

Figure 1. Bird Island: Physical map, with position of tern colony and location of vegetation plots.

BIRD

BY

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GEOLOGY, TOPOGRAPHY AND CLIMATE

Bird is the northernmost island of the Seychelles, lying around 90 km north of Mahé, the largest of the granitic Seychelles, at the northern edge of the Seychelles bank. Different published sources vary in the estimated area of Bird Island with figures of *c.* 70 ha given by Feare (1979), 82 ha in Stoddart and Fosberg (1981), 101 ha in Skerrett *et al.* (2001), and 120.7 ha from recent aerial photographs (Ministry of Land Use and Habitat, Seychelles, unpublished data). In part, this variation may be explained by seasonal or longer-term variations in the vegetated area of the island; Bird Island is relatively dynamic, experiencing considerable coastal changes over time (Feare, 1979). The maximum elevation is less than 4 m above sea level.

Unlike the majority of islands on the Seychelles Bank, Bird has no exposed granite and it is entirely formed of reef-derived sands. The accumulation of guano on sand deposits has led to the formation of phosphatic sandstone over 26% of the island's surface (Baker, 1963). Phosphatic sandstone is concentrated in a central band; the island's coastal zone is entirely sandy. Most of the original guano has now been removed for export. The soils of Bird Island are of two main series; over the central phosphatic sandstone area, Jemo series soils (missing their upper layer of guano) occur. In the rest of the island, soils of the Shioya series occur (Piggott, 1969).

The beaches of Bird Island undergo considerable seasonal change. An annual cycle of erosion and deposition occurs with erosion of western beaches and deposition of a sand spit at the north of the island during the south east trade season. During the north west monsoon the sand spit is eroded and deposited on beaches on the west and north east coasts. The extent of erosion varies between years (Feare, 1979).

Compared to the granitic islands to the south, Bird Island is relatively remote. The nearest island is the coralline Denis Island approximately 50 km to the west. The nearest large island in the granitic group is Praslin, approximately 80 km to the south and east.

The Seychelles islands experience a seasonal humid tropical climate (Walsh, 1984). The annual rainfall pattern on Bird follows that of the granitic islands, with most rainfall occurring during the NW monsoon period (between the months of September/October and February). For Bird Island, rainfall data are only available for 1961, 1962 (Stoddart, 1971) and part of 1972 (Feare, 1979). In both 1961 and 1962, total

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annual rainfall on Bird Island was lower than on Denis Island and lower than that on the high islands of the granitic Seychelles.

HISTORY

In 1771, the island was explored and charted by the cruiser *Eagle* (Stoddart and Fosberg, 1981). The earliest detailed scientific records were made on the visit of *H. M. S. Alert* in 1882 (Coppinger, 1885). At that time, the island had a coastal band of shrubby vegetation (probably *Scaevola sericea*, *Suriana maritima* and *Tournefortia argentea*) surrounding a central area dominated by herbaceous species. There were no land birds but abundant seabirds, including sooty terns *Sterna fuscata*. The human population consisted of only two people.

This situation changed soon after the visit of the *Alert*, with the extraction of guano deposits in 1895-1906 followed by the planting of coconuts. At first, the plantation was restricted to a narrow central strip of the island (Fryer, 1910) but, by the 1970s, coconut woodland dominated the island's vegetation (Feare, 1979; Stoddart and Fosberg, 1981). The sooty tern colony, which in 1908 occupied most of the island's area, was restricted to the north west part of the island and considerably reduced in size. In 1967, some of the coconuts around the colony of sooty terns were felled to allow the colony to expand (Feare, 1979).

In 1971-73, two airstrips were cleared and a small tourist lodge constructed (Feare, 1979). Tourism became the main source of income for the island although coconuts were still collected for export and sooty tern eggs collected for local consumption. Today the coconut plantation on Bird is no longer managed for production and the island is managed as a resort with 26 villas. The small permanent population of the island is employed in the hotel and tourists travel to Bird by small plane from Mahé. Sooty tern eggs are no longer routinely collected for export to the main islands of the Seychelles (although eggs were collected in 1999; Feare, 1999b).

The flora, fauna and ecology of Bird Island were the subject of two recent detailed studies (Feare, 1979; Stoddart and Fosberg, 1981). The sooty tern colony has been the subject of ongoing monitoring since 1993 (Feare and Gill, 1993-7; Feare, 1998, 1999b).

FLORA AND VEGETATION

Flora

A total of 105 plant species were recorded on Bird Island (Appendix 1), including one fern, one gymnosperm (introduced) and 103 angiosperms. Of these, 35 ornamental or edible species (all introduced) were restricted to garden areas and did not occur in natural habitats. In all, 71 (68.9%) of angiosperm species observed are regarded as introduced (or probably introduced) in Seychelles (Friedmann, 1994; Robertson, 1989) and 22 (21.4%) native. The remaining 10 (9.7%) were of unknown status. No species endemic to Seychelles were recorded.

Forty species recorded by earlier visitors were not observed; 21 of these (52.5%) introduced (Appendix 1). At least one of these species (*Pemphis acidula*) probably never occurred (Stoddart and Fosberg, 1981), and other records may have arisen out of confusion between Bird and Denis Islands; both *Acrostichum aureum* and *Typha javanica* are species of standing water (fresh or brackish) and both still occur on Denis Island. Some species are almost certainly extinct, including former crop plants (such as *Nicotiana tabacum*) and introduced trees that were planted in small numbers (e.g. *Ficus benghalensis*). Some crop plants in particular are probably occasionally cultivated, although not present at the time of the survey. Several native plants (especially grasses and small herbs such as *Sida parvifolia*) are probably still present but overlooked on the current short survey. If synonyms (four species), species that were never present (three species) and extinct plants (12 species) are excluded, the maximum number of plant species that may survive on Bird Island is 124.

Compared to the flora of the granitic islands, that of Bird is notable for its low species richness, lack of endemic species and the dominance of introduced plants (of the total Seychelles flora, around 54% is introduced and 9% endemic; Procter, 1984). Of the introduced plants established on Bird Island, only two can be regarded as invasive weedy species (Carlström, 1996a; Fleischmann, 1997): *Carica papaya* and *Passiflora Suberosa*. Both are widely distributed across the island. In addition to these alien species, the coconut *Cocos nucifera*, although probably native to the Seychelles, is present in extremely high numbers to the exclusion of other plants.

Vegetation

The extent of major vegetation types on Bird Island is shown in Table 1, and Figure 2, estimated using the figure of 120.7 ha as the total island size. In total, 20 vegetation plots were completed covering 2,000 m² or 0.17% of the island's surface. The plots were located randomly within habitats excluding grassland and garden; the survey covered 0.25% of the targeted area. A summary of results is shown in Table 2.

The vegetation of Bird Island had a relatively low density of trees, and the tree layer was species-poor. A total of only five tree species were recorded, four of which were probably native to Seychelles (although at least one of these, *Ochrosia oppositifolia*, may have been introduced to Bird Island). The most abundant species in the tree layer was *Cocos nucifera*; 26 of 84 trees (31.0%) were *C. nucifera*. Other abundant species were *Carica papaya* (22 trees, 26.2%) and *Pisonia grandis* (19 trees, 22.6%). *Casuarina equisetifolia* was relatively abundant in coastal vegetation but none were recorded within vegetation plots.

The shrub layer was generally dense. The lowest percentage cover in this layer (5%) was recorded in plot K8, which had a complete canopy of *Pisonia*. Other plots had a more mixed tree layer or more broken canopy and had a higher density of shrubs. The most widespread species of the shrub layer were *Carica papaya* (in 17 of 20 plots, with mean cover of 13.2% in plots where it occurred), *Cocos nucifera* (in 15 plots, with mean cover of 22.9% in plots where it occurred), and *Phyllanthus pervilleanus* (in 13 plots, with a mean cover of 7.1%).

In the herb layer, the most widespread species was again *Carica papaya* (in 14 of 20 plots with mean cover 4.1%). Three other species occurred in 10 or more plots:

Passiflora suberosa (in 11 plots, mean cover 2.3%), *Cocos nucifera* (in 10 plots, mean cover 2.1%), and *Nephrolepis* sp. (in 10 plots, mean cover 43.6%). Compared to most other islands studied, *Nephrolepis* showed a rather restricted distribution but was abundant where it did occur. Only one individual of *Pisonia* was recorded in the herb layer.

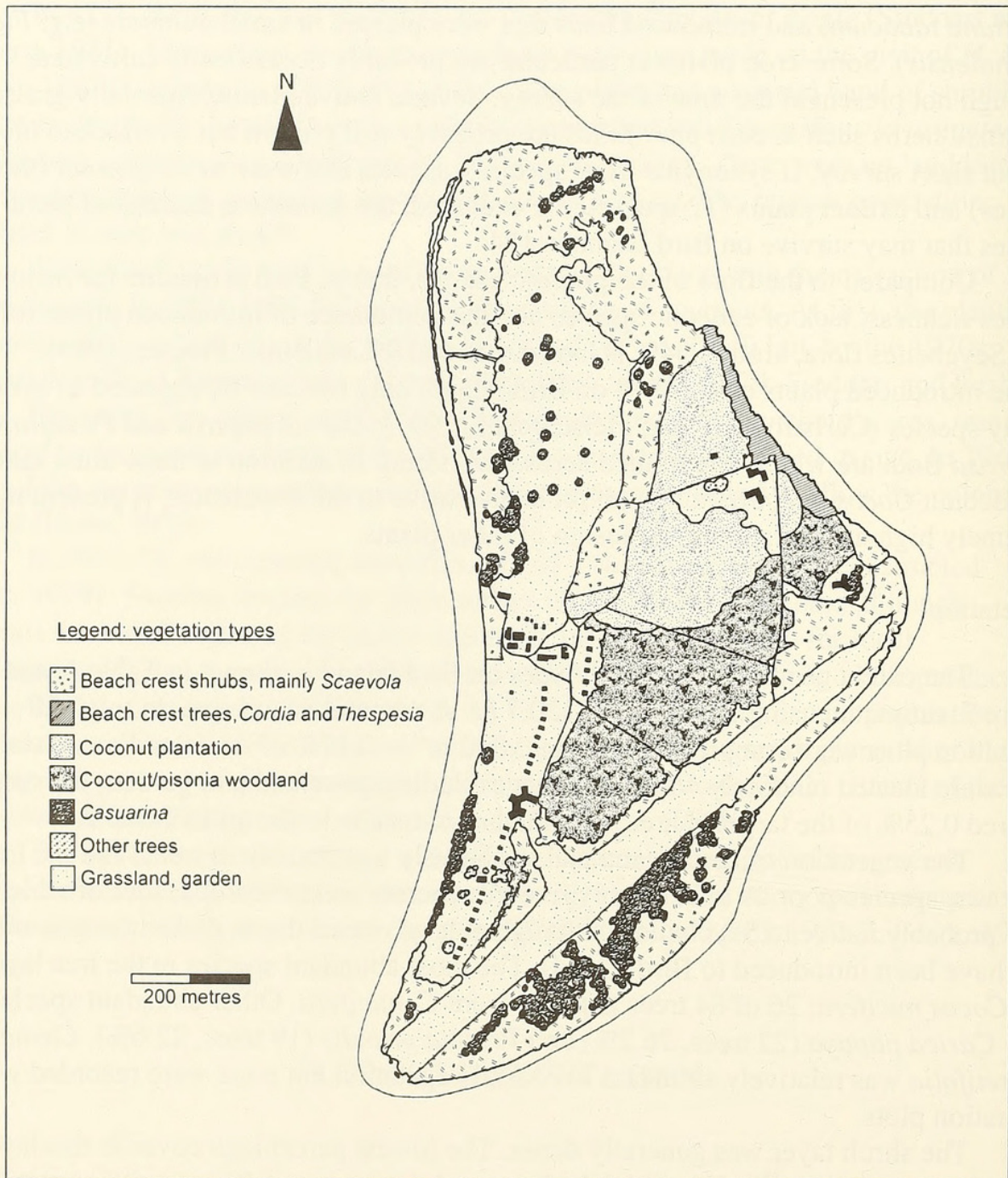


Figure 2. Bird Island vegetation.

Table 1. Extent of major vegetation types, Bird Island.

Vegetation type	Approx. area (ha)	%
Coconut plantation with scrub	13	11
“Native” woodland (<i>Cocos</i> + <i>Pisonia</i>)	18	15
Beach crest vegetation (<i>Scaevola</i> , beach crest trees)	50	41
Grassland/garden (includes Sooty Tern colony and airstrip))	39	33
TOTAL	120	

Table 2. Vegetation plot summary, Bird Island.

Habitat	Plots	Mean altitude (m asl)	Mean trees ha ⁻¹	Mean shrub layer cover (%)	Mean herb layer cover (%)	Open leaf litter cover (%)	Bare rock (%)	Dead wood (pieces per plot)
Woodland /scrub	20	<5	420	54.2	44.1	39.8	14.1	1.2

Compared to that of the other coralline island studied (Denis Island), the vegetation of Bird Island is species-poor and has low diversity. A large proportion of the island is made up of open habitats; the sooty tern colony has a mat of herbaceous vegetation consisting of *Portulaca oleracea*, *Boerhavia repens*, *Tribulus cistoides* and *Phyla nodiflora* together with grasses (Feare, 1979). The airstrip and areas around the lodge are dominated by grasses including *Eleusine indica*, *Eragrostis* spp. *Cynodon dactylon* and *Dactyloctenium aegyptium*, and herbs including *Phyla nodiflora* and *Boerhavia repens*. Coastal (beach crest) scrub was recorded by early visitors (Fryer, 1910).

The current inland woodland and scrub have developed since the early twentieth century when coconuts and papaya were first planted (Fryer, 1910). Since 1976, the native *Pisonia* has become an important part of this vegetation type; only one tree was recorded in 1976 (Stoddart and Fosberg, 1981), but at the time of the survey there were several hundred individuals. The increase in *Pisonia* coverage has reduced dominance by coconut. However, this trend has recently reversed; many *Pisonia* trees were showing loss of foliage or dieback, apparently because of the effects of soft bugs (Hemiptera: Sternorrhyncha) cultured on the trees by crazy ants *Anoplolepis gracilipes* (see below). *Pisonia* and papaya were both largely restricted to the central (phosphatic sandstone) area of the island.

INVERTEBRATES

Pitfall trapping

Pitfall trap assemblages on Bird Island were the largest from any of the island surveyed in the project (see Table 3). They also showed the highest degree of dominance by a single species, in this case the introduced crazy ant. The mean number of crazy ants

per plot was 4,890; three plots had less than 50 ants in five pitfall traps (plots G9, C4 and T12) and these are classified as “ant-free” plots in Figure 3.

Assemblages on Bird Island were much larger than those on the granitic islands and on the coralline Denis Island, even if ants are excluded (Table 3). Ants appear to have an influence on the taxonomic composition of the pitfall assemblages. While assemblages on Denis and Bird ant-free plots were dominated by crustaceans, ant-infested plots on Bird were mainly composed of one species of orthopteran, *Myrmecophilus* sp., which is closely associated with ants. Earwigs (Dermaptera) were completely absent in ant-infested plots on Bird Island but cockroaches (Blattodea) were relatively abundant. Species richness was lower in Bird ant-infested plots (mean 8.0 species plot⁻¹) than in ant-free plots (9.3 species plot⁻¹).

Table 3. Pitfall assemblages from Bird Island, and other islands in the same season. NI = number of individuals over 2 mm body length.

	Mean NI plot ⁻¹	Mean NI – ants
Bird	4947..3	52.7
Denis (NW season)	137..9	32.7
Granitic islands (NW season)	61.1	16.0

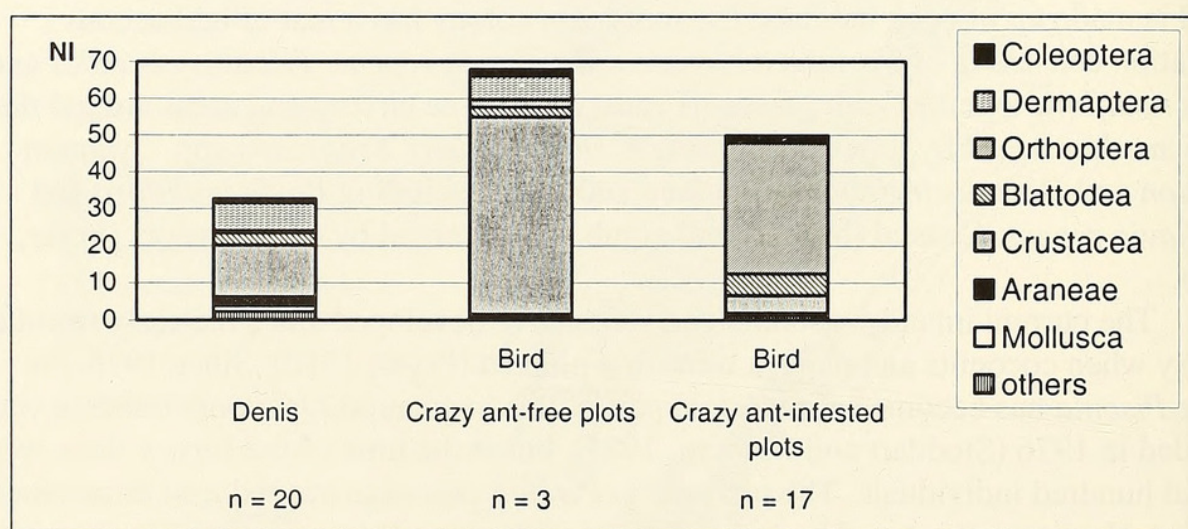


Figure 3. Composition of pitfall assemblages on Bird and Denis Islands, excluding ants. “Others” includes Annelida, Myriapoda, Thysanura, Lepidoptera, Diptera and insect larvae.

Leaf-invertebrate Counts

Leaf-invertebrate counts were carried out for six tree and shrub species, four in both crazy ant-infested and ant-free areas (see Table 4). Invertebrate densities were highest in ant-infested areas and especially on *Pisonia grandis*. Most of the invertebrates on trees in ant-infested areas were soft bugs (especially the coccid scale *Pulvinaria urbicola*), and crazy ants. Crazy ants encourage scale insects and feed on the honeydew they secrete. They also feed on other invertebrates, needing protein-rich food for their

larvae (Haines *et al.*, 1994); this could explain the low densities of other invertebrates encountered on *Phyllanthus* and *Scaevola*. On *Pisonia*, huge colonies of scale insects were tended by crazy ants and the density of other invertebrates was higher than in ant-free areas. Many of these other invertebrates were of species predatory on soft bugs (including ladybirds Coleoptera: Coccinellidae, lacewings Neuroptera) that apparently avoided heavy predation by ants.

Table 4. Density of invertebrates on foliage, Bird Island.

n = no. of leaves counted; NI = number of individual invertebrates.

	Ant-free areas				Ant-infested areas			
	n	mean NI leaf ⁻¹	mean NI m ⁻²	NI m ⁻² Exc. ants + bugs	N	Mean NI leaf ⁻¹	mean NI m ⁻²	NI m ⁻² Exc. ants + bugs
Introduced species								
<i>Carica papaya</i>	100	0.89	17.17	6.37	550	16.51	209.31	21.39
Native species								
<i>Ochrosia</i>					100	0.01	0.60	0
<i>oppositifolia</i>								
<i>Phyllanthus</i>	100	0.02	37.21	18.60	300	3.62	6866.72	12.71
<i>pervilleanus</i>								
<i>Pisonia grandis</i>	250	2.92	145.65	16.56	400	514.89	34439.19	308.01
<i>Scaevola sericea</i>	350	0.32	20.23	16.25	150	1.11	86.71	0
<i>Terminalia catappa</i>					50	1.54	34.04	0

Malaise Trapping

Malaise traps were situated in four locations, all of which were infested with crazy ants. Catches were very large, mean 2,477.25 individuals; however, most individuals were wingless crazy ants which walked into the trap from surrounding vegetation and the ground. *Anoplolepis* dominated Malaise assemblages from three of the locations, forming 69.8 – 89.5% of the total assemblage. At one location (plot M7), crazy ants were only 6.5% of the complete assemblage. This location also had the highest absolute numbers of other invertebrates, and the largest number of taxonomic groups present (14). The composition of Malaise assemblages is shown in Figure 4. The majority of taxa collected have yet to be identified to species level.

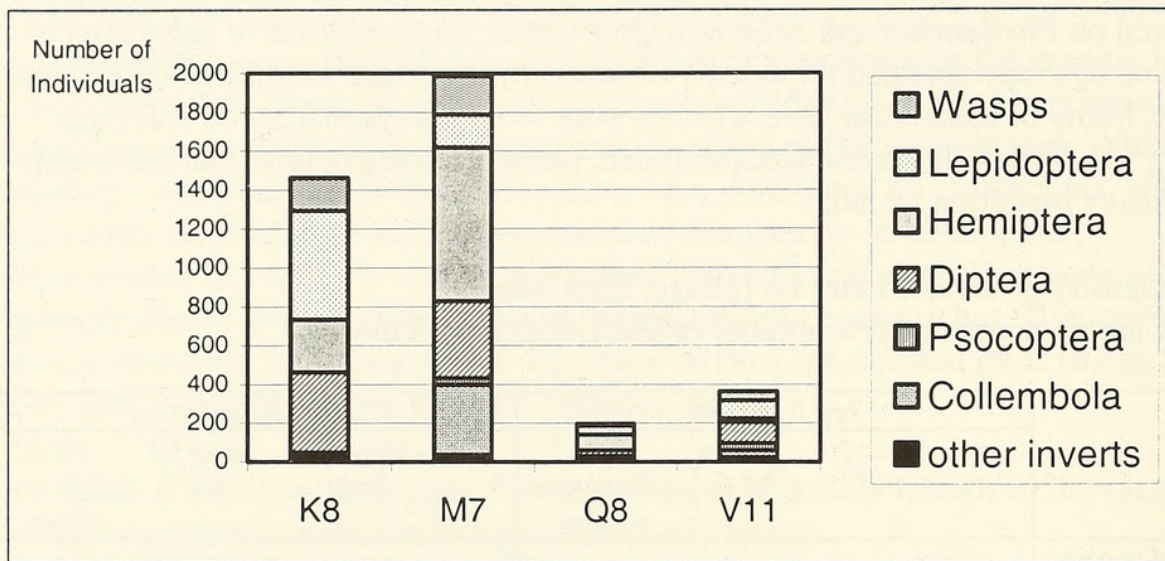


Figure 4. Taxonomic composition of Malaise trap assemblages (excluding ants).

Observation

A list of invertebrate species observed or collected in the current survey, and by previous observers, is given in Table 5.

Table 5. Invertebrates, Bird Island.

Order	Family	Species	Notes
Mollusca	Achatinidae	<i>Achatina ?fulica</i> (Bowditch, 1822)	African land snail
	Streptaxidae	<i>?Ennea</i> sp.	Occasional in pitfall traps
Arachnida:			
Acarinae	Argasidae	<i>Ornithodoros capensis</i> Neumann, 1901*	Recorded on sooty terns 1973 (Feare 1976)
	Ixodidae	<i>Amblyomma loculosum</i> Neumann, 1907*	Recorded on sooty terns (Hoogstraal <i>et al.</i> 1976)
Aranae	Tetragnathidae	<i>Nephila inaurita</i> (Walckenaer, 1841)	Abundant, March 2001
Scorpiones	Buthidae	<i>?Isometrus maculatus</i> (De Geer, 1778)*	Recorded by Feare (1979) under the bark of <i>Casuarina</i>
Crustacea:			
Amphipoda	Talitridae	Sp. Indet.	In pitfall traps, ant-free locations only
Decapoda	Ocypodidae	<i>Ocypode ceratophthalmus</i> (Pallas, 1772)	Ghost crab, beaches. Rare
		<i>Ocypode cordimana</i> Desmarest, 1825	Ghost crab, beach crest. Rare
Insecta:			
Coleoptera	Carabidae	<i>Tetragonoderus bilunatus</i> Klug, 1832	Rare in pitfall traps
	Coccinellidae	Sp. Indet.	On foliage
	Paussidae	Sp. Indet.	Abundant in pitfall traps
	Scarabaeidae	<i>Oryctes monoceros</i> (Olivier, 1789)	Larvae in pitfall traps
Hemiptera	Coccidae	<i>Protaetia maculata</i> (Fabricius, 1775)	Abundant
		<i>Pulvinaria urbicola</i> Cockerell, 1893	Abundant on <i>Pisonia</i>
Hymenoptera	Anthophoridae	<i>Xylocopa caffra</i> (Linnaeus, 1767)	Occasional
	Formicidae	<i>Anoplolepis gracilipes</i> (Smith, 1857)	Abundant
		<i>Cardiocondyla emeryi</i> Forel, 1881	Rare in pitfall traps

Order	Family	Species	Notes
		<i>Tapinoma melanocephala</i> (Fabricius, 1793)	Rare in pitfall traps
		? <i>Technomyrmex albipes</i> (F. Smith, 1861)	Rare in pitfall traps
		<i>Tetramorium bicarinatum</i> (Nylander, 1846)	Rare in pitfall traps
	Vespidae	<i>Polistes olivaceus</i> (de Geer, 1773)	Occasional
Lepidoptera	Lycaenidae	? <i>Zizeeria knysna</i> (Trimen, 1862)	Common
Lepidoptera	Nymphalidae	<i>Hypolimnys misippus</i> (Linnaeus, 1764)	Common, March 2001
Odonata		Sp. Indet. *	Dragonflies recorded by Feare (1979)
Orthoptera	Myrmecophilidae	<i>Myrmecophilus</i> sp.	Abundant, pitfall assemblages
Phthiraptera		<i>Saemundssonina sterna</i> (L., 1758)*	Recorded by Feare (1979) on Roseate tern

* species recorded by previous observers, not seen in current survey.

Discussion: Invertebrates

The crazy ant dominates invertebrate assemblages on Bird Island. This species has ill-defined multi-queen colonies that multiply chiefly by budding. They feed on honeydew from Hemiptera but also require protein-rich foods and have been observed taking ants and other insects, isopods, myriapods, molluscs and arachnids (Haines *et al.*, 1994) and land crabs (Feare, 1999a). It is significant that pitfall assemblages in ant-infested areas of Bird Island had no myriapods, Dermaptera, or molluscs and were relatively species-poor. A small number of invertebrate species seems to be able to survive in ant-infested areas and reach far higher densities than in ant-free areas. Some of the invertebrates recorded in crazy ant-infested areas feed on the bugs (including ladybirds Coleoptera: Coccinellidae) and others on the ants themselves (e.g. ant beetles Coleoptera: Paussidae).

On Bird Island the tree *Pisonia grandis* was favoured by crazy ants. The major Sternorrhynchine bug encouraged by the ants was the introduced coccid *Pulvinaria urbicola*. This species is widespread in the Caribbean, Asia and Pacific regions, but has not been recorded in Seychelles before (Gillian Watson, *pers. comm.*). It usually feeds on members of the Solanaceae and was probably introduced to Bird Island with agricultural produce. Exudates from the bug encourage sooty moulds to grow on leaves and heavy infestations of the insects can lead to plant death, as observed in *Pisonia* on Bird Island.

Some invertebrate species common on other islands in the central Seychelles appeared rare on Bird Island, possibly due to the effects of crazy ants. For example, the social wasp *Polistes olivaceus* was rarely seen and no nest was found. Although solitary carpenter bees *Xylocopa* sp. appeared abundant, nests were concentrated in an area of *Scaevola* in the south east of the island yet to be colonised by ants. Land crabs were also comparatively rare (crazy ants have been observed killing crabs: Feare, 1999a).

Feare (1979) recorded the presence of dragonflies (species not given), but as there is usually no standing water on the island they could only breed there in wet years. None were recorded in the current survey.

VERTEBRATES

Reptiles

Five reptile species were observed on Bird: three lizards and two land tortoises. At least two of these species (the land tortoises *Geochelone gigantea* and *G. pardalis*) were introduced on Bird Island. The Seychelles skink *Mabuya sechellensis* may also be introduced. It was not recorded by Fryer in 1908 (Fryer, 1910) and the first record of the species on Bird Island was that of Vesey-Fitzgerald (1947). The geckos (*Hemidactylus frenatus* and *Phelsuma* sp.) may have arrived by natural means. All of the lizard species appeared to be restricted to parts of the island free of crazy ants.

A further introduced reptile species, the blind snake *Rhamphotyphlops braminus* (previously recorded by Feare, 1979 and 1998) was not observed, but it is likely that this secretive species survives on the island, at least in areas free of crazy ants. Giant tortoises were present in 1787 (presumably belonging to one of the endemic species of the granitic islands) but this population became extinct before 1875 (Bour, 1984).

In addition to the land reptiles, two marine turtles breed on the beaches of Bird Island; Hawksbill *Eretmochelys imbricata* and green sea turtle *Chelonia mydas* (Frazier, 1984). Crazy ants have been observed to kill turtle hatchlings (Feare, 1999b).

Birds

Because of Bird Island's marginal position in the Seychelles archipelago and the presence of experienced observers, a large number of vagrant birds have been recorded for the island. There are recent records of breeding and non-breeding seabirds (Feare, 1979), resident land birds (Feare, 1979; Feare & Gill, 1995b) and migrant and vagrant shorebirds (Feare & High, 1977).

In the current fieldwork, 14 land birds and waders were recorded (Table 6) of which nine were migrants and five were resident species. Three of the resident species were obvious introductions (barred ground dove, common mynah, Madagascar fody), two of which have been present on the island since early in the twentieth century. Fryer (1910) recorded four land birds on Bird Island: *Geopelia striata*, *Foudia madagascariensis*, *Gallinula chloropus* and (possibly) *Bubulcus ibis*. The presence of moorhens is interesting given that no standing freshwater was recorded. Feare (1979) suggests that the moorhens recorded may have been vagrants from the granitic islands (Denis Island is another possible, closer, source). By the early 1970s, mynahs had colonised (Feare, 1979) and the Madagascar turtle dove *Streptopelia picturata* appears to be a more recent colonist (Feare & Gill, 1995b). No endemic land birds were recorded on the island although the turtle doves appear close to the endemic race *rostrata* (Feare & Gill, 1995b). A single Seychelles fody *Foudia sechellarum* has been recorded once (Diamond and Feare, 1980).

Ten seabird species were observed (Table 7), and there was evidence for breeding of five species. One breeding species previously listed by Feare (1979) was not observed during the present survey (wedge-tailed shearwater *Puffinus pacificus*). Since 1979, the lesser noddy *Anous tenuirostris* has been added to the list of breeding seabirds on Bird Island, and large numbers of this species breed in broad-leaved trees including *Pisonia*

grandis. Other seabirds have occasionally bred on the island in recent years, including *Sterna saundersii*, *Sterna bergii*, and *Sterna anaethetus* (Rocamora and Skerrett, 2001).

Table 6. Terrestrial birds and waders observed on Bird Island.

M = migrant species.

Species		Notes
<i>Bubulcus ibis</i>	cattle egret	One seen at farm, 27/3/00
<i>Charadrius mongolus</i> M	lesser sandplover	Seen in company of greater sandplover on airstrip
<i>Charadrius leschenaultii</i> M	greater sandplover	Several birds seen regularly on airstrip and beaches
<i>Charadrius hiaticula</i> M	Common ringed plover	One individual, grassland around the hotel
<i>Pluvialis fulva</i> M	Pacific golden plover	Several birds seen regularly on grassland
<i>Pluvialis squatarola</i> M	grey plover	Several birds seen regularly on grassland and beaches
<i>Numenius phaeopus</i> M	Whimbrel	Seen regularly. Group of 44 birds roosting on beach at North Point, 25/3/00
<i>Arenaria interpres</i> M	ruddy turnstone	Seen regularly, on grassland and beaches, in groups of up to 30
<i>Calidris alba</i> M	Sanderling	Several individuals seen with turnstones on southern beach, 26/3/00
<i>Calidris ferruginea</i> M	curlew sandpiper	Seen regularly, on grassland and beaches, in groups of up to 20
<i>Streptopelia picturata</i> ssp.	turtle dove	Seen occasionally in coconut woodland
<i>Geopelia striata</i>	barred ground dove	Seen regularly, especially around habitation
<i>Acridotheres tristis</i>	Common mynah	Seen regularly
<i>Foudia madagascariensis</i>	Madagascar fody	Seen regularly, especially around habitation

Table 7. Seabirds observed on Bird Island.

Species marked * are known to nest on the island.

Species		Notes
<i>Phaeton lepturus</i> *	white-tailed tropicbird	Juveniles observed March
<i>Fregata minor</i>	great frigatebird	Large mixed flock of frigatebirds (including many in juvenile plumage) seen over island 26/3/00, some apparently roosting in Casuarinas by airstrip
<i>Fregata ariel</i>	lesser frigatebird	
<i>Sterna bergii</i>	greater crested tern	Group of 10-15 with other seabirds and waders roosting on beach at North Point, 25/3/00
<i>Sterna anaethetus</i>	bridled tern	Group of 20-30 in Casuarinas by airstrip, 26/3/00
<i>Sterna fuscata</i> *	sooty tern	Birds beginning to return to their regular nesting area March
<i>Sterna albifrons/saundersi</i>	little/Saunders's tern	Group of up to 80 birds with other seabirds and waders, North Point 25/3/00
<i>Anous stolidus</i> *	brown noddy	Abundant, many with young. Nesting in coconuts and on the ground around the hotel
<i>Anous tenuirostris</i> *	lesser noddy	Many in <i>Pisonia</i> trees in woodland, some beginning to build nests
<i>Gygis alba</i> *	fairy tern	Juveniles observed March

Mammals

Three mammals were recorded on Bird Island, of which only one (house mouse *Mus domesticus*) was feral. Mice occur in semi-natural habitats on Bird Island and one dead individual was recorded. The other species were domestic pigs *Sus domesticus*, kept in covered pens, and a single domestic dog *Canis familiaris*.

A number of mammal species have occurred at Bird Island in the past but are now extinct. The only native mammals were the "Vaches Marines" after which the island was first named. Stoddart (1972) concludes that these were not dugongs but a seal species, extinct here before the 1880s. Introduced species, now extinct, include goats *Capra hircus*, rabbits *Oryctolagus cuniculus* and ship rats *Rattus rattus*. A semi-wild herd of goats was recorded by Pigott (1969). The rabbit was introduced sometime after 1979; there is no mention of the animal in the accounts by Feare (1979) or Stoddart and Fosberg (1981). Similarly, rats were also a recent introduction, probably arriving on the island in 1967 in a consignment of thatching leaves (Feare, 1979). Rats and rabbits were eradicated in 1995 (Feare, 1999a). Two cats *Felis catus* were removed at the time of rat eradication (S. Robert, *pers. comm.*).

DISCUSSION

The current vegetation and fauna of Bird Island are similar to those of the plateau of Cousin Island in the granitic Seychelles. Like Cousin, Bird Island is free of introduced mammalian predators. Although Cousin is smaller than Bird Island, it supports populations of several endangered endemic land birds of Seychelles. There are no historical records of Seychelles endemic land birds on Bird Island, probably because of the island's distance from the granitic islands of Seychelles, but also perhaps because of the sparse original vegetation.

Human activities (mainly the planting of coconuts) have helped create conditions more favourable to endemic land birds, allowing the development of woodland with the native *Pisonia grandis* once the plantation fell into disuse and the species (regarded as a weed in managed plantations) regenerated from seed spread by seabirds. Unfortunately, human activities also led to the introduction of the ant *Anoplolepis gracilipes* and the scale insect *Pulvinaria urbicola* in the late twentieth century; together these invertebrates appear to have had a severe effect upon the vegetation, with higher-order effects on species dependent upon that vegetation. *Anoplolepis* also has marked direct effects on crabs, turtle hatchlings and skinks, and nesting seabirds (Feare, 1999a).

Despite the presence of crazy ants, densities of other invertebrates were high. However, the composition of invertebrate assemblages had undoubtedly been affected by the ants, with certain taxa being excluded or confined to ant-free areas. The size of invertebrate assemblages on Bird Island and the similarity of vegetation to that of Cousin Island suggest that endemic birds (particularly those that occur on Cousin) could be introduced. However, while food availability would appear to be adequate, the establishment of birds would appear to be seriously impaired by introduced crazy ants. The ants occur throughout the woodland habitats on the island in which the birds would breed. Unless ant-proof nesting boxes could be provided, it is certain that ants would

disrupt nesting attempts. Nesting of sooty terns has already been disrupted by ants, causing them to abandon 1.5 ha of their traditional nesting colony in 1998 (Feare, 1999a).

It is possible that the present high density of crazy ants is a natural population explosion associated with the early stages of colonisation of new territory (a "boom and bust" path) as has been noted for some other species (see Williamson, 1996). If so, numbers should decline naturally until a more stable density of ants is reached (in some cases, the introduced species becomes extinct, although this appears unlikely in the case of *A. gracilipes*). A boom-and-bust pattern has been observed in the case of *A. gracilipes* on Rodrigues and Agalega, with the decline setting in 10-15 years after colonisation (Lewis *et al.*, 1976). On Mahé, a reduction in the crazy ant population has also occurred, although reasons for the decline may include control measures introduced from the 1970s to 1990s (Haines *et al.*, 1994). There is no guarantee that a similar pattern will be followed on Bird Island, where biological and physical conditions differ from those on Mahé; some native species (for example, *Pisonia*) may be lost before any reduction occurs.

CONSERVATION RECOMMENDATIONS

The first priority for conservation on Bird Island must be the eradication, or at least enhanced control, of crazy ants. Present control measures (which prevent ants from overrunning the hotel and tern colony) include clearing shrubby vegetation and the use of Cypermethrin as a direct toxicant (Feare, 1999b). This helps to maintain refugia for native reptiles and some insect species which are absent, or very rare, over the rest of the island but kills invertebrates other than ants and could present a hazard to other wildlife (including land birds). To achieve control over the island as a whole, much of the woodland vegetation of the island would probably have to be removed to allow chemical controls to be applied.

The eradication of ants would be an important conservation gain, as Bird Island is among a small number of islands in the central Seychelles free of introduced mammalian predators. If crazy ant control can be achieved, several endemic land birds could be introduced to Bird Island, including Seychelles magpie-robin *Copsychus sechellarum*, Seychelles warbler *Acrocephalus sechellarum*, and Seychelles fody *Foudia sechellarum*. Habitat management would allow larger populations of all three species to form.

Habitat management measures that should be considered include the replacement of coconut in woodland areas with native trees, particularly *Pisonia* and *Morinda*, to produce woodland similar to that of Cousin Island. Suppression of scrub and herbs within woodland areas would increase the area of foraging habitat for Seychelles magpie-robin, which prefers to feed in woodland with open ground layers (Komdeur, 1996). The control of mynahs, a potential nest predator, would aid the establishment of introduced land birds.

Appendix 1. Plant species recorded from Bird Island (excluding seagrasses)

Plants recorded in the current survey (mainly sight records) are numbered. For plants only recorded by previous authors, not in current survey, date of most recent record is given (see below). Taxonomy of dicotyledons as given by Friedmann (1994), of monocotyledons, as in Robertson (1989). Families arranged in alphabetical order.

Status: E = Endemic; N = Native; I = Introduced.

Abundance: A = Abundant (>1000 individuals observed); C = Common (100-1000 individuals observed); F = Frequent (10-100 individuals observed); Occasional (3-10 individuals observed); R = Rare (1 or 2 individuals observed).

Habitats: G = Grassland; W = Woodland; Sc = Scrub; BC = Beach Crest; Cu = Garden/farm.

Historical records (in Notes): ¹ Christensen, 1912; ² Stoddart and Fosberg, 1981; ³ Feare, 1979; ⁴ Summerhayes, 1931; ⁵ Fryer, 1910; ⁶ Procter, 1970 cited in Stoddart and Fosberg, 1981.

	Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA					
Adiantaceae					
	<i>Acrostichum aureum</i> L.	N	-	-	Recorded 1912 ¹ : in error for Denis Island?
Davalliaceae					
1	<i>Nephrolepis biserrata</i> (Sw.) Schott	N	A	W	
	<i>Nephrolepis multiflora</i> (Roxb.) Jarrett	N	-	-	Recorded 1976 ²
Polypodiaceae					
	<i>Phymatosorus scolopendria</i> (Burm. f.)	N	-	-	Recorded 1912 ¹
GYMNOSPERMAE					
Cycadaceae					
2	<i>Cycas thuarsii</i> Gaud.	I	F	Cu	Only in gardens
ANGIOSPERMAE: Dicotyledons					
Acanthaceae					
3	<i>Asystasia</i> sp. B (<i>sensu</i> Friedmann)	?I	F	Sc, W	
	<i>Asystasia multiflora</i> Kl.	?	-	-	Last recorded 1976 ² . Same as <i>A. sp. B</i> ?
	<i>Asystasia gangetica</i> (L.) T. Anders.	?	-	-	Last recorded 1977 ³ . Same as <i>A. sp. B</i> ?
4	<i>Pseuderanthemum carruthersii</i> (Seem.) Guillaumin	I	F	Cu	Only in gardens
Amaranthaceae					
5	<i>Achyranthes aspera</i> (L.) DC.	I	A	W	
6	<i>Alternanthera ?tenella</i> Colla.	I	F	Cu	Only in gardens
	<i>Amaranthus caudatus</i> L.	I	-	-	Recorded 1931 ⁴ . Now extinct?
7	<i>Amaranthus dubius</i> Mart. ex Thell.	I	A	G, W	
	<i>Amaranthus lividus</i> L.	I	-	-	Recorded 1977 ³ (as <i>A. oleraceus</i> L.). = <i>A. dubius</i> ?
8	<i>Gomphrena globosa</i> L.	I	F	Cu	Only in gardens
Annonaceae					
9	<i>Annona reticulata</i> L.	I	R	Cu	Only in gardens (at farm)
Apocynaceae					
10	<i>Catharanthus roseus</i> (L.) G. Don.	I	O	W, Cu	

	Species	Status	Abund.	Habitats	Notes
11	<i>Nerium oleander</i> L.	I	R	Cu	Only in gardens
12	<i>Ochrosia oppositifolia</i> (L.) K. Schum.	N	R	W, Cu	
13	<i>Plumeria rubra</i> L.	I	R	Cu	Only in gardens
Araliaceae					
14	<i>Polyscias</i> sp.	I	R	Cu	Only in gardens
Balsaminaceae					
15	<i>Impatiens balsamina</i> L.	I	R	Cu	Only in gardens
Bignoniaceae					
16	<i>Tabebuia pallida</i> (Lindl.) Miers.	I	O	Cu, G	
Boraginaceae					
17	<i>Cordia sebestena</i> L.	I	C	W, Cu	
18	<i>Cordia subcordata</i> Lam.	N	C	BC, W	
19	<i>Tournefortia argentea</i> L. f.	N	C	BC	
Caesalpiniaceae					
	<i>Caesalpinia bonduc</i> (L.) Roxb.	N	-	-	Recorded 1910 ⁵ : extinct?
20	<i>Caesalpinia pulcherrima</i> (L.) Sw.	I	O	Cu	
21	<i>Senna occidentalis</i> (L.) Link	I	C	G	
Capparidaceae					
22	<i>Cleome gynandra</i> L.	I	C	G, Cu	
	<i>Cleome viscosa</i> L.	I	-	-	Recorded 1977 ³ : overlooked in this survey?
Caricaceae					
23	<i>Carica papaya</i> L.	I	A	W, Sc	
Casuarinaceae					
24	<i>Casuarina equisetifolia</i> J. R. & G. Foster	I	A	BC, W, G	
Combretaceae					
25	<i>Terminalia catappa</i> L.	?N	A	W, Sc	
Compositae					
26	<i>Coreopsis lanceolata</i> L.	I	C	Cu	Only in gardens
27	<i>Dendranthema</i> sp. cultivar	I	R	Cu	Only in gardens
28	<i>Lactuca sativa</i> L. cultivar	I	C	Cu	Only in gardens
29	<i>Tagetes patula</i> L. cultivar	I	O	Cu	Only in gardens
30	<i>Vernonia cinerea</i> (L.) Less.	I	A	G	
31	<i>Zinnia</i> sp. cultivar	I	O	Cu	Only in gardens
Convulvulaceae					
	<i>Ipomoea batatas</i> (L.) Lam.	I	-	-	Recorded 1931 ⁴ .
32	<i>Ipomoea macrantha</i> Roem. et Schult.	N	A	BC, W	
33	<i>Ipomoea pes-caprae</i> (L.) R. Br.	N	C	BC	
Crassulaceae					
34	<i>Kalanchoe pinnata</i> (Lam.) Pers.	I	A	W	
Cruciferae					
35	<i>Brassica chinensis</i> L.	I	C	Cu	Only in gardens
Cucurbitaceae					
	<i>Cucurbita</i> sp	I	-	-	Recorded 1976 ² . Intermittent cultivation?
	<i>Cucurbita</i> cf. <i>maxima</i> Duchesne	I	-	-	Recorded 1976 ² . Intermittent cultivation?
	<i>Cucurbita moschata</i> Duchesne	I	-	-	Recorded 1977 ³ . Intermittent cultivation?
36	<i>Trichosanthes cucumerina</i> L.	I	F	W	
Euphorbiaceae					
37	<i>Acalypha indica</i> L.	I	A	G	
38	<i>Acalypha wilkesiana</i> Muell. Arg.	I	F	Cu, W	

	Species	Status	Abund.	Habitats	Notes
39	<i>Codiaeum variegatum</i> L.	I	F	Cu	Only in gardens
	<i>Euphorbia cyathophora</i> Murr.	I	-	-	Recorded 1931 ⁴ , in error for Denis Island?
40	<i>Euphorbia hirta</i> L.	I	A	G	
	<i>Euphorbia prostrata</i> Ait	I	-	-	Recorded 1977 ³ . = <i>E. thymifolia</i> ?
41	<i>Euphorbia thymifolia</i> L.	I	A	G	
42	<i>Euphorbia tirucalli</i> L.	I	R	Cu	Only in gardens
43	<i>Jatropha pandurifolia</i> L.	I	O	Cu	Only in gardens
	<i>Pedilanthus tithymaloides</i> (L.) Poit.	I	-	-	Recorded 1976 ² . Overlooked this survey?
44	<i>Phyllanthus amarus</i> Schumach. & Thonn.	I	A	G	
45	<i>Phyllanthus maderaspatensis</i> L.	I	A	G, Sc	
46	<i>Phyllanthus pervilleanus</i> (Baillon) Müll. Arg.	N	A	W, Sc	
47	<i>Ricinus communis</i> L.	I	C	W, Sc	
	Goodeniaceae				
48	<i>Scaevola sericea</i> Vahl	N	A	BC, Sc	
	Guttiferae				
49	<i>Calophyllum inophyllum</i> L.	N	O	Cu, G	Trees recently planted
	Hernandiaceae				
	<i>Hernandia nymphaeifolia</i> (Presl) Kubitzki	N	-	-	Recorded 1910 ⁵ (as <i>H. sonora</i> L.): extinct.
	Labiatae				
	<i>Plectranthus</i> sp.	I	-	-	Recorded 1976 ²
50	<i>Solenostemon</i> sp. cultivar	I	O	Cu	Only in gardens
	Lauraceae				
51	<i>Cassythea filiformis</i> L.	N	A	BC, Sc	
	Lecythidaceae				
52	<i>Barringtonia asiatica</i> (L.) Kurtz	N	O	Cu	
	Lythraceae				
	<i>Pemphis acidula</i> Forst.	?	-	-	Recorded (in error?) 1931 ⁴
	Malvaceae				
53	<i>Abutilon indicum</i> (L.) Sweet	?I	C	W, Sc	
54	<i>Gossypium hirsutum</i>	I	C	W, Sc	
55	<i>Malvastrum coromandelianum</i> (L.) Garcke	I	A	W	
56	<i>Sida acuta</i> Burm. f.	I	O	W	
	<i>Sida pusilla</i> Cav.	N	-	-	Recorded 1976 ² (as <i>S. parvifolia</i> DC): overlooked in this survey?
57	<i>Thespesia populnea</i> (L.) Soland. ex Correa	N	F	BC, W	
	Moraceae				
58	<i>Artocarpus altilis</i> (Parkins.) Fosb.	I	R	W	
	<i>Ficus benghalensis</i> L.	I	-	-	Recorded 1976 ² : Extinct?
59	<i>Ficus ?benjamina</i> L.	I	R	Cu	Only in gardens
	<i>Ficus lutea</i> Vahl	N	-	-	Recorded 1976 ² (as <i>F. nautarum</i> Baker): Extinct?
	Moringaceae				
60	<i>Moringa oleifera</i> Lam.	I	F	Cu, Sc	
	Myrtaceae				
61	<i>Syzygium samarangense</i> (Bl.) Merr. & Perry	I	R	Cu	

	Species	Status	Abund.	Habitats	Notes
Nyctaginaceae					
62	<i>Boerhavia repens</i> L.	?N	A	G	
	<i>Boerhavia diffusa</i> L. (<i>sensu lato</i>)	?	-	-	Recorded 1910 ⁵ . = <i>B. repens</i> ?
63	<i>Bougainvillea</i> sp. cultivars	I	O	Cu	Only in gardens
	<i>Mirabilis jalapa</i> L.	I	-	-	Recorded 1976 ² , 1977 ³ . Overlooked in this survey?
64	<i>Pisonia grandis</i> R. Br.	N	A	W	
Papilionaceae					
65	? <i>Canavalia</i> sp.	?	C	BC	
66	<i>Sesbania</i> ? <i>sericea</i> (Willd.) Link	I	F	W, Sc	
Passifloraceae					
67	<i>Passiflora edulis</i> Sims	I	O	W	
68	<i>Passiflora suberosa</i> L.	I	A	W, Sc	
Portulacaceae					
69	<i>Portulaca grandiflora</i> Hook	I	O	Cu	Only in gardens
70	<i>Portulaca oleracea</i> L.	N	A	G, BC	
Rubiaceae					
71	<i>Guettarda speciosa</i> L.	N	F	BC	
	<i>Morinda citrifolia</i> L.	?I	-	-	Recorded 1910 ⁵ : extinct?
Sapindaceae					
	<i>Cardiosperma halicacabum</i> L.	?N	-	-	Recorded 1910 ⁵ : extinct?
Scrophulariaceae					
	<i>Striga asiatica</i> (L.) G. Ktze.	?I	-	-	Recorded 1910 ⁵ : extinct?
Solanaceae					
72	<i>Capsicum frutescens</i> L.	I	F	Cu	Only in gardens
	<i>Nicotiana tabacum</i> L.	I	-	-	Recorded 1910 ⁵ : extinct
73	<i>Solanum americanum</i> Mill.	I	O	G	
74	<i>Solanum lycopersicum</i> L.	I	O	Cu	Only in gardens
75	<i>Solanum melongena</i> L.	I	F	Cu	Only in gardens
Surianaceae					
76	<i>Suriana maritima</i> L.	N	A	BC	
Turneraceae					
77	<i>Turnera angustifolia</i> Miller	I	F	W, Sc	
Verbenaceae					
78	<i>Phyla nodiflora</i> (L.) Greene	I	A	G	
79	<i>Stachytarpheta jamaicensis</i> (L.) Vahl.	I	C	G, Sc	
80	<i>Stachytarpheta urticifolia</i> Sims	I	O	G, Sc	
Zygophyllaceae					
81	<i>Tribulus cistoides</i> L.	?I	F	G	
ANGIOSPERMAE: Monotyledons					
Agavaceae					
	<i>Agave rigida</i> Northrop var. <i>sisalana</i> Perr. Ex Engelm.	I	-	-	Recorded 1976 ² , 1977 ³
82	<i>Agave/Yucca</i> sp.	I	O	Cu	Only in gardens
Amaryllidaceae					
83	? <i>Hymenocallis littoralis</i> (Jacq.) Salisb.	?I	R	G	
84	<i>Zephyranthes</i> sp.	I	F	Cu	Only in gardens
Araceae					
85	<i>Alocasia macrorrhiza</i> (L.) G. Don.	I	A	W	
	<i>Colocasia esculenta</i> (L.) Schott	I	-	-	Recorded 1976 ² : extinct?
Commelinaceae					
86	<i>Tradescantia spathacea</i> Swartz.	I	F	Cu	Only in gardens

	Species	Status	Abund.	Habitats	Notes
Cyperaceae					
87	<i>Cyperus conglomeratus</i> Rottb.	N	F	BC	
88	<i>Cyperus ?rotundus</i> L.	?	A	G	
89	<i>Mariscus dubius</i> (Rottb.) Fischer	N	C	W, Sc	
90	<i>Mariscus ligularis</i> (L.) Urb.	?N	C	G	
Gramineae					
91	<i>Cymbopogon</i> sp.	I	F	Cu	Planted at farm
92	<i>Cynodon dactylon</i> (L.) Pers.	?	A	G, BC	
93	<i>Dactyloctenium ctenoides</i> (Steud.) Bosser	?	A	G, BC	
94	<i>Digitaria</i> sp. (<i>D. ?horizontalis</i>)	?	C	W	
95	<i>Eleusine indica</i> (L.) Gaertn.	?	A	G, Sc	
96	<i>Enteropogon ?sechellensis</i> (Baker) Dur. & Schinz	N	A	G	
	<i>Enteropogon monostachyum</i> K. Schum. ex Engl.	?	-	-	Recorded 1976 ²
97	<i>Eragrostis tenella</i> (L.) P. Beuv.	?	A	G	
	<i>Eragrostis tenella</i> var. <i>insularis</i> Hubb.	?	-	-	Recorded 1941
98	<i>Eragrostis ?subaequiglumis</i> Renvoize	?	A	G	
99	<i>Lepturus ?radicans</i> (Steud.) Camus	?	A	W	
	<i>Lepturus repens</i> (Forst.) R. Br.	?	-	-	Recorded 1931 ⁴
100	<i>Panicum repens</i> L.	?	F	Sc	
	<i>Pennisetum polystachyon</i> (L.) Schult.	?	-	-	Recorded 1931 ⁴
101	<i>Pennisetum</i> sp. (purple)	?I	C	Cu	Only in gardens
102	<i>Saccharum officinarum</i> L.	I	R	Cu	Only in gardens
	<i>Sporobolus virginicus</i> (L.) Kunth.	N	-	-	Recorded 1970 ⁶
	<i>Stenotaphrum micranthum</i> (Des.) C. E. Hubb.	?	-	-	Recorded 1976 ²
Liliaceae					
	<i>Crinum</i> sp.	?I	-	-	Recorded 1976 ² . = <i>Hymenocallis littoralis</i> ?
Marantaceae					
	<i>Maranta arundinacea</i> L.	I	-	-	Recorded 1970 ⁶
Musaceae					
	<i>Musa sapientum</i> L.	I	-	-	Recorded 1976 ²
Orchidaceae					
103	<i>Dendrobium</i> sp.	I	O	Cu	Only in gardens
Palmae					
104	<i>Cocos nucifera</i> L.	N	A	G, W, Sc, BC	
Pandanaeae					
105	<i>Pandanus sanderi</i> Hort.	I	C	Cu	Only in gardens
Typhaceae					
	<i>Typha javanica</i> Schnizl ex Rohrb.	N	-	-	Recorded 1931 ⁴ : in error for Denis Island?



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