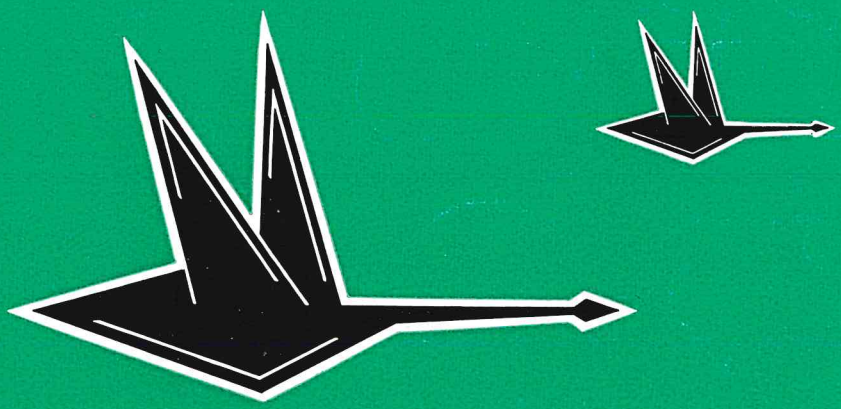
WESTERN AUSTRALIA



S.W.A.N.S.

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Winter, 1972

S.W.A.N.S

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WINTER, 1972

Issued by direction of the Hon. A. W. Bickerton, M.L.A., Minister for Fisheries and Fauna.

Director of Fisheries and Fauna: B.K. Bowen, B.Sc.

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The support of the public is an essential component in any conservation or reserve management programme—but an informed, educated public is needed to ensure its continuing success.

This publication is designed as a medium by which the various organisations, individuals, and wildlife management personnel may be kept informed of the work being carried out by this department; of departmental policies and directions; and for promoting a better understanding and appreciation of Western Australian wildlife and the role it plays in maintaining a suitable environment in which man can live.

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Something to think about....

"Yes, that's it," said the Hatter with a sigh, "it's always tea-time, and we've no time to wash the things between whiles."

"Then you keep moving round, I suppose?" said Alice.

"Exactly so," said the Hatter. "As the things get used up."

"But what happens when you come to the beginning again?" Alice ventured to ask.

"Suppose we change the subject," the March Hare interrupted, yawning.

—*Alice's Adventures in Wonderland.*

Get the point?

No?

See article on page 61.

IN THIS ISSUE....

WHAT BROUGHT AUSTRALIA THE KANGAROO?

When Captain Cook landed in Australia, he marvelled at the strangeness of the animals. The extraordinary kangaroo, which leapt along on its hind legs waving its powerful tail for balance, was something quite new. Odder still, it gave birth to its young when they were hardly bigger than a thimble, and raised them in a special pouch.

Although Captain Cook did not know it, marsupials such as the wallaby and the kangaroo were not unique to Australia. Back in geological time, Europe had animals which shared many of their characteristics, and there are still species of opossum and marsupial rat to be found in North and South America. But the range and variety of marsupials in Australia is unrivalled—the country has more than 170 different marsupial species, the Australian equivalents of Europe's dogs, rats, mice and even moles.

Sorting out why Australia should be so different has been an absorbing biological puzzle—Charles Darwin, in the last century, was one of those who grappled with it. But a recent paper by two British scientists in the publication "Nature" goes some way, at least, towards solving the puzzle. Dr. N. Jardine and Dr. Dan McKenzie of King's College, Cambridge University, England, have used the new discoveries of the movement of continental plates to explain at least part of the mystery.

"I won't say that we have finally discovered what did happen," says Dr. Jardine, "but at least we can now rule out nine-tenths of the hypotheses which have been put forward in the past."

Act as Boats

According to the theory, the continents act as boats in which the various species of animals are carried as passengers. When the boats are isolated from one another by vast oceans, the passengers form an isolated community within which the processes of evolution take place. These can be explained by the Darwinian theories of natural selection. But the boats are not stationary. It is now known for certain that they move about on the surface of the earth. Sometimes two or more of the continents may run into each other, allowing the passengers to mingle freely, before parting again to form isolated communities.

"The idea which is new is to regard the continents as agents of dispersal," says Dr. Jardine. "It's always been known that orchid seeds or fern spores could cross the Atlantic Ocean on the trade winds, and birds carry seeds when they migrate. But how does one explain the distribution of animals?"

Timetable Worked Out

What the two scientists have in fact done is to work out a timetable showing where the continents were at any time in the past. Continents move extremely slowly—but even a centimetre (0.4 inch) a year adds up to 1,000 kilometres (620 miles after 100 million years, not a long time in geological terms.

"We've worked out a straight timetable for the contact of the continental masses, and tied it in with the fossil record of marsupials," says Dr. Jardine. "This produces a simple scheme which fits the fossil record."

The timetable shows that until 43 million years ago, Australia, Antarctica and South America formed a single land mass. Then Australia separated itself from Antarctica and moved away northwards, taking its animal passengers with it. It was completely isolated until the last 10 million years or so, when it began to approach the islands of Indonesia.

Map of the continental drift in the world's southern hemisphere.

The Suggestion

"It has always been assumed," Dr. Jardine says, "that marsupials did not develop independently in Australia and spread out from there. The position of the continents in the past means that if the marsupials didn't develop in Australia, they must have got there by crossing Antarctica from South America when the three were linked to-

animals?"

(2)—11715

What the theory suggests is that the marsupials, originating from one primeval species in North America, reached Australia by way of South America and Antarctica at some time more than 43 million years ago. Then the continents separated, trapping the marsupials on Australia, where they developed their amazing abundance and variety in the absence of competition from other species. The marsupials left behind in South America were having to compete with better adapted mammal species, and so became extinct, or nearly so.

Species of opossum and marsupial rat are still to be found in North and South America. These pictures show a type of opossum native to New Zealand (top) and an American opossum with its young.

Several Possibilities

There is one loophole. Why was it that only the marsupials reached Australia? Why didn't the other mammals cross with them and compete with them in Australia?

"We don't know the answer to that," Dr. Jardine admits. "It is possible that because the marsupials were less specialised animals they were able to colonise Antarctica more easily than the specialised herbivores and carnivores, and hence were able to cross the land bridge more easily—but in a sense that's begging the question."

So there are still several possibilities open, and further research will be needed to sort out the details.

Wider Use Likely

But the idea of using the movement of the continents to explain the curiosities of biological distribution is bound to be more widely used.

"With the more dispersible organisms such as seeds, of course, we're on shaky ground," says Dr. Jardine, "because there are other ways they can be distributed. But one possibility is to use a kind of mirror-image of our technique to study the distribution of organisms in the sea.

"As the continents separated in the past there must have been a mixing of the ocean masses, and this will be recorded in the fossils of marine species. One difficulty, unfortunately, is that many of the crucial areas—the most interesting ones—are very difficult to reconstruct. For example, the Caribbean area is a place where many small continental plates meet, and it may never be possible to work out exactly how they moved in the past."

Quite clearly, not all the distribution of species in the earth's surface can be explained by the movement of the continents—but the new technique is a useful addition to the armoury of the palaeontologists.

GOVERNMENT TREBLES A.C.F. GRANT TO $150,000 A YEAR

The Federal Government has increased its grant to the Australian Conservation Foundation from $50,000 a year to $150,000. The decision was announced by the Federal Treasurer, Mr. Snedden, during his 1972-73 Budget speech on August 15.

The grant will meet the costs of the Secretariat only; funds for projects will still have to come from membership fees, gifts and bequests. The grant, however, will permit a significant expansion within the Secretariat.

After learning of the increased grant, the Foundation's Executive said: "We are most grateful to the Australian Government for its prompt action in providing such a useful grant. It will enable the Foundation to continue its task of reorganising for the future; its administrative machinery has been strained far beyond its capacity. The President said in June that if the Foundation were to represent the considered conservation opinion of the people of Australia, it must have the necessary financial support. The Australian Government's grant goes a long way towards meeting this urgent need."

EXPONENTIAL GROWTH AND THE EXAMPLE OF MINERAL RESOURCES

It is vital to an understanding of the environmental crisis that everyone appreciates the impact of exponential growth on the environment.

As one ordinarily sees growth, as of babies into adults or of seedlings into trees, it is a linear process, i.e. during the stage of growth, children and trees increase roughly by constant amounts in constant periods of time, an inch or a foot in stature each year, perhaps. A quantity exhibiting exponential growth on the other hand, increases by a constant percentage of the whole in a constant time period. In terms of the accumulation of money, for example, linear growth can be represented by a peasant putting away $10 each year under the mattress; exponential growth by compound interest.

It is useful to look at exponential growth in terms of **doubling times.** It is also necessary to emphasize the apparent suddenness with which exponential growth approaches a fixed limit. With any quantity growing exponentially we are always likely to be startled by a rapidity with which matters appear to go from comfortable, to tolerable, to completely intolerable—whether it be human numbers, or the usage of limited resources, or the pollution of the air, water or soil. The **rate of growth** need not change—what changes as time goes on is the magnitude of the quantity that is being doubled in constant time.

If we are moved to condemn it, we must at the same time realize that exponential economic growth is the feature of our life that has given us the wealth and comforts that we in the technologically advanced countries now enjoy. Nevertheless, its indefinite continuance is the basis of today's environmental crisis.

One example of the effect of exponential growth on a mineral resource is chromium, as studied by Dr. W. H. Behrens recently. It is clearly important to distinguish between the static reserve index (which is what most geologists and economists refer to as the 'reserves') and the exponential reserve index. If usage remained constant, reserves would be depleted linearly and would last for 420 years. If usage increases exponentially **at its present growth rate of** 2.6% p.a., reserves will be depleted in 95 years. If actual reserves are five times present proven reserves, chromium ore will be available for 154 years (assuming the present exponential increase in usage continues). Finally, even if all chromium were perfectly recycled, exponentially growing demand would exceed the 1970 known reserves in 235 years. You may say that the levels of demand postulated in the exponential increased demands are fanciful. They may be, but I can assure you that the under-developed three-quarters of the world fervently hopes they are not, for they aspire to reach the same 'standards of living' (i.e. utilization of resources) that are now found in U.S.A.

Non-renewable resources

Turning to non-renewable resources in general, we know that the earth's crust contains vast amounts of those raw materials that man has learned to mine and transform into useful things. Vast but not infinite. We have seen in the example of chromium how suddenly an exponentially growing quantity approaches a fixed upper limit. This leads us to a very important generalization, as follows: **Given present resource consumption rates** and the projected increases in these rates, the great majority of the currently important

Resource	Static Reserve Index (Years)	Projected Growth of Usage (% p.a.) (av.)	Exponential Reserve Index (Years)	E.R.I. with 5 x Known Reserves (Years)
Aluminium	100	6·4	31	55
Chromium	420	2·6	95	154
Coal	2,300	4·1	111	154
Copper	36	4·6	21	48
Iron	240	1·8	93	173
Lead	36	2·0	21	64
Manganese	97	2·9	46	94
Mercury	13	2·6	13	41
Natural Gas	38	4·7	22	49
Petroleum	31	3·9	20	50
Nickel	150	3·4	53	96
Tungsten	40	2·5	28	72

Exponential Reserve Indices for World Resources of Selected Minerals. From : Donella H. Meadows, Meadows, D.C., Randers, J., and Behrens, W. W. **The Limits of Growth**, London, 1972.

non-renewable resources will be extremely costly 100 years from now. This statement is true regardless of the most optimistic assumptions about undiscovered reserves, technological advances, substitution, or recycling—as long as demands for resources continue to grow exponentially. Examples are even now to hand for resources with the shortest static reserve indices—the price of mercury has increased 500% in the last 20 years, the price of lead 300% in the last 30 years.

Undiscovered reserves

As geologists rightly observe, there are still vast undiscovered reserves of many minerals, and at least some of these occur in places and concentrations that will allow them to be mined economically. But in the face of exponential increase in usage the best figures that are available for world resources are indeed startling (see tabulated figures) if we assume that current trends in increasing demand will continue. The last column shows that this is true even if we assume that there are enormous undiscovered reserves—five times what were known in 1970.

Comparable Australian data have not yet been compiled. In relation to internal usage we are well off in many minerals but certainly not in all that are needed to sustain a modern industrial state. However, since we export much more of our abundant minerals than we use ourselves Australia must be looked on, for many minerals, merely as part of the world reserves, to be mined for use in Japan, USA and Europe.

Extract from a public lecture, "Is there an Environmental Crisis?", delivered at the Australian National University on April 26, 1972, by Professor F. J. Fenner, Director of the John Curtin School of Medical Research and a Vice-President of the Australian Conservation Foundation.

Reproduced with acknowledgment to A.C.F. Newsletter, Vol. 4, No. 3, June, 1972.

CORELLAS OVER ROTTNEST

Honorary Warden Mr. W. A. Farmer, of Rottnest Island, has sent us the following interesting report:

"Rottnest residents saw for the first time a flock of Corellas [probably Long-billed Corellas, *Ed.*] flying overhead on August 30. They kept at great height and returned to the mainland without landing.

"This contrasted with the mobs of Black Cockatoos which visit Rottnest every few years and are the only visitors who reduce the local ravens to a state of terrified silence. After stripping all cones from the pine trees, the Black Cockatoos decide to depart; but because of their low-flying habits they circle the island for days, distracted by ravens who by then have lost their fear and attack continually. Then, one day, their leader sights the mainland and the black flock disappears."

DUCK SHOOTERS' LICENSES

In the event of a duck shooting season being declared this year, licenses (fee $2.00) will be available—

by post from:

Department of Fisheries and Fauna,
108 Adelaide Terrace, Perth;

by calling at any of the following district offices:

Albany
Bunbury
Busselton
Broome
Carnarvon
Dongara
Fremantle
Geraldton
Jurien Bay
Kalgoorlie
Lancelin
Mandurah
Mt. Magnet
Onslow
Pemberton
Perth
Pingelly
Shark Bay
Wongan Hills
Wyndham;

or the Clerk of Courts at:

Collie
Esperance
Harvey
Katanning
Manjimup
Narrogin
Northam
Wagin.

RED FACES IN ADELAIDE TERRACE

Did you notice our magnificent boo-boo on page 36 of the last issue of S.W.A.N.S. (Vol. 3, No. 2)? If not, then judging by the number of phone calls and letters we have had from our readers, you would appear to be in the minority.

The error was, of course, in the caption under the photograph on that page, for the two birds running alongside the fence are ostriches, not emus. We knew they were ostriches, meant to write ostriches, but in a moment of mental aberration they were titled emus—after all, the story was about emus.

One thing is certain, never again will we write the captions while the rest of the journal is being set at the printers. Meanwhile, there are two very red faces in one office in Adelaide Terrace.

PROPOSED RESERVE AT DRAGON ROCKS

In early August, 1972, officers from the Fauna Research Branch and the W.A. Herbarium began a detailed fauna and flora survey of land in the Hyden district of Western Australia. An area of approximately 80,000 acres was being considered as a potential reserve for the conservation of flora and fauna.

In brief, the purpose of the survey was:—

(1) To assess the land in terms of the quality and diversity of its flora and fauna.

(2) To determine suitable boundaries for the proposed reserve by discovering, as far as possible, the distribution and hence the habitat requirements of the indigenous animals.

Granite outcrop. Adult she-oak stand in background.

The country consists of high-level, undulating, scrub-covered sandplains with laterite breakaways and ridges giving way to long, gradual slopes supporting mallee associations. The shallow drainage lines contain Salmon Gum stands. One of the many exposures of granite rock, typically surrounded by "Tammar Scrub", has been given the name "Dragon Rocks". This picturesque name, highlighting the presence of the Dragon Lizard *(Amphibolurus ornatus)* on the exfoliating flaking granite tors and bosses, will be recommended as a suitable name for the reserve when it is acquired.

Barking gecko *(Phylluaus milii)*.

It was already known that the region supported some interesting animals. The Wuhl-Wuhl *(Antechinomys spenceri)* and the Fat-tailed Marsupial Mouse *(Sminthopsis crassicaudata)* had been captured in 1967. By the end of August, 1972, an extensive list of native animals had been confirmed and specimens lodged with the Western Australian Museum.

MAMMALIA

Marsupialia

MACROPODIDAE — Common Name
Macropus fuliginosus (Western Grey Kangaroo)
Macropus irma (Western Brush Wallaby)
PHALANGERIDAE
Trichosurus vulpecula (Brush-tailed Possum)
BURRAMYIDAE
Cercatetus concinnus (South-Western Pigmy Possum)
TARSIPEDIDAE
Tarsipes spencerae (Honey Possum)
DASYURIDAE
Phascogale calura (Red-tailed Wambenger)
Sminthopsis murina (Common Marsupial Mouse)
Sminthopsis crassicaudata (Fat-tailed Marsupial Mouse)
Antechinomys spenceri (Wuhl-Wuhl)

Rodentia

MURIDAE
Notomys mitchellii (Mitchell's Hopping-Mouse)
Pseudomys occidentalis (Western Mouse)
Mus musculus (House Mouse—non-native)

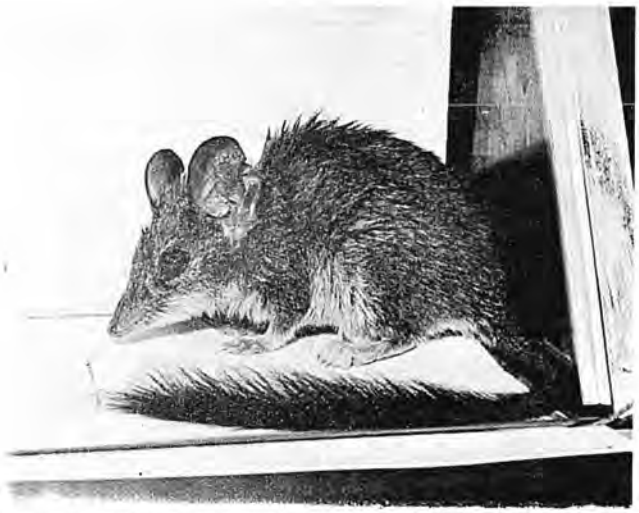
Chiroptera

VESPERTILIONIDAE
Nyctophilis sp. (Long-eared Bat)
Eptesicus pumilis (Little Bat)
Chalinolobus gouldii (Gould's Wattled Bat)

Monotremata

TACHYGLOSSIDAE
Tachyglossus aculeatus (Echidna)

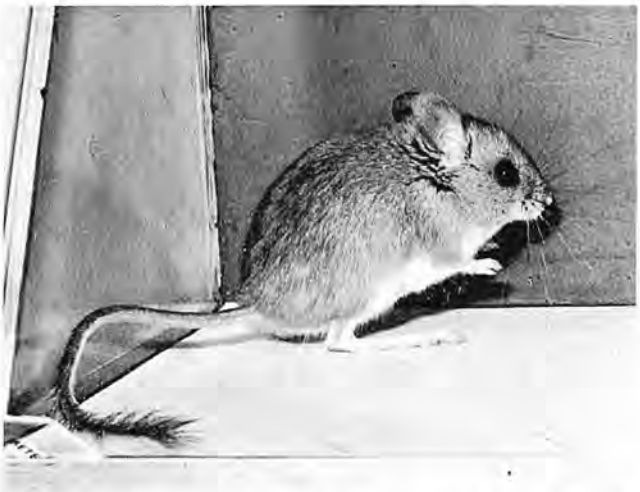
Many of the mammals in the above list are of particular interest. Very little is known about *Anthechinomys spenceri;* and *Pseudomys occidentalis* is listed as one of "The Rare Ones" by W. D. L. Ride in his book, "A Guide to the Native Mammals of Australia". The specimen of *Sminthopsis murina* was extraordinarily large and had a noticeably shorter tail than is characteristic for the species. A similarly large and apparently anomalous specimen was recently captured by Museum staff at Tarin Rock, a nearby flora and fauna reserve.



Red-tailed Wambenger *(Phascogale calura)*. This female had eight young in her pouch.

The Pigmy Possum and the Fat-tailed Marsupial Mouse are interesting because they can lower their body temperature well below that needed for normal activity (become torpid). By so doing these animals are able to enter a state of energy-saving inaction. It has been shown that this state may be prompted by a situation in which food supplies are unreliable, as they may often be in arid areas.

The Honey Possum *(Tarsipes spencerae)* has been described as a zoological enigma. According to Ride (1971) "it has no obvious close relatives, and much work yet remains to be done before we understand it or its ancestry."



Mitchell's Hopping Mouse *(Notomys mitchellii)*. Female.

AVES

Many birds were identified including both diurnal and nocturnal birds of prey. Several species were of special interest, such as the presence of the Purple-gaped Honeyeater and Square-tailed Kite.

REPTILIA

The reptiles collected are at present being identified by the W.A. Museum. Of interest was the large number of Little Whip Snakes *(Denisonia gouldii)* captured. A species of Blind Snake *(Rhamphotyphlops sp.)* from a meat-ant nest, and Fraser's Scale-footed Lizard *(Delma fraseri)* was found in rotting Salmon Gum logs. Aside from these species, a wide variety of skinks, geckos and dragons were captured.

AMPHIBIA

A number of different frogs were caught. The most notable was the specimen of *Myobatrachus gouldii* caught in a pit trap. A. R. Main, in his "Key to the Frogs of South-Western Australia", describes it as follows: ". . . having a very small head and extremely short limbs. Looks like a turtle and lives always beneath soil surface." This specimen was obviously wandering around on the surface when it fell into the trap. There had been very heavy rain during the night.

A species of tree-frog was also captured, but this is still to be identified.

The fauna listed above reflect more than 3,000 trap nights and some hundreds of man-hours of effort.

The quality and variety of the fauna captured on this block of land indicates that it is potentially one of the most valuable reserves in the State.

It is believed that small mammals in arid areas have habitat requirements which vary widely from season to season and from species to species. If most of the species indigenous to such an area are to be permanently conserved, large areas of all the native habitat types should be included in the reserve.

Myobatrachus gouldii An unusual frog which is turtle-like in appearance.

DECLARATION AND AMENDMENT OF RESERVES

NEW RESERVES

Name	Res. No.	Locality	Plan	Area	Previous Use	Purpose	Vesting	Gazetted
Durokoppin	A22921	11 miles North West of Doodlakine	25/80 B.1	254a. 2r. 3p.	—	Conservation of Flora & Fauna	W.A.W.L.A.	27-8-71
Morton	A31360	16 miles east of Bullaring	377/80 E.1	281a. 2r. 26p.	Land owned by Mr. A. Morton and donated to Dept. by him	Conservation of Flora & Fauna	W.A.W.L.A.	26-5-72
Chinamans Pool....	31444	Carnarvon	563/80	66a. 1r. 28p.	....	Conservation of Flora & Fauna	....	21-7-72
Mungaroona Range	A31429	30 miles North of Wittenoom	Pyramid and Marble Bar— 4 mile	261,542a.	....	Conservation of Flora & Fauna	W.A.W.L.A.	30-6-72

VESTING OF RESERVES

Name	Res. No.	Locality	Plan	Area	Purpose	Previous Vesting	New Vesting	Gazetted
Gillingarra	2332	Victoria Plains	58/80 D.4	260a. (approx.)	Conservation of Flora & Fauna	....	W.A.W.L.A.	16-6-72

CHANGE OF PURPOSE

Name	Res. No.	Locality	Plan	Area	Previous Purpose	New Purpose	Vesting	Gazetted
Tutanning	31163	Avon 28224	378/80	95a. 3r. 22p.	Conservation of Flora & Fauna	Biological Station and Conservation of Flora & Fauna	Minister for Fisheries & Fauna	7-7-72
....	4182	5 miles West of Esperance	423/80	300a.	Water	Water & Conservation of Flora & Fauna	Minister for Water Supply	5-7-72
Dongolocking Reserves	19082–7 19089–96 20070 20835–6	15 miles north of Dumbleyung	386/80	8877a	Timber	Conservation of Flora & Fauna	W.A.W.L.A.	23-6-72
Arthur River	30668	West of Arthur River	409/80	Abt. 174a.	Conservation of Flora	Conservation of Flora & Fauna	W.A.W.L.A.	16-6-72

AMENDMENT OF AREA

Name	Res. No.	Locality	Plan	Previous Area	New Area	Purpose	Vesting	Gazetted
Wagin	8821	Wagin	409/80	16a. 3r. 31p.	14a. 1r. 15·4p.	Conservation of Flora & Avian Sanctuary	....	3-3-72

CONSERVATION AND BIOLOGY OF THE WHITE MANGROVE

(Avicennia marina) on the Leschenault Estuary near Bunbury

by Dr. N. M. Morrissy,

Western Australian Marine Research Laboratories.

Southern estuary, Leschenault; looking from the northern bank south towards the town of Bunbury.

Conservation

The Leschenault Estuary is the only locality where the white mangrove, normally considered as a tropical species, is known to occur in the south of Western Australia. The two small stands of mangrove on this estuary are very vulnerable to the developmental whims of man.

Mangroves fringe the northern bank and Anglesea Island opposite the town of Bunbury, on the southern end of the estuary. Immediately adjacent to this stand is the new massive deep-water harbour development, the embankments of which separate this southern part of the estuary from the major northern reach. Between the mangroves, the northern bank, and the southern harbour embankment is a small ponding used to dump effluent from a nearby plant which extracts ilmenite from beachsands. The ponding does not appear to have affected mangroves close by (although the very few mangroves in the basin have died). At present these mangroves are more threatened by a proposal to straighten the estuarine channel so as to provide an extra few hundred metres for a 1,000 metre rowing course. There is also a proposal to bulldoze and fill the salt marsh backing the mangroves, so as to "control" mosquitoes.

The northern stand of mangroves is even smaller and is located on the isolated western shore of sand dunes, near the head of the estuary just north of Waterloo Point. Possibly careless upgrading, by bulldozing, of the track abutting the shoreline fringed by the mangroves, places the mangroves in constant jeopardy. Thoughtless destruction of natural areas, e.g. by unsupervised bulldozing, is being increasingly decried by many people.

In the present climate of ecological awareness, any development expected to adversely affect natural areas should not be allowed to proceed without reasoned argument, seeking to find an effective compromise for action, based upon the values of the proposed development and of the natural conditions (Morrissy, 1970a). In the area in question this democratic process is effectively undertaken by the Leschenault Estuary Conservation Committee, the members of which represent many points of view. For example, a proposal has been received for eradication of the salt marshes backing the mangroves in the southern part of the estuary which have been blamed for breeding the salt tolerant larvae of a mosquito, *Aedes vigilax*, the adults of which are a pest to the town people of Bunbury. However, Hodgkin and Smith (1971) have advised the above committee that breeding is not likely to occur in parts of the swamps which are regularly inundated by the tides. **But** where stagnant pools have been dug or enclosed by dumping and filling, as has been done in some places around the estuary, breeding does occur and, therefore, attention should be focused on these localities.

The social merit of a rowing course of Olympic standard near Bunbury must be weighed against the loss of part of the present southern stand of mangroves. However, there is a possibility that any losses of mangroves could be offset by creating suitable intertidal banks where seedlings could be planted in other places.

Biology

The word mangrove has an obscure origin; it is a combination of the Portuguese "mangue" and the English "grove". "Mangrove" is used either to describe an association of floristically diverse trees and shrubs **which grow in the intertidal region of the sea,** characteristically forming the lower part of the coastal vegetation of many tropical and sub-tropical areas, or it may be applied to an individual species of these trees such as *Avicennia marina* (MacNae, 1967; Connor, 1969).

In southern Australia there is only one species of mangrove, *Avicennia marina*. Its existence in Western Port Bay (latitude 38° 20′S) near Melbourne, St. Vincents and Spencer Gulfs (32° 30′S-34° 50′S) in South Australia, and near Bunbury (33° 20′S) represents the southern extremity of a distribution centred in tropical regions where many different mangrove species form vast areas of swamps and forest (Adams, 1969). Mangroves occur on tropical shores from the ever-wet to desert, i.e., from regions of high rainfall and high humidity to regions of low rainfall and excessive evaporation. Along desert coasts only one or two of the most hardy mangrove species survive. *Avicennia* occurs along the shore of the Red Sea (MacNae, 1966). Extensive mangroves occur around the northern shore of Australia, at all suitable localities between Houtman Abrolhos and Shark Bay in W.A. and the Queensland-N.S.W. border.

Avicennia is thought to be limited in its southward dispersal by low temperatures. Two hypotheses are put forward for its presence in southern Australia (MacNae, 1966). Firstly, its presence may be explained by the drift of floating fruits in known currents southward from the northern regions and across the southern coast from west to east. However the short life of the floating hypocotyl makes this hypothesis unlikely. Secondly, the three patches of *Avicennia* in southern Australia may be relics of past geological eras when the climate was warmer than it is today and *Avicennia* may have persisted in these especially favourable sites from the late Tertiary (about one million years ago). Beard (1967) has discovered an extensive stand of mangroves on a saline inland creek, isolated from tidal action, in the northwest of W.A. along the 80 Mile Beach He suggests that this occurrence is a relic of estuarine conditions prevailing at the time of maximum eustatic rise in sea level which occurred about 4,000 years ago.

Avicennia is a tree which is specially adapted to cope with salt and periodic flooding by tides (Adams, 1969). Water conducting tissue in the stem can almost completely desalinate saltwater. The leaves have epidermal glands which excrete salt. The tree has an extensive shallow root system, sensitive to erosion or sand deposition, which supports upright air-filled pneumatophores or aeration roots. At the base of these roots shallow nutritive roots form an interweaving mat, some 20-40 cm. below the surface of the fertile mud. On shores of high salinity the root system is more extensive and the aerial roots form copses up to waist height.

The seeds of *Avicennia* is viviparous, i.e. the young seedling grows out of the seed before it is released from the parent tree. This is an adaption to the salty conditions on the shore for the very young seedlings are not very tolerant of salt unlike older stages (see later).

Mangroves form the most seaward zone of the shore vegetation subjected to tidal flooding to a greater or lesser degree. According to MacNae (1966) mangroves occur between the extreme high-water mark and a level above but close to mean sea level. Some trees are surrounded by seawater only once or twice a year but the others usually have their bases inundated daily. Adams (1969) states that *Avicennia* (in contrast to the salt marsh) at Western Port Bay is right in the tidal water, and twice each day its breathing

roots (pneumatophores) are exposed to the air. The mangroves here mark the limit of the high tides. Patton (1942) observed that the junction between the mangroves and the salt marsh, landward behind it, is sharp where the banks are steep. Where the slope is gradual, however, the junction is not so well-defined and some of the marsh plants are regularly covered by the tide, although the depth of water is not great. The mangrove zone is seldom more than one or two large trees in depth. In front of these trees thickets of saplings and seedlings extend out onto the beach.

Mangroves promote a great stability of littoral mud flats because of their extensive shallow root system (MacNae, 1963). There is a tendency for one bank of an estuary to be an erosion bank and the other a bank of deposition (of silt, etc.), e.g. the southern and northern banks of the Leschenault Estuary close to Bunbury. The bank of deposition is colonized by *Avicennia*.

Avicennia marina.

The settlement and establishment of the seedlings appears to be the most critical stage in the life-cycle of *Avicennia marina*. MacNae (1966) states that many of the seedlings at the lowest (seaward) level can have their leaves covered by a layer of fine mud deposited by the tide, and they soon die if this occurs. Saplings also die if shaded by their parents and can develop to full maturity only if they are exposed fully to the sun.

[Clarke and Hannon (1971) have recently shown experimentally that MacNae's (1966) observation is incorrect. Growth of seedlings is noticeably reduced only in deep shade. Under partially shaded conditions growth is less rapid but the seedlings are much healthier than in full light.]

Clarke and Hannon (1969, 1970) have examined survival of seedlings near Sydney where diurnal flooding occurs daily in the lower parts of the mangrove zone. The frequency of diurnal flooding in the upper parts of the zone is lowest in December and January when the seedlings fall. They say that this phenomenon is undoubtedly significant in seedling survival and that the majority of the seedlings fall in the landward part of the zone. The young seedlings tend to become established among pneumatophores of their parents where the tidal scour is least. The seedlings' roots take approximately 5 days to become firmly established and seedlings uprooted after this time usually die. Therefore a greater number of seedlings may be expected to survive if establishment occurs in conjunction with a period of lower than average tides. Although the seedlings require the moist humid conditions provided by regular tidal action during their early growth, tidal action limits the seaward extension of mangroves because the seedlings cannot grow in completely submerged conditions.

Clarke and Hannon (1969) after extensive field observations of soil salinity, water table level, drainage and aeration as determined by tidal movement and the microtopography of an area, considered that the survival of young *Avicennia*, and hence the presence of mature trees, was largely determined by their tolerance of salinity and water-logging. They then (Clark and Hannon, 1970) performed glasshouse experiments to determine the tolerance of young trees. Freshly fallen seedlings of *Avicennia* can be obtained at the suitable stage for transfer (with 0-2 leaves) from the field for only about one week in each year near Sydney. A vermiculite culture saturated with 25% seawater was used to grow the seedlings to the 2-4 leaf stage. The solutions were renewed at two-week intervals but not aerated. Covering the culture vessels with inverted plastic bags improved growth since the seedlings were then exposed to higher humidities.

At the 0-2 leaf stage *Avicennia* requires seawater for optimal growth, particularly for root development. After the cotyledons had dropped, the seedlings grew well for several months in seawater and diluted seawater without an external nutrient source, although the greatest growth occurred in 20% seawater plus nutrient solution. Concentrations above 60% seawater retarded growth. Very few seedlings were able to tolerate more than 100% seawater for more than a few weeks, and no leaves were produced when more than 125% seawater was used.

Seedlings at the 2-4 leaf stage were more tolerant of higher salinities than the younger plants. The best growth of these older seedlings occurred with 40% seawater plus nutrient; 85% survival occurred in 100% seawater.

Pneumatophores in mud.

Extreme water-logging, including total immersion, of the very young (0-2 leaf stage) seedlings resulted in a high mortality but survivors, after passing through an unhealthy period, grew into plants as healthy and almost as large as those in the less water-logged treatments. Seedlings that had already developed 2-4 leaves were not adversely affected by water-logging.

Connor (1969) also found that the optimum level of salt for *Avicennia* occurred at about half the concentration of seawater. Connor concluded that the normal habitat of this species reflects its tolerance to high levels of salt rather than an optimum adaptation to it. However, by comparison with the other vegetated intertidal zones, the mangrove zone shows least variation in soil salinity on a seasonal basis due to the regular tidal flooding over it. The more landward zones show larger variations in soil salinity due to the more prominent effects of evaporation and freshwater drainage. The more frequent inundation of the mangrove zone keeps soil salinity close to that of seawater and satisfies the mangrove's metabolic requirements for salt and water.

Young saplings—seedlings of *Avicennia marina* colonizing the new embankment of the pondage for ilmenite.

Clarke and Hannon conclude that the seaward limit to the belt of mangroves bordering the sea is determined by tidal action on seedlings. Landward, high soil salinities for long periods, or wide variation in salinity and lower humidities, due to the more marked effects of evaporation, freshwater drainage, wind action and high temperatures with decreased frequency of tidal flooding, limit the further spread of the mangroves.

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QUEENSLAND ACTS ON BIRDS

Regulations governing the taking of birds in Queensland were recently altered.

By Order in Council, the open seasons on birds were deleted as from December 31, 1971. There are now no statutory open seasons on any birds in Queensland and the trapping of protected birds will not be permitted. However, open seasons for game species, such as wild ducks, may be declared from time to time. Pest fauna may be taken without a permit.

Fauna dealers are permitted to deal only in open season or pest fauna. The intention of closing the open seasons was to prevent further trapping of native birds. To enable fauna dealers to continue trading, special permits were issued to permit them to deal in any foreign birds and budgerigahs until the end of April. The position is now being reviewed and the future policy is being determined.

Persons with private aviaries are permitted to sell birds that had open seasons, provided they obtain prior written permission from the Department.

It is unlawful to remove any bird from Queensland without a permit issued by that State's Department of Primary Industries. A permit will not be issued without the authority of the importing State.

DOMESTIC CATS AND DOGS—A DANGER TO THE AUSTRALIAN FAUNA

(by M. Archer, W.A. Museum)

It is a sad but well-known fact (Rolls, 1969) that introduced animals in Australia have caused extensive damage to ecological diversity and habitats. Most of this awareness has focussed on the damage caused by eutherian herbivores such as rabbits, water buffalo and sheep. These animals are responsible for habitat destruction (e.g. Stocker, 1971) and compete with native herbivores for food. Less attention has been given to the effects of the introduced eutherian carnivores. Marshall (1966) suggested that the "astonishing prevalence" of feral cats was the probable reason for the few small mammals sighted during a trip into north-west Australia in 1965. Other authors have mentioned the havoc created by the introduction of the cat (Ride, 1970). But there is an additional aspect to the problem of introduced eutherian carnivores, which has escaped notice, perhaps because we are too close to the problem.

Natural predator-prey cycles are maintained by the fact that when prey becomes scarce the predator's numbers are reduced. The basic factors that theoretically control the numbers of a prey species at any one time include the availability of food, shelter and other essentials; the reproductive rate of the prey; and the amount of predation by carnivores. The population size of prey species may cycle in response to seasonal availability of food or achieve a homeostatic balance determined by the resources available and the amount of predation. This means that under natural conditions, a predator's population size is determined directly by the size of the prey's population and indirectly by the amount of food, shelter and other essentials available to the prey species. Take for example a feral population of eutherian cats. During a good season small vertebrates and birds would be abundant and the cat population size would not be controled by a lack of food. Accordingly, more of its young survive to eat more prey. As the good season ends, the prey species decline in availability and if the cats' numbers are too high, some will die of starvation. An equilibrium will be reached so that there are only as many cats during the poor season as can be maintained by the available prey. This means that from the prey's point of view, cat predation does not intensify in the poor seasons and there is no real danger that the prey's numbers will fall low enough to risk extinction. This balance will persist until the next good season. This is theoretically how a natural predator-prey cycle works.

Man, and his domesticated carnivores, violate this system. Domestic dogs and cats forage near and far from home, obeying instincts to kill, without in fact depending for an existence on the animals they kill. They return home for a meal which may be minced whale from a tin. They are not dependent on the immediate bush environment in which they move. Consequently they are not controlled by its limitations. If a prey species' population size is low during a poor season, it may not be able to sustain the artificially high predation pressure brought about by too many well-fed domestic cats and dogs. That this does happen is testified by the following observation by Rolls (1969), referring to a domestic cat and feral mice: "At the beginning of one mouse plague she (the cat) snatched all of fourteen mice that ran from beneath a sheet of corrugated iron on bare ground.

Kimberley Planigale. An adult individual caught by the Western Australian Museum team in the Ord River area in January, 1972. The first individual known to science since the species was described, in 1913, was killed by a domestic cat in 1949 at the Kimberley Research Station.

The mice followed each other down her throat head to tail. Then she walked off into the grass, vomited them all up, made sure they were dead, and came back to catch more." Similarly, many small dasyurid (native marsupials) specimens brought into the Western Australian Museum arrive with information such as "brought in by cat". These are often found as dead animals left uneaten in the kitchen or on the back porch. Certainly it is true that feral cats, foxes, dogs, stoats, etc., wreak considerable damage on the native fauna through competition with native carnivores and perhaps direct predation. But it is clear that domestic animals can be a danger. This is particularly important because domestic cats and dogs surround most woodlands

and reserves. The danger they present should be considered when faunal reserves are created and maintained near human habitation. For example, Kings Park in Perth is totally surrounded by urban and suburban development. At its widest point it is only about two miles long, barely a morning's walk for a cat. It is therefore reasonable to suppose that over-predation by cats could have been at least in part responsible for the absence of virtually all small native mammals from this once "virgin" woodland.

Perhaps it is impracticable to erect adequate fencing around reserves. Cats would be very difficult animals to fence out. In that case the pet owner should assume more responsibility in the situation by restricting the movement of the cat or dog. If it were possible to keep carnivorous pets entirely at home this would be a satisfactory way of dealing with the problem. Another satisfactory way of dealing with the problem might be to make pets of non-carnivorous indigenous animals such as kangaroos or possums instead of carnivorous cats and dogs. On the other hand, if nothing at all is done to control the activities of domestic cats and dogs, the pet owner must be prepared to assume part of the responsibility for severe and perhaps irrevocable damage which is now being done to Australia's native fauna.

(Reprinted with acknowledgement to "The Western Australian Naturalist".)

SUGGESTED READING

REPTILES.

"Australian Lizards"—Robert Bustard. Sydney, William Collins, 1970.

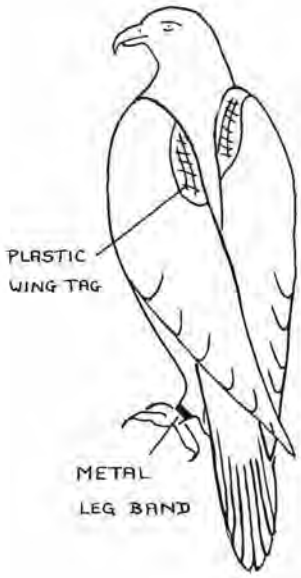
From the small geckos and skinks familiar to every city dweller to the large monitors and fearsome-looking dragons of the inland, lizards are among the most interesting and diverse creatures inhabiting the Australian continent. In spite of this, surprisingly little has been written about them.

Dr. Bustard's book fills a real need as far as knowledge of Australian wildlife is concerned. For several years he has studied lizards all over the continent and has also carried out a particularly intensive research programme in the Pilliga Scrub district of New South Wales. The result is a complete survey of the five lizard families which inhabit Australia, showing where and how they live and what can be done to aid their conservation.

While the writing is authoritative and therefore of great value to all naturalists, it is by no means academic or dull. This book will appeal to everybody who is interested in lizards, even in the most general way, and the liberal selection of photographs which accompanies the text makes it an ideal reference and identification guide.

In addition, there is a useful chapter on keeping lizards in captivity and an extensive bibliography for the reader who wishes to carry his study of these reptiles even further.

EAGLE MIGRATION STUDY



C.S.I.R.O. Division of Wildlife Research has banded a number of Wedge-tailed Eagle chicks and adults in W.A. and movements of up to 500 miles have been recorded to date.

The drawing above shows where the eagles are marked. **All** birds are given a numbered metal leg band. In addition, **some** are given a wing tag, usually in the form of a strip of coloured plastic wrapped around one or both wings.

It would greatly aid this study if the legs of all eagles found dead were inspected thoroughly for metal bands and, if found, these bands were forwarded to the address below, together with such information as where found and when. If wing tags are also recovered, their return would be appreciated.

Michael Brooker,
C.S.I.R.O.,
Clayton Road,
Helena Valley, W.A. 6056.

NEW FAUNA AUTHORITY FOR S.A.

As from July 3, 1972, the South Australian authority, the Department of Fisheries and Fauna Conservation, will no longer be responsible for fauna. This responsibility has now been transferred to the newly-created National Parks and Wildlife Service of the Department of Environment and Conservation.

Our Diminishing Heritage

Kimberley Planigales *(Planigale subtillissima)* are thought to be the smallest existing marsupials; so small in fact that they are close to the lower limits of size postulated to exist for warm-blooded animals. In his book, "A Guide to the Native Mammals of Australia", Dr. W. D. L. Ride places the Kimberley Planigale with the *Antechinus* (marsupial mice), suggesting that they are pigmy derivatives of this genus, but pointing out that their relationship is largely a matter of conjecture at present.

They are mouse-like animals with a characteristically flattened head which is little more than ⅜ in. from base to crown. The head and body together measure 1½ to 2 in. and the tail about 2½ inches. The general colouring of the body is greyish, the hairs being tipped with yellow near the sides of the body, and the colour becoming much lighter on the ventral surface. The ears are covered only with short hairs and appear quite transparent in strong light; the eyes are black and bulge when the animals are frightened. Tactile vibrissae ("whiskers") are a feature of the snout, and project to the width of the body; they form an integral part of the cleaning operations which follow every meal. The nostrils are set almost at the extreme tip of the snout in the same fashion as those of a dog, and a division extends back to the mouth which contains sharply pointed sets of teeth, both top and bottom. The tail tapers evenly from the base to tip and has a uniform covering of hairs with a very small tuft at the tip.

Note flattened head and black, bulging eyes. Whiskers extend to width of body. (Photograph: Courtesy of M. Archer.)

Kimberley Planigales are mainly insectivorous, with crickets and grasshoppers being the most favoured food, but it has been found that young rodent mice and even geckos are consumed with obvious relish. They can move quickly but only in short spurts, and have been seen to jump from, and land on, all fours over short distances. However, apart from a squatting posture which is adopted while feeding, they have no other kangaroo-like habits.

For many years the species was known only from a single specimen collected by a Swedish expedition in 1913. This had been caught in a crack in the earth on a plain near Noonkambah on the Fitzroy River in the West Kimberleys. No further specimens were discovered until 1949 when a cat brought a dead specimen into the Kimberley Research Station near Wyndham, but, in the next few weeks five other specimens were caught alive. Unfortunately, although an attempt was made to breed them in captivity, none survived. During the Ord Noah rescue operation in 1971 (see story, S.W.A.N.S., Vol. 3, No. 1) a further seven specimens were collected. Two of these were already dead, having been found inside Childrens' pythons; three died subsequently, but the remaining two (both females) have been sent to La Trobe University (Melbourne), where Dr. Patricia Woolley is carrying out research on the species. The only other specimen known to science was collected by departmental research officer Jim Lane during a field trip to the Kimberleys when studying the effects of pesticides on wildlife. This Kimberley Planigale was found in the stomach of a Nankeen kestrel; this and other dead specimens are being studied at the W.A. Museum by Michael Archer.

So little research having been possible, it is hardly surprising that knowledge of the species is so scanty. They were once thought to be exceedingly rare, but recent indications are that their status may not be as precarious as was feared and that the inaccessibility and ruggedness of their habitat, rather than lack of numbers, is the main reason why so few have been taken. *Planigale subtillissima,* however, causes enough concern for the species to be listed in the I.U.C.N.'s Red Data Book.

KIMBERLEY PLANIGALE

Planigale subtillissima

(Photograph: Courtesy of M. Archer.)

DISTRIBUTION:

Kimberley Division, W.A.; savannah woodland and grassland.

LOOKS:

Much smaller than a mouse, head flattened when seen in profile.
General colouring—grey, tipped with yellow. Moves rapidly, in short bursts.

LENGTH:

Overall—10-11 cm (4-4½ in.). Tail only —6 cm (2½ in.).

WEIGHT:

Full data not available at present, but weight is less than 5 g.

BREEDING:

Little data available, no young have been born in captivity.

DIET:

Mainly insects, preferably crickets and grasshoppers. Also will eat young rodent mice, geckos, etc. Usually eats a quantity of food at least equal to the volume of its body—**every day.**

STATUS:

"It is possible that this species may not be rare, but little collecting has been done in its area of distribution."

MARSUPIALS VERSUS LIVESTOCK

Public interest in conservation and the welfare of our wildlife has probably never been greater. Consequently, it is timely to take a look at some of the ways in which domestic livestock have interacted with our native species of wildlife. Most of the changes have been slow (with their beginnings more than a century ago), making it very difficult for one research worker to observe them. But Dr. A .E. Newsome, of the C.S.I.R.O. Division of Wildlife Research, has pieced together the story for some species of marsupials, partly from his own observations of the biology and present distribution of each species, but also by taking account of reports from explorers and stockmen.

When two populations of animals share the same resource, such as grass, it doesn't follow automatically that they have to compete for it, since there may be a surplus of the resource. Competition does occur, though, when there is too little of the resource to go round. On the other hand, sometimes the presence of one species may improve the supply of resource for another. As sheep and cattle were introduced to the arid and semi-arid areas of Australia the large kangaroos prospered. But many species of inoffensive, harmless marsupial became rare, and some died out. This article examines some of the likely reasons for these changes.

Europeans aid euros

The euro *(Macropus robustus)* is a large kangaroo living mostly in hills and rocky outcrops in inland Australia, which became extremely abundant in the Pilbara district of north-western Australia about 50 years after sheep were introduced there in 1880. Throughout the rest of their habitat euros were, and have remained, relatively uncommon.

The Pilbara, perhaps better known today for its mineral resources, is a very hot, semi-arid sandplain with scattered low hills and granite outcrops. Soft spinifex dominates the pastures, but this was not always so. Originally, more nutritious pastures including grasses and saltbush grew along the river flats and valley floors, especially after monsoonal summer rains; spinefex grew mainly on the hills and rocky outcrops.

Euros were unable to feed extensively on the flats because of a lack of water there. During the day they were forced to shelter in cool caves in the hills. As sheep (and some cattle) were introduced, watering points were provided every three miles or so along the grassy flats. The euros drank from them too, and this eliminated their severe water shortage. With that restraint removed, they multipled greatly and were no longer restricted to the hills and outcrops; they came out onto the plains and, like red kangaroos, sheltered under the trees by day and grazed at night. By 1930 the numbers were so high that euros were regarded as ruinous pests and blamed for the decline in the country's ability to carry sheep. Certainly the land was carrying a great many euros—in 1959 one station running 6,500 sheep killed 12,800 euros in two months. It was not surprising that most people blamed the euros for the decline in carrying capacity.

However, some years ago Dr. E. H. M. Ealey, of the C.S.I.R.O. Division of Wildlife Research, together with Mr. H. Suijdendorp, of the Western Australian Department of Agriculture, studied the euro problem and came up with a more complex explanation. They suggested that pastures had deteriorated, and attributed this change to heavy grazing, initially by sheep and later by euros as well. The more nutritious grasses had largely been eaten out and spinifex had taken their place. For much of the year spinifex was the only feed available, and since it is only a poor maintenance diet for sheep this greatly favoured the euros, which have always relied on it for dry season and drought fodder.

So two factors seem to have been responsible for the amazing increase in euro population in the Pilbara: improved water supply, and a favourable change in the pasture composition.

Red kangaroo increased too

The red kangaroo *(Megaleia rufa)* also lives in the arid zone and complements the euro ecologically by living on the plains and needing green nutritious herbage to eat. This species, too, became much more abundant after livestock were introduced, and Dr. Newsome has suggested an explanation for the rise in numbers. He found that the stock keep the herbage closely grazed, forcing perennial grasses to produce a continuous supply of green shoots. This happens best between 1.5 and 3 miles out from watering points; pasture closer to the water becomes grazed out, and pasture more than 3 miles away is not grazed heavily enough by the stock. These "marsupial lawns" of green shoots keep the kangaroos alive during drought.

Much has been written on the controversial question of competition for food between red kangaroos and stock during drought. Dr. Newsome feels that as yet, despite three published studies on the subject, there is no conclusive evidence. Two of the studies were made when food was abundant, while in the third the diet of the kangaroos was not examined in the same localities as that of the stock.

However, Dr. Newsome does conclude that, even if kangaroos could be completely removed, few additional stock could be run. Nevertheless, he believes that during severe drought there may be

strong competition for the remaining grass. The best policy is probably to harvest both livestock and kangaroos, but the most profitable way to do so remains to be worked out.

Small marsupials—a different story

In marked contrast to the large kangaroos, the small marsupials have invariably suffered from the influences of livestock and Man's other agricultural activities. Three main types of ecological change appear to have been involved: competition for food, removal of shelter, and increased predation. An exact explanation of the effects on every species is impossible; the evidence is sparse and not always reliable and the environmental changes are exceedingly complex. For many species, such as the hare wallabies, the grazing of long grass by stock removed an essential shelter resource.

For instance, the spectacled hare-wallaby *(Lagorchestes conspicillatus)* lived in and around the mulga woodlands of central Australia and was once quite common there. It sheltered in long grass during the day and was at one time so common that stockmen used their dogs to course the wallaby for sport. Today the grassy plains are often grazed almost bare and the species is extinct.

A solution?

Over inland Australia, probably four species of marsupials are already extinct, several more may be very close to it, and perhaps andother 20 are in danger. Many harmless native rodents are probaby in a similar position. Wildlife has also disappeared from areas where the rainfall permits cropping and sown pastures. What can be done? There are no easy answers, partly because we don't yet know enough about the delicate relations between the animals and their environments. But certainly it is now clear that most species cannot co-exist with livestock. If we want to preserve the native animals it seems that more national parks must be provided, although proper management of parks is hampered by our lack of knowledge.

It is ironic that so much attention has been diverted from our small native animals by public concern for the welfare of a few species of kangaroo that only became abundant in recent times, and which are not in great danger of extinction.

(Reprinted with acknowledgement to "Rural Research in C.S.I.R.O.", July, 1972.)

HONORARY FAUNA WARDENS APPOINTMENTS

MILLS, Phillip John, of "Meldakot", Lyon Road, Jandakot. (Gazetted 8/9/72.)

BROWN, Harold James, of Post Office, Jurien Bay. (Gazetted 8/9/72.)

HALSE, Norman James, of 156 Lockhart Street, Como. (Gazetted 8/9/72.)

WILLIAMS, Vivian Eldred, of P.O. Box 13, Moora. (Gazetted 8/9/72.)

VERSTEGEN, Peter Jan, of 7 Contour Road, Roleystone. (Gazetted 8/9/72.)

FAUNA WARDEN APPOINTMENT

SMITH, Raymond Leich. Notice of this appointment appeared in the *Government Gazette*, August 4, 1972.

11715/11/72—1850

WILLIAM C. BROWN, Government Printer, Western Australia