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ECOLOGY OF BIRD ISLAND, SEYCHELLES

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INTRODUCTION

Bird Island (55° 12'E, 3° 53'S) is the northernmost island of the Seychelles archipelago, 83 km NNW of Mahé, the largest island of the group. Bird and neighbouring Denis are the only two sand cays of the group (Stoddart 1970) (all other islands are granitic) and they lie on the northern edge of the Seychelles Bank.

The main published scientific accounts are those of Fryer (1910), Ridley and Percy (1957), Baker (1963), Piggott (1968) and Feare (in prep.), but ornithological observations were made by Vesey-Fitzgerald (1941), Bailey (1967), and Feare (1973, 1974, 1975a). This paper is based on observations made in June 1972, from August-November 1972, from May-October 1973 and in July 1974, and is concerned primarily with the vertebrate fauna.

RECENT HISTORY

Coconut planting began early in this century, and in 1907 this was confined to a narrow belt across the centre of the island, (Fryer 1910). Apart from beach vegetation surrounding the island, the remainder of the land was occupied by an enormous Sooty Tern *Sterna fuscata* colony. Eggs were collected and exported to Mahé: according to Fryer (1910), in 1907 909,000 eggs were collected, but claims of much larger egg crops (Ridley & Percy 1957) are probably not well-founded (Feare, in press). In addition to coconuts, pawpaws *Carica papaya* were planted for their papain on the phosphatic sandstone, and in the late nineteenth and early twentieth century guano was exported.

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Despite poor growth of the coconuts (Fryer 1910, Piggott 1969) planting was continued until most of the island was covered. Sooty Tern eggs continued to be a source of income, although coconut planting had restricted the colony to the northwest corner of the island (Fig. 1) and consequently reduced the number of breeding birds. The annual egg crop declined (Ridley and Percy 1958) and exploitation of eggs, except for local consumption, was stopped in 1957. In 1967 the island was bought by Messrs. G. Savy and R. Delorie, who began clearing some of the coconuts adjacent to the Sooty Tern colony in the hope of increasing the number of birds. The cleared area was rapidly occupied, and so more trees were felled; by 1973 the colony occupied 11.7 ha, and numbered c.395000 pairs. For one year tomatoes were grown on part of the cleared area. Since this time no further felling around the colony area has been undertaken.

During the cruises of the *Lindblad Explorer* it became apparent that the Sooty Tern colony and the beaches of Bird Island could be a tourist attraction, and with the impending opening of an international airport on Mahé the owners decided to build a small hotel on the island, and provide access to the island by building two air-strips. This work was begun in 1971 and completed in 1973. The hotel caters for 20 residents and a small number of day visitors. Apart from tourists, the island has a population of about 20 Seychellois.

Tourism, based on the tern colony, game fishing in the surrounding waters and the relative isolation and low human population of the island, is now the main source of income, but coconuts are still exported in small quantities, and Sooty Tern eggs are collected for the Seychellois labourers and for the tourists.

CLIMATE

The climate of the Seychelles is tropical and humid. From May to October (these months are approximate as there is some annual variation) the south east trades affect the islands. In 1972 and 1973 the wind reached a maximum velocity of around 17-20 knots. From December to March the islands are influenced by the north-west monsoon, a period of variable wind velocity and frequent calms. The Seychelles fall outside the cyclone belt, but during the north-west monsoon the effects of tropical disturbances to the south are felt as squalls and rough seas. The average annual temperature is 26.7°C (Piggott 1968), being slightly cooler in the south-east trades and slightly warmer in the north-west monsoon. The transition periods are calm and hot.

Rainfall has not been systematically measured on Bird Island, but for Denis Piggott (1968) gave a mean annual rainfall of 1714 mm (range 1176-2644), most of this falling during the north-west monsoon, as occurs elsewhere in the Seychelles. In 1972 on Bird Island 703 mm

fell between 15 August and 5 November, most of this falling as heavy showers over the periods 29 August-2 September, 16-20 September, 8-11 October, 16-19 October and 30 October-5 November. Rain fell on 43 out of the 83 days on which rain was measured. In contrast, in 1973 heavy showers fell on only 6 days between 28 May and 21 October, with light drizzle on a further 8 days. This dry trade wind period of 1973 is perhaps more usual, since local inhabitants remarked that the 1972 season was exceptionally wet.

GEOMORPHOLOGY

Bird Island has maximum surface dimensions of 1.7 x 0.7 km, and a land area of c.70 ha. It is situated on the northern rim of the Seychelles Bank, which is probably based on granite, which underlies the coral on the Seychelles Bank (Baker and Miller 1963). A patch reef extends around the south and east coasts, with a little coral also at the north of the island.

The beach sand is highly unstable and undergoes an annual cycle of erosion and deposition (Fig. 1). During the south-east trades the beaches on the west coast and in Hirondelle Bay, and to a lesser extent on the south-east coast, are eroded, but deposition occurs at the northern tip of the island to form an extensive sand spit. The amount of erosion that occurs each year varies: in 1972 it was severe and by October beach rock was exposed in Hirondelle Bay, while in 1973 the beach here remained wide. During the north west monsoon the process is reversed, with erosion of the sand spit and deposition on the west and north east coasts. The variable nature of these annual events is shown by various beach lines, marked by ridges of sand, driftwood (mainly dead *Tournefortia* and *Suriana* killed when vegetated sand was eroded) and *Cymodocea*. In 1972, and especially 1973, several of these beach lines were visible on the sand spit, and some were being colonized by *Suriana* and *Cyperus pachyrhiza*. Ridges on the sand spit contained much coarse sand with a little coral debris, but depressions were filled with very fine wind blown sand, occasionally up to ½m deep. Piggott (1968) said there was no evidence of coastal erosion, and that the island was increasing in size with the accumulation of sand from the reefs nearby: this interpretation seems to be incorrect.

In the centre of the island is a belt of phosphatic sandstone which represents the remains of a Jemo Series soil (Fosberg 1954), much of the guano having been exploited. In parts the remaining phosphatic horizon is 1 m deep (Piggott 1968). Elsewhere above the high-water mark the soil is Shioya Series with an organic horizon 5-22 cm deep (Piggott 1969). Wells have been sunk in both the phosphatic sandstone and the Shioya soils and these provide brackish water.

There is a little sea-borne pumice behind the beach on the western side of the island.

VEGETATION

Fryer (1910) found Bird Island completely surrounded by a scrub, mainly of *Tournefortia argentea* and *Scaevola taccada*. Inside this belt was a zone of bushes of the same species and also of "weeds", the only plant that he mentioned being *Tribulus cistoides* (Creole name "fagote"). The centre of the island he described as plain occupied by Sooty Terns, and with practically no vegetation, the birds having destroyed this. In addition, he mentioned a *Convolvulus* climbing bushes (= *Ipomoea macrantha*?) *Cassytha filiformis* and *Ipomoea pes-caprae*, and coconuts and pawpaws forming a belt across the middle of the plain.

In 1972-73 sight records were made of 58 species of plants on the island (Table 1) and seven associations were distinguished.

1. Stable beach fringe on sand

This is the belt of *Scaevola* and *Tournefortia* to which Fryer (1910) referred. It dominates the top of the beach on the more stable parts of the coast, from Hirondelle south down the eastern coast and up the western coast to just north of the settlement. Throughout this area *Casuarina* has been planted as a windbreak, although some of these trees were felled and the timber used for hotel construction. The only breaks in the *Scaevola/Tournefortia* belt are where the airstrips have been cut through.

2. Stable beach fringe on phosphatic sandstone

For about 200 m on the north-east coast the phosphatic sandstone reaches the shore, and in some south-east trade seasons the beach sand is eroded away to such an extent that sandstone on the beach becomes exposed. At the top of the beach here is a belt of trees, 7-10 m tall, of *Thespesia populnea* and *Cordia subcordata*. In 1973 *Ipomoea pes-caprae* grew out from beneath this tree fringe to produce an extensive mat over the beach.

3. Unstable beach fringe on sand

Parts of the beach at the northern end of the island were subject to considerable erosion and deposition. (Fig. 1). This varied considerably annually, and in 1972 and 1973 several beach lines were apparent on the north-west corner. These areas were dominated by *Suriana maritima* and *Cyperus pachyrhiza*, and recent beach lines lying outside the *Scaevola* belt on the south-west coast showed that these two plants were the first to colonize recently deposited sand. Interspersed amongst the *Suriana* were a few small *Scaevola* and *Tournefortia* bushes, but these appeared to reach a large size only on stable sand.

Table 1. List of sight records of plants on Bird Island 1972-1974

Abutilon indicum
Acalypha indica
Achyranthes aspera
Agave sisalana
Amaranthus oleraceus
Asystasia gangetica
Boerhavia repens
Calophyllum inophyllum
Capsicum minimum
Carica papaya
Cassia occidentalis
Cassytha filiformis
Casuarina equisetifolia
Catharanthus roseus
Cleome viscosa
Cocos nucifera
Cordia subcordata
Cucurbita moschata
Cynodon dactylon
Cyperus pachyrhiza
Dactyloctenium aegyptium
Datura metel
Eleusine indica
Euphorbia hirta
Euphorbia prostrata
Ficus sp.
Gossypium hirsutum
Guettarda speciosa
Gynandropsis gynandra
Ipomoea pes-caprae
Ipomoea macrantha
Kalanchoe pinnata
Lippia nodiflora
Malvastrum coromandelianum
Maranta arundinacea
Mariscus dubius
Mirabilis jalapa
Moringa oleifera
Musa sapientum
Nephrolepis biserrata
Passiflora suberosa
Phyllanthus casticum
Pisonia grandis
Portulaca oleracea
Ricinus communis
Scaevola taccada
Sida acuta
Solanum melongena
Solanum nigrum
Stachytarpheta jamaicensis
Stenotaphrum micranthum
Suriana maritima
Tabebuia rosea
Thespesia populnea
Tournefortia argentea
Tribulus cistoides
Turnera ulmifolia
Vernonia cinerea

(Procter (1970 and pers. comm.) recorded *Digitaria horizontalis, Enteropogon monostachyos, Enteropogon sechellensis, Eragrostis tenella,* and *Sporobolos viginicus* in July 1970. Fryer (1910) recorded a large *Hernandia peltata* at the settlement, but this is no longer present).

4. Sooty Tern colony

The main vegetation components of the original colony, i.e, that which was present before the felling of coconuts was begun, are *Portulaca oleracea, Boerhavia repens* and small areas of *Tribulus cistoides*. These species are characterised by an ability to survive burning off by the joint action of faeces and salt water from the birds. In 1973 this burning off was complete, and by October the colony was devoid of herb vegetation. However, in the much wetter 1972 season these plants continued growing to a limited extent: this may have been due directly to the presence of water, or indirectly through the unusually rapid leaching of salt and faeces. In 1972 the area of the colony which had been recently cleared of trees was dominated by grasses, but there were small areas of *Stachytarpheta jamaicensis* and *Achyranthes aspera,* and in parts, especially beneath Casuarina trees, *Lippia nodiflora*. Sooty Terns nested only at low density in the tall grass, and so before the birds returned to the island in March-May the grass was cut. This, together with the effect of salt water and faeces from the birds, killed some areas of grass, and by the beginning of the 1973 season *Portulaca, Boerhavia* and *Tribulus* had become established. To encourage the spread of these species remaining grass was burned off at the end of the 1973 season, and although grasses were still present in the area in 1974, *Portulaca, Boerhavia* and *Tribulus* had occupied more ground.

In addition to this form of management, bushes of *Tournefortia, Scaevola* and *Suriana* within the colony were cut down each year to provide more space for the birds. The cut bushes were stacked in piles around the colony, and while they provided some shade for Sooty Tern chicks, they also provided nesting areas for rats.

5. Coconut plantation in sand

The vegetation beneath coconuts on the sandy part of the island consists mainly of a herb layer, dominated by grasses of various species, *Lippia nodiflora* and *Boerhavia repens*. Where this vegetation was kept short eg. around the settlement, many other species were found including exotics, but where vegetation was allowed to develop occasional bushes of *Scaevola* occurred.

6. Coconut plantation on phosphatic sandstone

Here the vegetation was much more dense than on sand, doubtless due to the more fertile soil. Apart from *Carica papaya* which had gone wild, *Nephrolepis biserrata, Phyllanthus casticum* and *Kalanchoe pinnata* were abundant. A few bananas *Musa sapientum* had been planted but did not produce fruit.

7. Airstrips

The airstrips were cut through the coconut plantation on both sand and phosphatic sandstone. After clearance the parts of the airstrip on sand rapidly became carpeted with a binding mat of *Lippia nodiflora*. In 1972, during a break in the levelling operations on the sandstone, areas of broken sandstone supported dense areas of small *Carica papaya* and *Abutilon indicum*, but when levelling had been completed in 1974 phosphatic sandstone areas of the airstrips either consisted of bare sand or were colonised by *Lippia nodiflora*.

INVERTEBRATE FAUNA

No detailed observations on terrestrial invertebrates except ticks were made, but the following groups were recorded:

Crustacea

Two species of land crab were common, and one was an important scavenger in the Sooty Tern colony.

Myriapoda

A small millipede and a small centipede were occasionally seen around the settlement.

Insecta

Odonata
Dictyoptera
Isoptera
Hemiptera
Orthoptera
Coleoptera
Planipennia
Lepidoptera
Diptera: Mosquitoes were abundant during the wet 1972 season, but scarce in 1973. House flies periodically infested the island in July and August, but no direct relation with the state of the Sooty Tern colony was found.
Hymenoptera
Phthiraptera: Lice *Saemunssonia sternae* were found on the heads of a dead Roseate Terns *Sterna dougallii* and a louse, probably the same species was common on the heads of Sooty Terns.

Arachnida

Scorpionidea: A small scorpion was common under the bark of *Casuarina*.

Araneida

Acarina: Two species of tick were found. *Ornithodoros capensis* was common in the Sooty Tern colony in 1973 and caused part of the colony to desert (Feare 1976) and was found to carry Soldado virus. (Converse *et. al.* 1975). *Amblyomma loculosum* was found occasionally on Sooty Terns (Hoogstraal *et. al.* 1975), and specimens collected from two dead Roseate Terns were found to carry a new virus, Aride virus (Converse *et. al.* 1975).

AMPHIBIA

During this study Mrs. F.C. Feare and Mrs. M.F. Savy saw one frog, and frogs had been seen occasionally prior to this. This is most likely to be *Rana madagascariensis,* which may have been introduced to the Seychelles (Gaymer 1968), and is almost certainly an accidental introduction to Bird Island from the granitic islands.

REPTILES

The reptile fauna of Bird Island comprises a skink, two geckos, a snake, two marine turtles, and two tortoises.

Mabuya sechellensis

This endemic skink was common over most of the island, but was not found in the interior of the sooty tern colony. It occurs on most of the islands of the Seychelles, but Vesey-Fitzgerald (1947) thought that it may be an accidental introduction on the sand cays.

Phelsuma sp.

A *Phelsuma* gecko was common in the buildings around the settlement, and was also seen in the plantation. Again, this may have been an accidental introduction from the granitic islands, but the taxonomy of the *Phelsuma* geckos of the Seychelles is not clear (Gaymer 1968). Bird Island specimens appeared distinct from those seen on Mahe. Praslin, La Digue and Cousin. They were bright green, attained the size of those commonly seen at around 500 m on Mahe (i.e. smaller than those on Praslin and La Digue, but larger than on Cousin) and the red spotting on the back was sparse.

Hemidactylus sp.

A brown gecko, presumably introduced, was common in the buildings around the settlement.

Rhamphotyphlops braminus

Specimens of this parthenogenetic burrowing snake were found in damp soil under stones and timber. This species is widely distributed in the Indo-Pacific, and has also been found in Mexico and possibly in West Africa. It has previously been recorded in the Seychelles from Mahé (Vesey-Fitzgerald 1947) and Frigate (Gaymer 1968) and there are also specimens in the British Museum from Praslin and Cerf (J.C. Dring, pers. comm.). Specimens from Bird Island constitute the first Seychelles records from a coralline island, and two have been deposited in the British Museum (BMNH 1975. 1148-1149).

Vesey-Fitzgerald (1947) and Gaymer (1968) thought that *R. braminus* may have been introduced to the Seychelles, but in view of its wide distribution (in the western Indian Ocean it also occurs in the Maldives, Comores and on Mauritius - J.C. Dring, pers. comm.) it may in fact be indigenous. On coralline islands this may be less likely, and the importation of coconuts and various palm leaves (for use as thatch) from the granitic islands would facilitate introduction to Bird Island.

Chelonia mydas Green Turtle

The main laying season for Green Turtles on Bird Island is May-October, the period of the SE trades. In 1972 no search for nests or tracks was made, but at least six nests were known to have been made. In 1973, Green Turtles were known to have come ashore on 24 occasions between 2 July and 28 October, and 15 nests were made. All nests, and most attempts to come ashore, were on the north-east coast (Fig. 2), with two in July, nine in August, 11 in September and two in October.

How these figures compare with earlier populations is not known, but it is to be hoped that the prohibition of killing Green Turtles in the Seychelles will be effective, but the difficulties of policing isolated islands and the high regard which island dwelling Seychellois have for turtle meat will mitigate against this. At present, it appears that Bird Island (and possibly Denis?) are the Seychelles headquarters for Green Turtle.

Eretmochelys imbricata Hawksbill Turtle

Hawksbill Turtles are mainly north-west monsoon (November-March) breeders on Bird Island, and consequently few were seen during this study. One laid in November 1972, and in 1973 eggs were laid on 13 September and 28 October, while turtles came ashore but did not lay on 12 and 24 September.

Testudo gigantea Giant Tortoise

Two giant tortoises are free on the island, both having been recently imported.

Leopard Tortoise

The history of a Leopard Tortoise, sometimes kept in a pen and sometimes free-ranging, is not known.

MAMMALS

All mammals on the island have been introduced, and the 40 miles of sea separating Bird from the closest granitic island, Silhouette, appears sufficient to prevent fruit bats *Pteropus sechellensis* reaching the island. In 1972 and 1973 the only mammals present were a donkey, c.40 pigs, occasional mice ?*Mus musculus* seen around the settlement, and rats *Rattus rattus*. In the past a dog and goats, and possibly cats, have lived on the island.

The history of the rat infestation is notable. Until 1967 there were no rats, and it is thought that they were imported with a consignment of leaves for thatching from Praslin. They increased rapidly and by 1972 the entire island was infested. Attempts at control using warfarin and thallium sulphate in 1973 resulted in much reduced numbers around the settlement late in that year and in 1974. The rats lived all over the island and there appeared to be no noticeable movement into the Sooty Tern colony when the birds were breeding. Away from the colony the only food rats were seen to eat were pawpaws, but doubtless coconuts and other plants were taken, and eggs and chicks of Brown Noddies *Anous stolidus* and White Terns *Gygis alba* were known to have been eaten.

The number of rats did not therefore appear to be controlled by the seasonal appearance of the Sooty Terns, and the rats appeared to have little influence on Sooty Tern breeding success, being responsible for only small losses of eggs and chicks (Feare, in prep.). In 1973, six chicks, representing only 6.5% of total chick losses, that were known to have been killed by rats, had been losing weight prior to death, and in 1972 rat predation appeared to be restricted to weak or injured chicks. There is no evidence of a decline in the Sooty Tern population since the rats arrived (it is more likely that the colony is increasing, but counts are lacking), and the burrow-nesting Wedge-tailed Shearwater, *Puffinus pacificus* still breeds in cavities in the phosphatic sandstone. (Piggott's (1969) claim that fouquets - *P. pacificus* - disappeared long ago is erroneous.)

BIRDS

None of the land birds endemic to the Seychelles occur on Bird Island, but three of the land birds introduced to the Seychelles have become established on the island. Five species of seabird breed, and a further seabird, the Masked Booby, *Sula dactylatra* stopped breeding

around 1940, when the birds are said to have been killed by the islanders. The only other breeding species is the Cattle Egret, but many migrants, especially from the palaearctic, were recorded in 1972-3. Apart from these domestic chickens *Gallus domesticus* run free, and one Peahen *Pavo* sp. seen in 1974-1973 appeared to be the sole survivor of a flock that used to breed on the island. Quail *Coturnix coturnix* were present up to 1968, but have not been seen since.

(i) Breeding seabirds

Wedge-tailed Shearwater *Puffinus pacificus*

Between May and October birds were seen off the island most evenings, but numbers increased in July and August, with birds calling over the island at night. In October newly excavated burrows were found - of three whose cavities could be reached two had no egg or chick and one had an egg, while in another burrow whose cavity could not be reached a call thought to be that of a chick was heard. On the granitic islands Wedge-tails breed from October to December (Lousteau-Lalanne 1963).

On Bird Island Wedge-tails excavated burrows in pockets of sand in the phosphatic sandstone, especially around the holes dug for planting coconuts. No estimate of numbers was obtained, but plenty of suitable habitat was available in the interior of the island. However, some of the potential habitat was destroyed by the construction of the airstrips.

White-tailed Tropic Bird *Phaethon lepturus*

Few pairs, perhaps less than 20, bred in coconut and *Casuarina* trees. A pair was found on a nest with no egg on 28 August, 1973 and they had an egg in mid-September but this was eventually lost. On Cousin White-tailed Tropic birds breed throughout the year (Diamond, in press) as they probably do on other islands of the Seychelles (pers. obs.).

Sooty Tern *Sterna fuscata*

On Bird Island as elsewhere in the Seychelles Sooty Terns breed only during the south-east trades, usually late May to October.

The biology and history of the Sooty Tern colony has been reviewed by Feare (in press). No estimates of population size at the beginning of the twentieth century exist, but the collection of 909,000 eggs in 1907 (Fryer 1910) suggests that probably over a million pairs bred in that year. In the mid 1930's Vesey-Fitzgerald (1941) estimated that 65,000 pairs bred but in 1955 the colony was reduced to 18,000 pairs (Ridley and Percy 1966, correcting their 1958

estimate of 8,300 pairs). Bailey (1968) estimated 20,000 well feathered chicks on 4 November 1963. Ridley & Percy (1966) estimated 120,000 pairs. In 1973 Feare (in prep.) estimated that 395,000 pairs had bred, while due to food shortage which affected many seabirds in 1974 (Diamond, in press) Sooty Terns arrived to breed late and in reduced numbers (as they did also on Aride in the Seychelles, and on Desneufs, but to a much smaller extent on African Banks, in the Amirantes). This colony expansion as more nesting area is provided suggests that in the Seychelles breeding space is at present limiting the population, rather than food, which Ashmole (1963) considered to be limiting Ascension Island Sooty Terns. However, the 1974 observations show that food shortage can restrict the number of breeding birds in some years.

Brown Noddy *Anous stolidus*

Before coconuts were planted noddies nested in the *Scaevola* and *Tournefortia* bushes, but now they nest almost exclusively in coconuts, with (in 1972) about 20 pairs nesting in young *Casuarina* on the south-eastern coast. In these habitats they build a substantial nest of seaweed, in contrast to the situation on some rocky islands e.g. Aride and Ile aux Vaches (Grande Anse) where when laying on rock no nest is built (pers. obs.). On Bird Island Noddies are present throughout the year and may breed for most of the year. Chicks were seen and heard in all months from May to October and breeding is certainly not restricted to the south-east trades. In fact here breeding appears to be much less synchronous than on Aride, Cousin and Ile aux Vaches where ground nesting birds predominate. It would be interesting to know whether the substantial nest building and extended breeding season birds of Bird Island represented a population distinct from the reduced or no-nest, and more restricted breeding season birds of other islands.

In September 1972 the population was (number of nests/coconut tree x number of trees) estimated at about 10,000 pairs. Ridley and Percy (1958) considered there to be only 1000 pairs in 1955, and they thought the population had not increased in 1966. However, Mr. G. Savy, resident owner since 1967, thought that noddies had not increased since he bought the island. To what extent the population has increased, or whether Ridley and Percy's estimate was too conservative - is not known. The biology of this species on Bird Island has not been studied. Some losses of chicks occur through them falling from the nest; when these were small their parents did not continue to feed them on the ground, and they were eventually killed by rats. There may be competition with rats for nest sites in the tops of the coconut trees.

White Tern *Gygis alba*

This species was not mentioned by Fryer (1910), and although it may have nested in small numbers in the *Scaevola* and *Tournefortia*, it

may in fact be a recent colonist. It is now dependent for its nest sites on *Casuarina* and buildings at the settlement, though a few pairs lay their eggs on coconut fronds, on footholds on coconut trunks or even on pawpaw trees. In September 1972 the population was estimated at about 720 pairs.

This species is noted for its high egg and chick losses (Dorward 1963), and this situation prevails on Bird Island. Rats take both eggs and chicks from the buildings, but birds laying in *Casuarina* may not be subject to this loss. Breeding occurred throughout the south-east trades, but Mr. & Mrs. Savy thought that breeding stopped in January and February, when most birds left the island. If this is so, breeding on Bird Island differs from that on Cousin where it is continuous throughout the year (Diamond, in press).

(ii) Breeding land birds

Cattle Egret *Bubulcus ibis*

In 1972 there were seven nests (eggs and chick present mid-August) in two *Casuarina* trees at Passe Coco, but in 1973 these trees, with their nests, were cut down. Cattle Egrets on the island were very mobile, and no reliable estimate of the number of birds present was obtained, but there were probably over 40 birds. Sooty Tern eggs and young chicks, and regurgitated food, formed part of their diet during the tern breeding season (Feare 1975b) and egrets certainly bred at this time, but it is not known whether the egrets breeding season extended into the north-west monsoon; then their diet must consist almost entirely of insects, skinks, and refuse from around the settlement and pig enclosure. Cattle Egrets in the Seychelles appear to be an endemic subspecies *B.i. seychellarum* (Benson 1971), and they may be indigenous on the seabird islands. They were present on Bird Island in 1907 (Fryer 1910).

Ridley and Percy (1958) regarded Cattle Egrets as serious predators of Sooty Terns, but during the 1973 season on Bird Island very few losses of eggs and chicks could be attributed to egrets (Feare in press), and eggs and chicks that egrets did take had usually been left unattended by the terns. Losses would probably be increased as a result of human interference in tern colonies.

Barred Ground Dove *Geopelia striata*

Common all over the island, except the Sooty Tern colony, but no estimate of numbers was obtained. No nests were found between June and October, but increasing courtship in October of both years suggested that breeding occurred during the northwest monsoon. Fryer (1910) recorded ground doves on Bird Island.

Mynah *Acridotheres tristis*

Mynahs were not mentioned by Fryer (1910) and so it is presumably a recent arrival from the granitic islands. It was present all over the island in 1972 and 1973, and although no estimate of numbers was obtained there were probably well over 100 birds. Pawpaws appeared to form an important component of the diet, but birds were also frequently seen feeding in grassland on the airstrip and around the edge of the Sooty Tern colony. Nestbuilding in coconuts was seen in November 1972, so breeding presumably occurred during the north-west monsoon.

The most notable aspect of Mynah behaviour on Bird Island was the absence of noisy communal roosts typical of the species on the granitic islands. On Bird Island the Mynahs' food did not appear to be localised, while on Mahé, where ripe fruit, especially mangoes *Mangifera* sp. and guavas *Psidium* sp., was an important source of food, trees with ripening fruit were localised in space and time. The absence of communal roosting on Bird Island lends support to the hypothesis that such roosts assist bird populations to discover and utilize localised food sources (Ward 1965, Zahavi 1971, Feare *et. al* 1974).

Madagascar Fody *Foudia madagascariensis*

Common throughout the island, where unoccupied nests were found in coconut and *Casuarina* trees. Many birds roosted in a large *Ficus* tree at the settlement. Red males were uncommon from May to August, but a juvenile seen begging on 13 August 1972 suggested that limited breeding occurred during this period. Red and moulting birds were more abundant in September and October, when males became territorial. Breeding therefore occurred mainly in the north-west monsoon.

(iii) Migrants

Records of birds of which specimens or photographs have been deposited in Cambridge Zoology Museum have been published by Feare (1973, 1975) and a comprehensive account of shorebirds in Seychelles is given by Feare and High (in press). Full details are given in these papers.

Audubon's Shearwater *Puffinus lherminieri*

Commonly seen a few miles offshore from boats, but rarely seen from the island. One found dead on the beach 18 June 1973.

Wilson's Petrel *Oceanites oceanicus*

One seen close inshore around small fishing boat 2 November 1972.

Red-billed Tropic Bird *Phaethon aethereus*

One regularly seen over the island, frequently displaying to *Ph. lepturus*, in July-August and September-October 1973, and May-June 1974 (Feare 1975a). Recorded in the Amirantes by Stoddart and Poore (1970).

Red-tailed Tropic Bird *Phaethon rubricauda*

One adult over island throughout morning 25 September 1973.

Masked Booby *Sula dactylatra*

No longer breeds. Immatures occasionally seen, especially August-September and an adult 19 August 1972.

Red-footed Booby *Sula sula*

Single birds occasionally roosted with frigate birds in *Casuarina* trees.

Brown Booby *Sula leucogaster*

An immature flew over the Sooty Tern colony 20 June 1972.

Great and Lesser Frigate Birds *Fregata minor* and *F. ariel*

Frigate birds roosted in tall *Casuarina* at Hirondelle on most nights, and were frequently seen feeding during the day. Numbers varied considerably from day to day, with a maximum of 41 on 2 June 1973. Said to be more numerous November-April. Most were immatures, but adult males of both species were occasionally seen.

Purple Heron *Ardea purpurea*

Immatures seen 8 September (this bird found starving 20 September) and 4 October 1973 (Feare 1975a).

Little Green Heron *Butorides striatus*

One on the beach at Passe Coco on 28 September 1972 is the only record of this species, which is common on the granitic islands.

Madagascar Squacco Heron *Ardeola idae*

An immature Squacco, thought to be this species, was present 22-29 September 1973 (Feare 1975a).

Garganey *Anas querquedula*

Immatures seen 18, 20 and 21 September 1972, and one found dead November 1973 (Feare 1975a).

Black Kite *Milvus migrans*

A large raptor, thought to be this species, was seen flying north 21 September 1973. Vesey-Fitzgerald (1936) recorded several "buzzards" on Bird Island 1936]

Hobby *Falco subbuteo*

Recorded by Moreau (1938) in November 1936 and Feare (1973) in December 1972. Unidentified falcons were seen 18 and 23 October 1972, and Mr. G. Savy had seen several falcons on the island since 1967.

Corncrake *Crex-crex*

One 5-6 October 1973 (Feare 1975).

Moorhen *Gallinula chloropus*

Recorded by Fryer (1910), and seen occasionally since 1968, but not in 1972 and 1973. Presumably these birds come from the granitic islands.

Ringed Plover *Charadrius hiaticula*

Singles on 5 September and 1 October 1973.

Little Ringed Plover *Charadrius dubius*

One 13 November 1972.

Lesser Sand Plover *Charadrius mongolus*

Recorded in June and August-November 1972, and September 1973.

Great Sand Plover *Charadrius leschenaultii*

Small numbers May - late September increased October.

Caspian Plover *Charadrius asiaticus*

Singles June and September-October 1973, and three on 2 October.

Asiatic Golden Plover *Pluvialis dominica*

Singles 20 August and 19 October-mid November 1972 in the Sooty Tern colony.

Grey Plover *Pluvialis squatarola*

Present throughout year, migrants arrived September-October.

Turnstone *Arenaria interpres*

Present throughout year. Birds present during the Sooty Tern breeding season were egg predators and scavengers, but they fed throughout the coconut plantation, presumably on insects. At low spring tides they fed on the reef flat.

Rufous-necked Stint *Calidris ruficollis*

One in the Sooty Tern colony with Curlew Sandpipers 13-14 November 1972.

Temminck's Stint *Calidris temminckii*

Recorded by Bailey (1967) and one on airstrip 22 September 1972.

Pectoral Sandpiper *Calidris melanotos*

One feeding with Turnstones in the Sooty Tern colony 13 October 1972.

Curlew Sandpiper *Calidris ferruginea*

Seen singly and in small parties from September-May.

Sanderling *Calidris alba*

Present all year increasing in October. Usually restricted to the beach, but fed in Sooty Tern colony when the terns began leaving.

Ruff *Philomachus pugnax*

Singles 26 September-28 October 1972 and 24-30 September, 1973.

Greenshank *Tringa nebularia*

Singles 31 July 1972 and occasionally September-October 1972 and 1973.

Wood Sandpiper *Tringa glareola*

Singles 2-3 October, 16-18 October and 12-15 November 1972, on the airstrip and around the settlement.

Common Sandpiper *Actitis hypoleucos*

Recorded from late August in small numbers, mainly on island paths and around the settlement.

Terek Sandpiper *Xenus cinereus*

Singles 11-25 October 1972 and 9-19 October 1973.

Bar-tailed Godwit *Limosa lapponica*

Small numbers seen September-October 1972 and 1973.

Curlew *Numenius arquata*

Recorded June and September-October 1972, and May, but not autumn 1973.

Whimbrel *Numenius phaeopus*

Present all year, feeding mainly in the coconut plantation, but at low spring tides also on the reef flat.

Little Whimbrel *Numenius minutus*

Single 14 October 1972-April 1973 (Feare 1973).

Snipe *Gallinago* sp.

A snipe, probably *G. gallinago*, was flushed from *Scaevola* bushes 23 October 1972.

Jack Snipe *Limnocryptes minimus*

One 3 September 1973.

Crab Plover *Dromas ardeola*

Present all year. Family parties, each of two adults and one begging juvenile arrived October 1972 and September 1973. Only seen on the beach.

Collared Pratincole *Glareola pratincola*

Recorded by Bailey (1967) in November 1963. One seen daily 25 September-14 October 1972, with 4 27-29 September.

Lesser Black-backed Gull *Larus fuscus*

One adult 11 October 1972. Also recorded on Aldabra (Dawson 1966), and on Mahé in January-February 1972.

Roseate Tern *Sterna dougallii*

Occurs irregularly in small numbers, often associating with other terns on the beach. Usually in non-breeding plumage, but on 8 July 1973 two birds in breeding plumage were found dead with *Amblyomma loculosum* ticks on their feet. Breeds in the Seychelles and Amirantes.

Black-naped Tern *Sterna sumatrana*

Small numbers seen on the beach in June 1972 and 1973. Breeds in the Amirantes.

Bridled Tern *Sterna anaethetus*

Roosted at night in large numbers (5000+) in *Casuarina* trees throughout the periods of study, despite breeding every 7-8 months on some of the granitic islands (Diamond, in press). During two periods in mid July and mid August when Sooty Terns were short of food (Feare, in press) the number of roosting birds fell and several Bridled Terns were found starving or dead. Bridled Terns were rarely seen during the day, but roosting birds began returning in mid-afternoon.

Saunders Tern *Sterna ? saundersi*

From August-October in both 1972 and 1973 small terns congregated on the sand spit at the northern end of the island, the largest flock being 258 on 21 September 1973. Flocks of small terns have also been recorded on several other islands in the western Indian Ocean (Vesey-Fitzgerald 1941, Benson 1967, Bayne *et. al* 1970, Parker 1971). The identity of these birds is uncertain. Diamond (1971) thought that birds on Aldabra were *S.a. albifrons*, since they had yellow legs, but Vesey-Fitzgerald (1941) and Loustean-Lalanne (1963) considered them to be *S.a. saundersi* (regarded by Vaurie (1965) as a distinct species *S. saundersi*), while Mountford (1971) identified Bird Island individuals as *S. balaenarum*, Damara Tern of the cold waters of SW Africa, on account of their black bills. However, moulting birds in May had yellow bills with black tips, typical of *albifrons* and *saundersi*, and they never had complete black caps, which breeding plumage *balaenarum* has.

Crested Tern *Thalasseus bergii*

A party of 5-20 birds was present throughout the two study periods, with juveniles being fed by adults (Feare 1975c). The adults appeared to feed mainly inside the reef. The nearest known breeding colony is African Banks, about 240 km to the south west. Most adults were typical of the pale backed *T.b. thalassina* which breeds in the western Indian Ocean, but from 11 September-3 October 1973 an adult with a very dark back (as in British lesser black-backed gull *Larus fuscus graellsii*) and a more orange bill than *T.b. thalassina* was present in the flock. Comparison of photographs of this bird with specimens in the British Museum suggested that this bird was *T.b. velox*, which breeds around the coasts of the northern Indian Ocean. This individual was in breeding plumage, but during its stay on Bird Island it began primary moult.

Lesser Crested Tern *Thalasseus benghalensis*

Two on 28 May, 1975. Small flocks were occasionally seen round Mahé.

Black Noddy *Anous tenuirostris*

Occasionally a few birds roosted in *Casuarina* trees with Bridled Terns, but on each night from 10-14 September 1973 very large numbers roosted in coconut trees in the centre of the island. The birds assembled offshore in a flock estimated at well over 10,000 birds, and began flying into the island at 1830h (almost dark) usually in flocks of 30-50 birds, but some times in a long winding stream of birds. The movement continued until about 2130. They flew low over the water, but when they reached the shoreline they began erratic movements, each bird in the flock flying independently of the others. Throughout the flight they were silent, but once settled in the trees they called loudly. This behaviour, also seen in Brown Noddies returning to their nests, was reminiscent of defensive behaviour against aerial predators. However, in the Seychelles, there are no indigenous aerial predators, but migrant falcons could conceivably constitute a threat.

Turtle Dove *Streptopelia* sp.

An unidentified turtle dove was seen feeding in *Phyllanthus casticum* on 30 October 1972. It was uniform red/brown with no grey on head or rump, and no markings on the neck; the bill was the same colour, but the lower belly and undertail were buff; the tail had a narrow white terminal band.

Great Spotted Cuckoo *Glamator glandarius*

An immature seen 5-7 October 1973. Very long dark grey tail with white edges. Back grey, heavily spotted white. Chin, breast and belly warm cream with buffish tinge, especially on throat. Crown black, extending below eye and on to ear coverts, slightly crested. Rufous patch on primaries. Bill short and decurved. This is the only record for the Malagasy region.

Grey Cuckoo *Cuculus canorus*

Frequently seen 8 October-7 November 1972 with two on 1 November. The bird on 8 October was rufous, all others grey.

Barn Owl *Tyto alba*

A bird first seen 9 August 1973 remained for several months and was eventually found dead, but too decomposed for subspecific identification. Probably *T.a. capensis*, which was introduced on Mahé and spread to most of the granitic islands.

European Nightjar *Caprimulugus europaeus*

A ♀, nominate race, was found dead early December 1972 (Feare 1973).

Black Swift *Apus apus*

Black swifts (presumably this species, which has also occurred on Aldabra (Benson & Penny 1971), but on sight records *A. barbatus* cannot be ruled out) were seen in 1972 as follows: 2 on 30 September, singles 30 October, 6 November, 7 November and 14 November. All were all black except for white chin, and had slightly forked tails.

Pacific Swift *Apus pacificus*

Singles seen 20 October, 1 November and 13 November 1972, with three on 14 November and two on 15 November. These birds were black with pure white "square" rump patch; tail slightly forked. The bird on 20 October had pale whitish chin and a small white mark on under tail coverts. Birds on 14 November flying with *A. apus* were slightly smaller, had no white on under tail coverts, and an indistinct greyish throat patch. From these descriptions R.K. Brook thought they may be *A. pacificus* which had over-flown from S. India (but see Frith 1974 for white-rumped swifts on Aldabra).

Blue-cheeked Bee Eater *Merops superciliosus*

Four-five birds in November, 1972 were *M.s. persicus* (Feare 1975a).

European Roller *Coracias garrulus*

c.5 were present in November-December 1972, when others, both adult and juvenile, were present on Mahé.

Broad-billed Roller *Eurystomus glaucurus*

One on 14 November 1972 in fresh plumage was probably the nominate race, lost on its return from Africa to Madagascar (Feare 1975a). This is the first Seychelles record, but nominate *E. glaucurus* has occurred on islands further west (Benson & Penny 1971).

Swallow *Hirundo rustica*

From descriptions by Mr. & Mrs. Savy birds seen in several winters were this species, which has been recorded previously from the Seychelles (Crook 1960) and from Aldabra (Benson & Penny 1971).

Wheatear *Oenanthe oenanthe*

One from 26-29 October 1972 (Feare 1975a).

Tree Pipit *Anthus trivialis*

According to Mr. Savy pipits have been seen most years since 1968. In 1972, two were seen 21 October and three from 23 October to at least 15 November. In 1973 one present from 7 October until at least 21 October. They apparently remain throughout the northern winter. Crook (1960) also recorded this species from Frigate Island.

Red-throated Pipit *Anthus cervinus*

Singles 28 October and 10 November 1972. Identified by streaked rump, long hind claws, pink legs and call a loud "shup".

Grey Wagtail *Motacilla cinerea*

Present 8-13 November 1972, with maximum of three on 12 November (Feare 1975a).

Yellow Wagtail *Motacilla flava*

Winters on the island each year (G. Savy pers comm.). Singles seen October and November 1972, and October 1973. An ad. ♂ on 4 November 1972 had characters of *M.f. flava* with slate crown and nape with slightly darker ear coverts, and white eye-stripe, but one on Mahé in November 1972 resembled *M.f. beema*. Birds on Aldabra appear to be *M.f. lutea* (Benson and Penny 1971).

Ortolan Bunting *Emberiza hortulana*

An immature on 13 and 14 November 1972 (Feare 1975a).

Golden Oriole *Oriolus oriolus*

Frequently seen in October-November 1972, with three on 1 November. All were juveniles or ♀. Crown, head, nape and back yellow/green. Upper tail brownish green with yellow tip; rump, under tail and lower belly bright yellow. Breast grey/buff finely streaked brown; sides of breast yellowish buff. Belly buff with sparse fine streaking. These are the first records for the Seychelles, but Golden Orioles have occurred on Aldabra.

DISCUSSION

Bird Island, together with Denis and the islands of the Amirante group, probably have a Pre-Cambrian granite foundation (Baker and Miller 1963) and these sand cays and atolls may therefore be older than similar islands elsewhere which are based on more recent

volcanic rocks. The phosphatic sandstone of Bird Island suggests that for much of its recent geological history the island has been dominated by birds, and man's influence has probably been felt for less than 100 years. During this 100 years, however, the island has been transformed to such an extent that it is now difficult to separate the indigenous elements of the fauna and flora from what has been recently introduced. For example, while *Rana madagascarienses*, the three breeding land birds, and the rat have certainly been brought by man, the distinctiveness of Bird Island *Phelsuma* geckos suggests that it may be indigenous, as may be the burrowing snake *Rhamphotyphlops*. Both of these animals could, however, have been transported from the granitic islands amongst coconuts that were brought for planting. Vesey-Fitzgerald (1947) considered this to have happened with the skink *Mabuya sechellensis*. Similarly, while both the stable and unstable beach fringe plant associations on sand are certainly indigenous, and much of the flora of the coconut plantations is undoubtedly introduced, the beach fringe association on phosphatic sandstone, dominated by the trees *Thespesia populnea* and *Cordia subcordata*, was not mentioned by Fryer (1910). These plants may therefore have been introduced by man, and have become established in the habitat with which they seem to be naturally associated on other islands (e.g. on elevated limestone on Astore, Assumption and Aldabra - Bayne *et. al* 1970, Stoddart *et. al* 1970, Stoddart and Wright 1967).

The introduction that has had the most far-reaching effects has been that of the coconut. While it has been claimed that over-exploitation of eggs may have reduced the Seychelles populations of Sooty Terns, on Bird Island the main factor in the reduction of the colony has been the removal of space in which the birds could breed. This has been demonstrated by the recent removal of part of the coconut plantation, the newly-available space having been rapidly occupied by Sooty Terns.

The planting of coconuts, therefore, brought to an end a long period of domination of the island by seabirds, during which guano deposits were formed with a layer of phosphatic sandstone beneath. Fryer (1910) found Sooty Terns, Brown Noddies and Masked Boobies to be the main species living on Bird Island in 1907, but whether these three species were always dominants, and were therefore responsible for the formation of guano and phosphatic sandstone, is moot. Fosberg (1954) considered that an essential element in the formation of Jemo Series soils was the litter of *Pisonia grandis*. At present this is an uncommon plant on Bird Island, and since Fryer (1910) did not mention it, it was probably uncommon before coconuts were planted. On islands in the Seychelles where *Pisonia* woodland is well developed (especially Aride, pers. obs.) tree-breeding species are the main guano producers. Currently the species involved are mainly the two noddies (especially Black) and White Terns, but in the past larger tree breeding species, e.g. Red-footed Boobies and Greater and Lesser Frigate Birds, may have bred in these habitats in the

Seychelles and may have made a much greater contribution to guano formation than the smaller species. The presence of Jemo Series soil on Bird Island (and on other sand cays with Sooty Tern colonies e.g., African Banks: Feare, in prep.) suggest that either *Pisonia* is not an obligatory precursor in phosphatic sandstone formation, or that Bird Island has at one time been more densely vegetated than when described early this century, and for some reason much of this vegetation disappeared.

A characteristic of Jemo soils is that some of the phosphatic sandstone exists in the form of loose boulders or slabs, which Fosberg (1954) thought were pushed up by *Pisonia* root systems. Piggott (1969) said that the phosphatic sandstone of Bird Island existed as numerous cracked blocks, rather than as a continuous sheet, but the removal of most of the A_O horizon during guano exploitation, and the breaking of the sandstone during the preparation of pits for coconut planting, renders interpretation of the present broken form of the sandstone difficult. Although *Pisonia* occurs on many of the Seychelles islands, and being bird-distributed must have many opportunities of being constantly introduced to seabird islands (Ridley and Percy (1958) demonstrated inter-island movements by Sooty Terns), the absence of *Pisonia* forest on any of the sand cays of the Seychelles and Amirantes, while it occurs on Aride, suggests that Bird Island may never have had such forest. *Pisonia* may therefore not be necessary for the formation of Jemo soil and its phosphatic sandstone.

Fosberg (1954) considered the requisites for Jemo soil formation to be humus, acid, calcium phosphate, calcareous sand and rain. Although the humus layer on Bird Island is nowhere as well-developed as under the *Pisonia* on Aride, plants found in the Bird Island Sooty Tern colony, notably *Scaevola, Tournefortia, Suriana* and *Cyperus pachyrhiza* do accumulate litter and humus beneath them. Whether this is as acid as the humus formed under *Pisonia* is not known. In addition the plants which dominate the tern colony, *Portulaca, Boerhavia* and *Tribulus*, have a pronounced seasonal cycle of growth and die-back. During the wetter north-west monsoon, the rain (in conjunction with the absence of seabirds) leads to a luxuriant growth of these three species especially *Portulaca,* in the tern colony. In the usually dry south-east trades this vegetation dies off under the influence of lack of rain, salt water and faeces deposited by the birds, and through trampling. There is therefore a seasonal production of humus even in areas of mat vegetation, while the growth of *Scaevola* and *Tournefortia* within the tern colony provides more organic material. This humus, which is probably acid, together with calcium phosphate from the birds' faeces may be sufficient to react with the calcareous sand after leeching in the manner suggested by Fosberg to produce phosphatic sandstone. Sandstone production may be slower in the absence of *Pisonia* or other plants which deposit large quantities of litter, or where large colonies of larger seabirds,

e.g., boobies, breed.[1]

The future of the Bird Island Sooty Tern colony, probably the largest colony that is readily accessible to visitors, seems to be secure at present. In view of its being a tourist attraction, the colony will probably benefit from the presence of a small, exclusive hotel on the island, together with small number of day visitors, since the income from these may obviate the need for exploitation of eggs for all but local consumption. If the colony then continues its expansion it could become the main area from which recruitment to exploited colonies occurs: as such it will be vitally important to the Seychelles Sooty Tern population as a whole, and to the egg industry. It is doubtful whether aircraft using the airstrips will have a long term effect on the Sooties (they may cause tree-nesting noddies and White Terns to move away from the airstrips), and the airstrips in fact provide, together with the tern colony, a valuable habitat for migrants, especially shorebirds. Although Bird Island is the northernmost island of the Seychelles, and thus presents the first landfall for birds arriving from the north, the presence of expanses of open ground may be particularly attractive to arriving migrants, and this may account for the number of species that have been recorded from Bird Island but not from other islands of the group. Further potential habitat for migrants and breeding land birds is provided by the growth of a dense shrub layer under the coconuts, this resulting from the running down of the plantation under the influence of the falling value of coconut products and the increasing emphasis on tourism.

An important consequence of tourism is that steps have been taken to reduce the rat population, and through the use of warfarin rats had been almost eliminated from the settlement by July 1974. Although rats do not appear to be a significant mortality factor for the Sooty Terns, it is to be hoped that this recent introduction may be completely eliminated from the island in the near future.

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[1] It would be highly desirable that the possibility of Jemo soils being formed by interaction of guano with other types of humus than *Pisonia* be investigated more thoroughly — the amount and acidity of this humus should be determined and evidence of current formation of phosphatic sandstone searched for. This is essential in order to support or refute our present belief that the presence of Jemo phosphate is in itself sufficient evidence for the former presence of *Pisonia* forest on a coral island. In the Pacific native information of the former presence of *Pisonia* forest has led to location of phosphate beds where no *Pisonia* forest is now found. — F.R. Fosberg, Ed.

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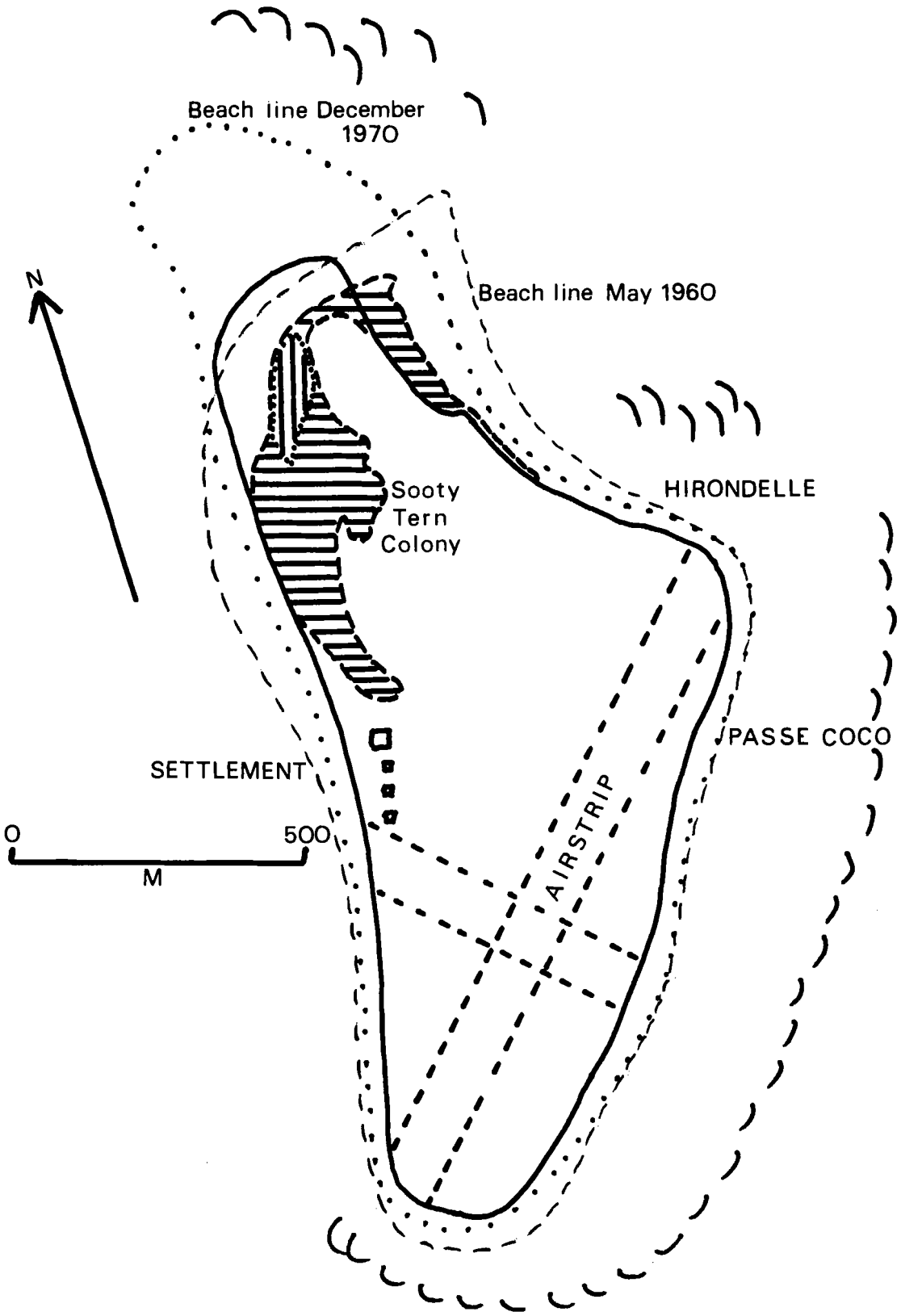

Fig. 1. Bird Island, Seychelles, drawn from aerial photographs. The May 1960 beach line shows the position at the end of the north-west monsoon, while the December 1970 beach line, at the end of the south-east trades, shows the northerly movement of sand forming an extensive spit at the north of the island. The area of the sooty tern colony in 1960 (vertical hatching) was taken from the aerial photograph, while the colony area in 1973 (horizontal hatching) was obtained by measurement with reference to land features.

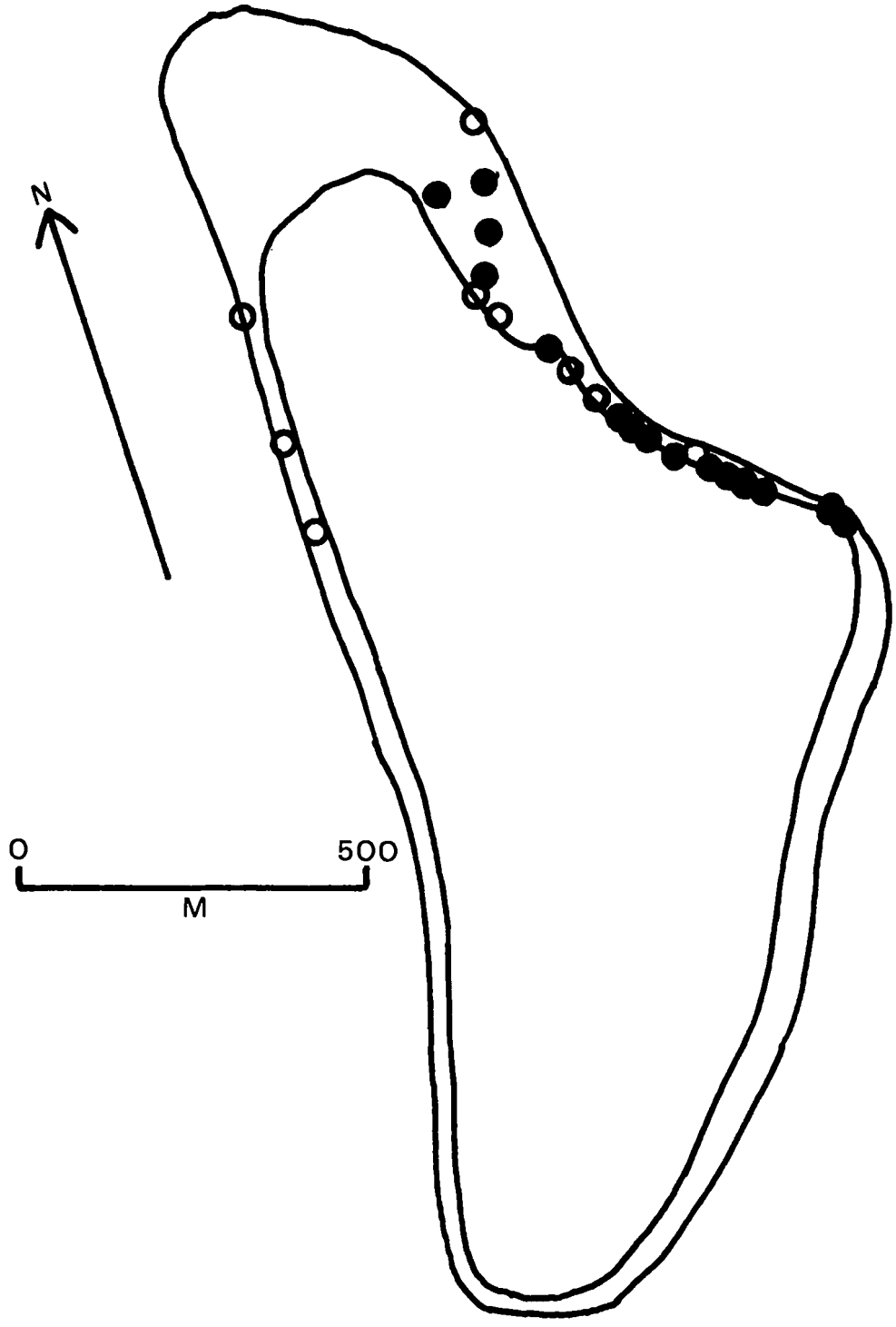

Fig. 2. The positions where Green Turtles came ashore in May-October 1973. Solid circles denote that a nest was excavated.

Plate 1. The settlement, with labourers houses in the foreground and chalets of the hotel behind.

Plate 2. The hotel on Bird Island.

Plate 3. The Sooty Tern colony in mid-May 1972.

Plate 4. A large *Tournefortia argentea* draped with *Cassytha filiformis* in the Sooty Tern colony, May 1973. Note the ground cover of *Portulaca oleracea* and *Tribulus cistoides*.

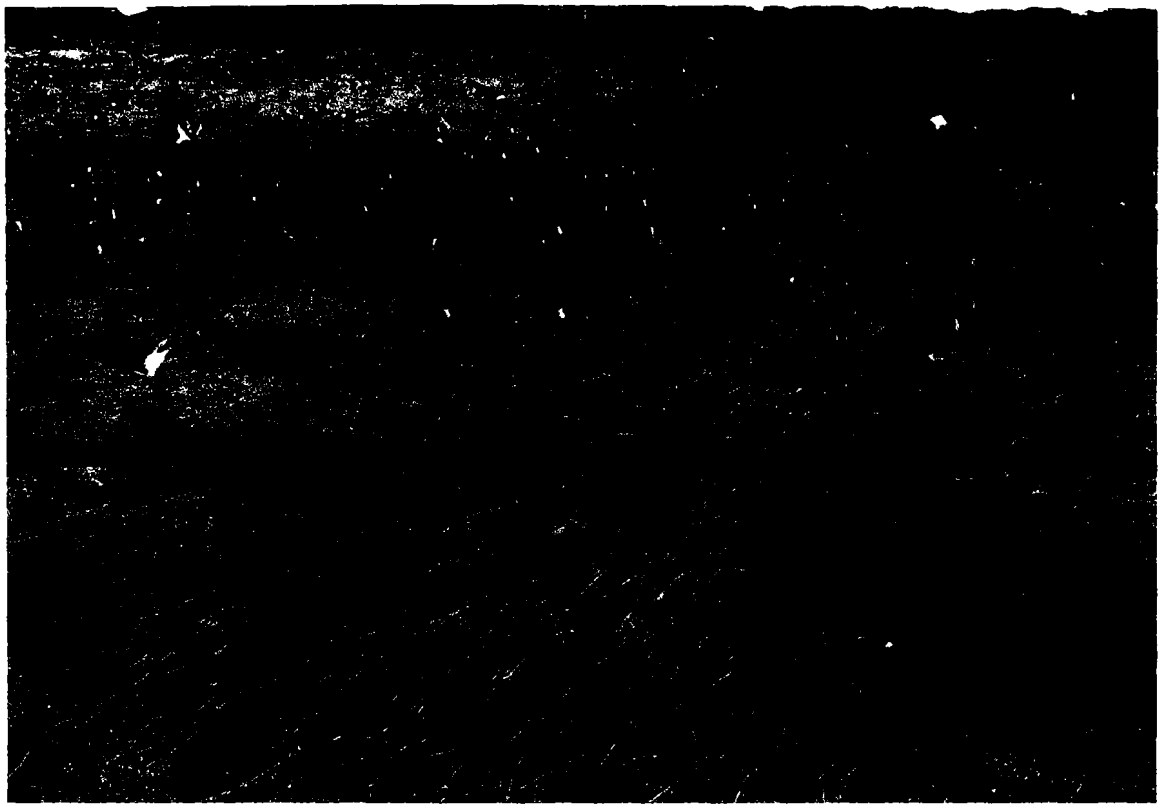

Plate 5. The Sooty Tern colony in October 1973. Note the absence of *Portulaca cleracea* and the mat of dead *Tribulus cistoides*.

Plate 6. Colonization of recently deposited sand by *Suriana maritima* and a few *Casuarina equisetifolia* seedlings. In the foreground are two *Tournefortia argentea* bushes killed by a new inundation of the sea.

Plate 7. Colonization of unstable sand on the west coast by *Suriana maritima* and *Cyperus pachyrhiza*. Behind this association is a belt of *Scaevola taccada* on stable sand, and the remnants of the *Casuarina equisetifolia* windbreak.

Plate 8. *Suriana maritima, Cyperus pachyrhiza* and a few young *Tournefortia argentea* and *Cocos nucifera* colonizing unstable sand on the sand spit at the northern end of the island. Behind this association is a belt of large *Scaevola taccada* on stable sand, and the coconut plantation.

Plate 9. The narrow belt of *Cordia subcordata* and *Thespesia populnea* growing on phosphatic sandstone in Hirondelle Bay on the north-east coast. At Hirondelle Point (left of picture) tall *Casuarina* are used for roosting by Frigate birds. On the beach is a mat of *Ipomoea pes-caprae* extending out from the *Cordia/Thespesia* belt. Note the beach driftwood, the remains of *Suriana maritima* and *Tournefortia argentea* killed by the sea during the annual erosion cycle. In the foreground is a Green Turtle *Chelonia mydas* nest.

Plate 10. *Cocos nucifera* interspersed with wild *Carica papaya* and *Phyllanthus casticum* growing on phosphatic sandstone near the east coast, September 1973. Note that the *Carica* and *Phyllanthus* are leafless, the trees having been defoliated during the south-east trades.

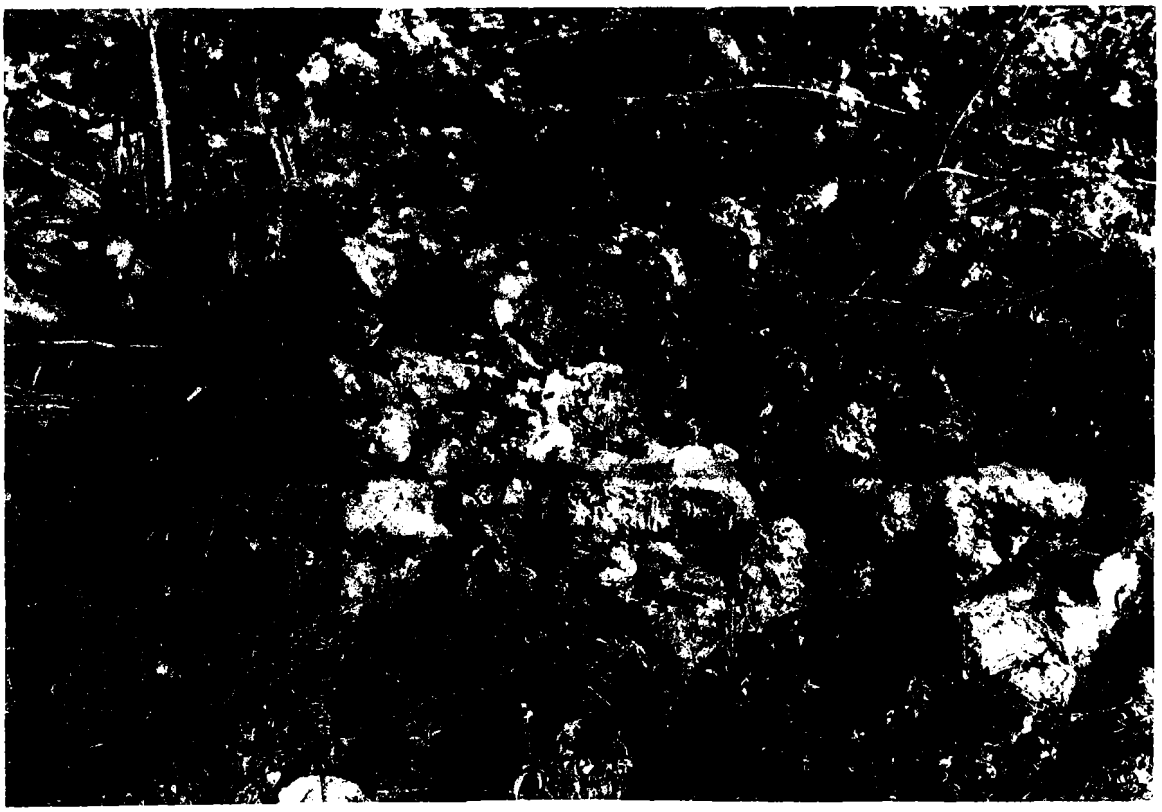

Plate 11. Rough and broken phosphatic sandstone exposed when vegetation was removed during airstrip construction.

Plate 12. Dense understory vegetation growing beneath *Cocos nucifera* on phosphatic sandstone. The dominant plant is *Phyllanthus casticum*, with some *Scaevola taccada*, *Cassia occidentalis*, *Ricinus communis*, *Kalanchoe pinnata* and *Passiflora suberosa*.