Western Australia

FISHERIES DEPARTMENT

BERNIER AND DORRE ISLANDS

(Fauna Bulletin No. 2)

Published by the Chief Warden of Fauna, Perth, under the authority of the Hon. Ross Hutchinson, D.F.C., M.L.A., Minister for Fisheries.

PERTH

By Authority: ALEX B. DAVIES, Government Printer

53321/11/60—1M.

ANDREW BURRIDGE

The Results of an Expedition to

BERNIER and DORRE ISLANDS

Shark Bay, Western Australia

in

July, 1959

By

W. D. L. RIDE, G. F. MEES, A. M. DOUGLAS,
The Western Australian Museum

R. D. ROYCE,
The Western Australian Herbarium

C. H. TYNDALE-BISCOE,
Zoology Department, The University of Western Australia

Editor: A. J. FRASER, Chief Warden of Fauna

1962

(1) 53321

FOREWORD

Bernier and Dorre Islands lie between latitudes 24°44′S and 25°17′S, some 30 miles off the Western Australian mainland. Together they comprise Class A Reserve 24869. The total area is approximately 26,000 acres, and the purpose of the reserve, which is vested in the Fauna Protection Advisory Committee of Western Australia, is " Conservation of Fauna."

Early in 1959 the committee, as the controlling body, was asked to relinquish some 20 acres of Bernier Island to permit its development as a tourist resort.

No recent information being available in relation to the status of the fauna and flora of this island, the committee, whose chairman is Mr. A. J. Fraser, Director of Fisheries and Chief Warden of Fauna, decided to arrange that a biological survey be made before coming to a decision. At the same time it was agreed that opportunity should be taken to make an examination of the adjacent Dorre Island.

Dr. W. D. L. Ride, M.A., D.Phil. (Oxon.), Director of the Western Australian Museum, at the committee's request organised a party to carry out the survey, and the Fisheries Department's research vessel *Lancelin* was placed at the disposal of the party. In addition, the services of the department's research officer were made available to co-ordinate the activities of the vessel and her crew with the needs of the members of the expedition.

The survey party consisted of Dr. Ride, as leader and mammalogist; Dr. G. F. Mees, Phil. Nat. D. (Leiden), Curator of Vertebrates, Western Australian Museum, ornithologist; Mr. A. M. Douglas, Experimental Officer, Western Australian Museum, herpetologist; Mr. R. D. Royce, B.Sc. (Agric.), Senior Botanist, Department of Agriculture, Perth, botanist; Mr. C. H. Tyndale-Biscoe, M.Sc. (N.Z.), Lecturer in Physiology, University of Western Australia, mammalogist; and Mr. B. K. Bowen, B.Sc., Research Officer, Fisheries Department, observer.

This is an account of the expedition and its findings. The period spent ashore on the islands was short, and it cannot be pretended that the results are complete. Nevertheless, all who took part have faithfully documented what they know of this piece of the Australian continent, which, though small, is of considerable importance biologically.

As Minister responsible for the administration of the Fauna Protection Act, I am most grateful to all members of the party for their worthwhile contribution to the State's store of knowledge. The recommendations at p. 120 have been adopted *in toto* by the Fauna Protection Advisory Committee.

ROSS HUTCHINSON,

Perth, May, 1961. Minister for Fisheries.

(2) 53321

CONTENTS

INTRODUCTION

by W. D. L. Ride.

Bernier and Dorre are two uninhabited islands which mark the north-western limits of Shark Bay on the Western Australian coast in latitude 25° South.

Today, they are reserves set aside for the preservation of fauna and flora; secure for this purpose unless declared otherwise by special Act of Parliament.

Shark Bay and its islands were first discovered by Dirk Hartogs in 1616. Dorre Island (Dor Eyland) was subsequently named by De Vlamingh who surveyed the area in 1696–97 and Bernier Island by Freycinet during the Baudin Expedition of 1801.

In common with some of the other islands off the west coast of Australia, elements of the fauna and flora of Bernier and Dorre have been known and recorded for longer than that of almost any other part of Australia. On the 6th of August 1699 William Dampier, in His Majesty's Ship *Roe-buck*, entered Shark Bay where members of his crew landed on Dirk Hartogs Island and on Bernier. Dampier wrote an account of the natural history of the bay and its islands and this relates almost entirely to Dirk Hartogs. He described in some detail the flowers and trees, the birds, some reptiles, and two mammals. One of these, a small wallaby, was almost certainly the Banded Hare Wallaby, *Lagostrophus fasciatus*, so common on Bernier and Dorre today.

For a century after Dampier's visit the islands remained undisturbed and then in June and July 1801 they were visited by the French corvette *Geographe* under the command of Baudin and carrying a number of scientists of whom F. Peron is probably the best known. This expedition landed on both Bernier and Dorre and, in addition, progressively explored Dirk Hartogs, other islands of the bay, and parts of the adjoining mainland. The scientific results of this expedition were never fully published owing to the premature deaths of the principal biologists, and all that was written was a general account of the natural history, written in narrative form by Peron before his death in 1810. Strange as it may seem, this introductory account remains to date the main source of our knowledge of the natural history of the islands.

Particular mention of Peron's comments on the fauna and flora of the islands will be made later and here it is sufficient to remark that the Frenchman found the islands desolate, inhospitable, lacking in water, and, to make matters worse, Peron became lost in the scrub on Bernier and considered himself lucky to have survived. In common with William Dampier, Sir George Grey, and ourselves, they experienced a violent storm during their stay.

The next expedition into the bay was also a French one. This was in the corvette *Uranie* which was commanded by Freycinet, Baudin's lieutenant in the earlier voyage of the *Geographe* and the *Naturaliste*. This expedition carried no biologists, but the medical officers Quoy and Gaimard made collections and published an account of them in 1824. Insofar as Shark Bay is mentioned, the account relates entirely to Peron Peninsula and Dirk Hartogs Island. However, it also adds to our knowledge of Bernier and Dorre, because two of the mammals (*Perameles bougainvillei* and *Bettongia lesueuri*), so common on them were first described in it.

During the next forty years three British expeditions entered the bay. These were led by Lieutenant Phillip King (H.M. Surveying Ship *Bathurst*, January 1822), by Captain H. M. Denham (H.M.S. *Herald*, 1858), and by Lieutenant, later Sir George, Grey (in three whaleboats, February and March 1839). Collections were made by King's and Denham's expeditions, but beyond King's narrative (1827) which contains an account of the plants collected on Dirk Hartogs Island, little has been published on them. Grey published a general account of his voyage in 1841 which, although it adds little to our knowledge of the natural history of the islands, gives a remarkable and inspiring picture of storm, disaster, desolation, and hardship in this waterless and inhospitable place.

The modern period of scientific exploration of Bernier and Dorre might be said to date from March, 1896, when J. T. Tunney, collector of the Western Australian Museum, visited one of them for a few hours and collected five wallabies. In April, of the same year, he again visited the islands for what appears to have been only a few hours and, finally, in February, 1899, he returned for about a fortnight. Unfortunately, the details of these visits, including the order in which he visited the islands and what he found on each, will probably remain unknown. The letters relating to the final, and most important, visit have been stolen from his correspondence in the Museum and his field diaries were destroyed by his family on his instructions. By curious coincidence, Shortridge's letters, which give an account of his expedition (see later), cannot now be found in the mammal section of the British Museum (Natural History). Labelled specimens collected on Tunney's three expeditions carry the locality Dorre Island.

The next collector on the islands was G. C. Shortridge who made a collection of mammals and birds for the British Museum (Natural History) in June, 1906, on behalf of Mr. W. E. Balston. Scientific papers resulted, and much of our detailed taxonomic knowledge of the mammals and birds on the islands results from this expedition.

In August and September, 1910, Otto Lipfert, the taxidermist of the Western Australian Museum, collected on the islands and a short general account of the mammals and birds was published. At approximately the same time G. F. Hill visited Bernier Island, but no account has been published of his stay.

Between November, 1910 and March, 1911, Bernier and Dorre were visited by an anthropological expedition from the University of Cambridge. This expedition comprised Professor A. R. Radcliffe-Brown and Mr. E. L. Grant Watson and went to study the aborigines in the hospitals there. They were accompanied by Mrs. Daisy Bates who later described the conditions under which the patients were living (1938). Grant Watson is said to have been a photographer and a biologist to the expedition and numbers of reptiles, collected by him in the islands, are in the collections of the Western Australian Museum. There is also one bandicoot. No account of the biological results of this expedition seem to have been published and no zoological material collected by Grant Watson on this expedition is in the Univerity Museum of Zoology in Cambridge.

Finally, in 1938, a party from C.S.I.R.O. Division of Fisheries visited the islands and made a small collection of plants from the strand and foredunes.

In Bernier and Dorre, therefore, we have something unique in Australian biology. We have two almost untouched natural populations

of fauna and flora of which there are general accounts spread over more than two hundred and fifty years. In addition to the accounts, collections are also spread over only a slightly less period and, in the pages which follow is the account of a further expedition and yet more collections. In this publication we have made an attempt to interpret the conditions which we have observed today in the light of past information. If the reader judges that success, in this respect, is only limited, we hope that he may reflect that the *next* expedition to the islands will have better comparative material and that they will be able, through our work, to have some clear-cut idea of the problems to be faced and the avenues which will lead to their solution.

Each part of this report was written in consultation with all members of the expedition who, as a team, co-operated in collecting material and in observations. However, since each member is a specialist in his own field, the chapters are shown under the names of the authors who are responsible for the analysis and presentation of the data. The conclusions and recommendations are those of all.

The report owes much to the people who have so willingly helped us in gaining the information which has gone into it; we cannot mention all of these here but we are, nevertheless, grateful for their help. In particular we must mention Mr. L. Glauert, who identified the reptiles, Dr. J. E. Glover, who discussed and identified the rocks, Dr. A. R. Main and Mr. G. M. Storr, of the Department of Zoology, University of Western Australia, Mr. R. Vollprecht, of the Bureau of Meteorology, Mr. A. R. McEvey, of the National Museum of Victoria, Dr. P. W. Crowcroft, of the British Museum, Dr. Chr. Jouanin, of the Paris Museum and finally, but not least in importance, we must mention the help given us by Mr. A. J. Fraser and the Fisheries Department, our own institutions and departments, and Mr. B. K. Bowen and the crew of *Lancelin*. Without them we would have accomplished nothing.

NARRATIVE

by W. D. L. Ride

The 1959 Bernier and Dorre Expedition sailed from Carnarvon at 0630 hours on July 14, 1959. The members of the party, and their fields of responsibility, were as follows :—

W. D. L. Ride and C. H. Tyndale-Biscoe, Mammals ; R. D. Royce, Botany ; G. F. Mees, Birds ; A. M. Douglas, Reptiles and Goats ; B. K. Bowen, Observer and Liaison Officer between the party and the crew of the Research Vessel *Lancelin*. The crew of the *Lancelin* comprised Skipper D. Wright, crew member C. R. C. Haynes and Fisheries Inspector N. E. McLaughlan.

Also on board *Lancelin* was Mr. W. G. Boksette and a party of the Department of Lands and Surveys. This department was taking the opportunity afforded by the expedition to obtain astro-fixes of various headlands on the islands.

The east coast of Dorre Island is forbidding and has almost continuous high cliffs, broken by re-entrants, which occasionally come down to the water's edge, and by a few beaches. In the distance, the vegetation on top is grey-green and nondescript. The Lands and Surveys party was put ashore at White Beach at the southern end of the island and then *Lancelin* moved north until Disaster Cove was reached. Disaster Cove is a beautiful little bay protected by cliffs and a reef and is almost certainly the " most convenient little boat harbour, sheltered by a reef from all winds " in which Grey camped on February 28, 1839. From the cliff above the cove the remainder of Dorre Island can be seen stretching, as

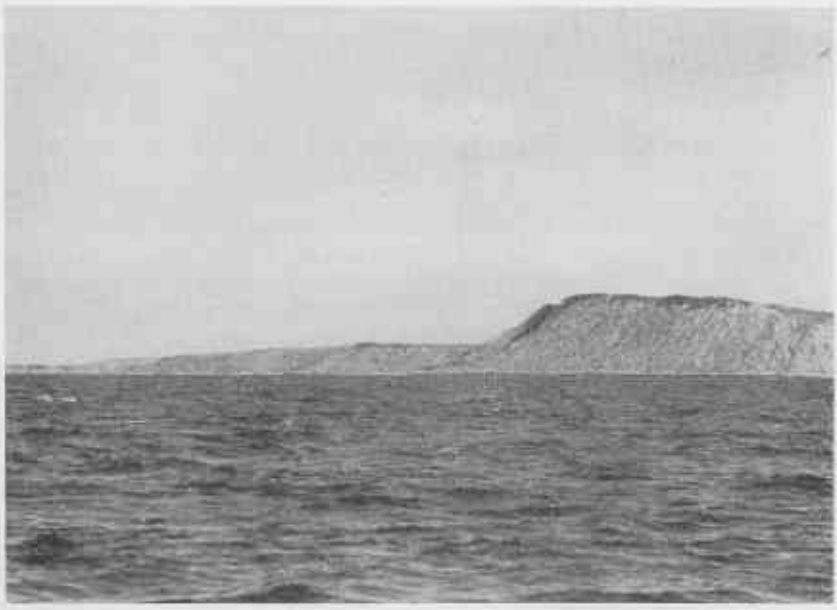


Plate 1. The east coast of Dorre Island showing Quoin Bluff, the highest point on the island.

Plate 2. Disaster Cove, Dorre Island.

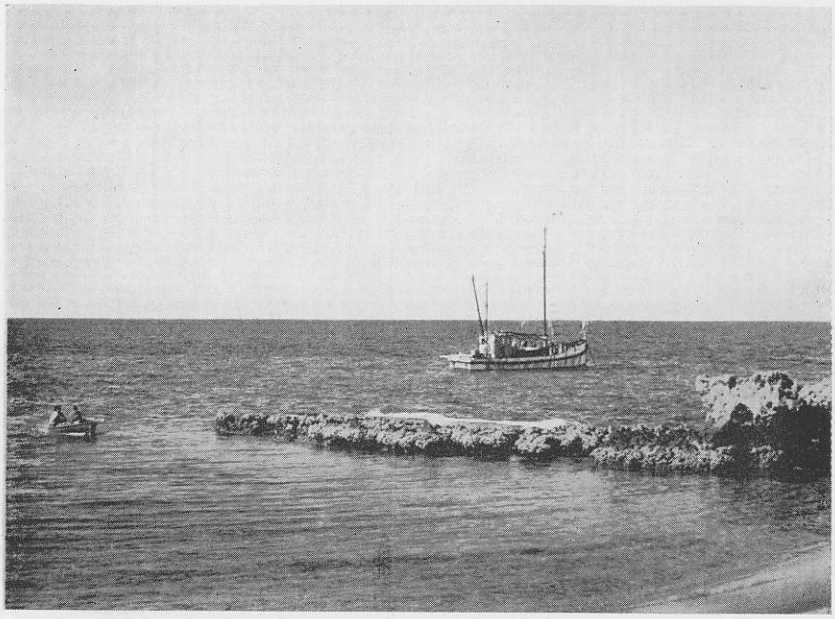


Plate 3. Approaching Disaster Cove at low tide. Lancelin lying off shore.

far as the eye can see, to the westward and southward ; while to the north is the narrow channel of turbulent water between Bernier and Dorre. Remembering the sudden storm that beset Grey in the same place, and in which the sea had come in for " fifty-three yards above the highwater mark," we set our camp high above the beach.

Disaster Cove is probably a misnomer. Although credited to Grey on the Admiralty charts, this is the place where Grey's party suffered the storm but saved their boats. Grey's disaster took place on Bernier where they lost a boat and all their stores. Unfortunately, in Grey's map (Grey 1841 Vol. II), he does not indicate the name Disaster Cove, nor even his route on Bernier Island.

The dunes around Disaster Cove are blowing out from around the bases of clumps of *Pileanthus limacis*, whose long, contorted, woody-roots are now exposed. The fine sand was covered with tracks of lizards, mice and wallabies ; and of particular interest were tracks which could easily be confused with the " rosettes " of foxes. These were found, upon close examination, to be made by wallabies overlapping the prints of their forepaws. They may be the origin of the stories of some seamen who have reported foxes on the islands.

Lancelin left us to return to Carnarvon and July 15 and 16 were spent by the party in working around Disaster Cove. Mammal traps were set, birds, geological specimens and mammals were collected, and small burrows of the Boodie (*Bettongia*), under the low bushes and " spinifex " of the plains (which we called the Open Steppe), were explored and, in the evening of July 15 the expedition witnessed a phenomenon unusual in such high latitudes. At 2345 hours the *aurora australis* became visible

Plate 4. Looking northwards across the narrow passage between Dorre and Bernier Islands.

through breaks in cloud as a deep crimson light between 240° and 140° extending about 40° above the horizon. It lasted for about five minutes. It was seen once more at 0115 hours on July 16, and the crew of *Lancelin* saw the lights again at 0400 hours as they were leaving Carnarvon.

On July 17 Douglas, Royce and Tyndale-Biscoe were taken to White Beach in *Lancelin* and walked back to Disaster Cove, crossing the island repeatedly, in order to obtain an overall impression of it. At White Beach there are the concrete floors and various other remains of the Lock hospital (see page 124). In the old underground water-storage tank, which was dry, the party found a considerable quantity of small bones which were clearly the debris left by roosting owls. This was an important discovery, because owls are very efficient " professional " catchers of small mammals, and the examination of their pellets gives an excellent idea of what is available in the district (see page 95). Mr. J. E. Bramley, Supervising Inspector of the Fisheries Department, had previously reported he had seen some large " white faced owls " (*Tyto alba*—The Barn Owl) in the tank in 1948. A sample of the debris was taken from the eastern half of the tank which is divided by a low wall ; apart from complete wallaby skeletons, which were lying on the surface of the western half, the rest was left untouched for future workers.

The return routes up the island, taken by the three walkers, were not easy going. Between Peaked Cliff and Quoin Bluff there are a large number of small valleys with dense scrub and, in the valleys of the western ridges, mammals were plentiful and quite large numbers of Boodies (*Bettongia*) and Banded Hare-Wallabies (*Lagostrophus*) were seen. The bandicoot (*Perameles*) was also seen. Tyndale-Biscoe noted that the small wallabies seemed to be confined to the edges of the island and their droppings seemed scarce in the centre. There was a well-marked track along the top of the western cliffs. Royce noted that mammals seemed to be thickest in the low scrub where the branches of bushes come right down to the ground and were rarely found in thickets of *Alyogyne* or *Pittosporum*. At one point Douglas paced out a square 200 yards by 200 yards and then walked through this. He saw two animals in it. These were Banded Hare-Wallabies.

No goats, dogs, foxes or cats were seen during the walk. The remains of nine dead wallabies were found.

July 17 and 18 were again spent collecting from the northern end of the island and on July 19 Royce, Bowen and Ride went to Quoin Bluff to collect in the area of flat exfoliated stones of travertine crust on the top of the Bluff and in the surrounding Open Steppe. Curiously there were no lizards under these stones. This was unexpected because similar environments on the mainland are excellent collecting places. Living snails (*Bothriembryon* and *Rhaggada*) appeared to be aestivating under the stones. The holes of mice (probably the Ashy-grey Mouse, *Gyomys*) were plentiful in the sand of the cliff and there were several pairs of Singing Honeyeaters (*Meliphaga virescens*) in the tall scrub of the valleys.

In the evening Bowen and Ride crossed the island due west from Quoin Bluff and back again. The total distance walked was about four and one-half miles and the journey took them two and three-quarter hours. The nature of the country can be pictured quite well from this traverse. The headland of Quoin Bluff is covered with loose flagstones

and very little vegetation. On either side of it there are deep valleys which run steeply down to the beach line ; that to the north and west is filled with dense tall scrub which is generally about eight feet high. Inland from the headland is a plain covered with Open Steppe. This is a typical " spinifex plain " with great round clumps of " spinifex " (*Triodia*). The plain is about a mile wide and at its western edge becomes mixed with low acacias and belts of small eucalypts (*Eucalyptus dongarraensis*) which are around three feet high. At 2200 hours on this July evening both walkers remarked on the chill damp air in their vicinity. The climate felt quite different from that of the surrounding steppe.

To the west of the belts of eucalypts, the plain ends at a series of high, stable sandhills with fairly thick, but low, vegetation in the valleys. The vegetation of each valley appears to differ from those on either side of it. These valleys were marked with innumerable mammal tracks and the last few were filled with *Olearia* about 30 inches high and were very difficult to walk through. The last sandhill sloped down to a low cliff (Low Point) and then on to the narrow beach beyond. At the beach there was a fresh wind blowing and the evening was dominated by the continual roar of breakers coming in from the open ocean.

On July 20 we left Dorre Island and set up a new camp at Hospital Landing, to the south of Wedge Point, and near the northern end of Bernier Island. Hospital Landing was so-called because this was the boat-landing place for the Lock hospital which lay just over the sandhills from the beach. Running north from the old hospital area is a desolate valley (see page 40) which we called Hospital Valley.

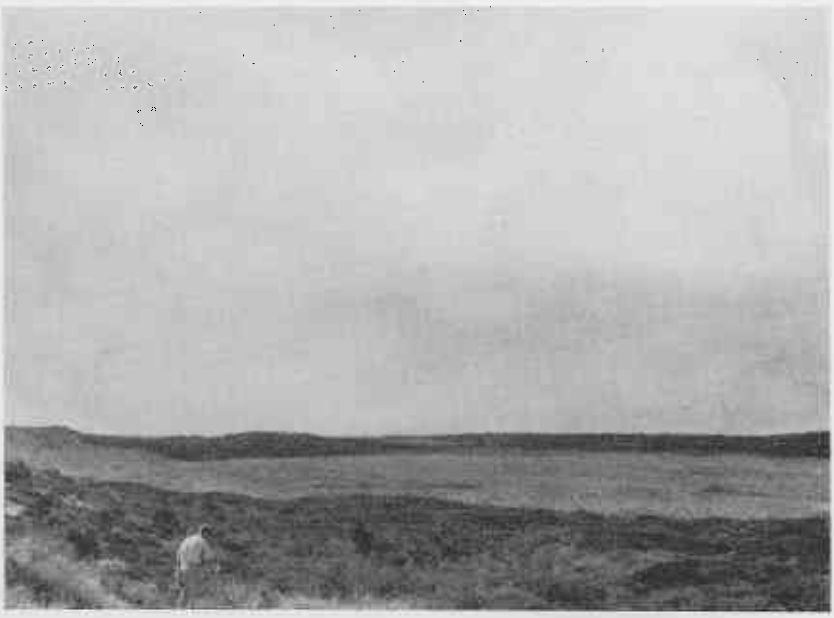


Plate 5. Northern end of Hospital Valley, Bernier Island, showing denuded ground surrounded by consolidated dunes. Thicket of *Acacia rostellifera* in foreground.

Immediately on landing, we saw numbers of goats and the first specimens were shot.

On the afternoons of July 20 and 21 we collected in the vicinity of Hospital Valley and Hospital Landing. The area was rich in mammals, birds, and reptiles, and everywhere were the remains of occupation during the hospital period. Broken bottles were lying about, clay pipes of the aboriginal patients, and charred bones of the wallabies on which they had been feeding, lay among the sandhills and an old cart stood under a bush. Goats were common and the vegetation appeared hedged and broken in a way not apparent on Dorre.

On Bernier Island large numbers of dung-burying beetles (Coprinidae) were active in the sands above the beach. These black beetles were also present in large numbers on Dorre, but there seemed to be more on Bernier. They appeared to be busy burying the scats of wallabies and goats; at first they were regarded as rather amusing but useful disposers of waste, but later were found to be a nuisance because they attacked the small mammals which had been killed by trapping and did so much damage that the skins of some mice were made useless for museum purposes.

The Bobtail (*Trachysaurus rugosus*) was common in the scrub, far more so than on Dorre, and specimens were usually found in pairs. On being approached they invariably took up their open-mouthed defensive attitude and one could not but be reminded of Dampier's wonderful description of this lizard on Dirk Hartogs Island. As far as is known, Dampier was the first white man to see a Bobtail and it is tempting to believe his description forms the basis of the "Pushmi-pullyu" of Dr. Doolittle's adventures.

> "And [we saw here] a Sort of Guano's, of the same Shape and Size with other Guanos' describ'd (Vol. I. p. 48) but differing from them in 3 remarkable Particulars: For these had a larger and uglier Head, and had no Tail: And at the Rump, instead of the Tail there, they had a stump of a Tail, which appear'd like another Head; but not really such, being without Mouth or Eyes: Yet this Creature seem'd by this Means to have a Head at each End; and, which may be reckon'd a fourth Difference, the Legs also seem'd all 4 of them to be Fore-legs, being all alike in Shape and Length, and seeming by the Joints and Bending to be made as if they were to go indifferently either Head or Tail foremost. They were speckled black and yellow like Toads, and had Scales or Knobs on their Backs like those of Crocodiles, plated on to the Skin, or stuck into it, as part of the Skin. They are very slow in Motion; and when a Man comes nigh them they will stand still and hiss, not endeavouring to get away. Their Livers are also spotted black and yellow: And the Body when opened hath a very unsavoury Smell. I did never see such ugly Creatures any where but here. The Guano's I have observ'd to be very good Meat: And I have often eaten of them with Pleasure; but tho' I have eaten of Snakes, Crocodiles and Allegators, and many Creatures that look frightfully enough, and there are but few I should have been afraid to eat of, if prest by Hunger, yet I think my Stomach would scarce have serv'd to venture upon these *N. Holland* Guano's, both the Looks and the Smell of them being so offensive."

On July 21 Mees accidentally drove a wooden spike into the sole of his foot and on the following day it became necessary for him to return to Carnarvon for treatment. Thereafter bird skins were made by Douglas, and a number of additional specimens were shot by other members of the party. These could not be prepared on the island and they were kept cool in the refrigerator on *Lancelin* and, before shipment to Perth by air, were frozen at the whaling station on Babbage Island. This procedure proved successful and no specimens collected in this way were lost.

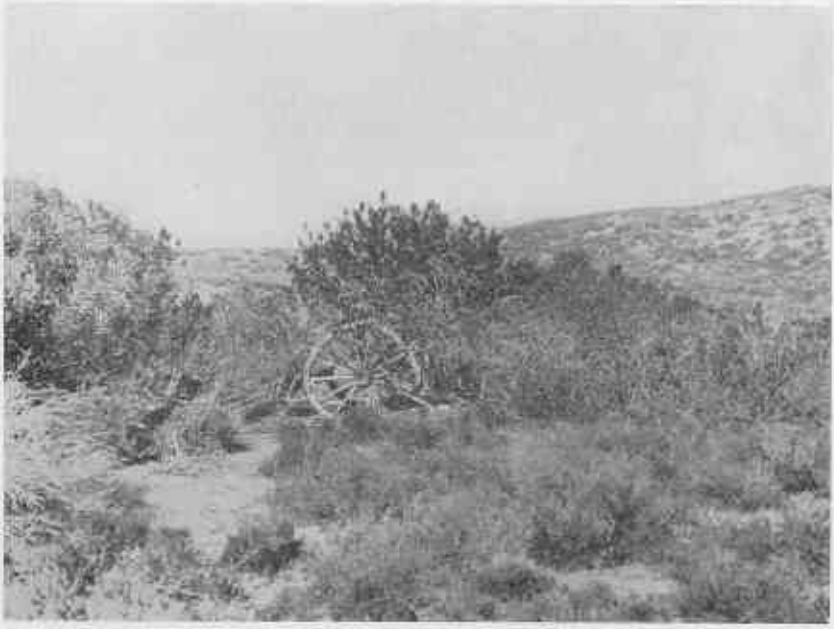


Plate 6. The remains of an old cart from the period of the hospitals. The cart stands under a bush of *Alyogyne cuneiformis*. Other shrubs are *Acacia coriacea*, *Santalum spicatum* and *Olearia axillaris*.

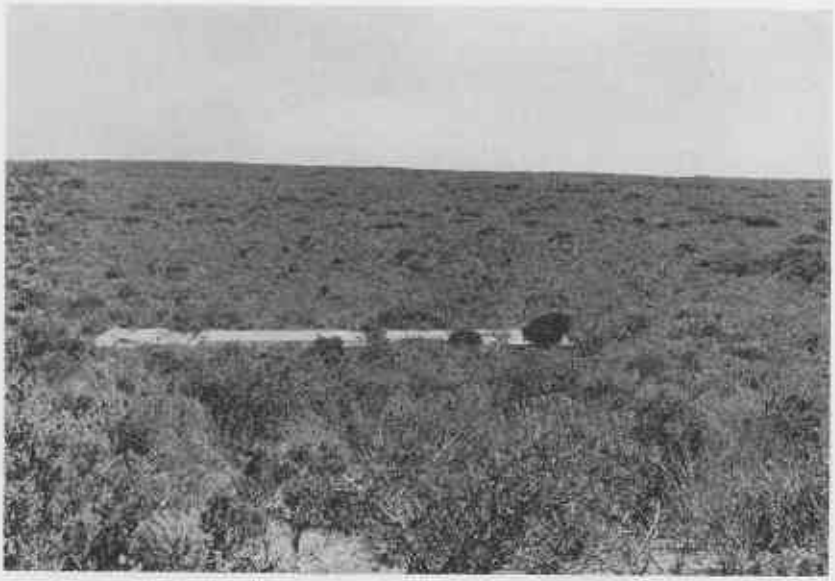


Plate 7. All that remains of one of the hospital buildings on the high ground above Hospital Valley, Bernier Island. The vegetation is typical of the Tall Scrub.

The 21st, 22nd and 23rd of July were spent by most of the party working in the northern part of Bernier and it was planned to move south on the 24th to land at Red Cliff Point and examine what appeared, from the aerial photographs, to be Open Steppe in its vicinity, since no Open Steppe had been found at the northern end of the island, merely one or two isolated patches of *Triodia**, but a storm arose and it rained and blew so hard for the next two days that the visit was impossible. Unfortunately, the party did not have the means to record this storm which was so typical of those in the Bay at that time of the year. It was a cyclone which moved south-east from west of Cocos Island on the 23rd and eventually passed between Cape Naturaliste and Cape Leeuwin in the early hours of the 25th. At Carnarvon the winds were strongest during the afternoon and evening of the 24th when they reached 65 m.p.h. (NE/N); by midnight they had decreased to light (NW/N) and persisted until 6 a.m. the next day. By 9 a.m. on the 25th they had increased to moderate to fresh southerlies. In Carnarvon 155 points of rain fell in the 24 hours ending 9 a.m. on the 25th.

After the heavy rain, the island was alive with numbers of yellow beach crabs (*Ocypode pygoides*) which we had not, to that time, seen inland of the beaches. They were even found moving among the ruins of the old

* A year later Mr. B. K. Bowen was able to get ashore again on Bernier and visited Red Cliff Point. He found only a few isolated clumps of *Triodia* there.

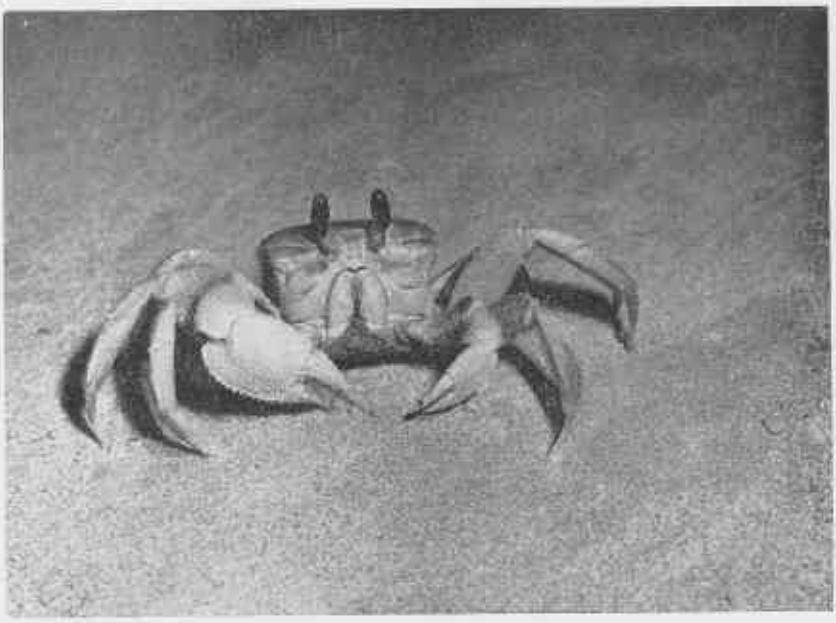


Plate 8. The Yellow Beach Crab, *Ocypode pygoides*. This is a common crab on the beaches and after the storm it was found among the sandhills some distance inland.

hospital, which is about a third of a mile from the sea, and were common right through the *Olearia* scrub on the stabilised sand hills.

The crew of the *Lancelin* experienced great difficulties during the blow and on the 26th were able to pull out into the Bay and back to Carnarvon. Finally, next day, *Lancelin* was able to get back into the landing and, just as the water supply had become low, relieved the expedition and returned it to Carnarvon.

THE PHYSICAL ENVIRONMENT

by W. D. L. Ride

Most of the account of this Expedition is devoted to the description of the fauna and flora, but here, in order to provide information on physical factors, an attempt is made to outline the geological history and character of the islands and to give an indication of their climate. Unfortunately, no geological or soil survey of Bernier and Dorre has been made, nor have accurate climatological data ever been collected on them. However, recent work on the Quaternary geology of Shark Bay by Logan (1959), on eustatic changes in sea level during the Late Pleistocene and Recent by Churchill (1959, 1960), and records from weather stations around the Bay, can be combined to give a general picture.

Geology

Bernier and Dorre are two elongated masses of Pleistocene Coastal Limestone at the north-western extremity of Shark Bay, a recent marine transgression of approximately 5,000 square miles into what was largely an aeolian dune landscape of Pleistocene times. The Bay now forms a system of peninsulas, bays, and islands on the Western Australian coastline between latitudes 24° 30' S and 26° 45' S, and longitudes 113° E and 114° 20' E (see Admiralty Chart 518 or U.S. Hydrographic Office Publication No. 3436). Bernier, the northern island, is approximately $16\frac{1}{2}$ miles long and is, at its widest, about $1\frac{3}{4}$ miles across. Dorre is 19 miles long and is, at its widest, 2 miles across. The Islands are underlain by sedimentary rocks which form the seaward extension of the predominantly Palaeozoic and Mesozoic Carnarvon Basin which has been a shelf depositional area since at least Silurian times; during the Tertiary there was deposition of some 1600 feet of limestone and calcarenites.

Logan says that, during the Quaternary, there appear to have been two distinct environmental patterns of sedimentation in the Bay. These are: firstly, the red quartz sands of probable deltaic origin which, together with dune sands, evaporites, calcarenites, and coquinas, fill the inlying synclinal depression; and secondly, the dominantly marine and aeolian calcarenites of the elongated calcareous dunes which mark its western border. These dunes have become indurated at depth to form Coastal Limestone and, today, they form the Edel Land Peninsula, Dirk Hartogs Island, Dorre Island and Bernier Island. The inlying Peron Peninsula is not one of these but is composed of the unfossiliferous ferruginous quartz sandstone of probable deltaic origin which Logan has called the Peron Sandstone. Today, on Peron Peninsula, the Peron Sandstone has a maximum elevation of approximately 150 feet, and since it interdigitates with the Coastal Limestone in the west, Logan believes that they are laterally equivalent and are both Pleistocene. If no uplift has occurred to these deposits during the Pleistocene or Recent (and if Logan is right in his contention that the Peron Sandstone is deltaic in origin) then it seems that it was deposited no later than the Milazzian phase of the Pleistocene, since at no time following that phase (500,000 years before Present) has the sea level exceeded 150 feet above present sea level (Zeuner, 1959 p. 307).

It cannot yet be stated with certainty that there has been no uplift in the Carnarvon Basin during the Quaternary. It has been held that

(3) 53321

the most recent anticlinal uplift occurred after the deposition of the Miocene Trealla Limestone and before the Pleistocene but Teichert (1957) believes that the uplift of some anticlines in this area continued into the post-Pliocene. However the evidence which he has presented does no more than emphasize the stability of the area since the period of the 10 ft. eustatic high water level of the sub-Recent.

During periods of low sea level in the Late Pleistocene it is likely that Bernier and Dorre together with Dirk Hartogs Island, Edel Land, and perhaps the Peron Peninsula, formed a single land mass separated from the eastern shores of the Bay by the northward flowing Wooramel River. Logan has indicated the presence of submarine channels which are cut into what are probably Cretaceous outcrops in the sea floor along the eastern shores of Hopeless Reach. The river would have flowed into the sea through the deeper valley which is now marked by Geographe Channel to the north and east of Bernier Island.

The bathymetry of the present Shark Bay clearly shows that Bernier and Dorre would have been connected with Dirk Hartogs, the Peron Peninsula, and the mainland when the sea level was 10 fathoms below present. This would place the date of separation at approximately 8,000 years before Present (Churchill 1959).

The channel between Bernier and Dorre is clearly no more than a breach in a formerly continuous dune, and it has about two fathoms of water in it. The Islands may have been isolated from each other at the time when sea level was two fathoms below that at present and before the period of the ten foot eustatic high level. If this is so, they may have been separate for as long as 6,000 years (dates of changes in sea level from Churchill 1960). However, the opening of the channel may be considerably more recent since the breach may have been made at a time when sea level was higher than it is at present and, during the sub-

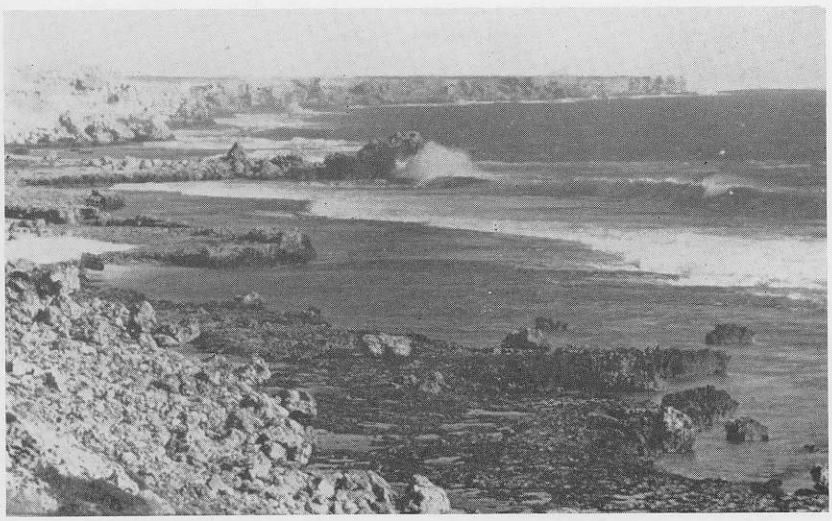


Plate 9. Wave cut platforms on the western coast of Bernier Island.

sequent fall, successively planated down by wave action to its present depth of about two fathoms which Logan says is wave base. Separation could thus have taken place between 5,000 and 3,000 years ago.

Today, the Islands are isolated from the mainland by 30 miles of open water and from Dirk Hartogs Island by 16 miles. They are predominantly flat-topped masses, girt by cliffs which mostly rise abruptly from the sea and reach an elevation of about 150 feet at Quoin Bluff on Dorre Island. In many places there is a narrow beach line along the foot of the cliffs and at intervals the cliffs are broken by re-entrants which run down from the plateau to the water's edge. There is an almost continuous intertidal reef platform along the western side of both islands, and the western cliffs commonly have large masses of tumbled rock at their bases. In places there are sea-caves.

The surface of the plateau of the Islands is not entirely flat. Locally it has extensive plains covered with a reddish sandy soil, but there are also stable sandhills rising above their level. The long axis of these fixed dunes is more or less due north-south, while the Islands themselves run from slightly east of north to west of south so that in general these dunes form long low features which run obliquely across the Islands. In places, particularly on Bernier, the dunes and the rims of the cliffs have blown out to form large areas of mobile sand (see plate 22). Measurements taken from aerial photographs indicate that the total area with scarcely any vegetation (beaches, blowouts and bare rock combined) on Bernier comprises approximately 2·5 square miles in a total land area of approximately 17·1 square miles, while on Dorre Island there are only approximately ·6 square miles of it in a land area of approximately 17·9 square miles.

The dune sands, of which the Islands are composed, are commonly indurated to form a limestone which is locally exposed on the surface of the plateau. In various parts of the account of this Expedition this is referred to as the " Travertine Crust." The main areas of exposed travertine are along the tops of the western cliffs of both Islands, the top of Quoin Bluff, and areas at the northern end of Dorre Island. In most of these places where the Travertine Crust is exposed it is without soil except in the solution channels and crevices which penetrate it. On Quoin Bluff the exposed limestone is mostly horizontally fractured so that large slabs like flag-stones are lying about on the surface.

Specimens of the country rock of the Islands were collected from the vicinity of Disaster Cove on Dorre and these have been examined for us and commented on by Dr. J. E. Glover (Department of Geology, University of Western Australia).

A typical piece of limestone from the cliffs of the west side of Dorre Island opposite Disaster Cove is described by him as a light brown, medium-grained, poorly indurated clastic limestone. In thin section he found the rock to be a medium-grained, quartzose calcarenite. Sand-sized, generally rounded calcareous fragments are one of the most abundant constituents and form about 35% by volume of the rock. Many of these grains show clear evidence of their skeletal origin, and some can be recognized as the remains of foraminiferal tests. Quartz grains are also abundant (35%): most of them are well rounded, but some are sub-angular. Minor constituents include garnet and microcline. Most of the clastic particles range in diameter between 0·2 mm. and 1·0 mm., and they are cemented by slightly cloudy to clear, fine-grained calcite, apparently of secondary origin, which makes up almost 30% of the whole.

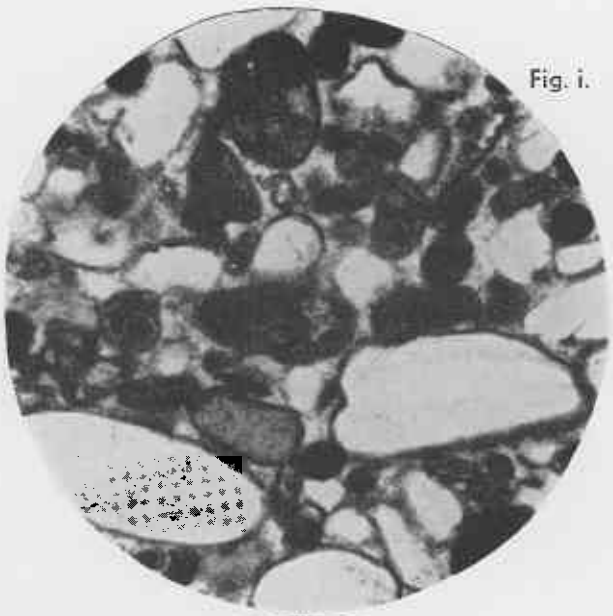


Fig. i.

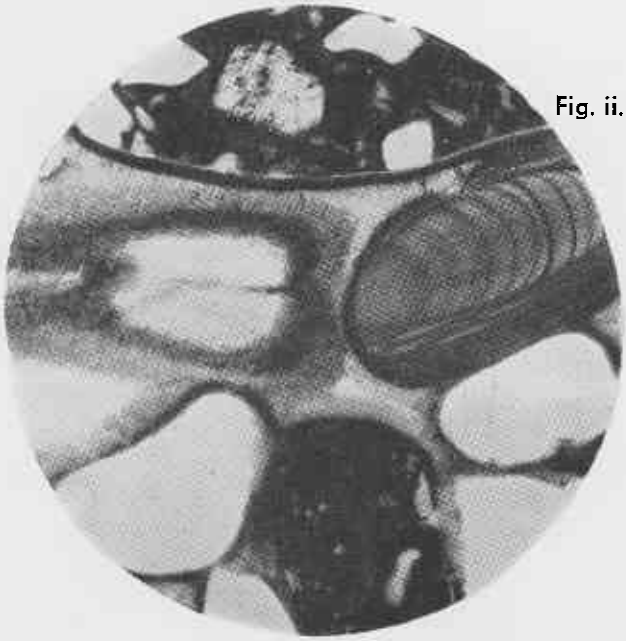


Fig. ii.

Plate 10

Fig. i. Thin section of calcarenite from the cliffs on the western side of Dorre Island opposite Disaster Cove. White grains are quartz and the dark grains are calcareous fragments some of which are clearly shell remains. Cement is finely crystalline calcite. Diameter of field 3.5 mm.

Fig. ii. Thin section of coarse-grained calcarenite from a boulder lying on the surface near Disaster Cove. The field includes several rounded quartz grains and three carbonate grains which differ greatly from each other in appearance : one of these is clearly a shell fragment. At the top of the field is part of a rounded fragment of finer grained, quartzose calcarenite which is unusual in that it contains a minute white vein of authigenic quartz, parallel to its boundary. This lithic fragment is very like the calcarenite illustrated in figure i. The whole rock is cemented by clear, crystalline secondary calcite. Diameter of field 3·5 mm.

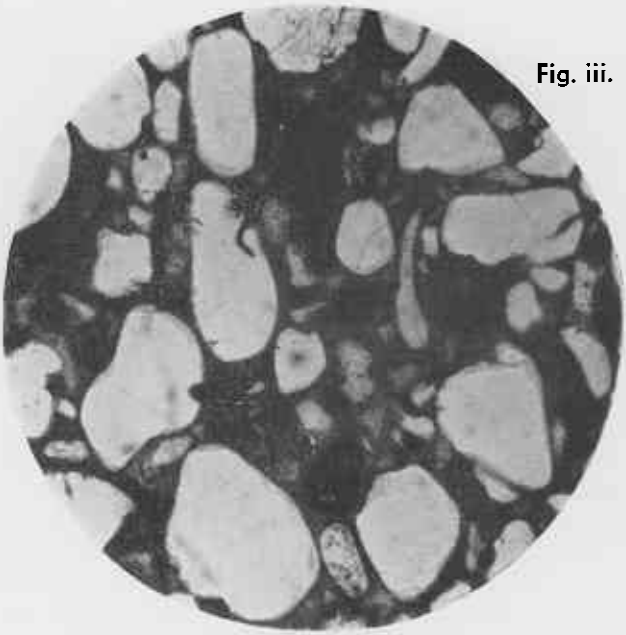


Fig. iii.

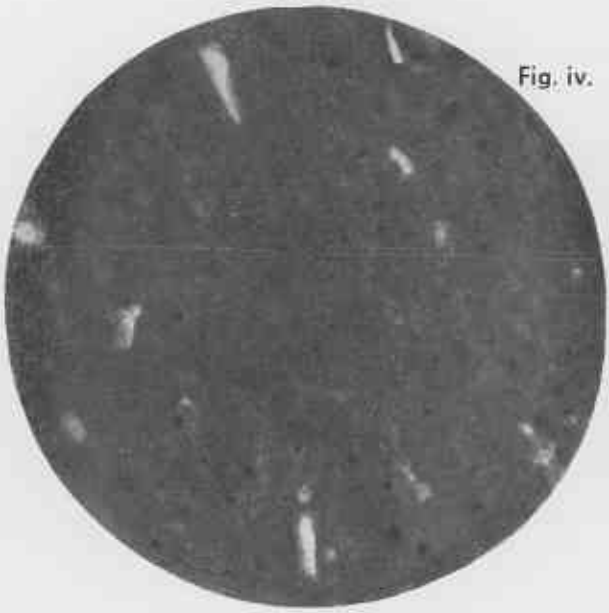


Fig. iv.

Fig. iii. Thin section of part of a compound specimen taken from a solution pipe. This represents the " country " rock of quartzose calcarenite, and shows how the originally well-rounded quartz grains have developed re-entrants due to solution. The clastic texture, so evident here, is absent from material in the post-depositional band elsewhere in the rock (see Fig. iv). Diameter of field 3·5 mm.

Fig. iv. Thin section of part of a finely banded area, post-depositional, in the same specimen illustrated in Fig. iii. Most of the field is occupied by iron-stained microcrystalline carbonate, and there are a few minute quartz chips whose general orientation is parallel to the band. Diameter of field 1 mm.

Legends by Dr. J. E. Glover, photomicrographs by Dept. of Geology, University of Western Australia.

In addition to this common country rock of the Island, pieces of a pale brown porous coarse- to very coarse-grained calcarenite containing numerous small shell fragments lay about on the surface in the vicinity of Disaster Cove. These were often pillow-shaped. Glover found that in a thin section of this rock most of the grains range between 0·5 mm. and 4 mm. in diameter but a few shell fragments are larger. Rounded quartz grains comprise about 10% of the rock and rounded grains of calcite, clearly derived from tests and shells, comprise about 45%. Many of the clastic fragments, however, are rounded, reworked grains of fine brown quartzose calcarenite. These lithic fragments contain calcareous pellets and organic fragments, quartz and fine carbonate cement, and make up about 35% of the rock. The clastic fragments (quartz, calcite and lithic grains) are surrounded by a fringe of clear, crystalline, apparently secondary calcite which cements them together. The rock is a coarse- to very coarse-grained quartzose, shelly calcarenite. It appears to be derived partly from pre-existing calcarenites and partly from more recently derived marine material.

In the country rock of the cliffs opposite Disaster Cove were numerous structures, some many feet across, which were obviously filled solution pipes or fissures in the limestone. These contained boulders of the surrounding limestone, concretionary bodies and numerous shells of a species of *Bothriembryon* which Dr. A. R. Main, of the Department of Zoology, University of Western Australia, has examined for us. He considers that it is somewhat close to *Bothriembryon dux* but not identical with it. *B. dux* is, today, only known from the triangle on the mainland bounded by

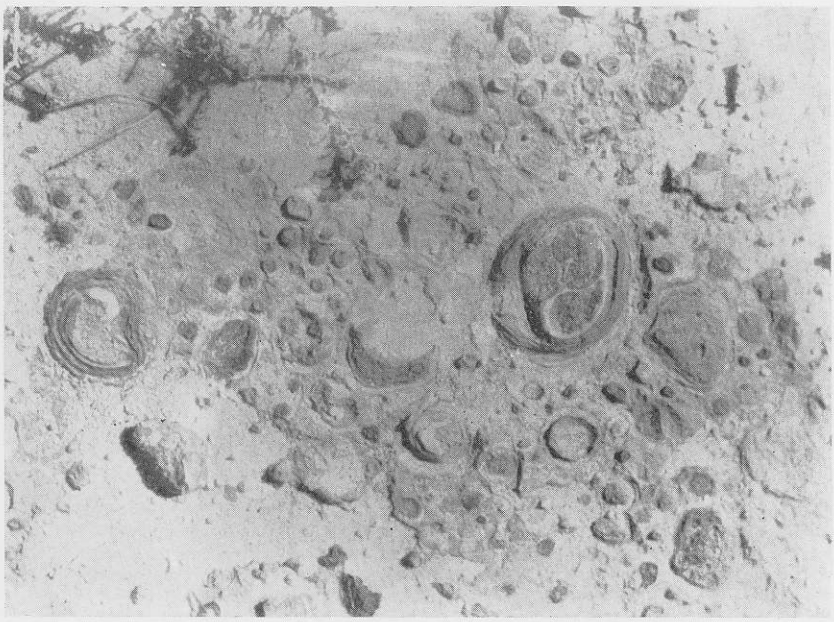


Plate 11. Weathered surface above the cliffs opposite Disaster Cove, Dorre Island. The filling of a solution cavity is exposed showing a fossil *Bothriembryon* and various concretionary bodies (Scale approx. × $\frac{1}{2}$).

Balladonia, Mount Ragged and Ongerup. The largest existing species of the genus at present found in the Shark Bay region is *B. costulatus* and the fossil shells do not fit into its size range. *B. costulatus* was not collected by the Expedition on Bernier and Dorre and the only living species found by the Expedition was *B. minor*, a much smaller species. *B. minor* is common on Bernier and Dorre Islands today. Peron had previously described the occurence of this fossil gastropod in the rocks of Bernier and Dorre and he also noted the generic relationship between the fossil species and that which lived on the Island at the time of his visit.

Rock specimens collected from these solution pipes have been examined by Glover. In hand specimen the rock is red-brown and fairly strongly indurated. Its clastic grains are generally sand-sized but fragments and complete shells of *Bothriembryon* are also present. Many areas of the rock are finely banded and little or no clastic material can be seen in these bands with a hand lens. The bands have no relationship to bedding, but commonly form irregularly shaped rings up to 4 cm. in diameter, some of which are confluent and form networks. Elsewhere concentric bands of the same material form bodies resembling pisolites, some of which have dark cores.

In thin section the rock is seen to be a quartzose calcarenite which has been subjected to repeated precipitation of carbonate, and to solution and perhaps minor precipitation of quartz. Calcite is soluble in acid environments and quartz though a relatively stable mineral, tends to dissolve in strongly alkaline environments. It is possible therefore that the textures described below have been caused by the percolation of waters whose pH has varied from time to time over a considerable range. Other factors however, such as changes in temperature and in the dissolved content of the incoming solutions, are likely to have contributed to what was probably a complex process.

Those parts of the rock where the original clastic texture has been at least partly preserved are made up of fossil fragments and quartz grains which range in diameter from minute chips to grains 0·8 mm. in diameter. Many of the quartz grains are well rounded, but some of them contain deep re-entrants indicating solution after their incorporation in the rock. Brown, iron-stained calcareous ovoid bodies with concentric layering are also very common. These range considerably in size, and the larger ones are the apparent pisolites visible in hand specimen. Some of these contain a brown cryptocrystalline carbonate core with numerous angular quartz grains throughout ; many of the smaller bodies have a core consisting of an individual shell fragment or an angular quartz grain. Some appear to have no core. All the grains, described above, are bound together, to form the rock, by a grey to colourless, microcrystalline to sparry, calcite cement.

The finely banded areas noted in the hand specimen consist of brown, iron-stained microcrystalline carbonate which contains small angular chips of quartz whose long axes commonly parallel the banding.

The only material for which primary clastic origin can be postulated are the rounded quartz grains and the shell fragments. The cement and the extensive banded areas of iron-stained microcrystalline carbonate are clearly post-depositional features, though apparently formed at different times. The ovoid bodies are partly made up of concentrically arranged

bands of the same material that forms the irregularly shaped banded areas throughout the rock, and are, therefore, probably not a primary feature.

The brown, iron-stained ovoid bodies with concentric banding were mentioned by Peron, who enthusiastically compared them with " *le Granit globuleux de l'île de Corse* " and " *Agathes-onyx.*" He said that the pebbles were capable of taking the finest polish and suggested that they might be used to make " ornamental objects of luxury."

As mentioned above, the fillings within the solution pipes also contained stones which appeared to be masses of country rock which had fallen into the solution channels while they were being filled. One of these was also examined by Glover who found that its structure is consistent with this explanation.

Fresh Water

There are no springs or natural reservoirs of fresh water on the Islands. Grey (1841) mentioned that he and his men obtained a little water on the northern end of Dorre Island " by suction from small holes in the rock, and then spitting it into a keg." Heavy dews, which are said to occur in summer, may provide some fresh water during the night and in the early morning.

Fishermen have reported seeing small wallabies apparently drinking on the beaches. It is possible that there are fresh water soaks here as has been demonstrated on Rottnest Island where the Quokkas (*Setonix brachyurus*) show the same behaviour.

Climate

Data from Weather Stations around Shark Bay, which have been provided by the W.A. Divisional Office, Bureau of Meteorology, Perth, give some indication of the climate of the Islands. These data are tabulated (see Tables 1 and 2).

From Table 1 it can be seen that most of the precipitation in the area occurs during winter (May, June, July), but occasional cyclones during January, February and March raise the summer averages.

Prevailing winds at Carnarvon are given in Table 2.

In all, the climate of Bernier and Dorre Islands is probably similar to that of Dirk Hartogs for which station we have only records of rainfall. From Table 1 it can be seen that there are fairly considerable differences between the various stations around the Bay. It is to be expected that the Islands have lower maximum temperatures, higher minimum temperatures, higher precipitation, and lower evaporation than Carnarvon and Hamelin Pool. Precipitation is probably close to that of Dirk Hartogs.

The differences between minimum temperatures at Carnarvon and the Islands, during the period of the Expedition, are shown in Table 3. It will be seen that, with the exception of the results for the 21st, minimum temperatures on Bernier and Dorre are considerably higher than those of Carnarvon. Mr. R. Vollprecht, of the Bureau of Meteorology, has examined these figures and comments that, apart from the anomalous result of the 21st, these are as expected. On the 21st of July weather conditions at

Carnarvon were abnormal. Midnight of the 20th was cloudless but from 3 a.m. to 6 a.m. there was low cloud. At 8 a.m. it was again cloudless. These factors would have combined to keep the local temperature high during what are normally the coldest hours of the night. If this was a purely local coastal effect (and its brief duration makes this seem likely) it is conceivable that the minimum temperature recorded on Bernier would be lower than that at Carnarvon. Mr. Vollprecht felt that this would be an infrequent occurrence. In his opinion the difference in minimum temperatures between the Islands and Carnarvon as shown by the Table is probably representative for July and supports the general statement that minimum temperatures on the Islands would be higher than at Carnarvon.

Maximum temperatures for Carnarvon and Bernier and Dorre are also given in the same Table. These are not comparable. The thermometer on the Islands was inadequately shaded and probably recorded considerable reflection from the surrounding sand. While having considerable effect on the maximum temperatures which occur during the hours of daylight, minimum temperatures are probably scarcely affected by the non-standard exposure of the instrument.

Temperature records, during the period of the Expedition, were made by R. D. Royce and our interpretations of them and other weather data are due largely to most useful discussions which we have had with Mr. Vollprecht.

Table 1

PRECIPITATION, TEMPERATURE AND EVAPORATION

Month	Av. rainfall in pts.			Evap. in inches			Av. Max. T °F.			Av. Min. T °F.		
	Hamelin Pool	Carnarvon	Dirk Hartogs Island	H.P.	C.	D.H.	H.P.	C.	D.H.	H.P.	C.	D.H.
January	26	41	25	12·2	11·5	....	98·0	87·7	....	68·4	71·7	....
February	50	70	41	9·2	7·9	....	97·3	88·3	....	69·3	72·3	....
March	57	66	54	9·5	9·3	....	93·9	87·5	....	67·3	71·1	....
April	39	64	64	7·1	7·3	....	86·9	91·5	....	62·3	64·4	....
May	124	149	218	4·7	5·3	....	77·0	81·7	....	55·3	56·2	....
June	195	240	350	3·0	3·6	....	70·4	74·8	....	50·3	49·9	....
July	151	156	243	2·9	4·1	....	68·9	71·4	....	48·0	51·2	....
August	76	68	141	4·1	4·8	....	71·6	73·0	....	48·7	53·1	....
September	35	23	53	5·4	6·2	....	77·5	75·5	....	51·5	57·0	....
October	14	12	25	7·5	7·4	....	82·0	77·6	....	54·7	60·7	....
November	14	3	6	10·2	9·4	....	89·2	81·4	....	60·2	65·5	....
December	9	16	7	11·2	10·2	....	94·7	84·6	....	64·8	69·0	....
Totals or Means for year	790	908	1,227	87·0	87·0	....	83·9	81·2	....	58·4	61·8	....
Period of years over which averages taken	57	60	42	....	....	....	44	43	....	44	43	....

Data provided by the W.A. Divisional Office, Bureau of Meteorology.

Table 2

WIND AT CARNARVON, WESTERN AUSTRALIA

Month	0900 Hours' Observations										1500 Hours' Observations									
	Percentage from—									Mean speed in knots	Percentage from—									Mean speed in knots
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	
January	3	1	6	16	42	23	6	2	1	10	0	1	1	2	35	42	14	4	1	13
February	3	2	4	12	44	23	6	4	2	10	0	1	1	1	24	53	15	4	1	11
March	2	5	14	26	29	18	3	2	1	10	1	1	4	6	34	41	9	4	0	11
April	7	4	21	29	24	7	2	0	6	9	4	1	2	7	39	32	6	4	5	11
May	7	7	16	40	18	5	1	0	6	8	2	0	4	6	39	37	6	4	2	10
June	9	15	24	34	9	1	2	2	4	8	5	1	6	18	29	18	11	11	1	9
July	4	8	18	48	8	3	2	2	8	9	2	1	3	21	36	23	6	6	2	11
August	7	11	13	35	12	7	6	3	6	9	1	5	2	6	30	34	10	11	1	11
September	2	1	8	37	27	15	7	2	1	10	0	0	1	5	37	41	12	4	0	13
October	0	1	6	26	51	12	2	2	0	12	0	0	1	4	42	48	5	0	0	15
November	2	0	8	14	43	21	9	2	1	13	0	0	1	1	32	50	13	3	0	16
December	0	0	5	11	52	26	4	2	0	12	0	0	1	1	34	54	8	2	0	15
Means	4	5	12	27	30	13	4	2	3	10	1	1	2	6	34	40	10	5	1	12
No. of years of observation	5																			

Data provided by W.A. Divisional Office, Bureau of Meteorology.

Table 3

MAXIMUM* AND MINIMUM TEMPERATURES

BERNIER AND DORRE ISLANDS AND CARNARVON BETWEEN 14th AND 27th JULY, 1959

Date	Maximum T °F.			Minimum T °F.		
	Dorre	Bernier	Carnarvon	Dorre	Bernier	Carnarvon
14	....	....	80	....	....	56
15	76	....	81	66·5	....	59
16	78	....	84	66·2	....	58
17	84	....	84	65·5	....	55
18	82·5	....	80	63	....	53
19	82	....	81	63	....	52
20	....	....	75	59·5	....	51
21	....	76·5	73	....	57·5	62
22	....	76	76	....	....	55
23	....	74	79	....	62	55
24	....	....	79	....	68	60
25	....	73	72	....	66	64
26	....	72	73	....	61	53
27	....	....	68	....	61	55

Data for Carnarvon provided by W.A. Divisional Office, Bureau of Meteorology.

* Maximum temperatures taken by the expedition were not taken under conditions comparable with those at the Carnarvon Weather Station.

BOTANY

by R. D. Royce

HISTORICAL INTRODUCTION

The first botanical collection from the islands of Shark Bay was made in 1699 by William Dampier. He made a small collection of plants, the majority of which are still preserved in the Sherardian Herbarium in the University of Oxford. Dampier's collection was described by C. A. Gardner when he was Australian Liaison Officer at the Herbarium of the Royal Botanic Gardens at Kew in England (Osborn and Gardner 1939).

In 1801 a French expedition in the corvette *Géographe*, under Captain Baudin with Leschenault as Botanist, called at Shark Bay. They landed on both Bernier and Dorre Islands, making a collection of plants in the Shark Bay area and along the mainland, and these are now housed in the Paris Museum. A number of these plants were described from time to time by Desfontain in the Memoirs of the Paris Museum, and others by de Candolle in his Prodromus Systematis Universalis Regni Vegetabilis (1824–73). Unfortunately, in neither was any detailed description of the flora attempted, nor were accurate localities given, so that it is now impossible to discover where the original plants were obtained. In publications these authors used in a general way, the name Isles Steriles, which probably applies to all three islands which lie to the north of Edelhand.

In 1818 a second French survey expedition visited the west coast of Australia. This was in the corvette *Uranie* commanded by Captain Freycinet. Extensive collections were made in the Shark Bay region and the results of the voyage were published by Gaudichaud in the Atlas and Botanical Supplement to Freycinet's " Voyage autour du Monde fait sur les Corvettes Uranie et Physicienne." (Gaudichaud 1826. This work is not available in Western Australia, but the Melbourne copy of it has been examined by the Victorian Government Botanist who informs us that it contains nothing relevant to the botany of Bernier and Dorre Islands).

Three years later, A Cunningham, the botanist attached to the survey expedition led by Lieut. King, collected extensively in Shark Bay, but principally on Dirk Hartogs Island. Some years later an expedition under Captain Denham explored and charted portions of the west coast including Shark Bay. A considerable number of plant specimens were collected by Denham and by Milne who accompanied the expedition as naturalist, and these specimens are now housed in the Herbarium at the Royal Botanic Gardens at Kew, England.

With the exception of the modern treatment of Dampier's collection and Gaudichaud's account of his own species, these plants have not been dealt with as collections. Various groups have been worked over by monographers or authors of floras, but there is no account of the collections as entities. It is therefore difficult to trace most of these early plants, particularly as collecting data were not very accurate, and more precise localities cannot be given to the material than the general label " Shark Bay."

An attempt was made by Baron von Mueller in 1883 to bring together the plants of the Shark Bay area from all the records available to him. He listed some 424 species, but most of these were from mainland collections gathered by himself in 1877, and by pastoralists, surveyors and others who sent specimens to him in Victoria. From records available it would

appear that since von Mueller's time no further botanical collections were made on Bernier and Dorre Islands until 1938. In July of that year a party from the C.S.I.R.O. Fisheries Division made a small collection of plants from the strand and foredunes on Bernier Island. Therefore when our party landed on the islands in July 1959 very little was known of the distribution of the species within the islands, nor was it likely that the floral list was complete. Our visit to Bernier and Dorre was made during mid-winter and the annual species, as well as many of the perennial shrubs were not in flower. Several plants, particularly annuals, could not be named in the absence of flowers, while many had to be identified from vegetative material or from the withered infructescences of the previous season. In spite of this the expedition resulted in a collection of 118 species with accurate knowledge of their distribution, and of these, 30 species are additions to the flora of Shark Bay (see Table 4).

DORRE ISLAND

The vegetation of Dorre Island falls into communities which are largely of four types, those of the travertine crust, those of the sandhills, the open steppe and the tall scrub. On all the headlands of the east coast and over a large proportion of the west coast, the travertine crust which caps the aeolianite has been exposed by wind action and now supports a characteristic flora. In isolated areas of Dorre, mobile sandhill formations occur, and although these are of limited extent, they carry a characteristic and fairly constant suite of plants.

The Open Steppe and the Tall Scrub are widely distributed. The Open Steppe (which is principally *Triodia*) occurs largely on the eastern half of the island, while the Tall Scrub is found in the undulating sandhill country which forms a range of low hills close to and parallel with the east coast in the central portion of the island. In the vicinity of Castle Point on the east coast, the dunes flatten out into a broad plain carrying a low scrub which is composed of the lower components of the Tall Scrub. To the south the dunes again become evident on the east of the island, with a plain of Tall Scrub to the west of them.

THE FLORA OF THE TRAVERTINE CRUST

Occurrence

For the greater length of the island, particularly along the east coast, the travertine crust is exposed and produces precipitous cliffs where it is eroded along the sea coast. On the landward side of these cliffs the crust is usually covered with sand to within a few feet of the edge, but in a few places the rock has been exposed over a much greater area. The surface of the rock is more or less cracked and broken, while sink holes are numerous and when filled with sand, both these and the cracks provide a footing for plants. On most of the headlands there is a greater or lesser amount of bare rock, while throughout the island there are numerous small denuded areas where the crust has been exposed. Three of these extensive areas are worthy of mention. These are :

(i) *South End.* The largest area of exposed travertine crust occurs at the south end of the island, from where it extends northwards along the west coast as far as the narrow neck south of White Beach, and parallel to the southern extension of the central ridge of dunes. This area was not visited by the party, but an examination of aerial photographs leaves no doubt of the extent of the crust in this area.

(ii) *Quoin Bluff.* This is the highest point on the island and is situated on the east coast some five miles south of Cape Boullanger, the northernmost point of the island. From the precipitous seaward edge it slopes gradually westwards and terminates in deeply eroded gullies draining northwards and southwards around the base of the outcrop. The action of weathering agents on the rock here has produced an extensive flaking of the surface into thin sheets, a condition which was not observed elsewhere.

(iii) *Low Point.* On the west coast and almost opposite Quoin Bluff is an expanse of level rock somewhat to the south of Low Point.

Description

The flora of this formation contains relatively few species. *Diplolaena dampieri* is the dominant plant, and in some areas occurs as a pure stand. In the coastal region it is stunted and usually no more than 2–3 feet tall, while in the more inland or sheltered areas it attains a height of 6–8 feet. *Scaevola crassifolia* and *Westringia rigida*, together with *Olearia axillaris* and *Frankenia pauciflora* occur with the *Diplolaena* and, together, these five shrubs constitute the major plant cover. The *Frankenia* rarely exceeds 12 inches in height but the other three species vary in size up to 3–4 feet. They are for the most part scattered over the area and rarely assume a dominance as does *Diplolaena*. Of lesser importance are *Carpobrotus equilaterus* and *Capparis spinosa*. The latter species is completely prostrate due to wind action and perhaps also to grazing by the native marsupials.

An interesting community is to be observed at Cape Boullanger, where the travertine merges into the sand. A clay filled depression has been developed in the rock, and this carries an almost pure stand of

Plate 12. *Diplolaena dampieri* and *Scaevola crassifolia* on the travertine crust at Disaster Cove, Dorre Island. Unconsolidated dunes in the background.

Frankenia with some admixture of *Carpobrotus*. This is an isolated occurrence and was not observed in any other portion of either island.

In all the areas of travertine investigated, annual plants were in evidence in the sandy pockets. Many had not progressed beyond the seedling stage and were not recognisable. *Triglochin* spp. *Anguillaria*, *Parietaria*, *Erodium*, *Brachycome* and *Nicotiana* are the principal plants together with several species of grasses.

Plate 13. Western coastline, Dorre Island, showing *Scaevola crassifolia*, *Angianthus cunninghamii* and *Olearia axillaris* in sand overlying travertine, and extending down the seaward slope.

THE FLORA OF THE SANDHILLS

Occurrence

The greater part of Dorre Island consists of consolidated dunes, and there are only isolated instances of wind erosion producing mobile sandhills.

The most extensive area of mobile dunes is in the vicinity of Disaster Cove to the north of Smith Point, with a few smaller areas to the south. At White Beach the travertine crust appears to be absent so that the beach is wider than usual and slopes gradually to low foredunes backed by a succession of level valleys and consolidated dunes. The moving sand is not extensive, but from aerial photographs it is evident that the vegetation has now covered what was formerly an extensive blowout in this area. Indeed a study of these photographs indicates that there are many instances of former sandy areas which have been completely vegetated.

On isolated dunes throughout the island small areas of mobile sand are to be seen, but nowhere do they appear to be spreading. Except at

Disaster Cove the sand mobility is not severe and little erosion has occurred. At Disaster Cove however, the residuals are some 8–10 feet in height, with exposed crust between them in many places.

Description

Of the six most common species found in the sand dunes and along the beaches, three are found in the littoral tracts of the south west, where they occur under similar conditions. These are *Olearia axillaris*, *Acanthocarpus preissii* and *Spinifex longifolius*. With these occur two spectacular species of the Myrtaceae, *Beaufortia dampieri* and *Pileanthus limacis*. These are low, almost prostrate shrubs 12–18 inches tall which occur in masses over the dunes, and make a colourful picture when in flower. *Frankenia pauciflora* is found on many dunes, and although very vigorous, it is here growing out of its normal association. It is usually found on rocky coastal areas or in saline soils and, as far as is known, its occurrence on mobile dunes on the Islands is unique.

Atriplex paludosa and *Rhagodia obovata* occur in certain areas, both on the dunes themselves and in the valleys between. *Angianthus cunninghamii* occurs at the base of the dunes, while the most common plant in the valleys is probably *Dampiera incana*. Seedling annual plants are evident in all areas.

In the coastal dunes and along the face of the cliffs and scree slopes, *Spinifex longifolius*, *Olearia*, *Beaufortia*, *Angianthus* and *Sporobolus virginicus* are the commonest species, with an occasional shrub of *Alyogyne cuneiformis*. In the White Beach area, towards the southern end of the island, *Atriplex paludosa* is abundant.

Plate 14. Coastal Dune in the vicinity of Disaster Cove, Dorre Island with *Beaufortia dampieri*, *Pileanthus limacis* and *Spinifex longifolius*.

(4) 53321

Plate 15. Sandhill in the Open Steppe, Dorre Island. *Triodia plurinervata*, *Thryptomene micrantha* and *Melaleuca cardiophylla* (plants of Open Steppe) in foreground. Principal vegetation of sandhill is *Heterodendron oleifolium*, *Spinifex longifolius*, *Rhagodia obovata* and *Olearia axillaris*.

Where the cliffs are red in colour and derived from the plateau behind, many of the plants of the open steppe are also present. Chief among these plants are *Triodia plurinervata*, *Pimelea microcephala*, and *Acacia rostellifera*.

THE FLORA OF THE OPEN STEPPE

Occurrence

The Open Steppe occupies the northern portion of the island from the vicinity of Disaster Cove southwards to Castle Point. To the south of the northern peninsula of the island, the Steppe occupies the eastern half of the area between the line of sandhills and the east coast. A small area at Cape Boullanger has been isolated from the rest of the formation by the sand hill area at Disaster Cove, but this has now lost its true character and appears to be slowly disappearing. Small isolated areas of *Triodia* and its associates also occur amongst the tall scrub to the south and west of the main belt.

Description

The dominant species over the whole area is *Triodia plurinervata*. This is a low tussocky plant 18–24 inches tall, while some older specimens have developed into the typical ring form and are 6–8 feet in diameter. This was described as a new species on material collected by the Expedition (see Burbidge 1960).

The most typical area occupies the narrow northern peninsula of the island where *Triodia* and *Thryptomene micrantha* are co-dominant. Other shrubs are *Melaleuca cardiophylla*, *Acanthocarpus preissii*, *Beyeria cyanes-*

Plate 16. Open Steppe on Dorre Island. *Triodia plurinervata* with low shrubs of *Melaleuca cardiophylla*, *Thryptomene micrantha*, *Beyeria cyanescens* and *Scaevola crassifolia*. Cliffs of the western coast are visible in the background at the right. Burrows of *Bettongia lesueuri* occur under these shrubs.

cens, *Stylobasium spathulatum* and *Brachysema macrocarpum*. The whole of this assemblage of species is of a uniform height of 12–18 inches and the ground cover is almost complete. Even isolated patches of *Eucalyptus* are not taller than the surrounding plants and only odd specimens of *Alyogyne cuneiformis* project above the general level of the *Triodia*.

To the east of the chain of dunes the character of the Open Steppe undergoes a change, associated at least in part with a more undulating terrain. Large shrubs become more evident, and chief among these are *Eucalyptus loxophleba* and *E. dongarraensis* which, near the east coast, attain a height of 4–5 feet, and actually take over the role of co-dominant with *Triodia* in mixed areas of scrub and steppe. These Eucalypts are not all of the mallee habit, despite their low stature. Some plants develop quite large trunks although these may be only 12–18 inches tall, with numerous horizontal branches trending predominantly in a general northerly direction. Southwards of this shrubby phase, the Steppe again becomes the typical low cover of the northern peninsula.

Rhagodia obovata and *Pimelea microcephala* also occur in the Open Steppe while in sheltered localities the other shrubby components, *e.g.* *Thryptomene*, *Melaleuca* and *Stylobasium* are able to develop into plants taller than the uniform *Triodia* clumps. Towards the west and south of the Steppe the shrub element becomes more abundant, but the *Triodia* still maintains a continuous ground cover. The actual line of demarkation is difficult to establish, and the Steppe merges imperceptibly into the Tall Scrub.

THE FLORA OF THE TALL SCRUB

Occurrence

The area covered by shrubby vegetation occupies the western consolidated sand ridges which extend from the base of the northern peninsula southwards to the vicinity of the White Beach. The ridges here flatten out into a series of low hummocks and for some distance to the southwards a gently undulating plain occupies the whole width of the island. To the south of the narrow neck at the southern end of White Beach the sand ridges reappear, but here they occupy the eastern portion and the scrub vegetation extends westwards over the hills on to the flatter country where it is largely broken up into small areas amongst the outcropping travertine crust.

Two small islands of scrub occur, one in the Disaster Cove area, and the other around the western rim of Quoin Bluff.

Description

The shrubs on Dorre vary in size up to eight feet or more, the taller plants being found in the valleys between the consolidated dunes where in some areas they form dense thickets with an almost complete cover. On the ridges, the plants are smaller and are more widely branched to form a dense low, tangled, woody cover.

The plant cover over the whole area is remarkably uniform and is not dominated by any particular species except in small areas. The plants of the higher ground change but little both as regards species composition and in the proportion of species present.

Plate 17. The Tall Scrub, Quoin Bluff, Dorre Island, showing the dense shrub cover. Species illustrated are *Diplolaena dampieri*, with *Solanum lasiophyllum*, *Heterodendron oleifolium* and some patches of *Triodia plurinervata*.

In the valleys however, although the same species are usually present, the proportion changes from one valley to the next. Thus while one or more species may be dominant in one valley they may play a very minor role in the plant cover in neighbouring valleys. To the north of White Beach and about west of Castle Point is one such area of different valley floras. One valley contains *Atriplex paludosa* with an admixture of *Rhagodia*. Adjacent valleys are : one given over to *Diplolaena dampieri*, one to *Acacia rostellifera*, one to *Acacia coriacea*, one to *Pimelea microcephala*, while in yet others the various species of Malvaceae are dominant.

Pittosporum and *Santalum* commonly occur in small groves while isolated specimens of these two species are scattered throughout the shrub area. *Trichinium*, *Myoporum*, *Eremophila*, *Alyogyne* and the three species of *Solanum* are fairly widely and uniformly distributed over the area, and rarely show any gregarious tendencies.

The vegetation of the isolated areas of shrubs at Disaster Cove and Quoin Bluff is similar in character to that of the rest of the Tall Scrub. At Disaster Cove the principal components are *Alyogyne cuneiformis*, *Acacia rostellifera* and *Rhagodia obovata*, with scattered shrubs of many of the other species. At Quoin Bluff the winter run-off, from the large rocky area, has formed a deep valley where shrubs have taken over from the *Triodia*. Here *Rhagodia*, *Solanum*, *Acacia*, *Pimelea* and several species of the Malvaceae occur, while of particular interest is the occurrence of clumps of *Ficus* and *Scaevola tomentosa* as well as *Pittosporum*, *Diplolaena* and *Hakea*. This is the only locality in which the *Ficus* and *Scaevola* were observed on Dorre Island.

Just as the shrubs on the elevated ground are smaller than those in the depressions, so the shrubs on the undulating plain to the west of White Beach are small in stature. Here *Abutilon exonemum*, *Thryptomene*, *Melaleuca* and *Corchorus walcottii* (the latter only observed in flower in this locality) were common and with them occurred areas of *Triodia*, the whole resembling in many respects the true Open Steppe of further north. Species of annual plants were common in small depressions where the rocky crust is near the surface, and it was in this area that Sow Thistle (*Sonchus oleraceus*), one of the two naturalised plants observed on the island, was found.

Shrubs of *Santalum*, seen on this undulating plain, are gnarled and of 1-2 feet in height, although in isolated areas this species, together with *Pittosporum*, *Acacia* and *Jasminum*, form thickets of 5-6 feet in height. The crust is exposed in many places and carries principally a low, prostrate, small-leaved form of *Scaevola crassifolia* and *Thryptomene* with abundant annuals.

BERNIER ISLAND

The vegetation of Bernier Island is comparatively uniform, and much of it resembles the Tall Scrub region as described for Dorre Island. This occupies the whole of the centre of the island, but is broken in many areas by active sand drifts. Around the coastline are areas of travertine crust similar to those observed on Dorre Island.

THE FLORA OF THE TRAVERTINE CRUST

Occurrence

Travertine Crust is only infrequently observed on the east coast where it forms isolated rocky headlands as at Red Cliff, Eagle and Wedge Points. Cape Ronsard, at the northern tip, and practically the whole of the west coast shows the pronounced travertine rim which was such

a familiar feature of Dorre Island. Throughout the interior of the island, bare areas of rock are of frequent occurrence. The largest extent is in Hospital Valley. This valley lies to the north of the old hospital site between two lines of consolidated dunes. There is a further dune to the south. The valley has been almost completely stripped of surface soil leaving the hard crust exposed. In most areas the surface of the rock is honeycombed with solution pipes usually filled in with soil. Wheel ruts and tracks are clearly visible in the rock.

Description

In most places, where the crust is exposed, *Diplolaena dampieri* is the dominant plant. In some inland areas it is the sole shrubby cover and forms dense thickets, while on others, *Pileanthus limacis* occurs as a pure stand. In the majority of areas, however, other shrubs such as *Pimelea* and *Ficus* are present, while on headlands and along the coast *Westringia*, *Frankenia*, *Capparis*, and *Senecio lautus* are common. In the sandy pockets, formed by the solution pipes, a large number of annual plants flourish. Prominent species are *Bidens*, *Brachycome*, *Poranthera*, *Oxalis* and *Erodium*, while it was in this situation that the interesting record of *Ophioglossum coriaceum* was made.

THE FLORA OF THE UNCONSOLIDATED SANDHILLS

Occurrence

On Bernier Island there are extensive " blow-outs " along the east coast, and in addition there are also numerous isolated areas of moving sand in the interior of the island. These appear to have resulted from the lack of outcropping travertine crust, together with concentrated grazing by goats.

Plate 18. East coast of Bernier Island at Hospital Anchorage, moving sand with tussocks of *Spinifex longifolius*. Fishing vessels sheltering after the storm.

The drifts are most extensive in the south, and here the island is repeatedly dissected by bare sand. Along the north-east trending stretch of the coast southwards from Red Cliff Point the old drifts are very extensive, although the present ones are smaller but appear to be extending rapidly. To the north of Digby Point, on the east coast, the areas of moving sand are fairly restricted, and only to the north of Hospital Valley is there any extensive area to be found.

Description

Near high water mark *Spinifex longifolius* forms dense tussocks with *Sporobolus virginicus* between the clumps. Shrubs of *Myoporum* are common and extend up the slopes and inland for some distance. *Spinifex* too has followed the drift and is established at some distance inland. *Frankenia*, *Angianthus cunninghamii* and *Olearia* are common.

Further inland *Pileanthus*, *Spinifex*, *Melaleuca* and *Rhagodia* together, or individually, form densely covered residuals where the roots have held the sand together. Some of these are several feet in height. Isolated plants of *Atriplex*, *Pimelea* and *Heterodendron* occur amongst the residuals, while around the sides of the dunes, *Diplolaena*, *Alyogyne* and *Heterodendron* are common.

A heavy germination of annuals was evident in the sandy valleys. Many were as yet too small to be identified, but prominent amongst those which could be named were *Lotus*, *Ptilotus* and *Euphorbia*.

THE FLORA OF THE TALL SCRUB

Occurrence

The greater part of Bernier Island is covered by a more or less uniform mixture of shrubby species, which are similar in character to the vegetation along the western ridge of sandhills on Dorre Island. Along the

Plate 19. The Tall Scrub of Bernier Island. Vegetation chiefly *Diplolaena dampieri*, *Olearia axillaris* amd *Hibiscus pinonianus*. A shrub of *Alyogyne cuneiformis* in middle distance at the right.

east coast, where little of the travertine crust is exposed, the shrubs are found right to the cliff edge and in places continue down the slope to the water line. It is of Bernier that Lipfert (1912) remarked, " Bernier Island has the same desolate appearance as Dorré (sic) perhaps even worse as there are no blooms and the scrub is thicker. To travel a mile and a half per hour may be considered good work, but even that is tiring."

Description

The outstanding feature of the vegetation of Bernier Island is the predominance of the species of Malvaceae, particularly towards the northern

Plate 20. *Heterodendron oleifolium.* A tree showing massive trunk development, Bernier Island. The Banded Hare-wallaby, *Lagostrophus fasciatus*, is commonly found in such thickets during the day.

end of the island. *Hibiscus pinonianus* is abundant on many valley floors, and was almost leafless, at the time of the party's visit, due probably to both the effect of the wind and the result of grazing by goats. It was the abundance of this grey-stemmed plant and the numerous shrubs of *Atriplex*, *Diplolaena* and *Olearia* which gave the vegetation, in certain places, a much greyer aspect than that of Dorre Island.

The surface of Bernier Island is of gently undulating nature with broad valleys and low hills. In certain areas, however, and particularly in the vicinity of the east coast there are steep sided dunes, formed by sand drifts blown in from the beaches and subsequently fixed by vegetation. Over the greater part of the island the shrubs are from 2–4 feet tall and form a fairly complete cover. In some areas, however, and particularly in the shelter of these larger dunes, some tall shrubs have developed and at times these form dense thickets. Towards the northern end of Hospital Valley, for instance, *Diplolaena dampieri* occurs in a dense stand some 10 feet in height, while not far away is a specimen of *Pittosporum*, some fifteen feet tall, which is probably the tallest tree on either island. Some species, which also attain a height well above the average, are *Acacia*, *Santalum*, *Alyogyne*, *Heterodendron* and *Eucalyptus*.

Triodia plurinervata occurs in isolated areas of no more than a few acres in extent, and nowhere dominates an extensive association. On the other hand *Eulalia fulva* is locally abundant and forms fairly extensive plains. It is rarely more than 12 inches in height, although, on the mainland, it frequently attains a height of 2–3 feet. In many places it is well eaten down and appears to be one of the principal fodder species.

Plate 21. One of the rare patches of *Triodia plurinervata* on Bernier Island. *Scaevola crassifolia* and *Rhagodia obovata* in fore-ground, *Hibiscus pinonianus* and *Alyogyne cuneiformis* in background.

The several species of Myrtaceae other than *Eucalyptus*, are abundant and attain a height of 2–3 feet among the other shrubs. The compact rounded form of the *Melaleuca* and *Thryptomene*, so common in the Open Steppe, was not observed on Bernier Island.

Acacia rostellifera and *A. coriacea* are widespread. In places these form dense low thickets of 3–4 feet providing excellent cover for the native fauna, while in others they are taller with well developed stems.

Eucalyptus loxophleba and *E. dongarraensis* appear to be confined to the rises and were not observed occupying extensive areas. Some of the trees are quite large, despite their low stature. One specimen of *E. loxophleba*, although only 5 feet in height, had a trunk of 18 inches with a circumference of 55 inches, and horizontal branches some 10–12 feet in length.

At some points on the coast between the sand drifts, the red sands of the interior extend down to the high water mark. These are covered by stands of *Olearia*, *Thryptomene*, *Atriplex*, *Pileanthus* with *Rhagodia*, *Acacia* and *Melaleuca* nearer the summit.

COMPARISON OF THE FLORAS OF THE ISLANDS

The most obvious difference between the two Islands is the stability of the Dorre Island vegetation and the apparent instability of that of

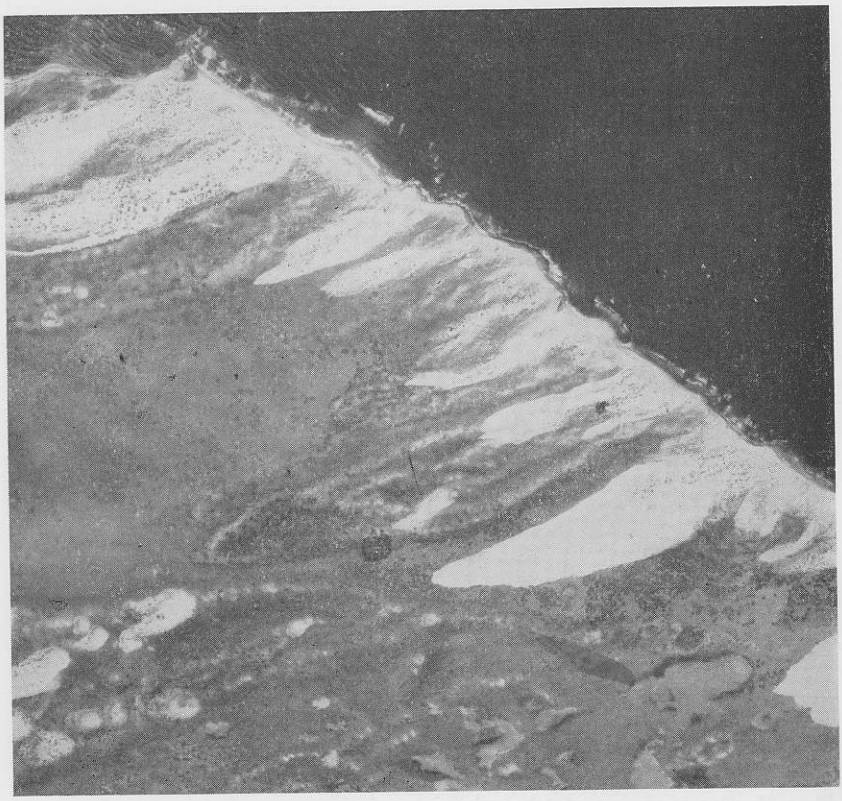


Plate 22. Blowouts at the southern end of Bernier Island. Photography W.A. Dept. Lands and Surveys, 19th Sept., 1959.

Bernier Island as evidenced by the widespread occurrence of sand drift (see p. 21). This, however, is probably more a measure of the effects of grazing by goats than a real weakness in the vegetation cover. Without the extra grazing pressure of the alien goat herd, the vegetation would no doubt be just as stable as on Dorre Island and the drifts would become consolidated as they have been in the past.

The extensive development of Open Steppe on Dorre is not matched on Bernier Island. As far as we can determine, the *Triodia* there is confined to small isolated areas of very limited extent, and is in no sense a dominant plant. On the other hand *Eulalia* is more extensive on Bernier and forms comparatively large meadows such as are not seen on Dorre Island.

The flora of the northern island is more uniform than that of Dorre Island, where certain species tend to form more or less pure stands in the valleys. Moreover, the actual composition of the floras is different. On Bernier Island, the family Malvaceae is better developed both as to the numbers of species and also the numbers of individuals. At the northern end of the island, in the vicinity of Hospital Valley, *Hibiscus pinonianus* is particularly abundant, while *Abutilon geranioides* was only noted in this area. *Abutilon exonemum*, *Sida calyxhymenia* and *Hibiscus sturtii* var., are all more plentiful on Bernier Island than on Dorre Island.

On the other hand, *Lotus australis* is the only species of the family Papilionaceae observed on Bernier Island. *Brachysema*, *Mirbelia* and *Indigofera* are associated with the Open Steppe on Dorre Island, and do not appear to be present on Bernier Island. The several species of *Solanum* are more abundant on Dorre Island while *Eremophila*, *Lasiopetalum*, *Dodonaea*, *Acacia bivenosa* and *Acacia sclerosperma* have not been recorded from Bernier Island.

PHYTOGEOGRAPHY

The vegetation of Dorre and Bernier Islands is predominantly that of the temperate region of the State. The distribution of the Island species in the large Flora Provinces of the mainland (Gardner 1944), are set out in the following table.

Northern Province	3
Northern and Eremean Provinces	15
Northern, Eremean and South Western Provinces	19
Eremean and South Western Provinces	43
Eremean Province	14
South Western Province	11
Shark Bay	9

Only 19 per cent. of the species recorded are known to occur in the Northern Province, and of these a number are known only from the vicinity of the Eighty Mile Beach. Here they occur in the Pindan, under conditions which closely approximate to those of the Eremean Province. The representatives of the true northern element of the flora are, therefore, very few.

Some 10 per cent. of the recorded species are widespread on the mainland and occur in all three Provinces. They are largely maritime species and would be expected to occur on off shore islands. A further 5 per cent. are indigenous to the Shark Bay area and have been known from the area for many years. Of these species, four have not, as far as is known, been seen again since the original type collection. These are *Rhagodia obovata*, *Brachysema macrocarpum*, *Beyeria cyanescens*, and *Beaufortia dampieri*.

Of the species only known from the south-west, five are cosmopolitan within that region, five occur on coastal sand and coastal limestone, one (*Acanthocarpus preissii*) occurs both in coastal sand and in sandy loam in inland districts.

Few of the Eremean species represented show any variation from the mainland forms, while, on the other hand, some of the insular representatives of south-western species differ considerably from those on the mainland. *Carpobrotus*, for instance has white flowers, while *Scaevola crassifolia* has simple axillary and terminal spikes with flowers much smaller than usual. The specimens from the travertine outcrops in the centre of the Islands are commonly even smaller in leaf and flower and are more resinous than the coastal form. *Cryptandra mutila* is very different in habit from the southern specimens, being low, intricately branched, and with numerous spinescent branches. *Phyllanthus calycinus* resembles the South Western specimens in being glabrous and having long pedicels but the perianth segments remain small. In some respects this specimen resembles *P. fuernrohrii*, a form of which has been recorded from Shark Bay, but it is completely glabrous.

The specimen of *Triodia* collected on Dorre Island (R.D.Royce 5884) has been nominated by Dr. Burbidge as the type of her species *T. plurinervata*. The collections of *Thysanotus*, *Hakea*, *Lepidium* and *Gymnema* are apparently different from any species described, and probably represent new species.

PLANT FORMS ON BERNIER AND DORRE ISLANDS

A number of the plants observed on both Islands assume a wind planed N. to N.E. trend caused by the frequency and strength of the south-west winds.

The most conspicuous species to be affected in this way is *Heterodendron oleifolium*. To the north of Disaster Cove on Dorre one specimen is only 28 inches in height, but possesses a trunk of 17 inches in circumference. At 8 inches from the ground this divides into two branches, each of about 9 feet in length and running in a northerly direction parallel with the ground. Other wedge shaped specimens occur, and are frequent in the Open Steppe area. On Bernier Island this species is more erect, but frequently has a northern trending branching habit. Because of its palatability to goats many of the bushes have been grazed into a compact woody form which accentuates the wind planing. Where they grow in groves, the outer sides of the bushes and the pendulous branches have been grazed hard back to form a dense woody cover some 2 feet above the ground.

Heavy grazing and wind action has produced a similar life-form in some specimens of *Exocarpus aphylla* on Bernier. The exterior of the shrubs consists of hard woody branches, and as a general rule it is only in the centre of the structure that young succulent growth is found. From the appearance of some of the shrubs it is apparent that the goats climb up the inclined trunks and graze the tops of the branches. This species is not markedly modified on Dorre Island where goats do not occur.

Capparis spinosa is confined almost entirely to the travertine crust in the vicinity of the coast. Here it is subjected to strong wind and its growth is almost entirely prostrate. Only where it is growing in shelter, in fissures between rocks or in large solution pipes, does it become a shrub more typical of its usual form.

FODDER PLANTS ON BERNIER AND DORRE

The grazing of the native marsupials on Dorre Island has little real effect on the survival of the present flora. This is to be expected since the animals and plants have existed in harmony here for centuries. Many species show some evidence of grazing and in the vicinity of some of the well established " runs " the palatable plants have been trimmed into rounded compact bushes, indicative of continual grazing.

Perennial species, which appear to be the principal fodder plants on Dorre Island, are comparatively few in number. These include : *Eulalia fulva*, *Mirbelia ramulosa*, *Abutilon exonemum*, *Alyogyne cuneiformis*,

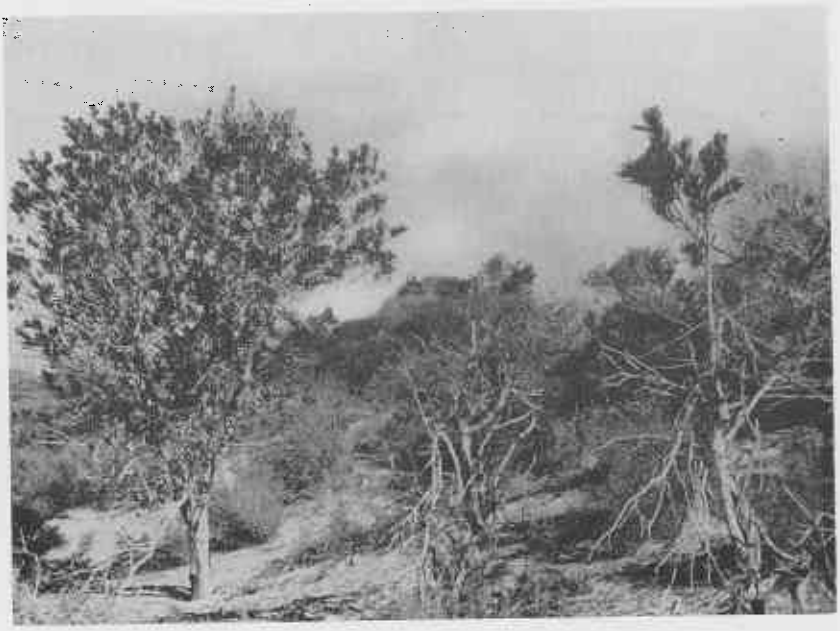


Plate 23. *Alyogyne cuneiformis* at north end of Bernier Island showing destruction caused by browsing goats.

Boerhaavia repandra, *Beyeria cyanescens*, *Hibiscus sturtii var.*, and *Pimelea microcephala*.

It is interesting to note that the Macropodidae on Dorre Island exhibit the same barking habit as is shown on Rottnest Island by the Quokka (*Setonix brachyurus*) and on Middle Island in the Recherche Archipelago by the Tammar (*Protemnodon eugenii*). Specimens of *Stylobasium* and *Alyogyne* were observed in several localities with the bark on the main stem and lower branches stripped off usually along one side.

On Bernier Island, however, the position is quite different due to the herd of goats. The effect that these animals have had on *Hibiscus pinonianus*, *Heterodendron* and *Exocarpus* has already been mentioned. Equally as spectacular is the damage being caused to *Alyogyne*. This species is apparently a favourite plant and the animals were frequently observed climbing on lower branches to reach the higher leaves. Many of the branches have been broken away, and some small shrubs have been completely stripped of laterals. *Stylobasium*, *Beyeria*, *Atriplex* and *Boerhaavia* have been heavily grazed.

In order to check the field observations regarding the grazing habits of the goats, three were shot and the contents of their stomachs examined. A great deal of the leaf material in the rumen could be identified quite accurately and Table 5 sets out the species concerned and their relative abundance in each animal.

FIRE

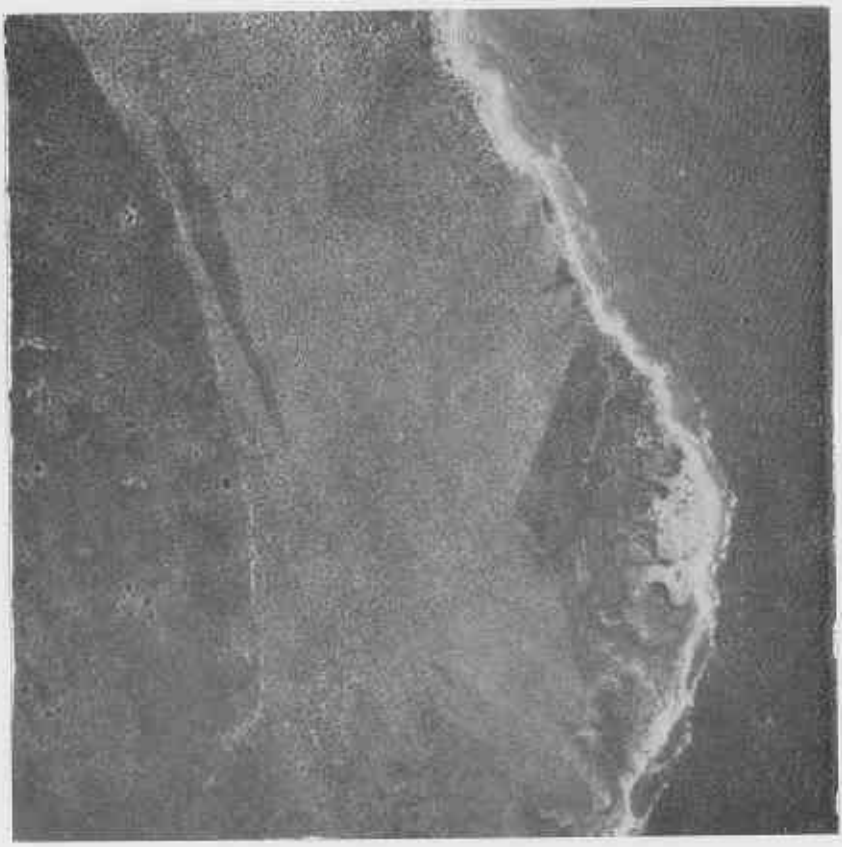
Dorre

A prominent feature of aerial photographs of the Open Steppe of the Quoin Bluff area of Dorre Island is a clearly defined break in the vegetation which has quite evidently been caused by fire. The western boundary is a definite line in the centre of the island running north and north-west, while to the east of this are many narrow areas elongated in the same direction which are evidently residuals left unburned by the fire.

These features are just as evident in photographs taken in 1959 as they are in those obtained in 1945. The fire, therefore, occurred some time before that date and, because of the long lasting effect, was evidently very severe. In the report of the Medical Officer at the Native Hospital in 1910 (see Appendix A, p. 124) mention is made of an extensive fire on Dorre Island which was visible from Bernier. At the time the collections were being made in this area, the party was not aware of these clear lines, and although the area was traversed on several occasions by members of the party, no vegetation change along the line of the burn was noticed. This remains one of the most interesting botanical problems, as yet unexamined, provided by either of the Islands.

Bernier

No evidence of extensive burns can be seen on the aerial photographs of Bernier Island. However, at the northern end of the Island charred stumps and boles of shrubs are fairly common. It is clear that extensive fires have occurred in the past.



Aerial Photograph 5019

Quoin Bluff, Dorre Island. Probable fire-streaks in the Open Steppe. Exposed travertine crust can be seen on the top of the bluff. 19th September, 1959.

Table 4

LIST OF PLANTS OCCURRING ON BERNIER AND DORRE ISLANDS

Because of the time of the year at which the expedition visited the Islands, it was not possible to identify all the plant species, since many were not in flower. The annual plants were only just commencing growth and many could be identified to genus only. The occurrence of each species on the Islands has been recorded in one of four categories, viz. rare, occasional, common, or abundant, while its mainland occurrence in the three main vegetation provinces of Gardner (1944) has also been listed.

Several of the specimens have been examined by specialists and acknowledgement is made of assistance from Dr. S. T. Blake (*Asclepiadaceae*), Dr. N. H. Brittan (*Thysanotus*), Dr. N. T. Burbidge (*Triodia*) and Mr. C. A. Gardner (*Eucalyptus*).

SPECIES	DISTRIBUTION		
	Dorre	Bernier	Mainland
OPHIOGLOSSACEAE			
Ophioglossum coriaceum A. Cunn.	occasional	occasional	N., Erem. and S.W. Provinces
JUNCAGINACEAE			
Triglochin calcitrapa Hook	rare	....	S.W. Province
trichophora Nees	rare	....	S.W. coast and islands
HYDROCHARITACEAE			
Halophila spinulosa (R.Br.) Aschers	....	after storm	Shark Bay
GRAMINEAE			
Enneapogon caerulescens (Gaud.) N. T. Burbidge	....	occasional	N. and Erem. Provinces
Eragrostis falcata Gaud	....	rare	N. and Erem. Provinces
Eulalia fulva (R.Br.) O. Kuntze	common	common	N. and Erem. Provinces
Paractaenum novae-hollandiae Beauv.	occasional	occasional	Erem. Province.
Paspalidium clementii (Domin) C. E. Hubbard	rare	rare	N. and Erem. Provinces
Setaria carnei A. S. Hitch.	occasional	occasional	N. and Erem. Provinces
Spinifex longifolius R.Br.	common	common	N., Erem. and S.W. Provinces
Sporobolus virginicus (Linn.) Kunth.	common	common	N., Erem. and S.W. Provinces
Stipa crinita Gaud.	rare	....	Shark Bay
Triodia plurinervata N. T. Burbidge	abundant	occasional	Erem. Province
LILIACEAE			
Acanthocarpus preissii Lehm.	abundant	abundant	S.W. coast and islands
Anguillaria dioica R.Br.	rare	rare	S.W. and Erem. Provinces
Thysanotus patersoni R.Br.	rare	rare	S.W. and Erem. Provinces
sp. nov.	rare	rare	? Erem. Province
MORACEAE			
Ficus platypoda A. Cunn.	occasional	occasional	N. and Erem. Provinces
URTICACEAE			
Parietaria debilis Forst.	occasional	occasional	S.W. and Erem. Provinces
PROTEACEAE			
Hakea sp. nov.	occasional	....	? endemic
SANTALACEAE			
Exocarpus aphylla R.Br.	common	common	S.W. and Erem. Provinces
Santalum spicatum (R.Br.) D.C.	common	common	S.W. and Erem. Provinces
CHENOPODIACEAE			
Atriplex bunburyana F. Muell.	....	occasional	S.W. and Erem. Provinces
paludosa R.Br.	abundant	common	S.W. and Erem. Provinces
Bassia astrocarpa F. Muell.	....	rare	N. Province
Chenopodium carinatum R.Br.	rare	rare	N., Erem. and S.W. Provinces
plantagineum (F. Muell.) Aellen	rare	rare	N. and Erem. Provinces
Enchylaena tomentosa R.Br.	occasional	occasional	N., Erem. and S.W. Provinces
Rhagodia obovata Moq.	common	common	Shark Bay
Salsola kali Linn.	occasional	occasional	N., Erem. and S.W. Provinces
Threlkeldia diffusa R.Br.	occasional	occasional	N., Erem. and S.W. Provinces
AMARANTHACEAE			
Amaranthus pallidiflorus F. Muell.	common	common	S.W. and Erem. Provinces
Ptilotus villosiflorus F. Muell.	common	common	S.W. and Erem. Provinces
Trichinium corymbosum Gaud.	....	rare	S.W. and Erem. Provinces
obovatum Gaud.	common	common	N., Erem. and S.W. Provinces
NYCTAGINACEAE			
Boerhaavia repandra Willd.	common	common	N., Erem. and S.W. Provinces
PHYTOLACCACEAE			
Gyrostemon ramulosus Desf.	....	rare	S.W. and Erem. Provinces

SPECIES	DISTRIBUTION		
	Dorre	Bernier	Mainland
FICOIDACEAE			
Carpobrotus equilaterus (Haw.) N.E. Br.	rare	rare	S.W. and Erem. Provinces
Sesuvium portulacastrum Linn.	....	rare	N. Province
PORTULACACEAE			
Calandrinia sp.	rare	rare	
RANUNCULACEAE			
Clematis microphylla D.C.	rare	....	S.W. and Erem. Provinces
CAPPARIDACEAE			
Capparis spinosa Linn.	common	common	N. and Erem. Provinces
CRUCIFERAE			
Lepidium sp.	....	rare	
CRASSULACEAE			
Crassula colorata (Nees) Ostf.	rare	rare	S.W. and Erem. Provinces
PITTOSPORACEAE			
Pittosporum phillyraeoides D.C.	common	occasional	N., Erem. and S.W. Provinces
ROSACEAE			
Stylobasium spathulatum Desf.	common	common	N., Erem. and S.W. Provinces
MIMOSACEAE			
Acacia bivenosa D.C.	rare	....	S.W. and Erem. Provinces
coriacea D.C.	abundant	abundant	N. and Erem. Provinces
rostellifera Benth.	abundant	abundant	S.W. and Erem. Provinces
sclerosperma F. Muell.	rare	....	Erem. Province
PAPILIONACEAE			
Brachysema macrocarpum Benth.	common	....	Erem. Province.
Indigofera georgei E. Pritzel	occasional	....	Erem. Province
Lotus australis Andr.	rare	rare	N., Erem. and S.W. Provinces
Mirbelia ramulosa (Benth.) C. A. Gardn.	common	....	S.W. and Erem. Provinces
GERANIACEAE			
Erodium cicutarium (Linn.) L'Her.	occasional	occasional	S.W. and Erem. Provinces (Introduced)
OXALIDACEAE			
Oxalis corniculata Linn.	occasional	occasional	S.W. and Erem. Provinces
ZYGOPHYLLACEAE			
Nitraria schoberi Linn.	....	rare	S.W. and Erem. Provinces
Zygophyllum apiculatum F. Muell.	....	rare	S.W. and Erem. Provinces
fruticulosum D.C.	occasional	occasional	S.W. and Erem. Provinces
fruticulosum D.C. *var. bilobum* Benth.	occasional	....	Erem. Province
RUTACEAE			
Diplolaena dampieri Desf.	abundant	abundant	S.W. and Erem. Provinces
EUPHORBIACEAE			
Beyeria cyanescens Gaud.	abundant	rare	Shark Bay
Euphorbia clutioides (Forst. f.) C. A. Gardn.	common	common	N. and Erem. Provinces
myrtoides Boiss.	common	common	N. and Erem. Provinces
Phyllanthus calycinus Labill.	common	rare	S.W. Province
Poranthera microphylla Brongn.	....	occasional	N., Erem. and S.W. Provinces
ANACARDIACEAE			
Schinus molle Linn.	....	Planted	
STACKHOUSIACEAE			
Stackhousia viminea Sm.	occasional	occasional	N., Erem. and S.W. Provinces
SAPINDACEAE			
Dodonaea sp.	rare		
Heterodendron oleifolium Desf.	abundant	abundant	Erem. Province
RHAMNACEAE			
Cryptandra mutila Nees	rare	....	S.W. Province
TILIACEAE			
Corchorus walcottii F. Muell.	occasional	occasional	N. and Erem. Provinces
MALVACEAE			
Abutilon exonemum F. Muell.	common	common	Erem. Province
geranioides (D.C.) Benth.	....	occasional	Erem. Province
Alyogyne cuneiformis (D.C.) Lewton	abundant	abundant	Shark Bay

(5) 53321

SPECIES	DISTRIBUTION		
	Dorre	Bernier	Mainland
Hibiscus pinonianus Gaud.	common	abundant	S.W. and Erem. Provinces
sturtii Hook. *var. muelleri* Benth.	common	common	N. Province
Sida calyxhymenia J. Gay	common	common	N., Erem. and S.W. Provinces
fibulifera Lindl.	—	rare	N., Erem. and S.W. Provinces
STERCULIACEAE			
Lasiopetalum angustifolium W. V. Fitzg.	rare	—	S.W. Province
FRANKENIACEAE			
Frankenia pauciflora D.C.	common	common	S.W. and Erem. Provinces
THYMELIACEAE			
Pimelea microcephala R.Br.	common	common	S.W. and Erem. Provinces
MYRTACEAE			
Beaufortia dampieri A. Cunn.	common	occasional	Shark Bay
Eucalyptus dongarraensis Maiden	abundant	abundant	S.W. Province
foecunda Schau.	—	rare	S.W. and Erem. Provinces
undescribed species	common	common	S.W. coastal areas
Melaleuca cardiophylla F. Muell.	abundant	common	S.W. and Erem. Provinces
Pileanthus limacis Labill.	common	common	Shark Bay
Thryptomene micrantha (D.C.) C. A. Gardn.	abundant	occasional	S.W. and Erem. Provinces
HALORAGACEAE			
Haloragis trigonocarpa F. Muell.	—	rare	Erem. Province
UMBELLIFERAE			
Trachymene pilosa Sm.	—	rare	S.W. Province
OLEACEAE			
Jasminum calcareum F. Muell.	common	occasional	N. and Erem. Provinces
ASCLEPIADACEAE			
Gymnema sp.	—	occasional	?
BORRAGINACEAE			
Trichodesma zeylanicum (Linn.) R.Br.	—	rare	N., Erem. and S.W. Provinces
VERBENACEAE			
Pityrodia cuneata (Gaud.) Benth.	—	rare	Shark Bay
LABIATAE			
Westringia rigida R.Br.	abundant	common	S.W. and Erem. Provinces
SOLANACEAE			
Nicotiana rotundifolia Lindl.	occasional	occasional	S.W. and Erem. Provinces
Solanum lasiophyllum Dun.	—	occasional	N., Erem. and S.W. Provinces
morrisonii Domin	rare	rare	Erem. Province
orbiculatum Dunal	common	occasional	S.W. and Erem. Provinces
MYOPORACEAE			
Eremophila leucophylla Benth.	occasional	—	Erem. Province
Myoporum acuminatum R.Br.	abundant	abundant	N., Erem. and S.W. Provinces
RUBIACEAE			
Opercularia vaginata Labill.	rare	—	S.W. Province
GOODENIACEAE			
Dampiera incana R.Br.	common	common	S.W. and Erem. Provinces
Scaevola crassifolia Labill.	abundant	abundant	S.W. and Erem. Provinces
holosericea De Vr.	rare	—	S.W. and Erem. Provinces
spinescens R.Br.	—	rare	S.W. and Erem. Provinces
tomentosa Gaud.	rare	—	Erem. Province
COMPOSITAE			
Angianthus cunninghamii (D.C.) Benth.	occasional	occasional	S.W. and Erem. coasts
Bidens bipinnata Linn.	—	occasional	N. and Erem. Provinces
Brachycome ciliaris Less.	common	common	S.W. and Erem. Provinces
iberidifolia Benth.	rare	—	S.W. and Erem. Provinces
Gnaphalodes uliginosum A. Gray	rare	—	S.W. and Erem. Provinces
Helipterum condensatum F. Muell.	rare	—	S.W. and Erem. Provinces
Millotia myosotidifolia (Benth.) Steetz.	common	common	S.W. and Erem. Provinces
Olearia axillaris F. Muell.	abundant	abundant	S.W. and Erem. Provinces
Senecio brachyglossus F. Muell.	—	rare	S.W. Province
lautus Sol.	common	common	S.W. and Erem. Provinces
Sonchus oleraceus Linn.	rare	—	cosmopolitan (introduced)

Table 5

Relative abundance of plant species in the stomach contents of three goats collected on Bernier Island. Leaves only were identified and all identifications were made in the field. X signifies greater abundance than 1.

Plant Species	Goat I (male)	Goat II (female)	Goat III (female)
Eulalia fulva (R.Br.) O. Kuntz	X	1	X
Atriplex paludosa R.Br.	X	X	1
Rhagodia obovata Moq.	X	X	1
Threlkeldia diffusa R.Br.	....	1	....
Boerhaavia repandra Willd.	....	1	....
Stylobasium spathulatum Desf.	1	X	....
Acacia coriacea D.C.	....	1	X
Acacia rostellifera Benth.	1	1	....
Zygophyllum apiculatum F. Muell.	1	1	....
Diplolaena dampieri Desf.	1	....	....
Euphorbia clutioides (Forst. f.) C. A. Gardn.	....	1	1
Beyeria cyanescens Gaud.	X	1	1
Heterodendron oleifolium Desf.	1	X	X
Alyogyne cuneiformis (D.C.) Lewton	1	1	1
Pimelea microcephala R.Br.	1	....	....
Gymnema sp.	....	....	X
Westringia rigida R.Br.	X	1	1
Solanum orbiculatum Dunal	....	1	1
Myoporum acuminatum R.Br.	1	X	....
Scaevola holosericea De Vr.	1	....	1
Senecio lautus Sol.	1	....	1

MAMMALS

by W. D. L. Ride and C. H. Tyndale-Biscoe

The indigenous mammalian fauna of Bernier and Dorre is unusually diverse for Western Australian islands, comprising four species of marsupials, two of native mice, and at least two of bats. These are the Banded Hare-wallaby (*Lagostrophus fasciatus*), the western Hare-wallaby (*Lagorchestes hirsutus*), the Boodie or Lesueur's Rat-kangaroo (*Bettongia lesueuri*) the Little Marl or Little Barred-bandicoot (*Perameles bougainvillei*), the, Ashy-grey mouse (*Gyomys albocinereus*), the Shark Bay mouse (*Thetomys praeconis*), the Little bat (*Eptesicus pumilus*), and the Lesser Long-eared bat (*Nyctophilus geoffroyi*). During the last century the Domestic cat, the House mouse, the Sheep, the Horse and the Goat were introduced either by accident or intent but, with the exception of the goat on Bernier Island, these do not appear to have established themselves. These populations of diverse native mammals flourish, while on the mainland the same species are extremely rare and, in some cases, are possibly extinct.

Collections of mammals have been made on the islands at intervals since 1801 and specimens and records exist in European and Australian museums. These provide additional insight into the populations and their changes over the years.

Material

A list of all mammals collected on the Islands has been compiled from available records and is presented in Table 6 on p. 91.

In addition to the specimens which were collected on the present expedition, the collections of Tunney, Lipfert, Steele and Grant Watson are available in the Western Australian Museum. Those from the Islands which are in the British Museum (Natural History) have been examined by Ride and those in the Australian Museum, Sydney, by Tyndale-Biscoe.

The sources of information are Peron (1807), Gray (1841), Thomas (1907), Shortridge (1910, 1936), Lipfert (1912), the Western Australian Museum Registers of Mammals; the files of the Lands Department; letters in the Western Australian Museum from Lovegrove, Tunney, Steele, Grant Watson; and letters from Shortridge in the British Museum (Natural History). (Photocopies of the Shortridge letters were supplied to us by the British Museum and have been deposited in the Western Australian State Archives).

Collecting Methods

1. **Traps.** These were of several kinds.

   Cage traps and trapdoor metal box traps, those used by the Department of Zoology, University of Western Australia, in their work on *Setonix brachyurus* and *Trichosurus vulpecula*.
   Longworth traps.
   Breakback mouse and rat traps.
   Spring snares with figure-of-four tripping device.
   Wire snares with running noose as for rabbit snaring.
   Baits used were bread, apple, toast and bacon.

2. **Shooting.**

3. **Hand netting.** This was carried out with " quokka nets " (Dunnet, 1955), head torches and portable 6 v. spotlight and motor-cycle accumulator.
4. **Long-netting.** Attempts were made to drive the animals into long nets.
5. **Digging.**

From the results shown in Table 7 it is clear that the effort expended in trapping on these Islands is not repaid. The cage traps are relatively successful catchers of *Bettongia* but comparison with results obtained by other methods leaves little doubt that even here trapping gives only a poor return. Records of trap successes by Davies (1960) in the Darwin area (Longworth traps) give similar low results (1 mammal per 112 trap nights).

Our experience (see Table 8) shows that shooting *Bettongia* and *Lagostrophus* is very simple but results in damaged specimens. In return for effort it is not much more productive or easy than the use of quokka nets and lights which resulted in undamaged material. Further, nets and lights also yield *Perameles* and the murids. Informed digging would probably result in useful catches of Muridae but this method was not used sufficiently for us to be certain. Driving into long nets was not successful.

All animals captured were weighed and measured. The measurements were : Total length, taken by placing the animal on its back on a table and measuring from nose tip to tail tip (excluding hair) in a straight line ; Tail length, measured from the tail tip to the angle between tail and body when the tail is fully drawn over the edge of a table ; Hindfoot, measured from heel to the distal end of the pad of the longest toe (nail excluded) ; Ear, measured from the notch to the tip.

Skins, skulls and skeletons were prepared from some animals while others were preserved entire in formalin. Dissections were made and stomachs were preserved in formalin, stomach nematodes and ectoparasites were preserved, and rectal faeces were collected dry for plant analysis. Testis material was fixed for histological and chromosome studies. Urogenital organs and pouch young of all females were obtained and preserved in Bouin's fluid. The uteri of all pregnant or lactating females were flushed with normal saline and were examined for early embryological stages with a stereoscopic microscope X100.

Ectoparasites (ticks) were numerous and collections of them have been submitted to Dr. F. H. S. Roberts, C.S.I.R.O. Veterinary Parasitology Laboratory, Queensland, to be worked up. Endoparasites have been submitted to Mrs. I. Thomas, Department of Zoology, University of Adelaide.

All members of the expedition searched for and collected skulls, or fragments of skull containing teeth, which were lying on the surface of the ground of Bernier Island. A few specimens only were collected on Dorre.

All material collected by the expedition is deposited in the Western Australian Museum.

THE BANDED HARE-WALLABY

Lagostrophus fasciatus (Peron)

This small wallaby was one of the earliest of Australian marsupials to be made known to Europeans. It was described by Dampier (Dampier, 1729) as " a Sort of Raccoons, different from those of the *West-Indies* chiefly as to their Legs ; for these have very short Fore-legs ; but go jumping upon them as the others do, (and like them are very good Meat :) . . ." Dutch mariners had earlier remarked on the Tammar (*Protemnodon eugenii*) of the Abrolhos and the Quokka (*Setonix brachyurus*) of Rottnest Island.

The first scientific description of the Banded Hare-wallaby was in 1807, by Peron, who named it *Kangurus fasciatus* which he said " peuple de ses essaims les trois îles de Bernier, de Dorre et de Dirck-Hartighs . . ." (people in its swarms the three islands of Bernier, Dorre and Dirk Hartogs). Succeeding authors included the species with the wallabies (*Halmaturus*

Plate 24. The Banded Hare-wallaby, *Lagostrophus fasciatus*. This animal is bounding away after being liberated. A hand-net is visible in the right background.

and *Macropus*—see Thomas, 1888) and Gould transferred the species to the genus *Bettongia* because he assumed that the hairless condition of the muzzles of the Type specimens in the Paris Museum was natural (see Waterhouse, 1846). Mainland specimens, which were collected for him by Preiss, he placed with the Hare-wallabies and named *Lagorchestes albipilis* Gould 1842. Waterhouse (1846) showed that both *albipilis* and *fasciatus* belong to a single species and Thomas (1886), because of its peculiar skull form and dentition, placed it alone in the new genus *Lagostrophus*. Finally, as a result of the extensive collections made by Shortridge from Pingelly on mainland Western Australia and from Bernier Island, Thomas showed that the mainland and insular forms are morphologically different and he separated the two sub-specifically. He revived Gould's name *albipilis* as the sub-specific name of the mainland form. Thomas' lectotype (Thomas, 1922) of the mainland *L. f. albipilis* is from Wongan Hills.

Today, *Lagostrophus* is possibly extinct on the mainland. It was once fairly widespread through southern parts of the State which are now well inhabited and no confirmed report of the species has been received by the Western Australian Museum since 1906.

On Bernier and Dorre Islands, *Lagostrophus fasciatus* is the most abundant mammal. During daylight hours the animals shelter, often several together, under low divaricating shrubs of *Acacia coriacea*, *Diplolaena dampieri*, *Pileanthus limacis*, and *Eucalyptus*, from where they can be flushed. At night they move about and large numbers were found among the *Spinifex* tussocks of the coastal sand dunes and *Spinifex* was found to be a favourite food of captive specimens. We did not find them on the beaches or among the fallen rocks of the cliffs which are character-

Plate 25. A juvenile Banded Hare-wallaby, *Lagostrophus fasciatus*, entering its mother's pouch. The banding across the lower back is very obvious in juveniles.

istically occupied by *Bettongia*. The *Triodia* of the Open Steppe, so common on Dorre, did not harbour *Lagostrophus*, although they frequently occurred in the patches of scrub amongst it.

Peron referred to maternal behaviour in this wallaby and said that when chased and wounded, females would deliberately assist their young from the pouch with their forepaws and then place them in safety and by so doing delayed their own escapes. This touching example of anthropomorphic behaviour has often been quoted by subsequent authors, but we saw no example of it,

When seen in the field, *Lagotrophus fasciatus* cannot be confused with any other mammal on the islands because of its generally dark appearance. Both the other wallabies are pale. Its ears are fairly long and kangaroo-like in shape. The tail has a short dorsal-crest of black hairs which are particularly well marked towards its tip. The banding of its lower back, from which it gets its name, is well marked in juveniles but in old mammals with non-fresh pelage it may not be at all obvious.

In order to assess the status of any wild mammal population it is desirable to know its age composition and reproductive potential. We have attempted to assess these with the limited *Lagostrophus* material available.

Reproduction

Sexual maturity is generally assumed to occur when ripe eggs are shed from the ovaries or spermatozoa are produced by the testes.

The ovaries of the 11 females collected were examined and eight were mature. The body weights of mature females ranged from 1,300 g. to 2,100 g. and in all of them the third molar was fully erupted (Table 9). All eight mature animals were lactating and six had each a corpus luteum on one ovary indicative of post-partum ovulation.

Post-partum ovulation occurs in several species of Macropodidae. If the resultant egg is fertilised it develops to the blastocyst stage, and its development is then arrested so long as the first joey occupies the mother's pouch. It may resume development and be born if the first joey dies or occasionally after the first joey vacates the pouch normally. Uterine blastocysts have been found in lactating females of *Setonix brachyurus* (Sharman 1955a), *Protemnodon eugenii* (Sharman 1955b), *Protemnodon irma* (one specimen, Tyndale-Biscoe), *Macropus robustus*, *M. rufus* (Sadleir & Shield 1960), *Bettongia cuniculus* (Flynn 1930) and *Bettongia lesueuri* (see below), and development of the quiescent blastocyst has been recorded from *S. brachyurus* (Sharman 1955a), *P. eugenii*, *M. robustus* (Sadleir & Shield 1960), and *M. rufus* (Carson 1912).

Our results, from *L. fasciatus*, indicate that post-partum ovulation occurs, but formation of a quiescent blastocyst is less common than in other species, since in only one female (WR26) was a blastocyst flushed from the uterus. This animal had a large joey in the pouch (66 g.) and degenerative changes were visible in the blastocyst.

The observations on the joeys are presented in Table 10. No. 49 had no joey when collected but milk could be expressed from one teat indicating a recent occupant of the pouch. The other two joeys were not examined on the island but were brought back to Perth with their mothers in order to establish a captive colony.

From these results we can see that the ability to squeak develops before 63 g. body weight ; that the eyes open and the young are nearly

able to stand at around this size and that by 170 g. weight they are furred and able to hop clumsily. The first steps out of the pouch probably occur shortly after this age, as the male of 330 g. was caught out of the pouch.

Tunney, who landed on the islands at the end of February, obtained at least one *Lagostrophus* joey. Peron, in June, found that all full grown females carried fairly large joeys. Since he mentioned joeys leaving and returning to the pouch we conclude from our results that some at least must have weighed more than 170 g. (see Table 10), but Shortridge made no mention of young on Bernier in July. Lipfert visited both islands in August and September and his collections included two " foetuses " and three juveniles.

From our results, and those of previous collectors, it is clear that joeys may be found at any time from February to August. In order to establish whether there is a non-breeding period at other times of the year, or a " reproductive peak," it would be necessary to visit the islands at other times of the year.

The testes of 5 males (WR20j, WR24, WR33, WR36, WR44) were examined by Professor Cleland for spermatogenesis and all but those of the joey (WR20j) were undergoing spermatogenesis (see Table 9 for body weights of these). Since all the mature females collected were breeding, it appears that male fertility is sufficient to realise the reproductive potential of the population.

Age Composition and Distribution of Mortality

In most kangaroos and wallabies (Macropodinae), the cheek-teeth follow a regular sequence of eruption and forward progression (see Ride, 1957, fig. 4) consequently any sample of skulls can be arranged in an order which it is reasonable to assume is correlated with age. No specimens of known age are available to confirm this for *Lagostrophus*, but observations show that the cheek-teeth of most Macropodinae behave similarly and in one species, *Macropus robustus*, it has been established that eruption pattern and dental progression are correlated with one another and are a valid indication of age (E. H. M. Ealey, personal communication). The terminology which we use in this paper for the eruption stages and progression is illustrated in Fig. 1. The assumption that dental stages are correlated with age is supported by observations on a few skeletons of *Lagostrophus*. The examination of many mammal species (including the marsupial *Didelphis*) has revealed that the sequence of the union of the epiphyses of the long bones and the vertebrae follows a pattern (see Washburn, 1946) which, in every case which has been tested, is related to age (see, for example, Watson and Tyndale-Biscoe 1953). Parts of the skeletons of 15 *Lagostrophus* collected were examined and it can be stated that epiphyseal union commences at dental progression stage 3 and becomes complete during stage 4 (see Table 9).

If the skulls of animals of all ages have an equal chance of survival upon the ground after death, then an indication of the age at which mortality most often occurs in the population can be obtained from the skulls which we collected on the surface of the Islands. It is probable, however, that the poorly co-ossified skulls of young animals are more likely to disappear through disintegration, so that the number of skulls of young animals in our sample may be disproportionally low.

The 32 skulls picked up on Bernier show a bimodal distribution around dental progression stages M1–2 and M3–4. The 6 skulls picked up on

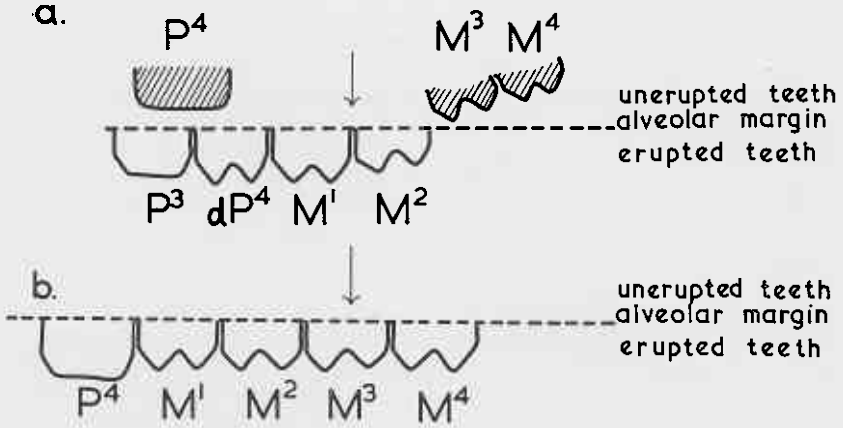


Fig. 1. Diagrams of the cheek-teeth, eruption sequence, and progression, in *Lagostrophus*. a, juvenile dentition. b, adult dentition. The arrow represents the position of the descending process of the zygoma.

Descriptive terminology applied to the examples above is: a, eruption stage $P^3M,^2$ progression stage M1–2; b, eruption stage P^4M^4, progression stage M^3.

In the terminology of eruption stages, a tooth which is not fully erupted but which has the anterior loph exposed fully from side to side is referred to with the addition of the suffix al., *i.e.*, the sequence M1, M2al, M2, etc., is adopted in description.

In determining progression stage, should the descending process lie opposite the crest of a loph, the name given is that of the interval posterior to that loph, *e.g.*, a tooth row which lies with the descending process opposite the crest of the posterior loph of M2 has reached the progression stage M2–3.

Dorre are too few to draw conclusions from. Bimodal distribution of death is well known in fossil mammal populations and in these cases it is usually held to indicate seasonal mortality in a seasonally reproducing population. However, we have no knowledge that a breeding season occurs in this species on the Islands; if there is one, it is clearly spread over a long period and during July most animals are breeding.

The work of the expedition clearly indicates that animals become sexually mature during dental progression stage 2 so that death mainly occurs in this population among the sexually immature and those well advanced in sexual maturity (see Tables 9, 11).

A bimodal distribution of stages of dental eruption (another age-indicator) in pick-up skulls has been recorded by Shield (1958) in a small wallaby, the Quokka (*Setonix brachyurus*), on Rottnest Island, Western Australia. Shield had a large sample of 575 skulls. A mainland population that he examined (34 skulls) was not bimodally distributed. A similar difference between insular and mainland populations occurs in the European Wild Rabbit (*Oryctolagus cuniculus*) in New Zealand (Bull, 1960, Table 2); Auckland Island contains a population in which a large proportion of individuals is more than three years old and it is clear that mortality occurs in the young and in the very old as we believe occurs on Bernier and Dorre. Populations on the mainland of New Zealand consist, overwhelmingly, of one year old animals. Lockley (1960) has stated that self-regulating populations of rabbits on small islands (and in experimental enclosures) show a pattern in which young and aged are eliminated during seasonal periods of stress (the European winter) while severe population crashes occur at intervals.

Unfortunately, the collection of living *Lagostrophus* made on either Island is insufficiently large for it to be tested for normality so that it is not possible for us to compare the composition of the living population with its known death structure. The samples, from both Islands, if combined, give a population which does not depart from normality ($\chi^2_3 = 3 \cdot 83$) but the assumption must be made that both populations are behaving identically. From the data available to us on 11 of Shortridge's specimens, his collection appears to be more or less evenly distributed over the classes.

Predation

Predatory birds were present on both Islands and we found some evidence of predation of *Lagostrophus* by them. Three skeletons were picked up which had been skinned and eaten in the manner typical of hawks. Since most joeys were still in the pouch at the time of the expedition we have no direct evidence on the importance of these birds as a factor in the mortality which we have observed occurs in the M1 stage of dental progression. The mandible of one very small joey was collected from an owl-accumulated deposit in the underground tank on Dorre and the remains of a juvenile were found in the gut of one of the goannas (*Varanus gouldi*) collected on Bernier.

General state of the population—Summary

Our observations indicate that Bernier and Dorre possess large and stable populations of *Lagostrophus*; all mature females were breeding but there was no predominance of juveniles as there would be in a rapidly growing population, or one in which there is heavy predation of adults (see Allee et al. 1949).

There is little indication of a breeding season since joeys of all ages were obtained by this and previous expeditions. There is a heavy mortality among juveniles (in part due to predation) and following this, death is rare until dental progression stage M3–4.

Diet

Rectal faeces were collected from 7 specimens from Dorre Island and 10 from Bernier. These were examined by Mr. G. M. Storr of the Department of Zoology at the University of Western Australia (see Storr 1961 for technique). Storr found that the 7 Dorre animals all contained grass. The samples contained, on an average, 66 per cent. grass epidermis and the remainder was unidentified plant tissue. In the 10 specimens from Bernier, only 3 had any grass and of the remainder, 2 had *Carpobrotus* epidermis and all had malvaceous hairs.

These results are somewhat difficult to understand. On Bernier grasses were common and *Spinifex* was particularly common in the area of dunes where most specimens were collected. Captives readily ate *Spinifex* and Royce found that *Eulalia* was often heavily grazed (see p. 43). On Dorre, on the other hand, *Eulalia* was so heavily grazed that specimens of it were very rare, yet all *Lagostrophus* caught on Dorre had been feeding on palatable grass while few from Bernier contained grass although it was common. Storr has suggested to us that the presence of malvaceous hairs in the Bernier specimens might be explained by bushes developing a greater number of lower shoots in response to the hedging of the upper parts by goats.

Attempt to establish yard populations

Four adult females carrying joeys in the pouch, and an adult and a juvenile male were brought back and kept in the yards of the Zoology Department, University of Western Australia. Husbandry was as for the quokka. Owing to the much lower temperatures of Perth compared with Shark Bay, the animals were kept in the animal house at c. 70°F. From an undetermined cause, possibly gas leakage from a faulty refrigerator in the room, all except the male and one female died one night. Subsequently in the yards these two were worried by stray dogs and the female died as a result. Only the one adult male survives in fair condition.

The species probably could be established in captivity with the precautions of supplying protection from dogs and artificial warmth for the initial acclimatisation. Being timid creatures they are easily frightened and damage themselves on the netting fences.

THE WESTERN HARE-WALLABY

Lagorchestes hirsutus Gould

The Western Hare-Wallaby was first described by John Gould from a specimen collected by Gilbert at York, Western Australia. Its presence on Bernier and Dorre was not noted by any of the early navigators or explorers, and the first specimens were collected on Dorre by Tunney in 1896. A further series was collected by Tunney, in 1899, and two of these were sent to the British Museum, and when these were ultimately compared with the series collected by Shortridge at the South end of Bernier Island, Thomas (1907) decided that the two insular forms required sub-specific separation from each other, and further, that they were both sub-specifically distinct from the mainland form. Our material does not contradict these views (see p. 87).

Lagorchestes hirsutus is rare today in Western Australia, but it has a wide distribution and was probably never very common anywhere. A series was obtained by Lipfert, during 1930 and 1931, on the Canning Stock Route between Wiluna and Halls Creek, and it certainly occurs in Central Australia. In 1906 this wallaby was plentiful on Bernier Island, and Shortridge obtained 24 specimens but we found that at present it is rare. More time was spent by the expedition searching for this animal than for *Lagostrophus*, and, even so, only two specimens were obtained, a male on Dorre Island and a female on Bernier.

Owing to lack of success in obtaining specimens, we can add little to what is already known of the habits of this wallaby. Shortridge (1910) said that it was found in heath and spinifex (= *Triodia*) country, where it constructed forms which were half hidden beneath bushes or spinifex clumps. We found no such forms in spinifex on Dorre, while, owing to the storm, we were unable to visit the southern part of Bernier. The two specimens we found were solitary and neither was flushed from bushes, and both were captured at night. That on Dorre was caught in flat open country on the edge of Open Steppe, and that on Bernier among sand dunes with true *Spinifex*. On the second occasion a number of *Lagostrophus* were caught at the same time. In the field, as has been emphasized by Finlayson (1958), it can easily be confused with the Boodie (*Bettongia lesueuri*), but it has long ears like the Banded Hare-Wallaby, not short and rounded like the Boodie. The hair around its hind quarters is long

Plate 26. The Western Hare-wallaby, *Lagorchestes hirsutus*, is the rarest wallaby of the Islands (adult female).

and orange coloured—far longer than the hair elsewhere on its body (the reason for the name *hirsutus*). In contrast, the hair beneath the base of the tail is pale, and when being pursued at night with a spotlight (or torch) the animal is easy to recognize because this pale area seems to be framed by the distinct orange pantaloons. Captive specimens are easily told apart from the Boodie because the claws of the forefeet of the Boodie are white, while those of *Lagorchestes* are black.

The apparent rarity of the species at the present day is supported by the fact that of the 66 skulls of Macropodidae picked up on both Islands, only one was of *Lagorchestes* and that a juvenile.

Reproduction

The living specimens collected were an adult male and female. The female carried a very young joey (crown rump length 23 mm.) on the right posterior of the four teats ; the right anterior teat was also elongated.

The ovaries of this animal contained the scars of two earlier corpora lutea, a large corpus luteum (1·13 mm. diameter) showing degenerative changes in the nuclei of the luteal cells and two enlarged graafian follicles (0·9 and 0·875 mm. diameter).

The corpus luteum corresponds to the recent pregnancy which resulted in the small joey ; post-partum ovulation had not occurred although the two enlarged follicles indicate that it would have occurred soon afterwards. No egg was found after flushing the uteri with saline.

One of the corpus luteum scars (0·375 mm. diameter) and the elongated but unoccupied teat suggest that this animal had produced an offspring and lost it prior to producing the small joey found at capture.

The testes of the male were examined by Professor Cleland and spermatogenesis was observed in them.

Diet

Faecal analysis showed that the specimen from Dorre Island had fed only on grass, whereas there was no grass at all in the specimen which we collected on Bernier. The latter animal contained unidentified dicotyledonous material and malvaceous hairs.

LESUEUR'S RAT-KANGAROO

Bettongia lesueuri (Quoy and Gaimard)

(Common name in South-western Australia—Boodie)

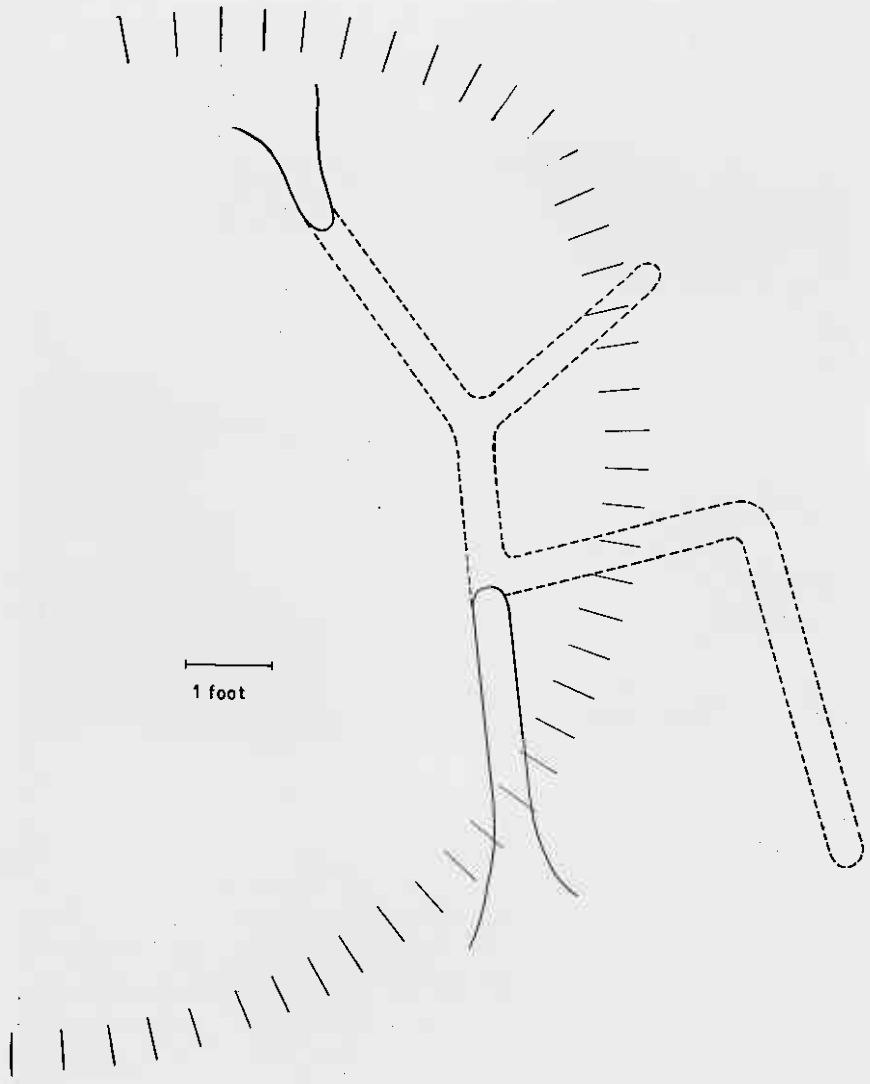
This species was first made known in the zoological results of Freycinet's second visit to Shark Bay in the corvette *Uranie*. Quoy and Gaimard described finding the skulls of many kangaroo rats together with the debris of birds, snakes, lizards, crustaceans and fish at the foot of the nest of an Osprey (*Pandion haliaetus* L.), on Dirk Hartogs. To these skulls they gave the name *Hypsiprymnus lesueur*. They obtained no entire animals but at the same place they caught fleeting glimpses of an animal that lived in burrows and foraged at night in the debris along the beaches. They said that this species did not occur on Bernier and Dorre or the mainland. They assumed that it was a giant *Perameles* but from their description, it can only have been *Bettongia lesueuri*. The first suggestion that *Bettongia* occurred on Bernier and Dorre came in Grey's account of his stay on the islands (Grey, 1841) in which he mentioned a small species of " kangaroo rat." Earlier, in a general comment on quadrupeds (p. 240), Grey had mentioned " a kangaroo rat, which last is always seen amongst the rocks on the sea coast." *Bettongia* behaves in this way on Bernier and Dorre, the hare-wallabies do not. Finally, Tunney obtained specimens from Dorre Island in 1899.

Bettongia lesueuri had a wide distribution throughout mainland Australia but, for various reasons, it now appears to be virtually extinct over most of its former range (see Finlayson, 1958). Certainly, no specimens from the mainland of Western Australia have been received by the Western Australian Museum since 1935 (South Dale via Brookton) and photographs, said to have been taken in 1942 (Pingelly), are mentioned in a Museum catalogue. On Bernier and Dorre, however, it is relatively common, and being, by nature, wary and living in a fire resistant burrow it would seem to be secure unless rabbits, foxes or cats were to become established on the islands. If the numbers of pick-up skulls which we obtained of the three species of Macropodidae be examined (Table 16, p. 97), it will be seen that far less *Bettongia* were obtained than *Lagostrophus*. It is probable that this comparison does not give a true indication of the relative abundance of these two species since the burrowing habits of *Bettongia* would probably result in less skulls of animals which died from natural causes being found on the surface. In some parts of the islands *Bettongia* seemed to be extremely abundant. A comparison of the numbers of whole skeletons of *Bettongia* which were found in the dry concrete under-

ground-tanks at the hospital site gives a totally different picture from that given by the pick-up skulls. Here were found the remains of 2 *Lagorchestes*, 3 *Lagostrophus* and 7 *Bettongia*. Unlike the mice and bandicoots found in the same tank on Dorre, many of these skeletons were still articulated and showed no signs of having been a prey of the owls ; they probably fell into the tank and could not get out (see Table 12). Since *Bettongia* has the habit of seeking refuge in holes, the proportion of the three macropods in this sample is probably biased in the opposite direction to that of the pick-up series.

Plate 27. Burrow of the Boodie, *Bettongia lesueuri*, under a shrub of *Melaleuca cardiophylla*. Open Steppe, Dorre Island.

On Bernier and Dorre, *Bettongia* burrowed freely. In some places, for example in the sloping sandy foot of the low cliff opposite Disaster Cove on Dorre, burrows lay close together beneath the mat of " pig-face " (*Carpobrotus equilaterale*) and formed a complex system of intercommunicating warrens of the kind described by Dahl (1926). Burrows also extended under the blocks of the fallen aeolianite and, where the cliff was little more than a bank, under the travertine crust. On the other hand, among the low bushes and *Triodia* of the Open Steppe small, self-contained, burrow units were common and were somewhat simpler than the single unit described by Finlayson (1958, p. 243) ; but in Central Australia the situation is complicated by the presence of rabbits in the same burrows (see Finlayson, 1958 and Jones, 1924). Two burrows which were dug out in the Open Steppe of Dorre are illustrated in Figure 2.


1 foot

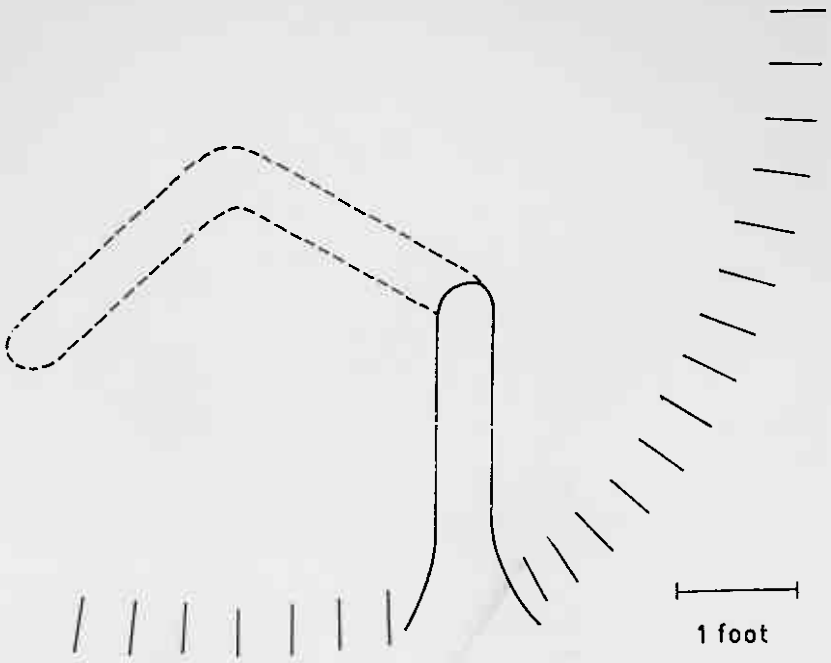


Fig. 2.—Burrows of *B. lesueuri*, Open Steppe of Dorre Island. Subterranean tunnels shown in broken line, entrance funnels in line. The edge of the clump of bush is shown by short parallel lines.

As mentioned by Quoy and Gaimard, bettongs are taken by birds of prey and, on Bernier, young animals probably also fall victim to the pythons (*Liasis childreni*) and goannas (*Varanus gouldi*) which are present.

Bettongia is easy to recognize in the field but it is seldom seen except by artificial light at night or, dimly in the late dusk. In the hand it will be noticed that ears are short and the tail is nearly hairless—in captivity the tail becomes extremely fat. The claws of the forefeet are white and by this it can simply be told apart from *Lagorchestes hirsutus* which it resembles in colour. When pursued with a torch it emits a succession of grunts and chuckles and on being handled will scratch savagely and invariably attempt to bite. The bite is extremely tenacious and painful.

Diet

G. M. Storr found that the rectal pellets which were collected contained no recognisable epidermis. There were some small brown particles which might have represented seed coats but most of the tissue was non-epidermal and was possibly the remains of roots. Small scratchings of *Bettongia* were often found around the bases of the succulent *Carpobrotus equilaterale* and Finlayson (1958) notes that in Central Australia the roots of the procumbent *Boerhaavia diffusa* form an important item in their diet and that bulbs and tubers are generally eaten.

Plate 28. The Boodie, *Bettongia lesueuri*, is a common marsupial on the Islands where it occurs among tumbled boulders above the water's edge. It also burrows among the small shrubs of the Open Steppe. (Adult female with enlarged pouch containing young one.)

Reproduction

Six females, excluding joeys, were caught on both islands ; four were lactating and the fifth had an elongated teat, though no milk could be expressed. This animal was released on Bernier Island so we are unable to say whether it was pregnant.

The sixth female (WR58) was thought to be immature at capture, having an empty pouch, but the next day had produced a joey. No scales fine enough to weigh this joey were available, but after a year in 70 per cent. alcohol it weighed 0·21 g. Its CRL at birth was 14 mm.

A quiescent blastocyst was found in the uterus of two lactating females. A third, the mother of WR21, escaped from the holding bag and was not examined, and the fourth Z1424 was brought back to Perth alive. Indirect evidence suggests that this animal had a uterine blastocyst which subsequently developed. Data, relating to the four joeys obtained in the field, are presented in Table 10 (p. 94).

Flynn (1930) recorded the occurrence of uterine blastocysts in lactating females of *Bettongia cuniculus*, another species of rat-kangaroo.

Further information on the breeding of this species has come from the colony established in the yards of the Zoology Department, University of Western Australia. An adult male and an adult female with joey were brought back on July 28, 1959. The joey died some time before August 17, 1959.

On September 28, 1959, a new joey about 40 mm. long was found in her pouch which was probably the result of the development of a quiescent blastocyst.

This offspring, a female, was itself carrying a joey (0·98 g.) on March 14, 1960, which it must have conceived at the end of January, 1960. Consequently this female had attained sexual maturity about 5 months after birth. We attempted to induce development of a quiescent blastocyst in this female by removing her joey and separating her from the male. No joey developed.

Meanwhile the original female (Z1423) on March 14, 1960, had a small male joey in her pouch, finely haired and squeaking. Five weeks later on April 22, 1960, this joey was fully haired and out of the pouch, which was now occupied by yet another small joey. By mid-July, 1960, this joey, another male, was ready to leave the pouch, so that in one year the original female had been breeding continuously and had produced three offspring. This suggests that *Bettongia* on Bernier and Dorre Islands has a high reproductive potential. The breeding success of the yard colony and the way in which the animals have adapted readily to captivity indicates that this could be a better experimental animal than the quokka which is currently used for studies in reproductive physiology.

LITTLE MARL or LITTLE BARRED-BANDICOOT

Perameles bougainvillei (Quoy & Gaimard)

Like *Bettongia lesueuri* this species was first made known as a result of the voyage of the *Uranie*. Quoy and Gaimard obtained a specimen at the foot of the elevated dunes of Peron Peninsula where they saw several of these bandicoots and tracks were common. Today, it seems that the species is confined to the islands of Shark Bay, but a proper search of Peron Peninsula has not been made in recent times. The Western Australian Museum has a single mainland specimen from close to Shark Bay (Onslow) which was collected in 1909.

The first specimen which was obtained from the islands was collected on Dorre by Tunney in 1899. When Shortridge visited the islands in 1906 he was unable to find living specimens and only obtained a weathered skull which he found on Bernier. He considered that the species was probably extinct as a result of the introduction of cats on the islands. Subsequently, however, Lipfert obtained 12 specimens during his visit to the islands in 1910.

Today, the species is extremely common on Bernier and although we did not obtain as many specimens on Dorre, we have no real evidence that it is any less common there. Our collecting techniques for these island mammals developed greatly as the expedition progressed and most of our results from Dorre could have been improved upon had we been as efficient there as we were by the time we left Bernier.

At night, this bandicoot was commonly found among sandhills. On one occasion a specimen appeared in the lighted doorway of the tent when the party was working at night and, during the last night on Bernier, one was seen in the kitchen area and for some considerable period this animal fossicked about within an arm's length of an occupied camp stretcher. During daylight, specimens were only occasionally seen. These suddenly appeared from underfoot in low scrub and disappeared into the dense vegetation with rapid leaps. On one occasion, Douglas encountered

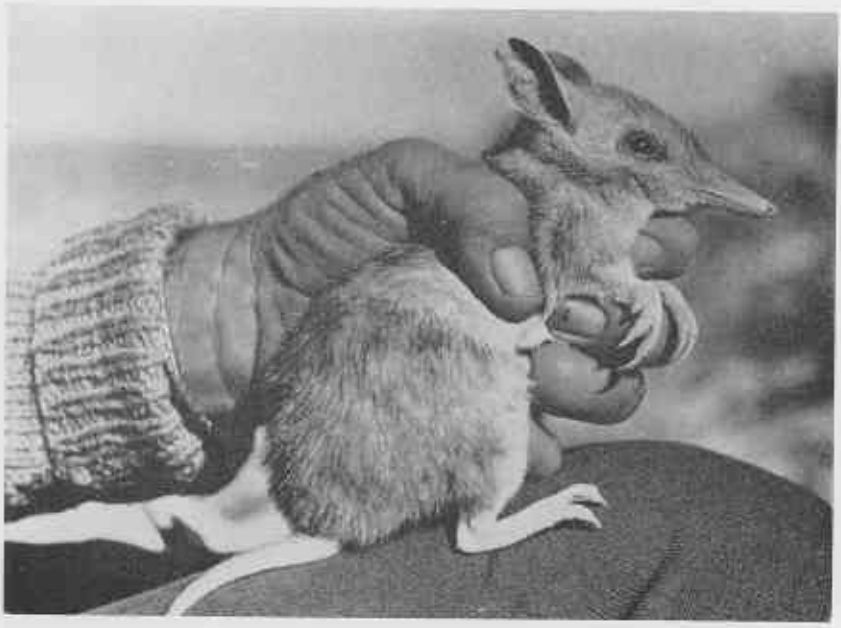


Plate 29. The Little Marl or Little Barred-bandicoot, *Perameles bougainvillei*, is common on both Islands. (Adult male)

a specimen in this manner on Dorre and, in its agitation it relaxed its pouch muscles as it fled and the joey (WR37) was dropped. The female did not return.

Three other females were obtained, all suckling joeys. One female had a pair of very young joeys (C.R.L. 12·5 mm.) and another had a pair each weighing 9·5 g. The abandoned joey collected by Douglas weighed 11 g. and we do not know if the mother carried another joey. The fourth female had one joey weighing 17 g.

The females have four teats in the pouch and in the female carrying two very young joeys the unoccupied pair of teats were elongated.

One is tempted to think that this indicates loss of a previous litter, perhaps jettisoned when the mother was frightened, and then development of a second litter, possibly from quiescent blastocysts as described for macropods and the pigmy possum *Cercaertus concinnus* (Bowley 1938).

The uteri of WR34, which had two joeys of 9·5 g and 2 corpora lutea on the ovaries, were sectioned to test this. The luteal cells of the corpora lutea appeared active, the uterine epithelium and glands were quiescent but there were no blastocysts. The corpora lutea may alternatively refer to the pair of joeys which would indicate absence of post-partum ovulation.

The testes of one male (WR29) were examined by Professor Cleland and active spermatogenesis was observed.

THE ASHY-GREY MOUSE

Gyomys albocinereus (Gould)

This attractive little native-mouse was first described by John Gould from specimens collected at Moore River, Western Australia by John Gilbert. At that time it also lived among sandhills near the beaches a few miles north of Fremantle (Gould 1863). Its present status on the mainland of Western Australia is uncertain. The most recent specimen of it to be received in the Western Australian Museum was collected in 1957 at Narrikup. It is suspected that it must be very rare on the mainland because many hundreds of mice have been collected in the field for the Western Australian Museum during the past twelve months, and most of these were the introduced house mice, *Mus musculus*. Some native-mice were collected but none of these was *Gyomys*. Previous to the 1957 specimen, two specimens were collected in 1939 at Chorkerup.

Plate 30. The Ashy-Grey Mouse *Gyomys albocinereus* is the common native rodent of the Islands. (Adult male)

The first specimens to be collected in the islands were obtained during Shortridge's visit in 1906. He collected a series of six specimens from Bernier Island (Shortridge, 1936). Thomas (1907) compared these with specimens from open sand plains around Beverley, Brookton, and Pingelly, on the mainland, and found that insular specimens were markedly smaller. He therefore separated the Bernier Island mice as a new sub-species which he called *Mus albocinereus squalorum*. Lipfert also found the species plentiful in 1910. Today, this little mouse still appears to be common on both islands, and its burrows and tracks are common in the sand-dunes

of the eastern coastlines. Like Shortridge, we found it difficult to trap, and of the four specimens taken in this way three were caught with a bait of toast and the fourth with apple.

The head and back of the Ashy-grey Mouse is silver-grey tinged with a distinct fawn colour. The fawn colour is most noticeable on the sides and over the hinder part of the back. The underparts are white. When the fur is disturbed, the dark grey bases of the hairs are noticeable. In the middle of the back, hairs are about 8 mm. long and they are nearly the same length in mid-belly. The back hairs are dark grey for about 5·6 mm. from their bases, there is then a pale zone, finally the hairs have brown tips. On the belly the hairs are dark grey for about half the lengths from their bases and are then white. The hairs of the feet, tail, chin, and around the genital apertures and anus, are white to their roots. In life the hands, feet, and tail are pink. Altogether it is one of the most attractive of our native rodents. It is slightly larger than the introduced house mouse, and when held in the hand does not attempt to bite. One specimen, caught by hand at night among the *Spinifex longifolius* and *Olearia axillaris* of the sand-dunes to the south of Wedge Point on Bernier Island squeaked when caught. None of the others made any sound.

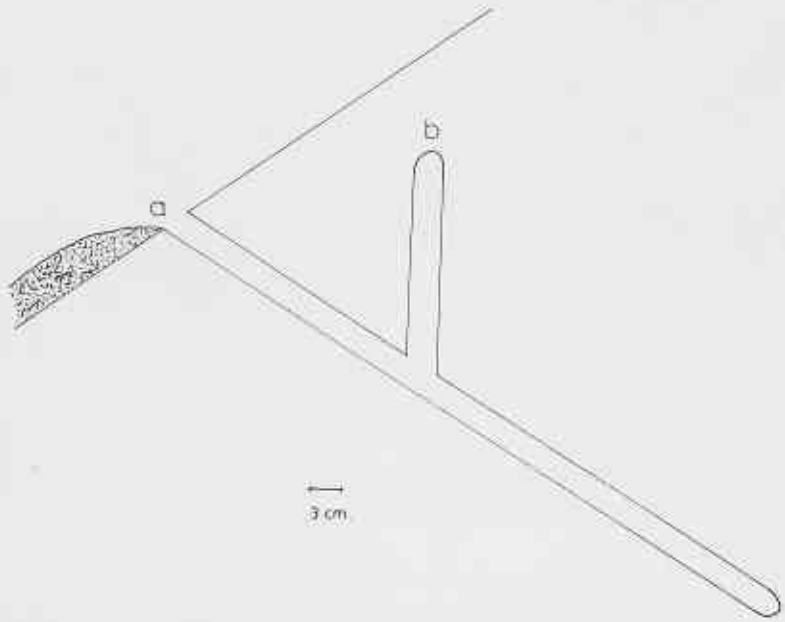


Fig. 3.—Short burrow of *G. albocinereus*, Quoin Bluff, Dorre Island. a, open entrance with excavated spoil. b, " escape " shaft not broken through. Vertical section.

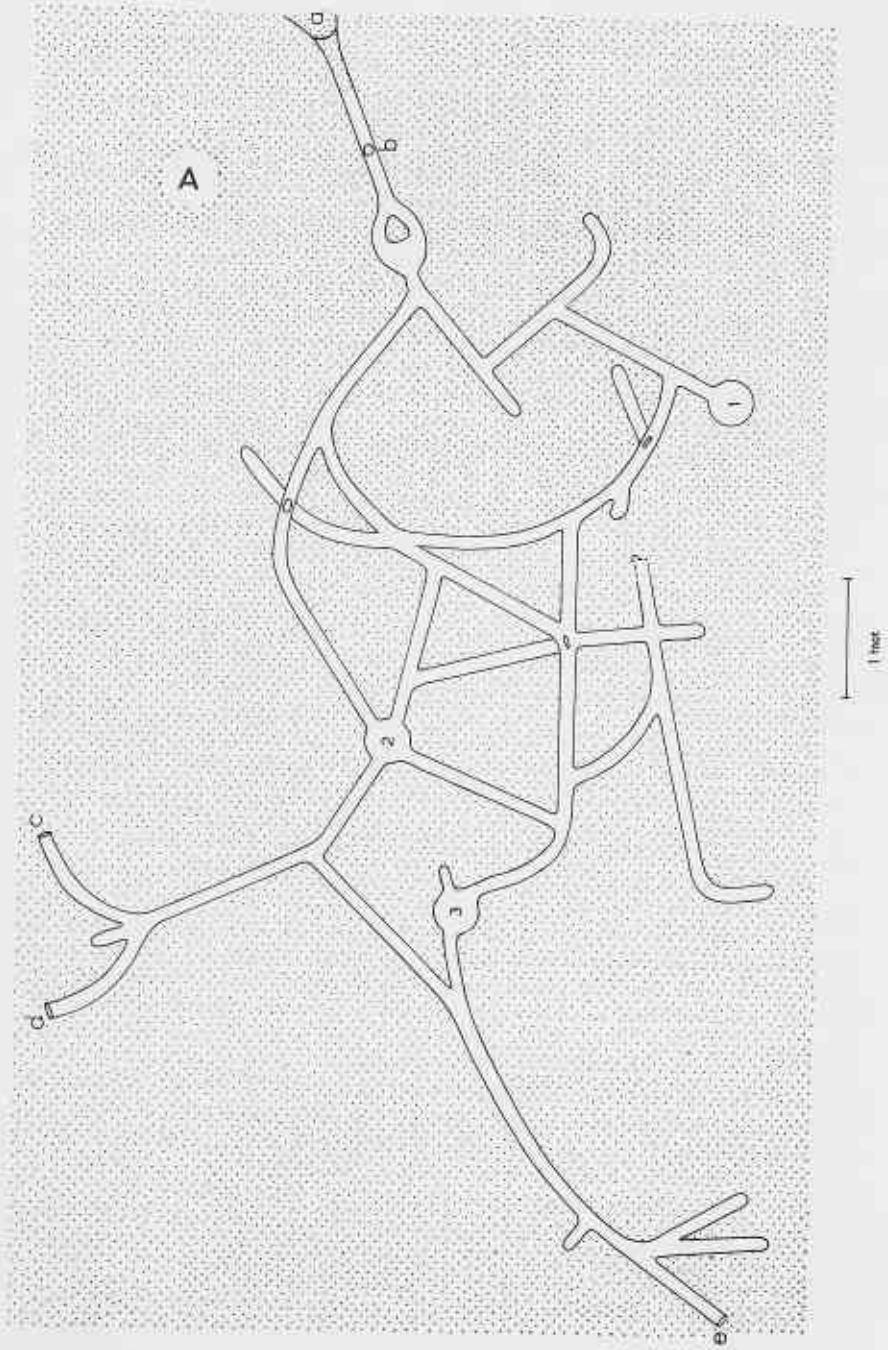
Burrows of the Ashy-grey Mouse were common, and a number were excavated. All except one were unoccupied and it appears that large numbers of short burrows are excavated by this species during the winter months, and, although obviously in use (droppings and tracks around their mouths testify to this) no nesting chambers were present in them and they are not permanently occupied. Bowen and Ride excavated about a dozen below Quoin Bluff on Dorre Island—a number were simply

false ends only a few inches in length, but seven conformed to a standard pattern (see Fig. 3). Of these, two had the " escape hole " (b. in Fig. 3) broken through, the remainder had some 10 cms. of undisturbed sand not excavated. There was invariably a small heap of excavated material outside the primary entrance (a. in Fig. 3). Shortridge (1936) makes particular mention of the fact that the openings (" escape exits ") of the burrows were frequently surrounded by a fragile network of small twigs and chopped grass-stems. He suspected that these were so placed to prevent sand from blowing in and choking the openings. We were unable to confirm this observation, and we suspect that he may have been misled by wind-accumulated litter which is common among the sand-dunes.

The only burrow dug out by us which contained an occupant, was on a stable sandhill to the west of Hospital Valley on Bernier Island. The burrow was extremely complex and contained three chambers, one of which (Fig. 4, 1) contained nesting material of bark, leaves of *Heterodendron oleifolia* and *Acacia coriacea*. The nearest bushes, from which they could have come, were about twenty yards away. Two empty shells of the terrestrial mollusc *Rhaggada* were also found in this nesting chamber. Another chamber (2) also contained leaves and the third was empty. Fig. 4 is a somewhat diagrammatic plan, re-drawn from field notes, of the burrow system, and it will be noticed that two of the openings (a. and b.) follow the pattern of the much shorter holes which were excavated at Quoin Bluff on Dorre Island. Entrance a. was blocked by loose sand, and there was some spoil outside, but the most obvious mound of excavated spoil was about two feet beyond entrance e. This was about two feet in diameter and six inches high. The tunnel system lay about 18 inches below the surface of the ground. The burrow shows many points of similarity to that of the closely related *Gyomys apodemoides* of South Australia, which was excavated in sandy heath country at Coombe in South Australia by H. H. Finlayson (1944). Finlayson also found a complicated system of passages, a nesting chamber, and vertical shafts with pop-holes. The warren described by Finlayson differed from ours in that it had a number of tunnels which were secondarily filled with sand. This had been excavated from other parts of the warren. The warren which we dug out was remarkable in that some tunnels occurred at a lower level and passed beneath others.

This extensive warren on Bernier Island was surprising in that it only contained one occupant (a male in breeding condition near entrance d.). Finlayson remarked that, in *G. apodemoides*, each burrow system appears to be originally the work of one breeding pair, and the part-grown young of one or more litters may share the shelter with the parents. Since most of the animals which we collected were in reproductive state (see below), it is possible that the unoccupied burrows which we excavated on Dorre Island were the early stages in the construction of warrens by breeding pairs, and that, later in the season these would have contained nesting chambers and additional drives. The large warren on Bernier may have been that of a previous season, and last season's litter may have grown up and left it. This warren did not appear to be freshly constructed as did the short burrows we excavated on Dorre Island but one of the nesting chambers contained fresh leaves.

Finlayson said that the tunnels of *G. apodemoides* had clean smooth sandy floors free from excrement, the nest was dry and non-odorous, and defaecation, which was carried out on the surface, was sometimes


A
1 mot

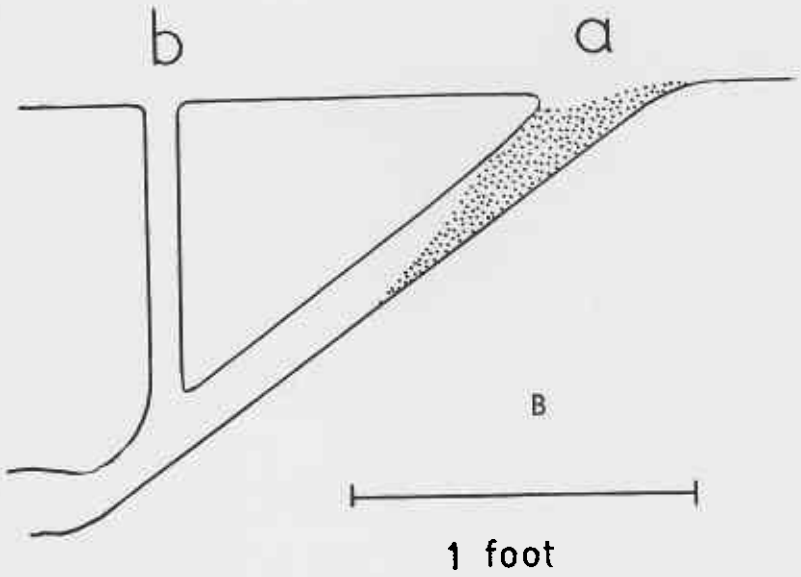


Fig. 4.—Burrow system of *G. albocinereus*, Hospital Valley, Bernier Island. (A.) Plan redrawn from field notes and sketches; 1–3 chambers, a-e entrances. (B.) Vertical section through entrances a and b for comparison with Fig. 3.

concentrated upon middens. We also found that the warren was clean, but we observed no surface middens. Mouse droppings were loosely scattered about the entrance of the small burrows on Dorre.

No specimens of *Gyomys* were seen on the surface during daylight, but they are extremely active on the surface at night and, as mentioned earlier, tracks were common. Near Disaster Cove on Dorre Island, Biscoe swept paths across the island clear of footprints. The two tracks made in this way stretched from the cliffs on the west down into the dunes on the east coast. The northern track was 126 paces long, and the southern one 74 paces long. These were swept clean at 1800 hours on the 19th July, 1959, and inspected again at 0730 hours the following morning. During the night the northern track had been crossed by two sets of *Perameles* tracks, 25 macropods, 1 mouse, 1 *Trachysaurus rugosus*, and 1 *Varanus*; the southern track by 3 *Perameles*, 8 macropods, and 9 mouse tracks. This gives some indication of the commonness of the mice as compared with various other vertebrates, but it must be recognised that this result is also affected by such factors as the relative activity of individuals of the different species and the degree of territorial behaviour which they possess. That the population of *Gyomys albocinereus*, on Dorre Island, is a large one is clearly shown by the results of the analysis of part of the owl-accumulated deposit near White Beach. The small part of the deposit which was analysed (see Table 12) contained the remains of at least 128 individuals of *Gyomys*, 28 individuals of *Perameles bougainvillei*, 10 reptiles of various sorts, and 4 small birds. The Macropodidae were represented by at least 5 individuals, but two of these were probably

fortuitous inclusions and not victims of owl predation. Least-numbers of individuals of each species were calculated on the analysis of premaxillary, maxillary, and mandibular fragments (method of Ride, 1960). The population of *Gyomys* on Dorre Island is clearly numerous enough to form the major food item and support of this colony of owls.

The stomachs of the pythons (*Liasis childreni*) and the goannas (*Varanus gouldi*) which were collected on Bernier Island were also examined and one python was found to contain the remains of *G. albocinereus*. No mice were found in the goannas but one contained the remains of a small Banded Hare-wallaby and it is clear that these must also take mice when opportunity offers. Finlayson mentioned, that at Coombe in South Australia, the chief predators of *G. apodemoides* are probably predatory night birds. A Brown Snake (*Demansia textilis*) was taken from a *Gyomys* burrow at Coombe but contained no *G. apodemoides*. Other snakes taken in the Coombe district contained introduced house-mice, but no *G. apodemoides*. Burrows, which had been partly dug out by foxes, were seen at Coombe and it is clear that, should these ever become established on the Islands, they might prove a serious menace to the continued existence of this remarkable population of native-mice which has existed for many thousands of years in balance with a formidable group of natural predators.

All specimens obtained by us appeared to be in excellent physical condition. Some fighting probably occurs in the population and is indicated by the damaged tail of WR31, a female collected on Dorre Island. Finlayson has commented that bickering in crowded quarters among *G. apodemoides* " usually resulted in nothing more serious than tail shortening."

Diet

Stomach contents of three specimens have been examined for us by G. M. Storr, and he found that they contained both dicotyledonous and moncotyledonous plants, a lichen, fragments of seed coats, insect remains, hairs (probably their own, ingested during toilet), grains of sand, and some small (?) nematode worms. In two of the animals, plant remains comprised the bulk of the contents while the other contained predominantly insect remains.

Reproduction

No litters or small juveniles of the Ashy-grey Mouse were collected by the expedition. However, the only female to be obtained on Dorre was in an advanced state of pregnancy, and of the two females obtained on Bernier, one was pregnant, From this, it is probable that our visit occurred early in the breeding season of this species.

The gravid female collected on Dorre (WR31, see Table 13) carried five large foetuses (CR length 21 mm., 20 mm., 19 mm., 21 mm., 19 mm.), three in the left horn and two in the right horn of the uterus. The pregnant female from Bernier (WR48b) carried four foetuses (CR lengths 12 mm. measured through the uterus). The other female (WR48a) had undistended uteri, although it appeared to be fully adult. Females have two pairs of abdominal teats and no pectoral teats (0 + 2 = 4).

The five spirit specimens (four males and one female) collected by Lipfert during August and September, 1910, have been dissected. The female had undistended uteri, enlarged mammary glands, and prominent teats. She had clearly bred recently and was lactating. The males were all in different stages of testicular development and it is unfortunate

that there is no indication of the dates on which various individuals were captured. One had enlarged scrotal testes, one had a fairly large, partly-descended, right testis and an inguinal left testis, another had large inguinal testes, and the fourth had very small inguinal testes. All appear to have been adult.

Of the four males collected by us only one had abdominal testes, and this was considerably lighter than the other specimens (see Table 13). This may have been a juvenile.

From these few observations it seems reasonable to postulate that testicular enlargement has occurred in most of the population by July and that regression occurs during August and September (it may even be complete by September). Impregnation probably occurs during July, and litters are dropped towards the end of July and during August. Shortridge (1936) makes no mention of having observed any pregnancies in June (although he mentions the presence of foetuses in another species of mouse which he collected on the mainland). In comparison with *Gyomys apodemoides* (Finlayson 1944) the breeding season starts rather later in Shark Bay and this may be correlated with the rather later onset of winter rains on the Islands as compared with Coombe in South Australia (see Table 14). Finlayson has mentioned that in *G. apodemoides* testicular enlargement is confined to a very short period at the beginning of the breeding season (*i.e.*, from March to April) yet litters are produced from the beginning of May to mid-August. Since the gestation period of mice is scarcely likely to be as long as three months, it would seem that males of this species with inguinal testes, are capable of impregnating females or that some form of delayed development takes place.

Litter size in *G. albocinereus* appears to be about four which, as Finlayson has noted, is the common number in most of the *Pseudomys* group of genera of native-mice. Finlayson also noted observing from four to seven uterine embryos in *G. apodemoides*, and litters of as few as three and as many as six nestlings have been taken by him.

THE SHARK BAY MOUSE

Thetomys praeconis (Thomas)

The Shark Bay Mouse was first collected on Peron Peninsula in 1858 by Dr. F. M. Rayner during the voyage of H.M.S. *Herald* (Capt. H. M. Denham). No further material was collected until Shortridge picked a skull up on the surface of Bernier Island in 1906. Even at that time it was not recognised that this was a distinct species and Shortridge's specimen was referred to *Pseudomys gouldi* (see Shortridge 1936, p. 20); however, in 1910 Thomas completed a revision of the genera of the Australian Muridae (1910a) and recognised that the mouse was clearly a distinct species. He named it *Pseudomys* (*Thetomys*) *praeconis* (1910b).

This species must be very nearly the rarest of the Australian native-mice and since the date of its description only two further specimens have been obtained, one (Nat. Mus. Melb. R4997) was collected by G. F. Hill on Bernier Island on the 26th September, 1910, and the other by us, also from Bernier Island. *Thetomys praeconis* has never been recorded from Dorre Island. To date, collections of it have been so small that its absence from the collections from either Island is scarcely a matter for remark except as evidence that the density of this species is low; however, the owls at White Beach on Dorre Island did not appear to have collected

it (see Table 12), while they clearly collected large numbers of *Gyomys albocinereus* and *Perameles bougainvillei* which, like *Thetomys praeconis*, are nocturnal and found among vegetated sand dunes. It seems likely that the Shark Bay Mouse did not occur within the hunting range of this owl population, *i.e.*, the southern part of Dorre Island. No *Thetomys* was found in the stomach contents of the pythons and goannas from Bernier.

The Shark Bay Mouse is easily separable from *Gyomys albocinereus* because it is much more generally brown over its dorsal surface, its hair, too is much longer. Its head appears shorter and more blunt than *Gyomys*. Because of its rarity, the specimen was preserved entire in spirit and the only description of colour available is from field notes. These are as follows : " Length of hair in middle of back 12·7 mm., length of hair in mid-belly 7 mm. Hairs on dorsal surface, grey for basal 8·5 mm., then brown with black tips especially on crown of head. Belly, except in mid-ventral line, white tipped hairs with grey basal parts, general appearance white. Mid-ventral, especially in sternal area, hairs white to roots. On the cheeks under eyes, and along flanks in transition area between the white tipped hairs of the belly and the brown tipped hairs of the back, the hairs are tipped ochraceous (almost orange). Tail is darker above than below but this is not obvious at first glance, except in distal portion where dorsal hairs are distinctly sepia while ventral ones are white. Dorsal surface of snout brownish grey."

This mouse (a female) was caught among the sparse sandhill vegetation to the south of Wedge Point on the evening of the 23rd of July, 1959. It was a very dark humid night without a moon. The mouse was seen by spotlight and was caught by hand after having been cornered in a mixed clump of *Acanthocarpus* and *Spinifex*. It did not attempt to bite when caught and made no noise. Weight 40 g., length 210 mm., tail 115 mm., hindfoot 26·5 mm., ear 19 mm. The species has only abdominal teats (0 + 2 = 4). The uteri were unenlarged.

Stomach contents of the specimen were examined by G. M. Storr who found mostly plant material (especially the epidermis of an annual species of grass), a single fragment of an insect, hairs which were probably ingested during toilet, and grains of sand.

THE DOMESTIC MOUSE

Mus musculus (Linnaeus)

This introduced species, the House Mouse of North-western Europe, is widely distributed throughout Australia today. It is, in most places, the commonest rodent to be found in the bush and is by no means confined to the vicinity of human habitation. At times its numbers reach plague proportion and there can be little doubt, that in the more arid areas of Australia, it is one of the most successful of mammals. No studies have yet been made on the ecological interaction between this species and native rodents but the vast plagues of house mice which are a periodic, but common, feature of life in Australian agricultural districts must have a considerable effect upon competing populations of native murids.

Mus musculus was collected on Bernier Island by Shortridge in 1906. This was not surprising since both Bernier and Dorre were occupied by the lock hospitals at that time and the species could have been accidentally introduced among provisions. Unfortunately, no field notes were pub-

lished with these specimens so that it is not possible to say whether the species was entirely commensal with man in the islands. Lipfert (1912) makes no mention of introduced mice on either Island (nor does he mention cats, although Shortridge said that these were present on Bernier Island in 1906—Shortridge in Thomas 1907, p. 773). It is possible that Lipfert ignored the animals which were non-native. Lipfert did not collect specimens of *Mus musculus* from either Island.

We found no sign of *Mus musculus* on the Islands and it is possible that they are no longer present. In the analysis of the owl pellet debris from the underground tank on Dorre (Table 12), 210 isolated maxillae, 163 isolated premaxillae, 237 mandibular rami and 14 crania were compared with undoubted *Mus musculus* and *Gyomys albocinereus*. None was *Mus*. The pythons and goannas taken on Bernier Island contained the remains of no *Mus musculus* although *Gyomys albocinereus* was present.

If *Mus musculus* has indeed become extinct on Bernier Island, this is the first occasion known to us in which an introduced rodent has become extinct while native rodents have survived.

THE LITTLE BAT

Eptesicus pumilus (Gray)

The Little Bat is widely distributed throughout Australia and it was first collected on Bernier Island by Shortridge (Shortridge 1936) where five specimens were found hiding in crevices under the roof of one of the houses. Shortridge said that the species usually roosts by day in the hollow branches of trees and attributed the presence of the bats in the roof to the treelessness of the Island. In our experience, this bat is commonly found in large numbers in caves, dark rock crevices, and in mine workings. It is almost certainly present in the sea caves which occur at various places around the coasts of the Islands. Small bats were seen entering one of these on Dorre Island and they were frequently observed in the light of our fires. Unfortunately, no specimens were obtained of these small bats and it is impossible to confirm that they were, as we suspect, *Eptesicus pumilus*.

No specimens of *Eptesicus pumilus* were obtained by Lipfert.

THE LESSER LONG-EARED BAT

Nyctophilus geoffroyi (Leach)

This species is a common cave bat and occurs in the Islands. The bat which Lipfert obtained on Dorre Island (WAM 10650) and recorded (Lipfert 1912, p. 98) as *Nyctinomus planiceps*, the Little Mastiff Bat, was misidentified and is of this species.

On the evening of the 23rd of July, 1959, the day before the storm, numbers of these small bats were hawking for insects in the still, humid, air above the blowout between Wedge Point and the northern end of Hospital Valley. At intervals the bats appeared to land on the flat ground, out of sight beyond tussocks of low vegetation. At the time, this was thought to be an illusion, but subsequently captive specimens of this species have demonstrated that they will land and take off again from perfectly horizontal surfaces in order to pick up non-flying insects.

Two specimens were obtained, a male, forearm length 35 mm., weight 7 g.; a female, forearm length 39 mm., weight 11 g.

5198

Aerial Photographs, 5198 and 5028

Blowouts to the north of Red Cliff Pt., Bernier Island. (5198) 26th May, 1949, (5028) 19th September, 1959. Note the spreading sand.

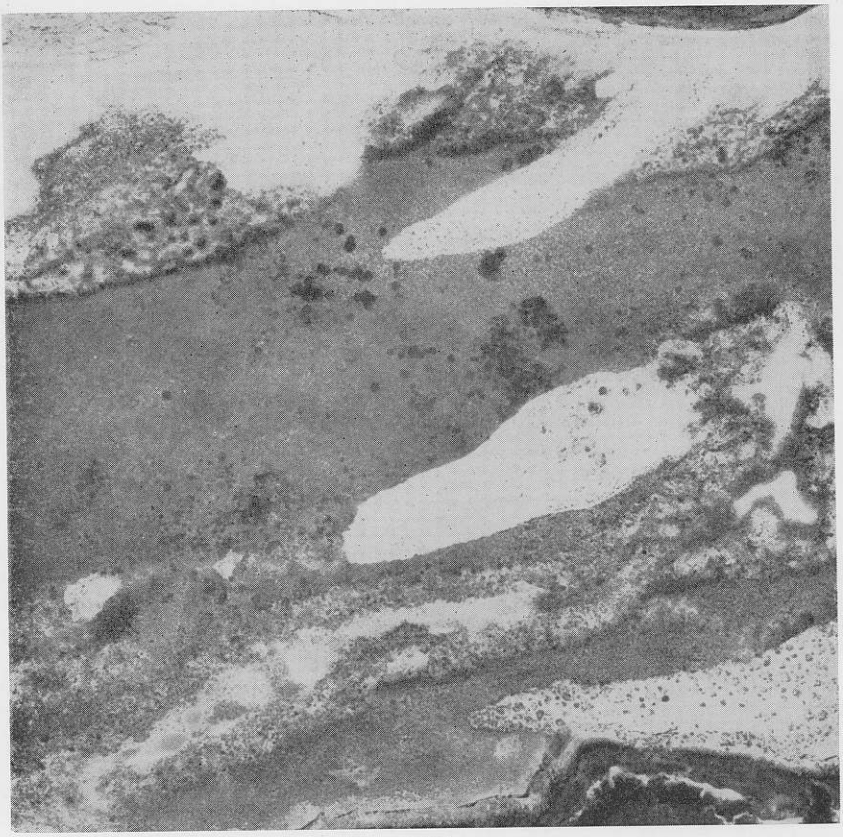
THE GOAT

Capra hircus Linnaeus

The domestic goat gone wild is now a very common animal in many parts of Western Australia and there is, as yet, little realisation among the general public of the great damage which this species will do to the vegetation of the more arid regions unless strong measures are taken to control it. There can be little doubt that the treeless areas of the arid countries which surround the Mediterranean today are largely the result of its activities (Furon 1958).

There has been no previous mention by past workers of goats on the Islands, but today they are common on Bernier though apparently absent from Dorre. An account of the damage which these animals are doing to the vegetation of Bernier has been given in the description of the botany of the Island (p. 44). The presence of increasing blow-outs in the sand-hills of Bernier and their almost complete absence from Dorre is probably also the result of their activity.

All members of the expedition had searched for signs of goats on Dorre without success but on Bernier it was impossible not to see them.



5028

Immediately on landing, up to 15 goats were seen by various members of the party and during the rest of the time that the party spent on the Island, A. M. Douglas gathered what information he could about the herd. This was done in addition to his normal role as collector of reptiles. Unfortunately the amount of biological information gained by the expedition was slight in spite of the unique opportunities which this Island offers of observing a feral goat herd under almost ideal conditions. Goats in the Islands are all pale coloured and are easily visible, while it is not difficult to find adequate cover for the observer but the activities of the party constantly disturbed the herd and, after the first day, behaviour was almost certainly atypical. Most information was gathered by shooting. (37 females and 15 males were shot. Of these, Douglas collected 45.)

Most goats shot were white, a few were blotched with brown and one was of a uniform light brown colour. Old males were fat and were feeding well.

At the time of our landing, the herd appeared to be broken up into small groups, but the population rapidly became so disturbed that these small parties became broken up, or in some cases, merged with others to form larger (and possibly artificial) groups. Owing to the shape of the Island, any activity, directed at the goats or not, had the effect of driving

them and this was bound to upset the population structure. Nevertheless, what information we have does not appear to indicate that during July the population is broken up into discrete billy and nanny-kid herds as Riney and Caughley (1959) found during the New Zealand winter in their study of home range in a feral goat herd ; but it is clear that some pure male parties occur. In the area in which Riney and Caughley worked, there was dense forest and the males moved into this. On Bernier, even if males tended to move away from the nanny-kid herd, they would still be in almost constant sight of parties of nannies.

As a result of observations made on the 21st of July (the day after we landed on Bernier) Douglas is of the opinion that the herd, before it was disturbed, was broken up into small groups with the following composition : Only old males. Small groups of females without males. Mixed herds of females with one or more young males. In support of this observation a group comprising males only (7) was shot by Douglas and Ride during the first three days in the sandhills to the south of Hospital Valley. This group appeared to retain its identity despite our persecution and members of it were often observed from the camp site climbing into the upper branches of *Alyogyne*. These males had very large horns and many were almost hairless on the shoulders and hind quarters. On July 21 Douglas shot the members of a group of nannies which were unaccompanied by males. All females in this herd were gravid. Embryos were small (C.R. length approximately 1 inch to 3 inches). On that day Douglas also saw herds with the following composition : 3 males and 6 females. 1 male and 3 females. 2 males and 4 females. From this, Douglas gained the impression that there were few groups which contained more than 7 animals although animals which were being driven often formed large parties. (Twenty-three were observed on one occasion.)

Of the 37 female goats shot by the party, all but 4 were pregnant. Of the non-pregnant animals, 3 appeared to be well under their full growth and the other had the young kid at heel. This kid was the only one shot and since a nanny with a small kid had been seen on several occasions prior to this, we have only this evidence of kids in our part of the Island. Embryos varied from about 1 inch C.R. length to about 12 inches, but most were of small size.

The population is clearly in excellent condition. Individual animals are healthy, there are large numbers of adult males and the majority of females are carrying young. The reproductive potential of the population is being fully realised and it is surprising that there are not more young animals in it. In a population of this composition, it is probable that mortality among kids and yearlings is high, but we have no actual evidence of this mortality peak. Nests of sea eagles examined contained no kid bones and the only actual evidence of predation comes from the discovery of several adult goat skeletons on the island which lacked the hindquarters. It is clear that the Islands are occasionally visited by shooters. The skeletons of some kids were noticed but it is not known what caused their deaths and these did not noticeably outnumber those of adults. It is probable that dehydration is an important factor in mortality among weaning animals because there is no free water on the Island. The goats appear to use the sea caves along the north-west coast of the Island and it is possible that these serve as a shelter against excessive heat.

Darling (1937), in his notes on wild goats in Scotland, has remarked that in these feral populations mortality among kids is almost certainly high and plays a large part in the rapid reversion of domestic goats (*C.h. hircus*) to the long haired and long horned form which represents the feral type. The domestic goat is derived from the Persian or Grecian Wild Goat, *C.h.aegagrus*.

The area from which the goats were collected, and these observations were made, comprises only the northern part of the Island to about three miles south of the Hospital site. Douglas estimates that this area contained some 60 to 70 individuals during our visit, and he doubts if the total population of the Island is much more than 150 individuals ; this estimate represents about one goat to 70 acres which, in comparison with the carrying capacity of sheep on stations on the adjacent mainland and Dirk Hartogs Island, is far below what the vegetation will support (see Table 15).

THE DOMESTIC SHEEP

Ovis aries Linnaeus

Despite the fact that both Bernier and Dorre Islands have been leased at various times for pastoral purposes, we are unable to find any published statement that sheep were actually introduced to the Islands, or any account of their numbers, except that of Shortridge (1910, p. 818) who said of Bernier " It may be noted that sheep had been temporarily introduced there, while in the south of Dirk Hartog there is a large sheep station, and the wallabies are said to have entirely left that end of the island." From the information available, it seems unlikely that sheep ever occurred on Dorre.

Mr. Baston of Carnarvon, who had the grazing lease of Bernier immediately before the hospitals were established, had a house and improvements on the Island which were later bought for £1,000 by the Aborigines and Medical Departments. Shortridge says (letter to Thomas 4/6/06) " There is a sheep station on the island & only one man on it — . . . ." He also mentions good feed for sheep. Later, he (Shortridge 1910) stated that *Bettongia* occasionally ate dead sheep on the Island.

The grazing of sheep on this Island for a number of years probably had some effect on the vegetation.

THE HORSE

Equus caballus Linnaeus

During the period of occupation by the hospitals, there was a horse on Bernier Island. A photograph in the collection of the Native Welfare Department, Perth, shows this horse in the shafts of a cart on Bernier. The expedition found this cart in Hospital Valley.

THE DOMESTIC CAT

Felis catus (Linnaeus)

The domestic cat occurs widely in Western Australia and, in its feral state, is one of the most common mammals encountered in the bush. It is an extremely efficient predator and probably causes much havoc among the smaller marsupials, native rodents, and birds. It is successful, and emaciated specimens are seldom seen.

The cat clearly occurred on Bernier Island during the period of Shortridge's visit since he attributed his inability to obtain specimens of the bandicoot *Perameles bougainvillei* to its extermination by cats on the Island. (Thomas 1907, p. 773, and Shortridge, 1910 p. 833).

In 1919, W. B. Alexander, both as Keeper of Biology in the Western Australian Museum and as Secretary to The Royal Society of Western Australia, made strenuous efforts to have the entry of cats to the Islands forbidden and finally, in the lease which was granted in 1939, it was stated that " No cats or firearms shall be allowed on these Islands."

All members of the expedition were watchful for the presence of cats and their tracks but none were seen. It is hoped that this species is now extinct on the Islands.

AQUATIC MAMMALS

Dugong dugon (Muller), the Dugong, occurs in Shark Bay and probably around the Islands. Shortridge (1936) obtained a specimen from the Bay and the object, described by Dampier in the maw of a shark, was probably also of this species. The expedition saw no Dugong.

Megaptera nodosa (Bonnaterre), the Humpback Whale, is a common mammal in Shark Bay and in the waters outside the Islands. These whales are known to spend the summer feeding in the Antartic between 70°E. and 130°E. (Antartic Area IV) (see Chittleborough 1959). From this area they migrate northwards along the Western Australian coast into tropical waters where they breed in the warmer waters and the whalers of the Nor-West Whaling Company, which operates from Babbage Island outside Carnarvon, take these whales during their breeding migration. In addition, this population is hunted by whalers operating from Albany

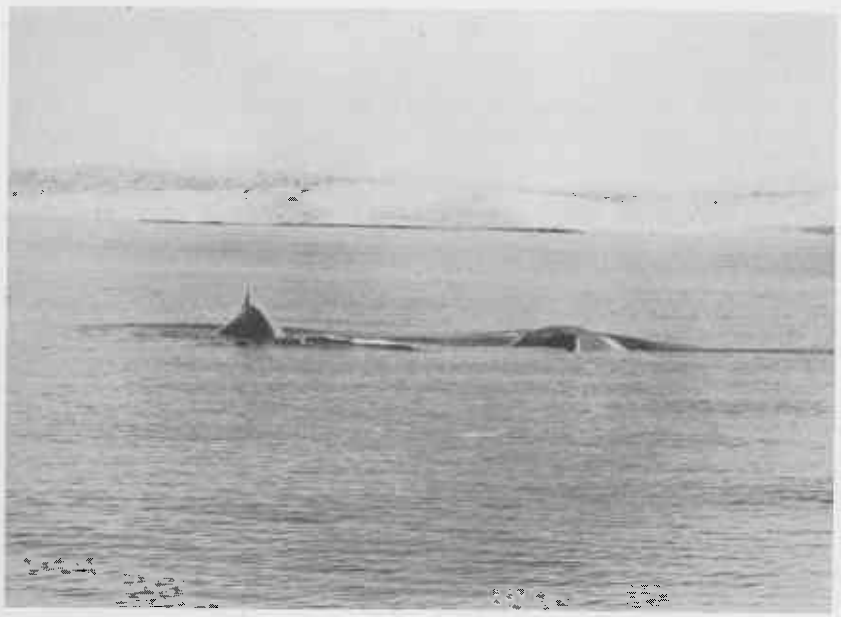


Plate 31. Humpback Whales, *Megaptera nodosa*, at the surface in-shore of the southern end of Bernier Island.

in Western Australia and on their feeding grounds in the Antartic. Chittleborough (1960) has shown that the rate of catching increased at Carnarvon from 1951 to 1953 and that since then the rate of catching has fallen fairly regularly each year to the latest time for which figures are available (1959). At Albany the rate of catching increased from 1952 to 1955, declined very considerably to 1957, and has since remained at a low level. He has also shown that the sizes of both male and female whales (as indicated by their lengths) have decreased from year to year, the decline being relatively small each year from 1956 to 1958 and abrupt in 1959. Recent catches also contained more younger individuals than did those of earlier years.

Numbers of these magnificent mammals were seen by the expedition in the quiet waters of the Bay, and Chittleborough has shown that the population, as it migrates along the western coast of Australia, divides in the region of Shark Bay, part of it passing inside the bay and the other outside Bernier and Dorre Islands. During the earlier years of whaling operations from Carnarvon, whales were extensively hunted within Shark Bay where conditions were more favourable for the whalers than in the open ocean. However, in recent years, hunting has extended outside the Islands and it is now clear that this population has declined very seriously in recent years and, as Chittleborough has pointed out, this bears resemblances to similar declines which occurred in the whale populations of South Georgia and of French Equatorial Africa (Congo). In South Georgia the intensive hunting of migrating whales has resulted in the poplation becoming so severely depleted that today, forty-five years later, it has still not recovered and in French Equatorial Africa whaling ceased in 1952 following a decline in catches despite a twelve year rest up to 1949. This population was given a further rest of six years and, when whaling was resumed in 1959, only 200 whales were taken on a quota of 500.

Seals have not been reported from Bernier and Dorre Islands and the expedition saw no sign of them.

DISCUSSION

Composition of the mammalian fauna

Shortridge (1910, p. 819) believed that mammal fauna of the Islands of Shark Bay corresponds with the sand-plain fauna of the South-west. But of the six terrestrial species of mammals indigenous to Bernier and Dorre, *P. bougainvillei* and *T. praeconis* have been collected from the mainland of Shark Bay during historic times. *L. hirsutus* is known to occur widely in Central Australia (Finlayson, 1958) and, in Western Australia, it has been recorded from York, its type-locality, and also from the Canning Stock Route (Glauert, 1933). *B. lesueuri* had a similarly wide distribution in Western Australia and it even occurred as far north as the vicinity of Broome (Dahl, 1926). The two remaining species (*L. fasciatus* and *G. albocinereus*) have not definitely been recorded from north of the Murchison River on the mainland, but Shortridge had been informed by residents of the Carnarvon district that as late as the eighteen eighties " wallabies were as plentiful around Carnarvon as on Bernier Island and the idea of everyone here seems that the most acceptable way of explaining the complete disappearance of mammals—which is that some epidemic probably to do with white settlement or the introduction of sheep—killed them all off." (Letter Shortridge to Thomas, 10/11/1906). Later he (Shortridge, 1910) recorded the probable distribution of *L. fasciatus* as being from Eucla in the south to the vicinity of Port Hedland in the north, extending as far east as Laverton. In south-western Australia Shortridge omitted only the highest rainfall areas from its range.

The distributions of the various species thus indicate that the island fauna is not a South-western fauna which is, as a result of being " stranded " on an island, out of place in relation to its latitudinal position along the Western Australian coast. A similar fauna certainly extended into the sand-plain country of the South-west during historic times where sandy areas with good drainage provided the conditions of little free water and scrubby vegetation to which it was suited.

Since the Islands have been separated from the mainland for some 8,000 years, and since the fauna which is on them at present is not out of place in relation to the fauna of the mainland, it would appear that there has been little significant climatic change since the time of their isolation (at least, significant insofar as mammal distribution is concerned). This conclusion agrees with that of Lundelius (1960) who examined the composition of a succession of fossil faunas from 7,800 years ago to the present day in the Jurien Bay area (400 miles to the south of Bernier and Dorre). He found that the arid conditions which prevail at present began some time prior to 7,800 years ago, and that there is no evidence of a more arid period between that time and now.

It is of interest to compare this mammal fauna with that of the Wallabi Islands of Houtman Abrolhos. These islands have some twenty-five fathoms of water between themselves and the mainland and have probably been isolated for about 2,000 years longer than Bernier and Dorre. Their indigenous mammal fauna comprises a rat (*Rattus glauerti*) whose affinities are not fully understood, and a small macropod (*Protemnodon eugenii*) which has not been recorded north of the Moore River (two hundred miles to the South) in historic times. This fauna, in contrast to that of Bernier and Dorre, does appear to have been " left behind " by a changing pattern of distribution on the mainland.

Evolutionary changes within the species following separation

Thomas was of the opinion (Thomas, 1907) that the mammals found on Bernier and Dorre (with the exception of *T. praeconis* which he described later) differed sub-specifically from their relatives on the mainland. All his comparisons were made with forms from further south. Owing to the inadequacy of our comparative material we are unable to add much to Thomas' statement except that his views appear to be well founded in the case of *Gyomys albocinereus* and *Bettongia lesueuri*. Like Thomas, however, in these species we have made comparisons with specimens from the South-west and not from the mainland of Shark Bay. In the case of *Lagorchestes hirsutus* the position is somewhat different and, where Thomas had only material from York, we had a small series from the Canning Stock Route. This had been collected in the vicinity of Lake Disappointment on the Tropic of Capricorn. Comparison of this series and Dorre Island specimens would also appear to support Thomas' conclusions.

Since Bernier and Dorre are separate from each other, and may have been for some considerable period, it is also pertinent to ask whether there is any detectable morphological difference between the various species on the two islands.

Thomas (1907) believed that the Bernier Island form of *L. hirsutus* differed sub-specifically from that of Dorre, the main difference being that the inter-orbital region of the Bernier Island form is in the vicinity of 13 mm. while only being 10 mm. in the Dorre Island form. In his original comparison, Thomas had seventeen specimens from Bernier Island which he said were remarkably uniform and two specimens from Dorre Island which had been collected earlier by Tunney and presented by the Western Australian Museum to the British Museum. Glauert (1933), having almost the same material for comparison which is available to us, questioned the validity of the two sub-species and their distinctness from the mainland form. Better comparative material is clearly needed to establish the validity of Thomas' two insular sub-species, but it may be said in favour of his conclusions that the inter-orbital constrictions of the eight Dorre Island specimens in the Western Australian Museum, range from 10·5 to 11·7 mm. (10·5 mm., 10·6 mm., 10·9 mm., 11·2 mm., 11·2 mm., 11·2 mm., 11·3 mm., 11·7 mm.) while our single Bernier Island specimen has a constriction of 12·7 mm. The probability that the measurement of the Bernier Island specimen belongs to the series from Dorre is less than 1 per cent. Neither Thomas nor we were able to distinguish any morphological character which separates the two island populations of *Lagostrophus*.

Interaction of the macropod species

Bernier and Dorre Islands have been separated from each other for some time and from the mainland for even longer and each carries a population of three species of small macropod, yet these species appear to be absent today from the adjacent mainland so that one is concerned to know how the population is maintained on them ; further, do the absolute numbers fluctuate, and if so, do the proportions of the three species change in the same way on each ?

The most useful comparisons which could be made, in order to help us to determine how the populations are maintained on the islands, would

be with Dirk Hartogs Island, with Edel Land, and with the Peron Peninsula. Unfortunately, these data are not available beyond the knowledge that sheep, foxes and rabbits are present in these localities while they are absent from Bernier and Dorre (except for a short period during which sheep may have been on Bernier Island and the modern presence of goats on this island). Shortridge (1910, p. 818) says that the wallabies are said to have entirely left that part of Dirk Hartogs where there is a sheep station and there can be no doubt that these introduced mammals have a deleterious effect upon indigenous mammal populations (see Marlow 1958).

We have better documentation of fluctuations of numbers on the islands. Accounts of six visits by naturalists to one or both islands in the past 160 years and several collections (see Table 16) indicate that the relative numbers of the three species have not been the same at the time of each visit. These figures need to be carefully assessed before drawing conclusions from them because the collectors were primarily concerned to get good series of each species. It is the low figures or absences which are most significant because it can be assumed that special efforts were made to get the rare species, as we did in the case of *Lagorchestes*.

In 1801 Peron only mentioned *Lagostrophus*. He said that it swarmed on both islands, but no mention was made of the other two species. He was on the islands in daytime which could account for the absence of *Bettongia* from his record; the absence cannot be due to confusion in this case because he knew of the genus. The absence of *Lagorchestes* from his record may indicate that it was relatively uncommon then, though the method of capture he used, flushing the animals from bushes, is not one which, in our experience, would get *Lagorchestes*. However, his description of *Triodia* on both islands clearly indicates that he was at times in a suitable environment for the capture of *Lagorchestes* and he did not see it.

In 1896 and 1899 the populations on Dorre of all three species were presumably substantial since Tunney obtained them all. Unfortunately, none of Tunney's field notes are available but all three species were common enough for him to remark in a letter written after his first visit, which only lasted " a few hours," that there were three kinds of wallabies on the Islands. (Letter Tunney to Woodward 28/3/1896). At least two of the five specimens obtained on this first visit were *Lagorchestes*, one was *Lagostrophus*, but no record remains of the other two which may have been *Bettongia*. In his next visit in 1899 he obtained essentially equal numbers of *Lagostrophus* and *Lagorchestes*. Presumably the populations were building up to the peak of 1906 when all three species were common.

Shortridge visited the Islands in 1906 and, unfortunately, his visit was confined to Bernier so that in considering his account in this documentation of fluctuation of numbers upon the Islands we have to assume that the two Islands behaved similarly because the visits of Shortridge and Tunney were to different Islands. Shortridge seems to have witnessed a " population crash " and (in Thomas, 1907) stated that " *Lagorchestes*, *Lagostrophus* and *Bettongia* swarmed in the island. In the case of *Lagostrophus* I have never seen any animal, not even rabbits, in such numbers. It has been a particularly dry season, and they were very thin. Food was evidently insufficient for them all, and dead specimens

were lying about in all directions. It would seem that they have no natural enemies on the island ; and they breed to such an extent that the island will carry no more, and in times of drought a number have to die. *Lagorchestes* was not so plentiful." But later he (Shortridge, 1910) said that *Lagorchestes hirsutus* was " Plentiful on Bernier Island in heathy and spinifex country." Of *Bettongia* he said (Shortridge, 1910) " it is very plentiful, making burrows among the cliffs along the seashore. Feeding to a great extent on marine refuse and dead matter, even dead sheep being occasionally partly eaten."

In 1910 Lipfert visited both Islands and he said " The Wallabies, of which three species are to be found, are not at all numerous." (Lipfert, 1912). Unfortunately, Lipfert gave no statement of relative abundance of the various species, but it is most likely that *Lagorchestes* on Bernier suffered most in the " crash." Lipfert obtained no specimen of this species on Bernier and Steele, a resident on the Island who collected some material for the Western Australian Museum, obtained only one, while at the same time Lipfert and Steele collected fourteen *Lagostrophus* from Bernier. *Lagorchestes* was still common enough on Dorre for Lipfert to get six.

In 1959 the populations of *Lagostrophus* and *Bettongia* were found by us to be moderately abundant but could by no means be described as swarming, or as common as animals in a large rabbit population, and *Lagorchestes* was very rare. Our experience on Dorre would incline us to believe that *Lagorchestes* has declined there since Lipfert's visit as well as on Bernier. This is judged by our collection of dry skulls and living material.

Comparison of these records leads us to believe that populations of *Bettongia* seem to have changed less than those of the other two species.

Lagostrophus appears to have suffered considerable fluctuations in number during our knowledge of the islands, but it has recovered from a well documented " crash " and appears to be secure under its **present environmental conditions.** It appears unlikely that these conditions will persist in the presence of the goat population on Bernier Island.

The decline of *Lagorchestes* since 1906 is the most significant change which emerges from the account, and it is tempting to correlate this with the introduction of sheep and goats which first occurred around the turn of the century. But, as far as we know, this occurred only on Bernier. However, the " crash " was only witnessed on Bernier and from Lipfert's results it was on Bernier that *Lagorchestes* suffered most. Shortridge considered that the " crash " was the normal result of high numbers but we are inclined to believe that it may have been the first effects of interference in the habitat by men. The populations were thinned out to some extent by the use of the Wallabies as a main article of food by aborigines between 1907 and 1918 but it seems unlikely that this would have compensated for the widespread destruction of their habitat by introduced mammals and fires. Extensive fires on Dorre were seen from Bernier by members of the hospital staff in 1909 and modern aerial photography clearly shows the " fire streaks " of extensive burns in the Open Steppe of Dorre. On Bernier, blackened stumps and tree trunks are visible in many places.

Lagostrophus and *Lagorchestes* seem to overlap in habits and food requirements more than either does with *Bettongia*, and it may be that interference with the island habitat has upset an 8,000-year balance between the two species in favour of *Lagostrophus*.

Another factor which may have affected *Lagorchestes* on Bernier is the apparent absence of large areas of *Triodia* on this island. At the time of Peron's visit he described *Triodia* as being common on both islands and even Dampier mentioned obtaining it on the southern end of Bernier. Shortridge found *Lagorchestes* common in *Triodia* on Bernier while we did not find any extensive areas of *Triodia*. It appears to be absent from aerial photographs and neither our own wanderings in the northern end of the island, nor Bowen's subsequent crossing of the island in the vicinity of Red Cliff Point, revealed its presence in any quantity. A proper transect should be made to clarify this point and, if Open Steppe is now absent, the widely different biological environments of the two Islands will present to the future a fascinating pair of natural laboratories in which to study the interaction of small mammal populations under different environmental conditions.

Reflections

The most curious part of the problems raised by the persistence of the three macropod species on Bernier and Dorre is that it is precisely the species which is rare on the islands (*Lagorchestes*) that persists on the mainland, whereas the two most successful island species are either possibly extinct (*Lagostrophus*) or exist in very diminished range and possibly close to extinction (*Bettongia*). *Lagostrophus fasciatus* was declining in South-west Australia when Shortridge collected it in 1906 near Pingelly and no other specimens have been recorded since. The clearing of scrub for agriculture, thus destroying the main habitat of this gregarious animal, was possibly the primary factor in its demise, but rabbits, foxes and stock no doubt played their part. Similar factors may have affected *Bettongia*. On the other hand, *Lagorchestes* is known, from its mainland congeners, to be a solitary animal of open country. The population may therefore have survived at low densities on Bernier and Dorre as it still does in Central Australia but the species is presumably more secure on the mainland because of the enormous areas available to it where it can survive despite local invasions by introduced grazers, and the calamity of fire. On Bernier and Dorre, on the other hand, it is much more vulnerable because its limited habitat is liable to total destruction and subsequent recolonization would be impossible.

Whether or not these reflections on the persistence of the island populations are well founded, it would certainly be most desirable to remove the goats from Bernier Island as soon as possible to prevent further alteration to its natural environment but this alone will not be enough; we must also prevent man-caused fires and rigorously protect the islands against the thoughtless liberation of further alien species. In these ways alone can we hope to ensure that Bernier and Dorre will retain their faunas—faunas which make them biologically unique and a living and irreplaceable part of the " old " Australia.

Table 6

COLLECTIONS OF MAMMALS FROM BERNIER AND DORRE

(Data for Tunney, Lipfert, Steele and Grant Watson from W.A.M. Catalogues, Shortridge from Thomas (1907), and Hill from Nat. Mus. Melb.).

Species	Peron, June, 1801	Tunney*, March, 1896		Tunney, February, 1899		Shortridge†, July, 1906		Lipfert, Aug.-Sept., 1910		Hill, Steele and Grant Watson, 1910–11	Expedition, July, 1959	
		♂	♀	♂	♀	♂	♀	♂	♀		♂	♀
Dorre Island—				1				4	5	....	1	1
Perameles bougainvillei	....	....	....	3	1	....		2	1	....	4	3
Bettongia lesueuri	....	....	2	8	5	....			6	....	1	
Lagorchestes hirsutus	....	....	1	5	9	....		5	5	....	5	3
Lagostrophus fasciatus	Numerous	....	....	....		....		3	7	....		1
Gyomys albocinereus	....	....	....	....		....		1		....	....	
Nyctophilus geoffroyi	....	....	....	....		....				3	1	3
Bernier Island—						skull picked up		3		....	2	3
P. bougainvillei	....	....	....	....		3	6	1	3	1		1
B. lesueuri	....	....	....	....		10	7	....		10	8	7
L. hirsutus	....	....	....	....		3	5	1	3	....	4	2
L. fasciatus	Numerous	....	....	....		1	4	3	2	1		1
Gyomys albocinereus	....	....	....	....		skull picked up		....		....	1	1
Thetomys praeconis	....	....	....	....		....		....		....	....	
Nyctophilus geoffroyi	....	....	....	....		5		....		....	37	15
Eptesicus pumilus	....	....	....	....		....		....		....	....	
Capra hircus	....	....	....	....		1	1	....		....	....	
Mus musculus	....	....	....	....		present		....		....		
Felis catus	....	....	....	....								

* Tunney sent 5 wallabies to the Western Australian Museum but it is only possible to establish the identities of 3.

† Shortridge states (1910) that 23 *Lagorchestes*, 15 *Lagostrophus* and 18 *Bettongia* were obtained.

Table 7

TRAP SUCCESS

Type of trap	No. of traps available	Trap nights	No. of animals caught	No. of trappings per mammal caught
Cages	6	48	3 *Bettongia* 1 *Lagostrophus*	12
Box traps	10	40	0	....
Longworth	36	174	3 *Gyomys*	58
Breakback	24	114	1 *Perameles* 1 *Gyomys*	57
Snares :				
(a) Spring	6	24	0	....
(b) Common	16	64	0	....

Table 8

RESULTS OBTAINED BY SUCCESSFUL NON-TRAPPING METHODS

		Shooting	Net and Torch	Digging
Wallabies	*Bettongia*	2	6	1
	Lagostrophus	9	23*	....
	Lagorchestes	....	2	....
Bandicoot	*Perameles*	1	4	....
Mice	*Gyomys*	....	2	1
	Thetomys	....	1	....
Bats	*Nyctophilus*	2	....	....
		14	38	2

* 9 of these *Lagostrophus* were released without examination. Even more could have been captured by this method had we been able to handle the material.

Table 9

BIOLOGICAL DATA OF *Lagostrophus fasciatus*

Field No.	Museum No.	Sex	Eruption Stages		Progression of Molars	Epiphysial Union							Body weight (g.)	Reproductive condition
			Premolars	Molars		Elbow	Ankle	Wrist	Knee	Hip	Shoulder	Vertebrae		
WR20J	M3635	♂♀♂♂♀♀♂♂♂♀	3	1	1	o	—	o	o	—	o	—	330	Immature
Z1418	M3633		3	1	1	o	—	o	o	o	o	o	170	Immature
Z1413	M3637		3	2 al	1	—	—	—	—	—	—	—	500	Immature
Z1416	M4132		3	2	1–2	o	o	o	o	o	o	o	1000	Immature
Z1422	M4134		3	3 al	1–2	o	o	o	o	o	o	o	900	Immature
WR45	M3677		3	3	1–2	—	—	—	—	—	—	—	1600	Not examined
WR19	M3634		3	3 al	2	—	—	—	—	—	—	—	1200	Immature
WR24	M3636		3	3	2	—	—	—	—	—	—	—	1500	Spermatogenesis
WR49	M3624		3	3	2	—	—	—	—	—	—	—	1600	Lactating
WR50	M3629		3	3	2	—	—	—	—	—	—	—	1700	Not examined
WR44	M3638		4	4 al	2–3	—	—	—	—	—	—	—	1550	Spermatogenesis
WR39	M3630		4	4 al	2–3	—	—	—	—	—	—	—	2100	Not examined
Pick up B	....		4	4	—	o	—	o	o	o	o	o	....	....
WR33	M4129		4	4	3	—	—	—	—	—	—	—	....	Not examined
WR36	M3632		4	4	3	—	—	—	—	—	—	—	1800	Spermatogenesis
Pick up F	....		4	4	3	—	o	—	o	o	—	o	....	....
WR56	M4130		4	4	3	+	o	+	o	o	o	o	1300	Lactating
WR59	M4131		4	4	3	+	♁	♁	o	o	o	o	2050	Not examined
Pick up E	....		4	4	3	o	o	o	o	o	o	o	....	....
Z1419	M3625		4	4	3	+	o	o	o	o	o	o	1500	Lactating
Z1421	M4133		4	4	3	+	o	♁	o	o	o	o	1600	Lactating
Pick up C	....		4	4	3–4	—	—	—	o	o	—	o	....	....
Z1420	M3626		4	4	3–4	+	♁	o	o	o	o	o	1500	Lactating
WR20	M3635		4	4	3–4	—	—	—	—	—	—	—	1600	Lactating
WR38	M3766		4	4	3–4	—	—	—	—	—	—	—	2100	Lactating
WR51	M3631		4	4	3–4	—	—	—	—	—	—	—	1900	Testes 4·5 g.
WR52	M3628		4	4	3–4	—	—	—	—	—	—	—	2050	Testes 6·0 g.
Pick up D	....		4	4	4	+	—	—	+	+	+	+	....	....
WR26	M3627	♀	4	4	4	—	—	—	—	—	—	—	1950	Lactating

Key to signs in table of Epiphysial Union : — Not seen; o Unfused; + Fully fused; ♁ Partly fused

Table 10

DATA FROM JOEYS OF *Lagostrophus*, *Lagorchestes* and *Bettongia*

	Sex	Body weight (g.)	Hind foot (mm.)	C.R.L. (mm.)	Eyes	Fur	Voice	Stance, etc.
Lagostrophus—								
WR56J	♀	20	25	....	....	None	....	Dead in pouch
WR38J	♀	63	52	....	Open	....	Squeak	Unable to stand
WR26T	♀	66	52	....	Closed	None	Squeak	Nearly able to stand
Z1418 25/7	♀	170	82	....	Open	Furred	....	Hopping clumsily, 3rd incisor breaking gum
Z1418 17/8	....	194	....	....	Open	....	....	Leaving pouch
WR20J	♂	330	91	....	Open	Furred	....	Out of pouch
Lagorchestes—								
WR57J	....	....	....	23	Closed	....	....	
Bettongia—								
WR58J	....	0·21	....	14	Closed	None	Not squeaking	New born
WR18J	♀	17	23	....	Closed	None	Squeak	
WR35J	♀	38	39	....	Closed	None	Not squeaking	
WR21	♀	82	65	....	....	Well furred	....	

Table 11

ANALYSIS OF SKULLS BY DENTAL PROGRESSION

Lagostrophus fasciatus

Number of individuals in each progression stage.

Progression Stages (see fig. 1)	M1	M1–2	M2	M2–3	M3	M3–4	M4	Total
Pick-up skulls—								
Bernier	4	4	—	1	4	16	3	32
Dorre	....	3	—	—	1	2	—	6
Live caught—								
Bernier	1	3	2	2	5	4	....	17
Dorre	2	....	2	—	1	1	1	7

Table 12

CONTENTS OF THE UNDERGROUND TANK, DORRE ISLAND

A. Specimens selected from debris.

(i) Fortuitous inclusions (represented by complete skeletons):
Bettongia lesueuri 3, Lizards 2, Snakes 1, *Gyomys albocinereus* 1.

(ii) Probable fortuitous inclusions (specimens of large size showing no evidence of predator damage beyond the disarticulation of their remains):
Bettongia lesueuri 3, *Lagorchestes hirsutus* 1.

B. Analysis of sample of debris (least-numbers of individuals):
Gyomys albocinereus 128, *Mus musculus* 0, *Thetomys praeconis* 0, *Perameles bougainvillei* 28, *Lagorchestes hirsutus* 1, *Bettongia lesueuri* 1 (probably a fortuitous inclusion), *Lagostrophus fasciatus* 2 (1 probably a fortuitous inclusion), Unidentified macropod 1, Reptiles 10, Birds 4, Numerous beetle elytra and some terrestrial molluscs.

An analysis of part of the contents of the Underground Tank at White Beach, Dorre Island. It is probable that the debris was accumulated by Barn Owls. For method employed in calculating least-number of individuals see Ride 1960.

Table 13

DATA FROM SPECIMENS OF *Gyomys albocinereus* COLLECTED DORRE AND BERNIER ISLANDS, JULY, 1959

No.	Date caught	Sex	Weight in g.	Total length in mm.	Tail in mm.	Hind foot in mm.	Ear in mm.
Dorre Island—							
WR31	18/7/59	♀ (gravid)	30*	157†	75†	21·5	15·5
Bernier Island—							
WR40	23/7/59	♂ (testes descended)	15	164	89	19	15·5
WR48a	24/7/59	♀	15	166	96	21	15
WR48b	24/7/59	♀ (gravid)	17*	157	84	20	15
WR49c	24/7/59	♂ (testes descended)	....	....	....	22	16
WR53	25/7/59	♂	11·5	152	85	20	14·5
WR54	25/7/59	♂ (testes descended)	14	180	98	21	16

* Weight includes that of the uterus and its contents.

† Tip of tail missing.

Table 14

BREEDING DATA OF *Gyomys albocinereus* AND *G. apodemoides* SHOWN AGAINST MONTHLY RAINFALL AVERAGES OF STATIONS AROUND SHARK BAY AND COOMBE, S.A.

	Monthly rainfall averages												
	J.	F.	M.	A.	M.	J.	Jy.	A.	S.	O.	N.	D.	Total
Cooke Plains, S.A.	67	70	92	119	156	182	164	180	168	140	97	95	1530
Keith, S.A.	66	96	85	128	208	201	212	212	206	160	126	101	1801
Serviceton, Vic.	52	71	77	123	225	215	236	236	226	176	117	112	1901
Carnarvon, W.A.	41	70	66	64	149	240	156	68	23	12	3	16	908
Hamelin Pool, W.A.	26	50	57	39	124	195	151	76	35	14	14	9	760
Breeding of *G. apodemoides* at Coombe, S.A.:													
♂				scrotal testes									
♀							litters produced						
Breeding of *G. albocinereus* on Bernier and Dorre:													
♂							?	scrotal testes	?				
♀								litters	?				

The onset of winter rains is shown by a broken line.
(Weather data provided by the Perth Weather Observatory and from Specht. 1951).

Table 15

SHEEP ON STATIONS AROUND SHARK BAY

Station	Total acreage of station	Average No. of sheep	Years over which average taken	Actual No. of acres per sheep (average)
Nanga	82,000	3,499	1934–41	23·4
Tamala	432,000	13,976 (has carried over 18,970)	1930–45	30·9
Hamelin	499,680	18,931	1930–45	26·4
Yaringa (north and south)	471,339	12,307	1930–45	38·3
Quobba	152,637	10,011	1930–45	15·2
Marloo	215,890	8,320	1930–45	26·0
Brickhouse	300,000	31,914 (has carried in excess of 49,893)	1930–45	9·4
Peron	261,600	9,752	1934–41	26·8
Dirk Hartogs	152,400	10,601	1930–40	14·4

Data provided by Department of Lands and Surveys (W.A.)—Pastoral Division.

Table 16

NUMBERS OF MACROPODIDAE TAKEN BY SUCCESSIVE COLLECTORS ON BERNIER AND DORRE

	Lagostrophus	*Lagorchestes*	*Bettongia*	Total
Peron, 1801—				
Both Islands	Swarms	—	Not mentioned though genus known to Peron	—
Tunney, 1899—				
Dorre	14	13	4	31
Shortridge, 1906—				
Bernier	15	23	9	47
Lipfert, 1910—				
Dorre	10	6	3	19
Bernier	4	0	4	8
Steele and Grant Watson, 1910—				
Bernier	10	1	0	11
W.A. Museum, 1959—				
Dorre	8	1	7	16
Bernier	27	1	5	33
Pick-up Skulls—				
Dorre	7	0	6	13
Bernier	44	1	8	53

BIRDS

by G. F. Mees

INTRODUCTION

The first scientific expedition to take account of the birds of Bernier and Dorre Islands was that of Baudin in 1801. In July of that year the naturalists of the *Gēographe* went ashore on the islands, but as a consequence of the premature death of Maugé, the ornithologist of the expedition, off Tasmania in 1802, and of Péron the naturalist who was working out the zoological results in 1810, when only an introductory volume on the zoology had been published, very little exact information is available on their ornithological results. The only reference to birds of Bernier Island in the narrative is the following:

" Si l'on en excepte quelques genres incommodes ou nuisibles dont nous ne tarderons pas à parler, tous les animaux sont rares sur le sol malheureux qui nous occupe ; la classe des *Oiseaux*, par exemple, se réduit aux tristes cormorans, à diverses espèces de foux, de pétrels, de goëlands, d'aigles de mer et d'huîtriers, qui, loin des hommes et de leurs traits, multiplient sur ces rochers arides leurs voraces essaims. La division des oiseaux de terre s'y composoit exclusivement de gobe-mouches et de pies-grièches : on y trouvoit cependant une belle espèce de mésange à collier bleu, qui méritera de nous occuper plus particulièrement."*

Evidently the French were not impressed by what they saw. With none of the naturalists surviving to complete the report of the expedition, the bird specimens collected went into the collection of the Paris Museum provided with only such general labels as " l'Australasie " and " la Nouvelle Hollande." No general account of the birds was ever published but Vieillot subsequently described many of them in the volumes of the " Nouvelle Dictionnaire d'Histoire Naturelle," 1816–1819.

Mathews, in a series of publications, arbitrarily restricted many of these vague type-localities, usually to Sydney. Stresemann (1951) showed that many of Mathews's restrictions are conflicting with known facts about the expedition's itinerary, and about Bernier Island he remarks:

> " The expedition seems to have collected a number of waders on Bernier Island, off the Péron Peninsula, among them being *Haematopus longirostris* Vieillot and perhaps also the types of *Certhionyx variegatus* Lesson (" Timor "), *Meliphaga virescens* Vieillot (" Nouvelle Hollande ") and *Artamus minor* Vieillot (" Terres Australes ")."

As regards *Meliphaga virescens*, Stresemann was probably right, as the type-specimen, that is still preserved in the Paris Museum, agrees with material collected on Bernier and Dorre Islands (Mees 1961). But neither *Certhionyx variegatus* nor *Artamus minor* have ever been recorded from the Islands by subsequent visitors. If the conspicuously coloured black and white *Certhionyx* had occurred on Bernier Island during the visit of the French, one might have expected a reference to the species in Péron's narrative. As regards *Armatus minor*, this species is, in Mid-

* " With the exception of some useless and harmful species which we shall not bother to discuss, all animals are rare in the wretched place under discussion. Of birds, for example, there are only dreary cormorants, several species of boobies, petrels, gulls, sea-eagles and oystercatchers, which, far from man and his doings, multiply their voracious numbers on the barren rocks. Landbirds are represented only by flycatchers and shrikes ; there is, however, a beautiful species of blue-collared tit which deserves our special attention."

Western Australia, partial to rocky gullies, and Bernier Island is ecologically unsuitable, so that I feel quite certain that it has never occurred there.

It appears therefore that with reasonable certainty two forms of birds may be regarded as having been described from Bernier Island as a result of the activities of the Expedition Baudin: *Haematopus ostralegus longirostris* Vieillot (Mathews restricted its type locality to New South Wales) and *Meliphaga virescens virescens* (Vieillot).

Apart from short visits to both Islands by J. T. Tunney, collector of the Western Australian Museum, in 1896 (cf. Whittell, 1938) and 1899 (see p. 8), during which, as far as I am aware, no birds were obtained, the next collector to visit Bernier Island was C. G. Shortridge, who stayed on Bernier Island in June and July, 1906. He made a good general collection of birds, including many migrant wading birds, which went to the British Museum (Natural History). Two new forms were described from his collections by Ogilvie-Grant (1909a): *Malurus bernieri* and *Sericornis balstoni*. The type of *Haematopus unicolor bernieri* Mathews was also collected by him. Some of Shortridge's field notes were published by Ogilvie-Grant (1909b, 1910).

Dorre Island had remained ornithologically unexplored until H. F. O. Lipfert, on behalf of the Western Australian Museum, visited both Dorre Island and Bernier Island in August and September, 1910. His most interesting results were the discoveries of a nest of *Aquila audax*, and of the occurrence of *Calamanthus fuliginosus* on Dorre Island, but not on Bernier Island. One of his specimens of the last-mentioned species subsequently became the type of *Calamanthus campestris dorrie* Mathews Lipfert (1912) published a paper on this trip that, though very useful, cannot be relied on in every respect, as, evidently, much secondhand information has been included, without this being clearly stated.

In September and October, 1910, G. F. Hill, collecting birds for H. L. White of Scone, N.S.W., stayed on Bernier Island. Nothing seems to have been published on his collection, but the skins remain preserved in the National Museum of Victoria ("H. L. White Collection").

Nearly fifty years passed without any further zoological exploration, until our party visited the islands. Our stay was short, too short, and on Bernier Island a minor accident occurred and I had to stop collecting and observing after only one day. Further, on Dorre Island, our camp was sited near the northern tip of the Island which meant that only the northern part of the Island could be covered on foot in a day. These factors prevented us from obtaining as good a picture of abundance and distribution of birds as we would have wished. A list of all bird species observed by us on the Islands is given in Table 17 (p. 112).

ORNITHOLOGICAL SIGNIFICANCE OF THE ISLANDS

Previous authors have stressed the importance of the Islands as breeding places of sea-birds, particularly terns and cormorants. Lipfert is positive in his statement about the breeding of *Phalacrocorax varius* on Dorre Island, and he mentioned that on the north end of "Knock's Island" (correctly Koks Island) numbers of both *Sterna bergii* and *S. nereis* had been breeding. But note the expression "had been," that makes

it evident that Lipfert himself did not find them breeding, and in his list of species observed, *Sterna bergii* is listed as a breeding bird with the remark : " young, fully fledged on 17th Sept.", and under *Sterna nereis* the same is said. We know now that the observation of fully fledged young does not automatically justify the conclusion that the birds have been breeding in the same place. Lipfert's notes can therefore not be taken as proof that breeding colonies existed at the time.

The records of Serventy & Whittell (1951) of breeding on Dorre Island and Koks Island, and of Hitchcock (1959) of breeding on Bernier Island, are evidently based on Lipfert's observations and therefore are also doubtful.

Our visit fell in the middle of winter, and presumably outside the breeding season of seabirds. On some rocks concentrations of *Phalacrocorax varius* and *Sterna bergii* were seen, but there was no evidence of breeding. Therefore it remains to be decided how important the Islands are as breeding places of seabirds and shorebirds.

The land fauna of the islands is poor as far as birds are concerned. During our stay one addition to the known resident land-bird fauna could be made and it is very unlikely that any more resident species remain to be discovered, though a few irregular breeders will doubtless be found in future. The list of visitors (especially shorebirds) and stragglers can certainly be augmented considerably in future, but the rocky structure of the islands makes it unlikely that they are an important feeding ground for migrant waders, and stragglers have no real significance in the avifauna.

The list of breeding landbirds is the following ; the list includes all birds observed on the islands that may reasonably be expected to breed there. Factual proof of breeding exists only in the case of the three eagles and the cuckoo.

Aquila audax audax (Latham)
Haliaeetus leucogaster (Gmelin)
Pandion haliaetus (Linnaeus)
Falco cenchroides cenchroides Vigors & Horsfield
Chalcites basalis (Horsfield)
Hirundo neoxena Gould
Anthus novaeseelandiae australis Vieillot
Calamanthus fuliginosus dorrie Mathews
Sericornis maculatus balstoni Ogilvie-Grant
Malurus lamberti bernieri Ogilvie-Grant
Meliphaga virescens virescens (Vieillot)
Corvus sp.

Though the islands are important as type localities of six described forms of birds there is only one endemic race : *Malurus lamberti bernieri*, a well marked subspecies confined to Bernier Island—the population from Dorre Island is intermediate between *bernieri* and *mastersi* of the mainland.

LIST OF SPECIES

PIED CORMORANT

Phalacrocorax varius (Gmelin)

Common near the islands and often resting on rocks offshore. Ogilvie-Grant and Lipfert list this species under the name *Phalacrocorax hypoleucos* and Lipfert mentions large breeding colonies on Dorre Island, but without giving satisfactory evidence.

AUSTRALIAN PELICAN

Pelecanus conspicillatus Temminck

In a letter dated June 6, 1912, addressed to the Director of the Western Australian Museum, Dr. F. Lovegrove, who was Medical Superintendant of the Bernier and Dorre Island Hospitals at the time of Lipfert's stay—mentions that one evening he observed a flock of seven Pelicans flying over Dorre Island from the direction of the mainland.

WHITE-FACED HERON

Notophoyx novaehollandiae (Latham)

On July 21 I saw a specimen fly across the northern part of Bernier Island. As there is no fresh water or marsh on the islands, this was doubtless only an accidental visitor. There are no previous records.

GREAT WHITE HERON

Egretta alba (Linnaeus)

Shortridge observed one example on Bernier Island. There are no other records.

REEF HERON

Egretta sacra (Gmelin)

Single individuals, all in the grey phase, were regularly seen on the coast of Dorre Island and one specimen was collected. On Bernier Island I did not observe the species, a fact doubtless due to the shortness of my stay. Shortridge found it plentiful on Bernier Island, where he obtained several specimens. Lipfert mentioned Reef Herons as breeding on both islands, but failed to give particulars.

WEDGE-TAILED EAGLE

Aquila audax audax (Latham)

On July 18 I saw a specimen soar above Quoin Bluff, Dorre Island; this is my only observation. Lipfert found a nest of this species with two young on Dorre Island, of which he published a photograph. The species has not been recorded from Bernier Island.

The downy nestlings were collected by Lipfert and one is still in the collection of the Western Australian Museum.

WHITE-BREASTED SEA-EAGLE

Haliaeetus leucogaster (Gmelin)

Observed regularly on both Islands. I did not find inhabited nests, but Lipfert located three nests on Dorre Island and one on Bernier Island. This probably gives a fair idea of the number of pairs actually present at the time, and I don't think that their status has changed much. Shortridge mentioned that several pairs were breeding on Bernier Island at the time of his visit. A downy chick from Dorre Island, taken by Lipfert on August 27, 1910, is still present in the museum's collection.

SPOTTED HARRIER

Circus assimilis Jardine & Selby

Shortridge observed the species on Bernier Island, but did not collect specimens, and Lipfert once saw a specimen near the southern end of Dorre Island. I did not see the species and it is probably only a visitor.

(a)

(b)

Plate 32. Nests of Ospreys or Sea Eagles—(a) on the west coast of Dorre Island, (b) on the east coast of Bernier Island. The grass in (b) is *Spinifex longifolius*.

OSPREY

Pandion haliaetus (Linnaeus)

Ospreys were common on both islands, and on each island I found one inhabited nest with three eggs. Several other empty nests were present, these may have belonged either to Ospreys or to Sea-Eagles. Having visited only part of the islands I find it difficult to make an estimate of the number of pairs present, but Lipfert records ten or more nests from Dorre Island and four on Bernier Island.

KESTREL

Falco cenchroides cenchroides Vigors & Horsfield

Kestrels were regularly observed on both islands, so that it is likely that a few pairs are permanent residents, but there is no proof of breeding. Shortridge mentions the species from Bernier Island, and Lipfert saw it on both islands. A female taken by him on Dorre Island on August 18, 1910, is in our collection.

PIED OYSTERCATCHER

Haematopus ostralegus longirostris Vieillot

The Pied Oystercatcher is fairly common on the shores of both islands. If Stresemann's (1951) suggestion that the type of *longirostris* was collected on Bernier Island, is correct, the species was found by the Expedition Baudin. Subsequently both Shortridge and Lipfert obtained specimens on Bernier Island (one of Lipfert's specimens is still in our collection).

Shortridge wrote about the species: ". . . . common on Bernier Island. It appeared however to be a less robust bird than *H. fuliginosus* and was rarely found on the windward side of the island, where the Sooty Oystercatcher was most abundant." The true explanation is that *H. ostralegus* is mainly a bird of sandy beaches, whereas *H. fuliginosus* prefers rocky shores. Most of the seaward side of both islands is rocky.

SOOTY OYSTERCATCHER

Haematopus fuliginosus subsp.*

This oystercatcher is fairly common on the shores of Dorre Island where one specimen was collected. I have not observed the species on Bernier Island, which, because of the short duration of my stay there, is not surprising. Shortridge obtained several specimens on Bernier Island and Lipfert lists the species for both Islands, but did not collect material.

Lipfert lists the species as breeding, and there is little doubt that it is a breeding bird, but proof is lacking.

EASTERN GOLDEN PLOVER

Pluvialis dominicus (Statius Müller)

This plover was only mentioned by Lipfert who collected a specimen on Bernier Island on September 1, 1910. The skin is still in the collection of the Western Australian Museum.

* It is possible that *bernieri* Mathews (type, AMNH no. 735125, ♀, July 8, 1906, collected by G. C. Shortridge on Bernier Island) is a valid race, which inhabits the North-Western coast of Australia, but the material at hand is insufficient to decide on this with certainty.

LARGE SAND-DOTTEREL

Charadrius leschenaultii Lesson

A single female was collected by Shortridge on Bernier Island on July 9, 1906. No other records.

RED-NECKED STINT

Calidris ruficollis (Pallas)

Specimens were taken by Shortridge on July 8, 1906, on Bernier Island. Lipfert lists the species for Bernier Island without comment; he did not collect any.

RED-CAPPED DOTTEREL

Charadrius alexandrinus ruficapillus Temminck

Shortridge collected several specimens on Bernier Island, and commented on the fact that these, though taken in July (midwinter), are in breeding plumage. There are no other records.

WHIMBREL

Numenius phaeopus (Linnaeus)

On 18th July, and again the following day, I flushed two extremely shy and wary individuals from a sandy beach on the eastern coast of Dorre Island, between Quoin Bluff and our camp.

Previously only recorded from Bernier Island where, according to Lipfert, the species had been observed by Dr. Lovegrove.

TURNSTONE

Arenaria interpres (Linnaeus)

This wader was not observed by us. Shortridge collected five specimens on Bernier Island and Lipfert lists it without comment as having been observed by him on Bernier Island. There is no material in our collection.

PACIFIC GULL

Larus pacificus Latham

Fairly common along the coasts of both islands. Shortridge collected specimens on Bernier Island, and Lipfert mentions it as a breeding bird on both islands. Lipfert's list suggests that he found the species breeding in August and September, but in the text on Dorre Island he only states that: ". . . there were large colonies of Cormorants, Seagulls and Terns; these had quite finished their breeding." Though it is more than likely that gulls of both species do, in fact, breed on the islands, Lipfert's notes can not be regarded as proof.

This species is sometimes placed in a separate genus *Gabianus*, but it is so evidently a representative of the *L. argentatus* group of the Northern Hemisphere, that this is unwarranted.

SILVER GULL

Larus novaehollandiae Stephens

Common round the islands. One specimen was collected on Dorre Island. We found no evidence of breeding, and Lipfert's notes cannot be accepted as proof that breeding took place in 1910 (see the discussion of the preceding species).

CRESTED TERN

Sterna bergii M. K. H. Lichenstein

Common round the islands and often seen resting on rocks or reefs off the coasts. On July 20th I counted about 40 individuals on a rock off the east coast of Bernier Island.

Shortridge collected three specimens on Bernier Island, two of which are in breeding plumage; he says nothing about breeding. Lipfert assumed that this tern was breeding but, as I have mentioned (p. 100), the evidence he gave, *e.g.*, the observation of fully fledged young birds, is insufficient. Several breeding colonies, whence fully fledged young might have come, are known to exist on small islands in the southern part of Shark Bay.

FAIRY TERN

Sterna nereis Gould

Lipfert's observations have already been discussed. There are no specimens from the islands in our collection, and no other collector has recorded the species.

BRONZE CUCKOO

Chalcites basalis (Horsfield)

A few individuals were observed on both islands. As the males were in full song, and therefore could easily be located, it was not difficult to find the species and therefore I feel safe in stating that on each island the population is probably less than 25 individuals. This estimate is also based on the fact that one single male was found to have quite a large territory. "Breeding" was ascertained (see below).

The species had not been previously recorded from the islands.

Two specimens were obtained on Dorre Island, both females; The second one, collected on July 17th, first drew my attention when it was being chased from low *Eucalyptus*-scrub by a small brown bird, probably a female *Malurus*. When, after shooting it, I picked it up, a ripe egg, pale pinkish with a number of dull brownish red dots of various sizes, fell from the cloaca, and broke on the ground.

BARN OWL

Tyto alba subsp.

In 1948, Mr. J. E. Bramley, Supervising Inspector of the Western Australian Fisheries Department, found in the underground concrete tanks near White Beach, Dorre Island, some large white-faced owls. A photograph taken at the time, and which is reproduced here (Plate 33) clearly shows that these were Barn Owls. No owls were present during our stay, but remains of pellets were collected (see p. 95).

WELCOME SWALLOW

Hirundo neoxena Gould

Fairly common on both islands, especially along rocky shores. An adult female was obtained at Quoin Bluff, the highest point of Dorre Island, on July 16th.

Shortridge collected a series on Bernier Island between June 19th and July 4th, and Lipfert listed the species for both Islands as a breeding bird, but gives no particulars.

In the latest check-list (Peters et al., 1960) the Welcome Swallow from Western Australia appears under the trinomial *Hirundo tahitica carteri* (Mathews). I prefer to regard *H. neoxena* as a species distinct from *H. tahitica*. As regards *carteri*, proposed by Mathews for the birds from south-western Australia, and allegedly differing from *neoxena*: ". . . . in being paler on the forehead and throat and lighter on the abdomen and flanks," it is likely to be invalid. There is no material from eastern Australia in our collection but specimens in the National Museum of Victoria, Melbourne, examined for me by Mr. McEvey do not bear out the differences which Mathews claimed to exist.

Plate 33. The Barn Owl, *Tyto alba*, being held outside the underground concrete tank near White Beach, Dorre Island, by Mr. J. E. Bramley during his visit to the Island in 1948. The owl was caught inside the tank.

AUSTRALIAN PIPIT

Anthus novaeseelandiae australis Vieillot

A few times I observed solitary specimens flying from one patch of bare soil to another in the Open Steppe on Dorre Island. The two specimens collected, however, were taken by Douglas from a flock of seven on the rocky foreland north of our camp. On Bernier Island a specimen collected was the only one seen by me. Ride observed an individual on bare ground in the north west of Bernier. I do not expect that more than a few dozen individuals reside on the Islands.

Shortridge collected two specimens on Bernier Island, and Lipfert listed the species for both islands, but neither of these authors comments on their status. In our catalogue one specimen is entered as having been collected on Dorre Island by Lipfert, but it is no longer present in the collection.

The Australian Pipit is a vagrant. It prefers a habitat of open, uncovered soil. It is abundant in places where the vegetation has recently been burnt and a temporary favourable habitat has been created and

subsequently moves away when the vegetation is being restored. I am not only perfectly certain that specimens often fly from Dorre Island to Bernier Island and vice versa, but have no doubt that they move to and from the mainland. Though it is likely that Pipits breed on the Islands, I do not think that they could properly be called a resident population. The nomadic habits of the species, incidentally, doubtless account for its lack of geographic variation throughout Australia.

SPOTTED SCRUB-WREN

Sericornis maculatus balstoni Ogilvie-Grant

On Dorre Island not common, for only after several days did I observe and collect the first specimen from a dense growth of *Hakea* scrub. Subsequently a few more were seen in *Hakea* and *Eucalyptus dongarraensis*. Though the species leads a fairly concealed life, it would not have failed to draw my attention by its harsh alarm-note, had it been common at all on Dorre Island. On the northern part of Bernier Island, in strange contrast to Dorre Island, I found the species plentiful. Perhaps this difference is caused by the fact that north Bernier Island has a taller scrub vegetation of the kind the species prefers.

Shortridge, the discoverer of this subspecies, described it as fairly plentiful on Bernier Island; Lipfert found them on both islands, but gave no exact opinion as to their abundance, only the general statement quoted in the introduction; Hill collected three specimens on Bernier Island in September and October, 1910.

There are three specimens from Dorre Island and one from Bernier Island taken by Lipfert in our collection. I secured one individual on Dorre Island, but none on Bernier.

Sericornis maculatus balstoni has generally been regarded as a form endemic to Bernier and Dorre Islands, other races having been described from Dirk Hartogs Island (*hartogi*) and Geraldton (*geraldtonensis*). Mayr & Wolk (1953), however, synonymized both *hartogi* and *geraldtonensis* with *balstoni*, consequently extending the range of the latter to include Dirk Hartogs Island, and the mainland from the Peron Peninsula and the Wooramel River south to Geraldton. Nevertheless, the population of Bernier Island is of great interest, not only because the island is the type locality, but also because the birds are so common on this island which is north of the northern limit of their occurrence on the mainland.

Sericornis maculatus was united with *S. frontalis* by Condon (1951); as I have not been able to revise these forms personally, I prefer for the moment to adhere in nomenclature to the more conservative course taken by Mayr (1937) and Mayr & Wolk (1953).

FIELD WREN

Calamanthus fuliginosus dorrie Mathews

Common on Dorre Island where occurring wherever low scrub is available; absent from Bernier Island. Any estimate of actual numbers present can be little more than a guess but as a basis for comparison I would put their number at at least a thousand individuals. Eight specimens were collected.

This species has previously only been recorded by Lipfert, who misidentified it as *Megalurus gramineus*. Lipfert regarded the species, as the other small passerine birds, as not common, "for one often tramped mile after mile without seeing a single bird." He also mentioned its absence from Bernier Island. Three of Lipfert's specimens remain in our collection, two others, including the type of *dorrie* went to the Mathews Collection.

The gap that separates Bernier and Dorre Islands is only a quarter of a mile across, yet it seems to prevent *Calamanthus* from colonizing Bernier Island where suitable habitat is certainly present.

Mathews (1912) originally described *dorrie* as an endemic race of Dorre Island, but Serventy (1937) showed that the bird from Dirk Hartogs Island, that had been named *Calamanthus campestris hartogi* Carter 1916, is identical with it. Serventy expressed as his opinion that the birds from Dorre and Dirk Hartogs Island are closest to *C. fuliginosus montanellus* Milligan from the south-western part of the State, and specifically different from the birds found on the mainland of Shark Bay that had been named *C. campestris peroni* Carter & Mathews 1917. At the time Serventy had not seen material from the mainland of Shark Bay and he was misled by Carter & Mathews's (1917) categorical and incorrect statement that the mainland form is very different from the island population. Serventy (1937) and later Whittell & Serventy (1948) united all forms described from the mainland of the mid-west under the name *isabellinus* North, in which they were probably following Ashby (1924).

The material now available reveals that the true situation is very different. I prefer to regard *C. fuliginosus* and *C. campestris* as conspecific, and arrive at the following classification for the Field Wrens of Western Australia :—

1. *Calamanthus fuliginosus montanellus* Milligan 1903.

   Synonyms : *Calamanthus fuliginosus carteri* Mathews 1912, *Calamanthus montanellus ashbyi* Mathews 1922, *Calamanthus montanellus leakei* Mathews 1922. South-western Australia, north to the Jurien Bay area. Boldly streaked, under surface yellowish, upper surface with a greenish tinge.

2. *Calamanthus fuliginosus dorrie* Mathews 1912.

   Synonyms : *Calamanthus campestris hartogi* Carter 1916, *Calamanthus campestris peroni* Carter & Mathews 1917. Dorre Island, Dirk Hartogs Island, southern and eastern shores of Shark Bay. Moderately streaked, upper parts greyish, forehead rufous. Three specimens from Dirk Hartogs Island do not differ from eleven topotypical specimens, though they may have a tendency to an increased amount of rufous on the forehead and crown. Two specimens from the mainland (Peron Peninsula and mouth of the Wooramel River) are identical but for the fact that the rufous tone is extended over the whole crown. As the amount of rufous is variable in the Dorre Island series, and the difference is at most very slight, it seems inadvisable to maintain a separate name for them.

3. *Calamanthus fuliginosus rubiginosus* A. J. Campbell 1899.

Very near to the preceding race, but whole upper surface more rufous brown, not greyish brown ; the difference is fairly slight but series are distinct. Coastal Western Australia from Point Maud to North-West Cape and on the eastern coast of the North-West Cape Peninsula at Learmonth.

4. *Calamanthus fuliginosus isabellinus* North 1896.

Synonym : *Calamanthus campestris wayensis* Mathews 1912. Our series of five specimens from Day Dawn and one from Mount Sir Samuel, shows uniformly more rufous above and a more cinnamon tinge on the under surface than any of the preceding races and moreover differs conspicuously from the other races by the reduction of the striation of both back and breast. Probably widely distributed in interior Western Australia, but the only formal records I know of are from Day Dawn, Lake Way, and Mount Sir Samuel. Topotypical material of *isabellinus* has not been available for comparison, but specimens identified as this subspecies from various localities in interior South Australia (received on loan from the South Australian Museum), do not differ from our skins from Western Australia so that the synonymy as given above is probably correct.

I am unable to confirm Ashby's assertion that: "Birds in which the striations on the crown were absent . . . . come from the same localities and were found breeding together with birds which show the striations . . . ." In my series, apart from the slight variation in amount of rufous on the crown mentioned under *dorrie*, specimens from one locality are remarkably uniform in appearance.

VARIEGATED WREN

Malurus lamberti Vigors & Horsfield

Dorre Island. *M. lamberti* intermediate between *mastersi* and *bernieri*

In the middle of the broadest part of Dorre Island, West and North-West of Quoin Bluff, extensive and dense growths of knee-high *Eucalyptus dongarraensis* occur, and in this vegetation *Malurus lamberti* was extremely plentiful. The species is somewhat local in distribution for it was never observed on the northern part of the island near our camp. I do not know how far south the *Eucalyptus* vegetation extends, but it is likely that the total population of *Malurus lamberti* is well over a thousand individuals. Five males and one female were obtained ; there are also three males taken by Lipfert in our collections.

The number of males in full plumage was remarkable, which suggests that the birds were at the beginning of their breeding season, a point further strengthened by the fact that dissected specimens had large gonads.

The birds from Dorre Island are intermediate in coloration between the races *mastersi* of the mainland and Dirk Hartogs Island, and *bernieri* of Bernier Island. Mainland birds normally have both the anterior part of the crown and the whiskers blue, violet on the head being more or less restricted to the nape ; specimens from Dorre Island have the whole crown violet, but the whiskers are bluish rather than violet, and in *bernieri* both crown and whiskers are violet, no blue at all being found in the plumage.

Bernier Island. *Malurus lamberti bernieri* Ogilvie-Grant

This interesting endemic race was quite common near our camp on Bernier Island. Because of the short duration of my stay I was unable to ascertain if it is just as plentiful in other parts of the island. One male in full plumage was collected.

Péron (1807) already mentioned the species as: "une belle espèce de mésange à collier bleu," though it was only described and named a century later on the basis of specimens collected by Shortridge. There are three males, taken by Lipfert, in our collection.

SILVEREYE

Zosterops lateralis gouldi Bonaparte

Not observed by us, but two specimens were collected on Bernier Island by Shortridge on 26th June and 12th July respectively, and Lipfert also mentioned the species from Bernier Island, where he regarded it as a visitor. Lipfert obtained three specimens which are still in our collection.

There is, as far as I can judge, no obvious reason why the species should be absent from the islands as a breeding bird, but, as we did not meet with it at all, Lipfert was probably right in listing it as a visitor only. The flight of some thirty miles out from Carnarvon, where it is common, would not be too much for wandering flocks of silvereyes of this form, as is shown by their occurrence on all small islands off the coast of south-western Australia.

SINGING HONEYEATER

Meliphaga virescens virescens (Vieillot)

Confined to places with fairly high scrub and low trees. On Dorre Island not common, which is doubtless due to the fact that suitable higher vegetation is scarce. Probably more common on Bernier Island. The species was usually seen in pairs. On Dorre Island, during a walk from our camp down to Quoin Bluff, and from there across the island and then back along the west coast, I did not see more than eight or, at most, ten specimens, and in view of the fact that the species is large and conspicuous in this open country and has a loud call-note, I do not think that many were overlooked. My estimate is that considerably less than a hundred pairs were present on Dorre Island during our stay. Four specimens were obtained on Dorre Island and one on Bernier. They are all in extremely abraded plumage; some are moulting.

Both Shortridge (who collected two specimens on Bernier Island) and Lipfert (one skin from Dorre Island in our collection) found this bird, but they do not comment on its status; there is also a specimen in the H. L. White Collection in Melbourne collected by Hill in September, 1910. Stresemann (1951) suggested that the type specimen of the species might have been collected on Bernier Island, and examination of the type specimen, that is still preserved in the Paris Museum showed that this is probably correct (see p. 98).

CROW

Corvus sp.

Crows, presumably *Corvus orru cecilae* Mathews, were observed on both islands, usually two or three together. As no specimens were collected, their identity remains uncertain, for the Raven *Corvus coronoides* may well reach up to here, and of *C. bennetti*, usually regarded as an inland species, the museum has a skin from Dirk Hartogs Island, so that it might also occur. I am unable to say whether the crows seen were breeding birds or only visitors. It is curious that, now the islands are uninhabited, we found crows present, and that in the early years of the century, when the islands served as hospitals, they were apparently never observed, for crows usually closely associate with human settlement.

DOUBTFUL RECORDS

Peltohyas australis (Gould). Listed by Lipfert from Bernier Island, but no specimens are in our collection or have ever been entered in our museum catalogue. As one would not expect this species, whose habitat is freshwater lakes in the interior, on the islands, the record must be regarded as doubtful.

Podargus sp. Lipfert mentions *Podargus* with a query as having once being seen on the West coast of Bernier Island. The observation may have pertained to *Eurostopodus guttatus*.

Eurostopodus guttatus (Vigors & Horsfield). Mentioned by Shortridge, under the name *Eurystopus argus*, as having been observed on Bernier Island, but no specimens were collected. It is not unlikely that the species occurs on the island, and Lipfert's observation of "*Podargus*" is perhaps also referable here, but its occurrence needs confirmation.

Apus pacificus (Latham). According to Lipfert, a visitor during April, May and June. As Lipfert's visit took place in August-September this must be second-hand information. Of course there is nothing unlikely in these migrants occasionally passing over the islands, but it seems better to accept only definite records.

Eupodotis australis (J. E. Gray). Only mentioned by Lipfert as a visitor, but record probably based on second-hand information.

Esacus magnirostris (Vieillot). According to Shortridge: "... A species of Stone-Plover, which is probably *Orthoramphus magnirostris*, occurs round Carnarvon and on Bernier Island."

Pigeon. Grey (1841, p. 333) mentioned that he saw a pigeon on Bernier Island, and Lovegrove in a letter (to Mr. Bernard Woodward, Director of the Western Australian Museum, June 6th, 1912), wrote: "..... a pigeon—probably a Brush Bronzewing—appeared outside my bedroom window at Dorre Island." The Brush Bronzewing *Phaps elegans* in Western Australia is not known to occur north of the Abrolhos Islands, so that Lovegrove's identification is unlikely to be correct.

Table 17

BIRDS OBSERVED ON DORRE (D) AND BERNIER (B) ISLANDS, JULY, 1959

Phalacrocorax varius	Pied Cormorant	D. and B.
Larus pacificus	Pacific Gull	,,
Larus novaehollandiae	Silvergull	,,
Sterna bergii	Crested Tern	,,
Numenius phaeopus	Whimbrel	*D.
Haematopus ostralegus	Pied Oystercatcher	D. and B.
Haematopus fuliginosus	Sooty Oystercatcher	D.
Egretta sacra	Reef Heron	D.
Notophoyx novaehollandiae	White-faced Heron	*B.
Pandion haliaetus	Osprey	D. and B.
Haliaeetus leucogaster	White-breasted Sea-Eagle	,,
Falco cenchroides	Kestrel	,,
Aquila audax	Wedge-tailed Eagle	D.
Chalcites basalis	Bronze Cuckoo	*D. and *B.
Hirundo neoxena	Welcome Swallow	,,
Anthus novaeseelandiae	Pipit	,,
Calamanthus fuliginosus	Field Wren	D.
Sericornis maculatus	Spotted Scrub-Wren	D. and B
Malurus lamberti	Variegated Wren	,,
Meliphaga virescens	Singing Honeyeater	,,
Corvus sp.	Crow	*D. and *B.

* Species not previously recorded.

REPTILES

by A. M. Douglas and W. D. L. Ride

Reptiles are common on Bernier and Dorre Islands but little concerning them has been published in the accounts of past expeditions. Collections were made by some of these, notably by Peron, Lipfert, and Grant Watson while a number of specimens were also collected by the resident medical staff in the islands (see Table 18). However, insufficient information is available for any of our results to be interpreted in the light of these. A single paragraph in Péron's account (1807, p. 118) and a few isolated records of the occurrence of certain species on Bernier Island in articles by Glauert in *The Western Australian Naturalist* still remain the only published information available on this part of the fauna.

Peron mentioned three lizards to which he gave new names. He said " Les *Reptiles* ne comptoient qu'une espèce de *Scinque* (*Scincus Tropisurus N.*), l'une des plus grandes de ce genre, et dont la queue très-courte et très-grosse fait paroître, au premier instant, cet animal comme ayant deux têtes ; une belle espèce de *Tupinambis* (*T. Endrachtensis N.*) de 12 à 16 décimètres de longueur (4 à 5 pieds), un *Gecko* (*Gecko Dorreensis N.*) de 10 à 13 centimètres (4 à 5 pouces). L'histoire de ces espèces, toutes les trois nouvelles, sera présentèe dans le tableau zoologique de la Nouvelle-Hollande, avec tous les détails qu'elle doit comporter."*

For reasons unknown to us, these names do not appear to have been used subsequently and this now presents a problem, since the *Scincus tropisurus* of Peron is, without any doubt at all, an earlier name for the bobtail than *Trachysaurus rugosus* Gray, and quite valid. Gray's name has been used for this species for more than one hundred years, while, as far as we can determine, Peron's name has not yet been used outside of his original publication and its subsequent editions and translation. Article 23 (b) of the International Code of Zoological Nomenclature requires that this name be referred to the Commission to be placed on the Official Index of Rejected or Invalid Names as a forgotton name (*nomen oblitum*). The species is common and widely distributed and it is the opinion of all zoologists and naturalists whose views we have sought that a change of name to Peron's original would be most undesirable. Accordingly, no application will be made by us to the Commission for the name to be placed on the Official List of Specific Names in Zoology.

The names *T. endrachtensis* and *T. dorreensis* are clearly *nomina nuda* since no differentiating characters, which can enable their identification to be made, are given.

During the visit of the Expedition, very few lizards were seen on the beaches but occasional *Ablepharus* could be burnt out of clumps of *Melaleuca cardiophylla* on rises and large dunes. The Dragon Lizard *Amphibolurus maculatus* was collected on one occasion under seaweed near the water's edge. This was the only specimen which was collected on the beach itself. On another occasion a specimen of *Amphibolurus adelaidensis pallidus* was collected in the loose sand on a dune immediately behind the beach. Tracks of *Varanus* were common on the beach where they had apparently hunted along the shore but neither the tracks nor burrows of skinks were found along the beach or in the fore dunes.

* " The reptiles do not comprise more than a single species of Skink (*Scincus tropisurus* N.), one of the largest of this genus, with such a very short and very thick tail that, at first sight, the animal appears to have two heads ; a beautiful species of *Tupinambis* (T. *endrachtensis* N.) of 12 to 16 decimetres in length (4 to 5 feet) a Gecko (*Gecko dorreensis* N.) of 10 to 13 centimetres (4 to 5 inches). The natural history of these species, all three new, will be given in the zoological account of New Holland with all their particulars."

Table 18

REPTILES COLLECTED ON BERNIER AND DORRE BY SUCCESSIVE EXPEDITIONS

	Grant Watson		Steele		Lipfert		Expedition 1959	
	B.	D.	B.	D.	B.	D.	B.	D.
Lizards								
Geckonidae—								
Heteronota binoei	....	....	....	....	1	....	17	24
Gehyra variegata	7	....	....	....	5	....	....	2
Phyllodactylus ocellatus	....	....	....	....	....	....	6	7
Diplodactylus vittatus	1	....	....	....	1	....	....	....
Diplodactylus pulcher	1	....	....	....	....	....	....	....
Pygopodidae—								
Lialis burtoni	....	....	1	....	....	....	1	....
Scincidae—								
Egernia whitii	....	....	....	....	....	....	2	....
Trachysaurus rugosus	1	....	1	....	....	....	9	7
Ablepharus lineo-ocellatus	3	....	....	....	1	....	10	6
Ablepharus boutoni plagiocephalus	....	....	....	....	....	....	2	2
Ablepharus greyi	2	....	....	....	....	....	....	....
Ablepharus elegans	....	....	....	....	....	....	4	....
Lygosoma (Sphenomorphus) lesueuri	1	....	....	....	....	....	4	3
Lygosoma (Rhodona) miopus	....	....	....	....	1	....	....	....
Lygosoma (Rhodona) praepeditum	....	....	....	....	....	....	1	....
Lygosoma (Rhodona) planiventrale	2	....	....	....	....	....	....	....
Agamidae—								
Amphibolurus maculatus	4	....	....	....	2	1	20	14
Amphibolurus adelaidensis	6	....	....	....	1	....	1	....
Amphibolurus cristatus	2	....	....	....	....	....	....	....
Amphibolurus barbatus	1	....	....	....	....	....	....	....
Amphibolurus reticulatus	3	....	....	....	....	....	....	....
Moloch horridus	2	....	....	....	....	....	....	....
Varanidae—								
Varanus gouldi	....	....	....	....	....	....	2	....
Snakes								
Pseudechis australis	1	....	....	....	1	....	....	1
Rhynchoelaps bertholdi	....	....	....	....	1	1	....	....
Demansia psammophis reticulata	1	....	....	....	....	....	1	1
Liasis childreni	....	....	....	....	....	....	11	....
Hydrophis ornatus ocellatus	....	....	....	....	....	....	....	1
Turtles								
Chelonia mydas.	Reported by Gray and by Lovegrove (see p. 119).							

On the plateau behind the cliffs and among its stabilised dunes, *Amphibolurus* was extremely common. These small dragon lizards were constantly visible to walkers among the sand hills because they were very wary and moved with great rapidity as soon as they were disturbed. A number of specimens of these were taken from different kinds of vegetation and no particular habitat seemed to be favoured. Although animals of this genus are active burrowers, Douglas did not obtain any from the burrows which he excavated; the animals simply preferred to run from

clump to clump of vegetation rather than seek security underground. *Lygosoma* was quite often seen but the great density of low vegetation made collecting difficult; a number were obtained close to the cliffs where the vegetation was more sparse.

In the account which follows, each species which was obtained by us, or by past workers, is listed, together with brief field notes which were made with each specimen as it was collected. No attempts at broad generalisation are made. All determinations were made for us by Mr. L. Glauert, the former Director of the Western Australian Museum. The species found in the islands are not redescribed here, but in each case reference is given to an easily available paper by Glauert in which the characters of the species are described and its distribution in Western Australia given. These references are given in parentheses immediately after the name of each species.

LIZARDS

Geckonidae

Heteronota binoei Gray (Glauert 1955: 179-80)

On Dorre Island the species was collected at White Beach under debris of the old buildings and from under stones in various parts of the Island. On Bernier Island it was collected at the hospital site and in Hospital Valley from under sheets of old iron and such debris.

Gehyra variegata (Dumeril & Bibron) (as *Peropus variegatus* in Glauert 1955: 184)

Two specimens were found under stones on Dorre. The species had previously been collected on Bernier.

Phyllodactylus ocellatus Gray (Glauert 1955: 180)

Six specimens were shot in *Spinifex longifolius* at the edge of dunes on Dorre Island. They were very timid. Another was shot among stabilised sand hills. On Bernier Island, five were taken from a rotten log and another from under a marsupial carcass.

Diplodactylus vittatus Gray (Glauert 1956a: 52–3)

A specimen of this species was collected by Lipfert, and another by Grant Watson on Bernier Island. It was not obtained by the Expedition and no data are available.

Glauert (1956a) recorded the occurrence of this species on Bernier; it has not been recorded from Dorre.

D. pulcher (Steindachner) (Glauert 1956a: 56)

One specimen of this species was obtained by Grant Watson on Bernier Island. There are no field data. It was not found by the Expedition.

This species was recorded by Glauert (1956a) from Bernier but has not been recorded from Dorre.

Pygopodidae

Lialis burtoni Gray (Glauert 1956b: 130)

A specimen of this species was collected on Bernier while it was sunning itself on the edge of a *Spinifex* tussock.

Scincidae

Egernia whitii (Lacépede) (Glauert 1960a : 76)

Two specimens were obtained by the Expedition on Bernier Island. One of these was shot near a rock on the western side of the island close to the cliff edge while the other was shot among stabilized sand hills near the camp. The two specimens collected by the Expedition have been examined by Storr (Storr 1960) who states that they are close to his species *E. bos*. In his account, Storr quotes a personal communication from Ride that the insular population does not burrow. It would have been more correct for Storr to have said that neither specimen which was collected by the Expedition was seen to burrow.

Glauert (1960a) has recorded the presence of this species on Bernier but it has not been recorded from Dorre.

Trachysaurus rugosus Gray (Glauert 1960a : 71–2)

Nine specimens were collected on Bernier Island and seven on Dorre by the Expedition. On both islands this species was fairly common and was collected in various environments, *e.g.*, *Olearia* thicket, Open Steppe. On Bernier Island it was noticeable that, in many cases, animals were found in pairs.

The first account of this animal was written, with vivid expression, by Dampier who encountered it on Dirk Hartogs Island (see p. 15) and, as mentioned above, it was first given a name by Peron who drew particular attention to its short stumpy tail and, like Dampier, remarked that at first sight the animal appeared to have two heads.

Glauert (1960a) has recorded the occurrence of this species on Bernier. It was obtained by H.M.S. *Herald* on Dirk Hartogs Island (Boulenger 1885).

Ablepharus lineo-ocellatus Dumeril & Bibron (Glauert 1960c : 116–7)

On Dorre Island, specimens were burnt out of *Melaleuca* on sand dunes ; it was very wary and on seeing movement would back into the fire. On Bernier, specimens were obtained at the southern end of Hospital Valley where it was taken among *Spinifex* with occasional *Olearia* bushes.

A. boutoni plagiocephalus (Girard) (Glauert 1960c : 116)

Two specimens of this form were obtained on Bernier and two on Dorre by the Expedition. The specimens on Bernier were collected on the western side of a small patch of *Triodia* near the northern end of the island.

A. greyii Gray (Glauert 1960c : 118-9)

Two specimens without data were obtained by Grant Watson on Bernier Island. It was not obtained by the Expedition.

A. elegans Gray (Glauert 1960c : 121)

Four specimens were obtained from Bernier Island by the Expedition. Two of them were found on a trunk of *Olearia* while the other two were obtained at the old hospital site six inches deep in the sand beneath a flat wooden slab.

Lygosoma (*Sphenomorphus*) *lesueuri* Dumeril & Bibron (Glauert 1960b : 83)

Specimens of this species were extremely agile and on Bernier Island were obtained along the first line of stabilised sand hills among low scrub

and among the unconsolidated dunes where it was found both in the open and collected by burning clumps of *Spinifex longifolius*. On Dorre Island it was obtained both among sand hills and burnt out of *Triodia* in the middle section of the island.

Glauert (1960b) has recorded its presence on Bernier Island; it has not previously been recorded from Dorre.

L. (*Rhodona*) *miopus* (Günther) (Glauert 1960b: 98)

There is a specimen in the Western Australian Museum collected by Lipfert on Bernier Island. There are no field notes with this specimen. It was not obtained by the Expedition.

Glauert (1960b) has recorded this specimen from Bernier Island.

L. (*R.*) *praepeditum* Boulenger (Glauert 1960b: 98–9)

One specimen of this species was obtained by Douglas on Bernier four inches deep in the sand beneath a stone.

Glauert (1960b) has recorded its presence on Bernier Island.

L. (*R.*) *planiventrale* Lucas & Frost (Glauert 1960b: 95)

Two specimens without field data were obtained by Grant Watson on Bernier Island. No specimen was collected by the Expedition.

Agamidae

Amphibolurus maculatus (Gray) (Glauert 1959b: 43)

This species was very common on both Islands and was collected in a variety of habitats; among those recorded were, under dry seaweed near the water's edge, among scrub, between clumps of *Triodia*, and among *Spinifex* of the sand dunes.

Glauert (1959b) has recorded the presence of the species on Bernier.

A. adelaidensis Boulenger (Glauert 1959b: 49–50)

This species has only been obtained on Bernier Island. Glauert regards both forms *pallidus* and *pulcherrimus* (which were described by Boulenger (1885) as separate species) as *adelaidensis*. The specimens obtained by Lipfert, and by the Expedition, agree with the description of *pallidus*, and those collected by Grant Watson with the description of *pulcherrimus*.

The specimen taken by the Expedition was caught in a clump of *Spinifex longifolius* on a sand dune (predominantly covered with *Olearia*) just to the south of Wedge Point. It moved slowly in loose sand and was difficult to see against the white background.

Glauert (1959b) has recorded the presence of the *pulcherrimus* form on Bernier Island.

A. cristatus (Gray) (Glauert 1959b: 46–7)

Two specimens were obtained by Grant Watson on Bernier Island. These have no field data. It was not obtained by the Expedition.

Glauert (1959b) has recorded its presence on Bernier.

A. barbatus (Cuvier) (Glauert 1959b: 50–1)

A single specimen was taken by Grant Watson on Bernier Island. This specimen has no field data. It was not obtained by the Expedition.

A. reticulatus (Gray) (Glauert 1959b : 48-9)

Three specimens of this species were obtained by Grant Watson on Bernier Island. There are no field data. It was not obtained by the Expedition.

Moloch horridus Gray (Glauert 1959a : 13)

Two specimens were obtained by Grant Watson on Bernier Island. Neither specimen has field data.

Douglas spent some time searching for this species and was unable to find any sign of it.

Varanidae

Varanus gouldii (Gray) (Glauert 1951 : 16)

Two specimens of this species were obtained on Bernier Island and one was seen on Dorre Island by the Expedition. The remains of specimens were also obtained from the underground tank on Dorre Island.

One of the specimens collected on Bernier Island was feeding at the carcass of a goat (R13527) and the other was taken from under a ledge of stone (R13260). A number of holes of this species were observed in the stabilised sand dunes near Hospital Valley on Bernier Island.

The stomach contents of the specimens collected contained : R13527, remains of a juvenile *Lagostrophus* (see p. 61) and the larvae of blowflies ; R13260, two small grey feathers, a phasmid head capsule, a large orthopteron (probably the remains of the phasmid), egg capsules of a phasmid, lepidopteran larvae, a small cricket, much chitinous material and vegetable rubbish.

SNAKES

Pseudechis australis (Gray) (Glauert 1957 : 30–31)

One specimen was collected on Dorre Island and another seen on Bernier. The Dorre Island specimen was collected by Mees as it entered a *Triodia* clump and the snake on Bernier was seen by Douglas in the vicinity of the hospital site. A specimen, possibly of this species was collected by Lipfert on Bernier, but it cannot be found. It was identified (by an unknown worker) as *P. denisonioides* in the Museum Catalogue (W.A.M. 11240).

Rhynchoelaps bertholdi (Jan) (Glauert 1957 : 39-41)

One specimen from Bernier and one specimen from Dorre were collected by Lipfert. There are no field data available for these.

Demansia psammophis reticulata (Gray) (Glauert 1957 : 32-33)

One specimen was obtained by the Expedition on Bernier Island. It was caught in sand under a sheet of corrugated iron near a clump of scrub at the hospital site. The remains of another were collected from the concrete tank on Dorre Island.

Liasis childreni Gray (Glauert 1957 : 19–20)

Eleven specimens obtained by the Expedition on Bernier Island at the hospital site, within a few feet of each other. These pythons were found under the debris of old buildings. Mouse tracks were common in the vicinity and one python was found to contain the remains of *G. albocinereus* (see p. 76), other stomachs were empty.

Plate 34. Children's Python, *Liasis childreni*, was common at the Hospital site on Bernier Island. One was found to contain the remains of *Gyomys albocinereus*, the Ashy-Grey Mouse.

Hydrophis ornatus ocellatus (Gray)

A single specimen was collected in seaweed on the eastern side of Dorre Island by Royce.

TURTLES

Chelonia mydas (Linnaeus)

This species is widely distributed in the tropical and sub-tropical seas around Australia and females visit the coasts to lay their eggs in the sand of the beaches. No specimens have been obtained by expeditions to Bernier and Dorre but accounts clearly show that turtles are common along the beaches of the islands at certain times of the year. Grey (1841) mentioned turtles on the islands and Frederick Lovegrove in his report of April, 1909 (made as Superintendent Medical Officer of the Lock Hospitals) mentioned that turtle eggs and meat were a staple diet of the aboriginal patients during the summer.

CONCLUSIONS AND RECOMMENDATIONS

by Members of the Expedition

Our brief examination of the biology of Bernier and Dorre Islands, and our survey of their history, has clearly shown that their fauna is quite outstanding, both in its biological interest and in its richness.

As biological reserves, they are of paramount importance to anyone who is conscious of the need for the permanent preservation of areas of natural land which clearly illustrate the state of Australia before the advent of the white man and his introductions.

To the scientist and naturalist the faunas are unique. They are rich in species, as compared with other islands off the Western Australian coast, and they contain representatives of species which are now either rare or extinct on the mainland, or are only known from the two islands. In addition, Bernier and Dorre will provide generations of Western Australian biologists with the opportunity to study the interaction of closely related species in a restricted, but natural, environment. They will also act as standards of reference against which the changes, occurring on Dirk Hartogs and the adjacent peninsulas, as a result of human activity, can be measured.

We are unanimous in recommending that Bernier and Dorre both remain natural reserves for the preservation of fauna and flora ; that no part of them be utilized for any other purpose because of the danger of the unwitting introduction of alien species or fire ; that no jetty or pier be built from them which, in allowing decked craft to moor alongside, might facilitate transference of alien species (such as rats) from vessels to the wharf ; that parties of visitors to the Islands be strictly supervised to prevent accidents with fires ; that dogs be prohibited ; that firearms be prohibited, except by special permission of the Chief Warden of Fauna ; that a major effort be made to acquaint the fishermen of the Bay with the great value of the reserves and the danger of lighting fires on them ; and finally, that the goat population of Bernier Island be exterminated without delay.

REFERENCES

Allee, W. C., Emerson, A. E., Park, O., Park, T., Schmidt, K. P. (1949).—*Principles of Animal Ecology*. W. B. Saunders Co., Philadelphia and London.

Ashby, E. (1924).—A review of the genus *Calamanthus*. *Emu* **24**: 44–45.

Bates, D. (1938).—*The Passing of the Aborigines*. John Murray, London: p. 96.

Boulenger, G. A. (1885).—*Catalogue of the Lizards in the British Museum (Natural History)*. **1**, London.

——— (1887).—*Catalogue of the Lizards in the British Museum (Natural History)*. 3, **London.**

Bowley, E. A. (1939).—Delayed fertilization in *Dromicia*. *J. Mammal.* **20**: 499.

Bull, P. C. (1960).—Parasites of the European rabbit, *Oryctolagus cuniculus* (L.), on some islands. *N.Z.J.Sci.* **3**: 258–73.

Burbidge, N. T. (1960).—Further notes on *Triodia* R. Br. (Gramineae) with description of five new species and one variety. *Aust. J. Botany* **8**: 381–395.

Carson, R. D. (1912).—Retarded development in a red kangaroo. *Proc. zool. Soc. Lond.* **1912**: 234.

Carter, T. & G. M. Mathews (1917).—The birds of Dirk Hartogs Island and Peron Peninsula, Shark Bay, Western Australia, 1916–17. *Ibis* (10) **5**: 564–611.

Chittleborough, R. G. (1959).—Intermingling of two populations of Humpback Whales. *Norsk Hvalfangst-Tidende* **48**: 510–521.

——— (1960).—Australian catches of Humpback Whales 1959. *C.S.I.R.O. Division of Fisheries and Oceanography Report.* No. 29.

Churchill, D. M. (1959).—Late Quaternary eustatic changes in the Swan River District. *J. Roy. Soc. W. Aust.* **42**: (2): 53–55.

——— (1960).—Late Quaternary changes in the vegetation on Rottnest Island. *W. Aust. Nat.* **7**: (6): 160–166.

Condon, H. T. (1951).—Notes on the birds of South Australia: occurrence, distribution and taxonomy. *S. Aust. Orn.* **20**: 26–68.

Dahl, K. (1926).—*In Savage Australia*. Philip Allan: London, p. 326.

Dampier, W. (1729).—*A voyage to New Holland, Etc. in the year* 1699. Vol. 3, 3rd Edition. J. and J. Knapton; London (Argonaut Press edition, 1939: London).

Darling, F. Fraser (1937).—Habits of Wild Goats in Scotland. *J. Anim. Ecol.* **6**: (1): 21–2.

Davies, S. J. J. F. (1960).—A note on two small mammals of the Darwin area. *J. Roy. Soc. W. Aust.* **43**: 63–6.

Dunnet, G. M. (1956).—A population study of the quokka, *Setonix brachyurus* Quoy and Gaimard (Marsupialia). I. Techniques for trapping and marking. *C.S.I.R.O. wildl. Res.* **1**: 73–8.

Finlayson, H. H. (1944).—A further account of the murid, *Pseudomys (Gyomys) apodemoides*. *Trans. Roy. Soc. S.Aust.* **68**: (2): 210–224.

——— (1958).—On Central Australian Mammals, Part III—The Potoroinae. *Rec. S.Aust Mus.* **13**: (2): 235–302.

Flynn, T. T. (1930).—The uterine cycle of pregnancy and pseudo-pregnancy as it is in the diprotodont marsupial *Bettongia cuniculus*. *Proc. Linn. Soc. N.S.W.* **55**: 506–531.

Furon, R. (1958).—The Gentle Little Goat—Arch Despoiler of the Earth. *Unesco Courier* No. 1 of 1958: 30–32.

Gardner, C. A. (1944).—The Vegetation of Western Australia with special reference to the climate and soils. *J. Roy. Soc. W. Aust.* **28**: xi-lxxxvii (Pres. Address).

Glauert, L. (1933).—4—The distribution of the marsupials in Western Australia. *J. Roy. Soc. W. Aust.* **19**: 17–32.

——— (1951).—A new *Varanus* from East Kimberley *Varanus mertensi* sp.n. *W. Aust. Nat.* **3**: 14–16.

——— (1955).—Herpetological Miscellanea—5. Western Australian geckoes, Part 1. *W. Aust. Nat.* **4**: 174–184.

——— (1956a).—Geckonidae (Part II). *W. Aust. Nat.* **5**: 49–56.

——— (1956b).—Herpetological Miscellanea VIII. Snake Lizards and Worm Lizards (Family Pygopodidae). *W. Aust. Nat.* **5**: 125–130.

——— (1957).—*A Handbook of the Snakes of Western Australia*. 2nd Ed. Western Australian Naturalists' Club, Perth.

——— (1959a).—Herpetological Miscellanea X. Dragon Lizards (Family Agamidae). *W. Aust. Nat.* **7**: 11–19.

——— (1959b).—Herpetological Miscellanea XI. Dragon Lizards of the Genus *Amphibolurus*. *W. Aust. Nat.* **7**: 42–51.

——— (1960a).—Herpetological Miscellanea XII. The family Scincidae in Western Australia. Part I—The Genera *Tiliqua*, *Trachysaurus* and *Egernia*. *W. Aust. Nat.* **7**: 67–77.

——— (1960b).—Herpetological Miscellanea XII. The family Scincidae in Western Australia. Part 2—The Genus *Lygosoma*. *W. Aust. Nat.* **7**: 81–99.
——— (1960c).—Herpetological Miscellanea XII. The family Scincidae in Western Australia. Part 3—The Genus *Ablepharus*. *W. Aust. Nat.* **7**: 115–122.
Gould, J. (1863).—*The Mammals of Australia*. Vol. III. London, Taylor & Francis.
Grey, G. (1841).—*Journal of two expeditions of Discovery in North-West and Western Australia during the years* 1837, 38 *and* 39 *etc.* T. & W. Boone, London.
Heeres, J. E. (1899).—*Het aandeel der Nederlanders in de ontdekking van Australie* 1606-1765/ *The part borne by the Dutch in the discovery of Australia* 1606-1765. Leiden, London.
Hitchcock, W. B. (1959).—A review of "least" terns in Australian waters. *S. Aust. Orn.* **22**: 86–106.
Jones, F. Wood (1924).—*The Mammals of South Australia*. Pt. 2. The Bandicoots and the Herbivorous Marsupials. Government Printer, Adelaide.
King, P. P. (1827).—*Narrative of a survey of the intertropical and western coasts of Australia performed between the years* 1818 *and* 1822. John Murray, London.
Lipfert, O. H. (1912).—A visit to Bernier and Dorré Islands. *Rec. W. Aust. Mus.* **1**: (1): 98–101.
Lockley, R. M. (1960).—Social structure and stress in the rabbit warren. *New Scientist* **8**: (213): 1580–1583.
Logan, B. W. (1959).—*Environments, foraminiferal facies and sediments of Shark Bay*. Ph.D. Thesis. Uni. of W.A.
Lundelius, E. (1960).—Post Pleistocene faunal succession in Western Australia and its climatic interpretation. *Proc.* 21. *Int. Geol. Congr.*
Mayr, E. W. (1937).—Notes on the genus *Sericornis* Gould. *Am. Mus. Nov.*, No. 904, 25 pp.
Mayr, E. W. & R. Wolk (1955).—The south-west Australian races of the Spotted Scrub-Wren, *Sericornis maculatus*. *W. Aust. Nat.* **4** (1953–1955): 66–70.
Mees, G. F. (1961).—An annotated catalogue of a collection of bird-skins from West Pilbara, Western Australia. *J. Roy. Soc. W. Aust.* **44**: 97–143.
Mueller, F. von (1883).—*The Plants Indigenous around Shark's Bay and its vicinity*. Perth, Government Printer.
Ogilvie-Grant, W. R. (1909a).—Descriptions of a new species of Australian birds. *Bull. B.O.C.* 23, 72–74.
——— (1909b).—On a collection of birds from Western Australia. *Ibis* (9) **3**: 650–689.
——— (1910).—On a collection of birds from Western Australia. *Ibis* (9) **4**: 156–191.
Osborn, T. G. B. and C. A. Gardner (1939).—Dampier's Australian Plants. *Proc. Linn. Soc. Lond.* **151**; 44–50.
Peron, F. (1807).—*Voyage de Découvertes Aux Terres Australes*. 3 Vols. Paris.
Peters, J. L. (1960).—*Check-list of birds of the world. IX*. Cambridge, Mass. Ed. by E. Mayr & J. C. Greenway Jr.
Quoy, J. R. C. & P. Gaimard (1824).—*Voyage Autour du Monde . . . sur les corvettes l'Uranie et la Physicienne . . . Zoologie*. Paris.
Ride, W. D. L. (1957).—*Protemnodon parma* (Waterhouse) and the classification of related wallabies (*Protemnodon, Thylogale*, and *Setonix*). *Proc. zool. Soc. Lond.* **128**: 397–402.
——— (1960).—The fossil mammalian fauna of the *Burramys parvus* breccia from the Wombeyan Caves, New South Wales. *J. Roy. Soc. W. Aust.* **43**: (3) 74–80.
Riney, T. and G. Caughley (1959).—A study of home range in a feral goat herd. *N.Z. Jour. Sci.* **2**: (2): 157–170.
Sadleir, R. M. and J. W. Shield (1960).—Delayed birth in marsupial macropods—the euro, the tammer, and the marloo. *Nature, Lond.* **173**: 302.
Serventy, D. L. (1937).—*Calamanthus* forms in the Shark's Bay District, Western Australia. *Emu* **37**: 103–105.
Serventy, D. L. & H. M. Whittell (1951).—*Birds of Western Australia*, 2nd ed. Paterson & Brokensha Pty. Ltd., Perth.
Sharman, G. B. (1955a).—Studies on marsupial reproduction. II.—The oestrous cycle of *Setonix brachyurus*. *Aust. J. Zool.* **3**: 44–55.
——— (1955b).—Studies on marsupial reproduction. III.—Normal and delayed pregnancy in *Setonix brachyurus*. *Aust. J. Zool.* **3**: 56–70.
Shield, J. W. (1958).—Aspects of field ecology of the Quokka, (*Setonix brachyurus* Quoy & Gaimard). *Ph.D. Thesis. Uni. of W.A.*
Shortridge, G. C. (1910).—Account of the geographical distribution of the marsupials and monotremes of South-west Australia, havnig special reference to the specimens collected during the Balston Expedition of 1904–1907. *Proc. zool. Soc. Lond.* **1909**: 803–848.
——— (1936).—Field notes (hitherto unpublished) on Western Australian mammals south of the Tropic of Capricorn (exclusive of Marsupialia and Monotremata), and records of specimens collected during the Balston Expeditions (November, 1904 to June, 1907). *Proc. zool. Soc. Lond.* **1936**: 743–749.

Specht, R. L. (1951).—A reconnaissance survey of the soils and vegetation of the Hundreds of Tatiara, Wirrega and Stirling of County Buckingham. *Trans. Roy. Soc. S. Aust.* **74** (1): 79–107.
Storr, G. M. (1960).—*Egernia bos*, a new skink from the south coast of Western Australia. *W. Aust. Nat.* **7**: 99–103.
———— (1961).—Microscopical analysis of faeces, a technique for ascertaining the diet of herbivorous mammals. *Aust. J. Biol. Sci.* **14** (1): 157–164.
Stresemann, E. (1951).—Type localities of Australian birds collected by the "Expedition Baudin" (1801–1803). *Emu* **51**: 65–70.
Teichert, C. (1957).—Notes on the geology of the Carnarvon (North-west) Basin, Western Australia. *J. Roy. Soc. W. Aust.* **40**: 65–72.
Thomas, O. (1886).—On the Wallaby commonly known as *Lagorchestes fasciatus*. *Proc. zool. Soc. Lond.* **1886**: 544–547.
———— (1888).—*Catalogue of the Marsupialia and Monotremata in the Collection of the British Museum (Natural History)*. British Museum Trustees, London.
———— (1907).—List of further collections of mammals from Western Australia, including a series from Bernier Island obtained for Mr. W. E. Balston; with field-notes by the collector, Mr. G. C. Shortridge. *Proc. zool. Soc. Lond.* **1906**: 763–777.
———— (1910a).—The generic arrangement of the Australian Murines hitherto referred to "Mus." *Ann. Mag. nat. Hist.* (8), **6**: 603–607.
———— (1910b).—New Australian Muridae of the genus *Pseudomys*. *Ann. Mag. nat. Hist.* (8), **6**: 607–610.
———— (1922).—A selection of Lectotypes of the typical Australian Marsupials in the British Museum Collection. *Ann. Mag. nat. Hist.* (9), **10**: 127–8.
Washburn, S. L. (1946).—The sequence of epiphyseal union in the opossum. *Anat. Rec.* **95**: 353–364.
Waterhouse, G. R. (1846).—*A natural history of the Mammalia*. I, Marsupiata. Bailliere: London.
Watson, J. S. and C. H. Tyndale-Biscoe (1953).—The apophyseal line as an age indicator for the wild rabbit *Oryctolagus cuniculus* (L.). *N.Z. J. Sci. Tech.* B **34**: 427–35.
Whittell, H. M. (1938).—Notes on field-trips of J. T. Tunney. *Emu* **38**: 322–326.
Whittell, H. M. & D. L. Serventy (1948).—*A systematic list of the birds of Western Australia*. Trustees, Western Australian Museum, Perth.
Zeuner, F. E. (1959).—*The Pleistocene period*. Hutchinson, London.

APPENDIX A

CHRONOLOGY OF HUMAN INTERFERENCE

1864—Lease of Bernier and Dorre granted to Mr. John Maxwell of Perth. Maxwell did not settle or graze the Islands.

1896—Sandalwood cutters operating on Bernier (letter Tunney to Woodward, 28/4/1896).

1900—Mr. G. Baston of Carnarvon grazed sheep on Bernier Island and built a house there. This sheep station and house were on the island at the time of Shortridge's visit (letter Shortridge to Thomas, 4/6/06). Baston may have been in occupation earlier than 1900 since Tunney says that Baston took him to the " Island " (letter Tunney to Woodward, 26/3/1896).

1905—Mr. Edward Pearson leased Dorre Island for grazing. It is not known whether he ever grazed the Island.

1907—The Aborigines and Medical Departments open Lock Hospitals on Bernier and Dorre Islands for aborigines suffering from venereal and other diseases. Female patients occupied the hospital on Bernier Island and the male patients the hospital on Dorre. The hospital on Bernier was at the southern end of Hospital Valley and Mr. Baston was paid £1,000 for his house and improvements on the island. The hospital on Dorre Island was at the White Beach and it is not known whether Pearson was compensated in any way. First patients arrived 6th October, 1908 (Report of the Chief Protector of Aborigines 1908/9 *V. & P. of W.A. Vol. II, No.* 25).

1909—In April a cottage of two rooms and kitchen were erected to provide accommodation for an increase of staff. It was necessary to floor and secure the chaff-house from the inroads of wallabies. Wallabies were hunted for meat and " Iguanas are also obtained in large numbers."

During the year 68 female patients were received on Bernier Island suffering from venereal diseases. " The patients are allowed to live in their own natural way as far as possible, game is at present very plentiful and hunting and fishing are the principal occupations of those who are fit to do it." (Chief Protector of Aborigines Report 1908/9 *V. & P. of W.A.* Vol. II, No. 25).

On the 9th July, 1909, extensive fires occurred on Dorre Island. (Chief Protector of Aborigines Report 1909/10 *V. & P. of W.A.* 1910–11 Vol. II, No. 34.

1910—Visit to the islands by Professor A. R. Radcliffe-Browne and E. L. Grant Watson and Mrs. Daisy Bates. Mrs. Bates was critical of the hospitals and said, " there is not, among all my sad sojourn among the last sad people of the primitive Australian race, a memory one-half so tragic and so harrowing, or a name that conjures up such a deplorable picture of misery and horror unalleviated, as these two grim and barren islands of the West Australian coast that for a period, mercifully brief, were the tombs of the living dead." (Bates, 1938 : 96–104).

1917—Decision made to move patients and hospital buildings to Port Hedland.

1918—A few patients still remained on Dorre Island. Bernier had been completely abandoned as a hospital settlement. (Chief Protector of Aborigines Report 1917/18 *V. & P. of W.A.* Vol. I, No. 4). It is not known when the last patients left Dorre Island.

1919—Mr. Edward Pearson of Carnarvon granted pastoral lease of both islands (Pearson had leased Dorre prior to the hospital period).

1922—Pearson abandoned lease without having used the islands for grazing purposes.

1924—Mr. C. A. R. Lloyd of Carnarvon granted the lease of both islands, but did not graze them.

1929—Lloyd's lease cancelled.

1939—Islands leased for grazing to Mr. K. A. Colbath who also intended to run a tourist resort. This was not allowed under the pastoral lease conditions. Islands not grazed.

1940—Department of Navy requested permission from the Lands Department to use both islands for gunnery targets for H.M.A. Ships.

Since 1940 a number of applications for leases have been made but nothing eventuated from any of them.

1957—The Islands were gazetted as Reserves (Class A) for the preservation of Fauna on 21/11/57 (Reserve A 24869).

APPENDIX B

A HISTORY OF CONSERVATION

1907—Dorre Island was declared a reserve for native game under the Game Act 1892 (Western Australian Government Gazette, 2nd August, 1907).

The Game Act protected fauna from wanton destruction but not from habitat interference.

The Natural History Society of West Australia requested that a number of islands, including "either Bernier, or else Dorre Island, Shark Bay" be set apart as Reserves for Flora and Fauna. (Letter to the Minister for Crown Lands, 9th August, 1907). This suggestion was not agreed to by Cabinet.

1919—W. B. Alexander, Keeper of Biology at the Western Australian Museum, wrote to the Lands Department requesting that cats and firearms be prohibited from Bernier Island because of rarity of native fauna. Application for a lease of the island for pastoral purposes had been made and he asked that this prohibition be included in the lease (Letter from Alexander to Lands Department 2918/1919). This request was refused.

Bernier Island was declared a reserve for native game under the Game Act on the 27th September, 1919 (*Government Gazette* No. 52, 1919).

The Royal Society of Western Australia also requested that cats and firearms be prohibited on the islands. (Letter from Royal Society to Lands Department 20/10/1919). This request was refused.

1939—Mrs. M. F. Phillips applied for a lease to mine guano on Bernier and Dorre Islands. This lease was approved, and one of the stipulations, included in it, was that "no cats or firearms shall be allowed on these islands." This lease was not finalised.

1948—L. Glauert, former Director, Western Australian Museum, in a letter to the Fauna Protection Advisory Committee, quoted a suggestion, made by F. F. Anderson, former Director of Fisheries, Commonwealth Department of Primary Industries, that Dorre Island should be reserved. (Letter from L. Glauert to Fauna Protection Advisory Committee 19/10/1948). No action was taken.

1957—A Resolution was passed by the Fauna Protection Advisory Committee that both Bernier and Dorre Islands be reserved under Section 29G of the Land Act. (Minutes Fauna Protection Advisory Committee 20/9/1957). On the 6th December, 1957, the Proclamation set out hereunder appeared in the Government Gazette of Western Australia No. 52, 1919. In the same Government Gazette an Order in Council vested Bernier and Dorre Islands in the Fauna Protection Advisory Committee of Western Australia.

"LAND ACT, 1933–1956

PROCLAMATION

WESTERN AUSTRALIA,
TO WIT,
CHARLES HENRY
GAIRDNER,
Governor

(L.S.)

By His Excellency Lieutenant-General Sir Charles Henry Gairdner, Knight Commander of the Most Distinguished Order of Saint Michael and Saint George, Knight Commander of the Royal Victorian Order, Companion of the Most Honourable Order of the Bath, Commander of the Most Excellent Order of the British Empire, Governor in and over the State of Western Australia and its Dependencies in the Commonwealth of Australia.

Corres. No. 2043/38.

WHEREAS, by section 31 of the Land Act, 1933–1956, the Governor may, by Proclamation, and subject to such conditions as may be expressed therein, classify as of Class "A" any lands of the Crown reserved to Her Majesty for any of the purposes specified in the said sections; and whereas it is deemed expedient that the reserve described in the Schedule hereto should be classified as of Class "A": Now, therefore I, the Governor, with the advice of the Executive Council, do by this Proclamation classify as of Class "A" the reserve described hereunder:

Schedule

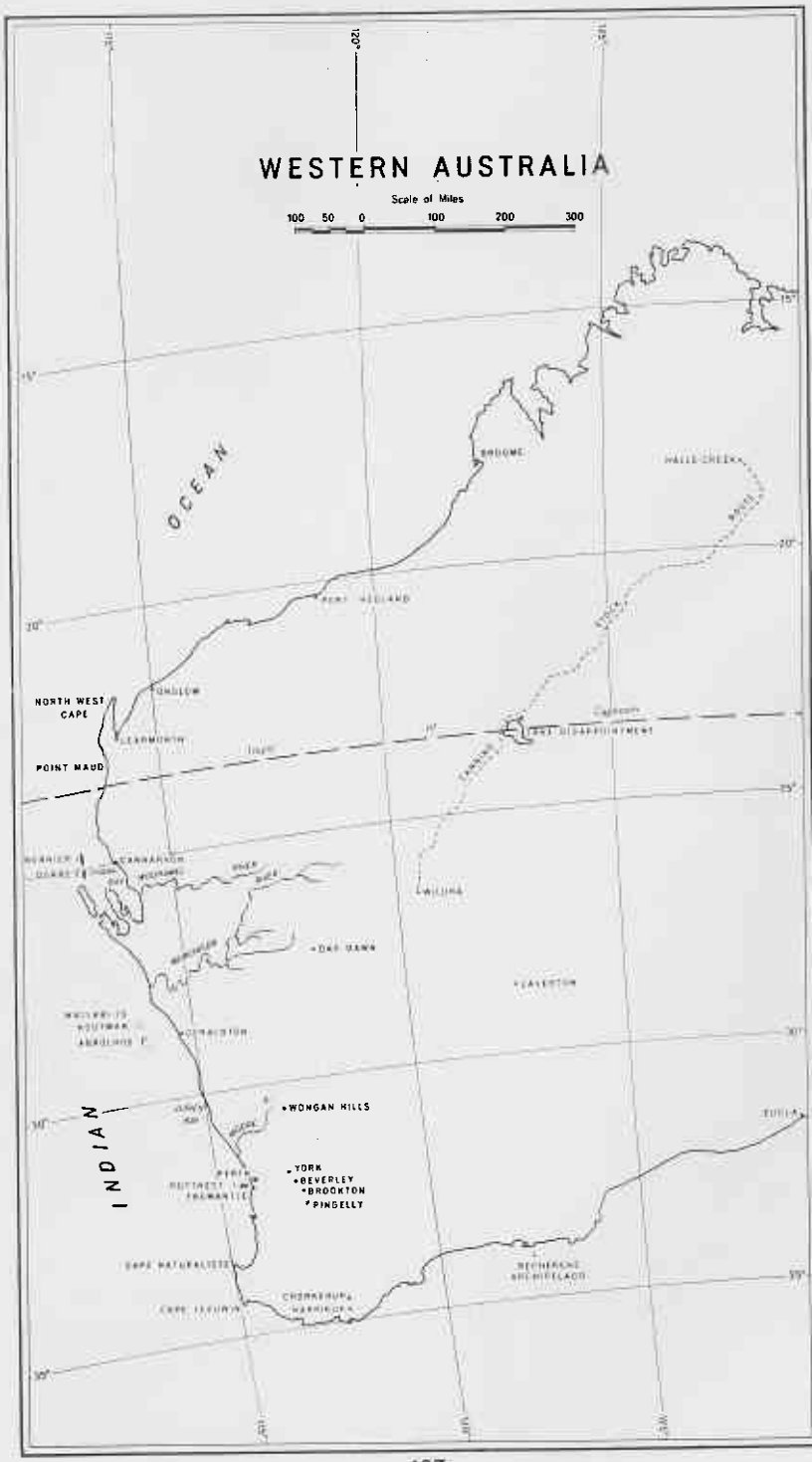
Reserve No. 24869 (Bernier and Dorre Islands), containing about 26,000 acres, for the purpose of "Conservation of Fauna" (Plan 75/300).

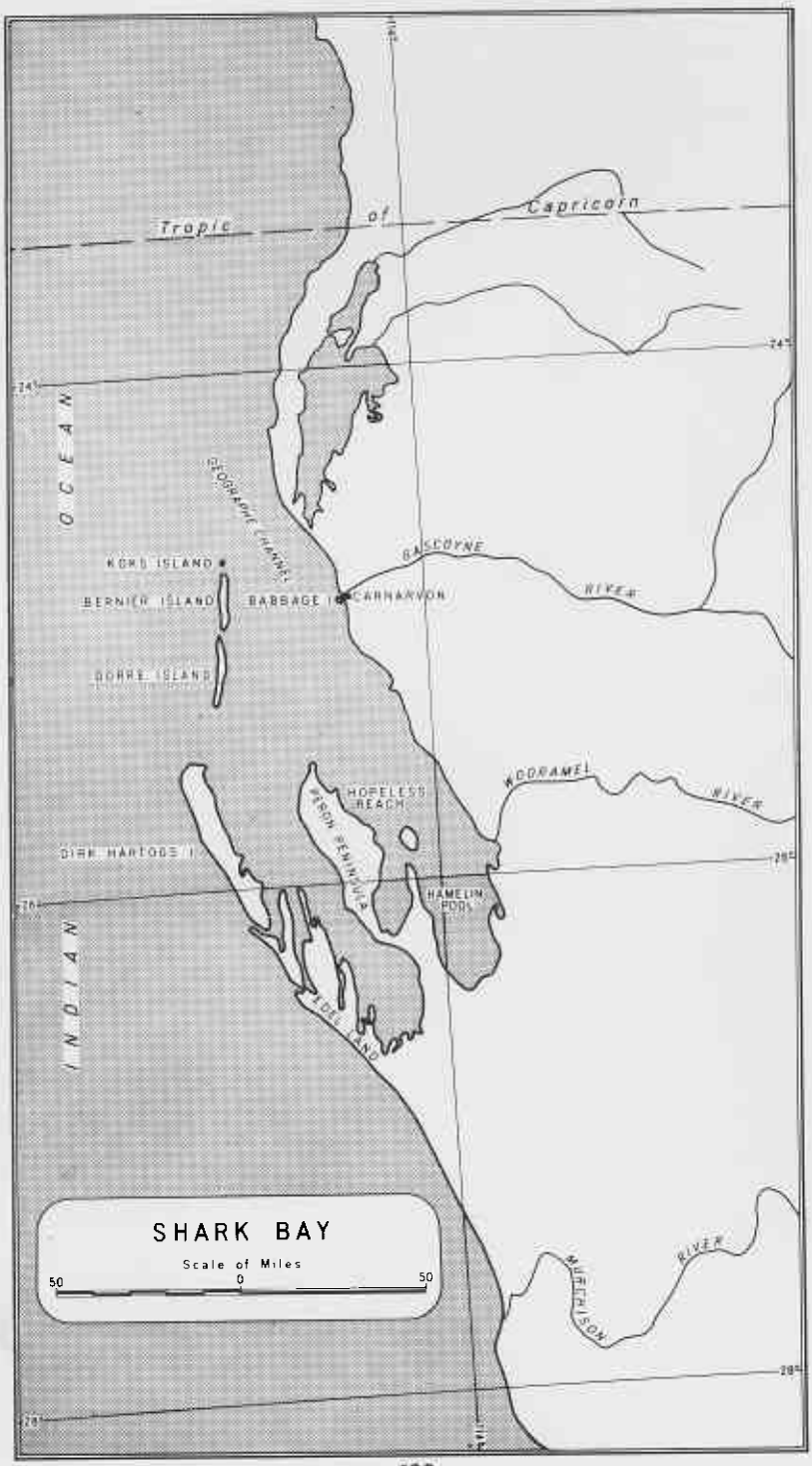
Given under my hand and the Public Seal of the said State, at Perth, this 21st day of November, 1957.

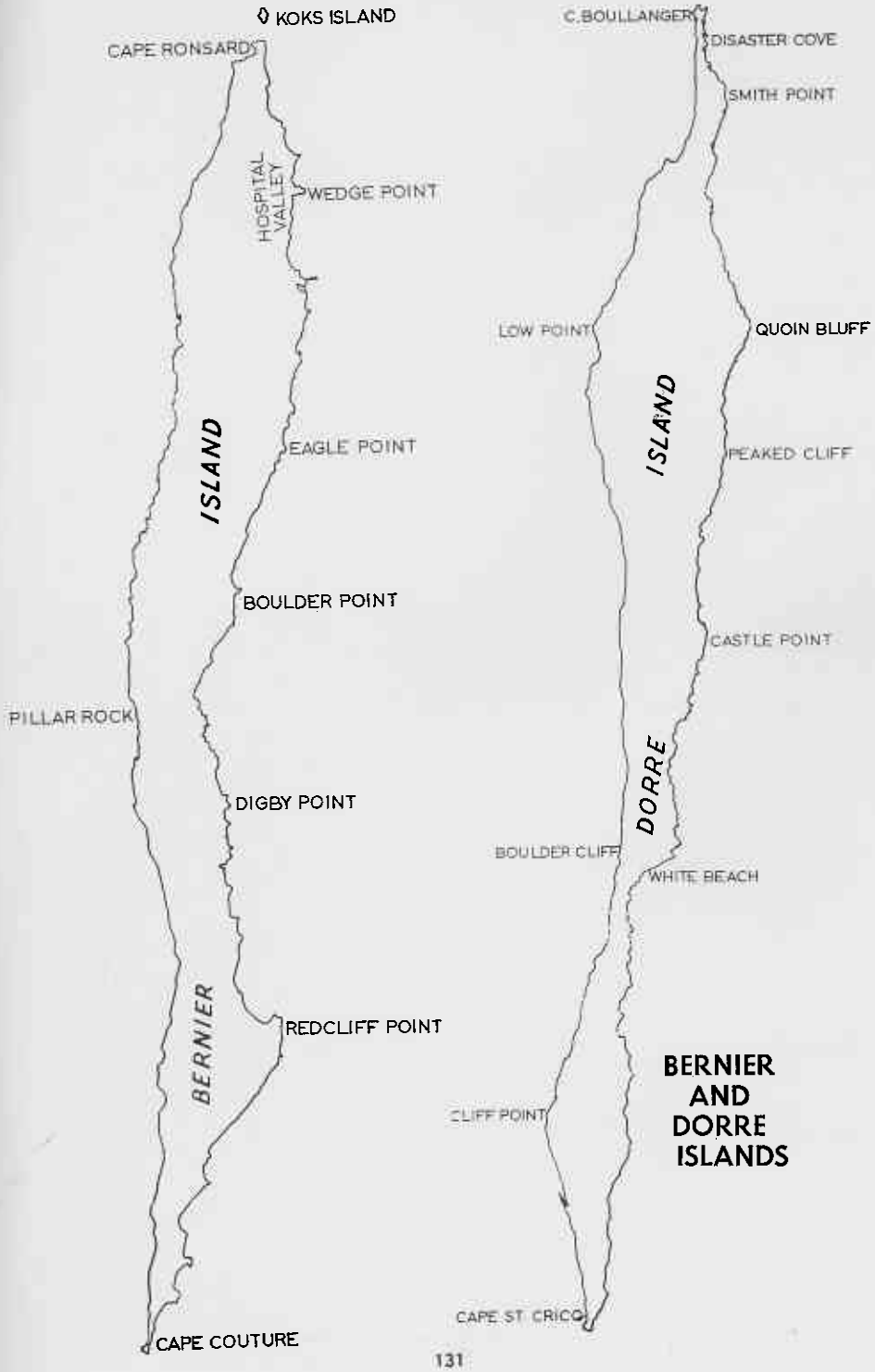
By His Excellency's Command.

(Sgd.) E. K. Hoar,
Minister for Lands.

GOD SAVE THE QUEEN ! ! !"


WESTERN AUSTRALIA
Scale of Miles
100 50 0 100 200 300
INDIAN OCEAN
BROOME
NORTH WEST CAPE
POINT MAUD
CARNARVON
GERALDTON
WONGAN HILLS
YORK
BEVERLEY
BROOKTON
PINGELLY
PERTH
FREMANTLE
CAPE NATURALISTE
CAPE LEEUWIN
ESPERANCE
RECHERCHE ARCHIPELAGO


Tropic of Capricorn
24°
INDIAN OCEAN
DENHAM
KOKS ISLAND
BERNIER ISLAND
DORRE ISLAND
BABBAGE I.
CARNARVON
GASCOYNE RIVER
HOPELESS REACH
PERON PENINSULA
DIRK HARTOGS I.
HAMELIN POOL
EDEL LAND
MURCHISON RIVER
SHARK BAY
Scale of Miles
50 0 50


KOKS ISLAND
CAPE RONSARD
HOSPITAL VALLEY
WEDGE POINT
ISLAND
EAGLE POINT
BOULDER POINT
PILLAR ROCK
DIGBY POINT
BERNIER
REDCLIFF POINT
CAPE COUTURE
C.BOULLANGER
DISASTER COVE
SMITH POINT
LOW POINT
QUOIN BLUFF
ISLAND
PEAKED CLIFF
CASTLE POINT
DORRE
BOULDER CLIFF
WHITE BEACH
CLIFF POINT
CAPE ST. CRICQ
BERNIER AND DORRE ISLANDS