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OBSERVATIONS ON THE REPRODUCTIVE SYSTEM OF THE FEMALE OF *MYOBATRACHUS GOULDII* (GRAY)

By J. A. L. WATSON* and L. M. SAUNDERS, Department of Zoology, University of Western Australia.

I. INTRODUCTION

Myobatrachus gouldii (Gray), one of the most specialised and atypical of the Australian Amphibia, is restricted to Western Australia and is known only from the area between Geraldton and the Abrolhos Islands in the north and the Stirling Ranges, Truslove and Esperance in the south-east (Fletcher, 1898; Glauert, 1945). The species is largely subterranean in habit and most of the specimens in collections have been taken through chance excavation or found under logs and stones. However, Philipp (1958) suggested that the frogs might move about on the surface on rainy nights and one of us (L.M.S.) observed a small individual walking in the open on a wet winter evening eight or nine years ago. Apart from the occurrence of the frogs in the field, the only aspect of the biology that is at all well known is the feeding behaviour. Calaby (1956) showed from extensive gut-content analyses that the food consisted almost entirely of termites and Philipp (1958) gave an account of *Myobatrachus* feeding on termites in captivity.

Very little is known of the reproductive biology of the species. From its distribution and behaviour, it appears to be independent of free water for reproduction. Harrison (1927) gave some indirect evidence for this, having found that in a specimen taken at Eradu "the ovarian follicles were well developed, measuring upwards of 3 mm. in diameter." Further, Glauert (1945) noted that "the eggs are very large and probably develop away from water." Main *et al* (1959) have also suggested that the larval development lacks an aquatic stage.

II. ANATOMY OF THE FEMALE REPRODUCTIVE TRACT

On September 14, 1958, one of us (LM.S.) obtained a *Myobatrachus* of length 47 mm. which had been excavated from a depth of about 1 foot in yellow sand at Mt. Pleasant. The frog appeared to be a gravid female and in an attempt to induce ovulation, a suspension of fresh pituitary glands from four female toads, *Bufo*

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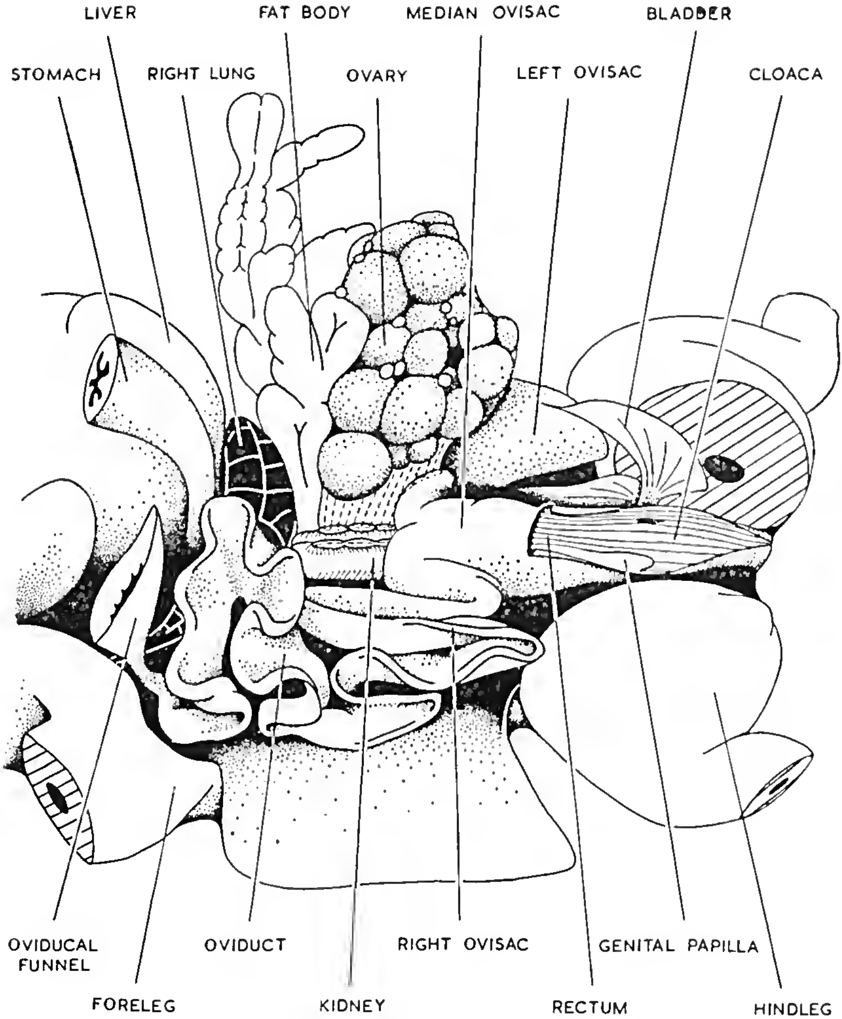

Fig. 1.—The reproductive system of a female of *Myobatrachus gouldii* (Gray). Accession no. R.13068. The right lobe of the liver and the right ovary have been removed. The oviducal funnel is drawn diagrammatically.

marinus (Linnaeus), was introduced into the dorsal lymph sac. The glands had no obvious effect on the reproductive system and the frog died on September 24, nine days after the injection.

Subsequent dissection showed that the genital system presented unusual features which help in the interpretation of the reproductive processes of the frog (fig. 1).

A. The eggs were few in number but were large and yolky. After fixation in 10% formalin for 24 hours, the largest ovum had a diameter of 5.1 mm. (measured with vernier calipers) and there were 48 ova with diameters greater than 2.5 mm. In addition, the ovaries contained approximately 50 small eggs, most of which measured 1 mm. or less (fig. 3).

B. The oviducts were broad and convoluted, opening anteriorly into a dilated funnel lying between the large liver and the heart. At the posterior end each oviduct was expanded into a folded lateral ovisac.

C. The lower ends of the lateral ovisacs narrowed and then joined into a median ovisac. This strikingly uterus-like structure discharged through a genital papilla on the dorsal wall of the cloaca. The inner wall of the median ovisac was strongly folded, probably to permit expansion after ovulation when the lower part of the tract becomes distended with eggs (see IIIC. below).

III. DEVELOPMENT OF THE REPRODUCTIVE SYSTEM

To obtain additional data on the reproductive cycle, the 42 opened *Myobatrachus* in the collections of the Western Australian Museum were examined. Of these, 29 proved to be females, ranging in length from 24-53 mm. and 13 were males, with lengths from 27-49 mm. The diameters of the ova in females of the series were measured with calipers to the nearest 0.5 mm. but preservation had caused some of the eggs to become compressed and in these cases the maximum dimension was taken. Ova smaller than 2.5 mm. were difficult to measure accurately and were not included in the calculated mean diameters of developing eggs.

A. The immature reproductive tract.

In immature females (i.e. females with undeveloped ovaries) the eggs were of approximately uniform size, 1 mm. or less in diameter. The lateral oviducts were uncoiled and threadlike, closely parallel to the outer border of the kidney, and the median ovisac was clearly distinguished but short and narrow.

B. Size and maturity.

The smallest *Myobatrachus* with developing ova measured 30 mm. from snout to cloaca. In this specimen only 6 ova had a diameter exceeding 2 mm. and the remainder were extremely small. In two 33 mm. frogs the ovaries contained 1 and 4 ova greater than 2 mm. but in the second of these frogs the ovaries had been damaged in the previous gut-content examination. In one specimen of length 34 mm. the left ovary was well developed and the right ovary was rudimentary. The smallest *Myobatrachus* with well developed ovaries measured 37 mm.

On the other hand, undeveloped ovaries were found in frogs with lengths ranging from 24 to 42 mm. These specimens had been received at the Museum at different times of the year.

C. Enlargement of the ova and ovulation.

A graph of the mean diameter of developing ova from each frog, plotted against the date of accession, showed a yearly growth trend (fig. 2). Two factors complicate the interpretation of the trend:—

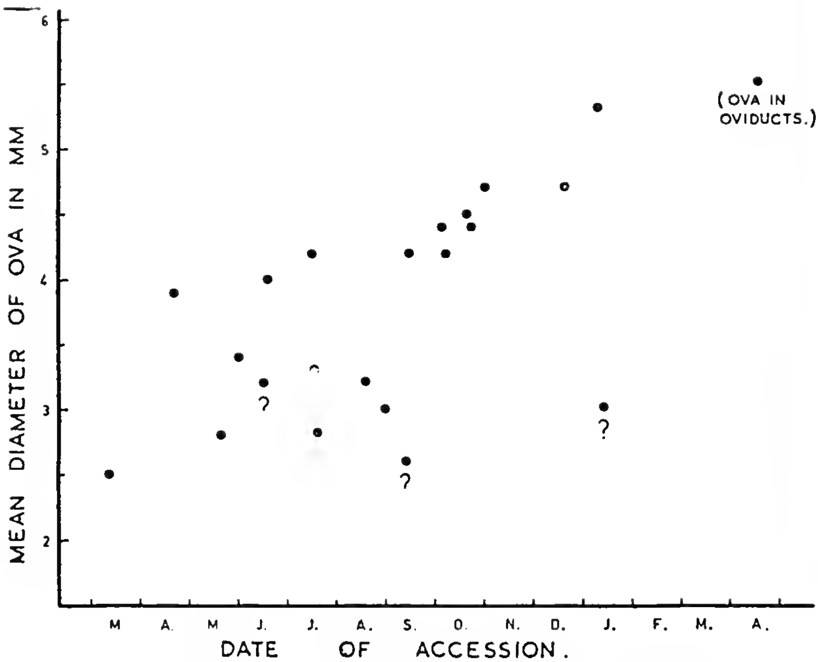

Fig. 2.—The growth of ova in *Myobatrachus gouldii* (Gray)

i. The date of accession as recorded, in the Museum registers, may not necessarily approximate to the date of collection.

ii. Climatic conditions differ between years of collection and also between localities. However, no correlation could be observed between the variability of egg sizes in the March-August period and the seasonal distribution or total amount of rain.

The points marked with a query represent measurements of less than 6 ova and all were taken from frogs apparently in their first year of reproduction (see IIIB above). Their value is questionable.

Only one specimen (R2590, accessed April 17, 1929) had eggs in the oviducts. These ova were the largest measured, ranging up to 7 mm. with a mean of 5.5 mm. and were taken to represent the end point of the yearly growth trend. None of the eggs showed any external sign of cleavage. Because of the distension of the lateral and median ovisacs and some prior damage, the limits of the reproductive tract were not clearly visible. However, there was no appearance of glandular thickening, the walls of the ovisacs being thin and transparent.

The possession of a median ovisac is not a feature peculiar to *Myobatrachus*. Bhaduri (1953) reported 17 genera, including representatives of almost every family of Salientia, as possessing a common "uterus" or ovisac. Despite the similarity in structure of the "uteri" of *Myobatrachus* and the ovoviviparous South African frog *Nectophrynoides* (Noble, 1931), the absence of ovoviviparity in any other of the 17 genera precludes an inference as to the status of *Myobatrachus* with regard to embryonic and larval development.

Measurements of eggs from frogs late in the reproductive cycle showed two size-frequency peaks, one representing the large developing eggs for the approaching autumn and the other, small eggs for subsequent autumns (fig. 3). Eggs smaller than 2.5 mm. were difficult to count, particularly those of R2590, in which they were attached to the ruptured walls of the ovary. The black columns for these sizes therefore represent minimum numbers. The two histograms illustrate clearly the difference in development of the ova at different times in the yearly cycle.

IV. CONCLUSIONS

A. Large yolky eggs are found commonly in Amphibia which develop away from water, metamorphosis proceeding either in a pool of jelly formed by the breakdown of the egg capsules, or within the egg itself. It may therefore be supposed that development in *Myobatrachus* is intracapsular but there is insufficient evidence to indicate whether the frog is oviparous or ovoviviparous.

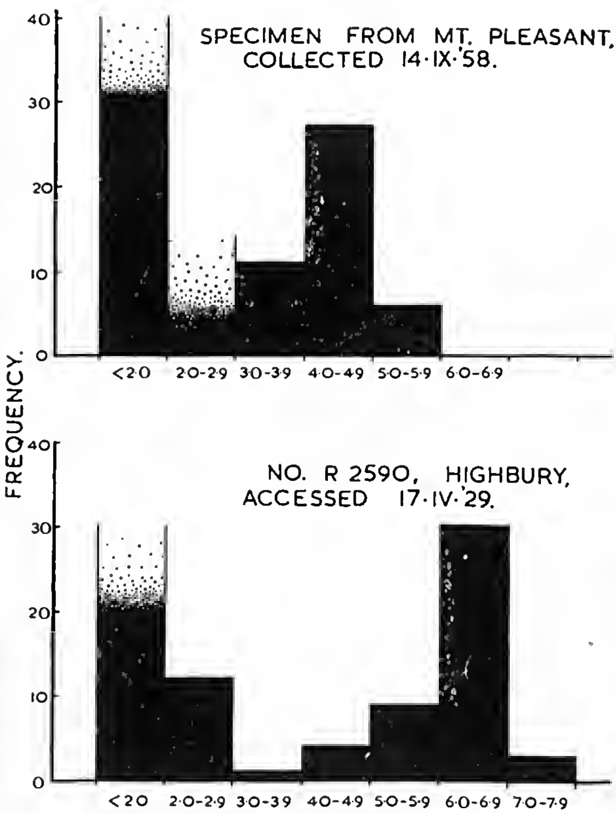

Fig. 3.—Size-frequency histograms of the ova of *Myobatrachus gouldii* (Gray). Horizontal scale shows the size-classes of ova diameters in millimetres.

B. Observations are consistent with the hypothesis that ovulation occurs in the late summer to early autumn, and that residual small follicles in the ovary enlarge during the succeeding 12 months, reaching a mature diameter of 5-7 mm. in the middle of the following summer.

C. Philipp (1958) collected 15 mm. *Myobatrachus* in August and suggested that these froglets hatched from eggs fertilised 3-4 months previously. The yearly growth cycle data presented here support this suggestion. As ovarian enlargement may be commenced at a body length of between 30 and 40 mm. a period of at least two years probably intervenes between hatching and the first ovulation.

V. ACKNOWLEDGMENTS

The authors wish to thank Dr. W. D. L. Ride and Dr. G. F. Mees, of the Western Australian Museum, for permission to examine the series of *Myobatrachus,* and Dr. A. R. Main, of the University of Western Australia, for reading the manuscript. The study was carried out during the tenure of research grants from the University of Western Australia.

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CATASTROPHIC DESTRUCTION OF THE LITTORAL FAUNA AND FLORA NEAR FREMANTLE JANUARY 1959

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INTRODUCTION

In late January 1959 there were exceptionally low tides on the coast near Fremantle. The Harbour Trust gauge was out of order during this period, but visual observations there were within $\pm$ 0.05 ft. of those recorded at Rottnest (table 1). Mean low water for

January is 1.3 ft. (1949-58), levels of 0.5 ft. or less have been recorded on only 24 days in the last ten years, and levels of 0.3 ft. or less were last recorded in December 1947 (reaching zero on 30th and 31st).

TABLE 1.—TIDE LEVELS AND MAXIMUM SHADE TEMPERATURES AT ROTTNEST

	Feet above Fremantle datum		Temperature
January	Low water	High water	degrees F.
23	0.7	2.8	72
24	0.5	2.5	73
25	0.1	2.2	74
26	0.3	2.2	78
27	0.5	2.0	84
28	0.9	2.2	102

On the four days 24th to 27th water level was below the one foot mark from before dawn until after 3 p.m. The sea was very calm on 24th to 26th, the small waves barely lapped the outer edge of the reef platform (as seen at Cottesloe) but on 27th there was more water movement (at Yanchep). Temperatures were not excessive until 27th and 28th. Morning winds were mainly southerly on 23rd and 24th, S.E. on 25th and 26th, E. on 27th, and N.E. on 28th; the usual S.W. winds followed in the afternoons.

The intertidal limestone platforms of the vicinity of Fremantle are at various levels, but few are less than 1 ft. or more than 2½ ft. above datum. During the above periods of low tide all except the lowest of these "reefs" were exposed to drying throughout the heat of the day for several successive days, or where shallow water was retained on them it stagnated and must have become very hot. Only the extreme outer edges of the platforms were periodically refreshed, by the very small waves.

The effect on the animal and plant life was catastrophic. Vast numbers of animals were killed and lay rotting on the reef platforms for weeks afterwards and the sea weeds suffered great damage.

OBSERVATIONS

Only two reefs were visited during the period of low tides and the full extent of the damage was not appreciated until Rottnest Island was visited on February 9 to 19.

At Cottesloe a low level platform (less than 1 ft. above datum) south of Mudurup Rocks is covered by coralline algae *(Jania)*. The chief casualties here were the small starfish *Patiriella* and a small sea slug; both were dying in large numbers on January 26. On the lower part of the Yanchep reef (January 27) *Patiriella* again suffered heavily and many recently dead specimens of the following were found: crinoids, ophiuroids, echinoids *(Heliocidaris, Holopneustes, Phyllacanthus)*, asteroids *(Coscinasterias, Pentagonaster)*, worms, shrimps, crabs, small fish, *Clavarizona* and other chitons, the fissurellids *Macroschisma tasmaniae, Amblychilepas javanicensis* and *Scutus anatinus*, *Quibulla* sp., the lamellibranchs *Pinna dolabrata* and *Electomactra antecedens*. Mr. G. Kendrick who kindly supplied the above list also noted small numbers of other species and remarked on the abundance and sluggish condition of others, particularly *Floraconus* and *Dyraspis*. This was in the early morning so that the mortality observed must be attributed to the heat of the previous days. *Haliotis roei* is particularly abundant on the edge of the platform here but there was no mass mortality although some recently dead specimens were found.

At Rottnest there was still abundant evidence of recent devastation two to three weeks after the low tides. Mortality was heaviest on platforms at North Point, round Cape Vlamingh at the extreme west end, and on the radar station reef on the south side of west end. Salmon Point and Green Island reefs suffered relatively little damage.

The outermost part of all these platforms, where waves normally break continuously, are thickly encrusted with coralline alga (lithothamnion) over which graze the following molluscs: *Onithochiton occidentalis, Clavarizona hirtosa, Poneroplax costata, Haliotis roei, Patellanax laticostata, P. peroni,* and *Patelloida alticostata;* the large barnacle *Balanus nigrescens* is also common. On the southern extremities of Radar reef (at + 2.5 to + 2.8 ft.) and the Cape Vlamingh reef (at a similar height) all these animals were still present, but large numbers of shells, empty or with the decomposing animals still in them, had accumulated on the inner part of the platforms and testified to the destruction that had taken place. Large *Balanus* shells stood empty in situ, some with the remains of the animal still present. At the extreme western end of the Cape Vlamingh reef a ridge rises to 4 ft. above datum. This is rarely accessible, but when visited some years ago by L. M. Marsh it had a very dense population of *Onithochiton, P. laticostata,* and *Balanus* over the encrusting lithothamnion. On February 18 almost all the *Onithochiton* and *P. laticostata* had disappeared from the upper part of the ridge and its landward face and the rock was covered with a new growth of blue-green algae. The *Balanus* shells were empty.

Immediately behind the outer fringe, at both Radar and Cape Vlamingh reefs, there is a belt of "limpet gardens" dominated by large *P. laticostata.* Few of these limpets survived, their empty "homes"* showed up prominently and a dense felt of filamentous blue-green algae covered the ungrazed rocks, with a few *Siphonaria luzonica* and *P. alticostata* cutting tracks through it.

Part of the wide reef to the north of Cape Vlamingh and part of North Point reef are bordered by platforms 10 to 20 yards wide and 3 to 3½ ft. above datum. When visited on previous occasions these had a thin cover of lithothamnion, a dense population of *P. alticostata* (up to 250 per sq. yd.) and smaller numbers of *Actinia tenebrosa, Clavarizona, Onithochiton, Poneroplax,* the mussel *Hormomya,* and colonies of the zoanthid *Palythoa heideri.* The only animals that survived were those within a yard or two of the outside edge, and *Actinia* in small pools. At North Point three other limpets had also been killed: *Patellanax peroni, Notoacmaea onychitis,* and *Siphonaria luzonica.*

* The sites to which limpets return regularly when the tide falls. These show up clearly when the animal is removed from the rock.

The north Cape Vlamingh reef is about 75 yards wide and some 600 yards long. Much of this lies at about + 2 ft. and does not retain water at low tide. Previously this was colonised by *P. alticostata*, almost alone, at a density of about 150 per square yard; very few survived and over a million must have died here.

On the south side of the Cape, behind the limpet gardens, there is an area (at about + 2 ft.) with sparse weed growth and extensive colonies of the zoanthids *Palythoa densa, P. heideri,* and the coral *Pocillopora damicornis*. Most of these colonies was dead. On a similar area at Radar reef they had suffered less severely. *Pocillopora* and several species of Zoanthid are common in pools in the platforms at Cape Vlamingh and at Salmon Point. The colonies were bleached white to the level to which water must have been retained; below this they were unaffected.

Also to the south of the Cape and close to the cliff is a high (+ 3 ft.) part of the reef that is normally wave-swept. This had previously had a large population of the urchin *Echinometra mathaei,* each urchin in its characteristic burrow. None had survived, and the burrows lay clean and empty. Part of the north platform at + 1.5 ft. always retains water. The abundant *Echinometra* here did not appear to have suffered; however, many of the large *Tripneustes gratilla* that also live here had been killed and were still rotting on the reef. There was also a high mortality among the only other population of *Tripneustes,* on the inner part of Radar reef. Considerable numbers of a third urchin, *Heliocidaris erythrogramma* had been killed on the outer part of Parker Point reef; some *Echinometra* had also been killed here.

A high mortality of one other sedentary animal was also noted. On the inner part of North Point reef there are large colonies of the mussel *Hormomya,* normally just at water level on the deeply pocketed platform (at + 2 ft.). Almost all the animals were dead.

Not only had the sedentary and semi-sedentary animals of the platforms been killed but many of the more actively moving had also died. Large numbers of empty shells of *Senectus intercostalis (=pulcher), Dicathais aegrota.* and *Ravitrona caputserpentis* strewed Radar and Cape Vlamingh reefs. At North Point small numbers of the following were picked up apparently dead: *Ninella whitleyi, Mayena australasia, Dyraspis dorcensis, Floraconus* sp., *Campanile symbolicum, Vertagus asper,* and *Quibulla* sp.

It was also reported that at the time of the low tides large numbers of many kinds of reef fish, up to a foot long, died on the platform. Dead and dying crayfish *(Panulirus longipes)* were picked up, dead octopus and many "sea slugs" were also seen.

It is more difficult to assess damage to the algae. On the north Cape Vlamingh reef large quantities of the coralline *Jania* were washed up on the beach. Here also the dominant algae on part of this reef (at + 1.5 ft.) are *Cystophora* and *Sargassum;* these had been killed back almost to the holdfasts and were covered with a heavy growth of *Hydrocoleum glutinosum*. On the outer edge of North Point reef (at + 1 ft.) only the bare stalks of *Cystophora retroflexa* remained.

Above the level of the platforms there had been no such catastrophic mortality. *P. alticostata* usually dominates the lower 1 to 2 feet of the undercut cliff. In many places there was a line of empty "homes" at the top of this zone, but rarely any general destruction. Above this *Notoacmaea onychitis* and *Siphonaria luzonica* are the dominant organisms. Again there were empty "homes" but no large scale recent denudation, nor was there any evidence of mass destruction of the littorinids *Melaraphe unifasciata* and *Tectarius rugosus* of the supralittoral.

DISCUSSION

Certain anomalies in the observed mortality may be noted here. The survival of *Patelloida* on the steep slope of the undercut while those on the platform below died may perhaps be explained by the different angle presented to the sun, and the fact that the rock is often shaded for part of the day. However, it was surprising to find *Patellanax laticostata* surviving in a similar situation (Green Island and Parker Point) since the favoured habitat of this species is the outer part of the platform consistently washed by the waves. Also it is difficult to understand why there should have been total destruction of *Patelloida* over most of the Cape Vlamingh platforms while there was no significant mortality on the Green Island and Salmon Point reefs which are at practically the same level (1.5 ft.), on a part of the North Point Reef which is even higher, or at Yanchep.

Mortality among intertidal organisms near the top of their normal vertical range is an annual event. During winter the higher sea level, almost continuous wave action, and lower temperatures allow plants and animals to establish themselves above the level at which they can survive in summer. This is particularly noticeable in the intertidal undercut where a variety of green and blue-green algae and the sporelings of brown and red algae establish themselves each winter, only to be killed off with falling sea level and calm seas about September.

Each summer the empty "homes" of *Notoacmaea* can be found and on hot days limpets which have strayed too high are seen dying. *Patellanax laticostata* are sometimes found dying on hot days, even when waves still lap them. Survivors from the January catastrophe were dying on the edge of the platform on February 19 when the sea was again very calm. On the granite rocks of the south coast of Cape Naturaliste large numbers of young *Balanus* that have settled too high have been found dead in early summer.

This annual mortality is doubtless a potent factor in maintaining the characteristic shore zonation. The catastrophic mortality recorded above is however of quite a different order, nothing like it has been seen here in the last ten years. Destruction on this scale must nevertheless recur from time to time when very low tides and calm seas combine to prevent water from flowing over the platforms throughout the heat of several successive days. It is a natural phenomenon with which the organisms have come to terms; it may, however, radically change the distribution of particular organisms on the platforms from time to time.

One can only speculate about how long it will be before the previous associations are re-established, if at all. Experience with experimental removal of limpets indicates that many years may elapse before these animals again dominate some of the areas from which they have been eliminated, and other animals will doubtless take time to recolonise their habitats. This large scale natural experiment will be watched with great interest.

[Note: Relevant tidal data will be found in: Hodgkin, E. P., and V. Di Lollo, 1958, The Tides of South-Western Australia. *J. Roy. Soc. W. Aust.*, 41: 42-54. A short description of the Rottnest reefs and the intertidal fauna and flora will be found in: Hodgkin, E. P., L. M. Marsh and G. G. Smith, 1959. The Littoral Environment (of Rottnest). *J. Roy. Soc. W. Aust.*, 43 (in press).]

HERPETOLOGICAL MISCELLANEA

By L. GLAUERT, Western Australian Museum, Perth.

X.—DRAGON LIZARDS (FAMILY AGAMIDAE)

Small dragon-like lizards having the head covered with small scales and those on the body and limbs overlapping. Limbs with five digits, the anterior at times reduced but still functional. Tail long and occasionally as much as three times the length of the head and body, terminating in a fine point, can be replaced when lost but not shed. Teeth situated on the top of the jaw, not attached to the side as in the other families of lizards.

KEY TO THE GENERA

I. Body covered with normal scales.
- A. No preanal or femoral pores, no transverse gular fold, pouch in the male .... *Chelosania*
- AA. Preanal pores present, transverse gular fold present or absent, no gular pouch.
  - B. Tympanum hidden .... *Tympanocryptis*
  - BB. Tympanum distinct.
    - C. Preanal and femoral pores at least in the males, body depressed .... *Amphibolurus*
    - CC. No femoral pores, body slightly depressed .... *Diporiphora*
      - D. Body compressed, toes denticulate laterally .... *Physignathus*
      - DD. Body compressed, neck with large frill .... *Chlamydosaurus*

II. Body covered with large spines .... *Moloch*

Chelosania brunnea Gray

Thick-headed Dragon Lizard

Head large, cheeks swollen, covered above with small rough tubercles. Nostril equally distant from the eye and the tip of the snout, labials very small, eye small, ear opening smaller. Scales on the body small, overlapping, forming regular transverse rows. Dorsal and gular scales with a short keel or tubercle. Ventrals strongly keeled, A slight nuchal crest. Limbs short, the adpressed hind limb reaches the axilla. Tail longer than the head and body, strongly keeled. Pale brown. Length up to 10½ in. (265 mm.).

Distribution: In this state confined to the Kimberley Division where it seems to be rare.

Genus *TYMPANOCRYPTIS*

Small lizards, less than 6 in. (150 mm.) in length, are distinguished from all other members of the family by the absence of an external ear opening. No dorsal crest; covered above with smooth or keeled scales intermixed with spinose tubercles. Ventral scales keeled or smooth. Strong gular fold often present. Body more or less depressed, stout. Tail round, flattened and expanded at the base. A preanal and a femoral pore on each side may be present in both sexes.

KEY TO THE SPECIES

A. Body stout, much depressed, dorsal scales smooth or with slight keels intermixed with blunt tubercles, ventrals smooth or faintly keeled .... *cephalus*

AA. Body less stout, depressed, dorsal scales strongly keeled intermixed with spinose tubercles, lower surface with strong keels. Five white lines along the body .... *lineata*

Tympanocryptis cephalus Gnthr.
Brown Earless Dragon

Body stout, scales on the head large, faintly keeled or granular, dorsal scales smooth or feebly keeled, the tubercles mucronate and spinose. Body brown above with more or less distinct darker cross bands which are also present on the limbs and tail where the interspaces are much paler. Under surface and inside of the limbs pale, almost white. Grows to about 5½ in. (140 mm.).

Distribution: Very widely distributed in the southern interior of the State, east of the agricultural area, north to Mardie Station and the Canning Stock Route, south to the Kalgoorlie area and eastwards beyond the boundary of the State. The type locality is Nickol Bay.

Tympanocryptis lineata Peters
Streaked Earless Dragon

Body less stout, depressed, dorsal scales strongly keeled, intermixed with spinose tubercles, lower surface with strong keels to the scales. Usually five white lines along the body, the three dorsal extending from the head on to the tail, the lateral, which may be very faint or even absent, reach from the axilla to the groin. Two colour forms may be distinguished. (1) Head light brown, body brownish with about six more or less distinct darker cross bands on the body with others on the tail. This is the typical form. (2) Head pale with a rufous patch on the snout, another in front of the eye and a third on the nape; the back is greyish with wide brown crossbands extending on to the tail where they become indistinct. Grows to 5½ in. (140 mm.).

Distribution: The single specimen, R11752, in the collection is said to have come from the Ord River Research Station in East Kimberley although the genus is a southern form. On the other hand the single paler specimen representing Sternfeld's *Tympanocryptis lineata centralis,* R12222, comes from 49 miles east of Goddard's Creek, in the south-east of the state.

More specimens of this species are urgently needed to provide fuller details of its distribution.

Chlamydosaurus kingii Gray
Frilled Lizard

This, the largest of the Dragon Lizards, may attain a length of nearly 3 feet. Its most striking characteristic is the bright coloured frill on its neck. This when expanded, in combination with the bright yellow mouth, gives the creature a terrifying appearance, the effect being heightened by a loud hiss. The head is long and pointed, body slender, fore limbs short, hind limbs long, which when adpressed reach the tympanum or the eye. Tail long slightly compressed, nearly twice as long as the head and body.

Distribution: This lizard has a wide range in the tropical north; it is known from Queensland in the east to West Kimberley in the west.

Moloch horridus Gray
Mountain Devil

A most bizarre creature; head, mouth, eyes and ears small, body broad and depressed, limbs short, the adpressed hind limb not reaching the axilla, tail tapering ending bluntly, shorter than the head and body. Head, body, tail and limbs above with large sharp spines and granular scales; under surface with the chin, throat and tail covered with granular scales, belly with keeled scales and short spinose tubercles. Colour very variable. The ground colour in fully coloured reptiles is a bright yellow or orange with elongated chocolate-brown cross bands on the body; the cross bands are continued down the sides of the body. Reported to grow to 8 in. (205 mm.).

Distribution: This lizard has a very wide range in the southern half of the State, east of the Darling Range into southern and central Australia.

Genus *PHYSIGNATHUS*

Dragon lizards of somewhat elongate form, the long hind legs when adpressed reaching the eye or beyond, the hind foot about as long as the fore limb. Tail roundish. Two or three preanal pores and a number of femoral pores on each side.

Small specimens are easily mistaken for *Diporiphora*.

Frilled Lizard (specimen from Hall's Creek). Frill folded.

Frilled Lizard with neck frill expanded.

—Photos V. N. Serventy.

KEY TO THE SPECIES

A. Keels on the rather large dorsal scales forming lines parallel to the crest or vertebral line .... *gilbertii* (Gray)

AA. Keels on the rather smaller dorsal scales forming lines obliquely directed to the vertebral line.

b. Head long and narrow, the nostril nearer to the eye than to the tip of the snout .... *longirostris* (Blngr.)

bb. Head normal, the nostril not nearer to the eye than to the tip of the snout .... *craduensis* Werner

Physignathus gilbertii (Gray)
Gilbert's Water Dragon

Head rather elongate compared with other dragons but normal for this genus, the species *longirostris* excepted. Snout about as long as the distance between the orbit and the hind margin of the tympanum; nostril a little nearer to the orbit than to the tip of the snout; cheeks swollen with a few erect spines behind. Upper head scales strongly-keeled, largest on the snout and between the eyes, very small on the back of the head and nape. Dorsal scales imbricate, keeled, the median ones largest, the keels forming rows more or less parallel to the vertebral line or crest. Dorso-lateral scales smaller, their keels directed obliquely upwards. Dorsal crest forms a small serrated ridge which does not extend on to the tail. Ventral scales keeled, smaller than the largest dorsals. Limbs long, the adpressed hind limb reaches to the eye, covered above with strongly keeled scales. Two to four femoral and two or three preanal pores on each side. Tail covered with strongly keeled scales, the keels forming parallel longitudinal rows tapering to the tip, the scales on the lower surface somewhat larger with the keels less developed. Grows to about 20 in. (500 mm.).

Colour very variable, changing considerably after preservation in alcohol, the white markings on the head and body being the most persistent. These start as a broad whitish or pale yellow band embracing both the upper and lower tips, widening at the swelling and then proceeding upwards to join the thin stripe from the eye and forming the prominent pale band which in most cases extends to the base of the tail. There may be indistinct dark blotches or cross bands on the body and dark rings or cross bars are usually present on the tail and limbs. The under surface may be uniformly pale, peppered with darker or even entirely brownish.

The arrangement of the keels on the central dorsal scales to form rows parallel to the vertebral line distinguishes this species from all the others of the genus.

Distribution: Very wide in the northern part of the State as far south as the Pilbara.

Physignathus longirostris (Blngr.)
Long-snouted Water Dragon

This lizard is easily distinguished from Gilbert's Dragon by its long slender head and smaller mid-dorsal scales which have their keels arranged in rows obliquely to the vertebral line instead of parallel to it. The nostril is nearer to the eye than to the tip of the snout and the snout is longer than the distance between the orbit and the posterior border of the tympanum. Upper head scales strongly keeled, smaller on the back of the head, smaller still on the nape where they resemble the dorsals. Nuchal crest consisting of a few enlarged scales continued along the body and tail as a low ridge. Gular scales fairly keeled, ventrals more strongly so. Limbs long, the adpressed hind limb reaching the nostril or tip of the snout. Tail long, up to three times the length of the head and body, its scales strongly keeled, the keels forming rows to the tip. Grows to about 15 in. (380 mm.).

The colour is very variable and changes during the mating season when a more gaudy coat is assumed. The colour is olive or reddish brown above. A light stripe on the lower lip bends up behind the jaw to join the whitish dorso-lateral band which extends to the base of the tail. A black patch behind the ear encloses a pale spot which may be white or yellowish white in life. In the nuptial dress the temporal region and the middle of the back may be a rich plum colour. This decoration gradually fades away when the specimen is preserved in alcohol. There is a phase in which the upper surface is rufous brown with numerous dark spots; a little later pale ones appear until at last the upper surface between the pale dorso-lateral bands becomes a pale brown with large dark blotches which almost form transverse bands across the dorsal surface. The under surface may be immaculate or peppered with darker, contrasting sharply with the whitish lower labials.

A specimen, R12621, in the Museum Collection caught at Woodstock Station in September 1957 was rufous along the back between the dorso-lateral bands, the rest of the upper surface, the head, limbs and tail being somewhat paler. By the end of the following December the centre of the back had changed in spirits to dresden brown and darker brown pale patches had begun to appear. It must be noted that the thin whitish line along the side of the body from the adpressed fore limb to the groin described in Sternfeld's description of *Physignathus longirostris quattuorfasciatus* is well developed.

The species is found in daylight under stones or other materials. It can run actively if disturbed, will climb trees or bushes and if these overhang will readily drop into the water below and swim to the other side of the creek to safety.

Distribution: The range appears to be more or less restricted to the interior. The material in the Museum comes from the Canning Stock Route, the Pilbara, Shark Bay area and south to the Gascoyne and Upper Murchison.

Physignathus eraduensis Werner
Eradu Water Dragon

Head normal, not elongate, the nostril equidistant from the eye and the tip of the snout; distance between the eye and the tip of the snout about equal to the distance between the eyes and the hind margin of the tympanum. Tympanum more than half the diameter of the orbit. Dorsal scales small, strongly keeled, the keels arranged in rows oblique to the vertebral line; ventrals somewhat smaller than the dorsals, strongly keeled. Nuchal crest low, reduced on the back to a very low ridge. Limbs long, the adpressed hind limb reaching the nostril. Five femoral and two preanal pores on each side in the male. Size small about 9½ in. (236 mm.).

Colour of specimens preserved in alcohol grey brown with a series of large dark blotches almost forming cross bands ending laterally; a pale band extending along the body to the root of the tail; a narrower band along the lower labials bends up posteriorly to link up with this behind the jaw.

Distribution: The type locality is Eradu; specimens in the Museum Collection are from the Greenough River and Galena.

Genus *DIPORIPHORA*

Tympanum distinct. Body slightly depressed, no gular sac, gular fold present or absent. Tail long, round, slender. One or two preanal pores on each side, sometimes absent in the females. No femoral pores. Nuchal crest usually absent.

KEY TO THE SPECIES

A. Prominent nuchal crest and odd series of flattened spines along the body and tail .... *amphiboluroides*

AA. No prominent nuchal crest.

- b. Habit slender, blue vertebral band .... *winneckei*
- bb. Habit stouter, no blue vertebral band .... *bilineata*

Diporiphora bilineata Gray
Gray's Dragon

Habit normal, head large with distinct canthus rostralis, covered above with keeled scales, largest between and behind the eyes, a more or less distinct crest from under the eye to over the ear, a slight oblique fold on each side of the neck, gular fold present or absent. Dorsal scales large, strongly keeled, forming rows which gradually converge on the vertebral line. Gular and ventral scales keeled Limbs and feet moderate, scales strongly keeled, the ad-

Gray's Dragon (*australis* form of *Diporiphora bilineata*)
—Photo Eric Lindgren.

pressed hind limb reaches the ear or the eye. Tail covered with large strongly keeled scales, about two and a half times as long as the head and body, often imperfect. Grows to about 10 in. (260 mm.). Head and body 3 in. (75 mm.), tail 7 in. (185 mm.).

The colour is very variable as is indicated by a large series from Wotjulum in West Kimberley. Spirit specimens may have a body colour of pale olive brown with about six dark brown cross bands interrupted by two or three white longitudinal lines, the two outer of which extend on to the tail. This form has the limbs and tail with dark cross bands and may have a dark blotch on each side of the neck and shoulders. The under surface may be pale and immaculate or with the chin peppered darker.

There is every gradation from this type to the other extreme with the body almost uniformly brownish above with indications of imperfect darker cross bands. There too the darker shoulder patch may be present or absent: the darker markings are more distinct upon the somewhat paler tail. These various colour forms can be seen among the 30 specimens from Wotjulum and suggest that *D. australis* and *D. bennetti* are synonyms of a variable species and not subspecies or separate species.

Distribution: The northern part of the State as far south as the De Grey Station and Marrilla Station near Exmouth Gulf. Specimens were also collected on the northern portion of the Canning Stock Route by O. H. Lipfert.

Diporiphora amphiboluroides L. & F.
Woodward's Dragon

Habit moderate, head narrow and somewhat elongate, snout anterior to the nostril, as long as the diameter of the orbit, sharp canthus rostralis, head scales keeled, largest on the snout and between the eyes. A short crest on the snout and two arched ones in front of the eyes which extend backwards to above the tympanum where they merge into a less defined one that disappears on the tail. Scales on the nape very small, smooth or feebly keeled, increasing in size backwards until they merge into the tail where the scales are much larger and more strongly keeled. Limbs also covered with larger, keeled scales. Under surface with smooth or faintly keeled scales, smallest near the gular fold. Limbs short with long digits and unusually long curved claws; the hind limb when adpressed reaches the axilla. Tail one and one-half times the length of the head and body.

Fresh specimens are creamy white with dark brown linear markings which on the head are mostly arranged along the crests. There are also longitudinal streaks along the back and sides, and numerous longer or shorter dark streaks along the lower surface and on the limbs.

Distribution: The southern interior specimens in the Museum come from Mount Sefton, Linden, Belele and Wedgingarra, 30 miles south of Yalgoo. Apparently rare.

Diporiphora winneckei L. & F.

Winnecke's Dragon

Habit slender, head narrow and pointed with sharp canthus rostralis, covered with keeled scales; tympanum moderate. A slight transverse gular fold present or absent. Dorsal scales uniform large, the keels directed to the vertebral line, gular scales almost smooth, ventral scales smooth or feebly keeled; scales on limbs and tail large, more strongly keeled. Tail about 2¾ times as long as the head and body, round, tapering. Limbs and digits long with long claws, the adpressed hind limb reaching the neck or tympanum. Pores absent. The largest W.A. specimen measures nearly 7½ in. (190 mm.).

Pale brownish grey with a broad bluish vertebral band and a series of large dark spots on each side divided by a thin white line which extends from the eye over the ear about half way along the back (spirit specimens). Under surface pale with various patterns in thin longitudinal dark lines from the chin to the tail. Tail in one case light with dark spots, in the other, dark with light spots.

Distribution: Originally collected at Charlotte Waters, Central Australia. The two specimens in the W.A. Museum came from Marrilla Station, 50 miles from Exmouth Gulf.

(To be continued, with an account of the species of the genus *Amphibolurus*).

THE CATTLE EGRET IN WESTERN AUSTRALIA

By C. F. H. JENKINS, M.A., Government Entomologist.

The Cattle Egret *(Bubulcus ibis)* is a native of the warmer parts of Asia, Africa and southern Europe, but about 25 years ago it suddenly appeared in South America and in the early nineteen fifties made its way to the United States of America.

The history of the bird in Western Australia is somewhat obscure, but it has been well established in the Kimberleys for some time and birds probably referable to this species have been reported from the South-West for the past five or six years. Early in May 1959 Mr. Jim Arbuckle kindly informed me that a dozen unfamiliar, large white birds were tending cattle and horses in a dry swamp on his property at Balcatta, north of Perth. On visiting the area on May 8 I was pleased to see 14 Cattle Egrets closely following the stock around the paddock and darting in to catch flies as they were disturbed by the animals. Since then reports have been received from districts as far apart as Esperance, Ravensthorpe, Bunbury, Bremer Bay, Mt. Barker and Baandee, indicating quite an extensive invasion of the South-West.

In 1933 the Pastoralists' Association advocated the introduction of the Cattle Egret to assist in controlling the tick pest on our Kimberley cattle stations. Twenty birds from India reached the

South Perth Zoo, and 18 were liberated on the Lennard River, at Kimberley Downs Station near Derby. Some birds were killed by hawks; the remainder gradually disappeared and their total loss was presumed.

Nothing more was known of the Cattle Egret in Australia until 1948 when the National Geographic Society-Smithsonian Institute Expedition to the Northern Territory saw hundreds of the birds in Arnhem Land, and collected specimens for the United States National Museum (Petersen, 1954). Since then these egrets have been seen in widely separated parts of Australia and extending as far south as Melbourne. Large rookeries have been located in the Northern Territory (Davies, 1959) and breeding has also been observed in northern New South Wales (Goddard, 1955). Although there has been a suggestion that the Arnhem Land birds were descendants of those liberated in Western Australia (Tarr, 1950) it seems much more likely that they found their way naturally either from New Guinea or Indonesia.

During a trip through the Kimberleys in 1944 I made enquiries from station owners concerning the egrets but could find no suggestion of their survival, and the district veterinary officer associated with the 1933 releases considers the survival theory most unlikely.

The first report of the Cattle Egret from the South-West came in 1953, when a bird fitting its description and habits, was seen by Mr. Carter at Norseman. In 1954 further reports were received from Wanneroo and Queen's Park, but the birds did not stay long and their identity could not be verified. It is too early to interpret the appearance of the Cattle Egret in the South-West as evidence of local migration by the species, but there is some evidence to suggest a regular seasonal movement. Mr. Carter reported that the egret visited his Norseman property three years out of four, arriving each time in April. The 1954 reports at Wanneroo and Queen's Park were in May and the current invasion occurred at the same time of the year.

As much information as possible is required about this new arrival in the South-West and any sight records should be carefully noted. Such information will assist in clarifying the pattern of movement within the State and the rate at which the species is able to colonise its new home.

Fortunately the cattle tick is not established in our South-West and so the Cattle Egrets may be of little practical value to stock owners. Should the birds continue to thrive in the North, however, they may be very useful. The ticks are widespread on many stations, and the large areas concerned, and the difficulty of mustering, mean that dipping and other treatments for tick control which may be practical on a small scale are usually quite out of the question.

The Cattle Egret should not be confused with the White Egret *(Egretta alba)*—often called the "white crane"—which may be seen on swamps and estuaries. This beautiful bird is considerably larger than the Cattle Egret, does most of its feeding in shallow water, and shows no special interest in livestock.

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FROM FIELD AND STUDY

A Ring-tail Possum at Midland Junction.—In recent years the Ring-tail Possum *(Pseudocheirus occidentalis)* has become a comparatively rare animal and it is of interest, therefore, to record the capture of a live individual at Midland Junction on February 24, 1958, by Mrs. H. Hudson. The animal first made its appearance at her home, right in the town, a fortnight previously, living on her grapes and sleeping in an old hat on the back verandah. It was a young female, still possessing its milk teeth and I estimated that it was two months out of the parental pouch. The body length was about 4½ in. and the total length about 12 in. The extremely long tail was covered dorsally with fine white fur and below was rat-like. It did not appear to use its tail, as the Brush-tailed Possum *(Trichosurus vulpecula)* does, for balance, but it could hang by this appendage when compelled. The body was covered with very dense black-brown fur, which was paler ventrally. It did not use its teeth for defence at any time. It fed mainly on fruit juice, bread, flowers and lettuce.

The animal is not caged and is allowed full liberty. It still (April 1959) comes when called and displays marked affection for its foster parents.

—ELIZABETH BAILEY, Nedlands.

Record of Scarlet-chested Parrot.—Although first collected in Western Australia, in the 1840s, the Scarlet-chested Parrot *(Neophema splendida)* was not again observed in the State until 1941 (*Emu,* 54: 280). Two further recent records have been published (Serventy and Whittell, *Handbook,* 1951, p. 233).

In Sept.-Oct., 1956, the writer accompanied Dr. A. R. Main, Dr. Frances Benedict and Mr. R. D. Royce on a University expedition to the Zanthus area. On Sept. 30, while driving a few miles from Coonana, a small parrot which appeared predominantly light blue, flew close to the truck. On walking through the scrub at the spot a small parrot which flew into a dead tree was flushed from dry grass. Dr. Benedict and the writer were able to approach close to the bird, a male Scarlet-chested Parrot, and watch it for some time with binoculars. The following field description was taken down: "deep blue head, scarlet from throat to breast, orangey feathers on thighs, dark green back, blue feathers in wings." As no red was seen on the bird which flew past the truck it was presumed to be a female.

The general habitat was a slope with a sparse short tree and shrub cover consisting mostly of *Acacia burkittii* with some mulga *(A. aneura)* and kurrajong *(Brachychiton gregorii)*. At the base of the slope were occasional small salmon gums *(Eucalyptus salmonophloia)* and a few mallees *(E. foecunda,* unnamed variety). The ground cover consisted largely of fairly sparse dried grass.

The plants were identified by Mr. Royce.

—J. H. CALABY, Canberra.

Scarlet-chested Parrot at Laverton.—Since our arrival at Laverton in April 1956 the first record of the Scarlet-chested Parrot *(Neophema splendida)* was made in February or March of 1957. This was a male bird which was brought in by a school girl who found it alive with a damaged wing near a fence close to the township. The weather had been particularly stormy, and the parrot had apparently become a victim. In spite of every care the bird was found dead next morning. The brilliance of the colours was most noticeable. The main points, from memory of an accidentally destroyed kodachrome of the subject, were: (a) the nuggety shape of the parrot, unlike the slenderness of the budgerygah; (b) beautiful blending of blues on the head and throat; (c) deep, almost orange-yellow abdomen; (d) brilliant red breast; (e) beak very dark grey. There was a rich green on the back and some blue on the wings.

Bird watching has been carried out at many windmill troughs since then, but there were no further records until March 30, 1958, when a possible sighting of a pair was made along a creek 8 miles N.E. of Laverton. These birds flew into mulga and were observed by the writer and wife, though not through binoculars. The birds were fairly timid and flew before a very clear view could be obtained. Most noticeable, through the light screen of foliage, was the splash of brillant red on one bird. The country around Laverton is chiefly flat mulga plains with many dry watercourses along which mallee grow frequently.

—KEVIN GRIFFITHS, State School, Laverton.

Extension of Known Range of Some Western Australian Birds.—The following observations extend the range of four species of birds as outlined by Serventy and Whittell in their *Birds of Western Australia.*

A Painted Quail *(Turnix varia)* was flushed from the ground at the deserted Naendip Copper Mine on March 7, 1958. The mine is located in low stony hills near the head of Dempster Inlet (30 miles west of Hopetoun). The vegetation around here is mostly mallee *(Eucalyptus annulata, E. redunca, E. tetragona, E. platypus,* and *E. lehmanni*) but in the immediate vicinity of the mine there is a relatively open stand of flat-topped yate *(E. occidentalis)*. The previous easternmost record of the species was at Broomehill, 110 miles to the west.

To be added to the list of breeding stations of the Bridled Tern *(Sterna anathaeta)* are Seal Island (1½ miles east of Cape Leeuwin) and Green Islets (30 miles south of Jurien Bay). On January

27, 1957, Mr. D. Churchill observed Bridled Terns sitting on single eggs laid in joint cracks in the granite-gneiss at Seal Island. Mr. G. Binsted visited the Green Islets on November 28, 1956, when hundreds of Bridled Terns were nesting on ledges and crevices in the aeolianite.

Apparently the White-breasted Robin *(Eopsaltria georgiana)* has not been previously recorded from the Porongorups. The species was quite plentiful there in karri forests on July 8, 1958.

The White-fronted Honeyeater *(Gliciphila albifrons)* was observed on April 27, 1958, 10 miles north-east of Gingin in sandplain vegetation dominated by *Banksia ilicifolia, B. attenuata, B. menziesii, Eucalyptus todtiana,* and *Jacksonia floribunda.*

—G. M. STORR, Nedlands.

Salt-encrustation Hazard to Ducks.—On January 29, 1959, I witnessed a peculiar incident concerning a big flock of Grey Teal *(Anas gibberifrons)* on a very saline lake near my house. I believe if the birds had been left on the lake they would have perished. The salt lake covers an area of about 25 acres and it is a sanctuary for ducks when a shoot is on at the Channels or Lake Mears. Through summer evaporation the surface area had been reduced to about 15 acres, the water overlying a bed of pure salt about six inches thick.

Following an intensive duck shoot on Lake Mears and the Channels about 1,500-1,800 Grey Teal landed on the lake by 7 a.m. They were still there at sundown so I went over for a closer inspection. The flock remained in the water and the birds merely looked at me. I ran into the lake and a few of the birds took to the air, just managing to fly at about four feet and about 15 miles per hour. I ran and caught one of the flying birds and found that every feather on its breast had a bead of salt on it as big as a B.B. shot. All the beads together must have weighed 4 oz.

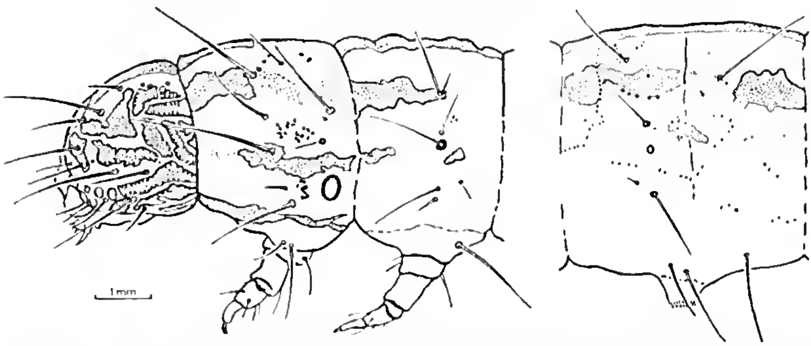
The birds landed on the salt again and it looked as though I had a major tragedy on my hands. So I organised the children on their bicycles and with myself in the utility flushed the flocks with gunshots and "herded" the slow-flying mob to a big dam. About 40 of the ducks came down in the paddock before they made the dam, but the main flock landed on it. The children gathered up 37 of the ducks that could not reach the dam and threw them into a small fresh-water pool. The salt beads dissolved in about 20 minutes and the birds took off quite well. I gave the ducks on the dam about half an hour and when I walked over the bank (it was nearly dusk) the mob took off with a normal roar of wings and headed for Lake Mears. They had made a mess of the dam preening themselves.

—HENRY G. HALL, Dangin.

[A water sample from the lake was sent to the Government Chemical Laboratories, Perth (received on February 20, 1959). Mr. R. C. Gorman (Deputy Government Agricultural Chemist) reported the analyses as follows: Total soluble salts (by evaporation), 41.0%; sodium chloride (calculated from chloride), 30.0%; reaction, faintly acid. Mr. Hall stated that a shower of rain had fallen between the time he witnessed the incident and collected the water sample.—Ed.]

A Tea-tree Caterpillar.—The caterpillars of the pyralid moth, *Macalla thyrisalis* (Walk.) have caused noticeable damage during the last few years to tea-tree hedges in many areas near Perth.

The fully grown larvae are approximately 31 mm. long. They are light brown in colour with orange-brown heads with dark brown markings. They have dark brown mesal and lateral lines interrupted by lighter coloured areas. A light brown ventral line is apparent. The markings and setal arrangement of the head prothorax, mesothorax, and fourth abdominal segments are sufficiently characteristic to enable these caterpillars to be distinguished from the other West Australian pyralids that have been studied. The size and relative positions of the setae and the disposition of the markings in *Macalla thyrisalis* are illustrated in the figure.



Lateral view of head, prothorax, mesothorax, and fourth abdominal segments of *Macalla thyrisalis* (Walk.). The drawing was made with the aid of a camera lucida.

The caterpillars construct loosely connected nests in which a great deal of their droppings are incorporated. The nests are made in the forks of twigs or branches of the host plant. Many caterpillars live within the same nest and they hide in neatly lined silken tunnels, the middle sections of which are not as firmly constructed as the extremities. When disturbed the caterpillars move forward or backward with about equal facility. They pupate within the nest and usually in the more strongly constructed extremities of the tunnels from which subsequently the empty pupal cases partly protrude.

Observations and breeding studies on the life-history of this insect over a period of two years indicate that there are two generations a year. Later instar larvae and pupae have been found in February, March, April and October, and adults have been observed to emerge during March and April and during October and November.

The moths actually bred from the larvae that were damaging the hedges were forwarded to Mr. I. F. B. Common, C.S.I.R.O., Canberra, to whom I am indebted for the identification.

In addition to attacking the Victorian tea-tree, *Leptospermum laevigatum* (Gaertn.) F. Muell., these caterpillars have been found damaging geraldton wax, *Chamaelaucium uncinatum* Schau.

—L. E. KOCH, Department of Agriculture, Perth.

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THE SEARCH FOR *NOTHOMYRMECIA*

By WILLIAM L. BROWN, Jr., and EDWARD O. WILSON, Museum of Comparative Zoology, Harvard University, Cambridge, Mass., U.S.A.

Despite the world-wide prevalence and great diversity of the ants, the origins of these insects remain shrouded in mystery. Presumably the most primitive forms arose from non-social tiphioid wasps, but the exact intermediate links are unknown. As a consequence, the origin of social behaviour in the ants can only be inferred from the study of living, completely social forms. It is therefore natural that entomologists should devote special attention to the primitive ants, which, it is hoped, will provide valuable clues to the critical early steps in ant evolution (Wheeler, 1933; Haskins and Haskins, 1950, 1951).

On the basis of purely morphological evidence, the most primitive known ant, living or fossil, appears to be the contemporary species *Nothomyrmecia macrops* Clark. This unusual form was described by the Australian entomologist John Clark in 1934 from two specimens collected in the arid country inland from Israelite Bay, in south-eastern Western Australia. It is a curious and unhappy fact that in the intervening twenty-five years, despite strenuous efforts by several teams of entomologists in the field, no additional specimens have been obtained. The purpose of the present paper is to call attention to the significance of *Nothomyrmecia macrops,* to add certain important morphological details omitted in Clark's original description, and to describe briefly the history of the field trips conducted in the area of the presumptive type locality.

Nothomyrmecia macrops looks in many ways like a smallish bull ant or large jumper ant (genus *Myrmecia*), although the jaws are broader and the eyes set farther back on the sides of the head. The ant is tawny yellow in colour and covered with long erect hairs. The claws are strong, with an extra tooth as in the bull ants, and well fitted for climbing trees or shrubs. A strong sting is present and probably used with good effect.

In a recent review of the phylogeny of the ants, one of us (Brown, 1954) has suggested that *Nothomyrmecia* is the most primitive member of the subfamily Myrmeciinae, which includes the most primitive known of the living and fossil ants. The Myrme-

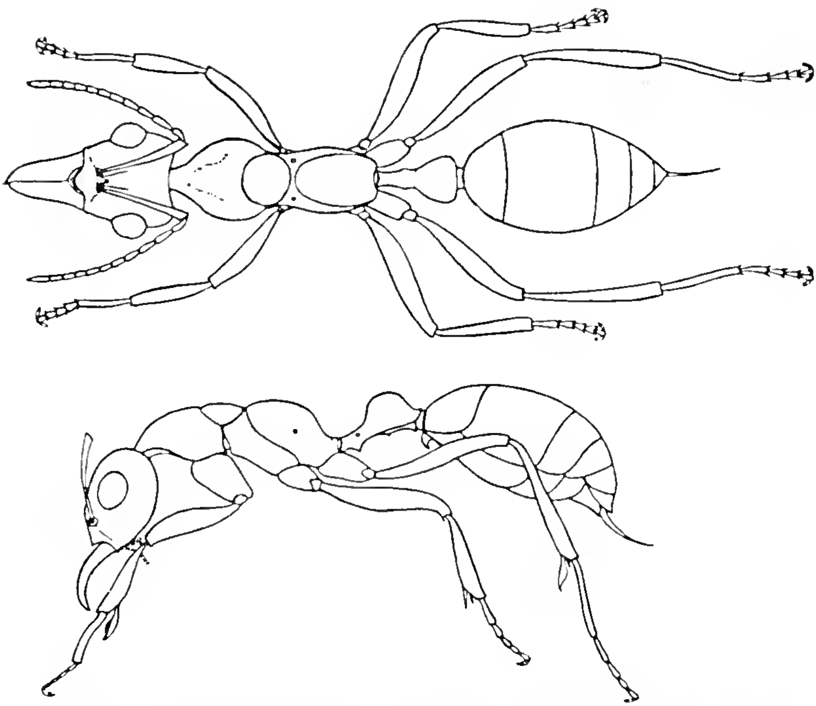

Fig. 1.—Reproduction of Clark's original figure of the *Nothomyrmecia macrops* worker, slightly retouched. A few minor errors in the drawings are left uncorrected. In actual size, *Nothomyrmecia* is about a half inch long.

ciinae have three genera: *Myrmecia* Fabricius,, the bull and jumper ants of Australia, with one species in New Caledonia; *Prionomyrmex* Mayr of the Oligocene Baltic amber of Europe; and *Nothomyrmecia*. One great difference shown by *Nothomyrmecia* as against *Myrmecia* and the fossil *Prionomyrmex* is that it has a single pedicellar node—in other words, the waist consists of but a single pinched-off segment instead of two. *Nothomyrmecia* differs from *Myrmecia* in its broader, serially dentate mandibles, the toothed borders of which meet at full closure; bull ant mandibles are much more slender, and cross when closed. *Prionomyrmex,* so far as we can see in the fossils available, has mandibles more as in *Nothomyrmecia,* and thus is intermediate between the two living genera. But *Nothomyrmecia* is more specialized than the other two genera in that it has greatly reduced ocelli and uniformly light body pigmentation.

A recent re-examination of the *N. macrops* types in the National Museum of Victoria, Melbourne, has resulted in the correction of one error made in Clark's description. These specimens were represented by Clark as completely lacking ocelli or ocellar pits, an important character with reference to the phylogenetic position of the species. In actuality, distinct but small ocellar pits are present. At the highest magnification used (100X), it was not possible to determine whether true ocelli are also present or not. If so, they are extremely reduced. Other important features noted were the well-developed metapleural glands, a basic diagnostic character of the Formicidae, and the irregular, serially arranged mandibular dentition.

The two *Nothomyrmecia* workers were collected by a small excursion party journeying in the isolated mallee and heath country south of Balladonia, during the period December 7, 1931, to January 7, 1932. A general collection of insects was made by several persons in the party, and this was later turned over to Mrs A. E. Crocker (neé Baesjou), of Balladonia Station, an amateur entomologist. Unfortunately, no specific locality records were kept,

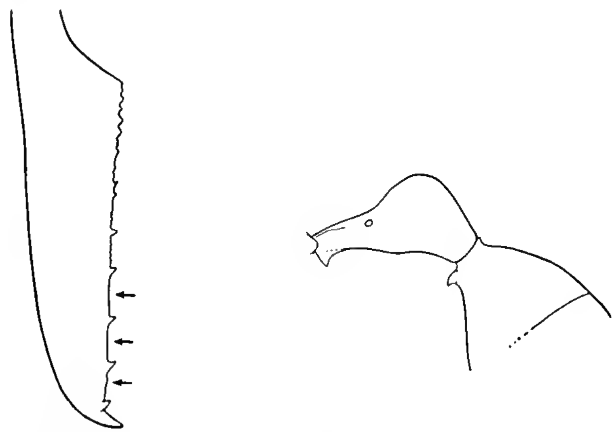

Fig. 2.—(Left) Drawing of the right jaw of *Nothomyrmecia macrops*, much enlarged, showing teeth. The arrows indicate parts of the border that were seen to be very finely serrate at higher magnifications. (Right) Detail of the petiole or "waist" of *N. macrops* and its attachment to the gaster. These drawings were made by E. O. Wilson in 1955 from one of the two original specimens.

and all of the material was placed together in common collecting bottles. Mrs Vern Thomas, who was a member of the party, recalls *(in litt.)* that most of the travelling was done by truck, with horses being used for occasional side trips into rough country. On the first day (December 7) a luncheon stop was made at Mt. Ragged, but apparently very little collecting was accomplished there. The same night, camp was made south of Mt. Ragged at a spot sometimes referred to locally as "Goora" (see map). Here insects were collected in mallee-heath transition during the early evening. The following day, camp was made south of Thomas River on the coast. In the next several weeks numerous excursions were made inside a ten-mile radius, and during this time insects were collected intermittently. On the final trip from the Thomas River to Esperance, collecting was conducted in the sandplain heath along the Esperance-Israelite Bay track. Mrs Thomas has no specific recollection of the collection of the *Nothomyrmecia*, but Mrs Crocker person-

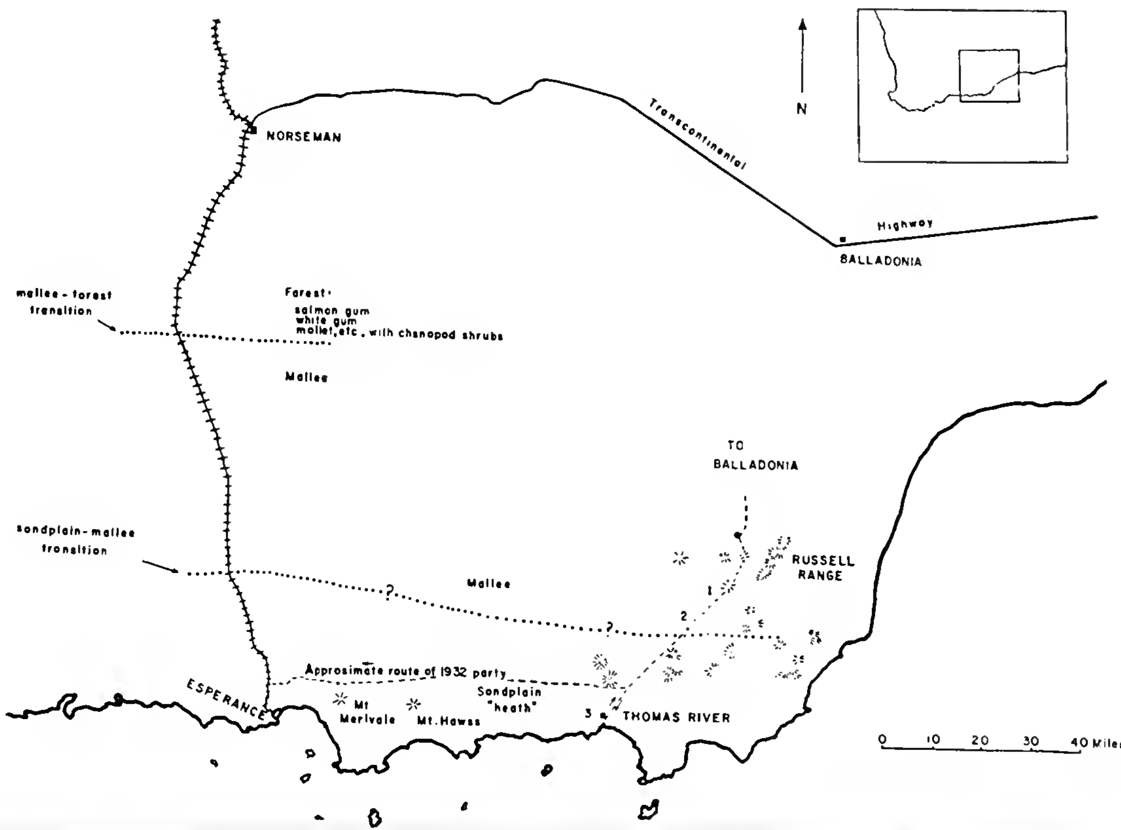

Fig. 3.—Map of the Esperance - Norseman - Balladonia area of Western Australia, showing the route taken by the party that collected *Nothomyrmecia* originally while travelling from Balladonia to Esperance via Thomas River. Stops were made at Mt. Ragged (1), at "Goora" (2), and at the abandoned Thomas River Station (3). The locality of collection along this route was not recorded.

ally affirms that the specimens were among the fresh insect collections turned over to her by the excursion party.

In November, 1951, W. L. Brown visited the Esperance area in an attempt to obtain additional specimens of *Nothomyrmecia*. Several days' eollecting in the vicinity of Esperance and Mt. Merivale proved fruitless. In January, 1955, a second, more intensive search was conductd by a party consisting of Bob Douglas, Caryl Haskins, Vincent Serventy and Edward Wilson. This group proceeded by truck directly to the abandoned Thomas River Station. From January 26 to 29, ants were collected in the Thomas River basin and in the sandplain heath for a distance of seven miles north of the Thomas River, or two miles north of the junction of the Balladonia-Thomas River and Esperanee-Israelite Bay traeks. Collections were made during both the day and night and involved excavations and sweeping. When these efforts proved unsueeessful, the group spent two days collecting at Goora and in the vicinity of Mt. Ragged. The great majority of ant species found at these several localities were encountered repeatedly, thus indieating that collecting was approaching the "saturation" level. But not a single *Nothomyrmecia* was found.

A note concerning the eeology of the Thomas River area is in order here. The Thomas River is set in a depression that appears to range between 75 and 100 feet below the level of the surrounding sandplain. Near the centre of the depression is the old homestead loeation, and this in turn is about three miles north of the beach. At least four "hollows," or shallow valleys, radiate outward from the centre and extend for distanees of a mile or more. The bottoms of the hollows are irregular, dry, salt stream beds, covered with a good growth of succulent halophiles and seattered paperbark trees *(Melaleuca cuticularis)*. Some of the latter are of very large size. Aecording to Mr Bob Douglas, a resident of Esperance, the depression was originally covered with large yate trees *(Eucalyptus cornuta)* and paperbark, and the floor supported a rich growth of grass. The loeality was settled in 1875, and overgrazing by sheep and the eutting of many of the yate trees has altered it greatly. In 1955 the grass were found to be mostly gone, and large stretches of wattle (*Acacia* spp.) covered mueh of the area. In only a few spots, e.g., a quarter-mile north of the homestead, did the yate forest appear to approach a relatively primitive eondition. The most abundant ant in the depression was *Iridomyrmex detectus* Fr. Smith (the eommon meat ant); this species appeared to be most abundant in disturbed situations. Species of *Myrmecia, Rhytidoponera, Crematogaster, Camponotus,* and *Polyrhachis* were also abundant. Less common genera ineluded *Amblyopone, Ponera, Meranoplus, Podomyrma, Oligomyrmex,* and *Stigmacros*. Perhaps less than 30 speeies occurred in the Thomas River depression, a much sparser local fauna than is to he found in the forested regions from Norseman to Balladonia in the north.

On leaving the Thomas River depression and proceeding onto the sandplain, a distinetly different fauna was eneountered. This included distinetive speeies of *Myrmecia, Rhytidoponera, Merano-*

plus, Dacryon, Colobostruma, Iridomyrmex, Notostigma, Camponotus and *Polyrhachis*. The fauna is probably smaller than that of the Thomas River depression and appears to share almost no species with the latter. It is further marked by having a much more distinct division between the diurnal and nocturnal elements. Several of the nocturnal sandplain species in *Colobostruma, Dacryon, Iridomyrmex* and *Camponotus* are notable for their very light coloration and large eyes, characteristics that are shared with *Nothomyrmecia macrops*. For this reason we consider it a strong possibility that *N. macrops* is nocturnal and a sandplain dweller.

In February 13-14, 1955, Athol Douglas and Edward Wilson collected in the arid eucalyptus forest from Norseman to Balladonia along the Transcontinental Highway. Other trips in the Norseman-Esperance-Balladonia area have been conducted independently by Athol Douglas, Tom Greaves and John Calaby. All of these efforts, like the ones before them, have been unsuccessful in finding *Nothomyrmecia*.

Few insect species have been the objects of such concentrated but consistently unsuccessful search as has the elusive *Nothomyrmecia macrops*. Because of its important phylogenetic position and our complete lack of information concerning its ecology and behaviour, its rediscovery and study in the living condition provide, in our opinion, one of the principal challenges of modern Australian entomology.

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COLOURING MATTERS FROM WESTERN AUSTRALIAN SUNDEWS II. THE RELEASE OF FREE PIGMENT.

By M. C. RUSSELL, Como.

INTRODUCTION

The following description by Rennie (1887) of the occurrence of free pigment in *Drosera whittakeri* is apt and can be applied to related Western Australian sundews: "This species is provided with a tuber, one apparently to each plant, which is found attached to a straight stem at a depth of 3 or 4 inches. These tubers invariably consist of an inner solid but soft nucleus, full of reddish sap or juice, and an outer series of easily detached thin and more or less dry layers of an almost black material. Between these layers is to be found small quantities of a brilliant red colouring matter, the amount varying in tubers of different size and age, but apparently more plentiful in the older plants."

An understanding of the manner in which the free pigment reaches this site has been obtained from a detailed study of the course of tuber formation in the related speics *D. erythrorhiza* and the bulk of this paper is devoted to that subject.

From a study of *D. peltata* and *D. auriculata* collected near Sydney, Joyce W. Vickery (1933) established for the first time that the persistent layers of old tissue surrounding the tuber are not due to an onion-like *(viz.:* bulbous) growth or to an annual exfoliation but arise as the result of a special method of tuber replacement. They proved to be the remains, mainly epidermal, of old tubers which had experienced the withdrawal of all their reserve materials and had then been thrust aside and compressed against the wall of the soil cavity by each successive new tuber. Vickery's paper gives a detailed description of this process as seen in *D. peltata* and *D. auriculata.* For the present purpose we need only remember that in these species the new tuber forms alongside the current tuber, *viz.: externally.*

THE PROCESS IN *DROSERA ERYTHRORHIZA*

In this Western Australian species an interesting variation occurs with the new tuher forming within the tissues of the current one.

The resting bud of the current tuber lies within a ring of scale leaves near the scar of attachment of the old stem. It shoots in early autumn to form a new stock and very early in this process the following significant events occur:

(i) within the ring of scale leaves on the current tuber the new stem swells hasally, pressing the surrounding scale leaves outwards to form a funnel-like structure around the swollen base.

(ii) from a site on the under surface of this swollen base a bud descends within the funnel of scale leaves until it presses on the current tuber. At the same time the epidermis of the current tuber ruptures around the stem base allowing the descending bud to penetrate the living tissues of the current tuber where it inverts and swells to form a new tuber (see illustration).

In the absence of special provision for such an unusual event it might he expected that the new tuber would become deformed and the current tuber wither prematurely following the damage done to it, but the exposed ground tissue appears to degrade only at the rate needed to allow for gradual expansion of the new tuber.

This process of degradation or reduction occurs in two ways:

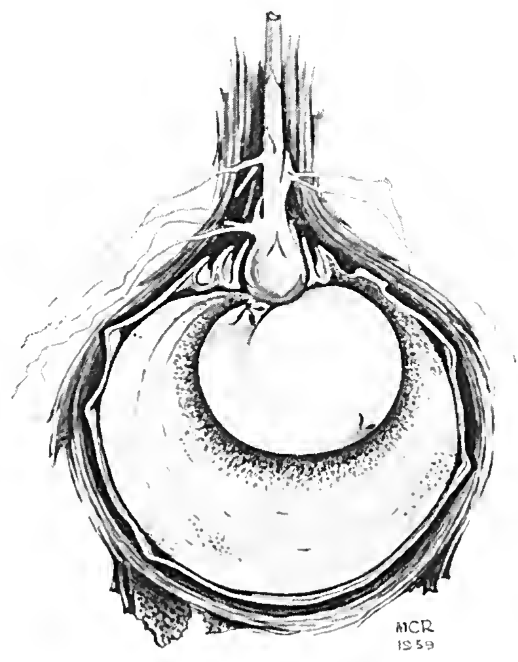
(i) by extraction of reserve materials through the intact connectives which continue to link current tuber and stem;

(ii) by autolysis of parenchyma cells at the exposed surface.

The first process leads to early shrinkage of the bulk of ground tissue and gives rise to a cavity beneath the epidermis. This is shown in the illustration and is a feature of the process recorded by Vickery as seen in *D. peltata* and *D. auriculata*. It is probable that much of the nourishment stored in the current tuber finds its way to the new tuber during this reduction phase.

The second process, that of breakdown of exposed tissues, is the more important for the limited purpose of this paper and will be discussed more fully below.

The combined effect of these two processes finally exhausts the current tuber but not without a corresponding growth in the new tuber which ultimately occupies the space thus provided for it inside the envelope of persistent epidermis. When the last available remnants of reserve material have been withdrawn from stem and leaves the tuber then enters the resting phase to become the current tuber of the next season. In Vickery's terminology the exhausted remnants of epidermis and a few layers of parenchyma which now totally surround the resting tuber are referred to as the old tuber. That some parenchyma does remain can be shown readily by soaking the material in dilute sodium carbonate solution which serves to swell the tissues to something resembling their original turgid condition.



The perennating organ of *Drosera erythrorhiza* showing a new tuber developing in the living ground tissues of the current tuber which is drawn in section for the purpose of illustration (x 3).

This interesting process can only be appreciated fully in its uniqueness and its superficial but striking resemblance to a placental form of development by the study of a full range of living material but an attempt has been made to illustrate it by means of a "cut-away" diagram drawn from *D. erythrorhiza.*

RELEASE OF FREE PIGMENT

The purpose of this work was primarily to explain the origin of the red pigment described by Rennie *(l.c.)* and it is in the course of autolysis of the exposed parenchyma, immediately within the ring of scale leaves, that this substance first appears. This site of entry of the descending bud is the most exposed region of all and here a considerable concentration usually occurs in the form of a damp red plug. It is concluded from this that release of free pigment is a direct result of breakdown of the epidermis and exposure of the underlying cells. It is found in the same way in the tubers of *D. whittakeri, D. bulbosa, D. rosulata, D. stolonifera* and *D. zonaria,* all of which adopt this *internal* form of tuber replacement. Furthermore, in *D. heterophylla,* which was not previously known to form a red pigment, microscopic quantities were found around the initial rupture zone when a search was prompted by the discovery that this species also adopts the *internal* method of tuber replacement.

As the reduction phase progresses red pigment granules appear generally in the cavity beneath the epidermis and later they may be found scattered throughout the body of the current tuber. These scattered granules consist of small groups of cells in which pigment has concentrated to the extent that it solidifies in a red amorphous form or, rarely, as yellow needle-like crystals.

At the conclusion of this phase the pigment lies compressed between the swollen new tuber and the persistent epidermis of its predecessor and it is easily seen how annual repetitions of this process give rise to alternate layers of pigment and dried epidermis so characteristic of these tubers. Once these rather unlikely events have been seen it is easy to understand also why early workers, faced with dried and shrunken herbarium specimens, were unable to explain the process adequately.

BIOLOGICAL VALUE OF PIGMENT AND PROCESS

By careful dissection of a large *D. erythrorhiza* tuber I have counted twelve more or less complete layers together with remnants of others—a result strikingly reminiscent of Drummond's (1839) observation on *Glossodia* that "the bulb is renewed every year in the centre of several layers of bark-like substance, one of which layers is added every year by the decay of the old bulb. . . . The layers can be easily traced back for ten or twelve years, and I have no doubt that many of these Orchidaceae have continued to flourish in half a square inch of earth for ages." We may conclude with Drummond that "their numerous coats must be of the greatest use in protecting their roots from the excessive heat of the summer sun." The same may be said of the similar layers surrounding the tubers of *D. erythrorhiza* and its allies.

The biological role, if any, of the pigment poses a more difficult problem. However, one observation may have a bearing on this. At any stage during what I have referred to as the reduction phase the tissues of the current tuber have been found to be crisp and juicy with no obvious signs of invasion by soil micro-organisms. The plug of red pigment already mentioned may serve as a mechanical bar to their entry but whether it functions as an inhibitor or repellant is a matter on which there is so far no experimental evidence.

FREE PIGMENT IN *D. GIGANTEA*

The occurrence of hydroxydroserone in the flowers of *D. gigantea* has already been reported (1958), but it has since been found that a very much greater yield can be obtained from the seed capsules of the wilted plants collected in mid-summer. The pigment then occurs as a red powdery deposit inside the capsules and in microscopic quantities on the seeds and, in this respect, affords an interesting parallel with lomatiol, also a naphthaquinone, which has been reported (Rennie, 1895; Hooker, 1936) from the capsules and seeds of *Lomatia* spp. (Proteaceae) of Eastern Australia.

The *external* method of tuber replacement is adopted by *D. gigantea* but it differs from *D. peltata* and *D. auriculata* in that the old tissues are rarely persistent for more than one season resulting in an almost naked tuber. No free pigment is found on the tuber but it is nevertheless elaborated in the plant which shares with the red-tubered species an obvious need to remove the substance to avoid its concentration in the new tuber. In each case it appears to be an end-product of metabolism.

Identification of hydroxydroserone in *D. gigantea* was carried out by the method already described (1958) and gave a satisfactory melting point (190° C., corrected) as well as visible absorption spectra in the three solvents, light petroleum, 95% alcohol and dilute sodium hydroxide which could not be distinguised from those given in the same media by pure specimens from *D. whittakeri* and *D. erythrorhiza*.

ACKNOWLEDGMENTS

Mr Leo Cady, of Kiama, N.S.W., kindly forwarded an interesting series of fresh *D. peltata* specimens which illustrated and confirmed much of what Miss Vickery reported in her valuable contribution to this subject *(l.c.)*.

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BREEDING PERIODS OF BIRDS IN THE KIMBERLEY DIVISION, WESTERN AUSTRALIA

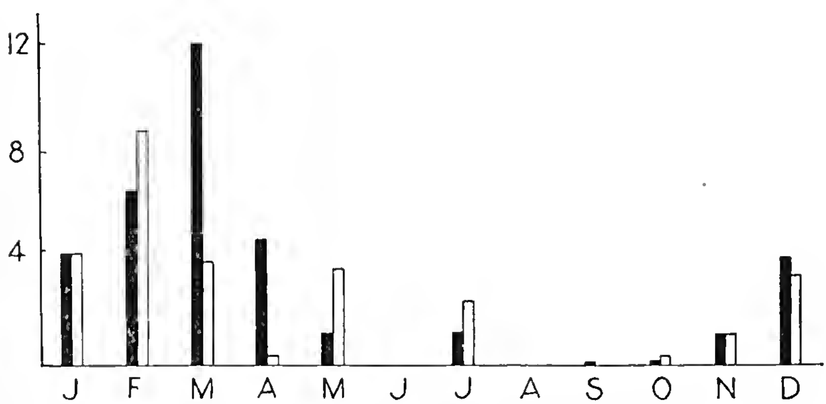
By P. SLATER, Claremont.

During 1955 and 1956 the writer was stationed at the Government School at the Kimberley Research Station and took the opportunity of making as extensive a study as his duties allowed of the ornithology of the district. A general account of the observations made will be published separately. This paper will report the situation regarding the nesting periods of the species which came under the writer's attention so that the breeding regime in the Kimberley Division may be compared with that in the northwest and southern parts of Western Australia (cf. *W. Aust. Nat.*, 4: 149, 187; *The Emu*, 57: 99). Unfortunately a complete coverage of the breeding seasons was not possible as the writer was absent from the station between the end of December and the beginning of February in both years.

The Kimberley Research Station is situated on the Ord River, on Ivanhoe Station, 67 miles S.E. of Wyndham (lat. 15° 35′ S., long. 128° 25′ E.). Several hundred acres are cleared for experiments in tropical agriculture and some of the area is under irrigation.

CLIMATE

The most important element which has a bearing on the reproduction of birds is the incidence of the rainfall. The precipitation is sharply seasonal and the year may be divided into a summer "wet" and winter "dry." However, the rainfall is undependable and some summers may not receive any rain at all. This may cause distressing droughts resulting in extensive bird movements, either within the Kimberley Division or irruptions to other parts of Australia (cf. *W. Aust. Nat.*, 3: 177). Some "out of season" rains fell in July 1955 and 1956. Neither fall had any easily-discernible



Monthly rainfall in inches, Kimberley Research Station, for 1955 (solid bars) and 1956 (hollow bars).

effect, although they may have triggered the spring nesters. Observations made in a dry year would probably clarify the matter. The average annual rainfall at Ivanhoe Station (1907-1945) and the Kimberley Research Station (1946-1957) is 29.10 inches. In 1955 the total fall was 36.74 inches, and in 1956, 28.97 inches. The monthly distribution of the rainfall is shown in the accompanying graph.

THE ENVIRONMENT

The Research Station is at an altitude of 100 feet. The Ord River in the region flows through a flat red and black soil plain bounded by the Deception Range in the west and a low red sandstone ridge to the east. The banks of the river are generally 40 to 50 feet high. There are three billabongs, one of which contains permanent water. The river ceases to flow towards the end of the dry season but never completely dries up, huge expanses of surface water in river pools thus being available at all times.

From the standpoint of bird habitats the environs of the station may be divided into the following:—

1. River Margin. The riverine forest is a narrow strip, less than one hundred yards in width, of densely grown *Ficus*, freshwater mangroves and vines. The birds typical of this belt are the Pheasant-Coucal, Bar-breasted Honeyeater, Olive-backed Oriole, Buff-sided Robin and Bar-shouldered Dove.

2. Savannah Woodland. Typical trees are the eucalypts Coolibah, Cabbage Gum and River Gum. Characteristic birds are the Blue-winged Kookaburra, Sacred Kingfisher and Black-tailed Tree-Creeper.

3. Plain. Generally flat country bordering the river for several miles, vegetated with a variety of grasses and *Bauhinia*. It is the home of quail, grass finches, doves, the Fantail-Warbler and Bustard.

4. Billabongs. In the Kimberleys any small area of water unconnected with a waterway is by common usage termed a "billabong." Two such occur on the station. True billabongs (former river channels) occur at the old Ivanhoe homestead and at Black Pat Swamp. Representative birds are the herons, egrets, ibis and White-headed Shelduck.

5. Swampy Grassland. This habitat is, in the area under study, man-made (irrigation pastures and rice cultivations) but approximates to the natural habitat of low-lying grasslands which flood in the wet season and bear crops of wild rice and similar native grasses. Typical birds are rails, Swamphen, Brolga, Magpie Goose and Sea Curlew.

6. River Mudflats. Vast expanses of the river margins are usually exposed, being inundated, for periods of up to a week, only after heavy falls of rain. Birds occurring here are migratory waders, dotterels, Masked Plover, spoonbills, ibis, egrets and Plumed Tree-Duck.

BREEDING SEASONS

Four well-defined periods of nesting activity may be recognised.

1. The summer months, covering the wet period from December to March.

2. The autumn, from the end of the wet season into the start of the dry, i.e., from the end of March to May.

3. The winter dry period, from the end of May until the beginning of August.

4. The spring months to the onset of the wet, i.e., from August until November.

The birds breeding during these periods are as follows:—

SUMMER BREEDERS

Diamond Dove *(Geopelia cuneata)*, Peaceful Dove *(G. striata)*, Nankeen Night-Heron *(Nycticorax caledonicus)*, Magpie Goose *(Anseranus semipalmata)*, Restless Flycatcher *(Seisura inquieta)*, Magpie-Lark *(Grallina cyanoleuca)*, Rufous Song-Lark *(Cinclorhampus mathewsi)*, Rufous-throated Honeyeater *(Conopophila rufogularis)*, Bar-breasted Honeyeater *(Glicipliila fasciata)*, Star Finch *(Poephila ruficauda)*, Yellow-rumped Finch *(Lonchura flaviprymna)*, Chestnut-breasted Finch *(L. castaneothorax)*, Pictorella Finch *(L. pectoralis)*, Crimson Finch *(Poephila phaeton)*, Banded Finch *(P. bichenovii)*.

AUTUMN BREEDERS

Diamond Dove, Peaceful Dove, Bar-shouldered Dove *(Geopelia humeralis)*, Swamphen *(Porphyrio porphyrio)*, Little Pied Cormorant *(Phalacrocorax melanoleucus)*, White Ibis *(Threskiornis aethiopica)*, Jabiru *(Xenorhynchus asiaticus)*, Little Eagle *(Hieraaëtus morphnoides)*, Whistling Eagle *(Haliastur sphenurus)*, Northern Fantail *(Rhipidura rufiventris)*, Reed-Warbler *(Acrocephalus australis)*, Golden-headed Fantail-Warbler *(Cisticola exilis)*, Red-browed Diamond-bird *(Pardalotus rubricatus)*, Black-headed Diamond-bird *(P. melanocephalus)*, Golden-backed Honeyeater *(Melithreptus laetior)*, Yellow-tinted Honeyeater *(Meliphaga flavescens)*, Horsfield Bush-Lark *(Mirafra javanica)*, Star Finch, Crimson Finch, Banded Finch.

WINTER BREEDERS

Diamond Dove, Peaceful Dove, Bar-shouldered Dove, Black Duck *(Anas superciliosa)*, Freckled Duck *(Stictonetta naevosa)*, Red-collared Lorikeet *(Trichoglossus haematodus)*, Little Corella *(Kakatoë sanguinea)*, Red-winged Parrot *(Aprosmictus erythropterus)*, Galah *(Kakatoë roseicapilla)*, Budgerygah *(Melopsittacus undulatus)*, Spotted Nightjar *(Eurostopodus guttatus)*, Buff-sided Robin *(Poecilodryas superciliosa)*, Red-browed Diamond-bird, Black-headed Diamond-bird, Yellow-tinted Honeyeater, Crimson Finch, Banded Finch, Long-tailed Finch *(Poephila acuticauda)*, Masked Finch *(P. personata)*.

SPRING BREEDERS

Peaceful Dove, Masked Plover *(Lobibyx miles)*, Brown Hawk *(Falco berigora)*, White Cockatoo *(Kakatoë galerita)*, Blue-winged Kookaburra *(Dacelo leachii)*, Sacred Kingfisher *(Halcyon sanctus)*, Red-backed Kingfisher *(H. pyrrhopygia)*, Rainbow-bird *(Merops ornatus)*, Fairy Martin *(Hylochelidon ariel)*, Restless Flycatcher, Brown Flycatcher *(Microeca leucophaea)*, Rufous Whistler *(Pachycephala rufiventris)*, Magpie-Lark, Black-faced Cuckoo-Shrike *(Coracina novae-hollandiae)*, White-winged Triller *(Lalage sueurii)*, White-breasted Wood-Swallow *(Artamus leucorhynchus)*, Black-faced Wood-Swallow *(A. cinereus)*, Little Wood-Swallow *(A. minor)*, Mistletoe-bird *(Dicaeum hirundinaceum)*, Red-browed Diamond-bird, Black-headed Diamond-bird.

RESIDENT BIRDS NOT OBSERVED BREEDING

For the sake of completeness the following list of resident species, but on which the writer has no breeding data, is appended:

Emu *(Dromaius novae-hollandiae)*, Plumed Pigeon *(Lophophaps plumifera)*, White-quilled Rock-Pigeon *(Petrophassa albipennis)*, Crested Pigeon *(Ocyphaps lophotes)*, Flock Pigeon *(Histriophaps histrionica)*, Banded Landrail *(Hypotaenidia philippensis)*, Marsh Crake *(Porzana pusilla)*, Little Grebe *(Podiceps novaehollandiae)*, Darter *(Anhinga rufa)*, Black-fronted Dotterel *(Charadrius melanops)*, White-headed Stilt *(Himantopus himantopus)*, Australian Pratincole *(Stiltia isabella)*, Southern Stone-Curlew *(Burhinus magnirostris)*, Bustard *(Eupodotis australis)*, Brolga *(Grus rubicunda)*, Royal Spoonbill *(Platalea leucorodia)*, Egret *(Egretta alba)*, Little Egret *(E. garzetta)*, White-fronted Heron *(Notophoyx novae-hollandiae)*, White-necked Heron *(N. pacifica)*, Whistling Tree-Duck *(Dendrocygna arcuata)*, Plumed Tree-Duck *(D. eytoni)*, White-headed Shelduck *(Tadorna radjah)*, Spotted Harrier *(Circus assimilis)*, Swamp Harrier *(C. approximans)*, Australian Goshawk *(Accipiter fasciatus)*, Collared Sparrowhawk *(A. cirrocephalus)*, White Goshawk *(A. novae-hollandiae)*, Wedge-tailed Eagle *(Uroaëtus audax)*, White-breasted Sea-Eagle *(Haliaeëtus leucogaster)*, Black Kite *(Milvus migrans)*, Little Falcon *(Falco longipennis)*, Kestrel *(F. cenchroides)*, Boobook Owl *(Ninox novae-seelandiae)*, Red-tailed Black Cockatoo *(Calyptorhynchus banksii)*, Cockatiel *(Leptolophus hollandicus)*, Frogmouth *(Podargus strigoides)*, Azure Kingfisher *(Ceyx azureus)*, Pallid Cuckoo *(Cuculus pallidus)*, Golden Bronze-Cuckoo *(Chalcites lucidus)*, Pheasant-Coucal *(Centropus phasianinus)*, Willy Wagtail *(Rhipidura leucophrys)*, Northern Shrike-Thrush *(Colluricincla woodwardi)*, Brown Shrike-Thrush *(C. brunnea)*, Shrike-Tit *(Falcunculus frontatus)*, Papuan Cuckoo-Shrike *(Coracina papuensis)*, Grey-crowned Babbler *(Pomatostomus temporalis)*, White-throated Warbler *(Gerygone olivacea)*, Weebill *(Smicrornis brevirostris)*, Red-backed Wren *(Malurus melanocephalus)*, White-winged Sittella *(Neositta leucoptera)*, Black-tailed Tree-Creeper *(Climacteris* *melanura)*, Brown Honeyeater *(Gliciphila indistincta)*, Blue-faced Honeyeater *(Entomyzon cyanotis)*, Silver-crowned Friar-bird *(Philemon argenticeps)*, Olive-backed Oriole *(Oriolus sagittatus)*, Pipit *(Anthus novae-seelandiae)*, Zebra Finch *(Poephila castanotis)*, Great Bower-bird *(Chlamydera nuchalis)*, Crow *(Corvus cecilae)*, Black-throated Butcher-bird *(Cracticus nigrogularis)*, Black-backed Magpie *(Gymnorhina tibicen)*.

MIGRATORY, PROBABLE BREEDERS

Koel *(Eudynamys scolopacea)*, Channel-bill Cuckoo *(Scythrops novae-hollandiae)*, Eastern Roller *(Eurystomus orientalis)*.

MIGRATORY, NON-BREEDERS

Grey Plover *(Squatarola squatarola)*, Oriental Dotterel *(Eupoda asiatica)*, Sea Curlew *(Numenius madagascariensis)*, Whimbrel *(N. phaeopus)*, Wood Sandpiper *(Tringa glareola)*, Common Sandpiper *(T. hypoleucus)*, Greenshank *(Tringa nebularia)*, Marsh Sandpiper *(T. stagnatalis)*, Sharp-tailed Sandpiper *(Erolia acuminata)*, Snipe *(Gallinago megala)*, Oriental Pratincole *(Glareola maldivarum)*, Fork-tailed Swift *(Micropus pacificus)*, Oriental Cuckoo *(Cuculus saturatus)*.

CASUAL VISITORS

Pelican *(Pelecanus conspicillatus)*, White-winged Black Tern *(Chlidonias leucoptera)*, Marsh Tern *(C. hybrida)*, Caspian Tern *(Hydroprogne caspia)*, Crested Tern *(Sterna bergii)*, Gull-billed Tern *(Gelochelidon nilotica)*, Pied Heron *(Notophoyx picata)*, Red Goshawk *(Erythrotriorchis radiatus)*, Square-tailed Kite *(Lophoictinia isura)*, Black-breasted Buzzard *(Hamirostra melanosternon)*, Black-shouldered Kite *(Elanus notatus)*, Peregrine Falcon *(Falco peregrinus)*, Black Falcon *(Falco subniger)*, Osprey *(Pandion haliaetus)*, Varied Lorikeet *(Psitteuteles versicolor)*, Northern Rosella *(Platycercus adscitus)*, Port Lincoln Parrot *(Barnardius zonarius)*, Brush Cuckoo *(Cacomantis variolosus)*, Banded Honeyeater *(Myzomela pectoralis)*.

SUMMARY OF BREEDING SEASONS

It will be seen that some species breed through more than one of the periods previously indicated; thus the Diamond and Peaceful Doves have the most protracted nesting periods, breeding virtually throughout the year excepting early summer. The two Diamond-birds also have a lengthy nesting period, exclusive of the actual wet months. Most of the other species have more restricted periods.

In the following tables are set out the detailed nesting observations made on the breeding species of the Kimberley Research Station during 1955 and 1956.

Except where otherwise indicated, dates refer to the finding of eggs.

TABLE 1.—NESTING RECORDS FROM KIMBERLEY RESEARCH STATION —1955.

Diamond Dove	Nests founds in all months except October, November and December. No apparent peak period.
Peaceful Dove	Nests found in all months except November and December. Peak period beginning of "dry."
Bar-shouldered Dove	April 19, April 23, May 7 (young), June 5, June 27, July 8.
Swamphen	April 19, April 20 (2 nests).
Masked Plover	October 3.
Magpie Goose	Young birds observed on swamps February, March and April.
Red-collared Lorikeet	June 20. Young birds sold by aborigines in July
Budgerygah	June 20, June 29, July 15, September 29.
Spotted Nightjar	Many nests found in June and July.
Red-backed Kingfisher	September 29, October 15, October 17, November 5 November 9, December 3.
Sacred Kingfisher	September 29, October 2 (2 nests).
Blue-winged Kookaburra	September 22.
Northern Fantail	May 29 (building).
Restless Flycatcher	September 29, October 2, October 17, November 9, December 3; but many other nests found in that period and not recorded.
Brown Flycatcher	September 29, October 8, October 15.
Buff-sided Robin	Large young observed in July.
Rufous Whistler	September 30, October 8, October 15.
Magpie-Lark	February 24, March 2, March 3, September 29 October 17, October 20, November 21, December 3.
Black-faced Cuckoo-Shrike	September 29 (building).
White-winged Triller	Large young observed in July.
Golden-headed Fantail-Warbler	Large young in April.
White-breasted Wood-Swallow	September 29 (young), October 8 (building).
Black-faced Wood-Swallow	September 28 (building), October 8 (young), October 15, October 17.
Little Wood-Swallow	October 17 (feeding young).
Mistletoe-bird	October 18 (young just left the nest).
Red-browed Diamond-bird	Records from April to October.
Black-headed Diamond-bird	Records from April to October.
Golden-backed Honeyeater	March 28 (building) two nests.
Rufous-throated Honeyeater	Records from February, March, April, November, December.
White-gaped Honeyeater	June 16, June 26, July 5.
Yellow-tinted Honeyeater	Records from April, May, June, July, August and November.
Bar-breasted Honeyeater	February 24 (young).
Horsfield Bush-Lark	Young observed in March and April.
Star Finch	Records in February, March, April and May. Building noted in December.
Gouldian Finch	June 26, recently-vacated nest found July 13.
Yellow-rumped Finch	Many nests in February, March, April.
Chestnut-breasted Finch	Do
Pictorella Finch	Do.
Crimson Finch	Records from February to July.
Long-tailed Finch	June 20, June 26 (building), July 5, July 13, July 20, July 21.
Double-bar Finch	Records from February to July.
Masked Finch	March 5, June 18, June 20.

SUMMARY

1. Number of species observed: 160.
2. Number of species noted breeding: 59. (a) Summer: 15. (b) Autumn: 20. (c) Winter: 19. (d) Spring: 21.
3. Number of resident species not observed breeding: 64.
4. Number of migratory species, probable breeders: 3.
5. Number of migratory species, non-breeders: 14.
6. Number of casual visitors: 18.

TABLE 2.—NESTING RECORDS FROM KIMBERLEY RESEARCH STATION —1956.

Diamond Dove	Records from all months except October, November, December.
Peaceful Dove	Records from all months except November and December.
Bar-shouldered Dove	Three nests with eggs in April.
Swamphen	May 18.
Little Pied Cormorant	22 nests containing eggs and young March 28.
Masked Plover	November 21, November 24, December 8, December 9.
White Ibis	Colony of ca. 100 nests March 28.
Jabiru	April 21 (eggs hatching).
Nankeen Night-Heron	Large colony of about 40 nests February 26. Mostly small young, a few with eggs.
Black Duck	Young birds noted June and July.
Freckled Duck	Young birds noted in June.
Little Eagle	April 21 (eggs just laid).
Whistling Eagle	April 21 (small young).
Brown Hawk	October 26 (2 half-developed young).
Red-collared Lorikeet	July 16
Little Corella	Young birds noted end of June and July.
Galah	June 29, July 8.
White Cockatoo	Young birds sold by aborigines in October and November.
Budgerygah	July 25, August 9.
Blue-winged Kookaburra	Young birds just left nest October 25.
Sacred Kingfisher	September 14, September 21, September 28, October 4, December 9.
Red-backed Kingfisher	September 8, September 14, November 11.
	Two nests August 28, one with eggs, the other with young.
Rainbow-bird	Began digging nesting burrows end of August, young emerged in November.
Fairy Martin	September 28 (large young).
Restless Flycatcher	February 26, March 9, August 7.
	August 8, August 28 (four nests, one with egg, three with chicks), October 21, October 28 (young), December 8 (young).
Buff-sided Robin	June 14.
Magpie-Lark	Records from February, March, October, November and December.
Black-faced Cuckoo-Shrike	August 9 (building), August 28 (building).
White-winged Triller	August 8, August 15, August 28 (two nests).
Golden-headed Fantail-Warbler	March 14 (young), July 26 (feeding young).
Rufous Song-Lark	February 14, March 25, April 2 (young).
White-breasted Wood-Swallow	September 2, September 9 (building), September 24 (young).
Black-faced Wood-Swallow	October 30 (one young, one egg).
Little Wood-Swallow	October 30 (entering nesting hole).
Black-tailed Tree-Creeper	October 31 (young birds).
Red-browed Diamond-bird	Recorded from April to June.
Black-headed Diamond-bird	Recorded from April to August.
Rufous-throated Honeyeater	Recorded from February, March, April, November and December.
White-gaped Honeyeater	July 18 (young).
Yellow-tinted Honeyeater	May 27 (2 young), July 2 (young), October 30 (2 young).
Bar-breasted Honeyeater	February 25 (Wyndham), March 8 (young).
Star Finch	Records from February to May.
Yellow-rumped Finch	Records from February, March, April.
Chestnut-breasted Finch	Do.
Pictorella Finch	Do
Crimson Finch	Records from February to July.
Double-bar Finch	Do.
Masked Finch	June.

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HERPETOLOGICAL MISCELLANEA

By L. GLAUERT, Western Australian Museum, Perth.

XI.—DRAGON LIZARDS OF THE GENUS *AMPHIBOLURUS*

These dragon-like lizards have a short, blunt head, small eyes with round pupils and moveable lids. The body is more or less normal and the tail long and tapering; the limbs which are pentadactyl are long, the hind foot often being as long as the fore limb. Some species even adopt a bipedal gait in times of emergency. There are both preanal and femoral pores, at least in the males. Many of these lizards are active in the day time.

KEY TO THE SPECIES

A. The adpressed hind limb reaches beyond the eye.

- a. Ventral scales keeled.
  - b. Nuchal crest absent, variegated greyish with white longitudinal stripes .... *maculatus*
  - bb. Nuchal crest present. Nostril on the canthus rostralis, brown with two or three black lines and white cross bands ...... *imbricatus*
- aa. Ventral scales smooth or feebly keeled.
  - c. Canthus rostralis swollen.
    - d. Nostril tubular, dorso-lateral fold smooth, faint nuchal and dorsal crests .... *ornatus**
    - dd. Low nuchal crest dorsal reduced to a row of scales, no dorso-lateral fold, tail with narrow black rings .... *caudicinctus**
  - cc. Canthus rostralis sub-angular, prominent nuchal and dorsal crests, dorso-lateral fold spinose .... *cristatus*
  - ccc. No dorsal crest, dorso-lateral fold not spinose .... *scutulatus*

B. The adpressed hind limb does not reach beyond the eye.

- a. Preanal and femoral pores 20 or more extending two-thirds or all along the thigh.
  - b. Ventral scales smooth.
    - c. Dorsal and lateral scales uniform .... *pictus*
    - cc. Dorsal and lateral scales heterogeneous ... *reticulatus* and *darlingtoni*
  - bb. Ventral scales keeled. Gular scales keeled or smooth, outer series of scales near the base of the tail projecting .... *adelaidensis*
- aa. Preanal and femoral pores 22 or less, on the proximal part of the thighs only.
  - d. Adpressed hind limb reaches the ear or the eye, small vertebral ridge .... *muricatus*

* At times the adpressed hind limb does not extend beyond the eye.

dd. Adpressed hind limb reaches the axilla or the shoulder.

e. Scales on the body large .... *barbatus minor*

ee. Scales on the body small .... *barbatus microlepidotus*

Amphibolurus maculatus (Gray)
Spotted Dragon

A rather small lizard, less than 8in. (200 mm.) in length, with the nostril below the canthus rostralis; head scales strongly keeled smallest over the eyes. Body covered with small uniform strongly keeled scales, the keels converging to the vertebral line and smallest at the sides. Gular scales keeled, smaller than the keeled ventrals. Limbs very long, the adpressed hind limb reaching beyond the tip of the snout, covered like the tail with keeled scales larger than the dorsals. Males with 50 or more pores in a complete series arched in front of the vent.

The coloration is very variable; preserved specimens are grey above with a white dorso-lateral band extending from neck to the tail and dividing regular series of transverse black spots which may be sufficiently abundant to form longitudinal stripes continuing on to the tail. Outside this a white streak bounded externally by a dark streak reaching from the axilla on to the tail. In addition to the dark lateral streak some of the tails have light brown ill-defined cross bars on the upper surface. The legs are roughly banded with darker above, and the lower surface whitish with the characteristic black V on the chin and the cross bar on the chest. Females lack the white streaks and have their lower surface immaculate.

Distribution: Known from Barrow, Lowendall and Bernier Islands in the north to the south coast, Ravensthorpe and inland to the Wheat Belt.

Amphibolurus maculatus gularis Sternf.
Sternfeld's Dragon

This lizard is very similar to its nearest relative, the main difference being the larger tympanum and the coloration. The latter which is rather variable has been described as follows from living specimens. "The male is bright brick red to dull reddish brown above with rounded black spots and yellow greyish ocelli, the latter, which are bordered by a narrow black line, are more or less confluent into longitudinal bands on each side of the body, converge on the nape and extend along the tail; a broad black band extends from the tip of the snout through the eye, above the fore limbs along the body and the front of the hind limb to the knee, a pale yellow line divides the black band from the axilla to the groin. The light markings on the head, the lips and the under surface yellowish white. A large jet black patch covers nearly the whole of the throat, chest and fore part of the abdomen and fore limbs." The females are coloured like the males but lack the black markings on the sides and ventral surfaces, the throat may be mottled or speckled with grey.

Distribution: As indicated by specimens in the Museum the species ranges from La Grange, Wallal and De Grey Stations in the north, and the Canning Stock Route to Kathleen Valley, north of Leonora.

Amphibolurus imbricatus Peters
Peters' Dragon

This little lizard, it rarely attains a length of 6 in. (150 mm.), can readily be recognised by the following characters, (1) nostril is situated on the sharp canthus rostralis, (2) the small uniform keeled scales of the back gradually increase in size towards the tail, (3) and the row of enlarged keeled scales along the vertebral line from the nape to the tail.

The scales on the snout are keeled, on the rest of the head more granular; dorsal scales keeled, gulars and ventrals less strongly so; those on the limbs and tail similar to the dorsals but larger, their keel forming distinct rows along the limb, ventrals larger than the dorsals, feebly keeled. Limbs long, the adpressed hind limb reaching beyond the tip of the snout, tail more than twice the length of the head and body. About 22 preanal and femoral pores in the male.

The colour in life is said to be variable, ranging from brownish grey to brick red with black spots along the neck and body, white spots may be present and even coalesce to form transverse bands; the tail is brown with narrow white crossbands. These colours are soon lost when the specimen is preserved in spirits or formalin.

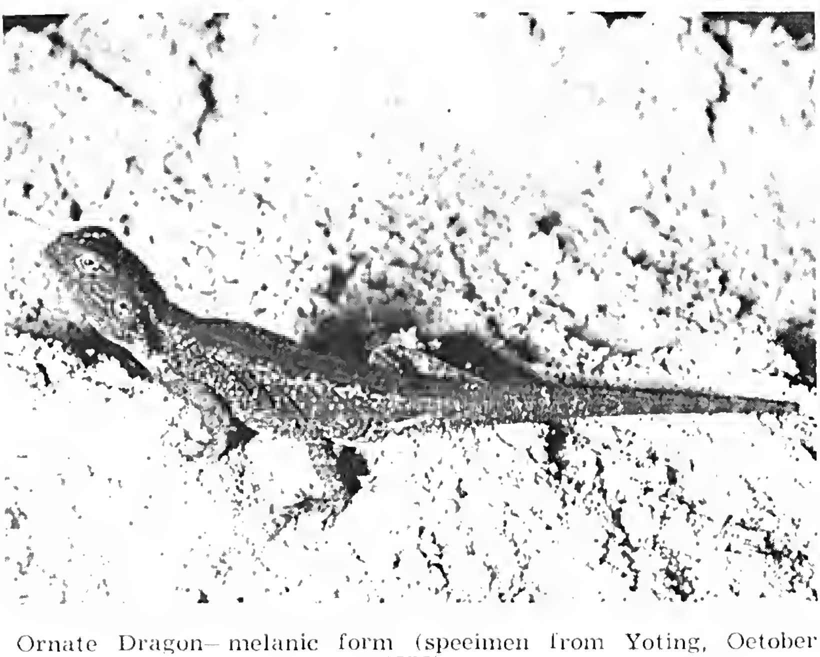
Distribution: Specimens in the Museum collection are from De Grey Station and Hooley Station in the north to Laverton in the Eastern Goldfields.

Amphibolurus ornatus (Gray)
Ornate Dragon

A rather large species growing to about 10 in. (255 mm.) with the adpressed hind limb of the male reaching to the eye or slightly beyond; head short, canthus rostralis rounded, nostril distinctly tubular, upper head scales tubercular, rough, smallest over the eyes. Body covered with small keeled scales, largest on the vertebral line, smallest at the sides where they are intermixed with a few scattered larger ones; a low nuchal crest; ventral scales, small, smooth; scales on the limbs much enlarged strongly keeled above. There are 60 or more pores in the males, females without pores. Caudal scales all round larger than the dorsals, strongly keeled. Tail about twice as long as the head and body.

The coloration is variable but consists mainly of black and yellow. The head is covered with symmetrical markings of black and the dorsal surface of the body black with a broad yellow vertebral band on which are situated a row of yellow black edged lozenges which may be replaced by black patches or irregular cross bands. Adjacent to this is a brownish dorso-lateral area which like the black sides of the body bears a number of small yellow spots. The limbs are yellow with black cross bands and the tail yellow with jet back rings. The normal and melanic specimens are illustrated.

Ornate Dragon (specimen from Jacup, September 1957).



Ornate Dragon—melanic form (specimen from Yoting, October 1956).

—Photos E. Lindgren.

Distribution: The species has a very wide range in W.A. throughout the South-West, as far north as Mt. Magnet and Lake Barlee. It occurs on the Archipelago of the Recherche and there is a single specimen in the collection from Bernier Island.

Amphibolurus caudicinctus (Gnthr.)
Ring-tailed Dragon

A moderate species growing to about 10 in. (255 mm.) with the adpressed hind leg reaching the eye in the male; head short and heavy, cheeks swollen, nostril below the swollen canthus rostralis its opening slightly upwards. Head scales tubercular, keeled, smaller over the eyes and on the temporal region, a few small spines behind the ear. A low nuchal crest continuing as a ridge along the body and tail. Body covered with small keeled scales, the keels gradually converging to the middle line, increasing in size towards the tail, smallest at the sides. Gular scales small smooth, ventrals smooth, as large as the dorsals. Tail slightly compressed about twice the length of the head and body, covered with keeled scales not much larger than the posterior dorsals. Limbs above covered with strongly keeled enlarged scales. About 36 pores in the male.

The coloration is variable. The head may range from light-ochraceous-buff to ochraceous tawny after the dust of the soil in which the lizard has been burrowing. The back may be almost uniform pale brown or range from pale brown to cinnamon brown with narrow irregular cross bands of dark brown, legs faintly banded with darker or uniform and the tail light with narrow blackish rings. The under surface is pale yellow with dark marbling on the chin and a black patch on the chest of the males extending on to the fore limbs. The young are brighter coloured than the adults.

Distribution: The type locality is Nicol Bay, specimens in the Museum are from stations in that area. The Harvard Expedition obtained specimens from Meekatharra, Wiluna and Hermannsburg, Central Australia.

Amphibolurus cristatus (Gray)
Crested Dragon

Habit slender, head fairly large with angular canthus rostralis, tympanum almost as large as the orbit, upper head scales subequal, rugose, strongly keeled, smallest over the eyes; a row of triangular spines from under the eye to over the tympanum, a few on the folds on the side of the neck. Body covered above with small keeled scales, largest at the middle of the back with scattered larger ones. Nuchal crest prominent passing into a dorsal crest which extends backwards almost to the end of the tail, dorso-lateral fold with a crest or serrated ridge. Gular scales smaller than the ventrals, very feebly keeled. Ventrals small, smooth or very feebly keeled. Limbs long, the adpressed hind limb reaches to beyond the tip of the snout, covered with small keeled scales. Tail about twice as long as the head and body covered with keeled scales larger than those on the body. There are 50 preanal and femoral pores. Grows to about 12 in. (300 mm.). The colour is not uniform, a specimen may have the head with a few dark markings, the fore part of the back olive with dark markings or reticulations and the rest of the back and the base of the tail as well as the limbs above dark olive brown, but the distal portion of the tail distinctly ringed with lighter and darker. Under surface black, hands and feet pale, as also is the basal part of the tail. The pale pores are very distinct.

Distribution: The southern part of the State from the Darling Range eastward. There is a single specimen from Learmonth in the north and Fitzgerald Peaks in the south. Most of the specimens are from the Goldfields. It is recorded from Bernier Island.

Amphibolurus scutulatus Stirling and Zietz
Lozenge-marked Dragon

Habit slender, in general shape closely resembling *A. ornatus* (Gray) but differing markedly in coloration, and the scales smaller throughout. The head is somewhat narrower, the tympanum larger, the head scales smooth not rugose and mostly bi- or tricarinate. The dorsal surface is covered with small sub-equal keeled scales not intermixed with larger ones. Finally the coloration is markedly different, dark lozenge shaped markings being prominent on both males and females, making the animals conspicuous in collections but probably having a great survival value in its natural environment. A single median series of large dark spots on the neck and fore part of the body soon breaks up into a double row of lozenge-shaped spots extending on to the tail; below these another row, light edged and often containing a variegated centre, can be traced on to the tail. The limbs and tail are also distinctly marked with light edged dark patches and more or less distinct pale cross bands.

The lizard may grow to 17 in. (420 mm.), the head and body 120 mm. and the tail 300 mm. From 40 to 60 pores along the thighs.

Distribution: Almost identical with *A. cristatus*. Specimens in the collection are from the Lyndon River in the north to the Kalgoorlie area in the south. It is known from many parts of the Murchison and Eastern Goldfields.

Amphibolurus pictus (Peters)
Painted Dragon

This little lizard, its greatest recorded length is under 9½ in. (240 mm.), is one of the short-legged group, its hind legs when adpressed not reaching beyond the eye. The body is covered with small smooth or feebly keeled scales both above and below but those on the limbs and tail are more strongly keeled. Throughout the scales are almost uniform in size, enlarged scales and tubercles being absent. There are from 32 to 44 pores in the male extending the whole length of the thigh.

The bright breeding season colours have been described by Lucas and Frost. "Male, brick red above, with faint black reticulations enclosing yellow spots on the back and sides. Head pinkish grey with lighter and darker markings. A broad leaden-blue vertebral stripe barred with numerous narrow black bands and a few broader light ones. Tail leaden-blue with narrow irregular light bands. Under surface yellowish white. Dark marks on the throat and chest." Females are less ornate, being rusty brown above with faint dark reticulations enclosing light spots on the sides; a vertebral series of short black bars; a few light bands across the back at intervals. Tail rusty-brown with light narrow cross bands; under surface whitish. Specimens in spirits lose the bright colours but the details can be distinguished some time after death.

Distribution: Appears to be very wide in the interior. In addition to occurring in South and central Australia it has been collected at Well 37 on the Canning Stock Route, Kurrawang and between Israelite Bay and Cape Arid.

Amphibolurus reticulatus (Gray)
Netted Dragon

A rather stout lizard growing to 10 in. (250 mm.) or so with the adpressed hind limb not reaching the orbit. Head short and heavy, nostril on a rounded canthus rostralis, directed upwards. Scales on the head tubercular, obtusely keeled, smallest over the eyes, short spines at the back of the head and on the folds of the neck variable in development. A low nuchal crest, dorsal crest represented by a row of enlarged keeled scales; enlarged smooth or faintly keeled scales intermixed with the smaller smooth ones of the dorsal and lateral surfaces, at times in more or less regular cross bands, at others merely scattered over the surface; they may be represented by tubercular scales of various sizes. Gular scales smooth, smaller than the smooth ventrals. Scales on the tail and limbs larger than the dorsals, strongly keeled. Tail about once and one-half as long as the head and body.

In this species females as well as males may have spores though less numerous, arranged along the whole length of the thigh when adult. The number of pores varied considerably in a series of 46 specimens from Wallal. The great majority are immature with the pores either absent or partly developed. Of six adults, one has 16, two 18 and 20 and another 24, thus agreeing with Sternfeld's *Amphibolurus reticulatus major*. This type appears to range as far south as the Murchison Railway. To the south of this and to the north also in places we meet the typical form which may have as many as 50 pores in the male. In both types the pores extend along the whole length of the thigh. The coloration of the species also shows considerable variation as well as sexual differences. In the adult male the head is covered with darker and lighter symmetrical markings often obscured by the dust of the soil in which the lizard has been burrowing. There is a pale vertebral band about a scale wide and the rest of the back and sides are covered with a dark network enclosing pale yellow spots; the tail is plain or has faint dark cross bands which become stronger towards the tip. The limbs have dark and light markings and the under surface is pale yellow with dark markings on the chin. The females have faint reticulations laterally but whilst the pale vertebral stripe may be present, the main pattern on the back consists of a number of dark patches arranged in pairs on each side of the vertebral line. The markings of the young and immature are so varied that they cannot be used as a means of identification. Excellent reproductions are given by Werner in *Fauna Sudwest-Australiens,* vol. 2, plate 14. Photographs of both sexes are included in an article on the species by S. R. White in *W.A. Nat.,* 1 (8), 1949: 157.

Distribution: Almost state-wide. It is known from the far north but does not appear to reach the west coast south of Geraldton, and is not recorded south of Ongerup.

Amphibolurus darlingtoni Loveridge
Darlington's Dragon

This lizard is described by Loveridge as a member of the *reticulatus* group apparently most nearly related to *inermis* De Vis. From this it differs (1) by the absence of small isolated spines behind the tympanum, (2) by the presence of three rows of strongly enlarged spines, the first continuing in a straight line behind and from the angle of the mouth, the second along the upper border of the tympanum and continued posteriorly beyond it, the third on a fold of the skin still higher on the neck, and (3) by the presence of transverse, though somewhat irregular, rows of greatly enlarged, flat, keeled scales on the back.

A series of 46 specimens from Wallal demonstrates the extreme variability of *reticulatus,* and although no specimen has been found in this series or in the general Museum collection with all the above features united in one individual, there seems little doubt that *darlingtoni* must be regarded as a synonym of *reticulatus.*

The only specimen in the collection is a paratype, R4460, from Mullewa.

Amphibolurus adelaidensis pulcherrimus Blngr.
Beautiful Queen Adelaide's Dragon

A small lizard not reaching more than 5 in. (125 mm.) in length; its nostril well below the sharp canthus rostralis; the head covered with keeled scales, some of those on the occiput with 3 keels and small spines. A distinct dorso-lateral fold. Body covered with irregular keeled scales, some of which form a distinct vertebral series extending from the nape to the base of the tail, intermixed with small spines, gular scales smooth or feebly keeled, ventrals keeled. Limbs short, the adpressed hind limb in the male reaching the tympanum and in the female to the shoulder. Scales on the upper surface of the limbs large, strongly keeled, those on the tail likewise, but the outer series at the base taking the form of white pointed tubercles, a feature peculiar to the species.

The colour in life is pale greyish with symmetrical dark markings on the head and a regular series of five or six angular dark brown white edged spots along the back from the nape to the base of the tail, a second series may be present below the dorso-lateral fold, tail with two series of dark spots laterally; under surface pale, chin of male with two Λ-shaped black streaks, a black patch on the throat and between the fore limbs continuing as a black streak along the body to the vent. Females with chin and throat marbled. The species is well figured on Plate 30 of the British Museum Catalogue of Lizards, vol. 1, 1885.

Distribution: Very widespread, from Point Cloates in the north to the south coast (Hamelin Bay and Esperance) and eastwards to South Australia. It is known from Bernier Island.

Amphibolurus muricatus (Shaw)
Tree Dragon or Bloodsucker

A large member (12½ in. (320 mm.)) of the short-legged section whose hind legs when adpressed do not reach beyond the eye. It is easily recognised by its series of keeled scales forming several prominent ridges along the dorsal surface and by its striking markings. Head covered with keeled scales, smaller over the eyes, and with short spines near the tympanum and at the back of the head. Body covered with small keeled scales and larger ones forming distinct crests along the dorsal surface from the neck to the hind limbs. Gular scales smaller than the ventrals feebly keeled, ventrals almost smooth slightly mucronate. Tail and upper sides of the limbs with rows of large, strongly keeled scales larger than the dorsals. In the male there are three or four femoral and two preanal pores on each side.

The colour is brown above with five large darker angular patches along the side of the vertebral area from the shoulder to the base of the tail bounded externally by the dorso-lateral crest or fold. Limbs with dark markings, hands and feet black. Under surface immaculate with faint dark lines on the chin. Tail with wide darker and lighter rings.

Distribution: An eastern species, of which the only specimen in the Museum was collected at Mt. Ragged by the late Mr. H. Tarlton Phillipps.

Amphibolurus barbatus minor Sternfeld
Western Jew Lizard

A large lizard of the short-legged series whose hind leg does not reach the eye when adpressed. Habit very much depressed. Head large, cheeks swollen giving the head a triangular appearance from above; nostril large below the angular canthus rostralis. Upper head scales keeled, largest on the snout, a row of spinose scales bounding the head behind. Three other series of spines can be recognised, one, the continuation of the canthus rostralis, consisting of enlarged plate-like scales and spines, extends to behind the eyes, a second passes from behind the eye over the ear, and the third starts at the angle of the mouth, passes under the ear to the neck where it sweeps round behind the transverse series. The spines near the bend and others below them form the poorly developed beard of this western form. A short row of spines is often present on each side of the neck. A distinct gular fold. Gular scales keeled, as large as the strongly keeled scales of the chest but smaller than the almost smooth posterior ventrals.

Scales on the middle of the back are large, keeled, and intermixed with numerous larger swollen ones. Scales smaller on the sides with numerous conical spines of various sizes and shapes. Limbs short, the adpressed hind limb reaching the axilla or slightly beyond, covered with large strongly keeled scales. Pores vary from 12 to 16 and are situated on the proximal portion of the thigh and the preanal region only. Tail round, slightly depressed at the base where the scalation is similar to that on the back, the rest of the tail being covered with regular strongly keeled scales. Grows to 14 in.

The coloration is variable, changing from almost uniform dark brown to buckthorn brown or ochraceous tawny; there are many specimens with lighter or darker blotches and often a regular transverse banding can be seen. In the lighter specimens a dark mark at the side of the neck is easily seen. The western form is distinguished from the eastern typical reptile by the slighter development of the spines forming the so-called "beard" and by its smaller size (see comparative photographs by S. R. White, *W.A. Nat.*, 2 (4), 1950: 95). A third subspecies *Amphibolurus barbatus minimus*, Loveridge, has been described to include still smaller specimens from the Abrolhos and the vicinity of Geraldton. A fourth form, *Amphibolurus barbatus microlepidotus* Glauert, known only from the Drysdale River area in the far north has been separated from its relatives by the smaller scales on the head and body and by the oblique arrangement of the enlarged keeled scales on the back, very few of which are spinose (*W.A. Nat.*, 3 (7), 1952: 168).

FROM FIELD AND STUDY

Terrestrial Activity of the Swamp Tortoise.—On July 23, 1958, I saw a Swamp Tortoise *(Chelodina oblonga)* crossing the old Bunbury road at Coolup. The tortoise was going from a roadside puddle on the west side of the road to another on the other side. It showed a strong desire to continue east even though it was turned back several times.

W. McARTHUR, Nedlands.

Northern Extension of Known Range of Brush Bronzewing.—In late March, 1959, we observed three individuals of the Brush Bronzewing *(Phaps elegans)* near the mouth of the Hill River. The first bird was flushed from a track through dense *Acacia rostellifera* scrub, 3 miles north of the ford over the lower Hill. The second was at a freshwater pool, a mile upstream from the mouth of the river. The last was flushed from the road, again in *Acacia rostellifera,* 5 miles south of the ford. Only the second bird was seen in circumstances that permitted no doubt of its identity.

It is noteworthy that the habitat of these pigeons (coastal *Acacia* shrub) is similar to much of Garden Island, where the species is common (G.M.S., unpublished data).

Previously there was no record of the Brush Bronzewing on the mainland further north than Moora (60 miles to the ESE).

—G. M. STORR, Nedlands, and J. R. FORD, Attadale.

Predation on Vertebrates by Mygalomorph Spiders.—In July, 1957 in a pile of concrete rubble near the trough of Tank No. 28, at the 253 mile peg on the Great Northern Highway, the rejectamenta collected by one of us (W.H.B.) from the occupied burrow of a trap-door spider was found to contain the shrivelled remains of 13 specimens of frogs. The spider was collected and identified as a specimen of the proto-*Idiosoma* race of *Aganippe raphiduca* Rainbow and Pulleine, and its burrow was observed to have attached twig-lines, which are used as feeling lines when foraging (see Main, B. Y., *Austral. Journ. Zool.*, 5, 1957: 416). The frogs were identified by Dr A. R. Main, as *Crinia pseudinsignifera* Main. The spider, a female, measured 13.7 mm. from the front of the chelicerae to the posterior tip of the abdomen, and had a carapace length of 6.0 mm. Due to the shrivelled condition of the frogs it was not possible to make accurate measurements of the body lengths, but they ranged between 7.5 mm. and 10.5 mm. In life adult specimens have a body length range of 14 to 23 mm.

McKeown (*Australian Spiders,* 1952, Angus and Robertson) documents Australian records of spiders capturing vertebrates. Most of such records concern birds trapped in aerial webs and a few instances of spiders capturing for food, fish, reptiles, frogs and mammals (mice and bats). Again few of the records are for Mygalomorph spiders and of these only one, *Atrax formidabilis* Rainbow, is reported to capture and eat frogs. Main, B. Y. and A. R. (1956, *W. Austr. Nat.*, 5, 1956: 139) note that *Selenocosmia* feeds on frogs.

The principal interest in the present note is that it is the only record of a door-building Mygalomorph feeding on frogs or any other vertebrate. There are two earlier accounts of trap-door spiders at least capturing vertebrates, in both instances small birds. One from South Australia is of a specimen of *Aganippe subtristis* Cambridge having hold of the legs of a White-fronted Chat *(Epthianura albifrons)*, whilst the spider remained in its burrow (Pearce, C., 1932, *South Austral. Ornith.)*. The other record is from Western Australia of a "common trap-door spider" having hold of the legs of a small bird "smaller than a silver-eye," from beneath the closed door of the burrow (*Producers' Gazette and Settlers' Record,* W.A., 1897: 1331). However, in both these instances the birds flew away upon human interference. It is doubtful if the spiders would actually have taken the birds into their burrows and used them as a source of food.

Spiders of the genus *Aganippe,* in the absence of positive evidence, are generally regarded as being non-dangerous to humans. From the present report it can be inferred that the toxin of some species is effective at least against cold blooded vertebrates. It is also of interest that although this spider, *Aganippe raphiduca,* is generally a beetle or ant feeder, depending upon the habitat occupied, it is in fact opportunistic.

—W. H. BUTLER and BARBARA YORK MAIN.

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THE FOSSIL MOLLUSCA OF THE PEPPERMINT GROVE LIMESTONE, SWAN RIVER DISTRICT OF WESTERN AUSTRALIA

By G. W. KENDRICK, Willagee.

INTRODUCTION

Late-Pleistocene marine fossils are exposed along the banks of the lower Swan River at intervals below Freshwater Bay. They are found at heights up to 30 feet above sea level, and have been observed by the author nowhere more than 2½ miles from the sea (see map).

Attention to the fauna has been sporadic over the years. J. L. Reath (1925) listed species found, and suggested that, as many did not appear to be living south of Geraldton, the deposit indicated warmer sea temperatures than at present. It was however recognised that "future work may weaken the case for a recent cooling of ocean temperatures."

The value of Reath's paper is vitiated by uncertain identifications, limited knowledge of living distributions, and obsolete nomenclature. Also the work does not differentiate between the fauna of the Peppermint Grove Limestone, and that of the younger unconsolidated shell beds which are so conspicuous in and near the Swan River below Rivervale.

Fairbridge (1953) described the formation and named it, as above, after one prominent exposure. He associated it with the 25 ft. rise in sea-level which occurred during the first warm interval of the Würm glaciation. No faunal re-examination was conducted, and general endorsement was expressed of Reath's tentative conclusion regarding the "warmer water character" of the deposit.

Carrigy and Carrigy (1952) discussed the fauna of a Mid-Recent beach deposit at Mosman Park. They questioned the correctness of some aspects of Reath's conclusions, and reported that the Mosman Park deposit "gave no evidence of a change in temperature during the time of the 10 foot sea level."

The significance of such fossil deposits, composed almost entirely of living species, can best be seen in direct comparison with the living fauna of the region, with this latter providing the measuring stick. At the outset of this work, it became clear that not enough was known of the distribution and composition of Western Australian mollusca to allow a proper comparison to be made.

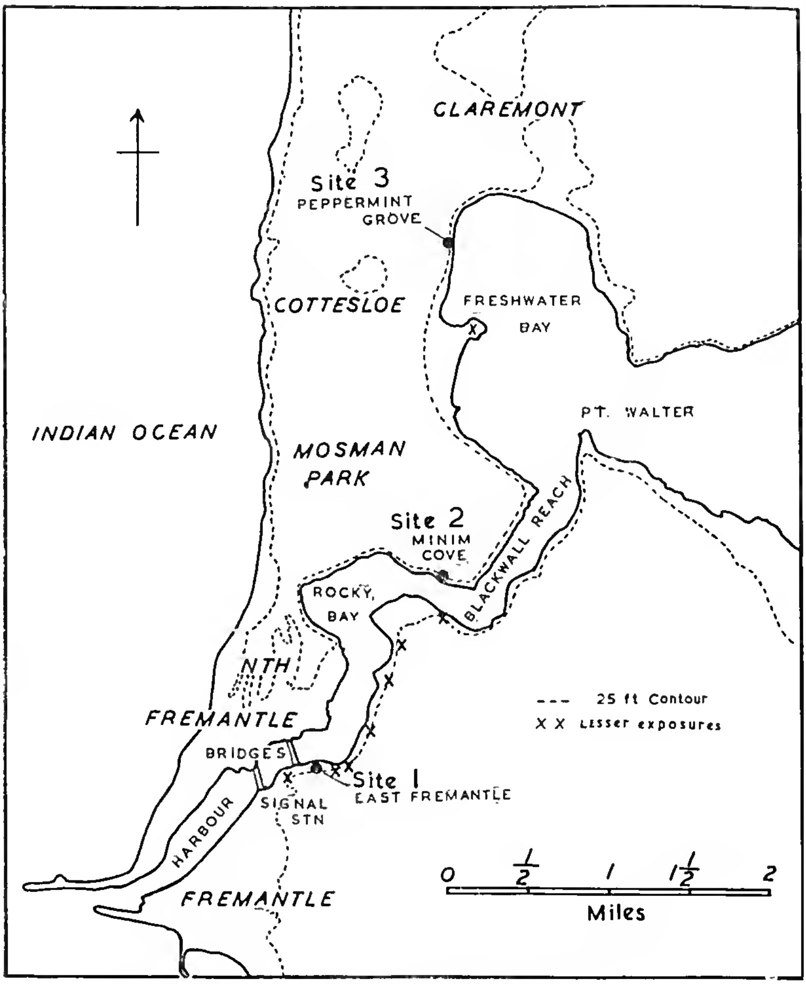
This deficiency has to some extent been remedied during several years' collecting by members of the Marine Research Group of the

W.A. Naturalists' Club, with which the author is associated. Localities which have provided living material include: Hopetoun, Bremer Bay, Cheyne Beach, Albany, Point D'Entrecasteaux, the Cape Naturaliste area, the coast from Shoalwater Bay to Cottesloe, Garden and Rottnest Islands, the waters of Cockburn Sound, Yanchep, the Geraldton district, some Abrolhos Islands, Shark Bay and Port Samson. It is the author's desire that the new information in this work will add to our understanding of Late-Pleistocene conditions in South-Western Australia.

METHODS OF EXAMINING THE FOSSIL MATERIAL

Specimens were obtained from three sites, one of which, at East Fremantle, has not been reported on prior to this work.

1. **East Fremantle:** Situated on the south bank of the Swan River; 150 yards upstream from the Fremantle Traffic Bridge; at



Locality map of exposures of fossils.

the foot of the Canning Highway embankment, 15 yards from the water's edge and 10 feet above low water. A pocket of shell two feet thick is mixed with rounded travertine pebbles and occasional rolled corals in a coarse brown shell-sand. Solution pipes pierce the shell layer, which overlies a soft rock containing scattered shells. Specimens were taken with ease from the exposed face to a depth of 12 inches and a note made of their relative abundance.

Small exposures of shells may be seen several hundred yards west of this site, and at intervals upstream to Blackwall Reach.

2. **Minim Cove:** Situated on the north bank of the Swan River between Rocky Bay and Blackwall Reach. The deposit may be seen over several hundred yards of the cliff-edge. Two samples were taken.

Lower sample: The largest sample worked. Several lbs. of the less-consolidated shell sand from 7 feet above low water were finely sieved. The residue, chiefly mollusc remains, was carefully sorted and counted. Each gastropod shell with apex intact was counted as one individual; every two pelecypod valves with hinges intact were counted as one individual. In addition, several species were identified from fragments showing characteristic detail. A small number of pelecypod chips with hinges were too worn or damaged to be identified or compared with other material, and have been omitted from the analysis.

Upper sample: From the highest coherent level of shell-sand, immediately above the lower sample, and about 20 feet above low water. Sorting and counting proceeded as above.

3. **Peppermint Grove:** Situated on the north bank of the Swan River, near the Scotch College boatshed, Freshwater Bay. Several lbs. of coarse shell sand were taken from the upper level of a conspicuous shell band 20 feet above low water. One sample only was worked; sorting and counting as previously described.

METHODS OF COLLECTING LIVING MOLLUSCA

The localities have already been referred to. In addition to scouring reefs and beaches, the aqualung, diving mask and schnorkel have been used to obtain alive the more elusive forms. Dredging has been successful in Cockburn Sound. Beach rolled shells in good condition have been accepted as an indication of living occurrence in a proportion of cases. All significant material so collected is in the collection of the W.A. Naturalists' Club, at the W.A. Museum, Perth.

Information so obtained which relates to species occurring in the fossil beds is included in the following tables.

RESULTS

These are essentially a comparison of living and fossil occurrences. Living distributions may be viewed broadly in three groupings, each of a particular significance to the fossil assemblages. The following key to categories is proposed.

Group A, comprising all fossil species which are also found living within 35 miles of Fremantle. Species are of several zoogeographical affinities, as follows:

A_1—species considered to be of north-west and/or Indo-Pacific affinity (Dampierian Province).

A_2—species considered to be of southern affinity (Flindersian and Peronian Provinces).

A_3—others, including species of uncertain affinity.

Group B, comprising all fossil species known to occur in life in Indo-Pacific waters (Dampierian Province), but *not collected alive south of Geraldton.*

Group C, comprising all fossil species known to occur in life along the south and south-east coasts of Australia (Flindersian-Peronian Provinces), but *not collected alive north of Cape Leeuwin.*

TABLE 1.—EAST FREMANTLE

84 species were observed, of which 70 were identified sufficiently for comparison with living material.

The 10 most conspicuous are:

	Species	Living occurrence	Key (as above)
1.	**Senectus pulcher** Reeve.	Northern Aust.-Geraldton-C. Naturaliste-Hopetoun	A_1
2.	**Katelysia rhytiphora** Lamy.	Albany-Victoria-Tasmania	C
3.	**Patellanax laticostata** (Blainville).	Geraldton-Recherche	A_2
4.	**Eumarcia fumigata** (Sowerby).	South Aust.-Tas.-Vic.-N.S.W.	C
5.	**Hormomya** ? sp. nov.,	identical with a species of uncertain identity collected living between the Abrolhos and Cockburn Sound	A_3
6.	**Fragum erugatum** (Tate).	Shark Bay-Geraldton-Rottnest and Sth. Aust. (rare). A single specimen also from Port Samson	A_3
7.	**Redicirce plebeia** (Hanley).	North-west Australia-Cockburn Sound	A_1
8.	**Haliotis roei** Gray.	Geraldton-Sth. Aust.	A_2
9.	**Dicathais aegrota** (Reeve).	Geraldton-Recherche	A_2
10.	**Antisabia erma** Cotton.	Cape Naturaliste-Geraldton	A_2

Other species noted are:—

	Species	Living occurrence	Key
11.	**Glycymeris striatularis** (Lamarck).	Geraldton-S.A.-sthn. N.S.W.	A_2
12.	**Anadara trapezia** (Deshayes).	Victoria-sthn. Qld., also Albany, W.A.	C
13.	**Gabinarca symetrica** (Reeve).	N.W. Australia-Geraldton-Cockburn Sound	A_1
14.	**Barbatia pistachya** (Lamarck).	Geraldton-Vic.-N.S.W.	A_2
15.	**B. laminata** Angas.	Geraldton-Sth. Aust.	A_2
16.	**Ostrea angasi** Sowerby.	Cockburn Sound-Sth. Aust.-N.S.W.	A_2
17.	**Crassostrea** cf. **tuberculata** (Lamarck).	Cockburn Sound	A_3
18.	**Spondylus tenellus** Reeve.	Cockburn Sound-Sth. Aust.-N.S.W.	A_2
19.	**Mytilus planulatus** Lamarck.	Cockburn Sound-Victoria	A_2
20.	**Septifer bilocularis** Linne.	North-west Aust.-Cape Naturaliste	A_1
21.	**Eucrassatella verconis** Iredale.	Cockburn Sound-Sth. Australia	A_2
22.	**Wallucina assimilis** (Angas).	Geraldton-Victoria	A_2
23.	**Codakia bella** Conrad.	Cockburn Sound-Geraldton-northern Australia	A_1
24.	**Divalucina occidua** Cotton and Godfrey.	Safety Bay-South Australia	A_2
25.	**Fulvia tenuicostata** (Lamarck).	Cockburn Sound-Vic.-N.S.W.	A_2
26.	**Regozara flava** (Linne).	N.W. Aust.-Geraldton-Cockburn Sound-Israelite Bay	A_1
27.	**Katelysia scalarina** (Lamarck).	Albany-Victoria	C
28.	**Gomphina undulosa** (Lamarck).	Geraldton-Victoria	A_2
29.	**Venerupis** cf. **iris** (Linne).	Cockburn Sound-Yanchep-Geraldton	A_3
30.	**Naranio lucinalis** (Lamarck).	Yanchep-Victoria	A_2
31.	**Homalina deltoidalis** (Lamarck).	Cockburn Sound-Victoria	A_2
32.	**Macoma dispar** Conrad.	Northern Australia	B
33.	**Angulus perna** Spengler.	Northern Australia-Cockburn Sound	A_1
34.	**Flavomala biradiata** (Wood).	Cockburn Sound-Victoria	A_2
35.	**Donax columbella** Lamarck.	Geraldton-Albany	A_2
36.	**Deltachion brazieri** (Smith).	Geraldton-Sth. Aust.	A_2

37. **D. chapmani** (Gatliff and Gabriel). Geraldton-Victoria ... A_2
38. **Mactra pura** Deshayes. Geraldton-Victoria ... A_2
39. **Mesodesma nitida** Deshayes. Sthn. Australia ... C
40. **Amblychilepas nigrita** (Sowerby). Geraldton-Victoria-sthn. Qld. ... A_2
41. **Clanculus consorbrinus** Tate. Geraldton-Sth. Australia ... A_2
42. **Herpetopoma aspersa** (Philippi). Geraldton-Tasmania ... A_2
43. **Clanculus personatus** (Philippi). Cockburn Sound ... A_3
44. **Austrocochlea rudis** (Gray). Geraldton-Recherche ... A_2
45. **Cantharidus pulcherrimus** (Wood). Geraldton-Victoria ... A_2
46. **Euninella gruneri** (Philippi). Geraldton-Tasmania ... A_2
47. **Ninella whitleyi** Iredale. Geraldton-sthn. Australia ... A_2
48. **Munditia australis** (Kiener). Fremantle-Victoria ... A_2
49. **Notoacmea onychitis** (Menke). Yanchep-Albany ... A_2
50. **Patelloida alticostata** (Angas). Geraldton-sthn. Aust.-sthn. Qld. ... A_2
51. **P. nigrosulcata** (Reeve). Geraldton-Victoria ... A_2
52. **Patellanax peroni** (Blainville). Fremantle-Victoria ... A_2
53. **Melaraphe unifasciata** (Gray). Shark Bay-sthn. Aust.-sthn. Qld. ... A_2
54. **Tectarius rugosus** Menke. Pt. Peron-north-west Australia ... A_1
55. **Notosetia nitens** (Frauenfeld). Shark Bay-sthn. Aust.-Victoria ... A_2*
56. **Sabia conica** Schumacher. Geraldton-Tasmania ... A_2
57. **Antisabia** sp. Fremantle and Geraldton ... A_3
58. **Cacozeliana granarium** (Kiener). Geraldton-Sth. Australia ... A_2
59. **C. icarus** (Boyle). Cockburn Sound ... A_3
60. **Eubittium lawleyanum** (Crosse). Albany-Victoria ... C
61. **Vertagus asper** (Lamarck). North-west Aust.-Cape Naturaliste ... A_1
62. **Granuliscala granosa** (Quoy & Gaimard). Cockburn Sound-Victoria A_2
63. **Notocochlis marochiensis** (Gmelin). Fremantle-Albany ... A_2
64. **Polinices conicus** (Lamarck). Shark Bay-Albany-Victoria-sthn. Qld. A_2
65. **Bedeva paivae** (Crosse). Cockburn Sound-Victoria ... A_2
66. **Euplica bidentata** Menke. N.W. Australia-Pallinup R. (east of Albany) ... A_1
67. **Fusus australis** (Quoy & Gaimard). Fremantle-Victoria ... A_2
68. **Oliva australis** Duclos. Geraldton-Victoria ... A_2
69. **O. ornata** Marrat. North-west Australia-Geraldton ... B
70. **Dyraspis dorreensis** (Peron). Shark Bay-Pallinup River (east of Albany) ... A_3

Thus, of the above 70 species, 62 live today in the vicinity of Fremantle (Group A). Of these, 44 show affinity with the fauna of southern Australia (A_2); ten with that of north-west Australia (A_1), and eight are of uncertain affinity (A_3). Six species are not now found living north of Cape Leeuwin (Group C). Only two species appear today to be restricted to warmer waters north of Geraldton (Group B).

ECOLOGY

Animals from the following three habitats are present in this assemblage: 1. Open rocky shore or reef flat, characterised by *Haliotis, Patellanax, Senectus, Dicathais,* etc. 2. Sandy beach with moderate exposure, characterised by *Gomphina, Glycymeris, Deltachion, Mactra,* etc. 3. Sheltered shallow marine gulf, a sandy to muddy bed, probably with sea grass, characterised by *Redicirce, Katelysia, Eumarcia, Anadara, Polinices.*

An examination of the species and their habitats reveals the following fact. Those from the first two—open reef and open beach—correspond closely with present day living species along the lower west coast. However, species from the sheltered gulf habitat include almost all of those which have not been collected alive in this region. These are *Katelysia* spp., *Eumarcia* (both conspicuous and

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** See note at foot of p. 61.

dominant elements), *Anadara*, *Mesodesma* and *Eubittium*. Their present living occurrences on the south and south-east coasts of the continent, do not indicate warmer sea temperatures at the time of deposition.

The two species of Group B—*Macoma dispar* and *Oliva ornata*—are of slight occurrence and are considered of little significance in the balance of affinity.

TABLE 2.—MINIM COVE—LOWER SAMPLE

58 species were observed, of which 32 were identified sufficiently for comparison with living material. Of the recognised species, 13 contributed 1% or over of all individuals, and these are as follows:—

Species	Number present	Approx. per cent	Living occurrence	Key (as above)
1. Notosetia nitens (Frauenfeld)	1861	31	Shark Bay-sthn. Aust.-Vic.	A_2*
2. Fragum erugatum (Tate)	964	18	Shark Bay-Geraldton-Rottnest-Sth. Aust. (rare)	A_3
3. Katelysia rhytiphora Lamy	495	9	Albany-Victoria-Tasmania	C
4. Diala lauta A. Adams	437	8	Cockburn Snd.-Tas.-Vic.	A_2
5. Eumarcia fumigata (Sowerby)	416	8	Sth. Aust.-Tas.-Vic.-N.S.W.	C
6. Diala lirulata Thiele	269	5	Shark Bay	B
7. Katelysia scalarina (Lamarck)	127	2	Albany-Victoria	C
8. Wallucina assimilis (Angas)	123	2	Geraldton-Victoria	A_2
9. Haminoea brevis (Quoy & Gaimard)	114	2	Cockburn Snd.-Vic.-Tas.	A_2
10. Diala translucida Hedley	112	2	Cockburn Snd.-Vic.-Tas.	A_2
11. Electroma cf. georgiana (Quoy & Gaimard)	110	2	Cockburn Sd.-C. Naturaliste	A_2
12. Elachorbis tatei (Angas)	72	1	South Australia	C
13. Redicirce plebeia (Hanley)	55	1	N.W. Aust.-Cockburn Sound	A_1
Other species (all under 1%), in order of frequency, are:—				
14. Macoma dispar Conrad	43		Northern Australia	B
15. Retusa apicina (Gould)	29		Cockburn Snd.-Vic.-Tasmania	A_2
16. Venerupis cf. iris (Linne)	16		Cockburn Sound-Yanchep-Geraldton	A_3
17. Angulus perna Spengler	7		N.W. Aust.-Cockburn Sound	A_1
18. Cacozeliana icarus (Boyle)	6		Cockburn Sound	A_3
19. Zeacumantus cerithium (Quoy & Gaimard)	5		Vic.-Sth. Aust.-Tasmania	C
20. Cavatidens perplexa Cotton and Godfrey	4		Geraldton-Victoria	A_2
21. Laternula creccina (Reeve)	3		Cockburn Snd.-Vic.-N.S.W.	A_2
22. Bullaria botanica Hedley	1		Geraldton-Victoria-N.S.W.	A_2
23. Anadara trapezia (Deshayes)	1		Vic.-sthn. Qld.-also Albany	C
24. Notocochlis marochiensis (Gmelin)	1		Cockburn Sound-Albany	A_2
25. Thracia alciope Angas	1		North-west Australia	B
26. Calliostoma interruptum Wood	1		Geraldton-Albany	A_2
27. Akera soluta (Gmelin)	1		Cockburn Sound-Victoria	A_2
28. Mesodesma nitida Deshayes	1		South Australia	C
29. Hormomya ? sp. nov.	1		Cockburn Sound-Geraldton	A_3
30. Senectus pulcher Reeve (operculum)	1		N. Aust.-Abrolhos-Hopetoun	A_1
31. Ethmonilia vitiliginea Menke	1		Cockburn Sound-Albany	A_2
32. Spirula spirula Linne	1		World-wide range	A_3

26 indeterminate species totalling 226 specimens.

Grand total of 5,505 specimens of 58 species.

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* See note at foot of p. 61.

The species identified sufficiently for comparison with living material total 32. These 32 species comprise 96% of all specimens, and are therefore an adequate basis for estimating the zoogeographical significance of the fauna.

Group A contains 22 species, and 3,849 specimens, aggregating 70% of all specimens.

A_1 contains 3 species and 63 specimens (1% of all specimens).

A_2 contains 14 species and 2,798 specimens (51% of all specimens).

A_3 contains 5 species and 988 specimens (18% of all specimens).

Group B contains 3 species, and 313 specimens (6% of all specimens).

Group C contains 7 species, and 1,117 specimens (20% of all specimens).

Thus, approximately 70% of all individual specimens in the sample are found living at present along the lower west coast of Western Australia, near Fremantle. A further 20% are found east, but not north, of Cape Leeuwin. Only 6% at present show exclusive affinity with the fauna of north-west Australia. Warmer sea temperatures are not indicated, in the author's view, by the composition of this fauna. Shallow marine-gulf conditions prevailed at the time of deposition. *Spirula* and *Senectus* suggest that the site was not completely free from contact with the open sea.

TABLE 3—MINIM COVE—UPPER SAMPLE

36 species were observed, of which 20 were identified sufficiently for comparison with living material. Of the 20 recognised species, 12 contributed 1% or over of all individuals, and these are as follows:—

Species	Number present	Approx. per cent	Living occurrence	Key (as above)
1. Notosetia nitens (Frauenfeld)	315	41	Shark Bay-sthn. Aust.-Vic.	A_2*
2. Eumarcia fumigata (Sowerby)	139	18	Sthn. Aust.-Tas.-Vic.-N.S.W.	C
3. Diala lauta A. Adams	96	13	Cockburn Snd.-Tas.-Victoria	A_2
4. D. lirulata Thiele	31	4	Shark Bay	B
5. Fragum erugatum (Tate)	28	4	Shark Bay - Geraldton-Rottnest-Sth. Aust. (rare)	A_3
6. Wallucina assimilis (Angas)	24	3	Geraldton-Victoria	A_2
7. Diala translucida Hedley	23	3	Cockburn Sound-Vic.-Tas.	A_2
8. Haminoea brevis (Quoy & Gaimard)	19	2.5	Cockburn Sound-Vic.-Tas.	A_2
9. Redicirce plebeia (Hanley)	12	2	Cockburn Snd.-N.W. Aust.	A_1
10. Retusa apicina (Gould)	8	1	Cockburn Sound-Vic.-Tas.	A_2
11. Katelysia scalarina (Lamarck)	8	1	Albany-Victoria	C
12. Zeacumantus cerithium (Quoy & Gaimard)	8	1	Sth. Aust.-Vic.-Tas.	C
Other species (all under 1%), in order of frequency, are:—				
13. Katelysia rhytiphora Lamy	3		Albany-Victoria-Tasmania	C
14. Electroma cf. georgiana (Quoy & Gaimard)	3		Cockburn Snd.-C. Naturaliste	A_2
15. Flavomala biradiata (Wood)	2		Cockburn Snd.-Vic.-Tas.	A_2
16. Antisabia erma Cotton	2		C. Naturaliste-Geraldton	A_2
17. Hormomya ? sp. nov.	1		Cockburn Sound-Geraldton	A_3

* See note at foot of p. 61.

18. **Homalina deltoidalis** (Lamarck)	1	Cockburn Sound-Victoria	A_2
19. **Venerupis** cf. **iris** (Linne)	3	Cockburn Sound-Yanchep-Geraldton	A_3
20. **Bullaria botanica** Hedley	1	Geraldton-Victoria-N.S.W.	A_2

16 indeterminate specimens totalling 32 specimens.

Grand total of 757 specimens of 36 species.

The species identified sufficiently for comparison with living material total 20. These 20 species comprise approximately 95% of all specimens, and are therefore an adequate basis for estimating the zoogeographical significance of the fauna.

Group A contains 15 species, and 536 specimens (71% approx. of all specimens).

A_1 contains 1 species, and 12 specimens (2% of all specimens).

A_2 contains 11 species, and 494 specimens (65% of all specimens).

A_3 contains 3 species, and 30 specimens (4% of all specimens).

Group B contains 1 species and 31 specimens (4% of all specimens).

Group C contains 4 species and 158 specimens (20% of all specimens).

Approximately 70% of the fauna is known to be living today along the lower west coast (Group A). A further 20% of specimens is today found living east, but not north, of Cape Leeuwin (Group C). There is a small element (Group B) of from 4-6%, not known to live at present south of Geraldton.

The fossil fauna indicates the presence of a shallow marine gulf with a sandy to muddy bed. Present-day distributions of the component species do not support the estimate of warmer sea temperatures at the time of deposition.

Four species from the Minim Cove samples (*Homalina, Flavomala, Bullaria* and *Akera*) are living today in the Swan River estuary. However, all four also occur in marine conditions in Cockburn Sound.

The two levels sampled at Minim Cove are shown by this analysis to be of the same essential character and composition, and need not further be compared for the purposes of this work.

TABLE 4.—PEPPERMINT GROVE

One sample was examined. 36 species were observed, of which 22 were identified sufficiently for comparison with living material. Of the recognised species, 12 contributed 1% or over, of all individuals, and these are as follows:—

Species	Number present	Approx. per cent	Living occurrence	Key (as above)
1. **Diala lauta** A. Adams	243	30	Cockburn Sound-Tas.-Vic.	A_2
2. **Elachorbis tatei** (Angas)	190	23	South Australia	C
3. **Zeacumantus cerithium** (Quoy & Gaimard)	86	11	Victoria-Sth. Aust.-Tasmania	C
4. **Eumarcia fumigata** (Sowerby)	46	6	Sth. Aust.-Tas.-Vic.-N.S.W.	C
5. **Redicirce plebeia** (Hanley)	39	5	N.W. Aust.-Cockburn Snd.	A_1

6.	**Cacozeliana granarium** (Kiener)	35	4	Geraldton-Sth. Australia	A_2
7.	**Wallucina assimilis** (Angas)	25	3	Geraldton-Victoria	A_2
8.	**Calliostoma interruptum** Wood	22	3	Geraldton-Albany	A_2
9.	**Notosetia nitens** (Frauenfeld)	20	2	Shark Bay-S. Aust.-Victoria	A_2*
10.	**Diala lirulata** Thiele	20	2	Shark Bay	B
11.	**D. translucida** Hedley	15	2	Cockburn Snd.-Victoria-Tas.	A_2
12.	**Parcanassa pauperata** (Lamarck)	15	2	Fremantle-Victoria-Tas.	A_2

Other species (all under 1%), in order of frequency, are:—

13.	**Cacozeliana icarus** (Boyle)	7	Cockburn Sound	A_3
14.	**Cavatidens perplexa** Cotton & Godfrey	4	Geraldton-Victoria	A_2
15.	**Flavomala biradiata** (Wood)	3	Cockburn Sound-Vic.-Tas.	A_2
16.	**Haminoea brevis** (Quoy & Gaimard)	3	Cockburn Sound-Vic.-Tas.	A_2
17.	**Katelysia scalarina** (Lamarck)	2	Albany-Victoria	C
18.	**Anadara trapezia** (Deshayes)	1	Vic.-sthn. Qld.-Albany, W.A.	C
19.	**Hormomya** ? sp. nov.	1	Cockburn Sound-Geraldton	A_2
20.	**Antisabia erma** Cotton	1	Cape Naturaliste-Geraldton	A_2
21.	**Fragum erugatum** (Tate)	1	Shark Bay - Geraldton-Rottnest-Sth. Aust. (rare)	A_3
22.	**Cadulus occiduus** Verco	1	Cockburn Sound	A_3

14 indeterminate species, totalling 37 specimens.

Grand total of 817 specimens of 36 species.

There are 22 species identified sufficiently for comparison with living material. These amount to over 95% of all specimens, and are therefore an adequate basis for estimating the zoogeographical significance of the fauna.

Group A contains 16 species and 435 specimens (54% of all specimens).

A_1 contains 1 species and 39 specimens (5% of all specimens).

A_2 contains 11 species and 386 specimens (48% of all specimens).

A_3 contains 4 species and 10 specimens (1% of all specimens).

Group B contains 1 species and 20 specimens (2% of all specimens).

Group C contains 5 species and 325 specimens (39% of all specimens).

Approximately 54% of this fauna lives at the present day along the lower west coast of Western Australia adjacent to Fremantle. A further 39% is now found living east, but not north, of Cape Leeuwin. A mere 2% of specimens has not been collected living south of Geraldton.

Compared with the Minim Cove fauna, the Peppermint Grove assemblage suggests stronger affinities with the southern Australian region, and slightly weaker affinities with the north-west region.

Once again, shallow marine gulf conditions are indicated. The fauna does not suggest warmer sea temperatures at time of deposition.

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* *Notosetia* has not actually been observed by the author living in the Fremantle region; its presence may be reasonably presumed from other definite records which are referred to.

DISCUSSION

1. Along the western coast of Western Australia between Shark Bay and Cape Leeuwin, the mollusca of the Dampierian (north-west) and Flindersian-Peronian (south-west to south-east) Provinces overlap and intermingle.

2. In addition there appears to be a small, though noticeable group of mollusc species of seeming "western" affinity which do not, on the basis of present knowledge, conform strictly to either of the other major groupings.

3. As could be expected, therefore, a similar mixed composition of the fossil assemblages has been observed—roughly comparable to the present living suites.

4. Ecological gradients between Shark Bay and Cape Leeuwin tend to be gradual and widely spaced. Thus the Late-Pleistocene fossil records from near Fremantle (160 miles from Cape Leeuwin, and 400 miles from Shark Bay) are particularly well placed to judge such changes in species distributions as have occurred.

5. *The Dampierian Element* in the fossil assemblages is referred to in the Key as "A_1" (those which extend southwards to at least as far as Cockburn Sound) and "B" (those not known to occur alive south of Geraldton). The Dampierian species are summarised as follows:—

Site	No. of spp. in Group A_1	No. of spp. in Group B	Total spp. A_1 + B	Total no. of identified spp.— all groups
East Fremantle	10	2	12	70
Minim Cove				
upper	1	1	2	20
lower	3	3	6	32
Peppermint Grove	1	1	2	22

Some prominent representatives of this element are: *Redicirce plebeia, Angulus perna, Macoma dispar, Diala lirulata, Septifer bilocularis, Gabinarca symetrica, Senectus pulcher* and *Vertagus asper.*

6. *The Flindersian-Peronian Element* in the fossil assemblages is clearly the dominant one, and is referred to in the Key as "A_2" (those species living today near Fremantle) and as "C" (those not known to occur north of Cape Leeuwin. They are summarised as follows:—

Site	No. of spp. in Group A_2	No. of spp. in Group C	Total spp. A_2 + C	Total no. of identified spp.— all groups
East Fremantle	44	6	50	70
Minim Cove				
upper	11	4	15	20
lower	14	7	21	32
Peppermint Grove	11	5	16	22

Some prominent representatives of this element are: *Katelysia* spp.,† *Patellanax* spp., *Eumarcia fumigata,*† *Haliotis roei, Dicath-*

† These, with *Elachorbis tatei,* are not now found north of C. Leeuwin.

ais aegrota, Barbatia pistachya, Wallucina assimilis, Flavomala biradiata, Deltachion spp., *Patelloida altieostata, Notosetia nitens, Polinices conicus, Diala lauta, D. translucida, Elachorbis tatei* and *Haminoea brevis*.

Worthy of note is the wide distribution of some members of this group. For example, *Notosetia*—Shark Bay to Victoria; *Polinices*—southern Queensland via the southern coast to Shark Bay. B. Wilson has collected specimens from Port Samson which appear indistinguishable from this species.

7. Some miscellaneous species in the fossil assemblages of seeming western affinity are referred to in the Key as A_3. In some cases this is due to lack of sufficient knowledge of their full range. However, others may prove to be valid exceptions from either of the two major provincial affinities.

Fragum erugatum: A single record exists from Port Samson. The species is strongly developed, with much variation, at Hamelin Pool, Shark Bay (from where it has been known as *hamelini* Iredale). It occurs sparsely in south-western W.A. (Geraldton, Rottnest). It also occurs in South Australia where it is not common.

Venerupis cf. iris: This Linnean species was described from the Mediterranean. The W.A. shell, while approaching the other, is reported to be smaller. Very occasionally specimens have been collected from beaches of Cockburn Sound, Yanchep and the Geraldton district.

Dyraspis dorreensis: This has been collected living from numerous localities between Shark Bay and the Pallinup River, to the east of Albany.

Hormomya ? sp. nov. This is a species of common living occurrence between Cockburn Sound, Geraldton and the Abrolhos. The limits of its range are not yet known with certainty. The species is morphologically distinct from *Brachidontes rostratus* Dunker and *H. erosus* Lamarck. Hitherto it appears to have been referred to under the former of these names.

Of interest also is the wide range of the Dampierian species *Euplica bidentata* and *Senectus pulcher,* which have been collected living east of Cape Leeuwin as far as the Pallinup River and Hopetoun, respectively (advice from B. Wilson).

8. The living and fossil faunas may be directly compared as follows:

The reef and open beach forms in the East Fremantle deposit compare very closely with contemporary forms from such habitats.

The sheltered gulf forms from all three fossil deposits differ principally from the local Fremantle fauna in the presence of a conspicuous southern element, not now known to occur north of Cape Leeuwin. There is also a smaller group of Indo-Pacific forms, not known to occur south of Geraldton. Notwithstanding the above, the largest part of the fossil suite has direct affinity with waters adjacent to Fremantle at the present day.

9. **Ecology.** The fossil suites (East Fremantle partly excepted) are composed of species found living under sheltered marine condi-

tions mainly along the western, southern and south-eastern coasts of the continent. At present, however, there is no habitat in the region directly comparable with the Late-Pleistocene Perth Gulf presumed to have existed from this work. Consequently one cannot expect a close correlation between the fossil assemblages and the local living ones. For this reason it has been necessary to examine the faunas of sheltered water habitats both to the north and south of the Swan River.

It is significant that many elements of the fossil Gulf fauna are today found living in nearby Cockburn Sound.

Since the time of deposition, a succession of events has led to the virtual disappearance of the marine gulf and its specialised fauna. Eustatic fluctuation has at times converted the gulf to dry land and extended the coastline to the west of present-day Rottnest. Marine gulf conditions were finally re-established during the Recent eustatic "high," only to be abruptly terminated by the onset of heavy regular winter flooding in the Swan River system.

The present living distributions of the gulf species which have been listed would, if taken together, range over most, if not all, of the Australian coastline (wherever the habitat is suitable). From this alone, however, one would be reluctant to concede that they share the ability to constitute one community. Yet relatively recently this was the case. The presence of many of the fossil species in the Perth Gulf was apparently marginal in relation to their range, thus leading earlier workers to concentrate attention on possible water temperature changes in their environment.

Closer study of the biology and ecology of the species concerned would no doubt reveal the common tolerances and aptitudes which they possess.

10. The present living mollusca of the lower Swan River estuary (below Perth) have little in common with the fossil groupings. Some common species are:

Monia ione Gray
Mytilus planulatus Lamarck
Modiolus pulex Lamarck
Kellia australis Lamarck
Venerupis crenata Lamarck
Homalina deltoidalis (Lamarck)
Flavomala biradiata (Wood)
Hiatella australis (Lamarck)
Velacumantus australis (Quoy & Gaimard)
Bembicium melanostoma (Gmelin)
Diala pulchra A. Adams
Bedeva paivae (Crosse)
Marinula patula Lowe
Bullaria botanica Hedley
Akera soluta (Gmelin)

Save *Velacumantus,* all the above have been observed locally in marine conditions. Heavy winter flooding now prevents the establishment of wholly marine forms in the Swan River estuary, as pointed out by Serventy (1955, p. 29), who has also drawn attention to the confusing citation by Hedley (1916) of the term "Swan River" as a locality reference. Hedley gives 123 species as occurring in the Swan River. Actually this refers to the Swan River Colony, as understood in the last century, and not to the Swan River proper.

INTERPRETATION

1. Shell deposits exposed in cliffs along the lower Swan River indicate the presence in Late-Pleistocene times of a marine gulf on the site of the present estuary. This occupied the low-lying area east of a sheltering peninsula now represented by the hills between North Fremantle and Claremont. The gulf opened to the sea through reefs and sandbanks between Fremantle and Leighton, the entrance being probably wider than the present estuary channel.

2. The sheltered and exposed shores of this peninsula each supported a characteristic mollusc fauna. Shells from three habitats (open reef, open beach, and sheltered gulf) were deposited after death by water movement to form the East Fremantle deposit. Reef and beach forms from this site closely correspond with present-day species in the region.

3. Within the gulf a specialised mollusc fauna was developed chiefly from the appropriate and more adaptable elements of both the southern and northern faunas. This fauna was essentially marine in character, not estuarine.

4. Since deposition the character of the gulf and its fauna have changed profoundly due to eustatic fluctuations and the advent of estuarine winter flooding. A proportion of the fauna, being some species of marginal occurrence, has not subsequently been able to maintain itself in the region. Most of such "absent" forms, being elements of the Flindersian-Peronian faunas, are now found in southern waters east of Cape Leeuwin. A lesser number, representative of the Dampierian fauna, are today living north of Geraldton. Further collecting may yet reveal the presence of some of these "absent" species (especially northern ones) still living in the vicinity of Fremantle.

Further information on the biology and ecology of the dominant forms is required.

5. The comparison which has been made of the fossil species and their present living distributions does not endorse previous estimates of a lowering of sea temperatures in south-western Australia since Late-Pleistocene times. Environmental changes are suggested as a significant factor in producing changes in mollusc distributions.

NOTES ON NOMENCLATURE

1. *Wallucina assimilis* (Angas, 1861) = *W. jacksoniensis* Smith, 1885. For discussion see Ludbrook, *Trans. Roy. Soc. S. Aust.*, 78, 1955: 51.

2. *Senectus pulcher* Reeve, 1843 = *Turbo intercostalis* Menke, 1846.

3. *Katelysia rhytiphora* Lamy, 1937 = *Venus strigosa* auct. and *Venus corrugata* auct., non Lamarck, 1818.

4. *Hormomya* ? sp. nov. Appears to have been considered previously as a western form of *Brachidontes rostratus* Dunker, 1856.

5. *Fragum erugatum* (Tate, 1888) = *Fragum hamelini* Iredale, 1949.

6. *Zeaeumantus cerithium* (Quoy & Gaimard, 1834) = *Z. diemenensis*, 1834 of the same authors.

7. *Dyraspis dorreensis* (Peron, 1807) = *Conus pontificalis* Lamarck, 1810.

8. *Notocochlis marochiensis* (Gmelin, 1801) = *N. gualteriana* Recluz, 1844.

9. *Amblychilepas* takes precedence over the synonym *Sophismelepas*.

LOCATION OF SPECIMENS

All recent material referred to in this work has been placed in the mollusc collection of the W.A. Naturalists' Club, at the Western Australian Museum, Perth. Fossil material has been retained temporarily by the author but will be donated to the Museum after further identification has been completed.

ACKNOWLEDGMENTS

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HERPETOLOGICAL MISCELLANEA

By L. GLAUERT, Western Australian Museum, Perth.

XII.—THE FAMILY SCINCIDAE IN WESTERN AUSTRALIA

PART I—THE GENERA *TILIQUA, TRACHYSAURUS* AND *EGERNIA*

FAMILY: SCINCIDAE

Skink Lizards

The skinks are perhaps the most familiar members of our lizard fauna because so many of the species are active in the day-time. With one or two exceptions their surface is smooth and shining even if keels are present on the scales. The best known exception is the Bob-tail, *Trachysaurus rugosus,* so often misnamed "Bob-tailed Goanna."

The limbs may be well developed and functional, reduced to mere bulbs, or even entirely absent externally. The tail is fragile and may be replaced but the replacement usually does not resemble the stump in markings and coloration.

In numbers of species and individuals skinks exceed all other kinds of Australian lizards.

The heads of skinks are covered with plates, not scales, which are important in the identification of genera and species. At the front of the head is the *rostral* behind which are two *nasals* containing the nostrils. These may be divided horizontally to form *supranasals.* These in turn are followed by the *frontonasal,* a large shield usually broader than long, which may be in contact with the rostral or separated from it by the nasals. It may be in contact also with the *frontal* if the *prefrontals* do not intervene. Over the eyes are usually four *supraoculars,* between which and the orbit is a narrow band of *supraciliaries.* The frontal is always longer than wide, is in contact with two or three supraoculars and followed by the *frontoparietals, parietals* and *interparietal.* In *Egernia* and *Tiliqua* this shield separates the parietals; in *Lygosoma* and *Ablepharus* it does not do so and they meet behind it. They may be followed by one or more transversely enlarged shields, the *nuchals.* The shields of the upper lip are known as *upper labials,* those of the lower lip are *lower labials.* Several shields behind the eyes are known as *temporals.*

The Western Australian genera may be distinguished by the following key.

A. Parietals in contact behind the interparietal.
- a. Lower eyelid moveable .... *Lygosoma*
- aa. Lower eyelid fixed disk .... *Ablepharus*

B. Parietals separated by the interparietal.
- b. Tail short, stumpy .... *Trachysaurus*
- bb. Tail normal, pointed.
  - c. Lateral teeth pointed crowns .... *Egernia*
  - cc. Lateral teeth with spheroidal crowns .... *Tiliqua*

GENUS *TILIQUA*

The lizards of this genus have the parietals separated by the interparietal. The nostril is in a single nasal and has a groove behind or below. There is a complete series of shields between the orbit and the upper labials. The frontoparietals and the interparietals are distinct. The lateral teeth have spheroidal or conical crowns. The limbs are short but functional, and have 5 digits with undivided transverse lamellae below. The genus differs from *Lygosoma* and *Ablepharus* in having the parietals separated by the interparietal.

KEY TO THE SPECIES

Tail longer than the head and body; coloration more or less variegated ... *luctuosa*

Tail shorter than the head and body; coloration not variegated.

(a) 5 or 6 prominent dark crossbands ... *o. occipitalis*

(b) 12 or 15 irregular crosshands ... *o. multifasciata*

(c) Crossbands limited to the sides, faint or absent dorsally ... *scincoides intermedia*

(d) No crossbands, back and sides with small dark spots.

- (a) 3 or 4 dark patches on the side of the neck ... *branchialis*
- (b) Patches absent, face and lips darker ... *melanops*
- (c) Under surface spotted, a much attenuated form ... *gastrostigma*

Tiliqua scincoides intermedia Mitchell
Northern Blue Tongue

This, the largest species of the genus and which may measure 23 in. in length, can easily be separated by the presence of 2 enlarged anterior temporal scales, the frontonasal in contact with the rostral and the prefrontals forming a median suture. These characters make identification easy when a comparison is made with the other larger species, *occipitalis*. Scales smooth, the laterals smallest. Fore limb as long as the distance from the tip of the snout to the ear opening, 3 to 4 times in the distance from the axilla to the groin. Hind limb rather longer. Tail shorter than the head and body, cylindrical, tapering to a point.

The largest specimen in the W.A. Museum collection measures 435 mm., head and body 275, tail 160, fore limb 53, hind limb 53.

The colour of the individuals from the Kimberley District differs considerably from the normal form of south-eastern Australia.

The head is covered with a fine buffy reticulation over russet brown, sharply separated at the back of the head from the paler body where each scale bears one or more ferruginous streaks. On the nape, where the scales are transverse, 3 or sometimes 5 longitudinal ferruginous streaks result. On the body where the scales are oblique no distinct pattern is developed beyond the more or less indistinct series of about 7 transverse bands, which are most pronounced laterally. The under surface is immaculate pale yellowish. The markings on the tail and limbs resemble those on the back. There are no indications of dark marks on the side of the neck.

As far as is known the species is represented in the far north only.

Tiliqua occipitalis (Peters)
Western Blue Tongue Lizard

This larger member of the genus, which may attain a length of 18 in., is the most strongly marked species owing to the sharp contrast between the pale brown body colour and the bone brown cross bands on the body and tail. There are 38 to 42 rows of scales round the middle of the body, all smooth and shining. Behind the parietals there are 3 or 4 series of enlarged scales, some of them much longer than wide, to which the lizard probably owes its specific name. The scales on the nape by contrast are much reduced in size and markedly wider than long. In due course these are succeeded by larger transverse scales slightly obliquely placed and increasing in size somewhat towards and on the tail. The limbs are short, not meeting when adpressed; the fore limb is as long as the head and about 3 times in the distance between the axilla and the groin. The tail is short, tapering and pointed, much shorter than the head and body, with four dark cross bands and a dark tip. A dark stripe along the side of the head, from the eye to over the ear, is very pronounced on all specimens examined.

The distribution is very wide, from Geraldton southwards and to the South Australian border.

Tiliqua occipitalis multifasciata Sternfeld
Desert Western Blue Tongue Lizard

This subspecies, described by Sternfeld in 1919, is the *Tiliqua occipitalis nossiteri* of Glauert, 1923, and the *Tiliqua occipitalis auriculare* of Kinghorn, 1931. It differs from the southern form in possessing a much larger ear opening with five lobules, and in colour markings.

The coloration is very distinctive, there being from 12 to 15 cross bands on the body and from 10 to 12 on the tail. This is probably due to the subdivision of the broader bands on the southern form, a tendency towards which is now and again indicated on specimens otherwise normal.

This subspecies is known from Central Australia (Hermannsburg), the Northern Territory and northern Western Australia. In this State it has been collected in East and West Kimberley, Wallal and Mardie Station near the Fortescue River.

A specimen from Hermannsburg measured: head and body, 230 mm.; tail, 94; and total length, 324. One from Wallal was 310 mm. overall.

Tiliqua luctuosa (Peters)
Mourning Skink

This small species, the largest specimen recorded measures 13½ inches, differs from all other Western Australian Tiliquas in its bright coloration and from the Egernias, which it closely resembles in appearance, by its typical tiliquan dentition. The scales are smooth and number from 24 to 26 round the middle of the body. The adpressed limbs meet or slightly overlap and the fore limb is as long as the distance from the tip of the snout to the centre of the ear, and from 2⅜ to 2½ times in the distance between the axilla and the groin. The tail is round, tapering and longer than the head and body.

The colouring is variable and varied. Dark blotches or pale markings may form a vertebral band outside which is a contrasting area. This is followed by a lateral band which, if black, carries numerous small white spots, and if pale has an abundance of dark markings. The under surface is immaculate. An Albany specimen measures 285 mm. (11¼ in.), head and body, 100; tail, 185.

The distribution seems to be the South-West. In the Museum are two specimens from the Perth area, the others coming from the extreme south.

Tiliqua branchialis (Gnthr.)
Gunther's Skink

This small short-limbed species is very attenuated, the distance from the tip of the snout to the fore limb being contained from 2 to to 2½ in the distance from the axilla to the groin. Snout short, lower eyelid scaly, 5th upper labial under the centre of the eye, 6th largest. Ear opening small with a single lobule. Three pairs of enlarged nuchals. Scales round the body smooth, the two vertebral series the largest, and the laterals smallest. Limbs short, the fore limb shorter than the head and nearly 5 times in the distance between the axilla and the groin; hind limbs slightly longer. Tail shorter than the head and body.

The colour varies. Specimens from Newmarracarra near Geraldton are pale brown above with a black spot or short stripe on each scale and series of black spots forming lines from the side of the head to the chin and throat, together with 3 large black spots on each side of the neck.

The species is known from Geraldton on the west coast.

Tiliqua gastrostigma (Blngr.)

Body much elongate, the distance between the tip of the snout and the fore limb from 2½ to 3 times in the distance between the fore limb and the hind limb. The younger and smaller individuals are shorter. Snout short; lower eyelid scaly; nostril in a single nasal with a groove behind. Rostral separated from the frontonasal, which is broader than long and forms a suture with the frontal. Frontal about twice as long as wide, as long as its distance from the tip of the snout, in contact with 2 of the 4 suboculars of which the second is the largest. Interparietal about twice as long as the frontoparietals; 2 or 3 pairs of nuchals. Ear opening about as large as the eye with a small white lobule, 5th or 5th and 6th upper labials under the eye. There are 26 smooth scales round the middle of the body, median pair of dorsals the largest, laterals the smallest; no enlarged preanals, gulars and ventrals smooth, the median pair under the tail enlarged. Limbs short, when adpressed they do not meet; 3rd and 4th toes equal. Largest specimen recorded 9¾ in. (245 mm.). Uniform olive brown above, scales often with a pale edge or black dot. Below almost white, nearly every scale with a black dot, which may be faint.

It occurs in the Pilbara District.

Tiliqua melanops (Stirling & Zietz)

A small short-limbed species with the distance between the snout and the fore limb about 2½ times in the distance between the fore limb and the hind limb. Snout short, lower eyelid scaly, 5th upper labial under the eye; nasals forming a suture behind the rostral, a groove behind the nostril; frontonasal forming a suture with the frontal which is longer than its distance from the tip of the snout and in contact with 2 of the 4 supraoculars, 6 supraciliaries; interparietal about twice as long as the frontoparietals and separating the parietals. Ear opening about as large as the eye with a small white lobule which may be minute or absent. There are 26 smooth scales round the middle of the body, 2 or 3 enlarged nuchals; no enlarged preanals. Limbs short, when adpressed they do not meet, 3rd and 4th toes equal. Tail about as long as the head and body, as in the dorsals the two vertebral series are enlarged, also the median pair below. Grows to about 6 in. Olive brown above, many of the scales with a black dot; in young specimens these may be absent, face and lips darker.

Occurs near Perth and eastwards to the goldfields and South Australia. *T. branchialis*, *T melanops* and *T. gastrostigma* are structurally almost identical so that they may be geographical races of the first-named and not separate species.

Trachysaurus rugosus Gray
Stumpy Tail or Shingle Back

This quaint lizard, the only species of the genus, is closely related to the blue tongues, *Tiliqua,* having the same kind of enlarged spherical teeth laterally but differing so markedly from members of that genus that it is given a generic name of its own.

The head is short and thick with a pointed snout, the body somewhat elongated thick and depressed, the limbs short but still functional and the tail short and flattened. The head, back and upper surface of the tail are covered with thick convex rugose shields and scales which become thicker with age. On the head many supplementary shields have been developed but it is possible to recognise those of diagnostic importance. The frontonasal is larger than the frontal. In all specimens examined with one exception the parietals are separated by the interparietal behind which the scales gradually increase to the back of the head. On the body the obliquely-arranged scales are largest on the vertebral area, gradually decreasing in size laterally until they merge into the smooth transverse scales of the ventral surface. The limbs and the under surface of the tail are also smooth.

The coloration is very variable. It may be darker or lighter brown with paler spots or irregular cross bands or dark brown with peppering or light spottings of pale yellow or even whitish.

The under surface may be pale with dark lines between the transverse scales, have yellowish brown blotches or even more or less developed irregular cross bands as shown by individuals from Bernier Island and by some mainland specimens.

The lizard is very widely distributed in this state south of the tropics. The Museum has specimens from Bernier Island and it is known from Dirk Hartog. At the Abrolhos Is. the normal coloration prevails, but on Rottnest I. the dark pigmentation is intense, with fine white peppering on the upper surface together with black longitudinal streaks laterally and below; the limbs also are marked in black and white. Specimens throughout the Wheat Belt and South-West appear to be normal in coloration.

GENUS *EGERNIA*

This genus includes some of the largest skinks known to occur in Australia. They are heavily built and usually have the tail as long as or longer than the head and body, except in the two spiny-tailed species in which they are markedly shorter.

Most of them have the scales smooth which in some of the species bear more or less well developed keels on the upper surface of the body, tail and limbs. On the head the parietals are separated by the interparietals as in *Tiliqua*.

KEY TO THE SPECIES

I. Tail subcylindrical almost as long or longer than the head and body.
- a. Dorsal scales smooth or striated.
  - b. No groove behind the nostril, eyelids and ear lobules white .... *whitii*
  - bb. Groove behind the nostril, eyelids and lobules not white.
    - c. Complete series of infraoculars.
      - d. Size large (up to 15 in.) .... *kintorei*
      - dd. Size small (up to 9 in.) .... *inornata*
    - cc. Series of infraoculars not complete .... *formosa*
- aa. Dorsal scales keeled.
  - e. Keels weak, markings bright .... *napoleonis*
  - ee. Keels strongly developed, markings not outstanding.
    - f. Size large, 7th and 8th upper labials enter the eye, markings pale linear or dark and light speckled .... *kingii*
    - ff. Size small, 6th and 7th upper labials enter the eye, markings dark, varied, lips white .... *carinata*

II. Tail flattened, short, very spinose, Caudal scales above with one spine .... *stokesii*
Caudal scales above with 3 spines .... *depressa*

Egernia carinata Smith
Smith's Skink

This small skink, the largest known specimen measures 10 in. (255 mm.), has a long subcylindrical tail, longer than the head and body. The dorsal and caudal scales are pluricarinate; there is an incomplete series of suboculars, a post nasal groove, 7 or 8 upper labials, with the 5th and 6th or 6th and 7th under the eye, and 7 lower labials.

The head is somewhat flattened and slender covered with roughened shields, frontonasal narrowly in contact with the rostral or separated by the nasals, also often separated from the frontal by the prefrontals which may form a short or pin point median suture. Frontal about 1½ times as long as wide, as long as and wider than the interparietal. Three pairs of pluricarinate nuchals. Dorsal scales on body and tail bi-or tri-carinate on the limbs also. Under surface smooth.

The coloration has been described as "dorsal, ground colour grey-brown with an ill defined dark dorsolateral stripe extending from the temporal region to about halfway along the body where it breaks up into an irregular series of spots. Three to five longitudinal series of quadrangular spots, each half the width of a scale, extend along the body and often along the tail also. In several specimens these spots have lost their serial arrangement and are scattered irregularly." The sides are often black and white spotted and the under surface, uniformly pale with blackish markings on the chin. The auricular lobules and the upper and lower labials white, the latter dark edged in many of the specimens.

The distribution is South-Western Australia and adjacent islands, from the vicinity of Perth and Rottnest to the Archipelago of the Recherche and inland to Norseman.

Egernia kingii (Gray)
King's Skink

This is the largest of our Egernias. It may attain a length of 22 in. (560 mm.) and is easily recognised by its colour pattern, which usually consists of pale longitudinal lines along the back and tail though a speckled form is often met with. In its young stages it is white-spotted above and black-spotted below. Specimens from the southern islands are darker.

The tail is subcylindrical and longer than the head and body. The head is normal and covered with rugulose shields, the frontonasal is in contact with the rostral and separated from the frontal by the prefrontals which form a median suture. The frontal is from 1 1-3 to 1½ times as long as wide. The interparietal is long and narrow, sometimes as long as the frontal but much narrower; 9 or 10 upper labials with the 6th and 7th or more often 7th and 8th under the eye, no complete series of suboculars; a groove behind the nostril. The vertical diameter of the ear opening is as long as the horizontal diameter of the eye, with three or four lobules. Usually 3 pairs of multicarinate nuchals, dorsals and upper caudals with 2 or 3 keels. Under surface smooth but striate on the tail. The adpressed limbs overlap having two- or three-keeled scales above. There are 34 to 40 scales round the middle of the body.

The known distribution is on islands off the west and south coasts, from the Dirk Hartog Island to the Archipelago of the Recherche, and inland as far as the Great Southern Railway to Toolbrunup, between Gnowangerup and Tambellup.

Egernia napoleonis (Gray)
Napoleon's Skink

This is a small species, less than 12 in. in length, with a subcylindrical tail which may be twice as long as the head and body.

The head is normal, fronto-nasal in contact with the rostral and separated from the frontal by the prefrontals which form a median suture. Frontal nearly 1½ times as long as wide, longer and wider than the narrow interparietal; 5 supraoculars, the 2nd the largest, series of infraoculars incomplete; 7 upper labials, the 5th and 6th under the eye, occasionally 8 with the 6th and 7th under the eye. A groove behind the nostril. One pair of enlarged nuchals. Dorsal scales with 2 or 3 weak keels, basal portion of the tail with feebly developed keels, the rest together with the limbs and the whole of the under surface smooth. The adpressed limbs meet or slightly overlap.

The coloration of spirit specimens is light olive brown, head above with darker markings or spots and narrow edges to the upper labials, eyelids and the 2 or 3 lobules lighter in some cases. A pale vertebral band, about 2 scales wide, extends from the nape on to the tail and is flanked by bands of dark brown, again 2 scales wide each with a row of white spots which also reach to the base of the tail. A thin pale line separates the dorsolateral band from the side which may be dark spotted or marbled. The distal portion of the tail above may be covered with light-edged scales. The whole of the under surface of body, tail and limbs a uniform pale olive-brown, paler than the ground colour of the upper surface.

The lizard inhabits the extreme south of the State, it has been found on Eclipse Island, near Albany and inland as far as the Stirling Range and Ongerup.

It seems to be rare and acts in its area as the representative of the widespread *Egernia whitii,* to which it is closely related.

Egernia formosa Fry

Fry's Skink

This is a typical small, smooth skink measuring up to 11¼ in. (285 mm.) in total length. The head is rather broad and the body normal; the adpressed limbs in the female overlap so that the hind foot reaches the wrist, and the tail is longer than the head and body; groove behind the nostril, the frontal 1 1-3 to 1½ times as long as broad; interparietal as long as the frontal; 3 pairs of enlarged nuchals. There are 7 upper labials, the 5th and 6th under the eye; ear almost as long as the eye, with from 2 to 4 lobules. No complete series of infraoculars. Body scales smooth or feebly striated, those on the sides smallest. Scales on the tail above not transversely enlarged.

Colour is variable, dark or yellowish olive above, the head shields are plain or with dark markings; two dark bands start at the back of the head but soon break up into rectangular spots along the back and on to the tail; outside these are a series of spots starting on the nape and likewise extending on to the tail. A wide dark brown stripe starts behind the nostril and proceeds through the eye and over the ear and shoulder to the side of the body where it disappears. Above this and below the dorsolateral band are scattered dark spots. The under surface is pale yellowish, the throat reticulated with dark brown, the limbs are plain brown above, their under surface and that of the tail are pale like the ventral surface of the body.

The distribution is very widespread. It is known from near Perth, Cottesloe Beach, West Wallaby Island (Abrolhos), Pindawa and the "Goldfields." It is not common.

Egernia inornata Rosen
Rosen's Skink

This small species from the more arid regions may attain a length of about 9 in. (230 mm.). It has a tail slightly longer than the head and body, is one of the smooth scaled forms with a faint groove behind the nostril, a complete series of infraoculars, 4 upper labials in front of the 5th or 5th and 6th, which are under the eye, and a single pair of nuchals. The distance from the tip of the snout to the fore limb is about 1½ times in the distance from the axilla to the groin; the adpressed limbs overlap.

The coloration is variable. A description reads: "the ground colour varies from rusty red through pink tinged cream to light fawn. Dorsal surface uniformly coloured, irregularly speckled with black or with regular longitudinal striations." These may extend on to the tail and be replaced laterally by numerous oblique stripes. There may also be distinct cross banding on the tail. A small specimen from Queen Victoria Springs closely resembles the markings of young *Egernia whitii.*

Specimens have been recorded from Merlinleigh Station, about 100 miles E.N.E. of Carnarvon, between Wells 48 and 50 on the Canning Stock Route, near Merredin, Fraser Range, and between Fraser Range and Queen Victoria Spring. It is also known from the Northern Territory, Central Australia and South Australia.

The lizard is closely related to Lord Kintore's Skink and is found in the same general area but has a more extensive range. It is also smaller when full grown.

Egernia kintorei Stirling & Zietz
Lord Kintore's Skink

This large desert skink may attain a length of 15½ in. (390 mm.). It is one of the smooth-scaled forms with a postnasal groove, a complete series of infraoculars and 5, sometimes 6, upper labials in front of the first under the eye. There is usually only one pair of enlarged nuchals and the scales on the upper surface of the tail are not transversely enlarged in any of the specimens examined. The adpressed limbs slightly overlap; the distance from the tip of the snout to the fore-limb is 1¼ times the distance from the axilla to the groin; the tail is longer than the head and body and tapers to a sharp point. The colour in life is said to be "red brown above with faint darker lines running longitudinally between the series of scales. Faint vertical barring on the flanks. Ventral surface pale yellow." The specimens in the Museum were similar on arrival but have now faded. There are traces of cross banding on the tail. The whole of the under surface is immaculate, as also is the entire fore limb and the under surface of the hind limb, the upper part of the latter being mottled lighter and darker in some cases.

The distribution is the far interior, where specimens have been collected on the Canning Stock Route, the Great Victoria Desert, and inland from Broome (*Egernia dahlii* Boulenger).

Egernia whitii (Lacep.)
White's Skink

A small skink which may attain a length of 8½ in. (219 mm.) belonging to the group with smooth or striated, not keeled scales. The head is normal in outline and covered with slightly swollen shields, the frontonasal is in contact with the rostral and usually separated from the frontal by the prefrontals which have a median suture or have just a pinpoint contact. The frontal is slender, twice as long as wide, narrower but longer than the interparietal and in contact with the first two supraoculars. Usually 8 upper labials with the 6th and 7th under the eye, when there are only 7 then the 5th and 6th are in that position. There is no groove behind the nostril. A complete series of infraoculars, one pair of enlarged nuchals. Scales on the body, tail and limbs all smooth without the faintest traces of keels.

The coloration is somewhat variable, in most cases the head is pale olive brown, a colour which continues as a vertebral stripe 2 scales wide, a fine dark line separating the two scales, the rest of the dorsal surface is blackish profusely sprinkled with white spots which may cover indistinct cross bands in the adults. On the sides the coloration is less intense, the tail has numerous dark cross bands, the under surface is blue-grey but there are dark lines on the chin. The upper and lower labials are pale, the individual shields having dark edges in most cases. The eyelids and the lobules in the ear are consistently white.

The distribution of this eastern species is restricted to the south coast east of Albany, and inland to Ongerup and the Great Victoria Desert. It has also been collected on Bernier I. in Shark Bay.

Egernia stokesii (Gray)
Large Spiny-tailed Skink

This and the Small Spiny-tailed Skink are easily separated from their kin by their short and spiny tails and therefore require no detailed description. The Large Spiny-tailed Skink has the body somewhat flattened and covered above with scales bearing 2 or 3 keels each ending in a sharp spine. On the sides the scales bear but a single keel. On the tail on the other hand the keels are absent being replaced by a single well developed semi-erect spine. The limbs are also keeled and spinose above but the whole of the under surface is smooth. It grows to 9½ in. (240 mm.). It is light brown with darker markings which may form irregular cross bands on the body and tail and are less intense than the markings on the smaller species; the under surface is uniform drab.

For the separation of young specimens from the individuals of the smaller species, three characters may be mentioned: (1) The unicuspid scales on the tail. (2) The frontonasal is in contact with the rostral. (3) The sixth upper labial enters the eye.

The Small Spiny-tailed Skink on the other hand has: (1) The tricuspid scales on the tail. (2) The nasals in contact, thus separating the frontonasal from the rostral. (3) The fourth upper labial enters the eye. Small specimens of the smaller species may have the spines on the tail still unicuspid but the other characters are valid.

The distribution is Western Australia south of the Murchison and inland to the Koorda district. Specimens have reached the Museum from as far south as Yarloop and the species is known from the Houtman's Abrolhos.

Egernia depressa (Gnthr.)
Small Spiny-tailed Skink

This little species, its maximum size appears to be about 6 in. (150 mm.), may at first sight be mistaken for the young of the larger spiny-tail. But a closer examination reveals its distinctive characters. The body and tail are both flattened and covered above with keeled or spiny scales. On the back they carry 3 keels which on the tail terminate in 3 spines, the central being the largest. The scales on the limbs are distinctly spinose on the supper surface. The entire under surface is smooth and shining. It is not uncommon for the dorsal scales to be worn through friction with the stones or rocks that form the lizard's retreat.

The distinctive characters are listed under the description of the larger species.

The coloration is variable, specimens preserved in spirits are light olive brown above with intense dark markings developing behind the head towards and on the tail making irregular cross bands. The under surface is immaculate pale olive or with a few dark dots.

The distribution is limited to Western Australia south from Well 46 on the Canning Stock Route and Abydos Station in the North-West. It is recorded in the Laverton and Kalgoorlie districts and south to Hopetoun. It is known from Beverley but is absent from the Perth coastal plain though specimens have been sent to the Museum from Perth and Fremantle where they probably arrived in consignments of sandalwood.

FROM FIELD AND STUDY

Record of the Frog *Notaden nichollsi* near Port Hedland.—Two specimens of this species (male, 63 mm. and female, 48 mm.) were collected 12 miles inland from Port Hedland on the Port Hedland-Marble Bar road on January 20, 1958, at about 2300 hours. Hitherto this species has been recorded from various localities in the Kimberleys and at an unidentified locality at the northern end of the No. 1 Rabbit Proof Fence (H. W. Parker, *Novitates Zoologicae,* 42, 1940: 64). This report therefore offers a more precise locality for a north-west occurrence.

It had been raining heavily for about five hours before the collection site was reached. There was no watercourse closer to the area than about one mile. There was a semi-permanent dam about half a mile away. Other species collected at the same time were *Cyclorana cultripes* and *Neobatrachus* sp. The females of *Notaden* and *Cyclorana* were both gravid while the female of *Neobatrachus* had shed its eggs.

In view of the report (Parker, *ibid.,* p. 60) that *Notaden bennetti* is myrmecophagous, the guts of the two specimens were removed. Examination showed that the heads and wings of ants (Formicidae) and the heads of a species of termite, having nasute soldiers, was also present. The gut contents are reported in greater detail by J. H. Calaby (see p. 79).

E. H. M. EALEY and A. R. MAIN, Nedlands.

Frogs at Jigalong.—Main and Calaby (*W.A. Nat.,* 5: 216-228) have pointed out that the frog fauna of the North-West is little known. It seems desirable therefore that range extensions and new locality records should be published..

I arrived at Jigalong (approx. lat. 23° 24′ S, long. 120° 46′ W) in February 1959. Since then the following frogs have been collected by native children and myself from the Jigalong Creek and land adjacent to its banks. Jigalong Creek flows in a north-westerly direction and eventually empties into extensive flats at about lat. 23° 0′ S, long. 120° 30′ W. It does not connect directly with any river system but these flats, in flood times, possibly provide a connection with the Fortescue River.

Hyla rubella Gray. This species frequents some rain water tanks. At night occasional specimens are found on the windows and inside the house catching insects attracted by the light. During the summer months these frogs were found in the drainage pipe from the bathroom, in salt water analysed by the Government Chemical Laboratories as having total soluble salts (by evaporation) 687 grains per gallon, and reaction neutral.

Limnodynastes spenceri Parker. This species has been found in burrows in the creek bed in the following instances:

a. 15 specimens were collected on April 12, after 40 points of rain had fallen in the previous three days.

b. 3 specimens were collected on April 16, after an additional 18 points.

c. 16 specimens were collected on May 18-19, after 36 points of rain had fallen. Of these 15 specimens were forwarded to A. R. Main.

In all instances the creek flowed slowly during the night the rain fell but by midday next day was still.

On May 18-19, 15 specimens were collected from coarse creek sand from which the water had receded. Each was in a burrow with a small pile of sand over it. It appears, therefore, that the frogs excavate the burrows during the night after the water has lowered.

The species is common after summer rain.

The call heard in captivity was a rapid "ho ho ho ho" ("o" as in cot), high pitched and like the noise made by a child's squeeze toy.

Notaden nichollsi Parker. Of this species 5 specimens were collected in March. Two were forwarded to A. R. Main.

One specimen was dug by native children from a burrow in the creek bed and another from about 200 yards from the creek. The other specimens were brought by children but they could give no information regarding their collection.

The gut contents of the specimen preserved soon after capture were predominantly termites. These have been identified by J. H. Calaby as *Drepanotermes rubriceps* (Froggatt).

Both *Notaden nichollsi* and *Limnodynastes spenceri* are known to the local natives as "Nan-kra"; "-kra" shows ownership in the local languages—*Mantjiltjara* and *Katatjara*—thus these are two frogs which own (= speak) "Nan."

The specimens of all species have been identified by Dr. A. R. Main of the Zoology Department, University of Western Australia.

—ERIC LINDGREN, Jigalong.

A Note on the Food of Australian Desert Frogs.—Main and Calaby (*W.A. Nat.*, 5, 1957: 216) have given some observations on the food of Australian desert frogs. The stomach contents of 9 specimens of *Limnodynastes spenceri* Parker and 12 specimens of *Cyclorana cultripes* Parker were examined, among other species. The prey consisted of a wide variety of arthropods, but was predominantly termites and ants. These authors concluded that the several species of frogs examined were unspecialized predators, and pointed out that the large number of termites and ants eaten was no doubt due to the fact that the weather conditions, which bring desert frogs to the surface for feeding and breeding, are the same as those which precipitate colonizing flights of termites and ants. Also, ants and surface-foraging termites, which appear above ground after rain or during humid weather, are dominant faunal elements in inland Australia. In this group of termites the most abundant and widespread is *Drepanotermes rubriceps* (Froggatt).

By courtesy of Dr. A. R. Main, the writer has been able to examine the stomach contents of a further 3 specimens of *C. cultripes* and 6 specimens of *L. spenceri*. The *C. cultripes* were collected 12 miles from Port Hedland on the Marble Bar road (E. H. M. Ealey, Jan. 20, 1958). One stomach contained a large number of alates of an *Amitermes* species and some sand grains. Another contained a large number of alates of the same *Amitermes* species and, in addition, a few alates of *D. rubriceps*, one small worker ant (*Iridomyrmex* sp.), a small centipede, and a mass of unidentified silky material which somewhat resembled spider egg-cases. The third specimen contained only a mass of the silky material and some sand grains. The only abundant food item in the 6 specimens of *L. spenceri* (Jigalong, E. Lindgren, April and May, 1959) was *D. rubriceps*. One stomach contained an alate and a few workers and soldiers, and the others contained soldiers and workers only, varying in numbers from 25 to about 150. Other food items were small numbers of ant workers in several genera *(Iridomyrmex, Meranoplus, Pheidole, Camponotus, Polyrhachis),* a small cockroach, a weevil, and 2 Pentatomid bugs. Some stomachs contained plant fragments and sand grains. Two specimens of an unidentified species of *Neobatrachus* (12 miles from Port Hedland, E. H. M. Ealey, Jan. 20, 1958) gave little information on food. One stomach was empty and the other contained fragmentary remains of one termite alate and an ant worker, and some plant fragments and sand grains.

Three specimens of the rarely-collected *Notaden nichollsi* Parker were also examined, two from the Port Hedland area (Ealey) and one from Jigalong (Lindgren), March 1959. The Jigalong specimen contained approximately 300 soldiers and workers of *D. rubriceps,* a fair number of worker ants in the following genera *(Rhytidoponera, Iridomyrmex* (*detectus* group), small *Iridomyrmex, Pheidole, Camponotus,* and unidentified), some plant fragments and sand grains. The Port Hedland specimens also contained termites (all castes of *D. rubriceps,* alates of *Amitermes* sp., and soldiers of *Tumulitermes recalvus* (Hill)) and worker ants (a small *Iridomyrmex, Xiphomyrmex,* a medium to large *Camponotus,* and unidentified). One contained in addition plant stalks and a seed, and a large sand grain.

For comparison, three available specimens of *Notaden bennetti* Gunther, from central inland Queensland, were examined. The stomach contents consisted largely of worker ants (species of *Rhytidoponera* (*metallica* group), small *Iridomyrmex, Monomorium, Camponotus)* ranging from about 60 in one specimen to approximately 90 in each of the other two. Other food items were 6 lepidopterous larvae about 20 mm. long, 6 small beetles, and a wasp 10 mm. long in one stomach, and a Carabid beetle in another. Two stomachs contained a few plant seeds.

Parker (*Nov. Zool.,* 42, 1940: 1) states of *Myobatrachus* and *Notaden* that "both are essentially myrmecophagous and specially adapted for life in termitaria." *Myobatrachus* is a specialized termite predator which feeds underground and is always found in association with termite galleries (Calaby, *W.A. Nat.,* 5, 1956: 93; Philipp, *W.A. Nat.,* 6, 1958: 131). *Notaden* on the other hand resembles other desert leptodactylid frogs in that it comes to the surface to feed during and after rain. Although the main food items found in *Notaden* stomachs were termites and ants it seems probable that the two species are similar to *C. cultripes* and *L. spenceri* in that they are not specialized feeders and the predominance of social insects in their diet is due to the fact that these are the most abundant available prey.

The foregoing observations favour the previous conclusions of Main and Calaby and give further support to the contention of Main, Littlejohn, and Lee (p. 409 in *Ecological Research in Australia,* ed. F. S. Bodenheimer (W. Junk: The Hague; 1959) that specialized feeding in frogs "is associated only with reliable climatic conditions and is unlikely to be found in desert frogs."

—J. H. CALABY, Canberra.

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HERPETOLOGICAL MISCELLANEA

By L. GLAUERT, M.B.E., Western Australian Museum, Perth.

XII.—THE FAMILY SCINCIDAE IN WESTERN AUSTRALIA

PART 2—THE GENUS *LYGOSOMA*

An extensive and very variable genus containing species with well developed and functional limbs as well as others in which they are much reduced or absent. When present they often fit into a depression. On the head are well developed eyes with a moveable lower eyelid which in burrowing forms has an undivided transparent disk. The ear may be distinct or hidden, if the latter, then it is indicated by a depression. The most important feature of the head-shields is that the parietals form a well-marked suture behind the frontoparietals and interparietal, thus differing from *Egernia* and *Tiliqua* in which they are always separated.

A number of sub-genera, at times regarded as distinct genera, have been established which can be distinguished as follows:*

1. Limbs well developed with five digits; the length of the hind limb greater than the distance between the centre of the eye and the fore limb. Lower eyelid scaly. Tympanum distinct. Frontal not wider than the supraocular region. Frontoparietals distinct .... *Sphenomorphus*
2. Limbs well developed, with five digits, the hind limb longer than the distance between the centre of the eye and the fore limb. Lower eyelid with an undivided transparent disk. Tympanum distinct. Rostral forming a suture with the frontonasal. Frontal not wider than the supraocular region. One or more pairs of enlarged nuchals .... *Leiolepisma*
3. Limbs short, the hind limb not measuring more than the distance between the anterior corner of the eye and the fore limb, limbs with five digits. Lower eyelid scaly. Tympanum distinct. Prefrontals well developed. Frontal not wider than the supraocular region .... *Omolepida*
4. Limbs very short, often with less than five digits. Lower eyelid with an undivided transparent disk. Ear covered with scales, indicated by a depression. Prefrontals well

* This key refers to Western Australian forms only, see *B.M. Cat.*, vol. III, p. 210.

developed. Frontal not wider than the supraocular region ... *Hemiergis*

5. Limbs short or rudimentary. Lower eyelid with an undivided transparent disk. Ear distinct, minute. Prefrontals very small or absent. Frontal wider than the supraocular region ... *Rhodona*

SUB-GENUS *SPHENOMORPHUS*

Limbs well developed, pentadactyle, the hind limb longer than the distance between the centre of the eye and the fore limb. Lower eyelid scaly. No supranasals. Frontal not wider than the supraocular region. Fronto-parietals distinct. A pair of enlarged preanals.

KEY TO THE SPECIES

I. Ear opening with lobules.
  A. Prefrontals forming a median suture.
    (1) Black white-edged vertebral band and white black-edged dorsolateral band, sides blackish white-spotted ... *lesueurii*
    (2) 8 or 10 rows of white spots edged above and below with black ... *ocelliferum*
    (3) Dark brown with 6 white longitudinal lines along the back, a white dorsolateral band ... *leae*
    (4) Yellowish brown, with broad dark bands along the back and 11 white lines along the back and sides ... *fasciolatum undecimstriatum*
    (5) Brown with 5 dark lines on the head and 6 white stripes on the back, a strong white line from the snout under the eye to the tail ... *colletti*
    (5) Brown with 3 black white-edged bands along the body and a white dorsolateral stripe from over the eye along the body and tail ... *essingtonii*
  B. Frontonasal forming a suture with the frontal.
    (1) Frontal in contact with 3 supraoculars. Brown with black vertebral line and 3 pale lines on each side, a white dorsolateral band from the upper lip to the tail, interspaces white-spotted ... *leonhardii*
    (2) Frontal in contact with 2 supraoculars. Brown above, a white dorsolateral streak from over the eye to the tail, below this a black white-spotted band followed by a white streak from the upper labials to the tail ... *labillardieri*

II. Ear opening without lobules.
  A. Frontonasal not in contact with the frontal. Scales smooth, the adpressed limbs do not meet, body and tail with numerous broad dark crossbands ... *richardsonii*
  B. Frontonasal in contact with the frontal.
    (1) Scales smooth, no nuchals, faint lateral markings ... *pallidum*

(2) Dorsal and caudal scales keeled one or two pairs of nuchals, broad brown cross bands, the adpressed limbs meet .... *monotropis*

(3) Upper caudal scales smooth, one or two pairs of nuchals, with dark and white spots most intense laterally .... *isolepis*

(4) Upper caudals, scales keeled, up to 3 pairs of nuchals, cross bands narrow and irregular .... *fasciolatum*

Lygosoma (Sphenomorphus) lesueurii D. & B.
Lesueur's Skink

Form normal, slender while young, distance from the tip of the snout to the fore limb about $1\frac{3}{4}$ or $1\frac{7}{8}$ times in the distance between the fore limb and hind limb. Lower eyelid scaly. Frontonasal wider than long, in contact with the rostral prefrontals in contact; frontal slender, longer than the frontoparietals and parietals together, in contact with the 3 anterior supraoculars; 7 or 8 upper labials, the 5th and 6th or 6th and 7th under the eye. Ear opening about as large as the eye with 3 or 4 white lobules. Four pairs of enlarged nuchals. Dorsal scales smooth, the two vertebral series the largest, the laterals smallest. The adpressed limbs overlap. Tail about twice the length of the head and body, rarely undamaged and replaced. The largest specimen measures 12 in. (350 mm.).

The coloration is striking. The background may be brown or olive above, more or less uniform on the head but not much in evidence on the body; there is a blackish white-edged vertebral band about a scale wide extending from the nape on to the tail; a thinner white black-edged dorsolateral line beginning over the eye gains in strength as it reaches the tail, where it becomes more prominent than the vertebral series; the sides are dark brown with a regular series of oblong white spots which may almost form a band; another very wide white streak starts behind the ear, passes over the limbs and fades away on the tail. The under surface is white and the limbs have dark longitudinal markings.

This species has a very wide range in this State. It is known from East and West Kimberley in the north to Chorkerup and Eucla in the south and from the west coast to as far inland as Laverton. It is also known from Barrow, Bernier and Rottnest Is.

A subspecies, *Lygosoma lesueurii concolor* Glauert, from Abydos Station, Limestone Station, Marble Bar, and Marrilla Station in the North-West, and Boolardy Station in the Murchison, differs from the nominate form by having shorter limbs and a plain coloration above. It grows to $12\frac{1}{2}$ in. (107 + 220 mm.). Another, *L. l. inornatum* (Gray) has white dark-edged dorsolateral bands beginning over the eye and a wider whitish streak from the ear to the hind limb; the type came from "Swan River."

Lygosoma (Sphenomorphus) ocelliferum Blgr.
Spotted Skink

Form normal, distance from the tip of the snout to the fore limb about 1½ times in the distance between the fore limb and the hind limb. Lower eyelid scaly. Frontonasal wider than long, separated from the rostral and from the frontal; frontal longer than the frontoparietals and interparietal combined, in contact with the three anterior supraoculars; usually 8 upper labials with the 6th and 7th under the eye, sometimes 9 with the 7th and 8th in that position. Ear opening as large as the eye with 3 or 4 white lobules, 2 pairs of enlarged nuchals. Dorsals smooth and largest, laterals smallest. Two enlarged preanals. The adpressed limbs overlap. It grows to 9 in. (95 + 130 mm.).

The coloration is olive brown or bronzy with 8 or 10 rows of white elongate spots, edged above and below with black, which may at times entirely enclose the white. Some of the head shields with dark markings and some of the posterior upper labials with dark vertical bars. The ocelli of the back continue on the tail but gradually fade, they are quite absent on the reproduced portion. Limbs with irregular dark markings which may at times become linear. Under surface white with a few dark markings, especially on the chin and tail.

The distribution is very widespread. The type locality is Roebuck Bay, and it has been collected on the Canning Stock Route, the North-West and as far south as the neighbourhood of Quairading and Beverley. It appears to be rather rare.

Lygosoma (Sphenomorphus) leae Blgr.
Lea's Skink

Form slender, the distance between the tip of the snout to the fore limb about 1½ to 1 2-3 times in the distance between the fore limb and the hind limb. Lower eyelid scaly. Nasals in contact behind the rostral or slightly separated; prefrontals forming a median suture. Frontal as long as the frontoparietals and parietals together, in contact with the 3 anterior supraoculars; 4 supraoculars, 3 pairs of enlarged nuchals; 8 upper labials, the 6th and 7th entering the eye. Ear opening oval with 3 or 4 small lobules. Dorsal scales smooth, the two vertebral series largest and the laterals smallest. Two enlarged preanals. The adpressed limbs overlap the hind foot reaching the elbow.

Dark brown above, head paler, 6 white longitudinal lines, the central pair extending from the nape on to the tail, the next pair start over the eye, and the outer begin behind the eye and pass over the ear along the body; a wider lateral band begins on the upper lip, passes through the ear and along the side of the body to the base of the tail; it may become ill-defined or absent on that appendage, which is paler like the head above.

The distribution as known today is limited to the south-east of the State, the specimens in the Museum coming from the country near Kalgoorlie and Eucla.

Lygosoma (Sphenomorphus) taeniolatum undecimstiatum (Kuhl)

Eleven-striped Skink

Form slender, the distance from the tip of the snout from 1 4-5 to 2 times in the distance between the fore limb and the hind limb. Lower eyelid scaly. Frontonasal in contact with the rostral and the frontal wider than long. Frontal as long as the frontoparietals and parietals combined, in contact with the first 3 of the 4 supraoculars; 3 or 4 pairs of nuchals; 5th and 6th of the 7 upper labials enter the eye. Ear opening oval, smaller than the eye opening with 3 or 4 lobules. Scales smooth, the two vertebral series much the largest, laterals smallest, about 28 round the middle of the body. Two enlarged preanals. The adpressed limbs overlap. Tail about $1\frac{1}{2}$ times as long as the head and body (partly replaced).

Colour, yellowish brown with dark longitudinal bands and 7 white lines along the body and 2 on each flank, those on the sides widest, some extend on to the tail which is yellowish brown above. Limbs with light and dark longitudinal streaks extending to the feet, labials, under surface and insides of the limbs white.

This skink occurs in the South-West as far inland as Ongerup and No. 5 Pumping Station of the Goldfields Water Supply. Most of the Museum specimens are from the Tambellup area.

Lygosoma (Sphenomorphus) colletti Blgr.

Collett's Skink

Form slender, the distance from the tip of the snout to the fore limb up to 1 2-3 times in the distance between the fore limb and the hind limb. Lower eyelid scaly. Frontonasal wider than long, separated from the rostral but in contact with frontal; frontal as long as its distance from the hind border of the parietals, in contact with the 1st 3 supraoculars; 4 supraoculars; 7 upper labials, the 5th and 6th under the eye, in one case 8 with the 6th and 7th under the eye. Ear opening smaller than the eye opening with 3 white lobules. Three pairs of enlarged nuchals. Scales smooth, the two vertebral series the largest, laterals smallest. The adpressed limbs overlap, the hind foot reaching the elbow. Two large preanals. Tail about $1\frac{3}{4}$ times as long as the head and body. Grows to $5\frac{1}{2}$ in. (50 + 92 mm.).

Colour light brown with 5 dark longitudinal lines on the head, back, with 6 white stripes, the outer commencing over the eye and extending on to the tail, the others starting on the nape and also reaching on to the tail, where they gradually disappear. A stronger white line begins on the snout proceeding under the eye and through the ear along the side of the body and on to the tail, which is pale yellowish brown. Limbs with pale and dark longitudinal streaks reaching the toes. Labials with dark markings. Under surface white.

The species is confined to the northern half of the State. The type was collected near Roebuck Bay. The Museum has specimens from Wotjulum in West Kimberley and from Marrilla and Abydos Stations in the North-West. Loveridge records its presence as far south as Meekatharra, Wiluna, and Caron.

Lygosoma (Sphenomorphus) essingtonii (Gray)
Gilbert's Skink

Form slender, the distance between the tip of the snout and the fore limb about 1½ times in the distance between the fore limb and the hind limb. Lower eyelid scaly. Frontonasal wider than long, separated from the rostral by the nasals, which have a median suture, in contact with the frontal. Frontal slightly shorter than the distance from the hind margin of the parietals, in contact with 3 of the 4 supraoculars; frontoparietals usually longer than the interparietal; 3 or 4 pairs of enlarged nuchals; 7 or 8 upper labials with the 5th and 6th or 6th and 7th entering the eye. Ear opening smaller than the eye opening and with four lobules. Scales smooth, the dorsals subequal, laterals smallest. The adpressed toes overlap the hind foot, reaching the elbow, toes long. Tail up to twice as long as the head and body.

The colour in spirits is pale brown or olive brown with 3 black white-edged stripes from the nape along the body to the tail where only the outer persist; there is a more prominent white stripe starting over the eye and extending along the tail, below which is a dark white-spotted band.

This lizard is confined to the far north, in West and East Kimberley, where it has been collected at Wotjulum and Lissadel Station.

Lygosoma (Sphenomorphus) leonhardii Sternf.
Leonhardi's Skink

Form slender, the distance between the tip of the snout and the fore limb about 1⅓ times in the distance from the fore limb to the hind limb. Lower eyelid scaly. Frontonasal broader than long, in contact with the rostral and the frontal; frontal as long as the distance to the hind edge of the parietals, in contact with the 3 anterior supraoculars; 4 pairs of nuchals. Ear opening smaller than the eye opening with 3 or 4 lobules. 7 upper labials, 5th and 6th enter the eye. Scales smooth, the 2 vertebral series the largest, the laterals the smallest. The adpressed limbs overlap, the hind feet reaching beyond the wrist. Tail much longer than the head and body.

The coloration is brownish yellow above with a black vertebral line and 3 pale lines on each side together with a much wider lateral stripe, the dark interspaces white-spotted. A wider white band extends along the side from the upper lip over the limbs on to the tail. Museum specimens are from Queen Victoria Spring and Grants Patch east of Kalgoorlie.

Lygosoma (Sphenomorphus) labillardieri (Gray)
Gray's Skink

Form normal, the distance from the tip of the snout to the fore limb 1 1-3 times or slightly more in the distance between the fore limb and the hind limb; the adpressed limbs overlap the hind limb, reaching the wrist. Lower eyelid scaly; frontonasal wider than long, in contact with the rostral and the frontal; frontal rather slender, about as long as the frontoparietals and parietal combined, in contact with the 1st 2 supraoculars. Usually 7 upper labials with the 5th and 6th under the eye but at times 8 with the 6th and 7th in that position. Ear opening about as large as the eye with 2 or 3 lobules. 3 pairs of nuchals. Scales on the body, tail and limbs smooth. Tail twice as long as the head and body.

The coloration varies. The back is olive brown or bronzy with or without traces of a pair of fine white vertebral lines followed dorsolaterally by a white streak from over the eye and ear opening on to the tail; below this is a black white-spotted band which in its turn is bounded below by an undulating white streak starting on the upper labials and extending under the eye through the ear and over the limbs to the tail; the area between the white lines and below the lower ones are white spotted. The under surface is whitish and the limbs are covered with irregular dark markings and an orange suffusion.

The distribution is mainly in the South-West but specimens have been obtained at Strelley near Port Hedland, Landor on the Gascoyne, and Belele in the Murchison. The species is also known from Eclipse I. and the Archipelago of the Recherche.

Lygosoma (Sphenomorphus) richardsonii (Gray)
Richardson's Skink

Body elongate, the distance between the tip of the snout and the fore limb about 1 2-3 times in the distance between the fore limb and the hind limb. Lower eyelid scaly. Nostril in a single nasal; frontonasal a little wider than long, forming a narrow suture with the rostral; prefrontals in contact; frontal as long as the frontoparietals and parietals, in contact with the 3 anterior supraoculars; 4 supraoculars; frontoparietals and interparietal distinct; a pair of irregular nuchals; 6th and 7th upper labials under the eye. Ear opening oval smaller than the eye, with 4 projecting granules. Smooth subequal scales round the body. A pair of slightly enlarged preanals. The adpressed limbs fail to meet, digits short. Tail very thick.

Pale brown above with dark brown cross bands, 9 between the head and root of the tail. Lower surface white.

The type specimen was collected on the Abrolhos in 1840 by B. Bynoe, the surgeon who sailed with Stokes in H.M.S. *Beagle.* The species is not represented in the WA. Museum and must be rare.

Lygosoma (Sphenomorphus) pallidum Gnth.

Form elongate, the distance between the tip of the snout and the fore limb 1 2-3 times in the distance between the fore limb and the hind limb. Snout depressed. Eyelid scaly; fronto-nasal wider than long, forming sutures with the rostral and the frontal; frontal slightly longer than the frontoparietals and interparietal combined, in contact with 3 of the 4 supraoculars; no nuchals; 5th and 6th upper labials under the eye. Ear opening small, without lobules. Smooth subequal scales. A pair of enlarged preanals. The adpressed limbs slightly overlap, subdigital lamellae strongly keeled. Total length $5\frac{2}{3}$ in. (135 mm.), tail somewhat shorter than the head and body.

Rufous brown above, white below.

A specimen from Carnarvon is in the Museum; the type locality is Nicol Bay.

Lygosoma (Sphenomorphus) monotropis Blngr.
Keeled Skink

Form normal, legs rather short but meet when adpressed, distance from the tip of the snout to the fore limb $1\frac{1}{2}$ times in the distance between the fore limb and the hind limb. Lower eyelid scaly; frontonasal wider than long, forming a narrow suture with the rostral, in contact with the frontal; frontal long and narrow, much longer than the frontoparietals and parietals combined, in contact with 3 of the 4 supraoculars; 8 upper labials, the 6th and 7th enter the eye. Ear opening oval, much smaller than the eye opening, lobules absent or represented by a few granules. No regular nuchals. Dorsal scales unicarinate, the keels forming distinct lines along the back, the keels may be distinct or feebly developed. Tail as long as or longer than the head and body in undamaged specimens. It appears to be easily lost as most of the specimens are imperfect, having lost part or even the whole of this appendage. One specimen very closely resembles the figure on plate XIV of the *British Museum Catalogue,* Vol. III. The lizard grows to about 8 in. (205 mm.).

The coloration is very consistent, the head and the body buff with broad dark brown cross bands, 9 or 10 between the head and the base of the tail and from 20 to 24 on the tail. The under surface is uniform whitish, with a few dark spots on the lower labials.

The distribution in this State is very wide. Specimens in the Museum collection range from Abydos Station in the Pilbara to Narrogin in the south, and from Geraldton on the west coast inland to Laverton.

Lygosoma (Sphenomorphus) isolepis Blngr.
Short-legged Slender Skink

Form slender, the distance from the tip of the snout to the fore limb about 1 3-5 times in the distance between the fore limb and the hind limb; limbs very short, when adpressed they do not meet. Lower eyelid scaly; frontonasal wider than long, forming sutures with the rostral and the frontal; frontal as long as or longer than the frontoparietals and interparietal combined, in contact with the 1st 2 supraoculars; 4 supraoculars; 1 or 2 pairs of nuchals. Upper labials 6 or 7 with the 4th or 5th under the eye. Ear opening oval, smaller than the eye opening, lobules absent. Scales smooth, laterals not much smaller than the dorsals. Two enlarged preanals. Tail long, often lost, up to 1 2-3 times as long as the head and body. Grows to about 8½ in (210 mm.).

Colour brown or olive brown above with numerous dark brown spots, which may be scattered over the surface or roughly arranged in lines along the body and denser along the sides. In fresh specimens white spots are also in evidence, especially along the sides. Labials dark-edged. Under surface of the body, limbs and tail white.

The distribution is in the northern parts of the State, as far south as the Fortescue River. It is not rare.

Kinghorn's *L. isolepis foresti* (sic) from the Forrest River, East Kimberley, has a much more attenuated body, the distance between the tip of the snout and the fore limb being twice in the distance between the axilla and the groin.

Lygosoma (Sphenomorphus) fasciolatum Gnth.
Thick-tailed Skink

Form normal, the distance from the tip of the snout to the fore limb about 1 2-5 times in the distance between the fore limb and the hind limb. Lower eyelid scaly; frontonasal wider than long, in contact with the rostral and the frontal; frontal as long as its distance from the hind edge of the interparietal, in contact with three supraoculars; one enlarged nuchal, although 3 are said to be present at times. 7 upper labials, the 5th and 6th enter the eye. Ear opening oval, much smaller than the eye opening, without lobules. The adpressed limbs overlap. Tail longer than the head and body; the upper scales obtusely keeled, keels forming continuous lines, there are also faint indications on the vertebral area on the back. Under surface smooth throughout.

The colour, in spirits, is buff above with irregular narrow cross bands, most pronounced on the sides and faint or absent on the back; they are very prominent on the tail.

The single specimen in the collection is from Marrilla Station, where it was collected by R. Ammon in 1935.

SUB-GENUS *LEIOLEPISMA*

Limbs well developed, the length of the hind limb exceeds the distance between the centre of the eye and the fore limb. Lower eyelid with an undivided transparent disk. Tympanum distinct. Rostral forming a suture with the frontonasal. Frontal not wider than the supraocular region. Distinguished from *Ablepharus* by the moveable lower eyelid.

KEY TO THE W.A. SPECIES

Fingers 5, toes 5. Scales smooth.
- 3 dark stripes .... *trilineatum* (Gray)
- One vertebral stripe .... *metallicum* (O'Shaug.)

Fingers 4, toes, 5. Scales on back and sides strongly keeled
.... *peronii* (Gray)

Lygosoma (Leiolepisma) trilineatum (Gray)
New Holland Skink

Form elongate, the distance from the tip of the snout to the fore limb from 1 2-3 to over twice in the distance between the fore limb and the hind limb. Lower eyelid with an undivided transparent disk; frontonasal forming a wide suture with the rostral and a narrow one with the frontal, which is smaller than the fused frontoparietals and in contact with the 1st 2 supraoculars of which there are 4; a very small interparietal. One pair of enlarged nuchals; 7 upper labials, the 5th entering the eye. Ear opening oval, is large as the transparent disk with 1 or 2 diminutive lobules. Scales smooth, dorsals and upper caudals sometimes faintly striated, not keeled. Preanals not noticeably enlarged. The adpressed limbs fail to meet. Tail longer than the head and body, usually imperfect. Grows to 7 in. (195 mm.).

A freshly-killed specimen was olive-brown, black-spotted, with a pale streak on each side, extending from over the eye along the body and tail, below this was a dark brown white-spotted band from the eye over the ear and limbs on to the tail and separated from the blue-grey under surface by an indistinct margin. The scales of the under surface are faintly edged with a darker colour.

The known distribution in this State is from the vicinity of Perth and Rottnest I, south to Margaret River, Bridgetown, Manjimup, Pemberton and Albany.

Lygosoma (Leiolepisma) metallicum (O'Shaug.)
Metallic Skink

Form normal, the distance between the tip of the snout and the fore limb 1 2-5 to 1 2-3 times in the distance between the fore limb and hind limb. Lower eyelid with an undivided transparent disk. Frontonasal broader than long, forming suture with the rostral and the frontal; frontal shorter than the parietal and interparietal combined; in contact with the 1st 2 of the 4 supraoculars.

A pair of nuehals and a pair of temporals border the parietals. 5th upper labial enters the eye. Ear opening large, roundish, without lobules. Seales smooth, the dorsals more or less striated. The adpressed limbs just meet or overlap. Tail about 1½ times as long as the head and body.

Bronzy above with small dark spots and a vertebral dark stripe; sides dark brown, white-spotted, often a light streak from the ear to the hind limbs. Under surfaee pale greenish or greyish uniform or with dark spots.

Known from the South-West from Perth, south to Augusta.

Lygosoma (Leiolepisma) peronii (D. & B.)
Peron's Skink

Form normal, the distanee from the tip of the snout slightly greater than that between the fore limb and the hind limb. Lower eyelid with a transparent disk eovering the whole of the eye. Frontonasal wider than long, with a large suture with the rostral and just in eontaet with the frontal; frontal about as long as the fused frontoparental but smaller and in eontact with 2 of the 4 supraoculars. 6 upper labials, the much enlarged 5th under the eye. Ear opening very small, with 1 lobule in front and 2 above. Dorsal and lateral scales on the body and tail with 2 sharp keels, which are present on the hind limbs also; those on the nape with 3 keels. 2 enlarged nuehals. Under surfaee of the body and tail and the whole of the fore limb smooth. The adpressed limbs overlap the hind limb reaehing the vicinity of the elbow. Fingers 4, toes 5. Preanals not enlarged. The only specimen in the eolleetion measures 2¾ in. (32 + 38 mm.), fore limb 11 mm., hind limb 13.6 mm.

The colour is bronzy above, laterally with a few dark dots and a faint light line beginning below the eye and passing through the ear to fade away on the side of the body. Under surface greenish white.

Occurs in the far north of the State; the only specimen in the collection was obtained at Wotjulum Mission, West Kimberley, by A. M. Douglas in 1955.

SUB-GENUS *OMOLEPIDA*
Lygosoma (Omolepida) australe Gray

Form elongate, the distance from the tip of the snout to the fore limb from 2 1-5 to 2 4-5 times in the distanee between the fore limb and the hind limb. Lower eyelid sealy. Frontonasal wider than long, in contact with the rostral and the frontal; prefrontals separated or with a pinpoint contaet. Frontal longer than the frontoparietals, in eontaet with the 1st 2 supraoeulars; 4 supraoeulars; frontoparietals and interparietals distinet, the parietals forming a suture behind the latter; 2 or 3 pairs of nuchals; 5th upper labial under the eye. Ear opening smaller than the eye opening, almost cireular. Seale smooth, the dorsals largest; a pair of enlarged preanals. Limb short, with 5 digits, 21 lamellae under the 4th toe;

the hind limb equal to the distance between the centre of the eye and the fore limb. Tail long and tapering, longer than the head and body. Grows to about 8 in. (80 + 120 mm.).

Pale brown above with blackish spots which may form a double vertebral line and a wider and more intense dorsolateral band, bounded above by a elear area and gradually merging below into the pale ventral surface. The ornamentation of the baek and sides extends on to the tail but the lower eaudal seales are dark-edged.

The species is confined to the lower South-West, Margaret River being the most northerly known locality. At the same time a specimen from the mouth of the Murehison River is eloser to this species than to the Queensland *punctulatum*.

SUB-GENUS *HEMIERGIS*

These lizards are characterised by their elongate form and very short limbs, which may bear 5, 4, 3 or 2 digits. Lower eyelid with an undivided transparent disk. No visible ear opening. Well developed prefrontals and the frontal not wider than the supraocular region. In many respects they resemble the Rhodonas from which they can be distinguished by the absenee of a visible ear opening indicated by a depression, well developed prefrontals and the frontal not wider than the supraocular region.

They are very similar to one another in coloration, being bronzy, golden or brownish above with 4 longitudinal lines of black dots and a more or less developed dorsolateral band. The sides are grey, with dark spots and the under surfaee whitish with each scale on belly and tail dark-edged.

The species ean be separated by the number of digits on the fore and hind limbs whieh usually agree, although there are intermediate forms, sueh as *woodwardi* Lueas and Frost, whieh has 4 digits on the fore limb and 3 on the hind limb. This "species" is in all probability an abnormality as the Museum eollection also contains individuals with 3 digits on the one limb and two on the other. Further Boulenger reports a specimen with 4 fingers and 3 toes among a bateh of *tridactylum* from Coolgardie.

Werner is of the opinion that there is only one species with varieties whieh do not deserve more than subspecific rank. Specimens may grow to about 6 in. (150 mm.).

KEY TO THE SPECIES

Fingers 5, toes 5 .... *initiale* Werner, around Perth
Fingers 4, toes 4 .... *quadridigitatum* Werner, lower S.W. to Esperanee
Fingers 3, toes 3 .... *tridactylum* Blngr., Yallingup and Coolgardie
Fingers 2, toes 2 .... *quadrilineatum* (Gray) Geraldton to Bunbury (Coastal)

The Museum has specimens of *woodwardi* from Wellington Mills and Busselton.

A typical species [*Lygosoma (Hemiergis) tridactylum*] may be described as follows: body elongate, limbs weak with 3 fingers and toes; the distance between the tip of the snout and the fore limb about twice in the distance between the fore limb and hind limb. Lower eyelid with an undivided transparent disk. Frontonasal broader than long, in contact with the rostral and the frontal; frontal as long as the frontoparietals, about the size of the interparietal, in contact with the first 2 of the 4 supraoculars; 3 pairs of nuchals; 5th upper labial under the eye. Ear covered with scales indicated by a depression. Scales smooth, dorsals largest; a pair of enlarged preanals. The length of the hind limb equals the distance between the centre of the eye and the fore limb. The useless fore limbs fit into a depression. Tail thick, longer than the head and body if entire.

Bronzy brown above, most of the scales with a dark dot arranged in the lines along the back, a black dorsolateral line extending from the tip of the snout to the end of the tail, the sides dark-spotted and the scales on the belly and tail dark-edged.

SUB-GENUS *RHODONA*

The species of *Rhodona* show many stages of specialization for a burrowing life in sand. All are considerably elongated and have a general resemblance in outline and coloration; the snout has become a digging/general instrument through its development and the tail may be merely a continuation of the body in shape. As a rule the coloration is pale. The scales of the dorsal surface are adorned with dark spots, which may be scattered over the surface or arranged in definite lines along the body and tail. On the other hand, some species have, in addition, broad longitudinal bands, 2 or 3 in number, extending from the snout or occiput to or on to the tail.

The sub-genus has been defined by Boulenger as follows: "Limbs short or rudimentary. Lower eyelid with a transparent disk. Ear distinct, minute. No supranasals. Prefrontals very small and widely separated or absent. Frontal broader than the supra-ocular region."

KEY TO THE W.A. SPECIES

Fingers 5, toes 5 .... *microtis*
Fingers 4, toes 4 .... *frosti*
Fingers 2, toes 3.
  Prominent ventrolateral keels, no dark lateral bands .... *planiventrale*
  No prominent ventrolateral keels, narrow dark lateral bands .... *goerlingi*
Fingers 2, toes 2 .... *walkeri*
Fingers 1, toes 2.
  Frontoparietals and interparietal free, three dark bands .... *gerrardii*

Frontoparietals and interparietals fused, no dark bands ..... *lineopunctulatum*

Fingers absent, toes 2.
Two lateral bands ..... *bipes*

Fingers a "bud," toes 2.
Three bands ..... *nichollsi*

Fingers a "bud," toes 2.
Two bands ..... *picturatum*

Fingers a "bud," toes 2.
Two bands of dots only ..... *lineopunctulatum*

Fingers a "bud," toes 1.
No lateral bands. Four rows of vertebral dots ..... *miopus*

Fingers absent, toes 1. Two lateral bands ..... *praepeditum*

Lygosoma (Rhodona) microtis (Gray)

Form elongate, the distance between the tip of the snout and the fore limb nearly twice the distance from the fore limb to the hind limb. Lower eyelid with an undivided transparent disk. Nasals in contact; frontonasal broadly in contact with the frontal which is broader than the supraocular region and as long as the fronto-parietals and interparietals combined which are distinct, not united; in contact with the 1st 2 supraoculars; 5th upper labial enters the eye. Ear opening circular as large as the nostril. 4 pairs of nuchals. Scales smooth, dorsals largest. A pair of enlarged preanals. Hind limb as long as the distance between the tip of the snout and the fore limb. All limbs with 5 toes. A specimen in the Museum measures body only 1 11-16 in. (44 mm.).

Colour greyish above with two black lateral bands on each side with a white one between.

The lizard is confined to the lower South-West, being known from Manjimup, Pemberton and Cheyne Beach.

Lygosoma (Rhodona) frosti Zietz

Form elongate, the distance between the tip of the snout and the fore limb from 2 to 2½ times the distance between the fore limb and the hind limb. Lower eyelid with a transparent disk. Nasals in contact behind the rostral; frontonasal large, wider than long forming a wide suture with the frontal; prefrontals small and widely separated; frontal wider than the supraocular region, in contact with the first and second supraocular, longer than the parietals and interparietals combined; 4 supraoculars; frontoparietals and inter-parietal free, 2 or 3 pairs of nuchals. Ear opening minute. Scales smooth, dorsals largest, laterals smallest. A pair of enlarged pre-anals. Limbs weak with 4 digits; hind limb as long as the distance from the eye to the fore limb. It grows to 3½ in. (35 + 42 mm.).

The colour is greyish above with 4 series of black dots forming lines along the back, a blackish lateral band from the snout on to the tail, sides below this darker than the back; tail brownish with irregular blackish dots. Lower surface greyish or brownish, each scale dark-edged.

Reported from the far interior.

Lygosoma (Rhodona) planiventrale Lucas & Frost

Form elongate, the distance between the tip of the snout and the fore limbs about 2 1-3 times that between the fore limb and the hind limb. Snout projecting; lower eyelid with a transparent disk; frontonasal forming a suture with the rostral and a wider one with the frontal which is a little wider than the supraocular region and as long as its distance from the tip of the snout, in contact with 2 of the 3 supraoculars; frontoparietals smaller than the interparietal. Two pairs of enlarged nuchals; 4th upper labial under the eye. Ear visible, indicated by a depression. Scales smooth, 22 round the body, laterals smallest, a pronounced keel separating the lateral surface from the flat ventral. A pair of enlarged preanals. Fore limb didactyle, hind limb more than 3 times as long as the fore limb, with 3 toes—3rd toe very long. Tail shorter than the head and body or as long. Grows to head and body, 2 3/8th in. (60 mm.), fore limb 5 mm., hind limb 16 mm. Tail usually imperfect.

Greyish brown above with 4 narrow faint dark lines and a dark brown dorsolateral stripe from the eye to the tail. Under surface pale brownish yellow. Tail with more irregular dark markings.

Found inland in the Eastern Goldfields and the North-West (Gascoyne, etc).

Lygosoma (Rhodona) planiventralis desertorum Sternfeld has scales in 20 rows and shorter limbs. As Sternfeld makes no mention of the prominent keels it is possible that his form is not related to this species.

Lygosoma (Rhodona) goerlingi Ahl.

Form elongate, the distance from the snout to the fore limb 2 2-3 times the distance between the fore limb and the hind limb. Lower eyelid with an undivided transparent disk. Nasals in contact; frontonasal large, widely in contact with the frontal which is wider than the supraocular region and longer than the frontoparietal and interparietal together; frontal in contact with the 1st and 2nd supraoculars, of which there are 4, the 2nd largest, and the 4th very small. The prefrontals small and widely separated; frontoparietals fused; interparietal distinct; 4 pairs of nuchals; the 4th upper labial under the eye. Ear opening minute, slightly larger than the nostril. Scales round the body smooth, the dorsals the largest; a pair of enlarged preanals. Two subequal digits on the fore limb; hind limb as long as the distance from the tip of the snout to the fore limb, with 3 unequal digits; tail rather thick, round in section, slightly shorter than the head and body. Grows to 5¼ in. (130 mm.).

The coloration is golden olive brown with a narrow black line along the two vertebral series of scales and a dorsolateral band from the nostril, through the eye, and along the body to half way along the tail. Sides peppered with darker, as also is the posterior part of the body and tail.

The type locality is Marloo Station, Wurarga, near Yalgoo.

Lygosoma (Rhodona) walkeri Blngr.

Body much elongated; limbs very weak didactyle; distance between the tip of the snout and the fore limb 2½ to 3 times the distance between the axilla and the groin. Snout obtusely conical. Eye very small; lower eyelid with an undivided transparent disk. Nostril in a large nasal which is in contact with its fellow; frontonasal twice as broad as long, forming a wide suture with the frontal; prefrontals small and widely separated; frontal broader than the supraocular region, in contact with the first and second supraoculars; 3 supraoculars, the 2nd largest; frontoparietals fused, smaller than the interparietal; 3 pairs of nuchals; 4th upper labial entering the orbit. Ear opening very small but distinct. 20 smooth scales round the middle of the body, dorsals largest. A pair of enlarged preanals. Fore limbs as long as the mouth, hind limb as long as the distance between the ear and the fore limb; 2nd toe more than twice the length of the first. Tail thick. Total length, 113 mm.; head and body, 60; tail, 53; fore limb, 5; hind limb, 9.

Greyish above, each scale with a black dot, which is the largest on the 4th scale from the middle line. Lower parts whitish, tail with black dots.

Roebuck Bay and Condillac Island, W. Australia.

Lygosoma (Rhodona) gerrardii (Gray)

Form much elongated, the distance from the tip of the snout to the fore limb nearly 3 times the distance between the fore limb and the hind limb. Fore limb monodactyle, hind limb with 2 toes. Snout slightly projecting; eye very small, lower eyelid with transparent disk. Nasals swollen, not or just in contact; frontonasal in contact or separated from the rostral, broadly in contact with the frontal which is much wider than the supraocular region and in contact with two anterior supraoculars and the interparietal; frontoparietals smaller than the interparietal; 3 pairs of nuchals; 4th upper labial enters the eye. Ear opening almost invisible. Scales smooth and shining, the dorsals the largest. A pair of enlarged preanals. Fore limb as long as the distance from the tip of the snout to the eye; hind limb as long as the distance from the mouth to the fore limb. Tail at the base as thick as the body but gradually tapering to the tip as long as the head and body in a perfect specimen. The species grows to about 6⅜ in. (82 + 79 mm.).

The colour is pale yellow above with three broad dark brown longitudinal bands, the central from the back of the head, the others from the snout.

Found from south of the Murchison, inland to Lake Moore and east of Moora.

Lygosoma (Rhodona) lineopunctulatum (D. & B.)

Body elongate, fore limb reduced to a styliform remnant, hind limb didactyle. Snout with a projecting labial edge. Eye small, eyelid with a transparent disk. Nostrils in large nasals which are in contact behind the rostral; frontonasal large, much wider than long, with a broad suture with the frontal; prefrontals small, widely separated; frontal much wider than the supraocular region, in contact with the 1st 2 of the 3 supraoculars. Frontoparietals and the interparietal fused. One or 2 pairs of nuchals; 4th upper labial entering the eye. Ear opening hardly visible. 20 or 22 smooth scales round the body, dorsals largest. A pair of enlarged preanals. Fore limb about as long as 2 scales, hind limb about as long as the distance between the nostril and the fore limb; second toe more than twice as long as the first. Tail thick, shorter than the head and body. Total length, 154 mm.; head and body, 92; tail, 62; fore limb, 1.5; hind limb, 9.

Ningaloo Station near Point Cloates, Carnarvon, Geraldton and south to Perth.

Lygosoma (Rhodona) bipes (Fischer)

Form very elongate, snout projecting, fore limbs absent, hind limb with 2 toes. Eye very small, lower eyelid with a transparent disk. Nasals in contact; no prefrontals; frontonasal broadly in contact with the frontal, which is much wider than the supraocular region and larger than the fused frontoparietals and interparietal. 3rd upper labial enters the eye. Ear opening minute. Scales smooth. Two enlarged preanals. Tail as wide as the body but tapering to a point, shorter than the head and body, often replaced whole or in part. Hind limb with 2 toes the one more than twice the size of the other. Length of head and body about 2 in. (54 mm.).

The colour is pale reddish brown with 2 rows of dark brown dots along the vertebral area and a broad dark lateral band on each side, the markings more pronounced towards and on the tail. The under surface is uniform whitish in preserved specimens.

First recorded from Nicol Bay, the lizard has been found in West Kimberley, along the Canning Stock Route, and as far south as Wiluna and the Murchison River.

Lygosoma (Rhodona) nichollsi Loveridge

Form elongate, fore limb a bud about half as long as an adjacent scale, hind limb with 2 toes. Snout projecting. Eyelid with an undivided transparent disk; nasals in contact; frontonasal wider than long, forming a wide suture with the frontal; prefrontals small, widely separated; frontal much wider than the supraocular region, in contact with 2 of the 3 supraoculars; frontoparietals and interparietal fused. Ear opening almost indistinguishable. One or 2 pairs of nuchals; 4th upper labial enters the eye. Scales smooth, the dorsals largest. A pair of enlarged preanals. Tail thick, as long as or longer than the head and body. The species grows to 5 in. (63 + 64 mm.).

The colour of spirit specimens is pale buff with 3 prominent, wide longitudinal bands, the vertebral starts on the nuchals and reaches the tip of the tail. The dorsolateral bands commence at the nostril and pass through the eye along the side on to the tail. The colour below immaculate white.

The species is known from the Murchison district, the type locality being Dalgaranga Station, 50 miles N.E. of Yalgoo.

Lygosoma (Rhodona) picturatum Fry

Form stout elongate, distance from the tip of the snout to the fore limb from 3 to 3½ times the distance between the fore limb and the hind limb. Snout projecting with a rounded edge. Eye small, the lower eyelid with a transparent disk. Nasals forming a median suture; frontonasal wider than long, broadly in contact with the frontal which is much wider than the supraoculars and as long as its distance from the tip of the snout; supraoculars 2; frontoparietals separated by the interparietal. 2 to 4 pairs of nuchals; 6 upper labials, the 4th entering the eye. Scales smooth and shining. Fore limbs minute, in a depression, 1 or 2 mm. in length; hind limb with 2 toes about 16 mm. in length; tail as thick as the body but tapering, apparently easily lost and replaced. The type specimen in the Museum with tail imperfect measures 3⅝ in. (92 mm.) from the tip of the snout to the vent, a specimen with body length of 93 mm. had a tail 64 mm., and another measuring 70 mm. had a tail 56 mm., partly replaced.

Fresh specimens are strikingly coloured; the dorsal surface is buff with 4 rows of dots from the head to the tail forming narrow stripes and 2 wide lateral bands from the nostril to the end of the tail.

The main distribution is in the far interior, east of Kalgoorlie, though a specimen is recorded from the Mullewa area.

Lygosoma (Rhodona) miopus (Gnth.)

Body elongate, fore limbs reduced to a "bud" behind which is a short groove, hind limb monodactyle about as long as the head. Snout cuneiform. Eye very small, lower eyelid with a transparent disk; nasals forming a median suture; frontonasal much wider than long, widely in contact with the frontal; prefrontals small, widely separated; frontal wider than the supraocular region, in contact with the 1st and 2nd supraoculars; 3 supraoculars, frontoparietals and, interparietal fused. Tail long tapering. Head and body of type specimen, 3¼ in. (82 mm.); tail, imperfect.

Pale olive above, with 4 very indistinct lines of minute black dots along the back, no dorsolateral band.

The type was collected at Champion Bay by Du Boulay. It is known from Bernier I.

Lygosoma (Rhodona) praepeditum Blgr.

Form very elongate, fore limb absent, hind limb monodactyle. Snout projecting; lower eyelid with a transparent disk; nasals in contact; no prefrontals; frontal very large; frontoparietals and interparietal fused to form a large shield; 1, 2 or 3 pairs of nuchals; 3rd upper labial under the eye. Ear opening almost invisible. Scales smooth, dorsals largest; a pair of enlarged preanals. Fore limb absent. Hind limb monodactyle, about as long as the adjacent scales. Tail as thick as the body but shorter. Grows to 4¾ in. (63 + 59 mm.).

Brownish white above with 2 rows of dark brown dots on the vertebral scales and a broad dark lateral band from the snout through the eye to the tip of the tail; lateral and ventrolateral scales dark-edged. Under surface pale, that of the tail dark-spotted.

Specimens in the Museum are from Carnarvon and Bernier I. in the north to the vicinity of Perth, Pinjarra and York.

(To be concluded with an account of the genus *Ablepharus*.)

EGERNIA BOS A NEW SKINK FROM THE SOUTH COAST OF WESTERN AUSTRALIA

By G. M. STORR, Zoology Department, University of Western Australia.

As implied by Mitchell (1950) in his review of the genus, an understanding has scarcely begun of the various smooth-scaled *Egernia* formerly lumped with *whitii* Lacépède. All south-western members of the species group were regarded by Mitchell as a geographic race of the south-eastern Australian *whitii*. That the situation is not so simple here became evident after the examination of recent collections from the south coast.

Two distinct populations, equally representative of *whitii*, were found occurring side by side at Cheyne Beach, 32 miles east of Albany. One of them was identical with *pulchra* Werner (1910), or at least agreed with his detailed description of the type from Torbay, 45 miles to the west. The other population, hitherto undescribed, is here named.

Egernia bos sp. nov.

Habit: Compared with *pulchra*, *bos* is a short, deep-bodied lizard with relatively shorter tail (1.3-1.5 times the head plus body; the ratio in *pulchra* is 1.6-1.8). The snout is short and steep in profile. Largest specimen 193 mm. (82 + 111).

Coloration: Generally similar to but paler than *pulchra*, from which it differs mainly in the nature of the two dorsal black streaks. In *bos* they usually begin broadly on the parietals and invariably enclose a *double* series of pale spots; whereas in *pulchra* the streaks usually begin narrowly on the nape, not attaining their full width before the shoulders and moreover enclose only a single series of pale spots (see Fig. 1). The chin and throat of *bos* is bluish grey, the sutures between shields darker; in *pulchra* the entire under-surface is white. The lower surfaces of the digits are pale in *bos*, dark in *pulchra*.

Scalation: The dorsal scales are smooth (they are weakly tricarinate in *pulchra*). The interparietal is as wide as or wider than the frontal (in *pulchra* it is consistently much narrower than the frontal). There are usually 8, sometimes 7, upper labials. (I have only seen 7 in *pulchra*.) Midbody scales number 40-44 (mostly 42 and 44), compared to 36-40 (mostly 36-38) in *pulchra*. The subdigital lamellae are divided, each semi-lamella being tuberculately keeled, and under the fourth toe number 20-24 (mostly 22 and 23); in *pulchra*, only the basal lamellae are divided, all are unkeeled, and they are more numerous (24-27). The ear aperture is narrow oblong in shape and almost obscured by the 3-5 (mostly 4) subequal lobules; it is much wider in *pulchra*, especially at the top, and is protected by only 3 lobules, decreasing in size downwards.

Material: The above description of *bos* is based on the following 23 specimens:—

Holotype. W.A. Museum no. R 10751 collected by B. Malcolm at Cheyne Beach in 1953.

Paratypes. W.A. Museum nos. R 10752-4 collected on same occasion as the holotype and 15 specimens in the Zoology Department, collected at Cheyne Beach in 1959 (8 by the Zoology Department Bald Island Expedition on May 25, and 7 by the writer on December 14).

Other material: 4 specimens in the Zoology Department collected by D. H. Edward and the writer on December 8, 1959; 2

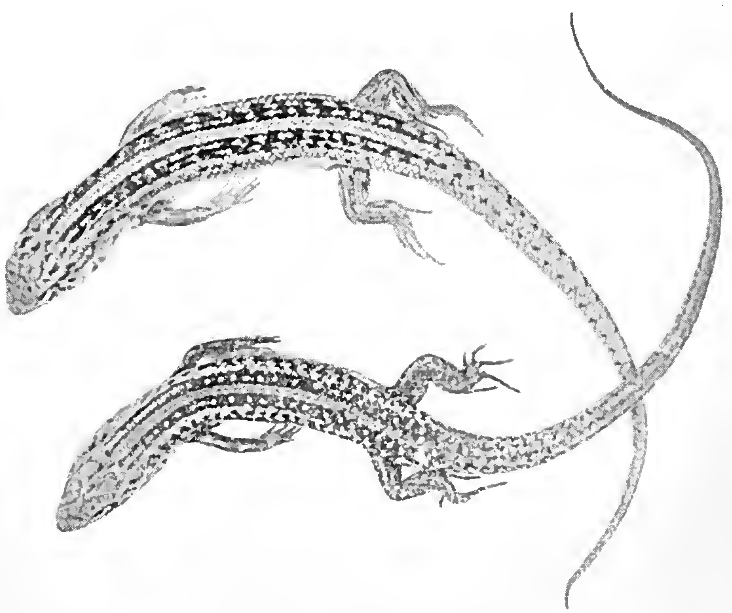

Fig. 1.—*Egernia bos* (at top) and *E. pulchra*, showing dorsal pattern.

were taken near Mt. Baring (20 miles north of Cape Arid) and 2 from 15 miles south-west of Israelite Bay.

Type locality: Cheyne Beach, Western Australia (34° 52′ S, 118° 23′ E).

Known distribution: South coast sandplains from Cheyne Beach is in the west to Israelite Bay in the east.

Ecology: Within this range *bos* occurs discontinuously, its habitat requirements being rather narrow. All the writer's specimens were taken from burrows in well-drained white sand free of laterite gravel. Most of the south coast sandplains overlie laterite, many others are waterlogged in winter, or the sand is mixed with large amounts of silt or organic matter. None of these situations are suitable for the species, but in the limited areas where they are present, their burrows are abundant.

The burrows slope gently downwards for 10-30 in. and often have more than one entrance. The lizards prefer to burrow into a vertical or nearly vertical surface, hence their concentration in road cuttings or the sides of wheel ruts in bush tracks.

In contrast *pulchra* is mostly found under stones and logs, though at Cheyne Beach two specimens were obtained from shallow burrows, partly in leaf litter, beneath shrubs growing round the base of a granite outcrop.

Some of the differences between the two species appear to be adaptations to their different ways of life. The relatively depressed head and body of *pulchra* recalls the contrast in form between rock-inhabiting species of *Amphibolurus* and those that live in the open or in burrows. The strong fore limbs of *bos* with their short thick digits seem well adapted for digging; and the narrow aperture, almost completely closed by lobules, doubtless prevents the outer ear from becoming clogged with sand.

Relationships: Most similar to *bos* are the poorly collected populations to the north of its range. A specimen in the W.A. Museum (R 2535) from Ongerup differs from *bos* only in minor details, e.g., low number of midbody scales (38), division of some rather than all subdigital lamellae, head uniformly pale grey rather than greyish brown blotched with black and the ear lobules and edge of eyelids greyish white rather than creamy white.

Two specimens (R 13118-9) from Bernier Island (Shark Bay) have undivided subdigital lamellae and differ slightly from *bos* in colour pattern. The pale vertebral streak is relatively wider and the black streaks narrower, and as their enclosed pale spots are large, there is dorsally much less black than in typical *bos*. This insular population does not burrow (Dr W. D. L. Ride, pers. comm.).

Of the described forms of the *whitii* group, *multiscutata* Mitchell and Behrndt (1949) is undoubtedly most like *bos*. The two agree in their smooth dorsals, high midbody scale count, broad interparietal and in having 8 upper labials. I have not seen specimens of *multiscutata*, but from its authors' description the two forms seem to differ mainly in the nature and number of subdigital lamellae. In *multiscutata* they are unicarinate, presumably undivided, and more numerous (25-29). Each of the dorsal streaks in *multiscutata,* as in *pulchra* and *whitii,* encloses a single row of pale spots. In at least the type locality (Greenly Islands) *multiscutata* does not burrow.

On the other hand, *pulchra* shares exclusively with *whitii (sensu stricto)* the following characters: slender habit, long tail, narrow interparietal, fewer than 40 midbody scales, only 7 upper labials and dorsal scales either weakly tricarinate or tristriate. The known distribution of *pulchra* is from the vicinity of Collie (Werner) south and east to Cheyne Beach, i.e., the wettest and coolest part of Western Australia. Further research may show that *pulchra* and *whitii* are the western and eastern representatives of a Bassian species, and *bos* and *multiscutata* the western and eastern representatives of a closely related Eyrean species.

However, before any such scheme can be presented with confidence, many more specimens and biological data are required from critical areas, especially that part of South Australia where *multiscutata* and *whitii* make contact (if they still do so). Meanwhile it seems best to treat both *pulchra* and *bos* binomially; the one thing certain is that these two are not conspecific.

Nomenclature: Loveridge (1934) unfortunately applied the name *napoleonis* to *Egernia pulchra* Werner, with which it has nothing to do. The original description of *Tiliqua napoleonis* Gray (1839: 290) reads like the lizard referred to as *nitida* by Loveridge, *striolata nitida* by Mitchell (who incidentally overlooked the fact that *nitida* is an older name than *striolata*) and *carinata* by

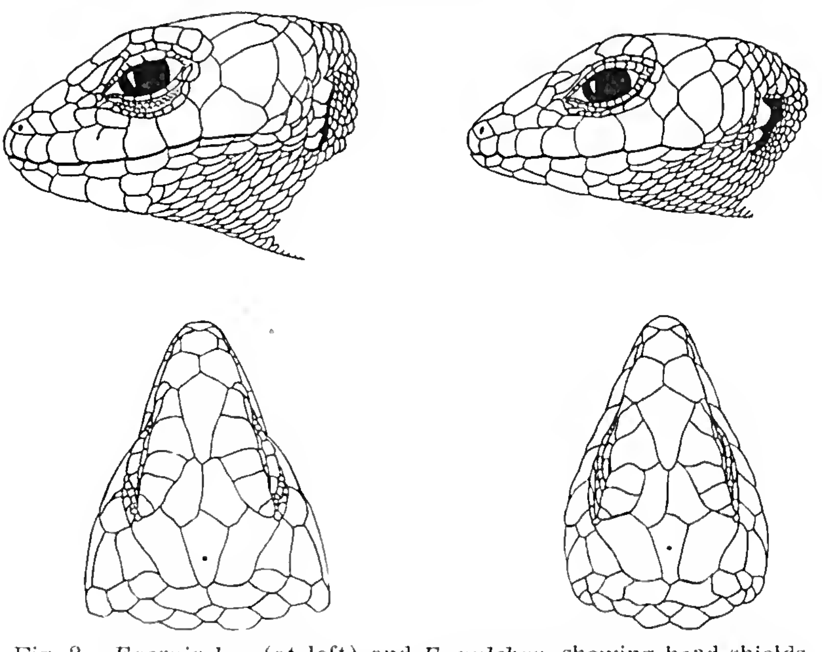

Fig. 2.—*Egernia bos* (at left) and *E. pulchra,* showing head shields.
—Del. G. E. Binsted.

Glauert (1960). *Tiliqua leucopsis* Gray (1839: 291) could possibly be an older name for *pulchra*. However, I recommend the use of *pulchra* for this lizard; Werner's excellent description leaves no doubt as to the identity of the animal he is describing.

The population here named *bos* was lumped under *Egernia whitii* with those from further north in Glauert's recent account of the genus.

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ON THE TAXONOMIC STATUS OF THE SOUTH-WESTERN AUSTRALIAN CHESTNUT-SHOULDERED WRENS

By JULIAN FORD, Attadale

In a revision of the genus *Malurus*, G. Mack (1934) considered the three chestnut-shouldered wrens of South-Western Australia to be separate species even though the material available indicated that they were only geographical replacements of each other and should most probably be treated as subspecies. No evidence was available as to whether any distributional overlap and consequent possibility of hybridisation occurred. Mack's taxonomic treatment was largely followed by N. W. Cayley (1949). E. Mayr and D. L. Serventy (1944), in their summary of the number of bird species in Australia, lumped all the chestnut-shouldered wrens under the one species name. However, K. G. Buller's (1950) discovery that both *Malurus lamberti* and *pulcherrimus* occurred together at the mouth of the Murchison River stimulated Serventy (1951) to review the situation afresh. The outcome showed that there was an overlap in the ranges of *lamberti* and *pulcherrimus* of 50 to 70 miles. This data, reinforced with the fact that the third chestnut-shouldered wren of the South-West, *elegans,* occupies a distinctly different ecological niche to the other two, led Serventy to recognize the three forms as worthy of specific rank. H. T. Condon (1951) lists *lamberti* and *pulcherrimus* as separate species but the inference is that he is rather dubious of *pulcherrimus* being classified as such.

Further material collected on this controversial subject indicates that *lamberti* and *pulcherrimus* have a very much wider range overlap along the west coastal strip than was previously suspected. Since October 1957 I have collected specimens of *lamberti* at the mouth of the Murchison River, Geraldton, Cockleshell Gully, Lancelin, mouth of the Moore River, Yanchep, and City Beach. This extends the known distribution of the species along the coastal plain for some 240 miles, to the vicinity of Perth. The furthest south along the coastal plain that I have collected *pulcherrimus* was at the Namban River, some 50 miles west of Moora.

DETAILS OF MATERIAL COLLECTED

Since specimens of both *lamberti* and *pulcherrimus* were collected at the mouth of the Murchison River by Buller, I will not elaborate on my experiences in this area other than that I collected two male specimens of the former in January 1959, and one in October 1957.

In the scrub thickets between Balline, Geraldton and Dongara, I found *lamberti* to be numerous and widespread. A male specimen was collected at Geraldton on November 2, 1957. East of Geraldton at Northern Gully, several parties of this wren were observed in January 1959.

On August 24, 1958, I collected a male specimen of *lamberti* in a patch of stunted *Casuarina glauca* in the coastal dunes, some six miles north-west of Yanchep. I saw only one party of this chestnut-shouldered wren, which comprised two fully plumaged males and several females. On September 14, this party was again seen. However, a search in the dunes immediately near the coast proved fruitless.

This surprising development induced me to re-examine the specific status of the red-shouldered wrens occurring along the coastal strip near Perth. On September 11, 1958, a party comprising two nuptial plumaged males and some two or three females, was seen in the coastal dunes at City Beach. A male specimen of *lamberti* was collected. Further observations made on November 8 and 20 at Swanbourne, City Beach and Scarborough revealed that *lamberti* was quite common. On November 20, in the *Acacia rostellifera* thickets growing in the coastal dunes at the Swanbourne rifle range, I found a nest of *lamberti* situated some 12 inches from the ground, containing three half-fledged chicks. The nest was placed in a clump of *Pelargonium drummondii* growing around the base of an *Acacia.* Attending the nest were at least two female plumaged birds and a brilliant nuptial plumaged male, which was subsequently photographed in colour by P. Slater and shown to be *lamberti*. On the same day, three or four males were seen in the dune wattle thickets in this locality.

At the mouth of the Moore River on October 18, 1958, *lamberti* was found inhabiting the thick scrub of the coastal dunes, particularly those along the river mouth. Three parties were observed and a male specimen was collected. The following day two parties with fully plumaged males were seen in the thick dune scrub between Lancelin and Edward Island. A few miles inland from Lancelin, in the thickets of *Acacia rostellifera, lamberti* was surprisingly common and a male specimen was collected.

The coastal strip between Lancelin and Dongara was investigated for the presence of *lamberti* at Cockleshell Gully where a male specimen was collected on March 27, 1959, and near Green Islets, where a male was taken on March 1, 1959. Red-shouldered wrens were plentiful at both localities and also in the dense wattle thickets along the lower portion of the Hill River, but the identity of the Hill River birds has not been ascertained.

M. pulcherrimus was found to be extremely common in the dense dune thickets of *Acacia rostellifera* at the Namban River, where three blue-breasted male specimens were collected on November 1 and 2, 1958. No evidence of the presence of *lamberti* was found but it doubtless occurs in the locality.

Observations on *elegans* were limited to the thickly grown margins of the Gingin Brook, north of Perth, and in the Darling Range, east of Perth. On October 18, 1958, at the Gingin Brook, some four miles from where it meets the Moore River, a male specimen was collected and others were seen. In the valleys of the Darling Range, particularly the Canning and Wongong, *elegans* was shown to be common, inhabiting dense *Grevillea diversifolia* and *G. manglesioides* thickets.

The specimens mentioned are now in the W.A. Museum.

VALIDITY OF PREVIOUS RECORDS

It was probably more than coincidental that only *lamberti* was collected in the coastal dunes near Perth since previously it was believed that the chestnut-shouldered wren inhabiting this region was *pulcherrimus*. No specimens had been collected prior to my investigation but W. H. Loaring (1950), J. Lyon (1951) and J. R. Ford (1954) recorded *pulcherrimus* in this area. Ford and Teague (1959) also reported *pulcherrimus* at Lancelin. The problem is whether these observations are valid.

Loaring recorded that the chestnut-shouldered wrens observed at the mouth of the Moore River had blue violet breasts which were unmistakable when the birds faced the direct sunlight. I would like to point out that this is not an infallible characteristic for field identification because I have collected male specimens of *lamberti* which, in the field, appeared to have dark blue breasts and conversely I have collected male specimens of *pulcherrimus* which, in the field, appeared to have black breasts. This demonstrates that field identification of *lamberti* and *pulcherrimus* is entirely unsatisfactory, and hence I would conclude that all chestnut-shouldered wrens seen in the coastal dunes near Perth and reported as *pulcherrimus,* are in fact *lamberti* until specimens of *pulcherrimus* are forthcoming.

Despite this last issue, there is an enormous overlap in the geographic ranges of *lamberti* and *pulcherrimus,* of some 240 miles, from the mouth of the Murchison River to the Namban River.

COMPARISON OF MATERIAL

All the specimens of *lamberti* collected near Perth were compared with those from further north, that is north of a line through Geraldton, Morawa, Caron and Kalgoorlie, and have been found to be identical. They clearly belong to the race *M. l. mastersi* (Mack, 1934 and Condon, 1951).

The specimens of *pulcherrimus* from the Namban River were identical with typical *pulcherrimus.*

This indicates that *M. lamberti* has passed through the geographic range of *M. pulcherrimus* to the vicinity of Perth, without any indication of inter-breeding, that is, the two forms are sympatric.

Serventy (1951) has previously shown that *elegans* occupies a distinctly different environment to that of the other two forms.

SUMMARY

The known distribution limit of *M. lamberti* has been extended southwards along the coastal plain to the Perth area. *Malurus lamberti* and *pulcherrimus* have large overlapping geographical ranges and are consequently sympatric. This supports previous views that the three forms of chestnut-shouldered wrens of the South-West are specifically distinct.

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ACKNOWLEDGMENTS

I am grateful to Dr. G. F. Mees (of the W.A. Museum) for allowing me access to museum material and to G. M. Storr for assistance with literature references. Dr. D. L. Serventy kindly made critical comments.

SOME MAMMAL REMAINS FOUND IN CAVES NEAR MARGARET RIVER

By D. L. COOK, Nedlands.

During two visits made by the author in March, 1959, to limestone caves near Margaret River, a quantity of mammal bone material was collected, three series of which are worthy of record; two extending species ranges and the others representing a species rarely found in this State.

Macroderma gigas (Dobson)
Great Carnivorous Bat or Ghost Bat

The present living distribution of this bat extends through northern Australia from the Pilbara district to Rockhampton in Queensland (Finlayson, 1958). Previous records of bone remains in South Australia and Western Australia showed its past distribution to have been as far south as Yanchep on the west coast and Carrieton, near Port Augusta, in South Australia (Lundelius, 1957).

The collection of a skull of this animal in a cave in the south-west of this State extends even further its past southern distribution. Details of the specimen are as follows:—

Locality: Nannup Cave, near Baranup Mill, south of Margaret River, on the Caves Road.

Deposition: 20 in. below a sheet of dripstone varying in thickness from 2 in. to 3 in. in association with a quantity of bone representing the following marsupials (in order of abundance): *Bettongia penicillata, B. lesueurii, Setonix brachyurus, Trichosurus vulpecula, Sminthopsis crassicaudata, Dasyurus geoffroii, Sarcophilus harrisii, Macropus giganteus, M. irma, Pseudocheirus occidentalis.*

Rodent material was common, but this was not identified.

Reptile (probably *Trachysaurus rugosus*) and bird remains were present, together with some possible artifacts.

Sarcophilus harrisii (Boitard)
Tasmanian Devil

Western Australian material representing this species has been collected previously from the Yonderup Cave, Yanchep; the Mammoth and Bride's Caves near Margaret River and Balladonia (Glauert, 1912, 1914, 1948).

A number of specimens consisting of 8 teeth, 2 maxillae and one almost complete left mandible were collected by the author.

Locality: Nannup Cave.

Deposition: At varying levels from 1 to 51 in. below a 2-3 in. thick dripstone floor in association with the species listed above.

Sminthopsis crassicaudata Gould
Fat-tailed Dunnart

The *Sminthopsis* material referred to above was at first attributed to *S. murina* Waterhouse, as more likely on distributional grounds. However the jaws collected from Nannup Cave were compared with a series of both species named by Dr E. Lundelius and they agreed with *crassicaudata*, the identification being checked by Dr. A. R. Main and Mr. G. M. Storr. An imperfect jaw from Giant's Cave was probably that species also.

Lundelius' distribution map (1957: 178) gives the range of *S. crassicaudata* as east of the Darling scarp. The present records are the first, to my knowledge, of the occurrence of the species further west into the South-West and would suggest drier conditions when the creature existed there. This would be analogous to the record by Glauert (1948: 102) of the Dalgite, *Macrotis lagotis*, from the Mammoth Cave.

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FROM FIELD AND STUDY

Salvinia rotundifolia **in Western Australia.**—*Salvinia rotundifolia* Willd., a free-floating, aquatic fern native to tropical America, is commonly cultivated as an ornamental in local aquaria and garden ponds. This fern was recently collected from a swamp on the Bunbury road near the townsite of Harvey, where it is growing in association with *Azolla filiculoides*. The *Salvinia* covers nearly the whole surface of this large swamp. This occurrence is thought to be the second known instance of the naturalisation of *Salvinia* in our countryside.

The Fresh-Water Group of the W.A. Naturalists' Club has recorded this collection in its check-list of aquatic plants. The Group would welcome specimens of aquatics from all parts of the State. Flowering and fruiting material is preferable, but sterile plants may often prove useful for records of distribution. Specimens may be mailed to Mr. G. G. Smith, Botany Department, University of W.A. They are best sent damp, in plastic wrapping, in a cardboard box. Aquatic plants, for the purpose of this check list, are taken to be flowering plants, ferns and stone-worts (Charales) occurring in fresh water, and those plants, such as sedges and rushes, which are restricted to margins of pools or swampy soils inundated for considerable periods each year. The Group hopes later to publish the check list with notes and illustrations.

—G. G. Smith, University of W.A.

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THE IMPORTANCE OF THE MARRI AS A FOOD SOURCE TO SOUTH-WESTERN AUSTRALIAN BIRDS

By ANGUS ROBINSON, Coolup

OCCURRENCE AND FLOWERING OF THE MARRI

Marri *(Eucalyptus calophylla)* is a feature of the landscape all through South-Western Australia where the soil is suitable. The tree is an important component of the heavy forest belt and of the lighter woodland of the coastal plain. In association with blackboys (*Xanthorrhoea* species) and anthills it is considered a sign of good agricultural land. Along the Great Southern Highway and the South-Western Highway, from Perth to Albany, the Marri is prominent in the pasture, having been left in most cases as a shade tree for stock. Its spreading habit and dense foliage make it an admirable tree for this purpose, while it adds to the beauty of the countryside, particularly when covered in creamy-white blossom.

The Marri flowers, as a rule, during February and March, but odd trees may carry blossom up to July or August. Late flowering appears to be more noticeable when there has been little blossom in the normal February-March period. A heavy crop of blossom in one year is usually followed by very little the following year. The number of trees flowering, and the amount of honey produced by the blossom, varies from year to year. In Coolup in 1943 there was a heavy blossoming of marri in February-March, followed by a heavy blossoming of Jarrah *(Eucalyptus marginata)* in September-November. In 1944 there was little or no Marri blossom; in 1947 a very heavy Marri blossom; in 1948 very little; in 1949 good, and in 1952 a quite exceptionally heavy flowering. Farmers generally consider a heavy Marri blossoming as a sign of a wet winter to follow, and if it flowers early, an indication of an early break in the season. This belief is quite erroneous, however. Thus the heavy blossoming of 1943 was followed by one of the driest 12 months for 52 years.

Now we come to the season just passed. The summer of 1959-60 was cool, with two inches of rain from December 30 to January 1. The Marri flowering was very heavy, reaching a peak I have never seen equalled before, except perhaps in 1952. In most seasons only a percentage of Marri trees flower and some trees only poorly. In 1960, however, in the Coolup area 90% or more of the trees flowered and the old trees, particularly, were completely covered with blossom and the honey flow was heavy. This flow of honey may have been helped by the late December rain, but the abnormally cool summer was probably the chief factor. In a normal season though the blossom may be profuse the flow of honey is controlled to a certain extent by the weather conditions prevailing at the time. Cool weather during the flowering period will increase the honey flow but hot dry weather, including strong east winds, will cut it off short.

BLOSSOM FEEDING BY BIRDS

The Marri honey flow, though of short duration (6 weeks to 2 months), is of value to the apiarist as at that time the other honey flora is at a rather low ebb. The Marri blossom is also a source of food to many nomadic honey- and insect-eating birds. The blossom is also sought after by most parrots and cockatoos in the area, whether for the pollen or nectar content is unknown. It is known, however, that some birds such as the White-tailed Black Cockatoo *(Calyptorhynchus baudinii)* consume large quantities of honey and there is no doubt that the King Parrot *(Purpureicephalus spurius)* and the Twenty-eight Parrot *(Barnardius zonarius)* also derive nourishment from the blossoms. The King Parrot is very partial to tree blossom and, besides Marri blossom, it eats the blossom of Jarrah, *Melaleuca,* and other plants, such as the Silky Oak *(Grevillea robusta)*.

The value of the Marri blossom to these birds was made conspicuously evident to me on a trip I took in February-March 1952 across the Darling Range at Dwellingup and down the Great Southern Highway to Albany, returning through Nornalup, Manjimup and Bridgetown. It was the best Marri blossom season I had seen up to that time and one could not help noting the number of birds, mostly honeyeaters, which were feeding on the nectar. They made themselves conspicuous by the noise they created. In a valley of the Porongorups where there is an outlier of Karri *(Eucalyptus diversicolor)* I lay on the ground and endeavoured to identify the birds in the topmost foliage of the odd flowering Marri. The birds were keeping up an incessant chatter but were themselves almost invisible to the naked eye. It was with some difficulty that I was able to identify some of the birds with 12 x 50 binoculars. Prominent among them were two species of honeyeaters and the Purple-crowned Lorikeet *(Glossopsitta porphyrocephala)* which follows the honey flow of the numerous eucalypts and banksias. The lorikeet was plentiful even in the stunted Marri round the coastline at Albany.

I found in the fruitgrowing districts that it was generally accepted that a heavy blossom on the Marri trees meant less trouble from parrots and Silvereyes *(Zosterops australasiae)* in the orchards. However, when Marri blossom was poor these birds caused a great deal of damage. This is confirmed by my own experiences at Coolup. In January 1960 Red Wattle-birds *(Anthochaera carunculata)*, Singing Honeyeaters *(Meliphaga virescens)*, Silvereyes and parrots were visiting the fruit in the garden in increasing numbers. But early in February, when the Marri started to flower, all these birds left the garden and did not reappear until the honey flow was nearly over at the end of March. On March 31 a pair of Red Wattle-birds came back into the garden, followed over the next two weeks by the rest of the company. Their absence for two months meant that the pears and grapes developed uninjured. During this period most of the small birds spent their time in the Marri blossom, probably getting insects. Notable among these were Splendid Blue Wrens *(Malurus splendens)*, Yellow-tailed and Brown Thornbills *(Acanthiza chrysorrhoa* and *A. pusilla)*, Western Warblers *(Gerygone fusca)*, Grey Fantails *(Rhipidura fuliginosa)*, Rufous Whistlers *(Pachycephala rufiventris)*, etc. In fact the only local birds not attracted to the Marri blossom were Magpies *(Gymnorhina dorsalis)*, Grey Butcher-birds *(Cracticus torquatus)*, Ravens *(Corvus coronoides)* and Hawks.

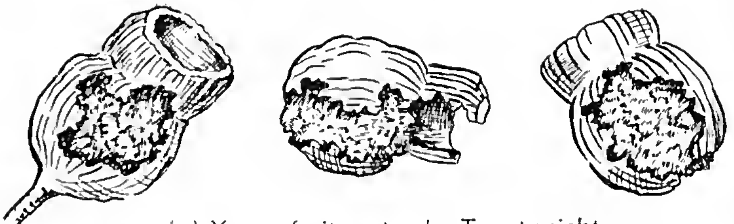
FRUIT-FEEDING BIRDS

THE IMMATURE FRUIT

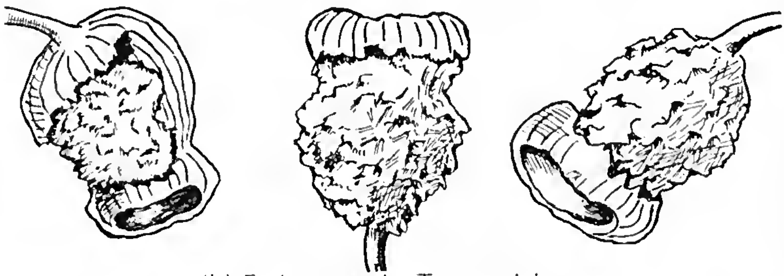
Following the blossoming a variable amount of fruit forms. The fruit, or "gum nut" as it is commonly called, matures to a hard, woody structure of comparatively great size, up to 2 in. in length, with the diameter of the bowl up to 1½ in. The fruit drops its black seeds over the next 16 months though the empty capsules may remain on the trees considerably longer. This means that some trees have new fruit forming, while they still have the green maturing fruit from the year before, besides the old brown and weather-worn capsules of previous years which had long since dropped their seeds. On April 21, 1960, odd trees had buds, flowers, immature fruit and green mature fruit from the year before. The dried up operculum in some cases was still adhering to the immature fruit.

If the Marri flowered regularly each year and produced an even crop it would provide a continuous supply of fruit in some form or other, particularly during the leanest period of the year, as far as food was concerned, and when the weather conditions were at their worst. Each fruit may develop up to three seeds of irregular shape. Most parrots and cockatoos are very fond of these fruits and spend much time extracting the seeds. As the fruit is procurable in some form throughout the year, though in variable quantity, it is of great economic value to these birds.

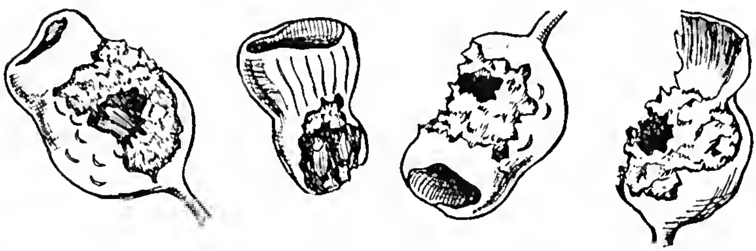
The association between the Marri and the King Parrot is well-known to ornithologists. Alexander (1930: 312) summarised and analysed most of the earlier records: McGilp (1931: 60) contributed a short paper; D. L. Serventy (1938: 169) mentioned it, and a number of writers since then. H. O. Webster (1948: 23) referred to the possibility of this parrot becoming extinct as clearing in the South-West continued and the number of Marri trees diminished. Though Marris are one of the few kinds of trees permitted to remain standing in cleared paddocks by farmers, they eventu-



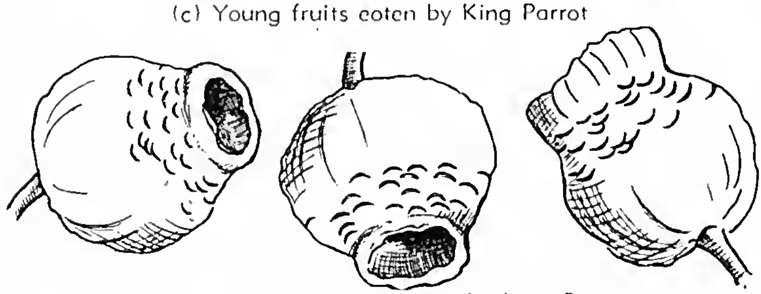
(a) Young fruits eaten by Twenty-eight



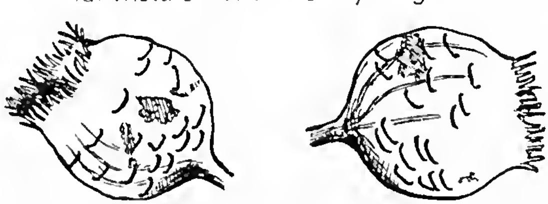
(b) Fruits eaten by Twenty-eight



(c) Young fruits eaten by King Parrot



(d) Mature fruits eaten by King Parrot



(e) Mature fruits eaten by Red-tailed Black Cockatoo

Fig. 1.—Characteristic marks of parrot and cockatoo attack on Marri fruits. Del. O. Seymour.

ally die or are blown down by winter storms and there is no regeneration, as stock eat out the seedlings. However, the trees are capable of rapid regrowth if left undisturbed. As yet there appears to be no decline in numbers of King Parrots in the Coolup district.

As soon as the Marri fruit has reached a stage where the seeds have developed the King Parrot attacks it. In 1960 this was about the third week in April (first observed on April 21). A few days before this the capsules had been tested by the birds inserting the point of the long bill into the bowl. When the parrots find a tree in which the fruit is just at the right stage all the birds in the vicinity concentrate on the one tree. The young birds pick off a fruit and, while holding it with one foot by the stem or the lip, remove the skin by passing it through their bill in the same manner as a Budgerygah removes the husk from the seed of grasses. The parrots chop off the stem up to 2 in. from the bowl of the capsule. The older birds, however, pick a fruit, test it, and, if unsatisfactory, drop it and pick up another one. If the fruit is in the acceptable stage the bird chops its way into the bowl to remove the seed. This is done in the minimum time and in a most efficient manner.

The Twenty-eight chops the fruit to pieces in its very immature stage while it is still quite soft. Later when the capsule is full size but still fleshy it removes the outside of the fruit and eats it. E. H. Sedgwick (1938: 82) estimated the freshly fallen capsules eaten by these parrots in the July-August period as 24,000 under one tree, but he had never noticed more than two Twenty-eights at any one time in the tree.

White-tailed Black Cockatoos tackle the immature fruit in a similar way to the King Parrot (cf. Carnaby, 1933: 106). The Red-tailed Black Cockatoo *(Calyptorhynchus banksi)* probably does the same, but not as neatly as does the King Parrot.

THE MATURE FRUIT

The great development of the King Parrot's upper mandible has aroused some controversy among ornithologists as to whether this is a special adaptation to extricate the seeds from the mature Marri fruit. The capsule is very hard and the bowl surrounding the seeds is almost impenetrable. The seeds are accessible only through the lip of the capsule. The black cockatoos (both species) to a certain extent mutilate the lip of the capsule, when extracting the seeds, and leave imprints of the lower bill anywhere on the bowl (Fig. 1 (c)).

The adult King Parrot, however, has the finest technique. It revolves the capsule round while picking out the seed, leaving a circle of imprints of the lower mandible just below the neck (Fig. 1 (d)). The immature bird does not make such a good job of it and the lip of the capsule is often marked. The adult birds can extricate the seeds without marking the lip at all. This would be impossible without the elongated upper mandible. That experience is also necessary is shown by the difference in performance of the young birds as compared with the adults when dealing with both green and mature capsules.

The Twenty-eight does not appear to be interested in the mature fruit, though both species of parrot eat the seeds dropped on the ground. The King Parrot also extracts the seeds from dropped Marri capsules lying on the ground.

Alexander (1930: 312) does not think that the bill of the King Parrot is a special adaptation to deal with Marri fruit, one of his arguments being that the bird occurs outside of the Marri region, a point made also by other observers. Actually, however, the main part of the geographical range of the parrot coincides with that of the Marri and the extension beyond is comparatively narrow (cf. distributional data in Serventy and Whittell, 1951: 230). I consider that the commonly held view of ornithologists, that the long beak of the King Parrot had been evolved for the more efficient exploitation of the food sources of the Marri fruit, is a valid and reasonable hypothesis. This food supply, as I have pointed out, is not universally present and in some years may be in short supply. The elongated bill is still useful in extracting seeds from other eucalypts. Thus the bird is very proficient in extracting seeds from the very much smaller capsules of the Jarrah.

Cockatoos and parrots are very adaptable in exploiting new foods in a changing environment. In recent years the White-tailed Black Cockatoos, King Parrots and Twenty-eights have all exploited new food sources. All have discovered the food available in apple and pear orchards and the two parrots, in addition, attack stone fruits, almonds, etc. Up to 1947 it would appear that the Twenty-eight was the worst offender in the Coolup district but since then the King Parrot has been responsible for most of the damage to fruit. That the Twenty-eight is considered the easier bird to shoot might account for this change in status, but it is probable that the King Parrot has taken longer to realise the value of the orchard as a food source whilst there was an abundant supply of Marri for its needs. It is noticeable in this district that the Twenty-eights have shown a strong tendency to try many new fruits not indigenous to the area. At Coolup they now eat white cedar berries, pine cones, pie melons, grapes and, over the last five years, have taken to eating oranges, though as yet only a few birds are implicated.

The King Parrot, which also includes Wild Pear *(Xylomelum)*, Sheoak *(Casuarina)* and *Hakea* seeds in its diet, may try these new foods but it has never become a consistent feeder on them. Orchard fruit appears to be the only unnatural food consumed in quantity by these parrots. Mr. J. H. Cox, of Coolup, informs me that they now regularly eat all the orchard oranges by making a small hole in the side and scooping out the contents, possibly in a search for the pips. The Silvereyes follow and clean up the inside of the fruit, the little birds almost disappearing into the hollow orange. Mr. H. P. Hannay, of Coolup, has found, however, that it is the Raven

(Corvus coronoides) which attacks his oranges as the initial predator.

The White-tailed Black Cockatoo, as shown by Perry (1948: 133), has resorted to the pine cones in the large plantations as part of its staple diet in recent years.

It is an interesting fact that all these birds only show interest in new foods during the winter period when the natural food is scarce. Twenty-eights do not eat pie melons except during this period. King Parrots do not worry the orchardist while the Marri is flowering.

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HERPETOLOGICAL MISCELLANEA

By L. GLAUERT, M.B.E., Western Australian Museum, Perth.

XII. THE FAMILY SCINCIDAE IN WESTERN AUSTRALIA.

PART 3—THE GENUS *ABLEPHARUS*

Small skinks with no movable eyelid, a transparent disk covering the eye. Ear distinct; nostril pierced in the nasal; a supranasal present or absent. Parietals meet behind the interparietal. Limbs more or less developed. The lizards of this genus can be distinguished from *Lygosoma* by the immovable lower eyelid which is permanently fused in position over the eye.

KEY TO THE SPECIES

I. Frontoparietals and interparietal fused. Fingers 5, toes 5.

Upper eyelid represented by 3 or 4 enlarged scales, frontal not half the size of the interparietal .... *boutonii*

Eye surrounded by granules, frontal more than half the size of the interparietal.

Ear opening with 1 or 2 lobules, supranasals absent .... *lineo-ocellatus*

Ear opening without lobules, supranasals present .... *taeniopleurus*

II. Frontoparietals fused, interparietal free. Fingers 5, toes 5.
  - Frontonasal in contact with the rostral and the frontal, limbs do not meet .... *davisi*
  - Frontonasal separated from the frontal, limbs meet or overlap.
    - Fingers 5, toes 5 .... *wotjulum*
    - Fingers 4, toes 5 .... *greyii*
    - Fingers 3, toes 3 .... *rhodonoides*

III. Frontoparietals and interparietals free.
  - Fingers 5, toes 5. 28 scales round the body .... *reginae*
  - Fingers 5, toes 5. 22 scales round the body .... *broomensis*
  - Fingers 4, toes 4 .... *elegans*
  - Fingers 3, toes 3 .... *muelleri*
  - Fingers 2, toes 3 .... *lineatus*

Ablepharus boutonii (Desj.)

Form fairly slender, the distance between the tip of the snout and the fore limb from 1 1/3 to 1½ in the distance between the axilla and the groin. The eye has upper eyelid represented by 3 or 4 flat scales. Rostral widely in contact with the frontonasal. Prefrontals large, in contact or slightly separated. Frontal longer than its distance from the tip of the snout, almost as long as the fused frontoparietals and interparietal, in contact with the first two supraoculars, touching the interparietal. Supraoculars 5, the 2nd the largest. One pair of nuchals. Ear opening large, with a single lobule. Scales smooth the two vertebral series somewhat enlarged, laterals smallest, subcaudals largest. Limbs well developed with 5 digits, the adpressed limbs overlap. Tail longer than the head and body. In one specimen selected head and body, 45 mm., tail, 55 mm.

More or less uniform olive-brown or olive-black, dorsally with or without small pale or dark spots, an indistinct pale dorsolateral line from the eye over the ear, to the tail, sides spotted, under surface pale; tail dark spotted, limbs above like the back, below like the under surface.

Very widespread in the State. Several subspecies have been recognised.

Ablepharus lineo-ocellatus (Gray)

Form slender, the distance between the tip of the snout and the fore limb 1.4 to 1.8 in the distance between the fore limb and the hind limb. Eye completely surrounded by granules. Rostral widely in contact with the frontonasal, which forms a narrow suture with the frontal. Frontal nearly as long but narrower than the fused frontoparietals and interparietal, in contact with the 1st and 2nd supraoculars; 4 supraoculars, the 2nd and 3rd the largest; one pair of nuchals; 4 upper labials in front of the much enlarged subocular. Ear opening oval with one or two lobules. Scales round the body in 26 or 28 rows, smooth, largest on the back, smallest on the sides. Limbs well-developed with 5 digits, when adpressed they meet or overlap. Tail somewhat longer than the head and body.

Total length, 113 mm. ($4\frac{3}{8}$ in.). Head and body, 53; tail, 60; fore limb, 14; hind limb, 21.

Olive or brownish, head shields spotted with black; back with more or less numerous white black-edged ocelli in transverse series on the nape but more or less in longitudinal series on the body and tail. A white band, not visible from above, starts on the snout, passes under the eye and through the ear to the hind limbs, a faint blaek border separates it from the immaculate whitish under-surface. Limbs like the baek but without the oeelli.

Distribution very widespread, from Northampton in the west to Esperance in the east; it oceurs on most islands off the west coast.

Ablepharus taeniopleurus Peters

Form normal, the distance between the tip of the snout and the fore limb 1.4 to 1.6 in the distanee between the axilla and the groin. Eye completely surrounded by granules. Rostral in contaet with the frontonasal, which is about as wide as long and in eontact with the frontal. Nasals divided to form supranasals; prefrontals large. Frontal about as long as its distance from the tip of the snout, in contact with 2 supraoeulars, mueh smaller than the fused frontoparietals and interparietal; 4 supraoculars; one pair of nuchals; 4 upper labials in front of the enlarged subocular. Ear opening large, oval, without lobules. Preanals slightly enlarged. Scales, smooth, subequal. Limbs well-developed with 5 digits, the adpressed limbs overlap slightly. Tail longer than the head and body. Length, 4 in. Head and body, 39 mm.; tail, 62 mm.

Fresh specimens are blackish above with a white dorsolateral band extending from the tip of the snout over the eye and over the ear to the base of the tail. Below this is a wider dark band whieh passes through the eye and over the ear to the tail. This is followed by a narrower white stripe from the upper lip to the end of the body; it is separated from the pale under surface by an ill-defined greenish black area which starts on the lower lip and passes under the ear. The tail in life is reddish.

Museum speeimens are from Marrilla Station near Exmouth Gulf, De Grey Station, and from Wotjulum Mission Station near Yampi Sound.

Ablepharus davisi Copland

Form rather sturdy, the distance between the tip of the snout and the fore limb 1 2/3 in the distance between the fore limb and the hind limb. Eye not completely surrounded by granules, there being 10 only. Suture between the rostral and the frontonasal long. Frontonasal wider than long. Prefrontals separated. Frontal kite-shaped as wide as the supraocular region, as long as its distance from the tip of the snout, in contact with the first supraocular. Frontoparietals fused; interparietal distinct, smaller than the frontal. Ear opening irregularly rounded, without distinct lobules. Four upper labials in front of the enlarged subocular. One pair of nuchals. Scales smooth, in 24 rows at the middle to the body; dorsals larger than the laterals, smaller than the subcaudals. Tail considerably longer than the head and body, limbs short, pentadactyle, when adpressed they do not meet. Length, 2½ in. (26 + 37 mm.).

Greenish with much brown on the head, tail and limbs; most of the dorsal scales, with two or three blackish lines which tend to form longitudinal lines. Head with many dark spots; upper lip and under surface almost colourless; laterally each scale has a dark speck forming 4 or 5 indistinct lines between the fore and hind limbs.

Known only from Munja Station, West Kimberley.

Ablepharus wotjulum Glauert

Form slender, the distance between the tip of the snout and the fore limb 1.3 to 1.4 in the distance between the fore limb and the hind limb. Eye completely surrounded by granules. Rostral having a short suture with the frontonasal, which is wider than long and about the size of the prefrontals. Prefrontals forming an oblique suture separating the frontonasal from the frontal. Frontal much wider than the supraocular region, much smaller than the fused frontoparietals, in contact with the first supraciliary and the much enlarged first supraocular; interparietal larger than the frontonasal; 2 pairs of enlarged nuchals; 3 upper labials in front of the much enlarged subocular, enlarged supraoculars almost in contact behind the frontal. Ear opening oval or subtriangular without lobules. Tail about 1½ times as long as the head and body. Limbs pentadactyle, when adpressed they slightly overlap. Scales smooth, in 30-32 rows, the largest on the back, smallest on the sides.

Metallic or pale bronzy above. A strong black dorsolateral band just visible from above begins at the nostril, passes through the eye and over the ear to the base of the tail, where it becomes indistinct. It is bordered above by a fine white line and below by a stronger white band starting on the upper lip passing under the eye and through the ear to the hind limbs. An indistinct and broken dark band separates this from the whitish under surface. The upper and lower labials are dark-edged as also are the chin shields; the limbs speckled with darker above; tail bronzy, in life it was reddish. Widely-spaced black dots may be present along the vertebral line, becoming more distinct on the tail; there may also be faint dark spots scattered elsewhere on the back.

So far this species is known only from Wotjulum Mission, opposite Yampi Sound, West Kimberley.

Ablepharus greyii (Gray)

A small slender species growing to about 3¼ in., the distance from the tip of the snout to the fore limb 2.4 in the distance between the axilla and the groin. Eye not completely surrounded by granules. Rostral widely in contact with the frontonasal, which is narrowly in contact with the small frontal. Prefrontals large. Frontal lozenge-shaped, not much larger than the interparietal, smaller than the prefrontals; 2 supraoculars, the 1st strip-shaped and almost in contact with its fellow behind the frontal; 1st supraciliary almost as long as the supraocular; 3 upper labials in front of the much enlarged subocular; one pair of nuchals; frontoparietals fused; interparietal free, very small. Ear very small, indistinct. Fore limb with 4 digits, hind limb with 5, the adpressed limbs do not meet; the hind limb as long as the distance from the tip of the snout to the fore limb. Tail a little longer than the head and body. In a complete specimen the measurements are: head and body, 38 mm.; tail, 42.5.

Olive-brown or brown above with a more or less distinct dorsolateral dark band from the snout, through the eye and over the ear to the hind limb; upper lip and under surface pale greenish white, the subcaudals spotted.

Widely distributed in the State from the Pilbara to the south coast and east to the South Australian border. It is known from the Canning Stock Route.

Ablepharus rhodonoides L. & F.

Form slender and attenuated, the distance between the tip of the snout and the fore limb about 2½ in the distance between the fore limb and the hind limb. Nasals large, forming a suture behind the rostral; frontonasal much wider than long, forming a suture with the frontal; prefrontals widely separated; frontal large, as long as the fused frontoparietals and free interparietal together; 3 supraoculars; 3 or 4 pairs of nuchals; 3 upper labials in front of the subocular. Ear opening distinct. Body scales smooth, the dorsals largest, 2 enlarged preanals. Limbs short widely separated where adpressed, with 3 digits. Tail partly replaced, shorter than the head and body. Head and body, 43 mm.; fore limb, 5; hind limb, 10; tail partly reproduced, 26.

Olive brown above uniform, no indications of dark spots or lines, lower surface paler with indistinct longitudinal lines.

Widely distributed in the interior of the State, the single Museum specimen is from Goddard's Creek. It is recorded from the Strelley River and Boulder. The specimen reported from Perth, now in the Australian Museum, Sydney, was probably collected inland.

Ablepharus reginae sp. n.

When in the Queen Victoria Spring area in January 1959, W. H. Butler collected a single specimen of an *Ablepharus* which is apparently new to science. It is a member of the section with a pair of frontoparietals and an interparietal but differs from the other Australian species in possessing five fingers and five toes, and in having 28 scales round the body. The coloration also is unusual, being white-spotted above.

Description: Head narrow, tapering, snout rounded; rostral not projecting. Eye incompletely surrounded by granules; nasals small, widely separated by the frontonasal; no supranasals; frontonasal wider than long, about as large as the frontal, having a wide suture with the rostral and a narrow one with the frontal; prefrontals large; frontal kite-shaped, about as long as its distance from the rostral, almost as wide as the supraocular region, in contact with two of the four supraoculars; second supraocular largest; five supraciliaries, second largest; frontoparietals almost as long as the frontal; in contact with the frontal and three supraoculars; interparietal small, lozenge-shaped; parietals large, as long as the distance from the tip of the snout to the frontal, narrowly in contact with the fourth supraocular; one pair of band-like nuchals about four times as wide as long, in contact with the enlarged upper temporal. Ear opening roundish, much smaller than the pupil, without lobules. Scales smooth, the two vertebral series enlarged; 28 rows round the middle of the body, ventral scales smaller than the dorsals, laterals smallest; preanals enlarged. Tail, basal part only preserved, covered with scales larger than the dorsals and ventrals of the body. Limbs short, when adpressed they do not meet, toes long and slender, the fourth much the longest, as long as the distance between the nostril and the ear.

General coloration: Above dark olive, the pale bases of the scales, which are minute on the scales near the vertebral series, increase in size until laterally the scales appear to be white-spotted and gradually pass into the whitish ventral surface; a brownish wash on the head, limbs and tail above; lips pale and a distinct white patch behind the eye.

Measurements: Distance from the tip of the snout to the fore limb 1.7 in the distance between the axilla and the groin. Head and body 39 mm.; fore limb, 9; hind limb, 11.5; tip of snout to fore limb, 13; fore limb to hind limb, 22.

Type locality: Queen Victoria Spring, Western Australia. Holotype R/3300 in the collection of the Western Australian Museum.

Ablepharus broomensis Lonnb. and And.

Eye not completely surrounded by granules. Rostral widely in contact with the frontonasal, which is narrowly in contact with the frontal; frontal small not much larger than a frontoparietal; in contact with the 1st supraocular and an enlarged supraciliary. Frontoparietals and interparietal distinct. Ear opening small. Four upper labials in front of the enlarged subocular. 22 smooth scales round the body, a pair of somewhat enlarged preanals. Limbs with 5 digits, the adpressed limbs overlap, the hind limb does not reach the axilla.

Brownish, each scale with a black dot and a wide brown margin; head above and on the sides mottled with black; lower side of head and body, bluish-white.

West Kimberley; the type locality is Broome.

Ablepharus elegans (Gray)

A small slender species, the distance between the tip of the snout and the fore limb 2.1 to 2.6 in the distance between the fore limb and the hind limb. Eye usually incompletely surrounded by granules; frontonasal narrowly in contact with the rostral or just separated by the nasals, widely in contact with the frontal; prefrontals fairly small, widely separated; frontal wider than the supraocular region, in contact with two supraoculars, almost as long as its distance from the nuchals, longer than its distance from the tip of the snout; 3 upper labials in front of the slightly enlarged subocular; 3 supraoculars, 3 or 4 pairs of nuchals; frontoparietals and interparietal separate, the latter shield the largest. Ear openings very small. Scales smooth, dorsals larger than the ventrals, laterals smallest but subcaudals largest. Limbs short, with four digits, the adpressed limbs do not meet; the fore limbs fit into a depression, toes on hind limb long and slender. Length $3\frac{5}{8}$ in. (41 + 51 mm.).

Bronzy above, head marked with darker; each dorsal scale with a dark spot producing 4 lines along the body, sometimes more or less distinct. A dark dorsolateral band, visible from above, extends from the snout through the eye and over the ear to the tail where it becomes indistinct; it is edged below by a fine white line. Lower surface uniform pale, sometimes the ventrals are dark-edged.

Distribution from Geraldton, south to Albany and east to Esperance and Eucla. It occurs on the Abrolhos, Rottnest and the Recherche Archipelago.

Ablepharus muelleri Fischer

Slender and elongate, the distance between the tip of the snout and the fore limb about 2 1/3 in the distance between the axilla and the groin. Eye incompletely surrounded by granules; nasals forming a suture behind the rostral; frontonasal wider than long with a wide suture with the frontal; prefrontals widely separated; frontal as long as its distance from the tip of the snout, in contact with 2 of the 3 supraoculars; one enlarged supraciliary situated between the 1st and 3rd supraoculars; frontoparietals and interparietal distinct, 3 upper labials in front of the slightly enlarged subocular. Ear opening very small, distinct. Two large preanals. Limbs short with 3 digits, the hind limb almost as long as the distance between the tip of the snout and the fore limb, the adpressed limbs do not meet. Tail longer than the head and body. A specimen in the Museum measures head and body, 48 mm.; tail, 56.

Metallic green or bronzy with a dark dorsolateral band from the nostril, through the eye and over the ear along the body, fading out rapidly on the tail. Under surface pale.

The specimens in the Museum are from Strelley River, Learmonth, Manberry Station and Minilya Station.

Ablepharus lineatus (Bell)

Form slender, elongate, the distance between the tip of the snout and the fore limb 2½ in the distance between the axilla and the groin. Eye incompletely surrounded by granules. Rostral slightly projecting, narrowly in contact with the frontonasal, which has a wide suture with the frontal. Prefrontals small, widely separated; frontal nearly as long as its distance from the tip of the snout, in contact with 2 or 3 supraoculars; frontoparietals and interparietal distinct; interparietal much larger than the frontoparietals; 3 pairs of nuchals; 3 upper labials in front of the slightly enlarged subocular. Ear opening very small. Scales smooth, dorsals largest, 2 enlarged preanals. Limbs short, fore limb with 2 digits, hind limb with 3, the adpressed limbs fail to meet; hind limb as long as the distance between the front of the eye and the fore limb.

Whitish, the two vertebral series of scales each with a dark streak forming a double band from the head on to the tail. A wide dark dorsolateral band extends from the nostril through the eye and over the ear to the tail, under surface pale cream, immaculate, limbs inclined to be reddish.

Known from Perth, Rottnest and Garden Islands.

NATURAL HISTORY NOTES FROM JIGALONG, NORTH-WESTERN AUSTRALIA

By ERIC LINDGREN, West Perth.

I. INTRODUCTION

Jigalong Mission lies on the edge of the Gibson Desert at lat. 23° 24′ S. and long. 120° 46′ W. It is about 280 miles north of Meekatharra, 50 miles north-east of Mundiwindi, and is 33 miles east of the Great Northern Highway.

Geologically Jigalong is situated in the area of the Nullagine Series (Pre-Cambrian) of sedimentary and metamorphosed rocks. These are predominantly sandstones, quartzites and conglomerates, but here and there are later intrusions of igneous rocks, notably quartz (Jutson, 1956).

To the west of the mission are low undulating hills covered mostly by "spinifex" (*Triodia* sp.) and Mulga *(Acacia aneura)*, while to the east lies a series of broken ridges, outliers of the nearby Robertson Range, over which according to the natives "the desert begins."

Lying in an area of rainfall averaging between 5 in. and 10 in., Jigalong is officially in the desert country. Rainfall is very erratic, there being marked peaks every five or so years, with drought and semi-drought conditions in between.

Temperatures range up to 120° F. during the summer months, when most of the rain falls, and down to about 45° F. in the winter, accompanied by chill easterly winds. Regular rains can be relied upon during the winter months also (a later paper on birds of the area gives more detailed rainfall data).

HISTORICAL

Historically Jigalong itself offers little as it was not established until 1907. The general area, however, holds many associations with the past. Giles was the first to pass nearby, when in 1876, returning to South Australia, he travelled about 50 miles to the south, near Savory Creek.

Calvert's Exploring Expedition, led by L. A. Wells, next visited the area in 1896. This party passed by farther to the east, and at Separation Well two members, G. F. Wells and G. L. Jones, left the main group to survey the country to the west and rejoin their companions at Joanna Springs. These two men lost their lives in the vicinity of Talawana, some 60 miles north of Jigalong, and a number of search parties set out to recover the bodies. One such party, led by Rudall (1897), came within 15 miles of Jigalong. At Braeside Station, farther north, Rudall learned that ". . . Messrs. Connaughton and Henty had been sent by Mr. Magarey's instructions with horses to search the western branch of the Oakover." The same Connaughton visited the rockhole described in the article below and left his name carved in to the rock face. This visit was a few months prior to Wells and Jones' disappearance.

Further exploration by F. H. Hann (in 1897), when he named Lake Disappointment, and R. H. B. Downes (in 1899) added to the knowledge of the area.

In 1904 A. W. Canning surveyed the route for the No. 1 Rabbit Proof Fence and in 1906 the Canning Stock Route. In 1908 Talbot made a comprehensive geological survey of the desert region (Talbot, 1928). The period of exploration by Canning and Talbot coincides with that of the construction of the No. 1 Rabbit Proof Fence, from Starvation Boat Harbour on the south coast to Bannangarra on the north.

With the establishment of the fence depots were installed from which regular maintenance patrols took place. Jigalong was one such depot, being the main central depot on the northern section of the fence, from which boundary riders patrolled south as far as the north shore of Lake Nabberu, and north to the coast. Camels were used on these patrols and Jigalong became a camel breeding station, some camels being sent to Kalgoorlie for use by the survey party mapping a route for the Trans-Continental Railway.

Constructed by the Public Works Department, the fence was completed on September 30, 1907, and on December 1, 1907, the final northern section, including Jigalong, came under the control of the Department of Agriculture.

Under the direction of the Native Welfare Department the superintendent at Jigalong was appointed Protector of Aborigines and rations were issued to the native people gathered about the depot. This continued until the establishment of the mission nearby by the Apostolic Church of Australia.

Original negotiations to establish a mission somewhere in the Nullagine-Marble Bar area made in 1941 were curtailed by World War II. It was not until 1944 that a further request was made by the Apostolic Church. Selection of a site proved difficult, the area east of Nullagine being favoured as a point where desert natives could be intercepted and cared for in their drift westwards. However in September 1945 the then Commissioner for Native Affairs, Mr. F. Bray, suggested the Vermin Control Depot at Jigalong as a site.

This was accepted by the church and a permit was issued for the establishment of a mission on Reserve 20285 on December 5, 1945. This reserve of 16,000 acres was known as Watch Point Paddock. Since that time, through the closure of station holdings nearby, the area of the reserve has been increased to about 500,000 acres.

The name Jigalong is now freely applied to the mission, while the original depot, three miles to the south, is known as "Old Jigalong."

Very little is available on the natural history of the district. In the 1920s James Hickmer, an employee of the Jigalong depot, collected insects and a live colony of honey ants from him was exhibited at a meeting of the Royal Society of W.A. by John Clark in September 1922. Perhaps other material from the same source may have been published elsewhere, but he is not mentioned in Musgrave's *Bibliography of Australian Entomology 1775-1930.* Only two recent workers have published natural history notes on the area: R. D. Royce (1948), who patrolled the fence north of Jigalong with George Beattie, the local Inspector of Rabbits, and published botanical notes, and J. H. Calaby, who was in the vicinity in September 1955, and has published some data on frogs and birds (Calaby, 1958; Main and Calaby, 1957).

The present series of articles are written from material gathered whilst I was on duty at the Government School from February to December, 1959.

ACKNOWLEDGMENTS

I wish to record appreciation of the help given to me by Mr. B. Redfern of the Native Welfare Department; Mr. F. W. G. Andersen, Acting Commissioner for Native Affairs, for access to the Jigalong files; Mr. J. S. Crawford, of the Department of Agriculture, for information on the Rabbit Proof Fence; and Mr. J. H. Plumb, missionary at Jigalong, for help in recording details of the paintings.

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II. ABORIGINAL ROCK PAINTINGS NEAR JIGALONG.

LOCALITY

The drawings described are situated at a temporary rockhole, known to the *Mantjiltjara* and *Katatjara* natives at Jigalong Mission as *Ngutjapungkanu.* This rockhole lies in the Robertson Range about three-quarters of a mile east of the 638 mile peg on the No. 1 Rabbit Proof Fence, on the western edge of the Gibson Desert.

Robertson Range is comprised of sandstones, conglomerates and grits (Talbot, 1928) and these drawings are situated on vertical and semi-vertical rock faces and overhangs on the east side of the rockhole. No doubt the west side would have been utilised too but no satisfactory sites are available.

Two white people visiting the area have inscribed their names in the rock faces: J. Connaughton, 29/4/96, and A. J. Keeling, 10/5/31. Connaughton has been mentioned above. Keeling was superintendent at Jigalong during the early 1930s.

MEDIA

Most of the drawings appear to be done with white ochre and are very faint. Near one drawing the rockface was eroded into a finely pitted surface which when rubbed resulted in a white powder line very similar in appearance to the drawing. This could only be done at the one spot.

The only bichrome drawing is that shown in Fig 1 (a), which is executed in white ochre on a background of red ochre.

Detailed measurements were taken of all the drawings and from these they were reproduced firstly on squared paper, then traced on cartridge paper for reproduction in this article.

No attempt has been made to show the width of the lines on the reproductions here, these generally being approximately ½ in. wide and probably done with a finger dipped in colour. The Emu footprint, Fig. 1 (b), had a maximum width of 1⅛in.

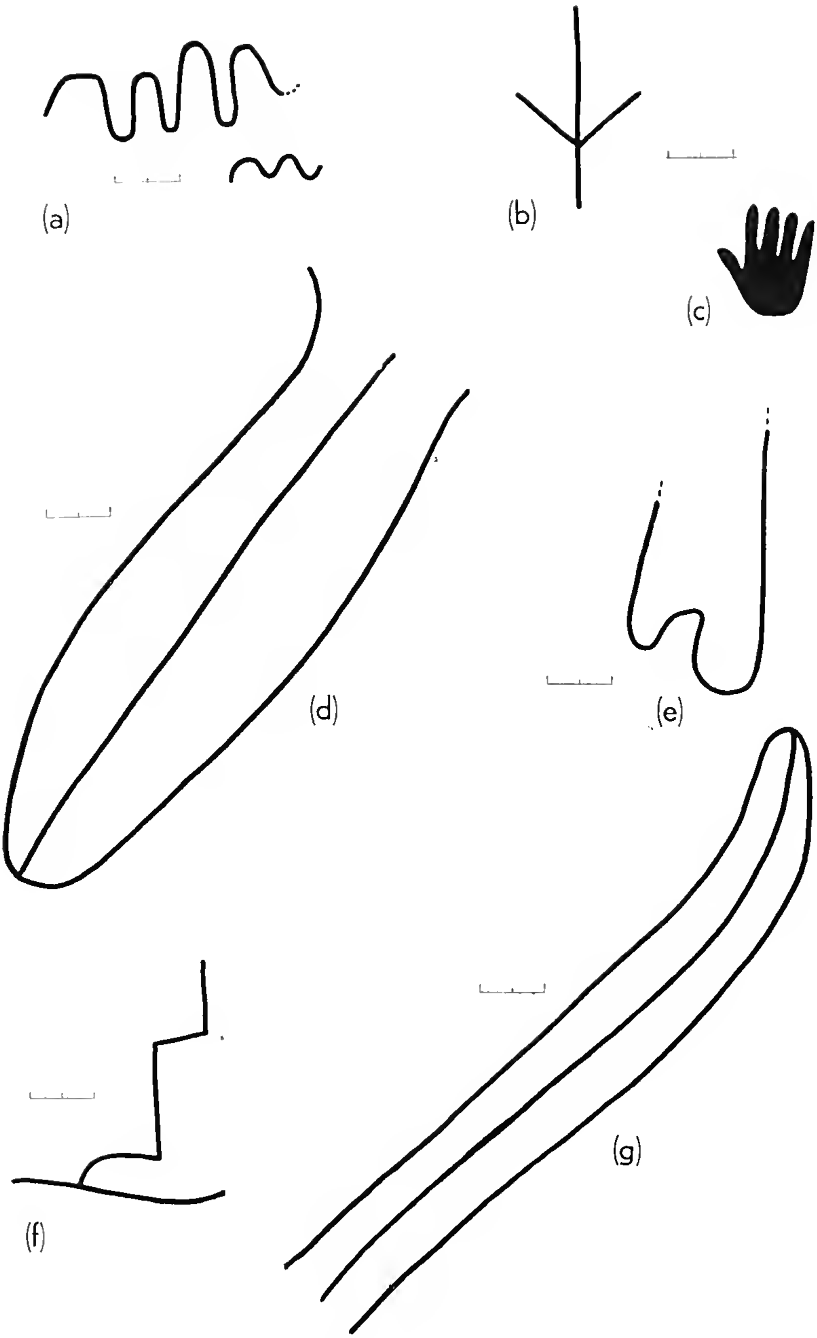

Fig. 1.—Pictographs near Ngutjapungkanu rockhole. Some of the drawings are interpreted in the text. The scale alongside each drawing represents 2 inches, divided into inches.

HISTORY OF THE DRAWINGS

Originally the land in this region was occupied by the *Ni:yapali* people, but in accordance with a general westward movement among many of the natives of the North-west, these people have now moved nearer the coast and the two tribes mentioned earlier, whose home ground is the land surrounding Lake Disappointment and the mid-Canning Stock Route, have taken their place.

When questioned about the significance of the drawings and their origin the only information the present natives could give was that "they were done in the early days." The Ni:yapali people, therefore, seem responsible.

The drawings conform to the type Elkin (1954) groups under the heading "The Southern and Western Arid Region," as typical of this area, and describes as ". . . typified by incised angular pat-

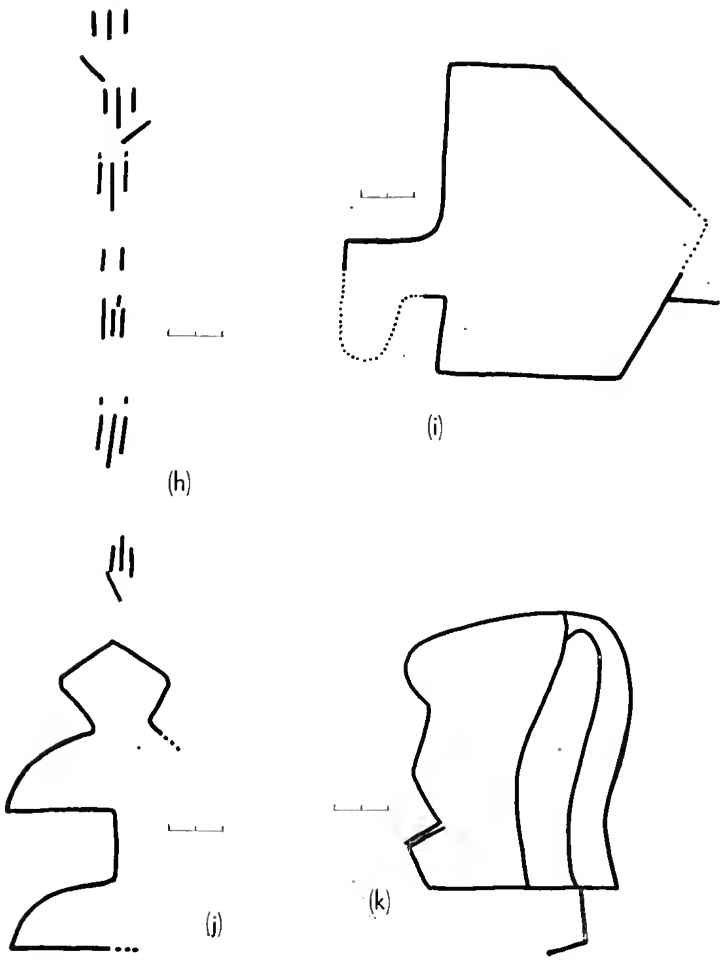

Fig. 2.—Pictographs near Ngutjapungkanu rockhole. Scale as in Fig. 1, except (h), in which the scale line represents 5 inches, divided into 2½ inches.

terns—concentric squares and rhomboids, zigzag, meander and key." This description applies to the easily transported personal articles such as spear throwers and shields as the natives were constantly on the move and as he says "Such a life did not encourage art."

Only four of the drawings can be interpreted with reasonable accuracy. Fig. 1 (a) probably represents a symbolical snake or tracks of the Two-legged Skink *(Lygosoma bipes)* very common in the area. Figs. 1 (b), 1 (c) and 2 (h) show respectively an Emu footprint, a human hand (drawn, not stencilled or printed) and a feeding kangaroo's tracks.

These interpretations are my own and more experienced observers may see more than I have.

Petroglyphs and pictographs are comparatively rare in the desert region and though this record provides no new media or format it is felt they should be recorded before their eventual disappearance.

Native names throughout this paper follow the alphabet set out by Douglas in his Grammar of the Western Desert Language.

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MALE BREEDING CALL AS AN AID TO IDENTIFYING SOUTH-WESTERN AUSTRALIAN FROGS

By M. J. LITTLEJOHN* and A. R. MAIN, Zoology Department, University of Western Australia.

The male breeding call of frogs functions to attract the female to the male of the same species. Hence, where several species may be breeding in a pond at the same time it is the distinctiveness of the call and the specific response patterns of the female which together reduce the opportunity for attempts at cross-breeding. The male breeding call of most of the South-Western species is so characteristic that verbal descriptions and comparisons of this behaviour may be efficiently applied to the field identification of species. Where some similarity exists the consideration of geographical range and breeding season affords clear separation. For the present purposes the geographical limits of the South-Western province are those defined by Main (1954), i.e. Western Australia south of the Tropic of Capricorn. In this region 25 species of frogs occur and the calls of 22 of these have been tape-recorded by the authors. One, *Myobatrachus gouldii,* has not been heard calling, and from its habits (Main, Littlejohn and Lee, 1959) it seems likely that no mating call is produced.

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Nomenclature used in this paper is based on Parker (1940), Lee and Main (1954), Moore (1954), Main (1957, a, b), Copland (1957) and Littlejohn (1957). As a result of detailed investigation of the frogs of South-Western Australia some modifications and additions to Main's (1954) key are required, namely:

1. The genus *Neobatrachus* is revived (Main, 1957 b), to include three species previously included in the genus *Heleioporus*—*pelobatoides, centralis* and *wilsmorei*. In addition a new species has been described—*sutor* (Main, 1957 b).
2. Two new species of *Heleioporus* have been described—*psammophilus* and *inornatus* (Lee and Main, 1954).
3. Three species previously included in the species *Crinia signifera* in Western Australia have been recognized—*insignifera* (Moore, 1954), *pseudinsignifera* (Main, 1957) and *subinsignifera* (Littlejohn, 1957). The original name *signifera* is now restricted to an eastern form.
4. *Hyla aurea* in South-Western Australia is now known as *moorei* (Copland, 1957).

Because of the diversity of the sounds attempts at keying would probably prove unsatisfactory. Rather, the species are arranged in a seasonal progression and each is included in that period when it is most commonly heard and when choruses are loudest (Table I).

This work was carried out with the assistance of Research Grants from the University of Western Australia.

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TABLE I.—Male breeding call, and calling position presented in a seasonal arrangement for 24 species of frogs occurring in South-Western Australia.

Season	Species	Call	Calling Position and habitat	Remarks
Summer (Dec.-March)	**Neobatrachus centralis**	short high-pitched trill	floating in shallow temporary ponds which fill after summer cyclonic rains and thunderstorms	also calls during autumn and winter if nights are warm
	Nebatrachus sutor	a long series of slowly repeated "taps"	as for **N. centralis**, but calls while sitting on edges of such ponds	Northern and Eastern Wheatbelt
	Neobatrachus wilsmorei	a loud explosive infrequent "tock"	as for **N. centralis**	
	Pseudophryne occidentalis	rather variable, long "squelch" to short "chick"	in shallow burrows in moist clay by temporary ponds of cyclonic rains and thunderstorms	sometimes calls during autumn if nights are warm; Eastern Wheatbelt and Goldfields
	Metacrinia nichollsi	a short grating call, slowly repeated: "ka-ak"	under moist logs in heavy forest	similar to **P. guentheri** and some of the call variants of **P. occidentalis**, but never found with these species
Autumn (April-May)	**Heleioporus eyrei**	a long low moan, slowly repeated	well-constructed burrow in sites of temporary swamps, before they fill	calling period very restricted
	Heleioporus psammophilus	a long series of rapidly repeated pulses: "put-put-put . . . ."	as for **H. eyrei**	,, ,,
	Heleioporus inornatus	groups of 2-3 pulses repeated frequently: "woop-woop"	as for **H. eyrei**, but prefers sandy peats	,, ,,
	Heleioporus albopunctatus	short high-pitched calls, slowly repeated: "coo-coo"	as for **H. eyrei**	,, ,,
	Heleioporus australiacus	a low-pitched owl-like "hoot" slowly repeated	well-constructed burrow in creek banks in hilly country of Darling Scarp	,, ,,
	Pseudophryne guentheri	a short grating call: "ka-a-ak," slowly repeated	under litter in shallow burrows in swampy country, before water table rises	found to the west of **P. occidentalis**
	Neobatrachus pelobatoides	a long soft purring trill, slowly repeated	floating in temporary ponds	may call in early winter if warm

Winter (June-August)	**Crinia insignifera**	a short rapidly repeated "peeping" call	floating in temporary ponds, or sitting in shallow water at edges	Swan Coastal Plain only
	Crinia pseudinsignifera	a short 4-pulsed "bleet", rapidly repeated	floating in temporary ponds, or sitting in shallow water at edges	Wheatbelt and to the edge of the Darling Scarp
	Crinia subinsignifera	a long drawn-out "squelch", slowly repeated	floating in temporary ponds supported by vegetation	found in southern sandy swamps from Manjimup to Mt. Barker, then east and towards the South Coast
	Crinia georgiana	a variable duck-like "quack-quack"	sitting in shallow temporary hillside streams and some of the streams on the coastal plain	
	Crinia leai	a metallic call: "chick, chick, chik-ik-ik"	in litter and vegetation by permanent water	odd calls through the year, especially along streams in the wetter forest country
	Limnodynastes dorsalis	a banjo-like "plonking" call	floating in temporary or permanent water	calls occasionally heard throughout year
	Hyla adelaidensis	an abrupt grating call: "ka-ark." occasionally ending in a high-pitched shriek	out of water from reeds and rushes in permanent lakes and swamps	some calls heard through year
Spring (September-November)	**Hyla moorei**	a long low modulated growl usually followed by 3-5 distinct grunts	floating or on floating vegetation in permanent swamps and lakes	
	Hyla cyclorhynchus	similar to **H. moorei** but faster and with parts of call less distinct	floating in permanent swamps and lakes (sometimes heard in rain-water tanks)	found to south-east of range of **H. moorei**; i.e. Ravensthorpe
	Hyla rubella	*"loud wheezing sound not unlike that made by the Silver Gull **Larus novaehollandiae**"	on vegetation adjacent to river pools	probably breeds opportunistically through the year whenever heavy rain falls
	Glauertia russelli	*"a short grating squelch: 'qrk . . . qrk' "	under dead fallen reeds by permanent water holes	probably also breeds opportunistically
Calls through whole year	**Crinia glauerti**	short tapping or rattling call with 5-7 taps, sometimes terminating in a "squelch"	sitting in shallow water in permanent streams and swamps or supported by vegetation	

* Breeding data is from Main and Calaby (1957)

A NEW ELAPINE SNAKE FROM WESTERN AUSTRALIA

By ERIC WORRELL, Australian Reptile Park, Gosford, N.S.W.

This tiny burrowing snake was forwarded to me for identification by Mr. Melbourne Ward, of Medlow Bath, N.S.W. The specimen has been in his collection since 1945.

Melwardia gen. nov.

Depressed head not distinct from neck, no canthus rostralis; pupil round; body short, stout, depressed; belly rounded; tail somewhat compressed.

Maxillary about as far forward as palatine with a pair of large venom fangs followed by a single smaller tooth on the end of the bone which terminates posterior to palato-pterygoidal suture; maxillary arch much larger than its distance to end of the bone; combined frontal bones about as long as broad; the small postfrontal is postorbital, and not in contact with frontal or prefrontal which is sutured to lateral margin of frontal almost precluding it from orbital periphery. No process on ectopterygoid. Nostril in an undivided nasal scale which contacts preocular; loreal absent. Body scales smooth, in 15 rows at midbody; anal scale divided; subcaudals mostly divided.

Melwardia differs from *Rhynchoelaps* in which there are outer processes in the ectopterygoid, from *Rhinelaps* in which the preocular does not contact the nasal, and from *Vermicella* in which the postfrontal bone is more developed and more anterior in position.

Type species, *Melwardia minima* sp. nov.

Melwardia minima sp. nov.

Type: An adult taken at Broome in Western Australia. It has been lodged in the Australian Museum, Sydney, by Mr. Ward.

Diagnosis: There are no close affinities. Characterized by 15 midbody scale rows; 124 ventrals; paired anal; 18 subcaudals of which the first three are single and the balance paired. Pale brown above, black patch on head and another on the neck, ventrals creamish.

Description: Head depressed, not distinct from neck, body short, depressed. Rostral broader than deep extending one-fourth its distance from tip of snout to frontal; internasals a little shorter than

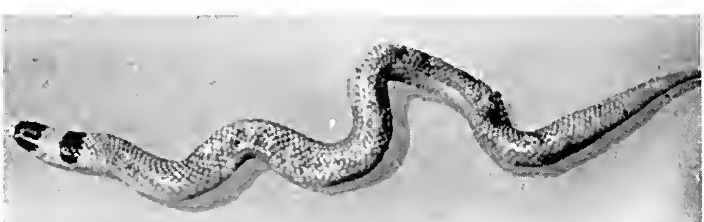

Fig. 1.—*Melwardia minima* sp. nov., photograph of type.

prefrontals; large single nasal contacting large preocular; large frontal, acute posteriorly, one and a half times length and over twice width of supraoculars; large parietals; two postoculars, superior larger; temporals 1 + 2, the posterior temporals being marginal; 6 supralabials, third and fourth subocular, fifth dilated and well in contact with parietal; 6 infralabials; chinshields subequal, third infralabial in contact with both anteriors and posteriors. Total length 175 mm. or 7 in., tail 16 mm. Body width 7 mm.

Colour: Pale brown dorsally, creamish snout with black across frontal to posterior of parietals; fifth infralabial black; a black collar four scales long dorsally and diminishing to a single scale laterally; creamish ventrally.

Affinities: While there are no close affinities, *Melwardia minima* bears a number of superficial points of similarity to several other snakes. In coloration it could be confused with *Rhinelaps warro* (De Vis) and *Vermicella calonota* (Dumeril & Bibron), the latter of which we propose to now include in the newly-created genus *Melwardia*.

In *Rhinelaps warro* the maxillary carries four smaller teeth following the fangs. Other important osteological conditions are present. In *warro* the preocular does not contact the nasal and the ventral and subcaudal scale counts are substantially higher.

Melwardia minima displays a number of specific differences to *calonota*. The arrangement of the temporal scalation is completely

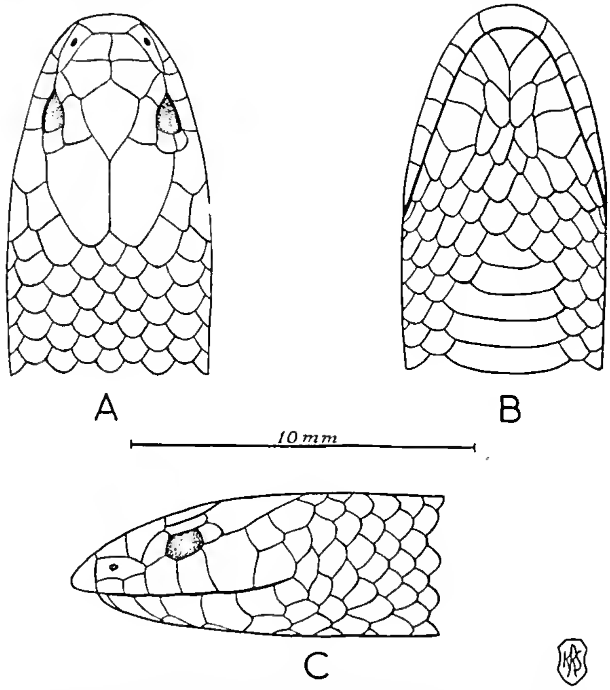

Fig. 2.—*Melwardia minima* sp. nov. A, dorsal aspect. B, ventral aspect. C, lateral aspect.

different. In *minima* the subcaudal count is appreciably lower and there is no vertebral stripe. The maxillary bones of both species are differently shaped. The only other small Australian Elapine snake which approaches the low combined subcaudal and ventral scale counts of *Melwardia minima* is *Rhynchoelaps bertholdi* (Jan.). However, *M. minima* is an unbanded snake and there are no outer processes on the ectopterygoid which are prominent features in *Rhynchoelaps*.

ACKNOWLEDGMENT

The figures were competently drawn by Mr. K. Slater, animal ecologist at the Australian Reptile Park, Gosford, N.S.W.

A NEW SPECIES OF WEED-FISH OF THE GENUS *PETRAITES* FROM WESTERN AUSTRALIA

By NORMAN E. MILWARD, Department of Zoology, University of Western Australia, Nedlands.*

FAMILY CLINIDAE

Petraites equiradiatus sp. nov.

D.iii,xxviii.3; A.ii,20; P.12; V.(i),3; C.11.

Body fairly elongate, the greatest height contained 4.6 times in the standard length (5.4 in the total length including caudal). Snout rounded; head 4.1 times in standard length (4.9 in total length). Minute cycloid scales. Nasal cirrus well developed, multifid with 8 or 9 filaments. Supra-orbital tentacle with a long, tapering outer filament and two short inner ones, all broadly joined at base. First three dorsal spines about equal in length, very slightly longer than those following from which they are separated by a gap approximately equal to third spine when depressed; first spine situated just before vertical from margin of pre-operculum and the third joined by membrane to basal portion of fourth, which is placed over hind border of operculum. Anal fin commences beneath twelfth dorsal spine. First anal spine about two-thirds length of second; rays subequal, the posterior ones, with exception of last, being a fraction longer than the anterior. Last dorsal ray wholly connected to caudal peduncle by membrane; last anal ray only joined basally. Pectoral fin rounded, thick simple rays. Ventral fin with a concealed spine and three similar finger-like rays; the middle ray is only very slightly longer than other two and reaches approximately half-way to vent. Caudal fin truncate. Lateral line distinct anteriorly as a series of closely-set tubed-scales extending over about two-thirds of the pectoral fin, the series then descending to mid-line and continuing to tail, becoming very widely spaced and obscure.

Colour in formalin:—Fairly uniform yellow, except for paler abdomen. Faintest suggestion of about seven darker yellow bands on upper sides.

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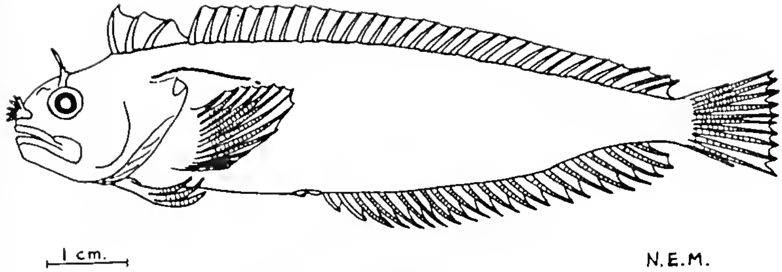

Petraites equiradiatus sp. nov.

Relationships.—The species differs from other members of the genus recorded from Australia in having the three rays of the ventral fin all similar and the supra-orbital tentacle with a long outer filament and two short inner ones, all of which are broadly joined at the base. In the other species, *P. roseus, antinectes, heptaeolus* and *nasutus*, the inner ray of the ventral fin is either reduced and slender or totally absent, and the supra-orbital tentacle consists of a short flap, which may be fringed or simple, without an elongate filament.

The species name is derived from the equality of the rays in the ventral fin, which forms a valuable diagnostic character.

The description is based on two specimens collected by Dr A. R. Main during February 1957. They were obtained at night from off the coastal-limestone platform at the western end of Wilson Bay, Rottnest Island. The specimens measured 97 and 83 mm. in total length and were identical in fin-ray counts.

The larger specimen is designated the type of the species and is lodged at the Western Australian Museum, No. P 4472. The smaller specimen is to be donated to the Australian Museum, Sydney.

FROM FIELD AND STUDY

Pigmy Possums at Bickley.—At my home in Piesse Gully, Bickley, on the afternoon of June 16, 1959, I found a South-western Pigmy Possum *(Cercaertus concinna)* drowned in an open water-tank at the edge of the bush. Remarkably enough after nightfall in the evening my wife found a domestic cat playing with another one of the little animals which it had caught and killed.

These were the first we had ever seen here over many years of residence. Fortunately, we were able to forward the two obtained to the Western Australian Museum, and we are indebted to the Director, Dr. W. D. L. Ride, for the identification.

—W. H. LOARING, Bickley.

Reappearance of Red-winged Wren in Old Haunts.—Towards the end of July 1959 my sister, Mrs. A. H. McWhirter, was astonished to see a male Red-winged Wren *(Malurus elegans)* in the garden of her home at Brookwood, Bickley. Brookwood is situated towards the lower end of one of the tributary streams of Piesse

Brook, where no Red-winged Wrens have been seen for over 30 years.

Banded Blue Wrens *(M. splendens)* were present in the garden at the time, and my sister could not be sure if the male was solitary or not.

Unfortunately, nothing has been seen of the bird since.

—W. H. LOARING, Bickley.

Flock of Galahs at Bickley.—In July 1959 a flock of Galahs *(Kakatoe roseicapilla)* appeared in Piesse Gully, Bickley.

I did not see the birds myself, but my neighbour, Mr. F. J. Bourke, told me that a flock of 15-20 of them settled in a dry Marri on his property on or about July 22. The birds came in from a north-easterly direction, apparently in two detachments, but eventually settled together in one flock in the dead Marri. They remained perched in the tree for a few minutes before flying on in a more or less southerly direction.

Mr. Bourke said the birds appeared to be in fresh plumage, with the pink coloration of their breasts strikingly vivid.

—W. H. LOARING, Bickley.

A Further Discovery of *Thylacinus* at Augusta, Western Australia.—Maxillary fragments of two small adult individuals of *Thylacinus* (Tasmanian Wolf or Tiger) have been found in a cave, near the Moondyne Cave, Augusta. On the Sussex Plan No. 88, in the Mapping Branch of the Lands and Surveys Department, Perth, it is marked as "Deep hole with cave," on a bearing of 299° 5′, and 780 ft. from Moondyne Cave.

The first fragment (W.A. Museum No. 60.2.2) was found next to the south-east wall of the cave at a depth of 9 ft. 7 in. from the surface of the soil floor, which consists of red clays and sands, with black layers of humus-rich material.

The second fragment (W.A. Museum No. 60.2.1) was found by G. Burney, approximately 11 yds. south-west from the location of the first fragment, also adjacent to the wall, but at a depth no greater than 2 ft.—the maximum depth of the excavation dug here. Associated with the first fragment, in a band 6 in. above and below the 9 ft. 7 in. level, were *Setonix, Trichosurus, Macropus giganteus* and Muridae. Besides these, this deep excavation, from the surface to 9 ft. 11 in., contained *Pseudocheirus* and *Dasyurus*. The surface soil of the whole cave yielded all the above genera, except *Thylacinus,* and also *Thylacis, Potorous* and *Canis familiaris.*

Previous discoveries of *Thylacinus* in Western Australia were made by Glauert, in the Mammoth and Museum Caves at Margaret River and in the Moondyne Cave at Augusta.

The author wishes to thank Dr. W. D. L. Ride, Director of the Western Australian Museum, for identification of specimens, and Mr. A. R. Hunter, former President of the Augusta-Margaret River Tourist Bureau Committee, for permission to enter the above-mentioned caves and others in the vicinity.

—R. M. HOWLETT, Zoology Department, University of Western Australia.

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RECENT ALTERATIONS IN RANGE AND ABUNDANCE OF MARINE INVERTEBRATES IN SOUTH AUSTRALIA

By BERNARD C. COTTON, F.R.Z.S., The South Australian Museum, Adelaide.

During the last twenty years there has been a noticeable increase in the number of certain species of invertebrates, notably Molluscs, living on South Australian beaches. This has been particularly observed in Gulf St. Vincent, where regular collecting is conducted by many enthusiasts. Some species of Molluscs taken previously only on open ocean beaches now inhabit Gulf St. Vincent.

The present paper discusses some of the species which have shown a notable change in status, either in distribution or numerical abundance, in recent years.

MOLLUSCA

PELECYPODA

1. *Anadara trapezia* (Deshayes)

The recent discovery of living *Anadara trapezia* at Oyster Harbour, Western Australia (Kendrick and Wilson, 1959) may be an example of the phenomena now being discussed. Besides South-Western Australia this bivalve lives at Phillip Island, Western Port Bay, Victoria, with the common *Katelysia*, a species plentiful at the Outer Harbour, S.A. It is found in vast quantities as a subfossil on the stranded beaches (of the 20 ft. level) in South Australia and attains to a large size. Many are *in situ* with joined valves and appear to have been wiped out suddenly, one would say catastrophically. There is every reason to suppose that if reintroduced into suitable S.A. territory the species might flourish again.

On September 25, 1956, a parcel of some two dozen *Anadara trapezia* were collected at my request by Mr. R. J. Plant at Rhyll, Phillip Island, which is the southernmost point where the species thrives. Through the organization of Mr. D. I. Hartley, President of the Malacological Society of Australia, the shells were delivered alive in Adelaide by air 23 hours later in good condition. With the approval of the Director of Fisheries the cockles were placed in the sea from the extreme end of the jetty at Largs, on the day of their arrival, September 26.

In April 1960, Mr. R. C. Edwardes brought in a fresh valve two inches long, picked up just south of the breakwater at the

Outer Harbour. This is the point at which objects are washed up by the prevailing south-westerlies from the locality in which the specimens were placed. No living cockles have been seen as yet.

2. *Parviperna nucleus* (Lamarck)

I first recorded this species as *Isognomon spathulata* Reeve in 1930, from a living shell from St. Francis Island, and later, after taking a specimen at Levens, Yorke Peninsula, concluded that it should be renamed. Iredale (1939) wrote: "apparently the first note of one of these small shells is that of Lamarck who names *Perna nucleus* (*Hist. Anim. S. Vert.*, 6 (1), p. 142, July 1819) with a length of 16 mm., and as 'Habite a l'ile S. Pierre-S. François de la Nouvelle Hollande. Peron et Le Sueur.' The colour is not given and the locality does not furnish such a shell as has been traditionally known under Lamarck's names. Then Gould (*Proc. Bost. Soc. Nat. Hist.*, 3, p. 312, December 1850) introduced *Perna nana*, a little black shell from Fiji, and this has been regarded as Lamarck's species." The species under consideration, however, is certainly a South Australian shell. *Pedalion franciscensis* was named by me from the type locality of Lamarck's *P. nucleus* and the latter name may be the correct one for the South Australian shell. This tropical shell is either re-established or extremely rare.

3. *Ostrea sinuata* (Lamarck)

Forty years ago the "Port Lincoln Oyster" was sold for food in South Australian shops alongside the Sydney Rock Oyster (*Crassotrea commercialis* Iredale). It was evidently becoming very scarce about this time and specimens were seldom found on local beaches. The same applied to the population of this oyster on our eastern coasts. After a strong wind it is now possible to collect some few dozen specimens at places such as Henley, Grange, Semaphore, Largs, and enjoy an attractive repast (Cotton, 1955). There seems to be a general increase in the "Port Lincoln" or "Mud Oyster" population around the Australian coast. An increase of the quantity of fresh water running into the sea, carrying microscopic food, is said to be the reason. In S.A. the more frequent and more severe storms washing the shells from the natural beds has been mentioned as an additional cause of their being taken.

4. *Crassostrea australis* (Lamarck)

This oyster, a Western Australian species, has made its presence noticed in South Australia within recent years (Cotton, 1950).

5. *Crassostrea scyphophilla* (Peron)

Mr. Edgar Mundy, of Port Lincoln, has large and typical specimens of the species taken at "Franklin Harbour, Cowell, in creek, left hand side, just in entrance 1910." Mr. Mundy writes that the "Mangrove Oyster" was plentiful in those days at Cowell, Shoal Water Point and Port Augusta. A specimen sent by him of the original series to F. L. Saunders, Adelaide, measures 80 mm. in length and the aperture of the "horn" is 40 mm. in diameter. The shell has a dark violet coloration externally and on the inner margin somewhat like that of *Crassostrea australis*. *C. scyphophilla* appears to be extinct in S.A. nowadays.

This mangrove-living oyster is an example of a tropical species, living in North-Western Australia, which has apparently crept southwards into South-Western Australia and could re-establish itself in S.A. if the west-east current were to wash larvae into such places where the mangroves still flourish.

6. *Notochlamys hallae* Cotton

Specimens of this two inch scallop were found alive at Largs in 1959. Over half a century of careful collecting had failed to find this distinctive species. It can only be presumed that it has recently appeared here or is now in sufficient quantity to be noticed from the few specimens found. Known species putting in a first appearance in South Australia usually prove to be from Western Australia. *N. hallae*, however, is quite a new species and is only known from the type locality.

7. *Phragmorisma watsoni* (Smith)

The species was described in *The Voyage of H.M.S. Challenger, Zoology*, vol. 13, p. 69, pl. 6, fig. 5-5b, as taken in Bass Strait, 38-40 fathoms, and fragmentary specimens have been recorded from Twofold Bay, N.S.W., 15-25 fathoms. It was not taken in the Verco dredgings between 1895 and 1918, nor have any fragments been seen from the Flindersian Region until 1957 (Cotton 1957 b).

That year David Howlett took a perfect typical living specimen in 14 fathoms off St. Francis Island, South Australia. A photograph of the unique specimen in the Howlett collection is to be reproduced in the current publication of *South Australian Mollusca. Pelecypoda*, Government Printer, Adelaide (now in press).

Thracia watsoni is the type species of *Phragmorisma* Tate, 1893, and belongs to the family Myochamidae. The species *P. anitinaeformis* Tate, 1893, described from the Eocene, Spring Creek, Geelong (holotype) and Yabee Cape, Tasmania, is a Tertiary fossil closely allied to the Recent species.

8. *Vasticardium flavum* (Linne)

This Western Australian species was rarely taken alive in South Australia in the past, but specimens now live around Eyre Peninsula. I wrote in 1938: "Appears to have died out in South Australia, all the specimens we have seen are dead shells and probably subfossil."

9. *Callanaitis disjecta* (Perry)

The nearest point to Adelaide beaches whence this shell formerly came was American River, Kangaroo Island, but by 1940 specimens were taken alive as far north as Glenelg. The population increased rapidly in that area, extending by 1950 as far north as Largs. In June 1960, Trevor Smith took 135 specimens in two days at Semaphore. A total of over 200 were known to be taken by collectors in the same area.

10. *Periglypta puerpera* (Linne)

This species was originally recorded from "Swan River," South-Western Australia. Only one old shell in the S.A. Museum collection has the label "S.A." J. Veitch dredged a living specimen at Spalding Bay, Port Lincoln, in 1945, measuring 70 mm. x 65 mm. (Cotton, 1950). This added another tropical species to the S.A. list.

11. *Panopea australis* (Sowerby)

A few odd dead valves of this species have been taken in S.A. over the last 50 years. J. Veitch, of Port Lincoln, took it alive in February 1951 at Cape Donnington, 7-8 fathoms, and also a dead valve at Boston Island (Veitch Collection). This is well to the west of previous records and the species is not recorded from Western Australia.

CEPHALOPODA

12. *Argonauta nodosa* Solander

In 1948 I wrote: "These shells were once very rare on the local Adelaide beaches, but during the last five years some specimens have been taken" (Cotton, 1948). On August 21, 1943, six were reported washed ashore on different local beaches between Outer Harbour and Brighton and another with eggs was taken on August 8 by Dr. Angas Johnson at Port Noarlunga (Cotton, 1943).

The largest specimen seen in South Australia, 10½ in. in diameter, was taken at Henley Beach and is on show in the S.A. Museum collection. A correspondingly greater number are also being washed ashore on southern Yorke Peninsula.

13. *Nautilus repertus* Iredale

This Pearly Nautilus was recorded alive in South Australia at Foul Bay, Southern Yorke Peninsula (Cotton, 1957).

GASTROPODA

14. *Austrocypraea reevei* (Sowerby)

This Western Australian species was once regarded as rare in S.A., odd specimens being taken as far east as the west coast of Yorke Peninsula, but not further east. In 1956 half a dozen collectors are said, by the Secretary of the Malacological Section of the Royal Society of South Australia, to have taken a total of about 80 specimens (some living) in one weekend at Normanville.

15. *Zoila thersites* (Gaskoin)

The Black Cowrie occurs in quantity around Eyre Peninsula and Yorke Peninsula. A collector is said, by Mr. P. Tremberth, to have taken 40 specimens near the Sir Joseph Banks' Group recently in one day. The species was unknown on the local Gulf St. Vincent beaches, dead or alive, until about ten years ago, when odd specimens were taken alive by collectors at Normanville and Outer Harbour.

16. *Drupa margariticola* (Broderip)

Just recently the Secretary of the Malacological Section, Robert Hall, took a specimen alive at Tumby Bay. This is the first record of this northern genus in the eastern Flindersian Province.

ECHINODERMATA

17. *Phyllacanthus kimberi* Cotton & Godfrey

In 1942 this distinctive and rare species of sea urchin was described from Port Willunga. It is now obtained occasionally alive.

18. *Adelcidaris tubaria* (Lamarck)

Until about 1942 this species of sea urchin was rare in S.A., but in that year 20 specimens were taken at Normanville in one morning. It is now quite common up to Marino in Gulf St. Vincent.

MANGROVE SWAMPS

Mangrove *(Avicennia officinalis)* swamps once extended at least as far south as Port Noarlunga and flourished for a short period about 3,000 years ago when the climate was warmer. The fauna was wiped out, probably by climatic change, and later silting by fine sand (Cotton, 1949). This is mentioned here as of recent years, since 1948, heavy and encroaching seas have repeatedly exposed the old mangrove swamps and their fauna along the Gulf beaches at such places as Henley, Glenelg and Brighton. Extensive damage to the sea front has been caused.

This violent disturbance has evidently helped to influence populations and distribution of our local fauna.

CONCLUSION

It seems that there has been a noticeable increase and change in marine invertebrate populations during the last twenty years.

Certain Western Australian species are entering the Flindersian Province and flourishing.

Certain local species are increasing in number and extending their range northward into Gulf St. Vincent.

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CONTRIBUTIONS TO THE BIOLOGY AND ETHOLOGY OF THE RED-EARED FIRETAIL (*ZONAEGINTHUS OCULATUS*)

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INTRODUCTION

This study is based on field observations on a single population of the Red-eared Firetail *(Zonaeginthus oculatus)* in the Wongong Gorge in the Darling Range, near Armadale, Western Australia. It is concerned with the behaviour of the species compared with other Australian finches I have investigated, especially the Beautiful Firetail *(Z. bellus)* which I have studied in Tasmania. Hitherto both the behaviour and the nature of the calls of *Zonaeginthus oculatus* were relatively unknown (Morris, 1958). My Wongong studies were made during the 1959-60 season.

HABITAT

Four pairs of Red-eared Firetails were constantly present in the study area. This was a broad gorge heavily covered with a dense undergrowth and lightly forested with Marri *(Eucalyptus calophylla)*. Through the valley ran a small creek known to hold water throughout the year. The locality is only 22 miles from the city of Perth.

The Beautiful Firetail has been found in similar habitats in Tasmania, but it does not seem to be as specialised as the Red-eared Firetail. It lives in a wider variety of habitats, from lightly forested country to open swamps. Furthermore, it even ventures into the gardens of towns and has been observed in Hobart several times. It is much less shy than its South-Western Australian relative.

Contrary to other Australian finches, tenacity to the one environment and solitary habits appear characteristic of the Red-eared Firetail and the unmated individuals and pairs alike demonstrated this strikingly during my observations at Wongong. In both the breeding and non-breeding seasons I found the birds regularly within their fairly large territories, which under normal conditions they never seemed to leave. This same persistence in one area has also been noted in the Beautiful Firetail (Ashby, 1920). The Western Australian species, however, appears to be even more extreme in its addiction to solitary existence. At Wongong no more than two adults or three young birds were ever seen together. This applied also to the non-breeding season. At this period the Beautiful Firetail forms flocks of up to 12 individuals (Gould, 1865; Cayley, 1932).

LOCOMOTION

The flight of both the Red-eared and Beautiful Firetails is light, steady and relatively slow, with scarcely any undulations. This is in considerable contrast to the flight of other Australian finches living in a more open environment. Their flight is rapid and vibratile, with distinct undulations. As a rule the Red-eared Firetail flies low. I have often seen it from one to two feet above the ground, weaving with great dexterity around trees and shrubs. Higher flight, however, is resorted to when longer distances are to be traversed, and is necessary in reaching the nest, which is usually high in a tree.

Whilst the birds are on the wing there is no song or calling. Air-borne calling, as heard in many other Australian finches, is quite unnecessary in this species since it characteristically does not form flocks. The Beautiful Firetail and the Diamond Firetail (*Z. guttatus*) also possess a flight call. In the flocking finches this type of call serves to hold the group together.

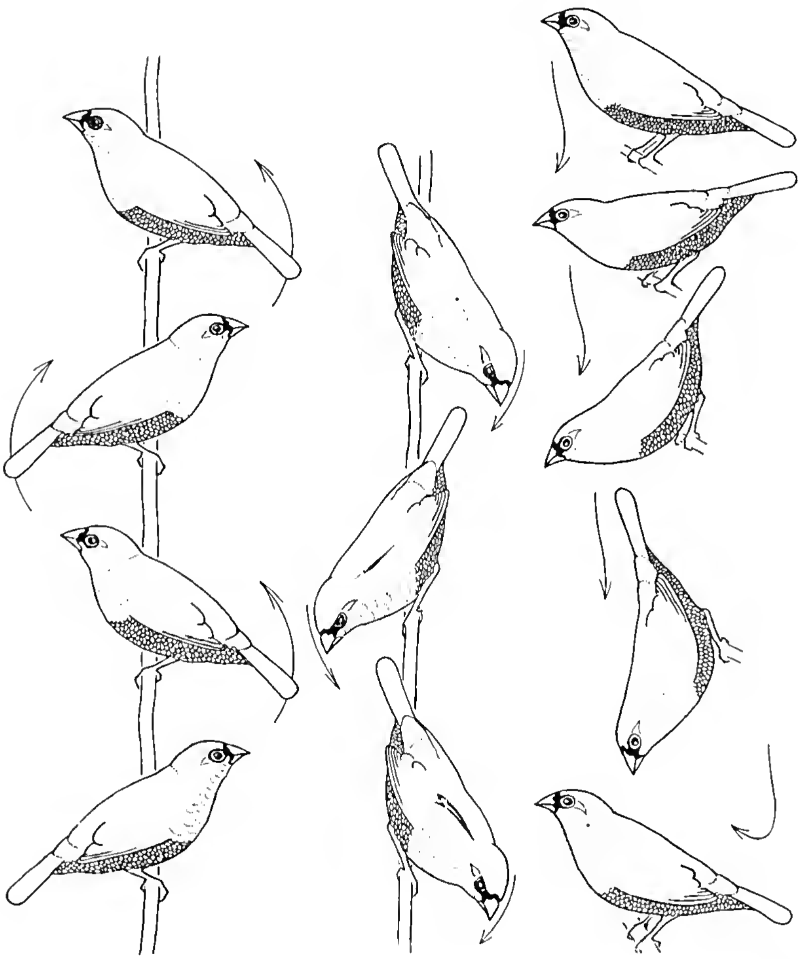

Fig. 1.—Locomotion in the Red-eared Firetail; left row, pivoting up a vertical branch; middle row, pivoting down a vertical branch; right row, method of descending branches of a tree.

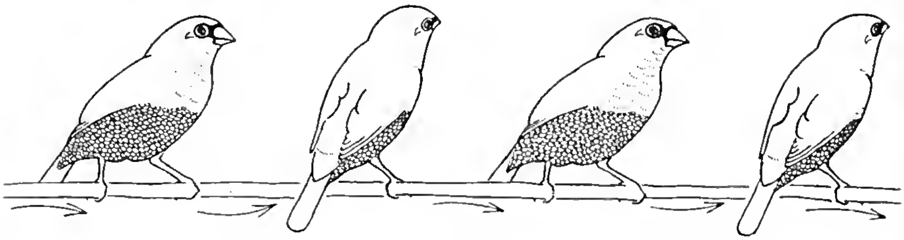

Fig. 2.—Red-eared Firetail pivoting along a horizontal branch.

When flying in sunlight the vivid red rump of all the species of *Zonaeginthus* is displayed with the clarity of a motor car's tail lights. This feature fades to relative obscurity in shade.

As in all Australian finches movement over the ground is performed by hopping, both feet in unison. Actually the Red-eared Firetail is very seldom seen on the ground itself, for even when feeding it prefers to sit on fallen twigs or branches. This is in striking contrast to the Beautiful Firetail in south-east Australia which is to be seen freely hopping and feeding on the ground and which does not share the western bird's marked adaptation to life amongst twigs and branches of trees. The Red-eared Firetail, in fact, is unsurpassed among the Australian finches in its ability to manoeuvre in and around the foliage of trees and bushes.

Ascending perfectly vertical twigs it releases its foothold to pivot to one side with each upward thrust. As the succeeding hop is made the pivot brings the bird over to the alternate side (Fig. 1, left row). Movement along a horizontal branch is also performed in arcs from side to side with pivoting hops (Fig. 2).

In descending limbs of a tree, one of two methods are employed. The bird usually leans out from a horizontal bough in the direction of a lower one, and, maintaining its foothold, falls forward as though beginning to rotate around its perch. When suspended upside down, it will suddenly relax its grasp and drop. Thus it comes down from branch to branch (Fig. 1, right row).

Rarely the side to side pivoting hop may be resorted to in the descent of a twig. In this situation the bird's body is hanging almost vertically, head directed downward, with the legs horizontal as the feet clutch the twig. Continually in this position, the pivots are executed in exactly the same manner as has been previously described. Foothold is momentarily lost as the bird hops (Fig. 1, middle row). So adept in these features, the Red-eared Firetail is able to hop straight through undergrowth that would force other finches to remain at the periphery. Being quite dense these bushes would present an impenetrable barrier to other species of finch, and would undoubtedly compel the bird to fly around to reach the opposite side.

With one exception, the wings and tail of the Red-eared Firetail are not obviously moved in the manner characteristic of other finches. When not in flight the wings are held absolutely motionless. There is no sign of the typical finch-like flicking. Further, it is only when the bird turns to one side that any appreciable diversion from the normal is obvious in tail movement. The tail is taken a little further through the arc made by the body of the turning bird, so that it is twisted out of its natural position.

I believe that this exaggeration of the tail turn is the origin of the more highly evolved tail motions seen in other finch species. The tail movements are the same in the Beautiful Firetail.

FOOD AND FEEDING HABITS

As stated by Serventy and Whittell (1951), grass seeds form the main diet of the Red-eared Firetail. I usually found the birds to be feeding on *Lepidosperma angustatum,* while Sutton (1926) identified seeds from the stomach contents of the Beautiful Firetail as belonging to a species of *Stipa.* Seeds of trees and shrubs are also taken. A further record of the diet of the Red-eared Firetail comes from H. E. Tarr (1948) who observed them eating the "nuts" of *Casuarina.* During the breeding season, both the Western Australian and south-east Australian Firetails pick small insects from the foliage (Cayley, 1932, 1958).

Seldom seen on the ground itself, the Red-eared Firetail usually feeds whilst perched on a fallen twig, beneath a tree or bush. Securing a hold on the seed head of a piece of grass, the bird will pull it forward with the bill, until it is able to clutch at the stem immediately behind the seed head with one foot. The seeds are then removed. When the supply in one particular head is exhausted, the foot grasp is relaxed and the empty grass allowed to spring back. Then, pivoting from side to side on its perch, the bird will detect another seed head and repeat the procedure.

When actually feeding on the ground a Red-eared Firetail persistently hops back to twigs scattered nearby, and pauses thereon to look about the area before resuming its meal. It will thus interrupt its own feeding approximately every minute. As in feeding from a fallen twig one foot is used to hold the grass. Sometimes it will alight at the foot of a plant just beneath the seed head, and pick out the grain from there. There seems to be no preference for which foot is used in holding the grass. Both are employed impartially. In keeping with its weaker adaptation to twig life the Beautiful Firetail mostly feeds on seed heads of grasses lying on the ground and very seldom uses its feet to hold a piece of grass.

If feeding from the side of a bush no attempt is made to grasp the inflexible branches in the same manner as is the grass. Instead the bird will alight as close to the seeds as possible, reach out if necessary, and take them direct.

As a consequence of its general solitary habits this finch feeds alone, and in shrubbery, not out in the open as do the other Australian grass-finches. As stated previously, the absence of a contact call correlates with the absence of flocking.

CALLS

I have found that the Red-eared Firetail utters three types of call. The first, already known, is a nearly monosyllabic *Identity Call.* The other two, previously unrecorded, I have named the *Intimate Nest Call* and the *Nest Site Call.*

The Identity Call can best be expressed verbally by the sound "oowee," but the note as heard from the bird seems to have neither beginning nor end. It is very difficult to locate the calling bird by its sound. It floats in the air and trails off in all directions, so that the sound could have originated anywhere one looks.

It is quite audible, and is uttered whilst the bird is sitting on a branch. During the vocalisation there is no movement of wings or tail, such as is characteristic of other finches in similar circumstances. The bill is kept completely closed, or barely half a millimetre open. Throat movements, however, are quite obvious. With every call the neck is stretched slightly as the head and bill are tilted in a faintly downward direction. The same remarks apply to the Beautiful Firetail, in which species the Identity Call is even more monosyllabic and might be rendered as "weee."

The Identity Call may be given as a single note, or part of a series of the same notes. In the non-breeding season the single note is the most common. It is also uttered during bathing, preening or normal activity. Of spontaneous origin it appears to be involuntary and un-orientated. The same meaning may therefore be attributed to this call as for the social calls of other species of finches (Morris, 1958: Immelmann, 1959).

When uttered in a series it is repeated from two to 20 times. It becomes functional when thus used, and has a distinctly "searching" characteristic, enabling a pair of mated birds to hold contact with each other over considerable distances. The rhythm of the series is variable. Sometimes the interval between the notes is only as short as the note itself, but at other times it may be two or three times as long. Usually the bird calling a series receives an answer from its partner which may be several hundred yards further away in another part of the territory. The answering call consists of the same series of notes as those given. Sometimes, however, an answer is lacking.

Whilst one individual is vocalising the series call the other is silent, and only on the cessation of sound from its mate will it answer. The pair may thus reciprocate for several minutes, giving series of calls each consisting of about 20 notes followed by a few seconds' pause. It is not always that the bird answering the primary instigator of the call series comes to its mate. As a rule the activity engaged in before the calls were made is reverted to at the termination of a calling period.

For approximately half an hour the pair carry on normally, before the calls are again repeated in the same manner as already described. In this way contact is held between the mated pair separated within the territory by some distance.

I believe it also has a slight sexual significance (Immelmann, 1959), since it is heard most commonly in the breeding season, and is rare in the non-breeding season. It may serve for the synchronisation of the two birds constituting a pair, or in the definition of territorial rights. Coupled with the purpose of long distance contact-holding, these features bring this series calling of the Red-eared Firetail into the same class as the loud calling of other species of finch.

With a pair actively nesting, the series calls were even passed between the bird incubating on the nest and its mate foraging nearby on the ground. Since there is no distinctive sexual dimorphism in the Red-eared Firetail, I could not ascertain whether it was the male or the female bird which initiated vocalisation in this manner. Mated birds, like young of a common clutch, answer to each other. On the cessation of calling by one individual the other would sometimes continue for several minutes.

In some instances these calls are given when a bird is searching for a nesting site. However, it is not always associated with the carriage of a piece of grass in the bill in this case. Its purpose nevertheless, becomes identical with that of the actual Nest Site Call (see below).

If in fear, or disturbed, single birds will give the series call. It is probably a type of warning when thus used.

Generally the Red-eared Firetail is very quiet during the non-breeding season. When breeding, however, the birds become so vociferous that the gorge constituting the study area echoed to their calls. This is in direct contrast to the behaviour of other species of finches which are especially noisy during the non-breeding season.

The Intimate Nest Call is uttered when a previously foraging bird comes to the entrance of the nest where its mate is incubating eggs or covering young chicks. This greeting is di-syllabic in structure, which I have interpreted in the phrasing "twit twit."

Although the bill is held closed during the call the wings are quivered slightly with each note. It is a sharply-defined sound by which the bird can be directly located if the direction of the call is followed. The answering call given by the bird within the nest is composed of four syllables. The first note is long and pronounced, while the following three are slightly different from the first and given in a short staccato manner. The entire call may be rendered "tweet tit tit tit."

Immediately the incubating bird answers the "twit twit" of the mate outside, the latter will enter the nest where several further of the same call sequences are given. A few seconds later the bird relieved of its incubating duty appears at the nest entrance and flies off.

As far as is known no other species of finch possesses a call so intimate in nature. Coincidentally, no other finch builds a nest with the same structure as that of the Red-eared Firetail. The long, relatively narrow tunnel obscures all sight of what lies within, so this call is presumably for protection. Through the mechanism of the Intimate Nest Call, the relieving bird may ascertain that the internal conditions of the nest are normal.

Confirmation of this theory was gained when an incubating bird was flushed from the nest due to my presence nearby. The relieving mate, arriving a short while later, called in the above described manner but naturally received no answer. After repeating the call for several minutes it hopped to the roof of the nest and waited. It was not until ten full minutes had elapsed that it began to move toward the entrance, which it doubtfully and hesitantly entered.

In normal circumstances the relieving mate enters the nest immediately the answer to its call is heard from within. If the flushed bird returns quickly it does not call prior to re-entering as it is aware of the nest being unoccupied.

The third call I describe as the Nest Site Call. The Red-eared Firetail utters these notes when in search of a suitable nesting place. There are six syllables in each phrase, the first of which is a variation of the Identity Call. Five short notes follow in rapid succession. Occasionally the first note is omitted. The entire phrase may be expressed as "ooweeee üüüüü." The five short sounds are similar in character to the German umlaut "ü." The introductory "ooweee" is of somewhat shorter duration than the Identity Call, but is not as plain. The five short notes are uttered with continually fading intensity.

BREEDING

(i) THE SEARCH FOR A NESTING SITE

As is usual with finches the male Red-eared Firetail chooses the site on which the nest may be built, after which it is shown to the female for acceptance or rejection. In these cases, sex was surmised by behaviour.

In a suitable tree the male hops back and forth, searching, with or without a piece of grass held in his bill. Sometimes he will stop in front of a conspicuous place and give a series of Identity Calls. In this instance the male Red-eared Firetail exhibits a vestige of display remarkably similar in character to that of the Diamond Firetail *(Zonaeginthus guttatus)*. The plumage of the underparts is fluffed out during the calling and a more erect stance adopted (Fig. 3). There is neither feather fluffing nor bodily erection during true Identity Calls, where the position is almost horizontal. The purpose in this display and utterance is very probably to attract the female so that she can be shown the site.

The call is, necessarily, given with closed bill, should the bird be holding a piece of grass. The grass itself is held in a unique manner (Fig. 3). It hangs vertically from the extreme tip of the bird's bill, its main length below and a small part projecting above the plane of the culmen. It thus appears to be impaled on the point of the mandibles, but I believe that it is very probably held in posi-

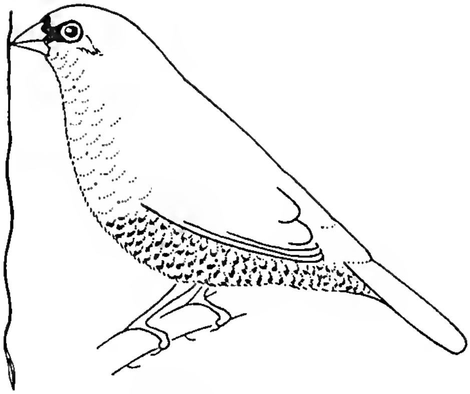

Fig. 3. –Red-eared Firetail holding grass and displaying.

tion by a peeled back strand of the stalk (Fig. 4). Green pieces of grass from 8 to 18 inches long are most frequently used, and only seldom are the dried yellow ones taken.

During flight and movement amongst branches the grass swings freely. Should it catch on a twig, the bird endeavours to release it by jerking his head back over to one side. In strong wind the grass is sometimes dropped as the call is made. It appears that vocalising and holding grass in the bill simultaneously are extremely difficult for this finch in more adverse weather conditions.

Symbolising nest building and breeding, the meaning in the carriage of a piece of grass by the male Red-eared Firetail is the same as that in the courtship of many species of finches (Steiner, 1955; Morris, 1958; Immelmann, 1959).

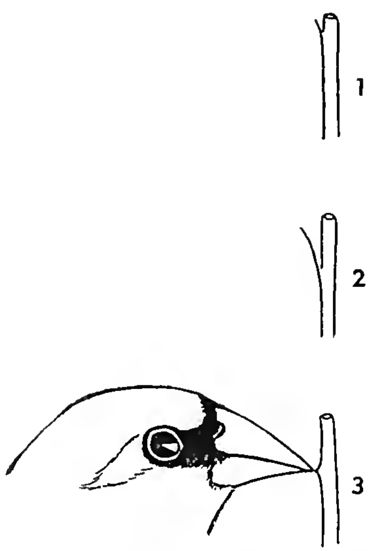

Fig. 4.—Mechanism of grass holding.

Depending upon the intensity of the nest building urge, the male may continue to search and call for as long as 45 minutes. If the female does not appear within this time the grass will be dropped and the bird flies off. Should the intensity be high, however, he obtains another piece of grass and begins over again. As soon as the female appears in the tree, the male hops to the denser foliage, where there may be a possible nesting site, and here gives the Nest Site Call as previously described. If he is still carrying the piece of grass, he will drop it now, prior to vocalising.

Contrary to the action of the Zebra Finch *(Taeniopygia castanotis)*, the Red-eared Firetail never fans out the tail during a Nest Site Call.

The female Red-eared Firetail shows her acceptance of the site thus chosen by the male by flying to or alighting near him, and hopping about on the chosen branch, in a fork of which the nest will ultimately be built. Rejection of the site is displayed by the female's flying away from the area. When this happens the male will repeat the entire procedure in another tree some time later.

(ii) COURTSHIP

During the period of nest site searching and nest building the courtship activity is performed. The courtship behaviour of the Red-eared Firetail conforms to a large degree with that of other species of grass-finches *(loc. cit.)*.

Courting is begun by the male bird as he utters the Nest Site Call with a piece of grass held at the tip of the bill. As soon as the female alights close by he will begin to jump back and forth between two branches, the piece of grass swinging pendulum-like with his momentum.

Directly upon landing after the completion of each jump he utters the call described above, although while in transit there is no vocalising. Still holding the piece of grass, he will eventually land near the watching female. Standing erect with the bill directed upwards he then commences to spring repeatedly up and down over the same spot, like a bouncing ball. The plumage will generally be fluffed out, but this feature is most noticeable in the abdominal region. The red ear-patches are not significantly erected.

At this stage a receptive female will begin to quiver her tail. As she does so the male drops the piece of grass and copulation follows.

Since the pair are usually high up in the tree, I cannot be certain as to whether there is any call during the bouncing dance.

(iii) NEST BUILDING

As is usual in Australian finches the male transports pieces of grass whilst the female sits in the growing nest and works them in. Green plant material is used exclusively. The grass is bitten off at ground level and by this end is carried to the nest. At the peak of nest construction activity one piece of grass is brought to the nest every 30 seconds (Peter Slater, personal communication). The material is gathered from the area beneath the nesting tree and is taken up in vertical flight, which resembles that of a beetle.

Having completed the outer parts of the nest the bird next gathers feathers and plant down which will be used as lining. A bundle of these articles is gathered together and held firmly in the middle as it is transported to the nest.

(iv) NESTING SITE

The Red-eared Firetail builds its nest higher above the ground than any other Australian finch. I found five nests from 25 to 50 feet up in the trees. As noted by Serventy and Whittell (1951), however, the Firetail in coastal areas may build in shrubs, such as *Hakea*. Campbell (1900) also found the nests in *Melaleuca* and *Banksia*.

In the Beautiful Firetail I found four nests from 6 to 22 feet from the ground. There were much higher trees in the neighbourhood and I conclude that this species does not favour as high an altitude for its nest as does the Red-eared Firetail. These four nests were built in introduced bushes (*Crataegus* spp.).

In my own study area at Wongong, the most frequently used sites were high in the forks of the outermost and denser branches of *Eucalyptus calophylla*.

The nest was usually set over a branch one-half to one inch in width, and was supported by surrounding twigs. In one case a nest had been placed in a dense mistletoe which had overgrown a large eucalypt. It was consequently very well camouflaged. Yet another was built on a branch overhanging the creek. A nesting site of this nature is characteristic of many species of Australian finches (Macgillivray, 1934; Campbell, 1900; Cayley, 1932).

In several instances a male Red-eared Firetail was observed with a piece of grass in his bill, uttering the Nest Site Call beneath the nest of a Brown Hawk (*Falco berigora*). This suggests that the Red-eared Firetail, in common with many other finches, also prefers to nest in the neighbourhood of birds of prey (cf. Souter, 1927; Sutton, 1927).

(v) THE NEST

When compared with the nests of other finches, it will be seen that the Red-eared Firetail builds by far the most substantial and attractive nest.

Serventy and Whittell (1951) have described the structure as retort shaped. It comprises a spherical nesting chamber connected to a long tunnel, together measuring up to 16 inches in length. The tunnel itself may be 7 inches long, by 2-3½ inches in diameter. Height and breadth of the chamber may be 6 inches. The chamber consists of two parts. In the interior is a second cup-shaped "nest," which has thin, weak walls and is almost devoid of roofing.

Both are constructed of different materials. The inner nest is made of pieces of grass, whilst the exterior is composed of strips of the liana-like Twining Fringe Lily (*Thysanotus patersonii*). Morgan (1919), in South Australia, found a nest of the Beautiful Firetail built of the twining *Clematis*. The four nests I was able to examine in Tasmania were built of grasses only.

The tunnel, likewise constructed of twining stems, is continuous with the under side of the chamber and lies along a branch with the entrance over toward one side of the distal end. The chamber and tunnel walls are from 1-1½ inches thick, the sides and roofing of the chamber being more durable than the base. This is in direct contrast with the inner nest. Even if a considerable pull is exerted on the outer chamber it is extremely difficult to destroy. Its great strength is probably due to the liana-like quality of the twining stems, which wind about each other. Since the nest is built in the weak terminal branches of a eucalypt, where the foliage frequently sways violently, such a tough construction is highly adaptive.

As far as I have observed the Red-eared Firetail uses only green plant material in the building of its nest, although this quickly dries and turns yellow in the sunlight. The protected inner parts, however, remain green for a good many weeks.

Of four nests investigated in detail, I found that the outer construction consisted of between 420 and 500 strips of twining *Thysanotus*. One piece was 35 inches in length—almost eight times as long as the bird which carried it—and this same piece also trailed 106 tendrils each varying from 2 to 14 inches in length!

The ability of the Red-eared Firetail to transport such material is outstanding. However, not all the pieces were of such lengthy dimensions.

The average length for the pieces which constituted the outer parts of the nest was between 16 and 20 inches. The pieces became progressively smaller toward the interior of the nest, and at the innermost limit the average length had become from 6 to 8 inches. In the Diamond Firetail I also observed this preference for very long pieces of grass for nest construction. Since the construction takes place from the inside and is brought outwards, an urge to bring longer and longer pieces results in this type of order in the building material.

The tunnel is built similarly and the *Thysanotus* strips constituting the outer nest chamber are laced into the fabric of the tunnel and vice versa. In this manner the two are bound inseparably together as one. The tunnel is constructed after the nest chamber is already built, so that the longest pieces are found in it. Some of them are wound around the circumference of this tunnel, which consists of between 150 and 185 strips. It is never lined with either plant down or feathers.

The cup-shaped interior nest is made up of between 230 and 360 pieces of grass, primarily *Stipa elegantissima*. This material is considerably softer than the twining stems of the outer nest and tunnel. Like the length order in the *Thysanotus* stems, the pieces of grass become shorter toward the interior. The outer pieces measure, approximately, 8 inches whereas the innermost are only about two inches long. The entire unlined nest comprises between 800 and 1,045 pieces of plant material, and is thus almost twice as large again as the nest of any other species of Australian finch.

The lining of plant down and feathers is added later. The amount used does not appear to be of a fixed quantity, but seems to depend upon its availability. Cayley (1932) cites F. L. Whitlock who reported: "It will be noted that there is no separate lining, the five or six pure white eggs simply lie on the general fabric of the nest."

In a breeding nest of a Red-eared Firetail Warham (1954) found only six feathers, whereas one of the nests investigated in my study area contained 310 feathers and the same amount of plant down. There were almost 2,000 pieces of material in this particular nest. The feathers in its lining very probably originated from a single Western Rosella *(Platycercus icterotis)*, which had died in the vicinity, and had been found by the Red-eared Firetails. The Beautiful Firetail also uses feathers for the lining of the nest. Feathers of any colour may be taken for lining but, as is usual in all Australian finches, the Red-eared Firetail has a preference for white. North (1909) recorded one nest of the Beautiful Firetail in South Australia lined with *black* feathers.

As well as breeding nests, the Red-eared Firetail probably builds roosting nests for use in the non-breeding season. Because of the unfortunate lack of time I was unable to ascertain whether these structures were made only for roosting, or if they were abandoned breeding nests, used for roosting after the end of the breeding season. All were unlined, and save for a two to three inch long extension of the entrance, almost entirely lacked a tunnel. In all other respects, the nests had been built in the same manner as the breeding nests.

Similar, but poorly constructed roosting nests are made by the Zebra Finch and other finches. Invariably, however, these birds first attempt to find an abandoned nest, belonging either to their own or another species, which may need only to be reorganised.

As has been demonstrated, the nest building of the Red-eared Firetail has reached a higher point in the evolutionary scale than has that of any other species of Australian finch.

For some time these grass-finches had been considered a subfamily (Estrildinae) of the true weavers (Ploceidae) (Delacour, 1942; Morris 1958). Because, however, of the great differences in anatomy, physiology and behaviour most recent workers are of the opinion that the grass-finches constitute a separate family, the Spermestidae or Estrildidae (Beecher, 1953; Steiner, 1955; Wolters, 1957; Immelmann, 1959; Ernst Mayr, pers. comm.).

The nest building of the grass-finches, especially that of the Red-eared Firetail, strongly supports this opinion. The true weavers (Ploceidae) begin nest construction by weaving a few pieces of grass around a twig. Then a ring is formed representing the side walls-to-be, after which the roof is added. Not until the end are the base and egg chamber proper built (Lack, 1935; Skead, 1956, 1959; Collias and Collias, 1959). This is in direct contrast to the method employed by the grass-finches. These build an open cup-shaped structure on the fork of a branch, but never weave it. The side walls and roof follow in that order.

(vi) INCUBATION

Both sexes of the Red-eared Firetail assist in the incubation of the eggs, as is characteristic of all finches.

Each period-on varies between 1½ and 2 hours, the average being one hour 40 minutes in 14 instances observed in the study area. At the end of this time the change-over of mates takes place, always preceded by the Intimate Nest Call described previously. Both birds incubate for the same total period of time each day, in interrupted sessions. At night the two retire into the nest together.

Never does the male Red-eared Firetail come to the nest to feed his mate by regurgitation, as has been described by Warham (1954). The feeding of an incubating bird by its mate is recognised as occurring only in the true finches (Fring'llidae), and is completely unknown in the grass-finches (Estrildidae).

At the relief of the incubating female the male Red-eared Firetail will sometimes bring a feather in his bill, held by the middle of the rachis. This behaviour depends upon the availability of feathers in the neighbourhood, as does the amount of lining incorporated in the nest. Feathers, when available, are brought in this manner throughout the incubation period, and Warham (1954) states that even when the young have reached eight days of age the behaviour was continued.

The Red-eared Firetail incubates more tightly than any other species of finch. While the latter leave the nest with extraordinary lightning-like rapidity on any disturbance, I found it extremely difficult to induce an incubating Red-eared Firetail to interrupt its incubation. Even by violently shaking the bough, which held the nest, or throwing stones against the branches, I was unable to force the bird out. It was not until my hand was actually at the entrance to the tunnel that the bird emerged.

This persistence in covering the eggs, even during unusual external circumstances, is probably the result of the type of nest built by the species. Within the walls of the strongly constructed nesting chamber, open only at the tip of a substantial and narrow tunnel, an incubating bird is well protected from intruders. The bird arriving to relieve its mate on the nest never alighted before the nest entrance. It always landed in the opposite side of the tree, and from there hopped through the branches toward the nest.

Unlike other species of Australian finches this bird employs a method of incubation change-over which I shall term Direct Relief. The relieving mate actually enters the nest and remains inside with its partner for a few seconds before the relieved bird emerges. The incubating Zebra Finch, and other species of finch, will leave the eggs and fly from the nest as soon as the mate alights somewhere nearby in the nesting tree. This type of change-over I term Indirect Relief.

Direct Relief in the Red-eared Firetail is probably an adaptation to the nest construction. Being completely hidden from view, the bird covering the eggs is able to assure its mate through the mechanism of the Intimate Nest Call that the internal nest conditions are normal.

At close of day the bird which happens to be out and foraging in the neighbourhood does not return to the nest until approximately 20 minutes after sunset. Most other Australian finches are settled for the night before sunset.

During the hatching period both birds of the pair sometimes remain together for up to 30 minutes at a time in the nest during daylight hours. It appears that this behaviour is nothing more than a prolongation of the Direct Relief change-over.

The eggshells of the newly hatched young are carried out by the parents at the change-over of incubation. They are never deposited in the immediate vicinity of the nesting site, but are dropped during flight, over 30 or 40 yards away. In the Beautiful Firetail the carrying out of the eggshells has been observed by H. E. Peir (Cayley, 1932).

There is no evidence of nest sanitation since the nest becomes soiled and hardened with the droppings of the nestlings. The statement of Warham (1954), that the parent birds swallow the faeces of their young, has not been proved for any species of grass-finch (Estrildidae).

BEHAVIOUR OF THE YOUNG

Due to the destruction of an active nest by a Carpet Snake I was unfortunately unable to observe the feeding and behaviour of the young both before and after leaving the nest. This particular nest was the only one which could have provided me with the data during my short visit to the area.

Warham (1954) states that the young are brooded by the parent birds until the eighth day of life. His belief, however, that only the female covers the young is certainly an error. The described "visits of the male every forty minutes" were only the change-over of mates in brooding sessions.

The period-on is necessarily shorter than that during incubation of eggs since the young must be fed at regular intervals. Therefore the 1½-2 hours period-on during incubation is reduced to only 40 minutes after the chicks have hatched.

In December I watched three young Red-eared Firetails at approximately 10 to 12 weeks of age, undergoing heavy moult into adult plumage. As the juvenal plumage of the Red-eared Firetail has not been described I have included the following notes.

The eye-ring of the juvenal bird has an inconspicuous tinge of blue. This signifies that the bright colour of an adult is attained only after the completion of the moult. Even in fully adult Red-eared Firetails the eye-ring tone is variable. In the breeding season the colour is intensified, becoming duller in the non-breeding season.

The bill of the young bird—as usual in most Australian finches—is black. As the post-juvenal moult continues, however, the typical red sheen becomes evident.

There is no red ear-patch and no black stripe through the eye.

The upper parts are grey-brown, considerably duller than those of the adult bird. The lower breast and abdomen show none of the white spotting seen in the mature individual, but are marked with equally spaced alternating light brown and dark brown undulating stripes. Thus the young Red-eared Firetail resembles the Beautiful Firetail of the east and it is only after the moult that the plumage differences between the two species become obvious.

The three young birds under my observation spent all their time within the parental territory. They were always together and called to each other with long Identity Call series as used by mated pairs in the breeding season. True Nest Site Calls were also sometimes uttered by these juvenals, but were never associated with grass carrying as in mature birds.

As is typical of many young birds, especially grass finches, the juvenal Red-eared Firetail shows indications of the awakening of sexual behaviour during the post-juvenal moult.

TERRITORIAL BEHAVIOUR

I have found most Australian finches tend to breed in colonies. This means that several pairs form a breeding community in the same bush or group of bushes. In such a case, the territorial defence tendency is weak. The Red-eared Firetail, however, always bred as solitary pairs. None of the nests I examined were within 100 yards of each other. Nevertheless there is no territory in the sense that is applied to many other species of distinctly territorial birds, and usually only the immediate vicinity of the nest is defended.

The entire territory comprises a circular area of from 100 to more than 200 yards diameter around the nest site.

Territorial defence behaviour is at its highest intensity during the nest-building and courtship period. During the moulting-period it is completely absent. As soon as a strange male—looking for a nesting site—approaches the area of an occupied nest, the breeding bird will fly towards and pursue it until more than 100 yards are between the nest and the intruder. In the defence of the nest itself the female is as active as the male.

No definite statement can yet be made regarding defence of the outer limits of the territory.

On several instances I observed an established male Red-eared Firetail finch chasing another male back and forth within the territory, to which the strange male had meandered. The intruder, which ultimately left, had been in search of a nesting site and was carrying a piece of grass in his bill. These males, however, could have been the same two observed feeding together some time later, beneath the nesting site of the bird in possession of the territory.

Obviously the territorial defence reaction is not always at high intensity, and reaches a maximum only at certain stages of the cycle. This is similar to the behaviour of the Beautiful Firetail and of the Zebra Finch, as well as the other Australian grass finches. It is quite possible that the response elicited was more powerful under the added stimulus of the piece of grass in the intruder's bill.

A nesting site is defended even though not definitely accepted by a pair. A male in search of a site, carrying a piece of grass in its bill, will vigorously chase off another male although there is no actual territory to defend.

The Red-eared Firetail thus possesses a large territory, but defence of the area as a whole appears to be relatively weak. The strongest defence is applied to the immediate vicinity of the nest. In several other species of Australian finch this trend has gone another step further. Since they build in close proximity to one another, defence is confined to the nest itself only.

RELATIONS WITH OTHER BIRDS

Singing Honeyeaters *(Meliphaga virescens)* pursued the young Red-eared Firetails, but never closed in with positive attack. This species of honeyeater caused much damage with the eggs and young in a breeding colony of Zebra Finches which were under my observation in York, W.A.

One male Red-eared Firetail was observed chasing a male Splendid Blue Wren *(Malurus splendens)*.

EVOLUTIONARY STATUS

The Red-eared Firetail is considered to be one of the most primitive of the Australian grass-finches and many of its activities are of low order in the evolutionary scale. On the other hand it is efficiently adapted to its environment, particularly in regard to nest construction and associated behaviour. The complex construction of the nest is unique amongst nests of all other Australian finches.

The Beautiful Firetail of south-eastern Australia seems to be even closer to the common ancestor of the Australian grass-finches. Its behaviour and biology show still more primitive characters and it lacks the special adaptations to life in dense undergrowth. From a species similar to the Beautiful Firetail the other members of the genera *Zonaeginthus, Bathilda* and *Neochmia* may have developed, the Red-eared Firetail being a side-line with special adaptations.

SUMMARY

In this paper the behaviour of a natural population of Red-eared Firetails *(Zonaeginthus oculatus)* has been described. Comparative observations on the behaviour of some other species of Australian finches are included.

The Red-eared Firetail lives in seclusion in heavy forest, usually only with its mate and always within the territory. The species never forms flocks as does *Zonaeginthus bellus,* its south-eastern Australian counterpart.

Flight is usually low, relatively level and slow, and is never associated with calls. The bird hops in finch-like manner, but with one exception the wings and tail remain motionless. A slight tail twisting following a turn in a new direction is the only noticeable divergence from the normal position.

Typically a seed eater, this bird may prey on small insects in the breeding season. It feeds alone, seldom directly on the ground.

Seed heads of grass are held with either foot whilst the seeds are removed by the bird perched on a fallen twig. No call is uttered during feeding, since there is no associated flocking.

Three types of calls given by the Red-eared Firetail are described, all of which are uttered in specific conditions: the Identity Call, the Intimate Nest Call, and the Nest Site Call. The Intimate Nest Call, given at the change-over of incubation, is unique amongst Australian finches, and has probably evolved from the manner in which the nest is constructed.

The male selects the nest site, after which it is shown to the female for acceptance or rejection. Calling by the male bird is associated with grass holding and some plumage erection in display when the female is to be attracted to the site.

The Nest Site Call is given when the female arrives at the site, but there is no tail fanning as in the Zebra Finch. If the site is accepted, the female remains, but if it is unsuitable she flies off, after which the male will begin afresh in another tree.

Courtship conforms largely with that of the majority of grass finch species. It is begun by the male uttering the Nest Site Call as he carries a length of grass in his bill. With the female nearby, the male will jump back and forth between two branches, uttering the call only upon each landing. Still holding the grass, he eventually alights near the female and springs repeatedly up and down. This is associated with some plumage erection and an exaggerated stance. A receptive female invites copulation by quivering her tail, stimulating the displaying male to drop the grass and mount.

In nest-building the male carries grass from beneath the nesting tree to the nest site, where the female does the construction. Green plant material is used exclusively, and lining is added after the outerparts of the nest are completed.

The nest is built between 25 and 50 feet above the ground, which is higher than that of any other Australian finch. It is constructed in the peripheral twigs of a tree and is the most attractive and substantial of all Australian finch nests, as well as almost twice as large. It is retort-shaped, with a spherical nesting chamber connected inseparably to a long, narrow tunnel. In the interior of an outer chamber, the actual breeding nest is constructed. The two are composed of different material, of which the outermost, composed of twining stems, is the stronger. Roosting nests are also constructed.

Both birds of the pair share in incubation, in periods-on of 1-1½ hours. The mechanism of incubation relief is different to that of other species of finch, and is fully discussed. The bird is persistent in incubation even during unusual external conditions. This is probably the result of the protection afforded by the robust type of nest. Eggshells are carried some distance from the nest, but there is no evidence of nest sanitation.

Juvenal birds show indications of sexual behaviour soon after becoming independent. The hitherto unrecorded juvenal plumage is described.

A large circular territory, of 100 to more than 200 yards in diameter, is occupied about the nest, but, on the whole, is weakly defended. Continually strong defence is applied only to the immediate nest vicinity.

ACKNOWLEDGMENTS

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LATE QUATERNARY CHANGES IN THE VEGETATION ON ROTTNEST ISLAND.

By D. M. CHURCHILL, Botany Department, University of Western Australia.

The present vegetation on Rottnest Island has been described by Storr, Green and Churehill (1959) as a *coastal complex* made up of fairly open microphyllous shrubs in the eoastal dunes; 10-20 foot high *Acacia rostellifera* scrubs in the sheltered valleys and slopes; elosed mixed shrubs of the limestone ridges; and salt marsh communities around the lakes and swamps. During white settlement, prior to administration by the Rottnest Island Board of Control, widespread destruction of the vegetation took place through elearing for agrieulture, ehopping down trees for building and firewood, and uneheeked burning which followed firing of the scrubs for Quokka shooting. The *Acacia rostellifera* serubs were redueed to isolated thiekets, and where the serub onee stood there now occurs a low dense formation eonsisting of sclerophyllous monocotyledonous plants, of which *Acanthocarpus preissi* and *Stipa variabilis* are the most prominent. The present balanee between the *Acanthocarpus-Stipa* formation and *Acacia* serub is eontrolled by fire frequeney and intensity of Quokka grazing.

From the foregoing aeeount it is evident that considerable changes to the vegetation have taken plaee on Rottnest Island over the last one hundred and fifty years. These ehanges may be attributed both direetly and indirectly to the influenee of white settlement. It is the purpose of this paper to give an aeeount of the prehistorie changes in the vegetation that have occurred since the isolation of Rottnest as an island between 4,000 and 5,000 years B.C.

FOSSIL EVIDENCE

During the reorganisation of the fossil plant collections at the Western Australian Museum, the attention of the author was drawn to a speeimen whieh consisted of the fibrous pith of the apieal meristem of a Blaekboy (*Xanthorrhoea* sp.). This specimen (Fig. 1) (Museum No. G9066) came from sediments eneountered 19 feet below the surfaee, when a well was sunk at Rottnest Island, and was given to the Museum by Mr. A. Armit. No Blaekboys have been found on the island sinee white settlement, and as this specimen showed no sign of replacement by inorganic carbonate, the Botany Department of the University undertook to have the material radiocarbon dated. The New Zealand D.S.I.R. Division of Nuclear Sciences, which made the analysis, gave the age of the Blackboy as 7,090 ± 115 years before 1960 (B.P.).

Examination of the present ecology of Blackboys on the coastal mainland opposite Rottnest Island showed that they are confined to sheltered habitats on stable soils in the Tuart and Jarrah Woodland, and further north they are found on sheltered slopes in heaths, well back from the coast. Evidence of their high resistance to disturbance by clearing, burning and competition from introduced weeds, may be seen along the sides of the railway tracks between Perth and Fremantle, where they are the most common remnant of the native plants. At no place have Blackboys been found in habitats exposed to salt pruning by the wind, on shifting sands, or in the *coastal complex* of *Acacia rostellifera* and *Olearia* dominated scrubs. These latter scrubs, often on stable soils, are a characteristic facies of the present vegetation on Rottnest. It seems reasonable to infer that lack of protection from exposure to salt pruning by the wind has caused the extinction of Blackboys on Rottnest Island. Whether or not they were protected in 5,000 B.C. by woodlands or distance from the sea will be discussed later.

The only other plant macrofossil from Rottnest Island is a specimen of *Callitris* wood from the Rottnest shell beds. This specimen, shown to the author for identification, was found by Messrs. C. W. Hassell and E. S. W. Kneebone during their investigations on the geology of the island. Radiocarbon dates from these beds show that its age is 3,950 ± 130 years B.P., thus showing that *Callitris* has been on the island since at least 2,000 B.C. Abundant fossil pollen in the swamp sediments shows that *Callitris* has been

Fig. 1.—Fossil Blackboy (*Xanthorrhoea* sp.), 7,090 ± 115 years old. Note the concentric rings of the leaf scars around the domed apex. This Blackboy was growing at Rottnest only a few hundred years before rising sea level isolated the area as an island. Diameter of stem, approx. 6 inches.

on the island since then, and its recent near extinction has been due to the heavy cutting of the tree for timber.

Fossil pollen, preserved in the swamp peats and calcareous gyttja sediments, shows the continuity of change in the floristic composition of the vegetation on Rottnest, probably since 2,000 or 3,000 B.C. The origin of the pollen preserved in these sediments must first be understood before interpreting changes in the pollen record. Did the pollen come from plants growing on Rottnest or from windborne pollen carried from plants on the mainland? To solve this problem, atmospheric pollen was collected at the Rottnest research station and compared with atmospheric pollen collected on the mainland, and with fossil pollen from Lake Serpentine and Lighthouse swamp on Rottnest Island. Table I contains an analysis of the relative proportions of the different pollen sporomorphs.

TABLE I.—RELATIVE PROPORTION OF POLLEN SPOROMORPHS OCCURRING IN THE AIR ON ROTTNEST; IN THE AIR ON THE ADJACENT MAINLAND; AND IN THE FOSSIL STATE IN THE SWAMP SEDIMENTS OF SERPENTINE LAKE AND LIGHTHOUSE SWAMP.

Pollen Sporomorph	Atmospheric Pollen Mainland	Atmospheric Pollen Rottnest	Fossil Pollen Rottnest
	%	%	%
Grass	24	69	1
Callitris	2	7	15
Pinus	26	5	—
Eucalyptus	9	4	3
Compositeae	3	3	6
Casuarina	5	3	2
Acacia	< 1	2	—
Unknown	—	2	2
Cyperaceae	—	1	19
Restionaceae	—	1	2
Adenanthos-Stirlingia	< 1	< 1	< 1
Liliaceae	—	< 1	< 1
Gyrostemon	—	< 1	—
Chenopodiaceae	—	< 1	36
Melaleuca	—	< 1	< 1
Halorhagus	—	< 1	—
Dryandra-Banksia	< 1	< 1	1
Euphorbiaceae	—	—	5
Macrozamia	—	—	1
Agonis	3	—	1
Rutaceae	—	—	< 1
Juncaceae	—	—	4
Others	25	—	—
Number of pollen grains counted	16,881	1,161	571

The pollen preserved in the swamps comes from two sources: first from the atmospheric pollen rain and second from pollen washed into the swamp. Where the relative frequency of the fossil pollen is lower than the Rottnest atmospheric pollen, as occurs in the grasses, we must assume either that the grass pollen has been destroyed in the sediments or that its abundance in the atmosphere is very recent. It is clear that grass pollen is preserved in the swamp sediments and in the profile from Lighthouse swamp (Fig.

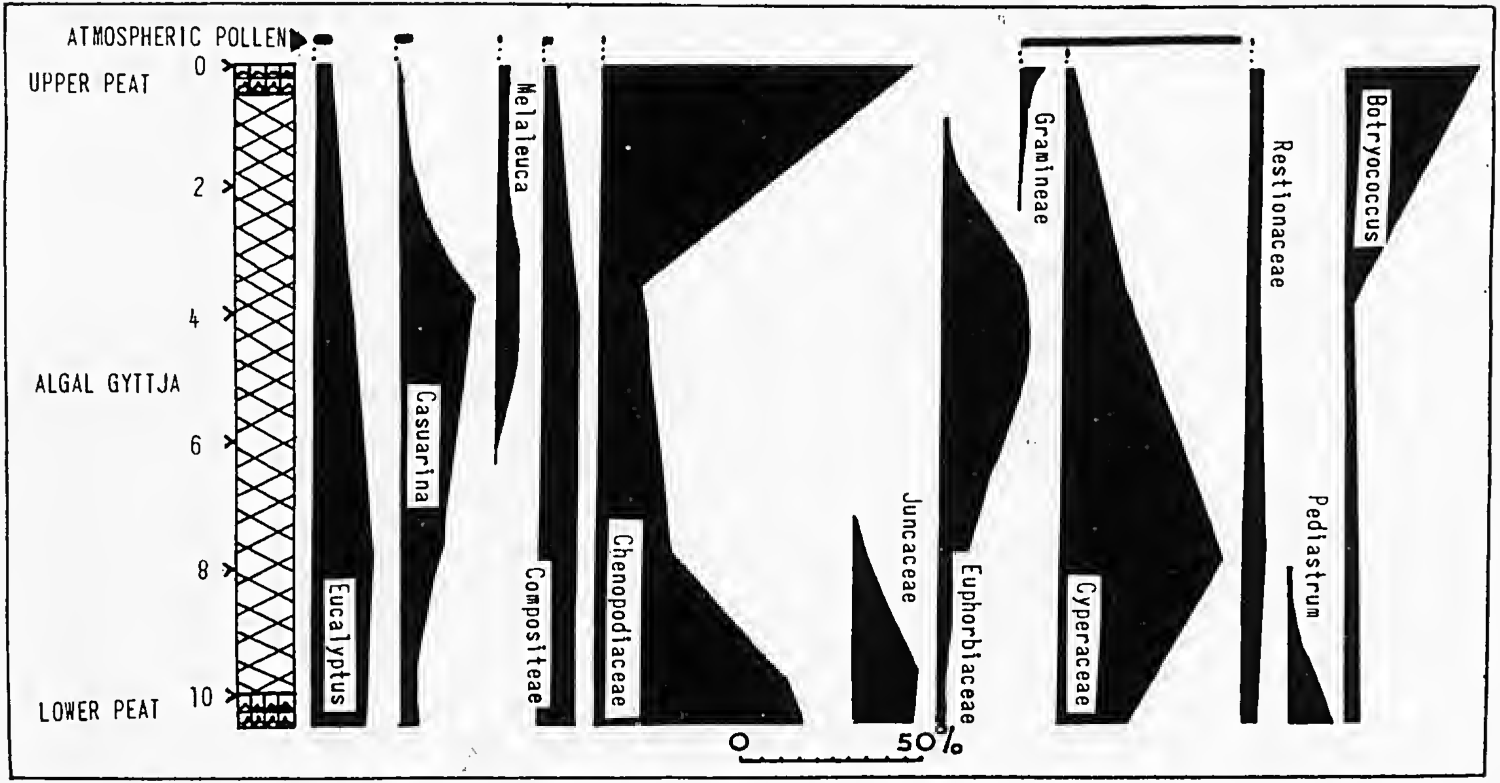

Fig. 2.—Pollen diagram from Lighthouse swamp, showing the relative frequencies of selected plants over an estimated 4,000 or 5,000 years.

2) is found only in the upper layers, thus indicating their recent prominence in the vegetation.

Where the relative frequency shows no significant difference between the fossil pollen and the atmospheric pollen it becomes impossible to say whether or not the pollen has been derived from plants on Rottnest Island or the mainland. Atmospheric pollen collected at Rottnest is derived from plants on Rottnest as well as on the mainland.

Where the relative frequency of the fossil pollen is significantly higher than that found in the atmospheric pollen, e.g., with the Compositeae, Cyperaceae, Juncaceae, Chenopodiaceae, Euphorbiaceae and *Macrozamia,* then, to account for the very high numbers in the sediments, plants from these families must have lived on the island at the time of pollen deposition.

The pollen diagram (Fig. 2) shows the history of certain plants over the last 4,000 or 5,000 years. From this record the following factors are evident:—

1. Peat deposition began in these swamps when they held open areas of fresh water, a condition no longer found on the island. These conditions are indicated by the planktonic freshwater alga, *Pediastrum,* which flourished during this period of peat deposition, but later died out.
2. *Juncus* (probably *J. maritimus*) was also abundant during this early period but later died out. This species, except for a single small stand near the Government House Lake, is now extinct.
3. The eucalypts show a gradual decrease throughout the sedimentary record. Their recent introduction to the island, however, has increased the amount of atmospheric pollen at Rottnest and if we subtract this amount at each level down the profile it is apparent that the numbers of eucalypts on Rottnest, during the early stages of swamp development, were little more than the number there at the present time.
4. The Casuarinas on Rottnest reached their maximum development during the middle of the record and then died out. They have subsequently been re-introduced into the settlement area by man.
5. The increase of *Melaleuca* (probably *M. pubescens*) on Rottnest commenced during the later stages of the swamp history.
6. The expansion of the grasses seems to have been an even more recent development.
7. The very high incidence of chenopods in the profile is probably due to water transport of the pollen into the swamp.

In spite of the widespread occurrence of *Acacia* on Rottnest and the presence of its pollen in the atmosphere, no fossil pollen was encountered in the Lighthouse swamp sediments. This anomalous situation has been observed in a number of swamps on the mainland, and has led the author to believe that *Acacia* pollen breaks down into its constituent nondescript massulae in the sediments, and thus becomes unrecognisable.

INDIRECT EVIDENCE

Indirect evidence of the past occurrence of *Casuarina* on the island is the presence of the trapdoor spider, *Idiosoma sigillatum* Cambridge, on Rottnest. This species has a "coastal" distribution on the mainland with a restricted association to *Casuarina* trees. On the other hand the closely related species, *I. nigrum* Main, is sometimes associated with *Casuarina* but usually with *Acacia* species such as Jam. Probably close to extinction on Rottnest, only a single male and female of *I. sigillatum* have been found running on the surface (Drs. A. R. and B. Y. Main, pers. comm.).

CHANGES IN THE ENVIRONMENT

The most important factor in the pre-history of the vegetation was the isolation of Rottnest from the mainland by eustatic change. Churchill (1959) showed that this event took place between 4,000 and 5,000 B.C. and since then rising sea level has reduced the area to an island, 7 miles long by 3 miles wide. By 3,000 B.C. sea level had risen to the same height as it is at present. That it continued to rise 10 feet higher, before falling to its present level, is shown by the following radiocarbon dated evidence:—

A beach deposit behind Pt. Peron 10 feet above M.S.L., 5,120 ± 130 years B.P. (ca. 3,000 B.C.).

Marine shell beds at Rottnest Island 9 feet above M.S.L., 3,950 ± 130 years B.P. (ca. 2,000 B.C.) (Fairbridge ms., cited by Hassell and Kneebone, 1959).

Ten foot sea platform in Victoria, 4,820 ± 200 years B.P. (ca. 3,000 B.C.) (Gill, 1955).

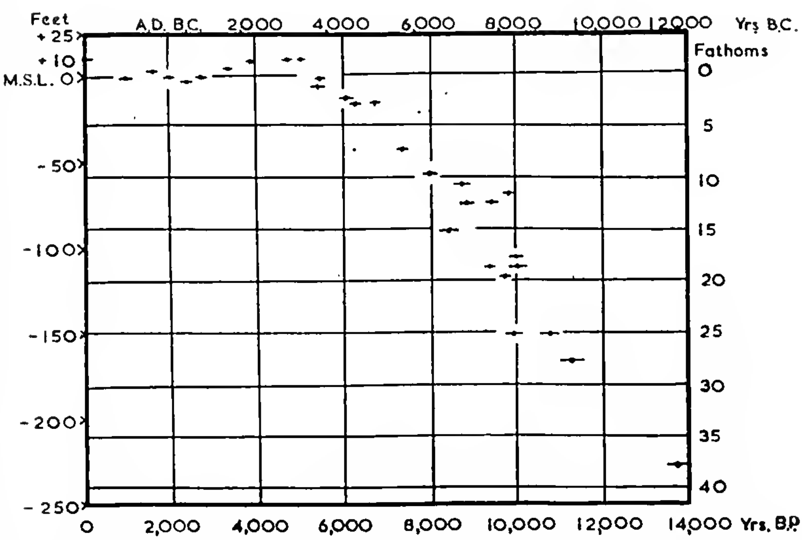

Fig. 3.—Changes in sea level since 12,000 years B.C.; compiled from data of Churchill; Fairbridge; Godwin, Suggate and Willis; Schofield.

Nine foot eustatic high in New Zealand (ca. 2,000 B.C.) (Schofield, 1960).

The change in sea level since 12,000 B.C. is shown in Fig. 3. The marine shell beds at Rottnest indicate a marine transgression to at least 9 feet above present sea level in 2,000 B.C. The reduction in the size of the island that followed its isolation from the mainland, the consequent deterioration in rainfall on Rottnest, loss of habitats and increased exposure to wind and salt, have led to the extinction of a *Eucalyptus-Casuarina* woodland, *Xanthorrhoea, Macrozamia,* and possibly *Banksia* and *Agonis* scrubs. The vegetation was thus reduced to elements of a *coastal complex* which, in historical times, has been altered further by clearing, selective cutting, firing, grazing and competition from introduced plants. The influence of these factors on the present vegetation of Rottnest Island has been discussed.

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FROM FIELD AND STUDY

A Record of the Ox-eye Herring, ***Megalops cyprinoides,*** **in Fresh Water in the Pilbara.**—On August 23, 1956, my assistant A. C. Heyndyk collected a large fish, weighing 2 lb. 13 oz. and measuring 420 mm. from the snout to the middle of the caudal fork, in a small pool three miles south of Woodstock homestead, in the Pilbara district.

The specimen was identified by Mr. I. S. R. Munro, of the C.S.I.R.O. Marine Laboratory, Cronulla, N.S.W., as the Ox-eye Herring or Tarpon, *Megalops cyprinoides,* and the first record known to him of its occurrence away from coastal or brackish waters.

The pool was in the bed of the Yule River and had been isolated since the river ran in early March 1956. It was only some 10 ft. in diameter and about 3 ft. deep at its deepest point at the time the fish was caught. The length of the watercourse, between the pool and its mouth, west of Port Hedland, was in excess of 110 miles. The fish was very active and shared the pool with a large number of Spangled Perch, *Therapon unicolor.*

—E. H. M. EALEY, C.S.I.R.O., W.A. Regional Laboratory, Nedlands, W.A.

Swamp Tortoise attacking Birds.—On December 2, 1958, while at the South Perth Zoological Gardens at 10 a.m., I noticed a commotion in the Flamingo Pond. This is a body of turbid water about one foot in depth. Close inspection showed that two Swamp Tortoises *(Chelodina oblonga)* were feeding on a dead pigeon. The bird had apparently been freshly killed that morning. Both tortoises were large ones, being near the upper range of the sizes I have encountered, the carapace being about six inches in length. (These pigeons are of the domestic variety, *Columba livia,* which are now feral; they feed on the grain laid out for the zoo animals.)

Some two months previously one of the attendants noted a pigeon fluttering on the surface of the water and went to its rescue thinking it had fallen in the water. However, on trying to lift the bird from the water the attendant found a tortoise had it firmly gripped by the neck. The wound made was of such severity the bird had to be destroyed.

Although both these observations were made under the special conditions of a zoological gardens, both pigeon and tortoise live very close to natural conditions. It would appear, therefore, that these reptiles could be an important predator on all water-frequenting birds small enough to be killed by them (cf. J. R. Ford, *W.A. Nat.,* 5: 44).

—V. N. SERVENTY, Subiaco.

Black Kites at Carnarvon in 1940.—In Western Australia the Black Kite *(Milvus migrans)* is regularly resident in the Kimberley Division. In dry years it has frequently appeared in the North-West, but prior to the 1952 penetration of the South-West, it was unrecorded from coastal areas south of Point Cloates (*W.A. Nat.,* 3: 146). However, there was at least one occasion when the birds came some distance further south.

A few years ago Mr. H. Stehn (then of Mandurah) informed the writer that numbers of the kites arrived in Carnarvon in 1940 immediately after the January floods. They flew around in flocks of about a dozen, but only remained in the vicinity of the town for a week.

Later I searched the *Northern Times* (January to April issues of that year). Though no reference was found to these or other hawks, there was abundant confirmation of the meteorological data given me by Mr Stehn. Carnarvon (and the Murchison and Gascoyne districts generally) had suffered their worst drought ever, a succession of five dry years resulting in great losses of stock and the dying of scrub. The drought was broken by heavy rains in January 1940, which brought the Gascoyne down in flood towards the end of the month.

—G. M. STORR, Nedlands.

The Australian Pratincole in the North-West.—The Australian Pratincole *(Stiltia isabella)* is recorded by Serventy and Whittell *(Birds of Western Australia,* 1951) as not occurring south of the Kimberley Division of Western Australia. The species ranges over a large part of northern, eastern and central Australia, and has recently been observed close to the South Australian-Western Australian border (V. N. Serventy, *W.A. Nat.*, 6: 152).

On January 11 and 12, 1959, I saw an individual at the Harding River, near Roebourne, in the north-west of Western Australia. A field description made at the time is as follows: "head, pale brown; breast and sides of neck, yellowish brown; upper parts, greyish; flanks and abdomen, blackish; wing primaries, black; under wing, mostly black; rump, white; tail, tipped black; beak, orange-yellow, tipped black; legs, long and trailed slightly in flight; call note, a double whistling *wee-woo*." Although this description differs somewhat from those given in texts, the identity of the bird was positive because allowance must be made for field conditions under which dark colours, such as deep chestnut, which is the actual colour of the flanks, appear to be black. I was not equipped to collect a specimen.

The Pratincole was observed near a freshwater pool in the Harding River, and made no attempt to associate with other waders such as the Red-necked Stint, Sharp-tailed Sandpiper, etc., which were fairly numerous. This dissociation from other waders appears to be typical of the species and has previously been noted by J. Liddy in North-west Queensland (*The Emu*, 59: 140).

—JULIAN FORD, Attadale.

The Distribution of the Jewel Beetle, *Stigmodera (Castiarina) magnetica* Cart.—Following the article by Barker *et al.* (*W.A. Nat.*, 5, 1956: 143) extending the known range of the jewel beetle *Stigmodera magnetica* from the type locality, additional data have been gathered by the authors, considerably extending the recorded distribution of the species. The beetle is now known to occur between Bunbury in the south and Horrock's Beach (Northampton) in the north. It has also been found on Rottnest and Lancelin Islands (island specimens were collected by G. M. Storr). The following list gives new locality records.

Horrock's Beach
Geraldton
Dongara
Lancelin Island
Lancelin
Mouth of the Moore River
Sorrento
Rottnest Island
South Fremantle
Naval Base
Kwinana
Point Peron
Waikiki
South Mandurah Peninsula
South Bunbury

At all localities the beetles have been collected on *Myoporum insulare* R.Br. when the bushes were in flower. The authors have also examined this shrub at Cheyne Beach, the mouth of the Margaret River, Garden Island, North, East and West Wallabi Islands (Abrolhos group) and at False Entrance (Shark Bay). No specimens of the beetle were taken from these localities, but the bushes were not in full flower at the time of examination.

The biology of the beetle is being investigated.

—S. BARKER, D. H. EDWARD and J. A. L. WATSON,
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NATURAL HISTORY NOTES FROM JIGALONG, NORTH-WESTERN AUSTRALIA

By ERIC LINDGREN, Shenton Park.

III. THE BIRDS

INTRODUCTION

Slater (*W.A. Nat.,* 7: 35) has given an account of the breeding seasons in the East Kimberleys during the years 1955-56, while Robinson (*W.A. Nat.,* 4: 187) and Carnaby (*W.A. Nat.,* 4: 149) have given quantitative data gathered over long periods in various parts of the State including the North-West. These data have been analysed by Serventy and Marshall (*Emu,* 57: 120, Fig. 4).

A further contribution of breeding at Jigalong (Lat. 23° 24′ S., Long. 120° 46′ E) in the little-documented desert region of Western Australia, to compare with the above-mentioned papers, is given here.

All records were made during the period February 10 to December 14, 1959.

DESCRIPTION OF THE AREA

The area has been described in the first article of this series (*W.A. Nat.,* 7: 122) and the only other point to be noticed is the presence of a small number of permanent and semi-permanent rock holes in the breakaway country to the east providing a reliable source of water for the fauna in their vicinity. Three were visited, being known by their native names from north to south as Mantjin, Ngutjapungkanu and Ngiyanunya.

CLIMATE

Some general data were given in the introductory article and the present more detailed information has been limited to rainfall as this is more specific to the conditions met with in the 1959 seasons.

Rainfall for the past 19 years (Fig. 1) has been extremely varied but shows regular cyclic patterns of a good year followed by a number of dry years. Reference to Table 1, in which totals for individual months in a series of three successive "good" years and three successive "bad" years are given, shows that regular rainfall can be expected in the summer and winter of each year, but that generally there is little or no rain in the spring months, August to October.

TABLE 1.—RAINFALL IN POINTS FOR THREE SUCCESSIVE GOOD AND THREE SUCCESSIVE DRY YEARS.

	Good Years			Dry Years		
	1941	1942	1943	1957	1958	1959
January	17	1530	223	73	15	35
February	143	320	220	79	13	61
March	256	762	207	—	46	41
April	52	18	319	—	—	48
May	113	406	2	11	31	36
June	—	205	5	149	48	93
July	131	12	224	20	144	149
August	10	—	25	—	75	—
September	8	—	—	—	25	—
October	27	—	39	—	—	—
November	197	67	35	12	188	—
December	189	15	146	192	36	135
Totals	1143	3135	1145	536	621	598

Conditions throughout 1959 were extremely dry and as will be seen from Fig. 1 the season had been preceded by a three year period in which low rainfall occurred.

This drought and the drought conditions in the previous cyclic troughs coupled with overgrazing by stock on the under-story plants and low tree branches has had a marked effect upon the vegetation. Sheep, cattle and goats are run on Jigalong. Goats being voracious feeders do the most damage but as they are usually run in small flocks each animal probably contributes equally to the denudation. Mulga *(Acacia aneura)*, the dominant tree of the plain country, is gradually thinning out. The trees which die are quickly eaten out by termites and young trees have no chance to establish themselves under the combined handicaps of the unreliable rainfall and grazing. Although rainfall totals seem sufficient

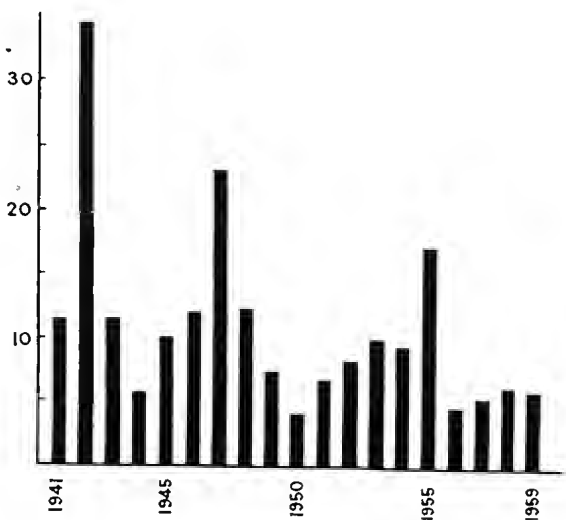

Fig. 1.—Annual rainfall at Jigalong for the years 1941 to 1959, recorded in inches (100 points = 1 inch).

to support the continued regeneration of species it must be remembered that most of the rain comes in thunderstorms which are extremely heavy but of short duration. These saturate the ground quickly and the excess water soon runs off into clay pans or creek drainage systems.

Plants which become established after germination during these storms do well for the first few days but with the disappearance of the ground water they quickly become scorched and die. This was particularly noticed with the few native grasses which germinated, the leaves rarely growing to more than a few inches before their death. Those that survived were soon eaten by the stock.

This competition with the stock probably accounts for the disappearance of the large tracts of native grasses which were common in the early pastoral days and their replacement by the hardy unpalatable "spinifex" *(Triodia)*. Talawana, a station 60 miles north-east of Jigalong shows this succession more markedly than Jigalong itself. Several stations nearby have been abandoned, the closest to Jigalong being Balfour Downs, Murramunda and Cockedina.

BREEDING

Carnaby and Robinson, reporting from areas closer to the coast, have both shown an extended breeding period commencing after summer rains and continuing into spring, with a drop during late autumn and early winter.

In their analysis of these North-West data Serventy and Marshall *Emu,* 57: 122) have correlated the lower level of winter breeding with the low temperatures, particularly during the night, which are characteristic of the inland regions at this time of the year. They further state, "In unfavourable years one or both peaks can be eliminated by the absence of rain and its effects."

Confirmation of this statement comes from the fact that no evidence of summer and autumn breeding was noted at Jigalong during 1959 after a season in which there were no effective summer rains. Rains commenced in the period November 25 to 28, 1958, when a total of 188 points fell, but between that time and my arrival rain fell in sufficient quantity to be recorded on only three additional dates. Although I was not present during the mid-summer months of the 1958-59 season I felt that breeding if it had taken place, could have been detected by the following evidence: firstly, allowing for reaction time after the November rains, incubation and fledging periods, species would still be feeding their young; and, secondly, the presence of young birds in juvenile plumage. No such evidence was noted.

Plotting the number of species nesting, the dates adjusted as near as possible to the presence of eggs in the nest, with the rainfall for the year, it will be seen (Fig. 2) that the main nesting season was in the dry months, August to October, after the winter rains, and that only one species, the Australian Dotterel, was actually found breeding during the rainy period. Rainfall, therefore, appeared to act as the initial trigger to stimulate the reproductive cycle.

Comparison with observations made in a wet year especially after good summer rains would probably clarify the matter.

Another factor to be taken into consideration is the amount of food available at this time of the year. During these warm dry spring months there was a noticeable increase in the numbers of caterpillars on the ground and butterflies in the air. A favourite game of the native children was now "chase the butterfly" and no doubt the birds were also just as active. Other insect life was probably relatively more abundant too, providing insectivorous birds with a reliable source of food.

It was found during the non-breeding season that ants and termites were a major food item for some birds in the area; two instances will illustrate this: 1. A White-plumed Honeyeater shot in June when display flights were becoming common, had its stomach crammed full with the remains of the ant common on the River Gum *(Eucalyptus camaldulensis)*, its preferred habitat. Its testes were undeveloped. 2. Again in June a small party of Black-faced Wood-Swallows was seen feeding intently at one spot on the ground for a number of minutes. When examined later an escape hole from a termite colony was found at this spot, with individual termites still near the exit.

Seed eaters such as finches, on the other hand, faced more direct competition with the stock and it was only around the permanent rock holes that their presence could be relied upon.

Table 2 gives details of the species found nesting during 1959.

HABITATS

The area studied, about 30 square miles and shown on the accompanying map (Fig. 3) can be divided into the following five habitats although no true boundaries can be made between each:

1. Creek. A comparatively dense cover of River Gums, two species of *Acacia,* with an occasional Sandalwood *(Santalum spicatum)* and *Pittosporum phillyraeoides* lining the banks. At places a lower layer of shrubby *Acacia* and *Eremophila* is present. The

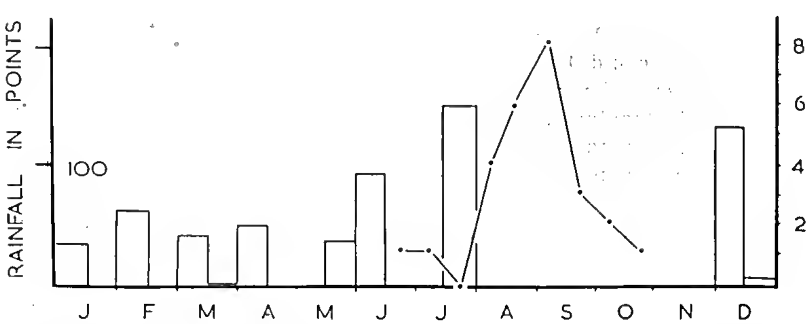

Fig. 2.—The number of species breeding in each half-month (line graph) plotted with the rainfall in the same periods (histograms).

cover extends to varying widths from the creek about 50 yards being the average. This habitat frequently runs into:

2. Mulga Flats. Sparsely vegetated red sand flats with openly foliated Mulga the dominant tree. The soil is loosely bound by a variety of smaller shrubs, mainly *Cassia desolata* and scattered *Eremophila.*

3. Gibber Plain. Wide plains covered by small stones, interspersed with areas of "spinifex" *(Triodia irritans.)*

4. Crab-hole Country. Clay-pan flats to which surface water flows in the absence of creek beds. This is typified by a very rough surface formed by water eroding the soil around grass roots and leaving hard clumps up to twelve inches high. Large shallow ephemeral pools of water lined mainly by *Pittosporum, Acacia tetragonophylla* and a white barked Eucalypt are characteristic of these flats.

5. Breakaway Country. Rugged sandstone and quartzite hills covered with irregularly sized boulders and spinifex, with an occasional Eucalypt on the slopes and *Acacia* in the valleys.

Using the above numbers as a key to the preferred habitats a detailed list of the birds follows, the species being divided into the following categories: Permanent residents; nomadic, depending upon the availability of surface water; nomadic, of unreliable occurrence; migratory; unclassified (insufficient data, mostly single records). Breeding birds are marked with an asterisk.

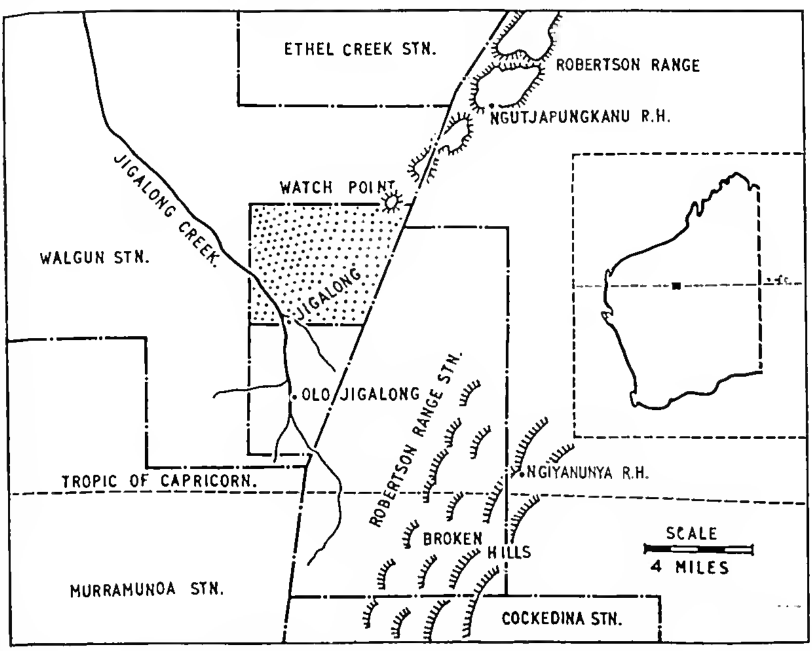

Fig. 3.—Jigalong and its environs (inset, position of Jigalong on a State map).

For relevant scientific names reference should be made to "A Handbook of the Birds of Western Australia," Serventy and Whittell, Second Edition, 1951.

TABLE 2.—BREEDING DATA FROM JIGALONG, 1959

Australian Dotterel	23.vi; 3e(1)* 28.vi; 3e(1) 11.vii; 3e(1) 18.viii; 3e(1)
Yellow-throated Miner	12.viii; 2e(1)
Pipit	13.viii; 2e(1) 14.viii; 3e(1) 29.viii; 2yle(1)
Crimson Chat	18.viii; 2e(1)
Galah	29.viii; 5e(1)4e(2)3e(2) 30.viii; fresh nest 5.ix; 4e(3)3e(2) 26.ix; fresh nest 1.x; 60 young taken by natives
Twenty-eight Parrot	29.viii; large young 5.ix; 4e(1) 3y(1) ?(1)
Tree-Martin	29.viii; ?(1)
Kestrel	3.ix; 3e(1)
Crested Pigeon	5.ix; 2e(1)
Cockatiel	5.ix; fresh nest
Willy Wagtail	5.ix; fresh nest
White-plumed Honeyeater	5.ix; 3e(1) ?(2)
Maned Goose	14.ix; 4y(1)
Ground Cuckoo-Shrike	18.ix; 1e(1)
Crow	26.ix; 4e(1)
Blue-and-white Wren	10.x; 2e(1)
Red-backed Kingfisher	14.x; 2e(1)
Black-faced Cuckoo-Shrike	14.x; 3e(1) 26.x; 3e(1)

1. **Permanent Residents**

Emu. 1, 2, 3, 4, 5.
Common Bronzewing. 1, 4.
*Crested Pigeon. 1, 4.
Bustard. 1, 2.
Wedge-tailed Eagle. 1, 2, 3.
Brown Hawk. 1, 2.
*Kestrel. 2.
Boobook Owl. 1.
Little Corella. 1, 2.
*Galah. 1, 2, 5.
*Twenty-eight Parrot. 1.
*Red-backed Kingfisher. 1, 2, 4.
Rainbow-bird. 1.
*Willy Wagtail. 1.
Red-capped Robin. 2, 4.
Hooded Robin. 2.
Rufous Whistler. 1, 4.
Western Shrike-Thrush. 1.
Crested Bell-bird. 2.
Magpie Lark. 1.
*Black-faced Cuckoo-Shrike. 1, 2.
Cinnamon Quail-Thrush. 1, 2.
Grey-crowned Babbler. 1.
*Crimson Chat. 2, 4.
Orange Chat. 2, 4.
Chestnut-tailed Thornbill. 1, 2.
*Blue-and-white Wren. 1.
Variegated Wren. 1, 2.
Black-faced Wood-Swallow. 1, 2.
Little Wood-Swallow. 5.
Mistletoe-bird. 1.
Red-browed Diamond-bird. 1.
Red-tipped Diamond-bird. 1.
White-fronted Honeyeater. 1.
Brown Honeyeater. 1.
Singing Honeyeater. 1, 4.
*White-plumed Honeyeater. 1.
*Yellow-throated Miner. 1.
Spiny-cheeked Honeyeater. 1.
*Pipit. 2, 4.
Zebra Finch. 1, 2, 5.
*Crow. 1, 2.
Little Crow. 1, 2.
Grey Butcher-bird. 1, 2.
Black-throated Butcher-bird. 1, 2.

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* These abbreviations read as follows:—
Nesting was observed on June 23, one nest with three eggs being found on that date. The month, in roman numerals, is preceded by the day of the month.
Young birds are indicated by the letter y and eggs by the letter e.

2. Nomadic, depending upon availability of surface water.

Diamond Dove. Summer only. 1, 2.

Black-tailed Native Hen. Summer only. 1, 4.

White Egret. Winter. Injured bird at Waigun. 1, 4.

White-faced Heron. Summer, rare in winter. 1, 4.

White-necked Heron. Summer, rare in winter. 1, 4.

Mountain Duck. Summer and winter. 1, 4.

Grey Teal. Summer and winter. 1, 4.

Pink-eared Duck. Summer and winter. 1, 4.

*Maned Goose. Summer and winter. 1, 4.

Black Duck. Summer only. 1, 4.

3. Nomadic, of unreliable occurrence.

*Cockatiel. 1.

Budgerygah. 1, 5. Many small flocks were seen flying north in summer, the only other record being in October.

Masked Wood-Swallow. 1, 2. An irregular visitor occurring in loose high flying flocks, attention being drawn to them by their calls.

*Ground Cuckoo-Shrike. 2. One pair present during spring made an abortive attempt to nest. A hide erected nearby attracted a, probably Corvid, predator.

4. Migratory.

*Australian Dotterel. 3.

Fork-tailed Kite. 2. Both these species have been provisionally placed in this category. The sudden arrival in winter months and equally sudden departure during spring of both species in large numbers, seems to indicate that they are migratory. Both birds are regarded as winter visitors by nearby pastoralists.

Fork-tailed Swift. One record only, a loose flock of about 20 birds seen on March 1 during humid weather.

Pallid Cuckoo. 1, 2
Bronze Cuckoo (? sp.). 1, 2 } The status of these birds is uncertain. Both were seen on February 28, then the Pallid again on June 16 and the Bronze Cuckoo on July 7. The Bronze Cuckoo was not heard calling and though seen the species was not determined.

*Tree-Martin. 1. Present from May to August.

5. Unclassified.

Sparrow Hawk. ♂ June 13.

Little Eagle. March 8, September 5.

Whistling Eagle. July 15.

Bourke Parrot. February 2.

White-backed Swallow. May 24, June 14, June 24, November 11.

White-winged Triller. September 26.

Weebill. April 14.

Fairy Martin. Old nests found but birds not seen.

Banded Whiteface. December 7.

Redthroat. May 30.

Rufous Field-Wren. A number of occasions during June and July. Habitat 3.

Black Honeyeater. June 13, June 27.

Pied Honeyeater. June 22, July 4, July 28.

Yellow-fronted Honeyeater. February 28, March 27.

Black Swan. Heard flying south during the evening of May 24.

Black-capped Sittella. September 26.

The following birds were not seen but are known to the natives in the area:

Black-fronted Dotterel
Southern Stone Curlew
Tawny Frogmouth

Some information on bird movements is available from recoveries of Corvids banded at Jigalong during 1959.

The trapping programme was started in June using a trap with a roof entrance and a funnel on the ground. By November when trapping was discontinued 63 birds had been trapped, of which 61 were Little Crows and 2 were Crows.

Three recoveries of Little Crows have occurred to date:

1. No. 100-04124, banded on June 16 and recovered at Walgun on June 28, 10 miles north.
2. No. 100-04119, banded on June 14 and recovered at Mt. Weld Station near Laverton on November 11, 390 miles S.S.E.
3. No. 100-04130, banded on June 30 and recovered 4 miles south of Menzies on April 29, 1960, 435 miles S.

In addition eleven birds were retrapped in the same trap as they were banded from, the longest time interval being shown by no. 100-04135, banded on June 23 and retrapped on October 5.

ABLEPHARUS BOUTONII CLARUS, A NEW SKINK FROM THE ESPERANCE DISTRICT, WESTERN AUSTRALIA

By G. M. STORR, Department of Zoology, University of Western Australia.

Probably the most widely distributed of all lizards, *Ablepharus boutonii*, ranges from coastal East Africa, through the archipelagoes of the Western Indian Ocean to the Lesser Sundas, Moluccas, New Guinea, Australia and most islands in the tropical Pacific. In his monograph of the species, Mertens (1931) described or redefined 36 geographical races, allotting three of them to continental Australia, *viz. metallicus* Boulenger for the centre and north-west, *virgatus* Jarman for the north-east (from Cape York to Rockhampton) and *plagiocephalus* Cocteau for the south.

Cocteau's name, like the later *Ablepharus peronii* of Duméril and Bibron, is based on the manuscript description by Péron of a skink from "Tasmania and Shark Bay." Since no form of the species occurs in Tasmania, Mertens restricted the name *plagiocephalus* to the Australian mainland. He gave the distribution of the race as the "whole of southern Australia from New South

Wales and Victoria to at least Shark Bay and perhaps a little further north."

However, Mertens' re-definition of *plagiocephalus* is based solely on material from Western Australia: two specimens in the Senckenburg Museum from "West-Australien," one of which is the type of *punctatus* Sternfeld; two in the Hamburg Museum from Kalgoorlie; and six in the Berlin Museum (one each from Guildford and York and four labelled "Sud-Australien, Preiss"). It was possibly the last label that induced Mertens to attribute *plagiocephalus* with so extensive a range. Their low catalogue number indicates that the specimens were collected in the first half of last century. Consequently "Preiss" must be the German naturalist J. A. L. Preiss, who resided in the Swan River district from 1838 to 1842 and collected, among many other things, 60-80 reptiles (Whittell, 1954).

Since Mertens was satisfied that *punctatus* Sternfeld was identical with *plagiocephalus* Cocteau, the latter may be restricted to Western Australia and, in view of the following, more precisely to the Swan River.

In the vicinity of Esperance *Ablepharus boutonii* differs markedly from *plagiocephalus* as redefined by Mertens and as exemplified by 31 specimens in the Zoology Department from the area between the mouth of the Murchison River and Salmon Gums. The Esperance population is described as

Ablepharus boutonii clarus subsp. nov.

Cotypes: 4 specimens in the Zoology Department, University of Western Australia, collected by the writer on December 10, 1959, along the lower Dalyup River in lat. 33° 45′ S and long. 121° 32′ E, i.e., 20 miles WNW of Esperance, Western Australia.

Paratypes: Esperance (1 specimen), 14 miles east of Esperance (1) and Mondrain Island (2), all in the Zoology Department.

Dorsal view of two races of *Ablepharus boutonii* (*clarus* at top, *plagiocephalus* at bottom).

Description: Size, shape and scalation as in *plagiocephalus,* except for slightly fewer rows of midbody scales (20-24, mean 23.0) and slightly fewer lamellae under the fourth toe (16-18, mean 17.2). [The corresponding figures for our series of *plagiocephalus* are 20-28 (24.6) and 15-20 (18.2).]

As in *plagiocephalus,* the anterior margin of the post-nasal in a minority of specimens is merely indicated by a groove. Largest specimen (from Mondrain Island): 88 mm. (42 + 46)—the tail has regenerated.

The two races are readily distinguished on their colour and dorsal pattern. The most prominent feature in *clarus* is the clear-cut bluish white stripe along each side of the back; it begins on the snout and passes through the superciliaries back to and along the tail. Confluent with the superciliary stripe is a sharp-edged black stripe extending from the superoculars to the anterior part of the tail, where it meets its fellow from the opposite side. Both stripes are widest a little anterior of the hindlimbs. The central strip down the back is greyish, flecked with black. A black vertebral line extends from the posterior nuchals to the level of the forelimbs. Head greenish white, blotched with black. Flanks and upper surface of limbs grey, dotted with black and white. Ventrally pale blue (in alcohol).

[In *plagiocephalus* the superciliary stripe is pale brown and ragged-edged. Instead of a black superocular stripe, there is an irregular line of black spots. Mid-back, flanks and upper surface of limbs brown, dotted with black and pale brown. No vertebral line corresponding to that in *clarus.* Head brown, dotted with black. Ventrally brownish white.]

Distribution: South coast of Western Australia in vicinity of Esperance, including at least Mondrain Island in the Archipelago of the Recherche.

Remarks: It may seem strange that *clarus* should be more similar in colour and meristics to distant *virgatus* than to neighbouring *plagiocephalus.* A possible explanation is that the area between Rockhampton and southern South Australia is occupied by populations that bridge the small morphological gap between *virgatus* and *clarus.* The specimen from Hornsby, N.S.W., briefly described by Loveridge (1934), evidently belongs to some such intermediate form. It is clearly not *plagiocephalus,* under which it is listed by Loveridge, who was doubtless influenced by the range given by Mertens to that race.

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THE SURVIVAL OF NATURAL ENVIRONMENT IN WESTERN AUSTRALIA

By J. GENTILLI, Nedlands.

The first large map of land utilization published in Australia* (Atlas of Australian Resources, 1957) shows a large area classified as of "No significant use." A more detailed if much smaller map (Gentilli, 1958) shows the corresponding area as "Unproductive areas, deserts." According to official records, the proportion of the State which was unoccupied in 1960 was 57.1 per cent. Against this, 36.5 per cent was occupied under lease or licence, and 6.4 per cent was alienated or in the process of alienation. The proportion of the State which was unoccupied amounted to 85 per cent in 1900, to 70.5 per cent in 1910, to 55 per cent in 1920 and 1930. After the resumption of part of the marginal agricultural districts and the abandonment of a few pastoral leases the unoccupied area rose to 61.3 per cent in 1940, to reach a new peak of 61.9 per cent in 1951, and fall gradually to the present figure of 57 per cent.

It will be seen that only certain types of natural environment are still unoccupied to any great extent. In the North Kimberleys some 34,000 square miles are unoccupied. It is mostly rocky country, with river flats and some basalt areas, in part reserved for aborigines, in very small part settled by missions, but generally remote from roads, and without any port. The vegetation is "savannah woodland, including monsoon woodland" (Wood†, 1950), "tropical woodland (mixed)" with, especially to the west, patches of "tropical deciduous woodland" and "tropical tree savannah" and especially near the Drysdale River, small areas of "tropical tussock grassland." Dampier Land, which is also unoccupied (part of it is an aborigines' reserve), carries "tropical woodland (mixed)." Perry‡ (1958) simplifies and shows all these areas as "savannah woodland." So does Williams§ (1959) who shows it all as "woodland" with the exception of small "tree and low tree savannah" areas in the west and north.

THE UNOCCUPIED LANDS

By far the largest area of one type of environment which is unoccupied is the desert country, most of which consists of long sand dunes, with the exception of a large stony area in the Gibson Desert. This type of environment occupies 25 to 26 per cent of the State's surface; the little vegetation there is consists of hummocks of *Triodia basedowii* and few other species. To the south-east of Halls Creek are also unoccupied some 6,800 square miles of coun-

* Manuscript maps of land utilization in Australia compiled by W. H. Maze at the University of Sydney and by the writer at the University of Western Australia were never published because of wartime difficulties. A land-utilization map and eight land-utilization profiles of Western Australia were included in the writer's "Atlas of Western Australian Agriculture" (Gentilli, 1941).

† J. A. Wood, late Professor of Botany, University of Adelaide.
‡ R. A. Perry, Principal Research Officer, Ecology and Forest Botany, Division of Land Research and Regional Survey, C.S. & I.R.O.
§ R. J. Williams, Research Officer, Plant Introduction, Division of Plant Industry, C.S. & I.R.O.

try variously defined as "sclerophyllous grass steppe" (Wood, 1950), "sclerophyll hummock grassland with sclerophyll shrub savannah" (Williams, 1955), "hummock grassland" (Perry, 1958), "shrub savannah and tussock grassland" (Williams, 1959). Evidently it is a transition between the *Triodia* hummock country to the south and the Pindan *(Acacia* and *Plectrachne schinzii)* shrub savannah to the west. It represents only 0.7 per cent of the State's area.

To the west, the dissected tablelands of the Hamersley complex are also unoccupied, because the terrain is too rugged. The vegetation, where present, is mostly hummocks of *Triodia pungens.* Dale Gorge, which thanks to its isolation, local climate and sheltered drainage, provides an almost unique type of environment, is now a nature reserve.

The western edge of the Great Victoria Desert is also unoccupied. It includes some 30,000 square miles of mixed "mulga scrub and sclerophyllous grass steppe" in part (Wood, 1950), "sclerophyll shrub savannah and semi-arid mallee" (Williams, 1955), "mulga woodland" in part (Perry, 1958), "low layered woodland and semi-arid mallee" (Williams, 1959). In fact, Williams shows that this unoccupied country differs from the country further north and further west, which is used for grazing. Wood (1950) showed it as being the same as the country to the north (mulga-*Triodia*), and Perry (1958) as being the same as the country to the west (mulga woodland). The fact that it remains unoccupied shows that it is different, probably in the abundance of *Triodia.*

The narrow belt of country which surrounds the Nullarbor Plain is unoccupied in its northern section, and used for grazing over very small areas to the west and south. Wood (1950) showed the northern edge as "mulga scrub and arid scrub" and the southern and south-western edge as "mallee scrub." On the northwestern side mulga is shown as reaching the edge of the Nullarbor Plain. The pattern shown by Williams (1955) is far more complicated: to the north is a very narrow belt of "arid scrub and semi-arid mallee" doubled by a belt of "arid scrub and semi-arid shrub savannah" which around Lakes Gidgi and Jubilee takes over the whole width. West and south of the Nullarbor Plain runs a continuous belt of "arid scrub and semi-arid mallee" which does not reach the coast. The coastal belt consists of "semi-arid mallee."

Perry (1958) simplifies into "drier scrub" to the north of the Nullarbor Plain, "mulga woodland" to the north-west, "mallee" to the south-west and south. Williams (1959) shows a continuous belt of "low layered woodland and semi-arid mallee" not reaching the sea, and a coastal belt of "semi-arid mallee." Pastoral occupation here depends on the availability of water and not on the type of vegetation. The "shrub steppe" of the Nullarbor Plain is entirely unoccupied.

The remainder of the unoccupied country, between the Nullarbor Plain and the agricultural lands, is shown by Wood (1950) as "mallee scrub," with, towards the west, "mallee heath and heath." Williams (1955) shows "semi-arid mallee" as far west as

Lake Cowan, and, north of Kalgoorlie, as far west as Mount Jackson. West of Lake Cowan and south of Mount Jackson he shows a mixture of "semi-arid mallee, heath, temperate woodland." Perry brings the whole area south and west of the Nullarbor Plain as far west as Esperance and Grass Patch under the heading "mallee and heath" to reach the agricultural districts. Williams 1959) shows a continuous coastal belt of heath in the south, but omits heath from the larger "semi-arid mallee-woodland" area.

Typical mallee environment is set aside as a nature reserve at East Pingrup, primarily for the protection of the Mallee Fowl *(Leipoa ocellata).*

Some 15,500 square miles of country east of a line from Mount Jackson to Youanmi are also unoccupied with the exception of a small enclave. It is mulga scrub, or "arid scrub and sclerophyll shrub savannah" of Williams (1955). The lack of good water on this part of the gneissic plateau, studded with salt lakes, is the reason for its not being utilized.

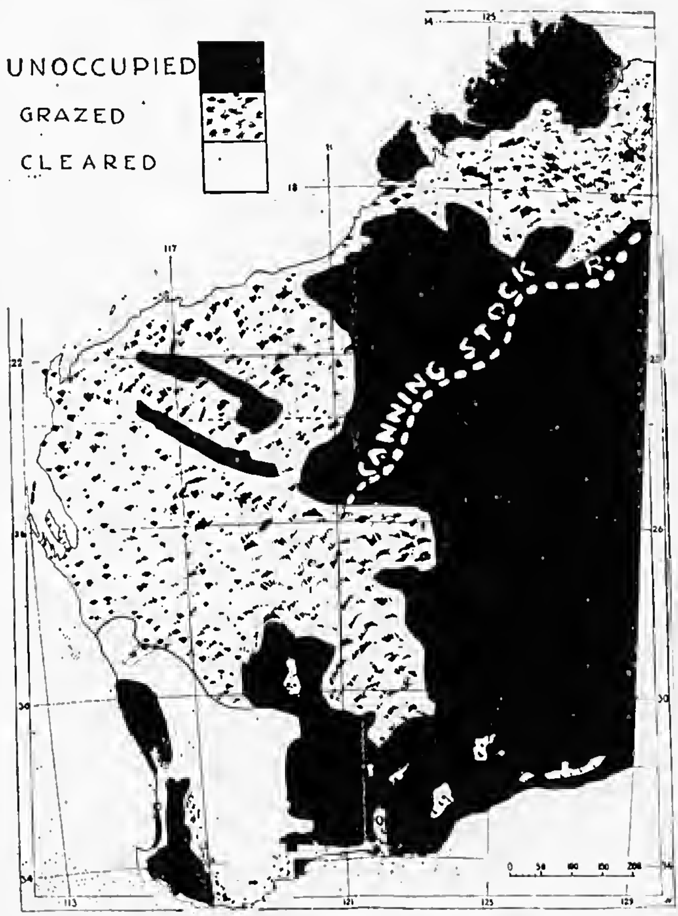

Fig. 1.—Main classes of modification of the natural environment.

PASTORAL LANDS

Most of the land under lease is used for grazing; pastoral leases cover 208,396,798 acres out of 216,810,793 acres of leased land. Nearly 4 million acres are held under timber permits, and 1 million acres under mining leases. Thus the leased land used for grazing may be estimated at about 209 million acres, or 33.5 per cent of the total (Fig. 1).

To what extent grazing alters the natural environment is somewhat difficult to assess. Generally, native animals are more efficient than sheep in finding food and water; they are much more mobile, do not congregate in large numbers, and have not had their instincts blunted by domestication. Kangaroos and wallabies tend to be very selective feeders, and it is the pastoralists' grievance against them, that they "pick the eye" of pastures, leaving the least palatable plants to the sheep. Feeding by kangaroos, euros and wallabies has been going on from time immemorial; the new factor is the great increase in numbers that has followed the provision of ample quantities of water on the pastoral holdings. With the only predator, the dingo, almost wiped out except in a few inaccessible places (Hamersley Plateau, Great Victoria Desert), the main natural check on population increase has disappeared, and the number of these marsupials has greatly increased. After surveys and experiments, Ealey and Suijdendorp (1959) state that "it is now known that the shrinking flocks have been caused by a deterioration in the pasture vegetation, particularly the disappearance of the more nutritious native grasses on which breeding ewes depended to provide the high-protein diet required for the production and rearing of their lambs. . . . The evidence now available points to the fact that the prime cause of the deterioration of the North-West pastures has been a stocking policy that is unsuited to the climate and conditions, and not to the grazing of euros that have bred up following increased water supply. . . . Moreover, experiments . . . have shown that stocking by sheep alone can quickly produce the pasture changes that have occurred in the region as a whole. . . . On first-year burns . . . one sheep to ten acres consumed all that was produced in the way of palatable forage in the first wet season leaving nothing to produce seed or carry on until the following year."

The plant cover of the overgrazed landscape has been greatly altered, and in some places has been almost wiped out. Wind erosion has appeared where it probably was not previously a factor in the making of the landscape. From the Eastern Goldfields to the Eighty Mile Beach, with the exclusion of the rugged plateaus in the North-West, this is the situation today. We have a detailed study by Wilcox (1960) of the effect of grazing on the Wandarrie grass associations, found "over most of the deeper and sandier soils of the mulga zone. In the ungrazed state the association consists of an upper storey of trees, a middle storey of shrubs and a ground storey of perennial tussocky Wandarrie grasses." Because of the preference shown by sheep for the better growth available in these areas, "in many cases the trees have been killed, the shrubs have been eaten out and the grass cover consists mainly of Windgrass and Wire Wandarrie grasses."

That even a short period of intensive grazing can affect the environment in a most drastic way has been proved by Wilcox, who had ten acres of degenerate Wandarrie country enclosed against any grazing. At the time of enclosing, Windgrass *(Aristida arenaria)* represented over 70 per cent, Broad Leaf Wandarrie *(Danthonia bipartita)* and Creeping Wandarrie *(Eragrostis lanipes)* 21 per cent of the plants present. After two years of complete protection the composition had changed to Windgrass below 50 per cent and Wandarrie grasses over 50 per cent. Thus some of the effects of grazing are reversible, or at least remediable, but much longer periods may be needed to restore the environment to its natural state.

The area subject to grazing covers the entire "mulga scrub" formation of Wood (1950) called "arid scrub and sclerophyll shrub savannah" by Williams (1955) or "mulga woodland" by Perry (1958) and "low layered woodland" by Williams (1959), with the exception of the core of salt-lake country which remains unoccupied, as mentioned above. The total area is over 200,000 square miles, with considerable variation as to the exact limits, so that it is taken to vary between 20 and 25 per cent of the State's total area according as to what mixed formations are included or not. Wilcox's (1960) Wandarrie country is the best of these mulga formations.

South of the main mulga area, but north and east of the agricultural country, some mulga woodland mixed with mallee scrub is also subject to grazing; the area concerned is about 28,000 square miles, of which about two-thirds is east of the Eastern Goldfields.

The second main grazing area is that of "sclerophyllous grass steppe" (Wood, 1950), "sclerophyll hummock grassland and sclerophyll shrub savannah" (Williams, 1955), "hummock grassland" (Perry, 1958), "hummock grassland and shrub savannah" (Williams, 1959), extending over some 150,000 square miles or about 16 per cent of the State's area, with the exception of the rugged land of the Hamersley Plateau and of the other dissected tablelands to the south. This is an area where faulty grazing methods caused a catastrophic fall in sheep numbers after the pastures had deteriorated over a number of years. The hummocks of *Triodia pungens* are not likely to suffer from grazing, and tend to replace the other plants in the overgrazed areas.

Some intermittent grazing took place along the Canning Stock Route (Map 1) but the movement of cattle along this desert route declined considerably with the improvement of road and port facilities and disappeared even before the introduction of air transport.

Near Roebourne and Port Hedland, Wood (1950) shows over 5,000 square miles of "savannah." Williams (1955) shows nearly 12,000 square miles of "sclerophyll low tree savannah" interrupted by patches of "semi-arid tussock grassland" which amount to some 3,500 miles; these formations go from Roebourne to beyond Anna Plains. Perry (1958) does not recognize these formations in his generalized map. Williams (1959) changes the definition slightly to "tree and low tree savannah" while retaining the "hummock grassland"; the area remains the same. Grazing, as everywhere further south with the exception of the more rugged ground east of the Hamersleys, is by sheep.

The area leased for grazing in the Kimberley region amounts to over 70,000 square miles. Wood (1950) shows it almost equally divided between "grassy scrub" in the west, "savannah woodland" in the north-east, and "savannah woodland and savannah" in the south-east. Williams (1955) shows the western third, from the Christmas Creek basin, to the west and south of the Margaret River, as "sclerophyll shrub savannah"; the north-eastern quarter is "tropical woodland (mixed)"; the south-eastern portion is "low arid woodland and sclerophyll low tree savannah." East of Halls Creek and north of the Fitzroy River are patches of "semi-arid tussock grassland," some of it mixed with "sclerophyll low tree savannah."

Perry (1958) shows the south-western half as "hummock grassland" and the north-eastern half as "savannah woodland" but encloses small patches of "tussock grassland" both west and east of Halls Creek. Williams (1959) shows the south-western half as "shrub savannah" and the north-eastern half mostly as "low layered woodland with tree and low tree savannah" with a small area of "low layered woodland" in the east and two small areas of "tussock grassland" in the west. The extreme north-east is "woodland."

THE AGRICULTURAL LANDS

The agricultural lands of the State, from Ajana and Yuna to Southern Cross to Lake Varley to Mount Manypeaks, cover some 30,000 square miles. This country has been cleared of its natural vegetation and is used for crops, or lying fallow, or used for grazing. From a naturalist's point of view the main characteristic of it now is the destruction of the natural environment. I am indebted to Miss P. Watson for the computation of the following percentages:

STATE OF NATURAL ENVIRONMENT IN THE AGRICULTURAL DISTRICTS OF WESTERN AUSTRALIA

District	Land in private holdings			Crown land*
	Cleared	Uncleared Grazed	Uncleared Unused	
	%	%	%	%
Armadale-Kelmscott	15	4	4	76
Cockburn	14	11	6	69
Darling Range	8	2	5	85
Gosnells	16	7	6	70
Kwinana	14	33	6	48
Mundaring	11	6	17	66
Rockingham	13	10	4	73
Serpentine-Jarrahdale	25	9	5	62
Swan (part)	16	8	20	56
Wanneroo	3	24	6	67
SWAN DIVISION	14	10	9	67

* Including forest land, reserves, railway land, buildings, etc.

	%	%	%	%
Augusta-Margaret River	12	9	5	74
Balingup	21	8	9	63
Bridgetown	29	15	6	50
Bunbury	4	4	—	92
Busselton	31	18	6	45
Capel	43	20	3	33
Collie Coalfields	6	11	7	76
Dardanup	35	17	5	43
Drakesbrook	26	16	2	65
Greenbushes	34	18	12	36
Harvey	16	8	6	70
Mandurah	2	9	2	87
Manjimup	6	6	3	85
Marradong	9	7	5	79
Murray	23	11	6	60
Nannup	3	4	1	9
Preston	30	25	10	35
Upper Blackwood	31	22	13	34
SOUTH-WEST DIVISION	16	11	5	68
Albany	7	6	7	80
Broomehill	80	7	9	4
Cranbrook	18	27	11	44
Denmark	5	4	5	85
Dumbleyung	61	2	14	23
Gnowangerup	22	3	7	68
Katanning	76	6	9	9
Kent	16	1	18	65
Kojonup	49	24	15	11
Lake Grace	20	1	12	67
Plantagenet	22	11	20	47
Tambellup	51	12	20	17
Wagin	68	13	9	10
West Arthur	32	24	18	27
Woodanilling	52	11	12	26
SOUTH. AGR. DIVISION	28	8	11	53
Beverley	57	9	7	27
Brookton*	90	10	13	—
Bruce Rock	80	3	15	2
Corrigin	69	4	9	17
Cuballing	54	8	9	29
Cunderdin	90	6	3	1
Dowerin	72	3	6	19
Goomalling	72	10	7	11
Kellerberrin	81	3	13	3
Kondinin	35	2	15	48
Koorda	42	6	18	34
Kulin	35	2	12	51
Kununoppin—Tr.	69	7	15	10
Merredin	53	3	16	28
Mount Marshall	14	27	7	52
Mukinbudin	31	11	13	45
Narembeen	44	3	22	32
Narrogin	65	8	10	17
Northam	73	9	7	11
Nungarin	52	8	14	26
Pingelly	71	7	10	12
Quairading*	98	6	10	—
Tammin	77	3	6	14

* Includes parts of holdings outside the district.

	%	%	%	%
Toodyay	30	13	6	51
Wandering	20	8	9	63
Westonia	9	8	10	72
Wickepin	75	5	14	5
Williams	36	14	13	37
Wyalkatchem*	92	4	8	—
York	54	6	6	35
CENTRAL AGR. DIVISION	49	9	11	31
Carnamah	26	4	10	60
Chapman Valley	31	14	11	44
Chittering	20	12	25	42
Dalwallinu	23	59	6	12
Dandaragan	9	6	11	74
Geraldton-Greenough	46	22	17	15
Gingin	9	18	11	62
Irwin	10	5	19	65
Mingenew	48	27	12	13
Moora	65	11	13	11
Morawa	47	31	15	7
Mullewa	13	63	6	18
Northampton	6	18	6	70
Perenjori	25	55	9	11
Three Springs	31	6	13	50
Victoria Plains	57	13	14	16
Wongan-Ballidu	75	4	11	10
NORTH. AGR. DIVISION	24	29	9	38

The coastal plain environment has been described by Gardner (1926), Serventy (1948), and in detail with regard to soils by Bettenay, McArthur and Hingston (1960). The closer woodland growing on the clays of the Guildford Association has been cleared over most of the area, and replaced by pastures. Grazing is carried out on more than another 30 per cent of the area north of Harvey, and on less than 30 per cent of the area further south, as far as Boyanup. Grazing of uncleared land becomes more important again from Boyanup to beyond Margaret River. The amount of clearing is more than 50 per cent of the land as far south as Margaret River.

The sandy soils of the Bassendean Association are largely unused, but at Gnangara they have been planted with *Pinus pinaster* which has formed a very dense forest, typically with no undergrowth (Fig. 2).

Many swamps (Serpentine River soil association) have been drained and cleared of their natural vegetation and are now used for potatoes or clover.

The narrow belt of coastal limestone, which supports the typical tuart woodland, has been affected more by human settlement than by grazing or agriculture. The southward spread of beach and holiday resorts with their fishing shacks and beach cabins has modified the environment in yet another way. On the other hand the dune zone, though frequently disturbed, has not had many permanent structures erected upon it, and may be closer to its natural state than the limestone belt now is.

The 7,680 acres set aside as Yanchep Park and the 20,000 acres

* Includes parts of holdings outside the district.

of the Caves Reserves in the South-West ensure that no massive destruction of the limestone environment may take place.* A reserve of 5,000 acres set aside along the Old Coast Road south of Mandurah protects a unique combination of coastal types of environment.

Fig. 2 has been prepared to show the geographical significance of these statistics. The vegetation described by Gardner (1926) as "sclerophyllous woodland" and "savannah woodland" has suffered the most, and has practically disappeared from large areas. Gardner's "wandoo woodland" has been cleared over 30 to 70 per cent of the area, and of the remainder, between 10 and 30 per cent is subject to grazing, which does not affect the arboreal part of the environment but will certainly affect the undergrowth. To the writer's knowledge no reserve has been set aside to protect any sample of this type of environment.

The better forests of jarrah and karri ("dry sclerophyll forest" and "wet sclerophyll forest" respectively of Wood, 1950; Williams, 1955; Williams, 1959; amalgamated as "sclerophyll forests" by Perry, 1958) are reserved by the Crown and protected very effectively. Cutting is selective, and the natural environment is never drastically affected over large areas simultaneously, although marri is usually spared while jarrah and blackbutt are cut. The forests found within the water catchment areas (Mundaring, Canning, Wongong, Serpentine and catchments for irrigation further south) were cut over within the last century, and now consist of second or third growth, but it seems likely that the natural environment has not changed greatly, because the regeneration of the forest was allowed to proceed completely undisturbed. Serventy (1948) points out that the widespread occurrence of plants poisonous to sheep, especially of the York-road poison *(Gastrolobium calycinum)*, delayed and in many places prevented the "development" of this type of environment for grazing, especially in the earlier days when nothing was done to protect the forests.

Typical jarrah forests are wholly protected in the Forrest National Park (5,000 acres) in the north, and in the Collie parklands (1,000 acres) in the south. Karri forests have been included in the reserves at Pemberton (9,700 acres) and at Nornalup (33,000 acres). Small reserves north of Albany amount to 5,700 acres, and protect a mixture of forest and woodland environments. The Porongorup Reserve (5,400 acres) protects a small outlier of karri, much farther east than its usual range.

From Wanneroo to Dongara and also east of Mount Barker, Ongerup and Pingrup are large expanses of heath, floristically extremely interesting (Gardner, 1926), which constitutes a very distinct type of environment, and which is still unused because its soil does not support any economic crop. Scientific discoveries have now made the utilization of these soils quite possible, and it is to be hoped that suitably large and representative parts of this environment be set aside as National Parks before it is too late. In the

* Vandalism due to inadequate protection does occur within the caves, when unauthorised persons gain access to them.

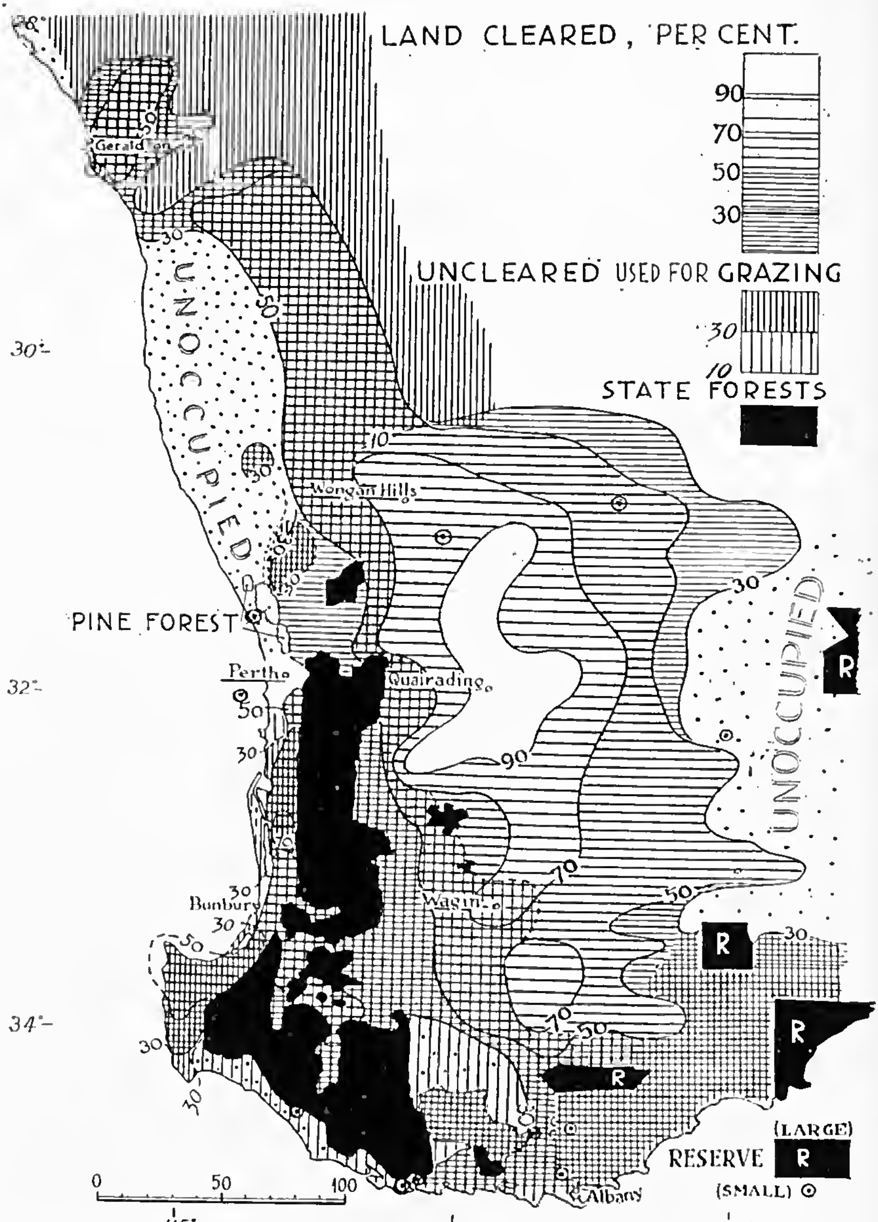

Fig. 2.—Modification of the natural environment in the agricultural areas.

southern area the Bremer Bay Reserve protects 604,670 acres of heath country.

It is probably too late to save any typical area of the central sclerophyllous woodland (salmon gum and gimlet woodland) but large areas of its drier variant still exist east of Southern Cross, and one of these not far from Southern Cross (Parkers Range-Jilbadgi) has been given a legal status as a reserve (Fig. 2).

Finally, it should be stressed that effective conservation of the natural environment must control grazing and fire in the most efficient way. Uncontrolled and prolonged grazing is most harmful because it cannot fail to be selective, thus affecting the natural balance and changing the specific composition of the plant cover. The soil structure is affected by trampling. Fire may help the regeneration of some plant species which need it to start the seed germinating, but repeated fires are undoubtedly very harmful, and they too have a selective effect. Good forest stands are well preserved as areas of natural environment for the very simple reason that they are well protected because of their economic value. The cost of keeping some 20 rangers in charge of the most representative nature reserves in the State should not prove beyond the resources of Western Australia's fast expanding economy, and, in view of the rapid development of tourism, this cost may well become a far-sighted economic investment.

SUMMARY

A study of land utilization in Western Australia shows that more than half the area is still unoccupied, and one-third of the remainder is leased for grazing. An analysis of vegetation maps, which show the main types of natural environment, discloses that most of the unoccupied area belongs to very few types of environment, among which the desert predominates. The land used for grazing has undergone changes in the balance of nature which may by now be permanent; the effect of grazing is far more drastic than was believed in the past, and this is why the setting aside of suitably large areas as nature reserves became so urgent in recent years. A detailed review is made of the agricultural lands, which have been extensively cleared, in some districts up to 90 per cent of the total area, as is shown by the map. It is feared that no typical salmon gum and gimlet country, no typical York gum and jam country may be saved now. No representative area of wandoo woodland has been reserved so far. Water catchments and forest reserves have ensured the conservation of forest environments. Small reserves badly in need of protection should ensure the survival of some of the coastal landscapes, but unless a small force of trained rangers is made available, the simple gazetting of reserved areas will not achieve its aim in the settled districts.

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FROM FIELD AND STUDY

***Psilotum nudum* at the Murchison River.**—On August 24, 1960, R. J. Butler collected a fruiting specimen of the primitive pteridophyte, *Psilotum nudum* (Linn.) Griseb. = *Psilotum triquetrum* Swartz., from Pine Thicket Gorge on the Murchison River south of Galena. The specimen was found growing in a crevice in a sandstone cliff face and about 20 ft. above the high water mark of the river.

The geographical distribution of *Psilotum nudum* is pan-tropical with extensions into both northern and southern moist subtropical regions. In Australia it extends from northern Queensland into the coastal and mountainous regions of New South Wales and occurs again in rocky areas of the Grampians in Victoria. In Western Australia it is only known from a collection made by W. V. Fitzgerald in 1905 from the Sprigg and Charnley Rivers in the West Kimberley.

The Butler collection is noteworthy as being the more southerly known occurrence of *Psilotum nudum* in Western Australia.

—G. G. SMITH and R. J. BUTLER, Nedlands.

Kangaroo Bot Fly Larva from Port Hedland.—A single larva of the Kangaroo Bot Fly, *Tracheomyia (Oestrus) macropi* Frog. (Diptera: Oestridae), was submitted for identification by Mr. R. M. Sadleir of the Zoology Department, University of Western Australia. The specimen was collected on August 16, 1960, in the mouth (between the two bottom incisors and under the tongue) of a female red kangaroo (*Macropus rufus* Desmarest) at Mundabullangana Station (managed by Mr. R. Lukis), at Port Hedland, W.A.

The Kangaroo Bot Fly was named as such and the larvae described as a new species by Mr. W. W. Froggatt in 1913 (*Agric. Gaz. N.S.W.*, 24: 567). His specimens were found crawling about in the mucus on the windpipes, just below the mouths, of kangaroos at Moramana Station, Walgett district, N.S.W.

The fly was previously represented, in the entomological collection of the W.A. Department of Agriculture, by specimens determined by Dr. S. J. Paramonov. These were some larvae, and an adult female, which had emerged from a pupa, obtained from a female red kangaroo at Warambie Station, Roebourne, W.A., in 1938. —L. E. KOCH, Department of Agriculture.

Homing Performances by Senegal Doves.—On September 2, 1960, I caught a Senegal Dove (*Streptopelia senegalensis*) in a mist net at my home at 184 Salvado Road, Wembley. It was transported, concealed in a gladstone bag, to the C.S.I.R.O. Wildlife Survey Section's Laboratory at 33 Caporn Street, Nedlands, where it was ringed (070-06630) and released. On October 12 it was re-taken in an automatic trap by Mrs. B. Tormey at 188 Salvado Road, Wembley, a distance of 3 miles north of its release point.

A second dove was trapped by Mrs. Tormey at 188 Salvado Road in the late afternoon of November 4, 1960, and ringed by me (070-01218) and released (after transportation, concealed in a box) at the corner of Warick Street and Wanneroo Road, 7½ miles north of its capture point. The dove was re-taken the following morning, November 5, by Mrs. Tormey at the original trap.

A third dove (070-06338) showed the best homing performances to date. It was caught and ringed at 184 Salvado Road on September 12, 1960. On November 3 it was re-trapped at 188 Salvado Road and released at 80 Matlock Street, Mt. Hawthorn (3 miles N.E.) It was re-trapped again at 188 Salvado Road on November 8 and released by Mr. A. Strawbridge at Upper Swan, about 17 miles N.E. On December 14 it was re-trapped for the third time at 188 Salvado Road.

Ringing of Senegal Doves, both at Caporn Street and Salvado Road, has indicated, through repeated recaptures, that these birds are highly sedentary and the performances of the three birds mentioned demonstrate that they will return to the home area even after being transported some distance away in a manner which precludes them from having visual knowledge of the route taken.

—R. H. STRANGER, Wembley.

Parthenogenesis in the Moth ***Zermizinga indocilisaria*****.**—A study of the biology of the geometrid moth, *Zermizinga indocilisaria* Walker, made it appear that parthenogenesis occurs in this species.

In September, 1959, six small potted pines, *Thuja orientalis*, were placed in the biology laboratory at Guildford Grammar School. A few days later some twig mimicking looper caterpillars were seen eating the green leaves on the pines.

The caterpillars were overall pale brown in colour with darker brown patches, small black spots resembling bark scars distributed over the body breaking up the outline, and a stripe of greenish black on each lateral surface. When resting, they attached themselves to a branch with their "tail claspers" and hung out at the same angle as the lateral branchlets of the pines with their ventral surfaces uppermost. In this position they resembled a broken twig. On close examination a fine thread, which served as a support, could be seen running from mouth to pine trunk. If the thread was cut the grub lost balance momentarily. After a short time it would bring its head up into contact with the branch again and replace the support.

On October 5 two brachypterous moths appeared on the bench where the pines were situated. They were gravid females, grey overall with black specks and black bands on abdomen and wings. Both specimens were collected and placed in separate containers.

On October 6 the moths were observed ovipositing. The eggs were green and were cemented to the walls of the container and to specimen labels, in groups of 15 to 20. One female produced about 350 eggs and the other approximately 370. Oviposition took place over 24 hours. On the 10th day (October 16) the eggs changed from green to a dark grey and then became black. On October 19 a great number of tiny black larvae emerged only to escape through the mesh on top of the containers. Eventually only 5 larvae were captured and placed on a potted cypress enclosed in a cage of fine nylon net.

The newly emerged larvae spun extremely fine silk strands which they used for aerial transport and bridging gaps. Most of the larvae that escaped migrated to the laboratory windows where they died on contacting insecticide. Freshly hatched specimens were approximately 2 mm. in length, they were black with occasional white bands on the abdomen and covered with very fine hairs. After the first moult they became grey-brown, matching the brown parts of the pine. There were possibly 5 instars and the last instar larvae measured approximately 30 mm.

On November 11 the larvae became sluggish and moved down the stem to the soil, where they burrowed to a depth of approximately one inch and pupated. The pupae were dug up and placed in separate containers.

On November 20, 4 moths emerged and on November 21 another moth appeared. All specimens were gravid females, they remained in their emergence containers and within 8 hours all had laid eggs. The eggs hatched into larvae on December 2 and these were released on to a covered pine. Unfortunately at this stage, due to other commitments, the investigation had to be temporarily abandoned but it is hoped to continue the observations at a later date.

No male moths were in contact with the females at any stage of the investigation indicating that parthenogenesis occurred.

I wish to thank I. F. B. Common, Principal Research Officer, C.S.I.R.O. Division of Entomology, Canberra, for identification of the moth; L. E. Koch, Entomology Branch, Department of Agriculture, W.A., for his helpful comments on the paper; and G. G. Smith, Botany Department, University of W.A., for identification of the host plant.

—PETER McMILLAN, Guildford.

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NATURAL HISTORY NOTES FROM JIGALONG

IV. FROGS

By ERIC LINDGREN and A. R. MAIN

Lindgren (1960) reported the collection of *Hyla rubella* Gray, *Limnodynastes spenceri* Parker, and *Notaden nichollsi* Parker, from Jigalong after rain in April and May 1959. Subsequently after summer rains it has been possible for him to collect from breeding congresses on Jigalong and Salem Creeks specimens of the following species:—*Cyclorana platycephalus* (Gunther), *C. cultripes* Parker, *Limnodynastes spenceri, Neobatrachus sutor* Main, and *Hyla rubella.* The number of specimens and size data are shown in Table 1.

TABLE 1.—FROGS COLLECTED AT JIGALONG, DECEMBER 5 AND 6, 1959.

Species	Sex	Number of Specimens	Mean Snout-vent length mm.	Standard Deviation
Hyla rubella	♂	14	35.6	1.7
	♀	5	33.4	1.2
Cyclorana platycephalus	♂	18	57.6	4.7
	♀	7	60.5	5.2
Cyclorana cultripes	♂	12	43.2	1.0
	♀	3	46.3	0.4
Neobatrachus sutor	♂	3	41.6	2.6
Limnodynastes spenceri	♂	82	42.0	2.5
	♀	24	43.7	2.1

BIOLOGY

Collecting took place on two succeeding nights in December 1959. On the 5th, 48 points of rain fell before 1800 hrs. and a further 34 points fell before collecting started at 0015 hrs. on the morning of the 6th. Both Jigalong and Salem Creeks flowed after this rain, but on the morning of the 6th frogs were breeding in congress in Salem Creek only. Air and water temperatures were not taken. Attention was directed to them by the volume of their calls, these being heard at the Mission, roughly 400 yards from the creek.

Salem Creek is the smaller of the two creeks, averaging about 15 ft. across with banks up to 6 ft. high and a bed consisting of fine red sand and mud. The banks are well wooded and small clay flats holding water up to 18 in. deep in places, in which the frogs were also breeding, occur nearby.

Jigalong Creek is much wider, at the collecting area being about 90 ft. across with a 6 ft. high bank on the east side and a sloping bank on the west side. Being close to the native camp most timber has been cut out for firewood and only a few river gums remain. The creek bed consists of coarse sand with little matrix, scattered throughout with small stones.

On December 6, from 0015 hrs. until 0315 hrs. and 1930 hrs. until 2145 hrs., frogs were collected indiscriminately so that an idea of relative abundance could be gained. Clasping pairs were captured and tied together by a label about their legs.

During collecting it was apparent that various species showed definite preferences in calling position.

1. *Cyclorana platycephalus* called mainly from the shallows, but rested on the bottom. The call is a long drawn-out "maw-w-w-w-w."

2. *Limnodynastes spenceri* called while floating, usually within three feet of the bank and occasionally while resting on the bottom. Some individuals called while floating between branches of creekside vegetation hanging into the water. The call is a rapid "ho ho ho ho ho ho," with a soft "o" as in "cot."

3. *Neobatrachus sutor* called from the water's edge, sitting only a few inches from the water. The call is a penetrating "tap tap tap" easily heard above the volume of other calls.

4. *Hyla rubella* called out of the water on the bank, usually with its body vertical, head up, but occasionally at various angles, rarely with its head pointing to the water. The call is a long rattling call similar to that of *C. cultripes* but much more uneven and lower in pitch. (Only a few individuals of this species were seen swimming, most being on the bank in rock or tree crevices.)

5. *Cyclorana cultripes*, no notes were made of the call position. Its call is a high pitched even "maa-a-a-a-a" somewhat like that of *H. rubella*.

One individual *Hyla* was heard calling from a rain water tank 200 yards from Jigalong Creek and was timed on two occasions, as shown in Table 2.

TABLE 2.—PARTICULARS OF CALL OF ONE HYLA RUBELLA RECORDED ON TWO SEPARATE OCCASIONS.

Date	Time of recording	Mean number of trills per call	Range	Duration of call, seconds	Range	Interval between calls, seconds	Range
7.12.59	2005	116.5	21-476	144.4	23 to 590	42.25	3 to 162
8.12.59	1945	93	16-221	114.0	18 to 284	72	3 to 255

Snout-vent lengths, in millimetres, of all clasping pairs are shown in Table 3.

TABLE 3.—CLASPING PAIRS TAKEN FROM THE BREEDING CONGRESS SHOWING THE USUALLY LARGER SIZE OF THE FEMALE IN EACH PAIR.

C. platycephalus	♂	59.8	60.5	62.1	52.5				
	♀	63.5	62.4	63.4	49.7				
C. cultripes	♂	42.7	42.8						
	♀	46.5	46.6						
L. spenceri	♂	42.3	39.2	37.5	39.6	41.5	42.3	40.9	40.4
	♀	44.0	40.6	43.6	40.0	42.0	40.9	43.8	41.3
						39.0	42.7	42.7	44.8
						46.5	40.3	44.0	43.7

Measurements of all species were plotted on histograms. These tend to follow a normal distribution. No class is excessively abundant or rare and so it has not been possible to discern either age or size classes reflecting periods of good or poor recruitment to the population.

DISCUSSION

From Table 1 it is apparent that *L. spenceri* is the commonest frog in the locality and it is of interest that it was also the commonest frog reported in the earlier paper (Lindgren, *op. cit.*). Nevertheless it is apparent that the earlier collection was not representative of the unexpectedly rich frog fauna of the area. Main *et al.* (1959) showed the Jigalong area as being occupied by four genera. The present collections indicate that five genera and six species occur in the vicinity. Some of the faunal richness is undoubtedly due to the presence of the water courses as all, except *Notaden nichollsi* and *Neobatrachus,* are more or less restricted to water courses. An additional species which might be expected from the locality is *N. centralis* Parker.

Of the species reported from Jigalong *H. rubella* is wide spread. *C. platycephalus* and *L. spenceri* occur as far south as 30 miles north of Menzies. *N. nichollsi* and *C. cultripes* must be near their southern limit. *N. sutor* has not been recorded further north and has not been collected again until south of Menzies.

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V. ABORIGINAL FLORA AND FAUNA NAMES

By ERIC LINDGREN.

INTRODUCTION

Three dialect groups of the Western Desert language are represented at Jigalong. These are known among the aborigines themselves at Katatjara, Mantjiltjara and Putitjara, but elsewhere in the great Western Desert region are known by "nicknames" depending upon idiosyncracies in the language, thus the Jigalong people are spoken of by the Warburton Range aborigines as *piniritjara*, *piniri* being the local word for "run" and differing from the Warburton *kukura* (Douglas, 1958). Numerically the *Katatjara* are the strongest, the numbers at a census taken in camp on November 16, 1959, being 45 males and 55 females, including children. There were 40 males and 53 females in the Mantjiltjara group and only one male and two females in the Putitjara.

The three dialects are basically similar, roughly 50% of the vocabulary being identical, but with the intermingling in the close confines of the mission a mixed language has originated. Superficially many irregularities appeared in my early attempts to record the language but once the distinction between the dialect groups was understood recording became much easier and clearer. This was assisted by the fact that the two main groups maintained separate camping areas, the Katatjara being on the west side of Jigalong Creek and the Mantjiltjara on the east side. The few Putitjara camped with relatives among the Katatjara.

Originally the tribal boundaries were to the east and north of the land at present regarded as the home ground. Katatjara ranged all round Lake Disappointment, which they knew as *Walu*, Mantjiltjara were much farther to the north, apparently meeting the Wanmatjiri on their northern boundaries and ranging south along the general area of the Canning Stock Route to the northern boundary of the Katatjara. Putitjara people lived directly to the south and west of the Katatjara in the vicinity of Savory Creek. This was known to them as *yunuru* and to the Katatjara as *kupayura*. With the establishment of the mission at Jigalong in 1945 it became a focal point at which these people could obtain regular food and clothing and a general drift to the westward resulted, small parties arriving at the mission from the desert throughout the years.

A start was made recording the language during nature walks with the children from school but it soon became apparent that a reliable alphabet was needed. This problem was solved by Douglas' work, "An Introduction to the Western Desert Language," University of Sydney, 1958. To make the following lists clearer a modified copy of this alphabet is given here.

A. Sounds having English equivalents.

1. Those comparatively easy to produce:

m as in mat	mama "father"
n as in nut	wana "digging stick"
l as in lot	yalu "liver"
ṛ as in rake	waṛu "fire"
w as in wet	wiya "no"
y as in yet	yuwa "yes"
i as in radio	yiwara "road"
a as in father	yapu "rock"
u as in put	nguntju "mother"

2. Those presenting difficulties:

p as in spike	papa "dog"
t as in stake	kata "head"
k as in skate	kapi "water"
ng as in singer	ngura "camp"
r as in run (Scotch trilled)	waru "rock wallaby"

B. Sounds not having English equivalents.

1. **Dentals** (tongue between teeth before **a** and **u**, behind teeth before **i** and preceding or following a non-dental consonant).
tj as in katja "son"
ny as in nyangu "saw"
ly as in palya "right"

2. **Long vowels** (twice normal length).
i: as in wi : lyka "native cat"
a: as in nya : ku? "what for?"
u: as in pu : nu "blew it"

3. Retroflex consonants (tongue turned up)*
t as in wata "tree"
n as in pana "ground"
l as in malu "kangaroo"

Stress: Primary syllable stress always occurs on first syllable of the word.

* Subscript type conventionally used for these consonants is unfortunately not available in Perth. Throughout this article the letter in solid black represents what should have been printed in subscript type (i.e., the letter with a dot below it).

Unfortunately the language is slowly being lost, each succeeding generation having slightly less knowledge than the preceding. It was found that much early work with the children was unreliable because of their unintentional ignorance, so finally recording was restricted to a reliable informant from each camp and later checked with other individuals of the same dialect group.

Because Putitjara is represented in such small numbers I feel that the words as recorded in the bird list may not be entirely accurate, but include them as a point of interest, and so that any person having the opportunity can check their accuracy.

The following are the word lists:

Where the dialect distinction is not known the word in general use about the mission is listed. All those marked * are used as food, the part eaten being named in the case of plants.

MAMMALS

English	Scientific	Katatjara	Mantjiltjara
Fur			Panku
Tail			Ngurpura
*Echidna	Tachyglossus aculeatus	Tjilkamata	Mangana
Marsupial Mole	Notoryctes sp.	Mantangangara	Mantararapa
Native Cat	Dasyurus or Satanellus sp.	Winmintji	Ngangalpa

English	Scientific	Katatjara	Mantjiltjara
Possum	Trichosurus vulpecula	Wayuta	Wayuta
Bandicoot (?sp.)		Makura	Mingatjuru
*Marsupial Mouse	Sminthopsis sp.	Tilyku	Tilyku
*Hill Kangaroo [Euro]	Macropus robustus	Yapuri : tja	Yapuri : tja
		Kalkany	Witjunu
*Plain Kangaroo [Red]	Macropus rufus	Palkari :tja Waringkura	
		Malu	Malu
A large boomer		Walanya	—
*Rock Wallaby	Petrogale lateralis	Nyurukita	Pakulyara
All Bats		Tjati	Milanpa
Dog or Dingo	Canis familiaris	Tjantu	Tjantu
*Domestic Cat	Felis catus		Tjutjukulu
*Rabbit	Oryctolagus euniculus	Mitara Malka-malka	Mitawuna Tji : puka
*Camel	Camelus bactrianus	Mutitikil	

BIRDS (for relevant scientific names see Serventy and Whittell. "A Handbook of the Birds of Western Australia," 1951).

English	Katatjara	Mantjiltjara	Putitjara
Bird	Pilun	Turu	
Wing	Mina	Wili	
Feather	Wuna	Nyalpi	
Egg	Tjanytji	Ngampu	
Nest	Tjanku		
Emu	Kalaya	Kalaya	Kalaya
Quail (sp?)	Pulparu	Pulparu	Pulparu
Diamond Dove	Kulakuku	Kulakuk	Kulurukun
Common Bronze-wing	Mau-kra	Mau-kra	Mau-kra
Spinifex Pigeon	Munkutakuta	Munkutakuta	Munkutakuta
Crested Pigeon	Pukatina	Pukatina	Kalpi
Black-tailed Native Hen	Nuntikanan	Nyuntikanan	Nyuntikanan
Pelican	Tjutara	Tjutara	Tjutara
Banded Plover	Kirki ki : n ki : n	Kirki ki : n ki : n	Kirki ki : n ki : n
Black-fronted Dotterel	Limpi	Limpi	Limpi
Australian Dotterel	Pitunkra	Pitunkra	Pitunkra
Bustard	Nalpintji	Nganuti	Nganuti
White-faced Heron	Tarkaru	Tarkaru	Tarkaru
All Ducks	Kukakura	Tji : puluka	Kukakura
Wedge-tailed Eagle	Walatu	Ngutila	Winkirt
	Walawuru	Kunturu	
Fork-tailed Kite	Tjunin	—	Pinanyka
Kestrel	Winti-winti	Winti-winti	Winti-winti
Boobook Owl	Kur-kur	Kur-kur	Ngunatji
Little Corella	Ki : niri	Ngagalyalya	Ki : niri
Galah	Pi : arku	Tiwa-tiwa	Pi : arku
Cockatiel	Turir	Turir	Turir
Alexandra Parrot	Piipai	Tumpura	Piipai
Twenty-eight Parrot	Tuntrun mata	Tuntrun mata	Tuntrun mata

English	Katatjara	Mantjiltjara	Putitjara
Budgerigah	Kulykilykari	Ngatatjiri	Kulykilykari
Frogmouth	Pi : wi		Pi : wi Nguri
Red-backed Kingfisher	Lun	Lun	Lun
Rainbow-bird	Tirun-tirun	Tirun-tirun	Tirun-tirun
Pallid Cuckoo	Pulatutu	Pulatutu	Pulatutu
Fairy Martin	Tjuntjangalanku	—	—
Tree Martin	Kintilyka	Kurawaka	Kintilyka
Willy Wagtail	Tjiti-tjiti	Tjinta-tjinta	—
[1]Crested Bell-bird	Wanpanpalala	Panpanpalala	Panpanpalala
Magpie Lark	Ti : wil-ti : wil	Ti : wil-ti : wil	Ti : wil-ti : wil
Black-faced Cuckoo-shrike	I : luru	I : luru	I : luru
Ground Cuckoo-shrike	Walputatjara		—
Grey-crowned Babbler	Turtu-wata	Turtu-wata	Turtu-wata
Crimson Chat	Pili : titi	Pili : titi	Pili : titi
All Wrens	Tjiltjilka	Tjiltjilka	Tjiltjilka
Masked Wood-Swallow	Tjitatjalpi	Tjalpintari	Tjitatjalpi
Black-faced Wood-Swallow	Wakatjalpi	Wakatjalpi	Wakatjalpi
[1]Red-browed Pardalote	Wanpanpalala	Wanpanpalala	Wanpanpalala
White-plumed Honeyeater	Intatjara	Intatjara	—
Miner	Pi : n-pi : n	—	—
Pipit	Puri-puri	Puril-puril	Puril-puril
Zebra Finch	Nyinyinka	Nyi : nyi	Nyinyinka
All Crows	Ka : nka Wankuna	Wankuna Tjilkilata	Wankuna Wa : ku
Black-throated Butcher-bird	Kakaraputa[2] Kurparu	Kakaraputa Kurparu	Kakaraputa Kurpantji

[1] Seemingly anomalous but both birds were heard called this on many occasions.

[2] Derived from kakara meaning east as it is the bird whose loud notes are easiest heard at sunrise.

REPTILES and AMPHIBIA

English	Scientific	Katatjara	Mantjjiltjara
Snake		Tjila	Kanatji
*Children's Python	Liasis childreni	Witu	Ngantjanpa
*Black-headed Python	Aspidites melanocephalus	Purayura	Purayura
*Gwardar	Demansia nuchalis	Wata-wata	Wata-wata
Five-ringed Snake	Demansia modesta	Kirkirpa	Kampapay
*Mountain Devil	Moloch horridus	Kataputa	Witiri
Banded Skink	Lygosoma monotropis	Tjaiuli	—
Striped Skink	Lygosoma leonhardii	Mulintjara	Muntjilingkara
2-legged Worm-lizard	L. bipes	Katapinti	Pula-yalil

English	Scientific	Katatjara	Mantjiiltjara
*Northern Blue Tongue	Tiliqua occipitalis multifasciata	Lungkuta	
All Geckos		Pi : n	Kanpartja
*Netted Dragon	Amphibolurus reticulatus	Pala-pala	Ka : nu
		Mani	
Rock Dragon	Amphibolurus caudicinctus	Mantanta	Putarpa
		Nga : kata	
Dragon	Amphibolurus muricatus	Talykintari	
*Water Dragon	Physignathus longirostris	Kurawara	Tjintjalpi
		Nantalpina	
Wood Varanus	V. caudolineatus	Wiru	Miiyu Wirui
	*V. acanthurus	Yalapara	
	*V. gouldi	Nati	Panapanti
		Pirur	Tjintjila
	*V. giganteus	Marantu	Panangu
			Kunaki : pin
Tortoise	*Chelodina steindachneri	Wuku	Yakuli
Tadpoles		Wipu-wipu	
Frog		Nan-kra	
		Nganmalya	

INSECTS and ARACHNIDS

English	Katatjara	Mantjiltjara
Fly	Mu : ngu	Ngurinpa
Maggot	Piiu	
Mosquito	Kimiritji	
	Kimirikin	
Louse		Puia
Grasshopper	Puntalka	Tjartjun
Cockchafer	Mupitata	
*Edible root grubs	Lunki	
Butterfly	Na-mina-mina	Wira-pinta-pinta
Cockroach	Kumpi-tjir-tjir	
Ant	Pinga	Pinga
*Honey Ant	Ukata	
Termite	Manturpa	
Edible Galls	Tarun	
Inedible Galls	Putar	
Scorpion	Wana	Wanamilyka
Centipede	Waralyarin	
Spider		Ta : piri

PLANTS

English	Scientific	Katatjara	Mantjiltjara
Tree		Wata	Wata
Leaf		Mipi	Parka
Flower		Purung	
Fruit		Wamula	
Seeds		Wilyki	
Root		Wanai	
	Cassia desolata	Kunaluru	
	Acacia aneura	Wanari	Wintamara
	*A. tetragonophylla (green seeds)	Karara	
	Acacia spp.	Wantan	
		Tjilyili	
		Putar	

English	Scientific	Katatjara	Mantjjiltjara
	Eucalyptus camaldulensis	Wurangka	Walytji
	Eucalyptus spp.	Kita-kita Pana-pana	
	Eremophila sp.	Nyinpingka	
	*Solanum lasiophyllum (fruit skin)	Kuran-kuran	
	*S. quadrilocatulum (fruit skin)	Pilytjiwin	
	*Solanum spp. (fruit skin)	Kuntunga : pala	
	Triodia irritans	Paru	Mankalpa
	*Hakea lorea (nectar)	Wamula	
	*Marsdenia australis (green seeds)	Kalkula	
	*Cynanchum floribundum (green seeds)	Wanyan	
	*Calestegia sepium (tuber)	Mata	
	*Plectronia latifolia (berry)	Nganungu	
	*Ficus puberula (ripe fruit)	Kunawinka	
	*Loranthus spp. (ripe fruit)	Milllyu	
Sturt Pea	Clianthus speciosus	Malukuru	
	Santalum spicatum	Tartja	
Blackboy	Xanthorrhoea sp.	Nyuntuliri	

NOTES ON SOME WADERS IN SOUTH-WESTERN AUSTRALIA

By C. F. H. JENKINS, M.A.

The Swan River Estuary and the numerous adjacent swamps have provided an ideal habitat for migratory waders and resident water birds for a very long time. In more recent years, however, rapid changes have taken place in the metropolitan area involving the reclamation of river foreshores and the "improvement" or filling of numerous swamps. Already Perth Water is almost completely enclosed by a stone wall, and the same applies to the north side of Melville Water from the Narrows Bridge to Nedlands.

It was with great interest and concern, therefore, that local naturalists watched bulldozers and dredges go into action along the river frontage at Como and South Perth in preparation for the Kwinana Freeway. Eucalypts, paper barks and rush flats were sacrificed in the cause of progress, and a once attractive shore line was reduced to a sandy waste. Fortunately, however, no retaining wall was erected in this part of the river and shelving beaches and broad shallows still provide ideal feeding grounds for water birds of all kinds. The formal plantings along the Freeway have of course completely supplanted the more picturesque native trees but fortunately rushes and other swamp plants are once again appearing near the water line and at least some natural cover may soon be restored.

Another favourable observation is that the birds are completely indifferent to the speeding traffic and contrary to earlier expectation visit the area in undiminished numbers. This fact can be put to good use in the development of other foreshore areas where scenic roads and swamp reclamation are considered essential. Where possible, such work should provide for a new beach line as at Como and South Perth, and not the type of stone retaining wall which has driven almost every bird from Perth Water and converted the area into little more than an oversized concrete basin. Some of the more picturesque stretches of the river foreshore should be preserved entirely in their natural state, but unless very prompt action is taken future generations will have no idea of the natural flora and fauna which once skirted the river's edge.

The most important area to be preserved is Pelican Point, for this region is not only first favourite with numerous water birds, but its proximity to the University makes it unique as a bird banding station and research centre. The rapid development projected for Perth in the next decade must lead to further clearing and land improvement, with its consequent destruction of wild life. The impact can be cushioned, however, by an understanding approach to the problem, and with some collaboration between planning authorities and wild life conservationists, a compromise could be reached which would preserve at least some of the natural foreshore for many years to come.

With the recent establishment of a bird banding station at Pelican Point our knowledge of the local waders should increase rapidly. Observers in the South-West are still relatively few, however, and the following notes may be useful in supplying distribution data concerning some of the lesser known species.

Turnstone *(Arenaria interpres)*

As recorded by Serventy and Whittell (1951) this bird is rather scarce on the southern mainland beaches. I have only seen one specimen on the mainland and this was near the mouth of the estuary at Mandurah in October, 1959.

Hooded Dotterel *(Charadrius cucullatus)*

The local distribution of this bird was defined by Serventy and Whittell (1951) as south of line from Geraldton, Wongan Hills, Lake Cowan and Balladonia. The northern limit was extended by Ford and Teague (1959) from Geraldton to Port Gregory. The north-eastern limit was also extended when I saw a pair of birds near the south end of Lake Deborah (north-west of Bullfinch) in September, 1959.

White-headed Stilt *(Himantopus himantopus)*

Serventy and Whittell (1951) record that this bird is "sparingly distributed in the South-West corner"; and "may be found as far south as Busselton." Several birds were seen near the mouth of Denmark River in May, 1955, and about thirty were seen at the same locality in May, 1956. A party of about twenty were seen at Hutt Lagoon, Port Gregory, in May, 1959.

Banded Stilt *(Cladorhynchus leucocephalus)*

The furthest north I have seen this species is Hutt Lagoon, Port Gregory, where about twenty mature plumaged birds were seen in May, 1959. About 150 immature birds were seen near the mouth of the Denmark River in May, 1956. They were in company with White-headed Stilts and Avocets.

Avocet *(Recurvirostra novae-hollandiae)*

This species is often very numerous on the Swan estuary during the summer. During dredging operations along the South Perth foreshore in 1954 some 300-400 birds were present during the late summer. The largest single group seen was in October, 1957, when 500 birds were present in the same locality. I have seen the birds as far north as Hutt Lagoon, and on the south coast near the mouth of the Denmark River. From 70 to 80 birds were seen in this area in May, 1956, and about 20 in May, 1958.

Eastern Curlew *(Numenius madagascariensis)*

These birds can often be seen during the summer on the estuaries at Bunbury and Mandurah. One was seen at Mandurah as late as August in 1959. A single bird was seen on South Perth foreshore in December 1959.

Black-tailed Godwit *(Limosa limosa)*

Small parties of this bird have been seen at Bunbury (February, 1956), at Pelican Point on several occasions and at South Perth foreshore (November 1956).

Bar-tailed Godwit *(Limosa lapponica)*

A small party was seen at Pelican Point in November 1956, a single bird was seen on South Perth foreshore in November 1957 and a single bird with one leg was seen at Mandurah in August 1959.

Wood Sandpiper (*Tringa glareola*)

A specimen of this bird was seen near Lake Gnangara (Wanneroo) in February 1958.

Grey-tailed Tattler *(Tringa brevipes)*

This bird is a rare visitor to the South-West, but it has been sighted on several occasions on the Swan River estuary (Jenkins, 1956).

Australian Pratincole *(Stiltia isabella)*

The pratincole has only recently been recorded from Western Australia, south of the Kimberley. Serventy (1956) saw the birds at Koonalda approximately 60 miles east of the State border and sugested its probable occurrence further to the West. J. R. Ford (1960) later saw it near Roebourne. My brother, L. H. C. Jenkins observed pratincoles at Mileura Station near Meekatharra in June and July, 1947. The birds were noted on bare plain country and their characteristic swallow-like form and flight were clearly seen. Unfortunately the significance of the observation was not realised at the time and specimens were not procured. In view of the recent sightings, however, this record is worth reporting, if for no other purpose than to alert other observers.

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IRRUPTION OF THE WHITE-WINGED BLACK TERN INTO THE SOUTH-WEST, 1960

By JULIAN FORD, Attadale.

The White-winged Black Tern *(Chlidonias leucoptera)* is a Palaearctic breeding species which during the northern winter moves into the tropical belt of the Ethiopian, Oriental and Australasian regions. Recent observations indicate that the species is not uncommon in coastal northern Australia during this period; L. Amiet (*The Emu*, 56, 1956: 95; 57, 1957: 55) and F. M. Hamilton (*The Emu*, 57, 1957: 147) observed the species in fairly large numbers along the Queensland coast, and D. L. Serventy (*W.A. Naturalist*, 1, 1947: 68) and P. Slater (*W.A. Naturalist*, 7, 1959: 39) recorded it in northern Western Australia. Occasionally as the result of cyclonic phenomena, the species is transported many hundreds of miles further south. Three such invasions into the South-West have been reported, *viz.* in 1917 (W. B. Alexander, *The Emu*, 17, 1917: 95), 1918 (W. B. Alexander, *The Emu*, 18, 1918: 134) and in 1956 (A. M. Douglas *et al.*, *W.A. Naturalist*, 5, 1956: 121). A further irruption into the South-West is now reported.

On about March 20, 1960, a tropical cyclone developed near Cape York, Queensland, and then moved westwards across the Gulf of Carpentaria and the Northern Territory, and intensified off the Kimberley and North-West coasts from March 23 to 25. It then travelled rapidly southwards along the west coast and passed the latitude of Perth on the west side of Rottnest Island on March 27, causing heavy precipitation and gale force northerly winds. Because the cyclone followed a route down the west coast somewhat similar to that taken by the cyclone of March 1956 (J. Gentilli, *W.A. Naturalist,* 5, 1956: 84, 135), conditions were favourable for the fortuitous transportation of the White-winged Black Tern. When I visited the coastal lakes south of the Swan River in the late afternoon of March 27, the following census of the tern-species was taken: Coolbellup Lake, 4; Bibra Lake, 4; Yangebup Lake, nil; Jilbup Lake, 1; Cooloongup Lake, 10; and Walyungup Lake, 17.

The following day another survey was made and 3 birds were seen at Monger's Lake, 7 at Coolbellup Lake, and none at Perry's and Herdsman's Lakes and Lucky Bay. On March 29, I saw 13 at Bibra Lake and 4 at Cooloongup Lake, but none at Coolbellup, Yangebup, Jilbup, Coogee, Richmond and Walyungup Lakes and the Mandurah estuary. H. Atkinson saw 21 at Coolbellup Lake on March 29. The lakes and swamps between Perth and Yanchep were surveyed on March 30, but no White-winged Black Terns were seen. On April 3, P. Fuller and I saw 8 birds at Bibra Lake.

Compared with the previous invasion, the 1960 irruption was on a considerably smaller scale and birds were garbed in a more advanced stage of the nuptial plumage. They mostly had the breast and throat dappled black; head with varying amounts of black; small amounts of black on the back; wing-linings, black; upper wings, grey; tips of primaries, dark grey; tail, white above and below; beak, black. A few terns had no black except on the nape. No moulting of the wing feathers was noted.

Their flight was a fluttering action, and periodically they would swoop down and pick up food from the surface of the water. They usually fed against the wind and kept reworking the same strip over the water.

I am indebted to Mr. R. Vollprecht of the Perth Weather Bureau for allowing me to examine climatic data on the movement of the cyclone of March 1960.

FROM FIELD AND STUDY

Aquatic Plants from Mingenew.—On a trip to Mingenew in October, 1959 to collect aquatic plants members of the Fresh Water Group examined a clay pan about forty feet in diameter, which yielded the following nine species of aquatics—*Lepilaena australis, Glossostigma drummondii, Damasonium minus, Callitriche verna, Crassula recurva, Ottelia ovalifolia, Marsilea brownii, Isoetes drummondii, Chara australis.*

This collection is a notably varied one for a small swamp when compared with collections which have been made from swamps in the vicinity of Perth.

—J. KNIGHT and G. G. SMITH.

An Unconfirmed Report of the Crab-eater Seal on the South Coast.—At Cheyne Beach in 1959 Mr. Jack Westerberg, a local fisherman, described to me a strange seal he saw in October 1958. It was the largest he had ever seen, longer and more slender than the resident species *(Neophoca cinerea)*, with large eyes and short pointed muzzle, and wholly pale in coloration. It first appeared on Cheyne Beach where it remained for a day or two. A little later it was seen on the small beach south of Lookout Point, then it disappeared for good.

Mr. Westerberg's description fits only the Crab-eater Seal *(Lobodon carcinophaga)*, an Antarctic species that wanders rarely to the coasts of New Zealand and south-eastern Australia.

—G. M. STORR, Nedlands.

Silvereyes Feeding on Kangaroo Paws.—On January 3, 1961, while camping near Bayonet Head, Albany, I noticed that a number of the petals of the flowers of the Tree Kangaroo Paw *(Anigozanthos flavida)* had been slit open, apparently by attacks of birds. While watching a clump of flowers I saw a flock of Silvereyes *(Zosterops australasiae)* feeding. The birds in obtaining the nectar make a cut just below the outer edge of the petal, then slit this down to the nectaries.

Clearly this method of feeding, so unlike that of the honeyeaters, is disadvantageous to the plant. It is interesting to speculate what effect this process of obtaining nectar by means of a short cut would have on the amount of seed set by the plant. Also if the birds were in large numbers whether it would have any long term significance on the biological success of the plant species.

—V. N. SERVENTY, Wembley Downs.

True Identity of a "Lost" Species, *Caladenia drummondii* Benth.—For many years the true identity of *Caladenia drummondii* Benth. has been a puzzle to Australian orchidologists. In 1960 I was able to examine Drummond's type collection at the Kew Herbarium, and solve the mystery. Bentham's species proved to be that which was given the name *Caladenia glossodiphylla* Rupp and Erickson (in *W.A. Nat.*, 4(3), 1953: 65) in the belief that it was a previously undescribed species. When considering differences between the Rupp-Erickson description and the original Bentham description the discrepancies, when checked with material, are to be found in the latter work. However Bentham can be excused for the indefinitude and inaccuracy of some points in his description in the light of the fact that he had only two small pressed specimens on which to base it. Of the labellum, Bentham's description states, rather indefinitely—"the lateral lobes broadly rounded, apparently white and entire." A drawing of the labellum based on the type material, executed in 1908 by M. Smith, clearly shows the toothing of these lobes, as noted in the Rupp-Erickson description. In considering his statement concerning the calli "in about 4 rows" it must be realised that the variability of rows of calli, from 4 to

6 rows, could hardly be assessed accurately from two pressed specimens. Many writers subsequent to Bentham placed undue emphasis on his statement concerning the leaf "broader for its length than any other species of *Caladenia*" and disregarded his qualification "but not yet fully developed."

—J. R. TONKINSON, Mosman Park.

Unusual Boobook Owl Call.—Storr *(W.A. Nat.*, 4 : 143.) recorded an unusual call of a Boobook Owl *(Ninox novaeseelandiae)* which he likened to a pumping plant, heard on March 12, 1954 at Dunsborough.

A similar call was heard at Carbarup, just north of Mt. Barker, during 1958. Carbarup siding is near a patch of low-lying Wandoo-Yate association providing a suitable habitat for hollow roosting birds. At 2300 hrs. on August 8 there was no moon and the night was still and clear. Three Boobooks were heard calling the normal "boo-book" call, regular calls being given every three to four seconds.

One bird then commenced calling much more rapidly with increasing tempo until at last the first syllable of the call was completely suppressed and only the final "book" was being given. For the first five minutes of the call I counted the "books"—450. The call then continued for about another five minutes, so altogether something like a thousand "books" must have been given during the time it lasted. Calling then ceased and all birds were silent.

It is worthy of note also that although the night was extremely dark Western Magpies (*Gymnorhina dorsalis*) were heard calling full carols at the time when the Owls started. At this time of the year moonlight songs might be expected (Robinson, *Emu*, 56 : 282) but calling in complete darkness seems unusual. Possibly the birds were disturbed when my Land Rover drove up.

—ERIC LINDGREN, Shenton Park.

Possible Record of a Yellow-billed Spoonbill near Narrikup.—In addition to the recent records of the Yellow-billed Spoonbill *(Platalea flavipes)* in the South-West *(W.A. Nat.*, 6 : 151, 196) is an observation on November 2, 1958 of what appears to be this species at a lake about 4 miles west of Narrikup, locally known as Lake Erie.

The lake is some 40-50 acres in area and is surrounded almost completely by a border of twig rush *(Cladium* sp.). At the time the birds were recorded there was shallow water outside the rushes, covering a firm surface of fodder and small water plants. This is mentioned because in the field I misidentified the birds as Royal Spoonbills *(P. leucorodia)* recording in my notebook that they had a yellow bill and black legs. Checking through Serventy and Whittell, *The Handbook of the Birds of W.A.*, I found that the Royal Spoonbill had black bill and legs and the Yellow-billed species yellow legs and bill. It seemed possible that the bird's legs might have become discoloured by mud, although improbable that they would be completely covered. However the nature of the habitat in which they were feeding precludes this idea.

To check, a week later I asked John Treasure, a young ornithologist who directed my attention to the lake, to send me a note giving the colour of the bird's legs and bill. These agreed with those I had recorded. He also stated that the birds had been present for some months, always being seen around the lake margin.

—ERIC LINDGREN, Shenton Park.

Additional Records of the Gull-billed Tern in Western Australia. —The status of the Gull-billed Tern *(Gelochelidon nilotica)* in Western Australia has been recently reviewed (J. R. Ford, *W.A. Nat.*, 6, 197). Further records are now available, indicating that the species is apparently increasing in abundance throughout the State.

On May 17, 1959, I saw 6 Gull-billed Terns at Jandakot Lake, about 15 miles south of Perth. Most of the birds were in full eclipse-plumage, the black on the head being confined to the lores and a small area around the eyes. The remainder had, in addition, a few blackish feathers on the crown. Excepting the ends of the primaries, which were a dark grey, and the small amount of black on the head, the plumage was apparently white, and the legs and heavy gull-like bill were black.

With the view of obtaining additional records of the species, Jandakot Lake was revisited on May 23, 1959, May 24, June 21, June 28 and February 7, 1960, when 4, 1, 30, 8 and 2 eclipse-plumaged birds, respectively, were noted. During these visits Marsh Terns *(Chlidonias hybrida)* were observed in flocks up to about 150.

The Gull-billed Tern's method of feeding is interesting and readily assists with its identification when the birds are some distance away when it is difficult to note accurately details of the plumage. From a height of 20 to 30 feet, with tail fanned, wings outstretched and occasional flapping, they glide swiftly down to the surface of the water. The head is then quickly tilted downwards so that the bill is nearly vertical and only the tip touches the water. Then, having seized the prey, the terns gain height rapidly and recommence their slow hawk-like flight around the lake. On no occasion have I observed a tern diving into or settling on the water.

Whilst at Roebourne, in the North-West, in October 1959, I saw 3 eclipse-plumaged birds along the Harding River.

—JULIAN FORD, Attadale.

Bristle-bird, ***Dasyornis brachypterus,*** **at Two People Bay.—** On January 1, 1961, shortly after 0600 hours, whilst observing on the access track to Two People Bay, in the vicinity of Lake Gardner, I was attracted by a single, loud, clear, short, but not unmusical note which I set down as "Beep." This was repeated at irregular intervals from positions on or very close to the ground. After watching for a few minutes, I obtained two brief views of a brown bird with semi-erect wedge-shaped tail.

I then brought my son, Lindsay, from our camp nearby and within a short time we both obtained views of a bird. My own view was particularly satisfactory as the bird was in a very favourable light, and, apparently attracted by my calling, remained in view for perhaps fifteen seconds. My general impression was as before, but I noted, through binoculars, the rich brown, almost chestnut tone of the wings with two or three quills appearing nearly black. Feathers of the nape and mantle appeared light-centred. The bill was dark. I was by that time almost certain that the bird was a Bristle-bird (I had previously encountered the species in Victoria) and looked carefully for the "bristles" surrounding the bill, but these were not discernible.

During these observations, other calls were heard, i.e. (a) a feeding (?) call comprising a muted note oft-repeated, (b) a six syllable call, which I set down as "Ests-per-per (pause) wid-der dit." L.E.S. noting calls at the same time recorded four variants of this call, adding the remarks: "First note, and odd single note, slightly liquid. Sharp, clear tone. Pitch, about that of Spotted Pardalote." His musical notation was as follows:

The habitat of the birds encountered comprised *Agonis* (6-10 ft. high) and *Melaleuca* with *Juncus*, *Ghania* and low shrubs. The area had suffered fire damage at some previous time, but recovery, as indicated by the size of the *Agonis* regrowth, was fairly well advanced. Similar habitat extended over a fairly large area, but was scattered, making the area difficult to assess. A drainage channel traversed the area and the whole was low-lying.

During the morning we examined the area between the track and Lake Gardner, encountering Emu-wrens and Brown Quail in several places. Calls of Bristle-birds extended the observed habitat to an area of c. 180 yards long and c. 80 yards wide, but this was not necessarily comprehensive as similar habitat occurred on the other side of the drainage channel and elsewhere.

—ERIC H. SEDGWICK, Collie.

Varanus semiremex **in Western Australia.**—The monitor lizard *Varanus semiremex* is but rarely represented in scientific collections and I have never seen a specimen from Western Australia though Glauert (1951: 16) has cited this species as living there. Therefore I reported in my study on the monitor lizards of Australia (1958: 238) that *Varanus semiremex* has never been found outside of Queensland.

To my great surprise I found a fine specimen of *Varanus semiremex* in a collection of reptiles made by Dr. Klaus Immelmann during his journey in the Kimberleys in Western Australia. This specimen (SMF 57 138) had been caught near Ivanhoe at the Ord River on November 23, 1959. It agrees completely with typical *Varanus semiremex* of Queensland except with regard to its relatively longer tail. The tip of the tail being damaged, the tail is nevertheless 1.78 times as long as the head and body (instead of 1.34-1.60 in specimens from Queensland). The proportion of the distances between the nares and tip of snout and the nares and the eye is 1 : 1.3 (in specimen SMF 53 259 from Woodstock, Queensland, the ratio is 1 : 1.34). There are no well differentiated supraoculars, 51 scutes from left to right angle of mouth counted around the head, 103 scutes around the body, and 84 transverse rows of ventral shields. The ground colour of the upper side is a dark grey with many light grey dots, some of them ocellated with black. The dorsal face of the head shows no pattern except a light dot in the pineal area, the temporal region shows a light longitudinal band. The upper side of the legs is dotted lightly, the dorsal face of the tail unicoloured black. The ventral side of this specimen is whitish with grey cross-bars, these being more distinct in the anterior part of the body. Compared with SMF 53 259 which has no light dorsal dots, the Western Australian specimen seems to retain a more juvenile pattern.

Measurements: head and body, 235 mm.; tail, 420 + ? mm.; fore-leg, 56 mm.; hind-leg, 77 mm.; length of head, 43.2 mm.; breadth of head, 22.5 mm.; height of head, 19.3 mm.; snout, 19.2 mm.; distance nares - tip of snout 7.3 mm.; distance nares - anterior border of eye, 9.5 mm.

With the discovery of *Varanus semiremex* there are now six species of monitor lizards known from the Kimberleys. It can be expected that the area of its distribution covers the northern part of the Northern Territory, too.

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—ROBERT MERTENS, Senckenberg Natural History Museum, Frankfurt, a. M.

Display in the Musk Duck.—The following observations were made on a male Musk Duck *(Biziura lobata)* at one of the Perry's Lakes near Reabold Hill on August 28, 1960.

The bird had two distinctive calls, one a hissing whistle and the other a metallic "plonk." Accompanying the calls were distinctive movements of the head, wings and tail which, owing to their being employed in a different sequence for the different calls, can be used to anticipate which call the bird is going to give. The normal "rest" position of the bird appeared to be with the head back over the body, the lobe just touching the surface of the water and the tail at an angle of approximately 30° to the horizontal. When swimming around while feeding, or when disturbed, the body was almost completely submerged and the tail was flattened out on the water.

Upon my uttering a whistle similar to the "hissing whistle" the bird disengaged from its feeding activities and started up a display of "hissing" and "plonking."

When preparing to whistle the bird stretches out its neck, the beak of the bird being at an angle of approximately 45° and lobe touching the water, and raises the fanned out tail over the back until it is almost in a horizontal position. The bird then flaps its wings and shoots out a spray of water on both sides of the body. The tail is then flattened down on to the back and, simultaneously, the whistle is given, the beak opening only slightly. The bird then relaxes and assumes the rest position before continuing the performance. The bird continually moves around while whistling and no two successive calls are uttered in the same direction. When the bird is reasonably close the sound of the water shot out from the wings can be heard immediately preceding the whistle.

The preliminary antics for the metallic plonk are the same as for the whistle, with the bird stretching out its neck, the lobe touching the water and the beak angled at 45°. Procedure from this position may follow one of two patterns: (a) With the tail at approximately 45° the bird flaps its wings as before. The tail is then jerked to a near vertical position and the plonk simultaneously uttered. Sometimes the tail is carried through past the vertical and angled over the back. (b) The tail is raised to a near vertical position. The wings are then flapped and, following this action, the tail is brought sharply up over the back and at the same time the call is emitted. The splash of the water is not so easily distinguished from the bird's call as in the whistle.

The bird when feeding adopted the submerged position but at times allowed the tail to rise up to an angle of approximately 10°. Preceding each dive the tail, regardless of whether it was flat or angled, was quickly raised a few inches and then lowered to its original position. The time that the bird stayed under water while feeding appeared to be rather constant and in the vicinity of 25 seconds. When surfacing the bird noticeably pauses with its head and neck above the water and its body completely submerged before it comes up to the submerged position.

The Musk Duck under observation was warned off by one of a pair of Black Swans with 5 cygnets but neither of the birds appeared unduly worried by the other.

—R. H. STRANGER, Wembley.

CORRECTIONS

In the paper on the Red-eared Firetail by Klaus Immelmann (*W.A. Nat.*, no. 6) the following corrections are necessary:

P. 143, line 11: insert "not" between "also" and "possess."

P. 150: line 10 from bottom: insert "or song" between "any call" and "during."

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SOME ABORIGINAL SITES IN THE MURCHISON DISTRICT OF WESTERN AUSTRALIA

By S. J. J. F. DAVIES

INTRODUCTION

In the course of bird investigations on behalf of the C.S.I.R.O. from 1959 to 1961 the writer visited a number of aboriginal sites in the Murchison district of Western Australia. The Anthropological Society of Western Australia, in a report on Aboriginal Sites issued in 1960, mentions some sites from the area, but the seven reported here appear to be unrecorded. This article locates and briefly describes these sites, and is complemented by a fully illustrated ms. deposited in the Western Australian Museum, containing all available photographs.

The place names used are from the Western Australian Lands and Surveys Department ten miles to the inch maps of the relevant areas, supplemented by names currently used by local inhabitants. The grid reference given after each site may be read from both Army series and Lands Department maps.

THE SITES

Anketell North Breakaways (180530)

Anketell Station is immediately east of the No. 1 Vermin Proof fence on the Mt. Magnet-Sandstone road. The site, the southern crest of a breakaway, can most easily be located by turning north at the cattle grid on the Mt. Magnet-Sandstone road, where it cuts the vermin fence, and following this fence north about ten miles, until it emerges from the mulga scrub onto a saltbush flat, with a north-south breakaway scarp to the east. The scarp turns east at this point and the site is about a mile east from the fence on the top of the southern, east-west scarp. Two gnamma holes, about 100 yards apart, are associated with stone arrangements, but it is possible that other such holes occur elsewhere along the edge of the scarp. The stones (Fig. 1) are in walls similar to those described from Canna by Serventy and White (1958), and the arrangements are still in good order. A sketch map of these has been placed in the museum, together with photographs. I am grateful to Mr. Paddy Hinds of Anketell Station for showing me the site.

Yarrameedie Gallery (523751)

Yarrameedie gallery is a rocky granite hill beside the Cue-Berringarra road, at the north end of Mileura Station. The road runs through a pass in the Yarrameedie Range about three miles north of Poonthoon Pool on Whela (Bindebarn) Creek. Where the road enters the range it turns sharply west for about half a mile

Fig. 1. Portion of the Anketell rock arrangements, looking south towards the edge of the breakaway

Fig. 2.—The cross-shaped figure at Yarrameedie Gallery; note also the emu track and cartwheel-like figure at the lower right

before continuing north, and passes between a long hill to the south and the main range to the north. The whole of the southern hill is covered with rock carvings, mostly in outline, but some solid figures. The designs are remarkably varied. Emu and kangaroo tracks mingle with horseshoe and cartwheel-like designs (Fig. 2), simple circles and groups of concentric circles, complete and incomplete. The three most striking are a pair of goannas, a large cross-shaped figure, some four feet by eight feet (Fig. 2), and a lengthy symbolic mural about ten feet long. The carvings appear to be of great age, since some are buried at least six inches in soil washed from the hill, and no indication of their meaning can be obtained from local aborigines.

Yarrameedie gallery is certainly the most extensive and varied of the pictorial sites visited in the district, and possibly ranks as the one most worthy of detailed study.

Ngumartna Rock Hole (535721)

The rock hole lies in Ejah breakaways on Mileura Station, just north of the Mileura-Nookawarra road and close to the boundary between the two stations. It is in a small valley in the northern face of a breakaway, about half a mile south-west of a prominent and aptly named breakaway relict, Windsor Castle. Both carvings and paintings occur in two rock shelters on either side of the rock hole. The paintings are all hands, stencilled in red ochre, but the carvings are more varied. As well as emu tracks there are extensive areas of outline, dotted with small holes, and considered by the present aborigines to represent a map of the area, showing the

Fig. 3.— A series of concentric semi-circles at Ngumartna

rock holes (information from Miss Julitha Walsh). There are also a number of symbolic figures and an excellent set of concentric half-circles (Fig. 3) possibly representing the rock hole itself. The carvings are subject to considerable wear by the local euro population, but are still very clear. A few other stencilled hands have been found by Mr. Eric Lindgren on the southern face of the same breakaway.

Tching Rock Holes (500700)

The Tching rock holes, on a westward facing granite in the Tching Range, Nookawarra Station, are well-known to pastoralists of the area. They are some seven miles north of the south boundary of the station and two miles north-east of Nookawarra's number six mill. Large numbers of carvings have been executed along the base of the granite both north and south of the rock holes, but particularly immediately south of the largest hole system. Although there are some concentric and symbolic designs, most of the carvings are of animal tracks, emu, kangaroo and human; some are very neatly made and in a good state of preservation.

Tching Rock Paintings (503690)

The site may be that referred to by Davidson (1952) and quoted in Appendix D: pictographic 23, in the Anthropological Society's report. The paintings, two stencilled hands, a stencilled boomerang and an elaborate, and earlier, outline drawing in red ochre, have been made on the roof of a granite rock shelter at the base of the west side of a granite hill half a mile north of the Nookawarra-Boolardy boundary and three miles east of Tching mill. The shelter is merely a large slab of granite, some 25 feet long, supported at one end by a large granite boulder. No other sites were found on this hill, but it is probable that others occur in the Tching Ranges.

Mellayalba Rock Holes and Breakaways (550650)

The Weld Range, on the Glen Station, 36 miles north-west of Cue contains the famous ochre mine of Wilgi-Mia. West of the range, along the boundaries of Madoonga, Glen and Noondie Stations the country is broken up by numerous breakaways, the overhangs of many of which are decorated with stencilled hands. The Mellayalba rock holes are on the Glen-Noondie boundary, north of the claypans where bulli-bulli grows, a chenopod the seeds of which the aborigines used to collect and grind to flour. The claypans are themselves about two miles north of the Glen-Kalli road, and the whole area is well known to local pastoralists. In the breakaways north of Mellayalba and also on the boundary fence, there are stencilled hands, a few symbolic paintings in red ochre and an extensive workshop site, where many worked flakes and cores lie on the talus immediately below the breakaway. Some of the hands are large and others small, apparently the hands of children; many are still well preserved. I am grateful to Mr. Leslie (Finn) Ryan of the Glen Station for showing me these sites.

Cheangwa Hill (440540)

The granite dome of Cheangwa is a conspicuous landmark on Murgoo Station, via Yalgoo, some ten miles south of the homestead. The road no longer runs past the hill, as shown on the Lands Department ten miles to the inch map, but four miles to the west of it. However, the hill can still be seen from the road. About ten yards east-south-east of the summit cairn is a small series of rock carvings, interesting because they appear to be very weathered and old, and because several of them are horseshoe figures exactly comparable to those of Yarrameedie gallery. Another, a symbolic outline, is too weathered to be readily recorded. The carvings are unknown to the station people.

CONCLUSION

Many more sites undoubtedly remain to be found and described, but it is hoped that the few reported here will show the variety of well-preserved examples of aboriginal art that typify the area. Little mention has been made of artefacts, but grinding stones and chipped tools of various sizes are commonly associated with the major sites, and often found elsewhere, for example around waterholes, and would be a rewarding field of study.

I am particularly grateful to Miss Julitha Walsh for her help in compiling this record, both in the field and in subsequent discussion, and to Messrs. Timothy Scott, Eric Lindgren and Neil MacLaughlan for their company and help in some of the field work.

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A CENSUS OF AQUATIC PLANTS OF WESTERN AUSTRALIA

By G. G. SMITH, Botany Department, University of Western Australia, and N. G. MARCHANT, State Herbarium, Western Australia.

The aquatic vascular plants of Western Australia have received little attention from collectors and taxonomists since the publication of Bentham's *Flora Australiensis*. Apart from the work of Ostenfeld (1916) on the western sea-grasses, they have not been surveyed as an ecological grouping. Distribution records of western aquatics given in *Flora Australiensis* are fragmentary and there are few other published records of their distribution. This census is an attempt to record the present state of knowledge of occurrence and distribution of aquatics in Western Australia. It will be apparent from this census that much more field work is needed before any accurate distribution pattern can be determined for most species.

In working on this ecological grouping of plants the authors realize the difficulties of limitation of the concept of an aquatic plant. Muenscher (1944) defined an aquatic as ". . . those species which normally start in water and must grow for at least a part of their life cycle in water, either completely submersed or emersed." Muenscher points out that this concept is subject to various interpretations, particularly in practice. As much as the authors agree with Muenscher's concept they cannot claim to be familiar with the life-histories of all Western Australian plants likely to come into the aquatic category. Therefore, apart from the obvious aquatics, it has been difficult to decide on inclusion or exclusion of the border-line species, but some marsh plants which are known to withstand long seasonal inundations are included. The algae of the Order Charales (stoneworts) are included as they are macroscopic plants commonly encountered in fresh waters by collectors of aquatics. A few exotic species with a single known record of naturalisation are included (e.g. *Salvinia* and *Nymphaea*) as it is likely that these species will spread through the countryside.

The localities given here for each species are those of specimens deposited either in the State Herbarium of the Department of Agriculture of Western Australia or in the Herbarium of the Botany Department of the University of Western Australia. Localities taken from literature are followed by the collector's name.

The authors wish to thank fellow members of the Fresh Water Group of the W.A. Naturalists' Club for their enthusiastic collecting of aquatic specimens. Indeed, the need for this census became apparent through the limnological activities of this group. Messrs. J. O. Knight, B. Parkes and Miss K. Vollprecht, in particular, made substantial collections of aquatics from the south-west of the State.

CHARALES

Chara australis R.Br.

= *Protochara australis* Woms. and Ophel

Distribution. Asia; New Zealand; Australia: W.A., Mingenew, Moora, Bibra Lake.

Chara contraria A.Br. ex Kuetzing

Cosmopolitan: Groves and Allen (1935) recorded it for Western Australia, but no locality was given.

Chara fragilis Desvaux

= *C. globularis* Thuill.

Cosmopolitan: W.A., Butler's Swamp, North Beach.

Chara gymnopitys A.Br.

= *C. fibrosa*, fide Zaneveld

Africa; Asia; Australia: W.A., Darlington.

Chara leptopitys A.Br. subsp. *sub-bracteata* Nordst.

Australia: W.A., Stirling Range (Nordstedt, 1891), Swan River district (Nordstedt, 1891), Cannington.

Chara preissii A.Br.

= *C. dichopitys* var. *preissii* A.Br.

= *C. ecklonii* A.Br. ex Kuetz.

Western Australia, Jandakot Swamp. Groves and Allen (1935) recorded this species from Western Australia but no locality was given.

Lamprothamnium macropogon (A.Br.) Ophel

= *Chara macropogon* A.Br.

Southern Australia: Common in seasonally saline pools and lakes throughout the South-West of Western Australia. Saline lakes near Perth, Rottnest Island, Narrogin, Dumbleyung, Wagin, Mandurah. Often much encrusted with sediments and salt crystals by the end of the growing season.

Nitella congesta (R.Br.) A.Br.

= *Chara congesta* R.Br.

Australia and New Zealand: W.A., Lake Leeuwin (Nordstedt, 1891).

Nitella gloeostachys A.Br.

Throughout Australia: W.A., Shark Lake near Esperance, Jandakot Lake.

Nitella subtilissima A.Br.

Western Australia, Swan River district (Nordstedt, 1891), Parkeyerring Lake, Wagin.

R. D. Wood of the University of Rhode Island, recently visited southern Australia and collected Charales intensively in all States, including the South-West of Western Australia. When these collections are worked up it is anticipated that our knowledge of the taxonomy and distribution of our stoneworts will be greatly enlarged.

PARKERIACEAE

Ceratopteris thalictroides Brongn.

Widely distributed in tropical regions. Northern Australia: W.A., Walcott Inlet, MacNamara Creek, Woollybutt Creek and Glenelg River in the Kimberleys (Fitzgerald, 1918). Sale, Glenelg and Calder Rivers, Bachsten Creek, in the Kimberleys (Gardner, 1923). Millstream on the Fortescue River. Plants free-floating or anchored in mud.

SALVINIACEAE

Azolla filiculoides Lam. var. *rubra* Diels
= *Azolla rubra* R.Br.

The type is cosmopolitan: Our form occurs throughout Australia and New Zealand. Common in still waters of swamps and creeks of the coastal plain of Western Australia, Welshpool, Bayswater, and Yanchep.

Salvinia auriculata Aublet.

Central and South America: A common ornamental of garden ponds in Western Australia. There have been two instances of its escape and naturalisation at Welshpool (now eradicated) and at Harvey where it is flourishing in a swamp. The Harvey occurrence was noted by Smith (1960) under the name of *Salvinia rotundifolia*.

MARSILEACEAE

Marsilea angustifolia R.Br.

Northern Australia: W.A., bases of Mounts House, Clifton and Brennan in the Kimberleys. In wet spots chiefly around billabongs (Fitzgerald, 1918). Billabongs near the Isdell River (Gardner, 1923).

Marsilea drummondii A.Br. — Nardoo
= *M. muelleri* A.Br.

Throughout Australia, except Tasmania: More common in arid parts of Australia where the fruits or "Nardoos" are collected by aborigines for food. Seasonally immersed, becoming stranded and dormant in the dry season. In clay pans, river banks and creeks at Charlotte Waters, Northern Territory; Western Australia, Gascoyne Junction, Cue, Galena, Irwin River, New Norcia, Miling, Mogumber, York, Upper Swan, Tincurrin, Geographe Bay (Oldfield).

Marsilea hirsuta R.Br.

Throughout arid Australia: W.A., Walcott Inlet, Duck Pool, Isdell River and near Mount Marmion (Gardner, 1923). Gogo, Carson River and Meda in the Kimberleys. South Barlee Range, Yalgoo. Chapman Research Station near Geraldton.

Marsilea mutica Mett. — Nardoo
= *M. brownii* A.Br.
= *M. quadrifolia* Benth. not of Linn.

Throughout Australia: Seasonally immersed. W.A., Carson River, West Kimberley (Gardner, 1923). Nookawarra Station and Glenorn in the North-West. In clay pans at Mingenew, Waroona, Coolup.

Pilularia novae-hollandiae A.Br. — Pill-wort
= *P. globulifera* Benth. not of Linn.

Southern Australia and New Zealand: W.A., in depressions of pasture land flooded in winter at Boyanup and Harvey. Semi-aquatic or marsh plant. Rare.

ISOETACEAE

Isoetes drummondii A.Br. — Quillwort

Temperate Australia. In marshy soils of creek banks, swamps and clay pans. W.A., Mullewa, Mingenew, Cannington, Harvey, Tincurrin, Toodyay.

TYPHACEAE

Typha angustifolia Linn. — Bulrush, Yanget

N. America; Europe; Asia; through Australia: W.A., abundant in inter-dunal swamps of the Swan coastal plain. Also in marshes and stagnant water inland. Calder River near Walcott Inlet, Port Warrender, Admiralty Gulf and Lawley River in the Kimberleys (Gardner, 1923). Rawlinson Range (E. Giles), bases of Mounts Brennan, Synott and Edkins Ranges (Fitzgerald, 1916), Carnarvon, Murchison River, Yanchep, Perth.

POTAMOGETONACEAE

Cymodocea angustata Ostf.

Marine. Ostenfeld (1916) described this species from drift material collected at Carnarvon, W.A. A few specimens have been collected from drift at Fremantle and Flinders Bay, but there is no record of this species *in situ*. Specimens in State Herbarium, W.A. and Botany Herbarium, University of W.A.

Cymodocea antarctica (Labill.) Endl. — Sea Nymph

Marine. South-western and southern coasts of Australia: W.A., abundant in the sandy and muddy sub-littoral where it often occurs in dense stands. Carnarvon and Sharks Bay (Ostenfeld, 1916), Abrolhos Islands, Fremantle, Rottnest Island, Safety Bay, Bunbury, Busselton, Yallingup, Albany, Esperance.

Cymodocea griffithii J. M. Black

= *Cymodocea antarctica* var. *griffithii*

= *Pectinella griffithii* J. M. Black

Marine. Shallow sub-littoral as for *C. antarctica*. South Australia. Common in Western Australia, Dongara, Cottesloe, Safety Bay, Rottnest Island, Flinders Bay. Black (1915) distinguished this species from *C. antarctica* by the longer, straight and narrower leaves, the much larger leaf sheath and the female flowers without bracteoles. In our specimens the "comb-anchors" of *C. griffithii* are always much more slender than those of *C. antarctica*, the comb lobes of the former not exceeding 6 mm. while those of the latter are mostly about 10 mm.

Cymodocea isoetifolia Aschers.

Marine. Red Sea eastwards to Oceania: Edgecombe Bay in Queensland (Ostenfeld, 1916). Not known *in situ* in W.A. but common in drift, Carnarvon, Geraldton, Dongara, Fremantle, Safety Bay.

Diplanthera uninervis (Forsk.) Aschers.

Marine. Tropical coasts of the Indo-Pacific region. Red Sea to Oceania. Ostenfeld (1916) collected drift specimens at Carnarvon, Western Australia. There are no records of it *in situ* in W.A.

Lepilaena australis J. Drumm. Austral Water Mat
= *Althenia australis* (J. Drumm.) Aschers.

Southern Australia: W.A., common in brackish pools of rivers, brackish swamps and clay pans of the South-West. Hutt River (Oldfield), Mingenew, Moora, Wagin, Rottnest Island, Avon River at Toodyay.

Lepilaena preissii (Lehm.) F. Muell. Slender Water Mat
= *Althenia preissii* (Lehm.) Graebn. and including *L. cylindrocarpa* (Koern.) Benth.

Southern Australia. In fresh to brackish water of swamps and rivers throughout the North-West and South West of W.A., Rottnest Island, Canning River (Preiss), Kelmscott, Dale River at Beverley, North Stirling Range (F. Muell.), Cape Riche.

Posidonia australis Hook.f. Fibre-ball Weed or Sea Grass

Marine. Southern Australia: W.A., in shallow sandy or muddy sub-littoral, usually in dense stands, Sharks Bay, Geraldton (Ostenfeld, 1916), Dongara, Fremantle, Garden Island, Rottnest Island, Yallingup, Cape Leeuwin, King George's Sound, Esperance.

The fibre "sea balls" of winter drift are formed by aggregation of wood fibres released from the dead leaves and stems of *Posidonia*.

Potamogeton drummondii Benth. Drummond's Pond Weed

Western Australia: In fresh water lakes and rivers, Lake Leschenault, Hill River, Shark Lake near Esperance.

Potamogeton javanicus Hassk.

Africa; Madagascar; Asia; Northern Australia: W.A., MacNamara Creek and Mount House Station in the Kimberleys. Isdell, Charnley, Calder and Hann Rivers in the Kimberleys (Fitzgerald, 1918), Marble Bar.

Potamogeton ochreatus Raoul Blunt Pondweed
= *P. obtusifolius* Mert. et Koch
= *P. obtusifolius* of F. Muell.

Throughout Australia: W.A., common in rivers and creeks of the South-West, Hill River, Gingin, Canning River, Herdsman's Lake, Wellard, Harvey, Balingup, Busselton, Manjimup.

Potamogeton pectinatus Linn. Fennel Pondweed

Temperate regions of the world. Southern Australia: W.A., common in rivers and swamps of the South-West, in both fresh and brackish waters; Greenough River, Avon River at Toodyay, Guildford, coastal swamps about Perth, Vasse River.

Potamogeton tricarinatus F.Muell et A.Benn.
Floating Pondweed

= *P. natans* R.Br., partly; not of Linn.

Southern Australia: W.A., in rivers and fresh-water lakes, Barradale Crossing, Gaseoyne River, Murehison River (Oldfield), Hill River, Caversham, Wellard, Narrogin, Busselton.

Ruppia maritima Linn.

Almost eosmopolitan. Throughout Australia: W.A., eommon and widely spread in fresh to braekish river pools and lakes, saline swamps and river estuaries. This speeies withstands the wide seasonal fluetuations of salinity eharaeteristie of many of our river and lake systems. Murehison River (Oldfield), Hutt River, Coorow, Goomalling, Perth, Guildford, Rottnest Island, Roekingham, Mandurah, Arthur River, Wagin, Lake Muir, Dumbleyung.

Zostera muelleri Irmisch — Grass Wrack

Marine. Temperate eoasts of Australia: W.A., in shallow sublittoral on sandy and muddy substrata. Rarely in large stands as some other sea grasses oceur; Dongara, estuaries of Swan and Murray Rivers, Garden Island, Rottnest Island, Oyster Harbour at Albany.

NAJADACEAE

Najas major All. — Water Nymph

= *N. marina* Linn.

Cosmopolitan: W.A., eommon in rivers and swamps of the North-West and South-West, Roebourne, Millstream on Forteseue River, Wilga Mia Pool, Murehison River Bridge, Greenough River, Gwellup Lake, Perry's Lake near Perth.

Najas tenuifolia R.Br.

Throughout Australia: W.A., Kimberley and North-West Divisions, King Leopold Range, Carlton Hill, Mount Marmion, Lennard, Isdell, Charnley and Calder Rivers in the Kimberleys (Fitzgerald, 1918), Millstream and Deep Dale Stations in the North-West.

APONOGETONACEAE

Aponogeton elongatus F.Muell.

Northern Australia: northern New South Wales: W.A., Isdell, and Charnley Rivers, bases of Artesian, Synnott, Isdell and Edkins Ranges, and of Mount Rason in the Kimberleys (Fitzgerald, 1918), Merry's Creek on the Upper Glenelg River in the Kimberleys.

SCHEUCHZERIACEAE

Triglochin procera R.Br. — Water Ribbons

= *Cycnogeton procerum* (R.Br.) Buehen

Throughout Australia: Common in both stagnant and running waters of swamps, ereeks and rivers of the South-West of Western Australia. Foliage varies considerably, ranging from short stout leaves when emersed under marsh eonditions to narrow ribbonlike leaves up to five feet in length when growing in swiftly flowing streams. W.A., Moore River, Gingin, Cannington, Mundaring, Kojonup, Dumbleyung, Balingup, Pemberton, Scott River, Albany.

Triglochin pterocarpa W.V.Fitzg.

W.A., Isdell and Charnley Rivers, Kimberleys (Fitzgerald, 1918). This species was described by Fitzgerald from the above collection.

Triglochin striata Ruiz et Pav. Streaked Arrow-Grass

North and South America; South Africa; Australia and New Zealand; A common marsh plant withstanding several months shallow submersion in fresh and saline lakes. W.A., Herdsman's Lake, saline lakes near Rockingham and Mandurah, Cape Leeuwin, Warriup, East Mount Barren.

ALISMACEAE

Alisma oligococcum F.Muell.

Ceylon and East India; Northern Australia: W.A., Meda and Mount Marmion in the Kimberleys, King Sound District (Froggatt), Lennard and Barker Rivers in the Kimberleys (Fitzgerald, 1918).

Damasonium minus (R.Br.) Buchen Star Fruit
= *Damasonium australe* Salisb.

Marshy places throughout Australia: A semi-aquatic or marsh plant. W.A., Mingenew, Hamersley River.

HYDROCHARITACEAE

Halophila ovalis (R.Br.) Hook.f.

Marine. Indian and Pacific Oceans: Shallow sub-littoral along the coasts of Australia from Western Australia to Tasmania and Queensland. Groote Eylandt, Northern Territory: W.A., on sandy and muddy substrata. Geraldton (Ostenfeld, 1916), abundant in estuaries of the Swan and Murray Rivers, Fremantle, Safety Bay, Yallingup.

Halophila spinulosa (R.Br.) Aschers.

Marine. Queensland; Philippines; Java; W.A., Ostenfeld (1916) collected many drift specimens at Carnarvon which strongly suggests its occurrence on our coast. However, it has not been recorded *in situ* for W.A.

Hydrilla verticillata (Linn.) Casp. Water Thyme

Asia; India; Africa; throughout Australia: Not previously recorded for Western Australia but now known to be seasonally abundant in the Canning River at Cannington and in a swamp at Rottnest Island. These two occurrences may be naturalisations of plants escaped from garden ponds in Perth where *Hydrilla* is grown by aquarium enthusiasts.

Maidenia rubra (W.V.Fitzgerald) Rendle

A single collection by Fitzgerald from King River, Kimberleys, Western Australia. Holotype in State Herbarium, W.A.

Ottelia ovalifolia (R.Br.) L.C.Rich. Swamp Lily

Throughout Australia except Tasmania: In shallow ponds, swamps, creeks and river pools of the South-West of Western Australia. Mingenew, Canning River, Safety Bay, Armadale, Brunswick, Boyanup, Harvey, Torbay.

Juvenile plants superficially resemble *Vallisneria spiralis* before the floating lamina develop, but they may be distinguished from *Vallisneria* by the colour and thickness of the leaf.

Vallisneria spiralis Linn.

Cosmopolitan in the tropics and sub-tropics. Throughout Australia except the South-West of Western Australia, but introduced and naturalised at Araluen near Perth. W.A., May, Meda, Lennard, Fitzroy and Isdell Rivers in the Kimberleys (Fitzgerald, 1918), Kimberley Research Station, Marble Bar, Mount Marmion, Barradale Crossing.

CYPERACEAE

Scirpus fluitans Linn.

Throughout Australia. Common in swamps of the South-West of Western Australia. Marradong, Capel, Busselton, Donnybrook.

LEMNACEAE

Lemna gibba Linn. Gibbon's Duckweed

Cosmopolitan except the tropics: Recorded by Bentham (1863) for Western Australia as collected by Drummond and Oldfield. No other record.

Lemna minor Linn. Duckweed

Cosmopolitan except polar regions and the tropics: Eastern Australia; W.A., common in stagnant waters of swamps, drainage channels, creeks and rivers in the South-West, Yanchep, Cannington, Guildford and Vasse River.

Lemna trisulca Linn. Ivy Duckweed

Almost cosmopolitan; throughout Australia: W.A., Ord and Denham Rivers; Parry's Creek, Kimberley (Fitzgerald, 1918). Not known from the South-West of Western Australia, despite the occurrence of this species in other southern States.

Spirodela oligorrhiza (Kurz) Hegelm. Duckweed
= *Lemna oligorrhiza* Kurz

Tropical Asia and America; throughout Australia; W.A., common in stagnant waters of swamps, rivers and creeks in the South-West. Usually associated with *Lemna minor* and *Azolla filiculoides*. Yanchep, Lake Monger, Cannington, Vasse River.

ERIOCAULACEAE

Eriocaulon setaceum Linn.

E. India and Malayan Archipelago; northern Australia; W.A., Woodhouse River (J. Bradshaw and Allen), Woollybutt Creek, base of Mount Rason, Artesian and Edkins Ranges, Isdell, Charnley and Calder Rivers, Kimberleys (Fitzgerald, 1918).

PONTEDERIACEAE

Eichhornia crassipes (Mart.) Solms — Water Hyacinth

Central and South America; naturalised in many warmer parts of the world including South Africa; Australia; New Zealand and Florida; W.A., Wanneroo, Monger's Lake, Dog Swamp, Manning Park. An escape from local garden ponds.

Monochoria cyanea F. Muell.

Northern Australia: W.A., Mount Marmion on Lennard River, West Kimberley, King Sound District (Froggatt). In billabongs along the side of Lennard, Fitzroy, Barker, Isdell and Adcock Rivers, bases of Mounts House and Clifton; Kimberleys (Fitzgerald, 1918).

CERATOPHYLLACEAE

Ceratophyllum demersum Linn. — Hornwort

Eastern Australia and much of the Old World. W.A., a single collection from Moore River.

NYMPHACEAE

Nymphaea gigantea Hook.

Northern Australia and New Guinea (Conard, 1905): W.A., Brooking Station on Fitzroy River, Gogo, Lower Prince Regent River, Lennard and Charnley Rivers northwards to King Edward and Drysdale Rivers, in billabongs or fringing the still pools of the larger rivers of the Kimberleys (Gardner, 1923), Millstream on the Fortescue River.

Two naturalisations of garden escapes of exotic Nymphaeas are known in the Vasse and Margaret Rivers in the South-West. Flowering material of these occurrences has not yet been collected.

CRUCIFERAE

Nasturtium officinale R.Br. — Water Cress

Temperate parts of the world. Introduced into many parts of the world from Europe: W.A., in creeks and drainage channels near habitation, Gingin, Cannington, Bayswater, Maylands, Brunswick River. Introduced and naturalised.

DROSERACEAE

Aldrovanda vesiculosa Linn.

S. France to Japan, south to Australia and tropical Africa (Lloyd, 1942), Northern Australia: W.A., Upper Isdell River, Kimberleys (Fitzgerald, 1918).

CRASSULACEAE

Crassula natans Thunb.

South Africa and Western Australia: W.A., Armadale (Ostenfeld, 1916), Newcastle (now Toodyay) (Diels and Pritzel, 1904).

Crassula recurva (Hook.f.) Ostenf.
= *Tillaea recurva* Hook.f.

Temperate Australia: A semi-aquatic or marsh plant withstanding seasonal immersion in stagnant waters. Common in ditches and swamps. W.A., Mingenew, Ballidu, Toodyay, Rottnest Island (Preiss), Bayswater, Cannington, Gnangara, Guildford, Mandogalup, Tincurrin, Bunbury, Albany.

CALLITRICHACEAE

Callitriche stagnalis Scop. Water Starwort

Almost cosmopolitan. North America; Europe; Asia; Australia and New Zealand: W.A., common in drainage channels, swamps and stagnant waters of rivers throughout the South-West, Mingenew, Hill River, Canning River, Harvey, Mandurah, Manjimup.

The genus is divided into 4 - 26 species according to the views of different botanists. Mason (1959) revised the species of *Callitriche* in New Zealand and Australia and concluded that the species attributed to *C. verna* Linn. in Australia are *C. stagnalis* Scop.

HALORAGACEAE

Haloragis brownii (Hook.f.) Schindler
= *Meionectes brownii* Hook.f.

Temperate Australia: A semi-aquatic of swamps and river edges. W.A., Guildford, Herdsman's Lake, Mandurah, Cape Leeuwin, Albany.

Myriophyllum amphibium Labill. var. *latifolium* Schindler
Broad-leaved Milfoil.

Southern Australia: Schindler (1905) claims Labillardiere collected this species in South-West Australia. No further records available.

Myriophyllum drummondii Benth.

Bentham (1864) records Oldfield as having collected it at Geographe Bay. Bentham found the species to be close to *M. integrifolium,* possibly a variety of it. No further records.

Myriophyllum integrifolium Hook.f. Small Milfoil

Temperate Australia: A semi-aquatic of creek banks and depressions subjected to seasonal inundations. W.A., Hamersley Range, Guildford, Swan River (Schindler, 1905), Eyre district (Diels and Pritzel).

Myriophyllum muelleri Sond. Slender Milfoil

Southern Australia; Victoria; South Australia; W.A., Bentham (1864) gives its range in W.A. as King George's Sound to the eastward, based on Baxter's collections.

Myriophyllum propinquum A.Cunn. var. *genuinum* Schindler
= *M. variaefolium* Hook.f.

Throughout Australia except the extreme north: W.A., Swan River to King George's Sound (Bentham, 1864), Guildford, Cannington, Kelmscott, Balingup, Bunbury.

Myriophyllum verrucosum Lindl. Red Milfoil

Throughout Australia: W.A., in creeks and marshy ground, Devil's Pass and Mount House in the Kimberleys, Marble Bar, Gascoyne Junction, Murchison River (Oldfield).

UMBELLIFERAE

Hydrocotyle lemnoides Benth.

W.A., (Drummond). "A very small Lemna-like plant, evidently floating in water . . ." Bentham, 3, 1866: 345. No further record.

GENTIANACEAE

Limnanthemum crenatum F. Muell.

Tropical Australia; New South Wales; Victoria and South Australia: W.A., Meda, May, Lennard, Isdell and Charnley Rivers, Bell Creek, Kimberleys (Fitzgerald, 1918), Carlton Hill Station and Lennard River, West Kimberley. Not known from South-West Australia.

Limnanthemum indicum Thwaites.

Northern Australia; Northern New South Wales: W.A., Mount Marmion and Lennard River, West Kimberley, Lennard and Isdell Rivers, Kimberleys (Fitzgerald, 1918).

Limnanthemum minimum F. Muell.

Northern Australia: W.A., Aquatic to semi-aquatic. Lushington Brook, Prince Regent River and Isdell River, West Kimberley, York Sound (A. Cunningham), Isdell River, floating in water (Fitzgerald, 1918).

Villarsia albiflora F. Muell.

South-West of Western Australia: Noble Falls, Toodyay, Gnangara, Cannington, Roleystone, Scott River.

LENTIBULARIACEAE

Utricularia spp. Bladderworts

Two collections of aquatic Utricularias are known from Western Australia. Bentham (1863) records a collection by Preiss of *U. ? flexuosa* from the Avon River. A barren floating specimen from Lake Gnangara is in the Herbarium of the Botany Department of the University of W.A.

The other nine species of *Utricularia* and the two species of the closely allied genus, *Polypompholyx,* recorded for Western Australia are all marsh plants.

COMPOSITAE

Cotula coronopifolia Linn. Water Buttons

South Africa; Temperate South America; Temperate Australia: W.A., common in swamps and creeks of the South-West. Partly submerged, often becoming stranded on mud in summer. W.A., Gingin, Perth, Northam, Cunderdin, Cape Naturaliste, Pemberton, Gardner River, Phillips River.

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HERPETOLOGICAL NAME CHANGES

By ERIC WORRELL, Australian Reptile Park, Gosford, N.S.W.

The following changes in nomenclature are proposed to explain the reason for their use in a handbook on Australian reptiles to be published shortly. I am grateful to Mr. H. Cogger, herpetologist at the Australian Museum, Sydney, and Mr. K. R. Slater, then ecologist at the Australian Reptile Park, Gosford, for their painstaking assistance. Other new genera and species have been described and published elsewhere.

Family CHELONIIDAE

Chelonia japonica (Thunberg)

1787 **Testudo japonica** Thunberg. Kongl. Vetensk. Acad. Handl. Stockholm. 8: 178. Type locality. Japan.

1831 **Chelonia mydas (var.) japonica,** Gray. Synops. Rept., 1 : 53. [This is not **Chelonia mydas** (Linn.): 1758. **Testudo mydas** Linn., Syst. Nat. edn. 10. 1 : 197. Ascension Islands.]

1880 **Chelonia depressa** Garman. Bull. Mus. Comp. Zool., Cambridge, 6: 124. East India and North Australia.

1908 **Natador tessellatus** McCulloch. Rec. Austral. Mus., Sydney, 7: 127. Port Darwin. Northern Territory.

1955 **Chelonia mydas japonica,** Mertens. Zoologische Jahrbucher, 83 (5): 323-440.

There is ample evidence in the cranial characters of *japonica* to warrant specific distinction, at least, from *C. mydas.* The two species are also sympatric in Northern Territory waters. Future investigation may warrant the revival of the genus *Natador.* The specific differences between the questioned species were adequately pointed out by Fry, "On the status of *Chelonia depressa,*" *Rec. Austral. Mus.*, 10 (7), 1913: 159-185.

Family CHELYDIDAE

Chelodina oblonga Gray

1841 **Chelodina oblonga** Gray. In Grey's Trav. Austral., 2: 446. Type locality. Western Australia.

1915 **Chelodina intergularis** Fry. Proc. Roy. Soc. Queensl.. 27: 88. Type locality. Australia.

I have examined the type of *intergularis* in the Australian Museum and have no hesitation in synonymising it with *oblonga.* Fry used the separation of the gulars by the intergular as a diagnostic character. However, the dermal plates have since peeled away revealing that the bone sutures are identical with *oblonga* and that the extension of the intergular is just a slight abnormality. All other characters agree with *oblonga.*

Family SCINCIDAE

Egernia bungana De Vis

1887 **Egernia bungana** De Vis. Proc. Linn. Soc. N.S.W. (2): 37. Type locality. Mt. Tambourine. Qld.

Specific rank is completely justified as *bungana* is sympatric with *Egernia major.* Both species coincide in scale descriptions only. They are completely different in coloration, reproductive rate, and size. No intermediate forms occur.

Tiliqua nigrolutea (Quoy and Gaimard)

1824 **Scincus nigroluteus** Quoy and Gaimard. Voy. Uranie Physic., Zool.: 176. Blue Mountains, N.S.W.

In captivity hybridization has occurred from unions between *nigrolutea* and *scincoides*. This was observed by Longley (1939) and later by me within our own vivariums. The young of these unions are fertile and reproduce. Some workers consider that this evidence is sufficient to relegate *nigrolutea* to subspecific rank. However, I do not agree. Having collected extensively and regularly in areas where the two species are sympatric I have never encountered an intermediate form, which indicates that mating between them does not occur under normal conditions.

Genus LYGOSOMA Gray

Following last reviewers of this genus, Smith (1937) and Loveridge (1948), I have treated as subgenera *Lygosoma, Sphenomorphus* and *Leiolopisma*. In later work, Mitchell (1953) has treated *Leiolopisma* as a full genus and Copland (1946) accords full generic rank to *Hemiergis* without reasonable explanation. While it is conceivable that both workers had a legitimate reason to follow this course I have no option but to follow Smith and Loveridge, until such time as this group is completely revised. Smith considered that *Siaphos* and *Hemiergis* should be absorbed into *Leiolopisma*, which he regarded as a section of *Lygosoma*. Loveridge preferred to refer to these sections as subgenera.

Family BOIDAE

Liasis amethistinus (Schneider)

1801 **Boa amethistinus** Schneider, Hist. Amph., 2: 254 [no type locality].
1933 **Liasis amethistinus kinghorni** Stull, Occ. Pap. Mus. Zool. Univ. Michigan, 227: 3. Type locality, Lake Barrine, Qld.

Loveridge (1948) appeared to doubt the validity of *L. a. kinghorni* which supports my findings on considerable overlap of scale characters and counts between those of New Guinea and Australia.

Morelia spilotes spilotes (Lacépède)

1804 **Coluber spilotus** Lacepede, Ann. Mus. Paris, 4: 191. Type locality, Australia [probably Sydney].

1869 **Morelia spilotes,** Krefft, Snakes of Austral., 29.

Morelia spilotes variegata Gray

1842 **Morelia variegata** Gray, Zool. Miscell., 43. Type locality, Port Essington, N.T.

1893 **Python spilotes** var. **variegata,** Boulenger, Cat. Sn. Brit. Mus., 1: 82.

1955 **Morelia spilotes variegata,** Mitchell, Rec. S. Austral. Mus., 11 (4): 374.

The two forms are regarded as subspecifically distinct due to the limited geographical range of *spilotes spilotes* (central and south coast of N.S.W.) with small populations of intermediate forms in marginal areas. We reject *arges (argus)* Linnaeus, "Africa," 1758, on the same grounds as Boulenger 1893, plus the date and doubtful locality.

Family COLUBRIDAE

Genus DENDRELAPHIS Boulenger = AHAETULLA Gray

In using *Dendrelaphis* Boulenger (1890), I am following advice given by Arthur Loveridge in a letter dated October 21, 1955, to K. Slater. I quote the passage from this communication. "I have just spent 2½ days on *Dendrelaphis,* a name which has to be applied to the Indo-Australian snakes we have been calling *Ahaetulla.* They form an extremely difficult group that may, or may not be subspecifically distinct, and we lack the material necessary to reach a firm decision. A revision of this genus is badly needed."

Stegonotus modestus (Schlegel)

1837 **Lycodon modestus** Schlegel, Phys. Serp., 2: 119. Type locality, Amboina Island and New Guinea.

1893 **Stegonotus modestus,** Boulenger, Cat. Sn. Brit. Mus., 1: 366.

1884 **Herpetophis plumbeus** Macleay, Proc. Linn. Soc. N.S.W., 8: 434. Type locality, Herbert River, Qld.

In synonymising *plumbeus* with *modestus* I am doing so after examining series from New Guinea and Australia and comparing skull and external characters. No differences at all were found. Live specimens were also studied from both localities in which the ecology is similar, and the range extended to the Darwin area.

Boiga irregularis irregularis (Merrem)

1802 **Coluber irregularis** Merrem, Bechstein, Herr de la Cepede's Naturg. Amphib., 4: 239 [no type locality].

1912 **Boiga irregularis,** Barbour, Mem. Mus. Comp. Zool. Harv., 44: 126.

1948 **Boiga irregularis irregularis,** Loveridge, Bull. Mus. Comp. Zool. Harv., 101 (2): 387.

1842 **Dendrophis fusca** Gray, Zool. Miscell., 54. Type locality, Port Essington, N.T.

Australian and New Guinea material cannot be separated on ecological, external or osteological characters. The condition of the palatine teeth previously used to separate *irregularis* and *fusca* is present in all specimens from all localities.

Family ELAPIDAE

Pseudonaja nuchalis nuchalis Günther

1858 **Pseudonaja nuchalis** Gunther, Cat. Sn. Brit. Mus., 227. Type locality, Port Essington, N.T.

1915 **Diemenia carinata** Longman, Mem. Queensl. Mus., 3: 31. Type locality, Charleville, Qld.

1950 **Demansia nuchalis nuchalis,** Glauert, Sn. of Western Australia, 24.

Pseudonaja is separated from *Demansia* on skull characters. An examination of the type of *carinata* revealed that the "keeled" condition described by Longman is not a normal morphological feature but a folding of the ventrals at the rib endings which commonly occurs through shrinkage in alcohol.

Demansia olivacea (Gray)

1842 **Lycodon olivaceus** Gray, Zool. Miscell., 54. Type locality, N.E. Australia.

1858 **Demansia olivacea,** Gunther, Cat. Sn. Brit. Mus., 212.

1877 **Diemenia papuensis** Macleay, Proc. Linn. Soc. N.S.W., 2 : 40. Type locality, S.E. New Guinea.

On skull characters *Demansia olivacea* is specifically distinct from the rest of the genus of which *psammophis* is the type species. Boulenger 1896 confused juvenile *olivacea* with *psammophis* and placed *papuensis* in the synonymy of *psammophis* instead of *olivacea* where it rightfully belongs. On distributional grounds *torquata* and *ornaticeps* are herein regarded as full species and not races of *psammophis* as previously held, despite the similarity of skull characters.

Pseudechis colletti guttatus De Vis

1905 **Pseudechis guttatus** De Vis, Ann. Queensl. Mus., 6: 49. Cecil Plains, Queensland.

Subspecific recognition is based on an examination of skull characters which differ in no way from *Pseudechis colletti colletti* Boulenger. A large series of specimens were examined, many from intermediate localities where intermediate colouring and ventral counts occur. Subspecific status in *guttatus* is retained on lower average ventral count and consistency of coloration within its range of the most north-westerly race, *colletti,* the type form. *Pseudechis colletti guttatus* extends from the central western slopes of N.S.W. to south-eastern Queensland.

The skull characters in a large series of *Pseudechis porphyriacus, P. australis* and *P. papuanus* were also examined. All species bear close relationship, *porphyriacus* being the most distinct species. Only slight differences were discerned between *papuanus, colletti* and *australis.* These differences were mainly in minute maxillary deviations. In the case of *papuanus* the coloration, larger average ventral count, greater venom potency, and geographical separation appear to be merely distinctions of subspecific importance to *Pseudechis australis.* Specific rank is, however, retained on the feeblest of osteological characters combined with these features.

The genera *Aspidomorphus, Brachysoma* and *Cacophis* are used and herein described adequately for the first time.

Genus BRACHYSOMA Fitzinger

1843 Fitzinger, Syst. Rept., 25.

Maxillary as far forward as palatine with a pair of venom fangs followed by four smaller teeth; maxillary arch more or less rounded and about as long as its distance to end of the bone which terminates about opposite palato-pterygoidal suture; turbinal enlarged; palatine teeth arising from inner margin of the bone; prefrontals diagonally sutured to frontal; frontal broader than long; diameter of prefronto-nasal periphery more than four times in width of frontals; postfrontal contacts frontal but not prefrontal; supratemporal about as long as quadrate.

Head depressed, slightly distinct from neck; pupil round, no canthus rostralis; body depressed, belly rounded, tail moderate. Nostril in single nasal which does not contact preocular; loreal absent; body scales smooth in 15 rows midbody; anal and subcaudals divided.

Brachysoma diadema (Schlegel)

1837 **Calamaria diadema** Schlegel, Phys. Serp., 2: 32. Type locality, Australia [probably Sydney].

The genus *Brachysoma* is revived to accommodate *diadema* which is the type species. I anticipate that specimens from Western Australia previously regarded as *diadema* can be referred to *christieanus* of Fry. An examination of a large series has revealed generic differences between the two snakes. Superficially similar in coloration, *diadema* is usually a darker snake in the juvenile stage with a reddish "patch" on the nape. Midbody scales are always in 15 rows and only four teeth follow the fangs on the maxillary. In *christieanus* the orange-coloured nape in juveniles is in the form of a broad "collar" which disappears with age. Adult snakes are dorsally black, midbody scale rows 15-17, and seven small maxillary teeth follow fangs. The generic differences are described elsewhere in this paper.

LUNELAPS* gen. nov.

Maxillary almost as far forward as palatine with seven small teeth following the large venom fangs; angulate maxillary arch, longer than its distance to end of bone which terminates posterior to palato-pterygoidal suture; enlarged turbinal; palatine teeth arising more or less on a median line; frontal longer than wide; prefrontals diagonally sutured to frontal; diameter of prefronto-nasal periphery less than three times in width of frontals; postfrontal contacts frontal but not prefrontal; supratemporal about as long as quadrate.

Head depressed, slightly distinct from neck; pupil round, no canthus rostralis; body depressed, belly rounded, tail moderate. Nostril in single nasal which does not contact preocular; loreal absent; body scales smooth in 15-17 rows midbody; anal and subcaudals divided.

Australia, north of Tropic of Capricorn.

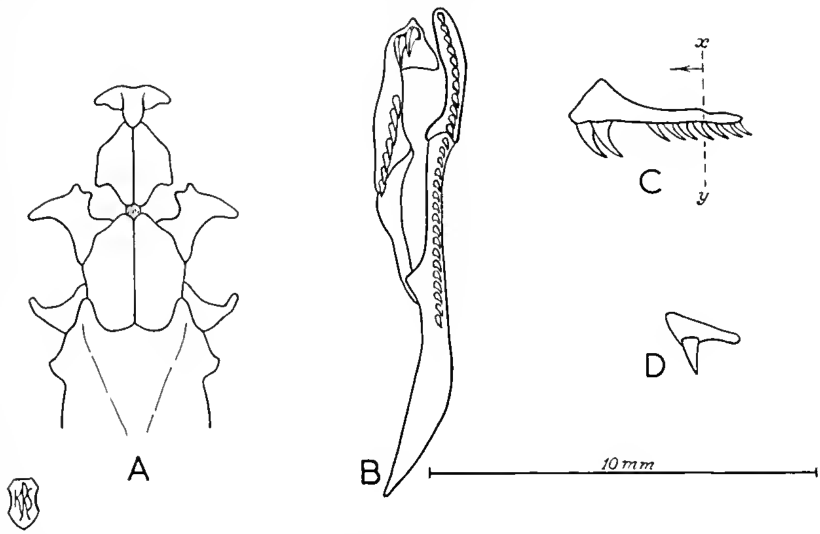
Lunelaps christieanus Fry

1915 **Pseudelaps christieanus** Fry, Proc. Roy. Soc. Queensl., 27 : 91.
1939 **Glyphodon barnardi** Kinghorn, Rec. Aust. Mus., 20 (4): 258.

The separation from *diadema*, both specifically and generically, has been explained in this paper. At one time both species were considered as members of the genus *Aspidomorphus* Fitzinger, but in this genus the pupil is elliptical and the frontal precluded from the orbital periphery, the opposite conditions applying in the genus *Lunelaps*. There are other differences which have been referred to in the previous description. Kinghorn (1939) included *barnardi* in

*North Australian aborigines frequently refer to this snake as a moonsnake, due to its nocturnal habits and lunate collar.

the genus *Glyphodon* Günther, on the grounds that the postfrontal and prefrontal bones were in contact in the skull that he examined. However he did not examine the skull of the type specimen which was a different snake. The type locality for *christieanus* is Darwin, and for *barnardi* Duaringa, Queensland.



Skull of *Lunelaps christieanus*. A, dorsal aspect of anterior portion. B, ventral aspect of maxillary, ectopterygoid, palatine and pterygoid. C, lateral aspect of maxillary. D, diagrammatic impression of transverse section of maxillary at x-y in C (not to scale).

Genus ASPIDOMORPHUS Fitzinger

1843 Fitzinger, Syst. Rept., 28.

Maxillary about as far forward as palatine with a pair of enlarged venom fangs followed by 7-10 smaller teeth arising from the median line of the expanded maxilla; maxillary arch shorter to about as long as its distance to the end of the bone which terminates posterior to palato-pterygoidal suture; combined frontal bones as long as to longer than broad; postfrontals and prefrontals in contact; quadrate shorter than to as long as supratemporal.

Head large, distinct from neck, pupil elliptical, canthus rostralis indistinct; body somewhat depressed, belly rounded, tail moderate. Nostril in an undivided nasal which contacts preocular; loreal absent; body scales smooth in 15 rows; anal and subcaudals divided.

Type species *Elaps mulleri* Schlegel, 1837. Type locality, Lobo, Triton Bay, Dutch New Guinea.

Aspidomorphus squamulosus (Duméril & Bibron)

1854 **Pseudelaps squamulosus** Dumeril & Bibron, Erpet. Gen., 7. 1235. Type locality uncertain.

No other species of Australian snake fits reasonably into this New Guinean genus and the inclusion of *squamulosus* is marginal.

Genus GLYPHODON Günther

1858 Gunther. Cat. Sn. Brit. Mus., 211.

Glyphodon differs from *Aspidomorphus* in that in the former the pupil is round; the preocular does not contact the nasal scale. Type species *Glyphodon tristis* Günther, north-eastern Australia.

Glyphodon harriettae (Krefft)

1896 **Cacophis harriettae** Krefft. Proc. Zool. Soc. London. 319. Type locality, Warro, Port Curtis, Queensland.

Genus CACOPHIS Günther

1863 Gunther, Ann. Mag. Nat. Hist. (3), 12 : 361.

Maxillary as far forward as palatine with a pair of enlarged venom fangs followed by two small teeth; maxillary arch round, about as long as its distance to the end of the bone which terminates posterior to palato-pterygoidal suture; combined frontal bones broader than long and excluded from orbital periphery by suture of prefrontals and postfrontals; quadrate as long as supratemporal.

Head only slightly distinct from neck, pupil round, canthus rostralis absent; body somewhat depressed, belly rounded, tail moderate; nostril in an undivided nasal which contacts preocular; loreal absent; body scales smooth in 15 rows; anal and subcaudals divided.

Cacophis krefftii Günther

1863 **Cacophis kreffti** Gunther, Ann. Mag. Nat. Hist. (3), 12: 361. Type locality, north of the Clarence River, N.S.W.

Genus DENISONIA Krefft

1869 Krefft, Proc. Zool. Soc., 321.

Palatine anterior to maxillary; a pair of enlarged venom fangs followed by five strongly recurved smaller teeth; postfrontals and prefrontals not in contact; supratemporal longer than quadrate. Pupil elliptical; canthus rostralis indistinct. Nasal scale contacts preocular; midbody scales in 17 rows; anal and subcaudals single.

Type species *D. maculata* (Steindachner).

Denisonia maculata (Steindachner)

1867 **Hoplocephalus maculatus** Steindachner, Reise Oesterr. Freg. Novara Reptiles, 81. [Type locality given as N.S.W. but undoubtedly in error as the species is not known outside 150 miles radius of Rockhampton, Qld.]

Denisonia devisi Waite & Longman

1920 **Denisonia maculata var. devisi** Waite & Longman, Rec. S. Austral. Mus., 1: 177. Type locality near Surat, Queensland.

Denisonia fasciata Rosen

1905 **Denisonia fasciata** Rosen, Ann. Mag. Nat. Hist. (7), 15: 179. Type locality, Western Australia.

A number of diverse species have hitherto been included in the genus *Denisonia*, but they can more properly be considered as generically separable. Therefore the following five new genera with a summary of diagnostic characters are proposed. The genus *Drepanodontis* has been dealt with already (Worrell, 1961: 54). Another paper, with illustrations of the skulls, is under preparation and in it the genera will be fully described. *Denisonia signata* (Jan) will also be dealt with separately.

Synopses of genera previously included in *Denisonia*:

Anal divided .... *Drepanodontis*
Anal single
    Elliptical pupil
        scales in 17 rows .... *Denisonia*
        scales in 19 rows .... *Suta*
    Round pupil
        preocular and prefrontal scales in contact .... *Unechis*
        preocular and prefrontal scales not in contact
            Postfrontal bones in contact with prefrontal bones .... *Cryptophis*
            Postfrontal bones not in contact with prefrontal bones
                canthus rostralis distinct .... *Drysdalia*
                canthus rostralis absent .... *Parasuta*

DRYSDALIA* gen. nov.

Maxillary about as far forward as palatines; a pair of enlarged venom fangs followed by three to four smaller teeth; postfrontals and prefrontals not in contact. Pupil round; canthus rostralis distinct; nasal scale contacts preocular; midbody scales in 15 rows; anal and subcaudals single. Type species, *D. coronoides* (Günther).

Drysdalia coronoides (Günther)

1858 **Hoplocephalus coronoides** Gunther, Cat. Sn. Brit. Mus., 215. Type locality, Tasmania.

Drysdalia mastersii (Krefft)

1866 **Hoplocephalus mastersii** Krefft, Proc. Zool. Soc., 370 and 63. Type locality, Flinders Range, S. Australia.

Drysdalia coronata (Schlegel)

1837 **Elaps coronatus** Schlegel, Phys. Serp., 2: 454. Type locality, "Australia." [It occurs in South-Western Australia.]

UNECHIS gen. nov.

Maxillary as far forward as palatine with a pair of enlarged venom fangs followed by five very short recurved teeth; postfrontals and prefrontals almost in contact; prefrontals sutured to lateral margin of frontal. Pupil round; canthus rostralis absent; nasal scale does not contact preocular; midbody scales in 15 rows; anal and subcaudals single.

Unechis carpentariae (Macleay)

1887 **Hoplocephalus carpentariae** Macleay, Proc. Linn. Soc. N.S.W. (2), 2: 403. Type locality, Peak Downs, Queensland.

SUTA gen. nov.

Maxillary almost as far forward as palatine with a pair of enlarged venom fangs followed by six slightly recurved smaller teeth; postfrontals and prefrontals almost in contact; prefrontals sutured to lateral margin of frontals. Pupil elliptical; canthus rostralis absent; nasal scale contacts preocular; midbody scales in 19 rows; anal and subcaudals single.

*After Mr. G. Russell Drysdale, Australian artist who accompanied me to Tasmanian Islands where I collected the material for this generic description.

Suta suta (Peters)

1863 **Hoplocephalus sutus** Peters, Monatsb. Akad. Wiss. Berlin, 234. Type from Adelaide.

PARASUTA gen. nov.

Maxillary about as far forward as palatine with a pair of enlarged venom fangs followed by four smaller teeth; postfrontal not in contact with prefrontal which is diagonally sutured to the frontal. Pupil round; canthus rostralis absent; nasal contacts preocular; midbody scales in 15 rows; anal and subcaudals single. Type species, *P. gouldii* (Gray).

Parasuta gouldii (Gray)

1841 **Elaps gouldii** Gray, in Grey's Journ. Exped. W. Austral., 2: 444. Type locality, W. Australia.

Parasuta nigrostriata (Krefft)

1864 **Hoplocephalus nigrostriatus** Krefft, Proc. Zool. Soc., 181. Type locality, Rockhampton, Qld.

CRYPTOPHIS gen. nov.

Maxillary about as far forward as palatine with a pair of enlarged venom fangs followed by five to seven smaller teeth; postfrontals in contact with prefrontals which are sutured more or less to the lateral margin of frontals. Pupil round; canthus rostralis absent; nasal scale in contact with preocular; midbody scales in 15 to 17 rows; anal and subcaudals single. Type species, *C. pallidiceps*.

Cryptophis pallidiceps (Günther)

1858 **Hoplocephalus pallidiceps** Gunther, Cat. Sn. Brit. Mus., 214. Type locality, Port Essington, N. Territory.

Cryptophis nigrescens (Günther)

1862 **Hoplocephalus nigrescens** Gunther, Ann. Mag. Nat. Hist. (3), 9: 131. Type locality, Sydney.

Cryptophis flagellum (McCoy)

1878 **Hoplocephalus flagellum** McCoy, Prodr. Zool. Vict., 7. Type locality, Victoria.

Cryptophis dwyeri (Worrell)

1956 **Denisonia dwyeri** Worrell, Austral. Zool., 12 (3): 202. Type locality, Glenmorgan, and Gayndah, Qld.

In the original illustration of the skull of the species the postfrontal and prefrontal in *dwyeri* (1956) are not shown in contact.

The following synopses of genera separate the three unlike species previously united with the genus *Vermicella*.

Genus VERMICELLA Günther

1858 Gunther, Cat. Sn. Brit. Mus., 236.

Maxillary more anterior than palatine with a pair of large strongly recurved venom fangs followed by three very small teeth; frontal bones acute posteriorly, longer than broad; minute postfrontal barely contacts frontal and prefrontal which is broadly sutured to the lateral edge of the frontal. Snout broadly rounded, canthus rostralis absent, scales on muzzle not obliquely disposed, pupil round; nasal scale in contact with preocular; midbody scale rows 15; anal and subcaudals divided.

Vermicella annulata (Gray)

1841 Calamaria annulata Gray, in Grey's Journ. Exped. W. Austral., 2: 443. Type locality, "Australia."

1915 Furina multifasciata Longman, Mem. Queensl. Mus., 3: 30.

Longman's *multifasciata* is reduced to a synonym of *annulata*, despite the fact that the ventral scale count (284) is well above other records. This could be freakish or even a count error caused by a slipping epidermis prior to sloughing, where a large number of additional ventrals can be clearly seen and not readily detected as such, particularly on small snakes. My specimens from the type locality (Darwin) and south to Mataranka showed that the internasal shield may or may not be present.

NAROPHIS gen. nov.

Maxillary more anterior than palatine with a pair of strongly recurved venom fangs only; frontal bones posteriorly rounded, broader than long; prominent postfrontal not in contact with frontal or prefrontal which is broadly sutured to the lateral margin of the frontal more or less excluding it from the orbital periphery.

Snout elongate with a large posteriorly acute rostral, concave on the lower side with an angulate anterior edge; internasals obliquely disposed; canthus rostralis absent; pupil round; nasal scale in contact with preocular; midbody scale rows 15; anal and subcaudals divided.

Narophis bimaculata (Duméril & Bibron)

1854 Furina bimaculata Dumeril & Bibron, Erpet. Gen., 7: 1240. Type locality, "Tasmania" [undoubtedly Western Australia].

The status of *Vermicella calonota* has already been dealt with (Worrell, 1960: 133).

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SPHAEROBOLUS STELLATUS, A NEW FUNGUS FOR WESTERN AUSTRALIA

By T. E. H. APLIN, State Herbarium

The existence of *Sphaerobolus stellatus* Tode ex Pers. was first brought to the notice of the author when Mr. R. C. B. Elson, Applecross, reported that since April 3, 1961 he observed little 'black spots' which to all intents and purposes were being shot up from his lawn. These were causing concern by the way they spotted the washing on the line, as well as the footpaths, house walls, etc. This report does not preclude the possibility that this phenomenon has been observed previously. It only means that this is the first instance in which the cause of the 'black spots' has been traced and determined. Specimens of the fungus were collected by the author on May 2, 1961, in and amongst lawn clippings of a healthy buffalo grass (*Stenotaphrum secundatum* (Walt.) Kuntze) lawn.

S. stellatus has one peridiolum (the 'black spot' referred to earlier) per peridium which is forcibly discharged by a catapulting mechanism (Fig. 1, A-E). In this regard it differs from the bird's nest fungi, to which it is closely allied; the bird's nest fungi possess several peridiola per peridium which are dislodged by the action of rain-splash.

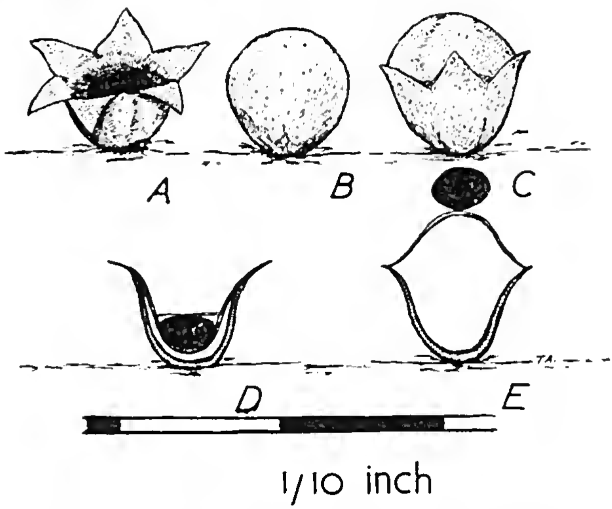

Fig. 1.—*Sphaerobolus stellatus* Tode ex Pers.

A., open peridium with dark peridiolum in centre. B., peridium. C., open peridium with evaginated endoperidium, peridiolum discharged. D., T.S. open peridium, showing exoperidium, endoperidium and peridiolum. E., T.S. open peridium, showing evaginated endoperidium and peridiolum being discharged.

The following description of *S. stellatus* is taken from Cunningham (1942): "Peridium sessile, partly buried in mycelium subiculum, subglobose, to 2 mm. diameter, fleshy, externally hirsute and dingy white, internally smooth and orange. Peridiolum globose reddish-brown, 0.75-1.25 mm. diameter, lenticular when dry. Spores obovate or broadly elliptical, often pip-shaped or irregular, 6-10 x 5-7μ, epispore hyaline, smooth, 1.25μ thick."

At maturity, the peridium opens by several lines radiating from the apex, so that the open fruiting body has a star-like (stellate) appearance, orange in colour. The peridium separates into two cups, fitting one inside the other, viz. the exoperidium and the endoperidium (Fig. 1, D). The exposed peridiolum lies within the endoperidium (inner cup) submerged in a fluid. With the discharge of the peridiolum the endoperidium remains evaginated, and may be seen as an opaque 'bubble' on the spent fruiting body (Fig. 1, C. and E.).

The spore discharge mechanism of *S. stellatus* has been ascribed by Ingold (1953) to the absorption of water by the palisade layer which forms the inner wall of the endoperidium, thus increasing its surface area. The outer wall of the endoperidium, which consists of interwoven hyphae, tends to impede this increase, so that strains are set up which are suddenly and violently released by the inner cup turning inside out. The peridiolum which was previously contained in the endoperidium is catapulted out with great force.

The maximum distances reached by the peridiola at Mr. Elson's home were conservatively estimated to be 10 feet horizontally and 9 feet vertically. Compare this with Cleland's (1934) estimate of 4 inches for the distance attained by specimens in South Australia. Nicol (1945), on the other hand, in more popular vein, reports on the 'great international fungus-gunnery competition' in which the two contestants Dr. A. H. R. Buller (Canada) and Miss L. B. Walker (U.S.A.) set records of 18 feet 7 inches for the horizontal distance and 14 feet 5 inches for the "all-time high" respectively.

S. stellatus has been recorded from a number of countries including India, New Zealand, Europe and North America. In Australia it has been recorded from South Australia and Victoria. This is the first authenticated record for Western Australia and it is interesting to note that since the initial report several people including the author have observed peridiola in various other localities (on walls, footpaths, etc., close to buffalo grass lawns), indicating that this fungus, rather than being rare, is fairly abundant in the metropolitan area of Perth, with buffalo grass litter appearing to be the most suitable habitat.

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FROM FIELD AND STUDY

Corvus **feeding on Oranges.**—On October 31, 1959, while inspecting an orange grove on the property of Mr. S. Byrd, of Harvey, my attention was directed to numbers of oranges on the ground with holes about $1\frac{1}{4}$ - $1\frac{1}{2}$ in. in diameter in the skin and the contents entirely lacking.

When the matter was referred to Mr. Byrd he stated definitely that this was the work of crows which fed upon the oranges. Mr. Byrd has handled locally killed birds but has not encountered any with the bases of the feathers white, so it seems reasonably certain that the birds in question are, as might be expected, Australian Ravens *(Corvus coronoides)*.

Angus Robinson *(W.A. Nat.*, 7, 1960: 114) mentions the King Parrot *(Purpureicephalus spurius)* as well as the Raven as responsible for puncturing oranges, the contents then being eaten out by Silvereyes *(Zosterops gouldi)*.

—ERIC H. SEDGWICK, Collie.

Black-throated Butcher-bird and Little Falcon hunting in Unison.—At Mt. Anderson, 70 miles south-east of Derby, on June 26, 1960 my wife and I observed a Black-throated Butcher-bird *(Cracticus nigrogularis)* and a Little Falcon *(Falco longipennis)* chasing a Rufous-throated Honeyeater *(Conopophila rufogularis)*. Our attention was attracted by the falcon stooping at a bush. The butcher-bird was then seen to dive into the bush after the honeyeater, driving it out. The falcon stooped again, missing, and the honeyeater gained shelter in another bush. The butcher-bird and the falcon perched side by side on top of the bush. After a minute the butcher-bird dashed through the branches, startling the honeyeater out. Again the falcon missed and the honeyeater regained the first bush. For about ten minutes the two predators chased their prey between the two bushes. Finally the honeyeater made a dash for a nearby tree and was taken by the falcon, which carried it out of sight.

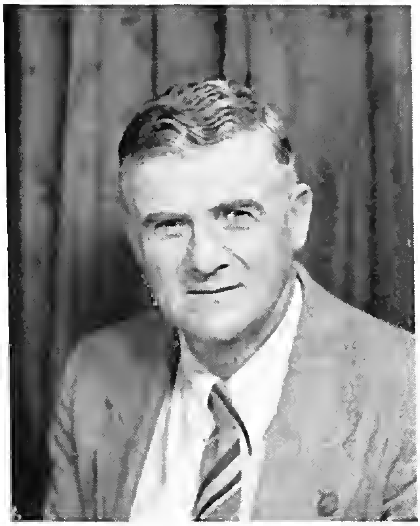
—PETER SLATER, Derby.

OBITUARY

C. B. PALMER

Cyril Bryan Palmer, a former president and one of the links with the very earliest years of the Club, died on March 4, 1961. He was born on October 18, 1893, at Folkestone, Kent, England and came to Western Australia in 1911. He took up land at Tenindewa, near Mullewa, where he was joined a couple of years later first by his father and then by his mother and three sisters. Here Cyril remained as a farmer for 15 years. However he had an ingrained feeling for scientific matters and at the farm developed interests which gave him a reputation in Perth and interstate. Another brother, who had remained in England when the rest of the family immigrated, also had the same natural inclination. He was P. Chetwynd Palmer, a London civil servant, who developed into a skilled microscopist and eventually became editor of *The Journal of the Quekett Microscopical Club*.

At the farm Cyril became interested in pedigree goat breeding and in 1926 he was a judge in the goat section at the Sydney Royal Show. He also judged at the Perth Royal Show and regularly judged at country agricultural shows. He was foundation president of the Goat Breeders' Association of Western Australia, of which he was later made an honorary life member. He also developed a great interest in the grasses, their speciation and genetics. He conducted wheat-breeding experiments and was a keen collector of grasses for herbaria, recording the first occurrence in Western Australia of several naturalised species. One of his discoveries was a new species of native grass, *Eragrostis lanipes,* originally collected at Tenindewa and which was subsequently found to be a widespread Murchison form. It was described by Dr. C. E. Hubbard, of Kew, in 1934.



C. B. Palmer, 1952

He joined the Naturalists' Club shortly after its foundation. Very soon afterwards, following the sale of the Tenindewa farm, after his father's death, he moved to the metropolitan area and lived for some years at Beechboro. Whilst here he established many scientific contacts, became active in the Naturalists' Club, joined the Royal Society of Western Australia and thought seriously of taking up a degree course in science at the University of Western Australia. He entered into correspondence with his brother in London on the subject and he, in advising him, at his mature age, against devoting "what should be your leisure to a rather exhausting grind for five or six years," offered some sage advice on how to capitalise his practical knowledge and make some useful contribution to scientific knowledge whilst working in co-operation with knowledgeable experts. Cyril did, however, take part-time courses in botany (genetics) at the University of Western Australia in 1927 and was invited to lecture to the other undergraduates on aspects of his own work in grass-breeding techniques.

From his brother Cyril gained valuable advice on microscopes and microscopical methods. He continued experiments with grasses and did some genetical work on finches in captivity. Genetics became an ever-absorbing study and he developed some interesting views on the nature of species formation. Years later he summarised these in a lecture he gave to the Royal Society of Western Australia in May, 1942. He was a regular attendant at the society's meetings and was a member of its council between 1947 and 1949. In 1960 he was made an honorary associate member of the society.

However it was with the Naturalists' Club that he was most active and with whose members he developed close ties of friendship.

He was elected to the council of the Club in 1928 and was president in 1945. In 1951 he was made an honorary life member for his services. During a critical period in the Club's affairs, in 1932-33, when the organisation almost dissolved, he was one of the stalwarts who held it together and steered it to better times. He was consistent in attending meetings, a regular lecturer and exhibitor of plant specimens.

In October 1932 he married Miss Evelyn Reynolds, from the Isle of Wight, England, and the two moved from Perth to Parkerville where Cyril became superintendent of the children's homes there. In 1938 he transferred to the management of a similar home at Werribee. In 1944 he returned to Perth and became assistant editor of *Elder's Weekly,* contributing agricultural articles under the pen-name of "Coningsby". Some of these were republished in book form in 1945 under the title of *The Interest of Farming.* In 1947 he joined the staff of Westralian Farmers Ltd., as the firm's agronomist and contributed numerous articles to the weekly *Wesfarmers News.*

Like all naturalists he gave much thought to conservation problems, and as an agriculturist he was keenly interested in that aspect of conservation where wildlife was encouraged to exist on land that was actively farmed, citing rural England as an example. When The Tree Society of Western Australia was being formed he served as its foundation secretary. He was a sympathetic animal lover and was active in societies concerned with animal welfare, including the R.S.P.C.A., the Dog's Refuge Home and the Animal Welfare League, of which he was a founder and president.

He encouraged young members in their natural history pursuits and bequeathed to his fellow Club members, who had need of them, his scientific equipment and volumes and journal series from his carefully selected library. The remainder of his books were left to the Club's library.

—D. L. S.

CORRECTIONS

In vol. 7, no. 2, p. 45 the lower figure represents the Netted Dragon *(Amphibolurus reticulatus)* and not the Ornate Dragon *(A. ornatus).*

In vol. 7, no. 4, p. 82, in the key to *Sphenomorphus,* read *taeniolatum undecimstriatum* for *fasciolatum undecimstriatum.*

THE WESTERN AUSTRALIAN
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PALAEARCTIC MIGRANTS IN THE KIMBERLEY DIVISION

I. EASTERN BARN SWALLOW *(HIRUNDO RUSTICA GUTTURALIS)* AT DERBY

By PETER SLATER, Derby

On our arrival at Derby on January 20, 1960, a flock of swallows in the main street attracted the attention of my wife and myself. It was immediately apparent that the birds were not Welcome Swallows *(Hirundo neoxena)* because of the pure white underparts, the black band separating the rust-coloured throat from the white breast and the extremely long tail streamers on some individuals. Most of the birds appeared to be in moult, and one or both streamers were missing in many instances. The lack of white on the back or rump precluded the possibility of the birds being any of the three remaining Australian species.

Available references were consulted: Glenister *(The Birds of the Malay Peninsula, Singapore and Penang,* 1951: 69, 185); Peterson, Mountford and Hollom *(A Field Guide to the Birds of Britain and Europe,* 1954: 194); Mayr *(Birds of the South West Pacific,* 1945: 302); W. T. Loke *(A Company of Birds,* 1957: 54-5, 150) and N. W. Cayley *(What Bird is That?* 1956: Plate xxvii). From these sources it appeared that the birds were Eastern Swallows *(Hirundo rustica gutturalis)*. A description and drawing of the birds were sent to Dr. G. F. Mees, of the W.A. Museum, who replied with information regarding the species, concluding, "I have always been very surprised about the lack of records for Australia, because the bird is a common winter visitor in Java and West New Guinea, whereas it has been recorded from several of the Lesser Sunda Islands, including Soemba, Flores and Wetar, but not Timor (Rensch, *Mitt. Zool. Mus. Berlin,* 17, 1931, p. 551). Personally I would expect the species to be a regular visitor to our north coast." A description and photographs, taken with 400 mm. lens with SLR 35 mm. camera on Kodachrome film, were also forwarded to Dr. D. L. Serventy, who confirmed the identification. Attempts to take a specimen were unsuccessful.

About 30 birds were present in the main street on January 20, 1960. On January 24 the same number was observed at the town water tanks. On later occasions the following numbers were counted on the light wires outside the Derby Junior High School: February 18, 92 birds; February 21, 110; February 25, 84. On February 27 the birds moved two miles east of the town to the Derby Meat Processing Company. They moved back to town several days later and, until March 22, 30 were observed daily at the school. On March 23 three swallows flew along the school verandah investigating the eaves. On the following day none were in evidence.

From September on a close watch was kept, and on November 7 a solitary bird was seen. On November 11 three were seen at the school. Between December 1 and 8, I opened the swimming pool daily at 6 a.m. and was able to observe three swallows bathing with Tree and Fairy Martins. A specimen was obtained at the pool after the bird had been bathing. It was fully mature and heavily in moult.

There was a slow increase of numbers, and on February 3, 1961, 15 were observed by Eric Lindgren and myself, and 63 by March 19. On April 2 some native children pointed out a large flock of about 300 birds apparently migrating. The flock moved in a north-easterly direction, and none were seen subsequently.

When the swallows were first identified, I alerted Mr. Kees Vermey in Wyndham and Dr. K. Immelmann at the Kimberley Research Station, but neither observer made any additional records. Mr. Vermey tried unsuccessfully to contact any birdwatchers in Darwin, and I have not been able to visit Broome or Yampi so am unaware as to the species' presence in these areas.

From available evidence it seems that *H. rustica gutturalis* is a regular visitor to Derby, arriving in early November and leaving at the end of March.

However according to the exhaustive review of the distribution and migration of the Barn Swallow by Arnold Frh. von Vietinghoff-Riesch (Verbreitung und Zug der Rauchschwalbe *(Hirundo rustica)*, *Bonner Zoologische Beiträge,* Sonderband 1955, p. 122) there is only one previous record of the occurrence of this species in the Australian area. It was taken by Dr. F. M. Rayner of H.M.S. *Herald* on the north coast of Australia on October 18, 1860, and was described by Gould as a new species, *Hirundo fretensis (Handbook to the Birds of Australia,* 1865, 1: 110). The specimen went to the British Museum and was determined by Bowdler Sharpe as a juvenile of *Hirundo rustica (Cat. Birds Brit. Mus,* 10, 1885: 137). Gregory Mathews gave a coloured illustration of it in *A Supplement to the Birds of Norfolk and Lord Howe Islands*, 1936, pl. 64. The accompanying map (Fig. 1) of the breeding distribution and migratory pattern of *H. r. gutturalis* was re-drawn by Mr. G. E. Binsted from the chart in Vietinghoff-Riesch's paper, provided by Dr. Serventy.

The accompanying illustrated key should assist non-ornithological naturalists to identify any swallows observed in northern Australia. The Pacific Swallow *(Hirundo tahitica)* has not yet

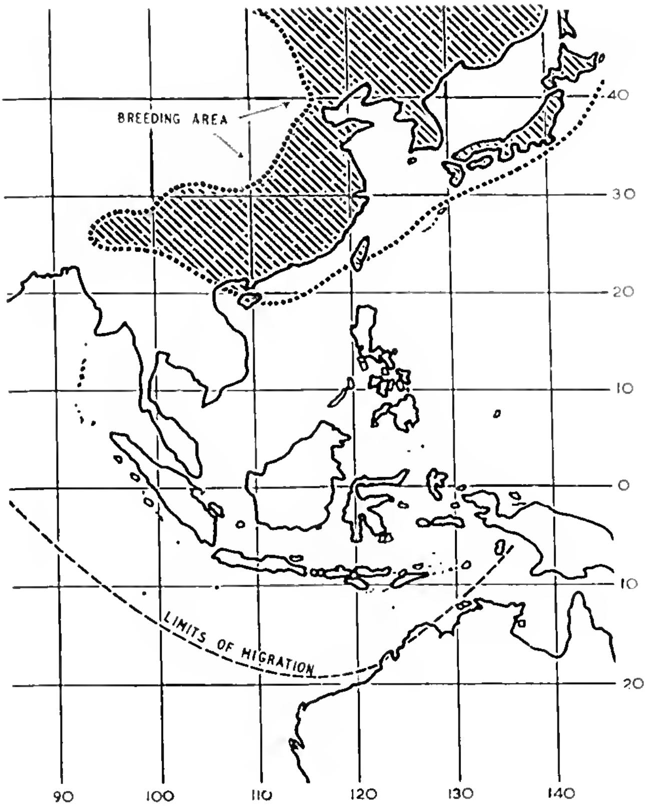


Fig. 1.—Breeding distribution and migration limits of the Eastern Swallow.

—After Vietinghoff-Riesch, 1955.

been observed in Australia, and as it is so similar to the resident Welcome Swallow *(H. neoxena)* any suspected record should be accompanied by a careful description and/or a specimen.

A GUIDE TO THE SWALLOWS

1.	A.	Black back and rump, white spots in tail	2
	B.	White on back or rump, no white in tail	5
2.	A.	Grey below	3
	B.	White below	4
3.		Chestnut face and throat.	
	A.	Long tail streamers	Welcome Swallow.
	B.	Short tail streamers	Pacific Swallow.
4.		Chestnut face and throat with black border	Eastern Swallow.
5.	A.	White on scapulars and back, rump black	White-backed Swallow.
	B.	Scapulars (back) black, rump white	6
6.	A.	Head rusty red	Fairy Martin.
	B.	Head largely black, rusty forehead	Tree-Martin.

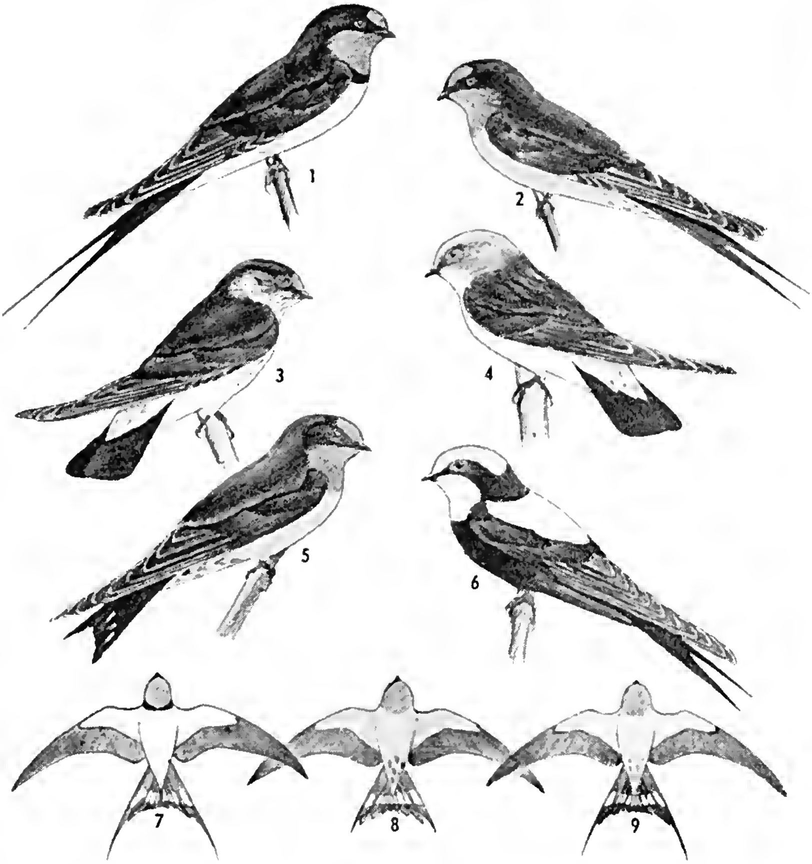


Fig. 2.—Plumage patterns of various swallows: 1, Eastern Swallow; 2, Welcome Swallow; 3, Tree-Martin; 4, Fairy Martin; 5, Pacific Swallow; 6, White-backed Swallow; 7, Eastern Swallow; 8, Pacific Swallow; 9, Welcome Swallow. The last three illustrations show the birds viewed from underneath.

—drawn by Peter Slater

II. YELLOW WAGTAIL *(MOTACILLA FLAVA)* AT DERBY

By ERIC LINDGREN, Shenton Park, and PETER SLATER, Derby

On December 7, 1960, a bird identified as a Yellow Wagtail *(Motacilla flava)* was seen near the overflow of Yabbagoody Mill, 7 miles east of Derby. The area about the mill has been trodden clear of undergrowth by cattle and the tank overflows almost continuously, forming a marshy patch only a few square yards in area in which there is a lush growth of grass.

The bird was first seen in the early afternoon, when one of us (E.L.), in the company of Mr. Kees Vermey of Wyndham, visited the mill to photograph birds coming in to drink. On first glance the bird was thought to be a Pipit *(Anthus novae-seeland-*

iae) but closer examination revealed a number of differences. A field description was therefore made, as follows:

Upper parts and wings uniform grey, not streaked as in a Pipit; with two pale bars on the wing coverts, secondaries darker grey. Breast greyish, darker in the centre. Remainder of underparts off-white, with a yellowish wash on the left thigh but not on the right. Head grey, similar to the back, with indistinct stripes above and below the eye. Throat white. Tail dark grey, edged white; legs long and brown.

The bird was watched for about 30 minutes from a distance of 20 yards with 10 x 50 binoculars. All the time it behaved in typical pipit-like manner, catching small insects in the swampy grass, and bobbing the body and tail in a constant up and down motion.

On returning to Derby reference was made to Delacour *(Birds of Malaysia,* 1947: 197) and to Peterson, Mountford and Hollom *(A Field Guide to the Birds of Britain and Europe,* 1954: 266). Both of these books left no doubt that the bird was a *Motacilla* and Delacour's description of the immature *M. flava,* "above olive brown; below whitish with yellow patches and wash," seemed to indicate that this was the bird. However the bird did not have the buff chin and brown bib described by Peterson *et al.* for the juvenile of the yellowest European race, *M. flava flavissima.* It was decided that the bird was either an immature *M. flava* or an adult in winter plumage.

An attempt made to collect the specimen an hour later when both of us were present unfortunately failed and the bird flew off in a southerly direction. We both decided the bird was definitely a *Motacilla* and confirmed the previous description before firing.

There is only one other record of this species in Australia. This was an adult male taken at Bimbi on the Dawson River in central east Queensland on June 10, 1905 by H. G. Barnard, who described the circumstances of its collection as follows: "When first seen it was on the ground, and ran along like the Australian Pipit. . . . During flight the white feathers on each side of the tail were very conspicuous. It is the only one I have ever seen, and my attention was first attracted to it by its sharp whistling note."

This specimen was exhibited at a meeting of the Linnean Society of N.S.W. on November 29, 1905 by A. J. North who proposed to describe it as a new species *Motacilla barnardi (Linn. Soc. N.S.W.,* Abstr. Proc., Nov. 29, 1905: vii.) The name was placed in the synonymy of *Motacilla flava simillima* by Hartert *(Die Vögel der paläarktischen Fauna,* 3, 1921: 2096) and this procedure has been followed by later authors.

Four subspecies of this Palaearctic species "winter" in the East Indies, *M. f. simillima, M. f. taivana, M. f. macronyx* and *M. f. tschutschensis.* The first-named is the commonest and the most far reaching of these, having been recorded as a straggler in the Mimika River region at the foot of the Nassau Mountains in Papua (Mayr, *List of New Guinea Birds,* 1941: 105) as well as the

Queensland record just cited. It is most likely, therefore, that the bird seen near Derby was of this subspecies. However in the absence of a specimen, particularly with the complex *flava* group, nothing definite can be said.

The foregoing account was submitted to Professor Ernst Mayr, of the Museum of Comparative Zoology, Harvard, and he commented as follows: "I have no doubt that the bird was correctly identified. I checked our specimens and find that individuals of *simillima* rarely have grey on the breast. On the other hand this marking is rather characteristic of a small *tschutschensis*. Naturally one cannot identify a sight record subspecifically in such a difficult species but there is a good chance that the bird was *tschutchensis*."

NOTES ON WESTERN AUSTRALIAN ORCHIDACEAE

By A. S. GEORGE, State Herbarium

I. REDUCTION OF FIVE SPECIES TO SYNONYMY

In the course of research into the original descriptions and type specimens of Western Australian orchids the author found that a number of species at present accepted as valid were identical with earlier described species. The following are some of these.

Prasophyllum paludosum W. H. Nicholls

Vict. Nat., 64, 1948: 175. Type locality: Bayswater, leg. W. H. Nicholls, Oct. 1946.

Specimens which had been identified as *Prasophyllum muelleri* C. R. P. Andrews (*Journ. Proc. Muell. Bot. Soc. W.A.*, 1 (9), 1902: 19; type locality: Guildford, leg. C. R. P. Andrews, Nov. 1901), and checked with its type, were sent to Melbourne, where Mr. J. H. Willis confirmed that they were also identical with the type of *P. paludosum*. The original descriptions were compared and found to differ only in the following particulars:

i. Leaf blade shorter than the flower spike in *P. paludosum*, as long or longer in *P. muelleri*.

ii. Petals narrower than sepals in *P. paludosum*, broader in *P. muelleri*.

iii. Anther shorter than the rostellum in *P. paludosum*, as long in *P. muelleri*.

Examination of all the specimens in the W.A. State Herbarium shows that such variation may occur within one collection. Thus there is no sound basis for the retention of both species and *P. paludosum* becomes a synonym of *P. muelleri*.

Prasophyllum muelleri has for some years been confused with *P. elatum* R.Br. (type locality: Port Jackson, R. Brown) but is actually a distinct species. Nicholls made it a variety of Robert Brown's plant, but it differs considerably in the floral details, especially of the column and labellum.

Prasophyllum horburyanum Rupp

Vict. Nat., 59, 1942: 122. Type locality: Kumarl, leg. L. Horbury, May 1938.

The type specimens are in the State Herbarium of Western Australia and only a very few flowers are in a reasonable condition. Specimens have since been collected from near Tinkurrin, Lake Grace, Newdegate, Lake King, Ravensthorpe, and Salmon Gums, and differ only in the size of the flowers. They are identical with Rupp's type specimens and also with the type of *Prasophyllum fuscoviride* Reader (*Vict. Nat.*, 14, 1898: 163; type locality: Lowan, Victoria, leg. Miss F. Reader, 1892), which was obtained on loan from Melbourne. Moreover, there is nothing in the original description of *P. horburyanum* to separate it from that of *P. fuscoviride*. It must therefore fall into synonymy with the latter which is the correct name for the western plant.

The species also occurs in South Australia.

Pterostylis turfosa Endl.

Lehmann, *Pl. Preiss.*, 2, 1845: 5. Type locality: "In turfoso-arenosis deflagratis ad Stirlings Terrace [= Albany] Preiss 2632, 20 Sept. 1840."

For many years *Pterostylis turfosa* has been regarded as occurring only in Western Australia and *P. barbata* Lindl. (Swan Riv. App. 54, 1839) only in the Eastern States. The difference between the two has been taken as the relative lengths of the filiform points of the lateral sepals. In W.A. all variations occur, from dry area plants with short sepal points to those from wetter parts with very long points. No other substantial differences are apparent, either from the original descriptions or from the numerous specimens in the State Herbarium. Now the type locality for *P. barbata* is "Swan River, leg. J. Drummond". Thus there is not even a geographical basis for separating the two species and *P. turfosa* must fall into the synonymy of *P. barbata*, the latter being the earlier and correct name for the western plant. It also remains correct for the Eastern States plant, unless the study of fresh specimens reveals sufficient differences to warrant a new name for it.

Caladenia tenuis Fitzg.

Gard. Chron., 1, 1882: 462. Type locality: Champion Bay, leg. R. Fitzgerald, Aug. 4.

This species was thought to have been unrecorded since the type was collected, until a photocopy of Fitzgerald's unpublished illustration was obtained from the Mitchell Library in Sydney. The plant was immediately recognised as *Caladenia hirta* Lindl. (*Swan Riv. App.* 52, 1839; type locality: Swan River, leg. J. Drummond). A check of the original descriptions revealed no significant difference. In *C. tenuis* the calli were described as being "in two bands each consisting of four rows", and in *C. hirta* in four to six rows. However, this is a variable feature of the plant and there is thus no basis on which to separate the two species. Consequently *C. tenuis* becomes a synonym of *C. hirta.*

Caladenia purdieana C. R. P. Andrews

Journ. Proc. Muell. Bot. Soc. W.A., 1 (10), 1902: 39. Type locality: Darling Range, Kelmscott, leg. C. R. P. Andrews, Oct. 1901.

This species and *C. paniculata* Fitzg. *(Gard. Chron.,* 1, 1882: 461; type locality: Upper Hay River, leg. R. Fitzgerald, Sept.) have both been retained due to a misunderstanding of the original descriptions. Fitzgerald described the calli as being "united by a long central callus" while Andrews referred to "a narrow longitudinal plate . . . bordered by two rows of thick, linear divergent calli." The type specimens of *C. purdieana* are in the Blackall Collection at the State Herbarium of W.A.; an examination of these and Fitzgerald's illustration in *Australian Orchids* shows that the structures are identical. There are no other differences, so *C. purdieana* must fall into the synonymy of *C. paniculata.*

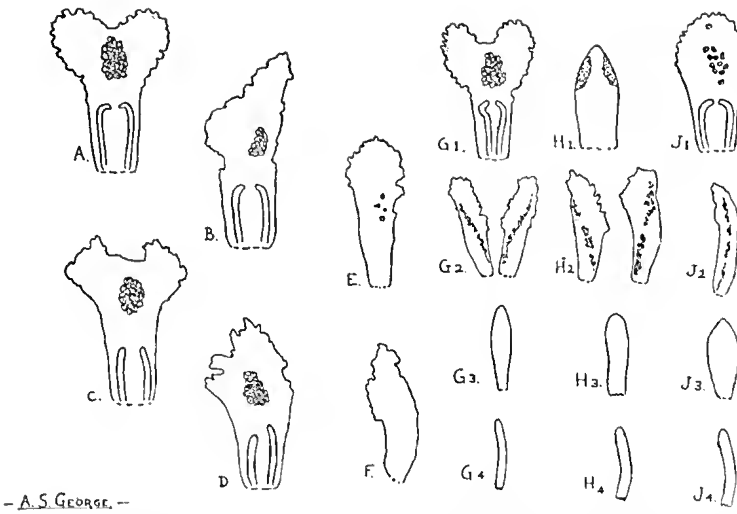
II. THE STATUS OF *GOADBYELLA GRACILIS* R. S. ROGERS

Trans. Roy. Soc. S. Austral., 51, 1927: 294.

Goadbyella gracilis, the "Lost Orchid", is known only from the type collection, made at Pindalup in 1927 by P. Barwise. Since then searching in the same area has failed to reveal any further specimens. The suggestion was made by Mr. R. D. Royce, of the State Herbarium of Western Australia, that the species may be a hybrid between species of *Microtis* and *Prasophyllum.* This prompted a study of the two plants of the type collection, with the following results.

i. *Habit.* The arrangement of the flowers is extremely haphazard. In the genera *Microtis* and *Prasophyllum* irregular spikes are usually only found in damaged plants, although in the former the spaces between individual flowers may vary slightly. The specimens of *Goadbyella* are not damaged, yet for the lowest few centimetres the flowers are irregularly spaced. Above this they become clustered with shorter intervals, often with several flowers arising from the same level (but not whorled). There follows a densely packed section, then a few more irregular intervals before a crowded apex.

ii. *Morphology of the flowers.* The only constant floral segments appear to be the petals and the dorsal sepal. The illustration shows the variation of the other parts. This is not even constant in both specimens. The flowers are reversed, as in *Prasophyllum,* though some appear to be almost vertical. The lateral sepals of some are reminiscent of the petals of *Prasophyllum hians* Reichb., though also similar to deformed *Microtis* labella. Other *Microtis*-



Goadbyella gracilis R. S. Rogers. A.-D., labella of holotype. E. and F., lateral sepals of holotype. G.-J., flowers of isotype: 1, labella; 2, lateral sepals; 3, dorsal sepals; 4, petals. All drawings enlarged.

like features are the labellum, petals and column (where it is properly formed).

iii. *Fertility of the flowers.* A few flowers, mainly along the lowest part of the spike, have ovaries ("pedicillate" according to Rogers). The remainder, which he termed "sessile", actually have no ovaries, or only abortive ones. Furthermore the column, while apparently normal in many flowers, is deformed in several. Although the lowest flowers are beginning to wither, there is no sign that any have been fertilised.

With such variation and deformation, this plant can hardly be normal, and must surely be regarded as an aberrant form rather than a true species. It may be a hybrid as mentioned above, or as seems more likely from studying the specimens, a deformed *Microtis*. Whatever the case it is apparently unable to reproduce itself and its genetics must remain unknown unless it is again seen in the fresh state.

ACKNOWLEDGEMENTS

I would like to thank the National Herbarium of Victoria for supplying on loan the type specimen of *Prasophyllum fuscoviride;* Mr. J. H. Willis, of the same Herbarium, for comparing *Prasophyllum muelleri* with *P. paludosum;* and the State Herbarium of South Australia for the type of *Goadbyella gracilis.* Miss A. M. White, the Librarian of the Department of Agriculture, obtained photocopies of Fitzgerald's unpublished illustrations. Mr. R. D. Royce gave assistance in preparing the article.

OCCURRENCE OF THE GHOST BAT, *MACRODERMA GIGAS,* IN THE GREAT VICTORIA DESERT, W.A.

By W. H. BUTLER, Bayswater

Hitherto the most southern recent records of live examples of the Ghost Bat, *Macroderma gigas,* in Western Australia have been from the Pilbara district (Finlayson, 1958: 923), though there was a sight observation from the Barlee Range (Robinson, 1957: 232). Subfossil remains in caves are known, however, as far south as Margaret River (Cook, 1960: 107).

In August-September 1961 I participated in an expedition by local naturalists to the Warburton Ranges and on August 29 collected a live specimen of the Ghost Bat in a shallow cave at Gahnda rockhole, on the Laverton-Warburton road, approximately 65 miles south-west of the Australian Inland Mission at the Warburton Ranges.

The locality is in the "Desert Zone" described by Talbot and Clarke (1917) and recent rainfall maps give a mean annual rainfall for the region as between 6 and 8 in. The surrounding vegetation is spinifex *(Triodia)* and mulga (*Acacia aneura*). The cave was in a low "desert sandstone" (ferruginous laterite) breakaway, the opening being 12 ft. wide and 6 ft. high, expanding into a chamber 22 ft. long, 12 ft. high and 18 ft. wide, with two small tunnels extending further back. Tracks and bone remnants indicated these to be a dingo's lair.

The bat was flushed from the dark area immediately behind the entrance when I entered the cave at 11.30 a.m. It flew out of the cave and immediately returned, inspecting me whilst it was still in flight. It flew out again and I temporarily lost sight of it. I located it soon afterwards in a shallow overhang nearby just shaded from the sun. I collected it by firing a .22 calibre copper slug into the rock wall just below its head and the spatter of fragments stunned the animal sufficiently to enable me to capture it.

Particulars of the specimen, which has been lodged at the Western Australian Museum (No. M4637), are as follows: Adult male. Dimensions, length of head and body, 115 mm.; head, 53; forearm, 119; thumb, 12; 1st finger (1st joint), 87; 2nd finger (1st joint), 75; 3rd finger (1st joint), 84; 4th finger (1st joint), 88; lower leg, 51; ear, 51; tragus, 27. Colour, white underparts and wing membranes, pale grey on the back and shoulders.

This record re-opens the problem of the disappearance of the species from the more southern parts of the State. The Gahnda locality is about 450 miles south-east of the Pilbara district, and in some of the harshest desert country in inland Western Australia. That the creature can exist here makes untenable the supposition of Wood Jones (1925: 444) that *Macroderma* disappeared from southern South Australia (he was referring to its former presence at the Carrieton Caves, east of Port Augusta) owing to increasing desiccation. Rather, it would appear, *Macroderma* in Western Australia (south of the Kimberley Division) and South

Australia is a desert animal and its former presence in southern localities may be evidence of a more arid climatic interval at that time. Cook (1960: 108) has already offered this explanation to account for the presence of remains of the Fat-tailed Dunnart *(Sminthopsis crassicaudata)* and the Dalgite *(Macrotis lagotis)* in certain of the South-West caves. Some of the distribution maps given by Lundelius (1957) would suggest the same thing, namely that creatures (such as *Dasycercus* and *Sminthopsis hirtipes)* now found living only in distant desert areas once inhabited localities in what is now more humid country towards the South-West corner.

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THE FLORA OF THE SHOALWATER BAY ISLANDS

By G. M. STORR, Zoology Department, University of Western Australia

INTRODUCTION

The Cape (or Point) Peron peninsula is the only portion of a north-south trending ridge of limestone that is now attached (as a tombolo) to the mainland. To the north of Cape Peron supramarine segments of the ridge constitute the present Garden and Carnac Islands, the Mewstone and the Stragglers. South from Cape Peron the ridge extends as a chain of islets and reefs to the southwestern corner of Warnbro' Sound. For geological details of this area see Fairbridge (1950) and Carrigy (1956).

The flora of Garden and Carnac Islands have been listed by McArthur (1957). The flora of the southern islands is described herein for the first time. All the islands forming the western boundary of Shoalwater Bay are vegetated. The rocks and islets stretching south from Penguin Island to the Seven Sisters were scanned from the former with field glasses and appeared devoid of plant-life.

A series of islands, such as Bird, Gull, Seal, Shag and Penguin, which vary in size and number of habitats, illustrates the process of floristic impoverishment in shrinking land masses. The larger islands, Penguin and Seal, with their beaches and dunes support a moderately rich flora. As the islands decrease in area from about three to two acres, especially when their longer axis as in Shag and Bird is east-west, dunes and beaches are swept away with ensuing loss of several plant species. Further reduction in area results in the extinction of the last remnants of sclerophyllous shrubbery, and the process is complete when such hardy lithophytes as *Carpobrotus* and *Nitraria* disappear.

Another fruitful field is the effect on the vegetation of hordes of nesting and roosting seabirds. This aspect will be dealt with separately by Dr. Mary Gillham who accompanied the writer on the islands in October 1959.

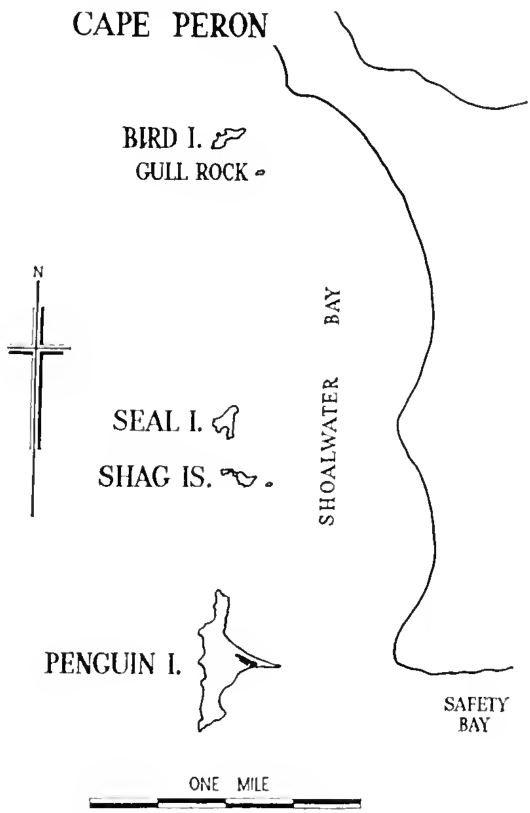

Fig. 1.—Map of islands south of Cape Peron. The extent of the settlement on Penguin Island is indicated by hachuring.

BRIEF DESCRIPTION OF THE ISLANDS

Penguin is by far the largest and most varied island in the group. In its orientation, shape and physiography, it is a small replica of Garden Island. The northern and southern headlands are rocky. The centre is covered with dunes whose western slopes are unstable and much of this area is blown out, the freshly exposed sand being reddish as on Garden Island. The steep sheltered eastern slopes of white sand are stable and heavily vegetated. To the east of the dunes a beach has been formed, which extends as a spit towards the mainland.

Shag Island has recently been fragmented into three unequal portions, herein referred to as West, Middle and East Shag. Owing to their east-west trend they lack dunes and beaches. The largest is Middle Shag, the top of which is a plateau gently dipping to the north and thinly covered with soil. Below the plateau on the northern side is a sand scree remarkable for a small but tenacious stand of *Myoporum insulare*. The southern face of the island is largely composed of rock falls interspersed with shelves of sand.

Seal Island consists of three rocky headlands (in the north, southwest and southeast) connected by a sandy saddle, in the lee of which a small beach has formed. Of the smaller islands its physiography is the most varied, as is consequently its vegetation.

Though a little larger and higher, Bird Island is very similar in orientation and physiognomy to Shag Island. Its plateau dips to the north and its western end is in process of being dismembered. Its eastern satellite is similar to East Shag but is further removed and has received a separate name—Gull Rock.

ISLAND HABITATS

1. **Honeycombed rock with soil restricted to cracks and depressions.** This comprises the whole of the smallest islands and the windward cliffs of the larger. *Nitraria schoberi* and *Carpobrotus aequilaterus* are usually the only plants present. *Salicornia australis, Sporobolus virginicus* and *Wilsonia backhousei* are rare and local in shallow depressions on rock edges drenched with spray.

2. **Talus slope.** Where undercut cliffs fall in sheltered situations there accumulate rock debris of various size together with sand formed locally by weathering of freshly-exposed soft limestone. Characteristic plants: *Nitraria, Carpobrotus, Enchylaena tomentosa, Threlkeldia diffusa, Tetragonia implexicoma, Calandrinia calyptrata, Senecio lautus, Bromus spp., Apium australe* and *Solanum nigrum.*

3. **Level or gently sloping rock with a thin mantle of soil.** This is typically represented by the plateau-like tops of the larger islands, and is the principal site of the gull rookeries. Characteristic plants: *Carpobrotus, Lavatera plebeia, Lepidium foliosum, Malva parviflora, Hordeum leporinum, Melilotus indica, Medicago denticulata,* and (where the soil is deeper) *Rhagodia baccata.* Where there are few or no surface-nesting sea-birds, as on Penguin Island, sclerophyllous species may be present, e.g. *Frankenia pauciflora, Scaevola crassifolia, Angianthus cunninghamii* and *Scirpus nodosus.*

4. **Foredunes.** Raised beaches occur only on the eastern side of the larger and north-south orientated islands, viz. Penguin and Seal; on the latter their extent is limited. Characteristic plants: *Cakile maritima, Arctotheca nivea, Tetragonia zeyheri, Salsola kali, Spinifex longifolius* and *Atriplex cinerea.*

5. **Windward slope of dunes.** Restricted to Penguin Island. Characteristic plants: *Spyridium globulosum, Alyxia buxifolia* and *Conostylis candicans.* Blowouts are common and there are extensive areas of bare sand near the central western coast.

6. **Leeward slope of dunes.** The sheltered eastern slopes of the dunes on Penguin Island are covered with *Acacia rostellifera* scrub. The habitat is absent on the other islands except for a slight development in the lee of the southwestern headland of Seal, where however there is no great depth of sand and the prevailing vegetation is a low, dense, wind-pruned thicket of *Pittosporum phillyraeoides*.

TABLE 1.—AREA, APPROXIMATE ALTITUDE AND HABITATS OF EACH ISLAND

island	area (acres)	altitude (feet)	niches present
Penguin	29.4	60	1,2,3,4,5,6
Seal	3.0	30	1,2,3,4,6
Bird	2.2	35	1,2,3
Middle Shag	1.1	30	1,2,3
West Shag	0.4	20	1,2,3
East Shag	0.1	15	1,3
Gull	0.1	10	1

ANNOTATED LIST OF PLANTS

Exotic species are prefixed with an asterisk.

GRAMINEAE

*Stenotaphrum secundatum (Walt.) O. Kuntze. "Buffalo grass" is established on the east side of Penguin in the vicinity of the settlement.

Spinifex longifolius R. Br. Coarse perennial grass, dominant above the eastern beaches of Penguin and Seal.

Spinifex hirsutus Labill. Coarse perennial grass, above beach at Penguin (rare).

*Ehrharta longiflora Sm. Annual grass. Penguin.

Stipa variabilis Hughes. Perennial tussock-grass. Penguin (dunes).

Sporobolus virginicus (L.) Kunth. Rare couch-like perennial grass growing near top of sea-sprayed cliffs. Penguin, Seal.

*Avena fatua L. "Wild oats." Penguin.

Poa caespitosa Forst. Perennial tussock-grass. Penguin (dunes).

*Poa annua L. Annual grass. Penguin, Seal, Bird.

*Vulpia myuros (L.) Gmel. Annual grass. Penguin.

*Bromus gussonii Parl. Annual grass. Penguin, Middle Shag, Seal.

Bromus arenarius Labill. Annual grass. Penguin, Middle Shag, Seal, Bird.

*Brachypodium distachyon (L.) Roim. and S. Annual grass. Penguin.

*Lolium rigidum Gaud. "Wimmera rye-grass." Penguin, Seal, Bird.

*Parapholis incurva (L.) Hubb. Annual grass. Penguin.

*Hordeum leporinum. Link. "Barley-grass." Common in gull rookeries: Middle Shag, Seal, Bird.

CYPERACEAE

Scirpus nodosus Rottb. Tall perennial sedge. Penguin.

Scirpus antarcticus L. Small annual sedge. Penguin (common in dunes).

Lepidosperma gladiatum Labill. "Sword-rush." Penguin (common above beach).

LILIACEAE

*Anthericum divaricatum Jacq. Perennial herb. Above beaches: Penguin, Seal.

Acanthocarpus preissii Lehm. Sclerophyllous, subfruticose perennial. Penguin (dunes), Seal (2 plants only).

AMARYLLIDACEAE

Conostylis candicans Endl. Perennial herb. Penguin (windward slope of dunes).

URTICACEAE

Parietaria debilis G. Forst. Annual herb. Penguin, Middle Shag, Seal, Bird.

POLYGONACEAE

Muehlenbeckia adpressa (Labill.) Meisn. Perennial twiner. Penguin (above beach and on dunes).

CHENOPODIACEAE

Rhagodia baccata (Labill.) Moq. Succulent shrub. Penguin, Middle Shag, Seal, Bird.

***Chenopodium murale** L. Annual herb. Middle Shag (common on northern talus slope), Bird (rare).

Atriplex cinerea Poir. Succulent shrub. Seal (above beach).

Salsola kali L. Annual herb. Above beaches: Penguin, Seal.

Enchylaena tomentosa R. Br. Spreading succulent shrub, common on talus slopes. Penguin, Middle Shag, Seal, Bird.

Threlkeldia diffusa R. Br. Ascending succulent perennial. All islands except Gull (common on rock and talus).

Salicornia australis Banks and Sol. Ascending succulent perennial. Penguin (top of northwestern cliffs).

AIZOACEAE

Carpobrotus aequilaterus (Haw.) N.E.Br. Succulent perennial. All islands (common).

***Carpobrotus edulis** (L.) N.E.Br. Succulent perennial, established in the settlement, Penguin.

Tetragonia implexicoma (Miq.) Hook. f. Succulent perennial, common on talus. Penguin, Middle Shag, Seal.

Tetragonia zeyheri Fenzl. Succulent perennial, common above beaches. Penguin, Middle Shag (rare), Seal, Bird (northern slopes).

PORTULACACEAE

Calandrinia calyptrata Hook. f. Prostrate succulent annual, common on talus. Penguin, Middle and West Shag, Seal, Bird.

CARYOPHYLLACEAE

***Cerastium viscosum** L., ***Stellaria media** (L.) Vill., ***Spergularia rubra** (L.) J. and C. Presl., ***Polycarpon tetraphyllum** Loef. Small annual herbs in dunes. Penguin.

RANUNCULACEAE

Clematis microphylla DC. Woody climber in **Acacia rostellifera** scrub, Penguin.

LAURACEAE

Cassytha racemosa Nees. Perennial climber, on **Acacia rostellifera**, Penguin.

CRUCIFERAE

***Sisymbrium orientale** L. Annual herb. Penguin, Middle Shag, Seal, Bird.

Lepidium foliosum Desv. Annual or short-lived perennial herb, common in gull rookeries. Middle Shag, Seal, Bird.

Cakile maritima Scop. Annual herb. Above beaches: Penguin and Seal.

Hymenolobus procumbens (L.) Nuttall. Small annual herb. Talus: Seal.

CRASSULACEAE

Crassula colorata (Nees) Ostenf. Small annual herb. Penguin (dunes), Seal and Bird (sandy talus).

Crassula pedicellosa (F.v.M.) Ostenf. Small annual herb. Penguin (**Acacia rostellifera** scrub).

PITTOSPORACEAE

Pittosporum phillyraeoides DC. Shrub. Penguin (rare), Seal (dense thicket).

LEGUMINOSAE

Acacia cyclopis A. Cunn. Shrub. Penguin (a single clump in open **Spyridium-Alyxia**).

Acacia rostellifera Benth. Tall shrub. Penguin (forms dense scrub on leeward slope of sand-dunes), Bird (northern slopes).

***Melilotus indica** (L.) All. Annual herb. Penguin, Middle Shag, Seal, Bird.

***Medicago denticulata** Willd. Annual herb. Penguin, Seal, Bird.

GERANIACEAE

*Erodium cicutarium (L.) L'Her. Annual herb. Gull rookeries: Middle Shag, Seal, Bird.

OXALIDACEAE

Oxalis corniculata L. Small annual herb. Penguin (shallow soil over limestone, rare).

ZYGOPHYLLACEAE

Nitraria schoberi L. Spreading succulent shrub, common on rock and talus, all islands.

Zygophyllum billardieri DC. Succulent scrambling herb. Seal (in sand among Rhagodia), Bird (sandy eastern top of western sector).

RHAMNACEAE

Spyridium globulosum (Labill.) Benth. Shrub. Penguin (windward slope of dunes).

MALVACEAE

*Lavatera arborea L. Tall perennial herb. Bird (a few with L. plebeia, western sector).

Lavatera plebeia Sims. Tall perennial herb. Gull rookeries: East, Middle and West Shag, Seal, Bird.

*Malva parviflora L. Annual herb. Gull rookeries: Middle Shag, Seal, Bird.

FRANKENIACEAE

Frankenia pauciflora DC. Small ericoid shrub. Shallow soil over limestone, especially above western cliffs: Penguin, Seal.

UMBELLIFERAE

Apium australe Pet.-Thou. Annual herb. Talus: Penguin, Middle Shag, Seal, Bird.

PRIMULACEAE

*Anagallis femina Mill. Annual herb. Penguin (dunes).

APOCYNACEAE

Alyxia buxifolia R.Br. Shrub. Penguin (windward face of dunes).

CONVOLVULACEAE

Dichondra repens R. and G. Forst. Small, stoloniferous herb. Penguin (shallow sand over limestone).

Wilsonia backhousei Hook. Small, ascending, shrublet. Penguin (a single colony in a sea-sprayed depression near top of northwestern cliffs).

SOLANACEAE

*Solanum nigrum L. Herb. Penguin, Middle Shag, Seal, Bird.

Anthocercis littorea Labill. Short-lived, mesophyllous shrub. Penguin (2 plants at eastern foot of dunes).

SCROPHULARIACEAE

*Dischisma arenarium E. Mey. Annual herb. Penguin.

MYOPORACEAE

Myoporum insulare R. Br. Woody shrub with semi-succulent leaves. Penguin, Middle Shag, Seal, Bird.

GOODENIACEAE

Scaevola crassifolia Labill. Low, spreading shrub with semi-succulent leaves. Penguin (a few plants above southwestern cliffs).

COMPOSITAE

*Erigeron canadensis L. Annual herb. Penguin.

Olearia axillaris (DC.) F.v.M. Shrub. Penguin (dunes), Seal (above beach), Bird (a few plants near top).

Senecio lautus Soland. Herb. Sandy talus: Penguin, Middle and West Shag, Seal, Bird.

*Arctotheca nivea (L.) Hoffm. Annual herb. Seal (a few on beach).

*Arctotheca calendula (L.) Levyns. Annual herb. Penguin, Seal, Bird.

Helichrysum cordatum DC. Perennial herb. Penguin (a few plants above beach).

Angianthus cunninghamii (DC.) Benth. Shrub. Penguin (a few plants in southwestern dunes).
***Carduus tenuiflorus** Curtis. Annual herb. Penguin (on sand in sheltered situations).
***Hypochoeris radicata** L. Annual herb. Penguin.
***Sonchus oleraceus** L. Annual herb. Penguin, Middle Shag, Seal, Bird.

TABLE 2.—CATEGORIES OF PLANTS ON EACH ISLAND

	Penguin	Seal	Bird	Middle Shag	West Shag	East Shag	Gull
Sclerophytes	22	7	3	1	0	0	0
Mesophytes	4	2	2	2	1	1	0
Succulents	8	9	7	7	3	3	2
Annuals	11	9	6	5	2	0	0
Total Indigenous	45	27	18	15	6	4	2
Exotics	27	14	13	9	0	0	0
Total Flora	72	41	31	24	6	4	2

DISCUSSION

When the number of indigenous species per island is plotted against the logarithm of its area, as in Fig. 2, the relationship is seen to be linear, which indicates a generally even rate of plant extinction with diminishing area.

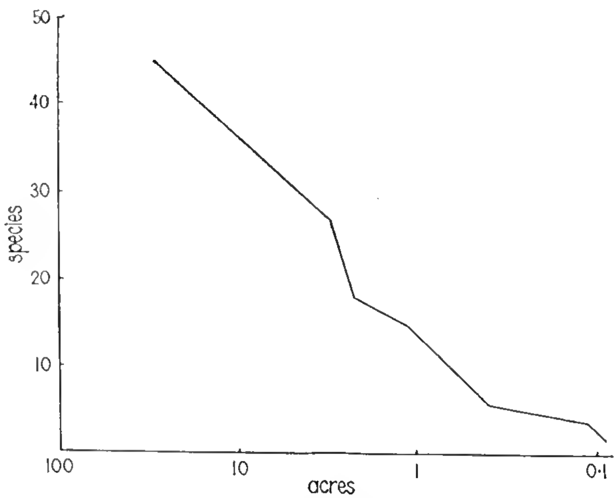

Fig. 2.—Number of plant species graphed against area of island (the scale of the latter is logarithmic).

The gradient is steepest between Seal and Bird, i.e. when area (aggravated by unfavourable orientation) becomes too small for the maintenance of dunes and beaches. These latter are the principal niches respectively for sclerophyllous shrubs and grasses (with sedges); consequently floristic disparity between Seal and Bird Islands is greatest in number of sclerophytes.

On the other hand the effect of diminishing area on number of succulent species is not nearly so marked; indeed Seal Island has

9 species against 8 on Penguin, which is ten times as large. The extinction rate for other plant categories lies between these extremes, the result of which is a steady change in composition of the flora, as well as its general impoverishment, as the islands diminish in area. For example, on Penguin Island sclerophytes comprise nearly half the indigenous flora; on Seal, Bird and Middle Shag their proportion is respectively 26, 17 and 7%.

Opportunity for exotic species to establish themselves likewise declines as the islands (and their number of niches) become smaller.

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FROM FIELD AND STUDY

Children's Python Preying on Free-tailed Bat.—On June 26, 1960, in a cave on Mt. Anderson, 70 miles south-east of Derby, I noticed a Children's Python *(Liasis childreni)* crawling along a rock ledge 20 ft. above the floor. Almost as soon as I saw the snake it struck at a Free-tailed Bat *(Taphazous georgianus),* secured a grip and coiled about it. The bat soon weakened and fell. The two creatures landed at my feet and when I picked them up the bat was dead. I carried them back to our camp a mile away and the snake did not release its hold until it was placed in a collecting bag. The snake measured 18 in. in length.

—PETER SLATER, Derby.

White Ibis in the South-West.—The White Ibis *(Threskiornis aethiopica)* has made its appearance once more in the Murray District. In the irruption of 1952, when there was a large influx of the Straw-necked Ibis into this area, White Ibis were seen. This year beside the usual 30-50 resident Straw-necked Ibis there has been an influx of ibis presumably from the north but not so many as in 1952. In July 1961 Colin Paterson saw a White Ibis among 20-30 birds two miles north of Pinjarra. On August 9 Fred Grantham saw a White Ibis with black head and black tip to wing in a flock of 20-30 birds two miles west of Coolup. I have not heard of any other species which was noted in the southern irruption of 1952 *(W.A. Nat.,* 3: 177-196) having been seen this year.

—ANGUS ROBINSON, Coolup.

Pheasants Feeding on Snails at Rottnest I.—On October 9, 1960 a hen Pheasant *(Phasianus colchicus),* a species introduced on Rottnest Island, struck a power line after a high speed take off and dropped dead. The crop seemed unduly swollen and hard. On examination I found it to be crammed with snails *(Theba pisana).*

This confirms the observation of Serventy and Storr (*W.A. Nat.*, 8 1959 : 196).

Pheasants also eat the dune snail, *Cochlicella acuta*. On March 30, 1961 I was brought a hen pheasant killed when it flew into a wire fence near the water catchment. Its crop was filled with the small shells of *Cochlicella*. Mr. George Dittmer, lighthouse keeper, told me that the crop of a hen pheasant killed recently when it flew into a wireless aerial was also crammed with dune snails.

—W. A. FARMER, Rottnest Island.

Calls of the Boobook Owl *(Ninox novaeseelandiae)*.—Two observations which I made on the Peel Estate in September-October 1936 may possibly throw some light upon the function of the calls described by Eric Lindgren (*W.A. Nat.*, 8 : 207) and by G. Storr (*W.A. Nat.*, 4 : 143).

Twice I tried to locate a calling bird and on each occasion a persistent "normal" call was modified to a rapid and sustained "cook-cook-cook", the usual measured "boo-book" being resumed after my withdrawal from the vicinity.

More recently, December 29, 1960, when my son Lindsay and I were camped in the Porongorups, the "book-book-book" call was heard followed by a muffled "boo-book" which developed into the characteristic call. In this case the bird *may* have been influenced by our proximity.

In the foregoing paragraphs I have followed the relevant field notes in rendering the call as "cook-cook" in one place and "book-book" in the other. This is not significant.

Twice in January 1951, at Wooroloo, we heard atypical calls. In the first instance two birds were calling and I recorded—rather vaguely—that the calls were "obviously *Ninox* but not typical being almost tri-syllabic", and a few days later my son saw and heard a Boobook Owl, "the call being quite distinct from that usually associated with the species." I saw the bird only.

From these records it would seem that there are at least two variants of the well-known "boo-book" call.

—ERIC H. SEDGWICK, Collie.

Possible Predation by a Lycosid Spider on a Vertebrate.—While collecting at Culham in September 1960 I turned over a stone and a small grey skink (possibly *Ablepharus* sp.) ran out. It was immediately seized by a spider (which was later identified by B. Y. Main as a juvenile *Lycosa*, possibly *L. leuckarti)*.

The lizard as it struggled shed its tail. The spider then dropped its victim and pounced on the wriggling tail and the lizard made its escape into a pile of rocks.

This instance of possible predation adds to the list of spiders preying on vertebrates reported by Main and Butler (*W. Aust. Nat.*, 7, 1959: 52).

—P. McMILLAN, Guildford.

Predation on Mouse by Centipede.—W. H. Butler and B. Y. Main *(W.A. Nat.*, 7, 1959: 52) refer to instances of frogs being preyed on by spiders. Another example of the phenomenon of a terrestrial vertebrate being preyed on by an invertebrate was reported to us by Mr. Ashburton H. Clark, fisheries inspector at Onslow. Mr. Clark wrote that in November 1960 a Public Works Department employee found a mouse being attacked by a centipede. The discovery was made when the employee lifted a large piece of timber and the centipede and the mouse were found struggling underneath it. Mr. Clark added that as far as could be observed, the mouse was the ordinary grey domestic species *(Mus musculus)* and of medium size. The centipede was described as being one common in those parts, with a pale bottle-green body and a reddish head. It was about 6½ in. long. When first seen the centipede was wrapped around the body of the mouse and had its

Centipede devouring a mouse.

jaws clamped into the mouse's spine near the back of its neck. At this stage the mouse was still struggling.

Later the centipede shifted its hold so that it lay along the spine of the mouse with some of its legs around the tail and hind quarters. The forepart of the centipede lay over the shoulder and neck of the mouse and the centipede had torn a hole in the throat and was busy devouring the flesh. One of the employees pushed a small stick, about the size of a pencil, between the centipede and the mouse and carried the two of them to the front of the goods shed for exhibition. This did not interfere, Mr. Clark said, in any way with the centipede, which continued its meal quite oblivious of what was going on around it. The two creatures were then photographed and, so far as Mr. Clark was aware, no further observations were made. The photograph is here reproduced.

—H. B. SHUGG, Fisheries Department.

OBITUARY

STANLEY FOWLER

Stanley Fowler, a noted pioneer in fisheries exploration and in aerial observations in marine ornithology, died in Melbourne on January 23, 1961. He was born at Williamstown, Victoria on November 23, 1895. Though he was not a member of the Western Australian Naturalists' Club he knew many members and was closely associated with their activities in the years he was working in this State, between 1942 and 1946. Some of our members who were war-time airmen also met Fowler as a fisheries observer with the R.A.A.F., where he was familiarly known as "The Admiral" and "Peg Leg."

Stanley Fowler, 1944.

The latter name was in allusion to a severe leg injury he received in World War I. He was at the Gallipoli landing and in France, and was severely wounded at Pozieres. Wounded in the leg he lay on the battlefield apparently dead and had just lifted his head when an enemy sniper shot him between the eyes. Almost miraculously he survived. However, by an amazing coincidence his brother John was killed by a similar shot in the same battle.

These wounds caused him great physical discomfort in later life and eventually led to his being invalided out of the Commonwealth Scientific and Industrial Research Organisation in July 1948, when he held the rank of Principal Research Officer in the Fisheries Division.

Though not a professionally trained biologist Fowler was the real founder, and in its earlier years the main driving force, of the Fisheries Division. He joined the Commonwealth Public Service in March 1920 and held responsible posts in the Bureau of Commerce and Industry, Board of Trade, Department of Markets and Migration, and the Development and Migration Commission. Whilst with the Commission he was organizing secretary of the Australian Fisheries Conference of 1927-29 and prepared a very valuable fisheries map of Australia, for long a basic work of reference. A programme of fisheries research and the planning of a research vessel was projected but the economic depression delayed progress. Funds only became available in 1934 after he had personally addressed Federal Cabinet on the subject. The fisheries investigations with Fowler as Commonwealth Fisheries Officer, were first attached to the Development Branch of the Prime Minister's Department and in July 1935 these were transferred to the Council for Scientific and Industrial Research.

As soon as he was able Fowler enthusiastically made personal surveys of pelagic fish occurrences (mainly of the tuna species) in the Tasmanian region in whatever craft were available for occasional engagement. In December 1937 he surveyed south-east Tasmania in the police patrol boat *Allara;* in January 1938 he was in the Flinders I. region in the police boat *Falcon*, and in February-March the same year he cruised in Bass Strait and northern and eastern Tasmania south to Pedra Branca in the auxiliary ketch *Peter R.* In May of that year, 1938, the *M.V. Warreen,* research vessel of the Fisheries Division, came into service and Fowler was a member of both parts of its first cruise (May 11 to June 9 from Melbourne to Tasmania; July 22 to August 19 Melbourne to the Furneaux Group and north to Cronulla, N.S.W.). He made several cruises in the vessel subsequently before it was taken over by the Navy in 1942 for use in World War II.

However, it was in connection with his aerial reconnaissances of Australian coastal waters that Fowler was best known. He became impressed with the possibilities of aerial observations after discussions with Squadron-Leader Hemphill of the R.A.A.F., who described to him the large schools of fish he saw off the north-west coast in W.A. Fowler wrote to Sir David Rivett in January 1936 suggesting the utility of aerial surveys and the Air Board agreed to the use of air force planes for fisheries reconnaissances.

The first series of flights were made in a Seagull Amphibian between October 21 and December 1, 1936 from south of Sydney to southern Tasmania. The second series were made in the same region in February-March 1937; the third in July-August between Cairns and southern Tasmania; the fourth in August in Port Phillip and Westernport whilst he was an observer accompanying a training flight. Most of these flights depended on aircraft being available and where there were some aeronautical facilities, such as landing grounds. The next flights were made in November-December 1938, in co-operation with surveys by the *Warreen*, and similar plane-ship co-ordinated surveys were carried out in South Australia in February-March 1939. Extension of the aerial surveys into Western Australian waters was planned for October 1939, but the outbreak of World War II led to their abandonment.

The War, however, did not extinguish the aerial work, but, in fact, led to Fowler making some of his most fruitful flights. After the War began an application was made at his instigation to the R.A.A.F. for permission for an observer of the C.S.I.R. to accompany some of the coastal patrols in order to capitalise, in a fisheries sense, on some of the extensive patrols being conducted at the time. This request was not met until late in 1942 when permission was granted to Fowler to accompany operational flights in Australia, except broadly, the north of Australia. He decided to use the operational flights offering in Western Australia since that State had not been surveyed in any way by C.S.I.R. Flights began in December 1942 and continued at intervals until 1946.

Much useful information was accumulated, not only of pelagic fish occurrences but of the movements of whales. He even arranged for the dropping of drift bottles out at sea for ocean current studies. In these war-time flights many hazards had to be contended with and the "Admiral" gained the esteem of many young officers for his intrepidity in seeking flights in dangerous situations. These were not without their moments of drama. On one occasion in an American aircraft, the pilot confused the identity of the Cape Leeuwin and Cape Naturaliste lights, and kept going on into the Southern Ocean. Fowler prevented a certain disaster by persuading the pilot of the accuracy of his own observations on their probable position.

In August 1944 the R.A.A.F. reverted to the pre-war arrangement by which an aircraft was made available especially for the fishery work and this was continued until the final aerial survey in 1946 (in which the writer of this article was able to participate) when the post-war dissolution of R.A.A.F. facilities made further flights of this nature impracticable. These planned flights added notably to the documentation of biological phenomena along the W.A. coast. In May and June 1945 Fowler discovered remarkable concentrations of pilchard *(Sardinops neopilchardus)* shoals in the western Bight, between the Recherche Archipelago and Point Culver. Gilbert Whitley, the Australian Museum ichthyologist who accompanied him on a second flight to the area, estimated there were 60,000 shoals visible along one strip of 50 miles *(Proc. Roy. Zool. Soc. N.S.W. for 1947-48:* 17-27). Later in the same year the flights were conducted in association with a boat survey along the coast from Fremantle to King Sound in the chartered lugger *Isobel,* skippered by the late Erik Akerstrom and in which Whitley was the scientific observer. These Western Australian flights ended in August 1946. However, Fowler continued his activities in the State by assisting to organise the re-commissioning of F.R.V. *Warreen,* which was now released by the Navy. It began its operations in Western Australian waters in 1947.

Fowler was very disappointed at this time at not receiving the leadership of a new section in the Fisheries Division (the Section of Fisheries Exploration) which he had been led to believe would be his. This was the crowning frustration in a fisheries career which was more than ordinarily turbulent. He was described by one of his colleagues as a "crusading type", and, as such men often are, not always easy to get on with. He firmly believed in the richness of Australia's fisheries potential, criticised the current belief in the necessarily low productivity of tropical seas, stressed the patchiness of plankton occurrences (based on his aerial observations of krill swarms), and developed a firm faith in the utility of aerial observation of pelagic fish occurrences. And he had the energy and persistence to advance these views uncompromisingly in defiance of the prevailing scientific thought of the time. The years have shown that he was right in many of the views he held. In respect to the value of aircraft he was vindicated whilst he was still in the C.S.I.R.O. service and in January 1946 he had the satisfaction of receiving the following tribute from Sir David Rivett: "Obviously there no longer remains any shadow of doubt about the practical value of aerial spotting; and in view of past history which will still be within your recollection, it all represents quite a triumph for you and your steadfast faith."

His war-caused physical disabilities became an increasing burden to him, and the loss of the control of the Fisheries Exploration Section was a blow which seems to have undermined his will to carry on with fisheries work. In July 1948 he retired from the service as medically unfit. The Exploration Section, without him, proved short-lived and the officer (from overseas) who was appointed as its head soon left the Organisation. The C.S.I.R.O. Executive honoured Fowler after his retirement by naming one of its research vessels after him, the F.R.V. *Stanley Fowler*.

Whilst he was engaged in fisheries surveys Fowler made detailed observations on sea-bird occurrences. In Western Australia he made low level flights over almost every island, of potential sea-bird interest, from Wyndham to the Archipelago of the Recherche, noted major sea-bird occurrences and documented much of his observation by a superb series of photographs. His knowledge of shorthand enabled him to write ample "on the spot" field notes of what he saw. He was also a talented sketcher. He did similar work in south-eastern Australia, where his most notable effort was on the five gannetries of *Sula serrator* which he photographed over successive seasons. All of these records were freely made available to other students, but unhappily he did not, as he had hoped, prepare any extensive publications on his work.

His bird papers are enumerated in Whittell's *The Literature of Australian Birds*. A very useful geographical account of the western coastline appeared in the report of the second annual conference of inspectors of the W.A. Fisheries Department, 1944.

Fowler was a robust virile man, brown-eyed and with a ruddy complexion, and who did not look his age; to the end he showed no grey in his dark hair. He had a zest for life, was something of a bon vivant, and, though his zeal for fisheries exploration and development gradually took over almost all his private life, he retained a wide interest in public affairs, literature and art.

—D. L. S.

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RE-DISCOVERY OF THE NOISY SCRUB-BIRD, *ATRICHORNIS CLAMOSUS*

By H. O. WEBSTER, Albany.

On December 17, 1961, in an area near Albany where I had been spending a good deal of time observing and photographing birds, my attention was caught by a series of bird calls which were quite new to me. They were fairly long and were also loud and frequent. I had to move over 200 yards and into very dense, high scrub surrounding a small sword or cut-rush covered swamp before I was close to the still calling bird. In spite of the noise I made in my approach it continued to call and I halted to listen about twenty feet from it. The loudness and richness of the calls were remarkable and I began to hope that it was indeed that will-o-the-wisp that has lured ornithologists in the past seventy-odd years into the thick scrubs of the South-West—*Atrichornis clamosus.** The bird moved off and I followed, unavoidably making enough noise to frighten any other bird away. This bird, however, repeatedly allowed me to get within ten or fifteen feet while it was calling, but I hardly caught a glimpse of it all that day, it was so adept at keeping itself under cover. I came away in the evening with impressions of a brown bird with a call that really made my ears ring and with the knowledge that it was almost certainly the Noisy Scrub-bird.

On the following Saturday morning, December 23, I was in the area soon after daybreak. I found the bird was calling in thick scrub on a sandy slope some distance from the sword-rush swamp. It heard me and a few minutes after I halted it appeared about ten feet away in a rather open bush. I had a reasonably good view of it with the naked eye as it was too close to use binoculars. It was dark brown, about nine inches long with a fairly long tail which had feathers graduated in length. The head and throat were hidden by leaves. It moved to my left and from a distance of ten to twelve feet gave a series of amazingly loud calls. I was by this time sure that it was the Noisy Scrub-bird. During the remainder of that day, I had only brief glimpses as I followed it when I could for the scrub was very difficult to get through. Next morning it was in a fairly extensive swampy flat which was rather more open but still densely covered by rushes, tall grasses, scrub and stunted banksia trees. As previ-

* The last published report of sightings of the species was in 1889, when A. J. Campbell collected a specimen at Torbay and heard the bird at Boogidup, 16 miles north of Karridale.

ously I was able to follow the bird about and had a number of views of it, none of them very clear. At last it ran up from the scrub into the fork of a banksia tree. This fork was about seven feet from the ground and luckily about twenty-five feet away so that I was able to make good use of my binoculars.

The Noisy Scrub-bird remained there for at least three minutes and also gave three calls in that time. The tail was held erect and vibrated slightly before and during the calls. The head was thrown up and as it was first facing me, I could see the yellow gape, the inverted white "V" under the beak and the blackish triangular patch below it. When the bird turned sideways to me, I noted that the wings were rounded, did not reach to the base of the tail and had darker brown fine barring running across them.

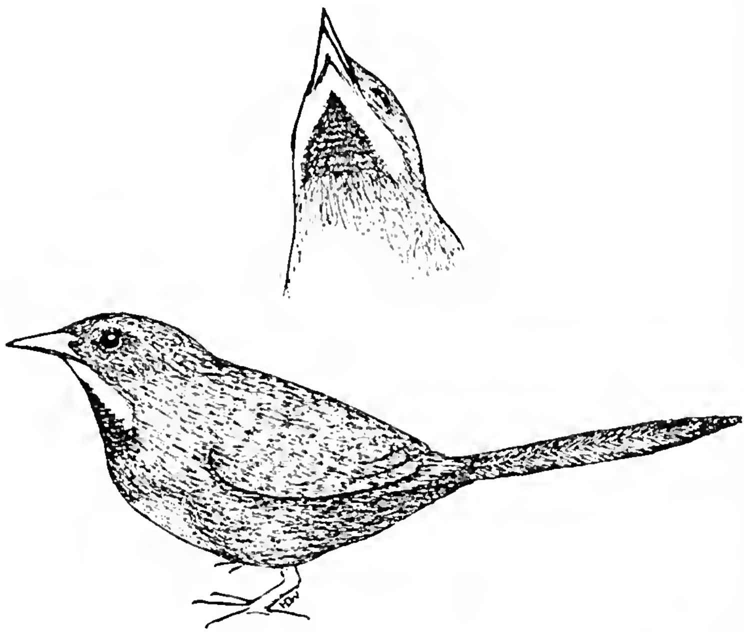


Fig 1.—The Noisy Scrub-bird, from field sketches by H. O. Webster.

The news of this reappearance of a bird thought to be almost certainly extinct was published in the *West Australian* newspaper on Christmas Day and on that morning I was very busy making tape recordings of its calls. Dr. D. L. Serventy was able to make the long journey down to Albany on December 28 and was delighted to confirm the identity of this remarkable bird, after seeing it a number of times and hearing its astonishing series of calls. The site has also been visited, and the bird seen and heard, by the following ornithologists: Dr. G. F. Mees, Messrs. C. Allen, J. R. Ford, J. B. Higham, C. F. H. Jenkins and D. W. Lamm. Mr. Allen recognised the notes we were listening to as calls he had heard in 1942 in this self-same swamp, where there has also been a regularly-tenanted holiday shack for many years. About 12 years ago a severe bushfire devastated the swamp and killed the large trees in it. This evidence suggests that the site has been occupied by Scrub-birds for a long period, despite human interference and fires. If the habitat is maintained in its present form there is no reason why the species should not continue here indefinitely. The site would make a very convenient study area and a scientific tourist resort.

Fig 2.—Habitat of the Noisy Scrub-bird, Albany district.

I hope to continue observations and record its life history as fully as possible. The precise locality is not given for obvious reasons and it is hoped that the area will shortly become a bird sanctuary. The photograph shows part of its habitat and the field sketches, though not especially good, do give some idea of the throat markings and the tail. The bird is extremely difficult to photograph and much patient work will be needed to obtain a good portrait.

MACRODERMA GIGAS SATURATA (CHIROPTERA, MEGADERMATIDAE) A NEW SUBSPECIES FROM THE KIMBERLEY DIVISION OF WESTERN AUSTRALIA

By A. M. DOUGLAS, Western Australian Museum, Perth.

INTRODUCTION

Adult specimens of *Macroderma gigas* from the south-western part of the Kimberley Division (Derby), throughout the Pilbara district, to the Warburton Ranges in the south-east of Western Australia, have a predominantly white ventral surface and agree in all respects with the original description of *Macroderma gigas* (Dobson, 1880), which is based upon a single specimen collected at

Mt. Margaret, Wilson River, Central Queensland. However, specimens from the north-west Kimberley Division (Kalumburu) and Arnhem Land (Millingimbi) are distinctly different and merit nomenclatural separation as a subspecies.

Macroderma gigas saturata subsp. nov.

Diagnosis: The new subspecies differs from the nominate race in its very distinct colour. In adults of the new subspecies the basal three-fourths of the hairs on the dorsal surface are Deep Mouse Gray changing to Hair Brown in the terminal quarter (colour names with initial capitals from Ridgway's *Color Standards and Nomenclature*). On the ventral surface the basal quarter of each hair is Neutral Gray and the terminal three-fourths off-white. The hair of the throat is off-white to its roots. Individual specimens vary in shades of brown and gray.

By comparison, in adults of the nominate subspecies, dorsal hairs are basally Pale Neutral Gray for one-third of their length while the terminal two-thirds are Pale Drab Gray. All hair on the ventral surface is white to the roots.

Fur colour in races of *Macroderma gigas*. 1-4, *M. g. saturata;* 5-6, *M. g. gigas*. 1.—Fur from dorsal surface of holotype of *M. g. saturata*. 2.—From ventral surface of holotype of *M. g. saturata*. 3.—From dorsal surface of ♂ paratype of *M. g. saturata* (M 4415). 4.—From ventral surface of ♂ paratype of *M. g. saturata*. 5.— From dorsal surface of ♀ *M. g. gigas* (M 4637). 6.—From ventral surface of ♀ *M. g. gigas* (M 4637).

Membranes (ie. ears and wing membranes) are brownish in *M. g. saturata,* but there is some individual variation. These membranes are pinkish white in *M. g. gigas.*

It should be noted that immature specimens of *Macroderma gigas* (of both subspecies) are much darker ventrally and browner dorsally than adults and comparisons should be made only between fully adult specimens.

There is considerable variation in measurements of *Macroderma* over the whole of its range but no consistent difference in size can be determined between the various populations.

Holotype. Western Australian Museum No. M 4416 ♀ (gravid). Collected in a cave at Kalumburu, north-west Kimberley Division (180 miles N.W. of Wyndham), on June 23, 1960, by A. M. Douglas. Paratypes M 4415 ♂ and M 4418 ♀ both collected with the type.

DESCRIPTION OF HOLOTYPE

A female in spirit (including embryo). Portion of skin removed from dorsal and ventral surfaces and mounted dry on card. This specimen had been in spirit for 12 months and kept in darkness before the removal of the portions of skin.

Live weight with embryo, 139 gm. Weight of the embryo, 1.7 gm. Weight of holotype removed from spirit, 141 gm. Length, 125 mm.; over the curves, 141 mm. Head, 44 mm. Ear, 52.4 mm.; tragus, anterior lobe, 13.5 mm.; posterior lobe, 25.2 mm. Nose leaf, 19 x 11 mm. Fore arm, 100.5 mm. Metacarpals—2nd finger, 78.5 mm.; 3rd finger, 69.2 mm.; 4th finger, 76.2 mm.; 5th finger, 79 mm. Tibia, 44 mm. All measurements, with the exception of the live weight, are taken from the preserved spirit specimen.

The animal is generally dark, especially on the flanks; the throat is lighter and there is another light patch on the thighs. Teeth are worn and the membranes of the wings and ear are brownish.

The clitoris and vulva are both enlarged and both inguinal and pectoral mammae are enlarged.

DISCUSSION

These dark coloured populations of *Macroderma gigas* were first brought to my notice on a visit to Kalumburu Mission in June 1960 where I examined a series of 70 individuals in one cave and collected four fully adult specimens. All of these were dark on the ventral surface. My host at the Mission, Fr. S. Sanz, O.S.B., assured me that these bats were invariably dark and he pointed out that the name "Ghost Bat," the accepted vernacular name in the south for this species, is singularly inappropriate for the Kalumburu form. Specimens of *Macroderma gigas* received at the Museum from Millingimbi Mission in Arnhem Land in June-July 1960 belong to this same dark form.

REFERENCE

DOBSON, G. E. 1880. On some new or rare species of Chiroptera in the collection of the Göttingen Museum. *Proc. Zool. Soc. London*; 461-462, pl. 46.

A SURVEY OF THE FAUNA AND FLORA OF ROCKY SHORES OF CARNAC ISLAND, WESTERN AUSTRALIA

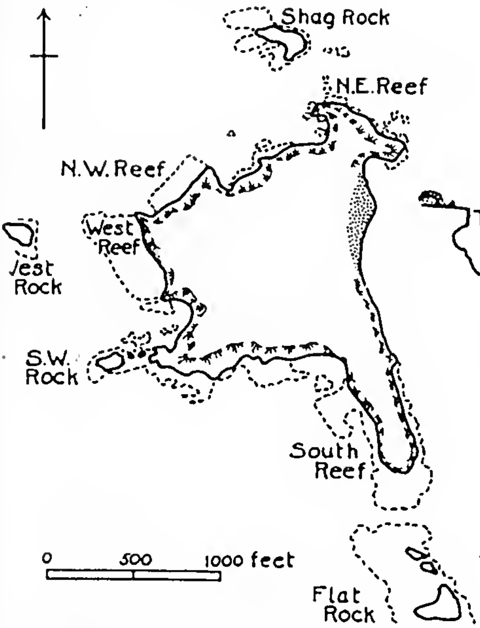
By LOISETTE M. MARSH and E. P. HODGKIN, Department of Zoology, University of Western Australia.

Carnac Island is a small island of 38½ acres surrounded on three sides by intertidal rock platforms similar to those of other limestone shores in the vicinity of Fremantle. These platforms vary both in width and degree of exposure to wave action and their study has helped considerably to an understanding of patterns of distribution of animals and plants on this type of rocky shore. Two visits were made by the writers to the island, the first on March 28, 1951 (recorded by Marsh, 1955) and the second between January 16-19, 1956. The latter was part of a more general survey of the island made by members of the Western Australian Naturalists' Club and the following account was originally issued as part of a mimeographed report of that survey.

The littoral environment of similar shores on Rottnest Island is described briefly by Hodgkin, Marsh and Smith (1959). On these shores the animals and plants show a vertical zonation of the kind observed on rocky shores in other parts of the world, and the same zones are recorded below on Carnac Island. A horizontal zonation across the width of the level platforms is also described; the zones, distinguished by the dominant organisms, are: Patelloida (limpet), Jania (coralline alga), brown algae, lithothamnion (encrusting coralline alga). The use of the term "zone" for both vertical and horizontal zonation is perhaps confusing, but is retained here pending more detailed discussion elsewhere.

TOPOGRAPHY

Carnac Island is five nautical miles south-west of Fremantle and two miles north of Garden Island. It is composed of coastal limestone (eolianite) eroded from portion of a line of consolidated Pleistocene sand dunes from the Murray Reefs and Penguin Island in the south, through Point Peron, Garden and Carnac Islands, the Straggler Rocks, to east of Rottnest Island (Fairbridge, 1948). A great part of the island is capped by a layer of travertine which has broken away abruptly at the coast where the wind has often eroded the soft rock beneath it; below this there are cliffs or fallen masses of soft rock and sand down to the level at which the rock is wetted by waves or splash. Here it is again hard, and eroded into a typical visor and notch (Fig. 2) or a ramp. Height of notch varies considerably from low notches with their deepest point at one foot above platform level on North Reef to notches rising to a visor at about 10 ft. and their deepest point at 6 to 8 ft. above the platform on S.W. Rock. Shore platforms surround much of the island (Fig. 1) and vary in width from 3 ft. (S.W. Rock) to about 200 ft. (West Reef). The eastern side is sandy with no platforms, although there are small patches of rock at the base of the cliff in places. In contrast, the small Shag and Flat Rocks, north and south of the island, have distinct though narrow platforms on their eastern faces. The platforms terminate abruptly at their outer edges and, where examined, a sublittoral undercut is well developed. The Admiralty chart shows depths of up to 13 feet immediately round the island, but depths of 20 feet were found just off the edge of some of the platforms.



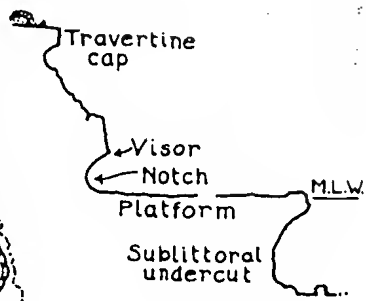


Fig. 1.—Carnac Island. Shore platforms and locations of reefs studied. Redrawn from survey by K. Tiller.

Fig. 2.—Typical shore profile.

WEATHER AND TIDES

The weather was fine and hot with easterly winds during the period of the survey. Tides were of typical summer pattern, with low water at about 7 am. and high water at 10 pm. each day, and ranged from a maximum height of 2.6 ft. to a minimum of 1.0 ft. above datum on the Fremantle gauge (January M.L.W. averages 1.25 ft.).

METHODS

Sketch plans of platforms studied were made from the cliff top, the principal measurements being determined on the ground. Fixed reference points were established on the shores and heights of these relative to Fremantle datum obtained by means of a portable recording gauge as described by Hodgkin (1956). Levels relative to the fixed points were obtained by horizon levelling and noted on the plans. Principal animal and plant associations were then plotted by observation and a traverse line across each platform selected for more careful study.

Along the traverse line a number of ¼ square yard (2.25 sq. ft.) sample areas were selected at random in each association. All the macroscopic animals within each square were counted and the algal species recorded. The results are summarised in Figs. 3 and 6. In these the animal populations are shown as being present, common, or abundant by lines of different thickness. Distribution of animal and plant associations are shown in Figs. 4, 5, 7 and 8.

Identifications were made by comparison with named material in our collections. Coral species have been named by Professor J. W. Wells to whom we are indebted. A list of all animal species found alive on the shores of Carnac Island is given in an appendix.

SOUTH REEF

The southern shore is bounded by narrow platforms which extend either from a notched cliff, at the southern tip, or from a deeply pocketed and dissected ramp rising 3-5 ft. above platform level on the south-west where the traverse was made. The platforms lie at about 1.5 ft. above datum with a narrow raised rim about 0.3 ft. higher. The platforms are exposed to moderate to strong wave action; they are open to the south-west but protected from the north-west.

A traverse was made across the reef where it faces west-south-west and the results are shown in Fig. 3. Distribution of the main associations is shown in Fig. 4.

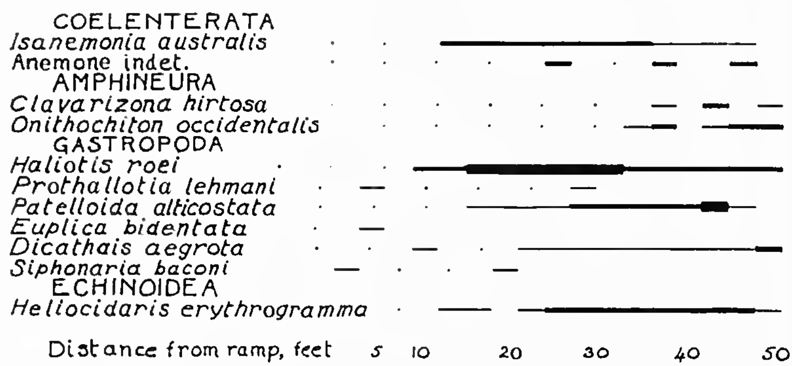


Fig. 3.—South Reef. Fauna found in traverse.

The commonest animal of these platforms was the mutton fish, *Haliotis roei,* which was present over the greater part of them. This was associated with a mixed algal turf of species of *Jania, Pterocladia, Ectocarpus, Laurencia, Hypnea, Dictyota* and *Cystophora,* short and sparse in some places and luxuriant in others. The horizontal zoning was less marked than on wider platforms; only in one part was there a narrow *Jania* zone of coralline algae with its associated fauna of small gastropods (area 8 in Fig. 4). The densest animal populations lay along the outer edge associated with a thick crumbly growth of lithothamnion, and the two chiton species were almost confined to this region. The fauna is typical of moderately wave-exposed shore platforms. The presence of *Balanus* *nigrescens* and *Patellanax laticostata* in area 14 suggests that this part may be exposed to rather greater wave action. *P. laticostata* was also common on high rocks near the edge at one end of area 9. In area 10 there were large colonies of the zoanthid *Palythoa heideri*, and *Zoanthus praelongus* was also present.

In the notch, above platform level, the zonation was typical of that found on other shores in the vicinity of Fremantle. The highest zone was occupied by the littorinids *Melaraphe unifasciata* and *Tectarius rugosus*; below this, in the region of wave wash, was a zone of small limpets—*Notoacmea onychitis* and a few *Patellanax peroni* (*Siphonaria luzonica* was not recorded from this shore). In

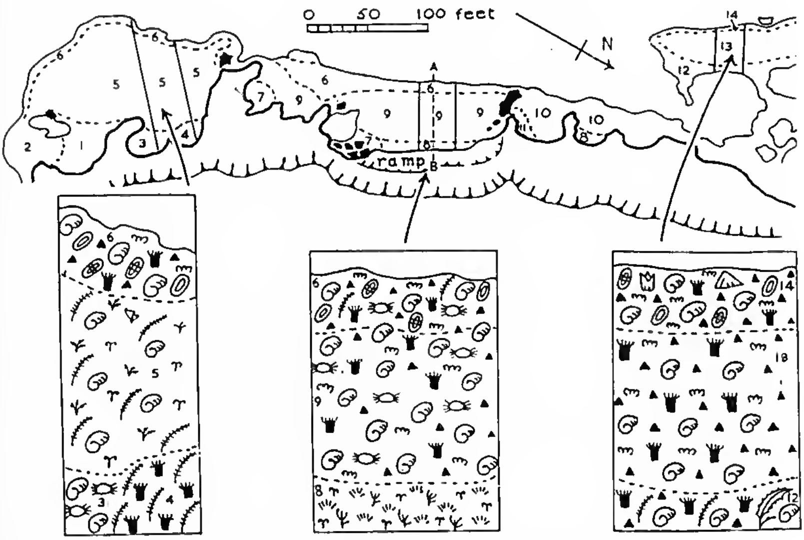


Fig 4.—South Reef. Animal and plant associations.

KEY TO SYMBOLS USED IN DIAGRAMS

ANIMALS

Isanemonia australis
Zoanthus praelongus
Onithochiton occidentalis
Clavarizona hirtosa
Haliotis roei
Patelloida alticostata
Patellanax laticostata
Hormomya sp.
Balanus nigrescens
Patiriella gunii
Heliocidaris erythrogramma
Pyura pachydermatina

PLANTS

Ulva lactuca
Jania fastigiata
Hypnea spp.
Pterocladia capillacea
Laurencia spp.
lithothamnion
Sargassum spp.
Cystophora uvifera
Ecklonia radiata

the lower part of the notch there was a band of chitons, *Clavarizona hirtosa* and *Poneroplax costata,* and below this *Patelloida alticostata* with, in sheltered places, the anemone *Actinia tenebrosa.*

SOUTH-WEST ROCK

This islet is surrounded by a narrow platform by which it is also attached to the main island; the platform is widest at the seaward end and only 2 or 3 ft. on the northern side. No traverses were made here, but distribution of the commoner animals and plants was plotted (Fig. 5). Levels were not taken, but most of the platform appears to lie at about 1 ft. above datum with raised areas on the narrow northern part.

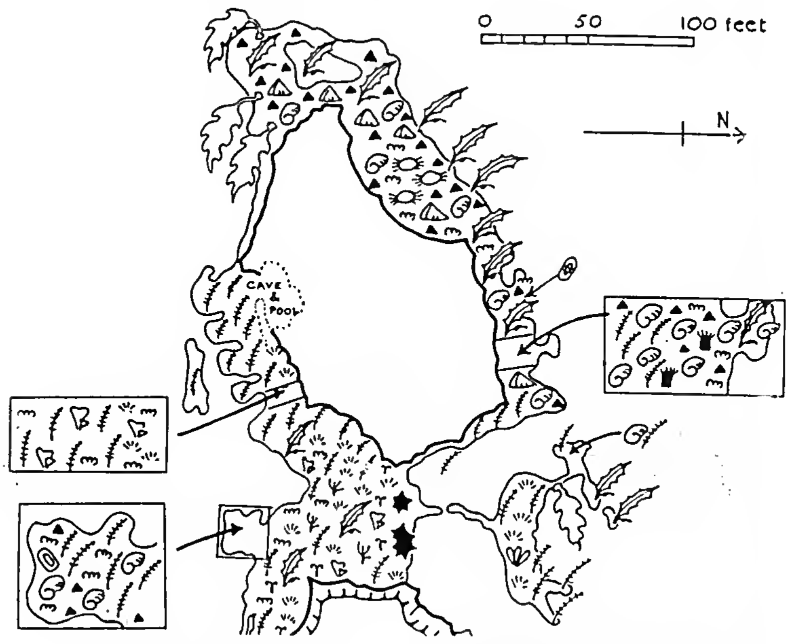


Fig. 5.—South-West Rock. Animal and plant associations.

Marked differences are evident in the plant and animal associations of this platform from the most wave-exposed western end to the relatively sheltered eastern part of the platform. At the western end *Patellanax laticostata* and *Patelloida alticostata* were common, with a few *Clavarizona* but no *Isanemonia;* with these were associated lithothamnia, *Sargassum* and *Ecklonia.* The same animals were also common on the north-west, together with *Haliotis,* and there was a small area of deeply pocketed platform with abundant *Heliocidaris.* On the north, more sheltered side, *P. laticostata* largely disappeared and was replaced by *Isanemonia* and *Clavarizona; Haliotis* was the dominant mollusc here. On all the eastern part of the platform animal populations were largely replaced by algae, mainly *Pterocladia capillacea,* and in the most sheltered part there was a mixed algal turf dominated by *Jania*. *Pseudobonellia biuterina* was abundant on this part of the platform.

The notch varies in height around the islet, on the sheltered side its deepest point is not more than 3 ft. above the platform while on the exposed side it is 6 or more feet. The animal zones were correspondingly raised. In an exposed place the zones were: a band of filamentous green algae replacing the usual littorinids; a mixed limpet zone of *Notoacmea*, *Patellanax peroni*, *P. laticostata*, with *Clavarizona*, *Onithochiton*, *Poneroplax*, and a few *Balanus nigrescens;* and below this *Patelloida*, *Actinia*, *Haliotis*, and lithothamnion. Where there was more shelter from wave action there were no *Onithochiton*, *Poneroplax*, *Balanus*, *P. laticostata* or *P. peroni*.

WEST REEF

This wide platform extends westwards from a sandy beach at the north-west corner of the island (Smith Point). The platform is fairly high, about 2 ft. above datum, and appears to be moderately exposed to wave action. Sand from the beach spreads on to it and modifies the distribution of animal and plant associations (Fig. 7). A traverse was made across the platform and the results of this are shown in Fig. 6.

At the shore, a partially exposed rock ramp was populated with patches of mussels, *Hormomya*, and the pulmonate limpet *Siphonaria baconi*. From the ramp the following associations succeed one another across the platform: (a) Jania zone with much sand; (b) shallow pool; (c) a short turf of coralline algae with some *Sargassum*, *Dictyota*, *Colpomenia* and *Hypnea;* (d) an outer zone of lithothamnion with a fairly dense population of browsing molluscs (*Haliotis roei*, *Patelloida alticostata*, *Patellanax laticostata*

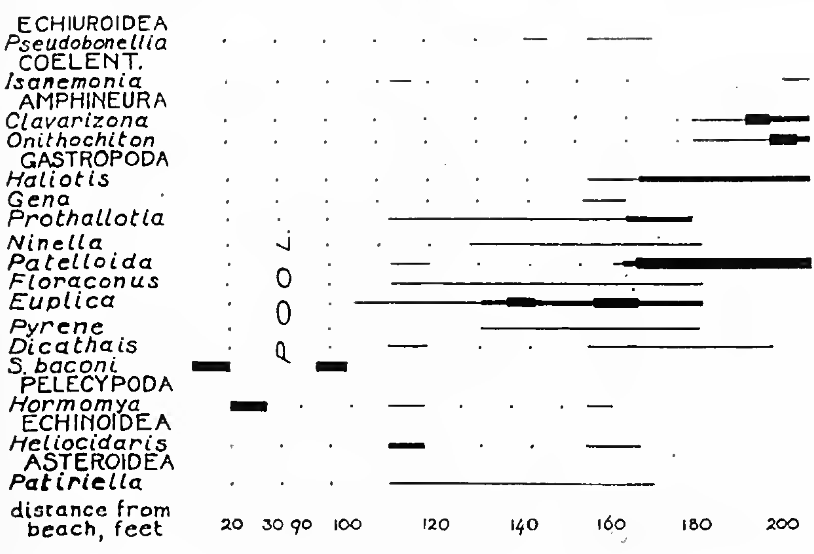


Fig. 6.—West Reef. Fauna found in traverse.

(few), *Onithochiton occidentalis* and *Clavarizona hirtosa)* with a few *Isanemonia australis*. Chitons are confined to the outer part of the zone.

On parts of the reef lower than the general level *Sargassum* and *Pterocladia* predominate. Occurring on the reef flat, between 135 and 180 ft. from the ramp, were these additional species, one specimen of each being found in the traverse: *Cryptoplax iredalei, Cominella* sp., *Mitra* sp., *Bellastrea* sp., *Notoacmea onychitis, Austrocochlea rudis,* and a few *Notogibbula preissiana. Ravitrona caputserpentis* was found here in the 1951 visit.

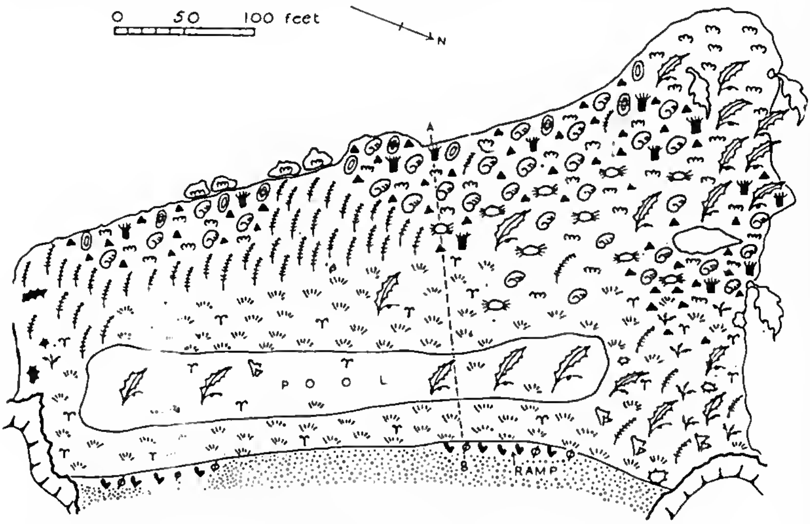


Fig. 7.—West Reef. Animal and plant associations.

NORTH-WEST REEF

This platform is about 120 ft. wide, but is dissected by several deep pools. It extends from the foot of a cliff with a low notch (deepest part about 1 ft. above platform level) and a wide overhang. Facing north-west, the platform is relatively sheltered. Levels are shown in the diagram (Fig. 8). No traverse was made.

Animal and plant associations are plotted in the diagram. These are horizontally zoned as follows: (a) an inner Jania zone of coralline turf with some *Sargassum* and sand, at about 1.5 ft. above datum, *Patiriella gunnii* was abundant in this zone; (b) algal zone of *Sargassum* with *Pterocladia, Hypnea, Laurencia, Ulva, Jania* and patches of *Cymodocea,* this was deeply pocketed and at a relatively low level (1.0-1.3 ft. above datum), *Pyura pachydermatina* var. *gibbosa* occurred here; (c) at the reef edge a narrow raised rim, at about 1.5 ft., on which a modified Haliotis-lithothamnion association was present.

The notch showed a sparse population, with only a few littorinids, *Melaraphe* and *Tectarius*; the limpet zone was dominated by *Notoacmea onychitis* with *Siphonaria luzonica* and a few *Patellanax peroni*; lower down were *Patelloida alticostata* with a few

Poneroplax and *Balanus*. The alga *Gelidium* occurred at the base of the notch and in places a tube-building polychaete of the family Sabellariidae was plentiful.

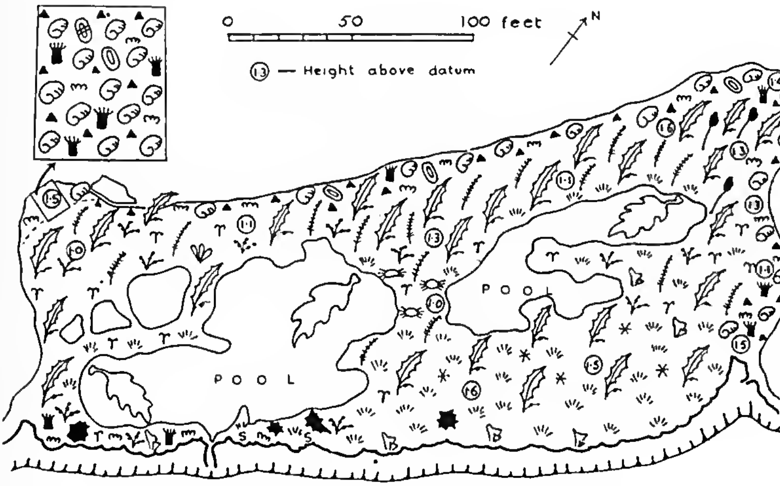


Fig. 8.—North-West Reef. Animal and plant associations.

NORTH-EAST REEF

On the northern tip of the island there are narrow, dissected platforms, 30 ft. wide or less. They are sheltered from wave action and provide a contrast to the more exposed platforms of other shores of the island.

We were not able to examine these platforms, but a survey of one was kindly made after our departure by J. A. L. Watson. The greater part was covered by a turf of coralline algae and sand with *Isanemonia*, *Patelloida*, *Euplica*, *Gena*, *Ninella* and *Hormomya*. The outer edge lacked the dense animal populations of wave-exposed platforms and was covered with *Sargassum* and *Pterocladia* with little lithothamnion and with a similar fauna to the rest. *Patelloida* was the only macroscopic animal species living on the rock surface, other species present being browsers on the algae, predators, detrital and plankton feeders.

DISCUSSION

On this small island of irregular shape there are considerable environmental differences between the various shores; differences of aspect and consequent wave action, of platform level and width, and in the presence or absence of sand. These variables can seldom be completely separated, nevertheless it is often possible to understand how they influence observed differences of plant and animal associations on the various shores.

The effect of sand is well seen on W. reef which is backed by a beach; sand accumulates over the inner platform and the faunal

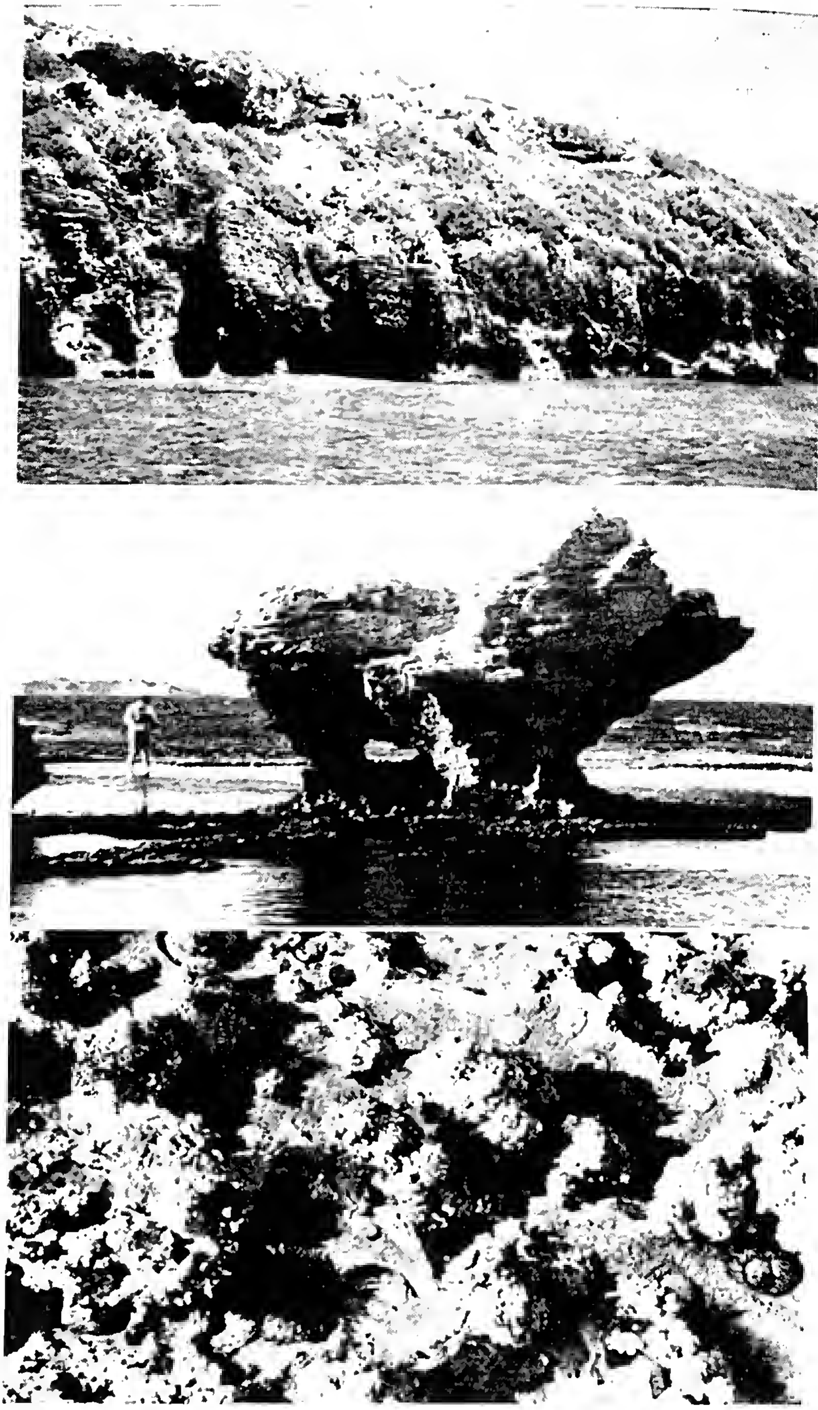


PLATE I
(Explanation at foot of opposite page)

poverty here is in marked contrast to the outer 20 ft. of platform. Sand is also retained among *Jania* on the inner part of N. Reef platform and again there is a restricted macrofauna. The same conditions exist over most of the N.E. platform. In contrast to these, S. and S.W. platforms are largely free of sand and carry an abundant and rich fauna and large algae.

Wave action is greatest at the outside edge of platforms and, irrespective of aspect, there is here both the greatest mechanical pounding and the most frequent renewal of water at low tide. The richest and most diversified fauna is found here, associated with a thick encrustation of lithothamnion, and this outer "lithothamnion zone" is present on all Carnac platforms (except N.E.). Even on the narrow S. Reef platform there is an evident change in composition of fauna and flora across the width of the platform; along the traverse line chitons and thick lithothamnion are confined to the outer 15 ft., and there is a narrow inner Jania zone with the associated small gastropods. Differences of level sometimes complicate this effect of distance from the outer edge; changes across the N.W. platform are probably partly attributable to this, the lower levels favouring a stronger growth of large algae.

The effect of differences of aspect is shown particularly well by the various animal and plant associations of the narrow platform surrounding S.W. rock, described above. It is unfortunate that time did not permit a more detailed survey here. Differences in the nature of the associations with aspect are also seen by comparison of the various platforms. *Patellanax laticostata* and *Balanus nigrescens* only occur on the outermost parts of S. and S.W. platforms (the most exposed situations), while elsewhere on the south and west shores of the island *Haliotis roei* dominates the lithothamnion zone. The associated fauna is similar in exposed and moderately exposed places, consisting of *Clavarizona, Patelloida, Isanemonia,* and *Onithochiton,* while *Heliocidaris* occurs in deeper pockets. Chitons were few on the most exposed part of the platform of S.W. Rock but plentiful in the notch. This zone, with much the same fauna, is present round the edge of the more sheltered N.W. platform, but here only as a belt about a yard wide, except on the western corner. It is altogether absent from the sheltered N.E. platform where algae, mainly *Sargassum* and *Pterocladia,* occur right to the edge of the platform. Differences of exposure to wave action are also reflected in the fauna of the notch. This is particularly noticeable on S.W. Rock where a number of species of the lithothamnion zone were present in the lower notch in the most exposed situation, but are absent from more sheltered places.

The fauna of Carnac Island shores is similar in composition to

Fig. 1 (top).—Coast at N.E. Reefs, N.E. Reefs, showing travertine cap, cliff and notch. Platform in foreground submerged. Fig. 2 (middle).—Notched rock on platform at S.W. Rock. Fig. 3 (bottom). —Lithothamnion zone on W. Reef. Photo shows thick lithothamnion encrustation, *Isanemonia australis, Haliotis roei* (with *Patelloida nigrosulcata*), *Patellanax laticostata, Patelloida alticostata, Clavarizona hirtosa* and *Isanemonia australis.*

that of Garden Island and Point Peron in that most of the species have a southern distribution. Tropical species abundant on Rottnest Island ten miles to the north-west are represented by a few species only; the zoanthids *Zoanthus praelongus* and *Palythoa heideri,* a few specimens of the cowrie *Ravitrona caputserpentis* and, in the sub-littoral, two species of coral.

ACKNOWLEDGMENTS

We wish to express our thanks to the State Fisheries Department of Western Australia for generously providing transport to the island, also to other members of the Naturalists' Club study group who helped us in the field work.

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APPENDIX I.—ANIMAL SPECIES FOUND ALIVE IN SURVEYS OF SHORE PLATFORMS.

Coelenterata. Actiniaria
- Actinia tenebrosa Farquhar
- Isanemonia australis Carlgren
- Cnidopus verater (Drayton)
- anemone, gen. et sp. indet.

Coelenterata. Madreporaria
- Favites magnistellata (M.E. & H.)
- Platygyra lamellina (Ehr.)
- Plesiastrea urvillei (M.E. & H.)

Coelenterata. Zoanthidea
- Zoanthus praelongus Carlgren
- Palythoa heideri Carlgren

Annelida. Polychaeta
- Fam. Sabellariidae, gen. et sp. indet.

Echiuroidea
- Pseudobonellia biuterina Johnston & Tiegs

Arthropoda. Cirripedia
- Balanus nigrescens Lamarck
- Tetraclita purpurascens (Wood)

Echinodermata. Echinoidea
- Heliocidaris erythrogramma (Valenciennes)

Echinodermata. Asteroidea
- Patiriella gunnii (Gray)
- Petricia obesa H. L. Clark

Chordata. Tunicata
- Pyura pachydermatina Herdman var. gibbosa Herdman

Mollusca. Amphineura
- Clavarizona hirtosa Blainville
- Poneroplax costata Blainville
- Onithochiton occidentalis Ashby
- Cryptoplax sp.

Mollusca. Gastropoda
- Haliotis roei (Gray)
- Patellanax peroni (Blainville)
- Patellanax laticostata (Blainville)
- Patelloida alticostata (Angas)
- Notoacmea onychitis (Menke)
- Gibbula preissiana (Philippi)
- Prothallotia pulcherrima (Wood)
- Prothallotia lehmani (Menke)
- Austrocochlea rudis (Gray)
- Gena auricula (Lamarck)
- Ninella whitleyi Iredale
- Bellastrea sp.
- Melanerita melanotragus (Smith)
- Melaraphe unifasciata (Gray)
- Tectarius rugosus (Menke)
- Ravitrona caputserpentis (Linne)
- Floraconus anemone (Lamarck)
- Euplica bidentata Menke
- Pyrene spp.
- Dicathais aegrota (Reeve)
- Cominella sp.
- Mitra sp.
- Siphonaria baconi Reeve
- Siphonaria luzonica Reeve

Mollusca, Pelycypoda
- Hormomya sp.

A NEW SPECIES OF GEKKONID LIZARD, GENUS *DIPLODACTYLUS*, FROM THE CARNARVON REGION, WESTERN AUSTRALIA

By ARNOLD G. KLUGE, Department of Zoology, University of Western Australia.

The widespread and diversified gekkonid lizard genus *Diplodactylus* (Gray) is found throughout almost all of Australia. However, by far the greatest concentration of species is in Western Australia, primarily the Carnarvon and North-West Regions (Clarke, E. de C., *Jour. Roy. Soc. West. Aust.*, 12, 1927: 117-132). While studying the large collections in the Western Australian Museum and the Department of Zoology of the University of Western Australia in preparation for a revision of the genus *Diplodactylus* five specimens were discovered which represent still another species from the Carnarvon Region. This very distinctive species with enlarged sharp conical scales covering the dorsal surface of the body is here described as

Diplodactylus squarrosus sp. nov.

Holotype: R13805 (Western Australian Museum). Collected at Hamelin Pool, Shark Bay, Western Australia, on May 14, 1959, by W. H. Butler.

Diagnosis: *Diplodactylus squarrosus* is unique within the genus in possessing a rectangular rostral shield, more than two and one-half times broader than deep, and greatly enlarged conical mid-dorsal body scales (Fig. 1).

Description of Holotype: Head somewhat flattened; eye large; rostral rectangular, 2.7 times broader than deep; dorsomedian rostral

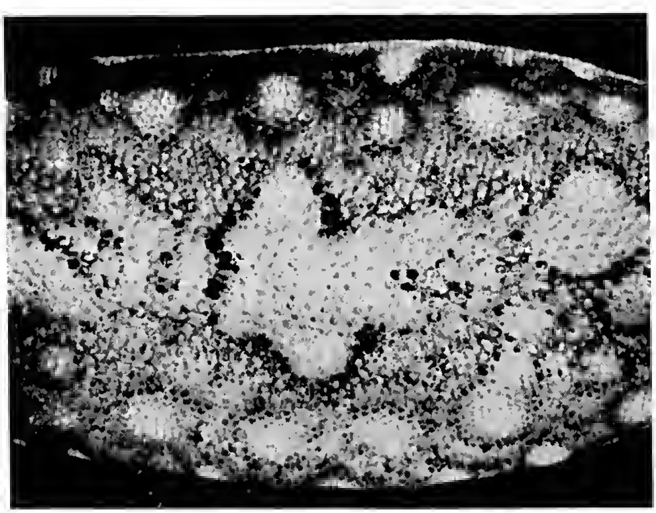

Fig. 1.—A dorsal view of the body of the holotype of *Diplodactylus squarrosus* showing the enlarged conical scales.

crease absent; nostril large, surrounded by first supralabial, two postnasals and two enlarged supranasals; anterior supranasal greatly enlarged, broadly in contact with counter part of opposite side and first supralabial; scales immediately posterior to supranasals enlarged; supralabials 8/9 (left and right sides respectively); 11/12 scales between nostril and anterior margin of orbit; twenty-six scales between centrolateral margins of orbits (excluding those of dorsal eyelid); four spinose scales on posterior border of dorsal eyelid; mental oblong, almost twice as long as broad; infralabials 7/8; scales bordering mental and infralabials slightly enlarged and flattened, gradually grading into granules of throat region; external ear opening small, almost round; dorsal body scales conical, at least twice as large as ventrals; dorsal region of conical scales sharply defined from smaller and more granular scales of sides and venter (Fig. 1); dorsal surfaces of limbs covered with flat slightly imbricating cycloid scales, those of ventral surfaces slightly more conical; digits long and slender, only slightly depressed; subdigital areas covered with small conical granules; subapical plates of digits small, twice as long as broad; claws moderately curved, strongly projecting beyond sheath; 11/12 granules covering inferior surface of fourth finger; 14/15 granules covering inferior surface of fourth toe; tail covered with flat imbricating cycloid scales, equal in size to dorsal midbody scales, forming definite annuli; sex—male; two sharp, strongly projecting cloacal scales at base of tail; two preanal pores, separated on midline by six scales.

Head covered with fine brown reticulation, somewhat concentrated on occipital region; postocular reticulation continuous over nape; dorsal surfaces of body and appendages with dense brown reticulation; large white spots on limbs and lateral region of body; four enlarged irregularly shaped white marks on vertebral region of body, seven on tail (Fig. 2).

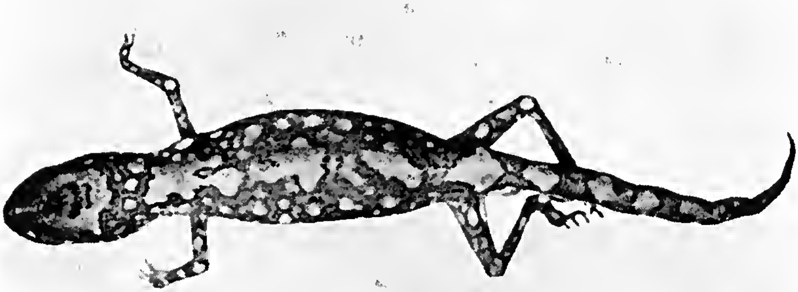

Fig. 2.—A dorsal view of the holotype of *Diplodactylus squarrosus.*

Snout-vent length 44.6 (all measurements given in millimetres); length of tail (unregenerated) 33.0; length of snout 4.7; head width 8.5; distance between eye and ear 3.5; diameter of orbit 3.8; axilla to-groin 21.7; length of fore limb 15.8; length of fourth finger 2.7; length of hind limb 22.9; length of fourth toe 4.1.

Variation: In the collection of the Department of Zoology of the University of Western Australia are three juvenile specimens and an adult male from seven miles north and twelve miles south of Booloogooroo, respectively. These specimens agree with the holotype in all respects except the following: Rostral shield two and one-half to almost three times broader than deep; supranasals separated by a single scale in one juvenile; supralabials nine to eleven, avg. 10; eleven to thirteen, avg. 12, scales between nostril and anterior margin of orbit; twenty-five to twenty-nine, avg. 27.2, scales between centrolateral margins of orbit; mental slightly longer than broad to broader than long; infralabials eight to ten, avg. 9.3; middorsal body scales more oval than conical in juveniles; ten to thirteen, avg. 11.6, granules covering inferior surface of fourth finger; fourteen to seventeen, avg. 15.7, granules covering inferior surface of fourth toe; preanal pores absent; cloacal scales undeveloped in juveniles; reticulation brown to brick-red; vertebral region of body and tail white, devoid of reticulation.

Relationships: *Diplodactylus squarrosus* appears to be most closely related to *D. stenodactylus*. This relationship is based on the similar shape and scalation of the digits and the peculiar position of the nostril between the supranasals, first supralabial and two to three postnasals.

Remarks: The three juvenile specimens from 7 miles north of Booloogooroo were excavated from lizard burrows, probably those of *Amphibolurus reticulatus*. The adult male from 12 miles south of Booloogooroo was collected at night on a small relatively hard claypan.

NOTES ON THE SLOUGHING IN CAPTIVITY OF SKINKS OF THE GENUS *TILIQUA*

By JOHN E. EDWARDS, Surbiton, Surrey, England.

Specimens of *Tiliqua* spp. in one of the writer's vivariums have been observed to exhibit a distinct behavioural pattern associated with the process of sloughing. These observations form the basis of the present note.

Hickman (1960) described the sloughing of the skink *Egernia whitii*, but similar information on *Tiliqua* has not been traced in the literature.

EXPERIMENTAL CONDITIONS

Specimens of *Tiliqua scincoides*, *T. gigas* and *Tiliqua* [*Trachysaurus*] *rugosa* were housed communally in a vivarium of the following dimensions: length 3 ft. 6 in.; width 2 ft.; height 2 ft. 6 in. Heating was provided by a single gas jet four inches below the metal floor of the vivarium, from which it was separated by a short, angular baffle plate. In the absence of any means of thermostatic control, the temperature within the vivarium ranged between approximately 70° F. and 85° F.

Sheets of paper and cork were placed upon the floor to provide shelter. Lighting, by means of a 15 W. bulb suspended within the vivarium, was supplemented by a car headlamp reflector.

The diet of the lizards consisted of raw meat, liver, fish, soft fruit and marrow. A supply of fresh water was always provided.

OBSERVATIONS

Sloughing was preceded by a fast of a duration of up to ten days, and towards the end of this period the consumption of water increased markedly. The lizards frequently sought shelter, and exhibited an irritable disposition when handled. This period was followed by one of restlessness.

During the final two or three hours before sloughing the lizards were observed to stand with their heads in as near to a vertical position as their structure permitted, taking deep inspirations so that their bodies alternatively expanded and flattened dorso-ventrally.

All species were observed to break the skin by rubbing the head against a sharply pointed rock. The skin of *T. gigas* and *T. scincoides* was abraded in small sections and eaten while still soft, but the *T. rugosa* slough was found to be cast as an entire sheath. The latter was observed to free itself from the reversed sheath by drawing its tail across the rock.

There appears to be a relationship between the frequency of sloughing and the environmental temperature. Subject to the maintenance of good health, and a temperature within the limits specified, sloughing occurred four or five times each year, but the frequency was reduced if the temperature was lowered to below 70° F. for an appreciable period. A specimen of *T. rugosa* suffering from a jaw infection did not moult for a period of seven months.

REMARKS

It is appreciated that the behaviour of skinks in captivity is likely to be different from that in the natural environment where, for example, they would not have access to water for much of the year.

The suggestion that environmental temperature influences the frequency of moulting has been reported by Hickman *(loc. cit.)*, who also found that *E. whitii* is similar to *Tiliqua* in moulting four to five times each year. Other factors, such as growth rate, must also determine the frequency.

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THE HAIRY-NOSED WOMBAT IN WESTERN AUSTRALIA

By C. F. H. JENKINS, M.A.

The Hairy-nosed Wombat *(Lasiorhinus latifrons)* is a species which once ranged widely in southern Australia and is still plentiful in parts of the Nullarbor Plain east of the Western Australian border (Troughton, 1951; Jones, 1924). Fossil bones attributable to several species of wombats have been found in local cave deposits (Glauert, 1910 and 1912), but no living specimens have been officially recorded from this State.

It is for this reason that I draw attention to a report (Crawford, 1900) concerning an expedition to "explore and report upon the large tract of country lying between latitude 30° S. and the sea coast and longitude 124° E. and the South Australian boundary." Referring to a belt of country described in his map as Premier Downs and lying south-east of Queen Victoria Spring, Crawford states—"Animal life of all kinds was much more plentiful than nearer the coast . . . In one part here we came on some very large wombat holes, and managed after a great deal of difficulty to get one out. Our native crawled into one hole, quite out of sight, and got hold of a wombat by one of the hind legs, he tried to pull him out, but could not move him, so called out to pull him back, I crawled in and got the native by the ankles and pulled, but still we could not manage, so my assistant caught me by the ankles and we all pulled, and at last got the wombat out after a hard struggle. We ate him, and although tough he was a welcome change from the tinned meat we had been living on for some time before we got him."

Support for Crawford's record occurs in the report of Mason's expedition in 1896 (Mason, 1897). Referring to country about 100 miles north-west of Twilight Cove, Mason writes: "There was every appearance of a good rainfall and we came across two small gnamma holes containing about four gallons of water. Some time ago there were numerous kangaroos and wombats, but the country was here perfectly destitute of game of any kind."

A further report comes from Mrs. A. E. Crocker of Balladonia who in August 1952 informed Dr. D. L. Serventy that wombats did not occur originally west of Eucla, but that when the rabbit invaded the area, wombats came on ahead of them and that two reached Balladonia about 1903-04.

These three independent reports concerning a creature so characteristic as the wombat, and coming as they do from the same general area, seem to indicate beyond doubt that wombats were established on Western Australian soil not so many years ago, and that a careful search may still find survivors on this side of the South Australian border.

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FROM FIELD AND STUDY

Western Silvereye Nesting in Limestone Cave.—The Western Silvereye *(Zosterops gouldi)* is a resident on the Green Islets (100 miles north of Fremantle) where it usually selects nest sites in bushy shrubs such as *Nitraria schoberi* and *Olearia axillaris*. During a visit to these islands on October 28, 1961, a nest with three addled eggs was found attached to solution tubes of small diameter near the ceiling at the back of a cave on the north side of the south island. Welcome Swallows *(Hirundo neoxena)* were also nesting in the cave.

—JULIAN FORD, Attadale.

The Spotted Scrub-Wren: A Fosterer of the Horsfield Bronze Cuckoo.—In their *Birds of Western Australia*, 1951: 249-250, D. L. Serventy and H. M. Whittell do not list the Horsfield Bronze Cuckoo *(Chalcites basalis)* as parasitising the Spotted Scrub-Wren *(Sericornis maculatus)*. On August 29, 1959, at Burns Beach, a pair of scrub-wrens were seen feeding a bronze cuckoo fledgling. After a period of observation during which time no other birds attempted to feed the fledgling, the individual was collected in order to ascertain its specific identity. The basal portions of the outer tail feathers of the specimen wre rufous-brown, demonstrating that it was the Horsfield Bronze Cuckoo and not the Golden Bronze Cuckoo *(Chalcites lucidus)*.

—JULIAN FORD, Attadale.

Waders at Mandurah.—With reference to "Notes on some Waders in South-Western Australia" by C. F. H. Jenkins (*W.A. Nat.*, 7: 201) I have seen the following lesser known waders at Mandurah.

Eastern Curlew (*Numenius madagascariensis*).—I have seen this bird in all months except July and September but only once in August (Aug. 7, 1961).

Whimbrel *(Numenius phaeopus)*.—One on January 20, 1960, near the mouth of the Estuary. Two on May 30, 1960, at Peel Inlet. Three on Feb. 4, 1961, on an open field near the Estuary. Two on November 23, 1961, at Peel Inlet.

Bar-tailed Godwit *(Limosa lapponica)*.—A party of five birds was seen during January and February 1961. A party of 20 was seen during the first two weeks of August 1961.

Grey-tailed Tattler *(Tringa brevipes)*.—One on November 23 and three on December 20, 1961, at Peel Inlet.

—A. A. BURBIDGE, Mandurah.

Young Swallow Perching on *Varanus*.—At Yarlamoola Mill on Mileura Station, via Cue, on May 4, 1960, I saw a fully-fledged chick of the Welcome Swallow *(Hirundo neoxena)* perched on the hind leg of a Bungarra *(Varanus gouldi)* which was clinging on the wall of the well just above the water line, about 20 feet below the surface. Evidently the chick had fallen from the nest in the well casing near the top. The parent birds were still feeding the chick on the goanna's leg as well as one in the nest.

Several days later I visited the mill and saw both chicks in the same positions, the goanna apparently not having changed its site. In a week's time I again inspected the wall and found that both of the young birds had departed. It is quite a common sight to see goannas in the wells during the summer months.

—T. C. SCOTT, Subiaco.

Association of Young and Adult Water Dragons *(Physignathus longirostris)*.—One day during August 1960 I visited Wilyun mill, on Mileura Station, via Cue, in the course of my work and was present there for four to five hours. Wilyun is an old shepherd's well situated in a creek and is shallow and quite open with a small stub-post fence around. On my arrival I noticed an adult Water Dragon on the edge of the well surrounded by six young Water Dragons each about five inches long. These young were more or less constantly associated with the adult during this period; sometimes climbing on its back, and were constantly feeding on flies and other insects present. Also the young had developed the characteristic "saluting" present in the adult. This "saluting" is the raising of one of the fore-limbs. The association of young reptiles with adults appears to have been rarely reported.

—T. C. SCOTT, Subiaco.

Morels in Abundance.—In August 1961 among the leaf litter of the burnt karri forests in the Augusta-Karridale area there were hundreds of fruiting bodies of edible Morels (*Morchella* sp.). So far no published record has been found of the occurrence in Western Australia of this fungus. There are two other collections in the Mycology Collection of the Botany Department of the University of Western Australia; one labelled Ludlow, 1942, N. Burbidge, and the other, of two specimens found in August, 1959, on the edge of a path in the valley below Canning Dam.

From the abundance of the Augusta-Karridale specimens and their occurrence in the other localities, it is probable that Morels will be found, if searched for, in many other places around Perth and in the South-West. They are known to occur on burnt as well as disturbed soil, and are said to have been seen in a vegetable garden at Augusta. A few species are recorded from the Eastern States and a number of species (six or more) are well known in Europe and North America.

The Augusta-Karridale specimens vary from 2-5 inches high and are up to an inch in width. The stalks are white, cream or with

Morchella sp., Canning Dam, August 1959 x ½.

a pinkish tinge, the chambered more or less conical heads fawn or pale brown.

For many centuries in Europe Morels have been gathered and eaten. The caps (not the stalks) are cooked and have a delicate and distinctive flavour, something like that of mushrooms. They are used fresh or dried, alone or as a flavouring.

—E. R. L. JOHNSON, Department of Botany, University of Western Australia.

CORRECTIONS

In the series, "Natural History Notes from Jigalong, North-Western Australia," in volume 7, the following corrections are necessary:

No. 7, p. 176, line 5 from bottom, Little Crow no. 100-04130 was banded on June 20, not 30 as printed.

No. 8, p. 198, in the upper table (Mammals), the scientific name of the Camel should read *Camelus dromedarius,* not *C. bactrianus.*

In the article, "Some Aboriginal Sites in the Murchison District of Western Australia," vol. 8, no. 1, p. 3, Fig. 3 has been printed upside down.

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RE-DISCOVERY OF THE NOISY SCRUB-BIRD, *ATRICHORNIS CLAMOSUS*— FURTHER OBSERVATIONS

By H. O. WEBSTER, Albany.

NARRATIVE

It can now be revealed that the Noisy Scrub-bird (*Atrichornis clamosus*) was re-discovered some 20 miles east of Albany at Two People Bay, a camping area for many years with a few beach cottages and fishermen's huts.* The territory of this first-found bird actually surrounds an isolated hut which is hardly a hundred yards from the beach and connected to it by a narrow path through thick scrub. In my opinion, this bird is familiar with and unusually tolerant of human beings. The sounds of voices, of children playing, of chopping wood and of people moving about do not frighten it but rather seem to stimulate it to louder and more frequent calls. On the other hand, the presumed female is extremely shy and has been seen only about four times. The impression of observers is that the female is rather smaller than the male and probably has no white markings on the throat.

On Saturday and Sunday, January 20 and 21, 1962, Dr. D. L. Serventy, Dr. G. F. Mees, Messrs. C. F. H. Jenkins, D. W. Lamm and myself stayed at the hut. In spite of a strong and unpleasant east wind it was an enjoyable weekend highlighted by the discovery of a second and then a third male Noisy Scrub-bird.

To Dr. G. F. Mees must go the credit for the finding of No. 2 bird. On the Saturday he decided to visit Mt. Gardner some two miles to the south and, accordingly, on Sunday before daybreak he set off on his walk. During the course of it he heard a Noisy Scrub-bird calling in a high valley on the flanks of the mountain. He returned to the hut about 9 a.m., and when breaking the welcome news, said he was afraid it would completely alter our ideas about the habitat of the bird. Shortly afterwards the whole party walked back to the scene of this find and heard the bird give a few short calls. Dr. Serventy and Mr. Jenkins then returned to the hut, to resume observations at the scene of the original find, and on the way flushed a Spotted Nightjar. The other members of the party continued on up the valley, walked round the end of a high ridge to the east of Mt. Gardner and into a valley similar to and parallel to the first one. A third Noisy Scrub-bird was heard to call in the thick

*A preliminary report of the discovery, in December 1961, appeared in the *Western Australian Naturalist*, 8 (3), January 1962: 57.

scrub on the south-east side of this valley, giving some loud calls and continuing to call regularly as we approached it. Neither of these birds was seen owing to the thickness of the scrub and to the wariness which is such a marked characteristic. However, Noisy Scrub-bird 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. The party returned to camp and later that day departed for Perth. All were highly satisfied with the trip and delighted that more birds had been found.

The next day, at the camp, I decided to follow up this discovery by exploring as much as possible of the isolated, mountainous promontory forming the southern horn of Two People Bay. Accordingly, I set off on what proved to be a walk of at least six miles to the south-east on a beautiful but extremely hot summer day. A number of Bristle-birds *(Dasyornis brachypterus)* were heard calling on the hill slopes on the way and at last I came to a deep mountain gully which runs for over half a mile up from the sea. In this gully, which is filled with trees and dense scrub and contains a small running stream, three Noisy Scrub-birds were heard to call in different parts. Separated by a steep ridge is another, shorter gully and in this another Noisy Scrub-bird was heard. Since that day I have visited almost all the mountain gullies in the vicinity of Mt. Gardner and in all of them, without exception, Noisy Scrub-birds have been heard to call. Also, during these walks, three birds have been heard to call in country similar to that where Dr. Mees found No. 2 bird. Thus at the present date, I know of upwards of thirty Noisy Scrub-birds in the Mt. Gardner section of Two People Bay. This is a very gratifying and unexpected result of Dr. Mees' early morning walk. A careful survey will be made during the next few months and it is hoped that a reasonably detailed map of the area will be available to plot numbers.

HABITATS OF THE NOISY SCRUB-BIRD

A rather clearer picture of the country favoured by this bird has now taken shape. There seem to be three sharply differentiated, yet to a certain extent overlapping, types of habitat and I will attempt a short description of each. First I should quote very briefly the accounts of habitat given by the early collectors. Thus Gilbert: "the densest and rankest vegetation on the sides of hills and the thick grass around swamps or small running streams"; Masters: "dense masses of vegetation consisting of tall reedy grass and thick-growing low bushy shrubs"; and Webb: "the margins of fresh-water swamps."

So Habitat No. 1, where the first or No. 1 Noisy Scrub-bird was found is in fact a fresh water swamp area, one part of which is almost dry in summer and covered by a dense growth of rushes, grasses and shrubs (predominantly *Phebalium argenteum*), with dwarf *Banksia* trees here and there. The other part is a thick sword-rush swamp which held water in January and which is completely surrounded by dense thickets of scrub and creepers. The second part also has, in its marginal areas, quite large and numerous Yate trees, many of which were killed by a bushfire some twelve years ago. The area over which No. 1 bird exercises territorial rights in this habitat has been estimated as about 10 acres. It is well separated from the other scrub-bird territories.

Habitat No. 2, where No. 2 bird was found by Dr. Mees, is an upland or high shallow valley some hundreds of yards across in places, which contains no water in summer and probably only briefly running streams and small pools in winter. It is covered, for the most part, by typical thick, low coastal scrub but contains extensive tracts of close-growing dwarf jarrah, marri, mallee, banksia, tea- tree and occasionally paper-bark thickets which range in height from five to twelve feet. These areas of dwarf trees fill the lower parts of the valley and follow the small gullies up to the rocky slopes of the hills. Three Noisy Scrub-birds so far have been found, checked and rechecked several times, in this type of habitat.

Habitat No. 3, where Noisy Scrub-birds have been found and which, I am almost persuaded, is the typical habitat now, if not before, may be described as mountain gullies or ravines. These gullies are a remarkable feature of the mountainous area of Two People Bay and all run down to the sea. Some of the larger ones have a number of subsidiary gullies or tributaries entering them. The longest and largest is probably a mile in length and the shortest a few hundred yards. All are extremely steep, usually descending in a series of giant steps over huge boulders and their sides are almost precipitous. In January the majority had small streams of water running or seeping over their rocky beds and several contained pools of water. These streams appear to be permanent, even in such a dry summer as the last, but sometimes disappear underground to rise again to the surface lower in the course of the gully. In winter brief but spectacular torrents must pour down into the ocean. The vegetation in these gullies is dense and occasionally almost luxuriant with quite large trees, yates, marris, paperbarks and jarrahs in favoured places. Often a bald slope of rock runs along one side, rising in a precipitous curve from the bed of the gully, with the other side a steep rock and earth wall thickly clothed with dwarf trees and heavy scrub. A walk, or rather climb, up one of these gullies is a fascinating and astonishing experience because the vegetation hides and disguises the steepness and the depths.

These mountain ravines appear to be the final refuge of the Noisy Scrub-bird and by their remoteness and difficulty of access at Two People Bay have previously escaped attention. Similar more difficult and remote country exists some ten miles or so to the north, in the vicinity of Mt. Manypeaks. It is very probable that the birds will also be found there, even though a short visit in the company of Mr. John Fisher of Narrikup and Miss Dianne Bickell of Mt. Barker on April 14 gave an inconclusive result.

CONSERVATION PROBLEMS

At present two grave dangers render the continued existence of the Noisy Scrub-bird here horrifyingly precarious. The most menacing is the possibility that an already surveyed and quite unnecessary townsite situated on the margins of this limited area may soon be thrown open for purchase. If a small town is established then the birds at Two People Bay are doomed and this will be a reproach to the people of Western Australia.

The second danger is from bushfires during the summer months. On January 29, 1962, a careless fishing party allowed a fire to escape and devastate a very large area of country near Mt. Gardner and on the mountain itself. The territories of at least four male birds were burnt out, but fortunately small areas of scrub were left untouched. Very surprisingly, for the fire in the gullies must have been fierce, at least three of these birds escaped and are still there. A further fire was wantonly lit along the southern section of the bay on the morning of February 18 but stopped at a sandy track and did little damage. It should be remembered that the Bristle-bird, another of our rarest birds, is also to be found over the whole of this mountainous promontory and in the adjacent sandhill country as well.

It is clear that steps should be taken immediately to avoid both of these dangers by establishing a national park or at least a fauna and flora reserve under the control of the Fisheries Department.

PREPARATION OF BEES FOR CONSUMPTION BY A CAPTIVE BEE-EATER *(MEROPS ORNATUS)*

By C. A. NICHOLLS and D. A. ROOK, Nedlands.

On December 12, 1961, a Rainbow-bird or Australian Bee-eater *(Merops ornatus)* with a broken wing was brought to the C.S.I.R.O. Wildlife Survey Section's Laboratory, Nedlands, for treatment. The bird, an adult, was somewhat emaciated and ill-kempt, and subsequent examination showed the right wing to be fractured at the distal end of the humerus. Since such a break is best left to correct itself unaided, the bee-eater was confined to an aviary whilst we focussed our attention on its food requirements.

Until we were able to procure a small flight of live honey bees *(Apis mellifica)*, the bird was given slaters, cicadas and blowflies. The blowflies it would snap up direct from their flight as they approached a lure designed for the purpose, and these were frequently swallowed after but one or two light taps against the nearest solid object. Cicadas, which were provided to the bird in a stunned state at the tip of a pair of forceps, received on an average two sharp whacks before consumption, whereas slaters were given no "killing" treatment at all and simply swallowed immediately.

At no time did the bee-eater seem inclined to flee and paid little attention to the proximity of human beings. It is on account of this that the subsequent observations could be made in the detail presented below.

When, on the second day, live bees were captured and a selection stunned and offered to the bird by forceps, it became immediately apparent that here we were witnessing what seemed a remarkable specialisation in the preparation for consumption of potentially dangerous prey.

The following is an account of the sequence of actions performed by the bee-eater in dealing with the bees. Observations were made at each feeding period, at four-hourly intervals over a period of four days, the bird accepting an average of six bees per meal. The bird's actions during this period were unvarying. A stunned bee, presented in forceps, would be eagerly snatched and held at its "waist" (petiole) by the tip of the bird's long beak. With a quick flick of the head it would rap the bee once (rarely twice) against the wooden perch usually over to the right hand side. This apppeared to suggest to the bird the orientation of the bee's anatomy, namely in what direction, right or left, the abdomen was pointing. It seemed that upon this experimental test the following sequence of events depended.

Having rapped the bees thus, a quick movement by the beak resulted in the insect being held near the extreme tip of its abdomen, just proximal of the "sting." The bee was never reversed, whilst held in the beak, to ensure that the abdomen was pointed in any set direction; after the initial experimental or test rap, the bird unhesitatingly proceeded to deal with the abdomen in whichever direction it happened to be pointing.

With the bee firmly held as described, a series of movements, likened to hand motions when using an eraser, would then be executed, the bird rubbing the projecting tip of the bee's abdomen against the perch. About six short bursts of this activity would be made, and, to an observer knowing the character of this end of a bee, it seemed that the bird was endeavouring to render the sting inoperable. Indeed, in two instances the entire sting was later found lying along the perch, though this find was quite by accident. and made at a time when unfortunately no further observations could be made.

The next step involved the return of the bee to its original position, held by the "waist," though the relative directions of head and abdomen remained unchanged. The bee's head would then be whacked violently against the side of the perch, opposite the side used for the abdomen rubbing, two whacks being usually delivered; rarely, as though an afterthought, a third whack was given, these presumably to kill the bee. Straightening up, the bird always tossed the prepared bee to the back of its bill, then swallowed. This act was followed by one or two vigorous beak wiping movements over the perch.

No one process, "destinging" or "head whacking," was ever repeated or made out of the order described. Each bee received the same number of blows, in sequence, whether it had been offered alive, stunned or dead, and "destinging" always preceded "head whacking." Once apparently orientated by the initial rap, the bee's abdomen would be dealt with first on whichever side it happened to be, and the head end on the other.

An interesting deviation from the routine was observed when a bee without its abdomen was offered the bird. The initial rap was executed as usual, but in its vain attempts to grasp the missing abdomen the bird became very confused, and rapped both sides. Each rap was followed by an attempt to grasp soft anatomy which, of course, failed. Finally both projecting ends were treated as head ends, being whacked twice each, and then swallowed in the usual manner.

In another feeding experiment a bee-sized blowfly was slipped into line in place of a bee in a succession of bees. The result was startling. The fly was snapped up, lightly rapped once, and swallowed with no further preparation whatsoever. The preceding and following bees were prepared as described, as indeed were all bees.

The bee-eater regurgitated large pellets, consisting of insect hard parts, to the number of two or three per day. One pellet measured 20 x 11 mm., this one approximating the average size.

SUMMARY

A captive adult Australian Bee-eater when fed with honey bees, blowflies, cicadas and slaters adopted an individual and stereotyped feeding technique with each type of animal. It instantly changed to the appropriate method when, for example, a harmless bee-sized blowfly was slipped into a feeding line of honey bees. The bees, but not the other insects, were invariably dealt with by a complicated series of movements which resulted in the stinging apparatus being rendered inoperative before the bee was killed and swallowed. The bird ascertained the position of the stinging end of the bee by one, sometimes two, initial blows of the insect against the perch.

HERPETOLOGICAL MISCELLANEA

By L. GLAUERT, M.B.E., Western Australian Museum, Perth.

XIII. A NEW SKINK FROM THE NORTH-WEST CAPE, WESTERN AUSTRALIA

Lygosoma (Rhodona) nigriceps sp. nov.

This species is closely related to *Lygosoma (Rhodona) miopus* (Gnth.) from which it differs in the shape and size of the head shields, its coloration and longer limbs.

Body elongate, the distance from the tip of the snout to the fore limb 3½ times in that from the fore limb to the hind limb. Fore limb represented by a bud in a depression or entirely absent, hind limb monodactyle. Head cuneiform, snout rounded with a projecting labial edge; rostral about twice as wide as high with a slightly concave suture to the nasals; nostril in a somewhat swollen nasal forming a short suture with its fellow and separating the rostral from the frontonasal; frontonasal about 1¾ as wide as long; wider than the frontal with which it forms a wide suture; prefrontals very small, widely separated, just visible from above, separated from the labials by the posterior loreal.

Frontal large, much wider than the supraocular region, as wide as long, about as long as its distance from the tip of the snout, fitting into the concave anterior margin of the fused frontoparietals, in contact with 2 of the 3 supraoculars; supraoculars 3, second largest, 6 or 7 supraciliaries; several small pre- and postoculars; frontoparietals and interparietals fused, wider and larger than the frontal; parietals long, forming a suture behind the frontoparietals; 5 upper labials, the 4th entering the eye, 6 lower labials; 2 narrow loreals. Eye small the lower lid with a transparent disk. Ear opening very small. Two or 3 enlarged nuchals. Two enlarged preanals. Twenty smooth scales round the body. Tail long and tapering, as wide as the body. Fore limb reduced to a bud in a depression or absent; hind limb monodactyle, shorter than the distance from the tip of the snout to the ear, longer than that from the ear to the fore limb, 4 lamellae under the toe.

Colour above uniform pale brown, each scale light-edged, the colour darkening towards and on the tail; head blackish, labials white with dark markings, 8 more or less complete dark brown lines from the occiput to the level of the ear; limbs dark-spotted; under surface uniform whitish.

Head, 9.2 mm. Head and body, 93 mm. Tail, 73 mm. Hind limb, 7.5 mm.

The type R 14039, now in the Western Australian Museum, collected at Vlaming Lighthouse, North West Cape by Mrs. Thomas.

The relevant portion of the key to the Western Australian species of *Rhodona* (on p. 79 of my *Handbook of the Lizards of Western Australia*, 1962) may be expanded as follows to include the new species:

Fingers a "bud," toes 2
  Two bands .... *picturatum*
Fingers a "bud," toes 1
  Four rows of dots .... *miopus*
  No bands, head black .... *nigriceps*

A WILLIAMS BIRD LIST

By ERIC H. SEDGWICK, Collie.

PERIOD OF OBSERVATION

The writer spent a nominal two years at Williams, but, owing to a lengthy absence, observations were practically confined to the period between May 1954 and December 1955.

THE DISTRICT

Williams, 100 miles S.E. of Perth, is situated in a transition area between the jarrah forest block and the open forest of the wheat-belt.

Dominant local timbers are jam *(Acacia acuminata)*, wandoo *(Eucalyptus redunca)*, marri *(Euc. calophylla)*, jarrah *(Euc. marginata)*, she-oak *(Casuarina huegeliana)* and, along water courses, flooded gum *(Euc. rudis)*.

Considerable areas have long been cleared and developed as pasture land or cropped, but much natural vegetation remains. Although alienated, the banks of the Williams River, a near-permanent stream, still carry flooded gums and associated vegetation. On the other hand the local bush fire prevention organisation is denuding the townsite and road reserves by its remarkable policy of annually burning everything that will burn in order to prevent fires.

CHARACTER OF AVIFAUNA

The bird life reflects the transition environment.

The following species occurring in the Williams District, though not necessarily confined to the jarrah block, are typical of it: White-tailed Black Cockatoo *(Calyptorhynchus)*, King Parrot *(Purpureicephalus spurius)*, Twenty-eight Parrot *(Barnardius zonarius semitorquatus)*, Kookaburra *(Dacelo gigas)*, Sacred Kingfisher *(Halcyon sancta)*, Golden Bronze Cuckoo *(Chalcites lucidus)*, Grey Fantail *(Rhipidura fuliginosa)*, Scarlet Robin *(Petroica multicolor)*, Western Yellow Robin *(Eopsaltria griseogularis)*, Western Warbler *(Gerygone fusca)*, Western Thornbill *(Acanthiza inornata)*, Dusky Wood-Swallow *(Artamus cyanopterus)*, Spotted Pardalote *(Pardalotus punctatus)*, Western Silvereye *(Zosterops australasiae)*, White-naped Honeyeater *(Melithreptus lunatus)*, Western Spinebill *(Acanthorhynchus superciliosus)*, New Holland Honeyeater *(Meliornis novae-hollandiae)*, Brush Wattle-bird *(Anthochaera chrysoptera)*.

Conversely, the following species are more typical of the savannah to the east of the jarrah block: Bustard *(Eupodotis australis)*, Square-tailed Kite *(Lophoictinia isura)*, Smoker Parrot *(Polytelis anthopeplus)*, Elegant Parrot *(Neophema elegans)*, Horsfield Bronze Cuckoo *(Chalcites basalis)*, Brown Flycatcher *(Microeca leucophoea)*, Red-capped Robin *(Petroica goodenovii)*, Hooded Robin *(Melanodryas cucullata)*, White-winged Triller *(Lalage sueurii)*, White-browed Babbler *(Pomatostomus superciliosus)*, Weebill *(Smicrornis brevirostris)*, Rufous Song-Lark *(Cinclorhamphus mathewsi)*, Masked Wood-Swallow *(Artamus personatus)*, Black-faced Wood-Swallow *(A. cinereus)*, Mistletoe-bird *(Dicaeum hirundinaceum)*, Brown-headed Honeyeater *(Melithreptus brevirostris)*, Tawny-crowned Honeyeater *(Glicipihla melanops)*, Singing Honeyeater *(Meliphaga virescens)*, Yellow-plumed Honeyeater *(M. ornata)*.

To the foregoing may be added: Crested Bell-bird *(Oreoica gutturalis)* and Western Shrike-Tit *(Falcunculus frontatus)*, recorded by Brian Teague (*W.A. Nat.*, 4: 145, and unpublished).

SPECIES LIST

The following list of species, with a few brief annotations, must be far from exhaustive. Unless specifically stated, all species were noted: (a) by the Williams River to the east of the town, (b) in the wandoo-jam forest of the railway water catchment area, (c) in wandoo forest to the west of the town—all three localities are within a mile of the townsite.

Common Bronzewing *(Phaps chalcoptera)*.—Bronzewings are fairly plentiful and may often be seen feeding on the townsite where they are confident, often permitting an approach to within 20 yards. I handled a fledged juvenile on March 10, 1955.

Senegal Turtledove *(Streptopelia senegalensis)*.—Not seen until

January 16, 1955, when two birds appeared. These were still present at the end of the year.

Coot *(Fulica atra)*.—At least ten birds noted on an extensive swamp 20 miles south of Williams.

Little Black Cormorant *(Phalacrocorax sulcirostris)*.—Noted once, December 11, 1954, by the river.

Little Pied Cormorant *(Phalacrocorax melanoleucos)*.—Occasionally seen, usually singly, along river. One seen by a small dam.

Banded Plover *(Zonifer tricolor)*.—Sometimes observed in flight over township. Probably fairly frequent on adjacent farm-lands.

Black-fronted Dotterel *(Charadrius melanops)*.—Observed by the river and by adjacent pools during the October-December period.

Australian Bustard *(Eupodotis australis)*.—A single bird, seen from a moving vehicle, in a paddock between Williams and Narrogin, on February 6, 1955, must almost certainly have been of this species.

White-faced Heron *(Notophoyx novae-hollandiae)*.—Noted from time to time by the river or by dams. A nest with two fairly well-grown but still downy young was located on April 17, 1955.

Black Swan *(Cygnus atratus)*.—On August 7, 1956, one bird was present on a pool 20 miles south of Williams.

Black Duck *(Anas superciliosa)*.—Single birds, or sometimes two birds in company, were noted from time to time on the river. Dams are sometimes frequented. After the exceptionally high floods of February 1955, ducks congregated in flooded paddocks by the river.

Maned Goose *(Chenonetta jubata)*.—Eight birds were observed on pasture near a dam nine miles east of Williams.

Musk Duck *(Biziura lobata)*.—On August 7, 1956, one bird was displaying on a large pool 20 miles south of Williams.

Australian Goshawk *(Accipiter fasciatus)*.—A pair frequented the railway water catchment. Other birds were seen occasionally. On November 7, 1954, I saw a cock alight in a large wandoo calling "kek-kek-kek." A hen joined the cock uttering a long drawn out "wit" or "weet." After both had perched together for some time, the hen flew about forty yards to a small wandoo, balanced on the outer foliage and plucked a leafy twig with her bill. She returned to the big tree, but shortly afterwards flew off in another direction and was lost to sight.

Collared Sparrow-hawk *(Accipiter cirrocephalus)*.—Present in wandoo forest nine miles east of Williams.

Wedge-tailed Eagle *(Aquila audax)*.—One bird, seen over the townsite on October 3, 1954, was being harried by Magpies—first four, then five. My only other record was of a dead bird found by the river.

Little Eagle *(Hieraaëtus morphnoides)*.—Noted occasionally.

Square-tailed Kite *(Lophoictinia isura)*.—One circled low over the townsite on December 29, 1954.

Black-shouldered Kite *(Elanus notatus)*.—One bird observed at three different places on the townsite on August 23, 1954.

Brown Hawk *(Falco berigora)*.—Noted occasionally.

Nankeen Kestrel *(Falco cenchroides)*.—Twice in September 1954 and once in September 1955 a single bird was seen. These are my only records.

Boobook Owl *(Ninox novae-seelandiae)*.—Calls heard in August and in November 1954.

Purple-crowned Lorikeet *(Glossopsitta porphyrocephala)*.—The number of birds present appeared to fluctuate, but it is probable that some were present throughout the period of observation.

White-tailed Black Cockatoo *(Calyptorhynchus baudinii)*.—Flocks, often small, seen from time to time. Most of my records were made in summer.

Galah *(Kakatoe roseicapilla)*.—Not established in the district, but I received a convincing report of one bird to the south of Williams.

Smoker Parrot *(Polytelis anthopeplus)*.—Records were mainly for the June to December period. Early in December 1954 a flock of c. 50 built up on the townsite and fed upon acacia seeds in the pod, the pods being fully developed, but not dehiscing.

Western Rosella *(Platycercus icterotis)*.—Frequently seen in patches of *Casuarina*. The birds sometimes appeared on the townsite, being seen more often in summer.

King Parrot *(Purpureicephalus spurius)*.—Observed in and about the town.

Twenty-eight Parrot *(Barnardius zonarius)*.—Birds are of the race *B. z. semitorquatus*—underparts entirely green and front crimson.

Tawny Frogmouth *(Podargus strigoides)*.—One bird observed calling in daylight—1030 hours—from a perch in a flooded gum by the Williams River.

Laughing Kookaburra *(Dacelo gigas)*.—This species is well-established and is reported to have been present for many years.

Sacred Kingfisher *(Halcyon sanctus)*.—My only records are of individuals seen on September 26 and October 15, 1954, and on October 1, 23 and 30, 1955. The last two observations were made in the same locality, but generally the birds gave the impression of being in passage.

Rainbow-bird *(Merops ornatus)*.—Present from September 26, 1954, until March 6, 1955, and from October 3, 1955, until the time of my departure.

Pallid Cuckoo (*Cuculus pallidus)*.—A bird was seen on May 22 and the first calls heard on May 24, 1954, after which birds were observed until December 5. In 1955, birds were seen and heard on May 1 and were conspicuous until the end of November. Calls were heard occasionally until December 24. See *W.A. Nat.*, 5: 21, for a record of the Golden Whistler as a fosterer of the Pallid Cuckoo.

Fan-tailed Cuckoo *(Cacomantis flabelliformis)*.—These birds were present during the May to November period, the recorded dates being: May 22, 1954, until November 28, 1954, and May 1, 1955, until November 13, 1955.

Horsfield Bronze Cuckoo *(Chalcites basalis)*.—My only notes for 1954 relate to calls heard on August 8 and August 15. In 1955, loud, clear calls, apparently of this species, were heard on April 24 and further calls were heard on June 19. From July 3 calls were frequently heard and these persisted until mid-December.

Golden Bronze Cuckoo *(Chalcites lucidus)*.—Records for 1954 extend from August 1 until December 15, and a fine example, with breast completely barred, was seen on January 16, 1955. I failed to record the first seasonal reappearance of these birds in 1955, but they were well established by September 18 and calls were heard until December 24, just before I left this district. Displays seen at Williams are described in *Emu*, 55: 254.

Welcome Swallow *(Hirundo neoxena)*.—A nest located on September 28, 1955, in a recess in the timbering under a shop verandah was unusual in that it was supported from below and for this reason I was careful to check the identity of the attendant birds. Tree-Martins nesting in timber buildings construct somewhat similar nests.

Tree-Martin *(Hylochelidon nigricans)*.—Frequent in open forest and over adjacent cleared land.

Grey Fantail *(Rhipidura fuliginosa)*.—Encountered in the town, by the river and in forest, throughout the year, but more conspicuous from September to March with a suggestion of a period of scarcity, at least by the river, in the April to August period.

Willy Wagtail *(Rhipidura leucophrys)*.—In 1954, nocturnal calling commenced on September 27, and in 1955 persisted from September 7 until December 1. Young, not long out of nest, were seen on December 7, 1954. Spirited attacks on Kookaburras, involving pecking, were witnessed on September 13 and 26, 1954, and on October 2, 1955.

Restless Flycatcher *(Seisura inquieta)*.—Observed in town and in forest, but mainly by the river. The birds were apparently present in limited numbers throughout the year. Most of the birds seen appeared to be on the move and were not seen again in the same locality.

On April 3, 1955, a pursuit flight was noted in which the birds perched with crests erect. This display was accompanied by a reedy "twee-et" call and a loud, clear and somewhat drawn out "joi-joi-joi."

Brown Flycatcher *(Microeca leucophoea)*.—Observed in wandoo forest nine miles east of Williams on November 13, 1955—a slight extension of the range of the species as recorded in *Birds of W.A.* (Serventy and Whittell).

Scarlet Robin *(Petroica multicolor)*.—Both this species and the Red-capped Robin were present on the townsite when I arrived in May 1954 but both species, including birds apparently holding territory, disappeared from the townsite about the end of July. Scarlet Robins reappeared in February 1955 and were present until early November. During the period that the birds were absent from the town they appeared scarcer in the bush than previously. Nests with young were noted in October 1954 and young were being fed from late September until the end of October 1955.

Red-capped Robin *(Petroica goodenovii)*.—For the first four months this and the previous species appeared about equally abundant, but thereafter the Scarlet Robin was dominant. This species was not seen on the townsite after July 1954.

Hooded Robin *(Melanodryas cucullata)*.—On September 5, 1954, I saw a pair of Hooded Robins 33 miles south of Williams. My only record for Williams and its immediate environs was a dead hen bird picked up on the school verandah on June 5, 1955. Although apparently undamaged, it appears likely that the bird had flown violently against the extensive glass windows of the building concerned.

Western Yellow Robin *(Eopsaltria griseogularis)*.—Occurs sparingly in jam and wandoo forest. Young, not long out of the nest, were being fed on September 18, 1955.

Golden Whistler *(Pachycephala pectoralis)*.—Birds were noted on a number of occasions in two forest localities. See note on Pallid Cuckoo.

Rufous Whistler *(Pachycephala rufiventris)*.—Well distributed through town and forest. There was a considerable volume of song almost throughout 1955, stimulated perhaps by January thunderstorms followed by record rains in February. On August 8, 1954, at 0915 hours, I observed two fully-plumaged cocks and an apparent hen pursuing and bowing with tails elevated. During this display a four-syllable note was uttered.

Western Shrike-Thrush *(Colluricincla rufiventris)*.—Encountered on several occasions in two forest localities, but not very plentiful.

Western Shrike-Tit *(Falcunculus frontatus)*.—On November 6, 1955, the late Mr. Brian Teague came to me with news that he had been watching shrike-tits. Unfortunately I did not record the information that he gave me, but from memory, his observations had been made on the previous day, when he had encountered two birds. Certainly only a very short time had elapsed between his observation and his visit to me. We went at once to the area of wandoo forest adjacent to the 109 mile peg on the Williams-Narrogin Road and made a thorough search, but without locating the birds. On November 13 I went alone and searched for three hours without result. Brian Teague intended submitting his observations for publication, but apparently did not do so.

Magpie-Lark *(Grallina cyanoleuca)*.—Normally there were a few pairs scattered in and about the town, but on December 30, 1954, I saw a flock of c. 25. Young were being fed on October 15, nest on April 10. These were reared successfully and young—probably of the same parents—were being fed on the ground on September 11.

Black-faced Cuckoo-Shrike *(Coracina novae-hollandiae)*.—Birds were seen from time to time throughout the period of observation.

White-winged Triller *(Lalage sueurii)*.—A fully-plumaged cock was observed on October 30, 1955, and a week later a pair was seen in the same locality. Calls were uttered in flight. These were my only records of this species.

White-browed Babbler *(Pomatostomus superciliosus)*.—Not encountered near the town, but B. V. Teague showed me a colony of these birds in wandoo forest nine miles east of Williams.

White-fronted Chat *(Epthianura albifrons)*.—On September 5, 1954, a pair was encountered 16 miles south of Williams.

Western Warbler *(Gerygone fusca)*.—Birds present and calling throughout the year.

Weebill *(Smicrornis brevirostris)*.—Occurs in forested areas.

Western Thornbill *(Acanthiza inornata)*.—Flocks of up to 12 birds were seen in wandoo and jam forest. Three fledglings were being fed on October 10, 1954.

Brown Thornbill *(Acanthiza pusilla)*.—A fairly frequent and well-distributed species. On September 7, 1954, I heard what I took to be the trill of a Fan-tailed Cuckoo, but when I attempted to find the bird I could locate only a Brown Thornbill. Absolute proof of mimicry was lacking, but the circumstantial evidence was strong. A month later, on October 3, I found a Brown Thornbill imitating the "cheer" call which accompanies the displays of the Golden Bronze Cuckoo. The thornbill was interspersing its own calls with those of the cuckoo and I observed that the "cuckoo" calls moved with the thornbill from tree to tree. A less perfect imitation of the cuckoo was heard at c. 0730 on November 21. At the time of noting this occurrence I had entirely forgotten the incident of October 3, which, I believe, was made in the same area. About an hour after hearing the "cuckoo" call I found two birds, in the same locality giving an unmistakable imitation of Silvereye calls including what is, at least to me, the most distinctive call of that species. A nest containing young was located on October 9, 1955.

Yellow-tailed Thornbill *(Acanthiza chrysorrhoa)*.—Noted in town and forest. The commencement of a nest was discovered on September 19, 1954. This nest was constructed from the bottom up and was apparently completed by September 26. On October 3 the nest was empty, but a week later contained three eggs. These were still present on October 24, but during the ensuing week the nest was damaged and deserted. A second nest was commenced five feet from the first, but was not completed.

Rufous Song-lark *(Cinclorhamphus mathewsi)*.—From October 4 to 12, 1955, a bird was present and calling persistently on the outskirts of the town. Singing perches included the top of a tall pine in the hospital grounds.

Splendid Wren *(Malurus splendens)*.—Encountered mainly along the Williams River.

Masked Wood-Swallow *(Artamus personatus)*.—At least six birds flying in a westerly direction at 1200 hrs. on October 27, 1955.

Dusky Wood-Swallow *(Artamus cyanopterus)*.—Small flocks were noted several times during 1955, though not in 1954. Nests and young birds were seen during the October-November period.

Black-faced Wood-Swallow *(Artamus cinereus)*.—Four seen 21 miles south of Williams on September 5, 1954, and one bird, almost certainly of this species, at Quindanning 20 miles west on April 8, 1955.

Black-capped Sittella *(Neositta pileata)*.—Noted from time to time on the Railway Water Catchment and to the west of the town.

Rufous Tree-creeper *(Climacteris rufa)*.—B. V. Teague introduced me to a strong colony in wandoo forest nine miles east of Williams. One bird was observed carrying teased bark to a spout on November 6, 1955.

Mistletoe-bird (*Dicaeum hirundinaceum*).—First encountered on July 10, 1954. A cock was singing persistently near my house where it had, apparently, established territory. Thereafter calls were frequently heard and it became apparent that several birds were holding territory on the townsite, while others were established in the environs. On at least one occasion I could hear three birds calling simultaneously. Calling birds which I sighted were invariably males. Relatively few hens were seen. The main song period was September-October. Birds were noted until the end of November and thereafter were not seen until April 17, 1955. Calling persisted until November and one bird was seen in December. It would appear that the birds are either absent or at least silent and retiring during the early part of the year. The periods of activity noted coincided with the availability of *Loranthus* fruit. Young birds were seen, including, on October 16, 1955, one with a bright red bill, comparable in colour with that of a Zebra Finch. The red bill of the young was mentioned recently by E. A. R. Lord, "Murphy's Creek Birds," *Emu,* 56: 122, but this striking feature does not appear to have received frequent notice. Several calls (probably territorial) I have set down as follows: (a) "weet-weet-swizet," (b) "weet-weet-swizet-it," (c) "swizit-swizit-swizit," (d) "per-swizit-it-per-swizit."

Spotted Pardalote *(Pardalotus punctatus)*.—Calls were noted shortly after my return to the Williams district in May 1954 and persisted until October, after which time I did not again record this species.

Red-tipped Pardalote *(Pardalotus substriatus)*.—Birds were inconspicuous during early 1954, but were present and calling throughout 1955.

Western Silvereye *(Zosterops australasiae)*.—A very frequent species by the river and often encountered in the townsite.

White-naped Honeyeater *(Melithreptus lunatus)*.—This species was encountered on several occasions associated with flowering *Dryandra* (spp.). Sometimes the following species was also present and on one occasion I encountered what appeared to be a mixed flock.

Brown-headed Honeyeater *(Melithreptus brevirostris)*.—York gum *(Eucalyptus foecunda)*, *Dryandra floribunda*, and tree lucerne blossoms were visited. A party seen on January 26, 1955, behaved in a peculiar manner which I am unable to explain. A number of birds were coming and going from about one-half of a square foot of the bole of a flooded gum *(Euc. rudis)*. About eight birds were present at any time and this number was actually counted twice.

Western Spinebill *(Acanthorhynchus superciliosus)*.—Recorded on a few occasions in 1954. One bird observed was probing *Astroloma* flowers.

Tawny-crowned Honeyeater *(Gliciphila melanops)*.—My only record is of a few birds calling in *Dryandra* near the town on May 25, 1954.

Brown Honeyeater *(Gliciphila indistincta)*.—These honeyeaters can usually be located in *Dryandra* thickets and were observed in flowering *Loranthus* (May), *Eucalyptus rudis* (Oct.) and tree lucerne (Aug.-Oct.). Brown Honeyeaters were especially frequent by the river from June to December, 1955.

Singing Honeyeater *(Meliphaga virescens)*.—Present in the town and by the river throughout the year and encountered occasionally in wandoo and jam forest.

Yellow-plumed Honeyeater *(Meliphaga ornata)*.—On August 8, 1954, one bird was seen in *Dryandra* near the town. This was my only record for the immediate vicinity of Willliams, but on November 6, 1955, B. Teague and the writer found these birds very frequent in wandoo forest nine miles east of the town. However, during three hours' observing in the same area a week later not one was seen.

New Holland Honeyeater *(Meliornis novae-hollandiae)*.—Observed by the river and, associated with *Dryandra* (spp.) and *Calothamnus*, in the forest.

Dusky Miner *(Myzantha obscura)*.—One bird was seen and heard on the townsite on January 16 and 17, 1955. This was my only record for this area. On September 5, 1954, Miners were encountered eleven miles south of Williams.

Little Wattle-bird *(Anthochaera chrysoptera)*.—A few birds could usually be located, mainly in *Dryandra* thickets.

Red Wattle-bird *(Anthochaera carunculata)*.—A fluctuating population. Influxes appeared to occur in September 1954 and in the March to May period and October of 1955.

Australian Pipit *(Anthus novae-seelandiae)*.—Observed mainly in cultivated areas. On June 26, 1955, two birds were perching in riverside flooded gums and indulging in soaring flights.

Raven *(Corvus coronoides)*.—Birds were well distributed and fairly frequent. No opportunity of confirming the field identification occurred. September-October appeared to be a period of moult.

Grey Currawong or Squeaker *(Strepera versicolor)*.—One bird observed near Albany Highway 11 miles south of Williams.

Western Magpie *(Gymnorhina dorsalis)*.—In 1954 nocturnal song commenced at the beginning of September. A brooding bird was observed on September 7 and young in a nest on October 10.

On January 17, 1955, three birds, one adult and two juveniles, were flying to long pendant stems of *Loranthus* and clinging, sometimes by only one foot and often upside down, and pecking at the plant. They were not, apparently, taking insects. Mistletoe berries could have been the attraction. Small portions of plant—either fruit or small leaves—fell to the ground. One juvenile broke off a small sprig of about four leaves and took it to the host York gum. I could see no berries on this spray. The bird moved about the tree with the spray and finally flew off, the other juveniles pursuing. I do not know how long this "game" was maintained as it was in progress when I first saw the birds, but I watched for perhaps three minutes.

A JAM FOREST BIRD POPULATION

An attempt was made to obtain information on the population of a typical forest comprising jam, York gum and she-oak. The area selected was five acres in the south-west corner of the railway water catchment bordered on all sides by similar forest.

Sixteen counts were made between August 1, 1954, and September 18, 1955. The average number of individuals seen was 16.3. In all 27 species (excluding species seen in passage) were recorded. The average number of species seen during a count was six.

The following table indicates the result of the census.

No.	Species Observed	Seen Times	Largest No. Seen
1	Rufous Whistler	14	3
2	Western Warbler	12	6
3	Weebill	12	6
4	Scarlet Robin	11	3
5	Grey Fantail	10	2
6	Yellow-tailed Thornbill	8	6
7	Western Silvereye	8	14
8	Raven	6	3
9	Mistletoe-bird	6	1
10	Golden Bronze Cuckoo	5	3
11	Red-tipped Pardalote	4	1
12	Red-capped Robin	2	1
13	Brown Thornbill	2	2
14	Western Thornbill	2	9
15	Tree-Martin	2	12
16	Brown-headed Honeyeater	2	8
17	Purple-crowned Lorikeet	2	5
18	White-naped Honeyeater.	2	2
19	Spotted Pardalote	1	1
20	Twenty-eight Parrot	1	3
21	Black-capped Sittella	1	6
22	Western Rosella	1	2
23	Aust. Goshawk	1	1
24	Smoker Parrot	1	8
25	Western Magpie	1	1
26	Brown Honeyeater	1	1
27	Black-faced Cuckoo-Shrike	—	—

The Red-capped Robin had been rather consistently present in the area just prior to the commencement of the series of counts. The Black-faced Cuckoo-shrike was recorded, but not during a count.

The only species found breeding within the area was the Western Warbler (one nest). However, the Yellow-tailed Thornbill bred a few feet outside the census area and the breeding of Scarlet Robins was suspected but not proved.

A NEW SPECIES OF GEKKONID LIZARD, GENUS *DIPLODACTYLUS* (GRAY), FROM THE SOUTHERN INTERIOR OF WESTERN AUSTRALIA.

By ARNOLD G. KLUGE,* Department of Biology, University of Southern California, Los Angeles 7, California.

The morphological characters associated with the digits of gekkonid lizards are almost invariably used at the intergeneric level of study and commonly referred to as "generic characters." In the Australian genus *Diplodactylus*, however, there is an extremely wide variety of digital types which appear to be best utilized only in differentiating between the species. Within the genus there is a gradual trend in the shape and scalation of the digits from short and depressed with large subapical plates and greatly enlarged transverse subdigital lamellae (as exhibited by *spinigerus* and *strophurus*) to long and slender with slightly enlarged subapical plates and granular inferior surfaces (as exhibited by *alboguttatus*, *squarrosus* and *stenodactylus*). The species of the former extreme primarily occupy an arboreal habitat and are commonly found at night on the extremities of low trees and shrubs. The species of the latter extreme are found on the ground almost without exception. It is interesting to note that *Diplodactylus vittatus* possesses an intermediate type of digit between the two previously mentioned extremes and is found on the ground and not infrequently on vegetation. The wide variety of digital types found in *Diplodactylus* has probably been one of the major factors for the success of the genus in occupying the many different habitats throughout Australia.

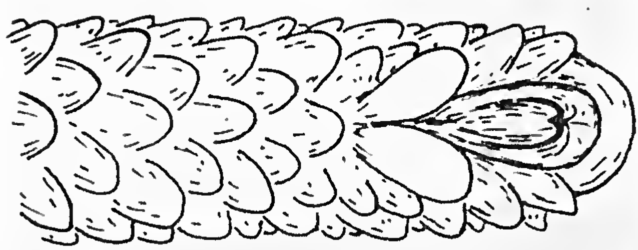

Fig. 1.—A ventral view of the distal one-fourth of the fourth toe of the holotype of *Diplodactylus maini* showing the extremely small subapical plates and inferior conical granules.

In the collections of the Western Australian Museum (W.A.M.) and the Department of Zoology of the University of Western Australia (U.W.A.) are a number of specimens from the southern interior of Western Australia which exhibit a peculiar type of digit yet unrecorded in *Diplodactylus*. The most striking features

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of this population are the extremely long slender digits, minute subapical plates and numerous conical subdigital granules. The population is described as a new species in honour of Dr. A. R. Main of the University of Western Australia who collected the holotype and who has helped me accumulate a large part of my data on Australian geckos.

Diplodactylus maini sp. nov.

Holotype: R12242 (W.A.M.). Collected 10 miles south of Queen Victoria Spring (33 miles north of Zanthus), Western Australia, by A. R. Main on October 2, 1956.

Diagnosis: *Diplodactylus maini* differs from all other members of the genus in possessing long slender digits with extremely small subapical plates (Fig. 1). The subapical plates are not obviously differentiated from the subdigital granules as they are in all other species of the genus.

Description of the holotype: Head convex; eye very large; snout short; rostral quadrangular, slightly more than twice as wide as high; dorsomedian rostral crease absent; nostril large, surrounded by first supralabial, rostral, two large supranasals and two small postnasals; anterior supranasal larger than posterior, meets counterpart on midline (internasal absent); scales immediately posterior to

Fig. 2.—A dorsal view of the holotype of *Diplodactylus maini* showing the colour pattern.

supranasals enlarged; scales of snout conical, 12/11 (left and right sides respectively) between postnasals and preocular granules; supralabials 8/8; thirty-four scales between centro-lateral margins of orbits (excluding those of dorsal eyelid); 6/6 spinose scales on posterior border of dorsal eyelid; mental lanceolate, slightly longer than broad; infralabials 9/10; scales bordering mental and infralabials slightly enlarged and flattened, gradually grading into small conical granules of throat region; external ear opening a small diagonal slit at level of angle of jaw; dorsal surface of head and body covered with small conical scales giving a somewhat beaded appearance; dorsal body scales equal size of small cycloid imbricating ventrals; limbs covered with imbricating cycloid scales, those of ventral surfaces slightly larger; digits long and slender, slightly angulate; subdigital surfaces covered with small conical granules; 15/15 conical granules covering inferior surface of fourth finger; 20/20 conical granules covering inferior surface of fourth toe; subapical plates extremely small, only slightly larger than subdigital granules (Fig. 1); nail short, strongly curved, not projecting distally beyond sheath; tail covered with flat square imbricating scales forming definite annuli; scales of dorsal surface of tail slightly smaller than subcaudals, twice as large as those covering dorsum of body; sex—female; cloacal spur replaced by obscure scales.

Dorsal ground colour yellowish-white; snout and inter-orbital regions covered with irregular brown spots; brown postocular reticulation meets counterpart on nape; dark brown reticulation of dorsal and lateral body surfaces encompasses yellowish spots which mid-dorsally become larger and more irregular (Fig. 2); reticulation of dorsum continues on to limbs and tail, very heavily concentrated on latter; throat and ventral surfaces of body and tail immaculate white, devoid of chromatophores; ventral surfaces of arms and legs sparsely covered with brown chromatophores; chromatophores heavily concentrated on palms, soles and digits.

Snout-vent length 46.0 (all measurements are given in millimetres); length of tail (unregenerated) 44.5; length of snout 4.6; head width 8.1; head length 12.0; diameter of orbit 3.5; distance between eye and ear 3.8; axilla to groin 21.0; length of fore limb 17.0; length of fourth finger 3.0; length of hind limb 23.0; length of fourth toe 4.7.

Variation: In addition to the holotype, *Diplodactylus maini* is known from the following specimens: (a) Kulin (R4183—W.A.M.), (b) Newman Rock, 88 miles east of Norseman (two specimens—U.W.A.), and (c) three specimens without locality data (U.W.A.). These specimens agree with the holotype in all important characters and exhibit the following variation: rostral slightly less to slightly more than twice as wide as high; rostral crease absent to completely dividing rostral shield; postnasals two to three, avg. 2.3; nine to twelve, avg. 10.2, scales between postnasals and preocular granules; supralabials seven to nine, avg. 8.4; twenty-seven to thirty-two, avg. 29.8, scales between centrolateral margins of orbits; three to five, avg. 4.2, spinose scales on posterior border of dorsal eyelid; mental slightly broader than long to slightly longer than broad; infralabials eight to eleven, avg. 9.5; external ear opening a small diagonal slit to moderately large and round; dorsal body scales smaller to slightly larger than ventrals; thirteen to sixteen, avg. 14.6, conical granules covering inferior surface of fourth finger; eighteen to twenty-four, avg. 20.0, conical granules covering inferior surface of fourth toe; males possess single greatly enlarged dorsolaterally projecting cloacal spur posterior to limb insertion, a slightly enlarged scale may be present at base of spur; preanal pores absent; brown reticulation of sides of body encompasses numerous small white spots; reticulation of dorsum may be completely absent from vertebral region or encloses four irregular but distinct white spaces.

A single specimen from Warburton Mission (U.W.A.) is tentatively assigned to *Diplodactylus maini*. This juvenile male exhibits the following characters: rostral twice as wide as high; rostral crease one-half height of rostral; 3/3 postnasals; 11/12 scales between postnasals and preocular granules; supralabials 8/8; twenty-five scales between centrolateral margins of orbits; 4/4 spinose scales on posterior border of dorsal eyelid; mental longer than wide; infralabials 8/9; external ear opening small and round; 12/11 conical granules covering inferior surface of fourth finger; 14/15 conical granules covering inferior surface of fourth toe; subapical plates larger than inferior conical granules; cloacal spur single; two preanal pores, separated on midline by four scales; dorsal ground colour reddish-brown; dorsal body reticulation very coarse, absent from vertebral region.

The specimen from Warburton Mission differs from typical *Diplodactylus maini* in possessing a smaller number of inter-orbital scales and fourth finger and toe inferior granules, slightly larger subapical plates and preanal pores. The differences in colour and colour pattern can probably be attributed to age as in many species of *Diplodactylus* the young are extremely different from adults. It is possible that this specimen represents an undescribed central Australian species closely related to *maini*.

Relationships: The affinities of *Diplodactylus maini* appear to lie within the Western Australian group of species, *alboguttatus*, *squarrosus* and *stenodactylus*, which exhibit long slender digits with granular inferior surfaces. In addition to the unique condition of the small size of the subapical plates, *maini* can readily be distinguished from *squarrosus* and *stenodactylus* in that the rostral shield borders the nostril (the rostral is excluded from the nostril by the enlarged anterior supranasal in *squarrosus* and *stenodactylus*). *Diplodactylus maini* appears to be more closely related to *alboguttatus* from which it differs in the following characters: (a) eighteen to twenty-four, avg. 20.0, inferior fourth toe granules (thirteen to seventeen, avg. 15.8, in *alboguttatus*), (b) a single enlarged cloacal spur in males (two enlarged spurs in *alboguttatus*) and (c) preanal pores absent in males (present in *alboguttatus*).

The digits of *Diplodactylus maini* are very similar to those of *Rhynchoedura ornata* and superficially like those of *Lucasius damaeus* (both genera are monotypic and endemic to Australia). A detailed examination of the skeletons and external meristic and measurable characters of the three species reveals such a large number of differences that their digital similarities are probably due to parallelism and are therefore homoplastic but not homologous.

Remarks: The holotype of *Diplodactylus maini* was collected at night on unblown yellow sand. The two specimens from Newman Rock were collected at night in a eucalypt woodland.

FROM FIELD AND STUDY

A Record of the Euro near Toodyay.—Barker (*W.Aust. Nat.*, 6, 1958: 154) records the occurrence of the Euro (*Macropus robustus*) in the Mokine area. I wish to add to his observations by reporting the sighting of four Euros at Culham in September 1960. The animals were all a dark brick red colour. One of them appeared sick, it was extremely thin and fell over several times as it hopped away.

The country where the sightings were made, is typical Wandoo breakaway, similar to that described by Barker at Mokine.

—P. McMILLAN, Guildford.

Glossy Ibis in the South-West.—The last published record of this species in the South-West (*W.A. Nat.*, 6: 55 and 6: 150) is of a single bird in the Fremantle area during November 1956 and January-February 1957. There are only half a dozen other published records for the South-West.

On February 6, 1962, I saw a Glossy Ibis (*Plegadis falcinellus*) at a backwater of the Peel Inlet near the area known as "The Chimneys."' It was perched on a rock in company with Little Pied Cormorants (*Phalacrocorax melanoleucos*) and a few White-faced Herons (*Notophoyx novae-hollandiae*), and Eastern Curlew (*Numenius madagascariensis*) were feeding in the close vicinity.

R. H. Stranger and Brian Leaky saw two Glossy Ibis flying over the northern section of Lake Joondalup (2½ miles north-west of Wanneroo township) during March 1959.

—A. A. BURBIDGE, Mandurah.

The Crested Pigeon Breeding near Northam.—The following item is a further contribution to the documentation of the gradual extension southwards of the Crested Pigeon (*Ocyphaps lophotes*). On September 8, 1961, I found a pair of Crested Pigeons nesting in a needlewood tree (*Hakea preissii*), at Seabrook, 4 miles S.E. of Northam. There were two eggs in the nest and these were still unhatched on September 20. When I next visited the nest, on the 25th, both eggs had hatched and subsequently the parent birds were observed with the young ones on several occasions.

Although Crested Pigeons have been seen in this area for several years, this is the first time I have recorded them nesting here.

—A. L. MILHINCH, Seabrook, via Northam.

Spread of the Crested Pigeon.—The southward movement of the Crested Pigeon (*Ocyphaps lophotes*) is further indicated by the following records:—

Wyalkatchem. Mr. M. W. Cook stated that in 1956 the birds appeared at this town. In 1952 they had arrived at Nalkain, 14 miles north of Wyalkatchem.

Tammin. Mrs B. R. Neck, writing on July 7, 1960, reported a bird which appeared to be a Crested Pigeon and stated that a number had been seen in the district and were new to the area.

Mundaring. Mr. A. P. Dillistone, in a letter of May 9, 1960, reported occasional birds. He also mentioned that in 1905 in the Chapman district north-east of Geraldton flights of these pigeons were common though the birds did not stay. In later years they became more confiding and began to feed in the stockyard.

Bickley. A bird was seen on the coastal plain flats west of the Darling Range scarp in October 1959. The children at the Orange Grove School stated that three birds were resident in the area.

Wembley Downs. At my home on April 11, 1960, a Crested Pigeon landed on the telephone wires. In the same district various friends had commented on the appearance of a "bird with a crest" about the same time. —V. N. SERVENTY, Wembley Downs.

Curlews in a Perth Suburb.—Recently, whilst sleeping on a poultry farm in Uranium-street, Kewdale—a suburb of Perth 6 miles S.E. of the G.P.O.—I was surprised to hear the call of Curlews *(Burhinus magnirostris)*, during each of three successive evenings.

On inquiry I learnt that these birds had been there for at least 8 years and had become quite used to living on the partly cleared banksia, paper bark and red gum land which is the general run of the country in that area.

On occasions when packing eggs a Mr. MacGregor who lives in Uranium-street tells of how these Curlews "land-in" close to the house at night where he works packing eggs and several times they have given him quite a fright when they called out almost under the window. They call out intermittently through the night, but were never heard earlier than 8 p.m. during the second week of February 1962.

Frogs are numerous in and around MacGregor's place and it could be one of the reasons for the birds having stayed there for so long.

On one occasion, some 4 years back, I saw two of these birds during the day standing close to a paper bark in the short dry grass. They were motionless but quite confident of their safety with human beings close by.

The above area is to be resumed shortly for a railway marshalling yard. —N. E. STEWART, Cottesloe.

A Record of the Parasitism of New Guinea Frogs' Eggs by Dipterous Larvae.—Whilst collecting amphibia near Nondugl in the Central Highlands of New Guinea in 1960, the writer observed numerous clumps of frogs' eggs laid by *Hyla* and *Nyctimystes* spp. heavily infested with dipterous larvae. The spawn of several species is laid from February to May on the surface of water at the edge of turbulent mountain streams. The ova are unpigmented and macrolecithal, with diameters of up to 4.5 mm., and the albumen is gelatinous, and firm so that the clumps retain a constant shape.

The dipterous larvae were up to 10 mm. in length, and devoured the developing embryos. They bored through the albumen leaving a meshwork of tunnels which frequently caused the spawn clump to disintegrate, confirming that each larva was responsible for the destruction of several ova. Pupation was not observed, and attempts to collect adult flies were unsuccessful.

Bokermann (1958) recorded a very similar infestation of the spawn of *Physalaemus cuvieri* Fitzinger found in the vicinity of Sao Paulo, Brazil. The clumps of spawn of this species are also laid at the waterline. The parasite in this case was identified as *Gastrops niger* Williston of the family Ephydridae, the larvae of some of whose members are known to breed in pools of crude petroleum.

Parasitism of frogs' eggs has not been previously recorded from the New Guinea region.

REFERENCE

BOKERMANN, W. C. 1958. Frogs' eggs parasitized by Dipterous larvae. *Herpetologica*, 13 (3): 231-232.

—MICHAEL J. TYLER, Department of Human Physiology and Pharmacology, The University of Adelaide.

Increase in Abundance of the Pink-eared Duck in Western Australia.—Although the Pink-eared Duck *(Malacorhynchus membranaceus)* is likely to be found anywhere in the State, it was until fairly recently considered to be rare (D. L. Serventy and H. M. Whittell, *Birds of Western Australia*, 1951: 192) since only a few specimens had been collected (H. M. Whittell, *The Emu*, 41, 1941: 164; D. L. Serventy, *The Emu*, 47, 1948: 270). A slight increase in numbers was reported during 1952 (D. L. Serventy, *W.A. Nat.*, 3, 1953: 187) and subsequently it was recorded in relatively large numbers at various localities in the South-West (J. R. Ford, *The Emu*, 57, 1957: 354; 58, 1958: 35; V. Serventy, *The Emu*, 58, 1958: 11) indicating that the species had undergone a remarkable increase in abundance.

Additional observations on the Pink-eared Duck demonstrate that the phase of relative abundance shows no indication of changing. Localities where I have recorded the species are listed hereunder from south to north.

Jandakot Lake: ca. 50 on May 23 and 24, 1959; ca. 12 on June 21, 1959; ca. 30 on December 19, 1959.

Yangebup Lake: 10 on February 23, 1958; 20 on May 11, 1958; 136 on April 5, 1959.

Coolbellup Lake: 51 on February 9, 1958; 38 on February 23, 1958; ca. 20 on March 16, 1958; ca. 7 on March 26, 1959; 6 on April 11, 1959.

Marrida Swamp, Moora: ca. 50 on December 13 and 14, 1958. John Warham carried out observations on the nesting of the species at this locality (*The Wildfowl Trust Ninth Annual Report*, 1958, 118-127).

Naraling, fresh water swamps about 6 miles south-east: 4 on February 3, 1959; ca. 150 including a pair with ducklings on January 9, 1961.

Harding River, near Roebourne: 2 on pool along river on November 1, 1959.

In the South-West, the species is known to breed on the fresh water swamps and lakes at Gundaring, Moora, Dowerin, Carnamah and Naraling, and only visits the coastal plain near Perth during the summer and autumn months when many of the inland expanses of water have evaporated.

—JULIAN FORD, Attadale.

Feeding of Young Passerine Birds by Nest-mate.—Owing to an accident on September 30, 1961, in which the nest of a Welcome Swallow (*Hirundo neoxena*) fell from beneath a Swan River jetty, I became foster parent to three recently-hatched swallow chicks. These were reared successfully on a diet of houseflies, mincemeat and meat meal.

The three chicks fledged on October 21, 1961, at 25-26 days of age, but continued to beg for food. On several such occasions, subsequent to the immediate food requirements being fulfilled, I observed one chick—never a particular individual—feed one or other of its nest-mates. It would beg for and receive a fly from me in the usual manner, but instead of swallowing the food, simply close its bill over it, all the while emitting a peculiar whining throaty chirp and looking abstractedly about as though searching for something. After a few seconds of so doing it would then proceed to thrust the fly against the body of the nearest begging nest-mate, which, on feeling the movement, would increase its activity. All begging was orientated toward me. However, the vigorous calling of the unfed birds seemed to stimulate activity on the part of the one still holding the fly, and after a few further thrusts the gaping bill would be located and the fly transferred in typical parent-chick feeding attitude. The two birds would then settle quietly.

I have sometimes observed this same behaviour in several of my hand-reared nestling and recently-fledged Zebra Finches (*Taeniopygia castanotis*). In this case the first-satisfied bird would cease to beg, but respond to the continued begging of its nest-mates by actually going through the process of regurgitating seed, producing a number which were held at the tip of the bill.

Inexperienced downward thrusts would then be made at the forward parts of the begging chicks. In almost all cases a gape would eventually be found, in this instance usually helped by the calling chick turning toward the bird with the seed, and an attitude fully suggestive of parent-chick feeding relation adopted.

I could not ascertain how much of one bird's feed was so shared, but certainly a few seeds were transferred.

If this behaviour is truly representative of what happens in the wild, it could have a marked effect on the survival rate in a brood of young birds, should one in particular receive an over-abundance of food from its parents compared with other nest-mates. It may be considered as biologically advantageous behaviour, a kind of built-in compensatory mechanism to equalise food distribution.

—C. A. NICHOLLS, Nedlands.

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THE OBJECTIVE ASSESSMENT OF THE FAITHFULNESS OF COLOUR REPRODUCTION IN COLOUR TRANSPARENCIES

By W. D. L. RIDE, The Western Australian Museum.

INTRODUCTION

In recent years naturalists have come to use colour photography extensively in order to record the natural colour of biological, geological and archaeological material. Few, however, make any provision for an objective assessment of the faithfulness of the colours preserved in their photographic records. Here, a simple method is described which will allow such an assessment to be made.

The photographic material discussed in this paper is Kodachrome; this does not imply that this material is more subject to variation in colour than other film; it has simply been chosen for particular reference because it appears to be the colour-sensitive photographic material most used by Western Australian naturalists. The colours of the positive emulsion layers which are mentioned in this paper do not necessarily occur in films other than Kodachrome; in other films, different coloured dyes may be used and colour sensitive elements may be differently distributed. However, the problems facing the interpreter and the recorder remain the same.

THE FAITHFULNESS OF COLOUR IN PHOTOGRAPHIC REPRODUCTION

The average photographer taking coloured pictures does little more than aim at achieving a pleasing result and he does not worry about a lack of faithfulness in his reproductions and his inability to recognize it in them. The scientific worker, on the other hand, must achieve accurate colour in his record, or the purpose of making it is lost. If this cannot be done, he must at least be able to check the amount that it deviates from accuracy and the way in which it does this.

Most naturalists make some attempt to achieve what appear to be reasonably natural colours in their positive images; they take care to ensure that constant amounts of light are admitted to the film upon exposure, they try to keep the brightness range of the subject within the limits set by the particular film in use, they use the correct type of film (or a compensating filter) to reduce the effects of abnormal illumination of the subject either by "visible" or by ultra-violet light, and whenever possible they keep the film under optimum storage conditions, but they make no provision which allows them to confirm that they have been successful in their attempts at accuracy.

For the benefit of those who are puzzled about the causes of inaccuracies in colour reproduction, the commonest of these are described below.

1. **Exposure:** The colours of the positive result will appear to vary in saturation and brightness in accordance with the amount of light admitted during exposure, thus an under-exposed blue sky will appear to be a much "deeper" blue than it was at the time of photography, while the same sky taken at the same time and over-exposed, is almost white.

2. **Lighting conditions:** The colour of the light which illuminates the subject will be recorded in the image. For example, photographs taken in the yellow light of early morning, or in the evening, will often be excessively yellow. "Tungsten" light has a similar effect. Under certain conditions, large amounts of ultra-violet light may be present. To the photographer, this ultra-violet light is not visible but film is sensitive to it and, in extreme examples, photographic images of white objects may be quite blue. The photographer most commonly meets such conditions at great heights. Blue light is also commonly encountered in shadows and in snow scenes; here it is probably due to reflected sky light (see Evans, Hanson and Brewer, 1953, p. 171).

3. **Instability of colour material in light or in time:** No reputable manufacturer of colour film guarantees the stability of the dyes in the emulsion of his colour film over long periods of time. Kodak Ltd. state "The dyes used in 'Kodachrome' Film, like other dyes, may in time change. This film, therefore, will not be replaced or otherwise warranted against any change in colour. In display or projection 'Kodachrome' transparencies should not be left illuminated for an undue length of time, otherwise fading of the dyes may result."

Uniform overall fading as a result of dye instability affects the saturation and brightness of the colours which are seen by the viewer of the photographic record and this is serious enough, but in addition to this, the image which is produced by the filtering effect of different combinations of different dyes may alter in colour since the separate dyes may fade at slightly different rates. Since most colours in the image are the result of the subtractive mixture of more than one dye (see Kodak, 1950, pp. 11-13 for an excellent and clear account of this), much of the image may actually change in hue as well as in saturation and brightness.

4. **Instability of unprocessed material:** Out-of-date film, or film kept under abnormal conditions of humidity and temperature, may behave differently upon exposure as compared with film kept under ideal conditions. The effect of abnormal storage may be abnormal colours in the positive image. Some very slight colour variations are unavoidable in manufacturing but variations as a result of these are much smaller than those due to poor storage and other causes.

5. **Physical characteristics of dyes:** The dyes used in colour photography are not perfect in that they do not transmit light

freely. They all absorb some of the light that they should ideally transmit. Further, they do not absorb identical quantities with the result that it is not possible to obtain, with the dyes at present available to manufacturers, *simultaneous* accurate reproduction of all colours. In practice, the properties of the dye-layers are balanced to give the most *pleasing* results and the departures need not readily matter providing they can be recognized (see Kodak, 1950, p. 36-39).

KODACHROME FILM AND THE COLOUR-CONTROL CARD

The recording process used in Kodachrome is a reversal process in which the positive colours seen in the image result from the subtractive mixture of three transparent layers of dyes in the developed emulsion (Kodak, 1950, pp. 31-35). When the transparency is viewed, light passes through these coloured layers and the filtered light is "seen" by the viewer. The colours of the dye-layers which act as filters in positive Kodachrome transparencies are yellow, "cyan" (blue-green), and magenta. If a saturated cyan-coloured subject is photographed, neither of the other two layers in the emulsion is coloured in the positive transparency while the cyan dye-layer is heavily coloured.

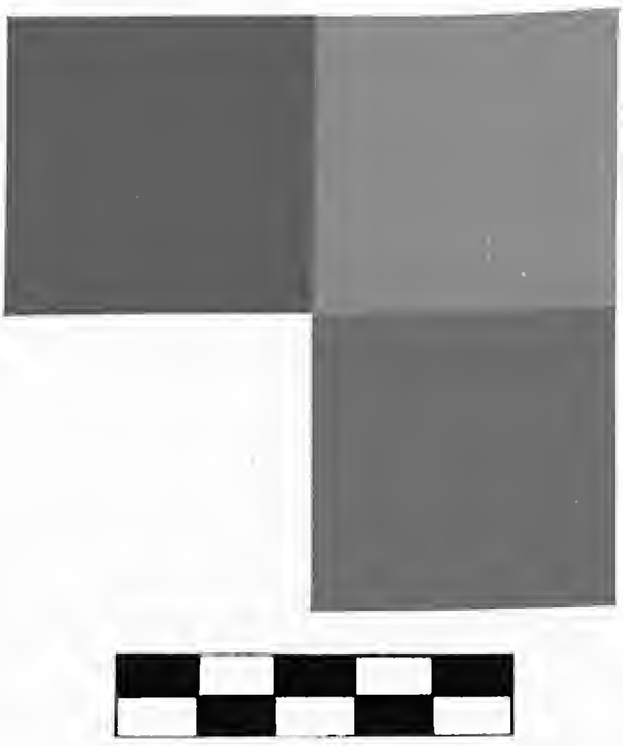
Thus a simple method of objective assessment of faithfulness of colour reproduction by Kodachrome film would be one which would allow the photo-sensitive reaction of each dye-layer in the emulsion to be examined independently. Inaccurate colour balance in the transparency due to abnormal behaviour of any dye layer resulting from incorrect illumination, or other reason, could thus be simply detected and the appropriate mental compensation made during interpretation.

*Additional copies of the plate may be obtained from the Western Australian Museum.

A simple colour-control card can be made (see accompanying plate*) to enable the behaviour of the individual dye-layers to be objectively assessed. Three coloured squares which match the saturated colours of the individual dye-layers are mounted together on a card. In addition to these, a white square is used to give a fourth "colour" control. A centimetre scale may also be conveniently included on the card.

THE USE OF THE COLOUR-CONTROL CARD

The colour-control card is included in each photograph for which colour assessment is desired. After the transparency is returned from processing, and at any time thereafter, the colours of the actual card are matched with those of the viewed image of it. It is important to note that the transparency should be viewed by filtered tungsten light, while the colour-control card must be viewed by natural daylight; in practice it is found that it is simplest to use a table viewer to examine the transparency, and the colour-control card can be held alongside it in daylight. Comparison of the coloured sections and their images allows the behaviour of the three dye-layers to be examined while the presence of excess ultra-violet or coloured light can be most simply detected by any deviation from "whiteness" in the white square.



COLOUR-CONTROL CARD

One major precaution must be taken in the use of the colour-control card. The dyes used in the card will probably themselves fade in bright light and in time. However, unlike biological records, these cards can be replaced. The user should merely protect his card as far as possible and compare it at intervals with a fresh card to ensure that the colours have remained unaltered.

AUTHOR'S NOTE

Naturalists may encounter some difficulty in obtaining supplies of paper of the correct colours. Kodak Ltd. of London, manufacture sets of colour separation guides which contain a strip of "colour patches" which include the three colours cyan, magenta and yellow. Unfortunately, six other coloured squares are included in the patches and for the purposes outlined in the paper the strip is unnecessarily bulky. Further, the colour separation guides include register marks and a grey scale which makes the set unnecessarily expensive. However, it appears that the separation guide remains the most satisfactory source of standard coloured squares for use in the technique I have described.

ACKNOWLEDGMENTS

The author wishes to acknowledge his indebtedness to Mr. E. Parlato of Kodak's Perth Office, for discussing the matter of colour control, obtaining the coloured materials which were used in the card described in this paper and critically reading the manuscript.

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ANNOTATED FLORA OF ROTTNEST ISLAND, WESTERN AUSTRALIA

By G. M. STORR, Zoology Department, University of Western Australia.

Since February 1955 the writer has been working on various aspects of nutrition in the Quokkas *(Setonix brachyurus)* of Rottnest Island. A large part of the field work in the first two years was spent in examining the vegetation for evidence of Quokka grazing. Field-notes were transferred to cards, including one for each plant species, on which were recorded the date and locality of observations, the intensity of grazing and the growth stage of the plant. Although these data were gathered primarily for an understanding of the Quokka's economy, they also provide a basis for a flora of Rottnest.

In the following systematic list, brief notes have been extracted from the cards concerning the habit, distribution, abundance, palatability, etc., of each species. Exotic species are prefixed with an asterisk.

For the location of place names the reader is referred to the map in the *Journal of the Royal Society of Western Australia*, 42 (3), 1959.

CUPRESSACEAE

Callitris preissii Miq. The Rottnest Pine is now rare and confined to the far eastern end of the island. Around the Settlement all the trees are hedged and despite its toughness the bark is often removed by Quokkas from stems and exposed roots.

POTAMOGETONACEAE

This family of water plants is represented on Rottnest by five species. **Zostera muelleri** Irmisch, **Cymodocea antarctica** (Labill.) Endl., and **Posidonia australis** Hook f. are marine species that are frequently east ashore. **Lepilaena preissii** (Lehm.) F.v.M. and **Ruppia maritima** L. oceur in brackish inland waters. None of these plants are eaten by the Quokka.

SCHEUCHZERIACEAE

Triglochin mucronata R. Br. A small winter annual. Occurs commonly in the damp soils around swamps and salt lakes. Heavily grazed in winter and spring.

T. trichophora Nees and **T. centrocarpa** Hook var. **brevicarpa.** Small winter annuals. Widespread in drier situations than the preceding species. Grazed in winter and early spring.

Cycnogeton procerum (R. Br.) Buchen. An aquatic plant; found on Rottnest only in Salmon Swamp. Not eaten.

HYDROCHARITACEAE

***Elodea canadensis** Mich. Only found in the fresh-water soak at the north-eastern end of the airstrip. Not eaten.

GRAMINEAE

The various grasses constitute a major source of food for Quokkas. Only a few of the species are indigenous. Most of the introduced grasses are winter annuals that flourish in disturbed areas, especially roadsides.

***Pennisetum clandestinum** Hoehst. There is a dense sward of Kikuyu Grass between Garden Lake and the Settlement. During the winter it dies back. Fresh leaves appear in September and provide the Quokkas with good grazing throughout the summer.

***Stenotaphrum secundatum** (Walt.) Kuntze. Buffalo Grass is restricted to the eastern part of the island, especially round the Settlement, where it is heavily grazed.

Spinifex longifolius R. Br. A coarse, ereet perennial. Common along sandy coasts. Only young plants are eaten.

S. hirsutus Labill. A coarse, flaccid perennial. Occurs on beaches and fore-dunes, but rare on Rottnest. Not eaten.

***Ehrharta longiflora** Sm. Annual Veld-grass. Grows to a height of two to three feet where inaccessible to Quokkas; otherwise grazed to the ground during winter and early spring.

***E. brevifolia** Schrad. **var. cuspidata** Nees. A relatively rare winter annual.

Stipa variabilis Hughes. A perennial tussock grass, the leaves narrow and inrolled, becoming wider and flatter in damp and sheltered situations. The dominant grass over most of the island. In spite of its abundance, this species is not ordinarily very important as food for Quokkas. They eat it only when it is young or kept green and short by continuous grazing. However, in burnt areas, because of its rapid regeneration, it becomes the principal food of Quokkas. And generally during the summer months it may locally be the only herbaceous plant available to the animals.

Sporobolus virginicus (L.) Kunth. A couch-like perennial. Occurs in mats around swamps and on seepage flats around salt lakes, and (rarely) on rock platforms beside the sea. During winter the mats may be under water, fresh or salt; as the water recedes with the advance of summer the grass renews its growth. Except where fenced off from Quokkas, it is grazed to the ground. A very important summer food plant in the swamp and lake areas.

***Polypogon monspeliensis** (L.) Desf. An erect annual, germinating in April and flowering in November. Plentiful in and around fresh-water swamps and in the seepage zone surrounding salt lakes. Heavily grazed.

***P. maritimus** Willd. A smaller and less plentiful species than the preceding. Occurs in much the same places and is likewise heavily grazed throughout the cooler part of the year.

***Lagurus ovatus** L. An erect annual, flowering in August and dying towards the end of October, except where persistent grazing has prevented flowering, in which case the plants remain green till the end of November. Widespread and plentiful in disturbed areas. Heavily grazed.

***Aira caryophyllea** L. A small winter annual. Uncommon and restricted to the vicinity of salt lakes.

***Avena fatua** L. Wild Oats. An erect annual, germinating in April-May, flowering in August-September, and dying in October. Widespread but seldom plentiful. Heavily grazed.

Danthonia caespitosa Gaud. A tussock grass, smaller and much less plentiful than *Stipa variabilis* and *Poa caespitosa;* but like them it is only eaten when young or when kept low by persistent grazing.

***Koeleria phleoides** Pers. A winter annual. Flowers in August-September and dies in early November (except where continuously grazed). Widespread and plentiful. Moderately grazed.

***Briza minor** L. A small annual, flowering in August and dying in late October. Widespread and especially plentiful in the seepage zone around lakes and swamps, where it is grazed to the ground.

Poa caespitosa Forst. A tall tussock grass. Widespread and common, but, except near the coast, much less plentiful than *Stipa variabilis,* from which it is scarcely distinguishable in the vegetative stage. As with *Stipa*, old plants are never eaten.

***Poa annua** L. A winter annual. Uncommon outside of fenced areas, owing to intense grazing by Quokkas.

***Vulpia myuros** (L.) Gmel. An annual, flowering in August and dying in October. Widespread and plentiful. Moderately grazed.

***Desmazeria rigida** (L.). Tutin. A small winter annual. Widespread. Grazed.

***Bromus gussonii** Parl. An annual, germinating in April-May, flowering in September, and dying in October. Widespread in disturbed areas. Heavily grazed.

***B. rubens** L. An annual, flowering in September and dying in October. Common on roadsides. Moderately grazed.

***B. molliformis** Lloyd. An annual, flowering in September and dying in November. Common in disturbed areas, especially roadsides. Moderately grazed.

B. arenarius Labill. An annual, germinating in May, flowering in September, and dying in October. Widespread but uncommon where accessible to Quokkas. Heavily grazed.

***Brachypodium distachyon** (L.) Roem. et S. An annual, flowering in September, and dying in late October. Widespread, but not common, in disturbed areas. Heavily grazed.

***Cynodon dactylon** Pers. Couch. A creeping perennial. A common plant of the roadside and other disturbed situations in the far eastern end of the island. Usually grazed to the ground. An important food for the Quokkas in and around the Settlement, where it is often the only green herbaceous plant present in summer.

***Lolium rigidum** Gaud. Wimmera Rye-grass. A winter annual, flowering in September. Widespread but uncommon where accessible to Quokkas. Usually grazed to the ground.

***Parapholis incurva** (L.) Hubb. A small winter annual, flowering in September. Uncommon. Grazed.

***Hordeum leporinum** Link. Barley-grass. An annual, flowering in August-September and dying in November. Widespread and plentiful. Heavily grazed.

CYPERACEAE

Scirpus nodosus Rottb. A tall sclerophyllous perennial sedge. Common in dense stands on the flats around salt lakes; also in coastal sand-dunes. Stems and leaves occasionally eaten in summer, especially in the vicinity of fresh-water seepages and soaks, where Quokkas become abnormally numerous in summer.

S. antarcticus L. A small relatively soft-leaved herb. Common and widespread. Heavily grazed, sometimes to extinction.

Lepidosperma gladiatum Labill. Sword-rush. A tall sclerophyllous perennial. Widespread, but only plentiful in hollows among coastal sand-dunes. This species was one of the first to regenerate after the big fires of February, 1955; fresh leaves grew rapidly from subterranean growing points. These leaves, especially their whitish underground portion, were often eaten in the desolated areas where no other forage was available. Otherwise the species is not touched.

L. resinosum (Nees) Benth. Similar to but much smaller than the preceding species. Occurs commonly on the stony ridges between Lighthouse Hill and the lakes. Most of this country was burnt in February, 1955, and as this sedge was quick to regenerate, it became a major source of food for the great numbers of Quokkas living there. Heavily grazed throughout the year and exterminated in areas of high Quokka density.

L. angustatum R. Br. Similar in habit to *L. resinosum*. Uncommon and confined to a few stony ridges in the eastern third of the island. Lightly grazed in summer and autumn.

Gahnia trifida Labill. A coarse tussocky sedge with sharp-edged, highly fibrous leaves. Occurs on saline flats round the salt lakes. Usually only the inflorescence is eaten, but after fire fresh shoots from the charred bases of the plants are frequently eaten. Where the plants are tall and dense they provide the Quokkas with daytime shelter.

Carex preissii Nees. A small perennial grass-like sedge that dies back each summer, reshoots in late autumn and flowers in August. Widespread but only abundant in disturbed situations, e.g., recently burnt country. Highly palatable.

ARACEAE

***Zantedeschia aethiopica** (L.) Spreng. Arum Lily. A garden escape, established in a few damp localities. Usually uneaten, but occasionally leaves are nibbled. Contains poisons, including a skin-irritant (Hurst, 1942: 52-3).

RESTIONACEAE

Hypolaena sp. A slender erect perennial. Occurs on flats around the lakes, usually in association with *Scirpus nodosus*. Lightly grazed in summer.

CENTROLEPIDACEAE

Centrolepis polygyna (R. Br.) Hieron. A minute winter annual growing on the flats around Garden Lake.

JUNCACEAE

Juncus bufonius L. A small winter annual, flowering in September and dying in December. Occurs on the flats around salt lakes and elsewhere on shallow soil over limestone. Heavily grazed in the spring.

J. maritimus Lamk. A tall perennial rush. Occurs sparingly among *Scirpus nodosus* at Government House Lake.

LILIACEAE

Anguillaria dioica R. Br. A small winter annual. Occurs on stony ridges. Eaten sparingly.

Thysanotus patersonii R. Br. A perennial with twining stems. Uncommon.

Bulbine semibarbata (R. Br.) Haw. A small erect herb. Observed only on Forbes Hill in *Templetonia* scrub.

***Asphodelus fistulosus** L. Onion-weed. Widespread and abundant in disturbed situations. Usually only grazed when there is little other forage. Young plants are eaten wholly, while in old plants only the central leaves are taken.

***Anthericum divaricatum** Jacq. A perennial herb, similar in habit to the preceding species. Seldom occurs away from coastal dunes. Occasionally eaten in summer.

Acanthocarpus preissii Lehm. A low, dense, spreading shrub with pungent leaves. Widespread and abundant. Seedlings are occasionally eaten. Less frequently browsed are the relatively soft tips of rapidly growing shoots of plants in the shade of taller shrubs. Dense stands of old plants serve as shelter for Quokkas.

AMARYLLIDACEAE

***Leucojum aestivum** L. A garden escape, established at Bathurst Point. Eaten only when young. Several of the cultivated members of this family have been proved poisonous.

***Agave americana** L. A garden escape, established in a few localities in the far eastern end of the island. The tough leaves are occasionally chewed by Quokkas.

Conostylis candicans Endl. A perennial herb. Widespread and abundant in open country. Over most of the island this species is seldom eaten, but in areas of high Quokka concentration the plants may be grazed to the ground.

IRIDACEAE

***Homeria miniata** Sweet. Two-leaved Cape Tulip. Established near the hotel. Not eaten. Poisonous to cattle and probably to other livestock (Gardner and Bennetts, 1956).

***Ferraria undulata** L. Well established in the vicinity of Bathurst Point. Leaves are eaten only when young.

ORCHIDACEAE

Four species of orchid have been found on Rottnest; they are small winter annuals. Three of them are rare, viz., **Prasophylum sp.**, **Acianthus reniformis** (R. Br.) Schlechter, and **Eriochilus dilatatus** Lindl. The fourth, **Caladenia latifolia** R. Br., is moderately common in parts of the centre of the island; its leaves are occasionally eaten.

URTICACEAE

Parietaria debilis G. Forst. A flaccid winter annual, germinating in April. Widespread and abundant, especially in shady situations. Not eaten.

***Urtica urens** L. Nettle. An erect winter annual, germinating in April. Seedlings occasionally eaten.

CHENOPODIACEAE

Although this family provides many important fodder plants in Australia, several species under certain circumstances may become toxic. For example, various species of *Chenopodium* have been found to be cyanogenetic; others, including *Atriplex* and *Threlkeldia* spp. may accumulate high concentrations of oxalic acid (Gardner and Bennetts, 1956: 24-5).

Rhagodia baccata (Labill.) Moq. A dense succulent shrub, sometimes climbing over other shrubs and into trees. Moderately plentiful in coastal situations and in wooded parts of the interior of the island. Wherever there is a shortage of alternative food, due either to fire or abnormally high Quokka density, this plant is heavily browsed, the stems as well as leaves being eaten. Otherwise it may be only sparingly eaten.

***Chenopodium murale** L. An odoriferous annual. Rare.

Atriplex paludosa R. Br. A succulent shrub. Locally plentiful around the salt lakes; also occurs along the coast, especially in rocky situations. Occasionally eaten in summer.

A. cinerea Poir. A succulent shrub. Coastal, especially on foredunes. Seldom eaten.

Suaeda australis (R. Br.) Moq. A low succulent perennial. Occurs in the samphire zone around lakes and swamps. Heavily grazed in summer.

Enchylaena tomentosa R. Br. A spreading succulent shrub. Occurs only at Cape Vlaming and on Dyer's Island. Lightly browsed in summer at Cape Vlaming.

Threlkeldia diffusa R. Br. A low succulent perennial, sometimes climbing over larger shrubs. Common around the coast, lakes and swamps, especially under *Melaleuca*. Lightly grazed in summer; the bark is gnawed off the larger stems.

Arthrocnemum halocnemoides Nees. A succulent shrub, becoming large and woody with age. Plentiful round the salt lakes and brackish swamps. Young plants are heavily grazed in summer.

A. arbuscula (R. Br.) Moq. A low, rounded, twiggy, succulent shrub. Occurs around some of the lakes; much less plentiful than the other samphires. Never eaten.

Salicornia australis Banks et Sol. A low, ascending, succulent shrub. Usually associated with *Arthrocnemum halocnemoides*. Heavily grazed in summer.

AMARANTHACEAE

Hemichroa pentandra R. Br. A very small, usually prostrate, succulent shrub. Occurs in the samphire zone of salt lakes. Renews its growth as the water recedes in early summer.

AIZOCEAE

***Cryophytum crystallinum** (L.) N.E. Br. Ice-plant. A prostrate succulent annual, germinating in April, flowering in November and dying in December. Occurs only at the far western end of the island. Never eaten.

Carpobrotus aequilaterus (Haw.) N.E. Br. Pigface. A prostrate succulent perennial. Common on islets and stacks and at Cape Vlaming; sparingly distributed along the remainder of the coast; rare inland. Eaten in summer.

Tetragonia implexicoma (Moq.) Hook. f. A succulent perennial, prostrate or climbing over other shrubs. Occurs around the coast; rare inland. Eaten.

T. zeyheri. Fenzl. Similar to the preceding species, but more erect in habit and much rarer.

PORTULACACEAE

Portulaca oleracea L. A small prostrate succulent annual. The single plant seen was in an exclosure. Presumably eaten.

Calandrinia calyptrata Hook. f. A prostrate succulent winter annual, flowering in August-September. Widespread and moderately plentiful in sandy country. Eaten. Several species of *Calandrinia* have a high concentration of oxalic acid (Gardner and Bennetts, 1956: 27).

CAROPHYLLACEAE

Sagina apetala L. A very small winter annual, flowering in August-September. Widespread and plentiful. Eaten, though probably only incidentally, for it is a common constituent of the dense mat of annuals in disturbed areas.

Cerastium viscosum L. A small winter annual, flowering in August-September. Widespread and plentiful. Moderately grazed.

Stellaria media (L.) Vill. Chickweed. A small winter annual. Widespread and moderately plentiful. Heavily grazed where alternative forage is scarce (e.g., in burnt-out *Acacia* copses); otherwise grazed lightly or not at all.

***Arenaria serpyllifolia** L. A small winter annual. Uncommon.

***Polycarpon tetraphyllum** L. A small winter annual. Uncommon.

***Silene nocturna** L. A small winter annual. Uncommon. Eaten.

RANUNCULACEAE

Clematis microphylla DC. A woody climber. Plentiful in wooded parts of the island, especially in copses of *Acacia rostellifera*. Seedlings and young plants are eaten, and the bark is stripped off older vines, especially in burnt country (bark was still being eaten in a burnt-out *Acacia* copse fourteen months after the big fire of February, 1955). The leaves of this and other species of *Clematis* contain a skin-irritant (Hurst, 1942: 114-5).

Ranunculus parviflorus L. A small winter annual. Only seen on Forbes Hill in *Templetonia* scrub. Sparingly eaten. Many species of *Ranunculus*, including the present one, are toxic (Hurst, 1942: 116-8).

CRUCIFERAE

***Sisymbrium orientale** L. A large annual, germinating in April and flowering in August; by November it is leafless. Only found in exclosures; presumably eaten out by Quokkas in most places.

***Diplotaxis muralis** (L.) DC. A large bushy herb where protected from Quokkas; otherwise small and prostrate. Occurs locally on roadsides and on bare ground. Heavily grazed.

Lepidium foliosum Desv. A small soft-leaved shrub. Observed only on Green and Dyer's Islands.

Heliophila pusilla L. A small winter annual. Rare.

Hymenolobus procumbens (L.) Nuttall. A small winter annual, flowering in August-September. Uncommon. Eaten.

***Coronopus didymus** (L.) Sm. A small prostrate winter annual. Observed only at Munt's Camp, where it was eaten.

Cakile maritima Scop. A plant of the beaches and fore-dunes. Uncommon. Not eaten.

RESEDACEAE

***Reseda luteola** L. A perennial herb. Rare. In summer the larger stems are barked and the cauline leaves stripped off; the fresh radical leaves appearing in April are sparingly eaten.

CRASSULACEAE

Crassula colorata (Nees) Ostenf. A very small succulent winter annual. Widespread and plentiful. Occasionally eaten.

C. macrantha (Hook f.) Diels et Pritzel. A very small winter annual. Widespread but less plentiful than *C. colorata*. Seldom eaten.

C. natans Thunb. An aquatic annual that continues to grow on mud after the water recedes. Never eaten.

PITTOSPORACEAE

Pittosporum phillyreoides DC. A shrub or small tree. Confined to shallow soil over limestone; occasionally on coastal cliffs; rare in western two-thirds of island. All accessible foliage is removed by Quokkas. Young plants are rare outside of exclosures.

LEGUMINOSAE

Acacia cyclopis A. Cunn. A small tree. Grows on shallow soil over limestone. Rare. Accessible foliage removed by Quokkas.

A. rostellifera Benth. A shrub or small tree. Widespread but becoming extinct over large areas of the island, particularly in the western two-thirds. Hardly a plant on the island has any accessible foliage; though it is the green bark of the smaller stems that is sought after, rather than the leaves. However, in burnt-out country the leaves of sucker shoots are heavily cropped.

A. cuneata A. Cunn. A dense prickly shrub. Occurs in coastal dunes. Seedlings are eaten and occasionally young shoots from old shrubs. The bark is frequently stripped off and eaten, the Quokkas often sitting in top of bushes to do so.

Templetonia retusa (Vent.) R. Br. An erect shrub. Confined to the eastern end of the island, where it grows in dense thickets on limestone ridges. All older shrubs seem to be hedged, and some of them carry old barking scars. However, north of the Salt Works there are several young bushy shrubs up to three feet high; none of these have been browsed. The animals, however, continue to eat seedlings and they occasionally bark shrubs in the summer.

***Trifolium tomentosum** L. and *T. suffocatum* L. Winter annuals, occurring at the Settlement. Grazed.

***Melilotus indica** (L.) All. King Island Melilot. An annual, germinating in April, flowering in August-September, and dying in November. Widespread and plentiful. Heavily grazed. Several workers (quoted by Hurst, 1942: 180) have found that paralysis in livestock has been caused by eating large amounts of *Melilotus*.

***Medicago denticulata** Willd. Burr Medic. An annual, germinating in April and flowering in August-September. Not so plentiful as

Melilotus. Heavily grazed. "Trefoil dermatitis," a kind of photo-sensitization, has been diagnosed in livestock that have eaten this plant (Gardner and Bennetts, 1956: 108).

GERANIACEAE

***Geranium molle** L. A small winter annual. Rare.

***Erodium cicutarium** (L.) L'Her. An erect winter annual. Plentiful on Green Island, but rare on the mainland of Rottnest.

Pelargonium australe Willd. A perennial herb, dying back in November-December; new shoots appear in March and seedlings in April-May. Widespread and abundant. Heavily grazed. In exclosures plants become quite bushy; but where exposed to Quokka grazing they remain small and prostrate, and may be locally exterminated.

OXALIDACEAE

Oxalis corniculata L. A small annual, germinating in April-May and flowering in August-September. Restricted to stony ridges.

ZYGOPHYLLACEAE

Nitraria schoberi L. A dense spreading shrub with succulent leaves, growing in pure stands in rocky coastal situations. Confined on Rottnest to the far western end of island and to offshore stacks and islets. Stems are barked by Quokkas.

Zygophyllum apiculatum F.v.M. A prostrate, succulent annual, germinating in May, flowering in August and dying in October. Occurs in sandy country, most frequently in coastal dunes. Eaten. Probably poisonous (Webb, 1948: 172).

RUTACEAE

Boronia alata Sm. A rigid shrub, the leaves relatively soft but strongly odoriferous. Confined to a few sites on the south coast. Stems barked and foliage hedged.

Diplolaena dampieri Desf. A rigid woody shrub. Patchily distributed along the coast in dune scrub. Stems are frequently barked, the animals often sitting on top of shrubs when doing so. The foliage is less frequently eaten. Seedlings and young plants are rare outside of exclosures.

POLYGALACEAE

Comesperma sp. A perennial twiner. Uncommon.

EUPHORBIACEAE

Most of the species in this family are believed to be poisonous.

***Euphorbia peplus** L. An annual, germinating in March-April, flowering in August-September and dying in November. Widespread and abundant in disturbed situations. One of the first of the annuals to appear in autumn, it is heavily grazed during that season in areas of high Quokka concentration or in localities with little alternative forage; during winter and spring it is seldom eaten. "The genus produces a substance which causes irritation of the mucous membranes and skin . . . ." (Hurst, 1942: 233).

Phyllanthus calycinus Labill. A small soft-leaved shrub. Moderately plentiful on limestone ridges, especially in the eastern half of the island. Lightly browsed in summer. Several species of *Phyllanthus* have been found poisonous to livestock (Hurst, 1942: 239-42).

Poranthera microphylla Brongn. A small annual, flowering in August-September and dying in November. Moderately plentiful on sandy soil in disturbed situations (e.g., in burnt country). Eaten. This species is cyanogenetic (Hurst, 1942: 242).

SAPINDACEAE

Dodonaea aptera Miq. A woody shrub. The only specimen seen was growing beside the main West End road a little east of the Narrow-Neck. It carried old barking scars.

RHAMNACEAE

Spyridium globulosum (Labill.) Benth. A tall shrub. A minor constituent of the limestone ridge scrub. Most plants are hedged, and in coastal situations where the shrubs are lower and denser Quokkas frequently climb on top of them to eat the foliage.

MALVACEAE

Lavatera plebeja Sims. A shrub. Not seen on the mainland of Rottnest; common on the islets.

***Malva parviflora** L. An annual, occurs on Green Island and sparingly round the Settlement. Responsible for staggers in sheep (Hurst, 1942: 270).

STERCULIACEAE

Guichenotia ledifolia J. Gay. A dense spreading shrub. Widespread and plentiful, especially in open country. Quick to regenerate after fire and generally tolerant of disturbance. Foliage rarely eaten, though leaves are often stripped off. Stems frequently barked where other forage is scarce.

Thomasia cognata Steud. A small shrub. A pioneer plant in burnt or otherwise devegetated country. Foliage very rarely eaten; stems barked occasionally in summer.

FRANKENIACEAE

Frankenia pauciflora DC. A small twiggy shrub with small leaves. Occurs in rocky situations on the coast. Seldom eaten.

MYRTACEAE

Melaleuca pubescens Schau. A tree or shrub. Confined to the eastern half of the island where the soil is shallow over limestone. On low-lying flats it occurs as a tree; in higher and sandier situations it becomes shrubby. In areas of high Quokka density all accessible foliage is eaten; elsewhere the plant is seldom touched.

UMBELLIFERAE

Hydrocotyle tetragonocarpa Bunge. A small prostrate winter annual. Widespread and plentiful. Occasionally eaten.

H. hispidula Bunge. A small winter annual. Uncommon. Eaten.

H. diantha DC. A small prostrate winter annual. Occurs in damp soil around lakes and swamps. Eaten. Various species of *Hydrocotyle* are suspected of being poisonous (Hurst, 1942: 307-8).

Didiscus pusillus (DC) F.v.M. A winnter annual. Uncommon. Probably eaten. Suspected of being poisonous to sheep and cattle (Hurst, 1942: 306-7).

D. caeruleus DC. Rottnest Daisy. An erect, gregarious annual, germinating in April, flowering in November, and dying in December-January. Widespread, but patchily distributed, in open country. Seedlings and young plants are occasionally eaten.

Daucus glochidiatus (Labill.) Fisch., May. et Ave-Lall. A small winter annual. Widespread; most frequent in coastal dunes. Heavily grazed.

Apium australe Pet.-Thou. A small winter annual, Plentiful on coastal cliffs; occasional on flats around salt lakes. Grazed.

EPACRIDACEAE

Leucopogon parviflorus (Andr.) Lindl. A dense rigid shrub. Occurs sparingly along the coast. Stems occasionally barked.

L. insularis R. Br. A low, very dense and rigid shrub with small pungent leaves. Rare.

Acrotriche cordata (Labill.) R. Br. A low rigid shrub with small stiff leaves. Restricted tc a few coastal localities, usually rocky.

PRIMULACEAE

***Anagallis femina** Mill. Blue Pimpernel. A flaccid annual, germinating in April-July, flowering in August-September. Widespread and moderately plentiful in shady situations. Occasionally eaten. This species and the closely related *A. arvensis* are poisonous (Hurst, 1942: 311-2).

Samolus repens (Forst.) Pers. A creeping perennial herb. Plentiful on the damp flats around salt lakes. Heavily grazed in summer.

LOGANIACEAE

Mitrasacme paradoxa R. Br. A small winter annual. Uncommon. Eaten.

GENTIANACEAE

***Erythraea centaurium** Pers. An annual, germinating in August, flowering in November-March, dying in April. Widespread but most frequent in damp situations. Mostly eaten only when other herbaceous plants are scarce.

APOCYNACEAE

Alyxia buxifolia R. Br. A tall shrub. A minor component of the limestone ridge scrub. Accessible foliage is hedged and stems are barked in summer.

ASCLEPIADACEAE

***Asclepias fruticosa** L. Cotton-bush. Established in a few damp places in the eastern end of the island, especially on the flats north of Garden Lake, where it grows in sufficiently dense stands to provide the Quokkas with good cover. Never eaten. Poisonous (Webb, 1948: 22).

CONVOLVULACEAE

Wilsonia humilis R. Br. A prostrate perennial herb. Common in the samphire zone around salt lakes, appearing as the water recedes in early summer. Rarer along rocky coasts. Not eaten.

Dichondra repens R. and G. Forst. Small, perennial, stoloniferous herb. Widespread but uncommon. Not eaten.

BORAGINACEAE

Myosotis australis R. Br. An ascending annual, flowering in August-September and dying in October. Uncommon. Seldom eaten.

LABIATAE

Westringia dampieri R. Br. A dense rigid shrub. A common member of the dune scrub; less frequently an undershrub in the limestone-ridge scrub. Occasionally barked.

SOLANACEAE

Many plants in this family produce highly poisonous alkaloids.

Solanum simile F.v.M. An erect soft-leaved shrub. A pioneer plant on bare soil. The leaves, young stems, and bark off older stems are only eaten in areas where little or no other herbage is available. The ripe fruits are eaten in summer and autumn. Ordinarily the plant is not important as food; it is more valuable as shelter when growing in dense thickets in burnt-out country.

***Lycium ferocissimum** Miers. Boxthorn. A large, spreading, intricately-branched, thorny shrub with succulent leaves. A few occur round the Settlement. Leaves and bark are eaten, the Quokkas climbing up as high as eight feet into old shrubs to reach fresh shoots in the spring.

***Nicotiana glauca** Grah. Wild Tobacco. An erect, soft-leaved shrub. There is a small stand north of the Settlement. Not eaten. Poisonous to stock, but seldom eaten by them (Hurst, 1942: 364-6).

SCROPHULARIACEAE

***Dischisma arenarium** E. Mey. An ascending annual, flowering in August and dying in November. Widespread and plentiful in sandy country. Eaten.

***Parentucellia latifolia** (L.) Caruel. A small winter annual. Rare. Probably eaten.

OROBANCHACEAE

Orobanche australiana F.v.M. An erect herb, parasitic on the roots of other plants. Rare.

MYOPORACEAE

Myoporum viscosum R. Br. A small shrub. Patchily distributed on shallow soil over limestone, usually near swamps and lakes. Frequently browsed in summer and winter.

M. insulare R. Br. A thick-leaved shrub, tree-like in sheltered situations. Patchily distributed around the coast. Often barked; the foliage is less frequently eaten.

Eremophila glabra (R. Br.) Ostenf. A shrub, usually small and slightly flaccid. Plentiful around the coast in rocky situations; rare inland. Where Quokkas are numerous it is heavily browsed, the bark being frequently stripped off; the leaves are less often eaten.

PLANTAGINACEAE

Plantago varia R. Br. A small perennial herb with radical leaves. Widespread and moderately plentiful. Grazed, heavily so after the winter annuals have died.

RUBIACEAE

***Galium murale** (L.) All. A very small winter annual, dying in October. Widespread and plentiful. Eaten, perhaps only incidentally along with the other annuals that comprise the grazed mats in winter and spring.

GOODENIACEAE

Scaevola crassifolia Labill. A low spreading shrub with thick, sticky leaves. Abundant around the coast, especially on sand (on the foredune and as a pioneer on bare sand further inland). Young shoots are eaten and older stems are barked. A very important food-plant for Quokkas living near the sea, especially in the summer months, when there is little other palatable forage.

COMPOSITAE

***Erigeron canadensis** L. An erect annual or perennial herb, flowering at the end of summer, and reshooting in May, at which time seedlings appear. Seldom seen outside of exclosures and presumably grazed heavily. The sap contains a skin-irritant (Hurst, 1942: 408).

Olearia axillaris (DC) F.v.M. A dense greyish shrub with small aromatic leaves. The dominant plant of coastal sand-dunes; less plentiful inland. In areas where Quokkas are numerous all shrubs are hedged and barked, and young plants are eaten out. But in most localities where the species is common, Quokka densities are low and the plant is not often eaten.

Cotula coronopifolia L. An ascending, succulent, perennial herb. Only found at Barker's Swamp, where it grows in the damp black soil above high water level. Unless protected by shrubby samphires, the plants are grazed down to the ground.

C. australis (Less.) Hook f. A small winter annual. Only seen at the Settlement, where it is an infrequent member of the grazed mat of winter annuals.

Senecio lautus Soland. An erect succulent herb, annual or perennial. Dies back in the summer and reshoots in March-April; seedlings appear in May. Widespread and especially abundant in burnt or otherwise devegetated sandy country. Very seldom eaten.

***Arctotheca nivea** (L.) Levyns. A plant of coastal beaches. Rare on Rottnest.

***A. calendula** (L.) Levyns. Capeweed. A winter annual. Locally common on roadsides. Occasionally eaten early in the season.

Podosperma angustifolium Labill. An ascending annual, flowering in September, dying in October. Widespread but only moderately plentiful in burnt-out sandy country. Eaten.

Millotia tenuifolia Cass. An annual, flowering in September and dying in October. Locally plentiful in open sandy country. Eaten.

***Inula graveolens** Desf. Stinkwort. An erect, aromatic, sticky annual; germinates in September, flowers in April, dies in June. Abundant on roadsides and in other disturbed situations, especially in low-lying areas. Seedlings and young plants may be grazed heavily in summer; old plants are infrequently browsed. Contact with the plant may give rise to dermatitis in man and other mammals (Gardner and Bennetts, 1956: 194).

Calocephalus brownii (Cass) F.v.M. A whitish shrub with very small leaves. Restricted to a few coastal localities, usually sandy. Not eaten.

***Carduus tenuiflorus** Curtis. An annual thistle. Rare. Eaten.

***Centaurea melitensis** L. A small annual, flowering in September, dying in December. Only seen in the immediate vicinity of Munt's Camp, where it is plentiful and heavily grazed.

***Hypochoeris glabra** L. An annual with radical leaves; flowers in September-October, dies in November-December. Uncommon. Eaten.

***Sonchus oleraceus** L. Sow-thistle. An erect annual with milky sap; germinates in April-July, flowers in August- September, dies in November-December. Heavily grazed.

DISCUSSION

Surprise is sometimes expressed that such typically south-western genera as *Eucalyptus* and *Banksia* do not occur naturally on the island, whereas other genera are present (*Pittosporum, Eremophila, Atriplex,* etc.) which are absent from the greater part of the South-western Land Division but reapppear in the arid interior of the State. Both phenomena stem from the one fact that Rottnest is an island and too exposed to support anything but essentially coastal vegetation. It so happens in this latitude that representatives of *Eucalyptus* and *Banksia* are generally absent from the coastal vegetation, whereas Eremaean elements are conspicuous in it. There are few if any plants on Rottnest that do not also occur on the nearby mainland coast. And the few species which are not found on Rottnest and could reasonably have been expected there (e.g., *Hemiandra pungens*) have possibly become extinct since the separation of Rottnest from the mainland. Certain dune species are disappearing even now, e.g., *Acacia cyclopis,* of which the writer has only seen four specimens, each growing in a widely separate locality; and *Dodonaea aptera,* only one bush of which, to his knowledge, remains on the island.

Despite the extinction that is inevitable on an island, Rottnest still retains a rich flora, owing to its varied physiography (see Storr, Green and Churchill, 1959). In the above list 180 species are recorded, of which 117 are indigenous.

The expenses of the writer's field-work on Rottnest were borne by C.S.I.R.O. and University Research Grants. The writer is also grateful to Messrs. R. D. Royce (Government Botanist) and J. W. Green (formerly of the Government Herbarium) for identifying most of his specimens and for much information on Rottnest plants.

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BREEDING OF BIRDS IN THE LOWER WONGONG VALLEY

By P. SLATER, Derby.

A number of recent papers have dealt with the breeding periods of birds in various parts of Western Australia: Robinson (*W.A. Nat.,* 4: 149), Carnaby (*W.A. Nat.,* 4: 187), Sedgwick (*W.A. Nat.,* 5: 46), Marshall and Serventy (*Emu,* 57: 99), Slater (*W.A. Nat.,* 7:35) and Lindgren (*W.A. Nat.* 7: 169). The present paper reports the situation in the foothills of the Darling Range between Armadale and Byford, as recorded by the writer in 1959.

The study area extended along the Wongong Valley for about two miles into the hills and for about four miles on to the coastal plain, confined to the immediate vicinity of the Wongong Brook. A number of distinct habitats can be recognised:—

(A) In the Darling Range

(1) Dense undergrowth immediately surrounding the brook. Typical birds: Red-eared Firetail, Spotted Scrub-Wren, New Holland Honeyeater, Red-winged Wren.

(2) Wandoo, Marri and Jarrah forest on the slopes, underlain by a thick carpet of harsh xerophytes. Typical birds: Splendid Wren, Western Thornbill, Spinebill.

(B) On the coastal plain

(1) Pasture. Typical birds: Banded Plover, Pipit, White-faced Heron.

(2) *Melaleuca* and bottlebrush swamp. Typical birds: Grey Teal, Brown Thornbill.

(3) Open Marri forest. Typical birds: Yellow-tailed Thornbill, Twenty-eight, Magpie.

Although the area was frequently visited through the year, no breeding was recorded until July 23, continuing into spring and early summer. There were no outstanding deviations from the climatic normal, and the season may be regarded as a typical one.

Forty species of birds were found nesting, representing about half of the resident species. In the following table, each bird is placed in the order of the date on which it was first noted as breeding. The following abbreviations have been used: (B) building; (E) eggs; (Y) young. The vernacular names used are based on Serventy & Whittell, *Birds of Western Australia* (2nd edn.), 1951, where the relevant scientific names may be found.

The writer wishes to acknowledge the assistance in the field given by his wife and Mr. M. K. Morcombe, of Armadale. Messrs. J. F. Orton and P. Kargotich kindly gave permission to enter their property in the Wongong Gorge.

NEST FREQUENCIES (In order of discovery of first nest)

Welcome Swallow—July 23 (B); Aug. 1 (B); Sept. 1 (B. B. B).
White-faced Heron—July 25 (B); Aug. 25 (E. E. Y. Y. Y); Aug. 26 (Y).
Yellow-tailed Thornbill—July 25 (B); Aug. 26 (Y); Sept. 3 (Y); Oct. 4 (Y); Dec. 24 (Y).
Western Magpie—July 26 (B. B); Aug. 2 (E); Aug. 26 (Y); Aug. 27 (E); Sept. 19 (E. E. E).
Scarlet Robin—Aug. 2 (B—eggs on Aug. 9); Aug. 28 (Y); Sept. 2 (Y); Sept. 3 (Y); Oct. 1 (B); Oct. 24 (E. Y); Nov. 16 (Y).
Willy Wagtail—Aug. 23 (E).
Grey Fantail—Aug. 23 (E); Aug. 28 (E); Sept. 20 (B); Oct. 25 (E); Nov. 16 (Y); Dec. 24 (E. Y).
Magpie Lark—Aug. 24 (B); Nov. 7 (Y).
Kookaburra—Aug. 25 (?); Sept. 2 (E).
Raven—Aug. 25 (Y).
Black-faced Wood-Swallow—Aug. 28 (B); Sept. 6 (B); Nov. 26 (E).
Splendid Wren—Aug. 28 (B); Oct. 24 (B. Y); Oct. 31 (B. B); Nov. 16 (Y).
Yellow-throated Miner—Aug. 29 (Y); Sept. 11 (Y).
Tree-Martin—Sept. 1 (B. 30 pairs in the one tree).
Twenty-eight—Sept. 1 (E); Sept. 20 (E).
Grey Teal—Sept. 1 (E).
Australian Goshawk—Sept. 3 (?); Sept. 111 (?); Sept. 19 (B).
Red-eared Firetail—Sept. 4 (B); Oct. 25 (E); Nov. 16 (E. E).
Spinebill—Sept. 11 (Y); Oct. 20 (B); Oct. 25 (Pallid Cuckoo).
New Holland Honeyeater—Sept. 19 (B); Oct. 1 (Y).
Red-capped Parrot—Sept. 19 (Y).
Black-faced Cuckoo-Shrike—Sept. 29 (Y); Dec. 24 (Y).
Black-capped Sittella—Oct. 1 (Y); Dec. 24 (Y).
Dusky Wood-Swallow—Oct. 3 (Y).
Western Warbler—Oct. 3 (B); Oct. 24 (B).
Western Silvereye—Oct. 3 (B. E); Oct. 4 (Y).
Brown Thornbill—Oct. 4 (Cuckoo); Oct. 24 (B); Oct. 25 (Cuckoo); Nov. 16 (?).
Bronze Cuckoo (sp.?)—Oct. 4 (Y); Oct. 25 (Y).
Western Thornbill—Oct. 4 (Y); Oct. 31 (Y).
Spotted Scrub-Wren—Oct. 4 (Y).
Little Eagle—Oct. 4 (E).
Spotted Diamond-bird—Oct. 4 (Y).
Brown Honeyeater—Oct. 24 (Y); Oct. 25 (E); Nov. 13 (E); Nov. 16 (Y).
Golden Whistler—Oct. 25 (E); Nov. 26 (E); Dec. 28 (E).
Pallid Cuckoo—Oct. 25 (Y); Dec. 28 (Y).
Rufous Whistler—Nov. 1 (Y); Nov. 16 (Y).
Rainbow-bird—Nov. 1 (B. B. B); Dec. 28 (Y. Y. Y. Y. Y).
Sacred Kingfisher—Nov. 26 (E. E); Nov. 30 (?); Dec. 16 (Y. Y).
Red Wattle-bird—Dec. 28 (Pallid Cuckoo).

GENERAL NOTES

It will be noted that breeding does not begin until the latter part of July. The main nesting months are August, September and

October, after which there is a falling off in breeding activity through November to December.

An interesting ecological relationship between the two Wood-swallows, the Dusky (*Artamus cyanopterus*) and the Black-faced (*A. cinereus*) was observed in the Gorge. The hillslopes for about a half mile into the gorge have been cleared for pasture, and the Black-faced Wood-Swallow has penetrated into this area to breed. A hundred yards farther on, in the open Wandoo forest, the Dusky Wood-Swallow was found in numbers, a nest in a hollow tree being noted on October 3. Thus although nests of both species were found within one hundred yards, each species remained in its chosen habitat.

The Little Eagle has seldom been observed on the Swan coastal plain. A pair nested about two miles from the foothills near the Armadale-Fremantle road in a giant Marri, and has used the nest three times in four years, on the other occasion moving to a lower Marri a hundred yards away.

In the gorge itself the Red-eared Firetail has staged a remarkable comeback. In 1958, one nest was found, and only one party of birds was observed. In 1959, four nests were found and in 1960, about two dozen occupied nests were discovered. In 1961, the Gorge was closed to entry, so no observations were made.

A VISIT TO THE SALT MARSH NORTH OF CARNARVON

By T. C. SCOTT, Crawley.

A striking geographical feature on maps of mid-western Australia is the large expanse of salt lake north of Sharks Bay and about 70 miles north of Carnarvon. The lake is approximately 90 miles long and 30 miles at the widest stretch. It appears that this area has not been visited often though it offers quite an interesting scope for the naturalist.

The lake is given the rather indefinite name of "Salt Lake" on most maps though locally it is known as the "Salt Marsh."

In November-December 1961 I was working around the Marsh for a period of five weeks and paid some attention to its natural history. Its most startling characteristic, on first view, is the brilliant, glistening white expanse of salt crystals. On my visit the lake was only partly filled with very saline water. I walked out about one mile, on a narrower part of the Marsh, through soft mud and salt crust and estimated the depth of water to be no more than 5 or 6 feet. The lake has no outlet to the sea. The local people claim that its level rises and falls with the tide on the adjoining coast, but during my stay I failed to notice any such movement.

The water was so highly saline that dead bushes which had been blown into the water were so heavily encrusted with salt they looked like icebergs. Branches lying on the edge were caked with as much as half-an-inch of salt crystals. No aquatic fauna was seen living, but thousands of small dead Spangled Perch *(Therapon unicolor)* were found desiccated above the water line on both western and eastern shorelines. Evidently they had been killed by the rising salt concentration of the lake, which must have been somewhat fresher at previous seasons. The species would periodically enter the lake, when conditions were suitable, from the Lyndon and Minilya Rivers which debouch into it. Brine shrimps *(Artemia* and *Parartemia)* and the gastropod *Coxiella,* so characteristic of most salt lake systems in Western Australia, were absent. Sub-fossil marine mollusca were plentiful on the lake margin some distance inland from the present western shoreline.

The flats around the Marsh are well-grassed and vegetated with various chenopods, such as "roly poly" *(Salsola kali),* and Trichiniums. The most conspicuous forms of life on these flats are birds, such as Zebra Finches *(Taeniopygia castanotis).* Samphire Thornbills *(Acanthiza iredalei).* Pipits *(Anthus novae-zeelandiae),* Blue-and-white Wrens *(Malurus leuconotus)* and Brown Song-Larks *(Cinclorhamphus cruralis).* Along the margins of the lake are found occasional Red-capped Dotterel *(Charadrius alexandrinus).* The absence of other water-birds on the lake was noteworthy.

To the west beyond the Marsh flats extended about 15 miles of very interesting sandplain with steep red sandhills, similar to the country around Sharks Bay and slightly reminiscent of the sandplain remnants at Wiluna. The vegetation consisted of a dwarf eucalypt, Banksias and other Proteaceae, spinifex *(Triodia)* and bogota *(Acacia linophylla).* This type of country becomes more open towards the coast and there are occasional clumps of figs *(Ficus platypoda)* on the travertine. On the east side of the Marsh occurs typical Murchison country, consisting of sclerophyllous Acacias with river gums *(Eucalyptus camaldulensis)* along the rivers.

FROM FIELD AND STUDY

Lesser Noddy at Perth.—On July 25, 1959, I saw a single bird on Langley Park reserve, Perth, which I identified as either a Common Noddy or a Lesser Noddy. Recently I ascertained that D. L. Serventy and V. N. Serventy recorded an irruption of the Lesser Noddy *(Anous tenuirostris)* on beaches in the Fremantle and Bunbury areas on July 24, 1959. Therefore the bird I saw was almost certainly of this species.

—A. A. BURBIDGE, Mandurah

Gull-billed Tern at Hamelin Bay.—On January 4, 1962, a single Gull-billed Tern *(Gelochelidon nilotica)* was observed over a small lake just to the east of the Hamelin Bay settlement. The bird was traversing the lake and dipping occasionally as though feeding.

This observation was made outside the area in which the species has been commonly recorded (see J. R. Ford, *W.A. Nat.,* 6: 197 and 7: 208), and is, therefore, placed on record.

E. H. and L. E. SEDGWICK, Collie.

Mortality Among Littoral Fauna at Rottnest Island.—In January 1959 Dr. E. P. Hodgkin reported the catastrophic destruction of littoral fauna and flora on the shore platforms near Fremantle (W.A. Nat., 7: 6-11). The catastrophe was due to a combination of several factors, very low tides, heat and still water. These effects were also noted at Rottnest.

When I was working on the reef at Cape Vlaming, Rottnest Island, on January 2, 1962, evidence of a similar catastrophe was noted. The following animals were dead or dying on the reef platform:—

Coelenterata

The Beadlet Anemone *(Actinia tenebrosa)*. These animals were found floating in pools; many were in a state of decomposition.

Mollusca

Chitons *(Clavarizonia)*, which usually stand extremes of desiccation and heat, were found lying at the bottom of pools near their homes.

The limpet colonies appeared to have suffered greatly. Dead specimens of *Siphonaria luzonica* and *Patelloida alticostata* were found and their empty home sites were very evident.

Many specimens of small Sea Hares *(Aplysia)* were found lying at the bottom of pools.

Crustacea

Small crabs were seen, many in a state of decomposition. They appeared to be those usually associated with sponges.

Echinodermata

Large numbers of dead *Echinometra mathaei* were found; all were in a state of decomposition. A few dead *Tripneustes gratilla* were also seen.

Vertebrata

Blennies were noted in an exhausted condition, swimming near the surface. They reacted very sluggishly when handled.

The weather at the time was very hot and the water on the reef particularly still and warm. Dr. Hodgkin informs me that on January 1 and 2 tide levels on the Fremantle gauge were normal for summer conditions, never falling below 1.9 ft. with a mean of 2.3 ft. on 1st. However, on December 28, 29 and 30, although not exceptionally low, they ranged between 1.0 and 2.1 ft. with a mean of 1.6 ft. The Cape Vlaming platforms lie between 1.7 and 2.5 ft. above datum and, if the sea was calm, there would be little renewal of water on them during these three days.

—PETER McMILLAN, Guildford.

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DISCOVERY OF SUBTERRANEAN FRESHWATER FAUNA ON THE EASTERN SIDE OF NORTH WEST CAPE

By PETER CAWTHORN, Western Australian Museum, Perth.

The occurrence of a specialised subterranean freshwater fauna in the western coastal plain of North West Cape has been known since 1945. However, it was not until 1962 that the species and their habitat were fully described and the origin of the fauna discussed (Mees, 1962).

The animals recorded from these wells are: 1. A blind fish of the family Eleotridae, *Milyeringa veritas* Whitley. 2. A blind eel of the family Synbranchidae, *Anommatophasma candidum* Mees. 3. Two species of blind atyid shrimps, *Stygiocaris lancifera* Holthuis and *Stygiocaris stylifera* Holthuis.

In August 1962, two members of the Speleological Group of the Western Australian Naturalists' Club (W.A.S.G.), Paul Symons and the author, on an exploration trip to the Cape Range, discovered in a cave on the eastern coastal plain of North West Cape the three types of subterranean freshwater fauna mentioned above. The cave is known as Kubura Well. It is situated 10 miles south of Vlaming Head lighthouse, and is 100 yards west of the track (Department of Army map reference: 188262, Onslow Sheet SF50-5, Edition I, Series R502). It was reputedly used as an aboriginal watering place, and many broken shells of marine molluscs may be found in the vicinity.

The water in the cave is now used for stock purposes, and is drawn out by means of a windmill erected over the entrance, which has been partly cemented up making entry quite difficult. In fact the author was unable to enter. However, the other member of the expedition, Paul Symons, managed to squeeze through.

From his description a narrow solution pipe leads into a small chamber, approximately 10 ft. high and 25 ft. wide (see Figs. 2 and 3). The floor is almost completely submerged by a pool of shallow water, which deepens to 4 or 5 ft. at the western wall of the chamber where it disappears under the ledge. A number of slow-moving white fish were immediately observed in the shallows, and a large white eel, about 9 in. long was seen in deeper water. A number of the fish were easily caught, but attempts to catch the eel resulted in its disappearance under the ledge. On closer examination of the water, small, almost transparent, shrimps were seen. A number of these were also collected. The fish and shrimps were put alive into a container of the well water, and by aerating the water twice daily they

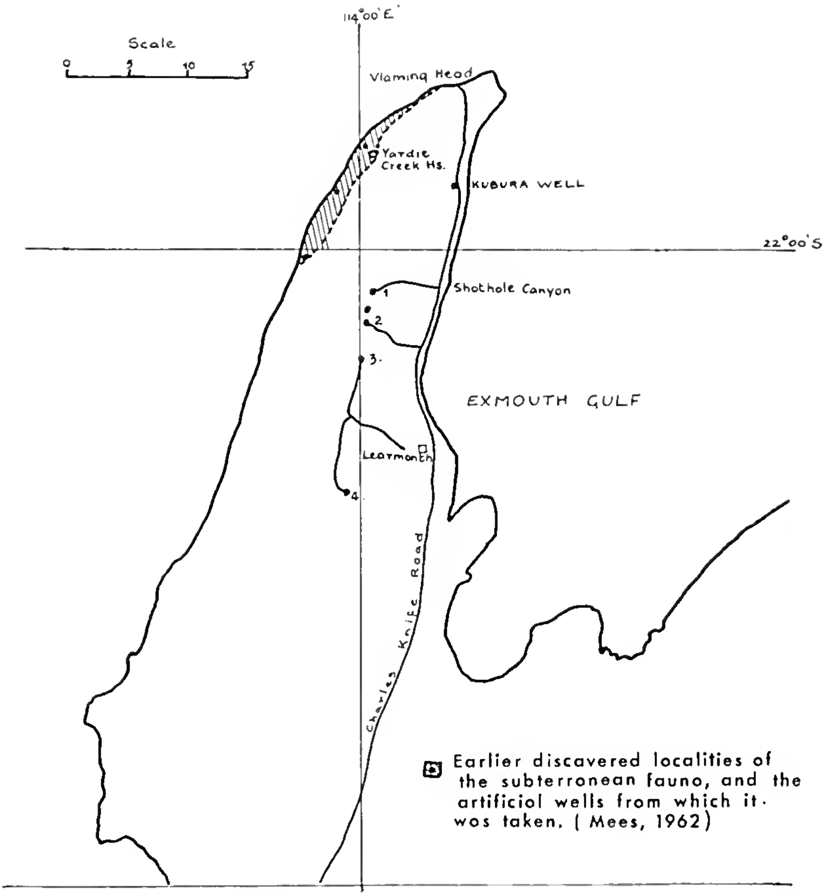

Fig. 1.—The North West Cape Peninsula, showing Kubura Well and other localities mentioned in the text. Scale in miles. Nos. 1-4 are Wapet oil wells. The area in which the subterranean fauna is known to occur on the western coastal plain is shaded. Modified from Mees, 1962.

were kept alive for three days. But on the night of the third day they succumbed, perhaps due to a rise in temperature, as they were put inside a heated room. The dead specimens were immediately preserved in alcohol.

Upon return to Perth the fish were given to Dr. G. F. Mees at the Western Australian Museum, and the shrimps sent to Dr. L. B. Holthuis at the Leiden Museum, Holland.

The four specimens of blind fish were identified as *Milyeringa veritas*. Their lengths varied from 21 to 31 mm. The 17 blind shrimps were identified as *Stygiocaris stylifera*, but Dr. Holthuis mentioned that they showed some difference from his type material of the species from the western side of the Cape. One specimen, he said, was totally aberrant with the legs much less slender than the

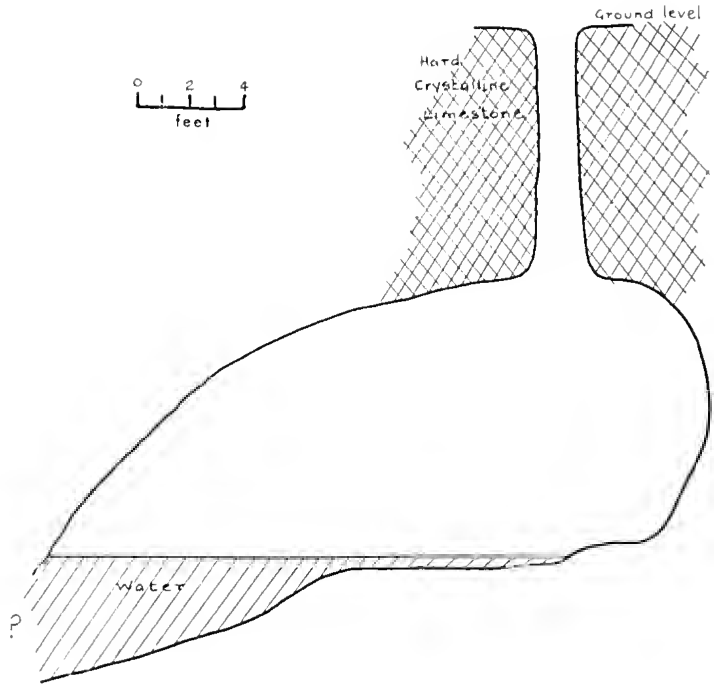

Fig. 2.—Section of Kubura Well.

others. It is interesting to note that of the 162 specimens of blind shrimps sent to Dr. Holthuis in 1959 from the western coastal plain of North West Cape, only 15 were named *Stygiocaris stylifera* by him. The remainder he named *Stygiocaris lancifera*.

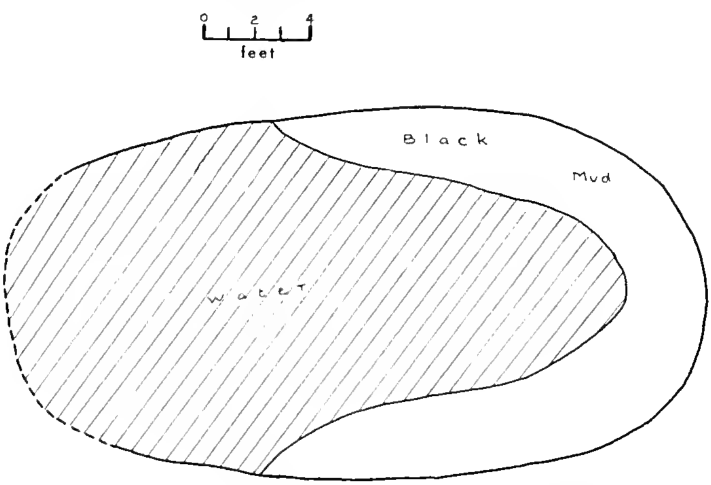

Fig. 3.—Ground plan of Kubura Well, at water level. On same scale as Fig. 2.

The discovery of this specialised subterranean freshwater fauna in the eastern coastal plain of the North West Cape does much to support Dr. Mees' theory that the fauna developed in the Cape Range in late Tertiary or Pleistocene times, and from there colonised the coastal platform when the sea retreated.

However the results of Dr. Holthuis' identification suggest that the two faunas are not now connected, but have developed independently in the last 5,000 years since their migration to the coastal platform from the range.

On the Cape Range, which separates the two coastal platforms, a total of 29 caves and solution pipes were found and explored by this and a previous W.A.S.G. expedition, by D. Cook and T. Fry, earlier this year. Of these only one contained any amount of water. This cave, named by us, Gaping Gill, was approximately 600 ft. above sea level at its deepest point. The water in it was about 2 ft. deep, in a narrow passage, which was followed for 15 yards where it became too narrow to continue further. No life was seen in the water, which was still and slightly brackish.

The large cave system which Condon, Johnstone and Perry (1953) suppose exists in the soft Mandu limestone of the Cape could not be entered from any of the 29 caves that were explored by us. These caves all occurred in the overlying hard Tulki limestone.

It can be seen that for any adequate study of this fauna and its origin, further examinations and collections from the wells on the eastern coastal plain and at Vlaming Head, besides geological examination of wells on both the eastern and western coastal plains, are necessary.

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NOTES ON *URODACUS* SCORPIONS

By L. GLAUERT, W.A. Museum, Perth.

I. A NEW SCORPION FROM THE CANNING STOCK ROUTE

When accompanying the party reconditioning the wells along the Canning Stock Route, between April 1930 and October 1931, the late O. H. Lipfert (taxidermist at the Western Australian Museum) collected five specimens of a scorpion which proves to be new to science. Unfortunately a precise locality is not available for any of the material, which bears only the generalised label: "Canning Stock

Route." Lipfert collected along the entire route, from Wiluna in the south to Billiluna, a total distance of some 860 miles. The whole of this Route must be regarded as the type locality.

Urodacus varians sp. nov.

Described from the male holotype (No. W.A.M. 62.1):

Form: slender, tail very long and about eight times as long as the carapace. Hand also long and slender.

Colour in alcohol: Clay colour (Ridgway). Carapace and hand brighter, legs and underparts paler, tail with fifth segment darker, vesicle like the legs.

Carapace: frontal lobes straight, separated by a shallow incision, ocular tubercle shorter behind the eyes, sulcus passing uninterrupted into the triangular depression whose sides are somewhat swollen; front to the level of the eyes more or less closely granular, the rest fairly granular. Carapace longer than the first caudal segment, nearly as long as the fifth. Tail nearly eight times as long as the carapace.

Tergites: minutely granular with smooth vertebral keels.

Sternites: smooth, the last with two smooth keels.

Tail: first four segments smooth, with smooth keels without any terminal tooth, fifth segment with five keels, the ventro-laterals strongly granular, the ventral slightly granular towards the tip, without bifurcation and intercarinal spaces smooth.

Brachium: all the keels slightly granular, thirteen pores at the ventro-lateral angle.

Hand: long and slender, movable finger longer than the palm, upper surface with a few rugosities and faintly granular keels, the finger-keel well developed, fingers with a single row of teeth in addition to the distantly spaced external series, with 16 pores and a group of three.

Legs: smooth, claws equal, first and second legs with six spines on the protarsus, sometimes five and a hair.

Pectines: with 25 teeth.

Dimensions (in millimetres): carapace, 7; trunk, 27.4; tail, 54; first segment, 9; fifth segment, 13.4.

The holotype male, W.A.M. 62.1, is in the collection of the Western Australian Museum, as are also three additional males and one female (paratypes, W.A.M. 62.2).

The female has the tail three times as long as the carapace. There are 16 pectines.

Remarks: The species is one of the long-tailed forms but surpasses all in the extreme length of the appendage, it being up to eight times the length of the carapace in males, with a range from nearly six times to nearly eight times in the specimens before me. However, this is only one of the characters which separates this distinctive species from other forms.

Urodacus varians differs from all previously described species in having the dorsal keels of the first four segments of the tail free from granules or tubercles although the first has them slightly corrugated. All distal terminations are rounded showing no trace of terminal spines or granules. Also, the hands have smooth keels and the rows of teeth on both fingers are in a single row as in *U. simplex* Pocock from Cape York. This has the dorsal keels "granular or subdenticulate," "and a little elevated posteriorly," the first four segments with a few granules laterally, the fifth with "granular intercarinal spaces and the inferior median keel double" (Pocock, 1902).

Urodacus macrurus Pocock, 1899, from North Queensland has a superficial resemblance to this species, but its inter-ocular area is smooth and polished not granular, its carapace is larger, 10 mm., and the teeth of the fingers are in a double series for the greater part of their length though single at the tip. The superior keels of the first four caudal segments are faintly crenulated terminating in a weak tooth.

II. *URODACUS MANICATUS* (THORELL)

The question of the nomenclature of the common species of *Urodacus* of south-eastern Australia has again been raised by Southcott (1955) who rejects Thorell's (1876) name because the description of the type is inadequate. He evidently overlooked the extremely detailed description in Latin given the following year and comprising over 2½ pages (Thorell, 1877).

In 1908 Prof. Kraepelin went fully into the matter after he had studied three specimens in the Berlin Zoological Museum including Peters' type of *U. novaehollandiae*. From this it emerged that the scorpion described and figured by Keyserling (1885) was not *novaehollandiae* but *manicatus*, an opinion confirmed by the figures given which show a somewhat tapering carapace and rounded frontal lobes among other features.

Urodacus abruptus Pocock, 1888, must be regarded as a synonym of *U. manicatus* (Thorell).

III. RECTIFICATION OF A PRE-OCCUPIED NAME

A confused situation has become apparent through the unwitting use of the same species name for two distinct species of *Urodacus* in Western Australia. In 1898 Pocock described *Urodacus granifrons*, a species which occurs in the coastal area from Geraldton to about the mouth of the Moore River.

In 1916 Kraepelin, having worked up the scorpions of Dr. E. Mjoberg's Swedish Scientific Expeditions to Australia, of 1910-1913, described as new a species of *Urodacus* from Broome. Unfortunately Kraepelin used *granifrons* as the species name, apparently unaware that it was preoccupied.

I propose

Urodacus kraepelini nom. nov.

as a replacement name for *Urodacus granifrons* Kraepelin, 1916, in honour of the late Professor K. Kraepelin whose works on the scorpions of Western Australia are well known.

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THE REPTILIAN FAUNA OF THE ISLANDS BETWEEN DONGARA AND LANCELIN, WESTERN AUSTRALIA

By JULIAN FORD, Attadale.

Along the coastline between Dongara and Lancelin are some 35 aeolianite limestone islands. They vary in size from 0.1 acre to 64 acres, lie from about 100 yards to six miles off the shore, are sometimes covered with dune sand, and were cut off from the mainland as a result of a post-Pleistocene rise in sea level (Churchill, 1959; Main, 1961). Their flora is typical of that occurring on small limestone islands along the west coast (*cf.* Storr, 1961). In 1959, 1960 and 1961, a detailed survey of the avian, mammalian and reptilian faunas was undertaken, this contribution giving details of the occurrence and ecology of the reptiles.

Since island size is significant in an ecological discussion, their areas in acres are given below:

Beagle Islands	
north-west island	1.2
south-west island	0.6
east island	3.8
Leeman-Green Head group	
Snag Island	0.5
Drummond Rock	0.1
Webb Islet	0.4
Lipfert Islet	0.5
Orton Rock	0.1
Milligan Islet	0.5
Fisherman Islands	
north island	3.5
south island	1.0
Sandland Island	3.6
Jurien Bay group	
Favourite Island	7.5
Boullanger Island	64
Whitlock Island	13.4
Tern Islet	0.5
Osprey Islet	0.3
Escape Island	26
Essex Rocks	
north island	1.0
middle island	0.7
south islet	0.3
Sandy Knoll	
north island	1.0
south island	0.5
Ronsard Bay	
north rock	0.1
south rock	0.1
Cervantes Islands	
north island	8.0
middle island	0.5
south island	2.3
Green Islets group	
north island	4.0
south island	8.5
Whittell Islet	0.6
Buller Island	1.1
Flat Rock	0.2
Wedge Island	4.8
Lancelin Island	18.8
Edward Island	0.4

Locality map. Scale, 1 in. = 36 miles.

Family: Geckonidae

Gymnodactylus milii (Bory)

Common on the north and south Cervantes Is., but absent from the middle island. Found under slabs of limestone. On the mainland it is located under slabs of rock and logs, and in the stumps of dead blackboys.

Phyllodactylus marmoratus (Gray)

Plentiful on Sandland I. and the north and south Green Islets; scarce on Milligan Islet and Buller I. Lives under limestone rocks. On the mainland it lives under the loose bark of trees, under logs and slabs of rock, and under sheets of galvanised iron on the ground.

Phyllodactylus ocellatus (Gray)

Plentiful on the northern end of Boullanger I., on Whitlock I., Escape I., and the north and south Cervantes Is.; scarce on Tern Islet. Occurs under slabs of limestone, both on the islands and the adjacent mainland.

Family: Scincidae

Tiliqua branchialis (Gunther)

Appears to be common on the central west side of Lancelin I. where there are numerous slabs of limestone under which it lives. It occurs in similar habitat on the adjacent mainland.

Egernia kingii (Gray)

Plentiful on many of the larger islands including Boullanger, Escape, the north and south Cervantes Is., and the north and south Green Islets. Inhabits the burrows of the shearwaters *Puffinus pacificus* and *P. assimilis*. It occurs in the coastal dune zone of the adjacent mainland but appears to be relatively scarce.

Egernia pulchra Werner

Plentiful on all the large islands of the Jurien Bay group, viz., Favourite, Boullanger, Whitlock and probably Escape. Inhabits crevices between and under rocks, and less frequently, petrel burrows. This particular form of *pulchra* is very distinctive and will be described in a separate paper. Apparently absent from the adjacent mainland.

Egernia bos Storr

Abundant on Sandland, Favourite, Boullanger, Escape and Lancelin; common on the middle Essex Rock. Possibly occurs on Whitlock I. although several attempts to locate it have been negative. This species makes shallow burrows, sometimes up to three feet in length, usually having several escape holes. It has not been seen on the adjacent mainland.

Lygosoma (Sphenomorphus) lesueurii Dumeril and Bibron

Common on Sandland, Favourite, Boullanger, Lancelin and south Green Islet; scarce on Wedge I. Possibly occurs on Escape and Whitlock. Usually active on the surface and lives under leaf litter and small depressions under rocks. Plentiful on the adjacent mainland but the population density would be lower than that of the islands.

Lygosoma (Sphenomorphus) labillardieri (Gray)

Lancelin I. only. Occurs in depressions in the sand under slabs of limestone where it appears to be not uncommon. Specimens are readily separable from those taken on the mainland and a full description will be given in a separate paper. The species has not been observed on the adjacent mainland but it is plentiful in the Darling Range country where it is found under rocks and logs.

Lygosoma (Hemiergis) quadrilineatum (Gray)

Relatively plentiful on the north and south Cervantes Is., the north Green Islet, and the north Essex Rock, less common on the middle Essex Rock. Found under rocks in sandy situations on the islands and the mainland. It is difficult to assess its relative abundance on the adjacent mainland but appears to be scarce.

Lygosoma (Rhodona) lineopunctulatum (Dumeril and Bibron)

Occurs on Boullanger and Whitlock Is. where it burrows in sand under limestone rocks. Because of its cryptic habits, no assessment of its status both on the islands and on the mainland can be made.

Ablepharus lineo-ocellatus (Gray)

Plentiful on the north Cervantes I., the north Green Islet and Lancelin I.; scarce on the north Fisherman I., the middle Cervantes I. and Buller I.; rare on the east Beagle I. Lives under leaf litter and rocks. Also common on the mainland but the population density would be less than that on the islands where this reptile is abundant.

Ablepharus elegans (Gray)

One specimen was collected in a petrel burrow on the north Fisherman I.

The families Pygopodidae, Agamidae and Varanidae, and snakes are not represented although some of the Jurien Bay islands appear to be large enough for snake lizards, worm lizards and snakes.

No lizards were found on the following islands despite diligent searching and they are therefore assumed to be absent: the two western Beagle Is., some of the small islands between Leeman and Green Head (Snag, Drummond, Webb and Lipfert), south Fisherman I., Osprey Islet, south Essex Rock, Whittell Islet and Edward I. The Sandy Knoll islands and Flat Rock were not visited.

ZOOGEOGRAPHICAL ASPECTS

Except for *Egernia bos* and *E. pulchra,* which have a southern distribution, the reptiles found on the islands between Dongara and

Lancelin are known to occur on the adjacent mainland (Glauert, 1961). A *bos*-like form occurs on Bernier I. (Storr, 1960), and possibly more extensive collecting will reveal all *Egernia* species on the adjacent mainland. It is therefore felt that no zoogeographical nor past-climatic inferences can be made at present.

ECOLOGICAL FACTORS

(a) PHYSICAL FACTORS

The number of species on an island is a function of the habitat diversity which depends on the size of the island. This is demonstrated by the fact that the largest islands have the largest number of species; for example, Boullanger I. has six species; Lancelin, six; north Cervantes I., five; Escape, four; and north Green Islet, four; while on some of the smaller islands only one or two species, such as a gecko or one of the small skinks, persist. Generally large islands have a greater number of available habitats. Habitat impoverishment and size reduction are continuous processes under the weathering action of the sea, wind and rain, until the stage is reached where the island is no longer suitable for any species; this appears to be the case with Drummond Rock, Lipfert Islet, Orton Rock, south Essex Rock, Osprey Islet, Ronsard Bay rocks and possibly Whittell Islet.

(b) BIOTIC FACTORS

(i) Effects of Other Animals

Islands inhabited by a large population of Hair Seals *(Neophoea cinerea)* invariably have a paucity of lizards both in species and numbers since the carrying capacity of the island is apparently reduced by the disturbing effects created by seals as they drag themselves over the ground, thus forming numerous broad tracks amongst the vegetation and causing a hard crust to form on the surface of the sand. On the Beagle Islands, where the seal population is probably in the vicinity of 100 individuals, only one reptile, a single individual of *Ablepharus lineo-ocellatus*, has been observed, and this was on the largest island of the group. The north Fisherman I., populated by about 60 seals, has two reptile species, *Ablepharus lineo-ocellatus* and *A. elegans*, but the latter would be relatively undisturbed by seal activity since it lives in petrel burrows and not on the surface. Other islands regularly inhabited by seals and having but few reptiles are the north Essex Rock (one species —*Hemiergis quadrilineatum*) and Buller I. (two species—*Ablepharus lineo-ocellatus* and *Phyllodactylus marmoratus*) although only about half of the latter island is affected by seal activity. Islands of sufficient area to hold reptiles but which are apparently devoid as a direct result of seal activity are the two western Beagle Is. and the south Fisherman I. The northern end of the south Cervantes I. is frequented by seals and does not have any lizards; however, the main plateau of this island is inaccessible to seals and has a high reptile population. Only one island, Sandland I., inhabited by a breeding population of seals, has a large population of reptiles and a relatively high number of species—*Egernia bos, Sphenomorphus* *lesueurii* and *Phyllodactylus marmoratus,* but only about half of the island is disturbed and the seal population probably does not exceed 10 individuals.

A few islands, such as Edward, Snag and Webb Is., appear to be devoid of reptiles because of the activity of sea-birds, mainly the Pied Cormorant *(Phalacrocorax varius),* continually depositing a layer of guano over the islands. This phenomenon, however, becomes important only on small islands. The effects of the burrowing sea-birds, which include the Wedge-tailed Shearwater *(Puffinus pacificus),* Little Shearwater *(Puffinus assimilis)* and the White-faced Storm-Petrel *(Pelagodroma marina),* are difficult to assess but they probably contribute an extra habitat in their burrows since these are frequented by a number of reptile species.

Probably the only important avian predator on the island reptilian fauna is the Kestrel *(Falco cenchroides).* This species breeds on Sandland, Favourite, Boullanger, Escape (?), Green Islets, Wedge and Lancelin Is., and is invariably observed hovering over the islands. It is significant that no Kestrels have been observed on the Beagle and Fisherman Is., which have small reptile populations, although the bird's absence may be due to the fact that the islands lie 6 and 3.5 miles respectively from the coast and thus do not have close proximity to the mainland where the bird species is common. The Sacred Kingfisher *(Halcyon sancta)* has been observed on Whitlock, Escape, Essex Rocks, Cervantes, Green Islets, Wedge and Lancelin and would no doubt be an efficient predator. The Boobook Owl *(Ninox novae-seelandiae)* and the Barn Owl *(Tyto alba)* have been observed on Favourite and Boullanger Is. respectively, but since they appear to be only casual visitors and are nocturnal in habits, their predatory effect would be of little importance except possibly on the geckos which are active at night.

That only one reptile species, *Sphenomorphus lesueurii,* has been collected on Wedge I., despite its relatively large size, may be due to the island being joined during the summer period by a wide sandbar to the mainland allowing small mammal predators to gain access. A small burrowing animal and the Fox *(Vulpes vulpes)* inhabit both the island and the adjacent mainland. Wedge I. may thus be considered to be a part of the mainland. Boullanger and probably Whitlock Is. are inhabited by the Dunnart *(Sminthopsis murina)* which is carnivorous but whether it takes reptiles is not known. The introduced mouse *(Mus musculus)* also occurs on Boullanger I.

(ii) Competition in Reptiles

A striking feature of many of the island reptilian populations, compared with that on the adjacent mainland, is that there are fewer species represented but they exist in greater density of individuals. This suggests that the total population of a fauna is not proportional to the number of species composing it, but to the carrying capacity, and that the population of the respective species in a fauna is dependent on the number of competing species. Thus the reduction of interspecies competition on the islands has allowed the few species present to reach greater densities than they do on the adjacent mainland, as already indicated for local islands by Serventy (1951).

In a study of the role of interspecies competition amongst passerine birds, Crowell (1962) has shown that the reduced competition on the island of Bermuda has allowed the fewer species present to attain greater densities than in continental North America. The increase in Bermuda appears to have been accomplished through broader tolerance of small or localised differences in habitat permitted by the absence of species normally competing for such sites. The replacement of missing species occurred without the acquisition of new behaviour since adaptive zones or niches are actually overlapping rather than discrete. Habitat tolerance of the reptiles on the Western Australian coastal islands is somewhat broader than on the mainland, particularly on those islands having a low number of species.

Interspecies competition probably accounts for the irregular distribution of several species (Serventy, 1951; Main, 1961). This is best exemplified in the genus *Egernia*. Only on two, possibly three islands, viz., Favourite, Boullanger and Escape (?), do both *E. bos* and *E. pulchra* occur, but since their preferred habitats are sufficiently large on these islands, *E. bos* living in shallow burrows in sandy situations and *E. pulchra* in crevices between limestone rocks, there is no undue ecological overlap. On Sandland I. and the middle island of the Essex Rocks, *E. bos* is the only representative and frequently lives in small burrows under rocks. *E. bos* on Lancelin does not burrow under rocks, this niche being occupied by *Sphenomorphus labillardierii* and *Tiliqua branchialis*. Whitlock I. is apparently only inhabited by *E. pulchra* which in addition to living in rock crevices, occupies petrel burrows. The distribution data indicate that when Sandland, Whitlock, middle Essex and Lancelin Is. were cut off from the mainland, they were probably inhabited by both *E. pulchra* and *E. bos*. Thus it appears that with the gradual reduction of island size, the distinction between ecological niches ceases to prevent undue competition so that one or the other species is eliminated.

In the case of *E. kingii* and the two smaller *Egernia* species the only overlap occurs on the largest islands, viz., Boullanger and Escape, and where *E. kingii* is the only representative of the genus, such as on the north and south Cervantes Is. and the two Green Islets, it is considerably more abundant. Of course the competition between these species only becomes important when the island has been reduced to a certain minimum size, and results in the extinction of one, then two species, whence only one survives as is now the case on eight islands. It has already been pointed out that on islands only inhabited by *E. bos*, this species takes over the *pulchra* habitat. This also applies to *E. kingii* which, on the Cervantes Is., lives under slabs of limestone in addition to petrel burrows but on Whitlock I., where only *E. pulchra* occurs, the reverse situation is found.

An interesting feature concerning the reptilian distribution on the two Green Islets is that *Sphenomorphus lesueurii* and *Ablepharus lineo-ocellatus* seem to replace one another, the former occurring on the south island and the latter, on the north, although the islands are only some thirty yards apart. These two species appear to have similar adaptive zones and only occur together on Lancelin I.

The geckos *Phyllodactylus marmoratus* and *Phyllodactylus ocellatus* have not been found on the same island. Their ecological adaptations appear to overlap broadly.

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At the commencement of the island survey, several of the islands were found to be unnamed and I proposed the names of the following naturalists for certain of them: K. G. Buller, Johnston Drummond, O. H. Lipfert, A. W. Milligan, C. L. E. Orton, P. T. Sandland, W. Webb, F. L. Whitlock and H. M. Whittell. To Miss L. Gardner, Secretary of the Nomenclature Advisory Committee, Lands and Surveys Department, I am thankful for assistance with this matter.

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A NEW SPECIES OF *CRINIA* (ANURA: LEPTODACTYLIDAE) FROM NATIONAL PARK, NORNALUP

By A. R. MAIN, Zoology Department, University of Western Australia, Nedlands.

At Deep River, Nornalup, in April 1961 I was being assisted by W. N. Holsworth in a search for *Metacrinia nichollsi* (Harrison) when he found a frog which was at first thought to be a juvenile *Crinia rosea* Harrison. Two further specimens were found—one proved to be adult and raised doubts as to the specific identity. In April 1962 accompanied by Arnold Kluge I revisited the Nornalup area and at the same site collected further non-breeding specimens. In October 1962 I again visited Nornalup and on this occasion I was able to collect two calling males and egg masses. The breeding males agreed with specimens previously collected, are morphologically distinct from *Crinia rosea* and are described below.

Crinia lutea sp. nov.

Holotype male, W.A. Museum No. R17616. Collected National Park, Nornalup, 23. X. 62. Vomerine teeth behind choanae. Snout longer than upper eyelid, rounded, as long as distance between eyes. Canthus rostralis concave, slightly oblique. Nostrils opening equidistant between eye and snout. Fingers short 3>4>2>1, large tubercle at base of first finger, others not prominent. Toes moderate, 4>3> 5>2>1, not fringed, a very small white inner metatarsal tubercle, no outer, others not prominent. Skin smooth above and below. Granular area on posterior of thigh.

Dark grey brown above, marked as in Figure 1. Ventrally; throat

Fig. 1.—*Crinia lutea* sp. nov.; left, dorsal view of holotype; right, ventral view of same.

black, a pale border around lower jaw. Belly pale fawn-brown with faint red-brown blotches which fade in preservative. Legs black except for lower surfaces of thigh which are coloured like belly though more reddish. Length, snout to vent 19.1 mm.

Type locality: A shallow valley on left bank of Deep River on western boundary of Nornalup National Park, where the Manjimup to Denmark road enters the park. Other specimens examined; males 2, females 3, juv. 4. These specimens agree with holotype with the following exceptions: Females lack the dark throat of males. Smaller specimens have pink spots on dorsum and flanks and a pink area on anterior of forearm and adjacent ventral surface. Also the dorsal pattern is outlined in pinkish grey. The length of the first finger and toe is very variable ranging from $\frac{1}{2}$ to $\frac{3}{4}$ length of second finger. Some of the specimens have pale tri-radial mark extending between eyes and down snout.

This species is morphologically close to both *Crinia rosea* and *Crinia laevis* (Gunther). From the former it can be distinguished by the fawn colour of the venter, smaller size, variable first finger and toe and from the latter by the paler relatively uniform colouration of the belly, smaller size and variable but larger first finger and toe.

The calls have been heard but not recorded on tape. *Crinia lutea* has a call similar to that of *Crinia rosea* but repeated more rapidly.

Habitat: Adjacent to a small stream in a broad shallow valley floor of peaty sand. Dominant vegetation Restionaceae, *Viminaria*, *Juncus*, etc., completely matted above, light does not reach soil surface which is series of pits and hummocks of mud. Male frog calls from tunnels near top of hummocks of mud or clay (to which the species name is an allusion). A number of similar tunnels were found to contain egg masses of 25 to 30 eggs. Larvae develop in the egg capsules without entering water. Early stage larvae, collected October 23, 1962, completed development December 10, 1962. In its larval life this species resembles *Crinia rosea*. However, the eggs of the latter appear to be always in a shallow depression and not tunnels as has been observed with *Crinia lutea*. *Crinia lutea* has not been heard calling or collected outside the type locality. As the distribution is at present known it is easily the most restricted of all frog species in Western Australia.

This work was carried out while the author was in receipt of a Research Grant from the University of Western Australia.

NOTES ON THE HERPETOFAUNA OF WESTERN AUSTRALIA

By ARNOLD G. KLUGE, Department of Zoology, University of Western Australia.

Only two scincid lizard species belonging to the large subgroup *Heteropus* of the genus *Leiolopisma* have been recorded from Western Australia (Glauert, 1961, p. 75). The distribution of this subgroup in Western Australia was thought to be confined solely to the Kimberleys and appeared to typify the western extreme of the Torresian Zoogeographic Subregion in its classical sense. The following additional localities for the two previously recorded species plus the occurrence of a third form known only from the Northern Territory, expand the range of this section of the genus *Leiolopisma* approximately 600 miles south-west of the Kimberley region. These range extensions only preclude the use of *Heteropus* as an example of the Torresian Subregion if we think of such areas statically in a single plane of time and not historically as major sources of faunal origin.

Leiolopisma pectoralis (De Vis)

1. Adult female (gravid): 6 miles south of Vlaming Head, North West Cape, Sept. 19, 1961.

Salient characters: four supralabials anterior to subocular; four supraciliaries; small lobule present on anterior margin of ear opening; dorsal and lateral body scales cycloid, smooth, becoming weakly tricarinate posteriorly; midbody scales in twenty-eight rows; subdigital lamellar formula for fore limb 6-11-16-6, hind limb 6-10-16-24-13; uniform brown dorsally, blue ventrally; distinct white subocular stripe continues to dorsal margin of ear opening and from its ventral margin to fore limb insertion; snout-vent length 39 mm., tail length 43 mm. (incomplete).

2. Juvenile male: 18 miles south south-west of Learmonth (Rough Range), North West Cape, Sept. 23, 1961.

Salient characters: three/four supralabials anterior to subocular (left and right sides respectively); four supraciliaries; small lobule present on anterior margin of ear opening; dorsal body scales cycloid, tricarinate, keels of lateral body scales being broken up into a series of points; midbody scales in thirty rows; subdigital lamellar formula for fore limb 6-12-17-7, hind limb 5-11-18-23-13; colour as for adult female; snout-vent length 27 mm., tail length 48 mm.

These two specimens from the North West Cape compare favourably with examples of typical *pectoralis* from Adelaide River, Northern Territory and Innisfail, Queensland (Mitchell, *in litt.*). The major differences are the shape and type of keeling of the dorsal and lateral body scales. In both Western Australian examples the body scales appear to be slightly more rounded than normal which is probably correlated with the reduced nature of the keels. The peculiar type of lateral body keeling found in the juvenile male has only been recorded in the *Heteropus* subgroup in *coense* from Coen, Queensland. A comparison of the North West Cape specimens with the series of *pectoralis* recorded by Glauert (1961) from Kalumburu Mission, Drysdale River, also reveals minor, yet consistent, morphological differences between the two populations. The Kalumburu Mission specimens are also slightly different from the Adelaide River and Innisfail material. There is some suggestion that the distribution of *pectoralis* is very fragmentary in western Australia. Each population appears to be slightly different morphologically which could indicate a series of incipient species.

The two specimens of *pectoralis* from the North West Cape were collected during the day among debris along the banks of dry creek beds. Both specimens appeared to be actively foraging for food.

Leiolopisma triacantha Mitchell

1. Adult female: 3 miles south of Mundiwindi (new location), Feb. 26, 1962.

Salient characters: four/five supralabials anterior to subocular; five supraciliaries; prominent lobule present on anterior margin of ear opening, posterior margin slightly denticulate; dorsal and lateral body scales strongly tricarinate with slightly emarginate posterior borders; midbody scales in thirty rows; subdigital lamellar formula for fore limb 9-15-17-9, hind limb 6-12-19-23-13; anal scales slightly enlarged; distance between tip of snout and fore limb less than that between axilla and groin; adpressed hind limb reaches axilla; dorsal body colour uniform light brown with irregularly distributed black-pointed scales; ventral surfaces bluish-white; snout-vent length 40 mm., tail length 69 mm.

2. Adult female: Cockatoo Island, West Kimberley.

Salient characters: four supralabials anterior to subocular; five supraciliaries; prominent lobule present on anterior margin of ear opening, dorsal margin strongly denticulate; dorsal and lateral body scales strongly tricarinate with moderately emarginate posterior borders; midbody scales in thirty rows; subdigital lamellar formula for fore limb 9-14-17-9, hind limb 6-12-19-23-14; anal scales not enlarged; distance between tip of snout and fore limb less than that between axilla and groin; adpressed hind limb does not reach axilla; dorsal body colour greenish-bronze with irregularly distributed light blue scales with dark brown margins; ventral surfaces bluish-white; snout-vent length 48 mm., tail length 86 mm.

The major differences between the Western Australian specimens and the original description of *triacantha* are the presence of lobules on the margins of the ear opening and in certain body proportions. In the type description of *triacantha*, Mitchell (1953) stated that the distance between the tip of the snout and the fore limb was equal to that between the axilla and the groin and that the adpressed hind limb reached beyond the axilla. The different proportions found in the Western Australian material are probably the single product of a slightly longer body.

Leiolopisma triacantha was previously known only from Adelaide River and Darwin, Northern Territory.

The Mundiwindi specimen was collected at night among eucalypt debris marginal to a *Triodia* flat.

Leiolopisma vivax is the only other species of the *Heteropus* subgroup thus far recorded from Western Australia. Glauert (1961) incorrectly identified as *peroni* a single specimen of *vivax* from Wotjulum Mission, West Kimberley. Recently, an additional example of *vivax* was collected on East Woody Island, Collier Bay, West Kimberley. In all major characters the Western Australian material of *vivax* falls within the range of variation discussed by Mitchell (1953) for that species.

Keast (1962, p. 402, fig. 8) showed *Leiolopisma (Heteropus) fuscum* as far west as North West Cape, Western Australia. To my knowledge, *fuscum* has not been collected in Australia west of Arnhem Land, Northern Territory.

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FROM FIELD AND STUDY

A Record of the Euro near Merredin.—Barker (*W. Aust. Nat.,* 6, 1958; 54) records the occurrence of the Euro *(Macropus robustus)* at Mokine and McMillan (*ibid.* 8, 1962: 101) reports the animal from Culham. On August 22, 1962, I saw a male Euro lying dead by the roadside about 15 miles north-east of Merredin in the Goomerin area. The identification was verified by checking the coarse reddish-brown fur and naked muzzle at close quarters. The adjacent country was scrub plain quite unlike the wandoo breakaway described by Barker and McMillan.

—C. F. H. JENKINS, South Perth.

Birds Attacking Swamp Tortoise.—V. N. Serventy (*W.A. Nat.,* 7; 167) reported on Swamp Tortoises *(Chelodina oblonga)* attacking birds in water. I now record a case of birds attacking a Swamp Tortoise on land.

On October 12, 1961, a tortoise was sighted moving away from the swamp toward the river bank behind Guildford Grammar School. It was under constant attack by four Magpies *(Gymnorhina dorsalis),* the birds diving on the animal from behind trying to peck its head. It was too quick for them, however, and at each attack the head was swiftly tucked into the protection of the carapace. At no time was a frontal attack made. The tortoise eventually reached shelter in long grass and the birds dispersed.

—PETER McMILLAN, Guildford.

Fork-tailed Swift on Rottnest Island.—Ford (*W.A. Nat.,* 1957, 6: 106-107) reported the occurrence of the Fork-tailed Swift *(Apus pacificus)* on Rottnest Island. I made a similar sighting of these birds on Rottnest from January 1-7, 1962.

The Swifts, approximately 100 in number, were hawking over most of the island during the daytime. In the late afternoon they would concentrate in the area of the Main Lighthouse and the Biological Research Station. In the latter spot they selected the army tower and appeared to use updraughts from the structure for soaring.

I noticed that the birds forked their tails when pulling up suddenly or in making steep turns. At all other times the tail appeared straight. The white rump was conspicuous whenever the birds turned. The weather at the time was extremely hot, with very strong easterly winds.

—PETER McMILLAN, Guildford.

Recovery of a Ringed Pacific Gull in Western Australia.—On October 29, 1961, I ringed a young Pacific Gull *(Larus pacificus)*, which was able to run but not to fly, on Middle Cervantes Island. On June 12, 1962, this individual (bearing C.S.I.R.O. band no. 110-02001 and the only Pacific Gull so far banded by me) was found alive and healthy by Mr. I. Condon, Fisheries Officer, in Geraldton harbour, 120 miles north of the banding point.

From 1959 to 1962, during a survey of the coastal islands between Dongara and Lancelin, it was found that solitary pairs of Pacific Gulls occur on Favourite, Middle Essex, Middle Cervantes and Buller Islands. These four pairs of adult birds appear to be strictly sedentary, and in fact, each pair shows great tenacity to the island on which it breeds. The recovery indicates, however, that immature birds wander a considerable distance from their natal areas.

—JULIAN FORD, Attadale.

A Note on the Life History of *Metallea puncticeps* Mall (Family Calliphoridae).—While collecting at Culham, W.A., in May 1960, nests of the termite *Tumulitermes petilus* (Hill) were investigated. From the tunnels of one of these nests, situated beneath a stone, five larvae of the fly *Metallea puncticeps* were collected.

Three of the larvae were a waxen white in colour, about half an inch long and very sluggish. They were found in upper galleries near the edge of the stone, possibly at points of emergence. The other two larvae were a pale yellow and very active; they were in a gallery filled with litter on which was growing a white mould.

The five larvae were placed in an observation jar on May 26, 1960. On May 29 the three white specimens had turned to pupae and the two yellow ones had become sluggish and changed to a waxen white; on June 4 these turned to pupae. On June 30 all the specimens emerged.

Observations made on the larvae in the nest indicated that the termites accepted their presence. The termite colony, as would be expected, had been very much upset with the removal of their protecting roof. Generally under these circumstances soldiers readily attack aliens. In this case the *Metallea* larvae moved freely among the termites and no attempt at attack was made on them at any time.

The active larvae in the litter appeared to be feeding on the white mould. Examination of the gut contents (stained with Cotton

Blue), of a specimen collected in May 1961, showed fungal hyphae to be present.

In May 1961 I confirmed the presence of larvae in other nests of *Tumulitermes petilus* in the same area, four more larvae being collected. In August 1961 many empty pupal cases were found, and two larvae which were small and watery white in colour. They were very active and failed to develop in an observation jar.

I wish to thank Dr. S. J. Paramonov, Division of Entomology, C.S.I.R.O., Canberra, for identification of the adult flies, and Mr. F. Gay of the same institution for identifying the termites.

—PETER McMILLAN, Guildford.

Birds of Prey Observed During a Train Journey Across the Nullarbor Plain.—On December 5, 1961, I left Port Pirie by train in continuation of my journey from Melbourne to Perth. I did not awaken next morning until the train had passed Watson, but from then on, except for three short intervals for breakfast and lunch and for a sleep in between, I was looking out of the window to the north of the railway line continually. This was how I came to notice a number of birds of prey which (with one exception) seemed to be flying steadily east at fairly regular intervals. Except for the interruptions mentioned above I kept watch until 1800 hours, but saw no more birds after 1535 hours. The following is my record of the birds seen, except that I have omitted those which were too far away to be recognised.

Time (Western Standard)	Approximate Locality	No. of Birds	Species	Direction of Flight
0735-0846	Between Watson and Cook	c. 10	Australian Goshawk	East
0940	Between Hughes and Reid	1	Kestrel	East
1010	Between Reid and Forrest	Sev.	Kestrel	East
1055	Between Forrest and Mundrabilla	1	Kestrel	East
1100	Between Mundrabilla and Loongana	1	Wedge-tailed Eagle	West
1100	do.	2	Kestrel	East
1105	do.	2	Kestrel	East
1112	do.	1	Kestrel	East
1117	do.	1	Kestrel	East
	No count until 1200 hours			
1200	Loongana	2	Kestrel	East
1225	Between Loongana and Nurina	2	Kestrel	East
1240	Between Nurina and Haig	2	Kestrel	East
		1	Australian Goshawk	East
		2	Brown Hawk	East
	Lunchtime			
1330	Between Haig and Rawlinna	2	Whistling Eagle	East
1340	do.	1	Kestrel	East
1350	Between Haig and Rawlinna	2	Crow/Raven	East
1445	Between Naretha and Kitchener	1	Kestrel	East
1500	do.	Several Brown Hawks, Kestrels and Crow/Ravens perched on telegraph poles.		
1520	do.	1	Peregrine	Perched
1535	do.	1	Brown Hawk	Perched

The first entry "c.10" in the "Number of Birds" column relates to the period when I first began to notice the birds of prey but had not realized there was a steady passage. The record of "several" kestrels means that a number passed at once too quickly for an estimate of their number to be made.

—D. A. ROOK, Nedlands.

Recent Records of the Mardo *(Antechinus flavipes)* **in South-Western Australia.**—John Gilbert, during his field work on natural history in Western Australia between 1839 and 1843, found the Mardo or Yellow-footed Marsupial-Mouse *(Antechinus flavipes leucogaster)* to occur fairly commonly from the Moore River in the north to the vicinity of King George's Sound in the south (H. M. Whittell, *W.A. Nat.*, 4, 1954: 106). Subsequently the species underwent an eclipse in abundance and L. Glauert (*ibid.*, 4: 130) suggested that it had possibly become extinct as, at the time, no specimen had reached the W.A. Museum since 1939. B. J. Marlow (*Marsupials of Australia*, Brisbane, 1962: 18) reports it as probably extinct in Western Australia. In the eastern States the species appears to have remained quite plentiful (C. W. Brazenor, *The Mammals of Victoria*, Melbourne, 1950: 25; B. J. Marlow, *C.S.I.R.O. Wildlife Research*, 3, 1958: 80).

However, there are now several recent records from South-Western Australia, suggesting that this is yet another species of native mammal which has entered on a cycle of relatively greater abundance (*cf. W.A. Nat.*, 4, 1954: 128).

On February 5, 1953, the W.A. Museum accessed a female specimen from Kulin; it is now represented in the collections as a skull (W.A.M. No. 3450). On March 17, 1960, the Museum received a male specimen (M3983) collected by Mr. R. Lehmann six miles north of Cranbrook. On January 14, 1962, I collected two specimens at Two People Bay, east of Albany, a male (M4899) and a female (M4900). On June 11, 1962, the museum received a fresh male specimen (M5075) from Mr. K. S. Blond who obtained it one mile east of Cowaramup.

The two specimens collected by me were taken at the site where the Noisy Scrub-bird *(Atrichornis clamosus)* was recently rediscovered at Two People Bay (H. O. Webster, *W.A. Nat.*, 8, 1962: 57 and 81). One individual was seen running up the trunks of small trees *(Agonis flexuosa)* on the margins of a thickly vegetated fresh-water dune swamp and the second was seen with a small piece of bread in its mouth leaving a nearby corrugated-iron holiday cottage. Another was observed running with great facility in bursts of activity followed by short periods of inactivity along tree-branches and, in agile fashion, hopping about in the open. The species became active towards sunset. Several specimens of the Western Swamp Rat *(Rattus fuscipes)*, whose runs are numerous in the swamps at Two People Bay, were also collected. Dr. and Mrs. Ride had also collected this rat at this locality in October 1959 in traps baited with bread.

E. Troughton (*Furred Animals of Australia*, Sydney, 1954: 25) states that the Mardo favours stony country, but the south coast habitat is mainly the dense vegetation fringing swamps and it probably lives in hollow logs and under fallen trees. The margins of the dune swamp in which the Two People Bay animals occur are vegetated with dense scrub up to ten feet in height consisting of peppermint *(Agonis flexuosa)*, prickly wattle *(Acacia decipiens)* and Logania *(L. vaginalis)*, with a dense undergrowth of sword sedge *(Lepidosperma gladiatum)*, saw sedge *(Gahnia trifida)* and bog rush *(Schoenus sp.)* entangled with dodder *(Cassytha racemosa)* and thickly matted with grasses, mainly bent grass *(Agrostis aemula)*, mat grass *(Hemarthria uncinata)* and tussock grass *(Poa australis)*. Dwarf trees, namely banksia *(B. littoralis)*, river banksia *(B. verticillata)* and paper-bark *(Melaleuca cuticularis)*, occur sparingly and nearby there is a large stand of fairly tall yate *(Eucalyptus cornuta)*, the undergrowth of which is identical with that described above.

I am indebted to Dr. W. D. L. Ride, Director of the W.A. Museum, for information on the museum material and for discussing this note with me, and to Mr. R. D. Royce, Government Botanist, for plant identifications.

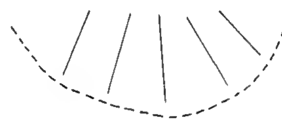
—JULIAN FORD, Attadale.

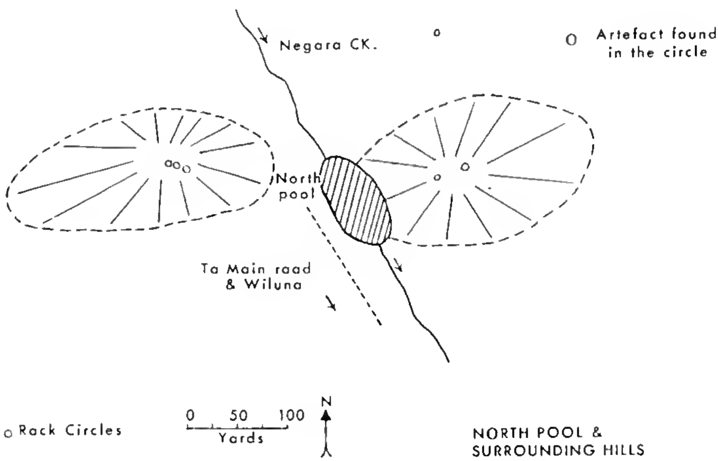
An Aboriginal Site at Wiluna.—Kevin Morgan, Roger Howlett and the author made some observations of rock circles and artefacts at North Pool near Wiluna during August, 1961. North Pool is a large permanent water-hole on Negara Creek, 16 miles north of Wiluna. It is marked on Map No. 8 of the ten mile series of the Lands and Surveys Department. The pool is surrounded by three low rocky hills, which rise about 60 feet from the flat plain of red sandy soil. The hills are composed of coarse-grained quartzite rock which has weathered into rough boulders and fragments on the hills, with smooth pebbles on the plain nearby.

Near the crest of the hill, to the west of the pool, three rock circles were found. They were fifteen yards apart, in a straight line, and on the same level. On the hill to the east of the pool, on either side of the crest and about 25 yards apart, there were two similar circles. These five circles were all of a similar size and design, namely, a bare level earth floor fringed with large rocks arranged in a rough circle, six feet in diameter (Museum photo No. A.P. 280). In addition, on the stony plain near the northern slope of the hill to the east of the pool, were two circular bare areas. These were also six feet in diameter, but were not completely fringed with stones.

On the hills, and to a lesser extent on the stony plain, scattered quartzite chips were found, none of which could be positively identified as artefacts. However, a number of fine-grained pieces of chert, a rock foreign to the area, were found near the two circles on the plain. These pieces were invariably scalloped or chipped. One piece, a small, neatly shaped cutting tool (Museum No. A 14379) was found within one of these cleared circles on the plain.

Rock circles of similar size to those described have been recorded from the Murchison and Kimberley districts (Davidson, 1954), and smaller ones have been recorded in conjunction with other stone arrangements at Canna, east of Geraldton (V. N. Serventy and S. R. White, 1958). Another type of stone arrangement was reported at Pithara (Glauert, 1952). However their significance is uncertain, except in the Kimberley district where similar circles are still being used by the aborigines for either:—(1) Yards to contain dingo pups. (2) Inquest stones, "by which responsibility for a death is divined" (Davidson, 1954).





The aboriginal site near Wiluna

By the number and nature of the rock circles at North Pool, these possible reasons for their construction can be discounted. The bareness of the circles, and the one artefact found in one of them suggests the use of these circles for ceremonial scarring or circumcision rites.

—PETER CAWTHORN, W.A. Museum, Perth.

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THE FOSSIL VERTEBRATE FAUNA OF STRONGS' CAVE, BORANUP, WESTERN AUSTRALIA

By D. L. COOK, Carpentaria Exploration Company, Brisbane.

INTRODUCTION

Fossilised remains of vertebrates have been known from caves in the coastal limestone of Western Australia for many years. This fauna is most extensively known from the caves of the Margaret River area (Glauert, 1910a, 1910b, 1912a, 1914, 1921b, 1948).

In July 1960 R. M. Howlett collected tooth fragments of *Nototherium* in Strongs' Cave, Boranup (Ar. 8)*, lat. 34° 09' S, long. 115° 04' E, which is approximately 30 chains on a bearing of 254° from the old Boranup Mill, burnt out in March 1961, and approximately 4.5 miles north of Karridale (Fig. 1).

Later the present author and others collected numerous teeth and bone fragments from this cave which suggest that the fossils represent a fauna similar to that recorded by Glauert (1910a, 1912a, 1914) from the Mammoth Cave.

This paper reports on what has been discovered and interprets the findings.

MATERIAL AND METHODS

1. Mode of occurrence: The material was collected from the bed of a south-west flowing stream, downstream from a mound of talus which partly fills the entrance chamber of the cave.

Teeth in the majority of cases have been found as enamel only. Some specimens still have a little of the dentine on the inside of the enamel, others are almost complete crowns, and rare specimens are almost complete.

The bone is fragmentary and extensively corroded in most cases. Only in rare cases is a specimen sufficiently complete for identification.

2. Two methods of collection have been used;

a. Quantities of material were collected from the bed of the stream and sieved using a flywire screen. Samples were taken at intervals downstream and upstream from the entrance chamber to determine the extent of the fossil material. The spoil resulting from the sieving was taken to the surface and sorted under the better lighting conditions.

* Western Australian Speleological Group reference, recorded in reports by this group and held by the Battye Library, Perth.

b. By walking upstream and examining the stream bed for tooth enamel which showed up white against the darker sedimentary particles.

Identifications were made using comparative material in the Western Australian Museum and the author's collections.

RESULTS

Descriptions and identifications of the material collected are given. All the material collected has been included, except the completely unidentifiable bone fragments and some fragments of enamel. Table I summarises this information.

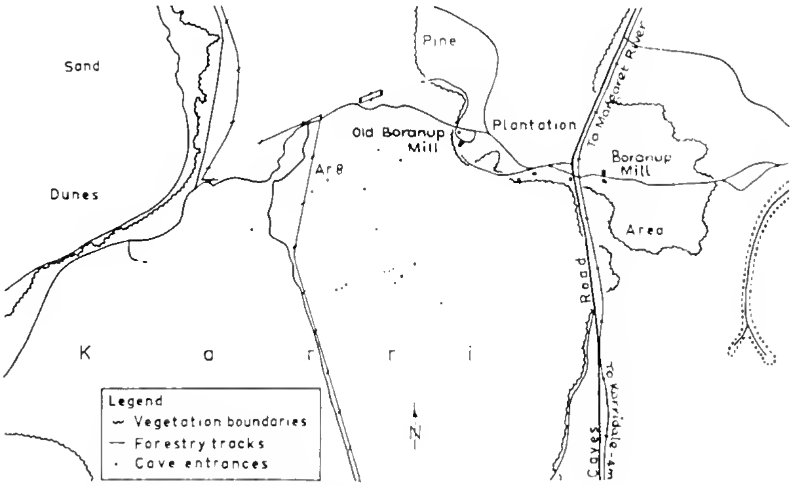

Fig. 1.—Locality map of the area west of the Boranup Mill, Karridale area, Western Australia, showing the position of Strongs' Cave (Ar. 8). Scale, 1 in. = 45 chains.

CHONDRICHTHYES

SELACHII

CARCHARODONTIDAE

Carcharodon sp.

Two shark's teeth were found. The larger (W.A.M. 61.11.1*), the broken off tip of an immature tooth from the right side of the upper jaw, agreed very well with that of *Carcharodon albimors* Whitley. Mr. Gilbert P. Whitley, Australian Museum, Sydney, later confirmed the generic placing but considered that further identification of the specimen was not justified. The second, well-worn tooth was not identified.

REPTILIA

SQUAMATA

SCINCIDAE

Trachysaurus rugosus Gray, 1827

The species is represented by an almost complete right maxilla (W.A.M. 61.11.44). The element is identical in all important features to that of a sub-adult *T. rugosus*.

Numerous ossicles compare well with those of scincids.

* Western Australian Museum catalogue number.

MAMMALIA

CHIROPTERA

VESPERTILIONIDAE

Nyctophilus timoriensis Geoffroy, 1806

A right mandibular ramus with M_2 only, agrees in size, shape and dental characters with comparative material of this species. The specimen is in the author's collection.

RODENTIA

MURIDAE

Rattus sp.

The root formulae and large coronoid spines of three right mandibular rami agree with this genus. The specimens are in the author's collection.

One left and one right lower incisor (both W.A.M. 61.11.45), and three lower right and one upper left incisor (the author's collection) are also murids.

MARSUPIALIA

THYLACINIDAE

Thylacinus cynocephalus Harris, 1808

This species is represented by the crown of a left M_4 (in the author's collection) and a third premolar (W.A.M. 61.11.47) which is almost certainly the lower right.

The molar is the largest of 12 fossil M_4 teeth measured from Western Australia and is therefore thought to have come from a male.

The premolar is amongst the smallest of 16 fossil P_3 teeth measured from Western Australia and is therefore thought to have come from a female.

DASYURIDAE

? Antechinus sp.

A right M_4 of a small dasyurid. Of the four species of small dasyurids which could occur in the area (*Antechinus flavipes, Sminthopsis murina. Phascogale tapoatafa* and *Parantechinus apicalis*) the specimen agrees in size with the first-named—unless it is of an unknown form.

Sarcophilus harrisii Boitard, 1841

The crown of a lower right canine has been compared with the corresponding tooth in *Sarcophilus harrisii, Thylacinus, Canis familiaris dingo* Blumenbach, 1780, and *Vulpes vulpes* Linnaeus, 1758.

The fossil tooth has a poorly developed carina and is subcircular in section. The dingo canine is more oval in section and tends to have a more distinct carina. *Thylacinus* has no carina and is more oval in section. In *Vulpes vulpes* this tooth is more oval in section. The tooth in *Sarcophilus harrisii* agrees in both characters with the fossil tooth.

PHALANGERIDAE

Cercaertus concinna Gould, 1845

One left mandibular ramus without teeth (W.A.M. 62.3.10) has been compared with modern *C. concinna* and is that species.

DIPROTODONTIDAE

Nototherium mitchelli Owen, 1845

Seven molar crown fragments, one molar and one premolar compared well with that of fragmentary *N. mitchelli* from the Mammoth Cave and an almost complete mandible from the Murchison River, Western Australia. Some of these teeth are in the author's collection and others in that of the W.A. Museum (61.11.19-21). A well-worn M_1 and two unworn and therefore unemerged molars indicate that at least two individuals, an adult and a sub-adult, were present.

MACROPODIDAE

MACROPODINAE

Macropus ocydromus Gould, 1842

Four right and four left I^3s (W.A.M. 61.11.4, 61.11.5, 61.11.71 and the author's collection) are this species.

Numerous molars and incisors and four premolars are *Macropus* and almost certainly this species on the association of the third incisors. The incisors represent at least four individuals. One badly eroded right mandibular ramus is an immature animal with M_1 unerupted. Material in the author's and W.A. Museum collections.

Protemnodon anak Owen, 1874

The following teeth are this species.

1. The anterior loph and cingulum of the crown of a right upper molar, almost certainly either the third or fourth. The fragment shows considerable occlusal wear, suggesting an aged* animal.

2. The antero-lateral part of the crown of an upper right permanent premolar (W.A.M. 61.11.58).

Identification of this material was made by comparison with fossil material from the Wellington Caves in New South Wales and the Mammoth Cave in Western Australia.

Published records of this species from W.A. are from three localities; Hastings' Cave, Jurien Bay (Lundelius, 1960; incorrectly referred to as Drovers' Cave); Quanbun Station, West Kimberley (Glauert, 1921a) and Balladonia, Eucla Division (Glauert, 1912b). There is no published record of this species from the Mammoth Cave. However in the W.A. Museum collection there is a right mandibular ramus and right maxilla of a sub-adult animal, labelled as collected from the Mammoth Cave by L. Glauert.

These two additional records extend the former range of the species into the south-west corner of the State.

* Aged is applied here to teeth in which occlusal wear has almost completely or completely destroyed major cusps. Individuals with this type of wear are assumed to have had their full complement of teeth and been of late adult age.

Protemnodon irma Jourdan, 1837

Nine molar crowns (all W.A.M. 61.11.56) compared well with modern material of *P. irma* and not with related species.

Protemnodon eugenii Desmarest, 1817

The crowns of two molars (W.A.M. 61.11.8 and 61.11.57) compared well with modern material of *P. eugenii* and not with related species.

Setonix brachyurus Quoy & Gaimard, 1830

This species is represented by the following teeth. Three left and three right P^4's (all in the author's collection). One right P_4 (in the author's collection). 28 crowns of molars and complete molars (W.A.M. 61.11.46 and the author's collection).

Potorous gilberti Gould, 1841

Represented by the following elements. Two fragments of left mandibular rami; one (W.A.M. 61.11.46) a sub-adult with Ms 1 & 2, the other (the author's collection) without teeth. One right ramus of an aged animal with Ms 3 & 4 missing (in the author's collection). Crowns of one left and one right P^4 (in the author's collection).

STHENURINAE

Sthenurus occidentalis Glauert, 1910

Fifteen incomplete teeth (in the author's collection and W.A.M. 61,11.10, 61.11.52; 61.11.53, 61.11.62, 61.11.63, 61.11.64, 61.11.68) have been compared with the type series of *S. occidentalis* in the W.A. Museum. They represent at least four individuals of the species.

PERAMELIDAE

Isoodon obesulus Shaw & Nodder, 1797

Represented by one right molar, either M^2 or M^3 (in the author's collection).

DISCUSSION

In the analysis of the data given in this paper it has been decided to follow the presentation adopted by Ride (1960: 76) in his treatment of a fossil mammalian fauna from the Wombeyan Caves, N.S.W. This seems the most satisfactory model to follow in descriptions of fossil faunas and aids comparison. The material is considered from the standpoint of the provenance of the bones and their mode of deposition, the zoogeographical and palaeoclimatic implications, and the age of the fauna.

Provenance of the Material and its Mode of Deposition

The mammalian and reptilian material has apparently been washed from its original site of deposition in the talus mound and transported along the stream where it is found for some distance in its bed; usually in pockets mixed with other sedimentary particles of similar size and density which have been sorted by the stream.

Transport of the material is further supported by polishing and some slight rounding of tooth enamel and the destruction of bone and dentine. This destruction of bone and dentine is almost certainly predominantly due to chemical action caused by prolonged immersion in running water, rather than abrasion. This is supported by well developed pitting in addition to rounding of bone.

TABLE I—RELATIVE ABUNDANCE OF INDIVIDUALS IN THE MATERIAL COLLECTED FROM THE STREAM BED OF STRONGS' CAVE, WESTERN AUSTRALIA.

Genera and species	Number of specimens	Minimum number of individuals
Carcharodon sp.	1	1
Trachysaurus rugosus	1	1
Nyctophilus timoriensis	1	1
Rattus sp.	3	3
Unidentified Muridae	6	4
Thylacinus cynocephalus	2	2
?Antechinus sp.	1	1
Sarcophilus harrisii	1	1
Cercaertus concinna	1	1
Nototherium mitchelli	9	2
Macropus ocydromus	71	4
Protemnodon anak	2	1
P. irma	9	1
P. eugenii	2	1
Setonix brachyurus	35	3
Potorous gilberti	5	2
Sthenurus occidentalis	15	4
Isoodon obesulus	1	1

As would be expected if the above is the case, a gradation can be seen from complete teeth and bone elements at the base of the talus pile to polished and rounded enamel fragments in the downstream sections.

The entrance to the cave is now effected through a narrow opening in the sides of a collapse dolina made up of limestone boulders which were once the roof of a larger cavern (Fig. 2, section AA).

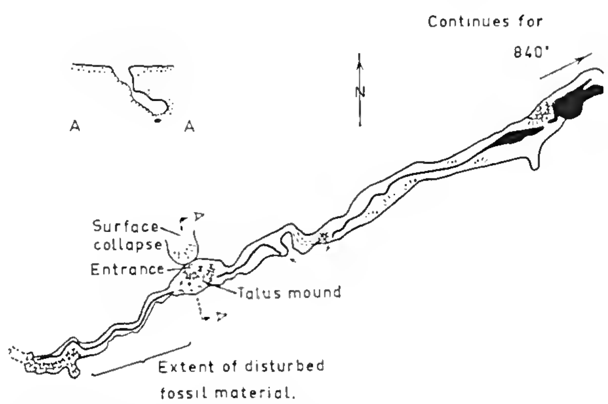

Fig. 2.—Plan and section of Strongs' Cave, Boranup, showing the source and extent of material described. Scale, 1 in. = 200 ft.

Prior to collapse of the roof there was apparently a wider entrance, no doubt a solution pipe, as these are common in the surrounding limestone and their remains can be seen in the boulders making up the dolina. Through this opening animals have fallen, leaving their remains over the surface of the talus beneath, which was accumulating through the additions of soil washed in and of rock falling from the ceiling. Eventually the cave reached a size where it could no longer support its roof and the resulting collapse sealed off entry to all but the smallest mammals.

For some time it was not known whether the provenance of the shark's teeth was the limestone in which the cave occurs, the talus mound, or a beach deposit* which outcrops in one section of the north-west wall of the downstream section of the cave.

A careful examination of all three provenances was made and shark's teeth were found in the sandy matrix of the beach deposit. These were the broken off tip of a tooth comparable with *Carcharodon*, together with two unidentified fragments of enamel, all polished and well rounded.

Zoogeography and Palaeoclimate

The material derived from the talus can be divided into four groups:—

1. Species which are extinct today, i.e., *Nototherium mitchelli, Protemnodon anak* and *Sthenurus occidentalis.*

2. Species which occurred in historic times but are now almost certainly absent from the area, i.e., *Setonix brachyurus* and *Potorous gilberti.*

3. Species which have existed in historic times in Tasmania, i.e., *Thylacinus cynocephalus* and *Sarcophilus harrisii.*

4. Species known to occur in the area at the present time, i.e., *Trachysaurus rugosus, Nyctophilus timoriensis, Cercaertus concinna, Macropus ocydromus, Protemnodon irma, P. eugenii* and *Isoodon obesulus.*

Certain conclusions are implied from the evidence of these groups.

1. The extinct forms are characteristic of Pleistocene deposits in many parts of Australia. Climatic conditions during this era are considered to have been more humid than at the present (reviewed by Gentilli, 1961).

2. Of those species which occurred in the area in historic times, *Setonix brachyurus* is now confined to small isolated pockets in swamps on the coastal plain of Western Australia as well as being

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* This deposit, which apparently lies at the base of the coastal limestone and on the crystalline basement, is made up of rounded boulders of gneiss (or banded granulite) up to 6 in. across, lying in a matrix of mainly well-rounded quartz grains and shell fragments. Occasional pieces of grey, spongy organic material occur, giving off a faint oily smell. The matrix is unconsolidated except for occasional pieces of flat, elongate limestone which occur in a band of yellowish, unconsolidated sand approximately ¼ in. thick. It is very similar in constituency to the Cowaramup Conglomerate, the basal member of the coastal limestone which rests unconformably on Pre-cambrian gneisses (or banded granulites) in the form of a beach plaster and outcrops on the coast (Kay, 1958). It is thought to be an older deposit than that outcropping on the coast, having formed when the sea-level was higher and the coastline was further east than now.

common on Rottnest and Bald Islands. *Potorous gilberti* is thought to be extinct, and was last collected by Gilbert in 1840 near Albany.

White (1952) has discussed the great decline of *S. brachyurus* on the mainland in the 1930s. That both species were common in comparatively recent times is further supported by the large quantity of remains found as superficial deposits in many of the caves in the south-west of the State. The reason for this apparent sudden decline is not clear, but may be due to the effects of European colonization, climatic change, disease or combinations of these. The effects of colonization have no doubt assisted faunal changes but in the case of *S. brachyurus* are not likely to have caused such a radical change in a short period, over 100 years after colonization began.

Rainfall fluctuations, not necessarily significant, have been noted by Gentilli (1951) in south-west Western Australia since records began in 1877; notably a decreasing summer rainfall with increasing winter rainfall. Again while such a change could be expected to initiate faunal changes, it has been small and gradual and a similar small and gradual faunal change would be expected.

The sudden effects of a fatal epidemic disease would seem to be a more likely cause for such a change in population levels.

No conclusions as to past climate are therefore warranted on the evidence of these two species.

3. The occurrence of *Sarcophilus harrisii* and *Thylacinus cynocephalus* may act as a climatic indicator. Both species occur today only in Tasmania, an area of high humidity which suggests itself as a necessary factor for their persistence. However, the possibility of other factors such as disease and competition with the Dingo must not be overlooked.

The fact that both species occur today in Tasmania seems to furnish further evidence that high humidity is a necessary factor for their existence.

The Age of the Fauna

An absolute age determination of this deposit has not been attempted for two reasons:—

1. There is insufficient collected skeletal material for a determination. If available, the material would not necessarily be contemporary and in most cases could not afford to be destroyed.

2. Because the material is not *in situ*, contemporary charcoal cannot be used instead.

A C14 date will only be warranted if and when a detailed excavation of the deposit in the talus mound is carried out.

A useful comparison can be made between this fauna and that from the nearby Mammoth Cave (see Table II) which has been dated at its upper level at greater than 37,000 B.P. (Lundelius, 1960) and is therefore at least as old as Upper Pleistocene.

Six of the nine extinct forms from Mammoth Cave have not yet been found in Strongs' Cave, which suggests that they may have already become extinct and the deposit therefore represents a more recent time. However, it seems from an examination of the W.A.

Museum material from Mammoth Cave that all six species were poorly represented and their absence so far from Strongs' Cave may purely be a reflection of low sampling there.

TABLE II—FAUNAL LIST FROM MAMMOTH CAVE BASED ON LUNDELIUS (1960) WITH MODIFICATIONS AND AN ADDITION BY THE PRESENT AUTHOR.

*Phascolomys hacketti Glauert
*P. parvus (Owen)
*Nototherium mitchelli Owen
†Phascolarctos cinereus (Goldfuss)
*Thylacoleo carnifex Owen
*Macropus magister (De Vis)
M. cangaru (Muller) (= M. ocydromus Gould, in this paper)
*Zaglossus hacketti Glauert
*Sthenurus occidentalis Glauert
†Sarcophilus harrisii (Boitard)
†Thylacinus cynocephalus (Harris)
Protemnodon irma (Jourdan)
*P. anak Owen
Setonix brachyurus (Quoy & Gaimard)
Trichosurus vulpecula (Kerr)
Pseudocheirus occidentalis (Thomas)
*Potorous gilberti (Gould)
Phascogale tapaotafa (Meyer)
Dasyurus geoffroyi (Gould)
Isoodon obesulus (Shaw & Nodder)
Macrotis lagotis (Reid)
Tachyglossus aculeatus (Shaw)
*Palorchestes sp.
Sminthopsis sp.
Rattus fuscipes (Waterhouse)

The conclusion then is that comparison of the Strongs' Cave fauna with the Mammoth Cave fauna and recent faunas, together with palaeoclimatic considerations, suggests that the deposit is Pleistocene in age. A slender argument can be brought forward that it is later than the Mammoth Cave fauna and extends in age to Recent or sub-modern times.

General Considerations

Pits such as the one into which the fauna of Strongs' Cave must have fallen before the final roof collapse, may be very efficient mechanisms for the sampling of past faunas. If this is the case very significant population studies could be made of past successive faunas. Unfortunately, at present it is impossible to determine with certainty the success of such a mechanism; the different habits of the species would seem to be enough in themselves to bring about variations in the sampling which are not a true reflection of the actual fauna.

Variation within a species may be well represented providing that individuals of the same age are used. Relative-age population studies will probably be unreliable due to the differing habits of individuals of different age within a single species and the tendency for poor preservation of juvenile elements. Both these factors will establish a sampling bias.

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*Extinct.
†Extinct in W.A.

The sample described in this paper should not therefore be treated as a true representation of the surface fauna during the period of deposition.

Further detailed study of this deposit in the region of the talus mound will no doubt result in a larger and more complete sample on which to base population studies.

ACKNOWLEDGMENTS

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NOTES ON THE BIOLOGY OF *NOTADEN NICHOLLSI* PARKER (ANURA; LEPTODACTYLIDAE)

By P. SLATER and A. R. MAIN.

Little is known of the biology of the frog *Notaden nichollsi* Parker, and the larva is undescribed. In November 1961 the present authors were able to dig from their burrows adult *Notaden nichollsi*. During the summer of 1962 one of us (P.S.) collected larvae of the same species. The information obtained is presented below and the larva described.

NON-BREEDING ADULTS

On November 3, 1961, two individuals were dug from burrows in sand, 14 miles south-east of Derby. The area was a sparse *Eucalyptus* woodland with an understorey of *Acacia*, spinifex *(Triodia)* and other grasses (see Fig. 1). Much of the soil was visible. Burrows were readily located by walking over the area where the raised rim and loosely filled central crater of the burrow could be seen. By excavating a hole adjacent to the burrow the loose fill of the burrow was permitted to run out. The excavation was continued until the aestivating frog was exposed.

Three burrows were excavated; one yielded no frog at 68 inches in depth. Two others in a site where about 18 inches of soil had been removed by a bulldozer contained frogs at 44 inches. These last two holes also each contained an individual of *Glauertia mjobergi* (Anderson). The burrows were 1.5 inches in diameter and vertical. Those containing frogs were dry to 24 inches and then moist to the bottom. Soil temperatures were taken with a Schultheis

Fig. 1.—Habitat of *Notaden nichollsi*.

—Photo A. R Main

thermometer; the top 4 inches were 36.5° C. *Glauertia mjobergi* were found at 29 and 35 inches where the temperature had fallen to 33.6° C. This was the temperature of the frogs at the bottom of the burrows.

LIFE HISTORY

Breeding

Egg masses have not been seen. However one adult female collected by Ealey (Ealey and Main, 1960) had fully developed ovarian eggs which were 1.3 mm. in diameter. The animal pole was black and yolk white. The size of the eggs and pigmentation are typical of frogs which lay eggs in water. It is not possible to suggest the nature of the egg mass. No precise date of spawning is known. Mature specimens appear in numbers during the first heavy rains which suggest that this is the time of spawning. During 1962 mid-January would be the earliest possible spawning time.

Larvae

A total of 16 larvae as well as some freshly metamorphosed frogs and rather large juveniles were collected at Munkayarra, 15 miles south-east of Derby, on March 11, 1962. The locality is situated in a flat valley 200 yards wide between two tree-covered sand ridges. General conditions are as shown in Fig. 1. Non-aquatic grasses are common and are partly submerged after rain which forms pools about 4 to 12 inches in depth. These vary in size from a few square feet to half an acre and are connected by a slow running stream seldom more than an inch in depth. The stream empties into Munkayarra swamp where only *Cyclorana dahli* were collected.

The temperature of the water varied from 26° C in shaded portions to 34° C. The running water was 34° C. The stream and most of the pools were dry two weeks after specimens were collected.

The 16 larvae obtained were staged from Gosner (1960) with the result shown in Table 1.

TABLE I—STAGES AND SIZES OF 16 LARVAE OF NOTADEN NICHOLLSI PARKER, COLLECTED NEAR DERBY, MARCH 1962.

	Stages (Gosner, 1960)						
	37	38	39	40	41	42	43
Number of specimens	4	4	3	1	1	1	2
Body length in mm.	12.4*	13.4* (mean)	13.1* (mean)	13.9	14.4	13.3	15*
Tail length in mm.	16.6*	18.4*	18.4*	damaged	19.2	16.8	—
Ratio Body : Tail	1.35	1.37	1.4		1.33		

*Mean of measurements of all larvae at this stage.

Description of larvae

Body oval, sides tend to be parallel. Spiraculum opens in the lower half of body, not visible from above. Opening of spiraculum slightly oblique to almost horizontal. Aperture not constricted and closely applied to body. Anus on median tube and not constricted.

Eyes oblique. Large triangular papillae across bottom of mouth. Small papillae around corners of mouth. Teeth in $\dfrac{\overset{1}{2\quad 2}}{\underset{1}{2\quad 2}}$ arrangement, the outermost lower row about $\frac{3}{4}$ length of preceding row. The dorsal skin of body is smooth and lightly mottled until stage 41 when the warts and adult colouration appear. There is a broken pale mid-dorsal line in most tadpoles. Tail is heavily pigmented, dorsal crest mottled, ventral crest clear for first half then posterior part mottled. Depth of tail, including crests from slightly less to not much more than depth of body.

The freshly metamorphosed frogs are 13-14 mm. long and have the colouration and skin pattern of adults.

The larvae of *Notaden* are small (33-34 mm. total length) when compared with the larvae of *Cyclorana platycephalus* (the water holding frog) (70 mm. total length) whose adult is of comparable size to adult *Notaden*.

Cyclorana platycephalus larvae may take 40 days to metamorphosis. The smaller froglet of *Notaden nichollsi* may require an even shorter period, which would be an adaptation to the ephemeral waters in which the species breeds.

DISCUSSION

Despite the absence of information there have been in the past several conjectures regarding the type of larval life. Fletcher (1889: 360) after discussing species of *Pseudophryne* which do not oviposit in water says: "Other Australian frogs, more particularly *Myobatrachus gouldii* (sp) from West, and *Notaden bennetti* Gthr., from East Australia, perhaps also *Heleioporus albopunctatus* Gr., may be expected to exhibit similar or perhaps more interesting modifications." Later (*op. cit.*, p. 361), after discussing low mean annual number of rainy days as well as the low average annual rainfall of areas of inland New South Wales from which *Notaden bennetti* was known, Fletcher concludes: "Hence in such a locality as this the frogs must sometimes be in great straits to get rid of their ova, if oviposition is of the ordinary character; and the young must often develop under difficulties unless there is some adaptation to circumstances."

Main *et al.* (1959) suggest that only three species of Western Australian frogs lack an aquatic larval life, namely *Crinia rosea* Harrison, *Metacrinia nichollsi* (Harrison) and *Myobatrachus gouldii*.

These authors point out that the foregoing species all occupy the region of reliable rainfall and none occupy arid regions. In their summary Main *et al.* list aquatic embryonic and larval life, opportunistic breeding, short larval life, larval tolerance of high water temperatures, and finally efficient adult burrowing as characters which allow successful occupation of Australian deserts. Thus these authors envisage different specialisations from those anticipated by Fletcher. In the absence of a precise spawning date it is not possible to assert that larval development of *Notaden nichollsi* is rapid though the small size of the metamorphosing froglet suggest that this is so. However, all the other information on the biology of *Notaden nichollsi* supports the inference of Main *et al.* that successful desert frogs have aquatic larval life and are tolerant of high temperatures at all stages of their life history.

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STATUS AND DISTRIBUTION OF SOME SPECIES OF OWLS IN WESTERN AUSTRALIA

By G. F. MEES, Western Australian Museum, Perth.

In the second edition of Serventy & Whittell's *Birds of Western Australia* (1951), the ranges of four of the species of owls occurring in the area dealt with are given as "state wide." About two years ago, in connection with a revision of the Australian owls, I began to examine museum material and published records of the four species concerned, and came to some rather unexpected conclusions as regards status and distribution.

Though full particulars will be published in my forthcoming revision, it may be useful to present the data hitherto assembled on Western Australia, in particular with a view to encouraging publication of field observations.

Boobook Owl, *Ninox novaeseelandiae*

The Boobook Owl has rightly been regarded as state wide in distribution; it inhabits both the forest areas of the South-West and Kimberleys and the most arid parts of the interior. It is fairly common throughout its range.

Winking Owl (Barking Owl), *Ninox connivens*

Of this species, originally I did not find any record outside the forested South-West and the Kimberley Division. At my request Dr.

Serventy went through his notes, and he also was unable to discover any evidence of the occurrence of the species in the huge intervening area. He amended the range accordingly in the third edition (Serventy & Whittell, 1962). Subsequently, however, I found a specimen from the De Grey River in the collection of the American Museum of Natural History, New York (collected by K. G. Buller), and one from the Ashburton River in the H. L. White Collection, National Museum of Victoria, Melbourne (collector not mentioned on the label, but specimen received from A. G. Campbell), so that the North-West of the state can be added to the range of the species.

Birds from the northern and the southern parts of the state are not identical. In the South-West, large and very grey individuals occur: the race *N. connivens connivens*. The Kimberley population averages slightly smaller, and can be distinguished by being brown in coloration rather than grey: the race *N. connivens occidentalis*. The two specimens from the North-West are identical with Kimberley skins.

While, judging from collected material, the species is not uncommon in the Kimberley Division, it seems to be very rare in the North-West and in the South-West. The Western Australian Museum, which has now been in existence for seventy years, has only three specimens from the South-West, a female from Herdsman's Lake, May 8, 1902, an individual of undetermined sex from Chillinup near Borden, July 1928, and a mounted female from Katanning, 1897, on display. In collections all over the world I have not managed to find more than six specimens altogether (these provided the additional localities: "Swan River," Lake Muir, and Stirling Ranges). Likewise, in the volumes of the *W.A. Naturalist* not a single observation has been published. However, in January 1963 a wing of an individual of this species was sent in by Mr. G. A. Lodge, of Boyup Brook, who found it dead on his property, and in view of the difficulty of observing nocturnal birds, the species may well be more common than the few published observations suggest.

At present it looks as if in Western Australia the Winking Owl is confined to the areas of forest and woodland savannah. There is a possibility that it ranges more widely than here indicated and that the lack of records from some areas is due to its general scarcity, but I regard this as unlikely.

Barn Owl, *Tyto alba*

The Barn Owl is state wide in distribution, though it seems to be rare in the heavy forest belt of the extreme South-West. Further discussion of its status follows below.

Masked Owl, *Tyto novaehollandiae*

Published notes as well as museum material show that the Masked Owl is strictly confined to the South-West, the extreme South-East (Nullarbor Plain), and the Kimberley Division, with one awkward exception discussed below.

Serventy & Whittell (1951, 1962) give the distribution of both Barn Owl and Masked Owl as state wide and mention that according to specimens received at the Western Australian Museum since 1920, the Barn Owl outnumbers the Masked Owl by ten to one. A superficial examination of the museum collection would seem to confirm this, for there are over thirty skins of Barn Owls, as against only nine skins and two mounted individuals of Masked Owls. It may be mentioned that not all the Barn Owl specimens received at the Museum have been retained as study skins.

Closer scrutiny, however, reveals an interesting fact. The localities from which there are Barn Owls in the collection are the following: Albany, Baandee, Belmont, Beneubbin, Bridgetown, Bruce Rock, Burnerbinmah Station via Yalgoo, Canning Stock Route at Well 48, Coodingnew Station via Wiluna, Cunderdin, Katanning, Kurramia, Leederville, Leonora, Maylands, Merredin, Nalya, Northam, Perth, Pippingarra near Port Hedland, Pithara, Three Rivers Station on the Murchison, Wagerup, Woolonara. Localities for Masked Owls are: Albany, Beverley, Boyup Brook, Herdsman's Lake, Monger's Lake, Pinjarra, Tingellup (near Mt. Barker), Victoria Park, Wotjulum Mission (Kimberley Division), Yandil Station via Wiluna, Yealering. These locality records show that the Barn Owl is widely distributed. It is common in the wheat belt and is also the commoner of the two species in the Perth area. But when only the forested South-West is considered, the Masked Owl outnumbers the Barn Owl, the former being represented by five skins, the latter by two (Bridgetown, Wagerup). In the Serventy-Whittell collection are two skins of the Masked Owl from Bridgetown as against only one Barn Owl. As Dr. Serventy has pointed out to me, however, this sample may be biased, as Major Whittell would have regarded the Barn Owl as more common than the Masked Owl, and therefore was more likely to prepare specimens of the latter brought in to him, than of the former; nevertheless, it may be significant, especially as Whittell & Serventy (1948) were already aware that the Barn Owl is not common in the South-West. Information supplied by Mr. A. D. Jones of Manjimup, who over the years has inadvertently caught a number of owls in rabbit traps, is that these always were Masked Owls, and previously Carter (1923) regarded the Masked Owl as common, the Barn Owl as very rare in the extreme South-West.

For years the Masked Owl has been known from the Nullarbor Plain in South Australia, where it inhabits caves, and in 1962 Mr. D. L. Cook found the desiccated but recent remains of an individual in the Murra-el-ellevan Cave near Cocklebiddy, thus extending the range of the Nullarbor population into Western Australia. The occurrence in a habitat so different from that in which the species is found elsewhere, is of considerable interest. Cayley (1931, p. 32) based on a specimen from Ooldea, Nullarbor Plain, the name *troughtoni*, thought to represent a distinct form which in literature has subsequently been referred to as the Cave Owl, but I cannot confirm this.

Summarising it may be said that, on evidence at present available, the Barn Owl is a bird of the more open country, which has probably recently followed settlement in the South-West; and that the Masked Owl is mainly an inhabitant of heavy forest and (in the

Kimberley Division) woodland savannah, which in the southern part of the state is confined to the lower South-West, where it outnumbers the Barn Owl, and the Nullarbor Plain.

The bird marked as coming from Yandil Station via Wiluna now needs attention. It was received from a Mr. A. G. Paterson and registered in August, 1924. Speaking from experience, I would say that there is a distinct possibility that Yandil Station is not the place where the owl was obtained (in those years it would have been difficult to forward a specimen from that area to Perth in a fresh condition), but was the address of its donor, who may have picked it up anywhere in the South-West and, on being asked where he lived when he handed it in to the museum, of course replied Yandil Station. On the other hand, in view of the occurrence of the Masked Owl in caves on the Nullarbor Plain, there is a possibility that the absence of records in interior Western Australia is due to its being rare rather than absent. It is also uncertain whether the distribution along the south coast is continuous. Only further observing can bring a solution.

A few characters for the identification of the four owls discussed in this paper may be given. The Winking Owl of the South-West differs from the Boobook Owl, besides in its larger size, by being essentially a grey bird. The Boobook Owl of the South-West is earth brown on the back, and rufous brown on the under surface. The Barn Owl and the Masked Owl differ in size, which, however, would not always be easy to judge in the field, and clearly in the colour and pattern of the back, which is rather smooth light grey, with a little bit of orange-yellow, in the Barn Owl, and boldly variegated blackish-grey and buffish yellow in the Masked Owl. The difference in appearance of the facial disc, described and illustrated by Serventy & Whittell, is not always clear and would be of doubtful value in the field.

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CORRECTIONS TO TYPE LOCALITIES OF THREE SPECIES OF WESTERN AUSTRALIAN *STIGMODERA* (BUPRESTIDAE, COLEOPTERA)

By S. BARKER, Canberra, and D. H. EDWARD, Department of Zoology, University of Western Australia.

Stigmodera (Castiarina) magnetica and *S. (C.) radians* were described by Carter (1933) with type localities Mount Magnet and Wembley, Western Australia, respectively, from two specimens of each given to him by H. W. Brown. The first specimens of *S. magnetica* were collected at Mudurup Rocks, Cottesloe, by L. Glauert who described their capture and subsequent examination by Brown (Glauert, 1948). Brown later forwarded specimens to Carter, but it is not known whether these specimens were Glauert's original ones or others collected subsequently.

The allotype of *S. magnetica* (identified by a red square of paper on the pin) which is in the Australian National Insect Collection in Canberra bears the following label "♀ Mt. Magnet W.A. H. W. Brown" (no date). The paratype of *S. radians* (identified by a blue square of paper on the pin) in the same collection bears the label "Wembley H. W. Brown" (no date). The handwriting on both labels is H. J. Carter's. The sex of the holotype of *S. radians* was not stated by Carter (1933) and the sex of the paratype in the A.N.I.C. has not been determined. The holotypes of *S. magnetica* and *S. radians* are not in the first Carter collection in the National Museum, Melbourne, and have not been located.

In recent years Barker, McMillan and Watson (1956) and Barker, Edward and Watson (1960) have found that a *Stigmodera* agreeing with Carter's description of *magnetica* and with the allotype, is a common beetle always associated with the coastal sand dune shrub, *Myoporum insulare* R. Br. Extensive collecting in other parts of Western Australia has not revealed *S. magnetica* in any other situation. The only specimens of *S. radians* examined by us were collected at Wialki and Wurarga, semi-arid inland country areas.

It seems certain that Brown's original labels on the type specimens were accidentally transposed by Carter. Glauert (1948) states that the specific name *magnetica* is "a misnomer owing to the transposition of the label with that of another specimen from Mount Magnet forwarded to him (Carter) at the same time." Presumably Brown collected further specimens of *S. magnetica* from Wembley and sent them to Carter, or possibly forwarded some of Glauert's original specimens from Cottesloe, under his own name, giving a collection locality other than Cottesloe. In Carter's paper Cottesloe does not appear as the type locality of any of the six new species of Western Australian *Stigmodera* described, five of which were collected by H. W. Brown, and none of the type localities of the other four species described in that paper are obviously incorrect.

We believe therefore that the labels on the type specimens were transposed, presumably by Carter when he relabelled them and discarded Brown's labels, and we hereby amend the type locality of *S. (C.) magnetica* to Wembley, Western Australia, and that of *S. (C.) radians* to Mount Magnet, Western Australia.

Stigmodera (Castiarina) booanyia Carter (emendation of *S. (C.) booyania* Carter). This species was described from a unique type by Carter (1933) who gave the type locality as Western Australia: Booyana, Norseman district. Carter's spelling is incorrect as the only locality with a similar name in the district referred to is

Booanya, a large granite outcrop in Lat. 32° 45′ S., Long. 123° 36′ E. The collector's name, given as "Miss A. E. Baisiou" is also incorrectly spelt and should be "Miss A. E. Baesjou" (now Mrs. Crocker of Balladonia, via Norseman) who was the only local insect collector and formerly resided at Booanya.

The spelling of the type locality is therefore hereby amended to Booanya (called Booanya Rock on Esperance, Western Australia, Australian Geographical Series 1 : 1,000,000 map, Department of National Development 1st edition 1958. Printed by the Royal Australian Survey Corps). Although it is not stated by Carter it is obvious that the specific name *booyania* is based on his incorrect spelling of the type locality. We consider this an "inadvertent error" in the sense of Article 32 (a) (ii) of the International Code of Zoological Nomenclature (1961). Under Article 32 (c) of the Code, an "inadvertent error" must be corrected. We therefore emend the name to *booanyia*.

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FROM FIELD AND STUDY

Second Record of the Little Pineapple Fish *(Sorosichthys ananassa* Whitley).—This species was known previously from the unique holotype trawled between Bald Island and Haul Off Rock, east of Albany, W.A., by the Government trawler *Penguin* in 1920 and described by Whitley (*Aust. Zool.*, 11, 1945: 22). Another specimen was recently collected by the skipper of the fishing boat *Ross Australia,* Mr. R. Poole, and forwarded to this Department for identification. It was taken 35 miles west of Mandurah, inside a crayfishing pot set in about 24 fathoms, on January 24, 1963.

The holotype (W.A. Mus. reg. no. P. 734), 52 mm. in standard length, was examined and Whitley's description confirmed, except that counts of 9 to 9½ anal rays were made instead of 8 as Whitley records.

The recent specimen (W.A. Mus. reg. no. P. 5506), measuring 61 mm. in standard length, 72 mm. in total length, agrees for the most part with Whitley's description, but shows variation in body proportions and scale counts.

Body proportions and scale counts are given. Those of the holotype are in brackets:—

Head 2.7 (2.7), depth 2.2 (2.4) in standard length. Eye 3.1 (2.7), snout 5.5 (4.7), least depth of caudal peduncle 3.1 (3.5) in head. Interorbital 2.2 (2.4), maxillary 1.6 (1.6), pectoral fin 2.4 (2.4) in head. Scales in lateral line 27 (27). Scales anterior to ventral fins 8 (about 15). Abdominal scutes 8 (12). About 5 to 6 predorsal scales (about 8). Anal rays 9 (9½).

—R. J. McKAY, W.A. State Fisheries Department.

Little Pied Cormorant Nesting on Islands on the West Coast.—During a survey of the islands to the north of Jurien Bay in May 1961, one of us (J.R.F.) found several solitary cormorant nests on limestone ledges on Snag Island, Drummond Rock and Milligan Islet. These were tentatively attributed to the Pied Cormorant *(Phalacrocorax varius)* although this species usually breeds in crowded colonies on the main plateau of the island or on the gently sloping sides, the nests being built on the tops of low bushes such as *Nitraria schoberi.*

The identity of these nests was subsequently ascertained during another survey on September 3, 1961, when we found a Little Pied Cormorant *(P. melanoleucos)* incubating a clutch of five eggs in a nest situated on a shelf under a limestone cliff on the north-east side of Webb Islet. The individual was flushed from the nest in order to compare its size with the Pied Cormorant, a number of which were nesting on and flying over the island, and an egg was removed to substantiate the identification. A cross-section of the limestone cliff illustrating the position of the nest was drawn and is herewith reproduced.

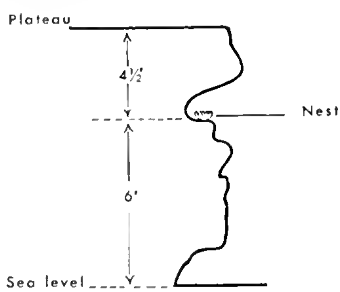

Diagram illustrating position of nest of little Pied Cormorant

In the South-West, the Little Pied Cormorant usually constructs its nest, a platform of sticks, in a tree growing in a swamp in water (D. L. Serventy and H. M. Whittell, *The Birds of Western Australia*, 1962; 113). W. R. B. Oliver (*New Zealand Birds*, 1955; 202-6) states that the species usually selects trees overhanging the water in rivers, estuaries, sheltered inlets and on small outlying islands. The species also nests in mangroves along the coast. K. A. Hindwood and A. R. McGill (*The Birds of Sydney*, 1958, 28) list it as having nested in such situations at Botany Bay, and P. Fuller (*pers. comm.*) informs us that it regularly nests in the mangroves near Carnarvon.

—J. R. FORD, E. H. and L. SEDGWICK.

Southward Extension of the Range of the Blue-and-White Wren and the Crested Bell-bird.—In their paper, "The Birds of the Moore River Gorge Country" (*W.A. Nat.*, 3, 1952: 107), W. H. Loaring and D. L. Serventy remarked that the status of the Blue-and-White Wren (*Malurus leuconotus*) appeared to have remained unchanged in the area since the earlier survey of F. L. Whitlock in 1903, though this species had made a notable advance southward nearer the coast. The Crested Bell-bird (*Oreoica gutturalis*) was mentioned in the list of species which have pushed farther into the South-West since 1903 or have increased in abundance, on the basis of Whitlock's assessment. In *Birds of Western Australia* (Serventy & Whittell, 3rd edn., 1962) the distribution of the Blue-and-White Wren is given as southwards to a line joining Mogumber, Corrigin and Norseman, with a broken distribution on the coastal plain south to Perth. Of the Crested Bell-bird these authors state that although it is not usually found in the South-West corner, south and west of Mogumber and the Great Southern Railway, in 1954 the species was observed at Beermullah, and in August 1957 H. A. Atkinson and J. R. Ford recorded it six miles north of Yanchep.

On October 18, 1962, following the report of an unknown bird from Mr. Graham Alcorn, I visited an area 1½ miles south-west of the southern end of Lake Pinjar, about 5½ miles eastwards in a direct line from the coast. Here I saw a small party of Blue-and-White Wrens—a male in full plumage and two or three brown birds. The country had been cleared by the Forestry Department for a pine plantation and was fundamentally sandplain with dead stumps and low shrubs.

On November 23, 1962, I visited the area again, still on the trail of the bird described by Mr. Alcorn, and this time I found a Crested Bell-bird, a male in full song, which was almost certainly the unknown bird.

Dr. D. L. Serventy informs me that in 1960 Mr. R. H. Taylor of Kalamunda saw a male Crested Bell-bird one mile north of the Gnangara pine plantation, that is about 8 miles further south-west again.

These records are the furthest south of the Crested Bell-bird, and the furthest inland observation of the Blue-and-White Wren along the coastal strip (apart from the estuarine occurrences along the Swan River), and are indicative of an expansion of range. It would be interesting to find out what is happening in the area south and south-west of Mogumber. It would appear that like the Crested Pigeon *(Ocyphaps lophotes)* and other species mentioned by Serventy & Whittell *(ibid.,* p. 60) these Eyrean species are steadily advancing into the South-West corner.

D. A. ROOK, Nedlands.

Wire Nests of Magpies.—Magpie nests constructed largely of pieces of wire are not infrequently reported and two Western Australian examples have been described in some detail (C. S. Hamilton, *Gould League Notes,* 1949-50: 25; D. L. Serventy, *W.A. Nat.,* 2, 1949: 46). It may be of interest to provide details of two other such nests which I have recently examined.

Nest no. 1: Constructed of wire, twigs, dried and denuded buffalo grass runners, and fine rootlets. There were 73 pieces of wire and they varied in length from 5 in. to 7 ft. 2 in. Most of the wire was less than 2.0 mm. in thickness but a few pieces were between 2.0 and 3.0 mm., and one 25 in. length of clothesline wire weighed 40.5 gm. One piece of wire 3 ft. 4 in. long had the ends joined and was in the approximate shape of a square. There were several lengths of plastic insulated wire, in red, yellow, white and brown colours, and rubber insulated wire in black and red colours. Interlaced with the wire were 14 twigs of varying thickness. The largest was 15 in. and the shortest was 7 in. The 134 pieces of buffalo grass varied from 5 in. in length to 6 ft. 2 in. in length and were woven in the shape of a circular bowl. Entwined with the grass were 10 thin twigs between 6 and 12 in. long. Approximately 100 small pieces of very fine rootlets and one small piece of bark furnished the lining to the nest. Lengths of wire joined or twisted together have been counted as one. The nest had been built in 1962 in a eucalypt growing in a park at Claremont.

Nest no. 2: Constructed of wire, rope, leaves and dried grass. The wire, which was of various thicknesses and lengths, weighed a total of 4.14 kilograms. There was a total of 321 pieces of wire, particulars of which are as follows:—

(a) wire 1.0 to 2.0 mm. thick—129 pieces. The longest piece was 7 ft. and the shortest 3 in.

(b) wire 2.0 to 2.5 mm. thick—47 pieces. The longest piece was 28 in. and the shortest 3.5 in.

(c) wire 2.5 to 3.0 mm. thick—136 lengths. The longest piece was 31 in. and the shortest 4 in.

(d) wire 3.0 to 3.5 mm. thick—3 pieces, the longest being 18 in. and the shortest 10.5 in.

(e) wire 3.5 to 4.0 mm. thick—4 pieces. The longest which weighed 33.5 gm., was 18 in. and the shortest 15.5 in.

(f) one piece of barbed fencing wire 16 in. in length.

(g) one piece of three-strand wire 18 in. in length.

Any two pieces of wire joined or twisted together have been counted as one and the wire was measured as it came from the nest —it was not straightened out. Included in the wire framework were two twigs 6 in. long and ¼ in. thick.

A short length of rope, which was very frayed and mostly in single strands, a few eucalyptus leaves, two white feathers and a handful of dried grass furnished the lining to the nest. This nest was found in a eucalypt in 1960 on the Dale River, 12 miles west of Brookton.

— R. H. STRANGER, Wembley.

OBITUARY

BRUCE W. LEAKE

Bruce Wyborn Leake, a foundation member of the W.A. Naturalists' Club, and a noted Kellerberrin naturalist, died in Perth on July 22, 1962. He was born at Cobham, York, on June 11, 1880, son of Robert Buck Leake, who pioneered the family's Kellerberrin properties by settling at Mooranoppin in 1868. Bruce Leake lived at "Cardonia," Woolundra, near Kellerberrin, where he established a merino stud. He carried on active farming until 1960 when he retired to live at Mt. Lawley.

Bruce W. Leake, 1921

Though he was a keen field naturalist, and he was a foundation member of the Royal Australasian Ornithologists' Union as well as of the Naturalists' Club, these farming activities took an increasingly large part of his time and he was compelled to allow his membership to lapse. During his ornithologically active period several visiting naturalists called on him at "Cardonia." The ornithologist Tom Carter stayed there on several occasions (including January 1903, May 1919 and March 1922) and collected bird specimens. At the close of the first R.A.O.U. congress in W.A., in October 1920,

W. H. D. Le Souef and A. J. Campbell spent a weekend at "Cardonia." Later visitors included Edwin Ashby (during the R.A.O.U. congress of 1927) and Major H. M. Whittell. These ornithologists were all driven around the neighbourhood in his buggy and pair, as Bruce Leake did not acquire a motor car until 1934.

He formed a collection of local birds' eggs and added to it a collection of British eggs obtained from Mr R. Trickett, of Coolup. This collection is still at "Cardonia" in the care of his son, Mr. Frank H. Leake.

Though he published little in scientific journals he contributed important articles in Perth weeklies, and some of these, summarising the fluctuations in the local fauna, were based not only on his own but on his father's records. His most important personal achievement was the hatching of Mallee Fowls' eggs in an artificial mound he constructed in an enclosure at his home, transferring eggs to it as they were laid in a mound in the bush. The experiment succeeded and the young were reared. Besides formal articles he contributed natural history items to the "Mutual Help" section of the *Western Mail*, conducted by the agricultural editor, H. Catton Grasby.

Publications by Bruce Leake include:

1921. The Dingo. Methods of Trapping and Poisoning, Observations on its Life and Habits. *Bull. Dept. of Agric. W.A.*, 94: 19 pp.

1921. Black-breasted Plover and Young. *Emu*, 21 (2), October: 148-149.

1927. The Mallee Fowl or Gnow (Leipoa Ocellata). *The Western Mail* (Perth), May 5: 39-40; photos [on this article was based a paper by E. Ashby, "Notes on the unique methods of nidification of the Australian Mallee-Fowl *(Leipoa ocellata)* with original data supplied by Bruce W. Leake, R.A.O.U.," *Auk*, 46 (3), July, 1929: 294-305].

1929. Pioneers of Kellerberrin. The Death of Edward Clarkson. *The Eastern Recorder* (Kellerberrin), August 16.

1939. Dry Cycles have been Frequent. *Westralian Farmers' Gazette* (Perth), November 10 [describes variations in the seasons since 1860 and fluctuations in the abundance of various animals].

1950. Pastoral Pioneers of the Eastern Wheatbelt. *Western Mail* (Perth), August 17: 20-21 (with map); August 24.

1951. Eastern Wheatbelt Wildlife. (1). *Western Mail*, June 14: 63. (2), June 21: 63, 69. (3), June 28: 63. (4), July 5 [an important record of the fluctuations and changes of status of mammals in the Kellerberrin district since white settlement].

1952. Birds of the Eastern Wheatbelt (1). *Western Mail*, May 22: 55, 61. (2), May 29: 55. (3), June 5: 55, 65. (4), June 12: 52, 53 [a similar record of the fluctuations of the birdlife in the district].

1961. *Reminiscences.* Privately published [includes a general account of the natural history and of the native people of the Kellerberrin district; the 1927 article on the Mallee Fowl is reproduced in full].

1963. *Eastern Wheatbelt Wildlife.* Privately published [deals more specifically with the natural history of the district].

—D.L.S.

THE WESTERN AUSTRALIAN

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DISPERSAL AND MORTALITY IN THE PIED CORMORANT IN WESTERN AUSTRALIA

By JULIAN FORD, Attadale.

A ringing programme on the Pied Cormorant, *Phalacrocorax varius* (Gmelin), was commenced in Western Australia in 1960 for the purpose of obtaining information on its movements and seasonal mortality. The results of this investigation on these hitherto little known aspects of the life history of the species form the basis of this contribution.

METHODS

Twenty-four recoveries from 100 Pied Cormorants ringed as nestlings on Middle Shag Island, in Shoalwater Bay, on July 3, 1960, and six recoveries from 200 nestlings ringed on East Beagle Island, 39 miles south of Port Denison, on May 26, 1961, are analysed. The birds were ringed with C.S.I.R.O. aluminium bands ovalised so as to fit neatly around the tarsus.

MOVEMENTS

Dispersal from Shag Island

Within two months of being banded, Shag Island cormorants were recovered at the Mandurah estuary and Peel Inlet, where 11 recoveries were made during the first year (see Fig. 1), mostly in the August/November period (see Fig. 2). Three recoveries within the first year were also obtained from the vicinity of Fremantle and the Swan River estuary. These band returns (14% of the total banded and 58.3% of the total recovered) indicate that a good number of young Pied Cormorants fledged at Shoalwater Bay move into the fairly sheltered waters near Perth and Mandurah.

Some first-year birds undertook relatively long movements both north and south of Shag Island, the limits being 215 miles north to Port Denison and 140 miles south to Manjimup. There were 4 (16.7% of the total recovered) such returns.

Second-year recoveries (5% of the total recovered) were all within 25 miles of Shag Island. Two were from the Harvey estuary and two from the Swan River estuary, both localities being favoured feeding stations of the species.

Dispersal from the Beagle Islands

Only four band returns (2% of total banded) were obtained during the first year. No birds were recovered north of the Beagle

Islands, but to the south birds travelled as far as the Harvey estuary, 215 miles away. One was found at the banding site.

The two recoveries in the second year were at the banding station and 25 miles to the south.

Occurrence Inland

Two inland recoveries were made. An individual was recorded on October 4, 1960, at Carmel, 20 miles from the coast, and another was shot on November 6, 1960, at Manjimup, 30 miles inland and

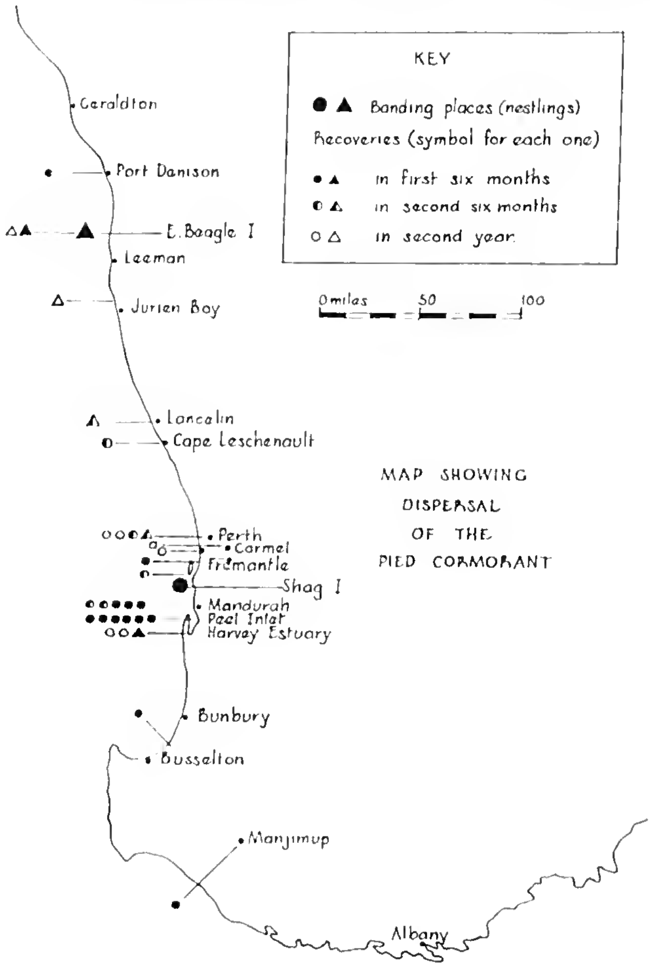

Fig. 1.—Places of banding and recovery of Pied Cormorants, *Phalacrocorax varius*, during 1960-1962. The largest symbol is the banding place of nestlings. Each small symbol indicates a reported band. Solid symbols are birds recovered in the first six-months, half solid symbols are birds recovered in the second six-months, and open symbols are birds recovered in the second year. Circular symbols indicate birds banded at Middle Shag Island on July 3, 1960, and triangular symbols indicate birds banded at East Beagle Island on May 26, 1961.

140 miles SSE of the banding place. The bird seen at Carmel was feeding on tadpoles and fresh-water crustacea at a dam, and was later recovered at Peel Inlet on March 8, 1961. These inland occurrences are somewhat unusual because in south-western Australia the Pied Cormorant favours the coastline and inlets.

MORTALITY

Seasonal distribution of recoveries is plotted in Fig. 2. It can be seen that practically all recoveries were made during the spring/summer period and that the peak falls during the September/November period. Eleven birds were recovered dead, five were taken alive, and data on the remaining fourteen returns were insufficient for a complete analysis although probably most of these were dead. Since 24 recoveries were from the 100 nestlings banded at Shag Island, it appears mortality in immature birds is very high; this is in agreement with findings on other species of marine cormorants (Kortlandt, 1942; Coulson and White, 1957). The high death toll in young birds is probably mainly due to inexperience, particularly with man, since many deaths are caused by birds being caught in fishing nets, etc., and to their being shot, but data are too meagre for any accurate analysis.

The low recovery rate of Beagle Island birds and long distance travellers from the Shag Island colony may be partly attributed to

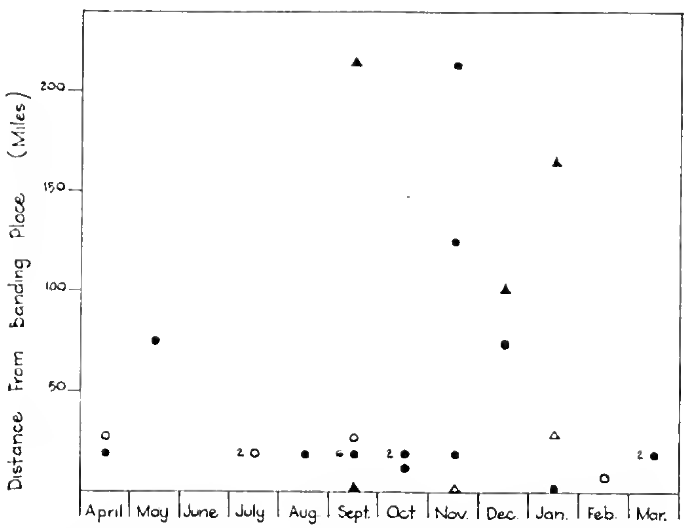

Fig. 2.—Seasonal distribution of recoveries of Pied Cormorants, *Phalacrocorax varius*, banded as nestlings in Western Australia during 1960-62. Each symbol represents a reported band except when accompanied by a figure in front of a symbol which gives the number of individuals recovered. Solid symbols are birds recovered in the first year, and open symbols are birds recovered in the second year. Circular symbols indicate birds banded at Middle Shag Island on July 3, 1960, and triangular symbols indicate birds banded at East Beagle Island on May 26, 1961.

the remoteness of much of the coastline, particularly north of Perth, from dense human population. A bias may also exist in the time of recovery of birds since during the spring/summer period there is a greater concentration of people on beaches and at inlets.

DISCUSSION

Investigations on the dispersal of marine cormorants in Europe and North America have shown that the longer movements are mainly undertaken by young birds, the adults usually remaining all the year in an area not too remote from their breeding place (Coulson, 1961; Palmer, 1962). Young birds usually disperse radially along coastlines from their place of hatching. Such movement patterns are exhibited by the Great or Black Cormorant *(P. carbo)* and the European Shag *(P. aristotelis)*. The distribution of recoveries of the Pied Cormorant shows that first-year birds of this species likewise disperse over the greater distances, and that older birds (second-year) remain within fairly close proximity of their natal area. Thus it appears that like the Black Cormorant and European Shag, the Pied Cormorant breeds at or near its birthplace.

This raises the question of how much interbreeding occurs between neighbouring populations. In the case of the Abrolhos Islands population, Serventy (1940) has suggested that the 40 miles between these islands and the mainland preclude much interchange of populations among this essentially inshore species and the fact that the Abrolhos birds breed in the spring while the mainland birds breed in the autumn serves as a double form of isolation. If the majority of Pied Cormorants do actually return to an area near their birthplace to breed, then the likelihood of much gene-interchange between the two populations appears to be still less. This behaviour would also tend to restrict gene-flow between neighbouring breeding populations on the mainland. Even if birds which survive to breed do so 25 miles from their birthplace, the present limit of second year recoveries, the amount of interchange so produced would appear to be rather small. In spite of this restricted gene-flow as indicated by these recoveries the species throughout its wide range in Australia and New Zealand has maintained a remarkably uniform morphology (cf. Condon, 1951), although Serventy (1940) recognised a race at the Abrolhos Islands.

On the west coast, the same offshore island is not used as a breeding ground every year, frequent shifts being made although usually only over short distances; my field observations have revealed transfers ranging from a few hundred yards to about 15 miles. For example, in 1960 the only site apparently used for breeding purposes between Leeman and Jurien Bay was Lipfert Island, but in 1961, only Sandland Island, about 15 miles south, was utilized. Whether such shifts in breeding location play an important role in facilitating the intermingling of populations is purely speculative for it is not known if breeding populations move as a unit or not, although the former seems the most likely on present evidence.

Owing to the fact that no data on the sex of recovered cormorants were obtained, no light can be thrown on the problem opened up by White (1916) and Serventy (1939), that samples of birds collected in different areas show striking disproportions in the sex ratio. Serventy offered the tentative explanation that females wander farther from the nesting stations than do the males. It would be desirable to have the sex determined of recovered banded birds for the elucidation of this interesting phenomenon.

SUMMARY

An analysis of 30 banding recoveries of Pied Cormorants *(Phalacrocorax varius)* ringed as nestlings in Western Australia has revealed the following life history:

(1) In their first year of life, cormorants disperse randomly along coastlines and up estuaries for distances up to 200 miles from their natal area. (2) Inland occurrences are rare. (3) Most birds in their second year return to an area relatively close to their birthplace. However, further banding is necessary to confirm this. (4) Mortality is high in immature birds and consequently probably low in adults.

ACKNOWLEDGMENTS

I am indebted to the following for assistance during the ringing programme: Messrs S. Bowler, B. Duff, L. G. Dobson, P. J. Fuller, E. LeSouef, and N. McLaughlan. Mr. W. B. Hitchcock, Secretary of the Australian Bird Banding Scheme, made helpful suggestions on banding techniques and supplied literature references. Dr. D. L. Serventy kindly criticised the manuscript.

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CHECK LIST OF WESTERN AUSTRALIAN SCORPIONS

By L. GLAUERT, Western Australian Museum, Perth.

Three families of scorpions are represented in the fauna of Western Australia, the Scorpionidae, the Buthidae and the Bothriuridae; of these the first two have a wide distribution in tropical and subtropical regions but the third is confined to Australia and South America.

The families are easily distinguished by the form of the sternum a structure situated in front of the genital operculum (Figs. 1 & 2). In the Scorpionidae it is pentangular or shield-shaped, in the Buthidae triangular and in the Bothriuridae reduced to a couple of narrow transverse bands placed end to end.

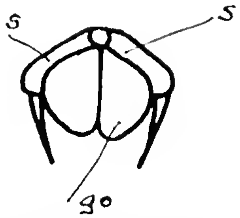


Fig. 1.—Details of genital area in the Family Bothriuridae; s, sternum; go, genital operculum.

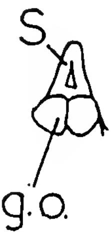


Fig. 2.—Details of genital area in the Family Buthidae; s, sternum; go, genital operculum.

I

Family BOTHRIURIDAE

Genus CERCOPHONIUS Peters

Small scorpions less than 40 mm. (1½ in.) in length.

Cercophonius michaelseni Kraepelin

Fauna S.W. Austr., vol. 2, part 7, p. 102.

Interior of Western Australia, from Cunderdin to Kalgoorlie and north to Beneubbin.

Cercophonius granulosus Kraepelin

Ib., p. 102.

Murchison district, Geraldton to Cue.

Cercophonius sulcatus Kraepelin

Ib., p. 103.

South-western Australia, from Perth to the south coast and inland to the Great Southern district.

KEY TO THE SPECIES

Tergites brownish with persistent yellowish vertebral band. Tail yellowish black-spotted laterally, the spotting extending to the ventral surface of the posterior segments. Vesicle yellowish. Last sternite with almost smooth lateral keels and faintly indicated median keels below. First caudal segment with two swollen granular median keels below .... *michaelseni*

Tergites brownish, each with a pale spot posteriorly or even absent. Tail and vesicle black-spotted. Last sternite without distinct keels.

Last sternite closely granular behind, first four caudal segments coarsely granular below but without distinct median keels .... *granulosus*

Last sternite somewhat wrinkled posteriorly, often with indications of lateral keels. First three or four caudal segments below with faint indications of five median keels, the depression between them often with a black longitudinal line .... *sulcatus*

II

Family BUTHIDAE

Sub-Family BUTHINAE

Genus LYCHAS C. L. Koch

Lychas marmoreus (C. L. Koch)

Lychas marmoreus marmoreus (C. L. Koch)
Southern Western Australia.

Lychas marmoreus variatus (Thorell)
Northern Western Australia.

Lychas marmoreus splendens Kraepelin
Murchison and further inland.

Lychas marmoreus kimberleyanus Kraepelin
Kimberley District and N.W.A.

Lychas mjobergi Kraepelin
Kimberley District.

Lychas bituberculatus (Pocock)
Shark Bay.

Lychas jonesae Glauert
Hampton Hill Station, Bulong.

Genus ISOMETROIDES Keyserling

Isometroides vescus (Karsch)
Widely distributed in southern Western Australia from the coast inland.

Isometroides angusticaudus Keyserling
From the Kimberley District south to the Murchison.

Sub-Family CENTRURINAE

Genus ISOMETRUS Hempr. and Ehrenb.

Isometrus melanodactylus (L. Koch)
West Kimberley.

Isometrus maculatus (Geer)
West Kimberley.

KEYS

Family BUTHIDAE

The distinguishing character is the triangular sternum which is well defined (Fig. 2).

Sub-Family BUTHINAE

Tibial spur on the third and fourth legs.

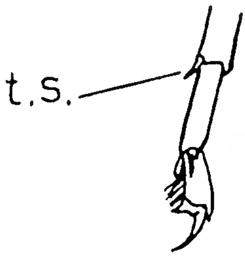


Fig. 3.—Tibial spur in the Family Buthidae.

Genus LYCHAS

Tooth under spine strong, triangular, pointed or small

KEY TO THE SPECIES

Tergites with indications of lateral keels.

Third caudal segment with 8 keels .... *L. jonesae* Glauert

Third caudal segment with 10 keels ...... *L. bituberculatus* (Poc.)

Tergites without indications of lateral keels.

Tooth under the spine minute .... *L. mjobergi* Kraepelin

Tooth under the spine large, usually with a dorsal tubercle, third caudal segment with ten keels.

Sternites dull, with a small triangular shining area near the posterior border of the third sternite. Sternites usually more or less pigmented with darker. Pectines and coxae pale with rarely indistinct darker markings on the coxae, tooth under the spine with dorsal tubercle .... *L. marmoreus marmoreus* (Koch)

Sternites more or less shining, the shining area not confined to the posterior margin of the third sternite. Pectines and coxae uniformly pale yellow.

Sternites pale yellow but the posterior ones at times pigmented or suffused with darker.

Vesicle swollen, egg shaped, with median keel passing evenly into the lower edge of the tubercle, median keel of the tergites yellowish anteriorly. Fifth caudal segment with yellow ocelli. Pectines with 17-21 teeth .... *L. m. variatus* (Thorell)

Vesicle more or less cylindrical, its median keel not passing evenly into the lower edge of the tubercle but forming a distinct angle. Median tergal keels often, but not always, intensely blackish, vesicle usually uniformly reddish-brown. Pectines with 13-14 teeth .... *L. m. kimberleyanus* Kr.

Tooth under the spine conical, without distal tubercle. Fingers more or less blackish, sharply defined from the pale yellow hand. Vesicle brown, laterally with two rows of large yellow ocelli, almost cylindrical, its inferior median keel not passing gradually into the tooth under the spine, but forming a distinct angle. Pectines with 14-16 teeth .... *L. m. splendens* Kr.

Genus ISOMETROIDES

No tooth under the spine, the vesicle passing evenly into the spine.

KEY TO THE SPECIES

Fourth caudal segment with eight well developed keels and short accessory keels. Intercarinal surfaces granular, surface of the strong fifth segment punctured, rugulose. Spine shorter than the vesicle. Pectines with 21-23 teeth .... *I. angusticaudus* Kr.

Fourth caudal segment keel-less or very feebly keeled. Surface smooth, surface of the fifth segment punctured smooth and shining. Spine as long as the vesicle. Pectines with 23-25 teeth .... *I. vescus* (Karsch)

There is very little difference between these two species which themselves are rather variable, so they may represent but one species, in which case *I. vescus* of Karsch has priority.

Sub-Family CENTRURINAE

No tibial spurs on the third and fourth legs.

Genus ISOMETRUS

KEY TO THE SPECIES

Pectines with 16-19 teeth (rarely 15); tooth under the spine sharp and conical. Superior keels of the caudal segments without enlarged terminal tooth; distal segments of the tail not, or but little darker than the trunk .... *I. maculatus* (Geer)

Pectines with 10-13 teeth; tooth under the spine laterally compressed. Superior keels of the caudal segments, particularly the second and third with enlarged terminal tooth. Distal segments of the tail darker than the trunk .... *I. melanodactylus* (Koch)

FROM FIELD AND STUDY

The Painted Quail in the Darling Range.—The Painted Quail *(Turnix varia)* has during the past two years increased in numbers in the jarrah forest country west of the Mundaring Weir. Pairs of these birds can often be flushed and several specimens have been obtained dead on the Mundaring Weir Road. They seem to be fairly evenly distributed throughout this area and if not actually seen their presence can be detected by their circular, debris-free, feeding circles. In one swampy locality they have their permanent sleeping depressions ringed with accumulated droppings in the shelter of tussock scrub or rushes. This roosting area was first noted on March 13, 1963.

Dr. D. L. Serventy informs me that he has seen these quail on various occasions since 1959 at The Knoll, Gooseberry Hill, around the upper end of the old zig-zag railway. On November 21, 1962, the British Museum (Natural History) Expedition here collected a male specimen which had greatly developed gonads.

—J. DELL, Kalamunda

Occurrence of the Spotted Diamond-bird in the Perth Area.—The Spotted Diamond-bird *(Pardalotus punctatus)* is one of the species which disperses radially from the South-West corner each autumn. In some years this dispersion movement fails to reach the Perth area. In recent years the birds reached Perth in 1958, 1959 and 1960. They were not recorded during 1960 and 1961 but have appeared again this year (1963). They are usually first met with in April. The extreme limits of the movement have not been adequately mapped. In the *Birds of Western Australia* Whittell and I place the northern limit of the species' occurrence as Cockleshell Gully, just north of Jurien Bay. On April 24, 1959, Dr. G. F. Mees collected a specimen at a swamp near King's Homestead, 20 miles north of Cockleshell Gully. To the south-east I know of no records of occurrence beyond the Stirling Ranges. It would be interesting if ornithologists could pay attention to the autumn, winter and spring occurrences of this species so that its movements, and their annual fluctuations in extent, could be better known.

—D. L. SERVENTY, Nedlands.

The Little Grass-bird in Central Western Australia.—According to D. L. Serventy and H. M. Whittell (*Birds of Western Australia*, 1962, 3rd edn., p. 303), the Little Grass-bird *(Megalurus gramineus)* is confined to the south-west of the State, between Hamelin Pool, near Sharks Bay, and Esperance. On August 30, 1962, while on a field trip in the region of the Canning Stock Route, north-east of Wiluna and Lake Nabberu, I heard the characteristic mournful trisyllabic song of this species at Windich Spring, and on investigating saw at least one bird in a patch of tall rushes.

Windich Spring is situated about 415 miles ENE of Hamelin Pool, and about 80 miles NNE of Wiluna. It is a permanent expanse of water about 400 yards long, 20 feet wide and up to 10 feet deep, situated in a somewhat deeply eroded portion of the Kennedy Creek which flows southwards into Lake Nabberu. It is fringed with tall river gums *(Eucalyptus camaldulensis)* and extensively overgrown with rushes *(Scirpus littoralis* and *Cyperus vaginatus).* There appears, therefore, no reason for the Little Grass-bird not to nest in the locality.

A live individual and a carapace of the northern tortoise *(Chelodina steindachneri)* were also noted at Windich Spring.

—JULIAN FORD, Attadale

Field Notes on Some Rottnest Crustacea.—Early in January 1931, when investigating some holes in a freshwater seepage at the western end of Lake Bagdad, Rottnest Island, I was surprised to find the burrows occupied by a burrowing crab, *Brachynotus octodentatus.* Males, females and immatures were collected.

One evening in December 1931 I observed, at the top of the sandhills at the eastern end of Longreach Bay, a beach crab, *Ocypodes pygoides,* come out of the bush holding in its claw a large longicorn beetle of the genus *Phoracantha.* The crab was on the way down to its burrow.

In 1929 the late Professor G. E. Nicholls described four new species of the rare marine isopod genus *Stenetrium.* The first, *S. machrochirium,* was obtained crawling on seaweed growing on the piles of the pier at Dongara. The other three, *S. spinirostrum, S. truncatum* and *S. glauerti,* were found on the under surface of rocks and stones in the Diving Pool near Bathurst Point, Rottnest. The first and third of these were fairly abundant but the second was represented by one damaged specimen only. I made collections of these isopods in September 1927 and 1928, November 1928, December 1929, February and November 1930, January and February 1931, December 1932, and January 1933.

—L. GLAUERT, W.A. Museum, Perth

Nesting of the Pink-eared Duck near Perth.—In his note on the increase in abundance of the Pink-eared Duck *(Malacorhynchus membranaceus)* in Western Australia, Julian Ford (*W.A. Nat.*, 8, 1962: 103) records that in the South-West this species is known to breed on the fresh-water swamps and lakes at Gundaring, Moora, Dowerin, Carnamah and Naraling, and only visits the coastal plain near Perth during the summer and autumn months when many of the inland expanses of water have evaporated.

However, on January 30, 1963, when I visited Lake Claremont (Butler's Swamp) with Miss M. Pollock, a visiting ornithologist from Northern Ireland, we saw two Pink-eared Ducks which were accompanied by four small ducklings. There were about 30 birds of this species on the swamp, but we only saw these two birds with young. The ducklings were easily distinguished by the striking patterning (mentioned by John Warham in his paper on the Pink-eared Duck in *The Bird-Watcher,* 1 (2), 1959: 27) which made them resemble miniature adults. The party was swimming in line astern with one adult leading, followed by two ducklings one behind the other, then the other adult and the last two ducklings, also one behind the other. One adult was much more brightly coloured than the other.

—D. A. ROOK, Nedlands

[On March 21, 1963, Mr. D. W. Lamm, of Canberra, and I visited Butler's Swamp and saw a Pink-eared Duck accompanied by several small ducklings in close array. There were at least five and possibly six ducklings present. These would be a much later brood than that reported above by Miss Rook. Several adult Pink-eared Ducks were scattered over the swamp.—D. L. SERVENTY.]

Additions to the Esperance Bird-list.—The following 14 species, not recorded by E. H. and L. E. Sedgwick (*W.A. Nat.*, 2: 111) or V. N. Serventy (*W.A. Nat.*, 3: 95), were observed during brief visits to the Esperance district in March 1958, December 1959, and December 1962.

Swamp-hen *(Porphyrio porphyrio)*. Two on a small permanent pool 3 miles N. of Mt. Le Grand.

Little Grebe *(Podiceps novae-hollandiae)*. A few with the more numerous Hoary-headed Grebes on the Washpool, a permanent fresh-water lagoon near the mouth of the Lort River.

Pelican *(Pelecanus conspicillatus)*. A flock of 14 circling above the flats and dunes 12 miles E. of Esperance.

Wood Sandpiper *(Tringa glareola)*. Three with a Greenshank at Lake Condingup, a fresh-water lagoon 40 miles E. of Shark Lake.

Brown Bittern *(Botaurus poiciloptcrus)*. Heard at night at Shark Lake, 6 miles N. of Esperance.

Wood Duck *(Chenonetta jubata)*. A flock of c. 80 on the Washpool.

Whistling Eagle *(Haliastur sphenurus)*. One 3 miles N. of Esperance.

Smoker Parrot *(Polytelis anthopeplus)*. A flock in the wooded *(Eucalyptus occidentalis)* valley of the Young River.

Elegant Parrot *(Neophema elegans)*. One beside the Lort River at the Ravensthorpe-Esperance road crossing.

Frogmouth *(Podargus strigoides)*. An adult and juvenile in paperbark scrub round a swamp 14 miles E. of Esperance.

Little Grass-bird *(Megalurus gramineus)*. Many calling in the dense beds of *Cladium articulatum* growing round the edge of Shark Lake.

Reed Warbler *(Acrocephalus stentoreus)*. At Shark Lake with the grass-birds.

White-cheeked Honeyeater *(Phylidonyris niger)*. A flock in flowering *Banksia speciosa* scrub at Lake Condingup.

Squeaker *(Strepera versicolor)*. In scrub towards the mouth of the Dalyup River.

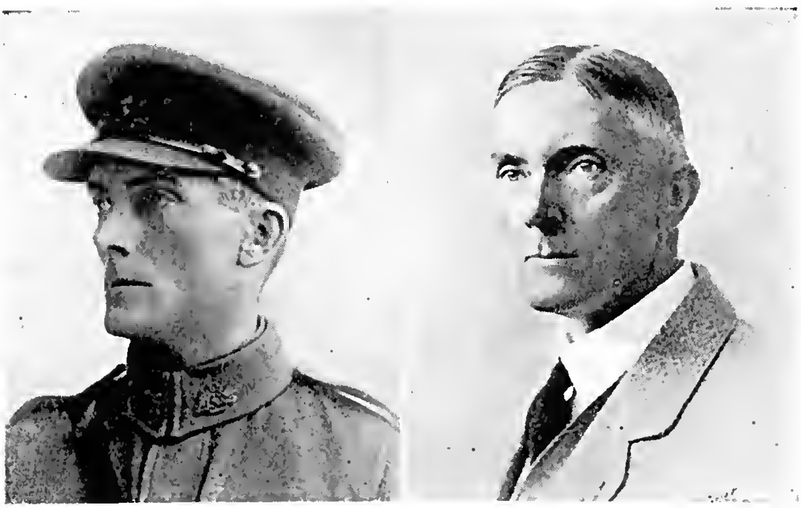
—G. M. STORR, W.A. Museum

OBITUARY

L. GLAUERT, M.B.E.

Ludwig Glauert, Director Emeritus of the Western Australian Museum, a foundation member and Patron of the Western Australian Naturalists' Club, died at the Repatriation General Hospital, Hollywood, W.A., on February 1, 1963. He was in his 84th year.

An extended notice of Mr. Glauert's career appeared in volume 5 of this journal, no. 7 of which, issued on March 8, 1957, was published as a valedictory number in his honour, on the occasion of his retirement from the directorship of the Western Australian Museum. The present account, therefore, will not duplicate the information given in that number but will be confined to supplementary details and items overlooked in the earlier article.



L. Glauert, left, 1919; right, 1935.

In summary Mr. Glauert's career was as follows: He was born in Sheffield, England, on May 5, 1879, and after training as a geologist came to Western Australia in 1908. After a period with the Geological Survey of Western Australia he was appointed to the staff of the Western Australian Museum in 1910. On his return from World War I in 1920 he became head of the Museum as Keeper of the Biological Collections; this title was altered to Curator in 1927 and to Director in 1954. He was an active member of Perth scientific societies, becoming president of the Royal Society of Western Australia and of the Western Australian Naturalists' Club, receiving the gold medal of the former and honorary membership of the latter. He was well known to the public as radio broadcaster and public speaker and was constantly interviewed by the press on natural history matters. To young naturalists and University students he was a refreshing and stimulating guide and mentor. Undoubtedly for about 40 years he can be claimed to have been the leading force in guiding and stimulating natural history in this State and no person in the natural history field was better known.

Mr. Glauert always held the Naturalists' Club in warm regard and, although unable to attend very many meetings in his later years, always retained an interest in its work. Both in education and in conservation he felt the Club was doing pioneering work comparable to any being carried out in other parts of Australia. Probably nothing gave him greater pleasure in the last few years than the Club's publication of his two handbooks, one on the snakes and the other on the lizards. He had always emphasised the difficulties local naturalists laboured under in the past owing to the lack of suitable field identification books and of a journal like the *W.A. Naturalist* in which they could record the results of their original work.

Mr. Glauert's most notable personal researches in the earlier years were on the fossil vertebrates in the South-West caves and his investigations were then transferred, after World War I, to various groups of living animals, including crustacea, scorpions, amphibia, reptiles and mammals. He was a leader in the conservation field. Despite heartbreaking restrictions of finance and personnel he carried on active research; his publication record extended over a period of 58 years and continued to his death. In fact he never retired from research.

When he was able to retire from active Museum duties, on the arrival of the new Director, Dr. W. D. L. Ride, in July 1957, he continued work at the Museum on reptiles. The Museum trustees conferred on him the title of Director Emeritus and provided him with a study room and facilities for continuing his investigations. In spite of increasing frailty his routine was to arrive at the Museum at 9 o'clock each morning and work until 11 o'clock. Then he would return by tram (and later by bus, when trams ceased operating) to his hotel, first the King Edward Hotel in the city and later the George, further west. He continued so until a few days before his death. A few weeks before he died he demonstrated to me under the microscope certain features in the morphology of a scorpion species on which he was working, with frequent references to texts in German and Latin, to clarify a point he was making in a paper for the *Naturalist.*

In 1962, having completed his revisions of the local reptiles, he transferred his attentions to this earlier interest, the scorpions. His intention was to revise the local species and prepare a handbook on them. A first paper appeared in 1962 and he completed an annotated checklist and keys on the species of two of the three local families of scorpions when he had to enter hospital towards the end of January for the treatment of a minor eye infection. Whilst in hospital he died suddenly from a heart attack. To the end he remained mentally alert and though his friends noted an increasing weariness in him at times and a despondency which was formerly quite foreign to his nature, the familiar mood of the old fervour remained predominant. A few days before his death he asked me to come to the hospital so he could correct the manuscript of the scorpion article which appears on page 181. He read this through with keen application, made his corrections and told me that the typist was now completing the draft of the Family Buthidae, that it was to be sent to him for checking (unhappily this was fated not to be) and that I would find the illustrations on his table at the Museum. This duty done we conversed of old times and of former acquaintances, most of whom had passed on. These recollections pleased him; he seemed very happy and contented and gave me a cheery farewell. I never saw him again. Friends who were at the hospital ward with him spoke of his sturdily independent bearing. He would walk the ward slowly but with an erect carriage, like, they said, an old soldier.

At the last farewell, at the Karrakatta Crematorium on February 5, many of his friends and colleagues followed the cortege, staff associates, including some of long standing, representatives of several government departments, the University, C.S.I.R.O., and members of his family.

Biographical Articles.—Biographical articles on L. Glauert, published on various occasions, include the following:—

Pen Portraits. Science—Profession and Hobby. *Daily News* (Perth), December 10, 1928, with portrait.

The Naturalist (Leeds), no. 921, October 1933: 239.

Kelvin Medallist, 1945. *Journ. Roy. Soc. W. Austr.*, 31, 1946: vi-viii, with reproduction of Buckmaster's portrait (see later).

Who's Who in Australia, editions of 1944, 1947, 1950, 1955, 1959, 1962.

Biography by H. M. Whittell, *The Literature of Australian Birds*, 1954: 276-278.

Fossils Can Teach Us Plenty. By Max Brown. *Daily News*, September 30, 1954, with portrait.

Australian Journal of Science, 19 (3), 1956: 239.

Ludwig Glauert—Museum Director and Naturalist. By D. L. Serventy, *W.A. Naturalist*, 5, 1957: 148-165 (with portraits and other illustrations).

Obituary by C. F. H. Jenkins, *The Countryman* (Perth), February 21, 1963.

Obituary by W. D. L. Ride, *Kalori*, 26, April 1963: 7.

Obituary by D. L. Serventy, *The Emu*, 63, 1963 (1): 74-75.

Obituary by G. P. Whitley, *Australian Zoologist*, 13 (1) (in press).

Portraits.—Apart from the two reproduced in this article, the only portraits available of Mr. Glauert are press photographs. Besides those mentioned in the articles above, portraits were published in the following newspapers: *West Australian*, September 22, 1931, November 29, 1939, June 23, 1956, March 16, 1957, April 16, 1957, June 14, 1957, February 2, 1963. *Daily News*, June 10, 1932, January 3, 1933, July 9, 1955. *Western Mail*, June 19, 1914. *Westralian Farmers' Gazette*, September 12, 1929.

In 1936 Mr. Glauert had his portrait painted in oils by Ernest Buckmaster (see *West Australian*, October 15, 1936). This was done at the suggestion of the artist who was at the time painting portraits of various Perth notables at the Museum and Art Gallery. The painting now hangs in the library of the Western Australian Museum.

Animals named after Mr. Glauert.—The following are additional to the list given in the *W.A. Naturalist*, 5: 160:

Amphibia: *Hyla bicolor glauerti* S. J. Copeland, 1957.

Insects: *Neodon glauerti* Carne, 1957.

LIST OF SCIENTIFIC PUBLICATIONS BY L. GLAUERT

The following list brings up to date that given in the *W.A. Naturalist*, 5: 160-165, which ended with the year 1956. Several items published earlier than this, and which were previously overlooked, have been added. It may be mentioned that Mr. Glauert published numerous articles in newspapers and popular journals which have not been cited in this bibliography. Many, however, contain valuable original data and it is proposed later to make a collation of these. Such journals include the *Western Mail*, *Westralian Farmers' Gazette*, *Our Rural Magazine* (of the Education Department) and others. Furthermore he gave freely to other authors information which is cited as "personal communications" in their works.

1909

Ab. Proc. Geol. Soc., June 29, No. 881: 120; item 3.

1910

List of fossils collected at Fossil Cliff, Irwin River. *In* The Irwin River Coalfield, by W. D. Campbell. *Bull. Geol. Surv. W. Austr.*, 38: 52-53.

Brief Notes upon some Irwin River Rocks. *Ibid.*, 38: 93-99 [with E. S. Simpson].

1911

Further Notes on the Gingin Chalk. *Geol. Surv. W.A., Annual Rept. for 1910.*

1929

A Fascinating Fauna. Chapter XII in *A Story of a Hundred Years*, *ed.* Sir Hal Colebatch, Govt. Printer, Perth, pp. 149-159.

1954

Reptiles and Frogs. *In* The Archipelago of the Recherche, part 5, pp. 29-35. *Austr. Geogr. Soc. Reports*, no. 1.

1957

Scorpions. *Walkabout*, February.

A Further Record of *Pseudemydura umbrina*. *W. Austr. Nat.*, 6 (3): 81.

A Bandicoot New to Western Australia, *W. Austr. Nat.*, 6 (3): 81.

A New Fresh-water Fish for Australia. *W. Austr. Nat.*, 6 (3): 81.

A Handbook of the Snakes of Western Australia. Handbook No. 1, 2nd edn., W. Austr. Nat. Club, Perth, 62 pp.

1958

The Honey Mouse. *Aust. Mus. Mag.*, 12 (9), March 15: 284-285.

Scorpions. In *The Australian Encyclopaedia*, ed. A. H. Chisholm, Angus & Robertson, Sydney. Vol. 8: 31-32.

Mammals and Reptiles of King's Park. *W. Austr. Nat.*, 6 (6): 155-156.

The Fauna of Western Australia. *Official Year Book of Western Australia* 1957: 53-55. Govt. Printer, Perth.

1959

Herpetological Miscellanea. IX—*Ablepharus wotjulum*, a new Skink from West Kimberley. *W. Austr. Nat.*, 6 (8): 192-193.

Herpetological Miscellanea. X—Dragon Lizards (Family Agamidae). *W. Austr. Nat.*, 7 (1): 11-19.

Herpetological Miscellanea. XI—Dragon Lizards of the Genus *Amphibolurus* *W. Austr. Nat.*, 7 (2): 42-51.

1960

Herpetological Miscellanea. XII—The Family Scincidae in Western Australia. Part 1. *W. Austr. Nat.*, 7 (3): 67-77.

Herpetological Miscellanea. XII—The Family Scincidae in Western Australia. Part 2. *W. Austr. Nat.*, 7 (4): 81-99.

Herpetological Miscellanea. VII—The Family Scincidae in Western Australia. Part 3. *W. Austr. Nat.*, 7 (5): 115-122.

1961

A Handbook of the Lizards of Western Australia. Handbook No. 6, W. Austr. Nat. Club, Perth, 100 pp.

1962

Herpetological Miscellanea. XIII—A New Skink from the North-West Cape, Western Australia. *W. Austr. Nat.*, 8 (4): 86-87.

1963

Notes on *Urodacus* Scorpions. *W. Austr. Nat.*, 8 (6): 132-135.

Check List of Western Australian Scorpions. I and II. *W. Austr. Nat.*, 8 (8): 181-185.

Field Notes on Some Rottnest Crustacea. *W. Austr. Nat.*, 8 (8): 186.

—D. L. SERVENTY

C. G. JESSUP

Christopher George Jessup was born at Northam on Christmas Day, 1881, and died at Northam on December 9, 1962. He was elected to the Club in May, 1930. However few of the present-day metropolitan members knew him; he wrote no papers and he could easily be forgotten by posterity. Yet this kind, gentle and sincere bush naturalist exercised a remarkable influence in his home district and encouraged many young people in the path of serious natural history. In my own case I was a constant visitor to his home and eagerly imbibed some of his rich stock of bush lore. Scholars from the Northam High School also received stimulation and help. Local and overseas scientists were in correspondence with him.

C. G. Jessup, with Mrs. M. B. Mills at the Merredin Wild Life Show, 1951.

From an appreciatory article in the *Northam Advertiser* of October 19, 1962, written during his last illness by Dr. Barbara Main (who was a student at the High School between 1942 and 1946) I extract the following eulogy: "Small or large, every township has its wise men; often unrecognised. Now when Mr. C. G. Jessup is in poor health and not as active in the exposition of his interests as in previous years, we are bound to consider the depth of his contribution to the district of Northam. It is apparent, upon reflection, that Mr. Jessup has the attributes of a legendary figure. His quiet influence has permeated not only the life of this district but spread far beyond its precincts into other parts of the wheatbelt. He is known by many for his lifelong interest in natural history . . . [and has] been able to explain many phenomena peculiar to the natural history of his chosen region which would have baffled the less persistent. . . . Mr. Jessup has always had a deep sympathy for the aborigines of this region and an interest in their culture and tools and, above all, the way they respected the land upon which their livelihood depended—and on which in turn our livelihood depends . . . . It is significant that at this time, when so much of the countryside has been denuded of its natural bushland and the continuity of the drama of the centuries-old natural history life has been broken for ever, not only in this district but many others of the wheatbelt, Mr

Jessup is one of the very few people who holds an unwritten record of this; he is indeed a vital link between the early days of settlement (when there was indeed a kind of balance between the farms and the natural bush) and the future! In the past too little attention has been given to the then present in its vision of the future—that is, development went on without a comprehensive realisation of the vanishing scene, the diminishing bushland." It was because of his poignant awareness of all this, felt Dr. Main, that Mr. Jessup was so ready, and eager, to pass on his knowledge to others and encourage them in recording the local natural history.

Chris Jessup's father arrived in the Northam district from England in 1860. Besides farming he was a part-time sandalwood gatherer. Chris, the tenth child in a family of eleven, was brought up in the old family farm house near Burlong Pool, West Northam. He was the only one of the children to share his father's interest in natural history and the things of the bush. After he left school he worked at the family farm for four years. These were stirring times and, like so many others, he found it impossible to resist joining the rush to the 'Fields. However he contracted typhoid fever and was brought back home at the end of 1898. Next year he joined the W.A. Railways Department as a "call boy" and steadily progressed through the grades of cleaner, fireman and engine-driver. He was stationed at various centres including Northam, Midland Junction, Geraldton and Kalgoorlie. In 1910 he finally settled again at Northam and his home there at 46 Broome Terrace, became a mecca for naturalists for the next 50 years.

His main study was in reptiles but he had an interest in all groups of animals, as well as plants, geology and aboriginal lore. He formed extensive collections and much carefully labelled material was passed on to local and overseas scientists and institutions. He delivered talks to local schools, occasionally contributed articles to country newspapers and during World War II lectured at the Northam Army camp on aspects of survival in the bush.

He was a fairly frequent speaker at the meetings of the Naturalists' Club, both in the pre-World War II years and after. These visits were eagerly looked forward to by members because, apart from the actual specimens he invariably exhibited, his talks were full of "meat" in terms of new and unpublished facts. He became known to a wider audience when the post-war Wild Life Shows were started in 1946. At the first show, a two-day event, he remained with his exhibit throughout. In later years a full table was always reserved for him and there, surrounded by specimens, he held court with his admirers, both young and old. These visits only ceased when physical infirmity made the trip to Perth no longer possible.

He also assisted with country wild life exhibitions and helped me materially with the mobile wild life shows. The illustration shows Mr. Jessup at the Merredin Art and Wild Life Show organised by our member Mrs. Margaret Mills in November 1951; the two are discussing a large fungus, *Boletus polyporoides*, from Nungarin.

—W. H. BUTLER

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