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Ecology of Aldabra Atoll, Indian Ocean
edited by Dr. David R. Stoddart

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Chapter 1

SCIENTIFIC STUDIES ON ALDABRA ATOLL

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1. THE ECOLOGY OF ISLANDS

Oceanic islands have been recognised since the time of Darwin and Wallace to be of special significance in the study of biogeography and evolution. The work done in the past century, particularly in the Lesser Antilles, the Australasian archipelagoes, and the Hawaiian Islands, has permitted the formulation of general principles of dispersion, colonisation, and speciation in island biotas. By the time that these problems were being recognised, however, and hypotheses were being formed about them, many of the more accessible and congenial islands were being newly settled by man, with the resulting disruption of many unique assemblages of plants and animals by economic activities, or by the unexpected impact made by introduced species. This has happened particularly on the more accessible tropical islands, in many of which the opportunity to study undisturbed indigenous floras and faunas has gone for ever.

Much recent work on island ecology has, therefore, concentrated on those islands where disturbance has been minimal, particularly in the more remote and hostile environments of the southern cold temperature zone (Holdgate and Wace 1961; Wace 1965) (for all references see the "Bibliography of Aldabra", Chapter 6 of this Bulletin); on Amsterdam, Kerguelen, Crozet and St Paul in the southern Indian Ocean; on Macquarie, Auckland and Campbell Islands; and, in the south Atlantic, on Tristan da Cunha, Inaccessible and Gough Islands. Here the problems of insularity have been linked with that of the circumpolar distribution of many plants and animals (Pantin 1960; Darlington 1965). Within the tropics, classic studies have been carried out in the Galapagos Islands, initiated by Darwin himself and recently intensified since the opening of the Charles Darwin Research Station there (Bowman 1966). Other islands, including some in low latitudes, have been studied for the light they throw on the processes of replacement of native by introduced species, as in the case of St Helena and Ascension in the Atlantic Ocean, and Clipperton in the Pacific.

From these studies of islands, certain principles of island ecology emerge (Hesse and others 1951, 621-635; Darlington 1957, 476-544; Gulick 1932; Holdgate 1960; Carlquist 1965). First, islands are isolated by the sea, which acts as a barrier or filter of variable intensity for different groups of plants and animals, and the degree of isolation is a function not only of distance but also of the time available for colonisation: the older the island, the greater the probability that successful introduction has occurred. In this property of isolation we may include Wallace's distinction between oceanic and continental islands. Second, islands have limited area, and hence carrying capacity, which for larger animals may be less than a minimum threshold for survival, and they also possess unique environmental characteristics, particularly in climate. Work so far has concentrated on volcanic islands, such as the Tristan group, but coral islands, with a narrower range of environments, have the advantage for study of a simpler biota. Third, the combination of a peculiar environment with the fact that successful colonisation is dependent on a capacity for long-distance over-water dispersal and for survival in new habitats means that the biota of islands tend to be small and disharmonic. The absence of many continental genera and species means that competition is reduced,

and island species may increase their ranges. Infrequent colonisation and prolonged isolation favour the evolution of endemic varieties, species, and genera, especially on the older and larger islands such as Hawaii. Finally, the smallness of the biota, and its under-exploitation of the island environment, means that such communities are often unstable and are specially liable to large-scale disruption by invading alien plants and animals. This is well seen in the disappearance on many islands of large breeding colonies of sea birds, and of such ungainly creatures as the dodo, which are clearly unfitted to compete with introduced predatory mammals and competitors.

The islands of the Indian Ocean include granitic islands, volcanic islands, sea-level coral reefs and atolls, and islands formed of elevated reef limestones. Of the islands of coralline origin, the atolls have been studied in some detail at the beginning of the century, particularly in the Maldives (bibliography in Stoddart 1966, 107-122) and at Cocos-Keeling, on which Darwin worked and which has been studied more recently by Gibson-Hill (bibliography in Sachet and Fosberg 1955). The elevated limestone island of Christmas, near Java, was monographed by Andrews in 1900, and has been studied since. The high islands of the Andamans and Nicobars, visited by Seymour Sewell, have attracted comparatively little attention by comparison with those of the western Indian Ocean.

These latter, between the African coast and the approximate line of the mid-ocean ridge (Figure 1), are of considerable importance in the study of the geography and land ecology of islands. They include, besides the great landmass of Madagascar, the volcanic Mascarene Islands (Mauritius, Rodriguez, Reunion), the granitic Seychelles, the coral atolls extending from the Laccadives through the Maldives to the Chagos Archipelago, and the cluster of reef islands, many of them elevated, to the north of Madagascar, from Aldabra to the Amirantes and the Seychelles Ridge. Our knowledge of the biogeography of this area derives largely from a series of expeditions led by Professor Stanley Gardiner in 1899-1900, 1905, and 1908-09, culminating in the Fauna and Geography of the Maldive and Laccadive Archipelagoes (Gardiner 1903-06) and in the eight volumes of Reports of the Percy Sladen Trust Expedition (Gardiner 1907-36). Since Gardiner's work, several of the islands, particularly in the southwest Indian Ocean, have been devastated beyond the possibility of further useful work, mainly by guano diggers, and even when he wrote, many of the most interesting forms, such as the giant flightless land birds of the Mascarene Islands and the giant land tortoises of the southwest Indian Ocean, had been hunted to extinction or near-extinction by man and his introduced predators.

Of the elevated reef islands of the western Indian Ocean, only Aldabra has escaped massive interference by man. By contrast, the guano reserves of nearby Assumption have been mined for many years, and this applies also to St Pierre, Astove and others (Baker 1963, 110-127; review by Hutchinson 1950; and Chapter 3 of this Bulletin). The lack of economically workable guano deposits on Aldabra, together with an environment unsuited to agriculture or even to human settlement, has meant that here isolation has continued to the present day.

The ecology of Aldabra is of interest for three main reasons. First, it is an uplifted atoll, and hence provides a wider range of habitats than most

sea-level reef islands. Second, it is oceanic, in the sense that there is no evidence of any former land connections with continental areas, and hence the biota must have been derived by normal dispersal processes; but at the same time its relative proximity to Africa, and particularly to Madagascar and the Comoros, means that the probability of successful colonisation from these sources has been high. Combined with the diversity of habitat, this has produced a fauna and flora exceptionally rich for a coral atoll. And third, its isolation has not only led to the development of endemic species of both plants and animals, but has favoured the development or survival of such creatures as flightless land birds and the giant land tortoise. With the devastation of nearby islands which originally possessed very similar ecosystems, Aldabra is thus of special importance in the category of elevated coral atolls. Most of the similar high limestone islands in the Pacific have been devastated for guano (Ocean Island, Nauru, and Makatea being the worst examples), and those which remain (such as Henderson and Vostok) are so far from continental land as to be biologically impoverished. Scientific understanding of elevated reef-limestone islands can thus only be obtained by detailed work on Aldabra Atoll.

2. PREVIOUS INVESTIGATIONS

Much early information on Aldabra was frankly speculative, and once it appeared in the literature it was repeated by many authors. Horsburgh, for example, states that "from the appearance of these islands, water is perhaps plentiful, and also timber of sufficient size to be useful to any ship in distress for spars" (Horsburgh 1852, 176), and according to Pridham (1846, 307) "water would appear to be plentiful". Opinions such as these were clearly not based on any real knowledge of the atoll.

Table 1 lists the scientific expeditions, official parties, and some of the more significant individuals to visit Aldabra since the first hydrographic survey in 1878. Of these investigations, four resulted in large collections of flora and fauna: those of Abbott in 1892, of Voeltzkow in 1895, of Dupont in 1906 and on several later occasions, and of Fryer in 1908-09, in connection with Professor Gardiner's last expedition. The most important general memoirs are those of Voeltzkow (1897, 1902), Dupont (1907), and Fryer (1911), and an outline of the salient features of the ecology of Aldabra has been given by Stoddart and Wright (1967a). More detailed papers are referred to in this Bulletin, and an attempt to give a complete bibliography is made in Chapter 6. Early voyages to Aldabra, with comments on the origin of the name, are listed by Voeltzkow (1897, 40-41).

In recent years, mention must be made of Ommanney's visit in 1948 and the popular account he later wrote (Ommanney 1954); of the visit of the Calypso, Commander J.-Y. Cousteau, in 1954, which resulted in large additions to our knowledge of the birds, crustacea and Lepidoptera; and of the Bristol Seychelles Expedition in 1964-65. This party, led by M. J. Penny, visited Aldabra first between 11 November and 14 December 1964; a second visit was made by one member, R. Gaymer, between 4 October and 20 November 1965.

Table 1.--Previous Investigations at Aldabra

Date	Investigator	Field of Study	General Publication
1878 July	H.M.S. Fawn, Dr. Wharton	Survey	Wharton 1879, 1883
1892 May	H.M.S. Redbreast, Mr T. R. Griffith	General	Fairfield, Griffith and Abbott 1893
1892 Sep-Dec.	Dr W. L. Abbott	Birds, insects, plants	Abbott 1893
1895	Mr Wilson	Molluscs	Von Martens and Wiegmann 1898
1895 Apr-May	Dr A. Voeltzkow	Geology; all groups	Voeltzkow 1897, 1902b
1904 Dec.	Mr F. R. Mortimer	Birds	-
1905	Anon.	General	Anon. 1920
1906 May	Valhalla, Lord Crawford	Birds, insects	Nicoll 1908, 114-123
1906 Oct-Nov.	Mr R. P. Dupont	Plants, insects, birds	Dupont 1907
1907	Mr H. P. Thomasset	Insects, birds	-
1908 Aug.-1909 Feb.	Mr J. C. F. Fryer	Geology; all groups	Fryer 1910, 1911
1916	Mr W. Fox	Botany	Hemsley 1919
1937 Oct.	Mr D. Vesey-FitzGerald	Birds, vegetation	Vesey-FitzGerald 1940, 1941, 1942
1948	Seychelles-Mauritius Fisheries Survey Mr J. F. G. Wheeler Dr F. D. Ommanney	Commercial fisheries Turtles	Ommanney 1952, 258-294; Wheeler and Ommanney 1953
1953 Nov.	Italian Zoological Expedition: C. Prola, F. Palombelli, F. Prosperi, S. Nievo	General; insects	Prosperi 1955, 1956, 1957; Berio 1956, 1959

Table 1. --(continued)

Date	Investigator	Field of Study	General Publication
1954 May	Calypso, J.-Y. Cousteau G. Cherbonnier	General, crustacea birds	Cousteau 1959, 1963
1956	Mr W. Travis	Turbo	Travis 1959, 157-193
1957 Dec.	Yale Seychelles Expedition Dr A. J. Kohn Dr W. D. Hartman	General, tortoises	
1959	H.M.S. Leopard	Birds	Boulton 1960
1959	Mr H. Legrand	Lepidoptera	Legrand 1965
1960 Sep. 1961 Jan.	Dr B. H. Baker, Mr C. J. Piggott	Geology	Baker 1963
1962 Jan.	H.M.S. Owen	Birds	Morris 1963
1964	R. E. Honegger	Birds, tortoises	Honegger 1966a, b
1964 Mar.	H.M.S. Owen	Birds	Bourne 1966
1964 Nov.-Dec.	Bristol Seychelles Expedition: M. J. Penny, C.M. Penny, R. Gaymer, R. Blackman, P. G. Dawson	Birds, tortoises	Blackman 1966
1965 Oct.-Nov.	R. Gaymer	Birds, tortoises	Gaymer 1966b
1966 Sep.-Oct.	Dr D. R. Stoddart Dr C. A. Wright	Geomorphology, land ecology	Stoddart and Wright, 1967a

3. PRESENT INVESTIGATIONS

Aldabra has recently been considered as a possible site for the construction of a military airfield by the Ministry of Defence. With the co-operation of the then Minister of Defence for the Royal Air Force, Lord Shackleton, and of the Hydrographer, Rear-Admiral G. S. Ritchie, it has been possible, with the support of the Southern Zone Research Committee of the Royal Society, to

begin detailed investigation of the geography and land and marine ecology of Aldabra, for the purposes of preparing long-term conservation plans and of gaining knowledge of this unique island ecosystem. Dr C. A. Wright and the author were attached, in September and October 1966, to the British Broadcasting Corporation's Expedition Turtle, as a result of which further investigations are now being planned. This Bulletin has been designed to summarise present knowledge of Aldabra, within the framework of the work carried out during the 1966 expedition. Chapter 2 covers the whole range of geography and ecology, so far as is known. Chapter 3 summarises the very scanty and often old information on the islands near to Aldabra, to provide comparative data for the assessment of the importance of Aldabra itself. In Chapter 4 Mr C. W. Benson presents a full analysis of the birds of the atoll and the neighbouring islands, with special reference to the land birds, based on his own field experience in the Comoro Islands and an exhaustive study of the collections made by Abbott, Voeltzkow, Dupont and others. Chapter 5 presents some observations by Mr R. Gaymer, made during his two visits as a member of the Bristol Seychelles Expedition, on the natural history of the birds, again with reference to the land birds. Finally, Chapter 6 gives a full bibliography. It is intended that this account will not only stimulate scientific interest in this too-much neglected atoll, but will serve as a working paper for the project of further investigations now being planned.

From our knowledge of the biota, it is clear that the importance of Aldabra stems first of all from its population of the giant land tortoise, a relic of a once wider population which demands both urgent study and effective conservation, and second, from the isolation of the atoll and the distinctive assemblage of both plants and animals which has formed as a result. Many species of both plants and animals may be distinct; and it was on such endemic species that scientific interest at Aldabra, as indeed in most insular biotas, formerly centered. Some of the endemics, such as the rail Dryolimnas, last flightless bird of the Indian Ocean islands, are of special concern, but their interest is far below that of the giant tortoises. More important from an ecological viewpoint are the island populations of more widely ranging species, particularly the great colonies of frigate birds and boobies, and the breeding populations of the migratory green turtle. Other species, while probably not distinct, no longer exist in large numbers, and efforts must be made to preserve them before they disappear: this applies to the Sacred Ibis, and particularly to the Flamingo.

With the possibility of military development, these problems immediately become acute: for while we already know a great deal about the composition of the biota, in the sense of lists of plants and animals, we know very little about the island ecology and its areal variation. Many ecological problems, such as those of food chains and population structure, cannot be adequately studied during brief visits. The realisation of the scope and importance of purely ecological problems, as opposed to taxonomic ones, coincides, furthermore, with a changing emphasis in island biology, from the simple recognition of peculiar species to the study of the genetics of change in remote, insular populations (Carlquist 1966). Studies in population genetics again require detailed long-term work. It is not too much to say that only now are theoretical concepts becoming available which can enable us to understand structure,

function, and change in island ecosystems, but by this time few island ecosystems remain to be studied.

The Royal Society, with the active assistance of the Ministry of Defence, and following a conference in London in January 1967 attended by many scientific and conservation organisations from Britain and the United States, is organising a programme of further scientific work at Aldabra in 1967–68. The Royal Society Expedition to Aldabra 1967–68 will consist of three parts. The first, in August and September 1967, during the dry season, will concentrate on further land reconnaissance, and on lagoon ecology. A resident party to carry out long-term studies of the sea bird colonies, of the land birds, of the lagoon biota, and of the tortoises and turtles, will remain on the atoll for the second part of the expedition, from August 1967 to March 1968, some members spanning both wet and dry seasons. Finally, in January to March 1968, the third part of the expedition, a wet-season party will concentrate on land flora and vegetation and land zoology. By the end of this programme, enough data will have been gathered to serve as a permanent record of an unspoiled oceanic island, and as a basis for meaningful conservation measures if military development takes place. If, on the other hand, military development is averted, then this scientific project will provide a base-line for continuing studies of this remote and still largely unspoiled unique island ecosystem.

4. ACKNOWLEDGMENTS

Thanks are due first of all to the Ministry of Defence, and to Lord Shackleton, former Minister of Defence for the Royal Air Force, and Rear-Admiral G. S. Ritchie, Hydrographer, for their active assistance and co-operation in making scientific participation in the 1966 expedition possible; to the British Broadcasting Corporation and the leader of the expedition, Mr A. Bosworth, for giving Dr Wright and myself every facility and aid on Aldabra; and to the Royal Society for their interest and support. Dr Wright and I are also grateful to Mr C. E. Loveridge, Ministry of Public Buildings and Works, Wing-Commander P. A. S. Thompson, Ministry of Defence, Mr G. Dawson, British Broadcasting Corporation, and other members of the expedition for their help and companionship in the field, and to the late Professor C. F. A. Pantin, F.R.S., for his initial encouragement. We thank the Director of the Royal Botanic Gardens, Kew, Sir George Taylor, for the loan of equipment and for the identification of the botanical collections by members of his staff (Dr J. P. M. Brenan; and Mr Clayton, grasses; Miss Hooper, sedges; Dr Jarrett, fern; and Mr Bullock, other groups). I am grateful to Professor H. C. Darby and the University of Cambridge for temporary leave of absence for part of the expedition.

I am also grateful to Mr C. W. Benson and Mr R. Gaymer for their contributions to this Bulletin. Mr Gaymer, who visited Aldabra twice with the Bristol Seychelles Expedition, has very generously allowed me to read his unpublished memoranda and papers based on his work during that expedition. Lady Joan Fryer, widow of the late Sir John Fryer, whose memoir on Aldabra is still the most useful account available, has very kindly loaned me Sir John's manuscript journal and other papers to do with his visit to Aldabra in 1908–09.

I thank also Dr F. R. Fosberg and Dr Marie-Helene Sachet for their interest and advice on the conservation of Aldabra during the last several years.

Dr W. R. P. Bourne has read the whole manuscript of this Bulletin and has made many most useful suggestions. Other sections have been read by Dr F. C. Fraser and Mr John Peake of the British Museum (Natural History) (Chapter 2); Dr F. R. Fosberg, Smithsonian Institution (Chapter 2); and Dr R. E. Moreau, Edward Grey Institute, Oxford, and Dr G. E. Watson, Smithsonian Institution (Chapter 4).

Mr Daniel Labworth very kindly gave permission for the quotation of sections of the commercial lease agreement for Aldabra, signed in 1955, used in Chapter 2.

Finally, I am grateful to Miss R. King, who drew the maps; Mr R. Coe, who made the prints; and to Mr R. Balmforth, who carried out a very great deal of xerox work in connection with this project.

Chapter 2

GEOGRAPHY AND ECOLOGY OF ALDABRA ATOLL

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1. LOCATION AND REGIONAL SETTING

Aldabra Atoll (latitude 9°24'S., longitude 46°20'E.) lies 260 miles northwest of Madagascar and 400 miles from the East African mainland. With the adjacent islands of Assumption and Cosmoledo, it rises as an isolated mountain in a basin 2000-2500 fathoms deep, bounded to the west by the African coast, to the south by Madagascar and the Comoros, and to the east by the Farquhar and Amirantes Banks and the Seychelles-Mascarene Ridge. Farther north, this basin has been shown to contain thick sequences of sedimentary rocks and to have a normal crustal structure (Francis and others 1966). The Seychelles-Mascarene Ridge, clearly defined by the 2000 fathom isobath (Figure 1), appears to be of complex structure. The Seychelles Bank itself is underlain by Pre-Cambrian granite, which emerges to form the main islands (Baker and Miller 1963; Matthews and Davies 1966). Matthews believes, from geophysical evidence, that similar rocks, with later basic dykes, are found between the Seychelles Bank and the Saya de Malha Bank, and again underlying Cargados Carajos Shoals near the southern end of the Ridge. Conversely, the Amirantes ridge, southwest of Seychelles, is

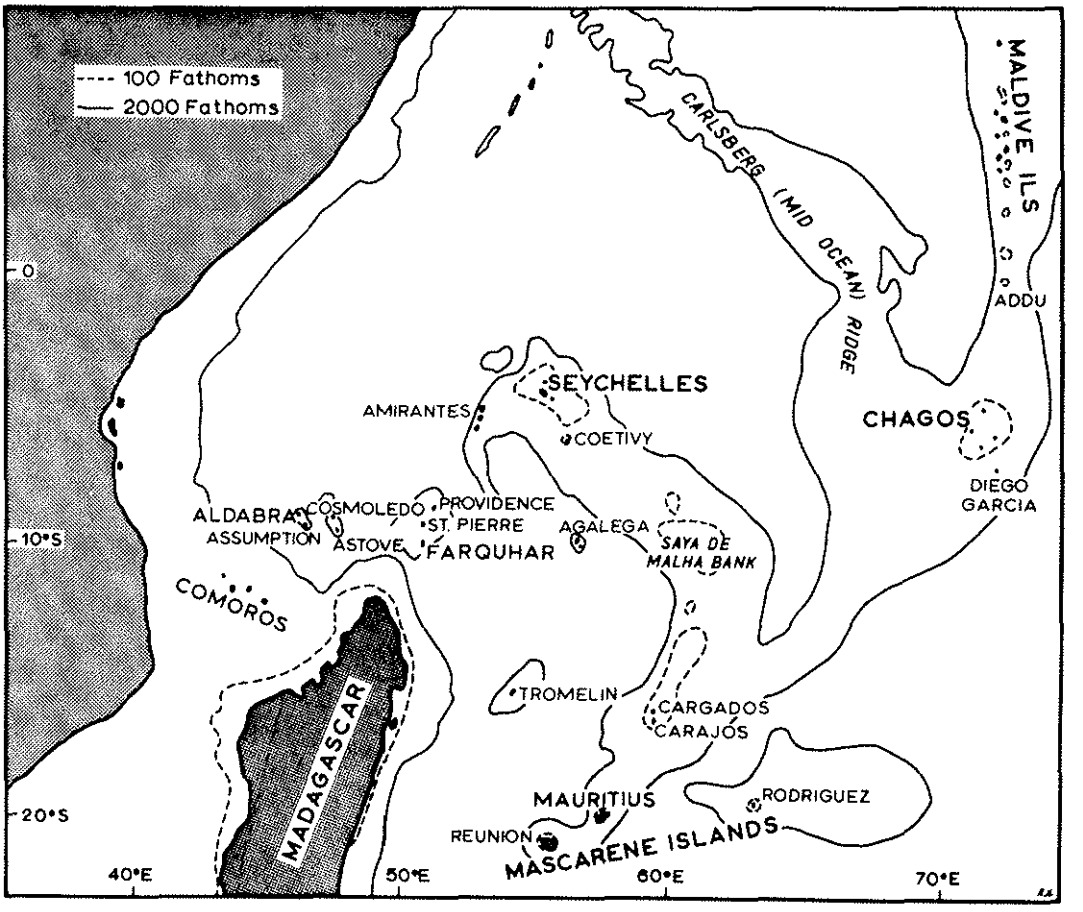

Figure 1.--Location of Aldabra

thought to consist of a coral capping, less than 1 km thick, overlying a basaltic volcanic arc (Matthews and Davies 1966). The Saya de Malha Bank itself, near the middle of the mid-ocean ridge, is also thought to consist of volcanic rocks capped with coral (Shor and Pollard 1963), and the islands of Mauritius and Réunion are themselves volcanic. South of Aldabra the Comoro group consists of a series of volcanoes of different ages (Guilcher and others 1965), and large areas of the Madagascar granites are covered with volcanics.

Little is know of the crustal structure north of the Comoros, or between Aldabra and Farquhar and Madagascar and the Amirantes. The conclusions of earlier biologists, concerned with problems of distribution, calling for isthmian links and drifting continents, are no longer tenable. Although geophysical evidence is lacking, the isolated nature and considerable relief of the mounts of the Aldabra group, rising steeply from uniform depths of c. 2200 fathoms, together with the proximity of recent volcanoes in the Comoros, suggests a volcanic basement at undetermined depth beneath the islands. This interpretation is supported by the presence of fragmental basalts, similar to rocks from Madagascar, associated with foraminifera of Eocene-Oligocene age, from the slopes of Providence, 300 miles east of Aldabra, at a depth of 744 fathoms (Wiseman 1936), and by the similar trends of both the Aldabra and Comoro ridges. This may imply the former existence of high volcanic islands, similar to the Comoros, perhaps in the early Tertiary, at Aldabra, Assumption and Cosmoledo, and also at Farquhar, Providence and St Pierre, and their transformation into atolls by Darwinian subsidence.

Apart, therefore, from the Comoros, the volcanic Mascarene Islands, and the granitic Seychelles, the islands of this western sector of the Indian Ocean are of reef origin. They include either sand cays of reef debris on sea-level reefs, as in the Amirantes, Cargados Carajos, and the Chagos Archipelago, or islands formed of uplifted reef limestones, as at Aldabra, Astove, Assumption, St Pierre, Providence, Cosmoledo and Farquhar. Baker (1963) has described the geology of many of these smaller islands, and their distribution is shown in Figure 2.

The date of uplift of the raised reef islands, including Aldabra, is unknown. Contrary to earlier ideas, based on Daly's hypothesis of Holocene high stands of sea-level, it has now been shown that many elevated reefs, formerly thought to be of post-glacial age, are in fact Last Interglacial. Veeh (1965, 1966), using uranium-series radiometric dating techniques, has shown that elevated fringing reefs at Mahé and Praslin in the Seychelles and at Gabriel Island, Mauritius, at 9, 6 and 2 metres respectively above present sea-level, have ages of 140, 140 and 160 thousand years. Dates of low elevated reefs from Hawaii, the Tuamotus, the Cook Islands, and western Australia (all reported by Veeh 1965), and from Florida and the Bahamas (Osmond and others 1965; Broecker and Thurber 1965), are all greater than 80,000 years, and cluster round 130,000-150,000 years B.P. This suggests that many elevated reefs were formed during the Last Interglacial and have emerged subsequently, perhaps eustatically. This simple picture must be complicated locally by earth movement, but it provides a tentative time-framework into which the elevated Aldabra group of islands may fit. The freshness of the raised reefs at Aldabra itself suggests that the time-scale may be too long, and material has been collected for radiometric dating. There is

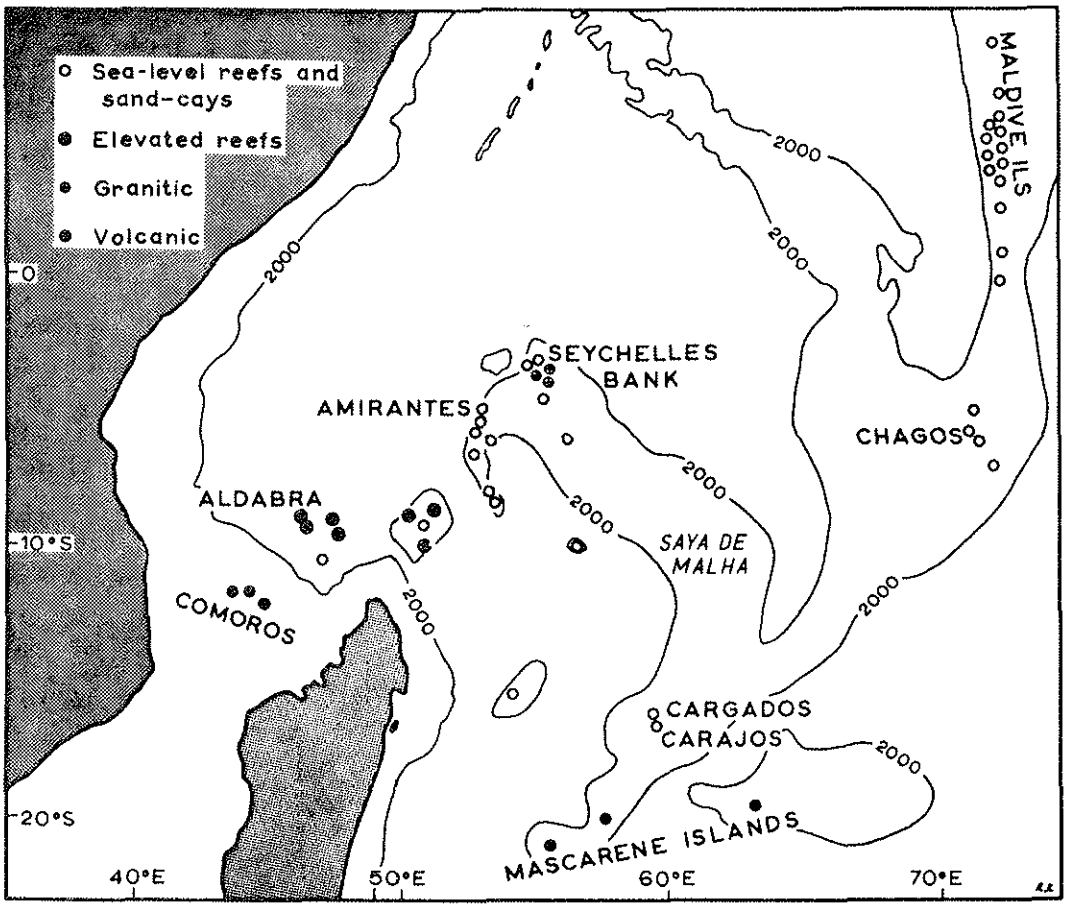

Figure 2.--Geology of Indian Ocean Islands

certainly no basis for Travis's statement (1959, 170) that the age of Aldabra is less than 3,500 years.

No climatic records are available for Aldabra, though a wartime station was established at Agalega, 450 miles to the east (Newnham 1945), and another has been established at Tromelin. The period May-November is that of the South-east Trades, and is dry; December-April, during the north-west monsoon, is a period of calms, oppressive weather, and rains. Estimates of total rainfall vary from 15 inches per annum (Vesey-FitzGerald 1942, 1) to 90 inches. Dupont in 1906-7 recorded 34 inches between October and January, with 25 inches during 17 days in January alone, when the wet season had just begun (Dupont 1907, 18). The mean annual total may thus be of the order of 50-60 inches. Mid-day temperatures are generally 85-90°F., and night temperatures may fall to 70°F. Aldabra lies to the northwest of the Indian Ocean belt of tropical cyclones, but it is occasionally affected. Perhaps the closest on record is that of February 1898, which passed over the atoll. Spurs (1892) mentions the defoliation and killing of vegetation during cyclones, and Fryer (1908-9) describes mangroves defoliated in 1907, but these must be rare events. Other cyclones have passed close by the atoll in recent years, but their effects have not been recorded.

2. GEOMORPHOLOGY AND GEOLOGY

Aldabra Atoll (Figure 3) is an elevated atoll, elongated east-west, with a maximum length of 21 miles and a maximum width of 9 miles. Its total area, bounded by the edge of the peripheral reef flat, is 141 square miles, and of this, land occupies 60 square miles. The land rim consists of four main islands (for a discussion of place names on Aldabra, see Section 7 of this paper: the asterisk attached to names in this paragraph indicates the name used in this report): South Island*, also known as Main Island and Grande Terre (42.5 sq. miles), Middle* or Malabar Island (10.2 sq. miles), Polymnie* (0.7 sq. miles), and West Island* or Ile Picard (3.6 sq. miles).

West Island and Polymnie are separated by Main Channel*, 1000 yards wide and carrying 10-12 fathoms at its entrance, and Middle and South Islands by the narrower East Channel* or Passe Houareau. Both of these channels are made dangerous for navigation by rapid tidal currents, and East Channel in particular is short and narrow. Main Channel branches dendritically lagoonward, and its branches maintain depths of up to 3-5 fathoms for 4 miles from its mouth. Johnny Channel*, between Polymnie and Middle Islands, unlike Main and East Channels, is a gap in the land rim rather than in the peripheral reef platform, which has been subsequently scoured out by tidal rips to a depth of 4 fathoms. West Channels* (Passe Lanier), between West and South Islands, are shallow gaps of recent origin eroded through a narrow sector of the land rim; they do not transect the reef platform. Of the West Channels, several of the individual passes between the small residual islands are named (Passes Femme*, Dubois*, Magnan*, Grabeau*); Passe Dubois is the deepest and is navigable by small craft and pirogues at high water.

In addition to the main rim islands, there are numbers of smaller islands within the lagoon, mostly close to the land rim and often connected to it at low water. These lagoon islands are concentrated along the south shore of Middle Island and along the eastern lagoon shore of South Island. Within the lagoon itself there are only two large islands: Ile Esprit* or Euphrates Island (0.13 sq. miles), with its tiny adjacent Ile Sylvestre* in the west, and Ile Michel* or Coconut Island, 0.16 sq. miles, in the east. The lagoon itself is shallow, and navigability depends entirely on the state of the tide. This has a maximum range of approximately 11 feet and is semi-diurnal: at low water springs, much of the eastern part of the lagoon, together with a fringe along its southern side, dries out, exposing mud flats and sandbanks; over the rest, Admiralty Chart 718 plots soundings of not more than 1 fathom in the inter-distributary areas of inner Main Channel. Because of the large area of the lagoon and the small and restricted entrances, there is a considerable lag in tidal behaviour within the lagoon compared with outside it: at springs the tide is still flooding in the Bras Takamaka* when it has begun to ebb outside.

1. Coastal Morphology

(a) Seaward side

The land rim is surrounded on its seaward side by an intertidal or slightly subtidal platform, which is narrowest (down to 100 yards) on the east or windward side, averages 200-300 yards in width along the north and south coasts,

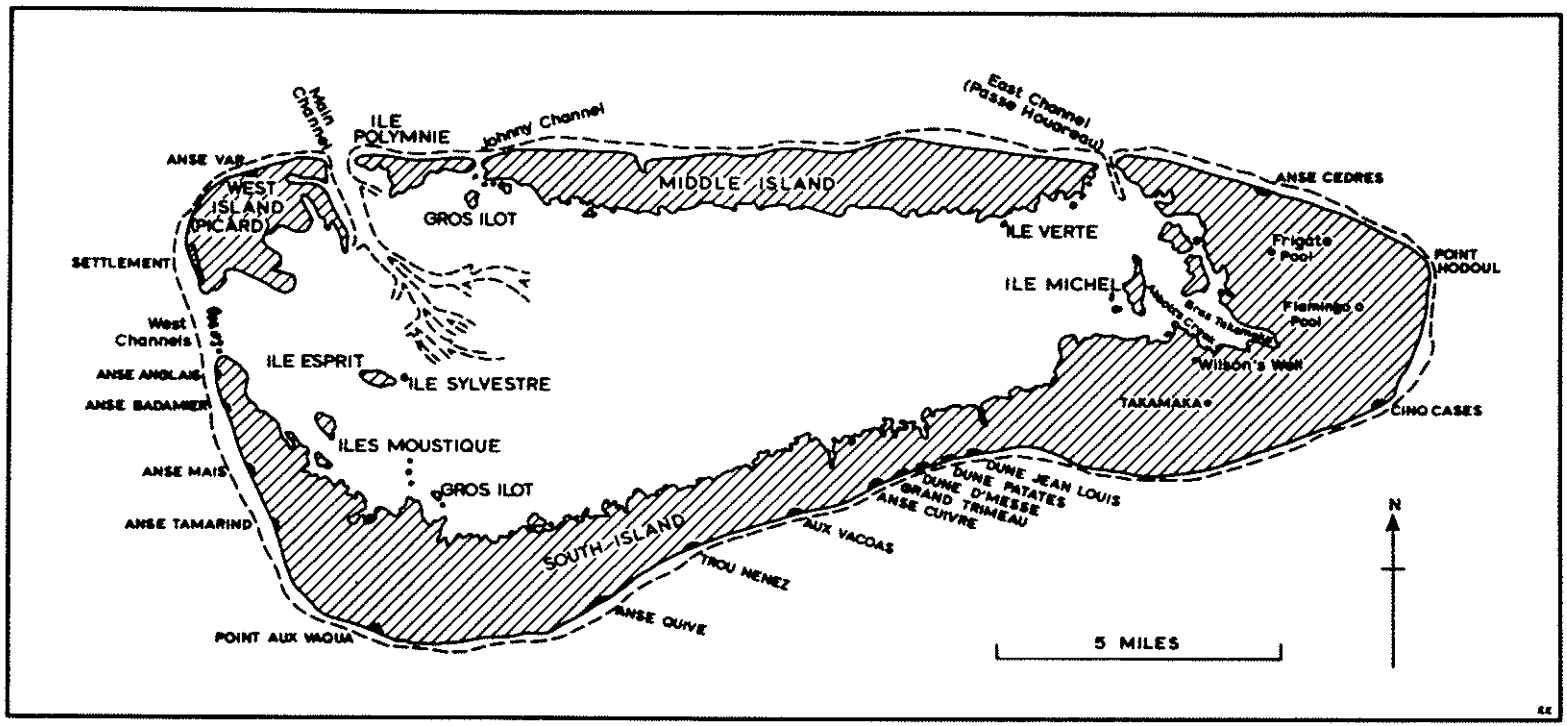

Figure 3.--Aldabra Atoll

and reaches 500 yards on the sheltered west coast. According to Travis (1959, 163), the reef front falls gently from the edge of this platform to a depth of 70 feet, before falling steeply to great depths, and this upper slope is marked by furrows 2 feet wide and 1 foot deep. The upper seaward slope may thus be equivalent to the 10 fathom terrace identified on many other atolls. Depths greater than 100 fathoms are generally found within half a mile of the edge of the intertidal platform, except at the east end, off Point Hodoul, where a shelf of bare limestone and algae extends seawards for two or three miles with depths of 20-25 fathoms (Travis 1959, 163).

The intertidal platform itself is an erosional feature formed of planed reef-rock with a thin, discontinuous sand cover and mats of Cymodocea, and is not a primary reef flat formed by contemporary reef growth. The seaward edge is marked by an intermittent boulder zone on the windward side (Plate 3), but there is no algal ridge, in contrast to the reefs of the central Indian Ocean (Stoddart 1966, 17). Baker (1963, 110) has argued that the platform is a growth feature, since if it were erosional it would be widest in more exposed locations. This misconceives the erosional process, however, which is mainly solutional and biological, rather than abrasional, and hence not so directly dependent on wave energy. His second point, that it must be a growth feature because it continues into the channel entrances, does not follow. The planed-rock surface cannot be a simple growth feature, nor could it form by reef growth at its present level, which dries at low water springs. No living corals were seen on the flat between East Channel and Anse Cèdres, nor at the seaward side of West Island. Fryer (1911, 413-414) suggested an erosional origin, and this is supported here. There is no information on reef growth on the seaward slope, though reef-blocks and cobbles suggest that Heliopora is important.

The inner margin of the intertidal flat or platform is generally formed by low retreating limestone cliffs in which corals are exposed. The cliffs rise to 15 feet above the platform in the east of the atoll, and to slightly lower in the west. Two distinct cliff morphologies may be recognised, the exposed type and the medium-energy type:

(i) Exposed Type

Locality: seaward coast from Takamaka to Point Hodoul. Here the cliff form is indistinct and ramp-like, rising at a high angle from a narrow basal intertidal platform with rimmed pools (Plate 1). The main peripheral reef platform appears to be at a lower level here than elsewhere, and surge breaks over the rimmed-pool platform, which is less than 3 yards wide and is coloured reddish-brown with algae. The upper part of the cliff-ramp is deeply and intricately dissected by salt-spray solution holes. There are no beaches. This type is homologous with several exposed shore profiles under study on elevated reefs of the southwest Pacific.

(ii) Medium-energy Type

Locality: Point Hodoul to East Channel, and the north coast of Middle Island. Here sea conditions are less extreme, and the dominant process is solutional: the cliff is vertical, deeply undercut by an intertidal solution notch, and the intertidal rimmed-pool platform is absent (Plate 2). The

notch has an amplitude at its mouth of not less than six feet; and the deepest notches extend back under the cliff for up to 30 feet. Small sand and cobble beaches may form within these deep notches, and are characteristically blue-coloured from their Heliopora content. Water constantly drips from the notch roof, where deposition may be taking place. Above the notch the cliff face rises vertically for 6-9 feet, and at the curve-over to the land surface it is intricately dissected by salt-spray solution cups. Occasional blowholes connect the land surface with the deeper notches. While the notch-forming process is clearly chemical and biological rather than mechanical, and analogous to that described from the Red Sea by Macfadyen (1930) and Guilcher (1955), the undercutting frequently leads to failure and collapse of sections of the cliff face. In plan, the recession process forms micro-headlands and bays, but the outline is surprisingly regular and outliers and residuals are rare. Immediately at the base of the cliff, between the notch and the intertidal platform, there is often a linear depression which may be up to 2 feet lower than the platform itself. This is probably partly excavated by mechanical action, and partly by increased solution associated with turbulence, at times of high water; at low water springs the notch is completely exposed, and at high water springs the sea reaches its upper lip.

Beaches are rare. In places, uneven cliff-retreat has formed small coves with "pocket beaches" (Plate 4), locally known as anses (the "lances" of Fryer 1911, 402). At Anse Cèdres (Plate 5) the beach is less than 100 yards long, with a 10^{0} slope, and a low-water width of 50 yards. Half the beach is lined with beachrock outcropping at high water level. Similar pocket beaches are reported on the south coast of Aux Vacoas, Trou Nenez and Anse Quive, but have not been visited: it is possible that at some of these locations the sand is so extensive that locally it covers the cliffs and joins the beach to the dunes above. At the east end of South Island, small perched beaches up to 3 feet in thickness are found on the cliff-top 15-20 yards inland from the edge (Plate 4). These are clearly storm deposits with much Halimeda. On the leeward side of the atoll, beaches are more extensive, as at Anse Mais, Anse Badamier, and Anse Anglais; and along the southernmost mile of the seaward coast of West Island beach deposits almost completely blanket the underlying raised reefrock (Plate 38). At the settlement itself the beach rises to a height of 15 feet above the intertidal platform, and has basal beachrock several hundred yards long and several yards wide.

Dunes are developed along much of the south coast of South Island, from Point Hodoul westwards. Between Point Hodoul and Takamaka the dunes are narrow and low, only locally exceeding 6 feet in thickness (Plates 6-8); further west, at Grand Trimeau, Dune d'Messe, Dune Patates and Dune Jean Louis, isolated dunes rise to heights of 50 feet above sea level, and are visible from the lagoon. Small dunes up to 13 feet high are also found at the south end of West Island (Plate 9).

(b) Lagoon side

The lagoon shores are formed either of undercut reef limestone or by mangrove communities; the latter are discussed in Section 3(3). The undercut cliffs

of the lagoon shore differ from seaward medium-energy cliffs mainly in their lower total height. The vertical amplitude of the solution notch is approximately the same (6-8 feet), but the vertical cliff above is rarely more than 1.5 feet and in many cases it is so low that it is overtopped by the sea at highest high water. The deep undercutting of the cliffs is striking (Plate 10). The width of the basal erosion platform formed by cliff recession is variable, but may reach 50 yards; it is generally a bare rock platform, with solution grooves normal to the shore, occasional residuals (which because of the calmer waters, especially at the east end of the lagoon, may be of most delicate form), and small patchy beaches at its landward margin. Active recession has isolated many stacks (Plate 11), of which the larger ones are vegetated. Several of these have surface dimensions several times as large as the pillar on which they rest, and it is to these that the term "champignon" (mushroom rock) originally referred. Undercut islands are well seen in both Main and East Channels, along the north shore of South Island, and particularly in West Channels, where the land rim has fragmented to form a series of small islands. Though both Wharton (1878) and Fryer (1911) argued that much of the lagoon cliff recession was caused by the mechanical and chemical action of mangrove roots, it is more likely that the undercuts are formed by a combination of physicochemical and biogenic (algal and molluscan) activities. Fryer, however, is clearly correct when he states that the lagoon is actively enlarging at the expense of the land.

Much of the lagoon floor is covered with a thin layer of calcium carbonate mud, overlying an irregular rock floor. Shoals of calcium carbonate sand are exposed during low tides. Living corals are confined to the neighbourhood of West and East Channels, but are scarce elsewhere. Air photographs indicate a watershed between the Main and East Channels, as shown by bottom sediment patterns, 4-5 miles west of the latter.

2. Surface Morphology

(a) General features

The main features of the surface geomorphology of Aldabra have been described by Fryer (1911, 401-405), when the local terms "champignon" and "platin" entered the reef literature. The distinction between the two tends to oversimplify the morphological variations. It is clear that two distinct sets of factors, lithology and process, have influenced the development of the present landforms. Champignon is used for deeply pitted and irregular solution-fretted reefrock, and platin for smooth surfaced, pavement-like cemented limestones. Champignon (Figure 4) occupies the greater part of West, Polymnie and Middle Islands, together with most of South Island from West Channels to 1.5 miles east of Dune Jean Louis. It forms a zone several hundred yards wide round the eastern end of South Island, and near East Channel occupies the whole width of the island. Platin, apart from small areas near the settlement on West Island, occupies the greater part of the eastern end of South Island, from Takamaka towards East Channel. It covers a total area of 14 square miles, 28 per cent of the dry land area (excluding mangrove), or one quarter of the total land area. Champignon forms the higher parts of the atoll rim, generally rising to 10-15 feet above

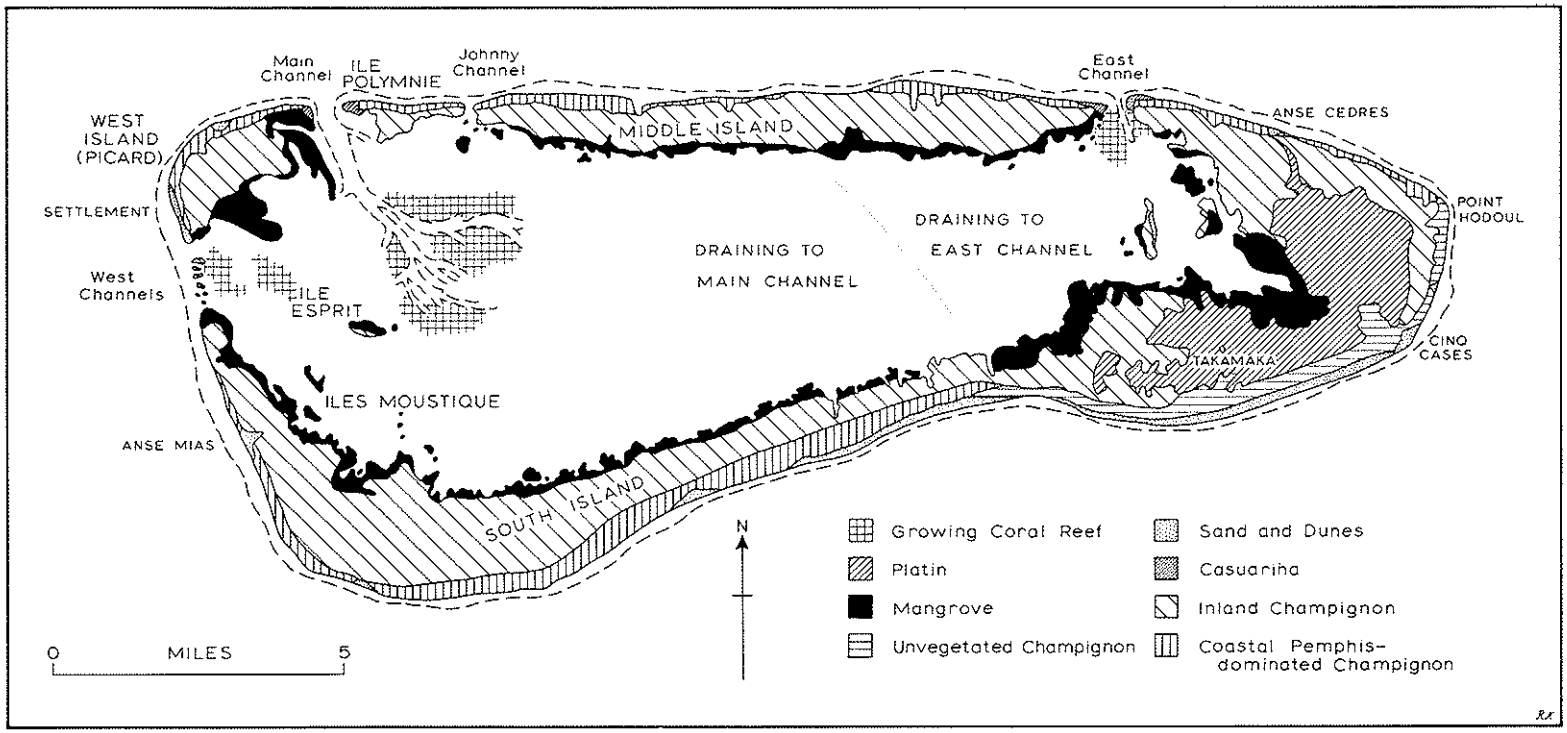

FIG 4 MAJOR HABITATS OF ALDABRA ATOLL

Figure 4.--Major Habitats of Aldabra Atoll

mean sea level; the platin is lower, and ranges from approximately 3-10 feet above mean sea level.

(b) Surface solution features

The nature of champignon dissection varies considerably in scale and origin, though no descriptive terminology exists for the resulting forms. The largest erosional features are tidal solution holes excavated to intertidal levels, tens or occasionally hundreds of yards in extent, and which are clearly expanding by solutional recession and undercutting of the marginal cliffs, exactly as on protected lagoon shores. These holes may dry completely at low water, but flood rapidly on the rising tide. They are normally close to the sea or the lagoon, but we have no information on tidal lag. The mollusc fauna is marine, and the floors of the holes are covered with soft sediment. Good examples were seen south-east of the West Island settlement at Basin Cabris, and west of Point Hodoul. In the latter (Plate 21), several small residuals have been isolated in the middle of the hole by the rapid recession of the margins.

Normal champignon sinkholes are on a smaller scale. They are vertical clefts, often in the centre of wider surface depressions, and in many cases become wider with depth. Their mouths are usually less than 15 feet wide, and their depth appears to be a function of the height of the land surface above sea level. The deepest seen on South Island, in areas of high champignon perhaps 15 feet above sea level, were 12-15 feet deep. Though it was the dry season, most had standing water, with a brackish-water molluscan fauna. The dry sinkholes have a bottom full of yellow-brown silt and clayey sediment. There is no evidence of the solutional undercutting characteristic of marine tidal solution, but the walls are vertically furrowed by freshwater solution.

The third level of dissection in champignon is that of pinnacle and pothole[1] formation on the surface, which gives champignon its distinctiveness. The most extreme and intricate pinnacle formation is found in the salt-spray zone on top of seaward cliffs, where holes and pinnacles are angled slightly seawards. The bottoms of the holes are round in plan, and flat, and at lower levels contain salt water. They are similar to salt-spray solution features described, for example, from Puerto Rico by Kaye (1959), and seen on many of the Solomon Islands, particularly on New Georgia. Away from the salt-spray zone, in areas where surface solution is by fresh water, the dissection is less extreme. In the most dissected salt-spray champignon the holes and pinnacles may have a vertical amplitude of more than 1 foot, with comparable diameters; in the freshwater zone this is infrequent, and the surface dissection grades towards a broken scoriaceous or honeycomb character. Champignon is generally devoid of surface soil, except for thin sandy deposits on the floors of some potholes (Plate 13).

Solutional processes on platin operate on two levels. Though gradients are gentle, the platin has a local relief of up to 6 feet, and the surface consists of many local surface-drainage basins centred on solution pans. Many of these

[1] The term 'pothole' is usually used for mechanically-scoured features formed by fluvial action (Baulig 1956, 106); the term as used here is synonymous with 'solution cup' and is used descriptively (Baulig 1956, 61-62).

dry out during the dry season (Plate 27), and even the largest are considerably reduced in size (Plate 24). Flamingo Pool, the largest, has a dry season diameter of about 200 yards. All are freshwater, as shown by their molluscan and crustacean microfauna; and it is clear that during the wet season these pools expand, some perhaps coalesce, and large areas of platin are covered by up to 2 feet of water. This is demonstrated by the solutional undercutting of limestone residuals between the pools, and by the distribution of shells of the freshwater mollusc Bulinus, found 1.5-2 feet above the general platin surface, lodged on limestone residuals. The gross topography of surface dimpling associated with these pools is probably solutional, though solution may be a discontinuous process. Several pools, during the dry season, are surrounded by ramps of mammillate limestone, samples of which show depositional layering. Clearly solution during the rains is followed by marginal deposition as pools dry out. Most of the surface drainage is local and unintegrated; only near Cinq Cases is there any sign of a short, semi-permanent drainage line leading to a central sink (Plate 23), though such features may be more widespread during the wet season.

The second platin solution process is small-scale and local. In areas of flat surface, lacking drainage systems, rainwater may stand for days after falling. By processes not yet studied, these rainwater pools are able to etch the limestone surface by solution, and gradually become incised, and bounded by cliffets showing pronounced basal solution-notching (Plate 16). Most of these incised pools are not more than 6 inches deep, though the deepest was more than 1 foot, and most are a few yards in maximum dimension. The floors are absolutely smooth, thinly-coated with a film of cream-coloured sediment, and strongly contrasting with the rougher grey surface of the interpool areas. The striking flatness of the platin results partly from the final smoothing by this process of the dimpled surface formed by the main solution pans (Plate 15).

3. Origin of Aldabra Landforms

Fryer (1911, 405-407) distinguished three main rock-types at Aldabra: the peripheral elevated reef, exposed in the sea cliffs; the champignon rock, which he termed a metamorphosed limestone; and the platin, which he considered a detrital limestone. He noted the abundance of reef corals in the position of growth in the sea cliffs, and deduced that these constituted an uplifted atoll reef. He drew attention to the freshness of many of the corals: on the surface near the cliffs there are many beautifully preserved Tridacna shells in the position of growth, with open valves, which, with the corals, suggests a relatively recent date for the emergence. The platin rock he considered to be a back-reef deposit, mainly of clastic sediments with molluscs and foraminifera, formed as a reef-flat deposit in the lee of the eastern reef and subsequently uplifted with it. The distinction between the elevated reefrock and the champignon rock was less clear, and Fryer considered the champignon rock to be a phosphatised reefrock. In Fryer's view, the morphology of Aldabra is the result of relatively minor solutional modification of a reef topography formed before the elevation of the atoll, and this interpretation superseded Voeltzkow's (1902a) thesis, influenced by Murray's theory of atoll formation, which laid stress on the uplift of a bank of deeper-water foraminifera coated by corals.

Fryer's interpretation neglects several geomorphic features which indicate a more complex history, as Fryer himself realised in his account of Ile Esprit (1911, 407-408). The platin surface of South Island is not simply a slightly modified depositional surface, but has undergone considerable vertical erosion. Following uplift of both platin and champignon, vertical solution holes are formed, and fine brown residual sediment is washed into them and ultimately lithifies. This brown pipe-limestone is much more resistant to solutional erosion than the surrounding white limestone, especially in the platin, and it weathers out to form stacks or pillars on retreating cliffy coasts, where it is morphologically identical with similar pipe-limestones studied in the British Solomon Islands. The pipe-limestones are also exposed by vertical erosion, and the flat surface of the platin is interrupted by massive irregular blocks of brown pipe-limestone 3-6 feet high, and in some cases 6-9 feet in diameter (Plates 18 and 19). The surfaces of the residuals are furrowed by solution lapies, and near the freshwater pools they may be solutionally undercut. With the open vegetation, the resemblance of the pillars to termite mounds gives the platin landscape a distinctly African savanna landscape appearance.

The residuals show that in spite of the flatness of the platin surface, the main platin surface is erosional, and the original surface must have been at least 6 feet higher and probably more. Over much of the platin, this would bring it closer to the level of theperipheral champignon. The residuals themselves must be distinguished from isolated patches of champignon within the platin area: these may stand up to 5 feet above the general platin surface, and have a typically scoriaceous surface. They are interpreted as patch reefs on the former reef flat, and demonstrate the original topography was itself irregular. Since the solution of these isolated champignon patches is purely by fresh water, their dissection is less extreme than on the coastal champignon.

The character of the platin surface is highly variable, with facies changes in the back-reef deposits. Generally the surface is strongly lithified, and weathering is taking place by spalling or exfoliation of large but thin slabs of rock, which ring musically when walked over (Plates 15 and 17). This process, which is more characteristic of igneous rocks, has also been observed at Rangiroa Atoll, Tuamotu Archipelago (Stoddart, in press), and in the northern Marshall Islands (F. R. Fosberg, personal communication), but the processes causing it are not fully understood. At another location on the platin, where the superficial deposits contained marine mollusca, it was found that these were weathering out of a loosely cemented coquina. It should ultimately be possible to map these facies zones in the back-reef area.

If the hypothesis of at least six feet of vertical downwearing is accepted, certain difficulties remain. The flatness of the platin surface and its level above mean sea-level are problems. It is also implied that in the past solutional downwearing has proceeded rapidly on platin, though at present these processes are slow, and in places deposition is taking place; whereas on the champignon, which is the area of deepest and most intricate dissection, it is argued that least downwearing has occurred. Complete explanation of these anomalies is not yet possible. In the case of the platin, we need to know the relationship between its near-equilibrium surface and tidal levels. In the case of the champignon, it is known that fresh rock exposures are less resistant than older ones, and it may be suggested that the most intricate dissection of champignon takes place

rapidly after exposure, and that case-hardening then decreases the rate of solution and protects the surface.

Fryer himself emphasised the anomalous character of Ile Esprit, in the lagoon. Here a complex topography of pinnacles and depressions with a vertical relief of up to 18 feet resembles in miniature a tropical Kegelkarst (Plate 14). The central part of the island is formed by a relatively undissected ridge rising to more than 30 feet. The island is composed of shelly limestone overlain by cemented limesands, with vitreous brown cavity fills. Fryer interpreted the whole as a lithified homologue of the soft sediments in the large tidal solution basin on West Island, the implication being that the reefrock surrounding these pan sediments, to a height equal to at least that of the highest part of the island (30 feet), has been eroded away. Comparison of the shell limestone and limesands, with the vitreous cavity fill, which Baker (1963, 109) found to have a phosphate content of 35-40 per cent, and the normal pipe-limestone of other parts of the atoll does not convince that they have a similar origin. The height of the Esprit ridge, approximately 15 feet higher than any other solid rock on the atoll, requires explanation. It is possible that the original uplift of the atoll was not less than 30 feet, and that Esprit is the last remnant of a widespread lagoon fill; but in this case the horizontal bevelling of the marginal cliff tops at about 15 feet presents an additional problem.

While in detail the morphology of the raised reefs is complex, therefore, and their history incompletely known, the two major controls are seen to be lithology and type of solution. The elevated coral limestones, with their coarse honeycombed structure and high permeability, lend themselves to deep and intricate dissection and the formation of sinkholes which may coalesce to form larger features. The fact that champignon dissection is most extreme near the sea indicates that salt spray is a powerful agent of solution. In the finer-grained, less permeable, back-reef deposits forming the platin, the original honeycomb structure is absent, and the solutional depressions formed by fresh water are broad, shallow features. Where patch reefs formerly existed on the platin, however, a modified form of champignon surface is formed, with freshwater solution giving a scoriaceous surface rather than deep honeycombing.

The land area is actively decreasing, by retreat of both the seaward and lagoon cliffs, forming wider seaward intertidal platforms and a larger lagoon. By measuring the rate of solution retreat of the cliffs, it should be possible to calculate the rate of formation of the seaward intertidal platform. Assuming (a) a mean width of 200 yards for the platform, and (b) a period of 5,000 years since sea-level reached its present level in the Holocene, suggests a rate of seaward cliff retreat of 1 yard in 25 years, if the platform is formed by cliff retreat wholly in the Post-glacial. This rate is probably excessive in view of the measured rates of notch formation, averaging 1 mm per annum, in other parts of the world: Aldabra would form an excellent location for field studies of limestone solution rates.

3. FLORA AND VEGETATION

The first botanical collecting at Aldabra was that of Abbott in 1892 (Baker 1894). Voeltzkow's collections made in 1895 were studied by Schinz (1897; also Voeltzkow 1902b). Further collections were made and reported by Dupont

(1907, 34-41, and later), by which time at least 100 species of flowering plants had been recorded. Fryer's account (1911, 414-416) includes the first detailed ecological notes, and his collections, together with those of W. Fox, who visited Aldabra in 1916, were worked up, with all the earlier material, in W. B. Hemsley's "Flora of Aldabra" (1919; also Hemsley 1916, 1917), which remains the standard reference. Christensen (1912) noted a single pteridophyte; and Vesey-FitzGerald (1942) added useful ecological notes on the vegetation. A further collection of 55 numbers, including 45 species, was made in 1966 and has been identified at Kew.

The flora is thus relatively well known. Hemsley's flora contains 173 species of flowering plants recorded from Aldabra, together with a number of common atoll species recorded from nearby islands, which might also be expected to occur at Aldabra, but which had not then been collected there; a few additional records were obtained in 1966. Of this total he considered 68 to be indigenous, in the sense of not being artificially introduced by man; and this compares with figures for the indigenous floras of the Chagos Archipelago of 49 species and the Maldive Islands of 87 species. Of the 68 species, Hemsely considered 18 to be endemic to Aldabra itself (forming about 10 per cent of the total flora), and 13 to be confined to the Aldabra group (Assumption, Cosmoledo, Astove, St Pierre, Gloriosa). Of the rest, 18 species are Madagascan, and 11 are East African; and the flora is thus clearly related to that of the nearby continental areas. Table 2 lists the strict endemics and Table 3 the group endemics recorded by Hemsely (1919); no attempt has been made to revise nomenclature.

Table 2. Endemic species in the Aldabra flora

Capparidaceae
- Maerua dupontii Hemsl.

Tiliaceae
- Grewia aldabrensis Baker
- Grewia salicifolia Schinz

Erythroxylaceae
- Erythroxylon acranthum Hemsl.

Ochnaceae
- Ochna fryeri Hemsl.

Leguminosae - Papilionatae
- Tephrosia aldabrensis J. R. Drum. and Hemsl.

Leguminosae - Caesalpinioideae
- Cassia aldabrensis Hemsl.

Leguminosae - Mimosoideae
- Pithecelobium ambiguum Hemsl.

Rubiaceae
- Oldenlandia sp. n. ? Hemsl.
- Tricalysia cuneifolia Baker
- Pavetta supra-axillaris Hemsl.

Compositae
- Vernonia aldabrensis Hemsl.

Plumbaginaceae
- Plumbago parvifolia Hemsl.

Oleaceae
- Jasminum aldabrense Hemsl.

Amarantaceae
- Apterantha oligomeroides C. H. Wright

Loranthaceae
- Loranthus aldabrensis Turrill

Euphorbiaceae
- Phyllanthus cheloniphorbe Hutch.
- Acalypha fryeri Hutch.

Table 3. Group endemics in the Aldabra flora

Capparidaceae
Cleome strigosa Oliv.

Icacinaceae
Apodytes mauritiana Planch.

Plumbaginaceae
Plumbago aphylla Bojer

Asclepiadaceae
Secamone fryeri Hemsl.

Solanaceae
Solanum aldabrense C. H. Wright

Acanthaceae
Hypoestes aldabrensis Baker

Verbenaceae
Nesogenes dupontii Hemsl.
Clerodendron minutiflorum Baker

Euphorbiaceae
Euphorbia abbottii Baker
Acalypha claoxyloides Hutch.

Moraceae
Ficus aldabrensis Baker

Dioscoreaceae
Dioscorea nesiotis Hemsl.

Liliaceae
Asparagus umbellulatus Sieber

Less is known, however, of the distribution and ecology of the vegetation, apart from the broad outlines sketched by Fryer (1911), followed by Hemsley (1919), and amplified by Vesey-FitzGerald (1942). Vesey-FitzGerald distinguishes four vegetation types:

1. Mixed scrub (Fryer's open bush);
2. *Pemphis* thicket (Fryer's *Pemphis* bush);
3. Mangrove communities; and
4. Psammophilous associations (Fryer's shore zone);

to which a further category may be added,

5. Man-induced vegetation.

These vegetation types are closely associated with the morphological zones defined in Section 2(2). Mixed Scrub is found on platin, *Pemphis* thicket on champignon, psammophilous associations on beaches, dunes and coastal cliffs, and the mangrove communities on the lagoon margins. The species-composition of each type is known only imperfectly, however, and there is little information on internal variation within the types. Analysis is made more difficult by the lack of activity during the dry season, when many trees in the Mixed Scrub lose their leaves, and few plants are in flower anywhere on the atoll. This was the situation during the 1966 expedition. By contrast, flowering is reported to be rapid and widespread at the onset of the rainy season, in January, when more collecting needs to be done.

1. Mixed Scrub

The Mixed Scrub is especially variable, both in floristic composition and in density. At the east end of South Island, the scrub is most dense on isolated patches of scoriaceous champignon, and more open on the platin, particularly near the freshwater pools (Plates 15-18). A number of species, including Euphorbia abbottii and Thespesia populnea, appear to vary in frequency in different areas, but the most conspicuous segregation is that of the screwpine, Pandanus vandermeeschii, at pool margins (Plate 24). Though most of the trees in the Mixed Scrub are slender and shrublike, and less than 15 feet tall, the denser scrub is very difficult to penetrate and is devoid of directional indicators: when it is possible to climb a low tree, the pandans are excellent indicators of the location of freshwater pools. In terms of normal atoll floras, it is the Mixed Scrub which has the most unusual and African aspect, and many expected atoll species are absent, or, as in the case of the leafless vine Cassytha filiformis, rare. Taller trees are found only occasionally, and the massive Ficus and Calophyllum at the Takamaka pool are best known (Plate 22). On the more open platin the orange-tinged sedge Fimbristylis spathacea forms an irregular tortoise-cropped turf (Plate 16), with small brittle rosettes of Eragrostis sp. on bare rock in between. In addition to the sedges, the tortoises also crop the lower leaves of shrubs up to a maximum height of about 4 feet. Other grasses and sedges growing beneath the trees include Eragrostis riparia, Cyperus obtusiflorus, Kyllinga nemoralis, and Fimbristylis ferruginea.

Floristically the area of Mixed Scrub on West Island is similar to that on South Island, though probably with more introductions from the settlement. Plumbago aphylla and the vine Abrus precatorius, with its distinctive black and red seeds, were collected here in 1966, and leafless Euphorbia abbottii trees were common.

Acrostichum aureum, the only recorded fern, is widespread in the deeper clefts and sinkholes on South Island (Plate 23), both in the Mixed Scrub and in Pemphis thicket.

It is likely that when the Mixed Scrub is better known it will be considerably subdivided, and differentiated in terms of substrate and location.

2. Pemphis Thicket

Pemphis Thicket is named after its dominant, Pemphis acidula, a species widespread on uplifted reefs in the Indo-Pacific, but here extraordinarily luxuriant (though absent in the Seychelles). The thicket has a maximum height of about 15 feet, and though the trunks and branches of the Pemphis are slender they are extremely tough and grow in such profusion that penetration is difficult. Because of its association with the soil-less champignon, Pemphis Thicket occurs to seaward of the Mixed Scrub on South Island, and to a lesser extent along the lagoon shore. It covers most of the exposed rock areas of the other main islands, except for an area of Mixed Scrub at the south end of West Island, and clumps of Pemphis are found even on minute reefrock islets in the lagoon. On the northern side of the atoll, Pemphis is normally the first shrub met with at the cliff-top (Plate 2), and largely replaces the Scaevola-Tournefortia zone normally found in sandier habitats. Inland its dominance is reduced,

and Pemphis is found with many of the Mixed Scrub species, forming a thicket that is much denser than the Mixed Scrub itself, and in places a woodland in which Pemphis itself is rare. Mystroxylon aethiopicum and Ficus sp. are common in such areas on South Island, and Dracaena reflexa was collected in dense mixed Pemphis thicket on West Island near Main Channel. In these transitional areas, Pemphis is most dense round the margins of the larger sinkholes, where it may be almost impenetrable, except with extreme labour. Smaller flowering plants in potholes include the thorny Capparis galatea, with a conspicuous white flower, and wisps of Oldenlandia sp. Most of the rock surface beneath the shrubs is bare, with sparse and scattered clumps of Mariscus ligularis and Eragrostis riparia.

The flatness of the ground combines with the uniform height (10-15 feet) of the vegetation to make travelling except with a compass very difficult; and Wharton (1883, 77) gives a graphic account of the difficulty of traversing Pemphis-covered champignon when he states that "a walk in Aldabra is the most aggravating and slowest piece of locomotion I have ever engaged in: and nothing short of the patience, perseverance, and general disregard of time of the tortoise tribe can make it an agreeable residence. Some of my Negro sailors were sent into the bush to hunt for tortoises, and after three days' search brought back one . . .; but they returned nearly as guiltless of artificial clothing as their captive."

3. Mangrove Communities

The mangrove communities have been discussed by Fryer and Vesey-FitzGerald. Both agree on the zonation of the genera: Bruguiera and Ceriops at the head of creeks; Rhizophora (R. mucronata) on deeper mud in the creeks themselves; Avicennia (A. marina) on open lagoon flats subject to tidal flooding; and Lumnitzera in isolated inland depressions. It has been argued (Wharton 1883; Fryer 1911, 403, 409) that the lagoon mangroves are instrumental in eroding the lagoon margins, both by the mechanical effects of root growth in crevices, and by the chemical activity of mangrove mud. It can, however, be seen that the undercut lagoon margins and creek systems are morphologically similar whether mangroves are present or absent. Wherever mangroves were seen growing in intimate association with eroding cliff forms, there was no evidence of mechanical activity; rather the trees appeared to be growing in pre-existing holes. Fine carbonate sediment is certainly being formed, however, and the processes need examination. The main mangrove area surrounds the Bras Takamaka, at the southeast end of the lagoon, where it totals more than 3 sq. miles. Large areas also exist on West Island (0.6 sq. miles), and at the west end of South Island, opposite Iles Moustique (1 sq. mile). Many of the small lagoon islands have areas of mangrove. The mangroves seen in Bras Takamaka are low and open. Taller trees, up to 40 feet high, were seen on the lagoon side of Middle Island, where the mangroves perch precariously on the edges of limestone islands intersected by deep tidal channels. Tall mature mangroves were described on West Island by Dupont (1907), but there was no opportunity to see these in 1966. Half a century of exploitation for timber and bark must have severely modified the mangroves of West and nearby South Island, but no investigation could be made of this in 1966. Further damage is caused from time

to time by cyclones, and defoliation is described by Fryer (1908-9). The mangroves play an important part in the ecology of sea and shore birds at Aldabra.

4. Psammophilous Communities

Fryer's Shore Zone Vegetation, in which most of the plants are common pantropical or Indo-Pacific strand species, may be further subdivided in terms of habitat. Vesey-FitzGerald (1942) distinguishes a spray-zone community, dune scrub, and a herb-mat community. The spray-zone community itself varies with aspect. On the windward side of the atoll, from Takamaka to Point Hodoul, a narrow belt of blown sand at the cliff top is succeeded inland by a zone several hundred yards wide of bare rugged champignon. At the seaward edge of the Mixed Scrub community, most of the larger shrubs and trees are gnarled and dead, leaning away from the wind (Plate 20), and even Acrostichum, the leather fern, nestling in crevices, is shrivelled and brown. The living vegetation in this maximum exposure area consists of dwarf flowering plants (Sida parviflora, Portulaca quadrifida, Evolvulus alsinoides, Hypoestes sp., Lagrezia madagascariensis, Oldenlandia sieberi) and sedges and grasses (Eragrostis sp., Dactyloctenium pilosum) sheltered from the wind in potholes and crevices, with thorn bushes such as Solanum aldabrense and Capparis galatea in the larger holes. Many of the common strand species, such as Tournefortia, Scaevola, Suriana and Ipomoea are absent from this habitat.

In more protected conditions, from Point Hodoul towards Anse Cedres, the Mixed Scrub and Pemphis communities approach within 30 yards of the cliff-top, and form a hedge of Pandanus with occasional clumps of Scaevola sericea (Plate 1). The zone between the Pandanus and the cliff edge, intermittently carpeted with sand, is colonised by a sparse community of coarse tussock grass (Sclerodactylon microstachyum) with scattered low Scaevola and occasional Tournefortia. From Anse Cèdres westwards, the vegetation approaches within a few feet of the cliff edge and is dominated by Pemphis, with occasional Guettarda speciosa, Scaevola sericea and Tournefortia argentea; a distinct spray-zone community can hardly be said to exist.

No observations have been made on the south and west coasts of South Island. Most of the coast is presumably covered with dune scrub, with tall Sclerodactylon macrostachyum, low carpets of a Paspalum-like grass, and Scaevola and dwarf Guettarda, according to Vesey-FitzGerald (1942). A modified dune scrub is also found at the south end of West Island (Plate 9), where it is interesting that some of the dwarf flowering plants, such as Sida parviflora, are the same as those inhabiting potholes in the most exposed spray zone of the windward coast. Tall shrubs on these dunes include Azima tetracantha and Acalypha claoxyloides, together with the grasses Dactyloctenium pilosum, D. aegyptium, and Eragrostis riparia, the attractive blue-flowered Cleome strigosa, and Scaevola. Low fresh sand spits below the dunes are being colonised by the sedge Cyperus maritimus and seedlings of Scaevola and Tournefortia (Plate 12). The low dunes between Takamaka and Point Hodoul are occupied only by a turf formed by a Paspalum-like grass, and bunch-grasses (Plates 6, 7 and 8).

Vesey-FitzGerald adds a third community, the herb-mat community, found in the western Indian Ocean islands particularly beneath dense bird colonies, but this does not seem to have an Aldabra counterpart.

5. Man-induced Vegetation

To the vegetation types distinguished by Fryer and Vesey-FitzGerald is added the category of man-induced vegetation. In addition to the 173 species listed in his flora, Hemsley (1919) refers to a number of introduced economic species reported from Aldabra, including

Amaranthus tristis
Amaranthus gangeticus
Brassica nigra
Carica papaya
Gossypium barbadense
Ocimum canum
Ricinus communis
Lochnera rosea
Cocos nucifera.

Further species were added to this list in 1966.

Man-induced vegetation is of three main types: coconut plantation, Casuarina thicket and woodland, and village vegetation. Coconuts are only found in small clumps at the settlement on West Island (Plates 38 and 39); intermingled with other species to form a coconut thicket on Ile Michel; and reportedly also at some of the pocket beaches at the west end of South Island (e.g. Anse Mais). Clumps of tall Casuarina are found at Anse Cèdres (Plate 37), on both sides of East Channel, at Ile Michel, and on both sides of Main Channel, as well as at the settlement on West Island (Plate 40). They vary from open woodland with no undergrowth to dense thickets of broken trunks and saplings, though much of this damage observed in 1966 had resulted from a recent cyclone. Needles carpet the ground, obscuring the irregularities of the champignon and in places making walking dangerous, and apart from rare Scaevola and Tournefortia seedlings there is no ground vegetation. At the landward margin there is some invasion by tall spindly Scaevola and other plants, and the red flowers of the aloe-like Lomatophyllum borbonicum are in places conspicuous.

The introduction of coconuts and the spread of Casuarina date from the end of the nineteenth century. H.M.S. Fawn planted fifty coconuts at Ile Michel in 1878, together with Casuarina (Findlay 1882, 550). Active planting of coconuts by lessees began about 1880, and for some time was made a condition of the lease. Dupont in 1906 found about 1000 coconuts at the West Island settlement up to 25 years old, and the small pocket beaches at the west end of South Island were also planted at this time (Dupont 1907, 21). It is likely that the main Casuarina groves, however, already existed at the time of the Fawn survey. It is said that James Spurs, when lessee, went so far as to dynamite holes in the champignon in which to plant nuts, in his efforts to establish thriving coconut plantations (Anon. 1920).

Village vegetation includes cultivated plants, such as cotton and sisal, and cultivated trees, together with common pantropic weeds and cultivated decorative plants. Agave and Gossypium grow in the settlement itself, with thickets of Caesalpinia bonduc and taller trees of Moringa pterygosperma. Fruitbats were

seen in 1966 apparently feeding on the flower buds of Agave during the day time. There are also early reports of the cultivation of maize and tobacco. The common weed Stachytarpheta indica is found only at the West Island settlement, and near the abandoned fishing hut on the west side of East Channel. The most common decorative flowering plant, planted round most of the houses in the settlement, is Catharanthus rosea, in both white and pink varieties. Clearly human settlements are acting as foci for the introduction of alien species, though these have not yet made much progress against the native vegetation and are still sharply circumscribed.

The role of man and animals in controlling native vegetation needs study. Man has harvested mangrove for timber and bark since the 1880s (Dupont 1907, 23-24), but on a small scale. Tortoises and goats crop the lower vegetation, including grasses, sedges, and the lower leaves of trees and shrubs, particularly in the more open Mixed Scrub. Birds must have a considerable direct effect on leaves and branches, and an indirect effect on soils and the phosphorus cycle, particularly in the large Middle Island breeding colonies, and this too needs further study.

4. TERRESTRIAL FAUNA

In common with most island faunas, that of Aldabra is notably disharmonic, with many groups unrepresented, and with a degree of probable endemism in those which are; and it is notable for the survival there of forms unsuited to competition with introduced species, in which class the land tortoise is the outstanding example. It is difficult to discuss the biogeography of the land fauna at the present time: in many groups the taxonomy itself has been inadequately worked out; many groups at Aldabra have been collected only casually or not at all; and for those which are better known, particularly the insects and the land birds, so little work has been done in neighbouring areas that the biogeographic relationships and degree of endemism are uncertain.

1. Mammals

Mammals are represented in the native land fauna only by fruit-eating and insectivorous bats, which are also found in both the Seychelles and the Mascarene Islands. The fruit bat was collected by Abbott in 1892, and was described as an endemic species, Pteropus aldabrensis, by True (1893). This beautiful animal was seen during the day in 1966 on the branches of large Ficus trees at Takamaka Pool, though Fryer (1911, 416) states that "it never forms large gatherings on a tree during the daytime." The insectivorous bats are more widely distributed. Fryer names them as Taphozous mauritianus and Triaenops furcula, and Miller (1902) names one as Nyctinomus pusillus. The insectivorous bats are seen at dusk at the West Island settlement, and in the Casuarina groves at East Channel, where a specimen taken in 1966 has been identified as Tadarida pumila (= Nyctinomus pusillus).

2. Birds

The land birds, of which there are sixteen known resident species, are most numerous in the Mixed Scrub on the platin, and in Casuarina and coconut groves.

Benson (1967) considers that only one, the Drongo Dicrurus aldabranus, is a full species endemic to Aldabra, but at the same time only two of the native Aldabra land birds cannot be distinguished from other members of the same species in nearby areas (the Grey Heron Ardea cinerea cinerea and the Barn Owl Tyto alba affinis). Endemic subspecies are the Sacred Ibis Threskiornis aethiopica abbotti, the rail Dryolimnas cuvieri aldabranus, the nightjar Caprimulgus madagascariensis aldabrensis, and the fody Foudia eminentissima aldabrana, the last of which commonly occurs at the West Island settlement and in Casuarina woodland elsewhere. Good subspecies found on Aldabra and also on nearby reef islands are the little Green Heron Butorides striatus crawfordi, the Madagascar Turtledove Streptopelia picturata coppingeri, and the Souimanga Sunbird Nectarinia sovimanga aldabrensis. Aldabra also has less distinct forms of the kestrel Falco newtoni aldabranus, the Comoro Blue Pigeon Alectroenas sganzini minor, the Madagascar Coucal Centropus toulou insularis, the Madagascar Bulbul Hypsipetes madagascariensis rostratus, and the Madagascar White-eye Zosterops maderaspatana aldabrensis. Benson finds the land avifauna to be mainly of Madagascan origin, and suggests colonisation either via the Comoros or via Gloriosa and the islands to the east of Aldabra. For detailed consideration of the native land birds, and also of recent arrivals such as the Pied Crow Corvus albus, see the accompanying papers by Benson (1967) and Gaymer (1967): three species only are considered further here, on account of their susceptibility to human interference.

The White-throated Rail Dryolimnas cuvieri aldabranus (Gunther 1879) is almost flightless. Rails, many of them flightless, are found on islands throughout the world, though many of the insular populations have recently become extinct following the introduction of predators and increased human activity. Thus the rails of Laysan and Wake Island in the Pacific have both recently become extinct. Fryer (1911, 418) reported that the Aldabra rail "is generally distributed over the atoll, though it is scarce on Picard (West Island), and has generally been exterminated in the neighbourhood of Takamaka by the cats". Abbott (1893, 762) feared that the rail would soon be exterminated, "as their arch enemy, the cat, has already exterminated them from Grande Terre (South Island), and must sooner or later reach the other small islands of the group, where the rails as yet abound in great numbers". Voeltzkow (1897, 63) had found them plentiful and extremely tame. They have been recorded from Ile Esprit by Fryer (1911, 418) and from Ile Michel (Anon. 1920, Ch. 8, 9; Vesey-FitzGerald 1940, 487). Rails now exist on Middle Island, where they were seen in 1966, and on Polymnie (Bourne 1966), but they have disappeared from West Island. Abbott (in Ridgway 1895, 528-529) gives an account of their behaviour. Related birds formerly existed on Assumption, Cosmoledo and Astove, but have all become extinct in this century, and the flightless rail of Aldabra is now the last of the flightless birds of the Indian Ocean islands, a series which once included the dodo and the solitaire (Lorenz 1908, Hutchinson 1953).

The Sacred Ibis Threskiornis aethiopica abbotti, is conspicuous on South Island, particularly round the major freshwater pools, each of which has one or two birds (Plates 28 and 32, and illustrations in Nicoll 1908). At Takamaka it is still extremely inquisitive and has to be kept away from baggage, as described by Nicoll (1908, 121), but elsewhere it is less approachable. It is rare at the west end of the atoll, and was absent from West Island near the

settlement fifty years ago (Nicoll 1908, 119). Fryer (1911, 417) reported it on Ile Michel, and also described the destruction of eggs by the birds in a nesting colony on South Island (1911, 417-418). Gaymer found the sacred Ibis nesting at Takamaka (Plate 33). Because of its inquisitiveness it would undoubtedly suffer if the human population of Aldabra increased.

Another species in considerable danger is the flamingo, Phoenicopterus ruber roseus, which is not yet definitely known to breed, and which Benson (1967) does not consider to be distinct. Abbott in 1892 found a population of 500-1000 birds, in flocks of 20-60 individuals, on the south and east shores of the lagoon (Ridgway 1895, 529). Dupont (1907, 21, 23) reported numerous flocks of several hundred birds along the south side of the atoll, and he and Fryer (1911, 419) describe their flight and cries. More recently, Travis (1959, 202) noted "several small flocks" on the north side of the atoll, but the Bristol Seychelles Expedition suggested that there may be only 50 left, and that the survivors breed in the Bras Takamaka (Plate 36). It was not seen in 1966. Fryer collected the bird louse Esthiopterum subsignatum from this species in 1908-9 (Scott 1914).

Sea and other shore birds are numerous (Vesey-FitzGerald 1941; Benson 1967), and include both breeding and migrant species. Frigate birds (Fregata minor aldabrensis and F. ariel iredalei) and Red-footed Boobies (Sula sula rubripes) nest in great numbers in the mangroves of Middle Island, where the former are concentrated towards East Channel and the latter near Johnny Channel, though the nests of both species are intermingled. Fryer (1911, 419) reported a nesting colony of frigates on West Island which has now disappeared. As is usual with this species the frigates parasitise the boobies, spending the day soaring on air currents to heights of a few thousand feet over the windward end of the atoll, awaiting the return of the boobies with food. Though no adequate observations could be made of these vast colonies in 1966, it appeared that the number of frigates greatly exceed that of boobies. Several of the large freshwater pools on South Island are frequented by frigates, which dive continuously to drink, scooping up water from the surface in their beaks while still on the wing (Plate 29). Similar diving behaviour of frigates (in this case F. minor palmerstoni) has been reported from a freshwater pool on Canton atoll in the Phoenix Islands (Degener and Gillaspy 1955, 6). It is thought that the Aldabra frigate colonies serve as the major breeding ground for the frigates of the western Indian Ocean, and that a considerable non-breeding population may be scattered over this area (W. R. P. Bourne, personal communication). If an airfield were to be built at Aldabra, the frigates would clearly represent a major aviation hazard, similar to that of the albatrosses at Midway Atoll in the Pacific (Fisher 1966), and any control measures would have to take account of the fact that birds may continue to return to Aldabra to breed for several years.

Red and White-tailed Tropicbirds (Phaethon rubricauda rubricauda, P. lepturus lepturus) were seen nesting on the ground on lagoon islets near East Channel in 1966. Other very common sea birds include the Noddy Anous stolidus pileatus, breeding on lagoon islets (Ridgway 1895, 527), and fairy terns (Gygis alba monte).

Shore and wading birds are especially numerous, particularly in the lagoon at low water. Dimorphic egrets Egretta garzetta dimorpha, in both white and dark phases, are perhaps most striking; together with the Crab Plover Dromas

ardeola, the Turnstone Arenaria interpres interpres, the Sanderling Crocethia alba, the Grey Heron Ardea cinerea cinerea, and the Little Green Heron Butorides striatus crawfordi. For other records, see Benson (1967). The feeding behaviour of the shore birds on the lagoon flats and their dependence on the unstudied invertebrate fauna would repay detailed investigation.

3. Land Reptiles

The land tortoises of Aldabra form, with those of the Galapagos Islands, the only surviving native populations of this giant form. Most of the study of these reptiles has been made on museum specimens, often of doubtful origin, and until recently no work had been carried out on the Aldabra species in the field. On the basis of museum identifications, two species in the Linnean genus Testudo have been segregated for the Aldabra tortoises: Testudo daudinii Dum. and Bibr., on South Island, and T. elephantina Dum. and Bibr., on Middle Island (Rothschild 1915; see also Siebenrock 1904). Günther (1877) distinguished 4 species in the Aldabra group (i.e. Madagascar, Seychelles, and small islands in between) of giant land tortoises, 5 in the Mascarene group, and 6 in the Galapagos Islands; Rothschild (1915) found 7 (plus a possible 2), 8 (plus a possible 2), and 13 (plus a possible 2) in each group respectively. Williams in 1952 placed the Aldabra tortoises in one species, in the genus Testudo, subgenus Asterochelys, species Testudo gigantea Schweigger; with the Galapagos tortoises in the single species Testudo elephantopus (Williams 1952). In their revision of the Order Testudinata, however, Loveridge and Williams (1957, 225) place both the Aldabra and Galapagos tortoises in the genus Geochelone Fitzinger (Family Testudinidae, Subfamily Testudininae). They erect a new subgenus Aldabrachelys Lov. and Will. for the Aldabra tortoise, with the single species gigantea Schweigger (Plate 26). The specific name elephantopus is retained for the Galapagos tortoise, genus Geochelone, subgenus Chelonoidis (Williams 1952). Comparative field studies of South and Middle Island tortoises by the Bristol Seychelles Expedition at Aldabra failed to establish any differences between the supposed species (R. Gaymer, personal communication). Geochelone (Aldabrachelys) gigantea of Aldabra has close relatives in the Pleistocene and Recent of Madagascar and the Indian Ocean islands, and in the Eocene of the Fayum depression, Egypt (Williams 1952; see also Wermuth and Mertens 1961).

Figure 5, based on data in Rothschild (1915), maps the distribution of the Indian Ocean giant tortoises in the early eighteenth century, when, according to Rothschild, they extended from Madagascar to the Seychelles, the Mascarenes, and even to the Chagos Archipelago. In the early eighteenth century, tortoises were abundant on Mauritius, Réunion, and Rodriguez; but during the period 1750-1800 they became extremely rare, and had disappared before 1840. In the eighteenth century they were abundant in the Seychelles and some of the smaller islands of the south-west Indian Ocean; but they had disappared on the main islands and on most of the lesser ones by 1840, surviving only as semi-domestic animals in a few places. We have found confirmatory records in the literature of the former existence of giant tortoises on the small islands of Assumption, Astove, and Cosmoledo, as well as Aldabra; but not for Gloriosa, Farquhar, St Pierre, and Providence, which Rothschild also cites, though

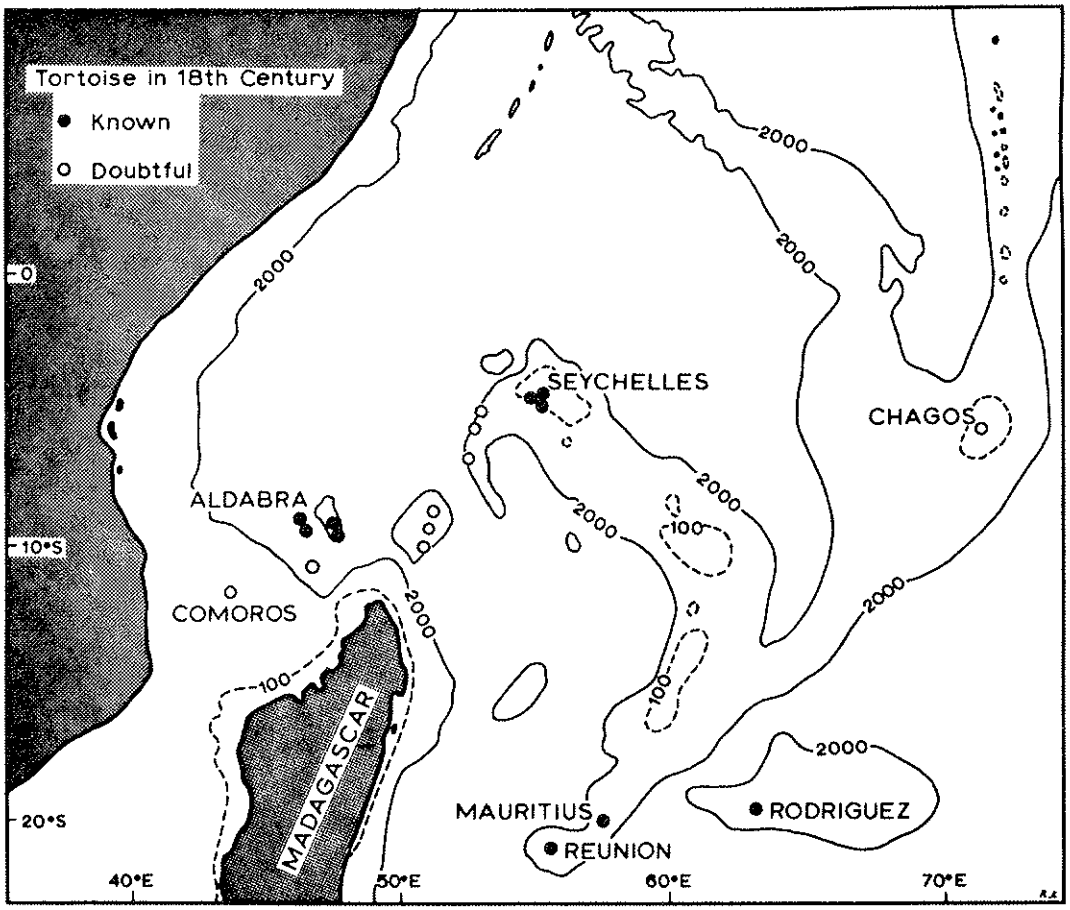

Figure 5.--Distribution of giant land tortoise in the eighteenth century in the Indian Ocean, after Rothschild (1915)

Coppinger in 1882 found seven giant tortoises imported from Aldabra roaming in the woodland on Providence (Coppinger 1883, 234). Nor can we find any record of wild populations in the Chagos Archipelago. These records are therefore marked as doubtful in Figure 5. The case of Providence is an example of the manner in which, as described by Rothschild, domestic herds were recruited from many different islands, and how transfer of wild tortoise took place from one island to another, thus making any detailed study of original variation impossible. Some of the Seychelles domestic tortoises, of unknown provenance, were released, for example, on the north and west islands of Aldabra (Rothschild 1915, 433).

The massive decline in tortoise numbers in the Malagasy Region seems to have resulted from many factors. Direct predation by man for food seems to have been considerable. Sauzier (1893) records exports from the Seychelles and Mauritius of more than 3000 tortoises in 1826, for example, and in 1847 two ships took 1200 tortoises from Aldabra alone (Rothschild 1915, 424; Voeltzkow 1897, 59; Parsons 1962 wrongly states that the animals were turtles). This trade was probably episodic; but with such a long-lived animal

on such small islands it could only have drastic long-term population consequences. Pens built of coral blocks in the nineteenth century, for confining tortoises prior to export, can still be seen in several places on Aldabra, as at Anse Cèdres and Cinq Cases, and are still occasionally used for this purpose. Second, the disturbance of the environment, particularly by the clearing of vegetation and the spread of cultivation, as in the Galapagos, forced the tortoises into more marginal environments, especially in the high islands. By the time that massive guano digging and habitat modification began in the smaller reef islands of the southwest Indian Ocean, the tortoises had generally disappeared: except at Aldabra, where fortunately commercial guano was absent. Third, tortoise numbers were directly affected by the introduction of competitors and animal predators. In the Galapagos, for example, feral pigs attack and kill young tortoises, and rats and dogs also harm the young and may destroy eggs. The introduction of goats, cattle and donkeys in the 1920s led to direct competition for food (Snow 1964), and recent studies have suggested that the Galapagos tortoises will become extinct in this century (Hendrickson 1966, 256). By the time that such introduced species spread to the smaller Indian Ocean islands, however, the tortoise populations had disappared, except at Aldabra, where the rats and feral goats do not seem to be a threat to tortoise survival.

Little is known of tortoise ecology at Aldabra, though a start has been made in field observation by the Bristol Seychelles Expedition. Voeltzkow collected some specimens, and Fryer (1911, 420-421) gives brief notes, but otherwise scientific attention has concentrated on the more accessible Galapagos tortoises. Recent studies have been made by Honegger (in press) in 1964 and by the Bristol Seychelles Expedition 1964-5 (Gaymer, in press). At Aldabra, the tortoises are concentrated on the platin (Plate 27), and are rare on champignon, where because of the irregular terrain and dense vegetation movement is difficult. No reliable estimate is possible of total numbers, though inland from Anse Cèdres, 57 were seen in a traverse of 1 hour in 1966, and 200 in less than 2 hours in a traverse between the lagoon and Takamaka Pool. Prosperi (1957, 201) suggested a total of 80,000 in 1953, and the Bristol Seychelles Expedition, from sample counts in three areas of South Island (at Anse Mais, with 360 tortoise in 3 sq. miles; at Takamaka, with 176 tortoise in 4.5 acres; and in another area of platin, with 8 tortoise in 19,200 sq. yards), and extrapolation on the basis of areas of platin and champignon shown on published maps, suggest totals of 30,000 tortoise on South Island, 3,370 on Middle Island, and perhaps several hundred on West Island (Gaymer, personal communication). From our observations in 1966, we would place the total at more than 10,000, but we would also stress the variability in habitat on South Island, and the need for caution in extrapolating sample counts, especially from lines of rapid traverse, which are likely to be the most open and hence most favourable locations. This order of magnitude contrasts strongly with the total of 1,000 estimated by James Spurs (Griffith, in Fairfield and others 1893, 153), and the general fear of imminent extinction and declining number in the second half of the nineteenth century. Wharton's sailors spent three days finding one tortoise in 1878 (Wharton 1883, 77). Fryer (1910, 258) comments that "it would be possible to live for years on Aldabra and never see a specimen." These reports may either indicate a spectacular increase in numbers in the last one hundred years, or

may simply result from the general rarity of tortoise in the areas of champignon and their concentration on platin at the remoter eastern end.

The greatest numbers of tortoise are found attached to the freshwater pools on the platin at the east end of South Island, though in the wet season they may be more widely-ranging. A few pools were seen crowded with tortoise (one with more than 80) in 1966, the tortoises lying in the mud and shallow water during the early morning (Plates 24, 25 and 28). Towards 10 a.m. they move to the shade of adjacent Pandanus, or Ficus at Takamaka (Plate 22), and stay there until sundown. We have no information on their nocturnal behaviour. Many of the pools, when almost dry, are green with organic matter, and this results in the formation of concentric drying marks of green or blue round the pool margins and on the backs of the tortoises. It was noticeable that tortoises with a given drying-mark colour were not found far from the corresponding pool. Many of the pools contained one or two dead tortoises. The animals are said to breed during the wet season, from January to April (Anon. 1920, Ch. 12, 8). On the South Island platin, droppings are found every few yards, and tortoises themselves are rarely out of sight. According to Fryer (1911, 420), they are also found on both West and Middle Islands, though on the latter he found only two specimens. Abbott (1893, 761) and Dupont (1907, 20) record that it became extinct on West Island in 1880, but was reintroduced a few years later by James Spurs, the lessee. In 1966 we found fresh droppings on Middle Island, but saw no tortoise. The tortoise clearly thrive in the platin habitat, feeding on sedges and grasses and the lower leaves of shrubs, even standing on their hind legs to reach these. The carrying capacity of the champignon is clearly much lower, and on the bare, seaward-coast champignon between Takamaka and Point Hodoul there are great numbers of bleached carapaces. Numbers of tortoises seem to wander into this barren area, and can be found sheltering in holes, under rare bushes, and even under washed-up tree-trunks on the cliff top, in what is during the dry season a completely waterless environment.

The conservation of the tortoises is discussed in Section 6(3)(a).

Aldabra has no snakes and no amphibians, and apart from the tortoises the land reptiles are represented by only two geckos and a skink. The geckos are Hemidactylis mercatorius (the H. gardineri of Boulenger 1911) and Phelsuma abbotti abbotti (the P. madagascariensis abbotti of Boulenger 1911 and Stejneger 1893). Hemidactylis is also found on Astove, Assumption and Cosmoledo (Honegger 1966b); Stejneger (1893) recorded H. mabouia from Aldabra, but Boulenger (1911) considered this to be identical with his H. gardineri. Phelsuma abbotti abbotti is also found on Assumption, and forms part of a series of species and subspecies of this genus in the southwest Indian Ocean, with P. abbotti menaiensis and a possible undescribed subspecies on Cosmoledo and P. astriata astovei on Astove (Mertens 1962, Honegger 1966b; also Boettger 1913). In 1966 we observed Phelsuma in symbiosis with the tortoises on South Island, running on the carapace and feeding on the Aedes mosquitoes which congregate round the soft neck and underparts of the tortoise; and a similar observation has been made by Honegger (1966b, 31). The skink Ablepharus boutonii peronii (Boulenger 1911) is of a species also found on Astove, Cosmoledo and Assumption.

4. Insects

By contrast the fauna is particularly rich in insects, especially by comparison with other Indian Ocean islands. While the Seychelles have more than two thousand species of insects recorded, none of the coral islands of the western Indian Ocean has more than one hundred, with the exception of Aldabra, which has more than 360 (Scott 1933, Legrand 1965). While this partly reflects the intensity of collecting by Abbott, Voeltzkow, Dupont, and especially by Fryer, himself an entomologist, it is also the result of the larger size and habitat diversity of Aldabra compared with the other coral islands, and also of its proximity to Madagascar.

The largest group represented is the Order Lepidoptera. After the Percy Sladen Expeditions there were 66 species recorded, with 7 endemics. Legrand's (1965) recent monograph, including the results of his own collecting together with that of the Italian Zoological Expedition of 1953, adds many new records of Microlepidoptera and increases the total to 127 species, 35 of which are endemic (about 28 per cent), and of which 12 are represented by endemic subspecies. The Order Coleoptera is represented by 93 species, of which 16 are thought to be endemic (about 25 per cent): three of these endemic species belong to endemic genera (Keeta, with two species, and Bikasha, with one: Maulik 1931). Other well-represented orders include the Diptera, Hymenoptera and Orthoptera. Scott (1933) gives biogeographical comments on each order, and Table 4 keys the entomological literature of Aldabra. Apart from cosmopolitan species, the insect affinities are dominantly Madagascan or East African, with few Oriental or Mascarene forms. Most of the possible endemic species are close to Madagascan forms, though so little is known of insect faunas in the Indian Ocean that Scott himself prefers the term "potential endemic" for species so far recorded nowhere else. The Aldabra insect fauna thus contrasts strongly with that of the Seychelles, which is dominantly Oriental in character (Scott 1933).

Apart from the species lists there is almost no information on the ecology and distribution of the insects of Aldabra, and the differences between the faunas of the champignon, platin and mangrove habitats. Information is also required on the insects associated with the large bird colonies.

Particular interest attaches to the mosquitoes of Aldabra because of the potential danger of malaria, which in fact occurred at Aldabra in 1908 and in 1930. Fryer collected Aedes aegypti (A. fasciata) at West Island, and Aedes albocephalus (Reedomyia seychellensis) and Aedes fryeri (Culicelsa fryeri) at Takamaka (Theobald 1912), the latter also taken by Dupont. Mattinly and Brown (1955) also record Culex sitiens Wied., collected by Dupont in 1907. Anopheles gambiae has been collected only once, in 1930 (Hermitte 1931), at the time of the malaria outbreak. This mosquito was then breeding only in small rainwater pools in West Island, and does not seem to have survived. In 1966 we took only A. fryeri.

Two species of horseflies taken in 1966 have been identified as Aegophagamyia remota and Neavella albipectus.

Table 4. Key to the Literature on the Insects of Aldabra

THYSANURA and COLLEMBOLA
- Carpenter 1916

ORTHOPTERA
- Bolivar 1912
- De Saussure 1897
- Linell 1893

DERMAPTERA
- Burr 1910

ISOPTERA
- Holmgren 1910
- Wasmann 1897

EMBIOPTERA
- Enderlein 1910

ANOPLURA
- Scott 1914

ODONATA
- Calvert 1898
- Campion 1913
- Linell 1893

HEMIPTERA
- Bergroth in Voeltzkow 1920b
- Distant 1913, 1917
- Green 1907
- Linell 1893
- Mamet 1943

NEUROPTERA
- Needham 1913

LEPIDOPTERA
- Aurivillius 1909
- Berio 1956, 1959, 1962
- Bourgogne 1963
- Fletcher 1910a, 1910b
- Fryer 1912
- Hampson 1908
- Herbulot 1962
- Holland 1895
- Karsch 1900
- Legrand 1965
- Meyrick 1911
- Viette 1958

COLEOPTERA
- Aurivillius 1922
- Bernhauer 1922
- Champion 1914
- Fairmaire 1896
- Gebien 1922
- Grouvelle 1913
- Kerremans 1914
- Kolbe 1902
- Linell 1897
- Maulik 1913
- Régimbart 1900
- Schenkling 1922
- Scott 1912, 1913, 1922b, 1926
- Sicard 1912

HYMENOPTERA
- Cockerell 1912
- Forel 1897, 1912
- Friese 1902
- Meade-Waldo 1912
- Turner 1911

DIPTERA
- Eaton 1913
- Edwards 1912
- Hermitte 1913
- Kertész 1912
- Lamb 1914, 1922
- Linell 1893
- Mattinly and Brown 1955
- Scott 1914
- Stein 1910
- Theobald 1912

5. Other groups

Little can be added on the other terrestrial groups to the results of collecting by Abbott, Voeltzkow, Dupont and Thomasset, and Fryer. The land crustacea have been reported by Rathbun (1894), Lenz (1905), and Borradaile (1910), who listed 17 species in 10 genera. The brachyuran decapod crustacea have recently been revised by Guinot (1964), using the collections made by Cherbonnier in 1954. She lists 33 species in 21 genera, including one new to science (Xanthias cherbonnieri). The land crustacean fauna is remarkable chiefly for the presence of the robber crab, Birgus latro, which is also reported from the Chagos Archipelago but is absent from the Maldives: clearly on Aldabra it cannot feed on coconuts. Cardisoma carnifex is common round the freshwater pools of the platin. There is a single earthworm (Ehlers 1897); a common scorpion (Isometrus maculatus, Hirst 1913); and several spiders (Hirst 1911), one of which, Nephila madagascariensis, is particularly prominent in the Mixed Scrub of the South Island platin, forming a large and strong web.

There is an inadequately known land molluscan fauna, which includes one endemic species, Rhachistia aldabrae (Von Martens, in Von Martens and Wiegmann 1898, 28, as Buliminus (Rhachis) aldabra), collected by a Mr Wilson in 1895. Other records listed by Connolly (1925) are Gulella (Molarella) gwendolinae, Gastrocopta tripuncta, Succinea mascarenensis, Isodora forkali, Assiminea punctum, A. parvula, and Truncatella valida. The microfauna is particularly poorly studied. In 1966, for example, we found a rich freshwater microfauna in the drying platin pools, including crustaceans (fairy shrimps Streptocephalus sp., conchostracans Bulimnadia sp., and ostracods Heterocypris sp.) and molluscs, including a species of Bulinus. We also obtained a semi-freshwater fish of the widespread gobiid genus Tamanka from the freshwater well at Cinq Cases: this was the first record of a freshwater fish from the atoll.

5. MARINE BIOTA

1. Turtles

The marine biota of the Aldabra group of islands is best known for its turtles: Aldabra, Cosmoledo and Assumption support "the greatest concentration of breeding turtles in the Indian Ocean in modern times, and perhaps in antiquity" (Parsons 1962, 47). It is, therefore, extraordinary that no field study of these turtles has ever been carried out, and that the available information is largely based on local reports and hearsay set down by infrequent visitors.

The green turtle, Chelonia mydas L. (Loveridge and Williams 1957, 472-484; Parsons 1962), is by far the most important on Aldabra, though it is now rare as a breeding species on Cosmoledo and may have vanished from Assumption. The hawksbill, Eretmochelys imbricata L., taken for its shell, is found in much smaller numbers, and at Aldabra has a distinctively lighter shell than elsewhere in the Seychelles, as a result, according to Fryer, of the muddiness of the lagoon. The loggerhead, Caretta caretta L., is also thought to occur, but does not seem to have been positively identified. Hornell (1927) draws attention to the fact that not only is the distribution of the hawksbill and the green turtle reversed (the former being abundant in the Seychelles and rare at Aldabra, and

vice versa), but also that their breeding seasons alternate. The hawksbill breeds from September to November, and comes up the beaches during the day; whereas the green, a nocturnal egg layer, lays from February through to September. Hornell believes that the green turtle appear from their feeding grounds, presumably in the Mozambique Channel, from December onwards, and begin to lay in February, perhaps in two groups of different origins (the main group in February-March, and a subsidiary group in May-September). However, there is no month in which turtles are not coming up the beaches to lay (Hornell 1927, 31). The numbers of turtles were declining rapidly by the end of the last century (Spurs 1892), and Hornell forecast ultimate extinction if exploitation continued under the lessee system without any attempt at conservation. Considerable losses of newly hatched green turtles were also said to have been caused by predation by herons and frigatebirds (Hornell 1927). Voeltzkow (in Boettger 1913) suggested that 3000 a year were lost in this way. Later surveys in 1948-49 (Wheeler 1953b) and more recently (Veevers-Carter 1962; Newman 1965; Gaymer 1966c) have shown that the decline in numbers has continued, though this is not precisely documented. Conservation measures and their results are considered in greater detail in Section 6(3)(b). Field studies to establish the status of the marine turtles at Aldabra and nearby islands are urgently required.

2. Other groups

Apart from the turtles, little is known of the marine biota, which does not appear to be rich. Voeltzkow made a small collection of marine fishes (Jatzow and Lenz 1899), echinoderms (Ludwig 1899), corals (Doederlein 1901), and marine mollusca (Thiele 1902, 244-246), but only the latter were at all thoroughly collected, and the fauna was typically Indo-Pacific. Travis (1959, 159-166, 182-188) draws attention to the abundance of Turbo on the forereef slopes on the east and south sides of the atoll, and this species is also found on the reef-flat boulder zone. The coral fauna appears curiously poor, by comparison with the period when the reef limestones were formed; so much so that Gardiner (1936, 426) drew a distinction between the decadent and eroding reefs of the Mascarene region, including Aldabra, and the flourishing, growing reefs of the Maldives and the Chagos. This conclusion is supported by Stoddart's own observations at Aldabra and in the Maldives. Apart from the forereef slopes, reef corals are only actively growing on the margins of the two main channels into the lagoon, and these are mostly massive slow-growing species: a few are listed by Matthai (1914, 1928). Fryer's small collection of marine algae was named by Madame Weber-van Bosse (1914). The commercial fishery potential of Aldabra was investigated by the Mauritius-Seychelles Fisheries Survey in 1948-49, and found to be disappointing (Wheeler and Ommanney 1953; Wheeler 1953a). The invertebrate fauna of the lagoon, which is almost entirely unstudied, must be considerable to support the large numbers of shore birds.

6. SETTLEMENT, EXPLOITATION, AND CONSERVATION

1. Human Settlement

The early history of human settlement at Aldabra is obscure. Voeltzkow (1897) summarises early knowledge, mainly from the charts in A. Grandidier's Atlas der Karten von Madagascar, from the sixteenth century onwards. Aldabra did not become well known until the middle of the eighteenth century, when Lacaze Picault and Jean Grossen called there in the Charles and the Elizabeth in 1742 (Findlay 1882; Keller 1901). According to Horsburgh (1852, 174-176), Aldabra was visited in August 1756 by a "Mr Morphey" (Nicolaus de Morphy), in November 1766 by the ship Asia, and in December 1815 by the Lord Castlereagh. Commander R. Moresby passed close by in August 1822, but did not land. Aldabra was visited in 1841 by Captain Jehenne in the ship La Prévoyante (Voeltzkow 1897, 41). The ship Euphrates, out of London for Karachi, anchored in the lagoon in 1862. At a much later date the German cruiser Königsberg hid in Main Channel for two months in 1915, before being destroyed by English warships on the African coast.

The atoll was apparently uninhabited in 1878, when H.M.S. Fawn, Commander Wharton, carried out the first hydrographic survey. In 1879, however, an attempt was made to settle by a party of 27 adults and 13 children, all Norwegians from Bergen, who arrived via Nossi-Bé to found a fishing station on communistic principles (Anonymous 1879; Reclus 1889, 155). The fate of this scheme is unknown. Shortly afterwards it was decided by the Government of Mauritius to exploit the atoll by leasing it commercially for a small annual rent. The first lease was allotted to Jules Cauvin of Mahé in 1888. Cauvin established a settlement at Ile Magnan in West Channels, where he planted coconuts while exploiting timber. In 1890 the lease passed to James Spurs, at a rent of Rs. 500 per annum, and he held it for ten years, moving the settlement to Ile Picard or West Island, its present site. Spurs had worked for many years as a manager at Diego Garcia in the Chagos Archipelago (Scott 1961, 165-169). The Administrator of the Seychelles considered that "the Government are fortunate in having secured Mr Spurs for a tenant; for it will be gathered from his report . . . that he is an observant man and a lover of Nature, nor do I think he is likely, to use an old and homely phrase, to kill the goose that lays the golden eggs by exhibiting that rapaciousness which has characterised the actions of others who have been there before him" (Griffiths, in Spurs 1892, 45). Nevertheless, Spurs proposed to take up to 12,000 green turtle a year from Aldabra, for what was then a "trifling" rent. He did, however, attempt to repopulate West Island with tortoises, warned of the disappearance of the hawksbill and of the consequences of taking many more female than male green turtles, and even brought Chinese to Aldabra from Mahé to make trepang. By the time of Voeltzkow's visit in 1895, there was a settlement at West Island of 20 Seychellois labourers in ten houses, growing maize and vegetables, and taking turtles and tortoises (Keller 1901; and also Fryer 1910 for an illustration). The earlier settlement site at Ile Magnan, and the site at Ile Michel, recommended after H.M.S. Fawn's survey as "the only suitable place for building a house" (Findlay 1882, 550), had both been abandoned.

The lease passed in 1900 to Messrs Baty, Bergne and Co., at a rent of Rs. 3000 per annum, and the company concentrated on fishing rather than on timber; and also planted many coconuts (cf. Baty 1896). In 1904 M. D'Emmerez de Charmoy became the lessee, with James Spurs as his manager; and his administration became notorious for its wasteful and inefficient exploitation of the turtle industry (Hornell 1927). D'Emmerez was still lessee at the time of Fryer's visit in 1908-9; and the atoll was leased in this way until 1945, when commercial exploitation lapsed temporarily. The lease was renewed ten years later, when in 1955 M. Harry Savy of Mahé obtained a 30 year lease, with an option on a further 20 years. His company employs up to 100 labourers to work the atoll, under contract from the Seychelles for periods of up to three years. They live in well-built wood and cement houses on West Island, and are supplied by schooner from Mahé. Rainwater is supplied from three large tanks (Plates 39 and 40). The company salts and dries fish for export, cuts mangrove for timber, collects a limited number of giant tortoises for export, and also takes the green turtle, maintaining a large turtle pen on the northernmost island in West Channels. Aldabra is leased jointly with Cosmoledo and Assumption.

No guano or phosphate ever seems to have been exported from Aldabra. Fryer (1911, 407) drew attention to the presence of phosphate, and Baker (1963, 107-110) estimated reserves at about 1000 tons, being uneconomic to work. He found no evidence of rich guano previously reported in the Cinq Cases area. One of the Western Channels, Passes Lanier, may, however, be named after one of the leading Seychelles guano companies.

The further prospects for economic development at Aldabra seem unpromising. The areas of sandy soil suitable for coconuts are very limited, and there is no possibility of extending the coconut industry. The Mauritius-Seychelles Fisheries Survey gave a disappointing picture of Aldabra's fish potential (Wheeler 1953a). It was estimated that eight men could produce 70 tons, at first, of fresh fish a year from the lagoon, falling to a steady figure of 12-16 tons per annum; and that eighty men could produce 460 tons per annum outside the atoll. The possibility of exporting orchella as an organic dyestuff (Dupont 1907, 28-29) collapsed with the development of synthetic dyes.

2. Introduced Animals and Plants

In 1966 the introduced mammals of Aldabra included goats, dogs, cats, rats and mice. Voeltzkow recorded the presence of a feral cat, though his narrative does not make clear where it was seen (Voeltzkow 1897, 66), and also rats and mice, in 1895 (Lorenz-Liburnau 1899). Abbott (1893, 762) and Fryer (1911, 417) considered the feral cats to be confined to South Island, and though an unidentified observer in 1906 considered they were "everywhere" he only saw them on South Island (Anon. 1920, Ch. 9, 5-7). The cats are said (Anon. 1920, Ch. 9, 7) to have been introduced by James Spurs to control rats, and that Spurs rejected the suggestion that only one sex should be introduced. Both Abbott and Fryer stated that the feral cats had exterminated the flightless rail, at least in the Takamaka area. Two were seen near Frigate Pool, at the east end of South Island, in 1966. Feral dogs were heard barking on South Island in 1966, but were not seen; they are reported to number only two, and to be of the same sex.

Goats were introduced by James Spurs when lessee in 1890. Griffith (in Fairfield and others 1893, 154) states that they were brought from Cosmoledo, but we have found no other reference to goats on that atoll. According to Dupont (1907, 13, 22) they were brought from Assumption, where they had been introduced by a whaler in c. 1887, possibly from Europa Island in the Mozambique Channel (Abbott 1893, 763). According to Dupont, they were soon exterminated on West Island (Dupont 1907, 22), though they were again reported there in 1905 (Anon. 1920, Ch. 9, 2). They became feral on South Island. Travis (1959, 178-181) describes considerable herds on the southern dunes, but in 1966 only one small group of four individuals was seen on two occasions at the east end of South Island. Prosperi (1957, 198) records goats at the east end of Middle Island, but this must be an error, as they are not otherwise recorded there. The feral goats at Aldabra do not seem to have reached the status of major pests that they have become on other islands, and do not appear to represent a major threat to tortoise food supplies.

Rats are thought to be more active predators; they probably feed on frigate and booby eggs and young, and possibly also on tortoise eggs and young, though not to a serious extent. Domestic fowl are also kept at West Island, and have become feral.

Introduced plants include such cultivated species as maize, cotton, sisal, and probably coconuts, together with common weeds such as Stachytarpheta, but these are all limited to the neighbourhood of the settlement and cultivated areas.

Because of their poverty in genera and species, island ecosystems normally have low ecological inertia and are specially liable to catastrophic invasion by animals and plants (Elton 1958). It is therefore remarkable that the effects of introduced species at Aldabra have so far been so limited; though the possible effects of the spread of the major predators and competitors already present on South Island to other parts of the atoll must not be ignored. It is fortunate that the introduction of rabbits, hares, and cattle--all potential herbivore competitors for the tortoises--which was proposed by Dupont (1907, 32) to augment food supplies, never took place.

3. Exploitation and Conservation

The scientific importance of Aldabra was not realised until the latter part of the nineteenth century, after the disappearance of tortoises and rare land birds from the Mascarene Islands. When the Government of Mauritius first proposed to lease the islands for woodcutting, there was a considerable outcry, and several species are now protected by legislation. "Legislation is one thing," however, "and the enforcement of laws against fishermen on the open sea or in uninhabited places is another" (Griffith, in Spurs 1892, 44).

(a) Tortoises

Active conservation of the tortoises was begun by the letter sent to the Governor of Mauritius in 1874 by a group of naturalists which included Charles Darwin, Joseph Hooker and Richard Owen (Günther 1877, 20-21), when it was first proposed to establish a woodcutting colony on the atoll. Particular concern

was expressed over the "imminent extermination of the Gigantic Land-Tortoises of the Mascarenes". Even at that time it could be stated that "Aldabra is now the only locality where the last remains of this animal form are known to exist in a state of nature", and it was argued that

> "The rescue and protection of these animals is, however, recommended . . . less on account of their utility . . . than on account of the great scientific interest attached to them. With the exception of a similar tortoise in the Galapagos Islands (now also fast disappearing), that of the Mascarenes is the only surviving link reminding us of those still more gigantic forms which once inhabited the continent of India in a past geological age. . . . It flourished with the Dodo and Solitaire; and whilst it is a matter of lasting regret that not even a few individuals of these curious birds should have had a chance of surviving the lawless and disturbed conditions of past centuries, it is confidently hoped that the present Government and people . . . will find a means of saving the last examples of a contemporary of the Dodo and Solitaire" (quoted in Günther 1877, 20-21).

Leasing of exploitation rights on the islands proceeded, however, without legislation to protect the tortoises. For a number of years they were conserved by the private philanthropy of the Hon. Walter (later Lord) Rothschild, who entered into an agreement by which he paid one half of the lessee's annual rent (Rs. 1500 per annum of a total rent of Rs. 3000) on condition that the tortoises were rigidly protected. This agreement was first made with Messrs Baty, Borgne and Co., the lessees in 1900-04, and was later transferred to their successors (Dupont 1907, 15-16).

No protective legislation covering the tortoises was passed until recently (Lane 1953a, 1953b), although the species could have been scheduled (but was not) under the Wild Birds and Animals (Protection) Ordinance of 1906. Action was eventually taken (Proclamation 4 of 1961) under the Customs Management Ordinance, to prohibit the export of the giant tortoise from the Seychelles without the written authorisation of the Colonial Secretary (Statutory Instrument 7, 1961: Seychelles Gazette, Supplement, 13 February 1961, p. 40). There is apparently no legislation concerning the taking of tortoises from Aldabra, or the killing of tortoise on the atoll. The Governor of the Seychelles has powers, however, to "make regulations for the protection of wild animals" under the revised Ordinance to provide for the Protection of Wild Animals and Birds, No. 37 of 1961 (Seychelles Gazette, Supplement, 26 December 1961, pp. 163-165). Under the terms of the 1955 commercial lease (see Section 6(3)(d)), the lessee is required to protect the tortoises and not to interfere with them. The West Island settlers kill tortoise occasionally for food, and though the total annual loss may be quite high, it is by no means catastrophic. If any future development of Aldabra were to exclude tortoises from the platin, however, there would certainly be a considerable fall in numbers, and further protective legislation would be necessary.

(b) Turtles

Commercial exploitation of the turtles, mostly the green, began about 1906, though they had been taken less systematically for several years before this.

Fryer (1910, 260) regretted their "wasteful slaughter", which even then (1908-09) was resulting in a considerable decline in numbers (Fryer 1911, 421-423). In particular the practice of turning females on the beaches when they came ashore to lay had greater long-term effects on the population than that of harpooning males at sea, particularly when carried out early in the season. Hornell, commissioned to enquire into the state of the Seychelles turtle industry, reported that at Aldabra "the policy of the lessees cannot but lead to an early extinction of the trade" (Hornell 1927, 37). At this time the total number of green turtle taken from the islands of Aldabra, Assumption and Cosmoledo was of the order of 3000-4000 per annum. Hornell made specific recommendations for conservation and for the revision of original conservation legislation which dated from the beginning of the century (Ordinances 16 of 1901 and 2 of 1904). The new legislation (Ordinances 5 of 1925 and 5 of 1929) specified minimum sizes for both green and hawksbill turtles taken, prohibited the taking of buried eggs, barred the use of torches at night and the taking of turtle within 1000 metres of the high water line, and laid down control procedures (Lane 1953a, 114-120; 1953b, 195-200). The major recommendation which was not adopted was that for a close season from December 1 to the last day of February, during which no turtle might be taken. Hornell also proposed the control, at Aldabra, of frigate birds, herons, and the ibis, all of which (but especially the frigate) were said to kill large numbers of newly hatched turtle. Dupont (1907, 29) had previously proposed the extermination of frigates and herons by shooting and poisoning, for the same purpose, but neither proposal was fortunately accepted.

In spite of the legislation of 1925 and 1929, the numbers of green turtles continued to decline, and by the time of the Mauritius-Seychelles Fisheries Survey the number taken annually was less than 1500. Following this survey, Wheeler (1953b) again put forward Hornell's close-season recommendations, and these were adopted in Government Notice 452 of 1948. Under this, the close season, during which no green turtle might be taken at Aldabra or Cosmoledo, was defined from December 1 to the last day of February; and it was further made illegal to turn turtle on the beaches between March 1 and May 31 (Lane 1953a, 200-201). This last provision was designed to protect females during the earlier of their repeated egg-laying visits. Minor changes in this legislation were made by Ordinance 22 of 1957 (Seychelles Gazette, Supplement, 23 December 1957, pp. 64-66).

There has been no detailed work on the Aldabra turtles since the Fisheries Survey, but numbers of the green turtle continue to decline, and those of the hawksbill are now very low. A further revision of the Turtles Ordinance was made by the Female Turtles Protection Regulations, 1962 (Seychelles Gazette, Supplement, 23 July 1962, p. 44), in which the close season, during which it is made illegal to catch, kill, harpoon or otherwise take female turtles, is extended from December 1 to March 31. This originally applied to both the green turtle and the hawksbill on Aldabra, Cosmoledo, Farquhar, Providence and other islands; but the hawksbill was deleted in revised regulations later the same year (Female Turtles Protection (no. 2) Regulations, 1962: Seychelles Gazette, Supplement, 1 October 1962, p. 68). Subsequently, the use of underwater guns or other underwater equipment for taking the hawksbill was prohibited (The Hawksbill Turtle Protection Regulations 1963: Seychelles Gazette,

Supplement, 3 June 1963, p. 48); and this provision specific to the hawksbill was later revoked and added as an amendment to the Turtles Ordinance, prohibiting the use of underwater equipment for either the green turtle or the hawksbill (Ordinance 1 of 1964: Seychelles Gazette, Supplement, 9 March 1964, pp. 9-11).

Under the terms of the 1955 commercial lease, not more than 500 green turtles per annum may be taken on or within three miles of Aldabra, and none at all at Cosmoledo and Assumption, without written permission from the Seychelles Government, and no turtle eggs may be taken on any of the islands (Article 9(a)).

(c) Birds

Birds have long been protected in the Seychelles under the Wild Birds and Animals (Protection) Ordinance of 8 December 1906 and the Plumage Birds (Exportation) Ordinance of 21 February 1914. The former gave the Governor of the Seychelles powers to prohibit the killing or taking of any scheduled bird, or the taking of its eggs, with exceptions permitted for scientific or natural history purposes (Lane 1953a, 124-125). The schedule of birds thus protected (Wild Birds and Animals Protection Ordinance of 21 June 1941) included the following species at Aldabra (nomenclature revised; original nomenclature given in brackets):

Phoenicopterus ruber roseus	(Phoeniconaias minor)
Threskiornis aethiopica abbotti	(Ibis abbotti)
Phaethon lepturus lepturus	(Phaethon lepturus)
Alectroenas sganzini minor	(Alectroenas minor)
Dryolimnas cuvieri aldabrana	(Dryolimnas aldabranus)

(Lane 1953b, 204-205). The schedule of birds protected under the Plumage Birds (Exportation) Ordinance includes (by Proclamations 5 of 1914 and 1 of 1947), for Aldabra, all the above except Phaethon lepturus lepturus, together with:

Phaethon rubricauda rubricauda	(Phaethon rubricauda)
Streptopelia picturata aldabrana	(Turtur aldabrana)
Dicrurus aldabranus	(Buchanga aldabrana)
Zosterops maderaspatana aldabrensis	(Zosterops aldabrensis)
Caprimulgus madagascariensis aldabrensis	(Caprimulgus aldabrensis)
Centropus toulou insularis	(Centropus insularis)
Foudia eminentissima aldabrana	(Foudia aldabrana)
Nectarinia sovimanga aldabrensis	(Cinnyris aldabrensis)

(Lane 1953b, 193). All these protected birds are land birds except for the tropicbirds, the sacred ibis, and the flamingo. The Bird's Egg Ordinance of 1933, designed to protect the Sooty Tern in the Seychelles, and subsequently extended and many times revised (chiefly by the Collection of Birds' Eggs Regulations, 1957, and the Collection of Birds' Eggs Regulations, 1962: Seychelles Gazette, Supplement, 17 May 1957, pp. 25-26, and 4 June 1962, pp. 32-34), has never extended to Aldabra.

In 1961 the Wild Birds and Animals (Protection) Ordinance and the Plumage Birds (Exportation) Ordinance, under which all the above birds were protected, were both revoked, and replaced by a single Ordinance to provide for the Protection of Wild Animals and Birds (Ordinance 37 of 1961: Seychelles Gazette, Supplement, 26 December 1961, pp. 163-165). This Ordinance gives the Governor in Council power to "make regulations for the protection of wild animals and birds". In addition to the two earlier ordinances, all the proclamations under them were also revoked; so that presumably new schedules of animals and birds protected must be issued.*

Under the terms of the 1955 commercial lease, no birds' eggs may be commercially exploited, and the only birds which can be taken are crows and poultry.

(d) Conservation Prospects

Following the Darwin-Hooker appeal over the tortoises, and the gradual development of protective legislation for tortoises, turtles and birds, commercial exploitation of Aldabra on a small scale became accepted. The next major issue was in the early 1950s, when it was proposed to settle 1200 Seychellois, discharged from the Army Pioneer Corps in the Middle East, on the atoll, the last commercial lease having lapsed in 1945 and not having been renewed. Fosberg (1954) prepared a memorandum on the scientific importance of Aldabra, and the inadvisability of this step, and the proposal was dropped, probably as much on account of the inhospitable environment as for scientific reasons.

Following the visit of the Calypso to Aldabra in 1954, Commander J.-Y. Cousteau became interested in the conservation of the atoll, at a time when the commercial lease was about to be renewed. Cousteau's proposal to lease the atoll "as a wildlife sanctuary and . . . tropical research centre on an island almost uncontaminated by man" (Cousteau 1963, 149) was rejected, but his publicity in London (Cousteau 1963, and also Cousteau 1959) led to important conservation clauses in the commercial lease concluded between the Seychelles Government and Mr H. Savy, of Mahé, on 2 and 5 February 1955. Proposals for turning Aldabra into a commercial breeding ground for Chinese ducks were also rejected. The lease is for 30 years, with an option on a further period of 20 years. Article 5 of the lease states:

> "That the lessee shall respect South Island in the atoll of Aldabra as a nature reserve. Without prejudice to the generality of the implications of this condition the lessee hereby covenants:--
> (a) That there shall be no settlement on South Island.
> (b) That he shall protect all animal life on South Island.
> (c) That he shall not introduce any new animal or plant on South Island.

*"The Commissioner, British Indian Ocean Territory, states that although the Protection of Wild Birds and Animals Ordinance was published in 1961, it did not come into force in the Seychelles until 1966, i.e., after the formation of the British Indian Ocean Territory on 8 November 1965. Hence it does not apply to Aldabra, where the Wild Birds and Animals (Protection) Ordinance (Cap. 24) and the Plumage Birds (Exportation) Ordinance (Cap. 19) together with the Regulations made under these Ordinances are still in force. The schedules of protected birds listed in Chapter 2 consequently still apply to Aldabra."

(d) That he shall not exploit any of the resources of the said South Island except mangrove which he shall have the right to cut and remove."

Article 6 allows "unrestricted exploitation" of coconuts, mangroves, seaweed, shell fish, sea slugs, fish, goats, crows and poultry. Quarrying of stone (Article 9(b)) and clearing of woodland (Article 10) are restricted; clearing by fire is prohibited without permission (Article 11). The total resident population is not to exceed 200 persons without permission (Article 17).

Articles 12, 13 and 14 add further conservation measures:

"12. That the lessee shall be the guardian and protector of all wild life and all the resources of the Islands and of the surrounding seas. The lessee shall ensure to the best of his ability that, save as provided in this lease, no wild birds, tortoises or other animals are molested, deprived of their proper sustenance, disturbed, taken or killed by any person not holding the express permission in writing of the lessor.

13. That apart from the restricted and unrestricted exploitation detailed above the lessee shall in no way exploit or permit the exploitation of the animal and mineral resources of the Islands or surrounding seas without the express permission in writing of the lessor.

14. That the lessee shall not exploit for export or otherwise birds' eggs without the express permission in writing of the lessor."

An important clause, Article 16, gave the Government of the Seychelles powers to establish a research station on the atoll:

"16. That the lessor reserves the right for the Government of Seychelles or for any person, body of persons corporate or incorporate, sponsored by the Government of Seychelles, to establish on any of the Islands, scientific research stations for the purposes of zoological, oceanographic and other scientific researches. The lessee shall be bound to grant, free of any charge, all the reasonable facilities on the Islands for the establishment of the said research stations and shall do everything in his power to promote and facilitate any researches that may be carried out."

Finally, Article 21 gives the Government of Seychelles power to resume possession of the islands at any time for a "public purpose", defined to include "the building of lighthouses, Police Stations, or other public buildings and all Admiralty and War Department requirements".

In 1964 it became known that the Ministry of Defence was considering the establishment of defence facilities, including an airfield, at Aldabra. This proposal, following discussions between the Ministry of Defence and the Royal Society, led to scientific participation in the joint B.B.C.-Ministry of Defence expedition in 1966, the formulation of preliminary conservation policies (Stoddart 1966b), and to the planning of a programme of further scientific work on the atoll, beginning with the Royal Society Expedition to Aldabra 1967-68.

The Ministry of Defence interest also led to a change in the status of Aldabra and certain other islands. Since 1903, when the Seychelles administration became independent of that of Mauritius, Aldabra has been administered from the

Seychelles as part of that colony, and in fact had been so administered informally since the 1880s. By the British Indian Ocean Territory Order in Council, 1965, however, Aldabra was detached from the Colony of Seychelles to form, with Farquhar, Desroches, and the islands of the Chagos Archipelago, a new Territory. Under the British Indian Ocean Territory Order 1965 and the British Indian Ocean Territory Royal Instructions 1965 (Seychelles Gazette, Supplement, 13 December 1965, pp. 184-193), the Territory is to be governed by a Commissioner, with powers of legislation, and laws in force in the individual islands at the time of the formation of the Territory are to continue to be valid. The first Commissioner of the B.I.O.T. is the Governor of the Seychelles; and the laws of the Seychelles will continue to apply and to be enforced in the Territory, including Aldabra (Ordinance to provide for the exercise of powers and duties in Seychelles in respect of the British Indian Ocean Territory, for the enforcement of process and the execution of judgment in Seychelles issued or given by Courts in the exercise of their jurisdiction in respect of the British Indian Ocean Territory, Ordinance 27 of 1965: Seychelles Gazette, Supplement, 20 December 1965, pp. 131-132). All the conservation measures so far discussed remain in force, therefore, in spite of the change in the status of Aldabra. A further measure which also remains in force is the designation of West Island (Picard) as a port for the purposes of Customs laws, under Proclamation 11 of 1956 (Seychelles Gazette, Supplement, 8 October 1956).

7. A NOTE ON PLACE NAMES

Place-name usage on Aldabra is complicated by the fact that the atoll is a British possession, but most of the place names were given by French-speaking people, and the local inhabitants speak a French patois. English names have been given to some of the larger islands, and are to some extent used locally, but most of the smaller topographic features only have French names. In at least one case (Johnny Channel) a topographic feature has an English but no French name. It is not therefore possible to adhere to a toponymy either completely English or completely French. A further complication is added by the fact that some features have been named by passing vessels or occasional visitors, the name has had brief usage and has appeared in the literature, but is no longer used locally and may be considered dead.

A basis for accepted toponymy is given by the two Department of Overseas Surveys 1:25,000 map sheets of Aldabra, which where possible give precedence to English names adding the French in brackets, and otherwise using French names where no English name is available. This usage is generally followed in these papers, with a few exceptions mentioned below. Where a choice of names exists, regard should be given to established usage, and as a further principle, new names should not be unnecessarily introduced.

1. Main islands

Polymnie

No alternative name is known. The name is presumably of French origin, and the correct version is thus Ile Polymnie, though the D.O.S. uses Polymnie Island.

Middle Island

This name is used on the 1878 Admiralty chart, by Fryer (1911), and on the D.O.S. map, all with the subsidiary form Ile Malabar or Malabar Island. Abbott (1893) uses "North or Middle Island" and "Ile Nord". The usage of of North Island has come into the zoological literature through Rothschild (1915). Middle Island is accepted.

South Island

This name is used on the 1878 Admiralty chart and by Fryer (1911) (who uses "Main or South Island"), and also on the D.O.S. map. Abbott (1893) uses Grande Terre. South Island is accepted.

West Island

This name is used on the 1878 Admiralty chart, by Fryer (1911), and on the D.O.S. map. The 1878 chart and Fryer quote as a subsidiary name Ile Picard, and the D.O.S. map uses the hybrid Picard Island. These names predate the existence of the settlement, and hence there is no case for using the name Settlement Island. West Island is accepted.

2. Lagoon islands

Ile Esprit

Ile Esprit appears on the 1878 Admiralty chart, in Fryer (1911), and on the D.O.S. map as subsidiary to "Euphrates Island". Esprit has priority and is used locally: the name Euphrates derives, according to Findlay (1882), from the visit of the ship Euphrates en route from London to Karachi in 1862. This does not seem a sufficient basis to establish the name. Abbott (1893) uses Ile Sepoy, which must be a misunderstanding or misprint. Ile Sylvestre is used for the small adjacent island on the 1878 chart, by Fryer (1911), and on the D.O.S. map, and has no English alternative name. Esprit and Sylvestre are accepted here.

Ile Michel

Ile Michel appears on the 1878 Admiralty chart, in Fryer (1911), and on the D.O.S. map as subsidiary to "Cocoanut Island". Cocoanut Island was introduced by Wharton during the Fawn survey, when coconut trees were planted there; and Michel has precedence and is used locally. Abbott (1893) also uses Michel. Michel is used here.

Other islands

The D.O.S. map gives French names to a number of other lagoon islands, all of which are acceptable and are used here. The name Ile Magnan should be used for the largest island in West channels, and appears on the 1878 chart.

3. Channels

The names Main Channel, East Channel, and West or Western Channels are used on the D.O.S. map and the 1878 chart, with the subsidiary names of Grande Passe, Passe Houareau, and (in the 1878 chart) Passes Lanier, respectively. This usage is followed here. The D.O.S. map gives French names to the minor channels of West Channels (Passe Femme, Passe du Bois, Passe Mannian, Passe Grabeau), and these are also accepted apart from Mannian, which is properly Magnan. Johnny Channel has no French equivalent.

4. Land names

The D.O.S. map gives a number of French names for dunes, beaches and headlands, and all are accepted. On South Island it is useful to add Takamaka (1878 chart), Wilson's Well (Dupont 1907),and Abbott's Creek (1878 chart and Fryer 1911). Bras Takamaka of the D.O.S. map is preferred to the East Bay of Fryer (1911). The names Camp Frigate, Ile Verte, and Couroupa are used by Fryer (1911) and may be usefully retained. Couroupa is also used by Dupont (1907), and is apparently the same as the D.O.S. feature named Anse Tamarind, though this is in a different location from Fryer's (1911) Tamarind Point: this should be resolved in the field. Fryer's (1911) location named Camp Frigate is named "Opark" on the D.O.S. map of Middle Island.

Two further names are proposed here for pools on the platin of South Island: Frigate Pool, a large pool used by diving frigate birds, and Flamingo Pool, the largest freshwater pool on the island, a name in local usage though we have not been able to discover any evidence of flamingoes using it. These names are located in Figure 3.

Chapter 3

SUMMARY OF THE ECOLOGY OF CORAL ISLANDS NORTH OF MADAGASCAR (Excluding Aldabra)

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1. Assumption
2. Astove
3. Gloriosa
4. Cosmoledo
5. Farquhar (Joao de Nova)
6. St Pierre
7. Providence

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The need to establish the ecological status of Aldabra among the islands of the southwest Indian Ocean has required the collection of information on several sea-level and elevated atolls and reef-islands in this area, and in particular on the islands between Aldabra in the west and Providence Bank in the east (Figure 6). Seven islands are included: Assumption, Astove, Gloriosa, Cosmoledo, Farquhar, St Pierre, and Providence. Much of the information on the ecology of these islands is very old, dating from the cruise of the Alert in 1882, the visit by Abbott in 1892-93, by Voeltzkow in 1895, the Valhalla in 1906, the Percy Sladen Expedition in 1905, by Fryer in 1908 and by Dupont, Thomasset and others early in this century. Much of the information on particular groups of animals is scattered through the Percy Sladen Expedition Reports and other lists, and has never been brought together for each island. Furthermore, most of the collections were made in the period

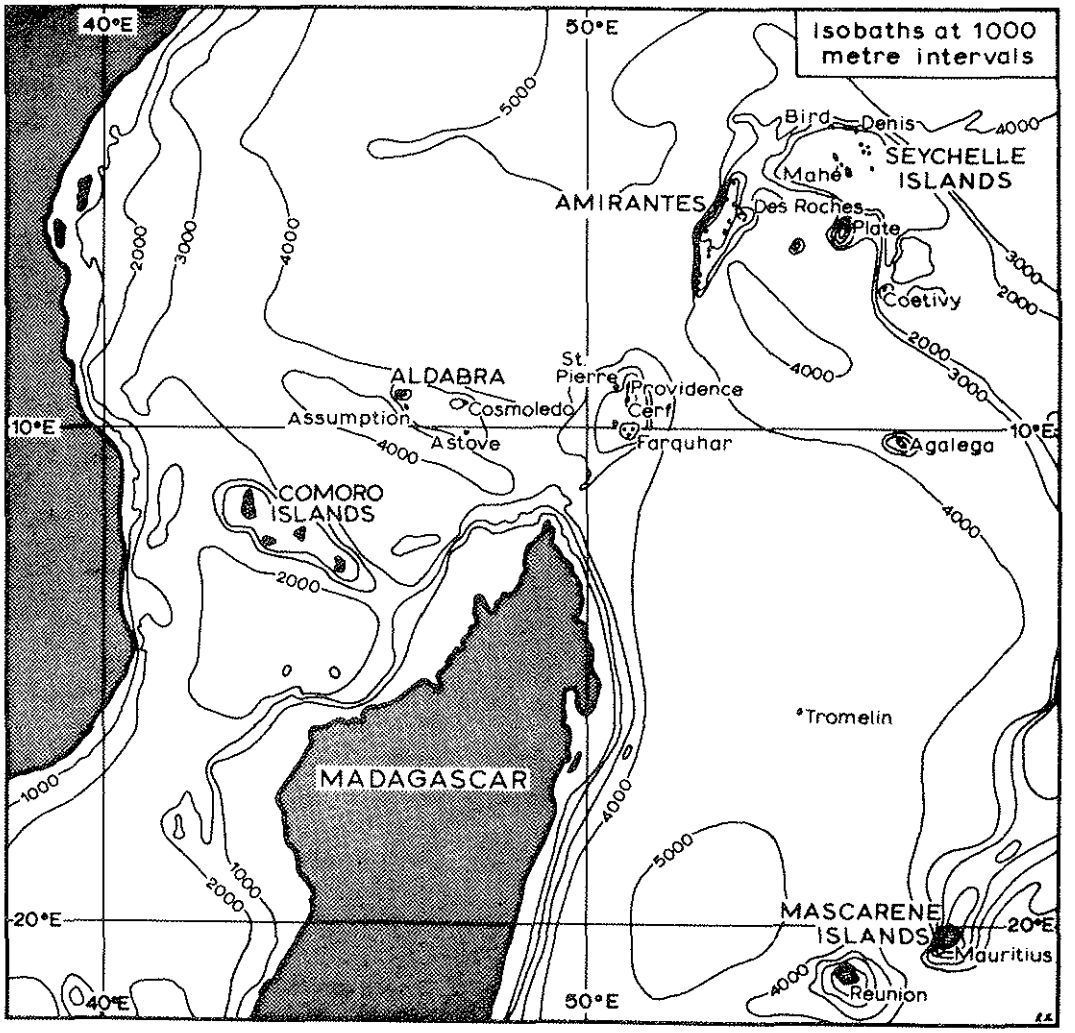

Figure 6.--Islands and Bathymetry of the South West Indian Ocean

preceding the mining of guano, during which the natural vegetation was destroyed on several islands and certain birds and other animals became extinct. In more recent years, we have the observations made by Vesey-Fitz-Gerald on the vegetation and the birds in 1937, and the largely geological observations of Baker and Piggott in 1960-61. The Bristol Seychelles Expedition spent some hours ashore on Cosmoledo Atoll (Menai Island) on 9 November 1964 and on Assumption on 10 November 1964. The following year R. Gaymer, of that expedition, made a short visit to Cosmoledo on 1 October 1965 and to Assumption on 3 October 1965. I am grateful to R. Gaymer for sending me a copy of his observations on these islands.

Because the information on these islands is so scattered, the salient features of the ecology of each of the seven islands or atolls listed are here summarized, with reference particularly to the vegetation, the reptiles, and the birds. In preparing this summary, lists were compiled of the plants collected or recorded from each island, based on published accounts, particularly those of Dupont (1907) and Hemsley (1919), and use was made of the lists of birds by Watson, Zusi and Storer (1963). For the information on insects I have relied on the summary by Scott (1936) and no special search has been made of the papers in the Percy Sladen Expedition Reports. The most important general sources are Coppinger (1883), Dupont (1907), Fryer (1911), Vesey-FitzGerald (1940, 1941, 1942), Watson, Zusi and Storer (1963), and Baker (1963). The summary account of each island does not contain citations for each statement, but a list of the more important references, less important references, and maps is appended to each: full citations are given in the "Bibliography of Aldabra" in this Bulletin.

This summary does not treat the Amirantes and Desroches, Cargados Carajos, Agalega, or Tromelin.

1. ASSUMPTION 9°46'S., 46°31'E.

Assumption is an elevated reef island 20 miles south of Aldabra, 3.75 miles long and 0.3-1.0 miles wide. The deeply dissected reef rock rises to 20 ft above sea level, with dunes on the east and south sides rising to 90 feet. Early in the century the island was wooded in the west and southwest, and the centre was only thinly vegetated. The vegetation resembled that of Aldabra, and 68 species of flowering plants have been recorded, three of them endemic (Panicum assumptionis, Eriochlea subulifera, Stenotaphrum clavigerum). The dunes are covered with Sporobolus and clumps of Sclerodactylon, with patches of Suriana, Scaevola and Tournefortia. The centre of the island had a few Hibiscus bushes, and coconuts are planted on sand along the west shore. The rest of the island has been stripped of vegetation during guano-digging, and there are now only a few stunted bushes in holes and pits, the ground being covered with Plumbago aphylla. Some Casuarina have been planted on the west coast. No mangroves are recorded.

Tortoises formerly existed here, and Fryer found their remains. There is a skink Ablepharus boutonii, and two geckos, Phelsuma abbotti abbotti and Hemidactylus mercatorius. 65 species of insects are recorded. Birgus latro was common in 1906. Marine turtles formerly nested here in large numbers, but only a few are reported to do so now.

Large numbers of boobies and terns formerly bred on the island, but have disappeared as a result of mining operations. Abbott's Booby, Sula abbotti, is now extinct on Assumption and is found only on Christmas Island. Vesey-FitzGerald gives the date of its disappearance as 1926. Sea and shore birds recorded as breeding on Assumption are Sula abbotti (extinct), Butorides striatus, Ardea cinerea, Egretta garzetta dimorpha, (which may also be extinct), and possibly Sula sula. Others recorded from the island are Sula dactylatra melanops, Sterna sumatrana mathewsi, Gygis alba monte, Phäethon rubricauda rubricauda, and Dromas ardeola. Resident land birds recorded are Streptopelia picturata coppingeri, Nectarinia sovimanga abbotti, Centropus toulou assumptionis, and Dryolimnas cuvieri abbotti. The rail, collected by Abbott in 1892 and described by Ridgway in 1893 and 1894a, became extinct between 1906 and 1937. The coucal and turtledove may also have disappeared. Gaymer recorded Corvus albus in 1965.

Guano reserves are the largest in the western Indian Ocean: 161,000 tons were exported during 1926-1945, and Baker estimates the remaining reserves at 160,000 tons. Mining ceased in 1945, but has started again since 1955; a mechanical crusher and light railway have been installed. Goats were introduced in early 1887 by a whaler, became feral, and were later used to colonise Aldabra; Abbott states that they were brought from Europa Island in the Mozambique Channel. Nicoll found twenty in 1906, but according to Gaymer they no longer exist. Nicoll also found numerous rats which were threatening to eliminate some of the rarer birds.

Main references: Abbott 1893, 763; Baker 1963, 101-106, 124-126; Dupont 1907, 12-13; Fryer 1911, 431-433; Nicoll 1906; Nicoll 1908, 107-113; Ridgway 1895, 520-523; Vesey-FitzGerald 1940; Vesey-FitzGerald 1941; Vesey-FitzGerald 1942, 12-13; Watson, Zusi and Storer 1963.

Additional references: Honegger 1966b; Ridgway 1893; Ridgway 1894b; Vesey-FitzGerald and Parker 1947.

Map: Baker 1963, 102.

2. ASTOVE 10°06'S., 47°45'E.

Astove is an elevated coral atoll 3.5 miles long and 2.5 miles wide, consisting of a reefrock rim 15 feet high, with sand dunes 45-50 feet high on the east coast. According to Baker reefrock covers 583 and sand 642 acres. The lagoon averages 3-4 feet in depth, with a maximum of 10 feet, and the entrance dries at low water. The fringing reef is 200 yards wide.

The dunes are covered with Suriana on the windward side, and with Scaevola and Tournefortia to leeward. Lagoonward of the dunes, champignon is covered with Pemphis thicket. The lagoon is filled with fine sediment, and is ringed with scattered Avicennia trees, but otherwise there is no mangrove. On the western lagoon shore, beach ridges are colonised by Sporobolus, and planted with coconuts and Casuarina. Pemphis grows on bare reefrock, and Scaevola and Tournefortia on sand. The sea coast on the leeward side has a thicket of Suriana, Scaevola and Tournefortia. A deciduous scrub covers the surface on the wider parts of the eastern side, with frequent Pisonia trees. 59 species of plants are recorded from Astove.

Tortoises formerly occurred here, according to Rothschild, and Fryer reports the finding of possible remains. Other reptiles include Phelsuma astriata astovei, Hemidactylus mercatorius, and possibly Ablepharus boutonii. Fryer also found that insects were numerous (27 species are recorded) and butterflies especially common. The land birds include Nectarinia sp., Zosterops maderaspatana, and a flightless rail, Dryolimnas cuvieri. Abbott reported the rail from hearsay, but it was probably extinct by 1906. Large numbers of Egretta garzetta have recently been recorded, together with Ardea cinerea and Butorides striatus. There are records of Bubulcus ibis ibis, Thalasseus bergii thalassina and possibly Demiegretta asha. Sula sula may be the only breeding sea bird; Corvus albus and Cisticola cherina have appeared; and there is a record of Hydroprogne caspia.

Guano is found on the west side, and has been mined since 1927. 70,000 tons have been reported, and 5000 tons are left, according to Baker. Most of the native vegetation in the guano area has disappeared, though some Pisonia grandis and occasional Sideroxylon inerme remain. It has been replaced by Plumbago aphylla, with Dactyloctenium pilosum and Stachytarpheta indica; Agave and Gossypium are also found. Coconuts are grown on the west side, though not very successfully, and maize has been grown in the dunes.

Main references: Baker 1963, 92-97; Dupont 1907, 2-8; Fryer 1911, 426-428; Piggott 1961, 6-8; Vesey-FitzGerald 1942, 10-12; Watson, Zusi and Storer 1963.

Additional references: Honegger 1966b; Vesey-FitzGerald 1940; Vesey-FitzGerald 1941.

Map: Piggott 1961; Baker 1963, 94.

3. GLORIOSA 11°34'S., 45°13'E.

The Gloriosa Islands are situated 114 miles west-north-west of Madagascar, and consist of two sandy islands with a grass-covered rock between them. Gloriosa, the larger island, is 1.5 miles long, and has dunes 50-60 feet high on its lee side, and a central tidal marsh which dries at low water. Ile du Lise, three miles away, is smaller, but has a dune 30 feet high, and also beachrock and conglomerate. Coppinger found a block of basalt on the reef, together with quartz pebbles.

Little is known of the biota. Gloriosa has been planted with coconuts and the "dense growth of virgin forest" seen by Coppinger in 1882 has since been cleared. Ile du Lise still has woodland on it, with Ficus, Hibiscus and Scaevola, and Pemphis in the central swamp. Maize used to be grown in large amounts on Gloriosa. Coppinger collected on the islands in 1882, and they were also visited by Abbott and Nicoll. According to Hemsley, Abbott found mangroves 50-60 feet high, but Abbott's actual record was of sand dunes. 30 species of plants have been recorded.

According to Rothschild, tortoises formerly existed on Gloriosa, but no supporting evidence for this can be found. Abbott records three small reptiles: Hemidactylus mabouia, Ablepharus gloriosus, and Zonosaurus madagascariensis. Nicoll found numerous butterflies and moths, and (on du Lise) Coppinger found many spiders and hermit crabs. Both Coppinger and Nicoll report Birgus latro on du Lise but not on Gloriosa. Green and hawksbill

turtles used to nest on Gloriosa and may still do so. The known resident land birds are Streptopelia picturata coppingeri, Hypsipetes madagascariensis grotei, Nectarinia sovimanga sovimanga, and Zosterops maderaspatana maderaspatana; together with Corvus albus, which is common. Nesting sea-birds include Sula sula, Fregata sp., Sterna fuscata, and Anous stolidus pileatus: large numbers of the noddies were nesting in 1906 on the rock between the islands. Sula abbotti may also have bred in the past. Phäethon rubricauda rubricauda may also breed, and other species recorded are Dromas ardeola, Sterna sumatrana mathewsi, Thalasseus bergii thalassina, and Thalasseus bengalensis. Two vagrants and one migrant are also recorded. The domestic fowl, Gallus gallus, has become feral. Feral cats were common in 1893, and were reducing the numbers of birds. In 1882 there were abundant brown rats on both islands.

Main references: Abbott 1893, 763-764; Coppinger 1883, 237-240; Coppinger 1884; Nicoll 1906, 686-692; Nicoll 1908, 100-106; Watson, Zusi and Storer 1963.

Additional references: Holland 1896; Ridgway 1895, 524-526.

Map: Guilcher and others 1965, 14, fig. 4.

4. COSMOLEDO 9°41'S., 47°35'E.

Cosmoledo is an atoll 9 miles long and 7 miles wide, with a lagoon 5 miles in diameter with maximum depth of 4-1/4 fathoms. There are five main islands and several smaller ones on the atoll rim, which has an average width of one mile. Menai Island has the largest area, but Wizard Island or Grande Ile, 2 miles long, is the longest. The islands are formed of uplifted reefrock, much eroded, reaching 12-15 feet above sea-level, with large amounts of sand banked against the rocky remnants.

At Menai Island on the west rim the seaward coast (leeward) has a dune scrub with Guettarda; dunes rise to 40 feet at the north end. The lagoon coast has mangroves 80 feet tall, with a succession of Avicennia-Bruguiera-Rhizophora from sea to land. Dunes are also found inside the mangrove. Pemphis scrub covers champignon in the centre of the island. The eastern islands, Polyte and Wizard, have a seaward dune fringe up to 55 feet high, covered with Sporobolus and Suriana on the seaward side, and with Tournefortia to leeward. Pemphis again covers the reefrock. The smaller islands are rocky, with Pemphis, Sideroxylon and Plumbago. The known flora totals 56 species.

Tortoises formerly existed at Cosmoledo, and Fryer reported finding their fossil eggs. Other reptiles include Phelsuma abbotti menaiensis, Hemidactylus mercatorius, and Ablepharus boutonii. 37 species of insects are recorded, and three species of land mollusca. There are three recorded resident land birds: Zosterops maderaspatana maderaspatana, Nectarinia sovimanga buchenorum, and Dryolimnas cuvieri. Abbott reported the existence of the rail from hearsay, and according to Fryer it existed in 1919 on South Island, though he did not land there and observe it. The breeding sea birds are Phäethon rubricauda rubricauda, Sula dactylatra melanops, Sula sula, Fregata minor, Sterna anaethetus, Sterna fuscata, and Anous stolidus pileatus. Large flocks of Egretta garzetta and small number of Dromas

ardeola have recently been recorded. Corvus albus is known and Cisticola cherina has been introduced. Both Ardea cinerea and Butorides striatus probably breed.

Guano deposits are found on North Island, and have been worked; there are reserves of 3,500 tons.

Maize and coconuts are grown. Dupont recorded rabbits in 1906. Apart from notes on sea birds there is no recent information on the biota of Cosmoledo, though the rail is thought to be extinct.

Main references: Baker 1963, 86-92; Dupont 1907, 8-12, Fryer 1911, 428-430; Vesey-FitzGerald 1942, 13-15; Watson, Zusi and Storer 1963.

Additional references: Connolly 1925; Ridgway 1895; Vesey-FitzGerald 1940; Vesey-FitzGerald 1941.

Maps: Admiralty Chart 718 (survey of 1878); individual islands mapped by Baker 1963, 87, 89, 91, 93.

5. FARQUHAR (JOAO DE NOVA) 10°10'S., 51°7'E.

Farquhar is an atoll 11.5 miles long and 6.5 miles wide, maximum dimensions, with two main islands (South Island, North Island) on the eastern rim, the small island of Goelette on the southeast side, and three small islets on the north. The lagoon is shallow and full of patches, except near the east rim, where there is a deeper basin with up to 6 fathoms and an entrance on the north side with 3-5 fathoms. Fryer reports some residual elevated reefrock, but according to Baker the islands are all sand cays and there is no elevated rock. Most of North Island is less than 10 feet above sea level, with dunes 5-50 feet high at the south end; South Island has dunes 50-70 feet high. Goelette is low and sandy.

Very little is known of the biota. Pemphis, Tournefortia, Scaevola, Casuarina and coconuts are the only plants recorded. According to Rothschild the giant tortoise formerly occurred here, but no supporting evidence is known for this. 63 species of insects are known. Among the sea birds Sula dactylatra melanops, Sterna sumatrana mathewsi, and Sterna fuscata breed on Goelette, and Sula sula rubripes on South Island. Anous tenuirostis tenuirostris is recorded roosting but not breeding. There is a single native land bird, Foudia madagascariensis, which is common. Gardiner states that the Barred Ground Dove Geopelia striata has been introduced and is common at the settlement on North Island (Grande Poste).

There are no commercial guano deposits, except for some phosphatic sandstone and guano on the two main islands, but according to Piggott mining has disturbed the breeding colonies of terns. There are settlements on both North and South Islands, and a jetty on the former.

Main references: Baker 1963, 80-85; Gardiner 1907, 142-145; Gardiner 1936, 432-433.

Additional references: Carpenter 1916; Cockerell 1912; Edmondson 1923; Fleutiaux 1923; Forel 1907; Fryer 1910; Fryer 1912; Gardiner 1906; Grouvelle 1913; Hampson 1920; Jordan 1939; Maulik 1931; Needham 1913; Scott 1912; Vesey-FitzGerald 1940; Vesey-FitzGerald 1950.

Maps: Admiralty Chart 718 (survey of 1878); Baker 1963, 81.

6. ST PIERRE 9°19'S., 50°43'E.

St Pierre is a circular uplifted atoll 0.75 miles in diameter, with an area of 417 acres, situated 270 miles east of Aldabra and 19 miles southwest of Providence. The coastal cliffs rise to 8-30 feet above sea-level, with no fringing reef, and the reefrock is deeply intersected by caves and crevices. Dunes 10 feet high are perched on the cliffs near blowholes. The centre of the island is close to sea-level, and has a small tidal pool. Physiographically the island resembles Assumption.

The native vegetation consisted of Sporobolus on the dunes; Suriana and Tournefortia, or Pemphis, along the lee coast; and a scrub of Pemphis, Hibiscus, Pisonia and Euphorbia over the rest of the island. Coppinger mentioned a dense growth of scrubby bushes and three or four palms in 1882. 25 species of land plants are recorded, and the flora was clearly like that of Aldabra and Assumption. Maize and tobacco have been grown.

The fauna formerly included the giant land tortoise, according to Rothschild, but no direct evidence of this has been found. Apart from the Madagascar fody, Foudia madagascariensis, there are no land birds, and though Sula sula rubripes formerly nested in large numbers, it does not do so now.

The ecology of the island has been drastically altered by the mining of guano and high grade phosphate rock, which began in 1906. Between 1926 and 1960, 151,000 tons were exported, and reserves of 10,000-15,000 tons remain. The island surface is now a "maze of pits and crevices as a result of guano working", according to Baker. The mining has resulted in almost total destruction of the vegetation. "On the east coast a few scattered specimens of Pemphis bushes still exist whilst only two extremely battered specimens of Pisonia have been left on the centre of the island. Of the herbs which survive on the remains of the soil, Stachytarpheta indica is the most common" (Piggott 1961). Piggott also records the introduction of Gaillardia pulchella; together with the following exotics near the settlement: Datura stramonium, Asystasia gangetica, Agave sp., Carica papaya, and Musa sp. Casuarina has been planted as a windbreak, and is doing well. The guano has continued to be worked, and a crushing plant has been installed.

Main references: Baker 1963, 100; Coppinger 1883, 236; Dupont 1907, 1-2; Gardiner 1907, 148-149; Gardiner 1936, 434-435; Piggott 1961; Vesey-FitzGerald 1941; Vesey-FitzGerald 1942, 15; Watson, Zusi and Storer 1963.

Map: Baker 1963, 100.

7. PROVIDENCE 9°14'S., 51°02'E.

Providence Island is situated at the north end of the 25 mile long, 6 mile wide Providence Bank. It is 2.75 miles long and 1200 yards wide, with a reef platform on the west side. The island is sandy, without elevated reefrock, and is covered with coconuts and Casuarina. 33 species of plants are recorded, mostly collected by Coppinger in 1882 and by Dupont. Coppinger also records the following cultivated plants: pawpaw, custard apple, pepper, sweet potato, onions, lettuce, and capsicum.

Very little is known of the fauna. Rothschild records the former existence of the giant land tortoise, but on unknown authority. Coppinger found seven

giant tortoise imported from Aldabra roaming in the woodland in 1882; and he also states that green turtle nest on the island in April. There are 22 recorded species of insects. There are no land birds. Sea birds breeding on the bank include Sterna bergii thalasseus, Gygis alba monte, and possibly Dromas ardeola. Shore birds breeding on the bank include Sterna bergii thalasseus, Gygis alba monte, and possibly Dromas ardeola. Shore birds breeding include Ardea cinerea, and Butorides striatus is recorded. There are also nine records of vagrants and migrants.

Guano reserves have been considerable, covering 147 acres at the north end of the island, out of a total area of 388 acres. Between 1935 and 1949 27,260 tons were exported, and Baker estimates reserves at 9,000 tons.

Cerf Islands (Banc du Sud), at the southern end of Providence Bank, is now a single large sand cay, with four smaller ones, while in 1905 there were seven small islands. Casuarina and Scaevola are recorded, and coconuts and cassava are said to be grown. Coppinger found only pioneer vegetation and bushes in 1882.

Main references: Baker 1963, 77-80; Coppinger 1883, 231-236; Gardiner 1907, 146-148; Gardiner 1936, 434-435; Watson, Zusi and Storer 1963.

Additional references: Butler 1884; Carpenter 1916; Coppinger 1884; Fryer 1911; Holland 1896; Linell 1897; Maulik 1931; Ridgway 1895; Schenkling 1922; Scott 1913; Warburton 1912.

Chapter 4

THE BIRDS OF ALDABRA AND THEIR STATUS

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1. HISTORICAL INTRODUCTION

Prior to 1892, the one and only piece of ornithological activity pertaining to Aldabra seems to have been the collecting by Commander Wharton, during the visit of H.M.S. Fawn to the atoll in July 1878, of two specimens of the rail Dryolimnas cuvieri aldabranus, described by Günther (1879). They are in the British Museum (Natural History). It is true that Sclater (1871) had described a turtledove as Turtur aldabranus from two specimens allegedly from Aldabra, but as will be shown their origin was almost certainly in the Amirante Islands. Although during the course of her voyage in 1881-82 H.M.S. Alert visited the Amirantes and Gloriosa, together with Providence, Cerf Islands, and St Pierre, she did not visit Aldabra or the nearby islands (Coppinger 1883; Coppinger and others 1884).

Dr W. L. Abbott spent three and a half months, from September to December 1892, on Aldabra, and made a thorough survey of the avifauna. His collections were sent to the Smithsonian Institution, United States National Museum. The new forms collected were described by Ridgway (1893, as amended 1894a; 1894b), certain nests and eggs by Bendire (1894), and finally Ridgway (1895) gave an account of Abbott's ornithological activities in the western Indian Ocean generally, quoting many field observations.

Dr A. Voeltzkow spent from 21 May to 21 June 1895 on Aldabra,[1] and collected 59 specimens, now in the Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt. The collection was catalogued by Berlepsch (1899). Voeltzkow (1917, 457-459) himself drew up a list of Aldabra birds, but it provided no new information. The yacht Valhalla, on which M. J. Nicoll was naturalist, arrived at Aldabra on 13 March 1906, and stayed there three days. The birds collected were reported on by Nicoll (1906), and are in the British Museum. There is also a more general account of the visit by Nicoll (1908).

J. C. F. Fryer spent from August 1908 to February 1909 in the archipelago--that is, including Assumption, Cosmoledo and Astove as well as Aldabra. He wrote a general account of the visit, including notes on the flora and fauna (Fryer 1911). These notes contain few references to birds, none of which were apparently collected. But Fryer (1911, 399) states that a bird collector for the Tring Museum spent a year there. No general account of this collection has been traced. There are merely incidental references in the literature to particular species, as by Lowe (1924). Two collectors appear to have been involved, namely F. R. Mortimer and a gentleman named Thibault. The bulk of the collection must now be in the American Museum of Natural History, to whom in 1932 Lord Rothschild sold the majority of the birds in the Tring Museum. But a few specimens formed part of a Rothschild Bequest to the British Museum in 1939. Two other small collections in the British Museum from Aldabra include one of 26 specimens presented as a Howard Saunders Bequest, collected in October and November 1906, the collector's name unrecorded, and one of 12 specimens collected and presented by R. Dupont, of the Botanic Station, Seychelles, and also dated October 1906.

[1] Voeltzkow (1897, 42-43) says he arrived on Aldabra on 21 April 1895, and (1897, 55) that he stayed for over one month, but this cannot be reconciled with his specimen labels - Editor.

Dupont (1907) has given an account of his visit to the archipelago, which was primarily an agricultural reconnaissance, and which lasted from September 1906 to January 1907. Two paragraphs (Dupont 1907, 23) are devoted to birds, and appended is a bare list of species for various islands in the western Indian Ocean, Astove, Cosmoledo, Assumption and Aldabra all being shown separately. It is not stated what is the basis for this list, and it is not referred to in Section 3 below except in the case of those records which are unavailable in any other source of information.

I have no knowledge of any further ornithological activity until 1937, when L. D. E. F. Vesey-FitzGerald visited the Aldabra archipelago. Few specimens were collected, but for accounts of the land and sea birds respectively, see Vesey-FitzGerald (1940, 1941). Vesey-FitzGerald also obtained specimens of the sunbird Nectarinia sovimanga buchenorum from Cosmoledo in April 1952 (Williams 1953a).

In May 1954 the French ship Calypso visited Aldabra. Thirty-one birds were collected by G. Cherbonnier, between 10 and 26 May. The collection is now in the Muséum National d'Histoire Naturelle, Paris, and Dr G. Roux has kindly provided a list of the species and numbers of specimens of each. During 1959-64 there were several visits to Aldabra by British warships, and accounts have been published of the observations made. The first was by H.M.S. Leopard, in November 1959, for a brief account of which see Boulton (1960). In January 1962 a party from H.M.S. Owen spent three days ashore on Aldabra, the ship returning for twelve hours at the end of the next month (Morris 1963, as annotated by Bourne). In March 1964 H.M.S. Owen again visited Aldabra (and also Cosmoledo, Astove and Assumption). The observations made by the ship's personnel were written up by Bourne (1966).

The Bristol Seychelles Expedition 1964-65 spent part of November and December 1964 on Aldabra, as a result of which there are already several publications. There is a general account of the birds by Penny (1965), the expedition's leader. Dawson (1966a) has reported on the sea birds of the Seychelles generally, including also the Aldabra archipelago, while Gaymer (1966) has presented a case for the conservation of Aldabra. They caught, measured, weighed and released many land birds, the results of which Gaymer has been kind enough to place at my disposal. They also collected 19 specimens, which he has allowed me to use in the writing of this paper, and which are to be presented by the Expedition to the British Museum.

2. ACKNOWLEDGMENTS

Dr D. R. Stoddart, of the Department of Geography, Cambridge University, who invited me to write this paper, has readily responded to various requests for assistance. Dr W. R. P. Bourne has made available papers from Sea Swallow, examined various specimens with me in the British Museum, and criticised part of the original draft of this paper. As already mentioned, R. Gaymer has placed certain information and specimens which he collected at my disposal. I am most grateful for his generosity in these matters. I must also thank D. Goodwin for examining with me in the British Museum material of the turtledove Streptopelia picturata.

The specimens studied at first hand are mostly in the British Museum (Natural History), London, where J. D. Macdonald and his staff have provided every possible facility. I have also been fortunate to have had available at my place of employment, in the Department of Zoology, Cambridge University, a collection of over 1,000 specimens from the Malagasy Region (for a definition of which, see Section 3). It was assembled by Professor A. Newton, in charge of the Department from 1866 until his death in 1907, and his brother Sir Edward Newton, resident on Mauritius from 1859 to 1877. It includes a few of Abbott's Aldabra specimens, obtained in 1894 by exchange with the Smithsonian Institution.

In May 1966 I spent a week in the Muséum National d'Histoire Naturelle, Paris, in pursuance of a long-term study of the origins of the land avifauna of the Malagasy Region, and received all possible help from Drs J. Dorst, C. Jouanin and F. Roux. At this time I had no special interest in Aldabra, though I did take some note of a few of the specimens collected by Cherbonnier. As already recorded, Roux has now provided a complete list of them, and has moreover lent me several of particular interest.

Special thanks are due to Dr George E. Watson, of the Smithsonian Institution, who lent me at short notice by air mail a number of Abbott's specimens, including the complete skin of a flamingo. He has also quickly responded to inquiries about some other specimens. I am also most grateful to Dr J. Steinbacher for lending me some of Voeltzkow's specimens and for information about others.

Finally, I thank R. E. Moreau, W. R. P. Bourne, R. Gaymer and D. R. Stoddart for their comments on this paper.

3. SYSTEMATIC LIST

This list is divided into (1) land birds and (2) sea birds. The latter heading includes consideration of species occurring (or likely to occur) on Aldabra included in Alexander (1955). The land bird list is subdivided into (a) species which breed on Aldabra and may be presumed resident; (b) migrants, (i) already recorded, and (ii) not yet recorded but likely to occur; and (c) species whose status is still uncertain.

The term Malagasy Region is employed in the same sense as by Moreau (1964), and includes Madagascar, the Mascarene Islands (Réunion, Mauritius and Rodriguez), and other oceanic islands in the western Indian Ocean to as far north as the Seychelles. The term Aldabra archipelago includes Aldabra, Assumption, Cosmoledo and Astove, though not Gloriosa.

In general, the nomenclature, both scientific and English, follows that of Watson, Zusi and Storer (1963). Subspecific names are not used except where they seem to have been reasonably satisfactorily established. English names are the equivalent of scientific specific, rather than subspecific, names.

A sign "o" indicates an unsexed specimen. The average of measurements is often given in brackets following the extremes.

It should be well-known that Bergmann's Rule is to the effect that in warm-blooded vertebrates the smaller-sized geographic forms of a species are found in the warmer parts of the range, the larger-sized in the cooler parts of the range.

(1) Land Birds

(a) Breeding Residents (or presumed so)

Dawson (1966a, 7) records the Indian Reef Heron Demiegretta asha as breeding exclusively on Astove. But if this is so, it could also do so on Aldabra. However, in the absence of supporting details one cannot be convinced that it breeds even on Astove, especially as according to Watson, Zusi and Storer (1963, 24) it is not known to breed otherwise nearer to Astove than Ceylon. It may also be mentioned here that Vesey-FitzGerald (1940, 488) found the Madagascar Grass-Warbler Cisticola cherina abundant on Cosmoledo and Astove, though he did not see it on Aldabra. Unfortunately the specimen which he collected and sent to the British Museum cannot be traced.

Ardea cinerea cinerea Linnaeus Grey Heron

According to Abbott (in Ridgway 1895, 530), this species breeds on Aldabra, and nests with young were seen in November. One specimen was collected, and likewise by Voeltzkow (Berlepsch 1899, 495). Nicoll (1906, 695) records it from both Aldabra and Assumption. Morris (1963) saw a few on Aldabra, but Bourne (1966) records "hundreds". Dupont (1907) lists it from throughout the archipelago.

Benson (1960a, 31) considers that two specimens from the Comoros are better placed with A. c. cinerea than A. c. firasa Hartert of Madagascar, the latter distinguishable by longer measurements for the culmen and tarsus (respectively 131 - 145 as against 110 - 133, and 185 - 200 as against 155 - 182 mm.). He thought that four immature specimens from Aldabra and Assumption were also best placed with A. c. cinerea, though possibly not fully grown. Berlepsch (1899, 495) gives the wing of Voeltzkow's specimen as 465, culmen 140, tarsus 165 mm. The tarsus measurement is well within the range of A. c. cinerea. That for the culmen agrees better with A. c firasa, but may have been taken from the base of the skull instead of the end of the frontal feathering as in Benson's measurements. A specimen in Cambridge from the Amirante Islands, collected in December 1864, has wing 424, culmen (from frontal feathering) 120, tarsus 170 mm., thus agreeing with A. c. cinerea. It is concluded that the populations frequenting all of the above-mentioned islands are best attributed to this subspecies, and are accordingly of African rather than Madagascan origin.

Butorides striatus crawfordi Nicoll Little Green Heron

B. s. crawfordi, of which I have seen the type, an adult male in the British Museum from Assumption, and another adult male therein from Aldabra, can easily be distinguished from B. s. rhizophorae Salomonsen, of the Comoros, by the paler grey of the underside. I have also been lent the specimen collected by Abbott on Aldabra (Ridgway 1895, 531). It is a male in immature dress, and cannot be used in considering subspecific differences based on colour. The same applies to a female in Paris collected on Aldabra by Cherbonnier, which I have also seen. But all four specimens are smaller than

rhizophorae, see below. Presumably there is the same sexual colour difference in the adult of crawfordi as in rhizophorae and B. s javanicus (Horsfield), that is, the female has the sides of the neck, chest and abdomen washed with brown, and the spotting on the throat more strongly pronounced (Benson 1960a, 34).

Benson (1960a) gives the wing-length of 16 specimens of rhizophorae as 170 - 180 mm. Thirteen specimens in London, Paris and Cambridge from Reunion, Mauritius and Rodriguez, doubtfully separable from the Asiatic javanicus, measure 167 - 181 mm. On the other hand, 10 specimens from the Seychelles (Mahé, Cousin, Praslin, La Digue), attributable to B. s. degens Hartert, measure 159 - 168 mm. only. Like degens, crawfordi is also small, as the following figures show:

Adult ♂	159, 161 mm.
Immature ♂	159 mm.
Immature ♀	157 mm.

An immature male collected by Voeltzkow which I have been lent has wing 152 mm., and may not be quite fully grown. This certainly applies to an immature specimen in Cambridge from the Amirantes, with wing 140 mm. only.

Benson (1960a, 34) accepts the contention of White (1951, 460) that rhizophorae is of Asiatic origin, and there is no reason to suppose that this does not also apply to crawfordi. On the other hand, B. s. rutenbergi (Hartlaub) of Madagascar is very close to B. s. atricapillus (Afzelius) of Africa, whence White suggests that degens of the Seychelles is also derived.

Abbott (in Ridgway 1895, 531) found this species quite common on Aldabra, breeding among mangroves in November and December, laying two eggs. Probably the breeding season is fairly extensive, since in the Comoros Benson (1960a, 35) obtained data pointing to egg-laying in August and September. Abbott also noted that the birds stand for hours on the backs of turtles, catching the blue-bottle flies which swarm on the turtles' backs and heads. Dupont (1907) lists this species from throughout the archipelago.

Egretta garzetta dimorpha Hartert Little Egret

E. dimorpha has often been regarded as a full species, as by Watson, Zusi and Storer (1963). However, I see no reason to differ from the opinion of Grant and Mackworth-Praed (1933) and Berlioz (1949, 20), for example, that dimorpha is conspecific with E. garzetta. Dimorpha inhabits Madagascar and the Aldabra archipelago, and is notable for the common occurrence of a dark blue-grey phase as well as a white phase. A grey phase also occurs in coastal eastern and north-eastern Africa and in coastal West Africa (White 1965, 25), but is rare or quite absent in the interior of Africa. Grant and Mackworth-Praed (1933) have separated the populations of Aldabra and Assumption as E. g. assumptionis, differing from dimorpha by its longer bill. This was on the basis of material in the British Museum. There is no further material available therein. While due note must be taken of this difference, the measurements presented show an appreciable overlap. On existing evidence it is difficult to justify recognition of assumptionis.

Abbott (in Ridgway 1895, 530, under Demigretta gularis) found this the commonest heron on Aldabra, and breeding in large numbers in December, laying from two to four eggs. The white phase was twice or thrice as numerous as the blue. Nicoll (1906, 696, 704, under Demiegretta sacra) collected it on both Assumption and Aldabra, finding it extremely abundant on the latter. A specimen collected on Aldabra was partially white and dark. I can confirm that this applies to both this and another specimen from Aldabra, both in the British Museum. Morris (1963) found both phases plentiful on Aldabra. Bourne (1966) records hundreds, of which about forty per cent were in the dark phase. He also records it from Cosmoledo, where the phases were about equal, while one "White-faced Heron" was seen on Astove (presumably this was a specimen of E. g. dimorpha in the dark phase, in which the chin and throat are still white). He gives no record from Assumption, and possibly it has been extirpated there. Dawson (1966a, 7) records large flocks on Cosmoledo, Astove and Aldabra, the proportion of light to dark birds being about seven to three, with the occasional intermediate piebald.

Milon (1959) found that in two breeding colonies in Madagascar selected for study the ratio of the dark phase to the white phase was about 35: 65. The observations from the Aldabra archipelago tend roughly to bear this out.

Threskiornis aethiopica abbotti (Ridgway) Sacred Ibis

This species occurs in Africa (T. a. aethiopica (Latham)), Madagascar (T. a. bernieri (Bonaparte)) and Aldabra (T. a. abbotti). The characters on which these three subspecies can be recognised may be summarised as follows (it should here be mentioned that immature specimens of all three have the head and neck feathered, whereas in adults these areas are bare):

Feathering on head and neck (in immature): In aethiopica and bernieri white heavily streaked black; in abbotti black streaking much reduced, and only on a few feathers. (Only one immature specimen of abbotti was available. But the difference was striking, and shows up well in three photographs in Nicoll (1908).)

Decomposed tertials: Glossy purplish slate in aethiopica, bluish slate in bernieri, much paler than in aethiopica; bluish slate in abbotti, as in bernieri, but darker.

Metallic green tips to remiges: Extending back 40 - 60 mm. in aethiopica; not more than 15 mm. in bernieri, in three out of eight specimens absent; not more than 10 mm. in abbotti, in four out of six specimens absent.

Iris (in adult): Brown in aethiopica (see for example McLachlan and Liversidge 1957); white in bernieri; bluish-white in abbotti. (The difference between bernieri and abbotti is as given by Ridgway 1895, 530, and is confirmed from the labels of one adult specimen of the former and two such of the latter. An immature specimen of abbotti had the iris very dark brown.)

Ridgway also suggests that the lower half of the neck is entirely naked in abbotti, but not so in bernieri. I cannot convince myself that the extent of feathering up the neck is not variable in the adult of all three subspecies, and that it can be used as a distinguishing character. Ridgway further suggests that the tips to the remiges differ in colour, but it seems that there is only a difference in its extent.

Presumably bernieri was derived from aethiopica, and probably abbotti from bernieri rather than aethiopica. The colour of the decomposed tertials, the reduction of the dark tips to the remiges, and the colour of the iris all suggest a closer relationship of abbotti to bernieri than to aethiopica.

The following are measurements in mm. of the material of bernieri and abbotti studied, in London, together with two specimens of bernieri in Cambridge:

	Wing			Culmen from base			Tarsus		
Bernieri									
Adult ♂	374			169			95		
Adult ♀ ♀	342	348	362	132	137	144	72	76	82
Immature ♂	357			182			84		
Immature ♀ ♀	334	340		136	143		74	78	
Immature ○	371			broken			87		
Abbotti									
Adult ♀ ♀	336	340		125	132		76	76	
Adult ○	335	337	338	125	133	136	70	70	72
Immature ♂	347			176			80		

These figures do not suggest any marked difference between the two subspecies. Evidently males are longer billed in both.

Falco newtoni aldabranus Grote Madagascar Kestrel

It is presumed that Madagascar, inhabited by F. n. newtoni (Gurney), has been the source of origin for the populations elsewhere in the Malagasy Region, namely F. punctatus Temminck of Mauritius, F. n. aldabranus of Aldabra, and F. araea (Oberholser) of the Seychelles. A single unsexed specimen of aldabranus (judging from its wing-length) from Anjouan, in the Comoros, is considered by Benson (1960a, 39) to have been a stray from Aldabra, but is discussed further below. Failure to colonise the Comoros may be because the islands as a whole were probably originally almost wholly covered with evergreen forest (Moreau 1966, 346). In Madagascar, Rand (1936, 378) found the species everywhere except in heavy forest.

Benson (1960a, 39) studied to some extent the material in London. It has been re-examined, 13 specimens in Cambridge have also been considered, and wing-lengths taken of three specimens of aldabranus collected by Cherbonnier, in Paris. Material of F. araea in London, Paris and Cambridge has also been considered.

From field observations, Gaymer tells me that the male of F. n. aldabranus is more brightly coloured than the female. I cannot make any personal judgment in this matter, since the only two specimens examined after I had

preceding the mining of guano, during which the natural vegetation was destroyed on several islands and certain birds and other animals became extinct. In more recent years, we have the observations made by Vesey-Fitz-Gerald on the vegetation and the birds in 1937, and the largely geological observations of Baker and Piggott in 1960-61. The Bristol Seychelles Expedition spent some hours ashore on Cosmoledo Atoll (Menai Island) on 9 November 1964 and on Assumption on 10 November 1964. The following year R. Gaymer, of that expedition, made a short visit to Cosmoledo on 1 October 1965 and to Assumption on 3 October 1965. I am grateful to R. Gaymer for sending me a copy of his observations on these islands.

Because the information on these islands is so scattered, the salient features of the ecology of each of the seven islands or atolls listed are here summarized, with reference particularly to the vegetation, the reptiles, and the birds. In preparing this summary, lists were compiled of the plants collected or recorded from each island, based on published accounts, particularly those of Dupont (1907) and Hemsley (1919), and use was made of the lists of birds by Watson, Zusi and Storer (1963). For the information on insects I have relied on the summary by Scott (1936) and no special search has been made of the papers in the Percy Sladen Expedition Reports. The most important general sources are Coppinger (1883), Dupont (1907), Fryer (1911), Vesey-FitzGerald (1940, 1941, 1942), Watson, Zusi and Storer (1963), and Baker (1963). The summary account of each island does not contain citations for each statement, but a list of the more important references, less important references, and maps is appended to each: full citations are given in the "Bibliography of Aldabra" in this Bulletin.

This summary does not treat the Amirantes and Desroches, Cargados Carajos, Agalega, or Tromelin.

1. ASSUMPTION 9°46'S., 46°31'E.

Assumption is an elevated reef island 20 miles south of Aldabra, 3.75 miles long and 0.3-1.0 miles wide. The deeply dissected reef rock rises to 20 ft above sea level, with dunes on the east and south sides rising to 90 feet. Early in the century the island was wooded in the west and southwest, and the centre was only thinly vegetated. The vegetation resembled that of Aldabra, and 68 species of flowering plants have been recorded, three of them endemic (Panicum assumptionis, Eriochlea subulifera, Stenotaphrum clavigerum). The dunes are covered with Sporobolus and clumps of Sclerodactylon, with patches of Suriana, Scaevola and Tournefortia. The centre of the island had a few Hibiscus bushes, and coconuts are planted on sand along the west shore. The rest of the island has been stripped of vegetation during guano-digging, and there are now only a few stunted bushes in holes and pits, the ground being covered with Plumbago aphylla. Some Casuarina have been planted on the west coast. No mangroves are recorded.

Tortoises formerly existed here, and Fryer found their remains. There is a skink Ablepharus boutonii, and two geckos, Phelsuma abbotti abbotti and Hemidactylus mercatorius. 65 species of insects are recorded. Birgus latro was common in 1906. Marine turtles formerly nested here in large numbers, but only a few are reported to do so now.

Large numbers of boobies and terns formerly bred on the island, but have disappeared as a result of mining operations. Abbott's Booby, Sula abbotti, is now extinct on Assumption and is found only on Christmas Island. Vesey-FitzGerald gives the date of its disappearance as 1926. Sea and shore birds recorded as breeding on Assumption are Sula abbotti (extinct), Butorides striatus, Ardea cinerea, Egretta garzetta dimorpha, (which may also be extinct), and possibly Sula sula. Others recorded from the island are Sula dactylatra melanops, Sterna sumatrana mathewsi, Gygis alba monte, Phäethon rubricauda rubricauda, and Dromas ardeola. Resident land birds recorded are Streptopelia picturata coppingeri, Nectarinia sovimanga abbotti, Centropus toulou assumptionis, and Dryolimnas cuvieri abbotti. The rail, collected by Abbott in 1892 and described by Ridgway in 1893 and 1894a, became extinct between 1906 and 1937. The coucal and turtledove may also have disappeared. Gaymer recorded Corvus albus in 1965.

Guano reserves are the largest in the western Indian Ocean: 161,000 tons were exported during 1926-1945, and Baker estimates the remaining reserves at 160,000 tons. Mining ceased in 1945, but has started again since 1955; a mechanical crusher and light railway have been installed. Goats were introduced in early 1887 by a whaler, became feral, and were later used to colonise Aldabra; Abbott states that they were brought from Europa Island in the Mozambique Channel. Nicoll found twenty in 1906, but according to Gaymer they no longer exist. Nicoll also found numerous rats which were threatening to eliminate some of the rarer birds.

Main references: Abbott 1893, 763; Baker 1963, 101-106, 124-126; Dupont 1907, 12-13; Fryer 1911, 431-433; Nicoll 1906; Nicoll 1908, 107-113; Ridgway 1895, 520-523; Vesey-FitzGerald 1940; Vesey-FitzGerald 1941; Vesey-FitzGerald 1942, 12-13; Watson, Zusi and Storer 1963.

Additional references: Honegger 1966b; Ridgway 1893; Ridgway 1894b; Vesey-FitzGerald and Parker 1947.

Map: Baker 1963, 102.

2. ASTOVE 10°06'S., 47°45'E.

Astove is an elevated coral atoll 3.5 miles long and 2.5 miles wide, consisting of a reefrock rim 15 feet high, with sand dunes 45-50 feet high on the east coast. According to Baker reefrock covers 583 and sand 642 acres. The lagoon averages 3-4 feet in depth, with a maximum of 10 feet, and the entrance dries at low water. The fringing reef is 200 yards wide.

The dunes are covered with Suriana on the windward side, and with Scaevola and Tournefortia to leeward. Lagoonward of the dunes, champignon is covered with Pemphis thicket. The lagoon is filled with fine sediment, and is ringed with scattered Avicennia trees, but otherwise there is no mangrove. On the western lagoon shore, beach ridges are colonised by Sporobolus, and planted with coconuts and Casuarina. Pemphis grows on bare reefrock, and Scaevola and Tournefortia on sand. The sea coast on the leeward side has a thicket of Suriana, Scaevola and Tournefortia. A deciduous scrub covers the surface on the wider parts of the eastern side, with frequent Pisonia trees. 59 species of plants are recorded from Astove.

Tortoises formerly occurred here, according to Rothschild, and Fryer reports the finding of possible remains. Other reptiles include Phelsuma astriata astovei, Hemidactylus mercatorius, and possibly Ablepharus boutonii. Fryer also found that insects were numerous (27 species are recorded) and butterflies especially common. The land birds include Nectarinia sp., Zosterops maderaspatana, and a flightless rail, Dryolimnas cuvieri. Abbott reported the rail from hearsay, but it was probably extinct by 1906. Large numbers of Egretta garzetta have recently been recorded, together with Ardea cinerea and Butorides striatus. There are records of Bubulcus ibis ibis, Thalasseus bergii thalassina and possibly Demiegretta asha. Sula sula may be the only breeding sea bird; Corvus albus and Cisticola cherina have appeared; and there is a record of Hydroprogne caspia.

Guano is found on the west side, and has been mined since 1927. 70,000 tons have been reported, and 5000 tons are left, according to Baker. Most of the native vegetation in the guano area has disappeared, though some Pisonia grandis and occasional Sideroxylon inerme remain. It has been replaced by Plumbago aphylla, with Dactyloctenium pilosum and Stachytarpheta indica; Agave and Gossypium are also found. Coconuts are grown on the west side, though not very successfully, and maize has been grown in the dunes.

Main references: Baker 1963, 92-97; Dupont 1907, 2-8; Fryer 1911, 426-428; Piggott 1961, 6-8; Vesey-FitzGerald 1942, 10-12; Watson, Zusi and Storer 1963.

Additional references: Honegger 1966b; Vesey-FitzGerald 1940; Vesey-FitzGerald 1941.

Map: Piggott 1961; Baker 1963, 94.

3. GLORIOSA 11°34'S., 45°13'E.

The Gloriosa Islands are situated 114 miles west-north-west of Madagascar, and consist of two sandy islands with a grass-covered rock between them. Gloriosa, the larger island, is 1.5 miles long, and has dunes 50-60 feet high on its lee side, and a central tidal marsh which dries at low water. Ile du Lise, three miles away, is smaller, but has a dune 30 feet high, and also beachrock and conglomerate. Coppinger found a block of basalt on the reef, together with quartz pebbles.

Little is known of the biota. Gloriosa has been planted with coconuts and the "dense growth of virgin forest" seen by Coppinger in 1882 has since been cleared. Ile du Lise still has woodland on it, with Ficus, Hibiscus and Scaevola, and Pemphis in the central swamp. Maize used to be grown in large amounts on Gloriosa. Coppinger collected on the islands in 1882, and they were also visited by Abbott and Nicoll. According to Hemsley, Abbott found mangroves 50-60 feet high, but Abbott's actual record was of sand dunes. 30 species of plants have been recorded.

According to Rothschild, tortoises formerly existed on Gloriosa, but no supporting evidence for this can be found. Abbott records three small reptiles: Hemidactylus mabouia, Ablepharus gloriosus, and Zonosaurus madagascariensis. Nicoll found numerous butterflies and moths, and (on du Lise) Coppinger found many spiders and hermit crabs. Both Coppinger and Nicoll report Birgus latro on du Lise but not on Gloriosa. Green and hawksbill

turtles used to nest on Gloriosa and may still do so. The known resident land birds are Streptopelia picturata coppingeri, Hypsipetes madagascariensis grotei, Nectarinia sovimanga sovimanga, and Zosterops maderaspatana maderaspatana; together with Corvus albus, which is common. Nesting sea-birds include Sula sula, Fregata sp., Sterna fuscata, and Anous stolidus pileatus: large numbers of the noddies were nesting in 1906 on the rock between the islands. Sula abbotti may also have bred in the past. Phäethon rubricauda rubricauda may also breed, and other species recorded are Dromas ardeola, Sterna sumatrana mathewsi, Thalasseus bergii thalassina, and Thalasseus bengalensis. Two vagrants and one migrant are also recorded. The domestic fowl, Gallus gallus, has become feral. Feral cats were common in 1893, and were reducing the numbers of birds. In 1882 there were abundant brown rats on both islands.

Main references: Abbott 1893, 763-764; Coppinger 1883, 237-240; Coppinger 1884; Nicoll 1906, 686-692; Nicoll 1908, 100-106; Watson, Zusi and Storer 1963.

Additional references: Holland 1896; Ridgway 1895, 524-526.

Map: Guilcher and others 1965, 14, fig. 4.

4. COSMOLEDO 9°41'S., 47°35'E.

Cosmoledo is an atoll 9 miles long and 7 miles wide, with a lagoon 5 miles in diameter with maximum depth of 4-1/4 fathoms. There are five main islands and several smaller ones on the atoll rim, which has an average width of one mile. Menai Island has the largest area, but Wizard Island or Grande Ile, 2 miles long, is the longest. The islands are formed of uplifted reefrock, much eroded, reaching 12-15 feet above sea-level, with large amounts of sand banked against the rocky remnants.

At Menai Island on the west rim the seaward coast (leeward) has a dune scrub with Guettarda; dunes rise to 40 feet at the north end. The lagoon coast has mangroves 80 feet tall, with a succession of Avicennia-Bruguiera-Rhizophora from sea to land. Dunes are also found inside the mangrove. Pemphis scrub covers champignon in the centre of the island. The eastern islands, Polyte and Wizard, have a seaward dune fringe up to 55 feet high, covered with Sporobolus and Suriana on the seaward side, and with Tournefortia to leeward. Pemphis again covers the reefrock. The smaller islands are rocky, with Pemphis, Sideroxylon and Plumbago. The known flora totals 56 species.

Tortoises formerly existed at Cosmoledo, and Fryer reported finding their fossil eggs. Other reptiles include Phelsuma abbotti menaiensis, Hemidactylus mercatorius, and Ablepharus boutonii. 37 species of insects are recorded, and three species of land mollusca. There are three recorded resident land birds: Zosterops maderaspatana maderaspatana, Nectarinia sovimanga buchenorum, and Dryolimnas cuvieri. Abbott reported the existence of the rail from hearsay, and according to Fryer it existed in 1919 on South Island, though he did not land there and observe it. The breeding sea birds are Phäethon rubricauda rubricauda, Sula dactylatra melanops, Sula sula, Fregata minor, Sterna anaethetus, Sterna fuscata, and Anous stolidus pileatus. Large flocks of Egretta garzetta and small number of Dromas

ardeola have recently been recorded. Corvus albus is known and Cisticola cherina has been introduced. Both Ardea cinerea and Butorides striatus probably breed.

Guano deposits are found on North Island, and have been worked; there are reserves of 3,500 tons.

Maize and coconuts are grown. Dupont recorded rabbits in 1906. Apart from notes on sea birds there is no recent information on the biota of Cosmoledo, though the rail is thought to be extinct.

Main references: Baker 1963, 86-92; Dupont 1907, 8-12, Fryer 1911, 428-430; Vesey-FitzGerald 1942, 13-15; Watson, Zusi and Storer 1963.

Additional references: Connolly 1925; Ridgway 1895; Vesey-FitzGerald 1940; Vesey-FitzGerald 1941.

Maps: Admiralty Chart 718 (survey of 1878); individual islands mapped by Baker 1963, 87, 89, 91, 93.

5. FARQUHAR (JOAO DE NOVA) 10°10'S., 51°7'E.

Farquhar is an atoll 11.5 miles long and 6.5 miles wide, maximum dimensions, with two main islands (South Island, North Island) on the eastern rim, the small island of Goelette on the southeast side, and three small islets on the north. The lagoon is shallow and full of patches, except near the east rim, where there is a deeper basin with up to 6 fathoms and an entrance on the north side with 3-5 fathoms. Fryer reports some residual elevated reefrock, but according to Baker the islands are all sand cays and there is no elevated rock. Most of North Island is less than 10 feet above sea level, with dunes 5-50 feet high at the south end; South Island has dunes 50-70 feet high. Goelette is low and sandy.

Very little is known of the biota. Pemphis, Tournefortia, Scaevola, Casuarina and coconuts are the only plants recorded. According to Rothschild the giant tortoise formerly occurred here, but no supporting evidence is known for this. 63 species of insects are known. Among the sea birds Sula dactylatra melanops, Sterna sumatrana mathewsi, and Sterna fuscata breed on Goelette, and Sula sula rubripes on South Island. Anous tenuirostis tenuirostris is recorded roosting but not breeding. There is a single native land bird, Foudia madagascariensis, which is common. Gardiner states that the Barred Ground Dove Geopelia striata has been introduced and is common at the settlement on North Island (Grande Poste).

There are no commercial guano deposits, except for some phosphatic sandstone and guano on the two main islands, but according to Piggott mining has disturbed the breeding colonies of terns. There are settlements on both North and South Islands, and a jetty on the former.

Main references: Baker 1963, 80-85; Gardiner 1907, 142-145; Gardiner 1936, 432-433.

Additional references: Carpenter 1916; Cockerell 1912; Edmondson 1923; Fleutiaux 1923; Forel 1907; Fryer 1910; Fryer 1912; Gardiner 1906; Grouvelle 1913; Hampson 1920; Jordan 1939; Maulik 1931; Needham 1913; Scott 1912; Vesey-FitzGerald 1940; Vesey-FitzGerald 1950.

Maps: Admiralty Chart 718 (survey of 1878); Baker 1963, 81.

6. ST PIERRE 9°19'S., 50°43'E.

St Pierre is a circular uplifted atoll 0.75 miles in diameter, with an area of 417 acres, situated 270 miles east of Aldabra and 19 miles southwest of Providence. The coastal cliffs rise to 8-30 feet above sea-level, with no fringing reef, and the reefrock is deeply intersected by caves and crevices. Dunes 10 feet high are perched on the cliffs near blowholes. The centre of the island is close to sea-level, and has a small tidal pool. Physiographically the island resembles Assumption.

The native vegetation consisted of Sporobolus on the dunes; Suriana and Tournefortia, or Pemphis, along the lee coast; and a scrub of Pemphis, Hibiscus, Pisonia and Euphorbia over the rest of the island. Coppinger mentioned a dense growth of scrubby bushes and three or four palms in 1882. 25 species of land plants are recorded, and the flora was clearly like that of Aldabra and Assumption. Maize and tobacco have been grown.

The fauna formerly included the giant land tortoise, according to Rothschild, but no direct evidence of this has been found. Apart from the Madagascar fody, Foudia madagascariensis, there are no land birds, and though Sula sula rubripes formerly nested in large numbers, it does not do so now.

The ecology of the island has been drastically altered by the mining of guano and high grade phosphate rock, which began in 1906. Between 1926 and 1960, 151,000 tons were exported, and reserves of 10,000-15,000 tons remain. The island surface is now a "maze of pits and crevices as a result of guano working", according to Baker. The mining has resulted in almost total destruction of the vegetation. "On the east coast a few scattered specimens of Pemphis bushes still exist whilst only two extremely battered specimens of Pisonia have been left on the centre of the island. Of the herbs which survive on the remains of the soil, Stachytarpheta indica is the most common" (Piggott 1961). Piggott also records the introduction of Gaillardia pulchella; together with the following exotics near the settlement: Datura stramonium, Asystasia gangetica, Agave sp., Carica papaya, and Musa sp. Casuarina has been planted as a windbreak, and is doing well. The guano has continued to be worked, and a crushing plant has been installed.

Main references: Baker 1963, 100; Coppinger 1883, 236; Dupont 1907, 1-2; Gardiner 1907, 148-149; Gardiner 1936, 434-435; Piggott 1961; Vesey-FitzGerald 1941; Vesey-FitzGerald 1942, 15; Watson, Zusi and Storer 1963.

Map: Baker 1963, 100.

7. PROVIDENCE 9°14'S., 51°02'E.

Providence Island is situated at the north end of the 25 mile long, 6 mile wide Providence Bank. It is 2.75 miles long and 1200 yards wide, with a reef platform on the west side. The island is sandy, without elevated reefrock, and is covered with coconuts and Casuarina. 33 species of plants are recorded, mostly collected by Coppinger in 1882 and by Dupont. Coppinger also records the following cultivated plants: pawpaw, custard apple, pepper, sweet potato, onions, lettuce, and capsicum.

Very little is known of the fauna. Rothschild records the former existence of the giant land tortoise, but on unknown authority. Coppinger found seven

giant tortoise imported from Aldabra roaming in the woodland in 1882; and he also states that green turtle nest on the island in April. There are 22 recorded species of insects. There are no land birds. Sea birds breeding on the bank include Sterna bergii thalasseus, Gygis alba monte, and possibly Dromas ardeola. Shore birds breeding on the bank include Sterna bergii thalasseus, Gygis alba monte, and possibly Dromas ardeola. Shore birds breeding include Ardea cinerea, and Butorides striatus is recorded. There are also nine records of vagrants and migrants.

Guano reserves have been considerable, covering 147 acres at the north end of the island, out of a total area of 388 acres. Between 1935 and 1949 27,260 tons were exported, and Baker estimates reserves at 9,000 tons.

Cerf Islands (Banc du Sud), at the southern end of Providence Bank, is now a single large sand cay, with four smaller ones, while in 1905 there were seven small islands. Casuarina and Scaevola are recorded, and coconuts and cassava are said to be grown. Coppinger found only pioneer vegetation and bushes in 1882.

Main references: Baker 1963, 77-80; Coppinger 1883, 231-236; Gardiner 1907, 146-148; Gardiner 1936, 434-435; Watson, Zusi and Storer 1963.

Additional references: Butler 1884; Carpenter 1916; Coppinger 1884; Fryer 1911; Holland 1896; Linell 1897; Maulik 1931; Ridgway 1895; Schenkling 1922; Scott 1913; Warburton 1912.

Chapter 4

THE BIRDS OF ALDABRA AND THEIR STATUS

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1. HISTORICAL INTRODUCTION

Prior to 1892, the one and only piece of ornithological activity pertaining to Aldabra seems to have been the collecting by Commander Wharton, during the visit of H.M.S. Fawn to the atoll in July 1878, of two specimens of the rail Dryolimnas cuvieri aldabranus, described by Günther (1879). They are in the British Museum (Natural History). It is true that Sclater (1871) had described a turtledove as Turtur aldabranus from two specimens allegedly from Aldabra, but as will be shown their origin was almost certainly in the Amirante Islands. Although during the course of her voyage in 1881-82 H.M.S. Alert visited the Amirantes and Gloriosa, together with Providence, Cerf Islands, and St Pierre, she did not visit Aldabra or the nearby islands (Coppinger 1883; Coppinger and others 1884).

Dr W. L. Abbott spent three and a half months, from September to December 1892, on Aldabra, and made a thorough survey of the avifauna. His collections were sent to the Smithsonian Institution, United States National Museum. The new forms collected were described by Ridgway (1893, as amended 1894a; 1894b), certain nests and eggs by Bendire (1894), and finally Ridgway (1895) gave an account of Abbott's ornithological activities in the western Indian Ocean generally, quoting many field observations.

Dr A. Voeltzkow spent from 21 May to 21 June 1895 on Aldabra,[1] and collected 59 specimens, now in the Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt. The collection was catalogued by Berlepsch (1899). Voeltzkow (1917, 457-459) himself drew up a list of Aldabra birds, but it provided no new information. The yacht Valhalla, on which M. J. Nicoll was naturalist, arrived at Aldabra on 13 March 1906, and stayed there three days. The birds collected were reported on by Nicoll (1906), and are in the British Museum. There is also a more general account of the visit by Nicoll (1908).

J. C. F. Fryer spent from August 1908 to February 1909 in the archipelago--that is, including Assumption, Cosmoledo and Astove as well as Aldabra. He wrote a general account of the visit, including notes on the flora and fauna (Fryer 1911). These notes contain few references to birds, none of which were apparently collected. But Fryer (1911, 399) states that a bird collector for the Tring Museum spent a year there. No general account of this collection has been traced. There are merely incidental references in the literature to particular species, as by Lowe (1924). Two collectors appear to have been involved, namely F. R. Mortimer and a gentleman named Thibault. The bulk of the collection must now be in the American Museum of Natural History, to whom in 1932 Lord Rothschild sold the majority of the birds in the Tring Museum. But a few specimens formed part of a Rothschild Bequest to the British Museum in 1939. Two other small collections in the British Museum from Aldabra include one of 26 specimens presented as a Howard Saunders Bequest, collected in October and November 1906, the collector's name unrecorded, and one of 12 specimens collected and presented by R. Dupont, of the Botanic Station, Seychelles, and also dated October 1906.

[1] Voeltzkow (1897, 42-43) says he arrived on Aldabra on 21 April 1895, and (1897, 55) that he stayed for over one month, but this cannot be reconciled with his specimen labels - Editor.

Dupont (1907) has given an account of his visit to the archipelago, which was primarily an agricultural reconnaissance, and which lasted from September 1906 to January 1907. Two paragraphs (Dupont 1907, 23) are devoted to birds, and appended is a bare list of species for various islands in the western Indian Ocean, Astove, Cosmoledo, Assumption and Aldabra all being shown separately. It is not stated what is the basis for this list, and it is not referred to in Section 3 below except in the case of those records which are unavailable in any other source of information.

I have no knowledge of any further ornithological activity until 1937, when L. D. E. F. Vesey-FitzGerald visited the Aldabra archipelago. Few specimens were collected, but for accounts of the land and sea birds respectively, see Vesey-FitzGerald (1940, 1941). Vesey-FitzGerald also obtained specimens of the sunbird Nectarinia sovimanga buchenorum from Cosmoledo in April 1952 (Williams 1953a).

In May 1954 the French ship Calypso visited Aldabra. Thirty-one birds were collected by G. Cherbonnier, between 10 and 26 May. The collection is now in the Muséum National d'Histoire Naturelle, Paris, and Dr G. Roux has kindly provided a list of the species and numbers of specimens of each. During 1959-64 there were several visits to Aldabra by British warships, and accounts have been published of the observations made. The first was by H.M.S. Leopard, in November 1959, for a brief account of which see Boulton (1960). In January 1962 a party from H.M.S. Owen spent three days ashore on Aldabra, the ship returning for twelve hours at the end of the next month (Morris 1963, as annotated by Bourne). In March 1964 H.M.S. Owen again visited Aldabra (and also Cosmoledo, Astove and Assumption). The observations made by the ship's personnel were written up by Bourne (1966).

The Bristol Seychelles Expedition 1964-65 spent part of November and December 1964 on Aldabra, as a result of which there are already several publications. There is a general account of the birds by Penny (1965), the expedition's leader. Dawson (1966a) has reported on the sea birds of the Seychelles generally, including also the Aldabra archipelago, while Gaymer (1966) has presented a case for the conservation of Aldabra. They caught, measured, weighed and released many land birds, the results of which Gaymer has been kind enough to place at my disposal. They also collected 19 specimens, which he has allowed me to use in the writing of this paper, and which are to be presented by the Expedition to the British Museum.

2. ACKNOWLEDGMENTS

Dr D. R. Stoddart, of the Department of Geography, Cambridge University, who invited me to write this paper, has readily responded to various requests for assistance. Dr W. R. P. Bourne has made available papers from Sea Swallow, examined various specimens with me in the British Museum, and criticised part of the original draft of this paper. As already mentioned, R. Gaymer has placed certain information and specimens which he collected at my disposal. I am most grateful for his generosity in these matters. I must also thank D. Goodwin for examining with me in the British Museum material of the turtledove Streptopelia picturata.

The specimens studied at first hand are mostly in the British Museum (Natural History), London, where J. D. Macdonald and his staff have provided every possible facility. I have also been fortunate to have had available at my place of employment, in the Department of Zoology, Cambridge University, a collection of over 1,000 specimens from the Malagasy Region (for a definition of which, see Section 3). It was assembled by Professor A. Newton, in charge of the Department from 1866 until his death in 1907, and his brother Sir Edward Newton, resident on Mauritius from 1859 to 1877. It includes a few of Abbott's Aldabra specimens, obtained in 1894 by exchange with the Smithsonian Institution.

In May 1966 I spent a week in the Muséum National d'Histoire Naturelle, Paris, in pursuance of a long-term study of the origins of the land avifauna of the Malagasy Region, and received all possible help from Drs J. Dorst, C. Jouanin and F. Roux. At this time I had no special interest in Aldabra, though I did take some note of a few of the specimens collected by Cherbonnier. As already recorded, Roux has now provided a complete list of them, and has moreover lent me several of particular interest.

Special thanks are due to Dr George E. Watson, of the Smithsonian Institution, who lent me at short notice by air mail a number of Abbott's specimens, including the complete skin of a flamingo. He has also quickly responded to inquiries about some other specimens. I am also most grateful to Dr J. Steinbacher for lending me some of Voeltzkow's specimens and for information about others.

Finally, I thank R. E. Moreau, W. R. P. Bourne, R. Gaymer and D. R. Stoddart for their comments on this paper.

3. SYSTEMATIC LIST

This list is divided into (1) land birds and (2) sea birds. The latter heading includes consideration of species occurring (or likely to occur) on Aldabra included in Alexander (1955). The land bird list is subdivided into (a) species which breed on Aldabra and may be presumed resident; (b) migrants, (i) already recorded, and (ii) not yet recorded but likely to occur; and (c) species whose status is still uncertain.

The term Malagasy Region is employed in the same sense as by Moreau (1964), and includes Madagascar, the Mascarene Islands (Réunion, Mauritius and Rodriguez), and other oceanic islands in the western Indian Ocean to as far north as the Seychelles. The term Aldabra archipelago includes Aldabra, Assumption, Cosmoledo and Astove, though not Gloriosa.

In general, the nomenclature, both scientific and English, follows that of Watson, Zusi and Storer (1963). Subspecific names are not used except where they seem to have been reasonably satisfactorily established. English names are the equivalent of scientific specific, rather than subspecific, names.

A sign "o" indicates an unsexed specimen. The average of measurements is often given in brackets following the extremes.

It should be well-known that Bergmann's Rule is to the effect that in warm-blooded vertebrates the smaller-sized geographic forms of a species are found in the warmer parts of the range, the larger-sized in the cooler parts of the range.

(1) Land Birds

(a) Breeding Residents (or presumed so)

Dawson (1966a, 7) records the Indian Reef Heron Demiegretta asha as breeding exclusively on Astove. But if this is so, it could also do so on Aldabra. However, in the absence of supporting details one cannot be convinced that it breeds even on Astove, especially as according to Watson, Zusi and Storer (1963, 24) it is not known to breed otherwise nearer to Astove than Ceylon. It may also be mentioned here that Vesey-FitzGerald (1940, 488) found the Madagascar Grass-Warbler Cisticola cherina abundant on Cosmoledo and Astove, though he did not see it on Aldabra. Unfortunately the specimen which he collected and sent to the British Museum cannot be traced.

Ardea cinerea cinerea Linnaeus Grey Heron

According to Abbott (in Ridgway 1895, 530), this species breeds on Aldabra, and nests with young were seen in November. One specimen was collected, and likewise by Voeltzkow (Berlepsch 1899, 495). Nicoll (1906, 695) records it from both Aldabra and Assumption. Morris (1963) saw a few on Aldabra, but Bourne (1966) records "hundreds". Dupont (1907) lists it from throughout the archipelago.

Benson (1960a, 31) considers that two specimens from the Comoros are better placed with A. c. cinerea than A. c. firasa Hartert of Madagascar, the latter distinguishable by longer measurements for the culmen and tarsus (respectively 131 - 145 as against 110 - 133, and 185 - 200 as against 155 - 182 mm.). He thought that four immature specimens from Aldabra and Assumption were also best placed with A. c. cinerea, though possibly not fully grown. Berlepsch (1899, 495) gives the wing of Voeltzkow's specimen as 465, culmen 140, tarsus 165 mm. The tarsus measurement is well within the range of A. c. cinerea. That for the culmen agrees better with A. c firasa, but may have been taken from the base of the skull instead of the end of the frontal feathering as in Benson's measurements. A specimen in Cambridge from the Amirante Islands, collected in December 1864, has wing 424, culmen (from frontal feathering) 120, tarsus 170 mm., thus agreeing with A. c. cinerea. It is concluded that the populations frequenting all of the above-mentioned islands are best attributed to this subspecies, and are accordingly of African rather than Madagascan origin.

Butorides striatus crawfordi Nicoll Little Green Heron

B. s. crawfordi, of which I have seen the type, an adult male in the British Museum from Assumption, and another adult male therein from Aldabra, can easily be distinguished from B. s. rhizophorae Salomonsen, of the Comoros, by the paler grey of the underside. I have also been lent the specimen collected by Abbott on Aldabra (Ridgway 1895, 531). It is a male in immature dress, and cannot be used in considering subspecific differences based on colour. The same applies to a female in Paris collected on Aldabra by Cherbonnier, which I have also seen. But all four specimens are smaller than

rhizophorae, see below. Presumably there is the same sexual colour difference in the adult of crawfordi as in rhizophorae and B. s javanicus (Horsfield), that is, the female has the sides of the neck, chest and abdomen washed with brown, and the spotting on the throat more strongly pronounced (Benson 1960a, 34).

Benson (1960a) gives the wing-length of 16 specimens of rhizophorae as 170 - 180 mm. Thirteen specimens in London, Paris and Cambridge from Reunion, Mauritius and Rodriguez, doubtfully separable from the Asiatic javanicus, measure 167 - 181 mm. On the other hand, 10 specimens from the Seychelles (Mahé, Cousin, Praslin, La Digue), attributable to B. s. degens Hartert, measure 159 - 168 mm. only. Like degens, crawfordi is also small, as the following figures show:

Adult ♂	159, 161 mm.
Immature ♂	159 mm.
Immature ♀	157 mm.

An immature male collected by Voeltzkow which I have been lent has wing 152 mm., and may not be quite fully grown. This certainly applies to an immature specimen in Cambridge from the Amirantes, with wing 140 mm. only.

Benson (1960a, 34) accepts the contention of White (1951, 460) that rhizophorae is of Asiatic origin, and there is no reason to suppose that this does not also apply to crawfordi. On the other hand, B. s. rutenbergi (Hartlaub) of Madagascar is very close to B. s. atricapillus (Afzelius) of Africa, whence White suggests that degens of the Seychelles is also derived.

Abbott (in Ridgway 1895, 531) found this species quite common on Aldabra, breeding among mangroves in November and December, laying two eggs. Probably the breeding season is fairly extensive, since in the Comoros Benson (1960a, 35) obtained data pointing to egg-laying in August and September. Abbott also noted that the birds stand for hours on the backs of turtles, catching the blue-bottle flies which swarm on the turtles' backs and heads. Dupont (1907) lists this species from throughout the archipelago.

Egretta garzetta dimorpha Hartert Little Egret

E. dimorpha has often been regarded as a full species, as by Watson, Zusi and Storer (1963). However, I see no reason to differ from the opinion of Grant and Mackworth-Praed (1933) and Berlioz (1949, 20), for example, that dimorpha is conspecific with E. garzetta. Dimorpha inhabits Madagascar and the Aldabra archipelago, and is notable for the common occurrence of a dark blue-grey phase as well as a white phase. A grey phase also occurs in coastal eastern and north-eastern Africa and in coastal West Africa (White 1965, 25), but is rare or quite absent in the interior of Africa. Grant and Mackworth-Praed (1933) have separated the populations of Aldabra and Assumption as E. g. assumptionis, differing from dimorpha by its longer bill. This was on the basis of material in the British Museum. There is no further material available therein. While due note must be taken of this difference, the measurements presented show an appreciable overlap. On existing evidence it is difficult to justify recognition of assumptionis.

Abbott (in Ridgway 1895, 530, under Demigretta gularis) found this the commonest heron on Aldabra, and breeding in large numbers in December, laying from two to four eggs. The white phase was twice or thrice as numerous as the blue. Nicoll (1906, 696, 704, under Demiegretta sacra) collected it on both Assumption and Aldabra, finding it extremely abundant on the latter. A specimen collected on Aldabra was partially white and dark. I can confirm that this applies to both this and another specimen from Aldabra, both in the British Museum. Morris (1963) found both phases plentiful on Aldabra. Bourne (1966) records hundreds, of which about forty per cent were in the dark phase. He also records it from Cosmoledo, where the phases were about equal, while one "White-faced Heron" was seen on Astove (presumably this was a specimen of E. g. dimorpha in the dark phase, in which the chin and throat are still white). He gives no record from Assumption, and possibly it has been extirpated there. Dawson (1966a, 7) records large flocks on Cosmoledo, Astove and Aldabra, the proportion of light to dark birds being about seven to three, with the occasional intermediate piebald.

Milon (1959) found that in two breeding colonies in Madagascar selected for study the ratio of the dark phase to the white phase was about 35: 65. The observations from the Aldabra archipelago tend roughly to bear this out.

Threskiornis aethiopica abbotti (Ridgway) Sacred Ibis

This species occurs in Africa (T. a. aethiopica (Latham)), Madagascar (T. a. bernieri (Bonaparte)) and Aldabra (T. a. abbotti). The characters on which these three subspecies can be recognised may be summarised as follows (it should here be mentioned that immature specimens of all three have the head and neck feathered, whereas in adults these areas are bare):

Feathering on head and neck (in immature): In aethiopica and bernieri white heavily streaked black; in abbotti black streaking much reduced, and only on a few feathers. (Only one immature specimen of abbotti was available. But the difference was striking, and shows up well in three photographs in Nicoll (1908).)

Decomposed tertials: Glossy purplish slate in aethiopica, bluish slate in bernieri, much paler than in aethiopica; bluish slate in abbotti, as in bernieri, but darker.

Metallic green tips to remiges: Extending back 40 - 60 mm. in aethiopica; not more than 15 mm. in bernieri, in three out of eight specimens absent; not more than 10 mm. in abbotti, in four out of six specimens absent.

Iris (in adult): Brown in aethiopica (see for example McLachlan and Liversidge 1957); white in bernieri; bluish-white in abbotti. (The difference between bernieri and abbotti is as given by Ridgway 1895, 530, and is confirmed from the labels of one adult specimen of the former and two such of the latter. An immature specimen of abbotti had the iris very dark brown.)

Ridgway also suggests that the lower half of the neck is entirely naked in abbotti, but not so in bernieri. I cannot convince myself that the extent of feathering up the neck is not variable in the adult of all three subspecies, and that it can be used as a distinguishing character. Ridgway further suggests that the tips to the remiges differ in colour, but it seems that there is only a difference in its extent.

Presumably bernieri was derived from aethiopica, and probably abbotti from bernieri rather than aethiopica. The colour of the decomposed tertials, the reduction of the dark tips to the remiges, and the colour of the iris all suggest a closer relationship of abbotti to bernieri than to aethiopica.

The following are measurements in mm. of the material of bernieri and abbotti studied, in London, together with two specimens of bernieri in Cambridge:

	Wing			Culmen from base			Tarsus		
Bernieri									
Adult ♂	374			169			95		
Adult ♀ ♀	342	348	362	132	137	144	72	76	82
Immature ♂	357			182			84		
Immature ♀ ♀	334	340		136	143		74	78	
Immature ○	371			broken			87		
Abbotti									
Adult ♀ ♀	336	340		125	132		76	76	
Adult ○	335	337	338	125	133	136	70	70	72
Immature ♂	347			176			80		

These figures do not suggest any marked difference between the two subspecies. Evidently males are longer billed in both.

Falco newtoni aldabranus Grote Madagascar Kestrel

It is presumed that Madagascar, inhabited by F. n. newtoni (Gurney), has been the source of origin for the populations elsewhere in the Malagasy Region, namely F. punctatus Temminck of Mauritius, F. n. aldabranus of Aldabra, and F. araea (Oberholser) of the Seychelles. A single unsexed specimen of aldabranus (judging from its wing-length) from Anjouan, in the Comoros, is considered by Benson (1960a, 39) to have been a stray from Aldabra, but is discussed further below. Failure to colonise the Comoros may be because the islands as a whole were probably originally almost wholly covered with evergreen forest (Moreau 1966, 346). In Madagascar, Rand (1936, 378) found the species everywhere except in heavy forest.

Benson (1960a, 39) studied to some extent the material in London. It has been re-examined, 13 specimens in Cambridge have also been considered, and wing-lengths taken of three specimens of aldabranus collected by Cherbonnier, in Paris. Material of F. araea in London, Paris and Cambridge has also been considered.

From field observations, Gaymer tells me that the male of F. n. aldabranus is more brightly coloured than the female. I cannot make any personal judgment in this matter, since the only two specimens examined after I had

by the very distinctively coloured Z. mayottensis Schlegel, and Grand Comoro by two forms considered of African origin. Z. m. maderaspatana of Madagascar exists undifferentiated on Gloriosa, and perhaps also on Cosmoledo and Astove (Moreau 1957, 402), but material is insufficient to decide the point for certain. Curiously, the family is apparently unrepresented on Assumption. Z. m. aldabrensis differs only from nominate maderaspatana in being yellower above, and relatively longer tailed and shorter winged. Measurements in mm. of two males which were not available to Moreau (1957, 428), the first in Cambridge, the second collected by Gaymer, are as follows:

Wing	Tail	Culmen from base
52	40	11.5
54	39	12.5

Gaymer has provided the following further particulars for his specimen: bill, upper mandible charcoal grey, lower pale blue-grey; legs pale blue-grey, likewise feet, with lemon soles; iris light brown, pupil with dark blue sheen; weight 6.5 gms.

In conclusion, aldabrensis was presumably derived from Madagascar, via Cosmoledo and Astove rather than via the Comoros.

Foudia eminentissima aldabrana Ridgway Red-headed Forest Fody

The details which follow in this paragraph are derived from Moreau (1960), the characters of aldabrana being confirmed from personal examination of material. In Madagascar and the Comoros this ploceine genus, confined to the Malagasy Region, is represented by two species, F. eminentissima Bonaparte inhabiting evergreen forest and F. madagascariensis (Linnaeus) in drier, more open country. On Mauritius there is an analogous segregation between F. rubra (Gmelin) and madagascariensis. The former is the local representative of eminentissima, from which it differs mainly by its more slender, insectivorous type of beak. Other, more distinct, species inhabit Rodriguez (F. flavicans Newton) and the Seychelles (F. sechellarum Newton). Madagascariensis is also known from the Amirantes and the Seychelles, but outside Madagascar may be a recent introduction by human agency, and shows no subspecific variation. Eminentissima is otherwise only known from Aldabra, and the genus is unknown on Assumption, Cosmoledo, Astove or Gloriosa. F. e. aldabrana is a well marked subspecies, presumably derived from the Comoros, each island of which has its own subspecies. In F. e. algondae (Schlegel) of Mayotte, the driest of the Comoros, the male has the red of the head less crimson, more orange in tone than on the other three islands. This is accentuated still further in aldabrana, and may be connected with a still drier, less shady environment. Also, melanin in the contour feathers is less intense, so that the ground-colour of the streaky back is paler, and the olive-grey of the underside is replaced by pale dull yellow. Two males which have been available to me have the olive of the mantle largely replaced by red, and Benson (1960a, 100) notes that most Comoro males have a few crimson feathers to be found in part of the plumage. The bill of aldabrana is stouter than in any other subspecies, possibly in adaptation to a seed rather than an insect diet.

According to Moreau (1960, 38), and see also Benson (1960a, 101), it is uncertain whether in the humid Comoro environment there is a dull nonbreeding plumage. However, Moreau (1960, 34) quotes Rand that there is in F. e. omissa Rothschild. As to Aldabra, a male in Cambridge collected by Abbott in October is in breeding dress, the red fully developed. This is also confirmed by Ridgway (1895, 538), who quotes Abbott that nesting takes place in November, December and January (and see also Bendire 1894). Two males collected by Gaymer on 14 and 30 November are in breeding dress, as are four collected by Nicoll in mid-March. Nicoll (1908, 116) also indicates that there were many such birds at the time of his visit, while Morris (1963), who visited Aldabra in January and February, from his account obviously also saw males in breeding dress. However, two males lent to me, collected by Cherbonnier on 12 and 20 May, are strikingly different. The first has no sign of red, the second has a small amount on the head and chest. No less remarkable is it that in both the olive tones of the mantle are replaced by rufous brown, this also being the coloration of the crown (obscurely streaked with dusky) and the rump. The chin, throat and abdomen are dull yellow, of the same tone as on the abdomen of males in breeding dress, and there is a heavy brownish wash across the chest and on the flanks. Also, the bill, instead of being black, is dark brown in the first specimen, paler horn in the second. Two females collected by Cherbonnier in May, which I have also been lent, are similar to the first male, in their rufous brown tones above and brownish wash on the chest and flanks. But a female collected by Nicoll on 14 March has olive tones above, and the whole underside dull yellow, with some olive (not brownish) wash rather strictly confined to the flanks. All three of these females have the bill horn coloured. There are two further specimens collected by Gaymer on 14 November, similar in all respects to Nicoll's female. One is sexed as a male, the other as a female. But see the measurements below, they have wings 78, 80,tails both 53 mm. Thus they seem to be both males, and to have failed to develop into breeding dress. They are placed accordingly in the measurements.[1]

It seems clear that, whatever may be the situation in the humid Comoros, on Aldabra there are well-marked seasonal plumage changes in both sexes, the colour of the bill of the male also changing.

Moreau (1960, 35) gives measurements for only four males of aldabrana, and it is worth giving them for all of the material now examined (in mm.):

	Wing	Tail	Culmen from base
11 ♂ ♂	78 - 84 (80.3)	48 - 57 (52.5)	17 - 20.5 (18.6)
3 ♀ ♀	72 74 74	43 47 47	18 18.5 20

The tail/wing ratio for males works out at 65, the same figure as arrived at by Moreau. It is curious that, although males have longer tails and wings than females, the bill measurements are so similar. The Comoro figures in Benson (1960a, 100) show a sexual disparity in all three series of measurements. How-

[1] Gaymer states, however, that the specimen with wing 80 mm. was a female with large gonads - Editor.

ever, only three females of aldabrana were available. Nevertheless, neither is there any indication from the further figures given below of any difference in the bill.

Gaymer gives the weights of the four specimens which he collected as 21, 24, 25, 26 gms. The following summary has been compiled from figures in mm. supplied by him for specimens mist-netted and subsequently released, all caught in November:

	Wing	Tail	Culmen (exposed part)	Notes
10 ♂♂	78 - 85 (80.9)	49 - 58 (53.7)	16 - 19 (17.6)	(a)
juv. ♂♂	62 76 76 83	46 46 48 52	17 18 18 19	(b)
13 ♀♀	68 - 75 (72.1)	43 - 53 (47.8)	16 - 19 (17.4)	
9 ○○	76 - 79 (77.3)	45 - 52 (50.0)	16 - 19 (17.3)	(c)

Notes: (a) in breeding dress.
(b) in female-like dress, but showing traces of red in plumage, so presumably males.
(c) wholly in female-like dress, but those in second series perhaps too long-winged to be females.

Weights in gms. of these four series were respectively as follows: 22.5 - 27 (25.7): 24, 25.5, 27.5, 27.5; 21 - 27.5 (24.8); 23 - 27.5 (24.9).

(b) Migrants

(i) Already recorded

Porzana marginalis Hartlaub Strip Crake

There is a male in the American Museum of Natural History, collected by F. R. Mortimer on West Island (Ile Picard), Aldabra, 10 December 1904 (Benson 1964, 56). This occurrence may be considered as accidental, and is the only record known to me from the Malagasy Region. Benson (1964, 56) has presented data suggesting that this species is migratory in southern Africa, only normally present during the rains, when it breeds. This particular specimen was probably blown off course on southward migration.

Squatarola squatarola (Linnaeus) Grey Plover

Collected by Nicoll (1906, 703, under the name S. helvetica) on Aldabra, and reported as common. At least one seen by Morris (1963). Probably regular from late September to early April, as in Madagascar (Rand 1936, 351), and see also Benson (1960a, 43) for the Comoros.

Charadrius leschenaultii Lesson Great Sand Plover

Collected by Abbott on Aldabra, and noted as "rather common" (Ridgway 1895, 527, under the name Aegialitis geoffroyi). There is also a specimen in the British Museum collected in 1906. Seen by Morris (1963). Dupont (1907) lists it from throughout the archipelago. Rand (1936, 354) found it fairly common in Madagascar from September to early May, and Benson (1960a, 43) found it on all four islands in the Comoros.

Numenius phaeopus phaeopus (Linnaeus) Whimbrel

Collected by Abbott on Aldabra, recorded as common (Ridgway 1895, 528). Also collected there by Voeltzkow (Berlepsch 1899, 494). Dupont (1907) lists both N. phaeopus and N. madagascariensis (presumably meaning N. arquata) from throughout the archipelago. Fryer (1911, 420), who was in the archipelago from August to February, states that both N. phaeopus and arquata were abundant. However, in Madagascar and the Comoros the former outnumbers the latter (Rand 1936, 348; Benson 1960a, 44). Bourne (1966) records hundreds of "curlews" Numenius sp. A solitary "curlew" seen by Morris (1963) may also have been N. phaeopus.

Numenius arquata orientalis Brehm Curlew

Under the heading N. madagascariensis, though presumably N. arquata was intended, found by Abbott to be not common, though no specimen was collected (Ridgway 1895, 527). See also other possible records under N. phaeopus. N. a. orientalis has been collected in the Comoros (Benson 1960a, 44), and the occurrence of N. a. arquata (Linnaeus) seems unlikely, see especially Rudebeck (1963, 499-501).

Tringa nebularia (Gunnerus) Greenshank

A specimen collected by Abbott on Aldabra (Ridgway 1895, 527) appears to be the only record from anywhere in the archipelago, other than the listing of it from throughout by Dupont (1907, under the name T. glottis). It may not be so very uncommon, for Benson (1960a, 44) gives a number of records from the Comoros, including one of a flock of 40, and Rand (1936, 349) found it in Madagascar from late November to early March.

Tringa glareola Linnaeus Wood Sandpiper

One specimen collected by Abbott on Aldabra, and he noted it as "rather scarce" (Ridgway 1895, 527). This appears to be the only record from the Malagasy Region, so that it must have been an accidental occurrence. This species perfers inland marshes to sea-coasts.

Actitis hypoleucos (Linnaeus) Common Sandpiper

One specimen collected by Abbott on Aldabra, but he found it "not common" (Ridgway 1895, 527). Dupont (1907) lists it from throughout the archipelago. It may not be rare, for Benson (1960a, 44) found it fairly common in the Comoros, Rand (1936, 349) records it from August to March in Madagascar, and it is even abundant and regular on Réunion and Mauritius (Berlioz 1946, 35).

Arenaria interpres interpres (Linnaeus) Turnstone

Collected by Abbott on Aldabra, where very common (Ridgway 1895, 527). Also collected there by Cherbonnier in May. Recorded by Fryer (1911, 420) as abundant in the archipelago throughout his stay, from August to February. In

March 1964 thousands were seen on Aldabra, also large numbers on Cosmoledo and 100 on Assumption (Bourne 1966). Dupont (1907) lists it from throughout the archipelago. Rand (1936, 351) found it fairly common in Madagascar, from late September to early May, while Benson (1960a, 43) gives various records from the Comoros.

Crocethia alba (Pallas) Sanderling

Collected by Abbott on Aldabra, said to be common (Ridgway 1895, 527, under the name Calidris arenaria). Nicoll (1906, 704), in dealing with the next species, mentions seeing it there, and (1908, 118) saw "a few". Although Benson (1960a, 44) gives only two records from the Comoros, Rand (1936, 350) found it fairly common in Madagascar from late September to early March.

Erolia testacea (Pallas) Curlew Sandpiper

Abbott records a small flock, and collected two specimens (Ridgway 1895, 527, under the name Tringa ferruginea). Nicoll (1906, 704, under T. subarquata) saw several, and collected a specimen. Five "dunlins" seen by Morris (1963) were probably this species. Benson (1960a, 43, under Calidris ferruginea) gives a few records from the Comoros, and Rand (1936, 349) found it fairly common from October to early March in Madagascar.

Eurystomus glaucurus glaucurus (Müller) Broad-billed Roller

At least four specimens have been collected on Aldabra: one in November 1906 (Benson 1960a, 55); one by Abbott on 10 December 1892, and one by Mortimer on 24 December 1904 (Benson 1963a); a female by Gaymer on 9 December 1964, wing 197 mm. Abbott (in Ridgway 1895, 534) was informed of several others previously seen there. Vesey-FitzGerald (1940, 488) saw one on Cosmoledo, 6 October. There are at least four specimens from the Comoros, one of which is dated 7 November, one 10 April, the others being undated (Benson 1960a, 55; 1963a).

According to Moreau (1966, 249-250), this subspecies (there are two other, smaller, ones which breed in Africa, see White 1965, 237) is present in Madagascar from October to March, breeding in October and November. The main "winter" quarters are probably in the Congo. Records from Malawi and Zambia are all for October-November and February-April, suggesting that the birds are only on passage through these territories. This must also apply to the Aldabra, Cosmoledo and Comoro records. Such a passage may be regular in small numbers.

Apus apus apus (Linnaeus) Eurasian Swift

Abbott collected a specimen on 1 December (Ridgway 1895, 534) which I have been lent. It agrees with material in the British Museum of nominate apus rather than of A. a. pekinensis (Swinhoe). The label is endorsed "The only one observed - undoubtedly accidental straggler". This appears to be the only record of the species from the Malagasy Region, though it is plentiful as a visitor to southern Africa, whence there is no lack of material of both subspecies (Irwin and Benson 1966, 15).

Riparia riparia riparia (Linnaeus) Sand-Martin

One was collected by Abbott on Aldabra on 2 December, another by him on Gloriosa on 29 January (Benson 1963a). Although this is a common palaearctic migrant to southern Africa, it is probably merely casual in the Malagasy Region, the only other record traced being a specimen from Lac Iotry, Madagascar (Rand 1936, 427).

Phedina borbonica madagascariensis Hartlaub Mascarene Martin

Abbott collected a specimen on Aldabra on 19 November, listed by Ridgway (1895, 535) as P. borbonica, and further reported on by Benson (1963a). No doubt it was on passage, even though the breeding season in Madagascar includes October and November (Moreau 1966, 252). As Moreau points out, the movements of this bird are not understood. Small numbers have been reported from Pemba Island in September-March, prior to 1930. The only other African record is from Lake Chilwa, Malawi, where hundreds were seen between 28 June and 30 July 1944.

Motacilla flava lutea (Gmelin) Yellow Wagtail

Abbott collected a male on Aldabra on 20 December (Ridgway 1895, 535, under M. campestris). It is evidently by a slip of the pen that Watson, Zusi and Storer (1963, 198) place this record under the Tawny Pipit Anthus campestris. I have been lent this specimen, the label of which is endorsed "accidental visitor". Indeed this seems to be the only record of the species from the Malagasy Region. The specimen is in full adult dress, except for some brownish feathers on the underside. It has the crown mainly green, with yellow restricted to the fore part and the forehead, and a well-developed yellow eyestripe. Thus in colour it agrees with the description by Vaurie (1959, 75, 78) of M. f. flavissima Blyth rather than lutea. However, the view of Dowsett (1965) that such specimens from eastern Africa are individuals of lutea showing the characters of flavissima is accepted, and applies also to Abbott's specimen.

Muscicapa sp. Flycatcher

Under this heading Abbott (in Ridgway 1895, 535) mentions seeing a small grey flycatcher with white rump on Aldabra in December. It is impossible to make any suggestion as to the identity of this bird, which might not have been a muscicapid at all.

(ii) Not yet recorded, but likely to occur

Ardeola idae (Hartlaub) Madagascar Squacco Heron

According to Moreau (1966, 249), this species is said to breed in Madagascar in the rains, and occurs in tropical eastern Africa as an off-season visitor during May to October. Benson (1960a, 34) collected it on Mayotte, in the Comoros, in October, presumably on passage back to Madagascar. It is likely to occur also on Aldabra on passage.

Falco eleonorae Géné Eleonora's Falcon
Falco concolor Temminck Sooty Falcon

According to Moreau (1966, 68) these two species winter entirely in Madagascar. Nicoll (1906, 680) records a specimen of F. subbuteo from Mayotte, in the Comoros, but it may well be an eleonorae (Benson 1960a, 105). There is an undated specimen of F. concolor from Tanga, in coastal north-eastern Tanzania, in Paris, and Reichenow (1900, 630) gives two other records of this species from eastern Tanzania, and one from Mozambique. Both these palaearctic breeders may well pass over Aldabra.

Charadrius hiaticula tundrae (Lowe) Ringed Plover

Rand (1936, 352) records it from Madagascar during December to March, and Benson saw it regularly from late August until he left the Comoros in late November. It may well be regular on Aldabra.

Limosa lapponica lapponica (Linnaeus) Bar-tailed Godwit

Since Rand (1936, 349) refers to its occurrence in the Seychelles and Madagascar, it presumably occurs occasionally on Aldabra.

Tringa totanus (Linnaeus) Redshank

A record by Dupont (1907, under the name T. glottis) for the Greenshank T. nebularia has already been referred to under that species. Dupont also lists T. nebularia, which he calls "Redshank", from Aldabra. It would seem that there has been a clerical error, and that both records refer to the Greenshank T. nebularia. Watson, Zusi and Storer (1963, 30) do not give any occurrence of T. totanus nearer than the Maldives. It is true that Dawson (1963a, 7) mentions it from the Seychelles. But its occurrence anywhere in the western Indian Ocean south of the equator requires proper substantiation, and moreover Rudeback (1963, 492) finds that south of 10°N. in Africa it is scarce and irregular.

The necessity for the inclusion of this species has arisen from Dupont's apparent clerical error. It can only be extremely rare on Aldabra.

Xenus cinereus (Güldenstaedt) Terek Sandpiper

Rand (1936, 348) found it not uncommon in Madagascar, and there is even a specimen in Cambridge from Mauritius, collected on 13 January 1864. Benson (1960a, 44) gives one record from the Comoros. Its occasional occurrence on Aldabra is very probable.

Erolia minuta (Leisler) Little Stint

Newton (1867, 343) found it common on Mahé, in the Seychelles, and there is a specimen collected there by him in Cambridge. Benson (1960a, 44) collected one on Grand Comoro, and Rand (1936, 350) gives one record from

Madagascar. It must occur occasionally on Aldabra, but its listing by Dupont (1907, under Tringa minuta) from throughout the archipelago requires confirmation.

Glareola ocularis Verreaux Madagascar Pratincole
Glareola maldivarum Forster Eastern Collared Pratincole

Moreau (1966, 251) refers to Galachrysia nuchalis, no doubt really meaning Glareola acularis, as quite common in coastal Kenya in August and September. Benson (1960a, 45) collected a specimen on Mayotte, in the Comoros, on 28 October. A. D. Forbes-Watson tells me he saw one on the Dzaoudzi airstrip, Mayotte, on 24 October 1965, and five days earlier three on the Moroni airstrip, Grand Comoro. Presumably all these Comoro records refer to birds on delayed passage back to Madagascar. It is likely to also occur on passage on Aldabra.

G. maldivarum, treated by Watson, Zusi and Storer (1963) as conspecific with pratincola, is known as an occasional visitor from the palaearctic to the Seychelles (Benson and Roux, in press) and has also been recorded from Mauritius (Rountree and others 1952, 179). It could also occur on Aldabra.

Cuculus canorus Linnaeus Grey Cuckoo

Nicoll (1906, 700) saw a cuckoo on Aldabra which he thought was this species. Its occasional occurrence as a migrant from the palaearctic is possible. Benson and Roux (in press) record such a specimen from Mahé, in the Seychelles. Abbott (in Ridgway 1895, 514) also gives a very probable record from Mahé, though he did not retain a specimen.

Cuculus poliocephalus rochii Hartlaub Lesser Cuckoo

According to Moreau (1966, 249), the Madagascar breeding subspecies is present in most of the island only from the end of September to April, and has been recorded from Kenya, Uganda, Tanzania, and the south-eastern Congo as a non-breeding visitor from June to September. So far there is no record from any of the intervening islands between Madagascar and eastern tropical Africa. But its occurrence on passage, including Aldabra, is likely.

Collocalia francica (Gmelin) Cave Swiftlet

Abbott saw a Collocalia sp. on Aldabra several times (Ridgway 1895, 535). Possibly the form frequenting Mahé, in the Seychelles, C. f. elaphra Oberholser, occurs occasionally on Aldabra. The genus is only otherwise represented in the Malagasy Region on Mauritius and Réunion, and its status in Madagascar is problematical (Moreau 1966, 331).

Merops superciliosus superciliosus Linnaeus Blue-cheeked Bee-eater

As Moreau (1966, 251) indicates, this subspecies, which breeds in Madagascar (and in tropical eastern Africa), has for long been regarded as a migrant between Madagascar and Africa. But he concludes that large-scale migration

from Madagascar remains to be proved. However, it probably occurs occasionally as a wanderer on Aldabra, especially as it breeds on Mayotte, in the Comoros (Benson, 1960a, 59).

Hirundo rustica Linnaeus Swallow

J. H. Crook has a record of it as a straggler to Frégate, in the Seychelles, in November (Lousteau-Lalanne 1962, 30). Rand (1936, 427) saw six or seven at Tulear, Madagascar, in January. This species is very plentiful as a visitor from the palaearctic to southern Africa, and may be expected to occur occasionally on Aldabra.

(c) Of Uncertain Status

Bubulcus ibis (Linnaeus) Cattle Egret

The only definite record traced from Aldabra is of one seen by Abbott (Ridgway 1895, 531), though Gaymer states that they are a recent arrival, and that in 1964 about 100 birds were roosting at Takamaka, in the eastern part of Aldabra. Bourne (1966) gives a record of six seen on Astove. With any development of the atoll, a breeding colony could well become established.

It is impossible to suggest whence the birds seen on Aldabra and Astove might have emanated. The nominate subspecies breeds in Madagascar (Rand 1936, 332) and on Anjouan, in the Comoros (Benson 1960a, 33), while the populations of the Amirantes and the Seychelles may have to be known as B. i. seychellarum (Salomonsen), despite the strictures on its validity by Dawson (1966b). As pointed out by Benson (1960a, 33), two of the specimens on which Salomonsen based his description are from the remote Bird Island, in the Seychelles. The third, in Paris, which I examined in 1966, is from Ile Cousine, and its wing measures 236 mm. only. Unfortunately the buff coloration is confined merely to a trace on the forehead, and I found it impossible to decide whether it was more golden cinnamon, as claimed for seychellarum, or buff, as in the nominate form.

Ridley and Percy (1958, 31, 45) found this species to be a serious predator of eggs on Desnoeufs Island, in the Amirantes, and to a lesser extent on Bird Island. They suggest that it was introduced at some time, but were unable to trace when or from where. If it was introduced, it seems odd that Abbott (in Ridgway 1895, 531) found it already plentiful in such remote places as Coetivy and the Amirantes 75 years ago. It may have established itself unaided and have evolved into a recognisable subspecies. If so, the coloration of seychellarum suggests a derivation from the Asiatic B. i. coromandus Boddaert. If the Asiatic Ixobrychus sinensis could establish itself unaided in the Seychelles as would appear to be the case (Benson, in preparation), there seems no reason why Bubulcus ibis should not also achieve this (and in the Amirantes). Further material is required of the latter species in order further to assess the validity of seychellarum.

Egretta alba melanorhynchos (Wagler) Great White Heron

Bourne (1966) refers to egrets which were abundant on Cosmoledo, and were evidently E. garzetta. Also present were five larger white birds which could have been E. alba, though the description of the bottom of the feet as orange is puzzling. One would expect the colour to be black, like the remainder of the feet and the legs. But be that as it may, it is likely that this species occurs occasionally as a wanderer, and might even establish itself, in the Aldabra archipelago, as it breeds on Moheli, in the Comoros (Benson 1960a, 32).

Phoenicopterus ruber roseus Pallas Greater Flamingo
Phoenicopterus minor Geoffroy Lesser Flamino

Abbott (in Ridgway 1895, 529) collected five specimens of a flamingo on Aldabra, which he thought was a breeding resident, there probably being between 500 and 1,000 birds on the atoll. But Nicoll (1906, 703) in his admittedly short stay did not see any, and was also informed that there was no breeding population. Dupont (1907, 23) records flamingos from Aldabra "all along the South East and South on the shores of the lagoon in numerous flocks of several hundreds". In his list he cites P. erythraeus, presumed to be the same as P. ruber roseus. Possibly the specimen dated October 1906 in the British Museum, mentioned below, was collected by him, since Dupont was on Aldabra in that month. Fryer (1911, 419) refers to the presence of a resident population of P. minor on Aldabra. According to Gaymer (1966), about fifty flamingos live in the southeast of the atoll, and probably breed there. He suggests that they belong to a new subspecies of P. ruber. Watson, Zusi and Storer (1963, 194) consider that five specimens (undoubtedly those collected by Abbott) appear aberrant, and refer them to P. ruber subsp.

Watson has most kindly lent me one of these five specimens, a male, consisting of a head and whole skin of the body as well. There is another such (unsexed) specimen in the British Museum, collected on Aldabra in October 1906, part of a Howard Saunders Bequest. Their measurements in mm. now follow, together with those of the other four specimens collected by Abbott, which Watson has been so kind as to supply (those of the first male listed were taken by myself from the specimen which I was lent):

	♂	♂	♀	♀	♀	♀
Wing	386	356	371	371	355	384
Tail	140	135	134	133	130	138
Tarsus	245	253	265	255	235	275
Culmen (exposed part)	120	115	118	110.5	116	122

These figures agree substantially with those of P. r. roseus provided by Witherby and others (1941, 166). The two Aldabra specimens personally examined, compared to material of this form from Africa in the British Museum, show no difference in either structure or colour. Both appear to be adult. The body-plumage of neither has any of the pink tinge said by Witherby and others to characterise adults, but several other adults also lacked any such tinge. It may

be that the colour varies quite temporarily, according to the food available. Abbott gives the iris of the specimen which I was lent as straw-yellow, and this also agrees quite well with Witherby and others (1941), who give it as lemon-yellow.

Rand (1936, 342) refers a specimen from Lac Iotry, south-western Madagascar, to P. r. antiquorum (=P. r. roseus) without any question, and he states that P. minor is very common there. Griveaud (1960) records only P. ruber from Lac Iotry, estimating the numbers of flamingos there to be between 25,000 and 30,000. The lower photograph on page 38 of his paper is certainly of a P. ruber, not a P. minor.

Satisfactory as it would be in the cause of the conservation of Aldabra to be able to show that an endemic form of Phoenicopterus exists there, I cannot find any such evidence. Dr Watson has also recently written to me to the effect that, despite the comment of Watson and others (1963), he no longer considers Abbott's material separable from P. r. roseus. Nor can I even find any definitive evidence of breeding on Aldabra. It may well be that both P. ruber and minor do so occasionally, particularly as minor as well as ruber is said to occur in Madagascar. So far the only report of the occurrence of P. minor on Aldabra is from Fryer, but it is very possible that he confused it with ruber. It should be emphasised that both species seem highly nomadic and capricious in their places of breeding. Thus Brown (1957) records attempted breeding by P. minor (a few ruber were also present) in north-eastern Northern Rhodesia (now Zambia) in 1955. There is no other such evidence from Zambia, and the attempt was due to unusually dry conditions preceding (see also Benson 1963b, 627).

Milvus migrans parasiticus (Daudin) Black Kite

Abbott collected two specimens on Aldabra, on 2 October and 19 December, stating that kites are occasionally observed but are not common, while he apparently saw it also on Gloriosa, which he visited in September (Ridgway 1895, 525, 533). Nicoll (1906, 687; 1908, 102) saw this species on Gloriosa in March, and regarded it as non-resident. Its status on Aldabra (and Gloriosa) cannot be regarded as certain, but presumably it is non-resident. Elsewhere in the Malagasy Region it is only known from Madagascar (Rand 1936, 381) and the Comoros (Benson 1960a, 36), where it is common. Rand saw an occupied nest in Madagascar in October. In southern Africa it is only normally present, as a breeding visitor, from August to March; see for example White (1965, 58). Although there is no definite evidence, it is reasonable to suppose that this also applies to Madagascar and the Comoros. If this is so, it could pass through Aldabra on its way to and from non-breeding quarters, perhaps in equatorial Africa. However, the dates of Abbott's specimens are not in keeping with this. The possibility cannot be excluded that the odd pair breeds on Aldabra, and perhaps also on Gloriosa.

Dromas ardeola Paykull Crab Plover

Abbott saw "large flocks" on Aldabra, and collected two specimens (Ridgway 1895, 527). It was also collected by Voeltzkow (Berlepsch 1899, 494). Nicoll (1906, 703) saw "enormous flocks" on Aldabra in mid-March. From observations also made in March, Bourne (1966) records "thousands" on Aldabra, and

20 and 40 respectively on Cosmoledo and Assumption. Morris (1963), who made short visits in January and February to Aldabra, records merely "several" and "three". But he might have been unlucky, and not have visited a locality on the atoll where large numbers were congregated. Dupont (1907) lists it from throughout the archipelago.

The status of this species on Aldabra is uncertain. But in view of the large numbers which have been reported it may well breed there. The nearest breeding locality to Aldabra which Benson (1960a, 45) was able to trace was the coast of former British Somaliland, though according to Watson, Zusi and Storer (1963, 115, 121) it may also do so in the Maldives and the Chagos Archipelago.

Corvus albus Müller Pied Crow

This crow has presumably colonised the Malagasy Region from Africa, but from the evolutionary aspect is of no interest, and no subspecies from throughout its wide range has ever been proposed. It definitely breeds in Madagascar and the Comoros, and apparently also does so on Aldabra, Assumption and Gloriosa, though this requires confirmation for Aldabra. It has also been recorded from Cosmoledo and Astove.

Benson (1960a, 87) found it common throughout the Comoros. He saw nestlings in early November, and probably throughout its range in southern Africa and the Malagasy Region it is essentially a pre-rains breeder. Abbott, who was on Aldabra from September to December, found it not common, likewise on Assumption, which he visited in September, yet plentiful on Gloriosa, visited in January and February (Ridgway 1895, 537, under C. scapulatus). While Abbott gives no evidence of breeding on any of these islands, Nicoll (1906, 689) was informed that it was resident on Gloriosa, saw empty nests on Assumption in March (1906, 693), while like Abbott he (1906, 700) found it uncommon on Aldabra, but was only there from 13 to 16 March. It does not appear in the catalogue of specimens collected by Voeltzkow (Berlepsch 1899). Vesey-FitzGerald (1940, 488) states that it is a visitor to Cosmoledo, Astove and Assumption, and nests on Aldabra, but gives no further details. Boulton (1960), who visited Aldabra in November 1959, records it, but gives no further information. Morris (1963), who visited the island twice in January and February, apparently did not see it. Gaymer collected a specimen on 5 December. Dupont (1907) lists it from throughout the archipelago.

In the light of the foregoing, it is remarkable that, as a result of the visit of H.M.S. Owen in March 1964, while Bourne (1966) was unable to give any record from Assumption or Astove, and only one pair from Cosmoledo ("the first for many years"), yet there were "hundreds" on Aldabra. Clearly the status of this crow on Aldabra and neighbouring islands is in need of further investigation. Has it recently increased there, or is there perhaps some movement between the islands? It is my experience in Africa that any extension of human settlement, with an increase in the availability of offal, favours it. The availability or otherwise of suitable tall trees as nesting sites may also be important (see for example Benson 1953, 69). The statement by Vesey-FitzGerald that it breeds on Aldabra should be confirmed, and in the meantime it is best to include the Pied Crow among the species of uncertain status.

(2) Sea Birds

No doubt species additional to those now listed occur occasionally on or around Aldabra, more especially representatives of the families Procellariidae and Hydrobatidae. Such possibilities can be found in Watson, Zusi and Storer (1963, 15-19). In the British Museum there is a specimen of Wilson's Petrel Oceanites oceanicus labelled as from Aldabra, November 1906. However, as it is further stated on the label that it was collected at sea, as far north as "latitude 2°", it evidently was not obtained so very close to Aldabra.

Phaethon rubricauda rubricauda Boddaert Red-tailed Tropicbird

Both Betts (1940, 504) and Vesey-FitzGerald (1941, 530) state that it breeds on Aldabra, but give no details. The latter author also states that it breeds on Cosmoledo. It has been collected on Assumption (Ridgway 1895, 522; Nicoll 1906, 697), and according to Ridgway, Abbott found it breeding there (and on Gloriosa). Dupont (1907) lists it from throughout the archipelago. Gaymer informs me that he found a population probably numbering some hundreds, mainly along the northern part of the lagoon, breeding on small islets under rock ledges or bushes: he found a nest with one egg on November 18. Stoddart tells me that he saw a number on Aldabra when he was there in September and October 1966.

Phaethon lepturus lepturus Daudin White-tailed Tropicbird

Collected by Abbott and by Voeltzkow on Aldabra (Ridgway 1895, 532, under the name P. candidus; and Berlepsch 1899, 496, under P. flavirostris). Morris saw a pair there in January 1962, and 20 were seen in all in March 1964 (Bourne 1966).

Sula abbotti Ridgway Abbott's Booby

There is no record of this species from Aldabra, and it is only known from Assumption and from Christmas Island (near Java). Unfortunately the breeding colony on Assumption was wiped out by labourers employed on guano extraction, and there is no record of its occurrence there since 1936 (Betts 1940, 502). Vesey-FitzGerald (1941, 52) in fact gives the year of its final extirpation as 1926.

Sula dactylatra melanops Heuglin Blue-faced Booby

The only evidence of its occurrence on Aldabra is from Morris (1963), who saw both adults and immature birds. It has been collected on Assumption, while Abbott found a few breeding (Ridgway 1895, 520; Nicoll 1906, 697, under the name S. cyanops). Vesey-FitzGerald (1941, 521) doubted if it still bred on Assumption, due to the depredations of the guano labourers, though he also gave several islands on Cosmoledo Atoll as breeding localities. Bourne (1966) records a few seen on Cosmoledo and Assumption.

Sula sula rubripes Gould Red-footed Booby

Collected on Aldabra (Ridgway 1895, 531; Berlepsch 1899, 495, under the name S. piscatrix), where Abbott found it very abundant. Nicoll (1906, 704) also found it abundant; likewise on Assumption, where he collected two specimens and saw nests with young. There are also specimens in the British Museum collected on Aldabra in October 1906. Vesey-FitzGerald (1941, 522) records nesting on islets in the lagoon of Aldabra, various islands in the Cosmoledo lagoon, and, before the start of guano extraction, on Astove and Assumption, but gives no details. According to Dawson (1966a, 6), it breeds in mangroves on the northern rim of Aldabra, and in mangroves on the inner edges of the islands of Cosmoledo atoll, the nests being made of twigs. Bourne (1966) records three in all seen on Cosmoledo, and thousands of birds, probably mostly this species, seen feeding 10 miles to the north of Aldabra. Stoddart tells me that it was plentiful on Aldabra when he was there in September and October 1966, but in much smaller numbers than the Frigatebirds.

Sula leucogaster Boddaert Brown Boody

One was seen off Aldabra in March 1964 (Bourne 1966). No further evidence has been traced of the occurrence of this species anywhere in the archipelago, though it breeds in the Amirantes (Vesey-FitzGerald 1941, 521; Ridley and Percy 1958, 19, 30).

Fregata minor aldabrensis Mathews Greater Frigatebird
Fregata ariel iredalei Mathews Lesser Frigatebird

It is convenient to consider these two species together. Abbott collected F. minor on Aldabra, and found colonies of many thousands, with eggs plentiful in November (Ridgway 1895, 522). He apparently saw both species, since there is mention of "all gradations of size between the two forms". It was evidently also F. minor which Voeltzkow collected, referred to by Berlepsch (1899, 495) as F. aquila. Nicoll (1906) makes no mention of frigatebirds on Aldabra, but saw F. aquila on Assumption, presumably also referring to F. minor. Vesey-FitzGerald (1941, 530) states that both species breed on Aldabra and Cosmoledo. Thousands of frigatebirds "of two sizes" were seen on Aldabra in March 1964 (Bourne 1966), and Stoddart informs me that they nest in very large numbers on the lagoon side of Middle Island, especially near East Channel. He also (Stoddart and Wright 1967a, 1175) describes them diving to drink on the wing at freshwater pools on South Island. Dupont (1907) lists both species from throughout the archipelago.

Lowe (1924, 308, 312) gives details of further specimens from Aldabra, in the British Museum and in the Rothschild collection at Tring. Those which were at Tring are presumably now in the American Museum of Natural History, including the holotypes of aldabrensis and iredalei (Hartert 1925, 275). The only specimens from Aldabra traced in the British Museum are the two of aldabrensis mentioned by Lowe.

Larus fuscus Linnaeus Lesser Black-backed Gull

Dawson (1966a, 8) reports a single bird seen from Aldabra, and this appears to be the only record from the Malagasy Region. Either this species or the southern L. dominicanus has been recorded from Beira, in coastal Mozambique (Benson 1948, 151; Worth 1960, 173). But except in the hand, these two cannot be certainly distinguished from each other. Fuscus is much the more likely on Aldabra.

Hydroprogne caspia Pallas Caspian Tern

There is no record from Aldabra, but this species is mentioned on the strength of sight-records, both during October, from Astove and Cosmoledo (Vesey-FitzGerald 1941, 527).

Sterna albifrons Pallas Little Tern

Dupont (1907, under the name Sterna minuta) lists this species from throughout the archipelago. Dupont's records of S. balaenarum may also refer to S. albifrons. Bourne (1966) records that "thirty small terns that might have been" this species were seen off Assumption on 17 March. Gaymer informs me that he saw perhaps a hundred in November along the northern coast of Aldabra, and rarely in the lagoon, and that it is locally reported to breed.

Sterna sumatrana mathewsi Stresemann Black-naped Tern

Collected on Aldabra (Ridgway 1895, 526; Berlepsch 1899, 496; Nicoll 1906, 704; in all these references under the name S. melanauchen). Thirty seen there in March 1964, likewise three on Assumption (Bourne 1966).

Sterna anaethetus antarctica Lesson Bridled Tern

There is no record from Aldabra, though Vesey-FitzGerald (1941, 526) states that eggs have been found on limestone islets in Cosmoledo atoll in October.

Sterna fuscata Linnaeus Sooty Tern

"Rare in Aldabra", not collected (Abbott, in Ridgway 1895, 496); one specimen collected by Voeltzkow on Aldabra (Berlepsch 1899, 496) (both notes under the name S. fuliginosa). Vesey-FitzGerald (1941, 525) states that it breeds on Wizard Island, Cosmoledo Atoll.

Thalasseus bergii thalassinus (Stresemann) Crested Tern

Abbott found it common on Aldabra, but did not collect a specimen (Ridgway 1895, 526, under the name Sterna bernsteini). Morris (1963) saw terns there which he thought were the next species, T. bengalensis, but were perhaps bergii. Gaymer reports frequently seeing it feeding at Aldabra, in shallow water over the outer reef or in the lagoon, sometimes in small groups, and states that it is locally reported to breed. Dupont (1907) lists both Sterna bernsteini and bergii from throughout the archipelago, but presumably refers to the one species only, now known as T. bergii. There is also a possible record of three seen on Astove (Bourne 1966). Benson (1960a, 45) collected specimens in non-breeding dress in the Comoros during August-November, and records one in breeding dress from Gloriosa, 10 March.

Thalasseus bengalensis par (Mathews and Iredale) Lesser Crested Tern

There is no certain record from Aldabra or elsewhere in the archipelago, though Abbott collected a specimen on Gloriosa (Ridgway 1895, 524, under the name Sterna media), and there are also specimens from the Comoros (Benson 1960a, 45).

Anous stolidus pileatus (Scopoli) Common Noddy

Collected by Abbott on Aldabra, and breeding in thousands on small islets in the lagoon (Ridgway 1895, 527). Also collected on Aldabra by Voeltzkow (Berlepsch 1899, 496). Seen by Morris (1963), and hundreds seen in March 1964 (Bourne 1966). Stated by Vesey-FitzGerald (1941, 528) to breed on Aldabra (and Cosmoledo), though no details are given. Listed by Dupont (1907) from throughout the archipelago.

Gygis alba monte Mathews Fairy Tern

Collected by Abbott on Aldabra, where common (Ridgway, 1895, 527), and also collected there by Voeltzkow (Berlepsch 1899, 496). Seen by Morris (1963), and hundreds seen in March 1964 (Bourne 1966). Listed by Dupont (1907) from Aldabra, Assumption and Astove.

4. THE LAND BIRDS: THEIR STATUS, ORIGINS AND TRENDS OF VARIATION

Status

Of the 16 species considered in Section 3(1)(a), only one, the drongo Dicrurus aldabranus, is considered to be a full species, endemic to Aldabra. The following are well marked subspecies, also endemic: Threskiornis

aethiopica abbotti (the species is only otherwise known in the Malagasy Region from Madagascar); Dryolimnas cuvieri aldabranus (the species is known also from Madagascar, Mauritius, and the remainder of the Aldabra archipelago, but only still survives on Madagascar and on Aldabra); Caprimulgus madagascariensis aldabrensis (the species is only otherwise known from Madagascar); and Foudia eminentissima aldabrana (the species is only otherwise known from Madagascar and the Comoros).

Other well-marked subspecies are: Butorides striatus crawfordi (known also from Assumption); Streptopelia picturata coppingeri (known also from Assumption and Gloriosa, the Aldabra birds being smaller); and Nectarinia sovimanga aldabrensis (admittedly there is a rather similar subspecies, N. s. abbotti, on Assumption, but these two are distinct enough from any other subspecies, including N. s. buchenorum, of Cosmoledo). Butorides striatus has an almost cosmopolitan distribution, Streptopelia picturata is widespread in the Malagasy Region, while Nectarinia sovimanga occurs also in Madagascar and on Gloriosa.

Two further subspecies endemic to Aldabra, but only certainly distinguished by their smaller size, are Falco newtoni aldabranus and Alectroenas sganzini minor. The former occurs also in Madagascar, the latter in the Comoros. Yet other, poorly marked, endemics are: Centropus toulou insularis (differing from C. t. toulou of Madagascar only by its longer tail and average longer wing-length, with C. t. assumptionis intermediate); Hypsipetes madagascariensis rostratus (differing from the populations of Madagascar, the Comoros and Gloriosa by a rather slight color-difference); and Zosterops maderaspatana aldabrensis (showing minor differences in colour and proportions from Z. m. maderaspatana of Madagascar and Gloriosa, and perhaps also Cosmoledo and Astove).

Egretta garzetta assumptionis has been separated on material from Aldabra and Assumption as having a longer bill than has E. g. dimorpha of Madagascar, but is not worth formal recognition. Finally, there are two species the Aldabra populations of which are indistinguishable. Ardea c. cinerea occurs in Europe, Asia, Africa, the Comoros, the Aldabra archipelago and the Amirantes, with A. c. firasa in Madagascar, while the populations of Tyto alba affinis inhabiting Madagascar, the Comoros and Aldabra differ from those of Africa merely by average larger size. Nor is there any evidence that any of the species whose status is uncertain (Section 3(1)(c)) show any peculiarity.

The status of the land birds proved to breed on Aldabra presents an interesting range, from one "good" endemic species and several well-marked endemic subspecies down to two in which no variation at all can be discerned.

Origins

In the Comoros, Benson (1960b) found the land avifauna to be mainly of Madagascar origin, though with some African elements. The Madagascar influence is proportionately even more preponderant on Aldabra, still more remote from Africa. The only claim to any African affinity arises in the case of Ardea c. cinerea, in any event not a land bird in the strict sense that most

of the other 15 species in Section 3(1)(a) are. The only other one not having at least an ultimate Madagascar origin is Butorides striatus crawfordi. Both this, and the populations of the Mascarene Islands and of the Comoros, appear to be of Asiatic origin, those of Madagascar and the Seychelles of African. B. s. crawfordi is again not a land bird in the strict sense, and an Asiatic derivation need not tax the imagination.

The following species, for none of which is there any definite record from the Comoros,[1] could have colonised Aldabra from Madagascar via Gloriosa and the islands to the east in the Aldabra archipelago: Egretta garzetta, Threskiornis aethiopica, Falco newtoni, Dryolimnas cuvieri, Centropus toulou, Caprimulgus madagascariensis, and Nectarinia sovimanga. This is all the more likely in the case of E. garzetta, D. cuvieri and N. sovimanga, recorded from throughout the archipelago, while C. toulou is also known for Assumption. This route may also have been used by Streptopelia picturata and Zosterops maderaspatana, the populations of which on these intervening islands are very similar to those of Aldabra.

Alectroenas sganzini is only otherwise known from the Comoros, where it may have originated after an earlier colonisation by Alectroenas stock from Madagascar. Tyto alba, Hypsipetes madagascariensis and Foudia eminentissima, also only known in the Aldabra archipelago from Aldabra, but occurring throughout the Comoros, are probably also of proximate Comoro (ultimate Madagascar) origin.

The origin of Dicrurus aldabranus is more obscure, though it is presumably Madagascar-derived. Possibly it arrived via Gloriosa and the other islands in the archipelago, where however the Dicruridae are unrepresented. There is a different species on each of the Comoros except for Moheli, where again the family is unrepresented. It may have been one of the earliest colonisers - it is considered to have attained specific rank - and possibly arrived before the frontal feathers of D. forficatus of Madagascar were as developed as they now are.

Trends of Variation

The most pronounced general trend in variation is towards small size, as shown by wing-length. Thus on Aldabra Butorides striatus, Alectroenas sganzini, and Streptopelia picturata are all smaller than in the Comoros, as is Falco newtoni than in Madagascar and likewise to some extent Zosterops maderaspatana. F. araea, the representative of newtoni in the Seychelles, is still smaller than is newtoni on Aldabra. Streptopelia picturata has become still smaller in the Seychelles too, while Butorides striatus is about the same size there as on Aldabra. On the other hand, Alectroenas pulcherrima of the Seychelles is larger than A. sganzini on Aldabra, and almost as large as that species is in the Comoros. With the exception of A. pulcherrima, these cases fall into line quite well with Bergmann's Rule, the effect of which has probably been accentuated by isolation. But Caprimulgus madagascariensis, which might

[1] Except for one record of F. newtoni on Anjouan as a stray.

also be expected to be smaller on Aldabra than in Madagascar, is larger. It has already been suggested that it may show an incipient tendency to gigantism in isolation. The same may apply to Nectarinia dussumieri in the Seychelles, considerably larger than N. sovimanga, from which it may have been derived long ago.

The striking reduction in wing-length in Dryolimnas cuvieri is not considered to be a reflection of reduction in size so much as in powers of flight, presumably the result of a lack of any natural enemies. The havoc caused by introduced enemies has been mentioned. D. c. aldabranus is almost flightless, while D. c. abbotti of Assumption, now extinct, was well on the way to this stage.

Compared to the Comoros, where (Benson 1960a, 10) the annual rainfall probably nowhere averages much less than 1000 mm. (about 40 inches), and around Mount Karthala, Grand Comoro, exceeds 5000 mm. (about 125 inches), there is a distinct tendency to reduction of melanin, often resulting in an increase of pallor. This is well shown by Streptopelia picturata and Foudia eminentissima. The pallor on the underside of Butorides striatus and brownish tone in Hypsipetes madagascariensis may be due to the same cause. In comparison with Madagascar, this may also apply to Zosterops maderaspatana, yellower above, and Caprimulgus madagascariensis, paler on the crown and scapulars. Nectarinia sovimanga, on Assumption and Cosmoledo as well as on Aldabra, shows a reduction of the olive and yellowish tones, brightest in Madagascar excepting the arid south-west. But it is puzzling to find an extension of black in males in the Aldabra archipelago. This is most marked on Cosmoledo, where by contrast reduction of the olives and yellows is also most marked. In N. dussumieri of the Seychelles these tones are only slightly apparent in juveniles. But perhaps the best example of reduction of melanin is in the immature Dicrurus aldabranus, grey above and white below instead of wholly black except for mere fringes of white on the underside as in D. forficatus of Madagascar and adsimilis of Africa. The almost wholly white feathering on the head of the young Threskiornis aethiopica abbotti may also be the effect of this influence.

Finally, an increase in length of bill, a characteristic of many island populations (see for example Grant 1965), is apparent to some extent in Dryolimnas cuvieri aldabranus. Yet in Nectarinia sovimanga it has shortened, the opposite to N. notata in the Comoros as compared to Madagascar (Benson 1960a, 92). Foudia eminentissima aldabrana has a relatively heavy bill, possibly in adaptation to a seed rather than an insect diet.

5. THE LAND BIRDS: COMPOSITION OF SPECIES

Table 9 shows the occurrence of the various species of land birds in the Aldabra archipelago, drawn up from Section 3(1)(a), with the addition of Cisticola cherina, and from Section 3(1)(c) of Corvus albus. Cosmoledo and Astove have been much less studied than Aldabra and Assumption, especially Aldabra. Nevertheless the list is probably reasonably complete. No record at

all of the first two species in the table has been traced from Cosmoledo or Astove, though it is likely that they do both occur, and may well breed. Some idea of the areas of the four islands can be obtained from Watson, Zusi and Storer (1963, 191). As might be expected from its relatively large land area (60 square miles), Aldabra has easily the largest number of species.

Moreau (1966, 345-357) considered the avifauna of the Comoros, but not that of Aldabra. A few comparisons between the Aldabra list and that for Grand Comoro in Benson (1960a, 17), slightly the nearest of the four Comoros to Aldabra, are worth while. Grand Comoro is of course far larger and higher, having an area of 380 square miles and rising to 7874 feet (for areas and altitudes of the four Comoros, see Watson, Zusi and Storer, 1963, 201). Nevertheless, Moheli, the smallest of the Comoros, area 84 square miles only and not rising higher than 2950 feet, is almost as rich in species as Grand Comoro (Benson 1960a, 17), having 34 as against Grand Comoro's 35, and Aldabra's 16.

Due no doubt to lack of development, Aldabra has none of the following four introduced species, occurring on Grand Comoro and fairly general in the Comoros as a whole: Numida meleagris, Agapornis cana, Acridotheres

Table 9. List of land birds breeding in the Aldabra Archipelago

'X' indicates that the species has been proved, or may be assumed, to breed on the island in question. A bracketed 'X' indicates that breeding is likely but cannot be assumed.

	Aldabra	Assumption	Cosmoledo	Astove
Ardea cinerea	X	(X)	(X)	(X)
Butorides striatus	X	(X)	(X)	(X)
Egretta garzetta	X	(X)	(X)	(X)
Threskiornis aethiopica	X			
Falco newtoni	X			
Dryolimnas cuvieri*	X	X	X	X
Alectroenas sganzini	X			
Streptopelia picturata	X	X		
Centropus toulou	X	X		
Tyto alba	X			
Caprimulgus madagascariensis	X			
Hypsipetes madagascariensis	X			
Cisticola cherina			X	X
Dicrurus aldabranus	X			
Corvus albus	(X)	X		
Nectarinia sovimanga	X	X	X	(X)
Zosterops maderaspatana	X		X	X
Foudia eminentissima	X			

*Extinct except on Aldabra.

tristis, or Passer domesticus. Foudia madagascariensis may also owe its presence in the Comoros to an artificial introduction. Nor has it been established on Aldabra, and the nearest approach to a species associated with human activity is Corvus albus, which in any case is not certainly known to breed there, even though it does on Assumption.

Nor has Aldabra any of the 10 African-derived species found on Grand Comoro, and mostly general in the Comoros, no doubt because it is more remote from Africa. Lack of suitable habitat might explain the absence of such Madagascar-derived species as Circus spilonotus and Saxicola torquata, associated with open grasslands (Cisticola cherina, unknown in the Comoros, also associated with this type of habitat, occurs on Cosmoledo and Astove), or Coracopsis nigra, Chaetura grandidieri and Coracina cinerea, associated with heavy forest (Corasopsis nigra is known also from Praslin, in the Seychelles). Yet Alectroenas sganzini and Foudia eminentissima, mainly forest dwellers in the Comoros, have both colonised Aldabra. Cypsiurus parvus, occurring at lower altitudes throughout the Comoros, may have failed to colonise Aldabra because of a paucity of introduced coconut palms, providing suitable nesting sites. Two other species whose presence might be expected are Alcedo vintsioides and Terpsiphone mutata, both occurring throughout the Comoros. So far as the former is concerned, possibly there is a lack of suitable banks for burrowing of nesting holes, while it may be noted that the genus Terpsiphone is represented in the Seychelles.

Of the first four species listed from Aldabra in Table 9, only Butorides striatus is on the Grand Comoro list. The absence of the other three (the Egretta and Threskiornis are absent throughout the Comoros) may be due to a paucity or lack of suitable habitat, which may also explain the absence of Dryolimnas cuvieri (also absent throughout the Comoros). As already suggested in Section 3(1)(a), Falco newtoni, Centropus toulou and Caprimulgus madagascariensis, all present on Aldabra but completely unknown in the Comoros (except for one record of the first named) may have failed to colonise the latter because originally they were too heavily forested.

6. SUMMARY

1. The history of ornithological exploration of Aldabra is outlined.
2. So far as is possible from existing knowledge, the status of every species of bird known on Aldabra is assessed in a systematic list, divided into two categories, land birds and sea birds.
3. Special attention is paid to the 16 known resident land birds, derived almost entirely ultimately from Madagascar, either via Gloriosa and the islands immediately to the south-east of Aldabra (Astove, Cosmoledo and Assumption) or via the Comoros.
4. One form, a drongo Dicrurus aldabranus, is considered to have attained specific rank, and there are a number of well-marked subspecies. In only two cases is there no apparent variation at all. Trends of variation include a strong tendency to small size in several species in comparison with Madagascar and/or the Comoros. On the other hand, a nightjar Caprimulgus madagascariensis has become somewhat larger than in Madagascar. The

other most marked tendency is a reduction of melanin, often resulting in an increase in pallor, and perhaps associated with a relatively dry climate.

5. A special case is that of a rail Dryolimnas cuvieri, which has become almost flightless, probably due to a lack of natural enemies. But due to the introduction of predators, its continued existence is precarious, and it is already extinct on Assumption, Cosmoledo and Astove.
6. The numbers of land birds on Aldabra, Assumption, Cosmoledo and Astove are listed in a table. Aldabra, the largest in area, has easily the highest number. The Aldabra list is compared with one from Grand Comoro. It lacks all of the African-derived species on Grand Comoro, nor has it any introduced species. But there are two herons and an ibis not on the Grand Comoro list, and a falcon, coucal and nightjar unknown in the Comoros generally, perhaps originally too heavily forested for their occurrence.
7. Various palaearctic migrants, mostly shore birds, have been recorded from Aldabra. Two species have also been recorded as visitors from Madagascar, and which also visit Africa. Other species in both these categories which may also occur are listed.
8. Among land birds of uncertain status, there is a flamingo, Phoenicopterus ruber. It appears not to be a distinct subspecies, and it is still uncertain whether it ever breeds on Aldabra. It is possible that there is a breeding colony of the Crab Plover Dromas ardeola. The nearest definitely known colony is in Somaliland.
9. Aldabra is important as a breeding area for various sea birds, including very large numbers of two frigatebirds, Fregata minor and ariel, a booby Sula sula, and noddy Anous stolidus.

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Chapter 5

OBSERVATIONS ON THE BIRDS OF ALDABRA IN 1964 AND 1965

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1. GENERAL OBSERVATIONS

Birds are conspicuous on Aldabra, for although the number of species is small, the species themselves are represented by large populations. This paper presents observations on the natural history of the land birds, together with some notes on the sea and shore birds, obtained during two visits to Aldabra made by the Bristol Seychelles Expedition, the first from 11 November to 14 December 1964, the second from 4 October to 20 November 1965.

Fourteen land birds are considered here, together with the flamingo, which spends much of its time at inland pools. Of these fourteen, only three have apparently not diverged from their Madagascan or Comoran ancestors (Benson 1967). These are the Pied Crow Corvus albus, which is extremely mobile amongst these islands; the Cattle Egret Bubulcus ibis, which seems to be a recent arrival; and the Madagascar Bulbul Hypsipetes madagascariensis. Pied Crows are frequent around the settlement on West Island, and also occur in areas of Mixed Woodland and beach vegetation on South Island. Their total numbers cannot exceed a few hundreds. Cattle egrets have previously been recorded only as rare vagrants, but as elsewhere there has been a recent increase, and at least 100 birds now live on South Island, around Takamaka.

There are no introduced birds on Aldabra apart from the few chickens on West Island, despite the many introduced species in neighbouring island groups. Very large numbers of migrants visit Aldabra, but these are mainly waders, which feed on the lagoon and among the brackish pools in the southeast. A number of vagrant land birds have also been recorded, and are listed by Benson (1967). Only the Broad-billed Roller Eurystomus glaucurus glaucurus may occur regularly, having strayed on migration between Africa and its breeding quarters in Madagascar. The Blue-cheeked Bee-eater Merops superciliosus might be expected, since it has been seen on Cosmoledo (R. Gaymer, October 1), as might the Madagascar Grass-warbler Cisticola cherina, which is common on Cosmoledo and Astove. Four specimens of a barn owl were collected on Aldabra in 1892 and one in 1906, but none have been recorded since, and they must be assumed extinct. They do not appear to differ from the African Tyto alba affinis (Benson 1963), which also occurs in Madagascar and the Comoros.

The main land bird habitats are (1) mixed scrub and woodland covering the interior of South Island, and to a lesser extent West and Middle Islands; (2) Pemphis scrub, which covers most of the rest of the atoll; (3) mangrove communities fringing the lagoon; and (4) the coastal vegetation, which is best developed in the west.

In probable order of abundance the commonest species are the Sunbird, the Fody, the Bulbul and the White-eye. These are omnivorous birds, able to utilise the many flowering shrubs and trees, with which their breeding season is synchronised. Excepting the pigeons, the larger birds are either scavengers with a wide range of foods and feeding sites, such as the Ibis and Pied Crow, or, like the Kestrel, Nightjar, Drongo and Coucal, they are more specialised and feed on lizards or large insects which are in more regular but limited supply. These birds are mostly less numerous, despite their smaller size.

The fruits and seeds of the flowering plants provide a large and continuous food supply for the ground-feeding Turtledove, since germination and decay are

minimal on the dry rocky or sandy ground. Fleshy fruits are much less abundant, and the supply must be very seasonal. This probably explains the rather small numbers of the Comoro Blue Pigeon, which are only common in the southeast, where Ficus and other trees are concentrated. The numbers and distribution of the other birds also correspond with the vegetation types.

1. Mixed Scrub on Platin

Most of the land birds are commonest here, with the exceptions of the Pied Crow and the White-throated Rail, which latter is confined to the mangrove, Pemphis scrub and beaches of Middle Island and Polymnie. The Comoro Blue Pigeon, Madagascar Coucal, Madagascar White-eye, and probably the Madagascar Nightjar are only otherwise found in areas of rich beach vegetation. The White-eye and the Coucal seem particularly dependent on dense cover. Although found inland, the Pied Crow is best considered as a littoral scavenger, and is commonest around the outer coast. Cattle Egrets roost in a large clum of trees at Takamaka, as do the Sacred Ibis and fruit bats.

2. Pemphis Thicket on Champignon

Pemphis appears to provide little food, and it is generally avoided by the birds. The White-throated Rail is an exception. Where mixed woodland is close, the Sunbird and the White-eye are sometimes seen, and the former at least may nest.

3. Mangrove

Mangroves are a major habitat for nesting sea birds, and dense stands of Rhizophora are also inhabited by occasional water birds, and by Drongos, which nest near the edges. Small numbers of Sunbirds occur in open mangrove of this type, and also of Avicennia and other genera, as do Drongos and sometimes Kestrels and Fodies. Sacred Ibis feed in mangrove on the lagoon margins. Turtledoves may nest in mangrove, but this has not been observed. The Flamingos are largely confined to this habitat, which also serves as winter quarters for many migrant waders.

4. The Settlement

The settlement area on West Island is visited by Sunbirds, Bulbuls and White-eyes, but only because it is an area of rich beach vegetation. The Fody and Turtledove exploit the food provided by the kitchens and the feeding of domestic animals, the Fody being especially efficient in competition with chickens for rice. Both species also exploit the many Casuarina trees along the beach, and the Fody breeds in the lower branches. Pied Crows scavenge for offal when possible, but are discouraged. The other birds avoid the settlement.

2. THE LAND BIRDS

Threskiornis aethiopica abbotti Ridgway Sacred Ibis

Because of its large size (70 cm.) and pleasant flesh, this bird is uncommon and is restricted to the more remote parts of South Island, where it is most abundant in well-developed mixed woodland and open mangrove. It feeds in small groups in the lagoon at low tide, or in twos and threes inland (Plate 28). Large numbers roost at Takamaka, where a colony was found nesting over a small tree by the pool (Plate 33). There were 21 nests, built in a mass at a height of 7-10 feet; 17 of the nests contained two eggs, two had one egg, and one had three. The eggs were off-white in colour, stained, and without lustre. By the following day (November 22) a further bird had laid. Over the next five days all the eggs vanished, despite minimal disturbance. Fryer (1911) found a similar colony in which two out of a total of 18 eggs were destroyed, according to him in gaining access to their own individual nests. The nests found in 1964 were about 45 cm. in diameter, composed of twigs, and lined with a small amout of tufts of grass and dead and fresh leaves, none of which were woven. The cavities were shallow. Nicoll (1906) found old nests in mid-March, at which time the young were fully grown.

Reports of feeding include the taking of scraps and turtle offal from around the camps of turtle fishermen, and small crabs and other marine animals. The bill is used to probe for food in the mud of the lagoon and of fresh and brackish pools inland. Many Ibis are also seen searching in leaf litter inland, and may eat lizards, large insects, and some vegetable matter. These birds were once extremely tame, but although all ages are still very inquisitive, only the juveniles now approach to within two or three yards: they are recognisable by their rather shabby appearance, smaller size, and feathered necks.

Phoenicopterus ruber roseus Pallas Greater Flamingo

The flamingos on Aldabra have been variously reported "resident . . . numbers 500 to 1000" or absent, and therefore previously only as migrants in passage. It is clear that they are regularly present at least in the southeast, where they occur in small groups or pairs in the brackish pools amongst the mangroves (Plate 36). There seemed to be about 50 birds at the time of our visit, but they are very shy and difficult to approach. They may breed, but this has not been confirmed. Although the mangroves in the southeast seem to be the main habitat, flamingos have also been reported in the lagoon proper; flying over Middle Island in the east; and over South Island near Dune Jean Louis.

Falco newtoni aldabranus Grote Madagascar Kestrel

This kestrel hunts lizards and rarely hovers, but is otherwise fairly typical. The male is chestnut and black dorsally, with a grey head, and spotted beneath. The female is larger, more spotted, and generally brownish above. The only prey seems to be the lizards Ablepharus and Phelsuma, and possibly some nocturnal geckos. Unlike the Madagascan form, this bird avoids human habitations. It occurs over much of South Island, but since breeding territories

are very large, the total population cannot exceed 100 birds. The only breeding record is one nest at Anse Mais, on the west coast of South Island. It was found on 18 November, in the crown of a coconut palm, at about 25 feet above the ground, and contained a little down and three large young (see Penny 1964, 40). Lizards were being brought to the young by the parents, who also defended the area against Pied Crows, Drongos and Bulbuls. On one occasion a kestrel was observed driving seven Pied Crows away. This behaviour was seen at Takamaka, indicating that breeding may also have been in progress there.

Dryolimnas cuvieri aldabranus (Günther) White-throated Rail

This Rail, the Aldabra form of which is flightless, has head, neck and breast a dull chestnut colour, otherwise the general colour is olive, with the chin and throat of adults white. It appears to be confined to Middle and Polymnie islands, but may also occur on Esprit and Michel in the lagoon. There is no evidence that rails have lived on South Island, although Abbott (in Ridgway 1895) states that they did and had been exterminated by feral cats. Rails were then common around the settlement on West Island, but were rare by 1908 (Fryer 1911) and have not been recorded since. Cats and rats are the most likely cause of their extinction on West Island.

It is possible that these Rails are in some way associated with the large colonies of sea birds which occur in the same areas. Eggs are certainly eaten with speed and efficiency when offered, although large insects and shore crabs may be more important foods in the wild.

Bendire (1894) describes the only nests recorded, collected by Abbott. They were rather loosely constructed from small twigs and plant stems, one at 18 inches above the ground, the other more typically in a cavity in the rock. The first nest was 25 cm. wide and 18 cm. deep, with a cavity measuring 11.5 by 9.5 cm., which meant that the hen sat with only the head protruding. The second nest was composed of finer materials, mainly dried grass, and was concealed behind a tuft of grass. Clutches were 4, 3, 2 and 2. The average size of the eggs was 4.25 x 3.0 cms. The shells were strong, fairly glossy with fine granulations, and of a creamy white colour, sparingly dotted with liver brown, vineaceous and lavender. The marks were heaviest at the larger end. These nests were taken in December, so it is surprising that others on Aldabra at the time have seen no signs of breeding. Abbott (1893) says that a few pairs were breeding in September, but that most did not breed until November-December. Nicoll (1906), who was on Assumption from 11 to 13 March, thought the breeding season of the Rail was over, though he did see several young still covered with black down. On Aldabra, Abbott gives the clutch size as three, rarely four, despite local reports that this is often exceeded. The hen sits very closely and quickly returns once disturbed. In Madagascar the breeding season of this species probably includes October, November, and January to March (Rand 1936).

A startling variety of calls is produced, with the head raised. A drum-like sound, often followed by a long curlew-like whistle, is common, and when excited a series of shrieks and grunts can be produced, which may be used to call the young (Nicoll 1906). Pairs are territorial and fighting has been reported.

Alectroenas sganzini minor Berlepsch Comoro Blue Pigeon

This medium-sized fruit pigeon is strikingly coloured pale grey and midnight blue, with bare red skin around the eye (Gaymer 1966; Penny 1965, 411). The male has some of the feathers on the head and neck faintly tipped with pink. Juveniles are green with some yellow above, and greenish grey below.

Small groups of blue pigeons are conspicuous in larger trees, and they are also seen flying overhead at some height in ones and twos. They are well distributed in the mixed woodland on South Island and West Island, often revealing their presence by a hoarse 'hoo', repeated four or five times. This is especially characteristic of the male display, in which he hops through the canopy of a tree after a female, cooing, bowing, and raising the plume feathers of the head and neck, often stopping to drive away other birds, including Bulbuls. This display has been regularly observed in November and December, but the testes of two males taken at that time were small (10 x 4 mm.) with little fat. Nesting and rearing may occur in February to March. Young birds have been seen with their parents in March (Nicoll 1906). In the Comoros Benson (1960) collected a female of this species containing an almost fully developed egg on 2 November, while in Madagascar Rand (1936) found that A. madagascariensis breeds from July to March. On Aldabra the nests are probably built in the tops of larger trees inland.

These pigeons eat the fleshy fruits of Ficus sp. (la fouche, banyan) and small flocks are attracted to these and other fruiting trees. Fruits up to 1 cm. in diameter are swallowed whole, many being dropped while feeding. Drinking has not been observed, nor have they been seen on the ground.

Streptopelia picturata coppingeri (Sharpe) Madagascar Turtledove

This pinkish grey-brown dove, about 30 cm. in length, spends much time on the ground in small groups, searching for seeds, which are the main food. Casuarina seeds are eaten where possible, and some rice and other scraps are eaten at the settlement. In the Comoros some insects are also taken (Benson 1960) but this has not been seen on Aldabra. Small freshwater pools are visited regularly in the morning and evening (at least in the dry season), being approached on the ground, usually in small flocks.

Remarkably little is known about breeding. Abbott (in Ridgway 1895) reports that nesting occurs in mangrove in September to November. This is surprising, since they are now rarely seen in mangrove. Males were observed courting and driving other males away during November and December. In the Comoros, Benson (1960) had evidence of this species breeding in August to November, while in Madagascar Rand (1936) found that the season probably extends at least from July to October. On Aldabra, two white eggs are probably laid on a flimsy platform of twigs in the canopy of a tree, as elsewhere.

Centropus toulou insularis Ridgway Madagascar Coucal

A large clumsy bird, about 45 cm. long, which includes a long graduated tail and heavy hooked beak. Both male and female have the characteristic call--a descending "tou-lou-lou"--but at different pitches, the male's being

the higher. This call carries very well, and often reveals their presence when the birds are well hidden in the canopy of a tree or in a bush. They are only found in areas of dense mixed vegetation, in which much of their time is spent in search of food. This consists of centipedes, lizards, crickets, and probably grasshoppers, cicadas, mantids, etc. Bird eggs are also eaten, and young may be taken too. Abbott (in Ridgway 1895) reports his belief that small rats are eaten. Food is swallowed whole, being captured mainly on the ground.

Abbott describes the nest, which is oval and very large, with an entrance at one end, by which he presumably means at the side. It is made of loosely interwoven strips of bark, grass, and, where available, coconut leaves. He gives the height as 5 to 8 feet above the ground, although Fryer (1911) describes a nest as "low down" in a bush. Three or four white eggs are laid. The birds are in breeding plumage by October, and pairs can be heard calling together in their large territories. As in Madagascar (Rand 1936), the breeding season of this species probably extends from December to March.

Caprimulgus madagascariensis aldabrensis Ridgway Madagascar Nightjar

This nightjar is about 24 cm. long, with typical grey and brown cryptic coloration. It is rarely seen, but at night the falling rattle and two-noted cry (with the second note stressed) can commonly be heard inland, especially in the southeast. Abbott (in Ridgway 1895) also reports a "winnowing" cry.

Occasionally a roosting bird may be flushed from the ground during the day. Almost nothing is known of this bird's habits. Abbott reports that beetles were taken at night from around a pile of refuse on West Island. He states that breeding occurs on open ground or sand hills, and found a nest with young in September. Rand (1936) records breeding of this species in Madagascar in August, September and October.

Hypsipetes madagascariensis rostratus (Ridgway) Madagascar Bulbul

This noisy bird is grey, with an orange bill and a short black erectile crest. It is sometimes in groups of up to a dozen, although a group of two or three is more normal. The song is a harsh, quite complex whistle, but many other sounds are made. Berries and other fruits, flowers, and flower buds form the major part of the diet, but mantids, orthoptera and other large insects are taken when possible, sometimes on the wing.

The breeding season probably extends from November to January, though in the Comoros Benson (1960) gives evidence of breeding starting as early as September, and in Madagascar Rand (1936) gives the season as extending at least from September to January. On Aldabra nesting material was being carried on 27 November, and two nests were collected by Abbott on 22 December and 31 December. These are described by Bendire (1894). They were rather slight, and composed of fine rootlets, small twigs, dry leaves and plant fibres, being lined with finer materials of the same kind, plus dry grasses. They measured 10.4 x 7.2 cm. externally, and 9.5 x 4.5 cm. deep internally. Both were at about 8 feet above the ground, in the crotches of thorny shrubs. One contained two eggs, the other only one, and these averaged 2.48 x 1.77 cm. The shells were close grained, glossy vinaceous pink, profusely spotted and blotched

with different shades of claret brown, vinaceous rufous and lavender, forming a wreath at the larger end.

Dicrurus aldabranus Ridgway Aldabra Drongo

Adults of this species are black, with a long forked tail and a total length of about 28 cm. The bill is stout and compressed, hooked at the tip, with strong nasal bristles at the base. Immature birds are rather unevenly grey, paler beneath. Drongos are commonly seen in pairs or family parties, sitting conspicuously on bare branches in mixed woodland near mangrove. It is a pugnacious bird, with large territories. The nesting area itself is successfully defended against even Ibis and Grey Herons. Bendire (1894) describes two nests, collected in November and early December. These were very firmly constructed of fine twigs and lined with finer ones, to form a rather shallow cup 7.5 cm. wide and 3.25 cm. deep, the outer dimensions being 14 x 5 cm. Three eggs were rich cream, with scattered spots of cinnamon rufous and brick red, some with one or two lavender dots. There was no lustre, and the markings were heavier at the larger end. Average measurements were 2.65 x 1.9 cm. These nests were built on a horizontal branch of Casuarina, but where this tree is absent, nests are built in mangrove, at a height of 15-20 feet above the ground. Inland, nests may be built in large Ficus and other trees. One such nest was composed mainly of dried sedges, looped over a fork at 18 feet. It was frail in appearance, with a fairly deep cup internally. Spider's web is often incorporated, and this was also noted by Abbott (in Ridgway 1895). Abbott gives the clutch size as three or four.

A nest with one young was seen at the end of November, but it was later found abandoned. Another nest was found on 2 December containing three young. Several family parties were seen in November and December, but none had more than two young, and most had only one, and this may be the usual number reared. Benson (1960) found eggs of D. waldeni on Mayotte in the Comoros in October and November, while Rand (1936) found the breeding season of D. forficatus in Madagascar to be from September to December. Nothing is known about feeding, but related species eat beetles, homoptera, and spiders. The young are fed by both parents on what appeared to be large insects.

Nectarinia sovimanga aldabrensis (Ridgway) Souimanga Sunbird

This is a typical sunbird, very small (about 11 cm.), with a long down-curved beak. The male has bright metallic coloration, the female and juveniles are dull brownish grey. These birds are very active, and hop continuously through bushes and trees, uttering a frequent high-pitched 'chink'. The males sing loudly in the breeding season, which is prolonged, extending at least from September to January (Abbott in Ridgway 1895). Morris (1963) found eggs in January. Nests are domed, and usually suspended from a branch at 4-12 feet above the ground, or sometimes hung from branches or roots over the edge of a pit in the ground. The nest is begun by fastening streamers of twice or more the final length of the nest to the chosen Pemphis, mangrove, or other branch. Abbott (in Ridgway 1895) describes the formation of an oval mass of nesting material, which the hen then opens out by pushing in her head

and body, later entering the cavity, and finally lining it with feathers. The nest includes bark fibres, grasses, dried marine grass from the beach, down from pods of wild cotton, and many hundreds of feathers. It takes about eight days to build, all the work being done by the female. Vesey-FitzGerald (1940) gives the internal dimensions of a nest on Astove as 10 cm. deep and 8 cm. wide, the entrance being 3.5 x 4.0 cm. Morris (1963) gives the entrance as 4 cm. in a nest about 11.5 cm. across. He describes the eggs as dirty white, mottled with umber. He later found this nest in "tattered ruins". Two nests which were built into a branch, rather than suspended, were also the highest seen, at 10 and 12 feet above the ground. The nesting density is sometimes very high. Eleven nests were counted at Anse Mais in mid-November. Two eggs are laid, and incubation takes 13 days, the sexes sharing the task. The eyes of the young open on the seventh day.

Nectar is sipped with the tubular tongue, sometimes while hovering, but generally while perched. Small flies are eaten in large numbers, with some solid vegetable matter, mainly stamens and other flower parts. All solid food is swallowed in very small pieces. The young are probably fed mainly on insects.

Although no longer so tame that they alight on one's arm (Abbott in Ridgway 1895), the females and juveniles will often inspect an intruder while hovering in front of his face.

Zosterops maderaspatana aldabrensis Ridgway Madagascar White-eye

This tiny yellow to olive-green bird, with a white ring around the eye, is usually seen in small flocks, which move through the bushes and trees with repeated soft calls, well described by Morris (1963) as a low, rather bell-like 'tee-eep", and an almost continuous low twittering. Although often hard to locate, white-eyes are very common in areas of rich beach vegetation and in the denser parts of the mixed woodland. The diet is mixed, consisting of berries (swallowed whole), small beetles and other invertebrates, nectar taken up with the brush tongue, and buds and flower parts. Food is not taken on the wing.

Breeding takes place from October to December (Abbott in Ridgway 1895). Nests are built at about 6 feet above the ground, slung into a fork at the top of a bush. They form a small deep cup, in which two or three pale blue-green translucent eggs are laid, and are composed of shreds of bark, leaves, grass and small twigs, with little lining. Casuarina needles have also been reported.

During courtship pairs can be seen preening each other around the head and neck while sitting side by side on a branch. The male sings, and pairs are territorial, but this is not so apparent as in most of the other birds.

Foudia eminentissima aldabrana Ridgway Red-headed Forest Fody

This bird is common and conspicuous, especially around the settlement on West Island. The female is somewhat sparrow like, but is more yellow, with dark streaks, and has a more powerful bill. The male in breeding plumage has a vivid orange-scarlet head and breast, with the belly and back yellow and the rump orange. Immature birds resemble the female.

Flocks of breeding adults may be formed while feeding, but this is unusual. Males are strongly territorial, with a characteristic threat display, in which the wings and tail are drooped, and the head, breast and rump feathers puffed out (Plate 35). The intruder is then challenged with a series of wheezing or fizzing calls, and a metallic 'ching-ching'. A female may be so challenged, but on recognition the calls become a series of thin high whistles at about half-second intervals, uttered by one or both sexes. The male then raises his wings high and quivering above his back (in obvious strong contrast with the threat posture) and if accepted mounts and copulates with the crouching female, keeping his wings raised. Copulating was observed in November and December. Territories may be as small as 1000 square yards in groves of larger trees, indicating a possible forest ancestry. Nests may be from 4 to 20 feet high, and if one is destroyed another is built nearby. Mixed woodland is preferred, and Casuarina is used if available. Nests in mangrove are rare. Abbott (in Ridgway 1895) gives the clutch as four, but those he collected were 3, 3, 2 and 2. We observed four nests with eggs: all had three eggs, these being laid in one case on consecutive days, ceasing after the third egg. Abbott also states that nesting is in November, December and January; it probably extends to February or March. The male assists in nest construction but not in incubation. Bendire (1894) describes the nest and eggs. Nests are domed, and are built into the branches of a tree or shrub. They measure 23 x 18 cm., with inner dimensions 7.5 cm. wide and 7.0 cm. deep. The eggs are pale glaucous green, nearer blue, unspotted, with a rather thin glossy shell. They average 2.05 x 1.4 cm. in size.

These fodies feed on seeds, flowers and beetles taken from among bushes and trees, or from the ground. Other small invertebrates may also be taken. Rice and kitchen scraps are eaten at the settlement, and Casuarina seeds wherever found. Abbott reports that unripe maize was eaten if opened by rats, but since the bill is very powerful, they must have been so unfamiliar with maize that they attacked it only when exposed.

3. NOTES ON SEA AND SHORE BIRDS

There have been no studies of the marine birds of Aldabra, apart from a small amount of collecting, and some scattered observations. Benson (1967) has listed the known species. The following notes on sea and shore birds are divided into (1) known breeding species, and (2) unconfirmed breeding species.

1. Breeding Species

Phaëthon rubricauda Red-tailed Tropicbird

A population probably numbering some hundreds lives mainly along the northern part of the lagoon, breeding on small islets under rock ledges, bushes or tall grass (Plate 31). Nest with egg found on 18 November.

Sula sula Red-footed Booby

Many thousands breed in colonies scattered amongst the frigate bird camps on Middle Island. Vesey-FitzGerald (1941) describes nesting, and states that

breeding occurs "around September". Some fledged young were seen in November (Plate 30). No dark morphs seem to occur as reported on Gloriosa.

Fregata minor Greater Frigatebird
Fregata ariel Lesser Frigatebird

Huge camps containing tens of thousands of these birds occur in the mangrove fringing the lagoon shore of Middle Island. Eggs of both species were present on 7 October, although the season has been given as May to August. Frigates may breed on the Cargados Carajos and Gloriosa, but otherwise the Aldabra colonies supply the entire western Indian Ocean. Vesey-FitzGerald (1941) reports that frigates nest on Cosmoledo but this no longer seems to be the case. The colony reported by Fryer (1911) on West Island, Aldabra, seems also to have gone, probably as a result of human activities. Benson (1960) supposes that frigates breed in the Comoros, but in view of the small numbers seen they may be visitors from Aldabra. Stoddart and Wright (1967) describe frigates diving for water at freshwater pools on the South Island platin.

Butorides striatus Little Green Heron

A local race, frequent around the west coast, but less common elsewhere. Probably nests, as in the Seychelles (Dawson 1966), over a long period, concentrated in the northwest monsoon, but this requires confirmation.

Egretta garzetta Little Egret

Many thousands feed in the lagoon at low tide, and elsewhere, and the bird is also seen inland. White morphs outnumber the slate-grey dark morphs by about 7 to 3 (Dawson 1966). Probably breeds in the mangrove, August-September.

Sterna sumatrana Black-naped Tern

Regularly seen in small numbers in the lagoon. A nest with one egg was seen on 17 November on a small bare island in the lagoon near Polymnie. Eggs have been found in September to November on other island groups (Vesey-FitzGerald 1941).

Anous stolidus Common Noddy

Thousands occur on small bare islands out in the lagoon, scattered amongst the frigate colonies on Middle Island, and on the cliffs of islands in West Channels. It breeds in cavities and ledges of islets in the lagoon (Vesey-FitzGerald 1941), and probably in the mangrove; the season may be June-August.

2. Unconfirmed Breeding Species

Phaëthon lepturus White-tailed Tropicbird

Rather more common and widespread than the red-tailed species. Would breed in similar situations.

Sterna albifrons Little Tern

Perhaps a hundred seen along the northern coast in November, and more rarely in the lagoon. They are locally reported to breed, laying one egg in a sand scrape.

Thalasseus bergii Crested Tern

Frequently seen feeding in shallow water over the outer reef or in the lagoon, sometimes in small groups. Locally reported to breed, young being taken from the bare low Chalen Islands, near West Channels.

Gygis alba Fairy Tern

Seen flying in twos and threes in the lagoon. Locally supposed to breed throughout much of the year.

Dromas ardeola Crab Plover

Flocks of up to several hundred feed on exposed sand and mud over the reef in the west and in the lagoon. Not locally thought to breed.

3. Non-Breeding Migrants, Visitors and Vagrants

The following species occur in large numbers in the creeks and pools of the mangrove around Bras Takamaka and elsewhere, and sometimes around the outer coast and in the lagoon at low tide: Turnstone Arenaria interpres, Whimbrel Numenius phaeopus, Sanderling Crocethia alba. Less common are the Greenshank Tringa nebularia, the Common Sandpiper Actitis hypoleucos, the Curlew Sandpiper Erolia testacea, and the Wood Sandpiper Tringa glareola. The Turnstone is probably the only species present throughout the year.

Other species of sea birds reported include the Sooty Tern Sterna fuscata, the Lesser Black-backed Gull Larus fuscus, and possibly the Blue-faced and Brown Boobies Sula dactylatra melanops and Sula leucogaster (Fryer 1911, and local reports).

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Chapter 6

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This Bibliography of Aldabra must be incomplete, since systematic searching of the literature has yet to be made for Aldabra references in many fields, particularly in history. It concentrates on recent scientific literature, but again, though a fairly intensive search has been made, many items must have been missed. It is likely, however, that no important item pertinent to the ecology of Aldabra has been missed. Specialist papers from the major expeditions are only cited if they contain records from Aldabra, though no attempt has been made to give complete coverage of purely taxonomic papers naming Aldabra species. This Bibliography also contains a number of items which are cited in Chapters 1, 2 and 3 of this Bulletin, but which do not specifically refer to Aldabra, and these are marked with an asterisk*.

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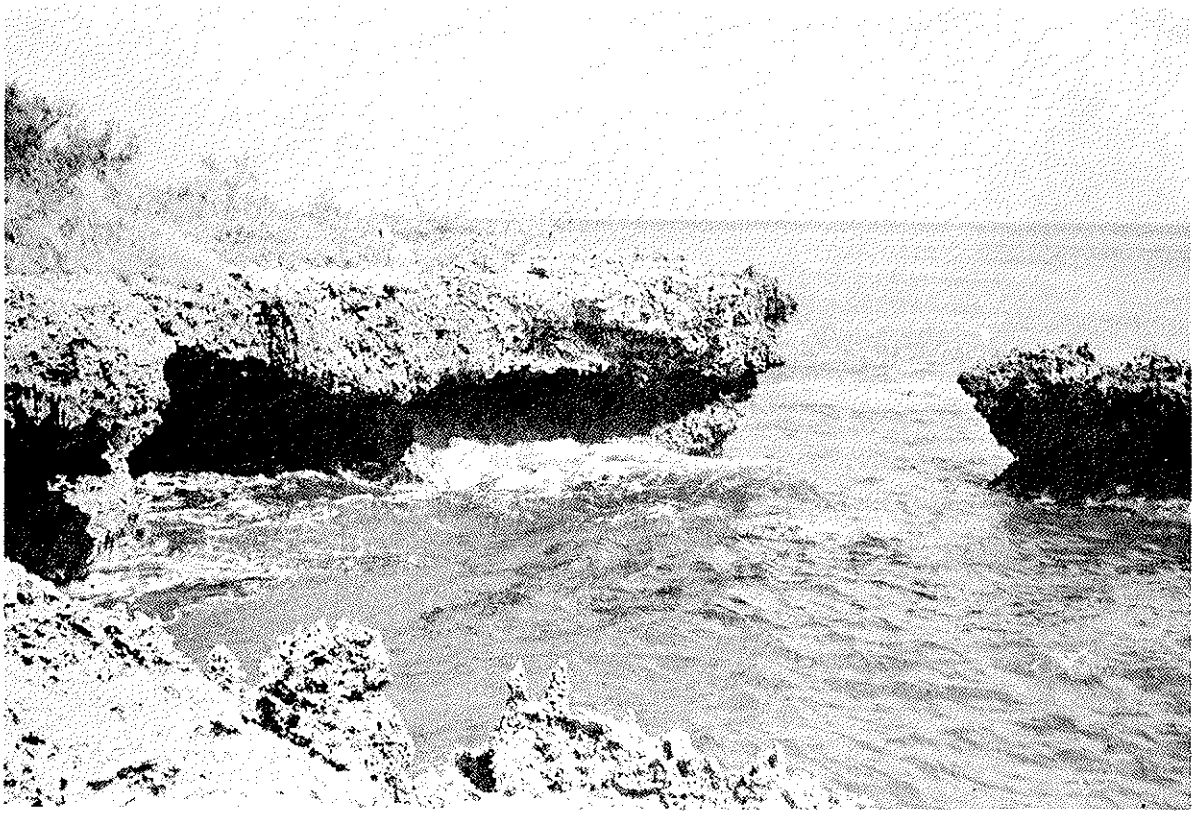
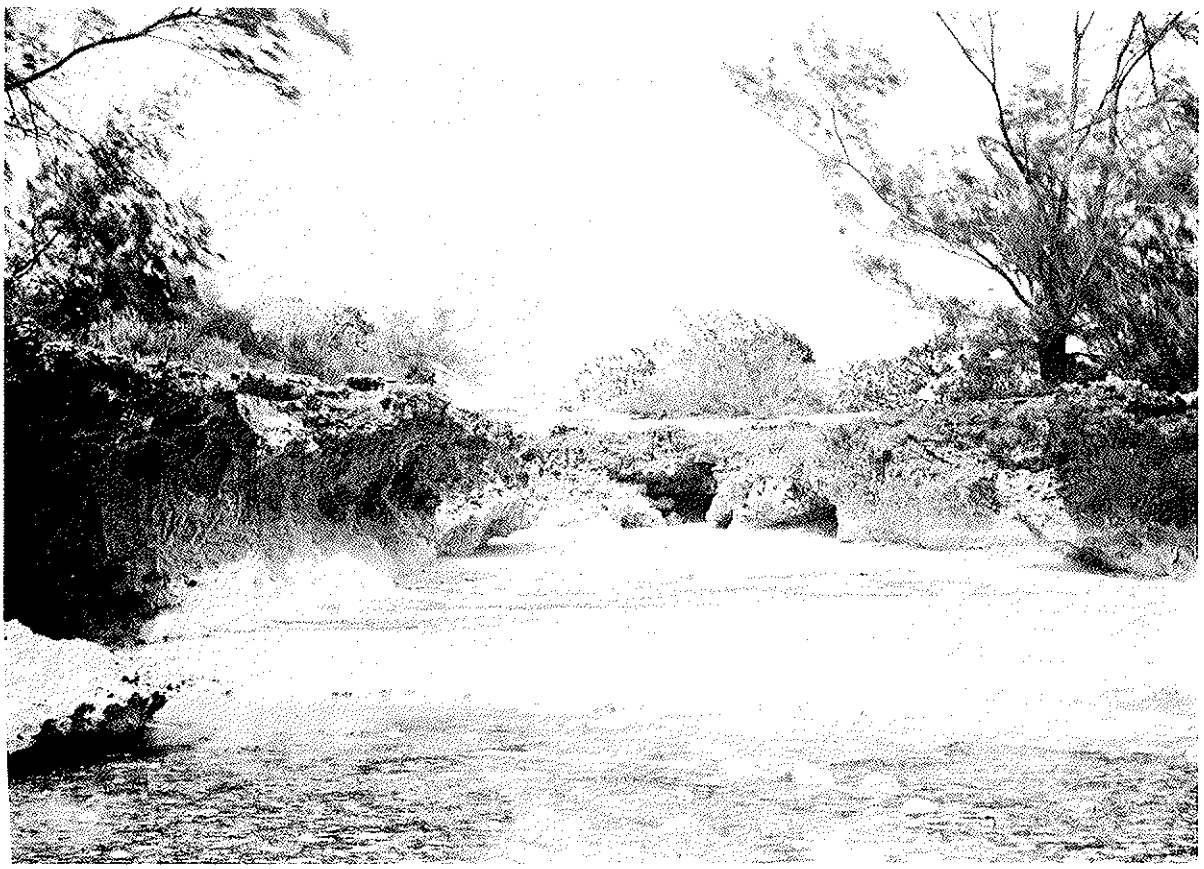
1. Exposed coastal cliffs, Point Hodoul. Note the extreme dissection of the champignon, and the intertidal algal platform.



2. Medium-energy coastal cliffs, east of East Channel, mid-tide.

3. Boulder zone on reef-flat at low tide, Anse Cèdres.



4. Small pocket beach on medium-energy coast, near Anse Cèdres, low tide. Note the perched beach above the cliff line.

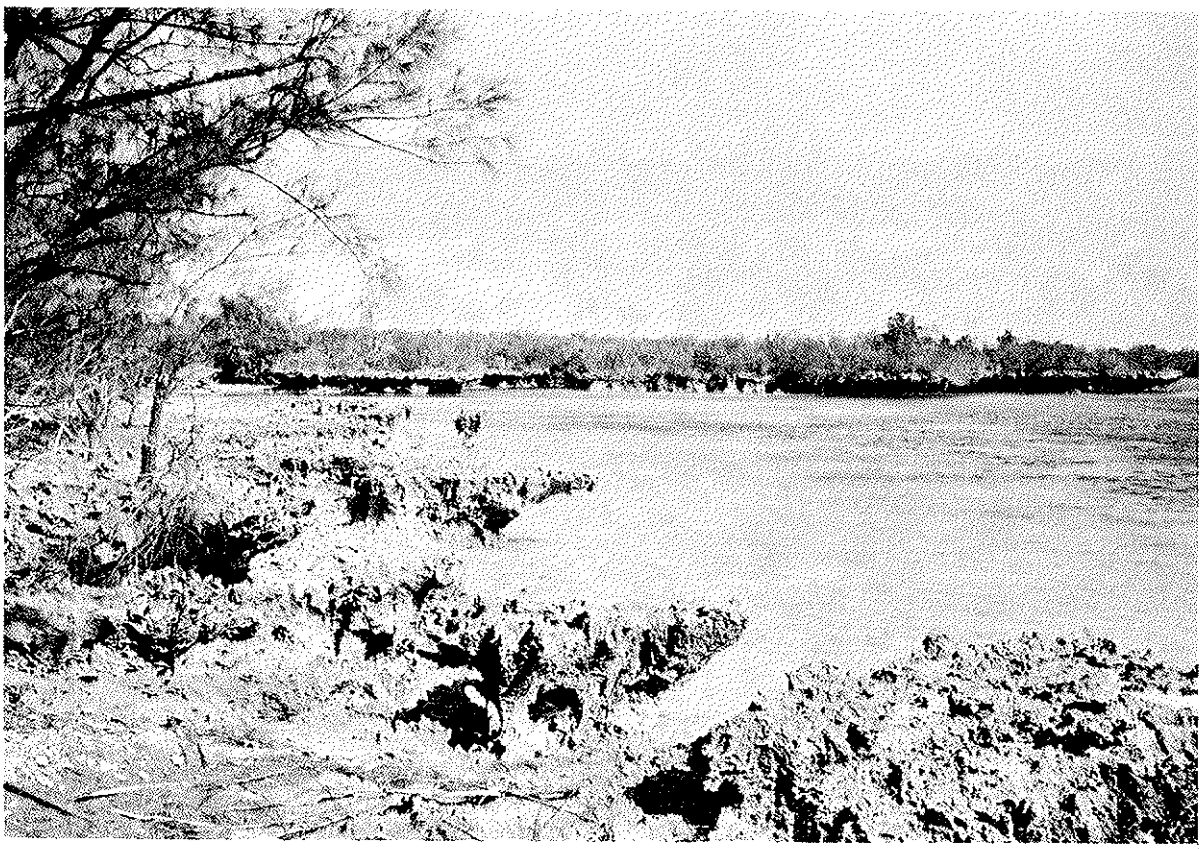
5. Pocket beach at Anse Cèdres, mid-tide; beachrock in the foreground.

6. Low coastal dunes, seaward coast near Takamaka.

7. Moderate coastal dunes, seaward coast near Cinq Cases.

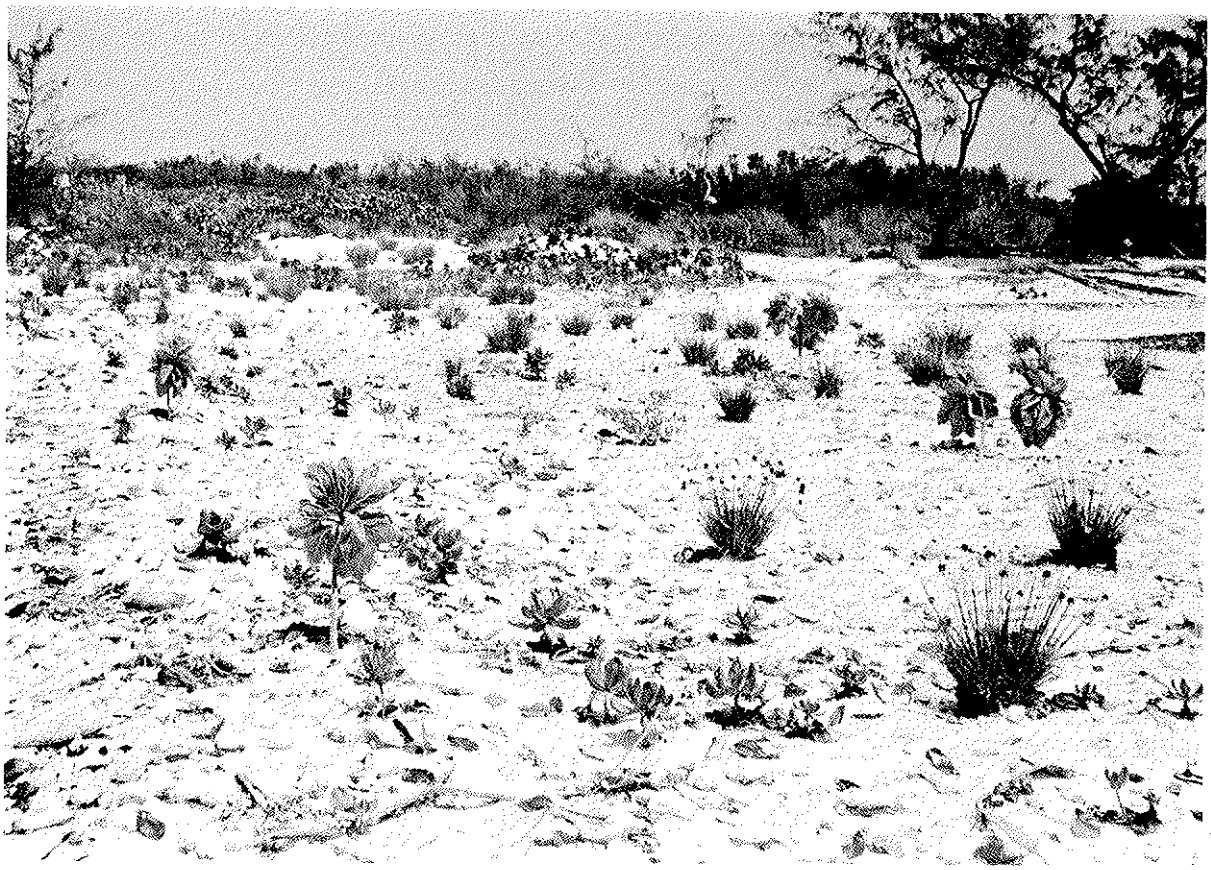
8. Moderate coastal dunes with coarse grasses between Takamaka and Cinq Cases.

9. Dunes at the south end of West Island; intertidal flat in the foreground exposed at low water.



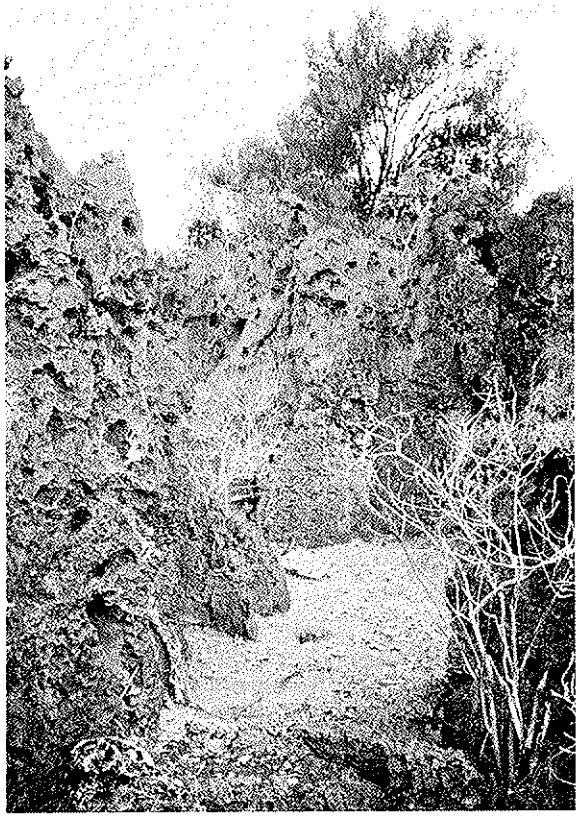
10. Undercut lagoon cliffs, South Island near East Channel.

11. Undercut lagoon islets, low tide, South Island near East Channel. The amplitude of the notch is about 6 ft.

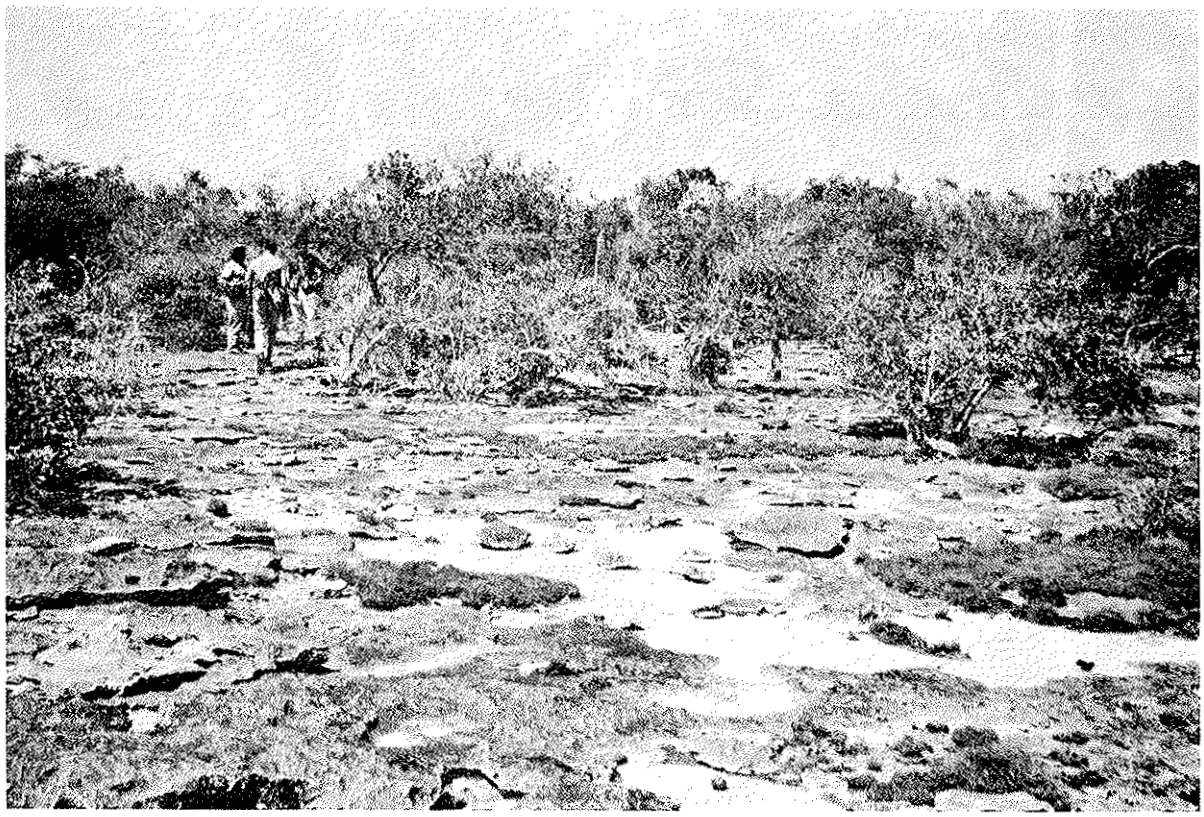


12. Sand-spit at the south end of West Island, colonised by Cyperus maritimus and seedlings of Scaevola and Tournefortia.

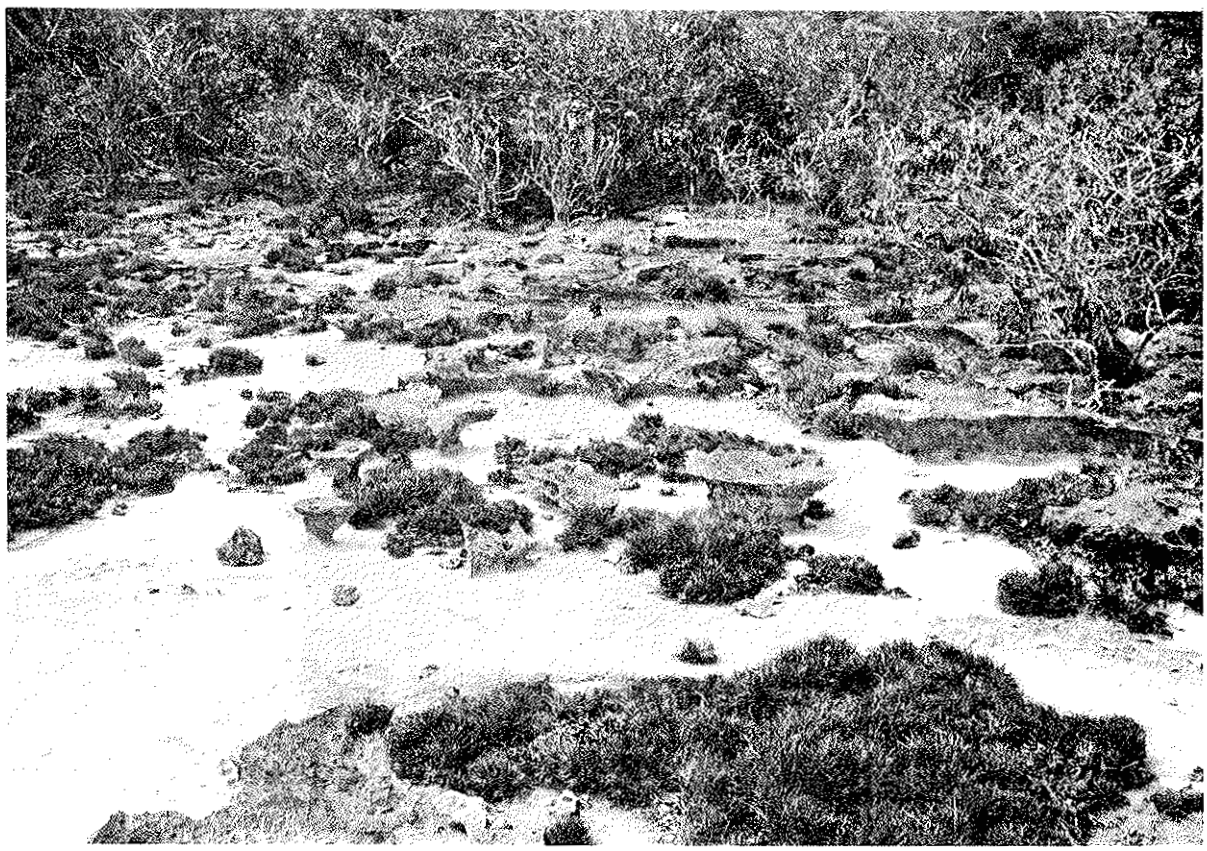
13. Pot-holed surface of champignon, South Island close to East Channel. Soil is found only on the floors of the potholes and not on the ground surface.



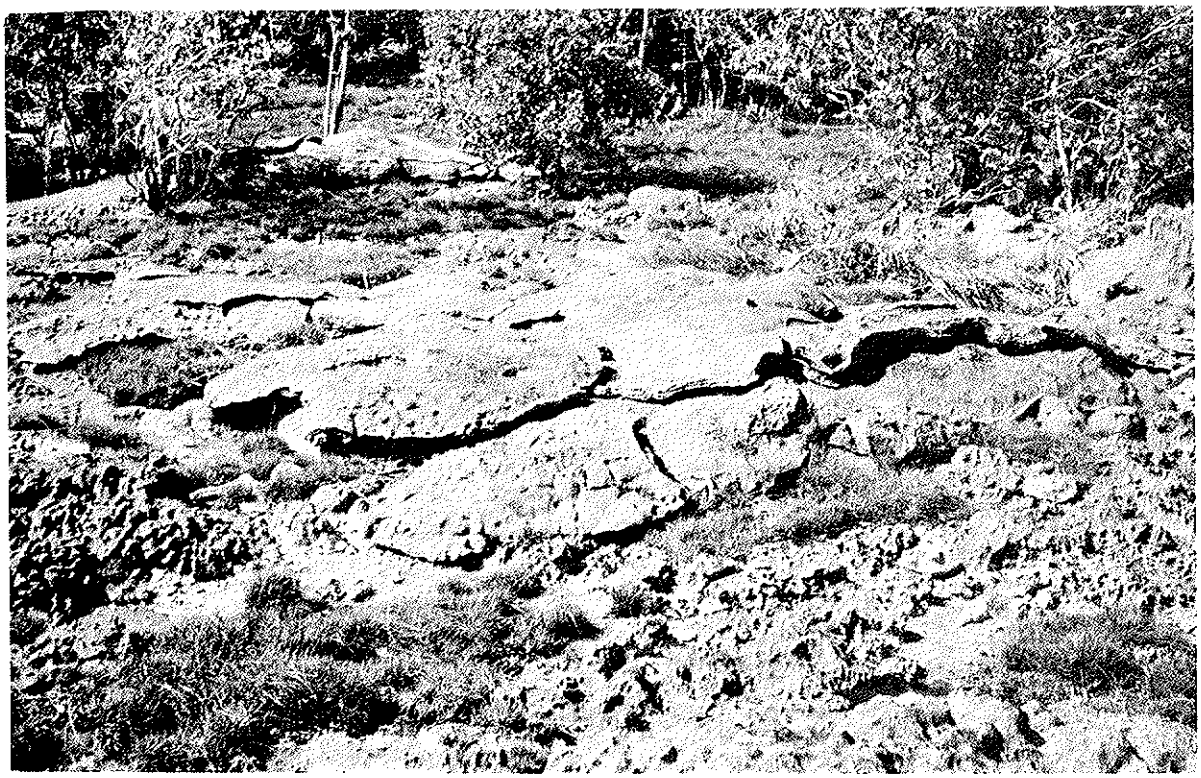
14. Karst landforms in shelly limestone on Ile Esprit. The vertical amplitude of the pinnacles from the flat enclosed floors to the summit ridges is 18 ft.



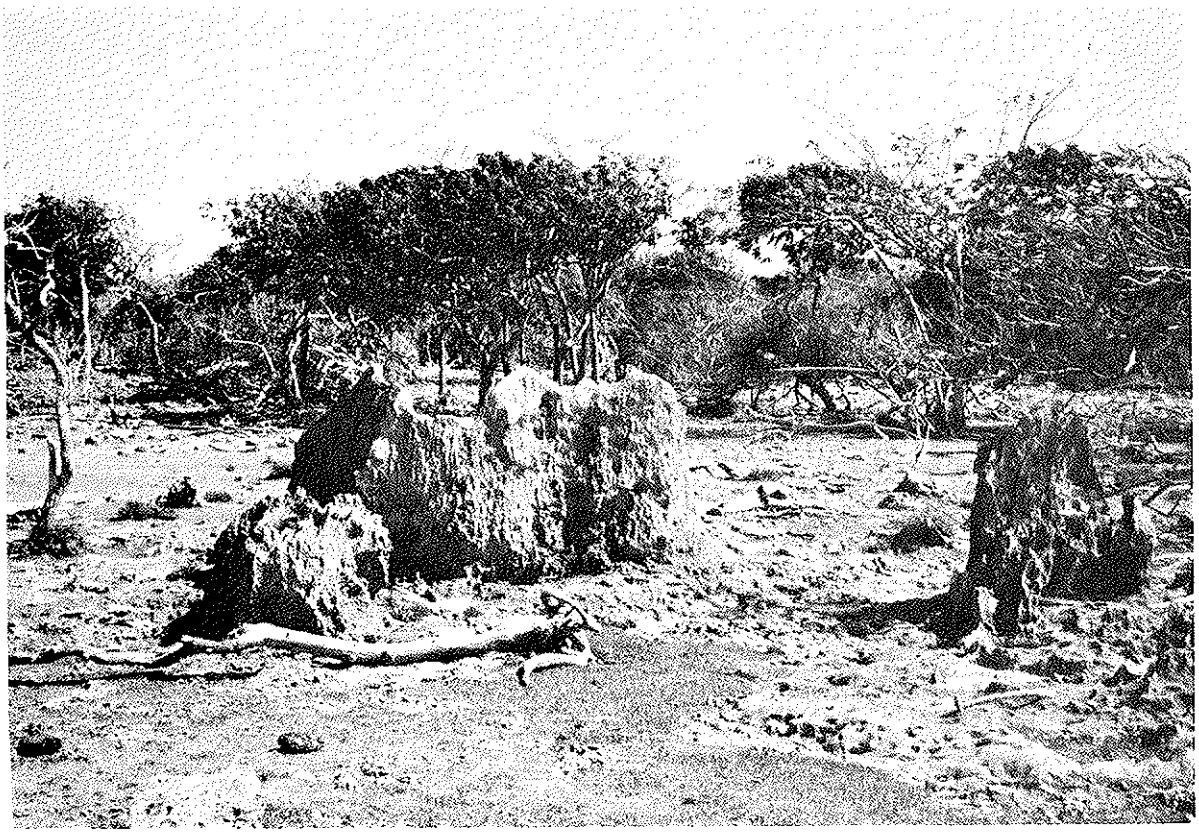
15. Platin with Mixed Scrub, three miles southeast of East Channel, on South Island.



16. Incised pools and residuals on the platin surface, South Island, near Frigate Pool. The ground vegetation is Fimbristylis spathacea.

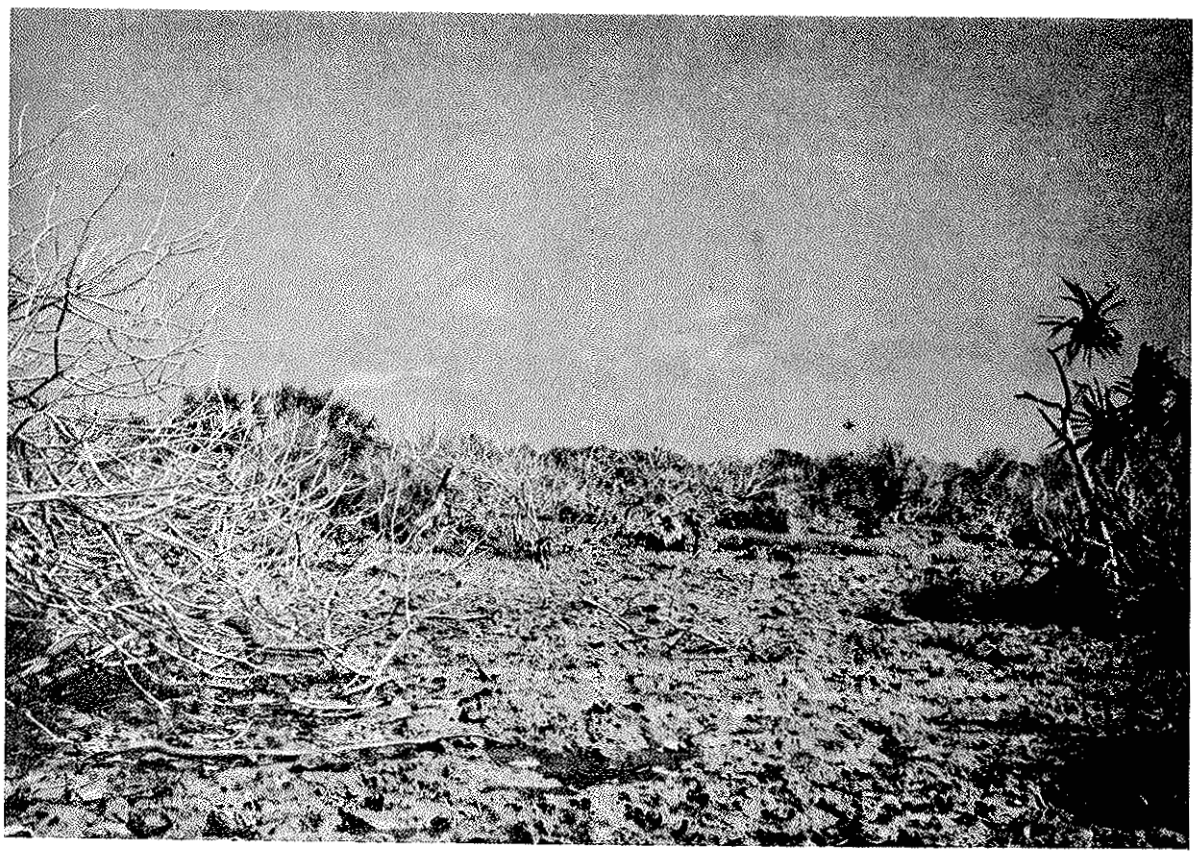


17. Surface exfoliation on platin near Frigate Pool, South Island. Some of the limestone sheets are completely detached. At the left of the photograph is a small area of mammillate limestone formed by secondary deposition.

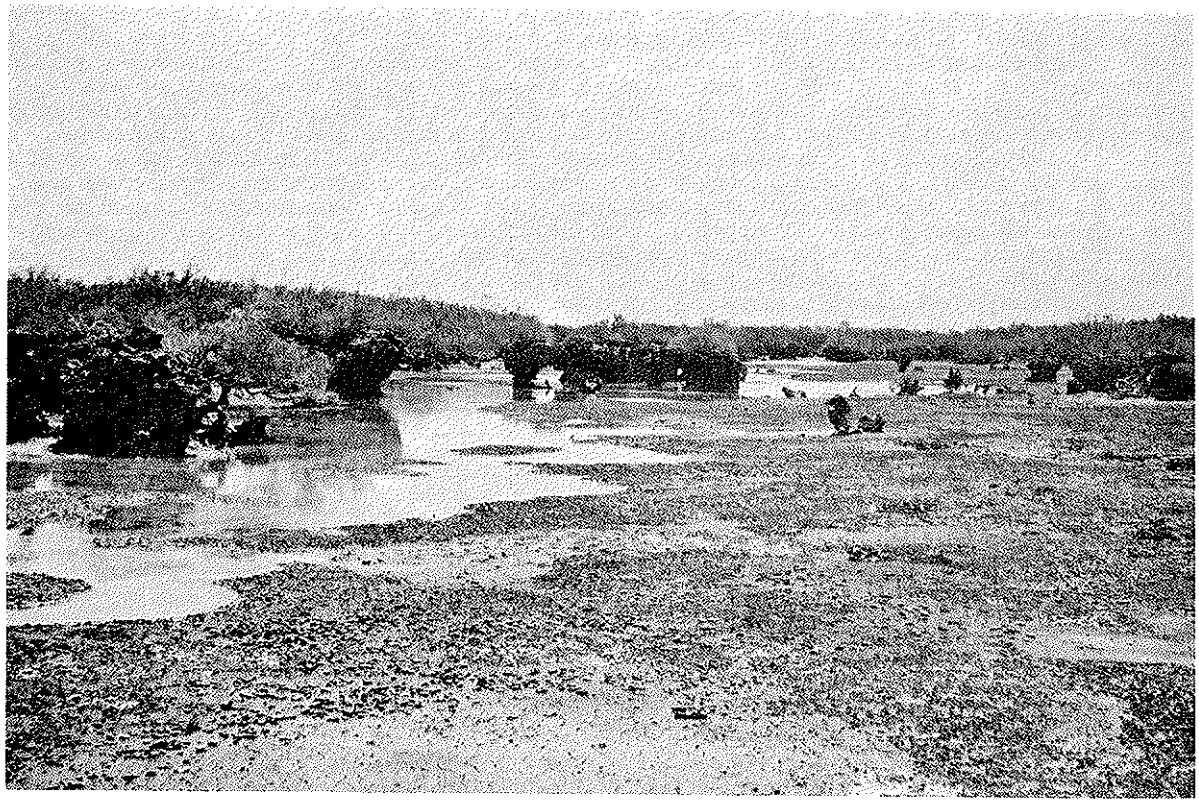


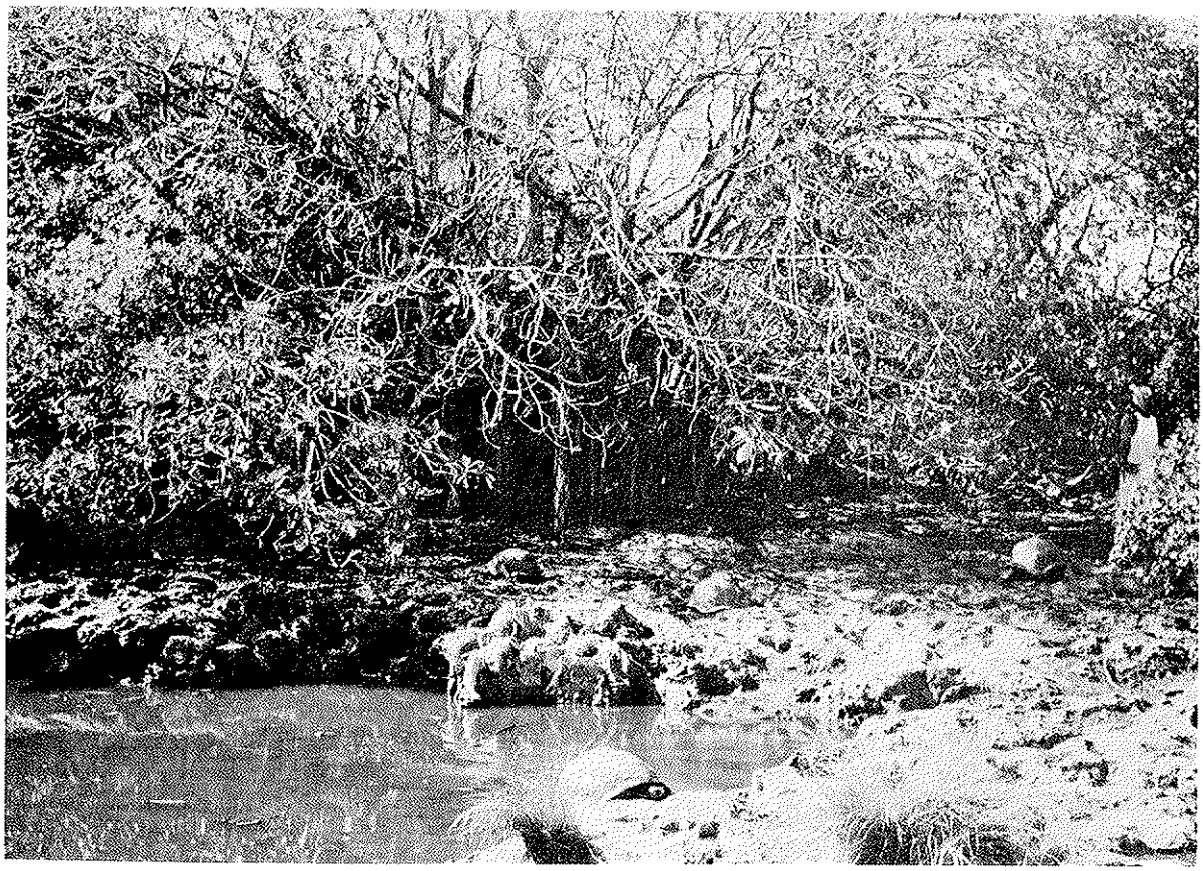
18. Flat platin under open Mixed Scrub, showing residuals of brown limestone 3–4 ft. high, near Flamingo Pool, South Island.

19. Brown-limestone residual 6 ft high, near Flamingo Pool, South Island. The surface of the residual is furrowed by solution.



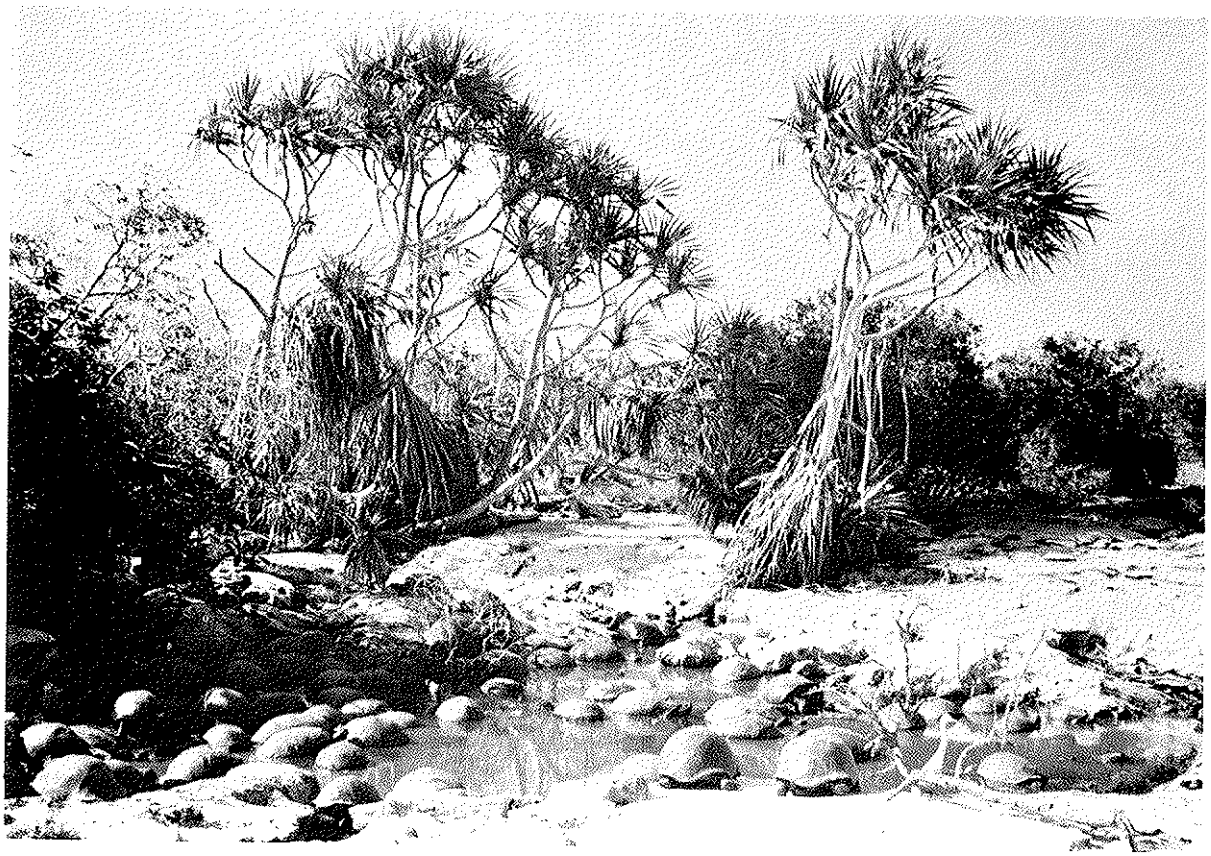
20. Seaward fringe of the Mixed Scrub community south of Takamaka. The vegetation is sparse and almost all the shrubs and trees are dead, except for Pandanus.



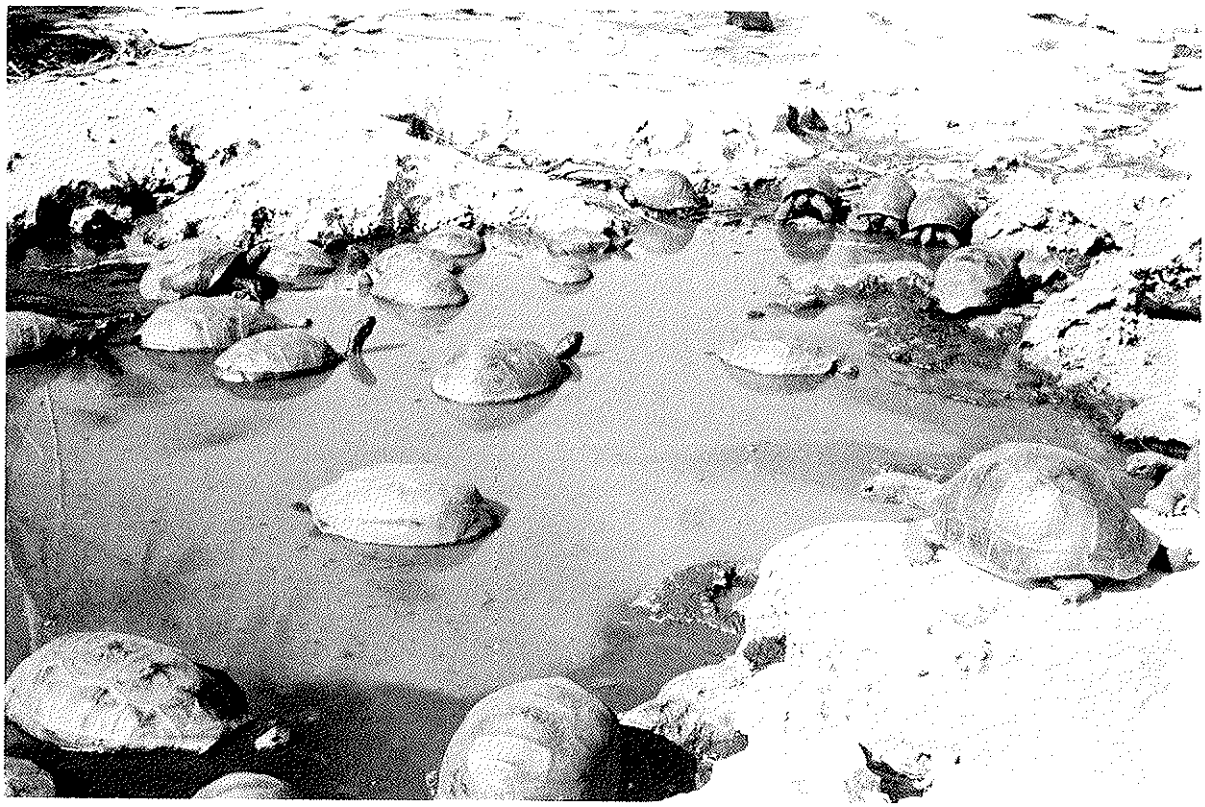


22. Takamaka pool, showing the large Ficus in which Pteropus aldabrensis is found.

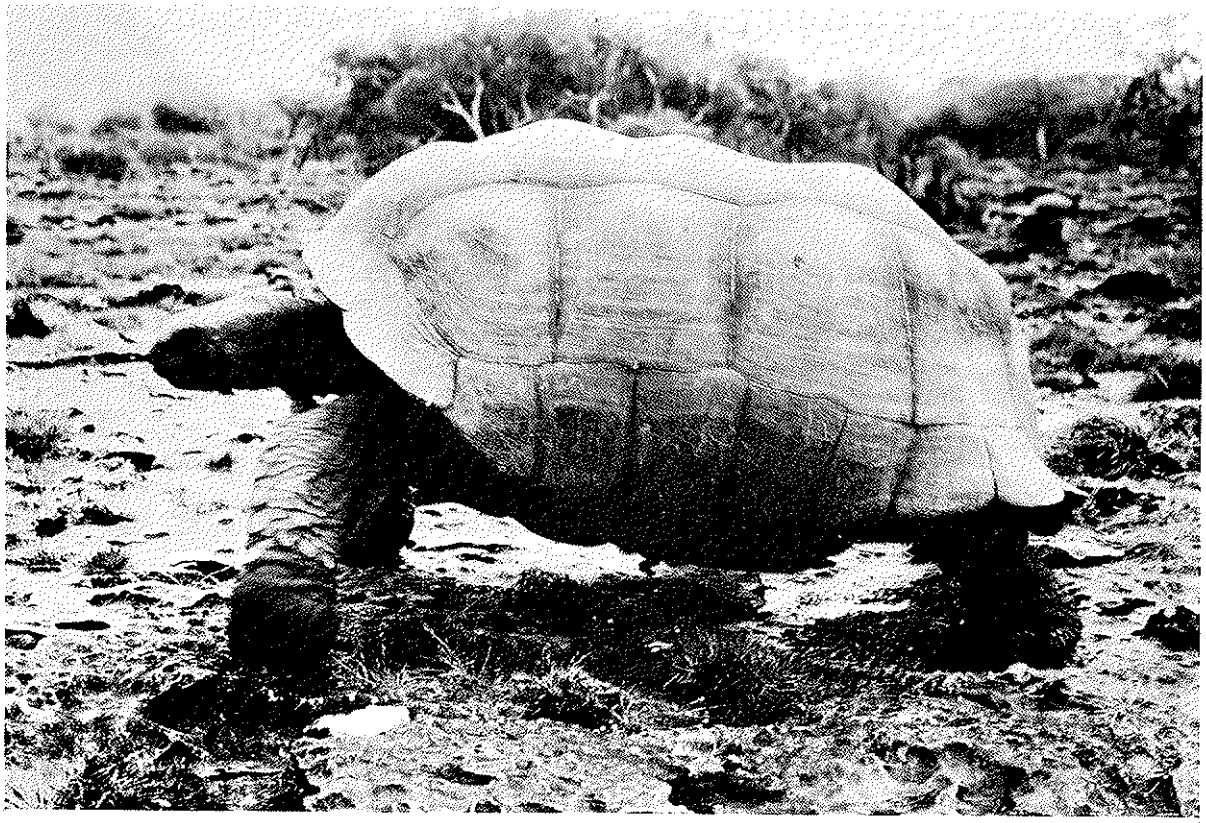
23. Fresh water in a semi-permanent water course at Cinq Cases, South Island, surrounded by dense Acrostichum aureum and Pandanus.



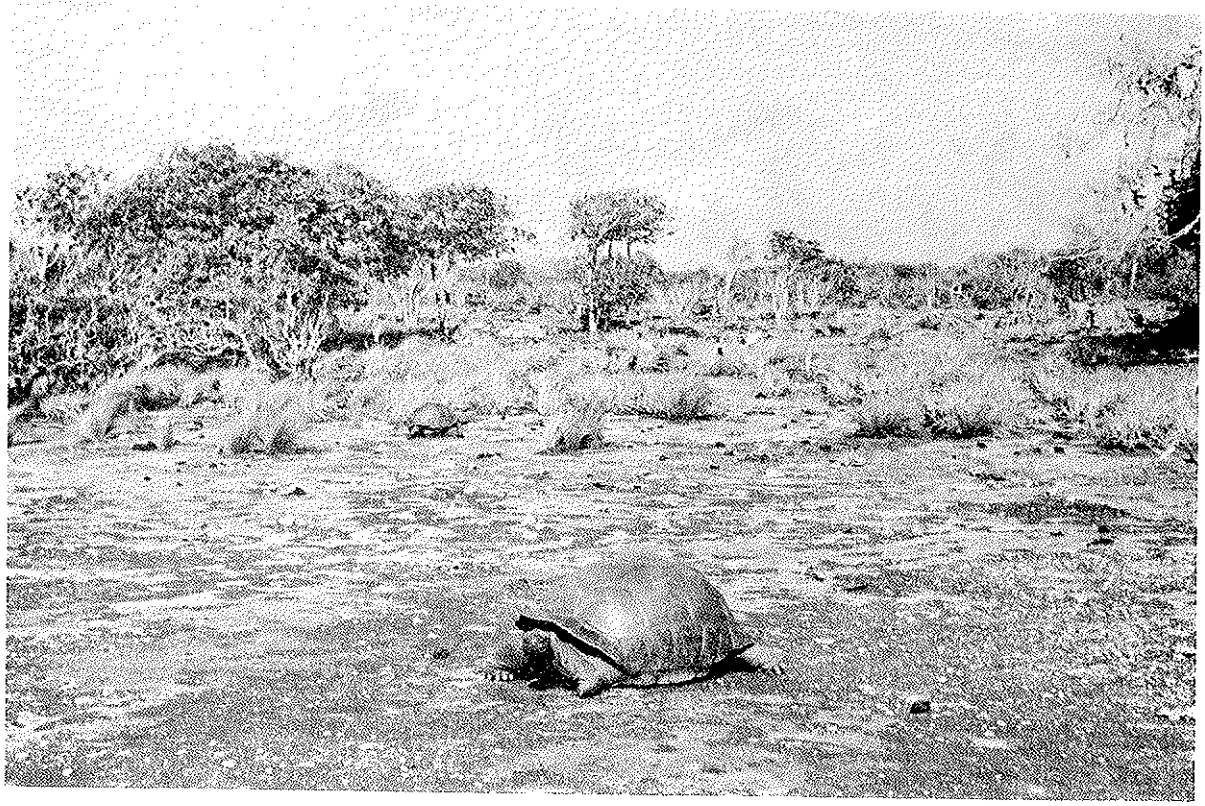
24. Freshwater pool used as a tortoise wallow, surrounded by Pandanus, on South Island, three miles southeast of East Channel.



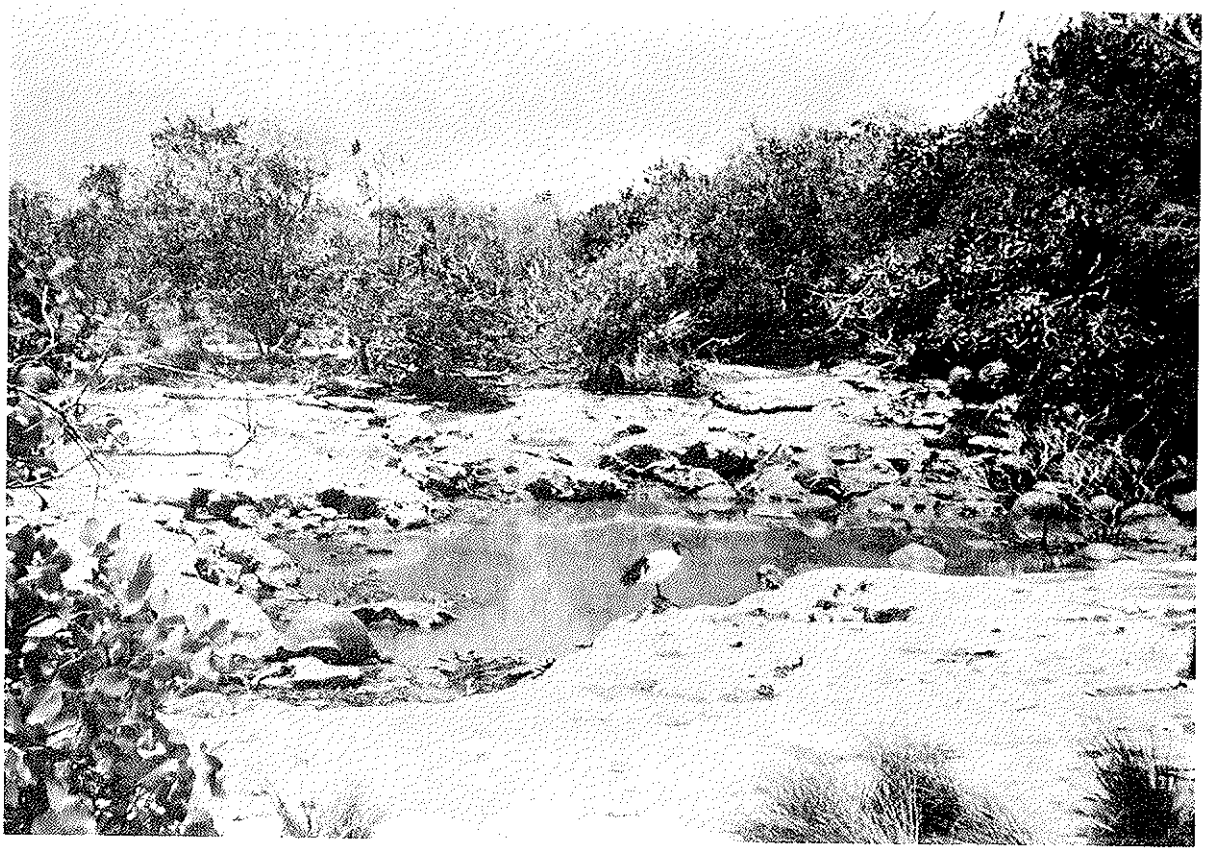
25. Tortoises wallowing in a freshwater pool during the morning: one in the centre of the pool is dead.



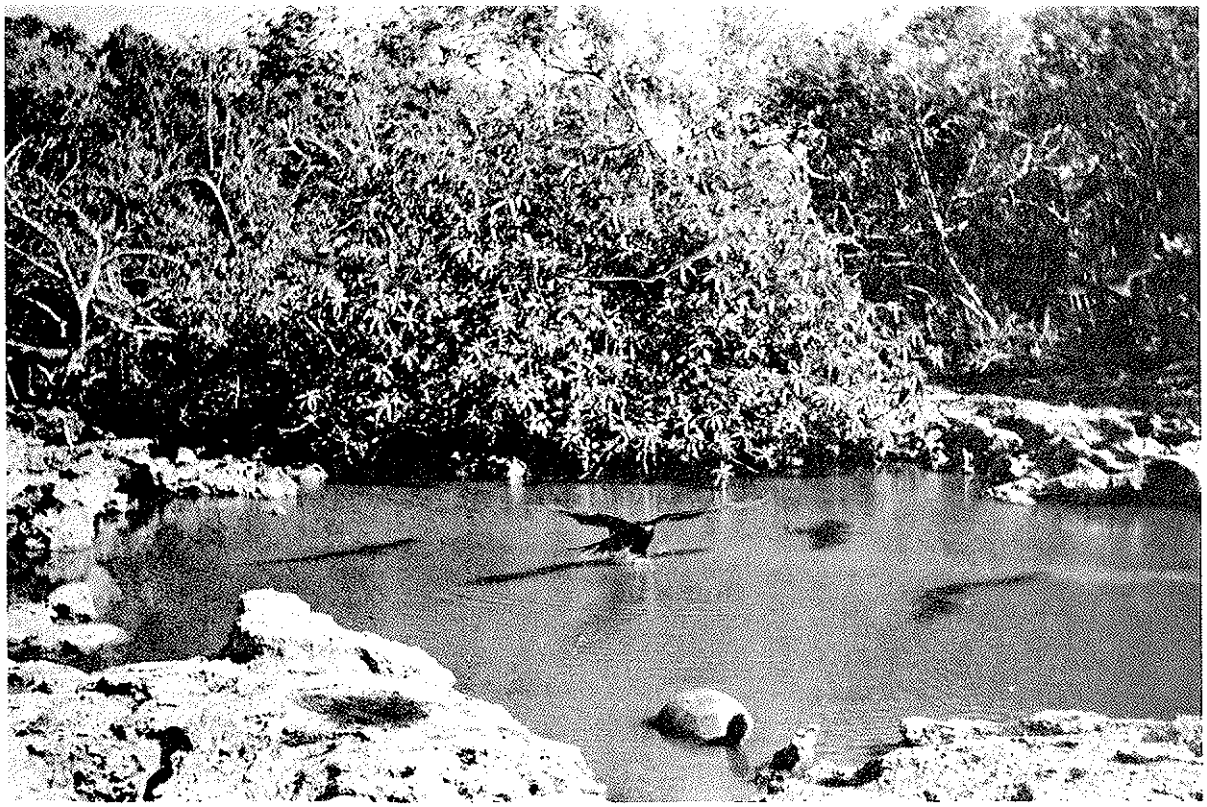
26. Giant land tortoise, Testudo gigantea (Photo: R. Gaymer).



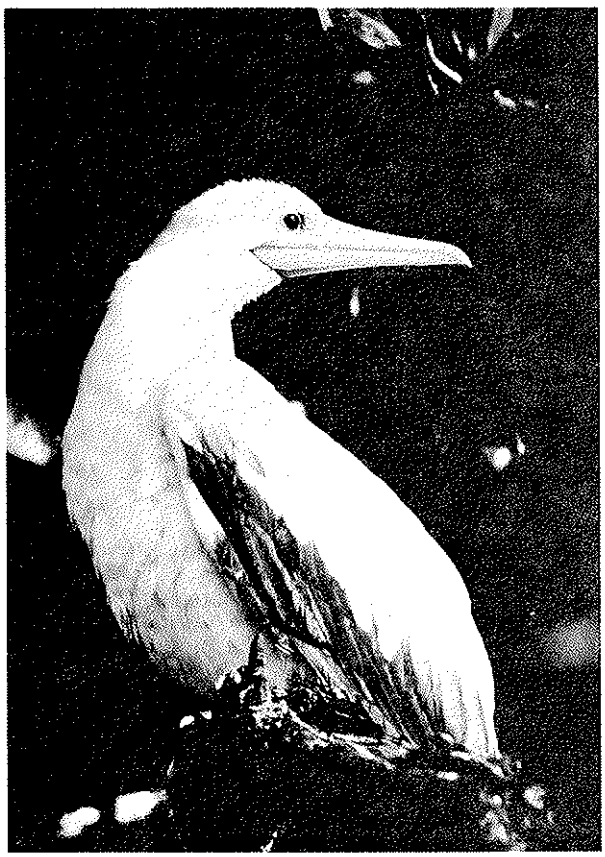
27. Tortoise on the dry floor of a freshwater pool, during the dry season, near Takamaka, South Island.



28. Tortoise and a Sacred Ibis, Threskiornis aethiopicus abbotti, near Frigate Pool, South Island.

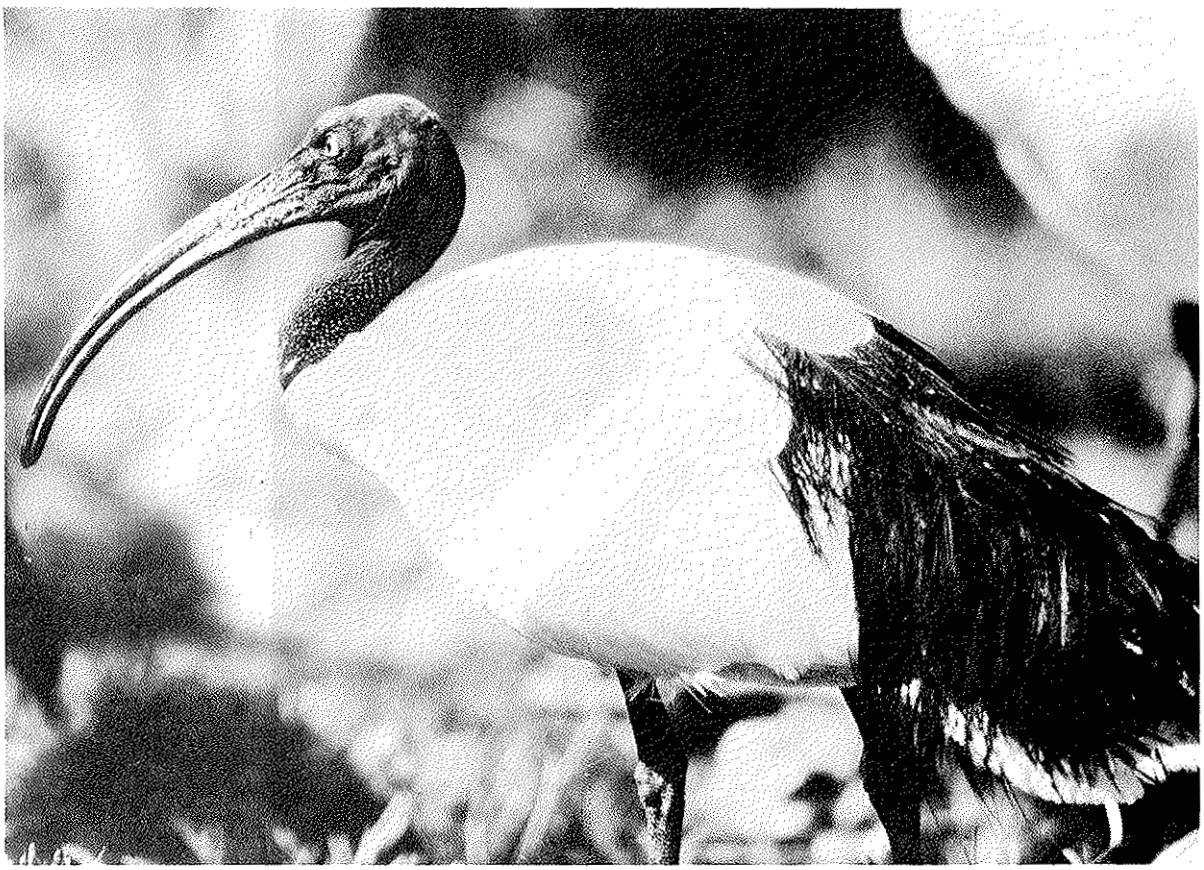


29. Frigate-birds diving for water at Frigate Pool, South Island.



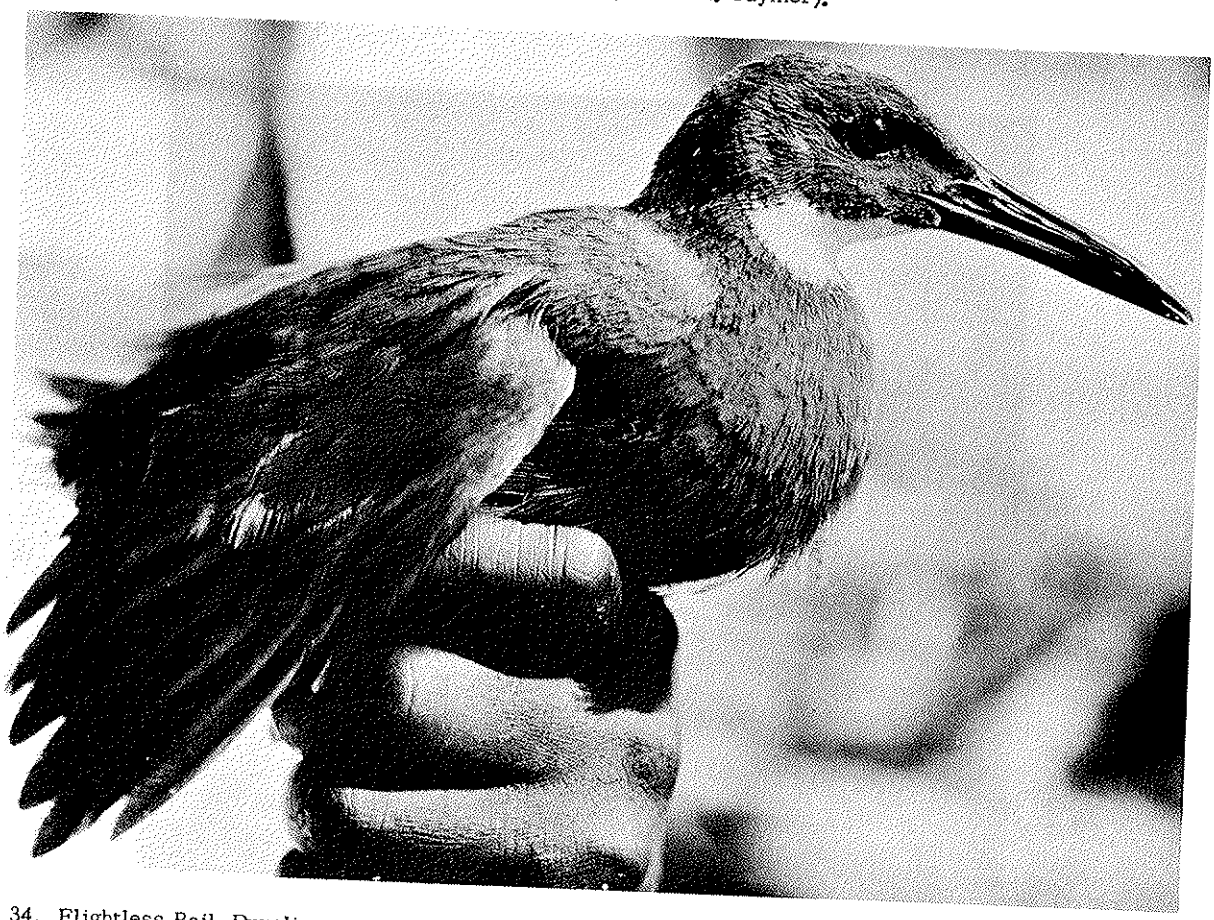
30. Juvenile Red-footed booby, Sula sula rubripes on Polymnie (Photo: R. Gaymer).

31. Red-tailed Tropic Bird, Phaëthon rubricauda rubricauda, on a lagoon islet inside East Channel.



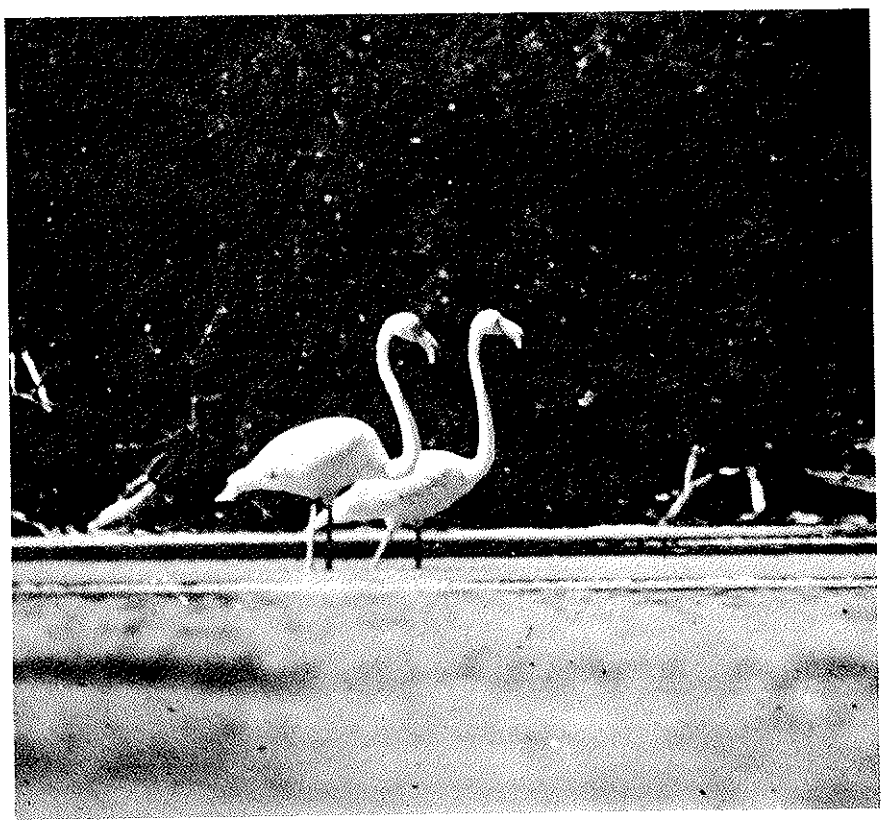
32. Adult Sacred Ibis, Threskiornis aethiopicus abbotti (Photo: R. Gaymer).

33. Colony of Sacred Ibis at Takamaka, South Island (Photo: R. Gaymer).



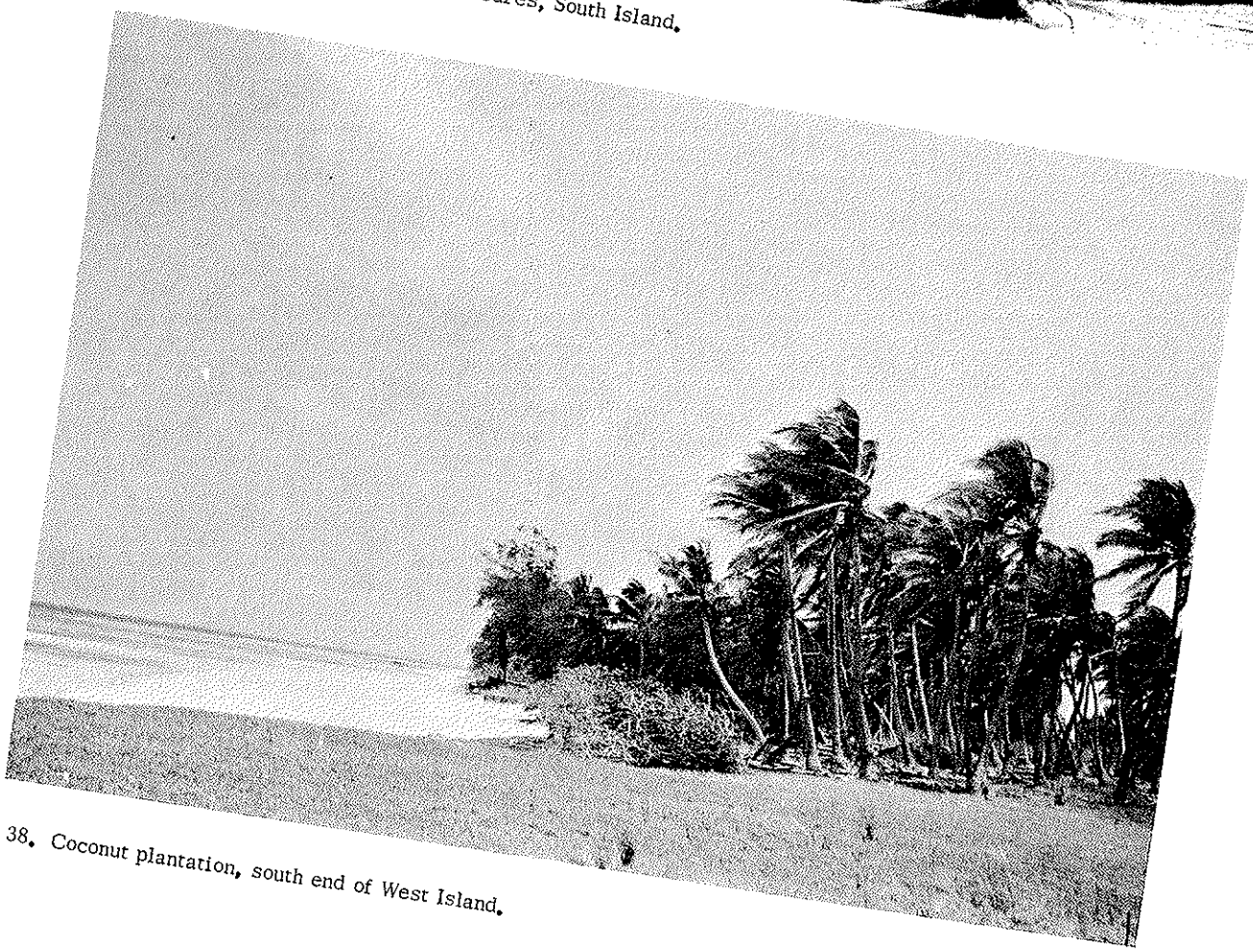
34. Flightless Rail, Dryolimnas cuvieri aldabranus (Photo: R. Gaymer).

35. Male Red-Headed Forest Fody, Foudia eminentissima aldabrana, giving threat display in his territory. Note the drooped wings and tail, and raised head and rump feathers (Photo: R. Gaymer).

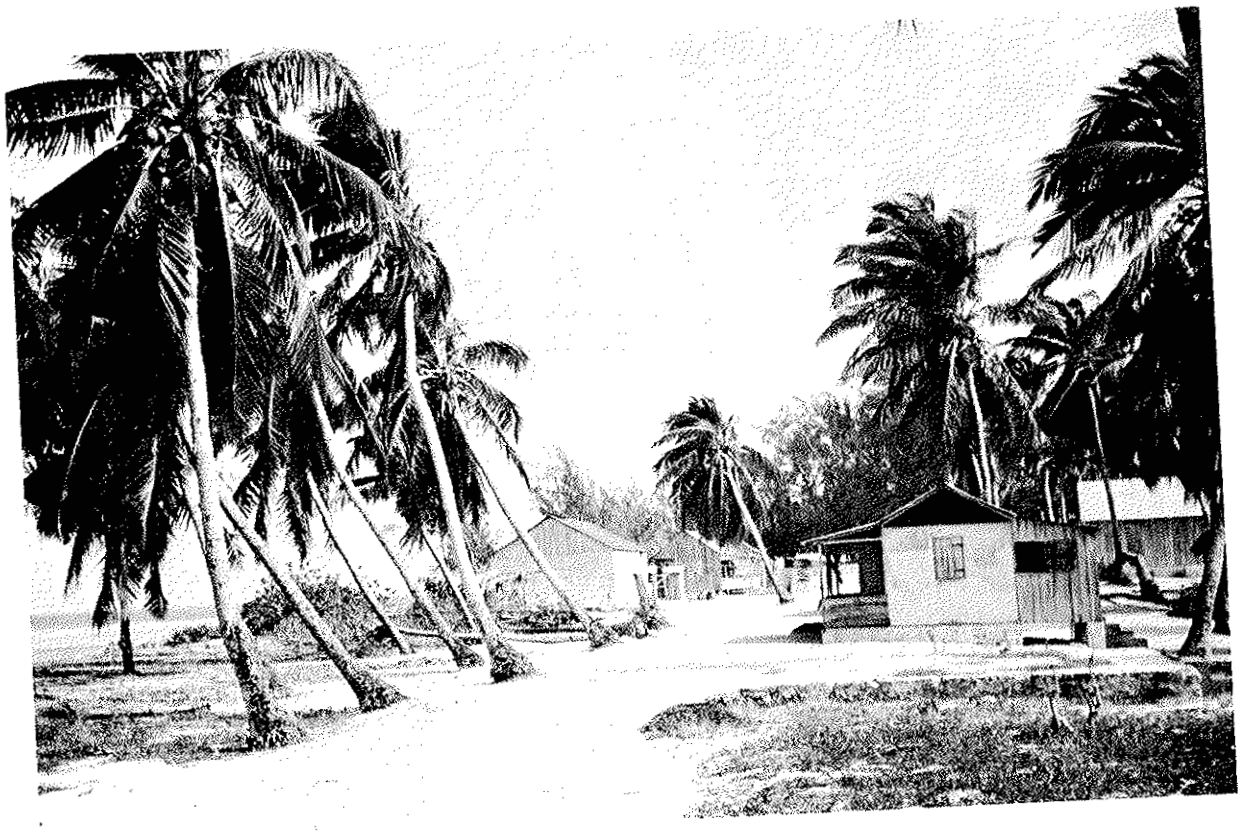


36. Pair of Flamingos, Phoenicopterus ruber roseus, wading in a brackish pool in mangrove on South Island (Photo: R. Gaymer).

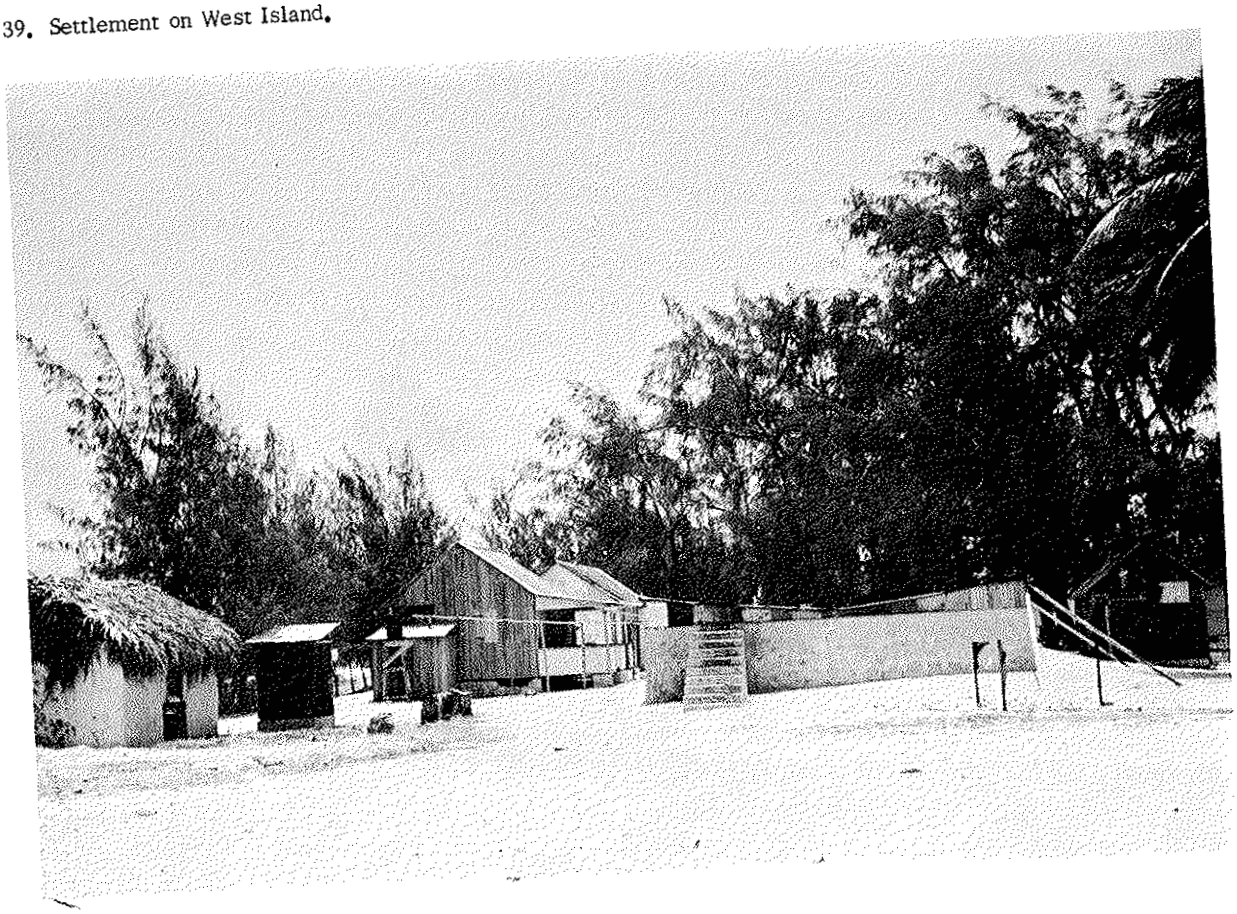
37. Casuarina woodland at Anse Cèdres, South Island.



38. Coconut plantation, south end of West Island.



39. Settlement on West Island.



40. One of the rainwater tanks in the West Island settlement.

41. Fishing shack on Middle Island, at East Channel.