourth being each a little longer and lower". Campbell (1901) "Its very peculiar loud note is a kind of sharp whistle repeated eight or nine times rapidly, with *crescendo,* concluding with a sharp crack that makes the woods resound".

The impression from these writers is of a loud, clear, almost musical (to some ears) song, but there is no mention of mimicry or of the monotonous repetition of a single note, either in their writings or in reviews by Whittell (1943) and Chisholm (1951). This is in marked contrast to the initial description of the song of the Rufous Scrub-bird *(Atrichornis rufescens)* discovered by Wilcox, who wrote (Ramsay, 1866) "I was almost inclined, although not superstitious, to think some evil spirit was playing me a trick, for at one moment it would give out its own notes apparently just in front of me, and the next minute the Spine-tailed Orthonyx *(O. spiniculata)* in another direction; then the Scrub-robin's note would be imitated in some other place . . . .". Jackson (1907) in describing his

Fig. 1.—Noisy Scrub-bird, *Atrichornis clamosus.* Female standing on nest platform looking towards nest entrance.
Photo G. T. Smith

first contact with the Rufous Scrub-bird in 1899 described it as "a great mimic".

Following the re-discovery of the Noisy Scrub-bird, Webster (1962a and b) noted of the song that "They were fairly long and were also loud and frequent" and ". . . . calls are so typical and so outstanding that once they are familiar to an observer, it is impossible to be mistaken when a call is heard". Again no mention of mimicry. However, Serventy and Whittell (1964) quote Webster as saying ". . . . . it is a superb mimic of the songs of other species living in its vicinity . . . .". Chisholm (1964) infers that the Noisy Scrub-bird mimics when he states, "Like its immediate relative, the Rufous Scrub-bird became revealed as . . . . and frequent imitations of the voices of other birds". Macdonald also (1973) writes "Loud, clear piercing 'Cheap' or 'Chip' repeated rapidly; rich vibrant song, frequently in mimic of other bird voices" and P. Slater (1974), "A rich powerful 'Chip-chip-chip- . . . . . The female call is 'Tit-tit-tit-tit'. Also mimics other species".

These statements are a result of an uncritical acceptance of an initial report on the mimetic ability of the first bird re-discovered. This bird did indeed mimic; one of us (FNR) heard it in the field, and both have heard tape recordings of its mimicry. The Noisy Scrub-bird like many Australian passerines is capable of mimicry but very rarely uses is because it has no functional significance. The bird does however have recognisable traces of mimicry in one of its song types, a song that would appear to be used in conflict situations. Robinson (1975) has suggested that the use of mimicry in the Menurae has developed from a basic passerine mimetic ability in response to conflict situations, and that through evolution it has acquired functional significance. In the Noisy Scrub-bird mimicry has been ritualized and now forms the basis of a variable song type. The mimicry of the first re-discovered bird was, we believe, the learnt response of one bird to the unusual and conflicting situation of having humans living in its territory. Subsequent close study of a number of other males has shown that mimicry is very rare, so that we conclude that most of the mimicry of the first re-discovered bird was in response to human intrusion, and that mimicry is not characteristic of Noisy Scrub bird song.

The monotonous and repetitive character of the song of the male implicit in the descriptions of Macdonald (1973) and P. Slater (1974) is more applicable to the song of the male Rufous Scrub-bird, whose song is indeed the repetition of a single note that may be described as "chip" or "cheap".

P. Slater's (1974) description of the call of the female as "Tit-tit-tit-tit" implies a song similar to that of the male; this is incorrect as the female mainly uses two alarm notes, one of which may occasionally be repeated rapidly a number of times. She may also use a three-noted call and the non-territorial song commonly given by the male. Details of the vocal repertoire are given in Smith and Robinson (in press).

HABITAT

As with song, the early descriptions of habitat tend to be more accurate than later ones. Gilbert states (in Whittell, 1951) "It inhabits the densest and rankest vegetation, on the sides of hills and the thick grass around swamps or small running streams"; Masters (in Ramsay, 1866) ". . . . . it inhabits dense masses of vegetation consisting of tall, reedy grass and thick-growing low bushy shrubs"; Webb (1895) ". . . . . is found on the margins of fresh water swamps near Albany . . . ."; and Campbell (1901) ". . . . in the forest . . . . . the Noisy Scrub bird which lives in the thickets of undergrowth".

Webster (1962b) also gives detailed descriptions of the areas at Two Peoples Bay where the birds are found. Yet despite these excellent descriptions we find the habitat described as "sandhill scrub" (Chisholm, 1964), "Coastal heathland" and "gullies in very thick heathland (Frith, 1973),

"dense vegetation of coastal scrub and hill gullies" (Macdonald, 1973) and "coastal rushes and densely vegetated coastal gullies" (P. Slater, 1974).

Although broadly relevant to the area at Two Peoples Bay, these descriptions are misleading in that they give the wrong impression of both location and vegetative association. From our knowledge of the habitat at Two Peoples Bay and our examination of the areas where the bird was formerly found, the primary habitat is the wetter areas of the Jarrah-Marri *(Eucalyptus marginata-E. calophylla)* forest where there is some break in the canopy, as along streams and on the margins of swamps. Here the increase in light and water allow the growth of dense associations of scrubs and rush which provide the essential cover for nesting. It is worthwhile noting that the Rufous Scrub-bird *(Atrichornis rufescens)* also inhabits areas where the canopy has broken down and a dense understorey has developed.

The description of the habitat as coastal although currently correct, is incomplete as Gilbert found it at Drakesbrook in the Darling Range and as far north of Albany as Mt. Barker (in Whittell, 1943; E. Slater, 1973 and pers. comm.). Its apparent coastal occurrence is in part a reflection of the greater early exploration of the coastal areas and partly due to its occurrence in outliers of the Jarrah-Marri forest as at Two Peoples Bay and the extension of tongues of the forests towards the coast in valleys such as, Boogidup creek, and the extensive areas of swamps interdigitating with the Jarrah-Marri in the Albany area.

CONCLUSION

We have gone to some length in refuting these inaccuracies for two reasons. First, they provide an excellent example of how old and essentially accurate information can be ignored when more "modern" information is available. Secondly, we believe that a true appreciation of the nature and extent of mimetic ability in the Noisy Scrub-bird is important in understanding the evolution of passerine song (Robinson, 1975). With regard to the habitat of the Noisy Scrub-bird, it is understandable that modern books have tended to describe the area where the present sole population exists.

Whilst it is obviously true that the bird does live in gullies in very thick heathland at Two Peoples Bay, this was not the preferred or common habitat when the bird was more widespread. An appreciation of the true habitat requirements of the species is fundamental to understanding the ecology of the species and thus, hopefully, of careful management for conservation into the future.

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FROM FIELD AND STUDY

Field Wren in the Albany Area.—Serventy and Whittell *(Birds of Western Australia,* 4th edn., 1967) give the western limits of the southern range of the Field Wren *(Calamanthus fuliginosus)* as Mt. Manypeaks and Two Peoples Bay. However I have seen one individual in coastal scrub west of Albany at Jimmy Newells Harbour, 30-35 km W.S.W. of Two Peoples Bay. The date was 14 May, 1973.

—M. K. TARBURTON, Carmel College.

Redshank on North-west Coast.—On September 2, 1974 I was observing wading birds at the muddy edge of a shallow salt lake about 1 kilometre north-east of Coral Bay when my attention was attracted by one odd sandpiper feeding with a large flock of Red-capped Dotterel *(Charadrius ruficapillus).* The following description was obtained using 10 x 50 binoculars at a range of about 25 metres with a good late afternoon light.

Upper parts, nape and crown sandy brown; light "eyebrow"; dark line through eye; lower parts creamy white; bill straight, medium length, black; legs medium length, very bright crimson; overall size about equal to Grey Plover (28 cm). No call noted. Flight low and direct; rump and upper tail white, but with a narrow dark terminal band; wings with conspicuous white stripe on the upper surface.

A positive identification may not be possible from these field notes, but it seems very likely that the bird was a vagrant Redshank *(Tringa totanus).* This is not usually regarded as an Australian species, but it does regularly migrate in August and September to the Malay peninsula, Sumatra, Borneo, Java and presumably the lesser Indonesian islands, and Christmas Island, and is regarded as common on mudflats in these countries in the (southern) summer months. An occurrence at Coral Bay would imply that the normal migratory flight had been extended by about 1,500 kilometres.

—L. E. SEDGWICK, Geraldton.

Moulting Mountain Ducks on Lake Preston.—The importance of the Yalgorup National Park, south of Mandurah, including as it does such large expanses of water as Lakes Clifton and Preston is widely recognised as a haven for waterfowl, particularly during the summer and in years of severe drought (Jenkins, *W. Aust. Nat.,* 12, 1971: 28).

Probably because of its high salinity Lake Preston usually carries fewer birds than Lake Clifton, but the following report by the National Park Ranger, Mr. R. Chandler dated November 25, 1974 shows the particular importance of Lake Preston to the Mountain Duck *(Tadorna tadornoides)* and a strong reason for restricting the use of boats and particularly power boats in the area.

"During a routine patrol of Lake Preston on the morning of Thursday 14 November I was proceeding south along the lake about one mile south of the causeway to Preston Beach.

I observed a very large number of Mountain Duck, on closer examination it was found that most of the birds were unable to fly. It appears as though a mass moult was being experienced by the birds.

I continued heading south and for about the next six miles I found very large "rafts" of Mountain Ducks. As far as I could tell about one-third of the birds had completed the moult, one-third were well into it and the remaining third just commencing to lose their feathers.

Further patrols have been carried out to this time to observe the birds, most of which have now departed. Only one large raft and one small one were observed at last check.

Apparently Lake Preston is used by the birds to carry out some kind of special "Moult Migration". To try and estimate the number of ducks from water level and with my limited experience was not possible, the only honest remark I can make is that there were many thousands.

I will attempt to observe this occurrence in future years to try and obtain more information. I have made enquiries amongst local people but no one seems to have any information that would help. Since the birds chose an isolated area and only remained for a relatively short time it is probable that this happens each year and has remained unobserved."

That shelducks, a group to which our Mountain Ducks belong, undergo "moult migrations" to safe bodies of secluded water is only a comparatively recently discovered phenomenon. Thus the bulk of the British-breeding population of the European Shelduck *(Tadorna tadorna)* is now known to concentrate for moulting in the late summer on the coastal flats off the River Elbe in Germany. In Western Australia the habit first came under notice in December 1964 when the English racing driver Donald Campbell was seeking a high speed record with his hydroplane, "Bluebird", on Lake Dumbleyung. He "was seriously impeded in his efforts by the presence of hundreds of moulting Mountain Ducks which could not be scared away as they were still flightless" (Serventy & Whittell, *Birds of Western Australia,* 4th edn., 1967: 139).

No doubt other open waters in Western Australia will be discovered to which this species resorts during its vulnerable moulting period. Dr. D. L. Serventy informs me that when investigating the new Pelican nesting colony at the sand island off the Yunderup Canals Scheme in Peel Inlet in 1974 he found several Mountain Ducks in the vicinity to be moulting. The period was between October 1 and November 5.

—C. F. H. JENKINS, Claremont.

CORRECTIONS

"Birds of the Gibb Rock Area," by E. H. Sedgwick, *W. Aust. Nat.,* 13 (1), July 1974: 7-14. The following corrections are necessary:

P. 8. In the list of "Observed order of appearance of farmland species" the following dates require alteration: Australian Bustard, "March 1967" should read "May 1968". Willy Wagtail, "August 1967" should read "May 1971". Stubble Quail, "December 1968" should read "December 1967".

P. 9. Under Stubble Quail the first date should read "1967" and not "1968."

"The Breeding Burrow of the Banded Ant-eater or Numbat *(Myrmecobius fasciatus),* by P. Christensen, *(W. Aust. Nat.,* 13 (2/3), March 31, 1975: 32-34. Due to an oversight no allowance was made for the reduction of the original drawings in Figs. 1 and 2 on p. 33. In Fig. 1 the scale "1 mm = 3 cm" should read "1 mm = 6 mm". In Fig. 2 the scale "1 mm = 1 cm" should read "1 mm = 1.5 cm."

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THE REPTILES OF BARROW ISLAND

By L. A. SMITH, Western Australian Museum, Perth

SUMMARY

The 38 terrestrial and 6 marine species of reptiles from Barrow Island are listed, including the first specimen of the sea snake *Emydocephalus annulatus* from Western Australia. The biology of the terrestrial species is discussed with respect to their distribution on the island, breeding condition, diet, body size and time of activity The relationships of the Barrow Island fauna to the mainland fauna are discussed.

INTRODUCTION

Barrow Island is an A class reserve situated 85.5 km north of Onslow, Western Australia. It is 29 km long and 8-13 km wide and rises to an altitude of 65 m.

The first collections were made in 1840 by J. Lort Stokes in HMS *Beagle*. Since then the island has been visited by many naturalists: J. T. Tunney (1900), F. Lawson Whitlock (1917-18), F. Hill (1955), a joint Western Australian Museum-CSIRO expedition (1958), W. H. Butler (1964 and 1965), A. A. Burbidge and A. R. Main (1969). All these workers were primarily interested in birds or mammals. W. H. Butler made the first extensive collection of reptiles in 1964 when he collected 28 species (*Western Australian Naturalist*, 11: 156-158), but even then reptile collecting was secondary to mammal collecting.

I was on Barrow Island from 17 August-13 September 1973 when I collected a sample of as many species of reptiles as possible.

For localities in the text, readers are referred to the map of Barrow Island in the *Western Australian Naturalist*, 11: 150.

METHODS

Where possible the following data were recorded for each specimen: date and time of capture, details of habitat and behaviour (its activity when first sighted and its reactions when flushed). Each specimen was given a field number.

Because of the cool conditions during my stay (mean daily maximum, 25.3°C) most of the 38 species were inactive. However, a combination of judicious burning of *Triodia* and *Spinifex* clumps, examination of rubbish sites and "stalking" in a fixed area over a period of time produced a reasonable sample of most species.

In addition pit traps were dug: a line of 6 just north of Town Point and a line of 12 at Flacourt Bay. Both lines ran from siliceous fore-dunes and traversed dunes, where possible alternating dune crest with interdune.

Each specimen was identified, measured in millimetres (snout vent length) and weighed (weight of preserved specimen) and had the stomach removed and the contents, where possible identified. Testes were measured and ovaries were examined for indications of breeding.

I have augmented my collection with specimens previously collected on the island.

LIST OF SPECIES

Where possible the following is recorded for each species: number of specimens examined (in brackets after the species names), snout vent length (mean in brackets after the range) and breeding data. Temperatures at which some species were active and some details of habitat are also given (see under discussion for more details of habitat preferences). The numbers preceeding species names refer to the numbers in Table 3.

TURTLES

Family CHELONIIDAE

Chelonia depressa Garman. Flatback Turtle (1).

The remains of one turtle were found at Dove Point.

Chelonia mydas (Linn.). Green Turtle

A survey of the island's coastline on 31 August and 1 September showed that there were approximately 350 Green Turtles, either on the beaches or wallowing in the shallows within sight of the beach. All but about 50, which were in Bandicoot Bay, were along the west coast.

Eretmochelys imbricata (Linn). Hawksbill Turtle.

Not seen by me. Commonly seen in shallow pools at low tide or swimming in the shallows (Butler, 1970).

LIZARDS

Family GEKKONIDAE

1 *Diplodactylus stenodactylus* Boulenger. Crowned Gecko (2).

SVL 33 and 40. Both under debris.

2 *Diplodactylus taeniatus* (Lonnberg & Andersson) (9).

SVL 32-40 (37). Breeding: 2 eggs. All specimens out of *Triodia angusta* on siliceous sands and loams.

3 *Gehyra punctata* (Fry). Spotted Dtella (6).

SVL 31-40 (35). Breeding: 1 egg. Previous collectors found this species in termite mounds. Those I collected came from conglomerations of man-made rubble such as cement.

4 *Gehyra variegata* (Dumeril & Bibron). Tree Dtella (10).

SVL 37-43 (37.8). Breeding: 1 egg. Under debris such as timber, iron and old tyres.

5 *Heteronotia binoei* (Gray). Bynoe's Gecko (27).

SVL 28-47 (37.7). Breeding: 2 eggs. In *T. angusta*. Particularly common under man-made debris.

Family PYGOPODIDAE

Kluge (1974) has shown that Butler's series of *Delma fraseri* (Butler, 1970) comprised three species.

6 *Delma borea* Kluge (1).

SVL 71. Out of *Triodia* just inland from Shark Point.

7 *Delma nasuta* Kluge (53).

SVL 53-100 (81.7). Females larger than males (mean 90.9 *vs* 79.5). Breeding: females 85-100 (2 eggs), non breeding females 73-86. In *T. angusta* on red sands and loams.

8 *Delma tincta* De Vis (3).

SVL 64-73 (67). Breeding: 1 egg. All three specimens came from rocky areas with sparse topsoil and *Triodia wiseana*.

Lialis burtonis Gray. Burton's Snake-lizard (17).

SVL 96-280 (186.6). In *T. angusta*.

Pygopus nigriceps (Fischer) (1).

The posterior half of one specimen was collected. It had 13 preanal pores.

Family AGAMIDAE

Amphibolurus caudicinctus caudicinctus (Gunther). Ring-tailed Dragon (26).

SVL 29-60 (45), all subadult. Seen all over island but most commonly in rocky areas. I watched a Nankeen Kestrel *(Falco cenchroides)* preying on them.

9 *Amphibolurus minor* Sternfeld. Western Jew Lizard (1).

SVL 100. Breeding: 6 eggs; collected 4 September; five others seen over the next three days. Mean maximum temperature for 22 days up to 4 September was 24.7°C mean maximum for three days after 4 September was 29°C. All but one, which was running, were perched 2-3 m up in dead *Hakea lorea*, or *Acacia* shrubs.

10 *Physignathus gilberti gilberti* Gray. Gilbert's Water Dragon (6).

SVL 50-102 (87.8). Breeding (one female with three follicles enlarged in one ovary, two in the other). Restricted to the few straggling mangroves of the east coast.

Family SCINCIDAE

11 *Carlia triacantha* (Mitchell) (1).

SVL 31. From a well vegetated interdune near Town Point.

12 *Cryptoblepharus carnabyi* Storr (4).

SVL 32-35 (33.7). Breeding: 2 eggs. Seems to prefer places where there are vertical faces to climb. Specimens came from mangroves, a eucalypt trunk, the wall of a building and the face of a sink hole.

13 *Ctenotus fallens* Storr (61).

SVL 26-97 (72.2). Males average 70, females 74. Breeding. This, the dominant skink on the island is found in all habitats. It is numerous on coastal dunes: in *Spinifex longifolius* on siliceous foredunes and on consolidated dunes where the vegetation tends to clump in thickets of *T. angusta*, acacias and small shrubs. Similar thickets are formed in gullies in the interior of the island. These thickets are similar to the clumps of *S. longifolius* in that they create a loose-knit lattice of vegetation. This situation suits *C. fallens* in its feeding. It is a forager, dividing its time between stalking in partly open (shaded) areas on the ground and climbing around in vegetation (up to 0.5 m above ground). Rarely seen feeding in open, unshaded areas.

14 *Ctenotus grandis* Storr (4).

SVL 34-112 (78.3). The one specimen I collected came from an area with light sand.

15 *Ctenotus pantherinus acripes* Storr (26).

Sample falls into two size groups viz. SVL 42-62 (52.2) and 72-94 (84.7) overall mean 66. Breeding: one female with 6 eggs, 7 mm in diameter. Rocky areas with *T. wiseana*.

16 *Ctenotus piankai duricola* Storr (2).

SVL 52 and 53. Both specimens from a rocky area near Shark Point.

17 *Ctenotus serventyi* Storr (1).

SVL 43. The single specimen was collected on siliceous sand at Surf Point.

18 *Lerista bipes* (Fischer) (15).

SVL 52-53 (49.2). This fossorial species was found in consolidated dunes and loamy flats.

19 *Lerista elegans* (Gray) (2).

SVL 28 and 30. These specimens, collected by Butler, came from "*Triodia* on sand".

20 *Lerista muelleri* (Fischer) (6).

SVL 25-37 (30.1). One female with one follicle enlarged. Found among consolidated dunes.

21 *Morethia lineoocellata* (Dumeril & Bibron) (1).

SVL 21. Still only known on the island from the original specimen collected by Butler.

22 *Morethia taeniopleura exquisita* Storr (9).

SVL 29-35 (32.4). In all habitats but mostly siliceous foredunes and consolidated dunes. Feeds by standing motionless in the open while curling its brilliant red tail horizontally back and forth as a lure.

23 *Notoscincus ornatus ornatus* (Broom) (9).

SVL 22-35 (28.8). Like the previous species it can be found in all habitats but is most often found on consolidated dunes and loamy flats.

Ecological differences between *Notoscincus ornatus ornatus* and *Notoscincus o. wotjulum* are notable. The nominate race occurs in a similar habitat to, and behaves like, many desert species of *Ctenotus* i.e. it sits motionless in open areas between clumps of *Triodia* waiting for prey or sunning itself. The Kimberley race *N. o. wotjulum* is smaller and has shorter legs and a strong dorsolateral stripe which gives it the superficial appearance of a *Lerista*. This race also feeds like some species of *Lerista* or *Carlia* i.e. it stalks through leaf litter beneath trees and shrubs.

This is the *Ctenotus wotjulum* of Butler (*W.A. Nat.*, 11: 157).

24 *Omolepida branchialis* (Gunther) (39).

SVL 57-108 (96.4). Breeding: up to 5 follicles enlarged. In *T. angusta* on consolidated dunes and loamy flats. 79 per cent of specimens have SVL greater than 90 mm.

25 *Proablepharus reginae* (Glauert) (15).

SVL 20-37 (29.5). Breeding: (one female with two enlarged follicles). All from *T. angusta* on sandy soil. This species is widespread on the Western Australian mainland: southern Kimberleys, Pilbara, Great Victoria Desert, but it is rare. It is one of the most common lizards on Barrow Island.

A notable absentee from Barrow Island is *Menetia greyii* which is common and widespread on the mainland. It appears from their similar size and their complementary distributions that *P. reginae* has almost been eliminated on the mainland by *M. greyii* but thrives on Barrow Island in the absence of *M. greyii*.

26 *Sphenomorphus isolepis isolepis* (Boulenger) (13).

SVL 35-60 (47). Confined to siliceous sand with *Spinifex longifolius*.

27 *Sphenomorphus richardsonii* (Gray) (3).

SVL 57-100. Confined (at least during the day) to caves and deep crevices where it burrows in soft, moist, karst soils.

Family VARANIDAE

28 *Varanus* (?) *acanthurus* (Boulenger) (3).

SVL 83-120 (103.6). All on gravelly or loamy soil; two under rubbish, the other out of *Triodia*.

Varanus giganteus (Gray). Perentie (1).

One specimen, a road casualty. However, a log of Perentie sightings was kept: 27 in all habitats. Every rock shelter, whether a cave or a simple overhang showed evidence of this species' presence.

SNAKES

Family TYPHLOPIDAE

Typhlina diversa (Waite) (1).

Butler (1970) collected one in gravel and *Triodia*.

Family BOIDAE

Liasis childreni Gray. Children's Python (13).

This species shelters in termite mounds during the day and forages in the open at night. From eight demolished mounds 6 *Liasis* were collected: 3 from one mound and 1 each of three others. *Heteronotia* was the only other reptile found in the mounds.

Family ELAPIDAE (including sea snakes)

Demansia psammophis reticulata (Gray). Whip Snake (2)

Butler (1970) collected a road casualty. Another road casualty has been collected since my visit.

Furina christieana (Fry) (2).

Butler (1970) collected one at night on road. One collected since my visit.

Pseudechis australis (Gray). Mulga Snake (4).

One collected in open *Triodia* at night. All but one of the specimens collected by Butler, which was flushed from *Triodia,* were collected on roads at night.

Vermicella semifasciata approximans (Glauert) Allied Bandy Bandy (2).

Both specimens collected since my visit.

Aipysurus duboisii Bavay (1).

One beach dereliet collected on islet in Bandicoot Bay. Head only kept. Ventrals 186, subcaudals 24.

Aipysurus laevis laevis Lacepede (1).

Butler (1970) speared one in 4 m of water.

Emydocephalus annulatus Krefft (1).

SVL 500. This specimen (R47852) is the first specimen collected from the Western Australian coast. The possession of only 3 upper labials (rather than at least 6) distinguishes it from other Western Australian sea snakes.

Ventrals 148, subcaudals 29. Smith (1926) records ventrals 138-144 and subcaudals 20-30.

Ground colour yellowish, with 21 bluish black bands on the body. These bands tend to be confluent on the back, constricted (sometimes broken) on the flanks. Scales in interspaces between bands with decreasing areas of bluish black from mid black (all bluish black) to lower flanks (all yellowish).

The specimen, a beach derelict, was collected by N. T. Allen in January, 1975.

DISCUSSION

The following discussion is restricted to the terrestrial fauna.

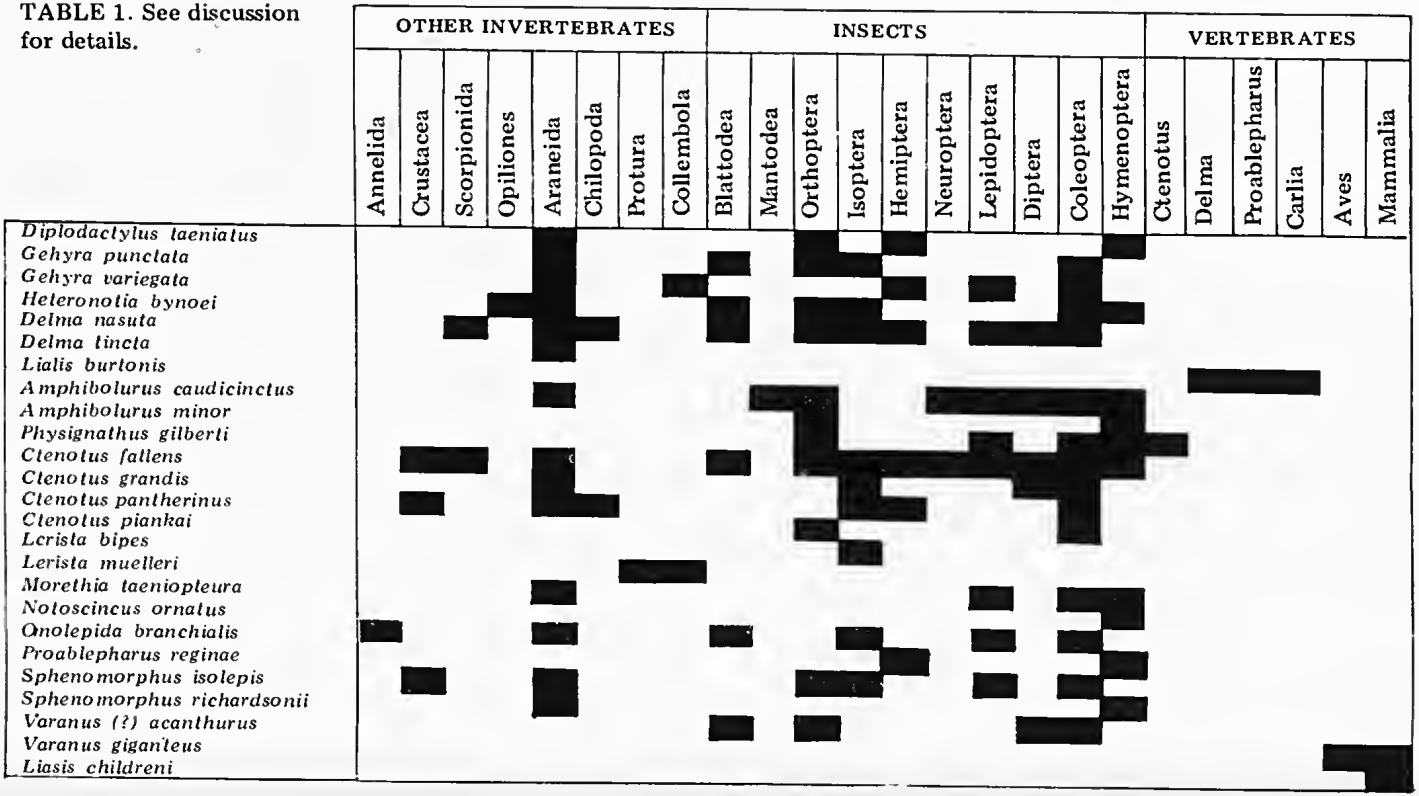
Barrow Island consists mainly of undulating limestone caprock intersected with deep cracks which contain alluvial loams. With the exception of 17-18 kilometres of cliffs on the north-west side, the island is bounded by acolian dunes. These white dunes are backed by several lines of reddish consolidated dunes. Further inland there are usually alluvial loam flats. These flats are largest at Flacourt Bay where, because of altitude the runoff is greatest.

The deep cracks (creekbeds) contain *Triodia angusta* through which are dispersed shrubs, principally *Hakea lorea, Petalostyles, Acacia bivenosa* and *Gossypium robinsonii.* The alluvial flats immediately behind the dunes are also vegetated with *T. angusta* and the occasional clump of wattle.

The foredune is vegetated with *Spinifex longifolius,* the consolidated dunes with *T. angusta, Acacia coriacea* and other shrubbery. In the south and north of the island the alluvial flats have formed claypans covered with grasses.

Thus, 80-90 per cent of the island is a rocky *Triodia* steppe, the remainder being a fringe of sand dunes vegetated with scrub. The overall impression, to quote Whitlock, "represents a desolate and most uninviting appearance". How then, with a limited variety of habitats do 38 species of land reptiles share the island's space and food resources? When each species is examined with regard to its distribution on the island, its diet, body size and time of activity (diurnal or nocturnal) there seem to be surprisingly few species in conflict.

TABLE 1. See discussion for details.



Distribution of species on Island

According to habitat preferences, the reptiles can be divided into 3 groups: (a) species confined to rocky areas; (b) species found in rocky and sandy areas. Sandy areas include white sands (foredunes), red dunes and loams; (c) species confined to sandy areas. (See annotated list for habitat preferences within the sandy areas).

The following species are only known from the island from one specimen: *Pygopus nigriceps, Ctenotus serventyi, Morethia lineoocellata* and *Typhlina diversa.* It is assumed that these species have the same habitat preferences as on the mainland *viz.* sandy areas.

Although rocky areas with *Triodia wiseana* constitute about 80 per cent of the area, only 4 (or more probably 5) species are confined to it. They are: *Gehyra punctata, Delma tincta, Ctenotus pantherinus acripes, Sphenomorphus richardsonii* and probably *Ctenotus piankai duricola.*

Species occurring in both rocky and sandy areas include: *Gehyra variegata, Heteronotia binoei, Amphibolurus c. caudicinctus, Cryptoblepharus carnabyi, Ctenotus fallens, Morethia taeniopleura exquisita, Notoscincus o. ornatus* and *Varanus gigauteus.* All but *Cryptoblepharus* appear more common in sandy areas.

The remaining 24 species are restricted to sandy areas, which constitute only about 20 per cent of the island.

Diet

Table 1 shows the qualitative results of the examination of stomach contents.

By adding the number of species which eat the animals in the various invertebrate groups mentioned in Fig. 1 an indication of overall food

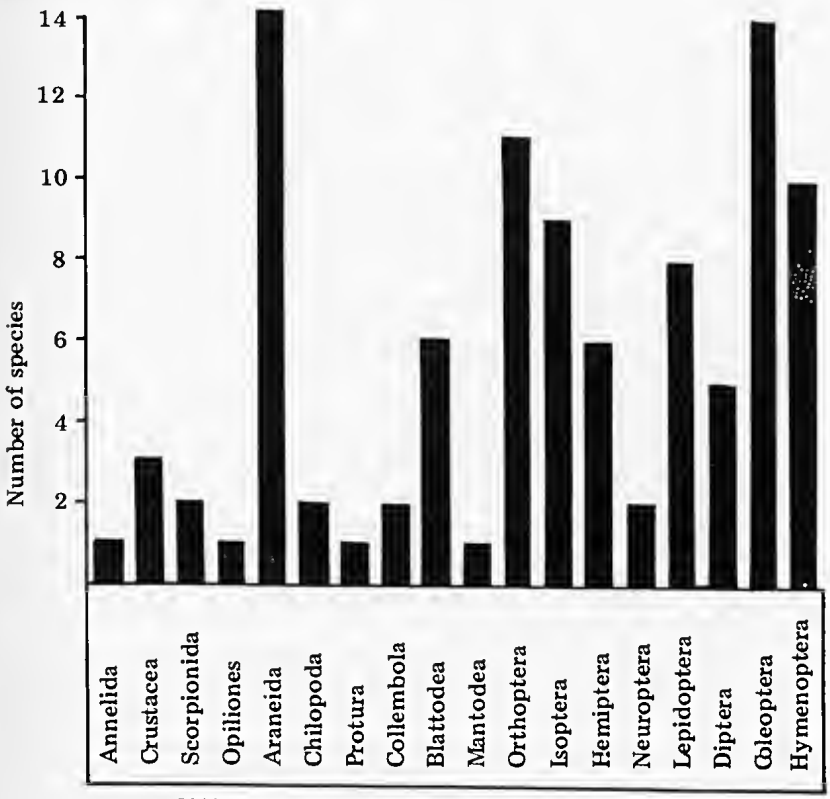


TABLE 2. See discussion for details, p.132.

preferences for the invertebrate-eating lizards can be obtained. This is summarised in Table 2.

Where there is a reasonable sample of animals with identifiable stomach contents, an indication of food preferences can be obtained by scoring the number of times any one of the food groups occurs in each stomach for any one species. From this come the following notable points:

(a) the 100 per cent reptilian diet of *Lialis* (66 per cent *Delma);* (b) every *Proablepharus* stomach with identifiable remains contained hemipterans (leaf hoppers). Only one stomach contained the remains of another

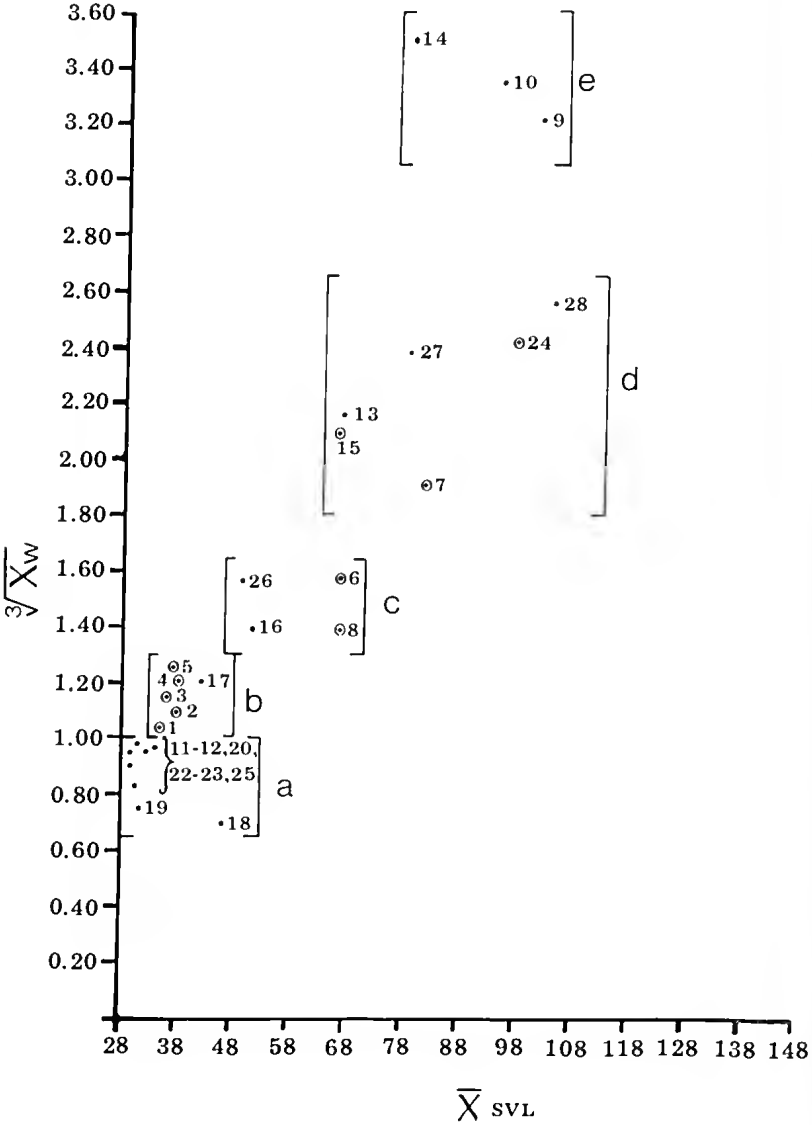


TABLE 3. See under discussion for details, p.133

insect (ants); (c) the 100 per cent ant diet of *Notoscincus o. ornatus;* (d) 92 per cent of the *Amphibolurus caudicinctus* stomachs contained ants.

The diets of *Delma borea, D. nasuta, D. tincta, Ctenotus pantherinus* and *Omolepida branchialis* suggest that they could be nocturnal.

Body Size and Time

In Table 3 cube root of mean wet weight is plotted against mean snout-vent length for adults of each species of lizard with the exception of *Pygopus nigriceps* (incomplete specimen), *Amphibolurus caudicinctus* and *M. lineoocellata* (no adults), and *Lialis burtonis* and *Varanus giganteus* (weight too great for graph). Nocturnal species are circled.

The lizards in Table 3 fall into 5 main clusters comprising:

(a) *Carlia triacantha, Cryptoblepharus carnabyi, Lerista* spp., *Morethia taeniopleura exquisita, Notoscincus o. ornatus* and *Proablepharus. Morethia lineoocellata* is comparable in size to *Carlia triacantha* and also falls in this group; (b) the geckos and *Ctenotus serventyi;* (c) *Delma borea, D. tincta, Ctenotus piankai* and *Sphenomorphus isolepis;* (d) *Delma nasuta, Ctenotus fallens, Ctenotus pantherinus, Omolepida branchialis, Sphenomorphus richardsonii* and *Varanus* (?) *acanthurus;* (e) *Amphibolurus minor, Physignathus gilberti* and *Ctenotus grandis.*

Summary

Of the species in group (a) above *Lerista elegans* and *Morethia lineoocellata* are litter inhabitants. *Cryptoblepharus carnabyi* restricts itself to areas where there are vertical faces to climb. *Lerista bipes* and *L. muelleri* are fossorial (although *L. muelleri* is probably as much a litter inhabitant as a "sand swimmer"). *Morethia taeniopleura* and *Notoscincus ornatus* have different methods of feeding and different diets. *Proablepharus* lives in *T. angusta* and appears to have a unique diet. The *Carlia* I collected came from an interdune; it could be another litter inhabitant or be found in *T. angusta.*

Of the species in group (b) above, only *Gehyra punctata* is confined to rocky areas. *G. variegata* was probably confined to an arboreal habitat before human occupation. Although still found in this habitat it now also shares rubbish sites with *Heteronotia binoei* and *Diplodactylus stenodactylus. H. binoei* and *Diplodactylus taeniatus* are found in *T. angusta. Ctenotus serventyi* is the only diurnal species in this group.

Of those species in group (c) above, *Sphenomorphus isolepis* is confined to foredunes. *Ctenotus piankai* and *Delma tincta* inhabit rocky areas. *C. piankai* is diurnal and *D. tincta* nocturnal. The one *Delma borea* I collected came from a loamy flat.

Of the species in group (d) above, all but *Ctenotus fallens* and *Varanus* (?) *acanthurus* are nocturnal. *Ctenotus pantherinus* and *Sphenomorphus richardsonii* are found in rocky areas; furthermore *S. richardsonii* is fossorial. *Delma nasuta* and *Omolepida branchialis* are common in *Triodia angusta* on loam flats. *Varanus* (?) *acanthurus* is found on loam and gravel, *C. fallens* in all habitats.

The species in group (c) above are diurnal. *Amphibolurus minor* is restricted to gullies and consolidated dunes where there are substantial shrubs *Physignathus gilberti* is restricted to mangroves. My single *Ctenotus grandis* came from a sandy area.

Of the species not included in Table 3, three occur in *Triodia.* They are *Furina christieana, Pseudechis australis* and *Demansia psammophis. D. psammophis* is diurnal, the others nocturnal.

Vermicella semifasciata and *Typhlina diversa* are fossorial. *Lialis burtonis* is exclusively a reptile eater, and *Varanus giganteus* eats mammals and birds.

Thus the following species from the foregoing groups seem to be competing for space and food resources. In group (a): *Lerista elegans, Morethia lineoocellata* and possibly *Carlia triacantha* and *Proablepharus.* In group (b): *Diplodactylus stenodactylus, D. taeniatus* and *Heteronotia binoei.* In group (c): *Delma borea* and *D. tincta.* From group (d): *Omolepida branchialis* and *Delma nasuta* and *Ctenotus fallens and Varanus* (?) *acanthurus.*

It is interesting to note that 7 of these 13 species are rare on the island.

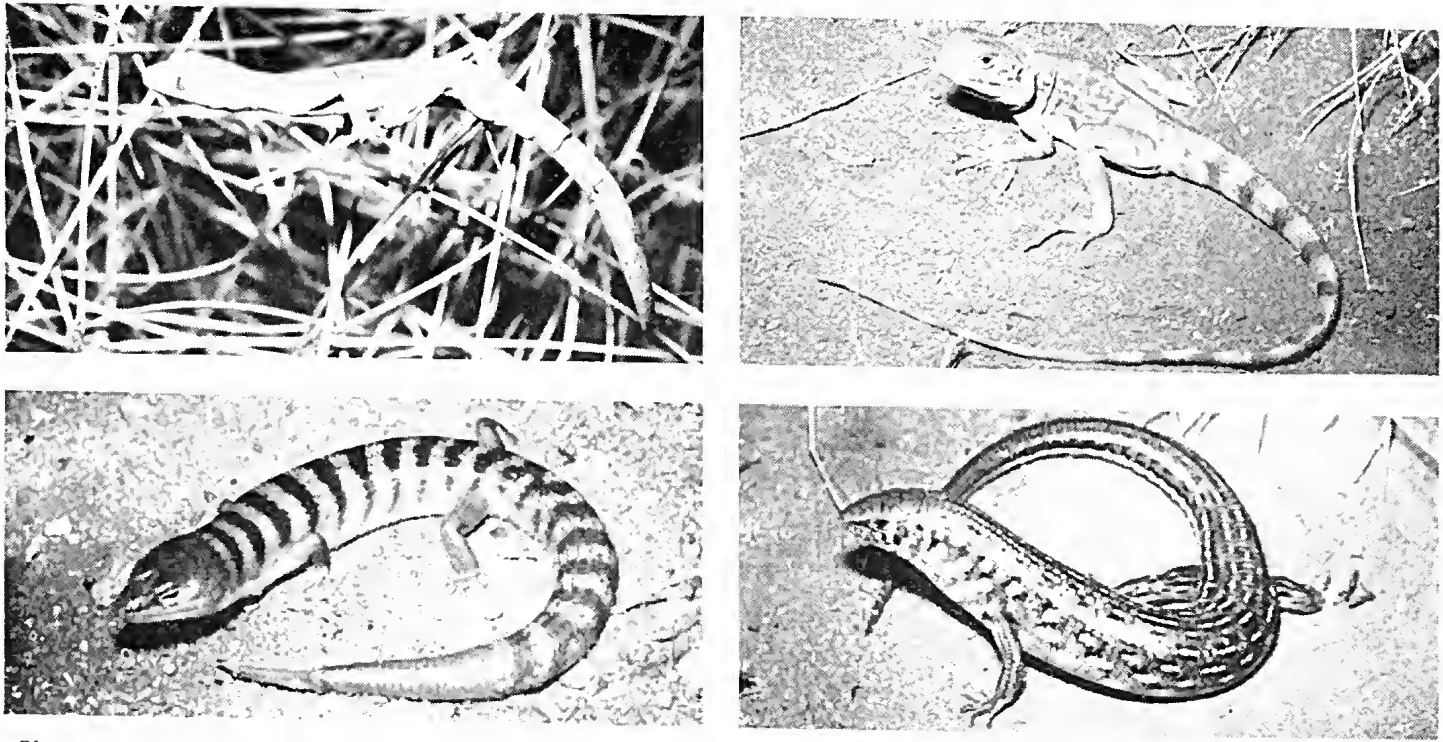


Plate 1.—Upper left, *Diplodactylus taeniatus;* upper right, *Amphibolurus caudicinctus caudicinctus;* lower left, *Sphenomorphus richardsonii;* lower right, *Ctenotus pantherinus acripes.*

—Photographs R. E. Johnstone

FAUNAL RELATIONSHIPS OF BARROW ISLAND TO MAINLAND

Barrow Island's rich reptile fauna can be attributed to its geographic position. Bassian species which extend northward from south-western Australia tend to have coastal or insular distributions. Similarly, Torresian species which extend southward from the Kimberleys tend to have coastal or insular distributions. Thus, the Eyrean component (approximately 66 per cent of the fauna) is supplemented by *Lerista elegans* and *Morethia lineoocellata* (southern species) and *Physiguathus gilberti, Delma borea, Ctenotus serventyi, Sphenomorphus isolepis, Varanus* (?) *acanthurus* and *Furina* (northern species). *Lialis, Liasis, Omolepida brauchialis, Cryptoblepharus carnabyi* and *Pseudechis australis* are members of all three zoogeographic faunas.

At least two species of mammal on the island are represented by endemic races. Two examples are *Macropus robustus isabellinus* and *Isoodon auratus barrowensis.* Both are smaller than their mainland counterparts.

Similarly *Pseudechis australis* exhibits dwarfism. Mean SVL of Barrow Island specimens is 633; mean SVL of specimens on the opposite mainland is 1208. It is possible that the small varanid that I have called *Varanus* (?) *acanthurus* is another example of dwarfism.

Four other species have diverged noticeably from mainland populations. They are *Ctenotus grandis, C. pantherinus acripes, Proablepharus reginae* and *Sphenomorphus isolepis.*

Barrow Island *Ctenotus grandis* have fewer midbody scale rows than specimens from the North-west Division of the mainland (mean 33.3 *vs* 36.2). Those specimens listed by Butler (1970) as *Ctenotus* sp. (affin. *grandis)* are in fact *C. grandis.*

Ctenotus pantherinus acripes is endemic to Barrow Island. It has more midbody scale rows than *C. p. pantherinus* (mean 38 *vs* 35.7). The spiny soles of the feet help distinguish this race.

Barrow Island *Proablepharus reginae* differ from mainland specimens in being smaller (mean SVL 30.3 *vs* 33.2) and darker and in having more subdigital lamellae (mean 23.6 *vs 22.8).* In most Barrow Island specimens the upper periocular granules are not hidden by the brow, whereas in most mainland specimens they are hidden.

The colour pattern of Barrow Island *Sphenomorphus isolepis* differs from that of North-west Division mainland specimens. This is described by Storr (1967: 16).

The frequency of 8 labials in *Omolepida brauchialis* is much higher in the North-west Division than elsewhere. 30 per cent of Barrow Island specimens have 8 labials compared to 53 per cent on the mainland of the North-west Division. The number of midbody scale rows is high (mean 26.1) in the Pilbara compared to those on Barrow Island and the south of the North-west Division.

The maximum depth of water between Barrow Island and the mainland is approximately 15 m. These data used in conjunction with Fig. 5 of Morner (1971) show that Barrow Island has been separated from the mainland for 7-8,000 years.

ACKNOWLEDGEMENTS

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BIRD NOTES FROM A WINTER VISIT TO ECLIPSE ISLAND, WESTERN AUSTRALIA

By P. J. FULLAGAR and G. F. van TETS, CSIRO, Division of Wildlife Research, Canberra

The following notes result from a short visit to Eclipse Island, Western Australia, in the winter of 1973. We arrived by boat from Emu Wharf, Albany on 2 August, and made our return on 9 August. We have included some sea-bird observations from these passages.

A general description of the birds of Eclipse Island was given by Warham (1955a). Also, there are more detailed accounts based on observations made at this island with respect to the Great-winged Petrel, *Pterodroma macroptera* (Warham, 1956, 1957), Fleshy-footed Shearwater, *Puffinus carneipes* (Warham, 1958), and the Little Shearwater, *Puffinus assimilis* (Glauert, 1946; Warham, 1955b).

In size the island is about 160 hectares and rises to its highest point at 108 metres where the lighthouse is situated (Fig. 1). The island is granitic with much of it covered in thick scrub, predominantly *Melaleuca lanceolata* (see for example Fig. 4, p. 11, Serventy *et al.*, 1971). In places other shrubs such as *Leucopogon revolutus, Verticordia plumosa, Andersonia sprengelioides, Hibbertia cuneiformis, Boronia alata, Calocephalus brownii* and *Chorilaena quercifolia*, form a compact low cover, in particular along the western ridge. Some *Casuarina* sp. occurs in places on the steeper northern slopes. Extensive areas of the N.W. of the island were burned by a severe wildfire in 1968. Much of the south-east side of the island is rocky and covered only by very short, cushion-like vegetation, predominantly *Verticordia plumosa*. Cliff Head and the isles off the western end are bare rock. A predominant introduced plant is a South African Arum lily, *Zantedeschia aethiopica*, which was in flower at the time of our visit. Open ground was otherwise closely covered by Pigface, *Carpobrotus aequilaterus*.

Lighthouse structures include an abandoned jetty and "Flying Fox". A bulldozed track leads from the new landing facilities to the light-station cottages close to the light-tower at the top of the island. Here there are several additional sheds and stores, some water storage tanks, radio transmission towers and wires, and a power generation plant. Some cleared areas and several additional tracks have been introduced since the island was first occupied in 1925.

Vertebrates on the island, other than a few domestic pets including the Domestic Pigeon, *Columba livia*, are the Rabbit, *Oryctolagus cuniculus*, and a small breeding colony of the Australian Sea-lion, *Neophoca cinerea*. The Rabbit is not numerous and appears to be in little conflict with the breeding avifauna. The history of its introduction is apparently undocu-

mented. Lizards are numerous and four species were noted, Marbled Gecko, *Phyllodactylus marmoratus;* King's Skink, *Egernia kingii;* Salmon-bellied Skink, *Egernia nitida,* and Yellow-bellied Skink, *Hemiergis peronii.*

To assess the breeding status of the Great-winged Petrel and the Little Shearwater, eight study plots, of 20 x 20 metres each, were searched thoroughly (Fig. 1).

The following annotated list summarises our observations.

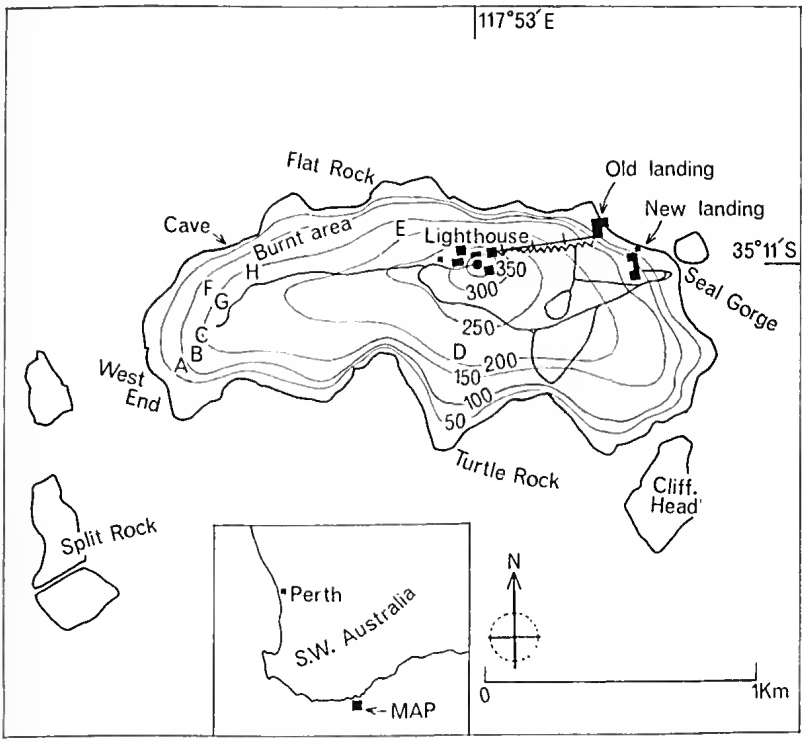

Fig. 1.—Map of Eclipse Island, Western Australia showing general features and contours at 50 foot intervals. Note, in particular, the location of tracks leading from the landing place to lighthouse; the track towards the west-end, the "flying-fox" between the quarters and the old landing site and eight plots (A to H) that were surveyed in detail for nesting petrels.

THE BREEDING BIRDS ON ECLIPSE ISLAND

Warham (1955a) lists 12 species that possibly breed on the island. We saw 11 of them and strongly suspect that the remaining bird, the Spotless Crake, *Porzana tabuensis* is no more than a vagrant (see later). We could add no additional species except possibly the Brown Goshawk, *Accipiter fasciatus,* and the Laughing Kookaburra, *Dacelo gigas.*

Little Penguin, *Eudyptula minor*

A few heard at dusk on the sea and at night under shrubs and trees. A couple of skeletons were collected, but this penguin did not appear to be common on the island.

Great-winged Petrel, *Pterodroma macroptera*

One was seen in the entrance to King George Sound 2 August. One was seen between Eclipse Island and the mainland and one was seen in the entrance to King George Sound 9 August.

This petrel nests over much of the island (Fig. 2). Nest sites were mostly well scattered, either in shallow burrows or more frequently using only the cover provided by the small isolated clumps of scrub. Such wind-shorn clumps would often shelter several chicks or incubating adults on surface nests to which access was gained from the perimeter of the bush. The highest density we noted was near the western end of the island. Here on one plot we counted 23 occupied sites in 400 square metres. Very few petrels were nesting in the severely burnt areas and in the short dense regrowth of *Melaleuca* either side of the road on the lower levels east of the lighthouse. Some concentration of sites was noted on the talus slopes around the lighthouse hill, particularly on the southern side. Some petrels were found at sites very close to the living quarters and even against the walls of the very noisy electric power generation plant building! In all, 60 nest sites were located and examined in detail. Of this number 37 were surface nests, 18 were inside 30-45 cm burrows; leaving only five sites where the burrows were between 60 cm and 90 cm in length. Again, 40 of these sites were below bushes (most often *Melaleuca)* 60 cm to 240 cm tall and 20 had only short cover, usually Pigface.

Most of the eggs hatched before our arrival, since we recorded 43 unattended chicks against seven adults still sitting on eggs. However, unattended eggs were found almost as often as those with the adult sitting. Warham (1956, 1957) suggests that hatching occurs from early to mid-July, which would be consistent with our observations. Several eggs hatched during our stay. The body weights of chicks varied from 50 g to 375 g, with an average from 45 chicks of about 175 g. Four eggs on the point of hatching weighed about 43 g, 65 g, 71 g, and 88 g. A three day old chick weighed 75 g. At this stage its bill was shiny jet black, the legs were pale-grey to creamy and the webs creamy. The down was grey-black. A persistent egg-tooth was noted on most chicks at body weights below 120 g (eight with against three without). However, body weight is not a very reliable indication of age even in small chicks of petrels, since enormous increases can follow meals. Also according to Warham (1967), the small chicks of the similar White-headed Petrel, *Pterodroma lessoni,* tend to lose

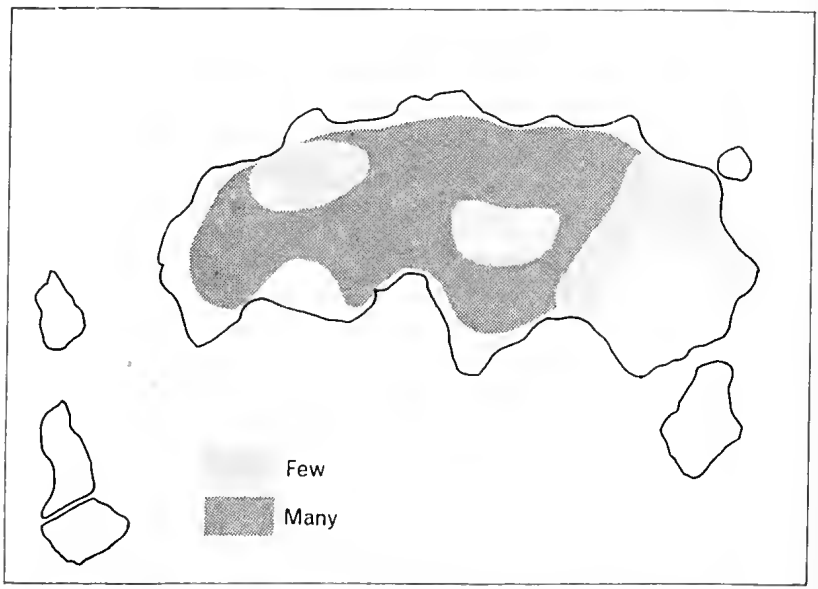

Fig. 2.—Distribution of nesting Great-winged Petrels, *Pterodroma macroptera* on Eclipse Island, Western Australia.

15 to 20 g per day when not fed. We recorded the same rate of weight loss with four Eclipse Island Great-winged Petrel chicks reweighed after four days.

TABLE 1.—SOME MEASUREMENTS FROM 10 BREEDING GREAT-WINGED PETRELS, *PTERODROMA MACROPTERA*, ON ECLIPSE ISLAND, WESTERN AUSTRALIA. THE MEASUREMENTS FROM 20 EGGS ARE ALSO GIVEN.

		Range	Mean	± S.D.
Culmen	to 0.1 mm	32.7 - 36.8	34.9	1.3
Tarsus	to 0.1 mm	43.3 - 45.6	44.2	0.7
Wing	to 1.0 mm	304 - 314	309	5
Tail	to 1.0 mm	110 - 128	125	5
Weight	to 10 g	440 - 500	478	21
Egg width	to 0.1 mm	40.2 - 50.0	47.6	2.1
Egg length	to 0.1 mm	60.1 - 68.8	65.1	2.4

The length of the exposed culmen of the newly hatched chick is nearly 20 mm, and the tarsus is also about 20 mm long. Some egg dimensions and measurements from 10 adults have been summarised in Table 1. These dimensions for adults do not differ from a small sample of measurements given by Murphy and Pennoyer (1952), for the race *P. m. macroptera*. Also, they are in general agreement with those given by Swales (1965) for eight birds measured on Gough Island, South Atlantic. In some individuals, slight body moult was noted. Filoplumes, as described by Imber (1971), could not be found readily on any of these adult individuals at this stage in the breeding season. Two chicks regurgitated squid eyes, and from a third individual the early stage larva of the Mantis shrimp, *Squilla* sp., was recovered.

Little night-time activity was noted during our stay. Presumably the petrels were quietly flying in to feed chicks, as noted by Warham during the month of September (Warham, 1956). Some aerial courtship chasing accompanied by calling was observed, but this was confined to fewer than 20 birds a night. It occurred over the lee-side of the island in the prevailingly high winds during our stay. These flight calls described by

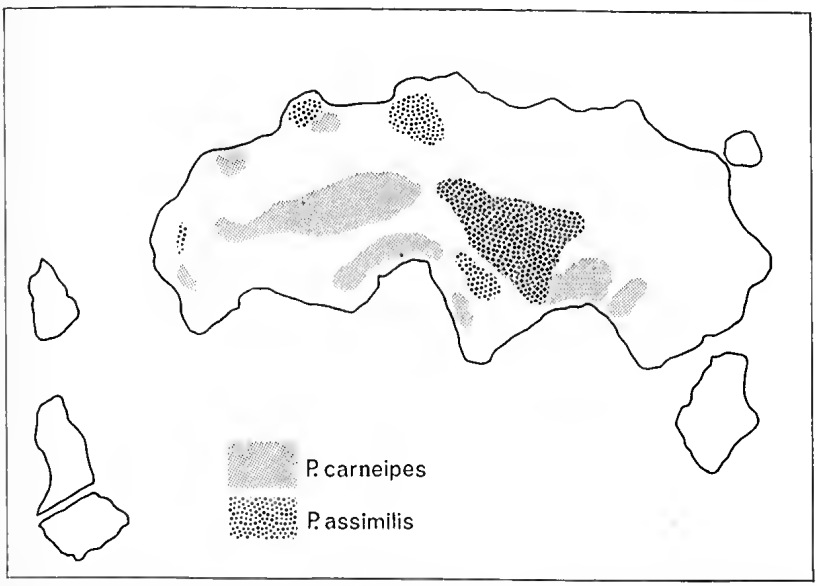

Fig. 3.—Distribution of major nesting colonies of the Fleshy-footed Shearwater, *Puffinus carneipes*, and the Little Shearwater, *Puffinus assimilis*, on Eclipse Island, Western Australia.

Warham (1956) were tape recorded, and representative samples have been deposited in the CSIRO library of bird calls.

The breeding population of Eclipse Island would probably be in the order of 10,000-15,000 pairs.

Fleshy-footed Shearwater, *Puffinus carneipes.*

One was seen and photographed over a school of tuna outside King George Sound 9 August. Nests and skeletons were found at several localities on Eclipse Island where it breeds during the summer.

No birds were seen on Eclipse Island, but an attempt was made to determine the nesting distribution of this Shearwater, and the locations of what we believe to be the colonies have been shown in Fig. 3.

Little Shearwater, *Puffinus assimilis*

One was seen outside the entrance to King George Sound 9 August. On Eclipse Island several recently killed adults were found with the flesh of the neck region eaten away, presumably by a Brown Goshawk.

The distribution of colonies of this Shearwater has been indicated in Fig. 3. Scattered and essentially isolated burrow sites are probably uncommon. The tendency seems to be for groups of Little Shearwater to be associated together or for extensive dense colonies to be formed in particular locations. Notable sites are those to the north-west of the island. Suitability of terrain for burrowing is clearly an important factor. Most burrows were in gritty soils or amongst loose rocks between and behind which these shearwaters can excavate. There is nearly always an open vegetation cover, though dense, tall *Melaleuca* may form a high canopy. Half of 16 occupied burrows which we examined were under 60 cm in length, but 150 cm was the longest found. We believe that fewer than 2,000 pairs of this shearwater breed on the island.

All Little Shearwaters were on eggs, which were well through incubation at the time (see Glauert, 1946). Some egg dimensions and measurements of adults have been summarised in Table 2. For comparison, the dimensions of Lord Howe Island birds have been given (unpublished data, Fullagar and van Tets).

The Eclipse population does not differ significantly in any of these measurements from Lord Howe Island birds. This suggests that distinction of the race *P. a tunneyi* from *P. a. assimilis,* as outlined by Fleming and Serventy (1943), is not supported by our more extensive data from breeding birds.

TABLE 2.—SOME MEASUREMENTS FROM 15 BREEDING LITTLE SHEARWATERS, *PUFFINUS ASSIMILIS* ON ECLIPSE ISLAND, WESTERN AUSTRALIA. MEASUREMENTS OF 17 EGGS ARE ALSO GIVEN. FOR COMPARISON DATA FROM 60 LITTLE SHEARWATERS MEASURED ON ROACH ISLAND, LORD HOWE ISLAND, IN MARCH 1971. (FULLAGAR AND VAN TETS, UNPUBLISHED) HAVE BEEN SUMMARISED.

		ECLIPSE ISLAND			LORD HOWE ISLAND		
		Range	Mean	±S.D.	Range	Mean	±S.D.
Culmen	to 0.1 mm	23.0 - 26.2	24.9	0.9	22.2 - 26.2	24.0	0.9
Tarsus	to 0.1 mm	37.4 - 39.8	38.3	0.9	33.5 - 39.1	37.1	1.1
Wing	to 1.0 mm	173 - 185	179	3	169 - 188	179	4
Tail	to 1.0 mm	61 - 73	68	3	65 - 74	70	2
Weight	to 5 g	165 - 220	195	15	140 - 200	172	14
Egg width	to 0.1 mm*	34.7 - 37.8	36.0	0.9			
Egg length	to 0.1 mm*	46.8 - 54.4	51.9	1.8			

* Glauert (1946) gives measurements of a further 11 eggs from Eclipse Island.

Brown Goshawk, *Accipiter fasciatus*

One was seen on Eclipse Island on 2, 4, 7 and 8 August. It was suspected as a predator of the Little Shearwater.

Nankeen Kestrel, *Falco cenchroides*

One seen on Eclipse Island 2 August.

Sooty Oystercatcher, *Haematopus fuliginosus*

At Eclipse Island at least two were seen 3 August, at least three were seen 4 and 7 August and at least two were seen 8 August. They were seen preying on limpets on the intertidal rocks.

Silver Gull, *Larus novaehollandiae*
At dawn about 200 were seen flying south out to sea at the entrance to King George Sound. One followed the boat out to Eclipse Island.
At Eclipse Island twelve were seen 2 August, at least five were seen 3 and 7 August, and at least six were seen 8 August. It was noted that legs and bills were more *purplish* red in colour than in eastern Australia.
At least 11 circled around the boat while it was fishing for tuna outside King George Sound 9 August.

Rock Parrot, *Neophema petrophila*
One was seen on Eclipse Island 2 August.

Laughing Kookaburra, *Dacelo gigas*
One seen on 8 August. This species is presumably resident on Eclipse Island and possibly preys on the skinks.

Welcome Swallow, *Hirundo neoxena*
At Eclipse Island one was seen 2 August, at least six were seen 3 August. A nest was found in the roof of an open cave at the western end of the island. The contents could not be seen but three swallows were circling back and forth nearby.

Pipit, *Anthus novaeseelandiae*
On Eclipse Island one seen 3 and 4 August.

Western Silvereye, *Zosterops gouldi*
It was very numerous on Eclipse Island.

OTHER SPECIES RECORDED FROM ECLIPSE ISLAND AND THE SURROUNDING SEAS

We saw 15 additional species either on or near the island, though some of them were observed only during the boat crossings. Of most interest was our record of several Sooty Shearwater, *Puffinus griseus*, between King George Sound and Eclipse; the sighting of a Red-tailed Tropic-bird, *Phaethon rubricauda*, over the island, and what appeared to be a sighting of two immature and an adult White-fronted Tern, *Sterna striata*, off the island. We have also had reported to us further descriptions of 'rails' seen on the island in recent years and conclude that they are the Black-tailed Native-Hen, *Tribonyx ventralis*. Eight species recorded by Warham (1955a), were not seen by us.

Wandering Albatross, *Diomedea exulans*
One very white adult was seen off Eclipse Island 3 August. One adult and one immature were seen between Eclipse Island and the mainland 9 August. This was the least common of the albatrosses seen.

Black-browed Albatross, *Diomedea melanophris*
One was seen outside King George Sound 2 August, and two near Eclipse Island 3 August. An adult and an immature were near Eclipse Island at 15.45 hours and four at 16.30 hours on 4 August. Two were seen near the island 8 August. At least two adults and two immatures were seen between Eclipse Island and King George Sound 9 August.

Yellow-nosed Albatross, *Diomedea chlororhynchos*
At least 10 were seen between King George Sound and Eclipse Island 2 August and at least 10 near Eclipse Island 3 August. Three were seen near the Island 4, 7 and 8 August. About 100 were seen over a school of tuna outside the entrance to King George Sound 9 August.

White-capped Albatross, *Diomedea cauta*
One sub-adult and one adult were seen near Eclipse Island 3 August. Two, including an immature, were seen 7 August and one immature was seen near the island 8 August. At least one was seen over a school of tuna outside King George Sound 9 August.

Southern Giant Petrel, *Macronectes giganteus*
A white form was seen inside the entrance to King George Sound 6.30 hours 2 August.

Giant Petrel, *Macronectes* sp.

At least two were seen outside the entrance to King George Sound 2 August. One was seen near Eclipse Island 3 August. At least two were seen over a school of tuna outside the entrance to King George Sound 9 August.

Cape Petrel, *Daption capense*

At least five were seen between King George Sound and Eclipse Island 2 August. One was seen near Eclipse Island 7 August. At least four were seen between Eclipse Island and King George Sound 9 August.

Sooty Shearwater, *Puffinus griseus*

At least ten were seen between King George Sound and Eclipse Island 2 August. At least 12 were seen over a school of tuna outside the entrance to King George Sound 9 August. Some of them landed within four metres of the boat and were photographed. Several of them were showing very worn plumage, particularly among flight feathers. They were immediately recognised by their pale underwing patterns and long bills. The Sooty Shearwater has not been recorded previously in Western Australia. See Fig. 4.

Fig. 4.—Sooty Shearwater, *Puffinus griseus*, one of 12 seen approximately 10 km off Bald Head, King George Sound, Western Australia, 9 August 1973. Note the long bill. Photo, P. J. Fullagar.

The very similar Short-tailed Shearwater, *Puffinus tenuirostris*, has been recorded rarely in Western Australia (see Serventy, 1947, 1948; and Reilly *et al.*, 1975).

White-faced Storm Petrel, *Pelagodroma marina*

Not seen. (Cf. Warham, 1955a, p. 166).

Australian Gannet, *Morus serrator*

At least one immature and one sub-adult seen between King George Sound and Eclipse Island 2 August. One immature was seen near Eclipse Island 3 August. One adult and one immature were seen near Eclipse Island 8 August.

Red-tailed Tropic-bird, *Phaethon rubricauda*

One adult with a pinkish sheen to its body plumage was seen hovering and circling over the west end of Eclipse Island 3 August. It did not

eall. It made several dives and passes at a Sooty Oystereateher flying near the shore over the sea.

White-faced Heron, *Ardea novaehollandiae*
Not seen (ef. Warham, 1955a, p. 167).

Osprey, *Pandion haliaetus*
Not seen (ef. Warham, 1955a, p. 168).

White-breasted Sea Eagle. *Haliaeetus leucogaster*
An adult was seen at Eelipse Island 2 and 8 August.

Swamp Harrier, *Circus approximans*
Not seen (ef. Warham, 1955a, p. 168).

Brown Falcon, *Falco berigora*
Not seen (ef. Warham, 1955a, p. 168).

Spotless Crake, *Porzana tabuensis*
Not seen (ef Warham, 1955a, p. 166). The only one recorded from Eelipse Island was received by the Western Australian Museum 30 Deeember 1938 from Mr A. E. Blythe. Its eatalogue number is A4954, a female.

Black-tailed Native-Hen, *Tribonyx ventralis*
A few were seen about five years ago on Eelipse Island by Ian White, now headkeeper on the island. He deseribed them as resembling Bantam Chiekens with red bills and legs. Warham (1955a) deseribes similar observations by previous keepers, but presumed that they were Spotless Crakes.

Banded Plover, *Vanellus tricolor*
Not seen (ef. Warham, 1955a, p. 167).

Paeific Gull, *Larus pacificus*
At Eelipse Island one adult was seen 2 August and 9 August. Two were seen 3 August by Ian White. None were seen at sea outside King George Sound.

Southern Skua, *Catharacta lonnbergi*
One seen near Eelipse Island 3 August. At least five were seen over a school of tuna outside the entranee to King George Sound and at least three in the entranee 9 August.

White-fronted Tern, *Sterna striata*
At 15.15 hours 8 August two immatures and one adult of what we believe were this speeies were seen eireling and diving elose in to the south shore of Eelipse Island. The following features were noted: slender pale grey wings with pale tips, dark area in front on top of wing; long forked tail, white forehead with a sharp border between white and blaek on erown in the adult; blaek bill.

This bird has not been reeorded previously in Western Australia. Other terns whieh resemble it are not likely to be in southern Australia in August. White-fronted Terns are known to disperse from the New Zealand Islands to eastern Australia in winter.

Fairy Tern, *Sterna nereis*
Not seen (ef. Warham, 1955a, p. 165).

Crested Tern, *Sterna bergii*
At least ten were seen in the entranee to King George Sound 2 August. One was seen at Eelipse Island 3 August. At least two were seen over a sehool of tuna outside the entranee to King George Sound. About 400 were seen resting on roeks at the entranee.

Saered Kingfisher, *Halcyon sancta*
Not seen (ef. Warham, 1955a, p. 168).

ACKNOWLEDGEMENTS

We wish to thank the Department of Transport, Western Australia, for permission to visit Eelipse Island and Dr Graeme Smith, CSIRO, Perth, for the help given in organising and assisting us to and from the island. We owe speeial thanks to Ian and Audrey White for their hos-

pitality while we were making use of their home as a petrel field laboratory. Mr R. D. Royee, Officer-in-Charge, Botany Branch, Department of Agriculture, Western Australia, kindly made the plant identifications for us. Dr R. W. George and Dr Glen M. Storr of the Western Australian Museum, identified a crustacean regurgitate and some skink specimens from Eclipse Island. Mr Frank Knight drew the figures.

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FROM FIELD AND STUDY

A Further Record of *Sminthopsis longicaudata* (Marsupialia, Dasyuridae).—On March 16, 1975, while on a Department of Fisheries and Wildlife survey, we obtained a female Long-tailed Dunnart *(Sminthopsis longicaudata* Spencer). It was collected at 26°51'S, 126°23'E in the proposed 1 050 000 ha Baker Lake Nature Reserve, in the Gibson Desert, south-west of Warburton, Western Australia.

The animal was flushed from a spinifex tussock at late dusk. The collecting site was on a laterite plateau supporting a low hummock grassland of *Triodia* sp. and *Plectrachne* sp. with occasional emergent *Hakea lorea* and *Acacia* sp. The soil was a shallow sandy gravel. About 10 m away was a laterite breakaway below which was a tall shrubland of *Acacia aneura* (Mulga) and *A. kempeana.*

Only four specimens have previously been reported. One of these is labelled only "Central Australia" (holotype, National Museum of Victoria, C7803) and the others all come from the Pilbara of Western Australia (W. D. L. Ride, *A Guide to the Native Mammals of Australia,* 1970, p. 201).

Ride does not provide any habitat information although H. J. Frith *(Wildlife Conservation,* 1973, p. 88) includes the species among ". . . mammals whose main habitats are woodlands do also live in grasslands where there are no trees." Our record extends the known distribution and provides specific habitat data of a currently extant population.

The specimen is lodged in the Western Australian Museum (M13348). A full report on the survey will be published in the Wildlife Research Bulletin.

—A. A. BURBIDGE and N. L. McKENZIE, W.A. Wildlife Research Centre, Wanneroo.

Incubation Period of the Pied Honeyeater, *Certhionyx variegatus.*—Recently the opportunity occurred to record within very narrow limits, the incubation period of the Pied Honeyeater. At 13.00 hours on August 31, 1975, a completed nest, later identified as that of a Pied Honeyeater, was discovered at a point 61 km north-east of Wubin on the Great Northern Highway.

The nest, empty at the time of its discovery, was located in a multiple fork of a hakea *(Hakea scoparia),* and was composed of fairly firm twigs lined with finer twigs and grasses. It was 72 cm from the ground, measured 9 cm across on the outside and 6 cm internally.

When the area was visited again at 10.00 hours on September 13, the nest contained two eggs, which, judging by the behaviour of the female, appeared to be on the point of hatching. This conclusion proved to be correct, as, when the nest was again visited at 07.15 hours on September 14, one egg had hatched, while a further inspection at 10.15 hours showed that the second egg also had hatched. It was noted that the eggshells had been removed from the vicinity of the nest and the female remained in close attendance throughout the period during which the nest was kept under observation. During the same period the male visited the nest site fleetingly, staying only long enough to enable a definite identification to be made.

Therefore, in a period 13 days 21 hours two eggs had been laid and hatched, which on the assumption that they were laid on two consecutive days and that brooding commenced immediately thereafter, indicated an incubation period of not more than 12 days 21 hours.

It may be worth adding, however, that the nesting proved unsuccessful, as on a visit to the area a week later, on September 20, the young had disappeared and the nest itself had been dislodged from the position in which it had been built. There was nothing to indicate the cause of the destruction.

—A. FEWSTER and M. T. MILLARD

First Record of the Kerguelen Diving-Petrel in Australia.—On 20 March, 1974 Mr. N. Whiteford found a recently dead seabird on Middleton Beach, near Albany, Western Australia, and gave it to Mr. H. O. Webster for identification. Realising that it was the first record of a diving-petrel for this State, Mr. Webster kindly donated the specimen to the Western Australian Museum where it was prepared into a study-skin (registered number A12761) and identified as *Pelecanoides exsul* Salvin.

Details of specimen: weight, total length and wing-span in flesh, 120 g, 212 mm and 419 mm respectively; exposed culmen 17, entire culmen 27, width of bill at base 9.3, wing 124.5, tail 45, tarsus 25, middle toe and claw 33; skull fully ossified; feet blue; wings and entire upper surface glossy black. Length of wing and tail are greater than the ranges (118-121.5 and 35-40.5) given for *P. exsul* by R. C. Murphy and F. Harper (A review of the diving petrels, *Bull. Amer. Mus. Nat. Hist.,* 44, 1921: 495-554). In most other respects it agrees well with our specimen (A6673) from Heard Island, a female *exsul* that was brooding an egg on 3 December 1949.

The combination of large size, broad bill with moderately converging sides (rather than narrow bill with almost parallel sides) and broad, unbroken grey band across throat and foreneck separates *P. exsul* from all subspecies of the Common Diving-petrel *(P. urinatrix). P. exsul* nests on

South Georgia, Marion Island, Crozet Islands, Kerguelen Islands, Heard Island, Auckland Islands and Antipodes Islands. As a breeding bird it thus shares with the Georgian Diving-petrel *(P. georgicus)* a more southerly zone than that occupied by *P. urinatrix*.

W. R. P. Bourne (Notes on the diving-petrels, *Bull. Brit. Orn. Cl.*, 88, 1968: 77-85) discusses the possibility that some of Murphy and Harper's subspecies of *P. urinatrix* might be better aligned with *P. exsul*. As the name of one of these subspecies, *berard* Gaimard, antedates *exsul*, the Kerguelen Diving-petrel would be known as *P. berard exsul* if Bourne's hypothesis proves correct.

—G. M. STORR and R. E. JOHNSTONE,
Western Australian Museum.

King Penguin Egg washed ashore in Western Australia.—On 10 January 1974 a large egg, well-covered with a growth of algae, was found on the beach about two miles east of Augusta on the south coast of Western Australia. Three beach fishermen picked it up at high water mark, looked at it, and threw it behind the first line of sand dunes. On 12 January, by sheer chance, I was in Augusta and one of the fishermen, Lew Yates of Bridgetown, mentioned the occurrence to me. With his son and several children I crossed the Blackwood River and walked down the beach approximately to where the men had found the egg. After an hour's searching and when on the point of giving up I found the egg, unbroken, among the sand dune vegetation.

The egg shell was white, although slightly stained, perhaps from the algae. The surface was pitted and the egg was typically penguin in its peg-top shape. Its measurement, 100 x 75 mm, fell within the size range of eggs of the King Penguin *(Aptenodytes patagonica)* as given by Serventy, Serventy and Warham *(The Handbook of Australian Sea-Birds*, 1971) and by Mathews *(Birds of Norfolk and Lord Howe Islands and the Australasian South Polar Quadrant, 1928)*. Unfortunately there are no specimens of King Penguin eggs in the Western Australian Museum with which to compare the Augusta egg, but there seems little doubt of its identification as that of a King Penguin, which was confirmed by Mr. T. E. Bush.

I blew the egg for a specimen and was surprised to find that it contained a well-advanced embryo, quite undecomposed and with no odour of decay.

The most reasonable explanation of its presence is that it had been washed into the sea from one of the sub-antarctic nesting colonies in the southern Indian Ocean (Marion I., the Crozets, Kerguelen or Heard Is.). Being in an advanced stage of incubation it floated and was carried eastwards in the West Wind Drift. The egg-laying season of the King Penguin is recorded as between late November and mid-April and Mr. Yates's party must have found the egg almost immediately after it had fetched up on the beach.

The finding of this egg will inevitably revive speculation that the celebrated and mysterious Scott River "Big Egg" had similarly drifted here from Madagascar (its finding was reported in the *West Australian*, May 3, 1962, p. 1, and its origins discussed by R. C. Hyslop and C. J. Spackman, *Augusta Jewel Caves*, 1967, pp. 16-17, and by Harry Butler, *Science Digest*, March 1969, pp. 70-73).

—G. A. LODGE, Boyup Brook.

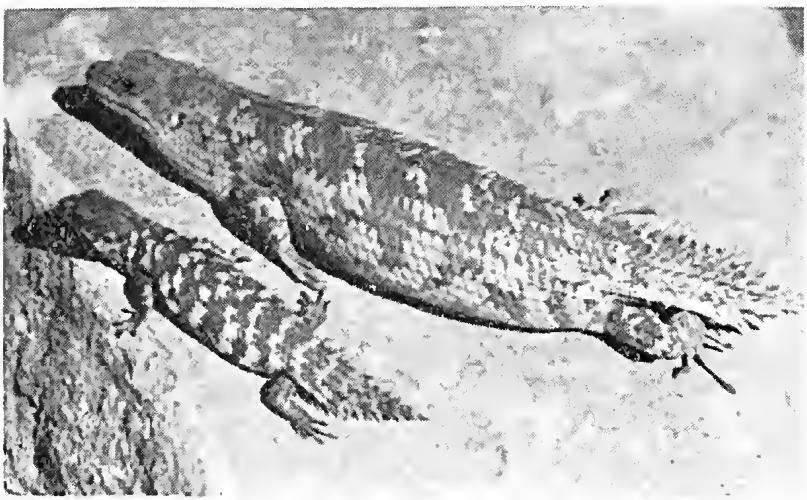
Breeding of the Larger Spiny-tailed Skink, *Egernia stokesii*.—In early July, 1975 when I was picking mallee roots on my father's farm 14 miles west of Wubin I found two lizards unusual in the district. They were 10 cm long and were at the bottom of an old pile of roots. The soil in the area was a red sandy clay. At school next day they were identified as young *Egernia stokesii*. They were released where found.

Over the next few weeks several other individuals of the species were

brought into the school, including two adults. These latter had been brought into Dalwallinu in a load of roots and were only found when the root was chopped. One skink had been injured, having a two-inch cut in the abdominal wall. It was kept at school for treatment. The skink responded to chloroform by going almost immediately into a state of semi-consciousness but it was difficult to induce a complete anaesthesia. The injury was repaired with the aid of some fishing line and adhesive tape and the skink appeared more alert after the operation. It was released at a later date but was not seen again.

My science teacher asked me to release the healthy adult skink where I had previously found the young lizards on my farm. The lizard was very fat in appearance and proved to be a gravid female. A young was born on August 12 and measured 10.8 cm. At the first opportunity, when the young was three days old, I brought them to school on the school bus. The young one was then weighed and measured. It was 11 cm in length and weighed 15.5 gm. Subsequently I took the skinks back home but before I was able to release them the young lizard disappeared. About three weeks later my mother found it in the passage of our house. I was hoping to do some more research on it but coincident with the re-appearance of the lizard was the appearance of a tick on my father. The skink got the blame and my mother ordered its immediate release.

—ROBERT NANKIVELL, Dalwallinu District High School.
(Year 9 Student).



Adult female *Egernia stokesii* with newly born young.

Predation on *Stigmodera (Themognatha) tibialis* by a fly.—The following observations were made on March 2, 1975, while we were collecting insects feeding on the flowers of *Eucalyptus foecunda* on Balladonia Station, W.A. near Afghan Rock (lat. 32°22' S, 123°40 E). At about 10.45 a.m. western standard time, we saw a large specimen of a *Stigmodera (Themognatha)* species fly into a clump of eucalyptus flowers 9 m above ground level at the top of a flowering tree. Some 15 minutes later in the same tree we noticed that a large beetle was suspended, apparently by one of its elytra, from a small branch underneath the blossom some 8 m above ground level. On closer inspection we saw that the beetle was being held by a large Asilid fly which was feeding on it. The fly was in a vertical position with its head down and was feeding on the beetle which it held vertically, also

in a head-down position. The feeding site appeared to be in the fold between the pro and meso-thorax. We did not observe the capture of the prey by the fly but assumed the prey to be the same beetle seen earlier flying into the tree, as this was the only large Buprestid observed in that area. We watched feeding progress for 3¼ hours hoping that the predator would eventually drop its prey and in post-prandial stupor fly to within net-reach. Eventually when time was running short we collected both prey and predator by the only method open to us, namely by shooting with a shotgun. Both specimens were somewhat damaged but still identifiable (Plate 1). The prey was identified as a female *Stigmodera (Themognatha) tibialis* Waterhouse, easily recognised by the tibial spur on the second leg and the predator by comparison with identified material in the South Australian Museum as a male *Phellus piliferus* D & F. We think the observation of interest as we are unaware of published reports of predation occurring on any of the large *Stigmodera* species.

We wish to thank Mrs. A. E. Crocker and family of Balladonia Station for permission to collect on their property; Mr. G. F. Gross of the South Australian Museum for assistance in identifying the fly; the W.A. Herbarium for identifying the tree. One of us (S.B.) gratefully acknowledges a grant-in-aid of research from the Australian Biological Resources Committee which made this work possible.

—S. BARKER & R. INNS, Department of Zoology, University of Adelaide.

Fig. 1.—Left, predator *Phellus piliferus;* right, prey *Stigmodera (Themognatha) tibialis.*

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THE SHARK BAY MOUSE *PSEUDOMYS PRAECONIS* AND OTHER MAMMALS ON BERNIER ISLAND, WESTERN AUSTRALIA

By A. C. ROBINSON, J. F. ROBINSON, C. H. S. WATTS and P. R. BAVERSTOCK, Institute of Medical and Veterinary Science, Frome Road, Adelaide, South Australia.

INTRODUCTION

As part of a study of Australian native rodents, Bernier Island off the Western Australian coast was visited by two of us, A. C. and J. F. Robinson, between 20 and 23 April 1975. The purpose of the visit was to collect, under the auspices of the Western Australian Department of Fisheries and Wildlife, three specimens of the little known Shark Bay Mouse, *Pseudomys praeconis*, and five specimens of the Ashy-Grey Mouse, *Pseudomys albocinereus*.

P. praeconis was first collected on Peron Peninsula, some 150 km south of Bernier Island, in 1858 (see Ride and Tindale-Biscoe, 1962). In 1906 Shortridge collected a skull from Bernier Island. Both these specimens were referred to *Pseudomys gouldii*, but Thomas (1910) recognized it as a distinct species and named it *P. (Thetomys) praeconis*. Since then few *P. praeconis* have been collected and all have come from Bernier Island, one being collected in 1910, one in 1959 and one during a recent Fisheries and Wildlife Department expedition. *Pseudomys albocinereus* was first collected from Bernier Island in 1906 and Thomas (1907) described these insular specimens as a separate sub-species *(Mus albocinereus squalorum)* from those on the Western Australian mainland *(P. albocinereus albocinereus)*.

Collections of these species from Bernier and Dorre Island up to 1959 have been summarized in Ride and Tindale-Biscoe (1962). They considered *P. albocinereus* to be far more abundant on the islands than *P. praeconis*, an impression supported by a recent W.A. Fisheries and Wildlife Expedition to the islands (A. Burbidge personal communication).

During our visit we managed to collect 12 live specimens of *P. praeconis* and two *P. albocinereus*.

The details of these captures plus those of other mammals either caught or observed during our stay form the subject of this paper.

METHODS

On the morning of 20 April a camp was established in the beach dunes behind Red Cliff Point beach and traps were set in the localities shown in Fig. 1. Two trap types were used, an aluminium folding Sherman trap 7 x 8 x 23 cm and a wire cage trap 130 x 130 x 350 cm. Traps were set in lines consisting of five Sherman and five cage traps set alternately, with a trap spacing of 20 m. These trap lines were left out for two nights with the exceptions of Lines 1 and 9 which were only left out for one night. In addition, following the capture of the first *P. praeconis* forty-five Sherman traps were set for two nights in the area shown in Fig. 2, in an attempt to estimate the population density of this species.

Between 8.30 p.m. and 11.30 p.m. on 20 April we spotlighted on foot westward from the camp to the first dunes on the opposite side of the island and returned on a parallel route. The following evening between 8.30 p.m. and 9.30 p.m. we spotlighted south along the sand dunes at

the back of Red Cliff Point keeping to the open areas and looking specifically for mice. The approximate routes are marked on Fig. 1.

Faecal pellets were collected from traps that contained *P. praeconis* and preserved in 70% alcohol. These were later examined in the laboratory by the method of Watts (1970).

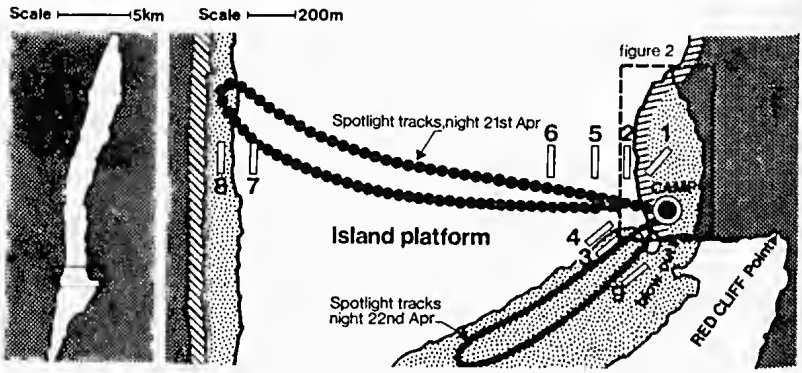

Fig. 1.—Left, outline map of Bernier Island, with the study area (in the vicinity of Red Cliff Point) blocked; right, enlargement of study area showing the location of trap lines and spotlight tracks.

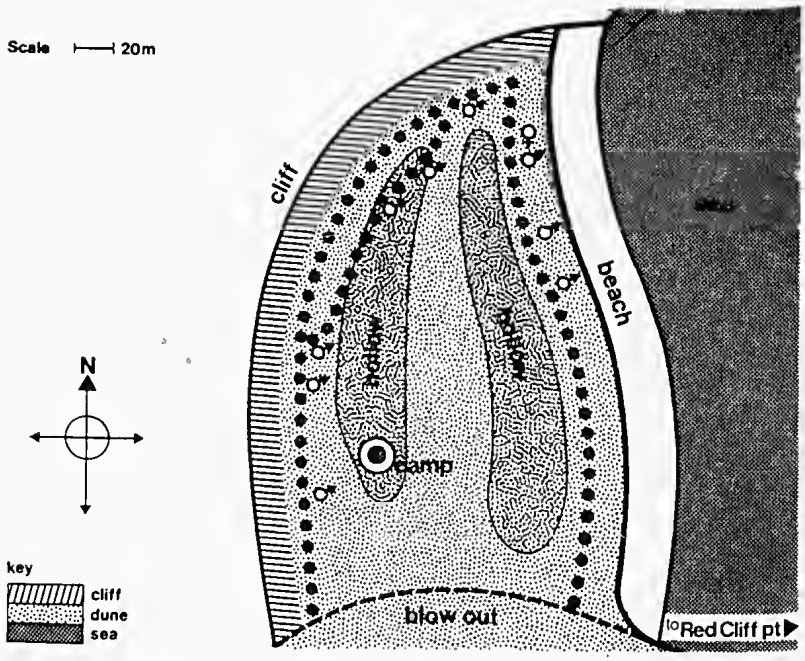

Fig. 2.—Further enlargement of portion of study area, indicated in Fig. 1. (right), which was intensively trapped for *Pseudomys praeconis*, showing capture sites (males and one female).

RESULTS

Pseudomys praeconis, Shark Bay Mouse (Fig. 3)

One male was caught in a Sherman trap in a dune valley on line 4 (Fig. 1). The vegetation in this area consisted of a dense mat of *Spinifex longifolius* and *Olearia axillaris* with scattered bushes of *Atriplex paludosa* and *Rhagodia obovata*. (Fig. 4).

Ten males (one of which may have been a recapture) and one female were caught in Sherman traps on a one hectare area of fore dune bounded by a steep blow-out to the south, the sea to the east and cliffs to the north and west (Fig. 2). The vegetation was similar to that of the first area apart from the lack of *Atriplex* and *Rhagodia* and the presence of heaps of sea grass *(Zostera)*, and dead bushes of the roly poly *Salsola kali* (Fig. 5).

Both the above areas are in the Sandhill Association of Royce (1962).

Faecal samples were collected from five individuals but one sample was too heavily contaminated with bait to be useful. The results from the analysis of the remaining four are given in Table 1. The main food

TABLE—% volume of different food stuffs eaten by four *P. praeconis*.

Individual	483	484	485	486	Average
Food Item					
Dicot. flower	60	85	50	50	61
Dicot. stem/leaf	40	15	30	50	34
(Prob. from a succulent)					
Olearia leaf	—	—	20	—	5
Fungi	—	—	—	T	T
Insect	—	—	T	—	T

T = Trace

eaten was the petals and anthers of some flower, probably those of *Olearia* which appeared to be the only plant flowering in the area at the time. The only other significant item eaten was the leaf or stem of a fleshy dicotyledon.

All individuals caught were adult. The one female had a perforate vagina. All were released at their points of capture except for three animals

Fig. 3.—The Shark Bay Mouse *(Pseudomys praeconis)* from Red Cliff Point, Bernier Island.

that were sent to Adelaide. One of these, a male, died from unknown causes three days after arrival. The remaining animals were paired and have since produced two litters of four and three young respectively. The reproduction in captivity of this species will be described in another paper.

Fig. 4.—Habitat of *Pseudomys praeconis* on trap line 4, Red Cliff Point, Bernier Island.

Fig. 5.—Habitat of *Pseudomys praeconis* in the intensively trapped area (Fig. 2) of the Red Cliff Point, Bernier Island.

Pseudomys albocinereus, Ashy-Grey Mouse

Two individuals (♀♀) were caught in cage traps on Lines 3 and 4 (Fig. 1). Both animals were trapped in the Sand Dune Association. One capture site (Line 3, Fig. 1) near a dune crest was a rather more open habitat than that where *P. praeconis* was trapped. One of the females gave birth to 4 young, 23 days after capture.

Perameles bougainville, Little Marl (Fig. 6)

Two individuals (1♀, 1♂) were trapped on Line 2 and 4 (Fig. 1) and six were seen while spotlighting. The female had a pouch young approximately 10 cm in length. The male was tailless and had lost a lot of fur from its rump, perhaps the result of severe fighting. One of the six seen while spotlighting was captured. This was a female whose pouch contained two young approximately 7 cm in length.

This species was found in both the Sandhill and Open Steppe Associations (Royce, 1962).

Lagorchestes hirsutus, Western Hare-Wallaby (Fig. 7)

Four were seen on the first night while spotlighting in the Open Steppe Association. Two individuals were flushed in the daytime from tunnels through porcupine grass, *Triodia plurinervata,* tussocks, also in the Open Steppe Association.

Lagostrophus fasciatus, Banded Hare-Wallaby

This species was not seen by us, although reported to be common on Bernier Island by Ride and Tindale-Biscoe (1962).

Fig. 6.—The Little Marl *(Perameles bougainville)* from Red Cliff Point, Bernier Island.

Fig. 7.—The Western Hare Wallaby *(Lagorchestes hirsutus)* from the Red Cliff Point area, Bernier Island.

Bettongia lesueur, Boodie

An adult female was trapped on the edge of the Open Steppe Association on the cliff top above Red Cliff Point beach on Line 2. (Fig. 1). The pouch contained one young with a crown-rump length of 165 cm.

Burrows attributed to this species were sparsely scattered througout the Open Steppe Association on the island platform above Red Cliff Point but no animals were seen while spotlighting.

Capra hircus, Goat

Three goats were sighted, one on the cliff above Red Cliff Point beach and two on the island platform approximately 1 km SW of camp.

DISCUSSION

Few specimens of *P. praeconis* have ever been collected. However our trapping results indicated that between 20 and 23 April 1975 in the area of Red Cliff Point Beach, the species was reasonably common. This was an area of matted *Spinifex* and *Olearia* and a thorough search of other similar areas on Bernier Island may reveal more populations of this species.

The original specimen of *P. praeconis* was collected on Peron Peninsula in 1858. During a brief examination of the tip of Peron Peninsula we noticed an area very similar to the Red Cliff Point trapping area. A systematic search of this and other areas in and around Shark Bay may reveal some mainland populations of *P. praeconis*.

The populations of the two wallabies *Lagorchestes hirsutus* and

Lagostrophus fasciatus appear to fluctuate on the islands (Ride and Tindale-Biscoe, 1962). It is possible that much of this apparent fluctuation is due to the differing habitat preference of the two species. *L. hirsutus* appears to be largely confined to the Tall Scrub Association (Royce, 1962), while *L. fasciatus* favours the Open Steppe Association. As very little of the former association was examined during our visit, our failure to record *L. hirsutus* is not surprising, and need not necessarily be attributed to a decline in the numbers of this species on the island.

There is some evidence that the vegetation of the island is recovering from the effects of the formerly large goat population (Ride and Tindale-Biscoe, 1962) which has been subjected to an intensive eradication programme (Anon, 1971; Chapple, 1972). Shrubs of *Diplolaena dampieri* heavily grazed by goats are sprouting again and the network of trails over the island show almost no signs of use and are gradually revegetating.

We think the results of this short visit reinforce the opinion that Bernier Island is a unique and extremely valuable conservation area. It is hoped that this report will be of some help to future workers trying to reach an understanding of the mammal populations of this island; an understanding we feel is imperative if its unique fauna is to be preserved.

ACKNOWLEDGEMENTS

We wish to thank the Western Australian Fisheries and Wildlife Department for permission to visit Bernier Island and collect specimens of *P. praeconis* and *P. albocinereus*. Particular thanks are due to Harry Shugg for solving all our permit problems and Andrew Burbidge who discussed the results of the recent Fisheries and Wildlife expedition to Bernier Island with us.

Thanks are due to Geoff Faulkner, Captain of the *Dampier*, and his crew and Leon Sylvester, Fauna Warden at Carnarvon who helped us in many ways.

Our special thanks must go to Jack Rochi, part owner of Peron Peninsula Station, who freely gave up his afternoons to drive us around the northern area of Peron Peninsula Station when our own transportation was restricted.

The study was funded by a generous grant from the Australian Biological Resources Interim Council.

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BREEDING SYSTEMS IN THE WESTERN AUSTRALIAN FLORA. II. POLLINATION OF *DIPLOLAENA* AND *CHORILAENA* (RUTACEAE)

By G. J. KEIGHERY, Kings Park & Botanic Garden, West Perth

ABSTRACT

Pollination vectors for four of the seven species of the genera *Chorilaena* and *Diplolaena* have been studied. In all cases these were shown to be honeyeaters (Meliphagidae).

All members of the genera *Diplolaena* (the Native Rose) and *Chorilaena* are endemic to South-Western Australia. They both possess a unique inflorescence morphology for the Rutaceae (Hutchison, 1969), and are considered ancient genera of uncertain affinity both within the Rutaceae and to each other (Smith-White, 1954).

This paper forms the first in a series on the pollination biology of the endemic genera of the Rutaceae, none of which have been studied previously. I will attempt to place these findings into the general scheme proposed by Keighery (1977).

OBSERVATIONS

Diplolaena

The flower head consists of a drooping cluster of flowers (Fig. 1, I) surrounded by bracts. The stamens and floral parts are generally orange-red with pale green bracts (see Gardner, 1959: 81). During flowering the inflorescences are visually striking, and the plants tend to occur in clumps massing the blooms. Flowering commences in August continuing till mid November. In cultivation the inflorescence remains open for 7-10 days and capable of pollination. All species appear self fertile.

Diplolaena dampieri was studied for vectors at Point Peron, Rockingham and Garden Island. Insect visitors to the flowers included small beetles, ants, cockroaches and honey bees. It is possible that the honey bee causes pollination, but it cannot be classified as a natural vector.

The major vectors were the Little Wattle-bird *(Anthochaera chrysoptera),* the Brown Honeyeater *(Lichmera indistincta),* occasionally Silvereyes *(Zosterops gouldi)* and the Singing Honeyeater *(Meliphaga virescens).*

Sightings of Brown Honeyeaters visiting *D. angustifolia* in Yanchep National Park were made in October 1972. Unidentified honeyeaters were seen visiting a large population of *D. microcephala* at the base of a large granite rock east of Yoting in August 1974.

Plantings of *D. angustifolia, D. drummondii, D. grandiflora* and *D. microcephala* in Kings Park and Botanic Garden are sporadically visited by the many types of resident honeyeaters.

Chorilaena

Again the inflorescence is organised into a drooping head, although much more loosely than that of *Diplolaena* (Figs. 1, 2 and 3). The flowers are white-pale green with light green bracts (see Erickson *et al.,* 1974: 59) and stand out in the gloomy Karri understorey. The plants are gregarious and flower profusely between August and January. In cultivation the flowers remain open for 5-9 days, and the plants do not appear to be self fertile.

Observations on the only species, *C. quercifolia* were made on a dense post fire thicket at the base of Mt. Chudalup, approximately 10 km south of Northcliffe, in October 1974. The bushes were flowering profusely and were being actively probed for nectar by White-cheeked honeyeaters *(Phylidonyris niger).* No other possible vectors visited the flowers during the periods of observation.

SUMMARY

Both genera are bird pollinated, and possess flower heads that are adapted to this mode of pollination. They are large, conspicuous, held in a pendant position near the alighting positions, have a good supply of

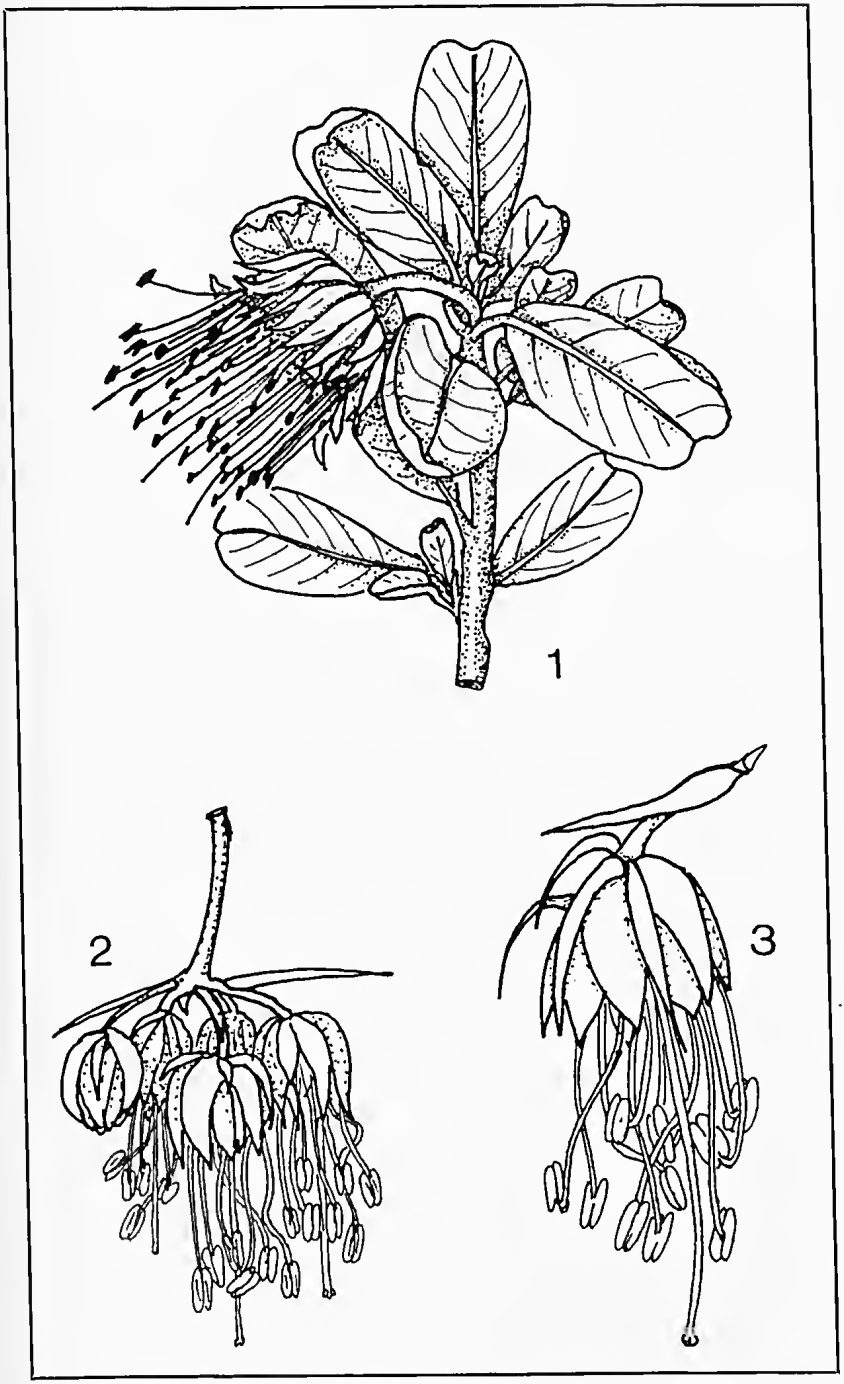

Fig. 1.—1. *Diplolaena grandiflora:* inflorescence x 1; 2. *Chorilaena quercifolia:* inflorescence x 2; 3. *C. quercifolia:* single flower x 4.

nectar which is difficult for smaller insects to obtain and have little smell as birds zero in by sight not scent.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the help of Mr. Allan Burbidge at Mt. Chudalup and the assistance of funds from the Australian Biological Resources Council which made a visit to this area possible.

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AVIFAUNA OF BLACK POINT—CAPE BEAUFORT AREA, S.W. AUSTRALIA

By IAN ABBOTT, Zoology Department, University of Western Australia, Nedlands.

I spent 22 and 23 April, 1976 investigating the avifauna of the Black Point-Cape Beaufort area. The Point and Cape are the S. and N. sides of a low (43 m) but conspicuous tessclated basalt tongue of land projecting from the coast, about 40 km S of Nannup, between Cape Leeuwin and Point d'Entrecasteaux. Nothing of the birds of this area appears to have been published before. Access to the Point is by four-wheel drive track, which is passable only between January and May. The area covered in this report is within a radius of 3 km of Black Point. During my visit the weather was fine and sunny.

The habitats available for birds are as follows.

1. Rocky seashore and sandy beaches on either side of the Point and Cape. Four plant species occur on the beaches: *Ammophila arenaria, Spinifex hirsutus, Arctotheca populifolia,* and *Cakile maritima.*

2. Zone of salt tolerant plant species. Main species are *Salicornia quinqueflora, Samolus repens, Apium prostratum, Carpobrotus rossii, Calocephalus brownii, Cotula* sp., *Lobelia alata, Poa australis, Threlkeldia diffusa, Scirpus nodosus, Sonchus oleraceus* and *Anagallis arvensis.*

3. Low heath on sand dunes, made up of thickets 1-2 m high. Main plant species are *Jacksonia horrida* (dominant), *Scirpus nodosus, Lepidosperma gladiatum, Olearia axillaris, Acacia decipiens, Boronia alata.* Further from the coast other species come in, the chief ones being *Agonis flexuosa, Cassytha* sp., *Casuarina* sp., *Hibbertia cuneiformis, Sollya heterophylla, Lepidosperma angustatum, Spyridium globulosom, Leucopogon parviflorus, Xanthorrhoea preissii, Loxocarya flexuosa, Scaevola nitida, Muehlenbeckia adpressa, Acacia heteroclita, Dryandra cuneata,* and *Hibbertia* sp.

4. Swales near the coast contain *Juncus* swamp with odd clumps of a white-barked *Melaleuca.* Further inland thickets of *Oxylobium* sp., *Banksia littoralis* (flowering), to 5 m, and odd clumps of stunted Jarrah occur.

Further inland still swales contain *Agonis flexuosa* woodlands (trees

5-7 m) with understorey of *Macrozamia riedlii, Rhagodia baccata, Pimelia clavata, Leucopogon revolutus, etc.*

LIST OF BIRD SPECIES

Twenty-one bird species were found.

White-fronted Heron, *Ardea novaehollandiae.* One bird disturbed in a *Juncus* swamp.

Silver Gull, *Larus novaehollandiae.* Flocks of 20-30 birds follow fishing parties around the Point and Cape, and also congregate on beaches (Habitat 1).

Crested Tern, *Sterna bergii.* 16 were seen on a large basalt rock, 3 m high, 600 m W of Cape Beaufort.

Western Rosella, *Platycercus icterotis.* Two birds were seen in *Melaleuca* trees in Habitat 4.

Swallow, *Hirundo neoxena.* About 20 birds were seen resting on, or flying over, Habitats 1 and 2.

Tree Martin, *H. nigricans.* One seen with Swallows near Black Point.

Pipit, *Anthus australis.* Three birds were seen singly on paths through the southern part of Habitat 3.

Splendid Wren, *Malurus splendens.* Common throughout Habitat 3; less common in Habitat 5. In small parties.

Emu Wren, *Stipiturus malachurus.* Very common in Habitat 3. In small parties.

Broad-tailed Thornbill, *Acanthiza apicalis.* Not as common as *Malurus, Stipiturus* or *Sericornis.* Found in Habitat 5 and taller portions of Habitat 3.

Spotted Scrub Wren, *Sericornis maculatus.* Commoner than *Malurus* in Habitats 3 and 5. Usually in pairs.

White-breasted Robin, *Eopsaltria georgiana.* Single birds seen or heard occasionally in Habitat 5 or in trees in Habitat 4.

Grey Fantail, *Rhipidura fuliginosa.* Found in pairs throughout Habitat 5 and occasionally in taller parts of Habitat 3.

Willy Wagtail, *R. leucophyrys.* One seen briefly in Habitats 3 and 4 on 23 April.

Golden Whistler, *Pachycephala pectoralis.* Commonly seen or heard in Habitat 5.

Silvereye, *Zosterops gouldi.* Seen or heard in small flocks throughout Habitats 3, 4 and 5.

Spinebill, *Acanthorhynchus superciliosus.* Common in Habitat 3.

New Holland Honeyeater, *Phylidonyris novaehollandiae.* Very common in *Banksia littoralis* groves and *Oxylobium* thickets in Habitat 4.

Red-eared Firetail, *Zonaegithus oculatus.* Two birds seen together briefly in Habitat 3 on 22 April.

Grey Butcher-Bird, *Cracticus torquatus.* Heard calling several times on both days in Habitat 5. This record is c. 40 km S. of the southern limit of the distribution of the species as recorded by Serventy & Whittell *(Birds of Western Australia,* 1967).

Raven, *Corvus coronoides.* Two briefly appeared on 22 April.

DISCUSSION

The area covered by this report is relatively undisturbed and should be more thoroughly investigated, especially to determine whether *Dasyornis brachypterus, Atrichornis clamosus* and *Psophodes nigrogularis* occur there or nearby. Several species that I would have expected to occur were not found. These include Sooty Oystercatcher, Rock Parrot, Kookaburra, Little Grass-bird and Reed Warbler. Visits during other times should determine whether these absences are permanent or not.

A SURVEY OF TERRESTRIAL VERTEBRATES IN THE CARNARVON REGION, W.A.

By M. G. BROOKER and A. J. ESTBERGS, Division of Wildlife Research, C.S.I.R.O., P.O. Box 84, Lyneham, A.C.T. 2602

INTRODUCTION

This paper records the terrestrial vertebrates observed during a study of the Wedge-tailed Eagle in the Carnarvon region of Western Australia.

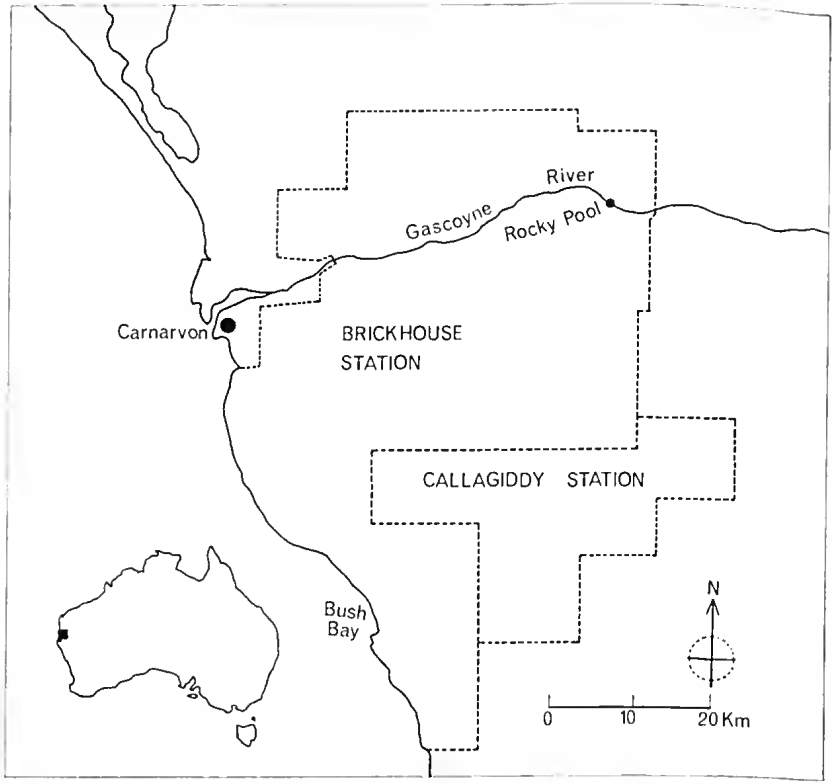

Figure 1.—Map showing location of Callagiddy Station.

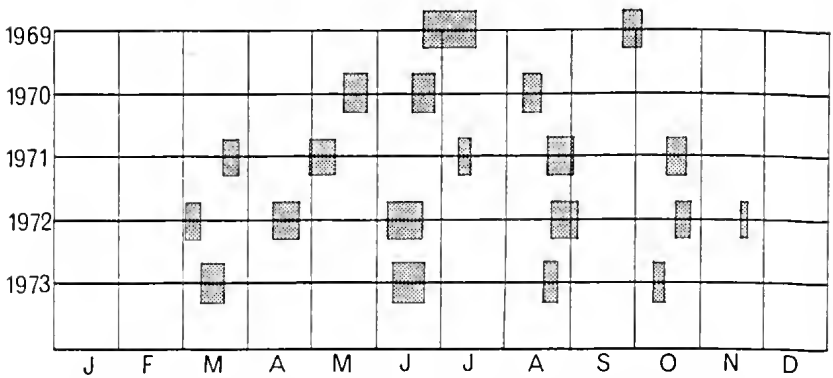

Figure 2.—Timetable of visits to Carnarvon area, 1969-73.

Most of the data were obtained on Callagiddy, a sheep station of 650 km², situated 40 km south-east of Carnarvon. Some records were made on neighbouring Brickhouse station. (See Fig. 1).

The observations were made during the five year period 1969 to 1973; the majority of visits being in winter and spring. No visits were made during summer. (see Fig. 2).

THE ENVIRONMENT

Topography and soil: Callagiddy is mostly flat with some high north-south sand ridges. There are numerous claypans and swamps which hold water after heavy rain. The soil is predominantly coarse red sand.

Land use: The station has run sheep for most of this century with a few cattle and horses. Water for livestock is provided by a system of windmills, bore drains and dams. The underground water has a high salinity.

Rainfall: The area has a low but reliable winter rainfall and a low unreliable summer rainfall resulting from cyclone activity. The monthly medians for Carnarvon and the monthly rainfall for Callagiddy homestead 1969-1973 are shown in Fig. 3.

Vegetation: *Acacia* scrub of various densities and heights dominates

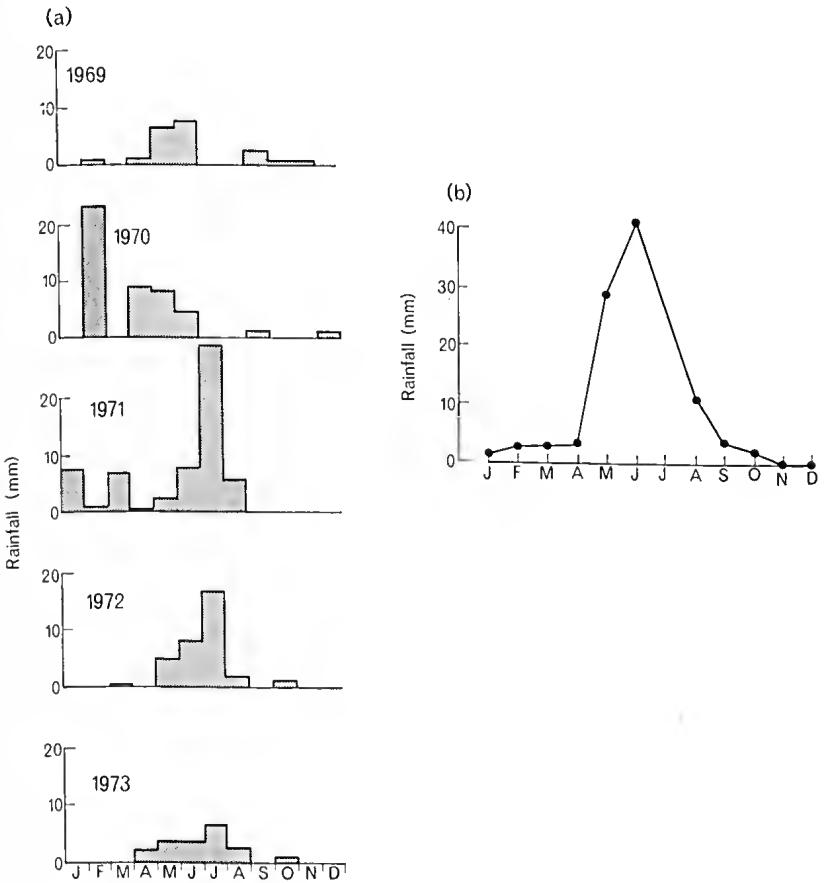

Figure 3.—(a) Monthly rainfall for Callagiddy 1969-73. (b) Monthly median rainfall for Carnarvon (66 years).

the vegetation. Summer rainfall results in a ground cover of Blow-away Grass *(Aristida browniana)* while winter rain is followed by the germination of Compositae e.g. *Helipterum splendidum, Cephalipterum drummondii, Brachycome cheilcarpa.* For the purpose of this paper, the vegetation of Callagiddy has been classed into six habitat types, mainly on the basis of the floristic composition of the tree and shrub components.

1. Sand-ridge: Dominated by a tall (to 10 m) single-stemmed form of *Acacia quadrimarginae* known locally as Gidgie. The understory is composed predominantly of young Gidgie with *Eremophila maitlandii, Stylobasium spathulatum, Adriana tomentosa* and occasional *Solanum* spp. and other *Eremophila species.* The edges of sand ridges are usually lined with dense thickets of Sandhill Wattle *(Acacia schlerosperma)* and Curara *(Acacia tetragonophylla).*

2. Dense acacia scrub: Basically a mosaic of large areas of Wanya *(Acacia linophylla),* Snakewood *(A. cuthbertsonii)* and Jam, the multi-stemmed form of *A. quadrimarginea.* Sandhill Wattle and Curara are found as a lower layer throughout this formation together with at least 21 other shrub species.

3. Coastal flats: Open habitat of Bluebush *(Kochia sp.)* with occasional clumps of Snakewood, Curara, and Standback *(Acacia sp.).*

4. Inland flats: Open habitat with large areas of bare ground. Clumps of *Eremophila fraseri* and scattered Myall *(Acacia sp.),* Prickly Wattle *(A. victoriae),* Curara, *Cassia spp.* and various *Eremophila* species.

5. Swamps: This habitat is dominated by Coolibahs *(Eucalyptus microtheca)* with *Teucrium racemosum* and *Melaleuca uncinata* in lower areas.

6. Bore drain: Along the bore-drains are dense, tall (to 6 m) stands of Prickly Wattle which are often heavily parasitised by the mistletoe *Lysiana casuarinae.*

METHODS

Plants: Material collected from most trees and shrubs and some of the grasses and herbs on Callagiddy were identified by the staff of the Western Australian Herbarium. *Acacia* specimens were identified by Dr. M. D. Tindale of the National Herbarium, Sydney. The collection is in the CSIRO Herbarium, Canberra.

Frogs and Reptiles: Specimens collected were identified by Dr. G. M. Storr of the Western Australian Museum where most of the specimens are housed.

Birds: During each visit, an attempt was made to record all birds present on Callagiddy. Although information on density, habitat preference and breeding was not collected systematically, some indication of status and habitat preference is shown for species other than water-birds. Status classes used are S—sedentary; PN—partial nomad (always present but numbers fluctuate); TN—true nomad (always present in good season and always rare or absent in dry season); M—migrant (absent autumn, present late winter-spring, regardless of the nature of the season); V—vagrant; SU—status unknown. Habitat preference is given by the number of the habitat as defined in Vegetation above.

Most of the breeding records have been forwarded to the RAOU Nest Record Scheme. Birds are listed mainly according to the *Index of Australian Bird Names (CSIRO).*

Mammals: Sightings were recorded and traps for small mammals were set during two visits. No special effort was made to collect bats.

LIST OF VERTEBRATES

Amphibia

Litoria rubella
Neobatrachus centralis
N. wilsmorei

Reptilia	Gekkonidae	
		Diplodactylus pulcher
		D. spinigerus
		D. squarrosus
		Gehyra variegata
		Nephrurus levis occidentalis
	Pygopodidae	
		Pygopus nigriceps
	Agamidae	
		Amphibolurus inermis
		A. maculatus
		A. minor
		A. reticulatus
		A. scutulatus
		Moloch horridus
	Scincidae	
		Ctenotus mimetes
		C. pantherinus
		Egernia depressa
		E. stokesi
		Lerista muelleri
		L. nichollsi
		Menetia greyii
		Tiliqua occipitalis
		Trachysaurus rugosus
	Varanidae	
		Varanus caudolineatus
		V. eremius
		V. gouldii
	Typhlopidae	
		Typhlina australis
		T. nigroterminata
	Boidae	
		Liasis childreni
	Elapidae	
		Demansia nuchalis
		D. modesta
		D. psammophis reticulata
		Denisonia monachus

AVES

Dromaius novaehollandiae (Emu). Common in all habitats and breeding recorded each year except 1973. Earliest record of eggs (seven) on 8 May 1971. S all.

Podiceps poliocephalus (Hoary-headed Grebe). Present August and October 1971 and breeding recorded August 1971.

Podiceps novaehollandiae (Little Grebe). A pair in flooded area August 1971.

Ardea pacifica (White-necked Heron). Seen occasionally on dams.

A. novaehollandiae (White-faced Heron). Not common but one or two birds seen on dams and bore drains during most visits. Three nests found 26 August 1972 near bore drain on Brickhouse contained respectively four eggs; one egg three chicks; and five chicks.

Threskiornis spinicollis (Straw-necked Ibis). Recorded only in May to August and none in 1973.

Anas gibberifrons (Grey Teal). Recorded June 1970, July to October 1971 and August 1972. Nest with eight eggs found in August 1971.

A. rhynchotis (Shoveller). Recorded in August 1971.

Malacorhynchus membranaceus (Pink-eared Duck). Pair observed August 1972.

Chenonetta jubata (Wood Duck). Recorded during periods of local flooding (May and June 1971 and August 1972).

Milvus migrans (Fork-tailed Kite). One recorded June 1970. V

Lophoictinia isura (Square-tailed Kite). One sighting in June 1972. V

Haliastur indus (Red-backed Sea-Eagle). Seen on the western edge of Callagiddy during June 1972 and August 1973. V

H. sphenurus (Whistling Kite). Seen during most winter visits. No records for March, October or November. SU all

Accipiter fasciatus (Australian Goshawk). Recorded all years except 1973. S All

A. cirrocephalus (Collared Sparrowhawk). Recorded occasionally usually along bore drains. S All

Aquila audax (Wedge-tailed Eagle). Common in all habitats on Callagiddy. Papers on a detailed study of this species are in preparation. S All

Hieraaetus morphnoides (Little Eagle). Seen during most visits but never common. S All

Circus assimilis (Spotted Harrier). Common during 1971, seen in August 1970 and 1972 and not recorded 1969 or 1973. An estimated six pairs present on Callagiddy in August, 1970. TN All

C. approximans (Swamp Harrier). One bird seen on Brickhouse October 1972.

Falco longipennis (Little Falcon). Seen occasionally in all years except 1969 and 1973. SU All

F. berigora (Brown Falcon). Common in all habitats. A flock of 13 recorded at 17.30 hours on 23 June 1970. Of six nests inspected in late August, five contained eggs (1, 2, 3, 3, 3) and one contained three large chicks. S All

F. cenchroides (Nankeen Kestrel). Numerous in all habitats with an apparent peak in numbers during March 1973. Breeding recorded August to October each year and details of nests inspected in late August 1971-73 shown in Table 1 below.

TABLE 1.—SUMMARY OF BREEDING DATA FOR NANKEEN KESTREL NESTS INSPECTED LATE AUGUST, 1971-73 ON CALLAGIDDY.

	Stage of breeding				
	Nest ready	Eggs present		Chicks present	
Date	No. nests	No. nests	Numbers of eggs	No. nests	No. chicks
23-29 August 1971	1	5	2,3,3,4,4	2	2,3
26 August-1 September 1972	1	13	1,2,3,4,4,4,4,4,5,5,5,5,6	0	—
20 August 1973	0	3	1,1,1	0	—

All were in old crow nests except one in a hollow Coolibah. One nest contained two downy chicks on 30 August 1971 and four fresh eggs on 17 October 1971. S All

Turnix velox (Little Quail). Common in grassy area *(Aristida)* in some years (June-October 1970, March-November 1972) and rare in other years (one record for 1971, none for 1973). Nests with eggs found August and October 1971 and September 1972. TN 3, 4, 5

Gallinula ventralis (Black-tailed Native-hen). Large numbers present around swamps in June and August 1972 and some still present in October. Recently-vacated nests found in cane grass swamp on Brickhouse 27 August.

Fulica atra (Coot). A pair on flooded area, August 1971.

Eupodotis australis (Bustard). Rare—an average of one observed each year. SU all

Vanellus tricolor (Banded Plover). Recorded during all visits but numbers present varied. (Only one pair observed during seven days in August

1970, "numerous" in May 1971). Nest with four eggs, July 1971; runners seen August 1972. PN 3, 4, 5

Erythrogonys cinctus (Red-kneed Dotterel). One recorded August 1972.

Charadrius melanops (Black-fronted Dotterel). Present August and October 1971 and August 1972.

Peltohyas australis (Australian Dotterel). Recorded June 1972. V

Himantopus himantopus (White-headed Stilt). One recorded June 1972.

Recurvirostra novaehollandiae (Red-necked Avocet). Present August 1972.

Tringa hypoleucos (Common Sandpiper). One seen August 1972.

Stiltia isabella (Australian Pratincole). A flock was recorded on Brickhouse, August 1972.

Chlidonias hybrida (Whiskered Tern). Seen occasionally on western edge of Callagiddy.

Columba livia (Domestic Pigeon). Seen occasionally at Callagiddy homestead. V

Geopelia striata (Peaceful Dove). Not recorded on Callagiddy although common on Gascoyne River at Carnarvon and Rocky Pool.

G. cuneata (Diamond Dove). Not common and usually found in Coolibah habitat. Breeding recorded August 1970. S5

Phaps chalcoptera (Common Bronzewing). Rare with only two records (June 1972 and August 1973), in sandridge habitat. On both occasions, the bird seen was incubating. S1

Ocyphaps lophotes (Crested Pigeon). One of most common species and found in all habitats. Breeding recorded August 1970. S All

Cacatua roseicapilla (Galah). Numerous in all habitats and breeding recorded each year from August to November. Of 13 nests inspected 20-23 August 1971, four were lined, one contained two eggs, five three eggs, and three four eggs. S All

C. sanguinea (Little Corella). One record for Callagiddy (June 1970), although this species common in Carnarvon. V

Nymphicus hollandicus (Cockatiel). Present during good seasons (May and June 1970, July and October 1971 and August and October 1972). TN All

Melopsittacus undulatus (Budgerygah). Common in good seasons especially 1972 when present from March to November. No records for 1969 and only one for 1973 (August). Breeding noted August and October 1971. TN All

Barnardius zonarius (Port Lincoln Parrot). Nomadic in this area—no records for 1969 and 1970, present March-June 1971-73. In each of the years when present, the previous summer had been dry suggesting a movement from the inland to the coast under these conditions. During March 1972, they appeared to be feeding exclusively on moth larvae (Brooker, 1973). SU 1, 2, 4, 5

Psephotus varius (Many-coloured Parrot). Common in all habitats and nests found in hollows in dead Gidgies and in vertical metal pipes (internal diameter = 90 mm) used as gate and sign posts. Eggs found August and early September with clutch of seven recorded September 1972. S All

Neophema bourkii (Bourke's Parrot). Present all years and usually seen in sandridge and thick Wanya habitats on the eastern end of Callagiddy. Two breeding records from same broken-off dead Gidgie (four eggs, 31 August 1971 and three eggs, 1 September 1972). S 1, 2

N. elegans (Elegant Parrot). Recorded on coastal side of Callagiddy but not common (no records for 1969 or 1973). SU 2, 3

Cuculus pallidus (Pallid Cuckoo). Common from March to October in 1970, 1971 and 1972. Uncommon in dry years (1969 and 1973). PN All

Chrysococcyx osculans (Black-cared Cuckoo). Common during 1971 and seen occasionally during other years (March to October). PN All

C. basalis (Horsfield Bronze-Cuckoo). Seen all years but not as common as Black-eared Cuckoo. No March records. PN All

Ninox novaeseelandiae (Boobook Owl). Present all years. Appears to call more frequently during June. S 1, 5

N. connivens (Barking Owl). Not seen but a prolonged bout of calling (reminiscent of the distress call of the domestic fowl) on the night of 7 July 1969 was attributed to this species. V

Podargus strigoides (Tawny Frogmouth). Seen occasionally. Three occupied nests found late August 1972—two contained one egg and one small chick and the other two fully-feathered chicks. One nest was in a Coolibah which also contained occupied nests of a Nankeen Kestrel and Little Crow. S. All

Aegotheles cristatus (Owlet-nightjar). Common in all habitats and heard calling March to October. The recorded breeding season was from July to October and clutch size three or four. Of seven birds disturbed during daylight in 1973, two were brown, one grey-brown and four grey. S All

Caprimulgus guttatus (Spotted Nightjar). Three records (May 1971, August 1972 and June 1973). S 1, 2

Dacelo leachii (Blue-winged Kookaburra). Present at Rocky Pool (see Figure 1), breeding observed October 1969.

Halcyon pyrrhopygia (Red-backed Kingfisher). Present during four visits (August 1969, May and June 1970 and August 1972). Breeding recorded August 1969. SU 5

H. sancta (Sacred Kingfisher). One recorded (June 1970). V

Merops ornatus (Rainbow Bee-eater). Not recorded on Callagiddy although common along Gascoyne River at Carnarvon (definite records during winter of 1970 (23 June), 1972 (also 23 June) and 1973 (June)).

Mirafra javanica (Singing Bushlark). One recorded on eastern end Callagiddy, October 1972. V

Cheramoeca leucosternum (White-backed Swallow). Two records (June 1969 and 1970) on coastal side of Callagiddy. V

Hirundo neoxena (Welcome Swallow). Common at all mills, dams and bore drains. Breeding recorded June 1969 and August 1970. S 5

Petrochelidon nigricans (Tree-Martin). Common except in dry years (one record in each of 1969 and 1973). Nesting at Rocky Pool, October 1969. PN All

Anthus novaeseelandiae (Australian Pipit). Common. Breeding recorded June 1969, August and October 1971 and August 1972. S 3, 4, 5

Coracina novaehollandiae (Black-faced Cuckoo-shrike). Common in all habitats. Breeding observed August to November. An immature was seen assisting adult birds at nest containing two chicks October 1971. Large flocks of juveniles recorded on Callagiddy, June 1969. PN All

Pteropodocys maxima (Ground Cuckoo-shrike). Recorded June 1972. V

Lalage sueurii (White-winged Triller). Common all habitats June to October. No record in March and only one in May (1970). Occupied nests found August 1970 and October 1971 and August 1972. Nests usually placed in horizontal forks of trees and shrubs 1-6.5 m high. Nests often found in close proximity to one another. Five occupied nests were found in two adjacent Coolibahs on 2 September 1972, one nest containing six eggs, the others two or three eggs. M All

Petroica goodenovii (Red-capped Robin). Present in winter and spring all years although only one 1973 record (June). Not common—only one pair during eight days in August 1970 and one pair in eight days April 1972. Not recorded in March. Breeding recorded October 1972. PN All

Melanodryas cucullata (Hooded Robin). Not common but recorded during most visits. Only one March record (1973). PN All

Pachycephala rufiventris (Rufous Whistler). Common especially on sand-ridges. Not recorded March 1971 and 1973. S 1, 2

Colluricincla rufiventris (Western Shrike-Thrush). Common during all visits and in all habitats. Nests with eggs found late August. S All

Oreoica gutturalis (Crested Bell-bird). Common in all habitats. Breeding observed August-October. S All

Rhipidura fuliginosa (Grey Fantail). Seen occasionally on sand-ridges; all sightings from May-August period. SU 1

R. leucophrys (Willy Wagtail). Seen in all habitats but number present appears to vary e.g. recorded as numerous May 1971 but only two pairs seen in five days March 1971 and only one pair in 13 days in August 1971. Breeding recorded September 1969 and May 1971. PN All

Sphenostoma cristatum (Wedgebill). Common in all habitats except open flats. Breeding recorded August-October and clutch size two or three. Nests usually built in Curaras and Sandhill Wattles 0.5-2 m above ground and often in creepers growing in these wattles. S 1, 2, 3

Cinclosoma sp. (Quail-Thrush). Rare. Three sightings all in vegetation fringing sand-ridges. Species not certain but probably *cinnamomeum*. S 1

Pomatostomus temporalis (Grey-crowned Babbler). Present at Rocky Pool.

P. superciliosus (White-browed Babbler). Common in all habitats. Breeding recorded June to October. S All

Cinclorhamphus mathewsi (Rufous Song-lark). Recorded twice (August 1970 and 1972). TN 2, 3, 5

C. cruralis (Brown Song-Lark). Common in good season (1970-72), uncommon in 1969 and not recorded 1973. Breeding observed August 1970-72. TN 3, 4, 5

Malurus splendens (Splendid Wren). Present in denser thickets especially along bore-drains. S 2, 6

M. lamberti (Variegated Wren). Common and usually seen in Wanya and along sand-ridge fringes. Nesting recorded August. Nest containing egg of Horsfield Bronze-Cuckoo found August 1971. S 1, 2, 5, 6

M. leuconotus (White-winged Wren). Common on open flats between sand-ridges and in *Kochia* flats on coastal side of Callagiddy. Breeding observed May to October. Nest containing chick of Cuckoo (Black-eared or Horsfield Bronze) found August 1972. S 3, 4, 5

Sericornis maculatus (Spotted Scrub-wren). A pair present along bore-drain on Brickhouse May 1971.

Pyrrholaemus brunneus (Redthroat). Recorded during most visits but not common; appears to prefer Wanya habitat. S 1, 2

Calamanthus fuliginosus (Field-wren). Not recorded on Callagiddy but common in coastal samphire flats near Carnarvon.

Aphelocephala leucopsis (Southern Whitefaee). Common in all habitats and breeding observed July-September. S All

A. nigricincta (Banded Whiteface). Recorded twice (June 1969 and August 1972) on eastern end of Callagiddy. In both cases, one pair seen in flock of Southern Whitefaces. V

Acanthiza apicalis (Broad-tailed Thornbill). Not common and most records from along sand-ridge fringes. S 1

A. uropygialis (Chestnut-rumped Thornbill). Common and usually seen on sand-ridges. Nests found in broken-off dead Gidgies and breeding recorded July-September. S 1, 2

Gerygone fusca (Western Warbler). Isolated birds seen June-August. SU 1, 2

Neositta pileata (Black-capped Sittella). Observed during most visits but not common. Breeding recorded August 1971 and September 1972. S 1, 2, 3, 5

Climacteris affinis (White-browed Tree-creeper). Not common and

always observed on sand-ridges. Breeding recorded August 1970, October 1971 and 1972. S1

C. melanura (Black-tailed Tree-creeper). Two adults seen feeding fledgling at Rocky Pool, October 1973.

Acanthagenys rufogularis (Spiny-cheeked Honeyeater). Recorded all visits. Breeding observed August and October. S All

Manorina flavigula (Yellow-throated Miner). Present during all visits. Breeding recorded August and September. S All

Meliphaga virescens (Singing Honeyeater). Common in all habitats. Breeding recorded June to October. S All

M. penicillata (White-plumed Honeyeater). Common in Coolibah habitat. Breeding observed August-October. S 5

Phylidonyris albifrons (White-fronted Honeyeater). Present May-August 1970 and June-August 1972. Nesting recorded June 1970. SU All

Certhionyx variegatus (Pied Honeyeater). Common in the winter and spring when season good (1970-72), rare in dry years. Nests containing eggs or chicks were found in August 1970-72. TN 1, 2

Epthianura tricolor (Crimson Chat). Common all years except 1973 when it was recorded only in June. Breeding observed August 1970 and 1972. PN All

Dicaeum hirundinaceum (Mistletoe-bird). Present May 1971 and March-June 1972. SU 1, 5

Pardalotus substriatus (Striated Pardalote). Recorded in June 1972 and 1973. SU 1, 5

Zosterops lutea (Yellow Silvereye). Two birds seen May 1971 in flock of Western Silvereyes along bore-drain on Brickhouse (13 km from coast).

Z. gouldi (Western Silvereye). Recorded occasionally on coastal side of Callagiddy (May 1971, April and June 1972). SU 3

Neochmia ruficauda (Star Finch). Recorded on Callagiddy May 1970 and at Rocky Pool, June 1970. V

Poephila guttata (Zebra Finch). Common during all visits. Most breeding records from period August-October although fledglings were present May 1971. One clutch of eight recorded August 1971. Nests frequently found in sticks of Wedge-tailed Eagle nests especially those occupied; also old corvid nests when occupied by Brown Falcons or Nankeen Kestrels. One occupied Brown Falcon nest had two occupied Zebra Finch nests attached to it with two others attached to nearby foliage. S All

Grallina cyanoleuca (Magpie-Lark). Present near all permanent water. Breeding recorded August-October. S 5

Artamus leucorhynchus (White-breasted Wood-Swallow). Present on coastal plain near Carnarvon, June 1970.

A. personatus (Masked Wood-Swallow). Common August-October all years except 1969 and occasionally seen before and after this period. Large flocks seen in May and August 1970. Breeding recorded August and September 1970-72 and October 1971. Six nests inspected 23-29 August 1971 contained 1-3 eggs. Of 20 inspected 28 August-1 September 1972, five contained one egg, eight contained two eggs, five contained three eggs and one contained two chicks. Nest invariably lined with the twining herb *Stenopetalum anfractum*. TN All

A. superciliosus (White-browed Wood-Swallow). A pair seen August 1972. V

A. cinereus (Black-faced Wood-Swallow). Common in all habitats. Clumping observed twice on 9 May 1971—10 birds at 12.00 hours and five at 12.30 hours. Breeding records from August-October. In period 20-30 August 1971, four nests contained two to four eggs and two contained four chicks. From 22 August-2 September 1972, four nests contained 2-3 eggs and two contained two chicks. S All

Cracticus torquatus (Grey Butcher-bird). Common in all habitats. Nesting reported June (1970) and August (all years). S All

C. nigrogularis (Pied Butcher-bird). Common and appears to be restricted to areas adjacent to mills and swamps. Breeding recorded August and September. S 5

Gymnorhina tibicen (Black-backed Magpie). Not common and localised in distribution. Nesting records in August and September S 1, 2

G. dorsalis (Western Magpie). Less common than preceding species and no breeding records S 1, 2

Corvus bennetti (Little Crow). Common all habitats. Nesting commenced June in 1970, July-August other years. Of 12 nests inspected late August 1971, three had fresh lining, six contained 2-6 eggs and three contained chicks. In late August 1972, 14 were inspected; one was lined, three contained 3-4 eggs; and ten contained 2-4 chicks, some ready to fledge. A nest with seven eggs recorded on Brickhouse on 11 July 1970. S All

C. orru (Australian Crow). Less numerous than Little Crows and usually found in Coolibahs around mills and swamp. S 5

MAMMALIA

Tachyglossus aculeatus (Echidna) Tracks seen in sand-ridge habitat.

Macropus robustus (Euro). Confined to sand-ridge and thick acacia scrub. Not as numerous as red kangaroos.

Megaleia rufa (Red Kangaroo). Common in all habitats.

Nyctophilus geoffroyi (Lesser Long-eared Bat). One collected from hollow tree August 1971.

Oryctolagus cuniculus (Rabbit). Occurs in isolated pockets mostly in acacia scrub habitat. No apparent increase in density or extension of range following good seasons.

Mus musculus (House Mouse). Present at Callagiddy homestead and shearing shed.

Pseudomys hermannsburgensis (Pebble Mound Mouse). Tracks attributed to this species seen in sand-ridge country after rain. One trapped August 1972.

Vulpes vulpes (Fox). Present in all habitats.

Felis catus (Cat). Seen in all habitats.

Capra hircus (Goat). Common in thick acacia habitats where flocks exceeding 20 individuals often recorded.

DISCUSSION

A total of 152 vertebrates were recorded on Callagiddy in 5 years. The majority of species were birds. Native mammals were poorly represented. Reptiles were well represented (31 species) although Pianka (1969) has recorded 40 species in one sand-ridge habitat in the Great Victoria Desert. The Bobtail Skink *(Trachysaurus rugosus)* was probably introduced to the banana plantations along the river at Carnarvon (G. M. Storr pers. comm.). It is now found on the western side of Callagiddy, an extension of 30 km.

There seem to be little published data on the bird fauna of this area. Kikkawa and Pearse (1969) considered there were 63 species of land birds in 12 selected orders in the Carnarvon area. Data presented here lists 83 species from these same orders and this figure does not include Mangrove Golden Whistler *(Pachycephala melanura)*, White-breasted Whistler *(P. lanioides)*, Samphire Thornbill *(Acanthiza iredalei)* and Dusky Warbler *(Gerygone tenebrosa)* which were recorded at Bush Bay (see Fig. 1) by the 4th Harold Hall Expedition in June, 1966 (Hall, 1974).

Table 2 shows the number of bird species found in each of the defined habitats.

TABLE 2.—NUMBER OF BIRD SPECIES (excluding vagrants and water-birds) ON CALLAGIDDY ACCORDING TO STATUS AND HABITAT.

Status	Total Species	Habitat					
		1. Sand ridge	2. Dense Acacia scrub	3. Coastal flat	4. Inland flat	5. Swamp	6. Bore-drain
Sedentary	48	38	35	28	25	34	25
Partial nomad	10	9	9	10	10	10	9
True nomad	8	6	7	8	7	8	6
Migrant	1	1	1	1	1	1	1
Status unknown	11	9	6	5	5	8	4
TOTAL	78	63	58	52	48	61	45

Sand-ridge and swamp appear to eontain the greatest speeies diversity although neither are as diverse botanieally as the dense aeaeia serub. The sand-ridge vegetation is dominated by Gidgie whieh grows to twiee the height of other trees in the area and so probably gives this habitat the greatest plant height diversity. Swamp vegetation is dominated by Coolibah whieh is the only native eucalypt on Callagiddy.

The same two trees (Gidgies and Coolibahs) are important nest sites for a number of bird speeies which either construet stiek nests (diurnal raptors, herons, buteher-birds, magpies, erows) or require hollows (some dueks, parrots, owlet-nightjars and some passerines).

Gidgie has a long straight trunk. During eyelones a number are broken, usually 1-3 m from the ground. The resultant stump beeomes hollow from the top and at least 10 speeies have been reeorded nesting in these hollows. Gidgie is used extensively in the Carnarvon area for fenee posts whieh also hollow with age and provide nest sites, especially for wood-swallows.

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BREEDING OF THE WHITE-TAILED BLACK COCKATOO IN CAPTIVITY

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The CSIRO Division of Wildlife Research at Helena Valley, W.A. has maintained a collection of short-billed White-tailed Black Cockatoos *(Calyptorhynchus baudinii latirostris)* in captivity since 1967. Initially, there were two males and two females caught in the wild and held in a converted chicken run. No nest hollows were supplied and these birds made no attempt to breed.

In 1970, a large aviary was constructed (12 metres long x 6 metres high x 6 metres wide) around an old wandoo *(Eucalyptus redunca),* which was pruned to fit inside the aviary. Four nesting hollows were placed in the aviary, two attached to the wandoo and the other two to the side of the aviary.

In late November 1970, a pair were released into the large aviary, the other pair remaining in the small cage. In late October 1971 the female in the large cage (Female A) laid one egg which was broken shortly after. A second egg was laid in the same hollow but it was also broken. It appeared as if a claw had been pushed through the shell.

In the third week of September 1972. Female A laid one egg but made no attempt to incubate it.

In October 1971 a new bank of holding aviaries was constructed, each flight area being 4.9 metres long x 2.4 metres high x 1.2 metres wide. Each flight had at least one hollow log at the end which also had weather screening round it. In November of that year five females and two males were caught in the wild and added to the collection. One of the females and one of the males were paired in the wild and they were caught together with their fledgling (Pair B). These birds and the pair from the old small cage were placed in the new aviaries, one male and one female together in each flight with the surplus females being placed together.

None of these pairs made any attempt to breed in these aviaries in 1972. In August 1973 Pair B were placed in the large aviary with Pair A. In the second week of September, Female A laid one egg, then another about one week later. She incubated these eggs for just over the 29 days required for incubation. Neither egg hatched and the female deserted.

Female B laid her first egg around 24 October 1973 and incubated it until it hatched in the third week in November. At about this time Female A laid two more eggs and incubated them for a month but neither hatched and she deserted them, too. The nestling of Female B died about 6 weeks after hatching. Neither pair made any further attempt to breed that season.

In 1974 Female A died of unknown causes and her male was removed from the big cage, leaving Pair B alone in the cage. During the breeding season of 1974, extensive earth works were carried out near the cockatoo cages and none of the birds attempted to breed.

In 1975 Female B laid one egg around 20 October in the same hollow she used in 1973. She laid a second egg within the next ten days. The female incubated the eggs and one hatched around 18 November. The second egg failed to hatch.

No other pair in the other aviaries made any attempt to breed in any of these seasons.

The nestling was brooded continuously by Female B for about two weeks after hatching, and during this time she was fed by the male and occasionally went and fed and drank by herself. Once the female stopped brooding continuously the nestling was fed by both parents in the morning and evening. The female continued brooding the nestling at night.

Towards the end of January 1976 the nestling started moving up and down the inside of the spout and spent progressively longer sitting in the entrance of the hollow. During this period the parents fed it at the entrance of the hollow.

On the evening of 8 February when the nestling was just over eighty days it flew from the hollow. It was found next morning on the floor of the aviary with one leg paralysed. The fledgling may have hit its head on the aviary side and suffered concussion.

The fledgling was left on the ground and the parents spent their time sitting on the ground near it and continued to feed it on the ground. The fledgling remained on the ground until mid-March, during which time, its leg became more usable. About mid-March it started flying round the aviary and perched on the tree or on the cage floor. It had a lot of trouble landing due to its inexperience, but it gradually mastered the art of landing gently instead of flying full speed at the perch and crashing into it.

By the end of April it could fly very well and it had completely regained the use of its previously paralysed leg. Although it was feeding itself, it still begged continuously from its parents. This is not surprising as fledglings in the wild are dependent on their parents for several months after leaving the nest hollow.

During the breeding season the birds were given sunflower seed, mature marri *(Eucalyptus calophylla)* nuts, *Banksia grandis* fruits and *Pinus pinaster* cones. The adults fed the nestling sunflower seed most of the time, although they occasionally gave it small amounts of the other foods.

This is the only published record, of which I am aware, of White-tailed Black Cockatoos fledging young in captivity. Forshaw (1969) says "he understands . . . . the White-tailed Black Cockatoo has recently been bred" but gives no details. Lendon (1973) on the other hand says he has "never heard of a successful breeding".

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CLADOPHORA, EUTROPHICATION AND THE PEEL INLET

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In many rivers and lakes large growths of *Cladophora* are associated with nutrient-rich waters and can be said to be indicative of eutrophication (Pitcairn and Hawkes, 1973). The natural enrichment of a body of water, leading to a rise in the level of available nutrients, such as nitrogen and phosphorus is known as eutrophication. Man often speeds up this process by polluting waters. Enormous accumulations of rotting algae build up in certain bays (e.g. Coodanup) of the Peel Inlet. The dominant species is commonly called 'Goat-Weed,' a species of *Cladophora* existing as dark green balls 1-3 cm in diameter. Associated with these balls, as a bright green surface mat, are an intertwined mixture of filamentous species of *Enteromorpha* and *Cladophora*. These mats are sometimes trapped over offshore beds of *Ruppia maritima*. In a few parts of the estuary large patches of *Chaetomorpha linum* are hazardous to boating.

Cladophora balls grow and accumulate in large offshore beds in water from 1 to 2.5 m deep. In summer, the algae rise from thick bottom patches, float near the surface of the water and then fall to the bottom. This cyclic pattern is probably caused by evolved gas being trapped between the filaments.

During spring and summer, presumably when *Cladophora* is actively growing, the balls begin to accumulate on the shore of the Peel Inlet due to the action of water movement and onshore winds. In this manner, extensive accumulations may build up, for example, in the mouth of the Murray River and extend a short distance upstream.

Cross (1974) reports that after the late 1950's in a period of lower than average rainfall, a noticeable change occurred in the Peel Inlet and

several species of algae, including *Cladophora* and *Enteromorpha* became established. These algae are reported to break away and form raft-like masses which accumulate along the shore of the estuary where they decay, releasing hydrogen sulphide and depleting oxygen levels in the water. Reports by Rippingale (1974, 1975) to the Metropolitan Water Supply, Sewerage and Drainage Board supported the claim made by Cross that *Cladophora* has increased in recent years in response to a hypothetical increase in eutrophication resulting from outside enrichment of the estuarine waters.

No comparable information is available on *Cladophora* elsewhere in Australia, though it has been reported as a nuisance in the Swan River Estuary (Royce, 1955). The lack of data suggests that *Cladophora* does not form large algal mats in other Australian estuaries. In Eastern Australia and New Zealand nuisance weed growth is more commonly due to aquatic angiosperms than to algae. Comparisons for *Cladophora* growth in the Peel Inlet must, therefore, be sought in the northern hemisphere. There *Cladophora* has been shown to respond to eutrophication. It is capable of rapid colonization of bare surfaces and of extremely rapid growth. Many species are favoured by high light intensities, high nutrient levels, high pH values, hard and turbulent waters (e.g. Whitton, 1970; Pitcairn and Hawkes, 1973). Productivity is governed by a natural annual rhythm of the alga interacting with environmental factors.

It is difficult to evaluate the factors affecting *Cladophora* in the Peel Inlet because there are no data available on a similar species of *Cladophora* in a similar estuary elsewhere. In order to predict control measures for *Cladophora* in the Peel Inlet we need to determine the status of the major benthic species.

ACKNOWLEDGEMENTS

I would like to thank Dr E. P. Hodgkin of the Department of Conservation and Environment for financial support and Mr. Harold Roberts from the Swan River Conservation Board for providing transport to and on waters of the Peel Inlet.

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FROM FIELD AND STUDY

Galahs and Little Corellas in the Claremont/Cottesloe Area.—On April 21, 1974, in the vicinity of my home at 82 Railway Street, Cottesloe, a flock of 12 Galahs (*Cacatua roseicapilla)* was sighted. At the final preparation of this note (April 1976) the birds were still in the area and had increased to about 30.

On April 23, at the Teachers' Training College, Princess Road, Claremont, a flock of about 100 Corellas was sighted flying over the college toward the north. The birds were identified as Little Corellas *(Cacatua sanguinea).*

—PETER McMILLAN, Claremont Teachers' College.

Little Wood Swallow at Ellendale.—Serventy & Whittell *(Birds of Western Australia,* 4th edition, 1967) give the southern limit of the Little Wood Swallow *(Artamus minor)* as the Murchison River gorge and the Gnows Nest Range. On June 15, 1974 we observed a party of about eight Little Wood Swallows at Ellendale, flying close to the cliffs on the southern bank of the Greenough River; this extends the species' published range by about 120 kilometres. However, the ironstone breakaway habitat favoured by the species further inland is very much the same as that provided by the Ellendale cliffs. About the same number of birds has been seen at Ellendale by one of us (L.E.S.) on July 28 and August 18, suggesting that the flock is resident rather than vagrant.

—ERIC H. & LINDSAY E. SEDGWICK, Geraldton.

Dusky Moorhen at Leonora.—A single Dusky Moorhen, *Gallinula tenebrosa,* was captured in the waiting room of the Leonora railway station on April 15, 1975. The bird appeared to be slightly injured, but, when released at the edge of Lake Raeside, moved off smartly.

There was no doubt of the identification. Field notes show a grey-black bird, with white undertail coverts, greenish legs, and yellow beak with a red frontal shield.

The bird no doubt reached the Leonora area as a consequence of the flooding of the Lake Raeside lake system 6 weeks earlier, when the North-eastern Goldfields received between 250-400 mm of rain in a few days. Lake Raeside received waters from as far west as north of Youanmi and reached a width of 3 kilometres south of the town. The flooding of lakes throughout a large area of the interior of the state allowed the bird to travel over 400 kilometres from its regular haunts.

—DON REID, Leonora.

Singing Bushlark in the Northeastern Goldfields.—On December 17, 1974, when 13 kilometres east of Duketon, in an area of open mulga, largely *Acacia aneura,* I noticed two immature Black-throated Butcher-birds plucking a small bird wedged in a branch fork. On investigation, I found a neatly plucked body of a Singing Bushlark, *Mirafra javanica,* wedged in the fork by the head. The head and neck were still feathered, and the tail feathers on the ground were still recognisable. Identification was made on the following characteristics: beak, short and somewhat finch-like, pinky-brown in colour; tail feathers short in proportion to the body. Pale eyebrow in finely ornamented head feathers.

The presence well south of its regular distribution may probably be attributed to the two exceptional seasons the centre and the goldfields experienced in 1973 and 1974, which led to a spectacular growth of grasses and annuals throughout. It would have been easy under these conditions for a species to expand its distribution, even temporarily.

—DON REID, Leonora

Red Plumed Pigeon in the Carnarvon Ranges.—An extension in recorded range of the Red Plumed Pigeon, *Lophophaps ferruginea,* is indicated by my sighting two parties of these birds at Katjera Spring in the Carnarvon Ranges, approximately 3 kilometres east of Mt. Methwin, on May 15, 1975. A party of at least 10 was flushed at the western end of the rocky range containing the spring. First knowledge of their presence was their 'explosive' flight overhead. They rapidly came to ground in very broken quartzite country. Later in the afternoon, two birds were sighted on the *Triodia*-covered hill pediment north of the spring, apparently heading to water.

In both sightings, it was quite clear that the birds had a brown breast and abdomen.

The area lies about 300 kilometres NE of Meekatharra. The ranges are the easternmost large hills of the Proterozoic sequence and occur toward the southern boundary of the Nabberu basin. It is probable that small populations of this bird occur throughout to the north and west wherever the right habitat occurs.

—DON REID, Leonora.

Marsh Sandpiper *(Tringa stagnatilis)* **near Leonora.**—A visit to Malcolm Dam, 7 miles east of Leonora, on November 3, 1974, led to my recording two Marsh Sandpipers. Two medium-sized waders were noticed on the north side of the dam, on a broad, recently emerged flat, in company with 10 Banded Plover *(Zonifer tricolor).*

The birds were later approached on foot, and observed from 50 up to 20 metres. The Banded Plovers flew off, leaving the sandpipers by themselves, feeding along the water's edge. My field notes are as follows:—2 Sandpipers, somewhat smaller than a Banded Plover. Black, long, straight bill, yellowish-green legs. Faint speckling on sides of shoulders forming a saddle. Speckled wing coverts. Pronounced white eyebrow mark. White forehead. White rump and tail while flying. Call a 'tehew-tehew-tehew'. Time of observation 1630 WST. Observed through 7 x 50 binoculars.

The size of the birds, the white rump and tail, leg and bill colour are diagnostic of *Tringa stagnatilis.* Their sighting so far inland is easily explained by the exceptional winter rains throughout the North-eastern Goldfields in 1973 and 1974. The numerous water-filled lakes and claypans have formed a favourable habitat for several of the migrating waders. Lack of observers rather than lack of birds in this area is no doubt responsible for the paucity of previous records.

—DON REID, Leonora.

Supplementary Notes on Turtledoves, *Streptopelia,* **in Western Australia.**—A summary of the results of an inquiry into the introduction and spread of the turtledoves in Western Australia appears in the *Western Australian Naturalist,* vol. 6, 1958, pp. 90 and 112, and in vol. 9, 1965, p. 153. The following are a few personal observations made during the ensuing ten years. *Streptopelia senegalensis* is now more properly called the Laughing Dove, and *S. chinensis* the Spotted Dove, but to avoid confusion I have retained the older vernaculars—Senegal Turtledove and Indian Turtledove—to conform with the earlier articles.

HARVEY: **Senegal**—This species appears to have increased slightly in numbers and is no longer confined to a limited area immediately north of the main shopping centre. Up to six birds frequent my garden on the southern edge of the town.

Indian—I first saw this species in Harvey on December 3, 1970. The only prior record of which I am aware was in 1956. On November 5, 1972, a bird appeared at my home and continued to frequent the area until mid-August 1973. A bird was recorded in July 1974.

ROCKINGHAM: **Senegal**—This species has increased greatly in numbers at Point Peron where they nest and roost in, and generally frequent, the thickets of Coast Wattle, *Acacia rostellifera.* I saw 14 birds together, apparently assembling to roost, in April 1966.

WILLIAMS: **Senegal**—This species appeared to have a tenuous hold in 1955. While passing through the town in May 10, 1974, I saw one dove fly to a pine tree by the Albany Highway.

The following previously unrecorded localities have come to my notice:

KONDININ: **Senegal**—One noted on September 6, 1966.

KULIN: **Senegal**—One noted on May 28, 1971.

MEENAR: **Senegal**—Noted from train on January 28, 1967.

NAREMBEEN: **Senegal**—One noted in the town on March 24, 1967. I have since found them to be fairly frequent.

PINJARRA: **Senegal**—Two, seen separately, on July 25, 1970. This appears to be the first definite record of this species in Pinjarra.

SERPENTINE: **Senegal**—One bird noted on February 1, 1966.

—ERIC H. SEDGWICK, Harvey.

Movements of the Spotted Pardalote.—The following table summarizes all observations which I have made of the occurrence of Spotted Pardalotes, *Pardalotus punctatus,* at various stations, arranged in order from north to south, within their range in south-western Australia.

LOCATION	Period of Observance. (dates inclusive)	Period of Occurence.
WOOROLOO	1951-1953	Mar.-Sept.
ROCKINGHAM	1937-1940	Apr.-Oct.
WILLIAMS	1954-1955	May.-Oct.
HARVEY (Plain)	1963-1975	Apr.-Aug.
HARVEY (Range)	1963-1975	Mar.-Oct.
COLLIE	1956-1961	Feb.-Nov.

February and November qualify for inclusion in the Collie "Period of Occurrence" on the strength of only one record in each month.

The pattern revealed is consistent with the statement in *Birds of Western Australia,* by Serventy and Whittell; "There appears to be an annual autumn movement from the south to the Perth district which in some years may be quite considerable. The birds appear during May and stay to nest in the spring."

From points south of Collie I have only incidental records, e.g. from Pemberton, Nornalup, Yallingup and the Stirling Ranges. Significantly, some of these are summer records.

All the foregoing points to a movement from the south during the cooler, wetter months and a return movement in spring, some birds remaining in the south throughout the year.

However, much of the above is an over simplification. The movement in any one area is not predictable. On Harvey townsite, for example, no Spotted Pardalotes were recorded in either 1970 or in 1974. In 1971 they were recorded in May only and in 1972 in May and June only. *Birds of Western Australia* indicates that the number of individuals appearing may vary considerably from year to year.

I suspect, too, that habitat, or associated food supply, available in an area may influence the occurrence of Spotted Pardalotes. In the Rockingham district they seemed to favour the Tuart, *Eucalyptus gomphocephala* and about Collie, the Flooded Gum, *E. rudis,* along the watercourses. The Bullich, *E. megacarpus,* may be favoured in the Darling Range and the Spotted Pardalote appears to be an integral part of the Karri, *E. diversicolor,* association. All these factors tend to obscure the underlying pattern of movement.

The foregoing observations and deductions are placed on record in the hope that other observers will be encouraged to fill in the gaps in the outline presented.

—ERIC H. SEDGWICK, Harvey.

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EJAH BREAKAWAYS, MILEURA, CUE, AS AN ABORIGINAL HOME

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INTRODUCTION

Davies (1961) described a number of Aboriginal sites in the Murchison District of Western Australia, one of which was the Gnumartna Rock Hole (Lat. 26°22'S; Long. 117°18'E). This site is a gully running into the Ejah Breakaways, a rocky outcrop at the headwaters of one of the tributaries of the Pindebarn Creek, which itself drains into the Murchison River. During the past sixteen years we have spent many weeks at the CSIRO Division of Wildlife Research Field Station on these breakaways, and have learnt to come to terms with the environment there under different seasonal conditions. In the course of these years we have been impressed to find that almost everything that we do, every track we take, every lookout we use, everywhere we recognise as a shelter, has evidence of prior use by Aboriginal people. It is perhaps not surprising that this is so for we are conspecific with the Aborigines and the behaviour of animal species contains many species specific elements and patterns. By living under field conditions we are forcing ourselves to meet the same problems of comfort and concealment, movement and location as did the Aboriginal people before the advent of European man. The environment seems to have changed little, and the fact that we have often come to the same solutions to problems as previous inhabitants of the area might have been expected. However the realization of this common experience has prompted us to speculate on the use Aborigines made of the Ejah Breakaways. This paper is, then, an analogue synthesis of Ejah as a habitat for men, an account of the best solutions we have found to the problems the environment poses. As such it can prove no theories. It records facts, correlations and experiences, and may perhaps be useful if it stimulates predictions that themselves lead to the discovery of new facts in the form of sites that can be excavated and analysed.

There is little contemporary record of the use made by Aboriginal people of Ejah. It is clear that it was used by people of the Wadjari tribe and that Gnumartna Rock Hole and its carvings were of some sacred or ceremonial significance. The name, Ejah, is an expression of surprise as 'oh' or 'ah' are in English. We have met no living people who witnessed Aboriginal occupation of Ejah. Figure 1 is a sketch map of the breakaways and Plate 1 shows portion of the southern face.

Excavations reported in this paper were made prior to December 1972. Subsequently the Western Australian Aboriginal Heritage Commission has issued a permit for the continuance of such exploratory archaeological work on Mileura and we are grateful to Mr. B. Wright of the Western Australian Museum for his advice and help in this regard. Dr. W. Bray of the Institute of Archaeology, London, kindly advised us on radio-carbon dating methods.

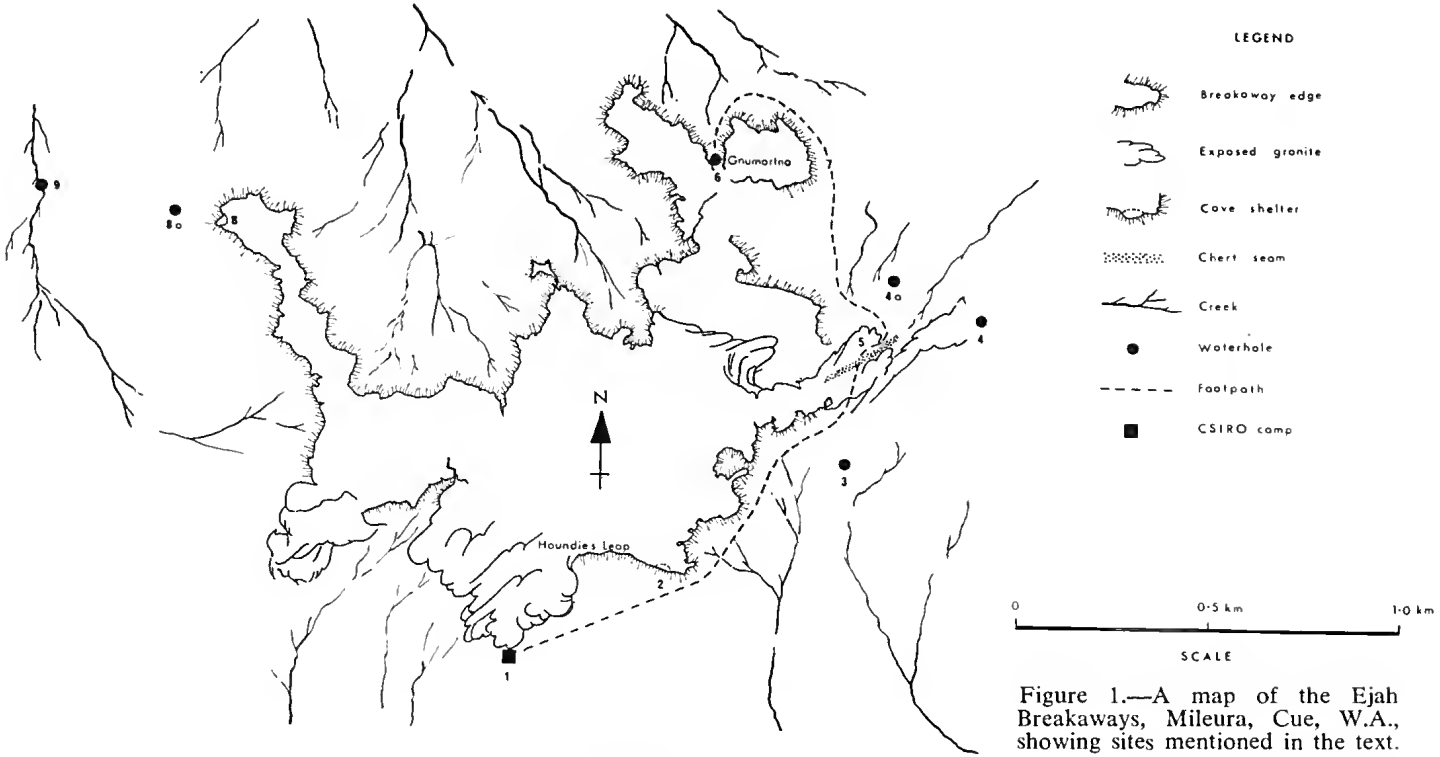

Figure 1.—A map of the Ejah Breakaways, Mileura, Cue, W.A., showing sites mentioned in the text.

RESULTS

1. **CSIRO Camp, Ejah** (Figure 1, 1)

The camp is located on the southern edge of a sloping granite outcrop, not far from the breakaway scarp known as Houndie's Leap, after a spaniel that followed a fleeing rabbit over the drop. Ejah had some obvious advantages for a base camp. It was centrally placed in the study area, Mileura Pastoral Lease, roughly defined by the watershed of the Pindebarn Creek. Ejah lies midway between the north and south ends of the lease, but is close to the western boundary. A main road close to Ejah makes access to the eastern side easy. This road runs eastward straight to the shearing shed and homestead in the middle of the lease, where it meets good roads running to all parts of the station, but the site was still far enough away from the homestead (15 km) to ensure that the surrounding countryside received minimal disturbance during stock management practices. The outlook was attractive and a good stand of tall *Acacia adsurgens* trees provided shade. The sloping granite north of the site not only sheltered it from the direction of prevailing storm winds and rain (the north-east in both summer and winter) but was a natural water catchment on which pools formed after rain. The surrounding breakaways provided numerous lookouts from which emus could be watched on the plains below. Because of its elevated position, the site was easy to locate during excursions on foot or vehicle into the surrounding countryside. Subsequently it was discovered that the site had two other advantages over a site by the main creek, which would have been a more conventional choice. First the blood-sucking Diptera were fewer there than in the creek, an important factor in an area where arthropod-borne virus diseases have been seen to

Plate 1.—The Houndie's Leap rock shelter from the south. The rock shelter is partly exposed on the right of the plate, and continues behind the boulder in the centre of the plate. To the left the roof of the shelter dips sharply, and the shelter is effectively unusable by man.

decimate the avifauna and where cyclones could conceivably bring down from the north not only viruses lethal to birds but ones lethal to man as well. Secondly the temperature relations of the area mean that the highlands such as Ejah are cooler in summer and warmer in winter than the main creek beds (Davies, 1973).

2. **Houndie's Leap rock shelter** (Figure 1, 2)

The site is a typical breakaway rock shelter (Plate 1), about 3 metres deep, 7 metres long and 2 metres high. The rock floor is covered with approximately 30 cm of soil and debris and is now used as a shelter by Euros *(Macropus robustus)*, Goats *(Capra hircus)* and many nesting and roosting birds. The entrance faces south and is about 10 metres above the level of the plain below. It gives almost exactly the same attractive prospect and degree of shelter from prevailing weather as does the CSIRO campsite, yet we were unaware of this rock shelter when we chose our own campsite. The rear walls of the shelter were decorated with a few disintegrating hand stencils in red ochre in 1961, but these have now disappeared. Excavation through the soil and debris on the floor has revealed three levels of hearths. Charcoal from the lowest of these, at the level of the rock floor, has been estimated as dating from 660 A.D. ± 100 years by the C^{14} method (RL 513). This result has some interesting implications.

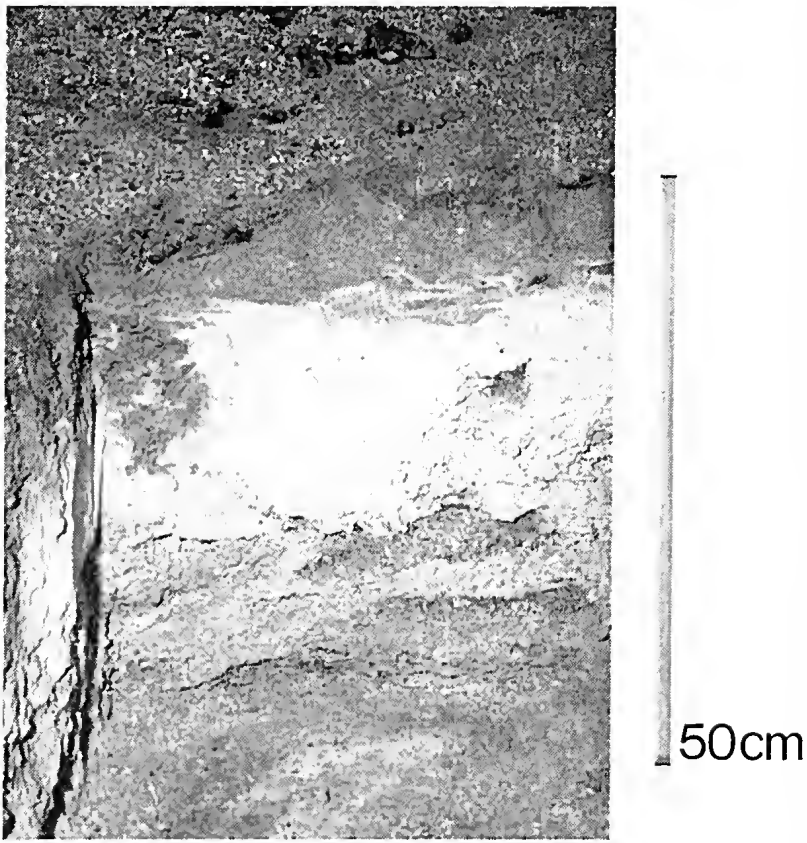

Plate 2.—A section through the floor of the Houndie's Leap rock shelter, showing the three hearth layers.

but in mentioning them it is as well to recognize that the dating method merely fixes the time at which the carbon was incorporated into the wood that made the charcoal. It tells us nothing of the time the tree stood, alive or dead, before it was used as fuel for an Aboriginal fire. Nonetheless it seems reasonable to suggest that the site has been used for over 1,000 years, and that the landscape, in particular the breakaway edge, has changed little in that time. Immediately above this lowest hearth layer is a layer of granite detritus, 3 cm deep, and then another hearth layer. Above this second layer is a layer of large rocks, 5-10 cm in diameter, which have obviously fallen from the roof of the shelter as part of a considerable rock fall. The layer is about 12 cm deep and above it lies another hearth layer. A layer of dusty soil of variable width separates the upper hearth layer from the disturbed recent detritus layer. Plate 2 illustrates a section through the cave floor exposed by the excavations. There seems to be little doubt that the Aborigines used this as a dwelling and the abundance of worked pebbles on the plain below the shelter is evidence in support of this view.

3. Houndie's Leap Gnamma Hole

There is a bowl-shaped depression in a superficial granite slab about 1 km east of the Houndie's Leap shelter. It holds water after rain and could have served as a well. The diameter of the surface hole is 20 cm, the chamber was 125 cm deep and opened out to a maximum width of 230 cm. Excavation of the detritus in the hole did not reveal any artifacts, but the rock around the hole was worn in the position where one would kneel to take water from the hole. It is the nearest significant rock hole to the cave shelter and lies on a path route from it around the breakaway to Gnumartna.

Plate 3.—Stone arrangements on the north-western side of Ejah Breakaways. Notice that the arrangement correlates visually with the three hills in the middle distance.

4. **Covered well** (Figure 1, 4)

About a kilometre further round the edge of the breakaway there is a rock hole in a large granite slope which is covered by three slab stones that were still in place when the site was found in 1975. The well holds water for most of the year and the cavity is 50 cm in diameter x 120 cm deep. This well is off the direct path from Houndie's Leap Cave to Gnumartna.

5. **Stone arrangements** (Figure 1, 4a)

Near the covered well there are three piles of stones; no natural process could be conceived that would have produced such an arrangement, but there are no associated worked artifacts. They are illustrated in Plate 3, which shows that, from a particular position they line up perfectly with three rises in the middle distance. If we wish to describe aspects of the countryside we draw a mud map. These rock piles are more permanent than a mud map, but could have served the Aborigines as a permanent visual aid for describing features of the countryside from this point. Davies (1961) has mentioned incised 'maps' near Gnumartna Rock Hole that were said to have served this purpose.

6. **Gnumartna Rock Hole** (Figure 1, 6)

No new information has been obtained from this site which is described by Davies (1961). It is, however, weathering badly in places and many of the stencilled hands that were visible in 1959 are no longer clear. A detailed series of photographs of the decoration of the site as it was in 1960 have been deposited in the Western Australian Museum.

7. **The path**

The path around the edge of the breakaways goes directly from the Houndie's Leap rock shelter to Gnumartna rock hole along a course that we have found is the best compromise between ease and directness. It is used by many animals as well as ourselves, especially Euros, Goats, Sheep *(Ovis aries)* and Rabbits *(Oryctolagus cuniculus)*. It crosses a dyke of a chert-like material (5 in Figure 1), chipped pieces of which are frequently found around the breakaway, and which seems to be the most suitable local stone for the preparation of stone tools.

8. **The north-west rock shelter** (Figure 1, 8)

This cave is more than 20 m deep, and unlike the Houndie's Leap shelter is concealed behind a thin granite screen, although it is also formed by erosion under a laterite cap. It has not been extensively explored, but seems likely to have been a shelter, or perhaps a watch-tower, for it overlooks an important water hole. There are traces of soot on the roof.

9. **The north-west water hole** (Figure 1, 9)

This pool is in a deep granite depression in a creek bed, and although no careful records have been kept of its permanence it has many tracks converging onto it and appears to be at least as important to the animals of the area as Gnumartna. At both water holes the scrapes made by kangaroos seeking water provide drinking points for other animals and birds when the surface water has evaporated. It is almost certain to have been used by Aboriginal man as well, and when full is about 50 cm deep. Between it and the north-west rock shelter there is a pattern of stones laid out adjacent to the pile of granite boulders closest to the shelter (8a on Figure 1).

10. **Extra-limital sites**

(a) **Milly factory**

This is a stone working site on a diorite dyke cutting across Milly breakaways 18 km south of Ejah and readily visible from it. Milly breakaways form the south side of the valley of which the Ejah breakaways

are the north. The diorite dyke is exposed for about 1 km and appears to be about 1 m wide, although its width varies and the broken, superficial rock is scattered over a greater width than a metre. Throughout its length worked cores can be found, as well as discarded and possibly imperfect stone tools.

(b) **Cattle camp pool**

The remains of the shelters of an old mustering camp lie beside a pool in a creek 6 km S.E. of Houndie's Leap shelter. Although this camp was undoubtedly used by European man the stream bed and bank contain numerous worked rocks and suggest that the Aborigines used the site long before European man reached the area. Possibly, as stockmen in his employ, they sited their muster camp on a traditional site. The pool holds water for several weeks after the winter rains and makes the site an attractive location at that time of year. No excavations have yet been carried out at this site.

(c) **Yarramcedie Gallery**

This site is described by Davies (1961) and lies 20 km north of Ejah. The Yarramcedie Range is a striking backdrop to the view north from Ejah and intrudes onto the horizon in most outlooks from the north side of the breakaways. The large and permanent Poonthoon Pool lies to the south of the range, east of the gallery, and must have been the summer refuge after the rock holes of the hills had dried out. Poonthoon provides a backstop to life at Ejah, where the rock holes cannot be relied upon to last through long dry periods.

DISCUSSION

Detailed examination of the Ejah breakaways show that they provide sufficient water and shelter to support human life for most of the year, and that they are conveniently placed within walking distance of other sites apparently important to Aborigines. There are Euros around the breakaways which could provide food, and no doubt much other food was available for people with traditional knowledge. The extensive carvings and paintings of Gnumartna confirm that it was much used by the Wadjari tribe and our experience suggests that it could have been a permanent base for the surrounding countryside from which its inhabitants need only have retreated in very long dry spells.

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THE WANDERER BUTTERFLY AT BUNBURY AND OTHER PARTS OF THE SOUTH-WEST, AND A NEW FOOD PLANT

By L. E. KOCH, Western Australian Museum, B. DELL, Murdoch University, and G. J. KEIGHERY, Kings Park Board.

Populations of the Wanderer butterfly *(Danaus plexippus)* were discovered near Perth in the late sixties (Koch, 1971, 1973*a* and 1973*b;* Dell, 1974). In recent years, the Wanderer has also become abundant in the lower South-West, particularly the Bunbury area, where its breeding places have been found.

Since January 1976, the Wanderer has appeared more abundantly than in previous years around Perth; there have been numerous sightings

at Glen Forrest, Helena Valley, Bayswater, Tuart Hill, Nedlands, Karrakatta and Fremantle.

Many persons in the South-West, especially Mrs. S. Mifflin and other members of the Leschenault Naturalists' Society, have reported Wanderers around Bunbury between January 1 and March 28, 1976. Of the more than 200 Wanderers sighted, 82 were along the Collie River at Roelands, 70 at Bunbury and 27 at Donnybrook. The butterflies were most abundant throughout March 1976, especially at the following localities (listed from north to south): Harvey, Binningup, Beela, Brunswick Junction, Roelands, Bunbury, Waterloo, Boyanup, Argyle, Capel, Donnybrook, Wyadup (near Yallingup) and Grace Town (on Cowaramup Bay).

The butterflies have been recorded even further to the South-West, viz, at Augusta in January 1968 (Koch, 1971) where they were seen again in mid-June 1976.

Wanderer butterflies are attracted to a variety of flowers, including those of *Lantana, Ageratum, Zinnia, Abelia, Buddleia, Dahlia, Poinsettia, Eriobotrya* and *Abutilon.*

The W.A. Herbarium has the following records of milkweed plants, the food of the caterpillar:

Asclepias curassavica—Carnarvon, Geraldton, Trayning, Fremantle, Mundijong.

Asclepias fruticosa—Kings Park, Armadale, Jarrahdale, Dwellingup, 7 mi. W of Busselton.

However, milkweed must have a much wider distribution than these data indicate, for, in April 1976, caterpillars of the Wanderer were reported from Augusta, Narrogin and Pingelly. Furthermore, during the course of the present increase of the Wanderer around Bunbury, the butterflies were found to be numerous at the following localities in which milkweed was growing: Harvey (Harvey river and roadsides), Roelands (along the Collie River), Bunbury (various gardens), Dardanup to Wellington Mill (in the upper reaches of the Ferguson River), and Joshua Brook (3 mi. E of Boyanup).

Some residents believe that the Wanderer has been present in Bunbury for at least 10 years. All stages of the Wanderer (and also the Lesser Wanderer) were associated with *A. fruticosa* growing along the railway line at Blair Street, Bunbury, e.g. on 18/5/1974, 21/7/1974, 10/6/1975, 1/8/1976. *A. fruticosa* was the food plant of large numbers of Wanderer caterpillars at the Collie River in April 1975.

In Kings Park, caterpillars of both the Wanderer and the Lesser Wanderer have been observed feeding on *Staphelia variegata* and *S. grandiflora* in the Botanic Gardens. Indubitably, the butterflies must recognise *Staphelia* species as food plants of the caterpillars, which thrive on these plants and at times are regarded as pests by gardeners. Previously species of *Calotropis* and *Asclepias* were the only recorded food plants of the Wanderer in Western Australia. Detailed information on these and other food plants elsewhere in Australia is given by Smithers (1973). The present record is the first of *Staphelia* as a food plant of the Wanderer in Australia.

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STATUS OF THE PURPLE-CROWNED WREN *(MALURUS CORONATUS)* AND BUFF-SIDED ROBIN *(POECILODRYAS SUPERCILIOSA)* IN WESTERN AUSTRALIA

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SUMMARY:

A review of the records of the Purple-crowned Wren *(Malurus coronatus)* and Buff-sided Robin *(Poecilodryas superciliosa)* in the Kimberleys of Western Australia is presented chronologically to show that the numbers of these once common species have been drastically reduced.

INTRODUCTION

In Western Australia the Purple-crowned Wren and Buff-sided Robin are found in the Kimberleys. They inhabit thick vegetation at the margins of watercourses, the Purple-crowned Wren preferring pandanus, rushes and "bamboo" (canegrass) thickets at the water's edge, and the Buff-sided Robin the taller, lush thickets. Both species were once common in the Ord and Fitzroy River drainages.

The fifth Harold Hall Expedition of 1968 began a period of intense ornithological activity in the Kimberleys. Since 1971, staff of the Vertebrate Department of the Western Australian Museum, independently, or in association with other institutions (such as the Western Australian Department of Fisheries and Wildlife) have spent many months in all parts of the Kimberleys. These efforts have been augmented by the contract work of W. H. Butler for the Western Australian Museum and the American Museum of Natural History. Greater mobility has allowed us to visit areas previously inaccessible. Thus the total time collecting and observing in the Kimberleys in the last 7 years probably outweighs the efforts of the previous 90-odd years. Despite the greatly increased effort since 1968, the Purple-crowned Wren has only been recorded at five localities, and the Buff-sided Robin at seven localities.

The rapid decline in numbers and area of distribution of these two species is best shown by examining the relevant parts of observers' notes in chronological order.

PURPLE-CROWNED WREN

T. H. Bowyer-Bower (1886, Ms). Aug. 26 - Sept. 27, on lower Fitzroy [13 km S of Yeeda], 23 specimens collected "as they pass along the rushes near the water's edge (far from which I have not observed them) . . . their numbers being from 5 - 7 . . . long rushes or bamboo up the stems of which they climb with ease . . .). (Observed in some bushes about to 200 yards from the riverside; this is the furthest I have seen them away from the banks; they are very wren like.") Oct. 17 - 29, Fitzroy River between Mount Anderson and Liveringa, 7 specimens collected. Nov. 8. lagoon near Mount Anderson, 2 specimens collected.

F. M. House (1902), "On the Pentecost River . . . great numbers of *Malurus coronatus* [May 1901]. After leaving this river [and travelling west] I did not see the bird again until we were traversing the Drysdale River . . . but not in such numbers."

R. Hall (1902), records 3 specimens collected Aug. 22, 1900 in J. P. Rogers' collection from the Fitzroy (between Derby and Brooking Crossing). Rogers: "I showed these skins to a black boy who resides up the river. He says they are always found in the billabongs high up the Margaret River . . ."

J. F. Kilgour (1904). Ord River Station, autumn 1904, "almost wherever there is water."

J. P. Rogers (1908). "I found the Purple-crowned Wren . . . very numerous on the small rivers between Turkey Creek Telegraph Station and Wyndham. This is a rare bird on the Fitzroy."

F. L. Whitlock (1925), on the Fitzroy, June 1924 - April 1925. "Local in the extreme. Only seen near the [Fitzroy] crossing and some 8 miles further down the river near Gogo Station. Favours *Pandanus aquaticus*. The greatest numbers I saw in one morning's walk was 4 parties of 3 or 4 birds. They were very difficult to find . . . "

D. L. Serventy (1958, Ms). Oct. 4, Geikie Gorge, "I. C. Carnaby shot a ♀ in dense vegetation on the left bank . . . Oct. 5, A. J. Marshall: ♀ in Triodia . . . "

H. R. Officer (1964). "On neither the 1959 nor 1962 visits were any seen or heard along the Fitzroy or Ord Rivers, or any of the creeks feeding them, although *Pandanus* is plentiful."

J. Wheeler (1965). "Considerable areas along the Ord and Fitzroy were searched [in 1963] for *M. coronatus*, without success."

J. Dell (1971, Ms). 3 - 10 Oct., "♂ in melaleuca along the Ord."

W. H. Butler (1971, Ms). 8 specimens collected at 16° 33'S, 128° 39'E; total of 3 on Oct. 4 and 5 and 5 on Oct. 25.

Mrs. H. B. Gill (*pers. comm.* to Dr. G. M. Storr, 1973). Drysdale Crossing (15° 41'S, 126° 25'E) "4 pairs in half mile of river . . . "

C. J. O. Harrison (1974), records 2 specimens collected on July 2, 1968 in pandanus along Manning Creek at Joint Hill (16° 27'S, 125° 56'E).

L. A. Smith and R. E. Johnstone (1975, Ms). 3 collected at Meelarrie Creek, a tributary of the Drysdale River. "2 parties seen, one of 7 and one of 4."

Judging by the number of specimens collected by Bowyer-Bower and also by the black boy's comment to Rogers the species was once common on the Fitzroy. However, as early as 1908 Rogers called it "a rare species on the Fitzroy". Shilling (1948), who spent about a year at Liveringa did not record the species, while Officer (in 1959 and 1962) and Wheeler (in 1963), despite deliberate attempts to find it, failed to do so. Thus since 1925 when Whitlock stated they were "very difficult to find" it has only been seen in 2 localities on the Fitzroy.

According to the notes made by House, Kilgour and Rogers, the wren was once common on the Pentecost River and in the Ord drainage. Since 1907 it has been found in two localities on the Ord River but these have subsequently been drowned by Lake Argyle. It has not been recorded from the Pentecost since 1902.

House's comment as he crossed the Drysdale is the only early record for the Drysdale River drainage. That Hill failed to record it during his 10 month stay at Napier Broome Bay suggests that it may have only been present in the more arid upper Drysdale drainage.

Thus the range of the Purple-crowned Wren which once included the Fitzroy, Ord and at least part of the Drysdale drainage has now been reduced to three isolated populations: at Manning Creek and Geikie Gorge in the Fitzroy drainage, and Meelarrie Creek in the Drysdale drainage. As the latter is only 4 kilometres from Mrs. H. B. Gill's record of the species, we treat the two localities as one.

BUFF-SIDED ROBIN

T. H. Bowyer-Bower (1886, Ms). Aug. 27 - Sept. 17, on lower Fitzroy [13 km S of Yeeda], 6 specimens collected. Oct. 28, Fitzroy River between Mount Anderson and Liveringa, 3 specimens collected.

A. J. North (1898), on G. A. Keartland's collection (Calvert Expedition, 1896-97). 1 adult ♂ near junction of Fitzroy and Margaret Rivers. Keartland: ". . . only seen in the dense [freshwater] mangrove scrub on the margins of the Fitzroy . . ."

R. Hall (1902), records 4 specimens in J. P. Rogers' collection from the Fitzroy (between Derby and Brooking Crossing).

J. F. Kilgour (1904), Ord River Station, autumn 1904, "common on river banks."

G. M. Mathews (1909), records 7 males and 5 females in J. P. Rogers' collection from Wyndham (Parry Creek). "Common. Always frequents patches of scrub near water."

G. F. Hill (1911), Aug. 1909 - July 1910. "Uncommon. Seen only in moist and densely timbered country near Napier Broome Bay and Drysdale River."

F. L. Whitlock (1925). On the Fitzroy, June 1924 - April 1925, mainly near the [Fitzroy] crossing " . . . of the river forests to which it was exclusively confined."

P. Slater (1959), Kimberley Research Station (Ivanhoe). Classified as a "winter breeder."

I. C. Carnaby (*pers. comm.* to Dr. G. M. Storr). "Fitzroy Crossing Feb. 28, 1959, nest under construction . . . Fitzroy River [Noonkenbah], June 10, 1959, nested . . . "

Carnaby also records five nests within 3 km of each other 48 km east of Wyndham (two on Jan. 3, 1965 and three in December 1965: one on Dec. 19, one on Dec. 26, and another on Dec. 27).

J. A. Smith (*pers. comm.* to Dr. G. M. Storr). "2 at Mitchell River Falls [14° 50'S, 125° 42'E], Nov. 22, 1970. Pair in patch of rainforest by Mitchell River [14° 50'S, 125° 42'E], Nov. 14, 1971. Building a nest on Nov. 21, 1971."

L. A. Smith and R. E. Johnstone (1973, Ms). 2 specimens collected from patch of rainforest at edge of Camp Creek, Mitchell Plateau (14° 52'S, 125° 50'E).

I. C. J. Galbraith (1974), records one specimen collected at Geikie Gorge on June 5, 1968.

G. M. Storr, R. E. Johnstone, J. Dell and L. A. Smith (1975). "Scarce along watercourses in Prince Regent River Reserve."

L. A. Smith and R. E. Johnstone (1975, Ms). "2 + 1 downstream from camp [on lower Drysdale in 14° 13'S, 126° 55'E], one collected. Thick riverside vegetation."

R. E. Johnstone, J. Dell, L. A. Smith and P. J. Fuller (1976). 2 collected Aug. 21, 1975. "At least 4 birds lived in the thicket of *Xanthostemon* and *Alphitonia* at the head of Fern Gully [14° 39'S, 126° 56'E]."

The Western Australian Museum has two specimens from the Ord River, collected July 1945 and two specimens from Kalumburu collected July 1960.

The above extracts indicate that the Buff-sided Robin was once common in the Fitzroy and Ord River drainages. Since 1925, however, there have only been three records from the Fitzroy drainage (Noonkenbah, Fitzroy Crossing and Geikie Gorge), and three from the Ord River drainage (Ivanhoe, 48 km east of Wyndham and Ord River).

Field work in the last 3 years has shown that it has a fragmented distribution in the subhumid north-west part of the Kimberleys (Mitchell Plateau, Mitchell River, two localities on the lower Drysdale and two in the Prince Regent River Reserve).

So, although the species has a wide distribution in the Kimberleys, the total number of individuals is small, there only being very few, small, scattered populations.

DISCUSSION

Of the two species, the numbers of the Purple-crowned Wren have been most affected. There are probably two main reasons for this. Firstly, the relatively low vegetation, such as pandanus and canegrass that the Purple-crowned Wren prefers, would be much more susceptible to damage

by grazing cattle than would the taller, sturdier trees and shrubs preferred by the Buff-sided Robin. Secondly, the original distribution of the Purple-crowned Wren was probably confined to the more arid areas of the Kimberleys: the Fitzroy, Ord and parts of the Drysdale River drainages, the very areas that have been subject to greatest alteration by the pastoral industry.

On the other hand, the Buff-sided Robin, as well as occurring in the Fitzroy, Ord and Drysdale River drainages, has been found in the wetter north-west Kimberley, areas where its habitat has suffered far less interference.

We consider the numbers of these two species to be so few, and their habitat so prone to alteration, that they warrant consideration as rare and endangered species.

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BIRDS OF BEDOUT ISLAND—A VISIT IN MAY 1972

By T. E. BUSH and G. A. LODGE

INTRODUCTION

Bedout Island (19° 35' 28" S., 119° 5' 46" E.) is a Class C reserve 22 nautical miles north of Larrey Point, the nearest part of the Australian mainland, but 55 nautical miles NNE of Port Hedland via the navigation channels. It is of interest to naturalists as it is the most southerly recorded breeding station in Western Australia of the Lesser Frigate-bird and of the Brown and Masked Gannets. However because of the diffieulty of access ornithologists have rarely visited it.

The first ornithologieal survey of the island was made by J. T. Tunney (1902, p. 73) who collected there in May 1901 for the W.A. Museum. In 1944 the island was surveyed from the air by Stanley Fowler during an aerial reeonnaisanee for the CSIRO. In October 1949 Dr. D. L. Serventy spent a few hours on the island whilst a member of a fisheries party aboard the F.R.V. *Warreen*. In his report (Serventy, 1952, pp. 48-50) he reviewed all the previous records.

The Lands and Surveys Department granted a lease of the island to Bernard Bardwell, Marie Fanny Harper and John David Dunn from January 1, 1928 to December 31, 1937, for the purpose of excavating guano. This was cancelled in 1930, prior to expiration, on a report from the Pearling Inspector at Broome, Mr. A. O. Ferguson, who stated that no guano had come through the port.

On May 14-15, 1972 we accompanied a fishing party from Port Hedland and spent a night and a total of 15 daylight hours on the island. Landing was made in a small dinghy, leaving the larger vessel anchored beyond the reef.

Bedout Island is a low-lying, undulating sand cay with an area of 45 acres at high tide and about 75 acres at low tide, surrounded by a white sandy beach varying from 20 to 75 metres in width. The large expanse of reef exposed at low tide is studded with pools in which marine life abounds. The rock stacks which protrude above the general level of the reef are covered with oysters. The island itself, apart from the two bare areas where heavy guano accumulation prevents plant growth, is covered with clumps of *Spinifex longifolius*. An automatic navigation beacon stands on the highest point of the island.

NOTES ON BIRDS OBSERVED

Brown Gannet, *Sula leucogaster*. This species was the commonest bird on the island, occupying almost the whole of it for nesting and we estimated there were about 5,000 breeding pairs. Nests were on the beach, with concentrations where the beach was widest, as well as amongst the *Spinifex* clumps. Breeding was protracted in the extreme. There were young at all stages, while other pairs were brooding eggs or constructing nests. Nests among *Spinifex* clumps, where material was readily available, were generally more substantial than those on the beaches. Here some eggs had been laid in a mere scrape in the sand. Two eggs were the normal clutch, with only one 3-egg clutch being observed. All nests inspected where the eggs had hatched contained only one chick. Brooding birds were very confiding, allowing easy photography. A few thousand birds were resting on the beaches. These included many immatures. A sample of 10 eggs averaged 61 x 40 mm, varying from 56-66 x 36-43 mm.

Masked Gannet, *Sula dactylatra*. This species was nowhere near as plentiful as the preceding and we estimated the breeding population as about 400 pairs. Apart from an isolated pair breeding took place among the Brown Gannets in the two bare areas and the maior beach concentrations. Breeding was protracted as with the Brown Gannet. The nests were generally not as substantial and were quite often only a scrape in

the guano crust. The clutch was of two eggs. A sample of 10 eggs averaged 62 x 44 mm, varying from 55-68 x 40-45 mm.

Lesser Frigate-bird, *Fregata ariel.* The estimated breeding population was about 2,000 pairs in a single, large, spread-out colony. The nests were closer together where good stands of *Spinifex* occurred. Breeding was protracted. Some birds were still constructing nests and others were caring for large young, but a high proportion were still brooding eggs, near-fresh in appearance. Nests were platforms of *Spinifex* stems cemented with their excreta and built on the tops of *Spinifex* clumps. Sitting birds sat tightly, "clacking" their bills loudly as we walked through the colony. The entire colony studded with the brilliant red inflated gular sacs of the males was a spectacular sight. The sacs were deflated as we approached each section of the colony. A single egg formed the clutch. The average size of a sample of 10 eggs was 63 x 45 mm, varying from 56 - 72 x 41 - 48 mm.

Crested Tern, *Sterna bergii.* An estimated 300 pairs were nesting in close proximity in four groups near the summit of the island. All nests contained either one egg or one chick. A sample of 10 eggs averaged 61 x 40 mm, varying from 57-65 x 35-44 mm.

Lesser Crested Tern, *Sterna bengalensis.* The presence of this species on Bedout Island was first noted by Serventy who, though he saw large numbers of individuals, failed to find any evidence of breeding. We located one nesting pair, incubating an egg near the middle of a group of about 100 nesting Crested Terns. We disturbed the group briefly several times and the sitting bird invariably returned to the same egg. This measured 55 x 37 mm. Several other birds of the species were feeding large young hidden among the *Spinifex* close to the water's edge.

Roseate Tern, *Sterna dougallii.* Several hundred of this species were observed during the voyage, in flocks of up to 100 birds, feeding on schools of small fish. Only an odd bird was noted at the island and they were not breeding.

Common Noddy, *Anous stolidus.* A flock of several thousand were perched on the tops of *Spinifex* clumps. When disturbed by our approach they flew, settling on the beach near the water's edge, so close that they appeared as a brown mass. While there was no evidence of breeding their behaviour suggested this was imminent. Tunney collected eggs on May 21, 1901; there was no nesting on Serventy's visit on October 19, 1949.

A single pair of a dark tern, either the Sooty, *Sterna fuscata,* or the Bridled, *S. anaethetus,* were present and incubating an egg on the bare sand among the *Spinifex.* Positive identification of the species was not made. The egg measured 49 x 35 mm. Tunney recorded both species breeding on his visit.

Reef Heron, *Egretta sacra.* A pair of white-phase birds were flushed from among the *Spinifex.*

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BIRDS OF BEDOUT ISLAND—A VISIT IN MAY 1975

By NICHOLAS KOLICHIS, Osborne Park

INTRODUCTION

In May 1975 I chartered a 12 m boat from Port Hedland to observe the effects of Cyclone "Trixie", of February 17-24, 1975, on the birdlife of Bedout and North Turtle Islands. On February 18 the eye of the cyclone had passed by the eastern side of Bedout I. and winds estimated between 130-185 km per hour blew over the two islands (Bureau of Meteorology). An earlier visit, three years previously, by T. E. Bush and G. A. Lodge provided the stimulus for the trip and a basis for comparison of the breeding regime between the two seasons.

BEDOUT ISLAND

Notes on my observations on May 11 follow:

Brown Gannet, *Sula leucogaster.* There were about 1,000 nesting pairs scattered all over the island, excepting the southern end, nesting on the beaches above high water mark and amongst the clumps of *Spinifex longifolius.* The nests varied considerably, eggs being laid either on the bare ground or in substantial structures of *Spinifex* stems, feathers, seaweed and odd pieces of sea shell. The constructed nests were much larger than those of the Masked Gannet, average measurements being about 45 cm across and about 4 cm deep. Most contained two eggs, the remainder one. One large chick was found on the island, covered in white down. Several dead adults were found among the *Spinifex* clumps.

Egg measurements of six selected clutches: A, 60.9 x 41.9 mm; 59.4 x 41.8. B, 60.9 x 42.0; 53.7 x 39.1. C, 61.5 x 42.7; 65.1 x 44.5. D, 53.3 x 39.8; 55.8 x 41.7. E, 59.6 x 41.6; 61.4 x 42.8. F, 59.9 x 38.3; 62.7 x 41.2. Average, 59.5 x 41.5 mm.

Masked Gannet, *Sula dactylatra.* About 270 nesting pairs were found in three separate groups. The greater number of nests were shallow scrapes, the eggs being laid on bare ground. Odd nests had loose linings of short pieces of *Spinifex longifolius,* feathers and small sea shells. Most contained two eggs, occasional ones had one egg, and one nest was found with three eggs. No young were seen. Nest sizes averaged about 30 cm across and were about 4 cm deep. Odd pairs of Brown Gannets nested among the Masked Gannets in all three groups.

In Group 1 about 90 pairs nested on a patch of bare ground surrounded by *Spinifex* on the south side near the base of the lighthouse. Group 2 comprised about 150 nesting pairs in a similar situation northwest of the lighthouse. Group 3 consisted of about 30 pairs on the northern end of the island, their nests being between high water mark and the edge of the *Spinifex.*

Egg measurements of seven selected clutches: A, 64.0 x 56.5 mm; 67.9 x 57.4. B, 68.4 x 39.5; 66.4 x 41.1. C, 66.0 x 46.1; 64.7 x 45.6. D, 63.0 x 44.0; 62.1 x 43.0. E, 59.1 x 47.4; 62.1 x 46.0. F, 66.3 x 44.5; 62.2 x 43.8. G (a 3-egg clutch), 55.9 x 41.8; 60.2 x 44.3; 60.0 x 42.0. Average, 63.2 x 45.5 mm.

Lesser Frigate-bird, *Fregata ariel.* About 900 nesting pairs were scattered practically all over the island, excepting at the northern end. The biggest nesting concentration was on the west side of the island. The birds nested in various size groups, from lone pairs to an aggregation of about one hundred, each individual just out of pecking range of its neighbours. About ten nesting pairs were the most frequent group. Both sexes were seen incubating at the same time in most groups, but others varied from all male to all female incubating birds.

The nests were built on the top of clumps of *Spinifex;* none were on the ground. They were shallow and saucer-shaped, constructed entirely of *Spinifex.* They averaged 25-30 cm across by 4 cm in depth. Incubation

stages varied from fresh eggs to newly hatched young. Only five young had hatched whilst we were on the island and no large fledglings were seen. Several dead adults were noticed.

Egg measurements of six selected clutches: A, 71.2 x 42.6 mm. B, 66.9 x 44.3. C, 58.5 x 39.6. D, 62.3 x 45.4. E, 60.5 x 43.0. F, 67.7 x 42.5. Average, 64.5 x 42.9 mm.

Crested Tern, *Sterna bergii.* About 200 nesting pairs were found in two separate groups—the larger, of 150 pairs, were at the southern end of the island, and the second, of about 50 pairs, at the northern end. The birds were on eggs; no chicks were found, but about 30 large fledglings were sighted in a group near the beach at the southern tip of the island.

Lesser Crested Tern, *Sterna bengalensis.* Several individuals were resting on the beach with a small party of Crested Terns. Two pairs were nesting—one pair in each of the Crested Tern colonies. The egg measurements in the two clutches were: A, 54.5 x 37.2 mm. B, 53.4 x 34.9 mm. Average, 53.9 x 36.1 mm.

Nankeen Kestrel, *Falco cenchroides.* One bird found dead. Rigor mortis had not set in when the body was discovered. There was no obvious cause of death, but the bird may have died of starvation as no mice or large insects were noticed on the island.

Sooty Storm-Petrel, *Oceanodroma matsudeirae.* Five individuals were seen flying close to the surface of the sea, sighted from our boat on May 12 between Bedout I. and North Turtle I. The birds were entirely blackish-brown with deeply forked tails.

DISCUSSION

Tunney between May 19 and 30, 1901 recorded eggs of the following species: Brown Gannet, Masked Gannet, Lesser Frigate-bird, Crested Tern and Sooty Tern. In addition he collected specimens of the Common Noddy on the nest, now in the Western Australian Museum (Serventy, 1952). Tunney did not record seeing any young but an accompanying photograph shows downy young of both Brown and Masked Gannets. Assuming that the photograph was taken on the date of Tunney's visit, and estimating the chicks' age at 4 - 5 weeks, this would indicate that egg-laying had commenced in early February.

Bush and Lodge (1977) on May 14 - 15, 1972 recorded breeding of Brown Gannet, Masked Gannet, Lesser Frigate-bird, Crested Tern and Lesser Crested Tern, ranging from nest construction to fledged young (Table 1). Some Brown Gannet young were large and fully feathered (Bush, pers. comm.), and egg-laying of this species probably continued throughout the summer months of that season. Serventy's visit on October 19, 1949 found Brown and Masked Gannets on eggs, with a few newly-hatched chicks of the former.

These records indicate that egg-laying in both species of Gannets on Bedout I. has two peaks, in the autumn and the spring.

TABLE 1.—NUMBER OF BREEDING PAIRS AND STAGES OF NESTING IN A NORMAL YEAR, 1972 (DATA FROM BUSH AND LODGE)

	Breeding Pairs	Nests Under Construction	Eggs	Small Young	Large Fledglings
Masked Gannet	400	*	*	*	*
Brown Gannet	5,000	*	*	*	*
Lesser Frigate-bird	2,000	*	*	*	*
Crested Tern	300	nil	*	*	nil
Lesser Crested Tern	Several	nil	*	nil	*

* means present

TABLE 2.—NUMBER OF BREEDING PAIRS AND STAGES OF NESTING IN THE YEAR OF CYCLONE "TRIXIE", 1975

	Breeding Pairs	Nests Under Construction	Eggs	Small Young	Large Fledglings
Masked Gannet	270	nil	*	nil	nil
Brown Gannet	1,000	nil	*	nil	(1)*
Lesser Frigate-bird	900	nil	*	(5)*	nil
Crested Tern	200	nil	*	nil	*
Lesser Crested Tern	2	nil	*	nil	nil

* means present

Comparing Tables 1 and 2 it can be seen that Cyclone "Trixie" had a marked effect on breeding numbers and stages of nesting on Bedout I. On my visit all breeding birds were at a similar stage of nesting. Because only five Lesser Frigate-birds/chicks were hatching I believe that the birds re-constructed nests and re-layed after the cyclone had completely destroyed their first attempt. No evidence of addled eggs or dead chicks was found, however, and any such not blown into the sea would have been removed by predators. Evidence that breeding *had* occurred before Cyclone "Trixie" is indicated by the presence of a large Brown Gannet chick and a group of Crested Tern fledglings. These young birds may have been among the few survivors of the cyclone by sheltering amongst the clumps of *Spinifex*.

Serventy and Whittell (1976) give the incubation period of the Lesser Frigate-bird as 41 days; chicks were hatching during my visit. A freshly broken Brown Gannet egg had a fully developed embryo not far from hatching. As the incubation period of this species is 43-47 days (Serventy *et al.*, 1971) I believe that egg-laying re-commenced approximately five weeks after the passing of Cyclone "Trixie".

Although the cyclone must have destroyed much bird-life and did disrupt the normal breeding season of these birds it is evident that breeding colonies will re-establish, but on a smaller scale. Provided such cyclones did not occur too frequently over the same area numbers would build up again.

NORTH TURTLE ISLAND

Notes on a visit on May 12:

Pied Cormorant, *Phalacrocorax varius.* A colony of approximately 1,500 nesting pairs were on the south-western end of the island. The nests were built on the ground about 60 cm apart; bowl-shaped, built of sticks and twigs, and lined sparsely with *Spinifex* stems, sea-weed and, occasionally, with odd feathers. All the nests contained eggs; clutches of three eggs were most common, followed by clutches of four; those with one and two eggs were least frequent. As these last-mentioned were clean, had no scratch marks, nor were polished from incubating birds, they could have been incomplete clutches. One nest contained five eggs. One dead adult was found in the colony.

Australian Pelican, *Pelecanus conspicillatus.* Three separate nesting colonies were found on the island, two active and one abandoned. The greater number of nests were shallow scrapes, lined sparsely with large pieces of *Spinifex longifolius*, feathers and grasses. A small number lacked any lining and the eggs were laid on the bare ground. The first group of nests was on the south-western end of the island, about 100 m from the shore in a patch of open ground. It consisted of about 200 nesting pairs sitting on eggs; two-egg clutches predominated with an occasional clutch of three. In some nests the eggs had started chipping. The second group, about 300 m to the north-west, comprised 40 nesting pairs. Seven nests contained two eggs, 24 nests had one egg, and nine nests were ready for laying. One clutch of two eggs was collected, measurements

being 93.1 x 55.4 mm and 96.1 x 51.4 mm, and incubation had barely started. The third group, the abandoned one, was on the north-eastern end of the island. It covered an area of about half a hectare and contained a large number of addled eggs and dead young, varying from recently hatched nestlings to larger, feathered young about five weeks old. Most of the eggs and dead young were blown against clumps of *Spinifex* and small bushes, undoubtedly by the strong winds of Cyclone "Trixie". It would appear that after the cyclone the birds re-nested as the two groups just mentioned, but in lesser strength. No dead adults were found on the island.

Lesser Frigate-bird, *Fregata ariel.* One lone bird was flying over the water at the southern end of the island.

Caspian Tern, *Hydroprogne caspia.* Ten birds were flying together along the shore. No nesting was taking place, though an abandoned egg, partly buried in the sand, was found just above high water mark. It was collected and found to be fresh.

Eastern Curlew, *Numenius madagascariensis.* Two birds were feeding on the tidal flats.

White-breasted Sea-Eagle, *Haliaeetus leucogaster.* A pair was soaring over the island. A nest, not in use, was found on the eastern side. The normal nesting period, at North-West Cape, is between June and August (Serventy and Whittell, 1976).

Mangrove Kingfisher, *Halcyon chloris.* One pair were seen perched on a discarded 44-gallon drum partly buried in the sand.

Australian Pipit, *Anthus novaeseelandiae.* Two pairs were seen amongst short vegetation.

ACKNOWLEDGEMENTS

I wish to extend my thanks to Messrs. T. and C. Allen, J. B. Woods and S. Filov, who accompanied and shared expenses with me on this trip. I am grateful to the skipper, Mr. K. Hanley and his crew of the *Phantom*, who made our trip quite pleasant. My thanks also go to the Bureau of Meteorology for the information on Cyclone "Trixie" in this area. To Dr. D. L. Serventy and Miss L. A. Hoare, I am very grateful for help in the preparation of this paper.

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NOTES ON KIMBERLEY BIRDS

By W. H. BUTLER, Wanneroo

In winter and spring 1975 I spent three months in the Kimberley Division collecting and observing birds for Dr. G. M. Storr (Western Australian Museum) who is preparing a checklist of the birds of the Kimberleys. My field work was financed by an Australian Biological Resources Study grant to Dr. Storr who directed the field activities.

The first half of the work was carried out in the far south-east of the Division, especially in the arid Gardiner and Denison Ranges, respectively at Granny Soak (19° 07' S, 128° 53' E) and Palm Spring

(19° 20' S, 128° 20' E). The second half of the work was carried out in the northern half of the Yampi Peninsula, including Kimbolton Spring (16° 38' S, 123° 43' E) and Port Usborne (16° 34' S, 123° 38' E). Listed below are some of the more interesting records.

White Goshawk *(Accipiter novaehollandiae).* On September 7 a brownish immature bird was collected in mangroves at Port Usborne. On the previous day an all-white bird was seen in the same mangroves. These are the westernmost records of this rare hawk. Gut content was a partly digested snake.

Flock Pigeon *(Histriophaps histrionica).* Relatively small flocks (up to 25 birds) were seen in flight over the Gardiner and Denison Ranges. In the much more suitable country around Sturt Creek HS (19° 10' S, 128° 10' E) a flock of more than a thousand birds was observed in early July.

White-quilled Rock-pigeon *(Petrophassa albipennis).* The dark West Kimberley race was locally common on the Yampi Peninsula on quartzite ridges and in sandstone country. A nest and two heavily incubated eggs were found near Kimbolton Spring on September 2.

Partridge Pigeon *(Geophaps smithii).* The West Kimberley race, *G. s. blaauwi,* characterized by yellow orbital skin, was common around Kimbolton Spring, the south-westernmost locality known for this bird.

Major Mitchell Cockatoo *(Cacatua leadbeateri).* On September 21 I saw a pair beside the Great Northern Highway at 19 km south-west of the turnoff into Thangoo HS (Roebuck Bay). The locality (18° 20' S, 122° 12' E) is the first for this cockatoo from west of Geegully Creek (160 km to the east).

Port Lincoln Parrot *(Barnardius zonarius).* Records of this species from the Gardiner and Denison Ranges are the first for the Kimberley Division. Specimens were collected at Granny Soak and Palm Spring.

Tawny Frogmouth *(Podargus strigoides).* An adult male collected at Palm Spring on June 29 is the first record of the southern race, *P. s. strigoides,* for the Kimberley Division; it matches well with Pilbara specimens. Further north in the Kimberleys the Tawny Frogmouth is represented by the smaller, paler and more delicately patterned *P. s. phalaenoides.*

Brown-breasted Shrike-Thrush *(Colluricincla woodwardi).* Specimens collected among granite boulders near the Great Northern Highway at 4 km E of the Laura River crossing (18° 34' S, 127° 15' E) and on quartzite ridges at Kimbolton Spring are respectively the southernmost and westernmost records of this superb songster.

Large-billed Warbler *(Gerygone magnirostris).* Three specimens collected in the mangroves at Port Usborne extend the known range of this species for 200 km to the south-west. The previous south-western limit was St. George Basin (Johnstone, 1975).

Spiny-cheeked Honeyeater *(Acanthagenys rufogularis).* This bird, previously unknown in the Kimberley Division, was collected at three localities: Palm Spring (Denison Range), near Sturt Creek HS (19° 10' S, 128° 10' E) and south of Lake Betty (19° 35' S, 126° 22' E). Other desert honeyeaters, rarely seen in the Kimberleys, were common in the Gardiner and Denison Ranges, namely the Pied, Black and White-fronted (respectively *Certhionyx variegatus, C. niger* and *Phylidonyris albifrons).*

Grey Butcher-bird *(Cracticus torquatus).* This bird was moderately common in riverine forests around Kimbolton Spring, which is the westernmost locality for the Kimberley-Northern Territory race, *C. t. argenteus,* the so-called Silver-backed Butcher-bird.

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OBSERVATIONS ON THE DISTRIBUTION OF BIRD SPECIES ON SMALL ISLANDS NEAR PERTH

By IAN ABBOTT, Zoology Department, University of Western Australia, Nedlands 6009.

During 1975 while studying aspects of the ecology of Silvereyes *(Zosterops lateralis gouldi)* I visited nearly all of the small islets around Rottnest Island, and those between Rottnest Island and the Six Sisters some 40 km to the south. In all, 120 islets and stacks were visited. Here I present brief distributional notes for nine seabird species and for several other species seen. Previously unrecorded breeding sites for Wedge-tailed Shearwater, Pied Cormorant, Osprey, Silver Gull, Caspian Tern and Bridled Tern were found.

Details of visits are as follows: On February 24, 1975 all islets between Bird and East Shag Islands, Shoalwater Bay; on March 25 - 26, 1975 Armstrong, Monday, Duck, Joan and Phillip Rocks, Parakeet, and Dyer Islands and three nearby rocks (all adjacent to Rottnest Island); on October 3, 1975 islands between Point Peron proper and the Sisters (excluding Penguin I.); on December 6, 1975 Straggler Rocks, Mewstone, Rowboat and Seal Rocks, all islets around Carnac (including Shag, West, South-west, Arch and Flat Rocks), Entrance Rocks and Mushroom-shaped stack opposite Mt. Lotus on Garden Island; on December 12 1975 stacks near Mt. Haycock and Pt. Atwick, Garden Island; and on December 19, 1975 all islets around Rottnest Island apart from the four in Rocky Bay. Penguin Island was visited on October 6, 1974, March 8, 1975, July 25, 1975 and October 6, 1975. I visited Carnac Island on August 27, 1974, and in 1975 seven weeks were spent there, as follows: January 20-26 (inclusive), March 11-17, April 29-May 5, June 24-30, August 5-11, September 23-29 and November 11-17.

I hope to publish comprehensive notes on the avifaunas of Garden and Carnac Islands later. Storr (1964) has already very fully described the avifauna of Rottnest Island and some of its stacks and no mention of the birds on Rottnest Island proper will be made here. The situation in the 1940's for the larger islands in Shoalwater Bay was documented by Serventy and White (1943). Storr's and Serventy and White's checklists provide reliable baselines with which to monitor subsequent distributional changes.

ANNOTATED LIST

Little Penguin, *Eudyptula minor.* Common breeding resident on Carnac Island, taking advantage of plentiful loose soil at base of limestone cliffs for burrowing. Serventy and Whittell (1962), but not Serventy *et al.* (1971) record the Mewstone and Green Island (near Rottnest) as breeding sites. Certainly the latter is too steep-sided on all sides for penguins to climb up, and although the former has suitable burrowing sites I did not notice any carcasses or characteristic guano. A carcass was found on Seal I. in March and several birds were heard braying under *Rhagodia* bushes just above the beach in October. None were noticed on Middle Shag I. or Bird I. Undoubtedly Penguin I. is, with Carnac I., their West coast stronghold.

Wedge-tailed Shearwater, *Puffinus pacificus.* Common resident on Carnac I., where the distribution of their burrows was mapped by Watson (1956). Burrows also were found on Green and Dyer Is. and Flat Rock and birds were seen on Carnac I. and Flat Rock. A few burrows, possibly belonging to this species, were found on East Cathedral Rock (Eagle Bay, Rottnest), Duck Rock and Shag Rock (north of Carnac I.). Burrows on Parakeet I. near Rottnest presumably are of this species, as *P. assimilis* was not recorded by Storr (1964) as still breeding there.

White-faced Storm-Petrel, *Pelagodroma marina.* Five burrows of this species were found in March on a cliff just north of the beach on Bird I. None was noted on Seal I., where recorded by Serventy *et al.* (1971).

Pied Cormorant, *Phalacrocorax varius.* Nesting colonies were found as follows: Dyer I. (March, eggs and large young but only about 20 nests active); Flat Rock (recently used nests); South-west Rock (recently used nests on north side); West Rock (a few old nests); southern peninsula of Carnac I. (a few nests in use on August 27, 1974, but none used in 1975); Bird I. (recently used nests); West and Middle Shag Is. (large young in October); North-west Sister I. (eggs) and South-east Sister I. (eggs noted).

Many islands have a substantial covering of cormorant guano, and are presumably favoured loafing sites. Such islets include Phillip Rock, Middle Twin Rock, Dyer, rock stack near beach in Stark Bay, Duck Rock (all near Rottnest), tallest of Straggler Rocks, Mewstone, Rowboat Rock, headlands and beaches of Carnac I., South-west Rock, Flat Rock, the western Entrance Rocks, South Brother Rock, stack off Mt. Haycock, Garden I., rock north of Fisherman Head, Cape Peron, Mushroom-shaped rock south of Fisherman Head, West, Middle and East Shag Is., Second Rock south of Penguin I., and Passage Rock. Of course many other rocks that are exposed at low tides are used for resting.

Mountain Duck, *Tadorna tadornoides.* My only records are from on or near the eastern beach of Carnac I.: Two in August 1974, four in March 1975, two in June 1975 and three in August 1975.

Osprey, *Pandion haliaetus.* I know definitely of five nests, one on Garden I. and four on Rottnest I.: on stack near Pt. Atwick, Garden I. (two adults and two free-flying juveniles); stack on beach in Salmon Bay (two adults, no eggs or young); stack at south-western end of Strickland Bay (two adults, one egg which was presumably addled and one large chick); Middle Cathedral Rock (unattended nest); one small, low nest on stack west of North Point of Rottnest I. is presumed to be a new nest. A large stack in Rocky Bay was not landed on but apparently has an Osprey nest.

One osprey was seen perched on a pole on one of the North-eastern Straggler rocks, and one was seen overhead at Carnac I. in March and two overhead there in August. There are certainly no nests on or near Carnac I., perhaps because the extent of reef is insufficient for a pair to forage over.

Turnstone, *Arenaria interpres.* Six were seen on eastern beach on Carnac I. in January, four on the Entrance Rocks and one on Bird I. in October.

Silver Gull, *Larus novaehollandiae.* Gulls were observed on Phillip Rock, Joan Rock (nesting in March), Dyer I., Green I., Middle Cathedral Rock (dead chick), eastern Cathedral Rock, stack west of first point north of jetty in Geordie Bay, Armstrong Rock, Parakeet I., Monday Rock (recently used nest), Duck Rock, Mewstone (dead chicks), Shag Rock (dead chick), South-west Rock (dead chicks), Flat Rock, islet farthest from Pt. Peron proper (50 birds, some nesting), White Rock (recently used nest), Bird I. (nesting in October), Seal Island (hundreds nesting), West and Middle Shag Is., Islet north-east of Penguin (one nest), Passage Rock and north-western Sister I. (one chick). On Carnac I. they mass around the eastern beach in March, and breeding begins soon after. Two chicks were found in April/May, and hundreds of chicks were found in June, August and September. By November breeding had markedly decreased. Gulls on Carnac I. have a double-brooding regime (Nicholls, 1974). The largest colonies in the area covered in this paper are on Carnac, Penguin and Seal Islands.

Pacific Gull, *Larus pacificus.* Non-breeding birds were reported from Penguin and Seal Is. by Serventy and White (1943). None noted, possibly because of increased populations of Silver Gulls there recently.

Caspian Tern, *Hydroprogne caspia.* None seen on the stacks around Rottnest I. One observed on Carnac on August 27, 1974. One pair nested near the northwestern end of Carnac I. and in August two large chicks

were present. In September and November two birds apparently nested on the southern peninsula of Carnac I. as I was dive-bombed consistently, but a thorough search did not reveal a nest. Three were observed on the eastern beach in February, and one in June, on Carnac I.

On Bird I. in October one pair was found with one large chick still on the nest and a pair was on Seal I. in October and from their behaviour toward me were probably nesting.

Crested Tern, *Sterna bergii.* Seen loafing on Armstrong Rock and Green I. in March. They occur all year round at Carnac I. In August 60 adults with eggs or very young chicks were found on the northern peninsula of Carnac I.; by September 40 adults with 50 large chicks (forming creches) were present, but by November all had flown. One large fledgeling was seen to beg from two adults on the eastern beach of Carnac I. in November.

A colony of 20 adults, with eggs, was present on the northern end of Seal I. in October.

Bridled Tern, *S. anaethetus.* Widespread. On Carnac I. found in January (but not March) but absent until September when six were seen. By November hundreds had arrived. Found on Phillip Rock (but not March 25), Joan I. (not March 26), Dyer I. (not March 26, one chick found in December), Middle and eastern Cathedral Rocks, rock west of first point north of jetty in Geordie Bay, Parakeet I. (not March 25), Clune Rock, Duck Rock (not March 25), but surprisingly not on Green I. or Monday Rock. Also occurs on the tallest of the Straggler Rocks, a vegetated rock southwest of the last, Mewstone, Shag Rock, West Rock, South-west Rock, Flat Rock, islet south west of Flat Rock, Arch Rock (one chick found), islet farthest from Point Peron proper, Bird I. (February and October), Seal I. (February and October), West and Middle Shag Is. (February and October), East Shag (October only), first islet south of Penguin (February and October), and eastern Tub Rock. It is probable that most, if not all, of these records are also breeding sites.

Silvereye, *Zosterops lateralis gouldi.* In March one was seen to fly across to Rottnest I. from Green I. Two were seen in *Nitraria* thickets on Flat Rock and presumably were vagrant from Carnac I., where some are present all year.

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NOTE ADDED IN PROOF

I revisited Carnac Island from August 31 to September 7, 1976. Conspicuous changes in abundance of two seabird species were noted. About 100 Pied Comorant nests were found on the southern peninsula, resulting in considerable damage to the vegetation. Six nests each had one chick close to leaving the nest, and four nests had either eggs or very small chicks. The rest had already been used. Hundreds of cormorants were observed resting on this peninsula, as well as on Flat Rock.

The Crested Tern rookery on the NE peninsula was reduced to seven birds, and I found one nest with one egg, one nest with one small chick, and two runners. A pair of Caspian Terns nested in exactly the same place as 1975, and I found a serape containing one large chick. No Bridled Terns had yet appeared.

THE COLLECTION OF POPLAR RUST SPORES BY HONEY-BEES

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SUMMARY

The Collection of uredospores of *Melampsora larici-populina* on *Populus nigra* var. *italica* by *Apis mellifera* is reported. Uredospores were identified from corbiculae as well as from the contents of larval food reserves in a bee-hive. This is the first record of the collection of rust spores by honey-bees.

INTRODUCTION

The spores of fungi have exploited the agents of wind and water very effectively for dispersal, there being few examples of insect-dispersed fungi. Insects are more often attracted to aromatic exudates, such as those associated with the conidia of *Claviceps* and pycnidiospores of some rusts, than they are to the spores themselves. Indirect dispersal of fungal spores by the movement of insects over infected trees or flowers can have serious consequences. The Dutch elm disease was effectively spread by bark-beetles. There are no reports in the literature on the collection of rust uredospores by insects. Rusts are important plant pathogens and the possible spread of rust spores by insects should not be overlooked.

OBSERVATIONS

During March and April, 1976, large numbers of the introduced honey-bee *(Apis mellifera)* were observed foraging amongst leaves of the Lombardy poplar *(Populus nigra* var. *italica)* in two stands, approximately 2 km apart, near Kalamunda. The trees were heavily infected with the European Poplar Rust *(Melampsora larici-populina* Klebahn). This plant pathogen was recently reported in Australia and New Zealand (Anon., 1974/5; Van Kraayenoord *et al.*, 1974; Walker *et al.*, 1974). The latter paper documents the detection, spread and host range of poplar rusts in Eastern Australia.

Infected leaves are characterized by necrotic patches, 2 - 5 mm across, on their upper surface corresponding to eruptions of uredia on the lower surface. The uredia produce elongated, spiny uredospores approximately 36 x 18 μm. The spores are bright yellow due to a pigment located inside the cells. Groups of yellow uredospores tend to aggregate because of their spines and fall in groups when the leaves are shaken. Due to their colour and dryness they have the superficial appearance of groups of pollen grains on the lower surface of the leaf. The lower leaves and older leaves are first infected by the disease, but on some larger trees examined, the disease had progressed about 18 m high to the top branches.

Bees were actively working infected poplar trees, gathering the yellow rust spores. Samples of bees collected from the trees had their corbi-

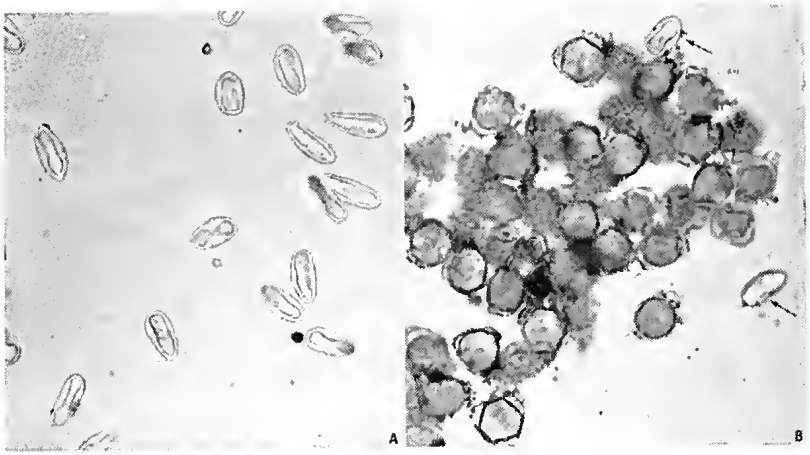

Fig. 1A.—Uredospores taken from the corbiculus of a bee foraging in poplar trees (x 170).

Fig. 1B.—Part of the contents of a nursery cell. The isodiametric cells are pollen grains. Two uredospores are arrowed (x 170).

culae (pollen baskets) packed with yellow material. Under the microscope (Fig. 1A), this was seen to contain the uredospores of *M. larici-populina*. Very little foreign matter was present.

At a distance of approximately 0.4 km from one stand of poplars, the contents of larval cells were removed from a bee-hive. The matrix consisted of a large number of marri *(Eucalyptus calophylla)* pollen grains and a smaller number of rust spores (Fig. 1B). The rust spores were recognizable because of their distinctive shape and yellow contents. This is good evidence that the bees were collecting rust spores for potential food. The hive was next to state forest and this would account for the large number of pollen grains. Apart from the stand of poplars mentioned above, the nearest poplars were over 2 km distant. It is unlikely that wind could have blown the spores into the hive because of the distances involved and the weight of the spore clumps. Sheridan *et al.* (1975) found very few rust spores in the air near poplar trees in New Zealand and suggested that the groups of spores were too heavy for wind dispersal.

DISCUSSION

The observation that bees were actively collecting uredospores of the European Poplar Rust raises some interesting points. It is not known, for example, why the bees were attracted to the spores. The spores are similar both in size and overall shape to many types of pollen and possibly could be mistaken by the bees as pollen grains. Apart from colour, bees may be attracted to potential food by scent. Adjacent to one stand of poplars, leaves of plum trees were heavily infected with the red-brown uredospores of the Plum Rust *(Tranzoschelia pruni-spinosae* (Pers.) Diet.). However, no bees were observed collecting these spores and no spores were present either in the samples taken from corbiculae or the bee-hive. This suggests that the bees may have been attracted to the poplar rust by the colour of the rust spores.

The value of rust spores as a food source for bee larvae needs to be established. Like most propagules it can be expected that the uredospores are highly nutritious. However, it is known that bees collect pollen and nectar which may be poisonous to bees (e.g. Bailey, 1963). Feeding experiments should be carried out to determine whether poplar rust spores are toxic to bees.

Clearly, foraging bees can lead to a rapid spread of the pathogen from tree to tree and may be responsible for the rapid dispersal of the disease in the Perth Metropolitan area. Sheridan *et al.* (1975) suggest that in New Zealand, sheep grazing under poplars and birds could be significant in dispersal of uredospores. The dispersal by bees appears to be more probable and should be investigated elsewhere.

ACKNOWLEDGEMENTS

I wish to thank Mr. and Mrs. H. T. Forteseue for drawing my attention to bees in poplar trees, Mr. R. Dell for samples from bee-hives, and Mr. R. N. Hilton for identification of the Plum Rust.

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ROOT PARASITISM OF *HAKEA SULCATA* BY *NUYTSIA FLORIBUNDA*

By BYRON LAMONT, Biology Department, Western Australian Institute of Technology, Bentley, 6102

During a study of the effects of waterlogging on root growth of *Hakea sulcata* R.Br. (Proteaceae) (Lamont, 1976), a number of parasitic roots of *Nuytsia floribunda* (Labill.) R.Br. (Loranthaceae) were encountered. These haustoriogens (groups of haustoria forming rings around the host root) were first described in detail by Herbert (1919), and further studied by Grieve (1975) and Göbel (1975).

Resulting from this present study, Fig. 1A shows a rootlet of *N. floribunda* attached to a lateral of *H. sulcata* by a haustoriogen. The *H. sulcata* specimen was growing in a seasonally waterlogged depression in the Kenwick reserve of the Botany Department, University of Western Australia. A 2 m high specimen of *N. floribunda* was located within the swamp at a distance of about 4 m from the parasitized *H. sulcata*, and the next closest possible source was a 5 m specimen on a sandy rise about 13 m away.

Proteoid roots are dense clusters of rootlets found in most species of Proteaceae (Lamont, 1972a) and at least one legume (Lamont, 1972b). Fig. 1B is of particular interest for it shows portion of a proteoid root of *H. sulcata* parasitized by two haustoriogens. The two arms of the collar of the smaller haustoriogen have not yet merged. The fact that the *N. floribunda* roots have not parasitized the proteoid rootlets suggests *either* (a) that there is a minimum surface of contact requirement with a potential host before haustoriogen formation is initiated *or* (b) that the rootlets were not exuding the necessary chemical stimulant in sufficient quantities for initiation (Grieve, 1975) *or* (c) that the parent root was parasitized before the rootlets had emerged. Closer examination showed that the first two hypotheses deserve further study, as rootlets arising beneath the collar were not distorted or retarded in any way, but merely displaced laterally.

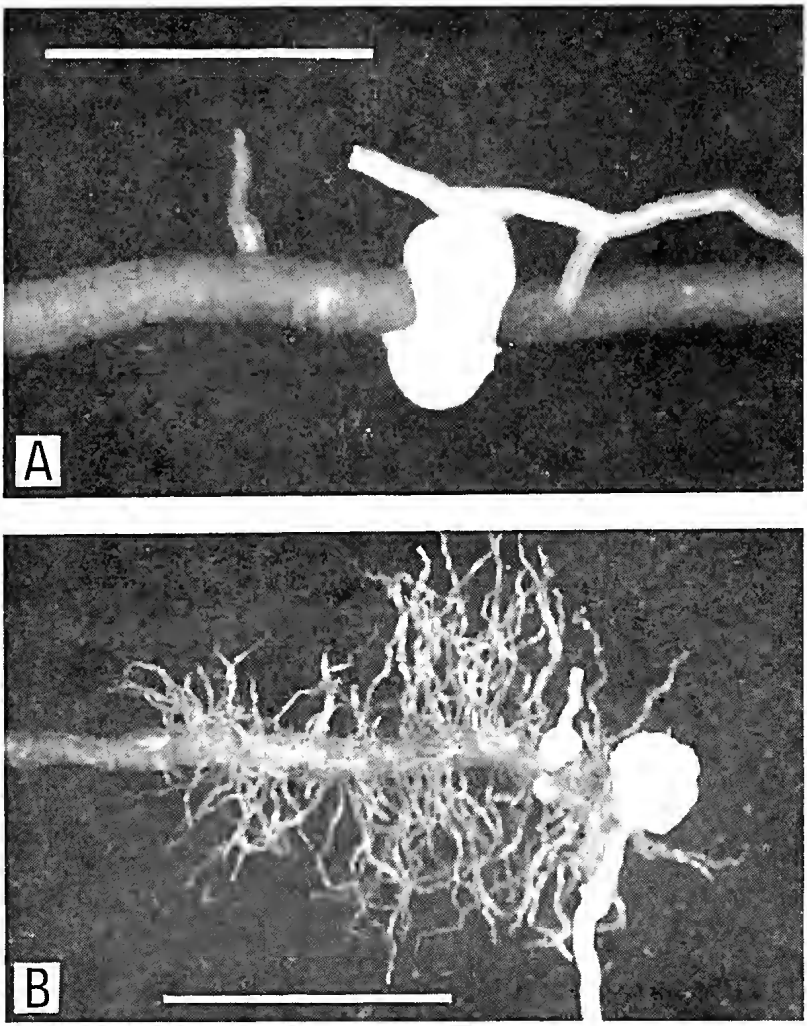

Fig. 1.—Haustoriogens of *Nuytsia floribunda* attached to (A) 'normal' and (B) proteoid roots of *Hakea sulcata*. Scales correspond to 5 mm.

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FROM FIELD AND STUDY

Early Arrival of the White-winged Triller.—Serventy and Whittell *(Birds of Western Australia,* 1967, p. 308) state that the White-winged Triller *(Lalage sueurii)* arrives in the southern parts of Western Australia in the "latter half of September or beginning of October." However on August 23, 1975, near Merredin, I observed a male of the species as it foraged through *Acacia* scrub. Another solitary male was again observed on August 28 in the same locality. This early sighting may eventually prove to be not so unusual as Loaring and Serventy *(W. Aust. Nat.,* 3, 1952: 113) recorded a singing male at Lake Wannamal on August 26, 1950.

—GREG. LINSTEAD, Merredin.

White-capped Albatross off Fremantle.—The White-capped Albatross *(Diomedea cauta)* is seen infrequently off Fremantle, W.A., hence the following report of a recent observation.

During the return trip from Rottnest Island on September 7, 1976, I observed a single albatross some distance from the vessel. At first sighting the underwing pattern and manner of flight indicated a Wandering Albatross *D. exulans;* a clear view showed the all-white underparts except for the dark tips to the wings. However, as the bird banked and changed direction, the dorsal view showed the completely dark wing pattern continuing across the back. The bird was viewed for some minutes before disappearing from sight.

At the time of the observation, a stiff, south-west wind was blowing and the sea was choppy.

S. G. LANE, Lane Cove, N.S.W. 2066.

The Short-tailed Shearwater in South-Western Western Australia.—Hitherto the Short-tailed Shearwater *(Puffinus tenuirostris)* was unknown in Western Australia from west of Hopetoun, 1,250 km west of the nearest breeding colony in the Nuyts Archipelago, off Ceduna, S.A. In 1976 three beach-washed specimens were found considerably further west.

On April 28, Drs. D. Kabay and A. N. Start collected the remains of an all-dark shearwater on the beach at Two Peoples Bay. From its condition we estimate that the bird had been dead about a month. The white of the under-wing is unusual but not unknown in *P. tenuirostris.*

On October 24 Mrs. Alma de Rebeira picked up a dead all-dark shearwater on a beach near Albany. Its legs and bill were dark and the under-wing was grey. It had probably been washed up a week earlier.

On November 6 Mrs. de Rebeira found a decomposed all-dark shearwater on the beach at Yallingup, south of Cape Naturaliste. Its underwing was grey, and it had probably been dead for 1 - 2 weeks. This specimen is the first from the west coast of Australia.

The measurements of all three specimens are consistent only with *Puffinus tenuirostris.* Respectively the exposed culmen is 33.0, 33.1, 33.4; wing 276, 274, 278; and tail 81, 87 and 82 mm.

Subsequently the following note was received from Dr. C. S. Lloyd, of the Edward Grey Institute, Oxford (she had visited the Esperance district in November-March): "On January 16, 1977 I found a partly decomposed all-dark shearwater at Twilight Beach, west of Esperance. The culmen length was 29.7 mm., consistent with *Puffinus tenuirostris.* The skull was shown later to Dr. D. L. Serventy who confirmed the identification."

—G. M. STORR and R. E. JOHNSTONE, W.A. Museum.

Swarming Ants.—On June 5, 1975 while travelling from Mandurah to Fremantle I drove through swarms of flying ants for approximately 12 km. The insects were so thick that their remains blocked the radiator of the car causing it to overheat and their mangled bodies, on the windscreen, made it extremely difficult to see. It was obvious that other vehicles and their drivers were in a similar predicament.

Another flight was recorded by Mr. Lloyd Pond, Principal, Claremont Teachers' College, who drove through a swarm on April 26, 1975 from the 95 km peg north for 26 km on the Albany Highway. He too had problems of poor visibility and an overheating vehicle.

The ants, winged males and females, were taking part in a nuptual flight. Specimens collected were identified by Mr. Athol Douglas, Western Australian Museum, as *Aphaenogaster barbigula* Wheeler.

The swarms encountered between Mandurah and Fremantle were being actively predated by great numbers of Silver Gulls, *Larus novaehollandiae*.

On each occasion the weather was hot and sultry and rain fell within 12 hours of the sightings.

—PETER McMILLAN, Honorary Associate, Entomology Department, Western Australian Museum.

The Biology and Burrow of a Salt Lake Wolf Spider, *Lycosa salifodina* McKay.—Recently McKay (1976, *Mem. Qd. Mus.*, 17(3): 417-23) described the new species of wolf spider *Lycosa salifodina* from specimens collected by Mr. A. M. Douglas and myself at Lake Lefroy, near Widgiemooltha, W.A. The present article gives information (especially about the burrows) that is additional to the few notes given with the description. The existence of this spider had long been known, e.g., Athol Douglas says it had been pointed out to him in the early 1930s by the coleopterist, Horace Brown.

The area worked by Athol Douglas and me was roughly a kilometre square. The specimens were collected in January when the surface of the salt lake was dry. The larger spiders occurred at about 90 m from the shore, the smaller towards the middle of the lake. The spiders were collected at night when they were easy to locate because their shiny eyes reflected the beams of our head torches as a white glow. The sample collected was found to comprise eight mature females, two mature males, and 22 juveniles. The specimens had been collected at random with regard to sex, but with a bias towards larger sized individuals.

Rolly McKay has figured the burrow as a simple vertical tube some 15 cm deep with a distinct rounded ending. However, my field records show that the largest burrows extended vertically into the salt for 15 to 20 cm, whence there extended at right angles a side tunnel for 6.5 cm. The main tube then continued obliquely downwards to the underground water (about 45 cm deep). Burrow entrances were mostly up to 1.6 cm in diameter; the largest was 3.0 cm. Some of the burrows had a small amount of very flimsy silk across the width of the burrow at about 1.3 cm below ground level.

Every spider was astride the top of the burrow: the third pair of legs was positioned at right angles to the body, and all the legs were spread wide across the entrance of the burrow. These spiders, especially the larger individuals, were very aggressive. The only insects abundant on the salt lake were the large green predacious tiger beetles of the genus *Megacephala*. On various occasions, Athol Douglas has dug up the spiders' burrows in random searches for the remains of this beetle, or other possible prey, but found none.

—L. E. KOCH, Western Australian Museum.

Black-eared Cuckoo in the Perth Metropolitan Area.—A Black-eared Cuckoo *(Chrysococcyx osculans)*, in perfect feather and condition, was brought to the Zoological Gardens, South Perth, on May 16 1976 from a house in Yokine where it had been captured after it suffered some concussion on flying into a closed window. It was kept in the zoo for a few days and then delivered to C. A. Nicholls who tended it for some two weeks before its release at Regan's Ford.

It has long been held, based on a reference by W. B. Alexander *(Emu*, 20, 1921: 164), that there was one previous record of this species from Perth. This provenance is now considered doubtful and the Yokine specimen stands as the only certain record from the Perth metropolitan area.

We asked Dr. Glen Storr, of the Western Australian Museum, for further particulars of the specimen mentioned by Alexander and he has replied as follows: "The specimen of Black-eared Cuckoo that Alexander referred to seems no longer to exist. It was presumably the specimen registered in the 'Catalogue of the Museum Perth No. 1' in 1896 as coming from Perth and obtained from one 'Heustern' (that is how I decipher it). This old catalogue was basically an index to the specimens on display; it was concerned with what showcase the specimen was placed in, rather than where, when and by whom it was collected. I therefore doubt whether much significance can be attached to the locality 'Perth'. We have searched the correspondence for 1896 but found no reference to a Black-eared Cuckoo."

—C. A. NICHOLLS, T. SPENCE and A. G. THORPE.

Aerobatics of the White-tailed Black Cockatoo in hot air pillars.—On our property in the Bickley Valley, six km east of Kalamunda, Western Australia (116° 06'E; 32°S) some clearing of bushland had taken place over the summer of 1975. Burning was used to remove the stacked timber over May 1975. On May 8 burning-off of some of the timber led to a fire spreading up the inside of a large 15-20 metre Marri *(Eucalyptus calophylla)* that had been left for its majestic size and beauty. However the fire formed a vent up the hollow trunk of the tree which because of its size continued to burn for several days.

At this time of the year large and small groups of White-tailed Black Cockatoos *(Calyptorhynchus baudini)* move freely through the forested areas of the Bickley Valley feeding mainly on the blossoms and newly forming nuts of the eucalypts. A group of five or six cockatoos found the fire in the gum tree at about 8.30 a.m. on May 9, 1975. The weather was cold and cloudy but with little wind. The birds settled in the area perched around the rim of the upper hole in the main trunk, obviously making use of the warmth. For some time they ruffled their feathers and preened themselves. The most interesting activity (by the birds) was the use of the hot air pillar above the tree for acrobatics. This was most spectacular with the birds flying to the top of the air pillar and somersaulting down in full flight with tumbling characteristics of the tumbler pigeon. This would be over some distance of 4 - 5 metres and down to the top of the tree vent itself. More than one bird would perform at the same time. Furthermore, the birds would also fly in and out of the updraft, created by the fire, gliding both up and down the air pillar.

The birds were very noisy and continued in the above activities for at least three-quarters of an hour before wandering off through the bush to the North East.

—D. KEAST, Department of Microbiology,
University of Western Australia.

Spotted Harrier breeding in the Mukinbudin area.—In October 1975 a pair of Spotted Harriers *(Circus assimilis)* were observed nesting on the property of Mr. L. E. Waters in the Shire of Mukinbudin. The nest was sited on the edge of a belt of mallee next to a cleared paddock which was fallow. Bounding on to this paddock is the Barbalin water reserve which contains mainly granite outcrops dispersed with low scrub.

The nest was a large platform of dry twigs with some fresh *Eucalyptus* leaves on top. It was placed 25 feet up in a gimlet mallee *(Eucalyptus salubris)*. Unfortunately at this time, after having spent two weeks in the district, I was only able to spend an hour observing the nest. Without being able to see into the nest I came to the conclusion that the Spotted Harriers had young chicks in the nest and that they were feeding.

This sighting is the closest record of the Spotted Harrier breeding near Perth.

—BOB GOODALE, Safety Bay

Observation of a Ground Parrot in the Cape Arid National Park.—In February 1965 while driving through the Cape Arid reserve, approximately 100 km east of Esperance, we flushed a green parrot from off the sand track. It flew low over the heath and plummeted into a small patch of mallee. Although I did not have my binoculars I pursued the bird, flushing it from its cover several times. Its flight and general colour convinced me it was a Ground Parrot *(Pezoporus wallicus)*.

In November 1975 I returned to the reserve and found most of it had been devastated by fire and much of the surrounding country being exploited for agriculture. The tracks of vehicles were much more evident. Again a parrot was flushed by our vehicle from off the track in similar country where we had seen a parrot some ten years before. The parrot flew fast and low, plummeting into the heath as would a quail. Several times I flushed the bird to find it each time in a different place from where it had alighted. The birds obviously run very quickly some distance after alighting. All flights were similar, fast and low for about 50 metres.

The striking barring of the tail feathers was easily seen and I was in no doubt that it was indeed a Ground Parrot, and the same as I had seen ten years earlier.

The area where the bird was seen was dry and sandy heathland, which had escaped recent burning. We covered many miles on foot looking for more birds but without success. However they appear difficult to flush, preferring to move quickly over the ground under the protection of vegetation.

—RAY GARSTONE, Woodanilling.

Notes on a Stranded Pygmy Sperm Whale from Broome.—On April 16, 1976, a Pygmy Sperm Whale *(Kogia breviceps)* was washed up on Cable Beach, Broome. It was a small (2 metres long) female. Apart from a shallow laceration on the snout and scrapings (mainly on the ventral surface) there appeared to be no external evidence of injury. An interesting feature noted however was that both flippers had been pierced. The right flipper had a well-healed 3 cm diameter puncture in the trailing edge, whilst the left flipper had been notched by a similar hole that had broken the edge.

Souvenir hunters had removed or broken all but six of the fine, recurved teeth of the lower jaw. As with the large Sperm Whale there were no teeth in the upper jaw.

The incoming tide allowed only a hasty internal examination. This revealed that the whale had died only hours earlier. Massive haemorrhage about the mandibles showed that the lower jaw had been drastically fractured while the animal had been alive. This injury may have occurred prior to the stranding of the whale or during its subsequent thrashings as it stranded. A morbid possibility that should not be overlooked is that souvenir hunters had broken the jaw while extracting teeth when the whale was alive but unconscious.

The eyes were large (3 cm in length) in proportion to the total bulk of the whale and of a vivid opalescent green—adapted probably for deep diving. On the other hand the mouth appeared ridiculously small—the length of the lower jaw being less than 10 cm (from the tip of the jaw to the corner of the mouth). It is difficult to imagine this type of whale catching large squid or fish; possibly it feeds on smaller species that school in open water.

Photographs were taken and the carcass was reclaimed by the spring tides which had earlier deposited it on the beach.

—KIM AKERMAN, Derby, W.A.

First Australian Record of the Pintail Snipe *(Gallinago stenura).*— On December 28, 1976 Dr. and Mrs. Alan P. Johnson found a recently dead and partly eaten snipe in their garden at Port Hedland on the north-west coast of Western Australia. After examining its tail feathers they concluded that they had the first Australian specimen of *Gallinago stenura* (Bonaparte). This species is not to be confused with *G. megala*, known as Swinhoe's Snipe everywhere outside of Australia and in the first edition of the RAOU Checklist, but called the Pin-tailed Snipe in the second edition and Chinese Snipe in the third.

Dr. and Mrs. Johnson kindly donated their specimen to the Western Australian Museum (registered number A14652). Its measurements in millimetres are: wing 133, tail 51, bill (total culmen) 69, tarsus 33. It has 24 tail feathers, the outer seven on each side being very narrow (the outermost have a maximum width of 2.0 mm).

G. stenura and *G. megala* are generally regarded as indistinguishable in the field. In the hand they are readily separated on characteristics of the tail. *G. stenura* has more tail feathers 24 - 26 (vs 20 - 22), including 10 (rather than 8) wide or normal central rectrices. The outer tail feathers are much narrower in *stenura* than *megala;* Hartert *(Die Vögel der paläarctischen Fauna*, vol 2, pp. 1663 - 5) gives a width of 1.0 - 1.5 mm for the outermost rectrix in *stenura*, and 2.5 - 4.0 for *megala* (he is apparently measuring towards the tip rather than at the widest part of the feather). It is also evident from Hartert's data that *stenura* is slightly smaller than *megala*, e.g. wing 129 - 137 (vs 135 - 149), tail 48 - 52 (53 - 60), bill 58 - 67 (61 - 70). The chestnut band across the central rectrices of the present specimen of *stenura* is darker than in our series of *megala*, and the subterminal band is wider and darker (black rather than grey).

Gallinago stenura has a more westerly distribution than *G. megala*. It breeds in Siberia and extreme north-eastern Russia and winters in north-eastern Africa and southern Asia, eastwards to long. 121°E (Formosa, Celebes and Flores). *G. megala* breeds in Siberia west to long. 81°E and winters from eastern India and Sri Lanka eastwards to the Philippines, western Micronesia and the Bismarcks.

According to Smythies *(The Birds of Borneo,* p. 210), *stenura* is the commonest snipe in western Borneo, and *megala* the commonest in northern and eastern Borneo, i.e. east of long. 115°E. As this meridian passes through the north-west of Western Australia, it is not surprising

that *stenura* has been recorded in the North-west Division but not yet in the Kimberley Division (where *megala* is a moderately common summer visitor). Moreover the paucity of swamps in the arid North-west Division makes it much less attractive for *megala* than *stenura*. The Pintail Snipe, as Smythies observes, is "more typically a bird of grazing grounds and grasslands where the ground is not so soft."

—G. M. STORR and R. E. JOHNSTONE,
Western Australian Museum, Perth.

Black-headed Gull at Geraldton.—There is a flock of about 60 Silver Gulls, *Larus novaehollandiae*, which regularly visits the grounds of the Geraldton Senior High School. While watching these birds alternately wheeling over the buildings and resting on the roofs, I noticed among them a gull of a different species. The following description was made while the gulls remained in the area for about half an hour. Observation was at ranges down to about 15 m in good light, but without the aid of binoculars.

Head and upper neck sooty black, sharply abutting the pure white lower neck. The white extended down the breast and belly to the tail and rump. The back and most of the wings, both upper and lower surfaces, were ashy-grey, and decidedly darker that the corresponding silver-grey areas of the Silver Gull. A narrow band along the leading and trailing edge of the wing, above and below, was white. Near the wing tip on the under surface there was a small strip of black, but much less extensive than in the Silver Gull, and without the white "mirrors". The bill was dark, probably black, and shorter and stouter than in the Silver Gull. The eye had a white iris and there was a conspicuous narrow white ring around the eye. The legs were dark, probably black. The bird was clearly a little shorter than the Silver Gull, and slightly plumper. In flight its wing beat was noticeably faster and stronger. Its general behaviour was identical with the Silver Gulls with which it was resting and flying. No call was heard. The main features of this description were checked and confirmed by Mr. Ray Harwood and Mr. Tony Little of Geraldton, to whom I pointed the bird out. Although flocks of gulls were watched carefully at the school and for several miles up and down the coast for several days I did not sight it again.

From W. B. Alexander's *Birds of the Ocean* it seems that the gull can be identified as an adult Chinese Black-headed Gull, *Larus saundersi*, in northern summer plumage. It normally inhabits rivers and estuaries in eastern Siberia, China, Korea and occasionally Japan and Taiwan. It seems that the gull may have arrived in Geraldton as the result of following a ship: the harbour is about 1 km from where the bird was seen. The Geraldton Port Authority informed me that four ships had entered port in the previous five days: one from Yokohama, Japan via Singapore; one from the Middle East and two from Australian ports.

The Chinese Black-headed Gull has not previously been reported in Australia. However, on at least two occasions other black-headed gulls have been recorded in the south west of Australia. One was made by Mr. Timothy Dixon *(Emu*, 58, 1958: 71) of a bird seen in Bunbury in 1957. This was identified as the American species, Franklin's Gull, *Larus pipixcan*, and corroborated by the late W. B. Alexander. The other record is in the RAOU Newsletter, No. 27, June 1976, in a report of the W.A. branch of the RAOU when Mr. Gerry Nicholls exhibited three photographs of a bird seen at Geraldton at the end of March 1976, and which he identified as Franklin's Gull. It is quite possible that the bird seen by Nicholls and by me was the same individual.

—LINDSAY E. SEDGWICK, Geraldton.

Musk Lorikeets at Alfred Cove.—On September 28, 1975 a group of Naturalists' Club members watched a fight between several birds in a tall eucalypt near the Swan River foreshore at Alfred Cove. Two birds fell from a height of thirty or so feet, still fighting, and, when approached, flew off. One was a Twenty-eight Parrot *(Barnardius zonarius)* and the other a small green lorikeet, clearly not the only endemic south-western species, the Purple-crowned Lorikeet *(Glossopsitta porphyrocephala)*. As we watched two lorikeets entered a hollow spout in the tree (an old Flooded Gum, *Eucalyptus rudis)* and shortly afterwards strongly defended their territory from the much larger Twenty-eights. They were identified as Musk Lorikeets *(Glossopsitta concinna)*, a species not represented in the West, their normal range being south-eastern Australia. The birds were a male and female in full breeding plumage, bright green with distinctive red and blue facial markings, a bright red bill and yellow on the side of the breast. They continued to ward off the Twenty-eights, flying directly towards them and calling loudly whenever they approached the hollow too closely.

Dr. G. M. Storr, of the W.A. Museum, positively identified the birds from colour photographs taken at the Cove and agreed that the most likely explanation of their presence was as escapees from captivity. However he pointed out that the possibility of the birds having flown unaided from the South-East cannot be ruled out. He has already advanced this explanation for the Rainbow Lorikeets *(Trichoglossus moluccanus)* established at Nedlands *(W. Aust. Nat.*, 12 (5), 1973: 116); incidentally these now occur also at Safety Bay. Neither the Zoological Gardens nor the Avicultural Society could account for the birds' presence.

The lorikeets were regularly seen in the area throughout the months of October and November. Soon after the first sighting they moved to another hollow spout a few feet away in the same tree, this hollow having two entrances. In the meantime a pair of Tree-Martins *(Petrochelidon nigricans)* nested in the original hole. The lorikeets appeared to enter their hollow in the evening to roost, flying in with a fast direct flight on short whirring wings. The call is a piercing shriek.

At the beginning of 1976 a Club member heard what may have been young birds calling from the hollow. Following this up, on March 15 and 22, 1976 (by which time the plumage of the adults had become much less colourful) three birds were seen to enter and leave the hollow, one being markedly duller than the other two in appearance. It seems likely that this represents the first recorded breeding of the Musk Lorikeet in Western Australia.

—BRUCE CORFE, Cairns.

Breeding Records of the Grey Honeyeater.—On October 27, 1975, in the Yalgoo district, B.A.W. found "a small nest of frail structure, attached to the extremity of a horizontal branch of a narrow leaved mulga, about 8 feet from the ground" (cf. Serventy & Whittell, *Birds of Western Australia*, 4th edn., 1967, p. 380, on the Grey Honeyeater, *Lacustroica whitei)*. The nest was completely filled by one well advanced nestling, the most obvious feature of which was a *golden* ring around the eye, corresponding to the similar feature of the Western Silvereye *(Zosterops lateralis gouldi)*.

The nestling was being fed by two small greyish unattractive birds which lacked any interesting or remarkable coloration except for whitish underbody. However when we approached the nest, the birds fluttered to the nearest tree with an aerial display of white feathers, seemingly intended to distract our attention from the nestling.

The birds were seen to feed in association with Yellow-tailed Thornbills *(Acanthiza chrysorrhoa)* and Western warblers *(Gerygone fusca)*. In this general company they were easily overlooked. However, their frequent calls were strikingly similar to that of the Western Silvereye.

At the time we failed to recognise the species, but later, the identification as Grey honeyeater was quite obvious.

On November 20, 1975, A.G.W. found another nest with two eggs, approximately one kilometre from the site of the earlier observation. It was just over one metre from the ground, attached to the extremity of a horizontal branch of curara *(Acacia tetragonophylla)*. Both exterior and interior aspects of the nests were loosely lined with the white woolly globules of bindi eye *(Bassia* spp.). The eggs were white with reddish-brown markings, and both parents shared the incubation.

During the following week in this locality, we observed other Grey Honeyeaters daily, estimating five pairs in a radius of about one kilometre. Their calls became a familiar sound in the vicinity of our camp. We gained the impression that they were not uncommon, at least in this area, and at that particular time.

Photographs taken at the first nest revealed the slightly down-turned beak of the parents, and also a faint whitish ring around the eye. Neither of these two features was distinguishable to us when using binoculars. Although the birds were seen to carry insects to the nestling, the only food recorded in the photographs appeared to be fruits of a mistletoe, and are shown as being reddish in colour with black markings.

In general profile, the birds were most unlike other honeyeaters. In fact a bird observer on first encountering the species would not seek its identification in the honeyeater section of a field guide!

On August 1, 1976 we camped at the entrance to a valley at the western end of the Hamersley Range, 3 km along an HEX track off the Paraburdoo-Nanutarra road. A pair of Grey Honeyeaters was observed by B.A.W. at close range in a stand of mulga. The birds were seen to copulate twice. Their characteristic call was not heard.

On October 10, 1976 we re-visited the same locality in the Yalgoo district referred to in the opening paragraph of this note. We parked our vehicle about 1 km from our previous campsite, and within a few minutes we both observed a pair of Grey Honeyeaters feeding a well advanced fledgling. No other fledgling was seen. We were at less than 10 metres range and watched the group for some ten minutes as it moved through several mulga trees.

On the following morning, in separate but adjacent localities, each of us observed a lone adult Grey Honeyeater, foraging in company with Yellow-rumped Thornbills mainly in curara bushes and mulga trees.

In all of the above instances identification was positive. We were easily able to note the main characteristics of the species, namely grey upper parts and head, whitish underparts, with a distinct whitish eye ring. The beak had a slight down turn. In flight there was a prominent display of white feathers.

On the latter two occasions the characteristic call, resembling that of the common Western Silvereye was clearly heard in fact it was the call which attracted our attention.

It was worth noting that this area had suffered severely from the prevailing drought. Mulga trees and curara bushes, which formed the main vegetation, appeared to have shed about 50% of their leaves. Grasses and small plants were almost non-existent. It therefore seemed remarkable that in spite of these adverse conditions which followed a good rainfall season in 1975, we were able so easily to find again this small and insignificant honeyeater, and that during our brief visit to Yalgoo, it was the only species of bird of which we saw evidence of breeding.

—A. G. and B. A. WELLS, Scarborough.

EXCURSION

WHICHER RANGE—DONNYBROOK SUNKLANDS

On October 9 - 11, 1976, a party of 15 Naturalists' Club members and four guests visited the Donnybrook Sunklands in order to expand on the survey work previously published by the Forests Department of Western Australia in its report, *Afforestation with Pines in the Donnybrook Sunklands—Statement of Intent,* September 1975. Specifically the party wished to consider the suitability of the boundaries proposed for the Whicher Range Reserve.

In its *Statement of Intent* the Department divided up the Sunklands area (State Forest No. 33) into three categories—reservations, proposed pine plantation cells and native hardwood areas. An account of this future management scheme of the Sunklands, with a map and colour illustrations, was given in the Department's periodical *Forest Focus,* No. 16, December 1975, 15 pp., which is, perhaps, more generally available than the *Statement* itself.

The proposed pine areas had been selected following soil and site surveys and consist mainly of the deep sandy soil preferred for pine planting. The area retained as native hardwood forest will be managed by normal forestry techniques, including prescribed burning. The "reservations" include areas set aside primarily for recreation or for biological purposes. One of these is the Whicher Range, selected to preserve a major occurrence of the Mountain Marri *(Eucalyptus haematoxylon).*

Previously, in 1974, the Conservation Through Reserves Committee recommended that a fairly substantial area of the Whicher Range be declared a Class A Reserve for the conservation of flora and fauna, to be vested in the W.A. Wildlife Authority (see Fig. 1). The Forests Department in its *Statement of Intent* designated a rather smaller area as a Forest Reserve for Recreation, Catchment and Flora. Finally Cabinet accepted the recommendation made by the Environmental Protection Authority in 1976 to make the area a "Forest Park", primarily for recreation and for flora and fauna conservation, under the control of the Conservator of Forests.

Method of survey:

The birds were recorded during walks into the centre of the Whicher block, along the Sabina River, and at various places along Sabina, Jalbaragup and Hill Roads (within the Whicher Range Reserve in the morning, and "elsewhere" in the afternoon). An attempt was made to survey the flora on a systematic grid basis. Groups of people drove to different areas, then collected all species around their stopping places for 15 minutes. A comparison of the different collections should give an overall picture of the flora. Unfortunately the grid system proved not as complete as hoped, for members found the amount of work involved, in the time available, rather daunting. Nevertheless the results did not lack interest.

Results:

Birds (Appendix I). The results can scarcely be considered as having any real significance. But the species recorded may suggest which are the conspicuous birds of the area. Furthermore, as three of the 37 species noted, namely the Red-tipped Pardalote, the Horsfield Bronze Cuckoo and the Hooded Robin, had been overlooked in the surveys of the Forests Department (as recorded in the appendices of the *Statement of Intent)* it may be assumed that the avifauna of the Reserve may prove to be fairly considerable when adequate surveys are made. The low number of species noted outside of the designated Reserve area may be due to the fact that the walks were made in the afternoon.

Plants (Appendix II). A total of 200 species were collected, 71 of which had not been recorded in the *Statement of Intent.* Of this total 78% occur within the Whicher Range Reserve. The most important of those

Fig. 1.—Map of Whicher Range Area

(redrawn from Conservation Through Reserves Committee Report, 1974)

that do not occur within the reserve are associated with swamps, e.g. *Stirlingia latifolia*, which had not been previously recorded as far west, and isolated populations of *Xyris* sp., and *Dasypogon hookeri*.

The Whicher Range also has a number of plants that show unusual distributions, e.g. *Dryandra formosa* and *Conospermum acerosum*, which are more common further east, and on the northern sandheaths, respectively. In addition the Range has a number of possible endemics including *Grevillea brachystylis*, *Synaphea favosa* and a large-flowered *Darwinia* sp. In fact all three *Darwinia* spp. found were of interest, as *D. citriodora* and *D. vestita* are atypical variants. The *Synaphea* population also shows intermediate characteristics and may prove to contain a new species. A white-flowered *Andersonia* and a *Calothamnus* found near the Sabina River also appear to be undescribed species.

CONCLUSIONS

The Whicher Range is an important and significant area and should remain reserved for flora and fauna conservation. Elsewhere along the northern section of the Sunklands there is little of natural significance except for the Margaret River swamps. If pine planting should take place in that region care should be taken to avoid disruption of the swamps, either by direct disturbance or by increasing erosion and so turbidity of the water and siltation of the swampland.

ACKNOWLEDGEMENTS

I thank the staff of the Western Australian Herbarium for their assistance with the identification of specimens.

APPENDIX 1

BIRDS

(Recorded by Arthur Fewster, John Hutchinson and M. T. Millard)

	noted within Whicher Range	EPA reserve	noted elsewhere
Wedge-tailed Eagle	x		
White-tailed Black Cockatoo	x		
Red-capped Parrot	x		
Twenty-eight Parrot	x		
Elegant Parrot	x		
Fan-tailed Cuckoo	x		
Kookaburra	x		
Sacred Kingfisher	x		
Bee-eater	x		
Tree-Martin	x		x
Splendid Wren	x		
Red-winged Wren	x		
Western Warbler	x		x
Broad-tailed Thornbill	x		
Spotted Scrub-Wren	x		
Weebill	x		x
Scarlet Robin	x		
Yellow Robin	x		
White-breasted Robin	x		
Grey Fantail	x		x
Willy Wagtail	x		
Golden Whistler	x		
Western Shrike-Thrush	x		
Spotted Pardalote	x		
White-naped Honeyeater	x		
Spinebill	x		x
Little Wattle-bird	x		
Squeaker	x		
Western Magpie	x		
Raven	x		
Dusky Wood-swallow	x		x
Rufous Tree-creeper	x		
Pallid Cuckoo	x		
New Holland Honeyeater	x		
* Red-tipped Pardalote	x		
* Horsfield Cuckoo	x		
* Hooded Robin (female)	x		

* denotes birds not previously recorded in the Statement of Intent as occurring in the area.

APPENDIX II

PLANTS

(In this list of plants collected the nomenclature follows *West Australian Plants*, ed. J. S. Beard, 2nd edn., 1970)

Name	collected within EPA Whicher Range	Reserve	collected outside EPA Whicher Range	Reserve
GYMNOSPERMAE				
CYCADACEAE				
Macrozamia reidlei, Zamia	x		x	
PODOCARPACEAE				
Podocarpus drouynianus, Native plum	x		x	
ANGIOSPERMAE—MONOCOTYLEDONEAE				
CYPERACEAE				
Lepidosperma angustatum	x		x	
Mesomelaena tetragona	x		x	
RESTIONACEAE				
Loxocarya flexuosa	x		x	
XYRIDACEAE				
* *Xyris* sp.			x	
LILIACEAE				
* *Burchardia umbellata*, Milkmaids	x		x	
Johnsonia lupulina, Hooded lily	x		x	
Thysanotus multiflorus, Fringe lily	x			
* *T. thrysoideus*, Fringe lily			x	
XANTHORRHOEACEAE				
Dasypogon bromeliifolius	x		x	
D. hookeri	x		x	
Kingia australis, Black gin	x			
Lomandra sp.	x			
Xanthorrhoea gracilis, Blackboy	x			
X. preissii, Blackboy	x			
HAEMODORACEAE				
Conostylis spp.	x		x	
IRIDACEAE				
* *Orthrosanthus laxus*, Morning iris	x			
Patersonia occidentalis	x		x	
P. umbrosa	x			
P. xanthina, Yellow flag	x		x	
ORCHIDACEAE				
* *Caladenia deformis*, Blue fairy orchid	x		x	
* *C. dilatata*, Green spider orchid			x	
* *C. flava*, Cowslip orchid	x			
* *C. latifolia*, Pink fairy orchid	x			
* *C. patersonii*, White spider orchid	x			
* *C. nana*, Pink fan orchid	x			
* *Diuris purdiei*, Donkey orchid	x			
* *Elythranthera brunonis*, Purple enamel orchid			x	
* *E. emarginata*, Pink enamel orchid	x			
* *Lyperanthus nigricans*, Elephant's tongues	x			
* *L. serratus*, Rattle Beak orchid	x			
* *Pterostylis recurva*, Jug orchid	x			
* *P. vittata*, Greenhood orchid	x			
* *Thelymitra antennifera*, Lemon orchid			x	
* *T. crinata*, Blue lady orchid	x			
ANGIOSPERMAE—DICOTYLEDONEAE				
CASUARINACEAE				
Casuarina drummondiana	x			
C. fraseriana, Sheoak			x	
C. humilis, Dwarf sheoak	x			
PROTEACEAE				
Adenanthos barbigera, Stick-in-jug	x		x	
A. meissneri	x		x	
A. obovata, Stick-in-jug	x		x	
Banksia attenuata, Candlestick Banksia	x		x	
B. grandis, Bull Banksia	x		x	
B. ilicifolia, Holly leaved Banksia			x	
B. sphaerocarpa, Round fruited Banksia	x		x	
Conospermum acerosum, Needle-leaved Smokebush	x			
C. caeruleum			x	
C. flexuosum	x		x	
C. teretifolium			x	
Dryandra bipinnatifida	x			
* *D. formosa*	x			
D. nivea, Shaving-brush Dryandra	x		x	
Grevillea brachystylis	x			
* *G. leptobotrya*	x		x	
G. manglesioides	x			
G. quercifolia	x		x	
Hakea ambigua	x			
* *H. amplexicaulis*, Prickly Hakea	x		x	
H. ceratophylla, Horned-leaf Hakea	x			
H. cyclocarpa, Curved-fruit Hakea	x			
H. lasiantha, Woolly-flowered Hakea	x			
H. ruscifolia, Candle Hakea	x		x	

Isopogon sphaerocephalus, Drumsticks	x	x
Persoonia elliptica, Snooty-goggle	x	x
P. longifolia, Red Paperbark	x	x
Petrophile diversifolia	x	x
P. linearis	x	x
P. serruriae	x	x
P. squamata	x	
* *P. striata*	x	
Stirlingia latifolia, Bluebush	x	x
* *S. teretifolia*		x
Synaphea favosa	x	
* *S. petiolaris*	x	x
S. preissii	x	x
* *S. sp. nov.*	x	
Xylomelum occidentale, Forest pear	x	x
SANTALACEAE		
* *Leptomeria cunninghamii*		x
LORANTHACEAE		
Nuytsia floribunda, W.A. Christmas tree	x	x
RANUNCULACEAE		
* *Clematis aristata*, Traveller's Joy	x	
DROSERACEAE		
* *Drosera gigantea*, Giant sundew		x
* *D. spp.*		x
PITTOSPORACEAE		
* *Billardiera variifolia*		x
* *Marianthus candidus*		x
MIMOSACEAE		
Acacia alata	x	x
A. divorgens		x
A. drummondii		x
A. ? extensa		x
A. gilbertii		x
A. pulchella, Prickly Moses	x	x
CAESALPINIACEAE		
Labichoa punctata	x	
FABACEAE		
Aotus villosa		x
Bossiaea ornata		x
* *Chorizema diversifolium*, Twining flame-pea	x	
Daviesia alternifolia	x	
* *D. polyphylla*	x	
* *D. cordata*, Book-leaf bitter-pea	x	x
D. quadrilatera	x	
Dillwynia uncinata, Silky parrot-pea	x	
Gompholobium burtonioides	x	
* *G. knightianum*	x	x
G. ovatum	x	x
* *G. tomentosum*	x	
G. venustum, Handsome Wedge-pea	x	
Hovea elliptica	x	x
H. trisperma	x	x
Kennedia coccinea, Coral vine	x	x
K. stirlingii	x	
* *Melilotus indica*, Melilot	x	
Mirbelia dilatata	x	
Pultenaea andrewsii		x
Sphaerolobium macrantnum	x	x
* *S. medium*		x
* *S. racemulosum*		x
* *S. vimineum*	x	
RUTACEAE		
Boronia crenulata	x	
* *B. spathulata*	x	x
* *B. ? ternata*		x
Crowea angustifolia	x	x
Eriostemon spicatus, Pepper and salt	x	x
TREMANDRACEAE		
* *Platytheca verticillata*	x	x
Tetratheca setigera	x	x
POLYGALACEAE		
* *Comesperma scoparium*, Broom milkwort		x
C. virgatum		x
* *C. volubile*, Love creeper	x	
EUPHORBIACEAE		
* *Phyllanthus calycinus*, False Boronia	x	
* *Poranthera sp.*	x	x
STACKHOUSIACEAE		
* *Stackhousia brunonis*		x
S. huegelii	x	x
RHAMNACEAE		
Trymalium ledifolium	x	
STERCULIACEAE		
* *Lasiopetalum acutiflorum*		x
Thomasia grandiflora	x	x

DILLENIACEAE		
* *Hibbertia lasiopus*		x
H. hypericoides	x	x
H. perfoliata	x	x
H. vaginata		x
H. sp. nov.	x	x
VIOLACEAE		
Hybanthus floribundus	x	
THYMELAEACEAE		
Pimelea rosea, Pink Banjine	x	x
P. spectabilis	x	x
P. suaveolens		x
MYRTACEAE		
Agonis parviceps	x	x
Beaufortia sparsa		x
* *Calothamnus gracilis*		x
C. sanguineus, One-sided Bottlebrush	x	x
* *C. sp. nov.*	x	
* *Calytrix flavescens*, Yellow star-flower		x
C. variabilis		x
* *Darwinia citriodora*, Lemon-scented myrtle	x	
D. vestita	x	
D. sp. nov.	x	
Eucalyptus calophylla, Marri	x	x
E. haematoxylon, Mountain Marri	x	x
E. marginata, Jarrah	x	x
Hypocalymma angustifolium, White myrtle	x	x
H. robustum, Swan River myrtle	x	
Kunzea recurva	x	x
Leptospermum ellipticum	x	x
L. firmum		x
Melaleuca sp.	x	x
HALORAGACEAE		
Glischrocaryon aureum, Pop flower	x	x
APIACEAE		
Platysace compressa	x	
* *P. tenuissima*		x
* *Trachymene pilosa*	x	
EPACRIDACEAE		
Andersonia caerulea	x	x
A. longifolia	x	
A. sp. nov.	x	
Astroloma epacris	x	
Conostephium pendulum, Pearl flower	x	x
Leucopogon australis	x	x
L. parviflorus		x
L. verticillatus, Tassel shrub	x	x
L. sp.	x	
Lysinema ciliatum, Curry plant	x	
Sphenotoma capitatum		x
LOGANIACEAE		
* *Logania campanulata*	x	
Mitrasacme paradoxa		x
DICRASTYLIDACEAE		
Pityrodia bartlingii, Woolly dragon	x	
LENTIBULARIACEAE		
* *Polypompholyx multifida*		x
LOBELIACEAE		
* *Lobelia* sp.	x	
GOODENIACEAE		
Dampiera cuneata	x	x
D. sacculata		x
Goodenia caerulea	x	
Leschenaultia biloba, Blue Leschenaultia	x	x
Scaevola striata	x	
Velleia trinervis	x	
STYLIDIACEAE		
* *Levenhookia pusilla*, Midget Stylewort	x	
* *Stylidium caespitosum*	x	
* *S. calcaratum*, Ballerina triggerplant	x	x
* *S.* sp. aff. *dichotomum*	x	
* *S. glaucum*	x	
* *S. repens*	x	
S. scandens, Climbing triggerplant		x
* *S. schoenides*, Cowkicks	x	x
ASTERACEAE		
* *Craspedia uniflora*, Billy buttons	x	
* *Cryptostemma calligula*, Capeweed	x	
Helichrysum bracteatum	x	x
* *Hypochoeris radicata*, Flatweed	x	
Lagenophora stipitata	x	

* denotes plant not included in Appendix II, List of Plant Species, in Forests Department Statement of Intent, 1975.

—B. M. J. HUSSEY

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