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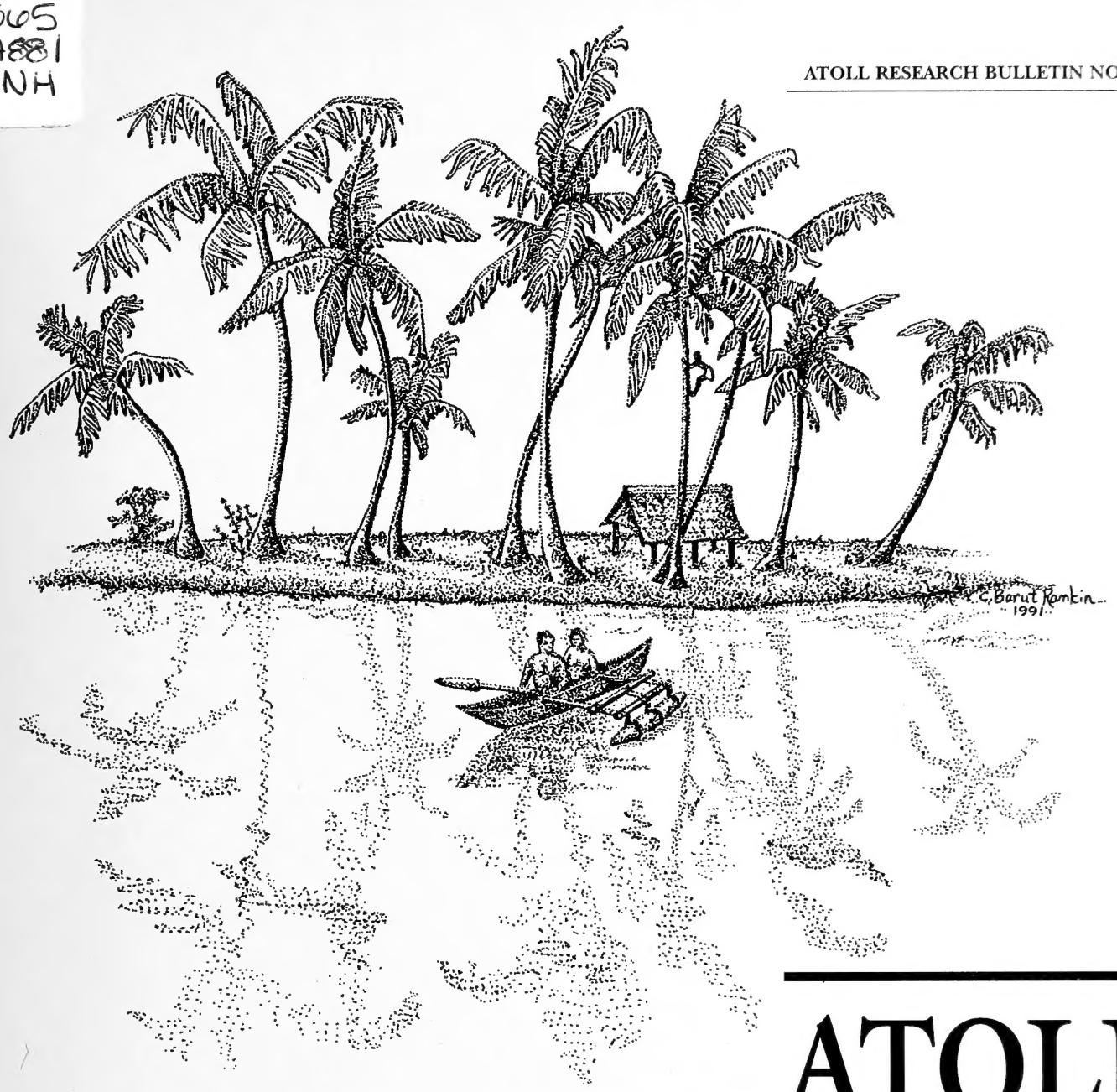

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BIODIVERSITY SURVEYS AND CONSERVATION POTENTIAL OF INNER SEYCHELLES ISLANDS

Edited by
MICHAEL J. HILL

Issued by

NATIONAL MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C. U.S.A.
JULY 2002

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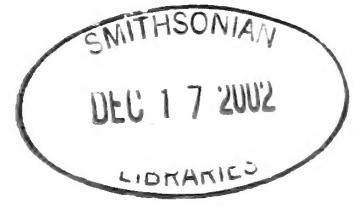

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ACKNOWLEDGMENT

The Atoll Research Bulletin is issued by the Smithsonian Institution to provide an outlet for information on the biota of tropical islands and reefs and on the environment that supports the biota. The Bulletin is supported by the National Museum of Natural History and is produced by the Smithsonian Press. This issue was financed by Nature Seychelles(formerly BirdLife Seychelles)and distributed with funds from Atoll Research Bulletin readers and authors.

The Bulletin was founded in 1951 and the first 117 numbers were issued by the Pacific Science Board, National Academy of Sciences, with financial support from the Office of Naval Research. Its pages were devoted largely to reports resulting from the Pacific Science Board's Coral Atoll Program.

Articles submitted for publication in the Atoll Research Bulletin should be original papers in a format similar to that found in recent issues of the Bulletin. First drafts of manuscripts should be typewritten double spaced and can be sent to any of the editors. After the manuscript has been reviewed and accepted, the author will be provided with a page format with which to prepare a single-spaced camera-ready copy of the manuscript.

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Aerial views of islands in the inner Seychelles: *Upper:* Granitic islands; Cousin and Cousine. *Lower:* Bird, a coralline island on the edge of the Seychelles Bank.

PREFACE

The Republic of Seychelles is made up of 115 islands spread over an Exclusive Economic Zone (EEZ) of 1,374,000 km^2 (99.97% of which is sea) in the western Indian Ocean. The islands fall into three main groups, each with a different geological character: the central or inner islands (actually the northernmost group), most of which are predominantly granitic; the low-lying sand cays of the Amirantes and Farquhar to the South; and the raised limestone islands of the Aldabra group (Aldabra and Cosmoledo atolls, Astove and Assumption) and St Pierre. Aldabra is closer to Madagascar (450 km away) than it is to the granitic islands (Mahé is around 1,150 km away). The inner islands and Aldabra atoll support a fauna and flora rich in endemic forms (because of the distance between the groups, few endemics are shared). Both sites have been recognised as 'Endemic Bird Areas' by BirdLife International.

Aldabra atoll (which makes up approximately a third of the land area of the Seychelles) is a World Heritage Site, with a tiny human population employed by the Seychelles Island Foundation in the conservation of the site. Because of the remote and relatively inhospitable nature of the atoll, it has never been permanently settled and exploitation has been less intensive than in the other island groups of the nation. In contrast, the inner Seychelles islands were settled in 1770 and now support around 80,000 people (on a total land area of 232 km^2). In the past 230 years the inner islands have seen extensive habitat change with the conversion of coastal forests to coconut plantation and loss of mangroves and hill forests for timber, fuel, and the production of cinnamon. Although vertebrate extinctions appear to have been minimal when compared to other remote archipelagos, eight bird species of the granitic islands are today listed as globally threatened.

Plantation agriculture in the Seychelles has through much of its history been only marginally profitable, primarily due to poor transport links with markets and the small scale of production. In the late twentieth century, falling world copra prices led to the abandonment of many plantations and the largest sectors of the economy today are fish processing for export and the tourist trade. In Seychelles, the low-volume, high-value tourist market is based on the apparently unspoilt environment of the islands and there is undoubtedly potential for ecotourism, already developed on islands such as Cousin and Bird. Ecotourism may in turn provide opportunities for increasing the amount of land devoted to conservation in Seychelles through active management of tourist islands, although it should not be seen as a panacea; on small islands, even low-volume tourism can have significant environmental impacts, and very few tourists actually make the long journey to Seychelles to observe the endemic wildlife.

Economic changes in Seychelles have coincided with a period of increased concern for the environment and flagship species in particular; today, further human-induced extinctions of Seychelles endemic vertebrates seem unlikely. The Seychelles Magpie Robin Recovery Programme initiated by Nature Seychelles in 1990 is a good example of long-term commitment that has led to a major increase in population and range of this endangered bird. However, the intense pressure of development and stochastic events, such as the introduction of novel alien species, are real threats to habitats and endemic species in Seychelles.

The work described in this volume was carried out as part of the project 'Management of Avian Ecosystems in Seychelles', funded by the Global Environment Fund through the World Bank and implemented by Nature Seychelles. The aim of the island assessment programme was to survey a range of medium-sized islands in the inner Seychelles in order to assess their current biodiversity value and potential to support endangered endemic vertebrates, particularly birds. The standardised survey methods were carried out on 10 islands (of 40 in the island group), making this the most extensive such survey in the Seychelles since the early twentieth century when expeditions in 1905 (the Percy Sladen expedition) and 1908 (led by J. Stanley Gardiner) contributed greatly to the understanding of the flora and fauna of Seychelles (although the objectives of these expeditions were largely taxonomic).

The collection of papers in this volume presents the results of the island assessments. The first chapter gives a summary of the methods used and provides further background to the project. In the following chapters, each island is treated in turn, with data on the biodiversity of each island, in addition to its historical and geographical context, and conservation recommendations to enhance its biodiversity value. In a final summary chapter, the potential importance of each to conservation of Seychelles endemic vertebrates is discussed.

Michael J Hill
Nature Seychelles (formerly BirdLife Seychelles)
May 2002

ACKNOWLEDGEMENTS

The island assessment work described in this volume was carried out as part of the World Bank-Global Environment Facility (GEF)-funded project, *Management of Avian Ecosystems in Seychelles,* coordinated by Nature Seychelles.

We would like to thank the owners and managers of all islands visited for their permission for the work, and in many cases active assistance in the fieldwork. In particular: Bird Island Lodge, Serge Robert (Bird Island); Marine Parks Authority Seychelles, Kevin Hoareau (Curieuse Island); Denis Island Development Company and Mason's Travel (Denis Island); North Island Ltd., Richard Slater-Jones and Mark Coetzee (North Island). The Marine Parks Authority of Seychelles provided transport to Conception, Curieuse, and Thérèse.

Fieldwork was carried out by a team of four to six people, and on each island the core team of three was joined by several workers, most from the Seychelles Ministry of Environment and Transport, the Ministry of Culture or Nature Seychelles. These included: Pierre-André Adam, Eugene Annacoura, Majella Athanase, Terence Athanase, Allain Camille, Perley Constance, Laura Davis, Marcel Dufrène, Joseph Francois, Barbara Hoareau, Camille Hoareau, Marline Isodore, Terry Jules, Victorin Laboudallon, Allan Marguerite, Charles Morel, Roland Nolin, George Ravinia, Dr Gerard Rocamora, Andy Roucou, Roland Tambarra, Jose Tirant, Terence Valentine, and Roy Youpa. The work described in this volume would have been impossible without the assistance of these field workers.

We would also like to thank those at Nature Seychelles who provided invaluable logistic support, including Dave Currie, Kerstin Henri and James Millett. The National Archives and Museums (Ministry of Culture and Information, Seychelles), provided historical records, the National Meteorological Services (Ministry of Environment and Transport, Seychelles) gave access to unpublished weather data, and the Geographical Information Systems (GIS) section of the Ministry of Land Use and Habitat provided recent aerial photographs of the islands. Maps for these reports were prepared by Rishabh Jivan.

Specimens collected in the course of fieldwork were identified by John Noyes of the Natural History Museum, London (wasps), Michael Saaristo of the Zoological Museum, University of Turku (spiders), Pat Matyot (beetles, Orthoptera, phasmids) and Gillian Watson of Commonwealth Agriculture Bureau (CABI: soft bugs).

A number of people contributed to the development of island assessment methods and assisted with the preparation of these reports, including Clive Hambler (Oxford University), Don Merton (Department of Conservation, New Zealand), James Millett and Steve Parr (Nature Seychelles). The authors would also like to thank David Stoddart, Ian Macintyre, Roger Clapp, Wayne Mathis and George Zug for comments on the manuscript.

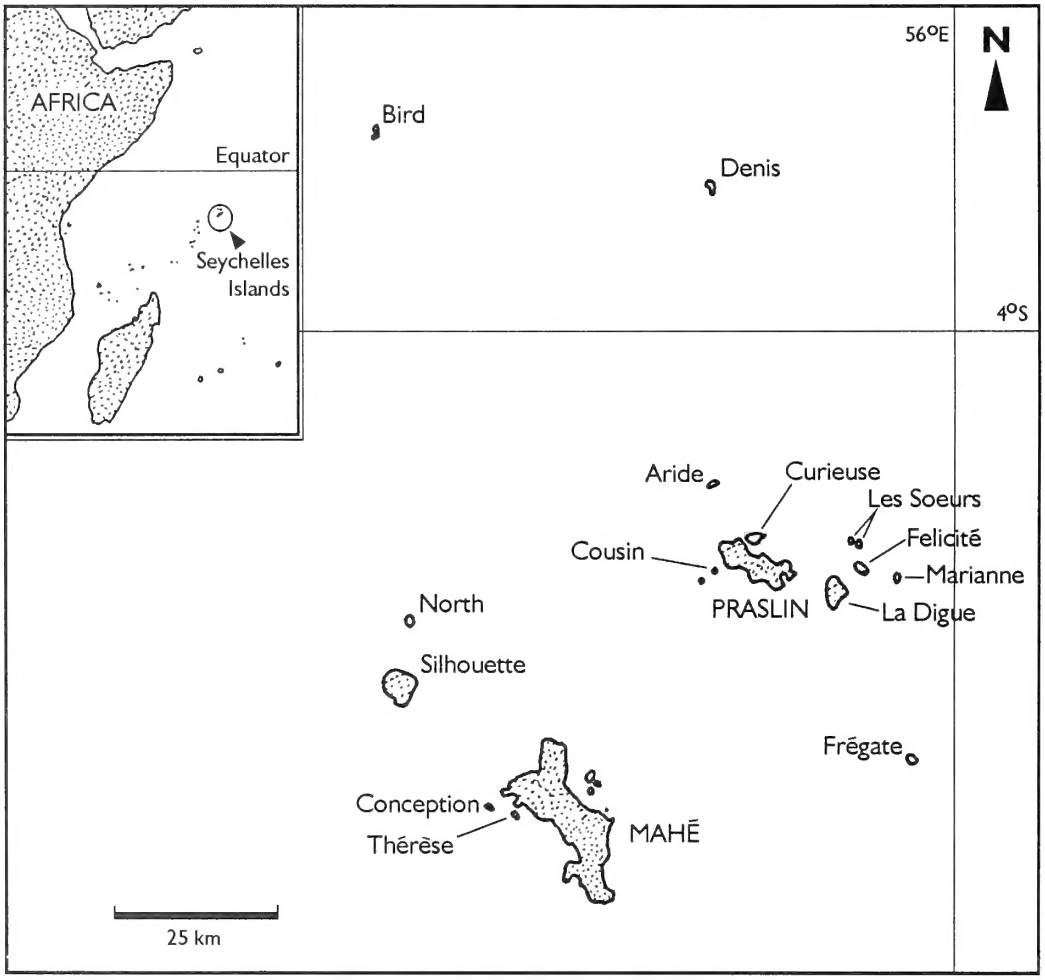

Figure 1. The central Seychelles.

INTRODUCTION AND METHODS

BY

MICHAEL J. HILL[1], TERENCE M. VEL[1], KATHRYN J. HOLM[2], and NIRMAL J. SHAH[1]

ABSTRACT

The central Seychelles islands support 12 species of endemic land birds, eight of which are regarded as globally threatened. As part of a project to evaluate the islands' potential to support translocated populations of endemic birds, biological surveys were carried out on 10 of the islands ranging from 28 to 286 ha in size. This paper describes the background of the project and the aims and methods of the island assessment survey, the results of which are presented by island in later chapters.

INTRODUCTION

The central Seychelles (Fig. 1) comprises a group of around 40 granitic islands (and two outlying coralline islands) situated approximately 1,600 km from East Africa and 1,700 km from India (Stoddart, 1984). The flora and fauna are derived from the Oriental and African regions but show a high degree of endemicity: Scott (1933) estimated that 51% of the insect fauna were endemic. There are about 76 extant endemic plant species (Carlström, 1996a), which comprise around 9% of the total flora (Procter, 1984). The islands also support a number of endemic land birds (12 extant taxa: see Table 1), and have been classified as an Endemic Bird Area (EBA), one of 218 such regions of global importance for their endemic bird species (Stattersfield *et al.*, 1998).

In common with most oceanic archipelagos, the granitic Seychelles has no native terrestrial mammals, the only non-marine mammals being two endemic species of bat (Racey and Nicoll, 1984). Since human settlement of the islands in 1770, habitat destruction and the introduction of alien animals and plants have lead to the complete extinction of at least three endemic bird taxa and the loss of many island populations (Diamond, 1984).

On smaller islands, habitat destruction accelerated in the nineteenth and early twentieth centuries with the expansion of coconut plantations. Many islands became devoted to the production of coconut together with a few other cash crop species. A few smaller or remote granitic islands remained predator-free despite conversion to plantation agriculture, and these islands offered refugia for endangered endemic avian species lost on other islands. As a result, species such as the Seychelles warbler *Acrocephalus*

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sechellensis, Seychelles fody *Foudia sechellarum*, and Seychelles magpie-robin *Copsychus sechellarum* are today found on a few small islands. These three species, together with five other endemic birds, are regarded as globally threatened (Stattersfield *et al.,* 1998). Several of these species have, at some stage, been reduced to single island populations (the Seychelles warbler on Cousin, magpie-robin on Frégate, black paradise flycatcher on La Digue, and scops owl on Mahé). Such small, isolated populations are vulnerable to extinction through stochastic events (Simberloff, 1998), especially when island refugia are small. In such cases, translocation to establish new populations is an important conservation tool.

Table 1. Endemic land bird taxa of the granitic Seychelles.

Scientific name	English name	Pop. Estimate (individuals)[1]	No. of islands[2]	Status[3]
Coracopsis nigra barklyi	black parrot	200-300	2	-
Copsychus sechellarum	Seychelles magpie-robin	85	4	Critical
Terpsiphone corvina	Seychelles black paradise flycatcher	150-200	2	Critical
Otus insularis	Seychelles scops owl	180-360	1	Critical
Zosterops modestus	Seychelles white-eye	280-380	3*	Critical
Falco araea	Seychelles kestrel	*c.* 900	7	Vulnerable
Collocalia elaphra	Seychelles swiftlet	2,500 – 3,000	3	Vulnerable
Acrocephalus sechellensis	Seychelles warbler	2,100	3	Vulnerable
Foudia sechellarum	Seychelles fody	3,260	3	Vulnerable
Alectroenas pulcherrima	Seychelles blue pigeon	> 3,000 pairs	14+	Least Concern
Hypsipetes crassirostris	Seychelles bulbul	> 7,000 pairs	5	Least Concern
Nectarinia dussumieri	Seychelles sunbird	> 8,000 pairs	15+	Least Concern

[1] Population estimates for seven endangered endemics from species action plans (Shah and Nevill, 2002), Seychelles white-eye and black parrot from Skerrett *et al.* (2001); other species from Rocamora (pers. comm.). Estimates for "Least Concern" species are pairs, all other species individuals.

[2] Only islands in the central Seychelles considered: Seychelles fody is also present (as naturalised population) on one outer coralline island.

[3] Global conservation status from BirdLife International (2000).

* Seychelles white-eye recently (2001) introduced to Frégate Island, previously restricted to Mahé and Conception (Rocamora *et al.* in press).

Recent economic changes and developments in the field of wildlife management have allowed an improvement in the status of several species of Seychelles endemic birds. In the late twentieth century, many plantations became uneconomic and were no longer maintained. Two small islands (Cousin and Aride) were purchased and dedicated entirely to conservation. Cats had previously been present on Aride but were eliminated in the 1920s or 30s (Warman and Todd, 1984); Cousin had no alien mammals apart from the black-necked hare *Lepus nigricollis* introduced in the early twentieth century (Racey and Nicoll, 1984). Inter-island transfers of some of the most endangered bird species have led to encouraging results. Following the eradication of cats on Cousine and habitat restoration on Cousine and Aride, the Seychelles warbler has successfully been established on both islands (from Cousin: Komdeur *et al.,* 1995) and the Seychelles magpie-robin has been successfully translocated to Cousin and Cousine (from Frégate: Parr *et al.,* 2000).

In recent years both rats and cats have been eradicated on several islands, including Bird Island (black rats eradicated 1996: Feare, 1999a), Frégate (Norway rats eradicated 2000) and Denis and Curieuse (cats eradicated 2000/2001). The eradication of alien predators and regeneration of broadleaf woodland and scrub in former coconut plantations should facilitate the translocation of endangered endemic bird species to new islands and the establishment of further populations. It was with this opportunity in mind that the project *Management of Avian Ecosystems in Seychelles* was designed, and implemented from 1999. As part of this project an island assessment process was carried out, which involved biological surveys of a selected range of islands in the central Seychelles from 29 ha (Cousin) to 286 ha (Curieuse). The primary aim of the survey was to assess the potential of a number of islands for habitat restoration and the translocation of endangered endemic land birds, in particular five globally threatened species known to survive on relatively small islands: the Seychelles magpie-robin, Seychelles white-eye, Seychelles black paradise flycatcher, Seychelles warbler and Seychelles fody.

For most islands surveyed, assessment visits were carried out in both major seasons, the drier southeast (SE: usually between June and August or September) and the wet northwest monsoon period (NW: approximately November to April). This allowed seasonal differences in (for example) invertebrate activity and freshwater wetlands to be taken into account.

This volume is based on the assessment of biological factors on each of the islands visited, describing each island in turn and including a summary chapter on the comparative values of each island for conservation.

ISLAND SELECTION

Not all of the 40 granitic islands could be visited in this survey: effort was directed at a smaller number of islands. The initial selection was made on the basis of island size, human population, and land ownership. All the central Seychelles islands are relatively small and within the group, both the smallest and largest were identified as having particular disadvantages. The smallest islands (under 20 ha) were rejected because (in most cases) they would only support small populations of endemic land birds, leaving populations vulnerable to stochastic extinctions. Of 43 named islands, 22 are under 20 ha (and 20 of these under 10 ha). Large islands (over 500 ha), while they support a high diversity of habitats and have great conservation potential, also have a number of disadvantages: most have large human populations with associated introduced animal species, and multiple ownership which complicates management. The only large island under single ownership (of four islands > 500 ha) is Silhouette (1,995 ha). Using size criteria, a list of 18 islands was produced. Of these, several inaccessible islands were not visited, and others (for example, islands in the Ste Anne Marine Park off Mahé with restricted access or multiple ownership) were also excluded from the survey. A total of 10 islands were included in the final study and a further island (Frégate) was also the subject of a short assessment visit. For each of the 10 islands studied, a short report is included in this volume.

METHODS

The islands listed in Table 2 were each visited at least once during the survey period. While temperature and humidity vary little through the year, rainfall is seasonal in the central Seychelles islands: dry months between about May and October are dominated by the SE trade winds. The rainy season (NW monsoon) lasts from November to April (Walsh, 1984).

Variations in rainfall (especially, the water stress of the driest months) are likely to have a profound effect on invertebrates (McCulloch and Norris, 1997) and plants in particular. Thus, two sampling periods were carried out, the first predominantly in the dry SE season and the second in the NW monsoon. Most islands were visited twice, once in each season.

Table 2. Islands studied and dates of survey.
(Island names generally follow map DOS 604: Seychelles, produced by the UK Directorate of Overseas Surveys in 1983, with the exception of Île aux Vaches, now generally known as Bird Island, and Île du Nord, North Island).

Island	Area (ha)	Geology	Survey time (days)	Survey dates	
				SE season	NW season
Curieuse	285	Granitic	23	2/8 - 14/8/99	5/1 - 18/1/00
Félicité	268	Granitic	6	8/11 - 14/11/99	-
North	210	Granitic	17	19/8 - 29/8/99	24/1 - 3/2/00
Denis	143	Sand cay	17	3/10 - 13/10/99	4/4 - 13/4/00
Bird	101	Sand cay	6	-	21/3 - 27/3/00
Marianne	95	Granitic	16	18/10 - 28/10/99	6/3 - 14/3/00
Grande Soeur	84	Granitic	9	17/7 - 27/7/99	-
Thérèse	74	Granitic	15	6/9 - 15/9/99	7/2 - 15/2/00
Conception	60	Granitic	15	22/9 - 28/9/99	21/2 - 28/2/00
Cousin	29	Granitic	16	14/6 - 25/6/99	1/12 - 8/12/99

For each island, vegetation and physical maps were produced using data from a variety of sources. Physical data came from existing physical maps (prepared by the UK Directorate of Overseas Surveys and the Seychelles Government; Series Y851[DOS 204]). Vegetation maps were prepared using field observations and data from recent (1998) colour aerial photographs of the islands (provided by the Ministry of Land Use and Habitat, Seychelles Government, for all islands except Thérèse).

Vegetation maps were based on a simple classification of habitats according to topography (whether on coastal lowland or "plateau", or granite hill >10 m above sea level) and the dominant plant forms and species. Major habitats included beach crest scrub (native), coconut plantations, plateau woodland (native or exotic), hill woodland (native or exotic), hill scrub (native or exotic) and vegetation of open, rocky places (locally known as "glacis"). Inhabited islands often had significant areas of open grassland and gardens.

Of these habitats, those of greatest importance to Seychelles endemic birds are woodland and scrub; many of the endemic species are particularly associated with woodland while anthropogenic habitats are more heavily utilised by introduced bird

species. In order to measure island quality for endemic birds, further sampling of vegetation and invertebrate numbers was carried out concentrated in woodland and scrub areas. Using the vegetation map for each island, random point locations were found within woodland/scrub habitats (15-20 points on each island visit). At each point, vegetation and invertebrate survey techniques were applied within a 10 m x 10 m plot.

Vegetation Survey

A number of measures were recorded to provide details of the structural and biological diversity of vegetation within each 10 m x 10 m plot. Only flowering plants and ferns were recorded; algae, lichens and mosses were excluded. Vegetation was recorded in three strata: canopy (woody plants and palms over 5m tall), shrub (woody plants and palms less than 5 m tall), and herb layers (herbaceous plants and seedlings under 0.5 m tall). In the canopy layer all individual plants were identified and height and DBH (Diameter at Breast Height: 1.3 m above ground) recorded. In the shrub and herb layers, all species present were recorded, and the percentage cover of each within the layer estimated. In addition, for the herb layer the percentage of the 10 m x 10 m plot with no vegetation was estimated. A measure of the quantity of dead wood (tree stumps, standing and fallen dead wood) was made for each plot.

Invertebrate Survey

Within each plot the following measures of invertebrate abundance were carried out: pitfall trapping, leaf insect counts, beating and sweeping. In a subset of plots, Malaise trapping was used. Pitfall traps were made of plastic cups with a diameter of 7 cm at the mouth. Traps were set about 2 m apart on a diagonal line across the plot and each trap was given a 'lid' of wire mesh (approx. mesh gauge 1.5 cm) to exclude land hermit crabs. Ethylene glycol was used as a preservative. Traps were in place for three nights, after which the invertebrate catch was preserved in 70% ethanol. Invertebrates were later counted and sorted to species or morphospecies.

Leaf-insect counts were developed as a measure of food supply for the insectivorous Seychelles warbler which mainly feeds by gleaning from the underside of leaves (Komdeur, 1994). Counts were made at, or around, each plot for each of the four most abundant tree species at the plot. For each tree species, five trees were selected. On each of the five trees invertebrates were counted on the underside of 10 leaves. Invertebrates were classified to order, suborder or family. In addition, two leaves were removed from each tree sampled in order to estimate the mean leaf size for each tree species. Leaf sizes were used to calculate the density of invertebrates per square metre of leaf. Since insect activity varies with time of day, temperature etc., counts were completed between 8 a. m. and 11 a. m. No invertebrate specimens were collected.

Beating and sweep-sampling were used to collect invertebrate specimens on abundant tree species and in herbaceous vegetation within the plot. Methods were standardised to ensure that sampling effort was standardised between plots and islands (see Hill, 2001).

Flight-intercept (Malaise) traps were used to collect flying invertebrates. Ethanol (70%) was used as a preservative in trap heads and the traps left in place for three nights.

All invertebrate specimens collected were stored in 70% ethanol and sorted to family or (for pitfall catches) morphospecies. Specimens were retained by Nature Seychelles with the exception of spiders (Araneae) and wasps (Hymenoptera). Spiders were sent for identification by Dr Michael Saaristo of the Zoological Museum, University of Turku, Finland, and remain in the collection of the museum; wasps for identification by Dr. John Noyes of the Natural History Museum, London.

Other Survey Methods

In addition to the vegetation and invertebrate survey methods carried out within plots, a number of further measures were made at the island level. Freshwater habitats occurred on many of the islands surveyed. These habitats have importance as they support a number of Seychelles endemic species including invertebrates and amphibians (Stevenson *et al.,* 1987), and have been implicated in the survival of the endemic black paradise flycatcher on La Digue (Watson, 1981). Wherever freshwater marsh, ponds or streams occurred they were surveyed physically and biologically. In most cases, the area of marsh was calculated, vegetation was sampled on a transect across the water body and aquatic invertebrates sampled using a hand net and, in some cases, a submerged aquatic light trap run overnight.

A complete list of plant species observed was compiled for each island. Species lists were compiled by one observer (MJH), mainly from sight records. Identifications were made using Beaver (1995), Friedmann (1994), Procter (1974), Robertson (1989), and Wise (1998). Species that could not be identified in the field (particularly grasses and sedges) were collected, and many of these were identified by comparison with specimens in the Seychelles National Herbarium (Natural History Museum, Victoria). Pressed specimens from the project are now held by Nature Seychelles. Plant species lists are included in each island account, where the taxonomy follows Robertson (1989) for monocotyledons, and Friedmann (1994) for dicotyledons. The tree *Ochrosia oppositifolia* (Lam.) Schum. should more properly be referred to as *Neisosperma oppositifolia* (Lam.) Fosberg & Sachet (D. Stoddart, pers. comm..), but the name *Ochrosia* (used in Fraidmann, 1994) is used here for purposes of uniformity.

Observation and opportunistic collection were used to identify members of certain invertebrate groups, including day-flying Lepidoptera (identified from Larsen, 1996), Odonata (identified using Blackman and Pinhey, 1967), and Phasmatoptera (identified using a key provided by P. Matyot). Vertebrates were identified by observation; no vertebrates were collected, with the exception of rats. For identification of bird species, Penny (1974) and Sinclair and Langrand (1998) were used, although taxonomic order in species lists follows that in Skerrett *et al.* (2001).

Introduced predators are of prime importance in determining the current restricted distribution of several endangered endemic birds in Seychelles. While the Seychelles has a relatively small number of introduced bird and mammal species, several introduced species are known or presumed to negatively affect native land birds. These include two *Rattus* species (*R. rattus* and *R. norvegicus*), domestic (feral) cat *Felis catus,* barn owl *Tyto alba* and common mynah *Acridotheres tristis* On each island, lists of all bird and mammal species observed were compiled and, in addition, tape playback methods were

used to confirm the presence of barn owls and trapping was used to identify rat species present. Lists of all birds and mammals observed were compiled.

Tape playback used recordings of barn owls from India and Britain played between 7 p.m. and 9 p.m. in at least three locations on each island. Recordings were played for a total of 20 minutes in each location.

Rodent trapping followed "index trapping" methods developed in New Zealand by the Ecology Division of the Department of Scientific and Industrial Research (Cunningham and Moors, 1983; Nelson and Clark, 1973). The methodology used differed in some respects from index trapping; live rat traps were used rather than snap traps (to reduce the inadvertent killing of land crabs, birds, etc.) and numbers of trap-nights were rather lower than the recommended minimum of 150 for each habitat type. The traps were in place for five nights with coconut flesh as bait. The trapline consisted of pairs of traps (with 1m between the pair) at 30 m intervals. Two traplines were laid on each island to sample major habitats represented. On each morning of trapping the number of rats trapped was recorded, together with other animals caught and the number of traps that had closed without trapping anything. These data were used to calculate an index of rats trapped per 100 trap-nights, corrected for traps closed (D. Merton, *in litt.*).

Tape playback was also used to give presence/absence data for three endemic bird species: Seychelles scops owl, Seychelles black paradise flycatcher and Seychelles white-eye. All three of these species may respond to taped calls of their own species by moving closer to the source of the calls and (sometimes) calling, although responses differ between the species and with time of year. Scops owls usually call in response to the tape and fly to perches close to the player, where they can be observed by torchlight (D. Currie, *pers. comm.*). Paradise flycatchers do not usually sing back to taped song but both males and females move close to taped sources. They tend to gather quickly but disperse again rapidly, at least when constant-loop tapes are used (D. Currie, *pers. comm.*). White-eyes sometimes respond to taped sources but may ignore them altogether (G. Rocamora *pers. comm.*).

Tape playback was carried out at sample points on walked transects (for example, existing paths). For all species, 60-second constant-loop cassettes were used. Location of playback sites and duration of playback differed, depending on target species:

- For scops owl, transects were located within hill forest habitat, or on the plateau adjacent to areas of hill forest. Tapes were played for 20 minutes at three points on each transect, at least 200 m apart. Playback was between 7 p. m. and 9 p. m.
- For the paradise flycatcher and white-eye, transects were located in all major habitats represented on an island. Tapes were played at five points on each transect, at least 100 m apart, for five minutes at each point. Playback occurred between 5.30 a.m. and 6.30 a.m. (Rocamora, 1997).

For each species, as many sampling events (mornings/evenings of playback) as possible were carried out. The date, time, habitat, and any responses were recorded.

RESULTS

Results are presented here by island, each of the following 10 reports giving the data gathered on each island and a final summary report discussing the implications of these island studies for the conservation of Seychelles native flora and fauna, and endemic birds in particular. Species lists for each island are given in the text of each island report (most taxa) or as an Appendix (in the case of plants). References are given at the end of the volume.

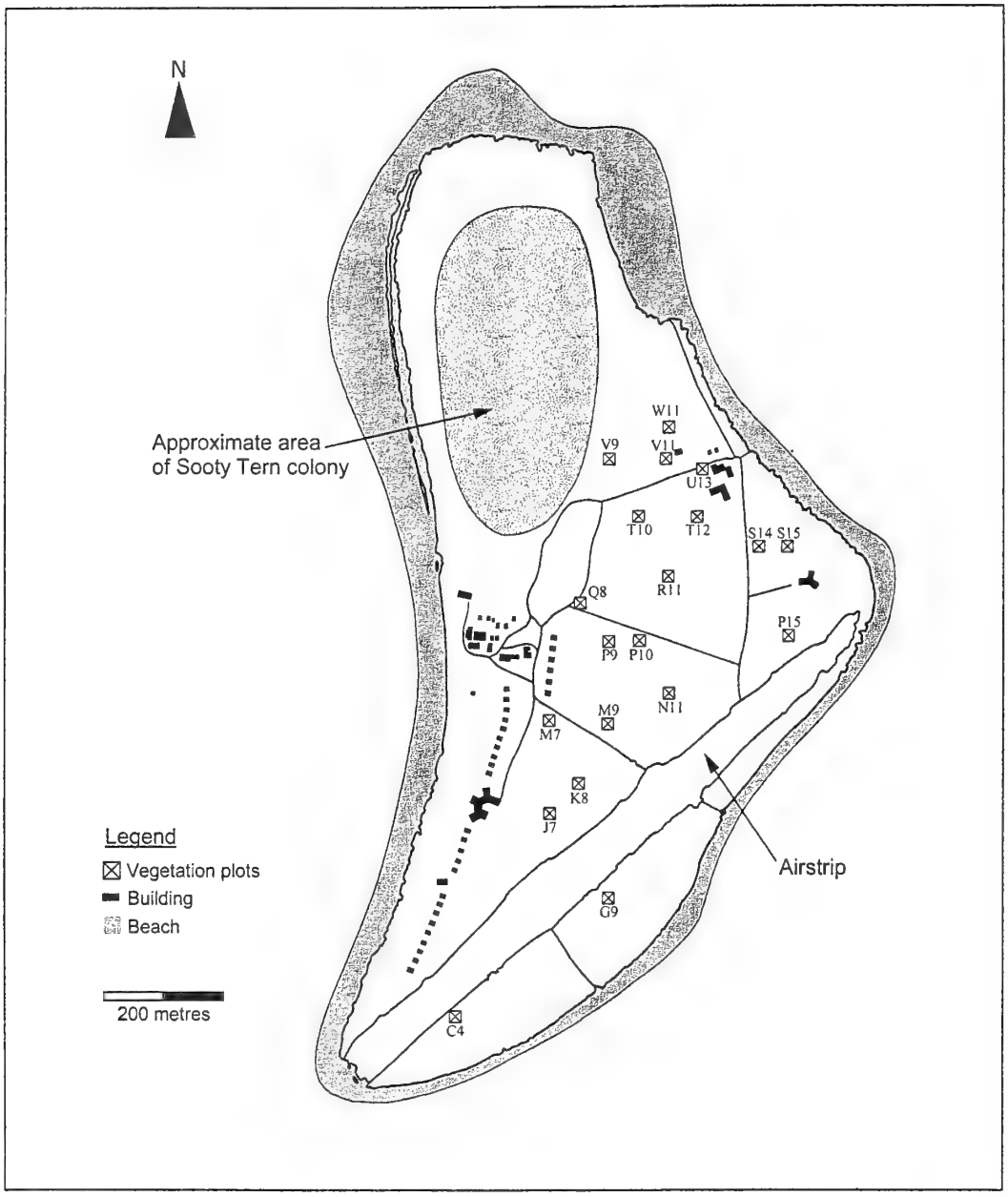

Figure 1. Bird Island: Physical map, with position of tern colony and location of vegetation plots.

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 *Tournefourtia 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 m^2 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.

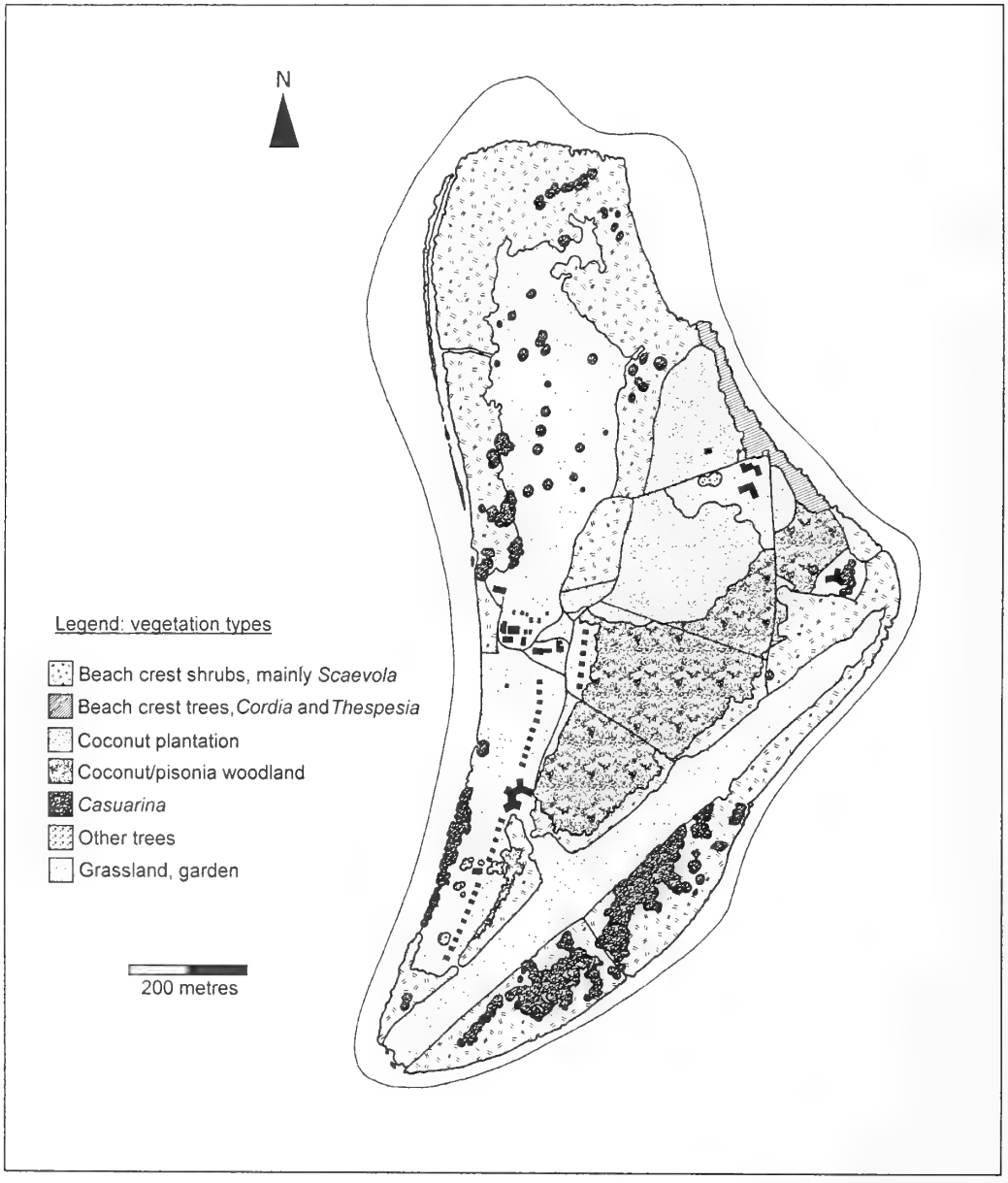

Figure 2. Bird Island vegetation.

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

Vegetation type	Approx. area (ha)	%
Coconut plantation with scrub	13	11
"Native" woodland (*Cocos* + *Pisonia*)	18	15
Beach crest vegetation (*Scaevola*, 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

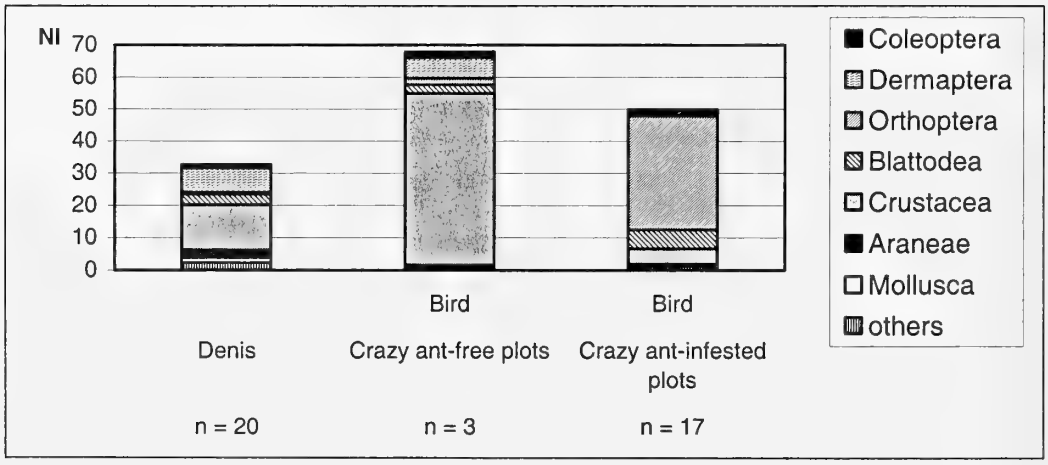

Figure 3. Composition of pitfall assemblages on Bird and Denis Islands, excluding ants. "Others" includes Annelida, Myriapoda, Thysanura, Lepidoptera, Diptera and insect larvae.

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								
Carica papaya	100	0.89	17.17	6.37	550	16.51	209.31	21.39
Native species								
Ochrosia oppositifolia					100	0.01	0.60	0
Phyllanthus pervilleanus	100	0.02	37.21	18.60	300	3.62	6866.72	12.71
Pisonia grandis	250	2.92	145.65	16.56	400	514.89	34439.19	308.01
Scaevola sericea	350	0.32	20.23	16.25	150	1.11	86.71	0
Terminalia catappa					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.

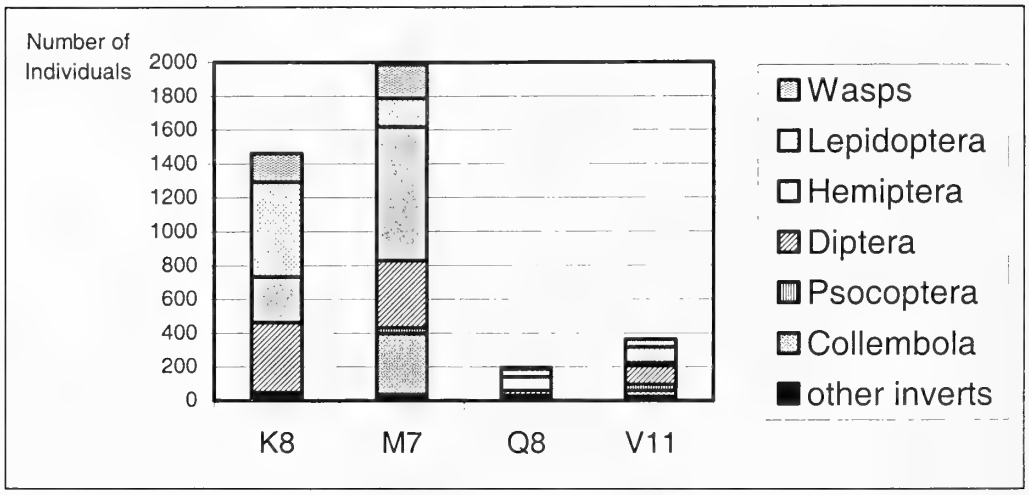

Figure 4. Taxonomic composition of Malaise trap assemblages (excluding ants).

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

Order	Family	Species	Notes
		Tapinoma melanocephala (Fabricius, 1793)	Rare in pitfall traps
		?Technomyrmex albipes (F. Smith, 1861)	Rare in pitfall traps
		Tetramorium bicarinatum (Nylander, 1846)	Rare in pitfall traps
	Vespidae	*Polistes olivaceus* (de Geer, 1773)	Occasional
Lepidoptera	Lycaenidae	*?Zizeeria knysna* (Trimen, 1862)	Common
Lepidoptera	Nymphalidae	*Hypolimnas misippus* (Linnaeus, 1764)	Common, March 2001
Odonata		Sp. Indet. *	Dragonflies recorded by Feare (1979)
Orthoptera	Myrmecophilidae	*Myrmecophilus* sp.	Abundant, pitfall assemblages
Phthiraptera		*Saemundssonia sternae* (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
Bubulcus ibis	cattle egret	One seen at farm, 27/3/00
Charadrius mongolus M	lesser sandplover	Seen in company of greater sandplover on airstrip
Charadrius leschenaultii M	greater sandplover	Several birds seen regularly on airstrip and beaches
Charadrius hiaticula M	Common ringed plover	One individual, grassland around the hotel
Pluvialis fulva M	Pacific golden plover	Several birds seen regularly on grassland
Pluvialis squatarola M	grey plover	Several birds seen regularly on grassland and beaches
Numenius phaeopus M	Whimbrel	Seen regularly. Group of 44 birds roosting on beach at North Point, 25/3/00
Arenaria interpres M	ruddy turnstone	Seen regularly, on grassland and beaches, in groups of up to 30
Calidris alba M	Sanderling	Several individuals seen with turnstones on southern beach, 26/3/00
Calidris ferruginea M	curlew sandpiper	Seen regularly, on grassland and beaches, in groups of up to 20
Streptopelia picturata ssp.	turtle dove	Seen occasionally in coconut woodland
Geopelia striata	barred ground dove	Seen regularly, especially around habitation
Acridotheres tristis	Common mynah	Seen regularly
Foudia madagascariensis	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
Phaeton lepturus *	white-tailed tropicbird	Juveniles observed March
Fregata minor	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
Fregata ariel	lesser frigatebird	
Sterna bergii	greater crested tern	Group of 10-15 with other seabirds and waders roosting on beach at North Point, 25/3/00
Sterna anaethetus	bridled tern	Group of 20-30 in Casuarinas by airstrip, 26/3/00
Sterna fuscata *	sooty tern	Birds beginning to return to their regular nesting area March
Sterna albifrons/saundersi	little/Saunder's tern	Group of up to 80 birds with other seabirds and waders, North Point 25/3/00
Anous stolidus *	brown noddy	Abundant, many with young. Nesting in coconuts and on the ground around the hotel
Anous tenuirostris *	lesser noddy	Many in *Pisonia* trees in woodland, some beginning to build nests
Gygis alba *	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					
	Acrostichum aureum L.	N	-	-	Recorded 1912[1]: in error for Denis Island?
Davalliaceae					
1	*Nephrolepis biserrata* (Sw.) Schott	N	A	W	
	Nephrolepis multiflora (Roxb.) Jarrett	N	-	-	Recorded 1976[2]
Polypodiaceae					
	Phymatosorus scolopendria (Burm. f.)	N	-	-	Recorded 1912[1]
GYMNOSPERMAE					
Cycadaceae					
2	*Cycas thuarsii* Gaud.	I	F	Cu	Only in gardens
ANGIOSPERMAE: Dicotyledons					
Acanthaceae					
3	*Asystasia* sp. B (*sensu* Friedmann)	?I	F	Sc, W	
	Asystasia multiflora Kl.	?	-	-	Last recorded 1976[2]. Same as *A.* sp. B?
	Asystasia gangetica (L.) T. Anders.	?	-	-	Last recorded 1977[3]. Same as *A.* sp. B?
4	*Pseuderanthemum carruthersii* (Seem.) Guillaumin	I	F	Cu	Only in gardens
Amaranthaceae					
5	*Achyranthes aspera* (L.) DC.	I	A	W	
6	*Alternanthera ?tenella* Colla.	I	F	Cu	Only in gardens
	Amaranthus caudatus L.	I	-	-	Recorded 1931[4]. Now extinct?
7	*Amaranthus dubius* Mart. ex Thell.	I	A	G, W	
	Amaranthus lividus L.	I	-	-	Recorded 1977[3] (as *A. oleraceus* L.). = *A. dubius?*
8	*Gomphrena globosa* L.	I	F	Cu	Only in gardens
Annonaceae					
9	*Annona reticulata* L.	I	R	Cu	Only in gardens (at farm)
Apocynaceae					
10	*Catharanthus roseus* (L.) G. Don.	I	O	W, Cu	

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

	Species	Status	Abund.	Habitats	Notes
39	*Codiaeum variegatum* L.	I	F	Cu	Only in gardens
	Euphorbia cyathophora Murr.	I	-	-	Recorded 1931[4], in error for Denis Island?
40	*Euphorbia hirta* L.	I	A	G	
	Euphorbia prostrata Ait	1	-	-	Recorded 1977[3]. = *E. thymifolia?*
41	*Euphorbia thymifolia* L.	I	A	G	
42	*Euphorbia tirucalli* L.	I	R	Cu	Only in gardens
43	*Jatropha pandurifolia* L.	I	O	Cu	Only in gardens
	Pedilanthus tithymaloides (L.) Poit.	1	-	-	Recorded 1976[2]. Overlooked this survey?
44	*Phyllanthus amarus* Schumach. & Thonn.	I	A	G	
45	*Phyllanthus maderaspatensis* L.	I	A	G, Sc	
46	*Phyllanthus pervilleanus* (Baillon) Müll. Arg.	N	A	W, Sc	
47	*Ricinus communis* L.	I	C	W, Sc	
Goodeniaceae					
48	*Scaevola sericea* Vahl	N	A	BC, Sc	
Guttiferae					
49	*Calophyllum inophyllum* L.	N	O	Cu, G	Trees recently planted
Hernandiaceae					
	Hernandia nymphaeifolia (Presl) Kubitzki	N	-	-	Recorded 1910[5] (as *H. sonora* L.): extinct.
Labiatae					
	Plectranthus sp.	I	-	-	Recorded 1976[2]
50	*Solenostemon* sp. cultivar	I	O	Cu	Only in gardens
Lauraceae					
51	*Cassythea filiformis* L.	N	A	BC, Sc	
Lecythidaceae					
52	*Barringtonia asiatica* (L.) Kurtz	N	O	Cu	
Lythraceae					
	Pemphis acidula Forst.	?	-	-	Recorded (in error?) 1931[4]
Malvaceae					
53	*Abutilon indicum* (L.) Sweet	?I	C	W, Sc	
54	*Gossypium hirsutum*	I	C	W, Sc	
55	*Malvastrum coromandelianum* (L.) Garcke	I	A	W	
56	*Sida acuta* Burm. f.	I	O	W	
	Sida pusilla Cav.	N	-	-	Recorded 1976[2] (as *S. parvifolia* DC): overlooked in this survey?
57	*Thespesia populnea* (L.) Soland. ex Correa	N	F	BC, W	
Moraceae					
58	*Artocarpus altilis* (Parkins.) Fosb.	I	R	W	
	Ficus benghalensis L.	I	-	-	Recorded 1976[2]: Extinct?
59	*Ficus ?benjamina* L.	I	R	Cu	Only in gardens
	Ficus lutea Vahl	N	-	-	Recorded 1976[2] (as *F. nautarum* Baker): Extinct?
Moringaceae					
60	*Moringa oleifera* Lam.	I	F	Cu, Sc	
Myrtaceae					
61	*Syzygium samarangense* (Bl.) Merr. & Perry	I	R	Cu	

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

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

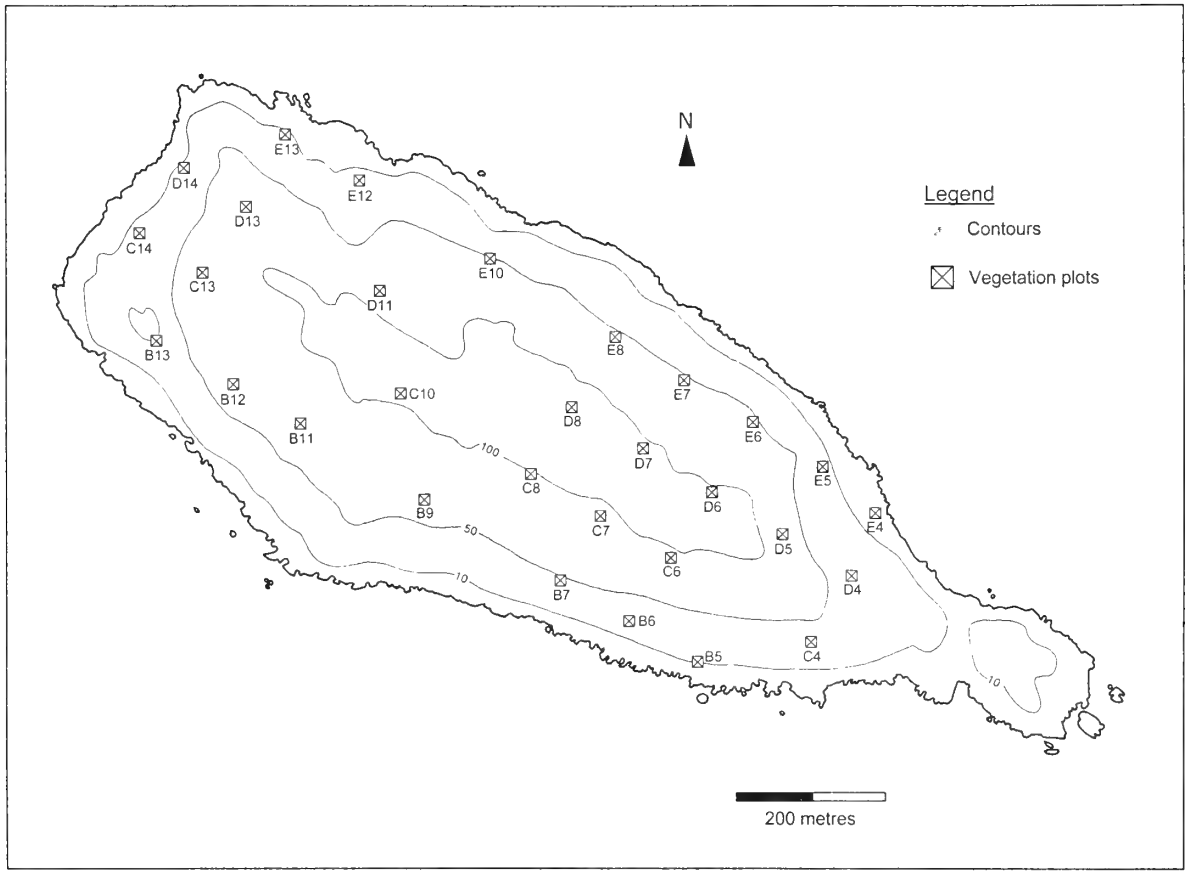

Figure 1. Conception: physical map, with locations of vegetation plots.

CONCEPTION

BY

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GEOLOGY, TOPOGRAPHY AND CLIMATE

Conception is a small granitic island with an area of approximately 60 ha, situated only 1,600 m from the east coast of Mahé, the largest of the granitic Seychelles islands. At its highest point it reaches 130 m above sea level (Fig. 1). The island is dominated by rocky, sloping ground. A single raised ridge, flat-topped at its northwestern end dominates the island. In the south east, a small lower hill (reaching only 20 m above sea level) is separated from the rest of the island by a low boulder-filled fault. There is no coastal flat land and no sandy beach. Most of the land is sloping ground between 10 and 100 m above sea level (Table 1). Geologically, the island is similar to the nearby west coast of Mahé, dominated by porphyritic granite (Braithwaite, 1984). The soils of Conception are mainly red earths, strongly eroded on steeper slopes. On the open glacis areas, soils are restricted to pockets between rocks

Standing water on the island is very limited. For much of the year a trickle of fresh water runs down rocks into the sea at the landing place (CK 1940 8432). At the height of the rainy season, ephemeral streams carry rainwater to the sea, although these were not observed during the assessment surveys of the island.A few small pools are less short-lived; in February, a shallow (1-2 cm deep) pool with an open surface of less than 2 m^2 was present in woodland on the eastern side of the island, and several deeper pools were observed in hollows on open rock at the top of the island (at CK 1870 8462); although exposed, some of these contained larvae of aquatic insects.

No weather data exist for Conception but the climate of the island probably follows a similar pattern to that of nearby Mahé. Port Glaud, on the west coast of Mahé opposite Conception, has lower annual rainfall than Beau Vallon to the north or Victoria to the east (Walsh, 1984). Although it is in the generally wetter northern part of Mahé, it is sheltered from the prevailing winds (in particular the north west wind of the rainy season) by hills.

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[2] 1991 Casa Marcia Crescent Victoria, British Colombia, Canada.

[3] Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, UK.

Table 1. Area of Conception by altitude (calculated from maps published by Directorate of Overseas Survey (UK)/Seychelles Government).

Altitude range (m. asl.)	Area (ha)	Percentage total area
100 - 150	8.2	13.7
50 - 100	21.3	35.3
10 - 50	17.7	29.3
0 - 10	13.1	21.7

HISTORY

Few early records exist for the island. Following the establishment of the first French settlement in Seychelles in 1770, the proximity of Conception to the main island of Mahé probably encouraged exploitation of the island even though landing was difficult all year round.

While Conception had at the time little interest for agriculture, it possessed other resources, including giant tortoises, which were among the principal resources of the islands. Exploitation was such that by 1787, Malavois wrote of Conception "there were formerly on this island large quantities of tortoises, which were there without having been brought there. Now there is only a small number left and these are generally small" (in Fauvel, 1909).

Despite the lack of freshwater, the island was settled, and there are now ruins of several small buildings. Coconut plantations were probably started in the nineteenth or early twentieth century, when a range of other species including cinnamon *Cinnamomum verum* and fatak grass *Panicum maximum* was introduced. Plantations throughout the Seychelles were abandoned in the late twentieth century.

Today the island (although still privately owned) has no permanent human population, and plantations are unexploited. The only visitors are staff of the Seychelles Ministry of Environment and Transport and occasional fishermen.

FLORA AND VEGETATION

Flora

A total of 92 plant species was recorded on Conception, including eight ferns and 84 angiosperms (Appendix 1). Of the angiosperms, 37 (44.0%) species are regarded as introduced (Friedmann, 1994) and 35 (41.7%) native. Of the native taxa (species and subspecies), nine are endemic to the Seychelles (10.7% of the total flora).

The proportion of the flora made up of introduced species was lower than that for the Seychelles as a whole, and the proportion of Seychelles endemics higher; of the total Seychelles flora, around 54% are introduced and 9% endemic (Procter, 1984). Compared to the flora of other small islands, Conception is relatively rich in endemic species. This high endemicity is due to the proximity of the island to Mahé, where almost all the endemic plant species of Seychelles are represented. The rocky slopes of the island and

soils of little agricultural value may also have contributed to the survival of a number of endemic plants here.

Few previous botanical surveys have been carried out on the island and Robertson (1989) lists just two species for Conception: *Premna serratifolia* (as *P. obtusifolia* R. Br.), and coconut *Cocos nucifera.* Both were recorded in the current survey.

Of the introduced plants established on Conception, 13 were invasive weedy species. Several of the woody weeds known to be particularly invasive on the smaller islands of Seychelles were present, including cocoplum *Chrysobalanus icaco* and cinnamon *Cinnamomum verum* (both abundant). Other potentially invasive introduced trees included *Alstonia macrophylla*, *Syzygium jambos* (well established on rocky areas on top of the island), *Psidium cattleianum,* and cashew *Anacardium occidentale.* Coconuts were common, especially on the south east and south west slopes of the island.

Vegetation

The extents of major vegetation types on Conception are shown in Table 2 and Figure 2. Most of Conception is dominated by mixed forest (exotic and native species), with some open glacis and scrub, and areas of coconut monoculture.

Table 2. Extent of major vegetation types, Conception Island.

Altitude	Vegetation type	Appox. area (ha)
>10 m asl	Woodland (predominantly introduced)	32
	Coconut with regeneration	6
	Scrub (native)	4
	Bare rock	5
< 10 m asl	Woodland (predominantly introduced)	1
	Coconut with regeneration	1
	Bare rock	11

Thirty vegetation plots were studied in hill woodland/scrub with a combined area of 3,000 m^2 (approximately 0.8% of the total area of this vegetation type). A summary of results is shown in Table 3. On average, plots had a relatively high density of trees with a fairly complete canopy (mean canopy cover = 64%). The tree layer had low species richness (only nine species were recorded) and was dominated by an introduced species, *Cinnamomum verum* (see Table 4).

The shrub layer was more species-rich than the tree layer with 13 species represented, eight of them native. The most widespread species, and the species showing the greatest dominance of the plots where it occurred, was the endemic palm *Phoenicophorium borsigianum* (see Table 5). *Cinnamomum verum* was widespread in the shrub layer, occurring in 73% of plots. *Cocos nucifera* occurred in fewer than half of the plots, but in these plots it occupied 14% of the shrub layer.

The herb layer included tree seedlings and herbaceous species. Twenty-five species were present, 15 of which were native. The most widespread species were *Nephrolepis* sp. and *Cinnamomum verum* (see Table 6). Species forming the largest proportion of the ground cover were the ferns *Phymatosorus scolopendria* and *Nephrolepis* sp.

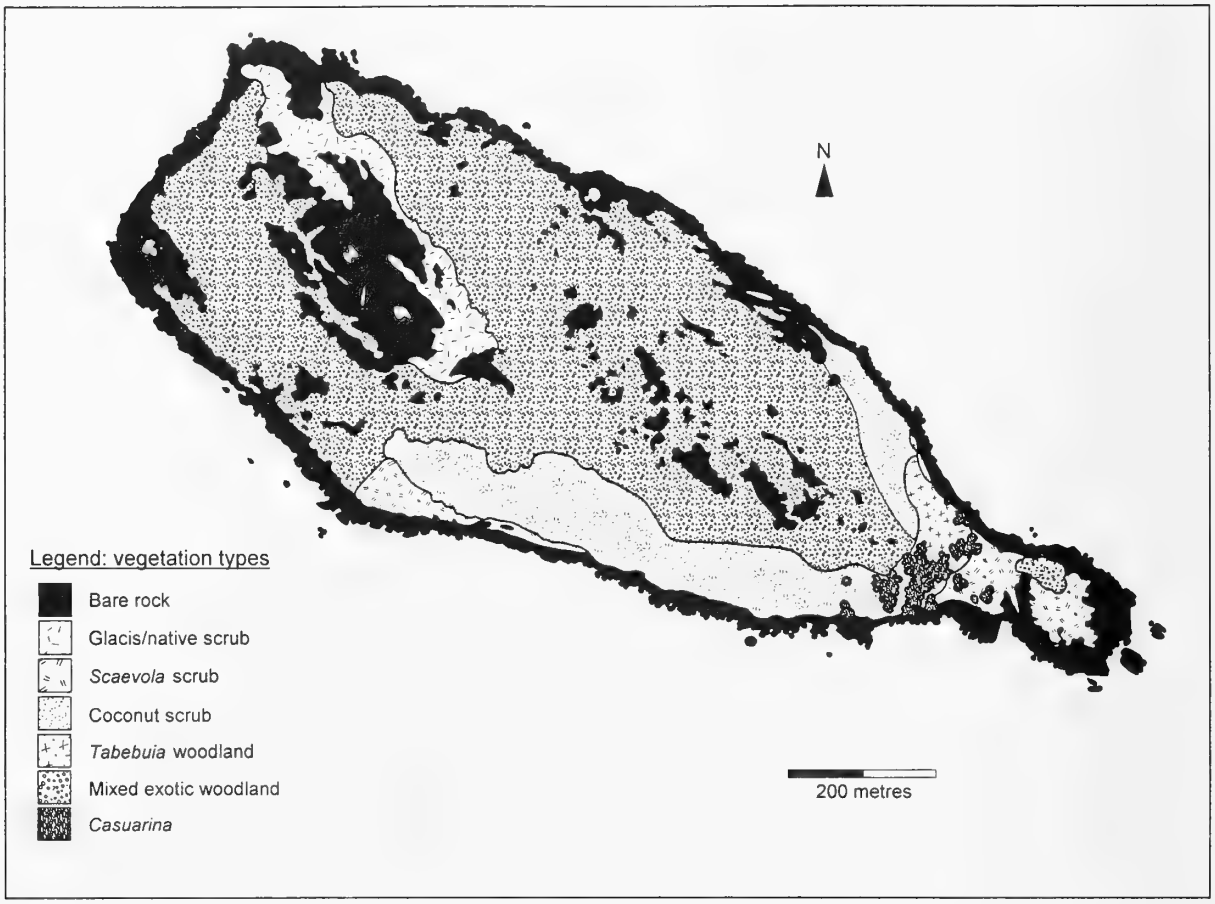

Figure 2. Conception vegetation

Table 3. Conception vegetation plot summary.

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)
30	56	667	37.3	37.9	27.9	33.8	1.8

Table 4. Conception Island: plants in tree layer (>5 m).

	No. individuals	% individuals
Introduced species		
Adenanthera pavonina	19	9.5
Anacardium occidentale	13	6.5
Cinnamomum verum	116	58.0
Native species		
Calophyllum inophyllum	15	7.5
Canthium bibracteatum	12	6.0
Cocos nucifera	15	7.5
Intsia bijuga	1	0.5
Premna serratifolia	7	3.5
Tabernaemontana coffeoides	2	1.0
Total	200	

Table 5. Conception Island: species of shrub layer.
Percentage shrub cover is the mean cover by the species for those Plots in which the species occurs.

	No plots	% shrub cover
Introduced species		
Adenanthera pavonina	3	2.2
Anacardium occidentale	7	6.3
Cinnamomum verum	22	9.9
Strychnos spinosa	1	1.0
Native species		
Calophyllum inophyllum	10	3.4
Canthium bibracteatum	14	7.0
Cocos nucifera	12	14.0
Dracaena reflexa	7	2.4
Ficus lutea	4	1.0
Ficus reflexa	1	8.0
Phoenicophorium borsigianum	24	20.6
Premna serratifolia	9	3.2
Tabernaemontana coffeoides	2	3.0
Total no. of plots	**30**	

Table 6. Conception Island: species of herb layer.
Only species occurring in three or more plots shown. Percentage herb cover is the mean cover by the species, for those plots in which the species occurs.

	No plots	% herb cover
Introduced species		
Adenanthera pavonina	14	1
Asystasia sp. B	11	2
Cinnamomum verum	28	5
Panicum maximum	3	2
Vanilla planifolia	7	2
Native species		
Calophyllum inophyllum	7	< 1
Canthium bibracteatum	11	< 1
Cocos nucifera	3	7
Davallia denticulata	8	6
Dracaena reflexa	6	< 1
Ipomoea venosa	3	2
Nephrolepis sp.	28	13
Phoenicophorium borsigianum	20	3
Phymatosorus scolopendria	23	19
Sarcostemma viminale	4	3
Total no. of plots	**30**	

The vegetation of Conception is dominated by low, species-poor secondary forest primarily made up of cinnamon with a shrub layer rich in *Phoenicophorium borsigianum.* Although an introduced species, cinnamon maintains a forest canopy on steep, rocky slopes and provides some shelter for endemic palms. It has probably replaced native trees such as the rare endemic *Mimusops sechellarum* and the native takamaka *Calophyllum inophyllum,* lost through timber extraction or fire. These species apparently dominated the vegetation of small islands which survived without complete clearance until the twentieth century (Vesey-Fitzgerald, 1940). The *Cinnamomum-Phoenicophorium* vegetation type found on Conception is similar to that of parts of Mahé, although perhaps more species-poor.

Other vegetation types are restricted in extent. There are currently no cultivated areas although some ornamentals, fruit trees and weeds of cultivation survive from previous settlement. There are no true plateau, marshland, or sandy beaches, although areas of "beach crest" vegetation (characterised by salt-tolerant plants such as *Scaevola*) can be identified in splash zones. Some of the habitat types listed (e.g., hill grassland) are very restricted in extent.

Like Mahé and nearby Thérèse, the flora includes a number of endemic species; on Conception, many of the endemic species are found on open glacis at the top of the island. Some of the endemics abundant on Thérèse (such as *Memecylon elaeagni* and palmiste *Deckenia nobilis*) appear to be absent or rare on Conception.

Two of the more notable plant records were *Pisonia grandis* and *Lagrezia* cf. *madagascariensis. Pisonia grandis* is a widespread tree particularly associated with seabird islands. In the granitic Seychelles, it is only abundant on the predator-free islands that have retained breeding populations of seabirds, particularly Cousin, Cousine and Aride; it is also present on Frégate. On Conception, two small but healthy young trees were found in a grassy area close to the old buildings beneath tall casuarinas. *Pisonia* appears to have arrived on Conception as seed carried by seabirds; during the February survey, large numbers of lesser noddies were recorded roosting in casuarinas here. Because the site is open, it is possible that *Pisonia* will become established on Conception and, if rats were eradicated, this might encourage seabird nesting. *Lagrezia* is a small, rather succulent herb found growing in cracks among rocks in the splash zone, on the south east shore of the island. The specimen collected has short, dense inflorescences
(3-4 cm long) closely resembling a specimen of *L. madagascariensis* from Roche Canon, Cousin, in the Seychelles National Herbarium. The Roche Canon specimen was originally assigned to *L. oligomeroides* (a species found on Aldabra, Assumption and Cosmoledo, as well as Agalega) by Fosberg (1970). *L. madagascariensis* has an extremely disjunct distribution being found in Eastern Madagascar, Poivre (Amirantes) and Cousin Islands (Friedmann, 1994). The record for Conception is only the second from the granitic Seychelles and Carlström (1996a) lists the plant as "critically endangered" in Seychelles, on the basis of its single known population in the granitic islands. Since it is an inconspicuous plant restricted to rocky areas of the splash zone, the Conception population may be long-established.

INVERTEBRATES

Pitfall Trapping

The total sizes of pitfall assemblages (numbers of invertebrates caught) are shown in Table 7. Only invertebrates over 2 mm body length are included (excluding minute invertebrates such as Collembola). Invertebrate assemblages were higher during the north west monsoon than in the dry south east season.

Pitfall assemblages were dominated by ants (Hymenoptera: Formicidae), which made up 73.3% of all invertebrates captured. The earwigs (Dermaptera) made up 19.2% of the invertebrates caught. Other taxonomic groups present included snails (mollusca: 1.9% of individuals), spiders (Araneae: 1.1% of individuals), Orthoptera, Lepidoptera and Blattodea (each 0.9%). The following groups each made up less than 0.4% of the assemblage: Coleoptera, Diptera, Hemiptera, insect larvae, Myriapoda, Nematoda, Psocoptera and wasps (Hymenoptera).

The most abundant invertebrate species was the ant *Odontomachus troglodytes*, which formed 42.8% of individuals overall. The ant *Technomyrmex albipes* was the second most abundant species, forming 21.7% of individuals. An unidentified earwig species made up 12.2% of total invertebrates and was the third most abundant taxon.

Table 7. Pitfall assemblages from Conception. Only invertebrates of body length >2 mm included (number in parentheses = number of invertebrates excluding ants).

	Mean no. individuals per 5 traps	
	SE season	NW season
Conception Hill woodland	34.4 (9.1)	50.3 (13.5)
Mean for all granitic islands	61.8 (9.4)	61.1 (16.0)

Leaf-insect Counts

Leaf-insect counts were carried out for seven tree and shrub species, five of these in both seasons (Table 8). The highest density of invertebrates (in terms both of individuals per leaf, and per square metre of leaf) was on the native tree *Premna serratifolia*. However, the introduced *Cinnamomum verum* had high leaf counts in both seasons, and density of invertebrates observed on *Cinnamomum* leaves exceeded that of most native species in both seasons.

Three of the five species which were counted in both seasons showed highest density of invertebrates in September rather than February. This runs counter to the trend on most islands, where leaf counts are significantly greater during the wetter north west monsoon, and may reflect weather conditions specific to Conception for the 1999/2000 season.

Table 8. Density of invertebrates on foliage, Conception.
n = no. of leaves counted; NI = number of individual invertebrates.

Species	SE season (September)			NW season (February)		
	n	mean NI leaf^{-1}	mean NI m^{-2}	n	mean NI leaf^{-1}	mean NI m^{-2}
Introduced species						
Anacardium occidentale	310	0.606	99.77	350	0.223	39.34
Cinnamomum verum	1100	0.854	131.55	1300	0.978	155.34
Native species						
Calophyllum inophyllum	220	1.204	131.19	450	1.009	108.06
Canthium bibracteatum	800	0.134	62.41	550	0.098	49.94
Ficus lutea	0			50	0.720	43.00
Premna serratifolia	260	1.600	163.12	250	2.548	349.42
Tabernaemontana coffeoides	100	0.250	32.50	0		

Malaise Trapping

Malaise trapping was carried out in plateau and hill woodland habitats, during both seasons. Main results are summarised in Table 9. The number of individuals trapped was similar in both seasons (slightly larger in September).

The most abundant taxonomic groups were Diptera, Lepidoptera and Hymenoptera. Other invertebrate groups represented included arachnids (spiders), Coleoptera, Collembola, Hemiptera, Orthoptera and Psocoptera. The majority of taxa collected have yet to be identified to species level.

Table 9. Malaise trap assemblages, Conception.
NI = number of individuals.

	SE (Sept.)		NW (Feb.)	
	NI	%	NI	%
No. traps	2		4	
Mean NI trap^{-1}	264.0		236.5	
Diptera	205	38.8	558	59.0
Lepidoptera	185	35.0	221	23.4
Hymenoptera	57	10.8	78	8.2
Coleoptera	43	8.1	23	2.4
Others	38	7.3	66	7.0

Observation

A list of species observed or collected is given in Table 10. In both September and February, dragonfly species were observed flying over open glacis on the top of the island. Pools here must be present for much of the year although probably not permanent. In February, mosquito larvae were abundant in these small pools so it is possible that dragonflies breed on the island.

The introduced crazy ant *Anoplolepis gracilipes* was not trapped in pitfall traps, but small numbers of ants were observed in the vicinity of the old settlement. This species is widespread on Mahé, where it is regarded as a nuisance (Haines *et al.,* 1994), and on Bird Island it has had negative effects on the island's ecosystems and conservation status (Feare, 1999a; Hill, in prep.). On Conception, it appears very restricted in distribution, suggesting that the species was recently introduced.

Table 10. Invertebrates observed and collected, Conception Island.

Order	Family	Species	Notes
Mollusca	Acavidae	*Stylodonta unidentata* (Chemnitz, 1795)	Endemic snail
	Achatinidae	*Achatina fulica* (Bowditch, 1822)	African land snail
	Helicinidae	*Helicina theobaldiana* Nevill, 1871	Endemic snail
	Subulinidae	*Subulina octona* Bruguière, 1792	
Arachnida:			
Araneae	Tetragnathidae	*Nephila inaurita* (Walckenaer, 1841)	
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	Land hermit crab
	Grapsidae	*Geograpsus crinipes* (Dana, 1851)	Land crab
Myriapoda:			
Chilopoda	Scolopendridae	*Scolopendra subspinipes* (Leach, 1918)	
Diplopoda	Trigoniulidae	*Spiromanes ?braueri* (Attems, 1900)	
Insecta:			
Coleoptera	Scarabaeidae	*Oryctes monoceros* (Olivier, 1789)	
		Perissosoma aenescens Waterhouse, 1875	
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)	
	Apidae	*Apis mellifera adansoni* Latreille, 1804	
	Formicidae	*Anoplolepis gracilipes* (Smith, 1857)	
		Cardiocondyla emeryi Forel, 1881	In pitfall traps
		?Camponotus thomasetti Forel, 1912	In pitfall traps
		Odontomachus troglodytes Santschi, 1914	In pitfall traps
		Pachycondyla melanaria (Emery, 1894)	In pitfall traps
		Plagiolepis ?alluaudi Emery, 1894	In pitfall traps
		Plagiolepis ?exigua Forel, 1894	In pitfall traps
		?Solenopsis seychellarum Forel, 1912	In pitfall traps
		Tapinoma melanocephala (Fabricius, 1793)	In pitfall traps
		Technomyrmex albipes (Smith, 1861)	In pitfall traps
	Vespidae	*Polistes olivaceus* (de Geer, 1773)	
Lepidoptera	Hesperiidae	*Borbo* sp.	
Odonata	Libellulidae	*Diplacodes trivialis* (Rambur, 1842)	
		?Orthetrum stemmale wrightii (Selys, 1877)	
		?Pantala flavescens (Fabricius, 1798)	
		Tramea limbata Selys, 1878	
Phasmatodea	Phasmatidae	*Carausius sechellensis* (Bolivar, 1895)	On *Agave*

Discussion: Invertebrates

Pitfall assemblages were slightly smaller than the mean size of assemblages on the granitic islands (Table 7). In general, plateau sites on granitic islands showed higher invertebrate catches in pitfall traps than hill sites. Conception had no plateau and little land under 10 m asl.

Leaf counts suggest that the cinnamon forest has high insect productivity: insect counts on cinnamon leaves are high, although the species is not native. This is the dominant tree species of the island. Although most of the invertebrates counted are ants, and bugs attended by ants (especially mealy bugs), the supply of invertebrates for

insectivores with a wide tolerance of small food items is good. Seychelles white-eye, for example are known to take mealy bugs (Feare, 1975).

Invertebrates on vegetation and in flight-intercept (Malaise) traps were more abundant in September than in February, contrary to expectations. The fact that both methods showed this decline suggests that it was a real effect, perhaps caused by local environmental conditions (especially, weather conditions) in 1999/2000.

Although few endemic species were collected in the current survey, Conception probably supports a large endemic invertebrate fauna, in addition to the introduced or cosmopolitan species found on most islands of the Seychelles. The island is close to Mahé, which has a large endemic fauna, and supports a range of endemic plants including native palms (which provide important microhabitats for endemic invertebrate species in leaf axils).

VERTEBRATES

Reptiles

Reptiles observed during the course of fieldwork were recorded, and a list of species identified is given in Table 11. The list includes four lizards, all endemic to the granitic Seychelles. One of the endemic giant tortoises of the granitic islands was recorded in the late eighteenth century (Bour, 1984).

Table 11. Reptiles observed on Conception.

Family	Species	Notes
Gekkonidae	*Ailuronyx seychellensis* (Dumeril & Bibron, 1836)	Observed 26/9/99 and 22/2/00
	Phelsuma spp.	Two morphotypes observed
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	
	Janetaescincus braueri or *Pamelaescincus gardineri*	Burrowing skink

Birds

In total, nine land birds and waders were recorded during the course of fieldwork (Table 12). Three of these were Seychelles endemics, two of which (Seychelles kestrel *Falco araea* and Seychelles white-eye *Zosterops modestus*) are globally threatened. The Seychelles white-eye is only known on two islands, Mahé and Conception; the Conception population was discovered in 1997 (Rocamora, 1997). The population on Conception is at least 250 birds, the Mahé population only about 50 (Rocamora and Francois, 1999).

Four seabird species were observed (Table 13) and at least one of these (the fairy tern) probably nests on the island.

Table 12. Land birds and waders observed on Conception.
M = migrant species; E = Seychelles endemic species.

Species		Notes
Falco araea E	Seychelles kestrel	Two individuals observed around hill glacis, 26/9/99. One individual over hill glacis, 23/2/00
Arenaria interpres M	ruddy turnstone	One individual observed flying close to island (over sea), 27/2/00
Streptopelia picturata picturata	Madagascar turtle dove	Observed every day in hill woodland and (occasionally) more open habitats
Geopelia striata	barred ground dove	A few individuals observed in hill grassland, February 2000
Alectroenas pulcherrima E	Seychelles blue pigeon	Observed every day
Tyto alba	?barn owl	Plucked feathers of Fairy Tern observed in coconut woodland, February
Zosterops modestus E	Seychelles white-eye	At least 200 resident birds (G. Rocamora, *pers. comm.*). Young birds observed in February
Acridotheres tristis	common mynah	Observed every day, especially in coastal habitats
Foudia madagascariensis	Madagascar fody	Regularly seen in small numbers in hill grassland, open scrub and coconut forest near camp

Table 13. Seabirds observed on Conception.

Species		Notes
Phaeton lepturus	white-tailed tropicbird	Observed flying in amongst trees in hill woodland on the eastern side of the island (close to point E10) on 26/9/99. Occasionally observed flying close to island in February
Fregata ariel	lesser frigatebird	Two individuals displaying in flight over glacis, 22/2/00
Anous tenuirostris	lesser noddy	Roosting in large numbers (hundreds of individuals) in large Casuarina trees, February
Gygis alba	fairy tern	Regularly observed in small numbers

Mammals

Only two species of mammals were recorded in the course of fieldwork: one bat and one rat. The endemic Seychelles fruit bat *Pteropus seychellensis* Milne Edwards 1887 was regularly observed and heard both in September and February, particularly in *Casuarina* trees around the old settlement area. Rodent trapping was carried out in September 1999, and February 2000 (Table 14). Two traplines were established, both in hill woodland with coconut and cinnamon. Only one species of rodent, *Rattus norvegicus* L., was trapped.

Table 14. Results of rat trapping, Conception.

Dates	Trap-nights	No. of rats	Rats per 100 trap-nights (uncorrected)	Rats per 100 trap-nights (corrected)*
22 – 29/9/99	140	82	58.57	88.65
23 – 28/2/00	112	49	43.75	59.76
Total (SE)			35.34	
Total (NW)			25.56	

*Corrected to account for the effect of closed traps: Cunningham and Moors, 1996.

Trapping rates were high for both trapping periods, although higher in September during the dry season when food and water stress were greater and rats more likely to be trapped. The generally high trapping rates could be due to the more terrestrial nature of Norway rats compared to ship rats (found on most other islands surveyed) which feed in trees and palms to a greater extent.

Biometric data show that the Norway rats on Conception are relatively small compared to continental populations (and possibly populations on Mahé), although larger and heavier than the ship rat *R. rattus* (which is more widespread in Seychelles). Almost all individuals showed a tail length less than the head plus body measurement, a trait which distinguishes them from ship rats.

The only natural enemy of rats on Conception is probably the barn owl. These owls were introduced to Seychelles in order to control rats (Penny, 1974) but seem to have little impact on rodent populations.

The impact of rats on other vertebrates and invertebrates is difficult to gauge, although probably severe. In both seasons, many young plants of the endemic thief palm (*Phoenicophorium borsigianum*) showed rat damage; the animals had gnawed palm petioles, causing collapse of the leaf-stem or complete loss of a leaf. This damage was seen even on palms with trunks over two metres in height.

CONSERVATION RECOMMENDATIONS

Conception is a relatively small island which has conservation interest principally because of the presence there of a population of the Seychelles white-eye *Zosterops modestus,* an endangered endemic bird. Natural populations of this species only occur on two islands, Mahé (where it is very rare) and Conception (Rocamora and Francois, 1999, 2000). Predation by mynahs, bulbuls (on Mahé) and rats may affect the breeding success of the species and rat eradication on Conception would probably be advantageous to the white-eyes, as well as other endemic elements of the flora and fauna. While eradication of rats would also reduce populations of ground-feeding birds such as doves, white-eyes would be at little risk.

Translocations of white-eyes to other islands have been proposed, and in 2001 birds were moved to Frégate (Rocamora *et al.,* in press). Because Conception remains the stronghold of the species, translocations of other endangered species to Conception should not be attempted.

The flora of Conception is of interest because of the prominence of endemic species. Probably as a result of the island's proximity to the largest island of the archipelago, Mahé, which has 65 of the granitic Seychelles endemic plant species, and the limits to human exploitation imposed by the difficulty of landing, lack of fresh water and its rocky slopes, nine endemic species occur on the island. Some of these species occur in large numbers, including the endemic palm *Phoenicophorium borsigianum* which is restricted to larger islands and their satellites. Many endemic invertebrates are found in association with endemic or native plants; Scott (1933) found a close association between endemic invertebrates and endemic vegetation, particularly native palms and *Pandanus* species. Conception is therefore likely to harbour a number of endemic invertebrates in addition to its plant species.

As with the nearby island of Thérèse, the island resembles lowland habitats of Mahé and thus presents the opportunity to conserve habitats and species present on the larger island, in more controlled (potentially predator-free) conditions. However, since the cinnamon forest of Conception appears vital for the survival of the white-eye, habitat management such as removal of exotics could not be carried out on a large scale. Some exotics (eg. *Anacardium*) and *Cocos* might be controlled in limited areas to encourage the growth of native shrubs such as *Premna*.

Appendix 1. Plant species recorded from Conception (excluding seagrasses)

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: HG = Hill grassland; HW = Hill Woodland/scrub; Co = Hill Coconut woodland; Gl = Glacis; BC = 'Beach Crest'.

Species	Status	Abund.	Habitats
PTERIDOPHYTA			
Adiantaceae			
1 *Acrostichum aureum* L.	N	F	BC, Co
Davalliaceae			
2 *Davallia denticulata* (Burm.) Mett.	N	A	HW, Gl
3 *Nephrolepis biserrata* (Sw.) Schott	N	A	HW, Gl
4 *Pellaea ?doniana* Hooker	N	O	HW
Lycopodiaceae			
5 *Lycopodium cernuum* L.	?N	O	HW
Polypodiaceae			
6 *Phymatosorus scolopendria* (Burm. f.)	N	A	HW
Psilotaceae			
7 *Psilotum* sp.	N	C	HW
Vittariaceae			
8 *Vittaria* sp.	N	O	Gl
ANGIOSPERMAE: Dicotyledons			
Acanthaceae			
9 *Asystasia* sp B. (*sensu* Friedmann)	?I	A	HW, Gl
Amaranthaceae			
10 *Lagrezia madagascariensis* (Poir.) Moq.	N	O	BC
Anacardiaceae			
11 *Anacardium occidentale* L.	I	A	HW
Annonaceae			
12 *Annona cherimola* Mill.	I	F	HG, HW
Apocynaceae			
13 *Alstonia macrophylla* Wall ex G. Don.	I	O	HW
14 *Catharanthus roseus* (L.) G. Don.	I	O	HW, Gl
15 *Plumeria rubra* L.	I	R	HW
16 *Tabernaemontana coffeoides* Boj. ex A. DC.	N	A	HW
Araliaceae			
17 *Gastonia* sp.	E	R	Gl
Asclepiadaceae			
18 *Sarcostemma viminale* (L.) Alton	N	F	Gl, HW
Bignoniaceae			
19 *Tabebuia pallida* (Lindl.) Miers.	I	C	HW
Cactaceae			
20 *Rhipsalis baccifera* (J. Mill.) Stearn	N	O	Gl
Caesalpiniaceae			
21 *Intsia bijuga* (Coleb.) O. Kuntze	N	O	HW
22 *Senna occidentalis* (L.) Link	I	F	HG, Gl

	Species	Status	Abund.	Habitats
Casuarinaceae				
23	*Casuarina equisetifolia* J. R. & G. Foster	I	F	HW
Chrysobalanaceae				
24	*Chrysobalanus icaco* L.	I	F	HW
Combretaceae				
25	*Terminalia catappa* L.	?N	R	HW
Compositae				
26	*Emilia sonchifolia* (L.) Wight	I	O	Gl
27	*Vernonia cinerea* (L.) Less.	I	O	HW
Convulvulaceae				
28	*Ipomoea obscura* (L.) Ker Gawl.	I	F	HW
29	*Ipomoea pes-caprae* (L.) R. Br.	N	A	BC, Gl
30	*Ipomoea venosa* (Desr.) Roem. & Schult.	N	C	HW, Co
Euphorbiaceae				
31	*Euphorbia pyrifolia* Lam.	N	F	Gl
32	*Phyllanthus amarus* Schumach. et Thonn.	I	O	HG
Goodeniaceae				
33	*Scaevola sericea* Vahl.	N	A	BC
Guttiferae				
34	*Calophyllum inophyllum* L.	N	C	HW
Labiatae				
35	*Plectranthus amboinicus* (Lour.) Spreng.	?I	C	Gl
Lauraceae				
36	*Cinnamomum verum* Presl.	I	A	HW
Lecythidaceae				
37	*Barringtonia asiatica* (L.) Kurtz	N	F	BC
Loganiaceae				
38	*Strychnos spinosa* Lam.	I	F	HW
Malvaceae				
39	*Abutilon indicum* (L.) Sweet	?I	O	HG
Meliaceae				
40	*Xylocarpus moluccensis* (Lam.) Roem.	N	R	BC, HW
Mimosaceae				
41	*Adenanthera pavonina* L.	I	C	HW
Moraceae				
42	*Ficus lutea* Vahl.	N	C	HW, Gl
43	*Ficus reflexa* Thunb. ssp. *seychellensis* (Baker) Berg	E(ss)	F	HW
Myrtaceae				
44	*Psidium cattleianum* Sabine	I	R	HW
45	*Syzygium jambos* (L.) Alston	I	C	HW, Gl
46	*Syzygium wrightii* (Baker) A. J. Scott	E	R	HW
Nyctaginaceae				
47	*Pisonia grandis* R. Br.	N	R	PG
Papilionaceae				
48	*Desmodium incanum* DC.	I	C	HW
49	*Desmodium triflorum* (L.) DC	I	F	HW
50	*Teramnus labialis* (L.) Spreng.	I	R	HW
Passifloraceae				
51	*Passiflora foetida* L.	I	F	HW
52	*Passiflora suberosa* L.	I	C	HG, HW
Rubiaceae				
53	*Canthium bibractatum* (Baker) Hiem.	N	A	HW, Gl
54	*Pentodon pentandrus* (Schumach.et Thonn.) Vatke	I	O	BC, Gl

Species	Status	Abund.	Habitats
Rutaceae			
55 *Citrus reticulata* Blanco	I	O	HW
Sapindaceae			
56 *Allophyllus sechellensis* Summerh.	E	O	HG
Sapotaceae			
57 *Mimusops sechellarum* (Oliv.) Hemsl.	E	R	Gl
Tiliaceae			
58 *Triumphetta rhomboidea* Jacq.	I	F	Gl
Turneraceae			
59 *Turnera angustifolia* Miller	I	F	HW
Verbenaceae			
60 *Clerodendron speciosissimum* Morren	I	R	HW
61 *Premna serratifolia* L.	N	A	HW, Gl
62 *Stachytarpheta jamaicensis* (L.) Vahl.	I	F	HW
63 *Stachytarpheta urticifolia* (Salisb.) Sims.	I	C	HW
ANGIOSPERMAE: Monotyledons			
Agavaceae			
64 *Furcraea foetida* (L.) Haw.	I	F	HW
Bromeliaceae			
65 *Ananas comosus* (L.) Merr.	I	C	Gl, HW
Cyperaceae			
66 *Cyperus compressus* L.	?	O	Gl
67 *Fimbristylis cymosa* R. Br.	?	A	BC, Gl
68 *Fimbristylis* sp. (glacis sedge)	?	C	Gl
69 *Kyllinga polyphylla* Willd. ex Kunth	N	C	HW
70 *Mariscus dubius* (Rottb.) Fischer	N	A	HW, Gl
71 *Mariscus ligularis* (L.) Hutchinson	?N	F	HG, HW
72 *Pycreus polystachyos* (Rottb.) P. Beauv.	?	F	HW
Gramineae			
73 *Axonopus compressus* (l.) P. Beauv.	?	F	HW
74 *Brachiara umbellata* (Trin.) W. D. Clayton	N	A	HW
75 *?Brachiara* sp.	?	C	HW
76 *Ischaenum heterotrichum* Hack.	?	A	HW, Gl
77 *Oplismenus compositus* (L.) P. Beuv.	N	A	HW
78 *Panicum brevifolium* L.	N	A	HW
79 *Panicum maximum* L.	?	C	HW, Gl
80 *Paspalum scrobiculatum* L.	?	R	HW
81 *Pennisetum polystachyon* (L.) Schult.	?	C	Gl
82 *?Sacciolepis curvata* (L.) Chase	?	A	HW
83 *Setaria barbata* (Lam.) Kunth.	?	O	HG
84 *Stenotaphrum dimidiatum* (L.) Brogn.	N	A	HG, HW
Liliaceae			
85 *Dracaena reflexa* Lam. var. *angustifolia* Baker	N	C	HW, Gl
Orchidaceae			
86 *Vanilla phalaenopsis* Reichb. f.	E	O	Gl
87 *Vanilla planifolia* Andrews	I	F	HW
Palmae			
88 *Cocos nucifera* L.	N	A	HW, Co
89 *Nephrosperma vanhoutteanum* (Wendl. ex van-Houtt) Balf.	E	O	HW
90 *Phoenicophorium borsigianum* (K. Koch) Stuntz	E	A	HW
91 *Raphia farinifera* (Gaertn.) Hylander	I	R	HW
Pandanaceae			
92 *Pandanus balfourii* Mart.	E	F	Gl, HW

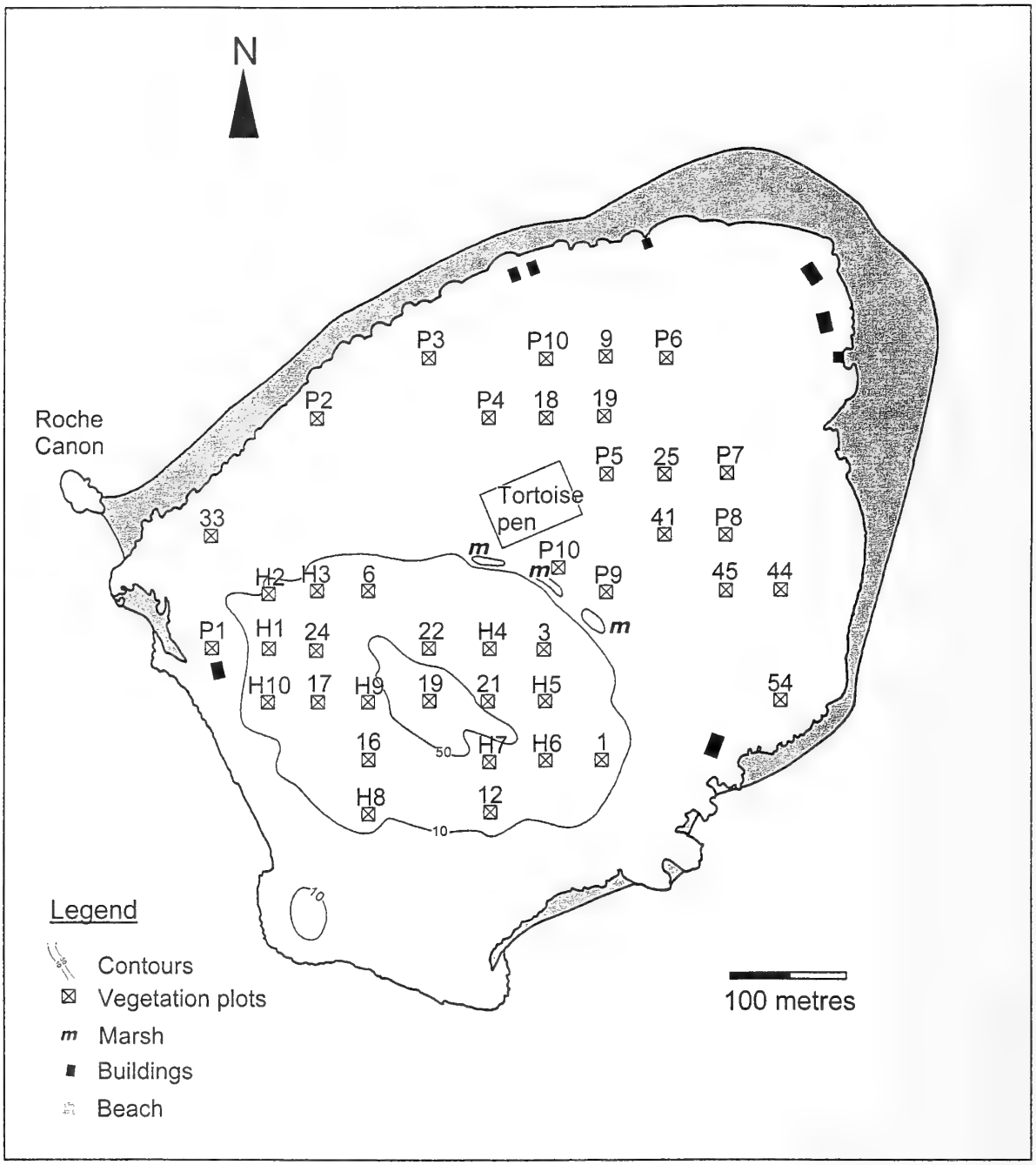

Figure 1. Cousin Island: physical, with locations of vegetation plots.

COUSIN

BY

MICHAEL J. HILL[1], TERENCE M. VEL[1], KATHRYN J. HOLM[2], STEVEN J. PARR[3] and NIRMAL J. SHAH[1]

GEOLOGY, TOPOGRAPHY AND CLIMATE

Cousin is one of the smaller islands of the granitic Seychelles with an area of only about 29 ha. It lies about 2 km from Praslin, the second largest of the central Seychelles islands, and 2.1 km north east of the slightly smaller island of Cousine.

The island is dominated by its plateau (Table 1), a flat coastal plain made up of phosphatic sandstones. This rock was formed by the action of seabird guano on loose deposits, largely of marine origin, in the presence of *Pisonia* litter (Fosberg, 1984). The southern part of the island consists of a granite hill which reaches 58 m. The granite of the hill is similar in quality to that of Praslin Island (Braithwaite, 1984). Along Anse Frégate in the south, there is a conspicuous line of fossil beach-rock (Fosberg, 1970). A granite outcrop, Roche Cannon, of similar granite to the hill, is connected to the north west corner of the island by a natural causeway.

The plateau rocks support a thin layer of soil. Fosberg (1984) describes the plateau deposits as a beheaded Jemo soil, except around the marshes where deeper alluvial deposits have accumulated. These deeper soils were used for crop cultivation, and small numbers of fruit trees survive at the base of the hill.

Cousin's beaches surround the island and their sand is highly mobile, shifting between beaches on the east and west sides of the island with the two main seasons of the Seychelles (Frazier and Polunin, 1973). Standing fresh water on the island is limited in extent and seasonal. On the plateau at the northern base of the hill there are several freshwater pools. To the south of the hill is a regularly inundated area of land colonised by mangroves. There are several small seasonal streams.

The Seychelles islands experience a seasonal humid tropical climate (Walsh, 1984). Historical weather data for Cousin Island are limited and current data are unavailable. A summary of data on rainfall for the period 1970-75 is shown in Table 2.

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Table 1. Area of Cousin Island by altitude (calculated from maps published by Directorate of Overseas Survey (UK)/Seychelles Government).

Altitude range (m. asl.)	Area (ha)	Percentage total area
50 - 100	0.6	2.1
10 - 50	5.5	19.2
0 - 10	22.5	78.7

Table 2. Cousin Island. Mean monthly rainfall (mm), 1970-1975 (from Shah *et al.* 1999).

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
232	141	143	110	56	30	41	100	112	205	139	310	**1619**

HISTORY

The island was briefly mentioned by Malavois (1787) who described it as wooded with difficult access (in Fauvel, 1909). In 1821, when the island was surveyed by the Mauritian Government surveyor, it was divided into three sections owned by freed slaves (Diamond, 1975). In the nineteenth and early twentieth centuries, the island had a succession of private owners. At this time mixed agriculture was probably practised and the natural resources of the predator-free island (turtles, seabirds and their eggs) exploited. Coconut plantations were begun on Cousin around 1910. Within 10 years, the natural vegetation of the plateau had been completely replaced by coconuts (den Boer and Geelhoed, 1990).

The island was managed for copra production until 1967 when it was purchased by the International Council for Bird Preservation (now BirdLife International) and subsequently managed as a nature reserve, largely to protect the Seychelles warbler *Acrocephalus sechellensis*, which was then known only from Cousin (Komdeur, 1988). Management from this time allowed the regeneration of semi-natural vegetation dominated by *Pisonia grandis* (Phillips, 1984). The island was designated a Nature Reserve by the Seychelles Government in 1968, and was designated a Special Reserve in 1969. The Special Reserve designation includes the sublittoral zone to 400 m beyond the high-water mark (Shah *et al.* 1999).

FLORA AND VEGETATION

Flora

Ninety-five plant species were recorded on Cousin Island, including three ferns and 92 angiosperms. Of the angiosperms, 47 (51.1%) species are regarded as introduced (Friedmann, 1994) and 32 (34.8%) native. Only one of these native species (*Pandanus balfourii*) is endemic to the Seychelles although the list also contains an endemic subspecies (*Ficus reflexa* ssp. *seychellensis*).

The flora of Cousin Island has a similar proportion of introduced species and a smaller number of endemics than the flora of Seychelles as a whole (of the total Seychelles flora, around 54% are introduced and 9% endemic: Procter, 1984). The small number of endemic taxa probably reflects the island's size; in general, smaller islands in the archipelago have fewer endemic species (Procter, 1984).

Of the introduced plants established on Cousin Island, a small number can be regarded as invasive weed species (Carlström, 1996a; Fleischmann, 1997). Of these, three are woody plants: casuarina *Casuarina equisetifolia* (frequent in beach crest vegetation; possibly native), papaya *Carica papaya* (abundant in plateau woodland) and agati *Adenanthera pavonina* (occasional in plateau woodland).

Other potentially invasive species are the herbs pineapple *Ananas comosus* and fatak grass *Panicum maximum*. Both species currently have a limited distribution on the island. The Rangoon creeper *Quisqualis indica* occurs at one point near the marsh. It has the potential to dominate large areas through vegetative propagation.

Several previous workers have produced plant species lists for Cousin Island, most notably Fosberg (1970, 1984). Fosberg recorded 132 species, many of which are still present on the island. Further surveys were carried out by Bathe and Bathe (1982) and Schumacher and Wüthrich (2000). In total, 54 species were identified in previous surveys but not in the current survey (Appendix 1). At least three of these previously recorded taxa are synonyms of other species on the list, and three may never have been present on the island. Many more (especially species of cultivation) are probably now extinct, or are occasionally cultivated. Some species were undoubtedly overlooked; a long-term survey of 1999 recorded 10 species not recorded by this survey (Schumacher and Wüthrich, 2000). If these, and species listed by previous authors which may survive (17 species: mainly herbs and grasses which may have been overlooked) are included, the total current plant species list for Cousin is 122.

Vegetation

The extents of major vegetation types on Cousin Island are shown in Table 3, and on Map 2. While most of the island was formerly coconut plantation, the plateau and part of the hill is now dominated by native woodland. The hill also has native scrub and large areas of bare rock.

In total, 40 vegetation plots were completed, 20 in June and 20 in December, covering 4,000 m^2 or 1.4% of the island's surface. Twenty vegetation plots were in plateau woodland covering 2,000 m^2 or 1.1% of this habitat type, and 20 were in hill woodland/scrub (excluding areas of bare rock), covering 2,000 m^2 or 4.7% of this habitat type. A summary of results is shown in Table 4.

Hill woodland plots had a relatively low density of trees with sparse shrub and herb layers. The most abundant tree was the native *Pisonia grandis* (Table 5). Introduced trees made up only a small proportion of the total tree layer (only one or two species, around three percent of stems). The shrub layer of hill plots was species-poor, with only eight species represented, seven of which were native. The most widespread species was *Euphorbia pyrifolia* (Table 6). Coconut *Cocos nucifera* was only present in one plot, although in that plot it constituted 38% cover in the herb layer. The herb layer of hill

plots had fewer species than plateau plots: only 18 species were recorded, four of them introduced. The only species occurring in more than 10 plots was the fern *Nephrolepis ?biserrata*, in 17 plots (with a mean coverage of 29.6% in these plots).

Plateau woodland plots had a high density of trees, relatively dense shrub layer, and sparse herb layer. The tree layer was more species-rich than that of hill woodland and included several species not present on the hill. *Pisonia grandis* was again dominant, but introduced species were more prominent due to the abundance of introduced papaya, absent on the hill. The shrub layer of plateau plots was more species-rich than that of hill plots with 15 species represented (three of them introduced). The most widespread species, and that forming the largest part of shrub cover in the plots where it occurred, was *Pisonia grandis. Cocos nucifera*, *Morinda citrifolia* and *Ochrosia oppositifolia* were also widespread in the plateau shrub layer. The herb layer of plateau plots was also species-rich with 20 species, seven or eight of which were introduced. Five species occurred in 10 or more plots: the most widespread and abundant were the liana *Canavalia cathartica* (in 15 plots, mean cover 14.8%) and the fern *Nephrolepis ?biserrata* (in 15 plots, mean cover 13.7%). *Morinda citrifolia* occurred in 12 plots (mean cover 1%), *Carica papaya* in 11 (mean cover 1%), and *Pisonia grandis* 10 (mean cover 4.7%).

Table 3. Extent of major vegetation types, Cousin Island.

	Vegetation type	Area (ha)
Hill	Woodland (*Pisonia grandis* dominant)	1.5
(> 10 m asl)	Woodland (figs, other native spp.)	0.4
	Scrub (native)	2.4
	Bare rock	1.1
Plateau	Woodland (*Pisonia grandis* dominant)	17.2
(< 10 m asl)	Woodland (other native spp.)	0.7
	Scrub (native)	0.1
	Coconuts	0.1
	Freshwater marsh	0.2
	Mangrove	0.8
	Beach crest vegetation (including *Casuarina*)	1.9
	Bare rock	1.5
	Grassland/garden	0.1

Table 4. Vegetation plot summary.

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)
Plateau woodland	20	<5	990	41.9	29.9	44.4	21.4	3.8
Hill woodland	20	21	390	15.9	29.6	22.1	47.1	1.3

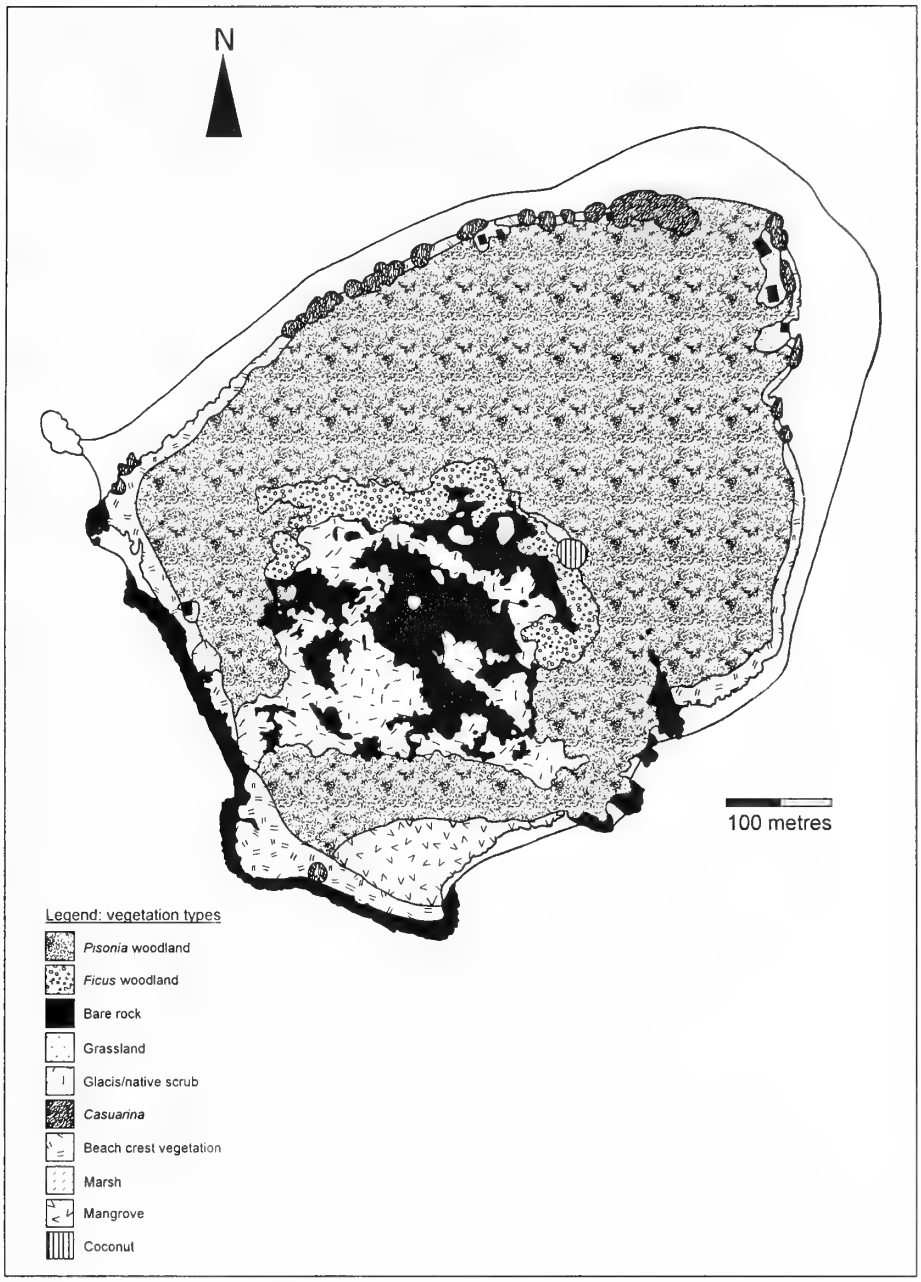

Figure 2. Cousin Island vegetation.

Table 5. Cousin Island: tree species recorded

	Hill		Plateau	
	No. stems	% stems	No. stems	% stems
Introduced species				
Adenanthera pavonina			6	3.2
Carica papaya			32	16.2
Eucalyptus sp.	2	2.6		
Native species				
Euphorbia pyrifolia	18	23.1	2	1.0
Ficus lutea	4	5.1	5	2.5
Ficus reflexa	9	11.5	2	1.0
Hibiscus tiliaceus			2	1.0
Ochrosia oppositifolia			13	6.5
Pandanus balfourii	11	14.1		
Phyllanthus pervilleanus			1	0.5
Pisonia grandis	33	42.3	88	44.4
Status unknown				
Morinda citrifolia	1	1.3	47	23.7
Total	**78**		**198**	

Table 6. Cousin Island: most widespread shrub species.
Shrubs occurring in five or more plots shown. Percentage shrub cover is the mean cover for those plots in which the species occurs.

	Hill		Plateau	
	No. plots	% shrub cover	No. plots	% shrub cover
Introduced species				
Carica papaya			8	3.3
Native species				
Cocos nucifera	1	38.0	15	13.4
Euphorbia pyrifolia	13	12.7	3	6.3
Ficus lutea	7	5.9	7	1.1
Ficus reflexa	7	2.3	5	1.2
Ochrosia oppositifolia			13	9.3
Phyllanthus pervilleanus			5	4.6
Pisonia grandis	5	8.0	19	14.9
Status unknown				
Morinda citrifolia	1	8.0	15	7.0
Total	**20**		**20**	

Flora And Vegetation: Discussion

A vegetation survey of the island was competed by Diamond (1975) before the island had become dominated by *Pisonia grandis* woodland. At the time, the island (especially the plateau) was still dominated by plantation palms. The hill, largely unsuited for cultivation, was less extensively planted. Following the island's designation as a Nature Reserve, attempts to replant native vegetation were deemed largely unsuccessful (Diamond, 1975) and a process of natural succession occurred with coconuts removed to prevent the island being overtaken by coconut scrub.

Fosberg (1970) predicted that the vegetation would undergo succession until dominated by *Pisonia*. This change has happened within a period of 30 years, assisted by the repression of coconut regrowth and the removal of mature fruiting palms. If mature palms had been left in place, and coconuts left to germinate, the plateau would probably now be a dense palmetum. Although *Pisonia* is a relatively fast-growing, short-lived tree with fragile wood, it can form climax vegetation through its ability to layer, and regenerate quickly from fallen stems (Schumacher and Wüthrich, 2000). It is possible that further change may result in areas of *Ochrosia*-dominated woodland (Fosberg, 1970); other abundant woody species on the plateau are small trees or large shrubs.

The flora of Cousin has lost many of the introduced species that were recorded by Fosberg (1984). Of introduced woody species, the most widespread in natural habitats were *Carica papaya* and *Adenanthera pavonina* (although a number of other species occur, especially in previously cultivated areas around the marshes). There was evidence for widespread regeneration of both species. Although the most abundant woody exotic on the island, *Carica* is probably not of major conservation concern: its fruits are eaten by a number of endemic vertebrates including *Foudia sechellarum* (Collar and Stuart, 1985) and *Mabuya* spp. (Brooke and Houston, 1983). Individual plants are relatively short-lived and small (the mean height of *Carica* in the tree layer was 7.4 m compared to 10.7 m for *Pisonia*), so they are unlikely to shade out other tree species.

Mature coconut palms were not found in any of the vegetation plots; large *Cocos* now have a restricted distribution on the island (mainly around the marsh; see Fig. 2). However, young *Cocos* plants were relatively widespread and abundant in the shrub layer on the plateau (more restricted on the hill). Management of coconut regrowth remains important.

INVERTEBRATES

Pitfall Trapping

Pitfall trap assemblages were relatively large, compared to those from other islands surveyed (Table 7). Assemblages (excluding ants) were larger in the north west monsoon period than in the dry season dominated by south east trade winds. The high value for hill plots in the SE season is due to extremely high ant numbers trapped in one plot. Ants dominated all pitfall assemblages forming between 57% of the total invertebrate individuals (NW, hill) and 98% of invertebrate individuals (SE, hill). Other

than ants, dominant invertebrate groups included Crustacea (including both Isopoda and Amphipoda), Blattodea, Dermaptera and Araneae (Fig. 3). In Hill plots, larger numbers of Crustacea were trapped. Only isopods were collected on the hill; amphipods were abundant but only trapped in plateau plots. Cockroaches (Blattodea) were also abundant in hill plots in both seasons.

Plateau woodland sites were dominated by ants which made up 78.6% of the total individuals in pitfall assemblages. The most abundant species was the native *Odontomachus troglodytes* (41.5% of individuals), followed by *?Cardiocondyla emeryi* (35.6% of individuals). The most abundant non-ant species (and the third most abundant species) was an amphipod crustacean which formed 5.0% of individuals. An earwig species (Dermaptera) made up 4.0% of individuals. A total of 73 morphospecies were collected in 20 plots.

In hill woodland/scrub, assemblages were similar but less species-rich. A total of 48 taxa were collected in 16 plots. Ants were again dominant, forming 90.0% of the total individuals. *Cardiocondyla emeryi* was the most abundant species (88.2% of individuals). An isopod crustacean was the second most abundant species (4.9% of individuals). Other species form much smaller proportions of the total assemblage: a cockroach species made up 2.3% of individuals, *Odontomachus troglodytes* 0.7%.

The crazy ant *Anoplolepis gracilipes* was collected twice. One individual was collected in a hill plot and one in a plateau plot.

Table 7. Pitfall assemblages from Cousin Island.
Only invertebrates of body length >2 mm included.
(Number in parentheses = number of invertebrates excluding ants).

	Habitat	Mean no. individuals per 5 traps	
		SE season	NW season
Cousin	Plateau woodland	58.0 (16.9)	122.9 (21.6)
	Hill woodland	410.2 (6.7)	62.7 (27.0)
Mean for all granitic islands		61.8 (9.4)	61.1 (16.0)

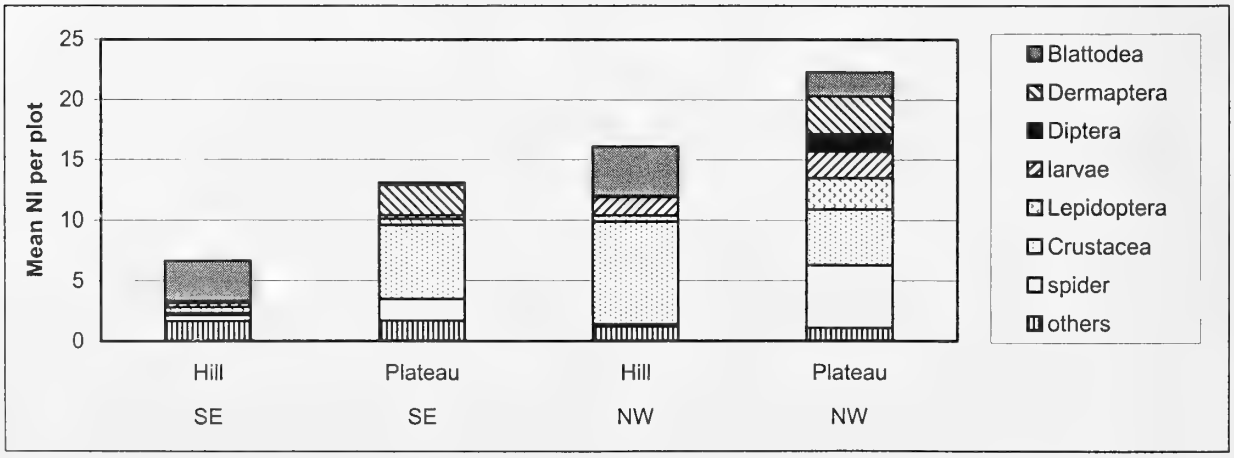

Figure 3. Composition of pitfall assemblages on Cousin Island, excluding ants.

Leaf-insect Counts

Leaf-insect counts were carried out for six tree and shrub species, five of these in both seasons (Table 8). For four of the species counted in both seasons, invertebrate densities were higher in June. For one species, invertebrate counts were higher in December, during the north west monsoon. As found on some other islands, the highest density of invertebrates was on the shrub *Morinda citrifolia*. *Pisonia grandis* also had high invertebrate densities (especially in June). Together, these two species dominate woodland vegetation on the plateau of Cousin.

Table 8. Density of invertebrates on foliage, Cousin Island
n = no. of leaves counted; NI = number of individual invertebrates.

Species	SE season (June)			NW season (December)		
	n	mean NI leaf^{-1}	mean NI m^{-2}	N	mean NI leaf^{-1}	mean NI m^{-2}
Native species						
Euphorbia pyrifolia	250	0.068	47.28	600	0.070	30.73
Ficus lutea	150	0.420	36.68	350	1.040	76.35
Ficus reflexa	0			400	0.193	57.88
Ochrosia oppositifolia	250	1.100	54.91	500	0.114	8.51
Pisonia grandis	400	3.133	150.93	1600	0.531	46.02
Status unknown						
Morinda citrifolia	250	4.332	322.56	550	0.342	33.27

Malaise Trapping

Malaise trapping was carried out in hill and plateau woodland habitats, during both seasons. Five Malaise traps (three in plateau plots, two in hill plots) were run in June, and four (two in each habitat) in December 1999 (Table 9). Assemblages were larger in the north west monsoon season (December), than in the south east season. However, there was no consistent difference in catch size between habitats. The major insect order in most seasons was the Diptera. In June, in hill plots, Hemiptera (especially Auchenorrhyncha) dominated assemblages. The majority of taxa collected have yet to be identified to species level.

Table 9. Malaise trap assemblages, Cousin.
NI = Number of Individuals.

	SE (June)		NW (December)	
	Hill	Plateau	Hill	Plateau
No. traps	2	3	2	2
Mean NI trap^{-1}	699.5	1038.0	2890.5	1875.0
Total NI Diptera	232	1262	4312	1137
Total NI Hemiptera	527	512	39	38
Total NI Hymenoptera	216	752	317	348
Total NI Lepidoptera	237	481	1013	288
Total NI Orthoptera	128	63	45	19
Total NI Other orders	59	44	55	45

Observation

A list of species observed or collected in the current survey, and by previous workers, is given in Table 10. Terrestrial invertebrates were collected on both assessment visits; aquatic invertebrates were only collected when there was water in the marsh, in December. At this time, the marsh had standing water with a combined area of about 1,000 m^2 and to a depth of up to 50cm. An aquatic light trap operated overnight collected two crustacean species in very large numbers.

Discussion: Invertebrates

Pitfall assemblages from Cousin Island were relatively large and assemblages on the plateau (excluding ants) were larger than those on the hill: plateau areas are more suitable for Seychelles magpie-robin than hill areas.

The presence of the crazy ant *Anoplolepis gracilipes* in pitfall assemblages, albeit in small numbers, is of concern. This pest species was introduced in Seychelles in the early 1960s (Haines *et al.*, 1994) and has since been spread to many islands including Marianne and Félicité. On Bird Island, especially high concentrations of ants have caused tree death (Hill, in prep.) and the eradication of native reptiles from large parts of the island (Feare, 1999a). Crazy ants were not recorded on Cousin in 1982 (Bathe, 1982b) but their presence has been reported on several occasions, and ants in the vicinity of buildings have been eradicated. It is possible that the species had been present on the island for some time but has not been able to reach the pest proportions found on other islands due to competitive exclusion by other ant species favoured in the semi-natural habitats of Cousin Island.

Leaf invertebrate counts were highest for the two tree species that currently dominate Cousin's woodland (especially plateau woodland). For most tree species (contrary to results for several islands) invertebrate densities were higher in the dry season (June) than in the north west monsoon season (December).

Few aquatic invertebrates were collected on Cousin, probably as a result of the seasonality of standing water on the island. No dragonflies were recorded, although six species have been recorded on the island, four breeding (Bathe, 1982c). Species lists have also been produced for Cousin bees (5 species: Bathe, 1982a) and ants (14 species: Bathe 1982b).

Table 10. Invertebrates, Cousin Island.
Previous records (in notes); 1 = Bathe and Bathe, 1982a; 2 = Mühlenberg 1977; 3 = Bathe and Bathe, 1982b; 4 = Bathe and Bathe, 1982c; 5 = Blackman 1965, in Blackman and Pinhey, 1967.

Order	Family	Species	Notes
Mollusca	Achatinidae	*Achatina* sp.†	Many empty shells
	Subulinidae	*Subulina octona* Bruguière, 1792	
		?Opeas sp.	
Arachnida:			
Amblypygi	Tarantulidae	*?Charinus seychellarum* Krapelin, 1898	
Araneae	Tetragnathidae	*Nephila inaurita* (Walckenaer, 1841)	
Scorpiones	Buthidae	*Isometrus maculatus* (de Geer, 1778)	
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	
	Grapsidae	*Grapsus tenuicrustatus* (Herbst, 1783)	
	Ocypodidae	*Ocypode ceratophthalmus* (Pallas, 1772)	
		Ocypode cordimana Desmarest, 1825	
Myriapoda:			
Chilopoda	Scolopendridae	*Scolopendra subspinipes* (Leach, 1918)	
Diplopoda	Spirostreptidae	*Seychelleptus seychellarum* (Desjardins, 1834)	
	Spirobolellidae	*?Benoitiulus flavicollis* Mauries, 1980	
	Trichopolydesmidae	*Cylindrodesmus hirsutus* (Pocock, 1888)	
	Trigoniulidae	*Spiromanes ?braueri* (Attems, 1900)	
		Spiromanes seychellarum Saussure & Zehntner, 1902	
Insecta:			
Coleoptera	Scarabaeidae	*Oryctes monoceros* (Olivier, 1789)	
Hymenoptera	Anthophoridae	*Ceratina nodosiventris* Cockerell 1912 *	Recorded 1982[1]
		Xylocopa caffra (Linnaeus, 1767)	
	Apidae	*Apis mellifera adansoni* Latreille, 1804	Recorded 1982[1] and 1999/2000
	Formicidae	*Anoplolepis gracilipes* (Smith, 1857)	
		Brachymyrmex cordemoyi Forel 1895 *	Recorded 1975[2]
		Camponotus grandidieri Forel, 1886 *	Recorded 1982[3]
		Camponotus hova Forel, 1891	
		Cardiocondyla emeryi Forel, 1881	
		Leptogenys maxillosa (Smith, 1858) *	Recorded 1982[3]
		Monomorium floricola (Jerdon, 1851) *	Recorded 1975[2]
		Odontomachus troglodytes Santschi, 1914	Recorded 1975[2], 1999-2000
		?Pachycondyla melanaria (Emery, 1894)	
		Paratrechina bourbonica (Forel, 1886) *	Recorded 1975[2]
		Paratrechina longicornis (Latreille, 1802)*	Recorded 1975[2]

Table 10 (cont.)

Order	Family	Species	Notes
		Pheidole megacephala (Fabricius 1793) *	Recorded 1982[3]
		Strumigenys rogeri Emery, 1890*	Recorded 1982[3]
		Tapinoma melanocephalum (Fabricius, 1793)*	Recorded 1975[2]
		Technomyrmex albipes (Smith, 1861)	Recorded 1975[2], 1982[3], 1999-2000
		Tetramorium ?bicarinatum (Nylander, 1846)	
		Tetramorium languinosa Mayr, 1870 *	Recorded 1982[3]
		Tetramorium simillimum (F. Smith, 1851)*	Recorded 1982[3]
	Halictidae	*Pachyhalictus mahensis* (Cameron) *	Recorded 1982[1]
	Megachilidae	*Megachile seychellensis* Cameron, 1907 *	Recorded 1982[1]
	Vespidae	*Polistes olivaceus* (de Geer, 1773)	
Lepidoptera	Hesperiidae	*Borbo* sp.	
	Lycaenidae	*Leptotes pirithous* Linnaeus, 1767	
Neuroptera	Myrmeleontidae	*Myrmeleon obscurus* Rambur, 1852	
Odonata	Coenagrionidae	*Ceriagrion glabrum* (Burmeister, 1839)*	Recorded 1980-81[4]
	Aeshnidae	*Hemianax ephippiger* (Burmeister, 1839)*	Recorded 1980-81[4]
	Libellulidae	*Diplocodes trivialis* (Rambur, 1842)*	Recorded 1980-81[4]
		Orthetrum stemmale wrightii (Selys, 1869)*	Recorded 1965[5], 1980-81[4]
		Tramea limbata (Selys, 1869)*	Recorded 1980-81[4]
		Zyxomma petiolatum (Rambur, 1842)*	Recorded 1965[5]

† extinct?

• species recorded by previous workers but not observed in current survey

VERTEBRATES

Reptiles and Amphibians

Six terrestrial reptiles were observed (Table 11), all native to Seychelles although one (Aldabra tortoise) was introduced in the granitic islands and was first recorded on Cousin in the 1960s (Bour, 1984). Four species of reptile previously recorded on Cousin were not observed in the current survey, the geckos *Urocotyledon inexpectata* and *Gehyra mutilata*, the Brahminy blind snake *Ramphotyphlops braminus* and the freshwater terrapin *Pelusios subniger*. Three of these (excluding *G. mutilata*) are rather cryptic, rarely observed species and were probably overlooked. *U. inexpectata* was recorded once, in 1979 (Shah *et al.*, 1999); its current status is unknown.. The introduced gecko *Gehyra mutilata* has been observed in houses (Shah *et al.*, 1999). It is common on larger islands such as Praslin and, if extinct, is likely to reinvade. The blind snake is a widespread introduced species found on many of the islands where agriculture formerly occurred, and probably survives on Cousin. The terrapin was introduced to the island from La Digue in *c.* 1940 (Bour, 1984). It is rarely observed by island staff but may survive.

Two of the native skinks of Cousin Island, Seychelles skink *Mabuya sechellensis* and Wright's skink *Mabuya wrightii*, reach extremely high population densities on

Cousin with a biomass of between 96 kg and 184 kg per hectare (Hunter, 1978: Brooke and Houston, 1983). Such high biomass is supported by the seabird colonies of the island. *M. wrightii* is restricted to islands with seabird colonies although the apparent association may be simply the result of its inability to survive on islands with introduced rats (Cheke, 1984). *M. sechellensis*, although endemic, is widespread in the granitic islands and the near coralline islands. The large gecko *Ailuronyx seychellensis* also survives on islands with rat populations, although it is most obvious on rat-free islands, where (as on Cousin) it is diurnal and often found in houses (Cheke, 1984).

In addition to the land reptiles, two marine turtle species breed on Cousin Island: green sea turtle *Chelonia mydas* (L.) and hawksbill *Eretmochelys imbricata* (L.). Breeding hawksbills were observed in December. October to January is the peak breeding season for hawksbill sea turtles on Cousin (Frazier, 1984).

One species of amphibian, an unidentified species of caecilian (possibly *Hypogeophis rostratus*) has been recorded on Cousin Island (Nussbaum, 1984b), but was not observed during the current survey.

Table 11. Reptiles observed on Cousin.
Status: E =endemic, I = introduced, N = native (in central Seychelles).

Family	Species		Status
Gekkonidae	*Ailuronyx seychellensis* (Dumeril & Bibron, 1836)	bronze-eyed gecko	E
	Phelsuma astriata Tornier, 1901	day gecko	E
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	Seychelles skink	E
	Mabuya wrightii (Boulenger)	Wright's skink	E
	Pamelaescincus gardineri Boulenger, 1909	burrowing skink	E
Testudinidae	*Geochelone gigantea* (Schweigger, 1812)	Aldabra giant tortoise	I

Birds

In total, 15 land birds and waders were recorded (Table 12). Five of these were endemic species, three of which are regarded as endangered or vulnerable species in Seychelles (Watson, 1984). For much of the twentieth century, Cousin was the only island on which the Seychelles warbler *Acrocephalus sechellensis* occurred (Komdeur, 1988). In 1988-90 birds were translocated to Aride and Cousine and further populations established (Komdeur, 1994). The Seychelles magpie-robin *Copsychus sechellarum* was translocated to Cousin in 1994 and the Cousin population is now the second largest of three island populations (Parr *et al.*, 1999). The Seychelles fody *Foudia sechellarum* is currently restricted to three islands in the granitic archipelago, with an introduced population surviving on D'Árros. Cousin probably holds the major population of this species (Collar and Stuart, 1985).

Penny (1974) noted that the endemic Seychelles form of the "Madagascar" turtle dove, *Streptopelia picturata rostrata*, appeared to survive on the island but a survey in 1990 suggested that very few individuals display the characteristics of true *S. p. rostrata*. Most individuals belonged to an intermediate form showing characteristics of both *S. p.*

rostrata and the introduced Madagascar form *S. p. picturata* (den Boer and Geelhoed, 1990), suggesting that *S. p. rostrata* has become effectively extinct through cross-breeding.

Two additional resident land bird species are known on Cousin. The black-crowned night heron *Nycticorax nycticorax* was found to be breeding on the island in 2000 (Anon, 2000), following natural colonisation of the island. There are also occasional records of the introduced barn owl *Tyto alba* and it seems likely that there is at least one resident bird. On Cousin, where rats are unavailable, barn owls prey on birds, especially fairy terns *Gygis alba* (Penny, 1975). Other bird species are also taken, suggesting that the presence of the barn owl represents a threat to endemic land birds on the island. In addition to the land birds, Cousin Island supports breeding colonies of seven seabird species.

Ten seabird species were observed (Table 13), seven of which breed on the island. Diamond (1975) lists 52 bird species that had been recorded from Cousin Island, including migrants and vagrants not recorded in this survey. Since his list was written, two new resident breeding birds have been added to the fauna of Cousin: Seychelles magpie-robin and black-crowned night heron, and the Seychelles blue pigeon *Alectroenas pulcherrima*, which only occurred occasionally at the time of Diamond's list, is now resident.

Table 12. Land birds and waders observed on Cousin.
M = migrant species; E = Seychelles endemic species.

Species		Notes
Bubulcus ibis	cattle egret	One observed in mangrove, 14/6/99
Butorides striatus	green-backed heron	One observed near Roche Canon, 7/12/99
Gallinula chloropus	common moorhen	Common at main marsh, and in a variety of plateau and hill habitats
Dromus ardeola M	crab plover	One individual, December.
Arenaria interpres M	ruddy turnstone	Regularly observed on beaches and plateau woodland, in small groups, both June and December
Calidris alba M	sanderling	One group of 5-6 birds observed on beach, June
Streptopelia picturata ssp.	turtle dove	Regularly seen around houses and in woodland, June and December
Geopelia striata	barred ground dove	Occasional at houses, and on hill glacis, June and December
Alectroenas pulcherrima E	Seychelles blue pigeon	Nesting close to houses. Flock of 7-10 seen feeding on figs 20/6/99 (observed by Alan Burger)
Copsychus sechellarum E	Seychelles magpie robin	Regularly seen in woodland
Acrocephalus sechellensis E	Seychelles warbler	Very common in woodland
Nectarinia dussumieri E	Seychelles sunbird	Very common in woodland
Acridotheres tristis	common mynah	One observed in *Casuarina* close to research house, 14/6/99
Foudia madagascariensis	Madagascar fody	Rarely seen
Foudia sechellarum E	Seychelles fody	Very common in woodland and around houses, June and December

Table 13. Seabirds observed on Cousin Island.

Species		Notes
Puffinus pacificus	wedge-tailed shearwater	Breeding birds present (June)
Puffinus lherminieri	Audubon's shearwater	Breeding birds present (June & December)
Phaeton lepturus	white-tailed tropicbird	Breeding birds present (June & December)
Sterna anaethetus	bridled tern	Breeding birds present (June)
Anous stolidus	brown noddy	Breeding birds present (June)
Anous tenuirostris	lesser noddy	Breeding birds present (June)
Gygis alba	fairy tern	Breeding birds present (June & December)
Fregata minor	great frigatebird	Seen overflying island several times, in both June and December
Sterna dougalli	roseate tern	Seen from beach 23/6/99 (observed by Alan Burger)
Sterna fuscata	sooty tern	Seen from beach 23/6/99 (observed by Alan Burger)

Mammals

Two mammal species were observed in the course of the survey, the endemic fruit bat *Pteropus seychellensis* and the introduced black-naped hare *Lepus nigricollis*. During both assessments, Seychelles fruit bats were observed feeding on fruit on Cousin. Most or all appear to roost on Praslin; bats were observed flying over the sea from Praslin to Cousin on the evening of 21st June. Black-naped hares are the only terrestrial mammal on the island. They were seen every day of the survey, usually singly, throughout the island in woodland, scrub and grassy areas. The population of hares was estimated to be between 50 and 100 animals in 1974 (Diamond, 1975). In 1981, the population was estimated as 120–170 individuals (Kirk and Racey, 1992). The effect of the animals on the vegetation of Cousin has not been fully documented. In the 1980s, faecal pellets were dominated by plants that are now rather rare on the plateau (grasses and sedges). Hares may also distribute *Boerhavia* and *Achyranthes*, although the former species is also now rare on Cousin in comparison to many other islands. It is also possible that hares reduce the regeneration of *Casuarina* (Kirk and Racey, 1992).

Rats (*Rattus* spp.), although widespread on other islands of the granitic Seychelles (and introduced soon after human colonisation to many of the islands: Fauvel, 1909), have never been present on Cousin. The absence of rats and cats accounts for the survival here of the Seychelles warbler and large colonies of breeding seabirds.

CONSERVATION RECOMMENDATIONS

Conservation recommendations have been given in various management plans for the Nature Reserve, including the most recent (Shah *et al.*, 1999). Recommendations generally centre on the preservation of the island's existing wildlife values, rather than on habitat restoration, as a natural process of rehabilitation has occurred since the island was acquired as a nature reserve. In 30 years, *Pisonia* forest has replaced coconut plantations and the forest existing today, at least on the plateau, probably resembles the original vegetation of the island (Fosberg, 1970).

The major recommendations of management plans concern the need to prevent invasion of alien species currently absent from the island, especially mammals. Vegetation management measures in the most recent management plan are limited to the removal of fallen coconuts and the management of beach-crest vegetation by encouraging native species and removing casuarinas. Additional measures that could be proposed in the light of this report include:

1) Monitoring of crazy ant populations and (if feasible) eradication of this species.

Crazy ants are present, but apparently in very small numbers. It is important to monitor populations. The species tends to undergo "boom and bust" demography after introduction to a new area (Haines *et al.*, 1994) and it can have important conservation implications (Haines *et al.*, 1994; Feare, 1999).

2) Removal of mature coconut palms around marsh.

Although probably a native species in the granitic Seychelles (Sauer, 1967), the present abundance of coconuts is a function of planting in the nineteenth and twentieth centuries. On Cousin, coconuts can be regarded as a weed because the regrowth of young palms from fallen nuts produces dense vegetation unsuitable for foraging by Seychelles magpie-robin, which prefers open areas of leaf litter (McCulloch, 1994). Coconut palms are currently controlled by removal of seedling growth and fallen nuts. Both are still abundant near the main area of mature palms surviving on the plateau at the marsh. Here mature palms shade the marsh and prevent the growth of aquatic macrophytes. Removal of most (or all) of these palms would allow more light to reach the seasonal marsh and reduce the need for management of coconut seedling growth.

3) Control/eradication of other invasive introduced species.

Few introduced plant species appear invasive in Cousin's semi-natural habitats. *Adenanthera pavonina* was rather widespread in vegetation plots and produces many seedlings; it should be removed. The introduced ornamental vine Rangoon creeper *Quisqualis indica* only occurs in one place near the marsh but is potentially invasive through vegetative propagation and could also be removed. Bamboo *Bambusa vulgaris* also has the potential for vegetative spread. The species rarely flowers so is unlikely to spread by seed at least one clump could be left in place.

Because a number of endangered endemic birds already exist on the small island of Cousin, further translocations of endemic birds to the island are not recommended unless a greater understanding of habitat requirements and compatibility of species can be gained.

Appendix 1. Plant species recorded from Cousin 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: Cu = Cultivation/settlement area; PG = Plateau grassland; PW = Plateau woodland; HW = Hill Woodland; Gl = Glacis; BC = Beach Crest; Ma = Marsh; Mg = Mangrove.
Historical records (in Notes): 1= Fosberg 1970; 2 = Bathe & Bathe 1982; 3 = Robertson 1989, 4 = Schumacher & Wüthrich 2000.

	Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA					
Adiantaceae					
1	*Acrostichum aureum* L.	N	R	Mg	
Davalliaceae					
2	*Nephrolepis ?biserrata* (Sw.) Schott	N	A	PW	
	Nephrolepis multiflora (Roxb.) Jarrett	N	-	-	Recorded 1970, 1982[1, 2]. = *N. biserrata?*
Polypodiaceae					
3	*Phymatosorus scolopendria* (Burm. f.)	N	F	HW, PW	
ANGIOSPERMAE: Dicotyledons					
Acanthaceae					
4	*Asystasia* sp B. (*sensu* Friedmann)	?I	A	PG, Gl	
	Asystasia gangetica (L.) T. Anders.	?I	-	-	Recorded 1970, 1982, 1999[1, 2, 4]. = *A.* sp. B?
	Justicia gendarussa	?I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
Aizoaceae					
5	*Glinus oppositifolius* (L.) A. DC.	?N	F	PW, Cu	
Amaranthaceae					
6	*Achyranthes aspera* L.	I	A	PW	
7	*Amaranthus dubius* Mart. ex Thell.	I	C	PW, Cu	
8	*Lagrezia* cf. *madagascariensis* (Poir.) Moq.	N	?	BC	
Anacardiaceae					
	Mangifera indica L.	I	-	-	Recorded 1970, 1982[1, 2]. Extinct on Cousin
	Spondias cytherea Sonn.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
Annonaceae					
	Annona muricata L.	I	-	-	Recorded 1970, 1982, 1999[1, 2, 4]
9	*Annona reticulata* L.	I	R	Cu	
10	*Annona squamosa* L.	I	O	Cu	

	Species	Status	Abund.	Habitats	Notes
Apocynaceae					
11	*Catharanthus roseus* (L.) G. Don.	I	C	HW, Cu	
12	*Ochrosia oppositifolia* (L.) K. Schum.	N	A	PW	
13	*Plumeria rubra* L.	I	R	Cu	
Avicenniaceae					
14	*Avicennia marina* (Forssk.) Vierh.	N	F	Mg	
Boraginaceae					
15	*Cordia subcordata* Lam.	N	F	BC	
16	*Heliotropium indicum* L.	I	O	Ma	
	Tournefortia argentea L. f.	N	-	-	Recorded 1970[1], 1982[2]. Extinct on Cousin
Caesalpiniaceae					
17	*Caesalpinia bonduc* (L.) Roxb.	N	R	PW	
18	*Senna occidentalis* (L.) Link	I	O	Ma, HW	
Capparidaceae					
19	*Cleome viscosa* L.	I	R	Gl	
Caricaceae					
20	*Carica papaya* L.	I	C	PW	
Casuarinaceae					
21	*Casuarina equisetifolia* J. R. & G. Foster	I	F	BC	
Combretaceae					
22	*Quisqualis indica* L.	I	R	Cu	
23	*Terminalia catappa* L.	?N	R	PW	
Compositae					
	Synedrella nodiflora (L.) Gaertn.	I	-	-	Recorded 1970[1], 1982[2]
24	*Vernonia cinerea* (L.) Less.	I	O	PW	
Convulvulaceae					
25	*Ipomoea macrantha* Jacq.	N	F	BC	
26	*Ipomoea pes-caprae* (L.) R. Br.	N	C	BC, Gl	
27	*Ipomoea venosa* (Desr.)	N	O	PW	
Crassulaceae					
28	*Kalanchoe pinnata* (Lam.) Pers.	I	O	PW	
Cucurbitaceae					
	Cucumis sp.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
	Cucurbita moschata (Lam.) Poir.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
	Momordica charantia L.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
	Trichosanthes cucumerina L.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
Euphorbiaceae					
29	*Acalypha indica* L.	I	C	PW	
	Euphorbia hirta L.	I	-	-	Recorded 1970, 1982[1, 2]
	Euphorbia prostrata L.	I	-	-	Recorded 1970[1]
30	*Euphorbia pyrifolia* Lam.	N	A	HW, Gl	
31	*Euphorbia thymifolia* L.	I	F	Gl	
	Euphorbia tirucalli	I	-	-	Recorded 1982[2], extinct on Cousin
	Manihot esculenta Crantz	I	-	-	Recorded 1970, 1982[1, 2], extinct on Cousin
	Pedilanthus tithymaloides (L.) Poit.	I	-	-	Recorded 1999[4]

	Species	Status	Abund.	Habitats	Notes
	Phyllanthus acidus (L.) Skeels	I	-	-	Recorded 1970, 1982[1, 2]. Extinct on Cousin
32	*Phyllanthus amarus* Schumach. et Thonn.	I	O	PW	
33	*Phyllanthus pervilleanus* (Baillon) Mull. Arg.	N	C	PW	
	Phyllanthus tenellus Roxb.	I	-	-	Recorded 1999[4]
34	*Ricinus communis* L.	I	F	PW	
Goodeniaceae					
35	*Scaevola sericea* Vahl.	N	C	BC	
Guttiferae					
36	*Calophyllum inophyllum* L.	N	R	PW, HW	
Labiatae					
37	*Plectranthus amboinicus* (Lour.) Spreng.	?I	O	PW, PG	
Lauraceae					
	Persea americana Mill.	I	-	-	Recorded 1970[1], 1982[2]. Extinct on Cousin?
Lecythidaceae					
38	*Barringtonia asiatica* (L.) Kurtz	N	O	BC	
Malvaceae					
39	*Abutilon indicum* (L.) Sweet	?I	R	PW, Cu	
40	*Gossypium hirsutum* L.	I	F	PW	
	Hibiscus surattensis L.	I	-	-	Recorded 1982[2]. Probably extinct on Cousin
41	*Hibiscus tiliaceus* L.	N	F	BC	
	Malachra capitata (L.) L.	?	-	-	Recorded 1970[1]. Not in Seychelles?
	Sida acuta Burm. f.	I	-	-	Recorded 1970[1]
42	*Sida cordifolia* L.	?N	F	Gl, HW	
	Sida stipulata Cav.	?I	-	-	Recorded 1989[3]
43	*Thespesia populnea* (L.) Soland. ex Correa	N	O	BC	
Mimosaceae					
44	*Adenanthera pavonina* L.	I	O	HW	
Moraceae					
	Artocarpus altilis(Parkins.) Fosb.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
	Ficus benghalensis L.	I	-	-	Recorded 1999[4]. = *F. rubra?*
45	*Ficus lutea* Vahl.	N	C	HW, PW	
46	*Ficus reflexa* Thunb. *seychellensis* (Baker) Berg	E (ss)	R	HW	
47	*Ficus rubra* Vahl.	N	R	PW	
Moringaceae					
48	*Moringa oleifera* Lam.	I	R	Cu	
Myrtaceae					
49	*Eucalyptus camaldulensis* Dehnh.	I	O	HW	
	Syzygium samarangense (Bl.) Merr & Perr.	I	-	-	Recorded 1970[1], 1982[2]. Extinct on Cousin
Nyctaginaceae					
50	*Boerhavia repens* L.	?N	C	PG	
51	*Mirabilis jalapa* L.	I	O	Cu	
52	*Pisonia grandis* R. Br.	N	A	PW	

	Species	Status	Abund.	Habitats	Notes
Onagraceae					
53	*Ludwigia octovalvis* (Jacquin) Raven	?I	O	Ma	
Oxalidaceae					
54	*Averrhoa bilimbi* L.	I	R	Cu	
Papilionaceae					
55	*Canavalia cathartica* Thouars	N	A	PW	
56	*Gliricidia sepium* (Jacq.) Walp.	I	R	PW	
	Sesbania bispinosa (Jacq.) W. F. Wight	I	-	-	Recorded 1970[1], 1982[2]. = *S. cannabina?*
	Vigna unguiculata (L.) Walp.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
57	*Sesbania cannabina* (Retz.) Poir.	I	O	Ma	
Passifloraceae					
58	*Passiflora foetida* L.	I	F	HW	
	Passiflora suberosa L.	I	-	-	Recorded 1970[1], 1982[2]
Piperaceae					
59	*Peperomia pellucida* (L.) H. B. K.	I	A	PW	
Polygonaceae					
	Polygonum senegalense Meisn.	?N	-	-	Recorded 1970[1], 1982[2].
Portulacaceae					
60	*Portulaca oleracea* L.	N	O	Gl	
Rhizophoraceae					
61	*Rhizophora mucronata* Lam.	N	R	Mg	
Rubiaceae					
62	*Coffea* sp.	I	O	Cu	
63	*Guettarda speciosa* L.	N	O	BC	
	Hedyotis corymbosa (L.) Lam.	?I	-	-	Recorded 1970[1]
64	*Morinda citrifolia* L.	?I	C	PW, HW	
Rutaceae					
	Clausena anisata (Willd) Hook f.	I			Recorded 1970[1], 1982[2]. = *Murraya koenigii?*
65	*Citrus* sp.	I	O	Cu	
66	*Murraya koenigii* (L.) Spreng..	I	O	PW	
Solanaceae					
67	*Capsicum frutescens* L.	I	O	Cu	
68	*Datura metel* L	I	F	PG	
	Nicotiana tabacum L.	I	-	-	Recorded 1982[2]. Probably extinct on Cousin
69	*Solanum americanum* Mill.	I	O	Ma	
70	*Solanum lycopersicum* L.	I	R	Cu	
	Solanum melongena L	I	-	-	Recorded 1970[1], not 1982, 1999[4]. Cultivated occasionally
Surianaceae					
71	*Suriana maritima* L.	N	O	BC	
Turneraceae					
72	*Turnera angustifolia* Miller	I	O	PW	
Umbelliferae					
	Centella asiatica (L.) Urb.	?I			Recorded 1970[1], not 1982[2].
Verbenaceae					
73	*Stachytarpheta jamaicensis* (L.) Vahl.	I	C	PW, PG	

	Species	Status	Abund.	Habitats	Notes
ANGIOSPERMAE: Monotyledons					
Agavaceae					
	Furcraea foetida (L.) Haw.	I	-	-	Recorded 1970[1], 1982[2]. Probably extinct on Cousin
Amaryllidaceae					
74	*Crinum asiaticum* L.	?I	O	PG	
75	*Hymenocallis littoralis* (Jacq) Salisb.	?I	F	PW	
76	*Scadoxus multiflorus* (Martyn.) Raf.	I	R	PW	
Araceae					
77	*Alocasia macrorrhiza* (L.) G. Don.	I	F	PW	
	Colocasia esculenta (L.) Schott	I	-	-	Recorded 1970[1], 1982[2]. Probably extinct on Cousin
Bromeliaceae					
78	*Ananas comosus* (L.) Merr.	I	F	Cu, Gl	
Cannaceae					
79	*Canna* hybrids	I	R	Cu	
Commelinaceae					
80	*Commelina diffusa* Burm f.	?	O	Gl	
Cyperaceae					
81	*Bulbostylis barbata* (Rottb.) C.B.Cl.	N	F	Gl	
	Cyperus alopecuroides Rottb.	?	-	-	Recorded 1970[1], not 1982[2]
82	*Fimbristylis complanata* (Retz.) Link	?	F	Gl	
83	*Fimbristylis cymosa* R. Br.	?	F	Gl	
84	*Fimbristylis* sp. (glacis sedge)	?	C	Gl	
	Kyllinga monocephala Rottb.	?	-	-	Recorded 1970[1], 1982[2]
85	*Kyllinga polyphylla* Willd. Ex Kunth	N	C	PW, Gl	
	Mariscus dubius (Rottb) Fischer	N	-	-	Recorded 1970[1], 1999[4]
86	*Mariscus ligularis* (L.) Urb.	?N	A	Gl	
87	*Pycreus polystachyos* (Rottb.) P. Beauv.	?	A	HW	
Dioscoriaceae					
	Dioscorea alata L.	I	-	-	Recorded 1970[1], not 1982[2]. Extinct on Cousin
Gramineae					
88	*Bambusa vulgaris* Schrad. Ex Wendl var. *aureo-variegata*	I	R	Mar	
	Brachiaria subquadripara (Trin.) Hitchc.	?	-	-	Recorded 1970[1], not 1982[2]
	Cenchrus echinatus L.	?	-	-	Recorded 1970[1], 1982[2]. Probably extinct on Cousin
	Dactyloctenium ctenoides (Steud.) Bosser or *D. aegypticum* (L.) Willd.	?	-	-	Recorded 1970[1], 1999[4]
	Digitaria horizontalis Willd.	?	-	-	Recorded 1970[1], 1999[4]
	Digitaria radicosa (Presl.) Miq.	?	-	-	Recorded 1970[1], not 1982[2]
	Digitaria setigera Roth.	?	-	-	Recorded 1970[1], not 1982[2]
	Eleusine indica (L.) Gaertn.	?	-	-	Recorded 1970[1], 1982[2]
	Enteropogon sechellensis (Baker) Dur & Schinz	N	-	-	Recorded 1970, 1982, 1999[1, 2, 4]

	Species	Status	Abund.	Habitats	Notes
	Eragrostis tenella (L.) Beauv.	?	-	-	Recorded 1970[1], 1999[4]
	Eragrostis subaequiglumis Renvoize	?	-	-	Recorded 1970[1], not 1982[2]
89	*Panicum brevifolium* L.	N	A	PW, PG	
90	*Panicum maximum* L.	?	R	Mar	
91	*Sporobolus virginicus* (L.) Kunth.	N	A	BC	
92	*Stenotaphrum dimidiatum* (L.) Brogn.	N	A	PG	
	Stenotaphrum micranthum (Desv.) Hubb.	?	-	-	Recorded 1970, 1982, 1999 [1, 2, 4]
Lemnaceae					
	Lemna sp.	?	-	-	Recorded 1970[1]; occasional outbreaks in marsh
Musaceae					
93	*Musa ?sapientum* L.	I	F	Cu	
Palmae					
94	*Cocos nucifera* L.	N	F	PW, HW	
Pandanaceae					
95	*Pandanus balfourii* Mart.	E	C	Gl, HW	

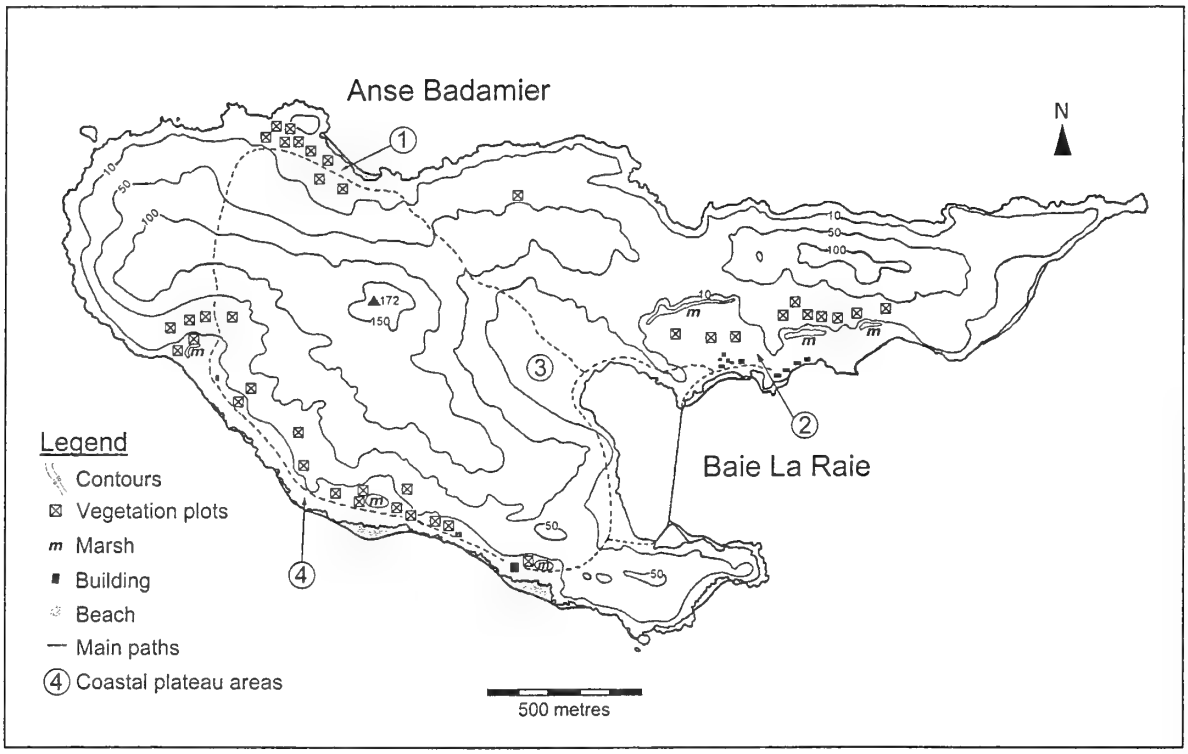

Figure 1. Curieuse Island: physical, with locations of vegetation plots.

CURIEUSE

BY

MICHAEL J. HILL[1], TERENCE M. VEL[1], STEVEN J. PARR[2] and NIRMAL J. SHAH [1]

GEOLOGY, TOPOGRAPHY AND CLIMATE OF CURIEUSE

Curieuse has an area of 286 ha and is the fifth largest of the granitic Seychelles Islands. It is situated little over 1 km from Praslin, the second largest of the islands. At its highest point (Curieuse Peak), it reaches 172 m above sea level. The island consists of two ranges of high ground enclosing a shallow bay (Baie La Raie). Most of the land is sloping ground between 10 and 100 m above sea level (Table 1). The periphery of the island has low-lying coastal areas. There are four main areas of low-lying ground:

1. North (Anse Badamier)
2. Centre-east plateau (around National Park HQ)
3. Central (Baie La Raie mangrove, partially inundated)
4. South (Leper colonies)

Geologically, the island is similar to the nearby island of Praslin. The central hills are made up of reddish-grey granite (Braithwaite, 1984). Surrounding lowland areas consist of weathering products of granite, together with more recent calcareous deposits. The soils of Curieuse are mainly lateritic red earths. On the central range of hills, these have been severely eroded (Piggott, 1968), reduced to bare sub-soil and quartz gravel (Baker, 1963). In some flatter areas (for example, the northern plain) these soils have been less eroded. Some areas of the hill have river valley soils. The soils of the coastal lowlands include red earths (northern plain), marsh and mangrove deposits (central mangrove area, parts of centre-east plateau), and soils of the Shioya series (parts of centre-east plateau, south) (D.O.S., 1966).

The island has a large number of marsh areas in the coastal lowlands, most with a marine influence, but there are at least two freshwater wetlands, one at the Doctor's House (at the eastern end of the leprosarium plateau) and one at the western end of the leprosarium plateau. There are five permanent freshwater streams (IUCN, 1993).

The Seychelles islands experience a seasonal humid tropical climate (Walsh, 1984). While no weather data exist for Curieuse, it could be predicted that the climate of the island follows a similar pattern to that of nearby Praslin. Praslin is one of the driest of the large granitic islands with mean annual rainfall of 1,842.8 mm for the periods 1946-58 and 1977-99 (records from Praslin Grand Anse and Airstrip; unpublished data, National Meteorological Services, Seychelles).

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Table 1. Area of Curieuse by altitude (calculated from maps published by Directorate of Overseas Survey (UK)/Seychelles Government)

Altitude range (m. asl.)	Area (ha)	Percentage total area
>150	2	0.7
100 – 150	32	11.1
50 – 100	67	23.4
10 – 50	111	38.8
0 – 10	74	25.9

HISTORY

Curieuse was first named Ile Rouge (after its exposed red earth soils) but its name was changed to that of one of the vessels of the Marion Dufresne expedition of 1768 (prior to settlement of the Seychelles). The same expedition noted little timber on the island, and very few land tortoises (this population later became extinct). Both coconut and Coco-de-Mer *Lodoicea maldivica* were recorded (Lionnet, 1984). Malavois (1787) recorded that the hill was covered with Coco-de-Mer (in Fauvel, 1909).

In October 1817, the island was leased, but it reverted to the control of the colonial government in 1827. A leper colony was established in 1829 for lepers from Mauritius and Seychelles, and 78 people were housed there by 1830 (McAteer, 2001). Lepers were later joined by old and infirm paupers, but by the late 1860s the colony was dwindling. When Edward Newton visited in 1866, there were only three lepers and "a few old decrepit paupers" remaining (Newton, 1867). The settlement was not closed until 1900, when the few remaining lepers and paupers were moved to new facilities on Round Island, Praslin, and Curieuse was commercially leased again. Coconut plantations were established, production reaching 300,000 nuts per year in 1930 (Anon, n.d.). Vanilla was introduced as a commercial crop in the early twentieth century; production ceased in the 1930s (IUCN, 1993). In 1909-10, a 500 m wall was constructed across Baie La Raie, enclosing the bay which was used for rearing sea turtles for meat. However, the project failed in 1914 when most of the turtles died of disease (Anon, n.d.).

In 1937, the government regained control of the island and reopened the leper colony to replace overcrowded facilities on Round Island, Praslin, and Round Island, Mahé (McAteer, 2001). The colony was abandoned in 1965 and the island and 1,370 ha of the surrounding seas were declared a Marine National Park in 1979 (IUCN, 1993). The island is still managed by the Seychelles Marine Parks Authority. The population is small (around 10 people). A large number of tourists make day visits from Praslin. In July 2000, a project of rat and cat eradication was undertaken on Curieuse, to eliminate alien mammals and enhance the conservation value of the island. Aerial application of pelleted bait was used for rats, and poisoning/trapping for cats.

FLORA AND VEGETATION

Flora

A total of 242 plant species was recorded on Curieuse, including 11 ferns, one gymnosperm (introduced) and 230 angiosperms (Appendix 1). Of the angiosperms, 131 (57.0%) species are regarded as introduced (Friedmann, 1994) and 81 (35.2%) native. Of the native plants, 23 taxa are endemic to the Seychelles (10.0% of the total flora). At least 43 species of introduced angiosperm (18.7% of the flora) recorded on Curieuse were restricted to gardens around houses and were not found away from cultivation. Most would probably become extinct were cultivation to cease.

The proportions of the total flora made up of introduced species and Seychelles endemics were similar to those for the Seychelles as a whole (of the total Seychelles flora, around 54% is introduced and 9% endemic; Procter, 1984). Compared to the flora of smaller islands, Curieuse is relatively rich in endemic plants. Several endemic species are abundant on Curieuse, notably the Coco-de-Mer palm *Lodoicea maldivica*; Curieuse and Praslin have the only natural populations of the species although planted specimens exist on many other islands (Procter, 1974). In addition, some of the endemic species recorded by previous observers but not in the current survey may still survive on the island (see Appendix 1). Two are known to be extinct there: wild vanilla *Vanilla phalaenopsis* has not been recorded on the island since the nineteenth century, and the parasitic shrub *Bakerella clavata* ssp. *sechellensis* is apparently completely extinct (Carlström, 1996a). Ten species recorded by previous observers may still survive on the island, bringing the total number of plants on the island to 252, with 25 Seychelles endemics.

Of the introduced plants established on Curieuse, 15 are invasive weedy species. Several of the woody weeds which are most invasive on the smaller islands of Seychelles are present, including cocoplum *Chrysobalanus icaco* and cinnamon *Cinnamomum verum*, both of which are abundant. Coconuts *Cocos nucifera* were not widely planted on the island and, although abundant in the north of the island, they are less common elsewhere; Curieuse has far fewer coconuts than most other small islands in Seychelles.

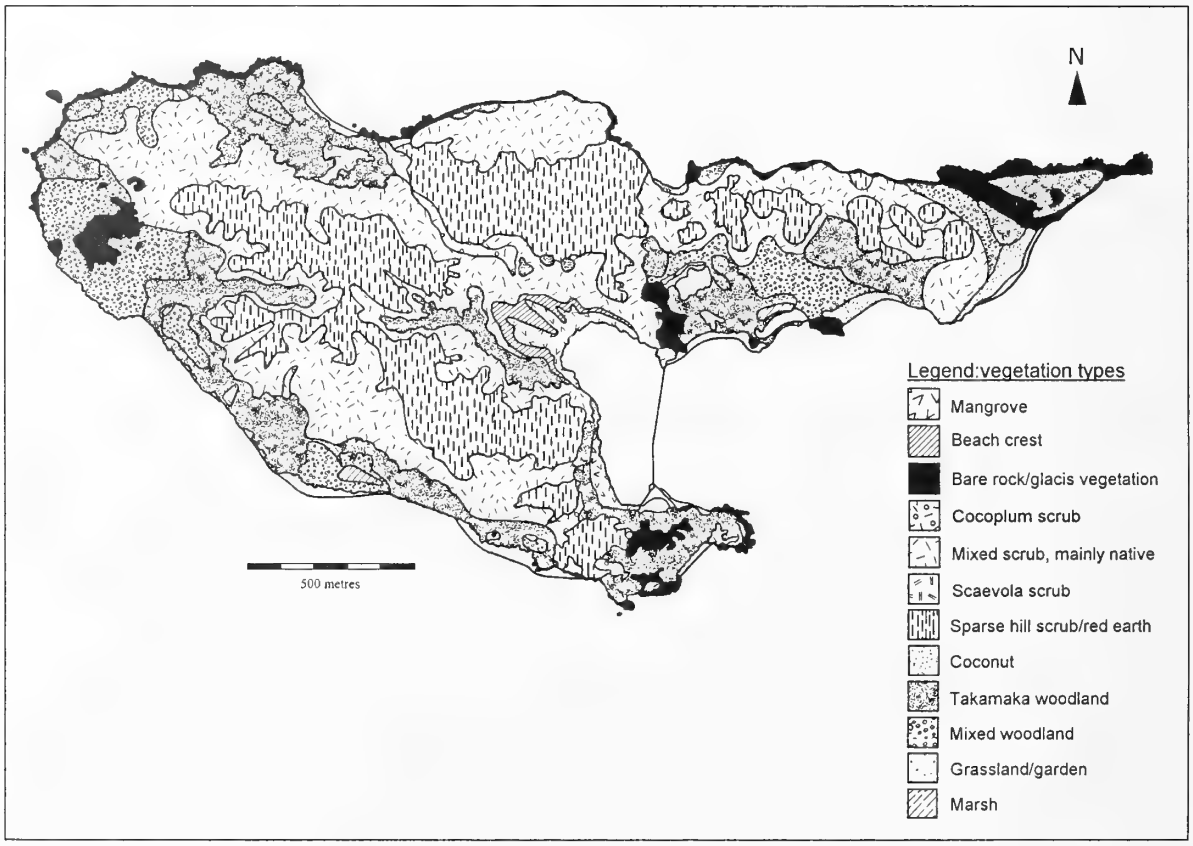

Figure 2. Curieuse Island: vegetation

Vegetation

The extents of major vegetation types on Curieuse are shown in Table 2 and Figure 2. Curieuse has a wide range of vegetation types and several were not studied in detail. Upland areas of Curieuse are dominated by scrublands that have a variety of endemic species together with one abundant introduced species, cocoplum *Chrysobalanus icaco.* There are some areas of open rock, and the plateaux have wetland vegetation including mangrove and freshwater marsh. The vegetation survey concentrated on areas of greatest value for endemic bird conservation: the woodland and scrub of plateaux and low hills.

Table 2. Extent of major vegetation types, Curieuse Island

	Vegetation type	Approx. area (ha)
Hill	Woodland (predominantly native)	27.4
(>10 m asl.)	Woodland (mixed)	17.6
	Scrub (native spp.)	85.8
	Scrub (mixed)	73.9
	Scrub (Introduced: predominantly *Chrysobalanus*)	2.1
	Bare rock	4.9
Plateau	Woodland (predominantly native)	27.9
(<10 m asl.)	Woodland (mixed)	6.8
	Coconut with regeneration	3.4
	Scrub (native spp.)	0.7
	Scrub (mixed)	8.8
	Scrub (Introduced: predominantly *Chrysobalanus*)	1.4
	Mangrove	4.8
	Freshwater marsh	0.7
	Beach crest vegetation	4.7
	Grassland/garden	1.4
	Bare rock	13.6

Twenty-five plots were carried out in plateau woodland with a combined area of 2,500 m^2 (approximately 0.7% of the total area of this vegetation type), and 15 in low hill woodland covering 1,500 m^2 or 0.3% of the total area of the habitat. A summary of results is shown in Table 3.

Table 3. Curieuse vegetation plot summary

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)
Plateau	25	<5	744	53.0	42.6	50.0	9.2	1.3
Hill	15	21	653	46.0	34.0	41.0	26.6	1.1

Plateau plots had a relatively high density of trees and a relatively complete canopy (mean canopy cover = 72%). At ground level, vegetation cover was less than 50% and there was a high proportion of open leaf litter. The tree layer was dominated by a native species, takamaka *Calophyllum inophyllum* (127 trees, 68% of total trees), although the introduced cinnamon *Cinnamomum verum* was also abundant (31 trees, 17% of total trees). The shrub layer was dominated by the invasive introduced shrub *Chrysobalanus icaco,* which was present in 18 of 25 plots and covered 25% of the shrub layer in plots where it occurred. Other widespread species of the shrub layer included cinnamon (in 17 plots, forming on average 14.2% cover), *Phoenicophorium borsigianum* (in 11 plots, mean 9.1% cover) and takamaka (10 plots, mean 2.6% cover).

Plots in low hill woodland had a lower density of stems and a less complete canopy (mean canopy cover=62%). Vegetation of the herb layer was less dense than that in plateau plots, but a larger proportion of the ground was outcrops of bare rock. The tree layer contained less natives than that in plateau woodland; 30.6% of stems were

introduced species. However, the most abundant single species was takamaka (28 trees, 28.6% of total trees). Cinnamon was again the second most abundant tree species (17 trees, 17.3% of total trees). Tree species diversity was higher in hill plots than in plateau plots, and the hill woodland contained a number of endemic shrub species including *Paragenipa wrightii, Erythroxlum sechellarum* and *Syzygium wrightii*. The shrub layer of low hill woodland was again dominated by *Chrysobalanus icaco,* found in 14 of 15 plots, with a mean cover of 23.6%. *Phoenicophorium borsigianum* was as widespread as *Chrysobalanus,* but contributed less to the shrub cover within plots where it occurred (mean cover was 13.9%). *Canthium bibracteatum* occurred in 13 of 15 plots, with mean cover of 7.8%. Cinnamon was found in 11 of 15 plots forming 11.5% cover in those plots in which it occurred.

The woodland of plateaux and low hills showed great similarity. In both cases, most of the trees present belonged to native species. The presence of native and endemic shrubs in hill woodland indicated that high woodland vegetation appeared to be advancing up-slope into areas previously occupied by native scrub.

In early 2000, several *Calophyllum* trees on the eastern plateau were suffering from symptoms of takamaka wilt disease caused by the fungus *Leptographium* (Verticillium) *calophylli* (Ivory *et al.,* 1996: Wainhouse *et al,* 1998). This disease has caused extensive death of *Calophyllum* trees on several other islands including North Island and Mahé and could threaten all high forest on Curieuse, which is dominated by this species.

INVERTEBRATES

Pitfall Trapping

Pitfall trap assemblages were smaller than average for granitic islands (Table 4); in part, this reflects the lower abundance of ants on Curieuse compared to some other islands, notably those infested with crazy ant *Anoplolepis gracilipes* such as Marianne and Félicité In fact, plateau sites were rather rich in invertebrates other than ants.

In both habitats, invertebrate assemblages were larger during the north west monsoon season, and on the plateau. Lowest invertebrate counts came from hill woodland in the dry south east season. The composition of assemblages also differed between the plateau and hill woodland, although both were dominated by ants (Hymenoptera: Formicidae). Ants formed a larger proportion of the total assemblage in hill woodland than in plateau woodland sites (Fig. 3). Plateau woodland contained greater numbers of earwigs (Dermaptera), beetles (Coleoptera) and woodlice (Crustacea: Isopoda). Woodlice were absent in hill plots.

In both hill and plateau woodland, the most abundant invertebrate was the ant *Odontomachus troglodytes,* which formed 39.1% of all individuals in the plateau woodland and 41.3% of all individuals in hill woodland. In hill woodland, the four most commonly trapped species were all ants. The most abundant invertebrate other than ants was an earwig (4.9% of individual invertebrates belonged to this species). In plateau plots, the two most abundant species were ants, and the third was an earwig (making up

8.3% of individuals). Cockroaches (a favoured food item of magpie-robins) were found on both hill and plateau; only two individuals (0.5% of total individuals) were trapped on the hill, while 14 (1.4% of total individuals) were trapped in plateau plots.

Table 4. Pitfall assemblages from Curieuse.
Only invertebrates of body length >2 mm included.
(Number in parentheses = number of invertebrates excluding ants).

	Habitat	Mean no. individuals per 5 traps	
		SE season	NW season
Curieuse	Plateau woodland	38.4 (10.7)	42.1 (22.5)
	Low hill woodland	17.0 (1.0)	32.2 (5.6)
Mean for all granitic islands		61.8 (9.4)	61.1 (16.0)

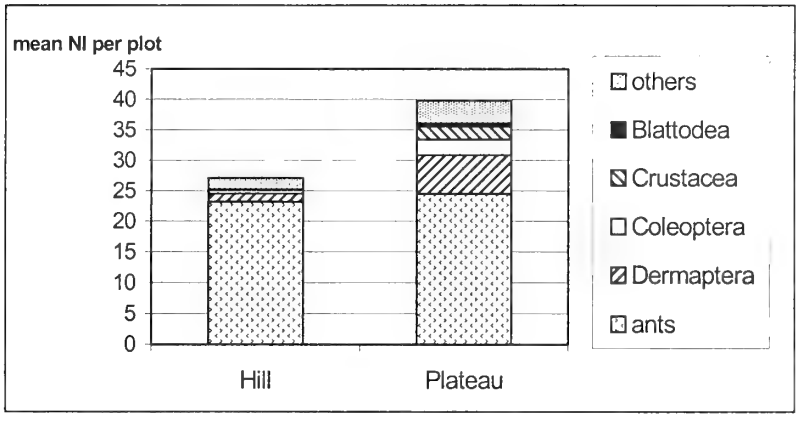

Figure 3. Total pitfall assemblages from Curieuse.

Leaf-insect Counts

Leaf-insect counts were carried out for 11 tree and shrub species, eight of these in both seasons (Table 5). In both seasons, the highest densities of invertebrates (both in terms of individuals per leaf and individuals per square metre of leaf) were on native plant species. *Terminalia catappa* and *Paragenipa wrightii* had particularly high invertebrate densities. However, the introduced *Cinnamomum verum* also had high invertebrate counts. Most invertebrates on cinnamon were soft bugs (Hemiptera: Sternorrhyncha) or ants (together these groups comprised 94% of invertebrates on cinnamon in August, 88% in January). In general, mangrove species (*Avicennia marina* and *Rhizophora mucronata*) had a low density of invertebrates but that for *A. marina* in August was particularly high. For five species, leaf counts were higher in January than in August. Three species had higher leaf counts in January.

Table 5. Density of invertebrates on foliage, Curieuse.
n = no. of leaves counted; NI = number of individual invertebrates.

Species	SE season (August)			NW season (January)		
	N	mean NI leaf^{-1}	mean NI m^{-2}	n	mean NI leaf^{-1}	mean NI m^{-2}
Introduced species						
Anacardium occidentale	50	0.18	24.21	100	0.11	20.73
Chrysobalanus icaco	300	0.08	21.06	800	0.04	11.58
Cinnamomum verum	650	0.59	85.23	960	0.22	34.03
Mean value: introduced		0.42	62.93		0.14	23.66
Native species						
Avicennia marina	500	0.16	117.21	1099	0.02	9.68
Calophyllum inophyllum	900	0.43	46.69	750	0.27	33.94
Canthium bibracteatum	800	0.07	22.54	1010	0.08	27.82
Hibiscus tiliaceus	50	0.52	28.44	0		
Memecylon elaeagni	0			300	0.06	43.65
Paragenipa wrightii	0			350	1.08	168.11
Rhizophora mucronata	500	0.05	5.40	1000	0.12	15.21
Terminalia catappa	50	1.54	71.28	200	2.55	126.22
Mean value: native		0.21	45.12		0.27	34.72

Malaise Trapping

Malaise trapping was carried out in plateau and hill woodland habitats, during both seasons (Table 6). Invertebrate assemblages were greater in January (wet season) than in August (dry season). Assemblages were larger in hill woodland than plateau woodland, probably due to the greater air movement in hill plots where trees are more well-spaced, and herb and shrub layers less dense. The most abundant invertebrates in traps were the Diptera, Lepidoptera and Hymenoptera (wasps and ants); the relative importance of these groups varied between habitats and seasons. The majority of taxa collected have yet to be identified to species level.

Table 6. Malaise trap assemblages, Curieuse.
NI = number of individuals.

	SE (August)		NW (January)	
	Hill	Plateau	Hill	Plateau
No. traps	1	4	3	3
Mean NI trap^{-1}	157	148	325	262
Mean NI Diptera	89	57.3	159.0	126.7
Mean NI Hymenoptera	9	23.0	59.3	34.0
Mean NI Lepidoptera	28	46.3	55.0	69.3

Observation

Many of the invertebrates observed were introduced or cosmopolitan species (Table 7). However, given the number of endemic plants present on the island, Curieuse probably also supports a number of endemic invertebrates. A more complete survey would be necessary to identify endemic taxa; microhabitats that could harbour endemic insects, not collected in the current survey, include the leaf bases of endemic palms and *Pandanus* species. Seventy-five species of insect in Seychelles are associated with the leaf bases of native palms and *Pandanus*, and half the beetle fauna of Praslin are associated with *Lodoicea* (Stoddart, 1984). Curieuse probably shares many or most of these species.

While many of the marshes of the plateaux showed a marine influence, that by the Doctor's House was entirely fresh and appeared permanently wet. Several species of Odonata were observed around this pool and collections in January included several species of water beetle, water bugs (Gerridae and Veliidae), ostracods and tadpoles of the Mascarene frog *Ptychadaena mascareniensis.* This marsh area and surrounding takamaka woodland was surveyed by Stevenson *et al.* (1997) who recommended it as a potential site for black paradise flycatchers on Curieuse.

Table 7. Invertebrates observed and collected, Curieuse.

Order	Family	Species	Notes
Arachnida:			
Araneae	Tetragnathidae	*Nephila inaurita* (Walckenaer, 1841)	
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	Land hermit crab
		Coenobita sp. 2	Mangrove hermit crab
	Gecarcinidae	*Cardisoma carnifex* (Herbst, 1784)	In mangrove
	Grapsidae	*Grapsus tenuicrustatus* (Herbst, 1783)	On coastal rocks
		Neosarmatium ?meinerti (De Man, 1887)	In mangrove
	Ocypodidae	*Ocypode ceratophthalmus* (Pallas, 1772)	Beach ghost crab
		Ocypode cordimana Desmarest, 1825	Beach crest ghost crab
	Palaemonidae	*Macrobrachium* sp.	Crayfish; in stream above leprosarium plateau
Mollusca	Achatinidae	*Achatina fulica* (Bowditch, 1822)	In pitfall traps
		Achatina ?panthera Ferrusac, 1822	In pitfall traps
	Cyclophoridae	*Cyathopoma blanfordi* Adams, 1868	In pitfall traps
	Littorinidae	*Littoraria ?scabra* (L., 1758)	Mangrove periwinkle
	Subulinidae	*Subulina octona* Bruguière, 1792	In pitfall traps
Myriapoda:			
Chilopoda	Scolopendridae	*Scolopendra subspinipes* (Leach, 1918)	
Diplopoda	Paradoxosomatidae	*Oxidus* (Orthomorpha) *gracilis* (K. Koch, 1847)	In pitfall traps
	Spirostreptidae	*Seychelleptus seychellarum* (Desjardins, 1834)	Giant millipede
	Trigoniulidae	*Spiromanes ?braueri* (Attems, 1900)	In pitfall traps
		Spiromanes seychellarum Saussure & Zehntner, 1902	In pitfall traps

Table 7 (cont.)

Order	Family	Species	Notes
Insecta:			
Coleoptera	Curculionidae	*Cratopus* sp.	
	Dytiscidae	Sp. Indet	
	Scarabaeidae	*Oryctes monoceros* (Olivier, 1789)	
		Perissosoma aenescens Waterhouse, 1875	
Hemiptera	Gerridae	Pondskater sp.	In freshwater marsh
	?Veliidae	Water bug	In freshwater marsh
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)	
	Apidae	*Apis mellifera adansoni* Latreille, 1804	
	Formicidae	*Camponotus grandidieri* Forel, 1886	In pitfall traps
		Camponotus hova Forel, 1891	In pitfall traps
		Camponotus ?thomasetti Forel, 1912	In pitfall traps
		Cardiocondyla emeryi Forel, 1881	In pitfall traps
		Odontomachus troglodytes Santschi, 1914	In pitfall traps
		Paratrechina sp.	In pitfall traps
		Plagiolepis ?alluaudi Emery, 1894	In pitfall traps
		Plagiolepis ?exigua Forel, 1894	In pitfall traps
		Technomyrmex albipes (Smith, 1861)	In pitfall traps
	Vespidae	*Polistes olivaceus* (De Geer, 1773)	
Lepidoptera	Hesperiidae	*Borbo ?gemella* Mabille, 1884	
	Lycaenidae	*Leptotes pirithous* Linnaeus, 1767	
		Zizeeria knysna (Trimen, 1862)	
Odonata	Agrionidae	*Ceriagrion glabrum* (Burmeister, 1839)	Around marshes
	Coenagrionidae	*Agriocnemis pygmaea* (Rambur, 1842)	Around marshes
	Libellulidae	*Diplacodes trivialis* (Rambur, 1842)	Around marshes
		Orthetrum stemmale wrightii (Selys, 1877)	Around marshes
		?Pantala flavescens (Fabricius, 1798)	Around marshes
		Rhyothemis semihyalina (Desjardins, 1832)	Around marshes
		Tramea limbata Selys, 1878	Around marshes
		Zygomma petiolatum Rambur, 1842	Around marshes
Phasmatodea	Phasmatidae	*Carausius sechellensis* (Bolivar, 1895)	

VERTEBRATES

Reptiles, Amphibians and Fish

Reptiles, amphibians and fish observed during the course of fieldwork are listed in Table 8. The list includes five lizards, one tortoise and one frog. None of the three snakes known from Seychelles (Nussbaum, 1984a) were recorded, although these are rarely seen and may occur there. The endemic caecilian *Hypogeophis rostratus* has been recorded on Curieuse (Nussbaum, 1984b), but was not observed in the current survey. Given the relatively large size of Curieuse, and its proximity to the large island of Praslin,

it is possible that other endemic amphibians and reptiles survive on the island and an extensive survey is recommended.

Giant tortoises were present in the late eighteenth century, but the population (presumably one of the endemic granitic Seychelles species) became extinct before 1875 (Bour, 1984). 42 Aldabra giant tortoises were brought to the island from Mahé in 1890-1902; these also became extinct. 252 tortoises were brought from Aldabra in 1978-82. Although the species breeds on the island, subsequent studies have revealed that the population is declining, probably due to poaching (Stoddart *et al.,* 1982; Samour *et al.,* 1987; Hambler, 1994; IUCN, 1993).

Table 8. Amphibians, reptiles and freshwater fish on Curieuse.
Status: E =endemic, I = introduced, N = native (in central Seychelles).

Family	Species		Status
Amphibians			
Raniidae	*Ptychadaena mascareniensis* (Dumeril & Bibron, 1836)	Mascarene frog	?I
Reptiles			
Gekkonidae	*Gehyra mutilata* (Wiegmann, 1835)	Pacific house gecko	I
	Phelsuma sundbergi Rendahl, 1939	day gecko	E
	Phelsuma sp. (*?P. astriata* Tornier, 1901)	day gecko	E
	Urocotyledon inexpectata (Steiner, 1893)	sucker-tailed gecko	E
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	Seychelles skink	E
	Pamelaescincus gardineri (Boulenger, 1909)	burrowing skink	E
Testudinidae	*Geochelone gigantea* (Schweigger, 1812)	Aldabra giant tortoise	I
Fishes			
Anguillidae	*Anguilla* sp.	eel	N
Rivulidae	*Pachypanchax playfairii* Günther, 1866	Seychelles Killifish	E

Birds

Land birds and seabirds were identified by sight and, in addition, tape playback was used to give data on presence or absence of four species (black paradise flycatcher, Seychelles white-eye, Seychelles scops owl and barn owl). There was a positive response for only one of these species, the barn owl. In total, 14 land birds and waders were recorded (Table 10). Three of these were Seychelles endemics, but two of these endemic species are currently widespread and common within the granitic islands. One, the black parrot, is endangered.

Perhaps because of the early introduction of predators to the island, and destruction of natural vegetation, few endemic species have ever been recorded on Curieuse; only Seychelles kestrel and Seychelles sunbird were reported by Newton (1867). Despite the presence of apparently suitable takamaka *Calophyllum inophyllum* woodland on the plateaux, the Seychelles black paradise flycatcher *Terpsiphone corvina* has never been recorded (Collar and Stuart, 1985).

Only two species of seabird were recorded (Table 9); one of these (fairy tern) breeds on the island.

Table 9. Seabirds observed on Curieuse Island.

Species		Notes
Sterna anaethetus	bridled tern	One individual seen regularly on beaches and flying offshore, January
Gygis alba	fairy tern	Breeding birds present in trees near headquarters buildings (chick seen, 6/8/99)

Table 10. Land birds and waders observed on Curieuse
M =migrant species
E = Seychelles endemic species; E(ss) = Seychelles endemic subspecies

Species		Notes
Butorides striatus	green-backed heron	Seen regularly around the marshes and mangrove, August and January
Gallinula chloropus	common moorhen	A small number occur at the plateau marshes: not common. Heard occasionally in August, only once in January
Gallus gallus	chicken	A few individuals free-ranging around houses on plateau
Arenaria interpres M	ruddy turnstone	Several birds seen in mangrove on two occasions (August). Many birds seen in mangrove areas and beaches (January)
Pluvialis squatarola M	grey plover	A few birds on beaches, January.
Numenius phaeopus M	whimbrel	One or two individuals seen regularly in mangrove, beaches: August and January
Streptopelia picturata ssp.	turtle dove	Regularly seen in lowland habitats
Geopelia striata	barred ground dove	Mainly around inhabited areas and gardens. Seen regularly
Alectroenas pulcherrima E	Seychelles blue pigeon	Seen regularly in woodland habitats (e.g., feeding on *Ficus reflexa* figs, January)
Coracopsis nigra barklyi E(ss)	Seychelles black parrot	Reported by park staff: population of around six birds, some of which appear to fly from Praslin but others possibly resident
Tyto alba	barn owl	A bird heard in lowland forest, January
Nectarinia dussumieri E	Seychelles sunbird	Very common in all habitats
Acridotheres tristis	common mynah	Common, especially in lowland habitats and beaches
Foudia madagascariensis	Madagascar fody	Fairly common around inhabited areas

Mammals

Four mammal species were recorded during the course of fieldwork: Seychelles fruit bat *Pteropus seychellensis*, feral domestic cat *Felis catus,* a small number of domestic dogs *Canis familiaris,* and ship rat *Rattus rattus* In addition, a fifth species, the house mouse *Mus domesticus,* was reported by residents.

Rodent trapping was carried out in August 1999 and January 2000 (Table 11). Two traplines were established, one in plateau woodland close to the Doctor's House and

ruins of the leper colony and one in hill scrub dominated by cocoplum *Chrysobalanus icaco*. Only one species of rodent, the ship rat *Rattus rattus,* was trapped. Capture rates were relatively low, although higher in August (a period of food and water stress) than in January. Curieuse has abundant fruit trees and shrubs (including mangoes and cocoplum) with fruit in season on both visits. The availability of alternative food sources could influence the readiness of rats to enter traps.

Table 11. Results of rat trapping, Curieuse

Dates	Trap-nights	No. of rats	Rats per 100 trap-nights (uncorrected)	Rats per 100 trap-nights (corrected)*
8 - 13/8/99	140	33	23.57	30.14
13 – 18/1/00	112	18	16.07	20.57
Total (SE)			35.34	
Total (NW)			25.56	

*Corrected to account for the effect of closed traps; Cunningham and Moors, 1996.

DISCUSSION

Curieuse is a relatively large island with a great diversity of habitats. Today its central hills have very eroded red earth soils and support sparse scrub which is rich in endemic species (including Coco-de-Mer) and cocoplum scrub. Repeated forest fires have exacerbated erosion on these slopes and caused degradation of the vegetation (Carlström, 1996). The coastal plains support high forest dominated by native takamaka but with many introduced invasive species. Takamaka typically forms dense stands with little undergrowth of shrubs or herbs but these have been invaded by cinnamon and cocoplum, especially where the canopy is interrupted. Some of these invasive aliens support high densities of invertebrates on their foliage but the most important trees for invertebrate communities (and, therefore, insectivorous birds) are native species. The native takamaka forest is threatened by takamaka wilt disease.

The island supports a rich endemic flora including important populations of several species of endemic plant (Carlström, 1996) and is likely to be of importance for conservation of endemic invertebrates. Although few species of endemic bird have been recorded here, the proximity of the island to Praslin suggests that several would once have been present before eradication by introduced predators (and, possibly, habitat change).

CONSERVATION RECOMMENDATIONS

In July-August 2000, a rat- and cat-eradication programme was undertaken on the island by staff of the New Zealand Department of Conservation in a project co-ordinated by the Seychelles Ministry of Environment and Transport. Initially, eradication appeared to have been achieved for rats and mice, although a single cat was caught in early 2001.

and it is possible that further individuals remain. However, in August 2001, ship rats were again trapped on the island and at this time a well-established population appeared to be present (M. Hill pers. obs.). It is unclear whether animals survived the eradication attempt or have subsequently re-invaded. Like the original population, rats captured in 2001 all had grey underparts and were relatively small, although significantly larger than the rats present in 2000. Given the high costs of mammal eradications, it is unclear whether further attempts will be made to remove rats. If alien mammals can be eradicated, the island has potential to support populations of several Seychelles endemic birds, in particular the Seychelles magpie-robin and black paradise flycatcher. Both of these species, but particularly the paradise flycatcher, are associated with coastal plateau areas. While the magpie-robin inhabits upland areas on islands such as Cousin and Frégate, hill territories are generally larger than coastal ones, indicating that they are less productive.

In order to enhance the suitability of the island for these endemic land birds, actions that must be taken include the control of cocoplum on plateau areas. This spreading shrub has been widely planted on Curieuse to control erosion on the hills. However, it has also spread to plateau areas where it can form dense monospecific stands. These areas are poor in invertebrate food for most bird species, and the density of stems would prevent foraging by the magpie-robin. The takamaka wilt disease threatens the success of paradise flycatcher introduction; this bird inhabits takamaka-badamier woodland on La Digue's plateau (Collar and Stuart, 1985). Takamaka is common on Curieuse but badamier (*Terminalia catappa*) relatively rare. Extensive planting of badamier and other native trees should be carried out to mitigate the effects of takamaka wilt disease on coastal forests.

Appendix 1. Plant species recorded from Curieuse (excluding seagrasses)

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: Cu = Cultivated area (including weeds and crops, and garden ornamentals); PG = Plateau grassland; PW = Plateau woodland; HW = Hill Woodland; HSc = Hill Scrub; Gl = Glacis; BC = Beach Crest; Ma = Marsh; Mg = Mangrove.

	Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA					
Adiantaceae					
1	*Acrostichum aureum* L.	N	C	Ma, Mg	
Davalliaceae					
2	*Nephrolepis biserrata* (Sw.) Schott	N	A	HW	
3	*Nephrolepis cordifolia* Schott	?	O	Cu	
4	*Nephrolepis multiflora* (Roxb.) Jarrett	N	C	PW	
Gleicheniaceae					
5	*Dicranopteris linearis* Burm.	N	A	HSc	
Hymenophyllaceae					
6	*Trichomanes* sp.	N	O	HW	
Lycopodiaceae					
7	*Lycopodium cernuum* L.	N	F	HSc	
Parkeriaceae					
8	*Ceratopteris cornuta* (Pal.) Lepr.	N	O	Ma	
Polypodiaceae					
9	*Phymatosorus scolopendria* (Burm. f.)	N	A	PW, HW	
Psilotaceae					
10	*Psilotum nudum* Sw.	N	C	PW, HW	
Thelypteridaceae					
11	*Thelypteris* sp.	?N	F	PW	
GYMNOSPERMAE					
12	*Cycas thuarsii* Gaud.	I	R	PG	
ANGIOSPERMAE: Dicotyledons					
Acanthaceae					
13	*Asystasia* sp. B (*sensu* Friedmann)	?I	A	HW, Gl, PG	
14	*Justicia gendarussa* Burm. f.	?I	F	PW	
Amaranthaceae					
15	*Amaranthus viridis* L.	I	F	Cu	
16	*Alternanthera brasiliana* (L.) O. Kuntze.	I	O	Cu	Only in gardens
17	*Alternanthera sessilis* (L.) DC.	I	O	Ma	
Anacardiaceae					
18	*Anacardium occidentale* L.	I	C	HW, HSc	
19	*Mangifera indica* L.	I	C	PW, [HW]	
20	*Schinus terebinthifolius* Raddi	I	R	Cu	Only in gardens
21	*Spondias cytherea* Sonn.	I	F	PW	

	Species	Status	Abund.	Habitats	Notes
Annonaceae					
22	*Annona muricata* L.	I	O	PW, HW	
23	*Annona reticulata* L.	I	F	PW	
24	*Annona squamosa* L.	I	O	PW	
Apocynaceae					
25	*Allamanda cathartica* L.	I	R	Cu	Only in gardens
26	*Alstonia macrophylla* Wall ex G. Don.	I	F	HW, PW	
27	*Catharanthus roseus* (L.) G. Don.	I	F	HW, Cu	
28	*Cerbera manghas* L.	N	O	Mg	
29	*Nerium oleander* L.	I	R	Cu	Only in gardens
30	*Ochrosia oppositifolia* (L.) K. Schum.	N	R	BC	
31	*Plumeria rubra* L.	I	R	Cu	Only in gardens
Araliaceae					
32	*Gastonia sechellarum* (Baker) Harms.	E	O	HSc	
33	*Polyscias* sp.	I	O	Cu	Only in gardens
Asclepiadaceae					
34	*Sarcostemma viminale* (L.) Alton	N	R	HW	
35	*Secamone schimperiana* (Hemsl.) Klack.	E	R	HSc	
Avicenniaceae					
36	*Avicennia marina* (Forssk.) Vierh.	N	C	Mg	
Balsaminaceae					
37	*Impatiens balsamina* L.	I	R	Cu	Only in gardens
38	*Impatiens wallerana* Hook. F.	I	R	Cu	Only in gardens
Begoniaceae					
39	*Begonia semperflorens*	I	R	Cu	Only in gardens
40	*Begonia* sp.	I	R	Cu	Only in gardens
Bignoniaceae					
41	*Tabebuia pallida* (Lindl.) Miers.	I	C	HW, HSc	
Boraginaceae					
42	*Cordia subcordata* Lam.	N	F	BC	
43	*Tournefourtia argentea* L. f	N	O	Mg/BC	
Caesalpiniaceae					
44	*Caesalpinia pulcherrima* (L.) Sw.	I	O	Cu	Only in gardens
45	*Delonix regia* (Hook.) Raf.	I	R	PG	
46	*Intsia bijuga* (Coleb.) O. Kuntze	N	F	Hsc, G	
47	*Senna occidentalis* (L.) Link	I	O	PG	
48	*Tamarindus indica* L.	I	F	PW, HW	
Campanulaceae					
49	*Hippobroma longiflora* (L.) G. Don	I	O	PGr	
Caricaceae					
50	*Carica papaya* L.	I	C	PW, Cu	
Caryophyllaceae					
51	*Drymaria cordata* (L.) Roem. & Schult.	I	O	Cu	
Casuarinaceae					
52	*Casuarina equisetifolia* J. R. & G. Foster	I	A	BC, HW	
Chrysobalanaceae					
53	*Chrysobalanus icaco* L.	I	A	HSc, HW, PW	
Combretaceae					
54	*Lumnitzera racemosa* Willd.	N	F	Mg	
55	*Quisqualis indica* L.	I	O	PW	
56	*Terminalia catappa* L.	?N	C	PW, HW	

	Species	Status	Abund.	Habitats	Notes
Compositae					
57	*Dahlia x hortensis* Guillaumin	I	R	Cu	Only in gardens
58	*Dendranthema* sp.	I	O	Cu	Only in gardens
59	*Emilia sonchifolia* (L.) Wight	I	F	Cu, PG	
60	*Tagetes patula* L.	I	F	Cu	Only in gardens
61	*Tridax procumbens* L.	I	O	PG, Cu	
62	*Vernonia cinerea* (L.) Less.	I	A	PG, Cu	
63	*Zinnia* sp. cv.	I	R	Cu	Only in gardens
Convulvulaceae					
	Ipomoea aquatica Forssk.	I	-	-	Listed in Robertson (1989), not seen
64	*Ipomoea batatas* (L.) Lam.	I	O	Cu	Only in gardens
65	*Ipomoea macrantha* Roem. & Schult.	N	F	BC, PW	
66	*Ipomoea obscura* (L.) Ker Gawl.	I	F	PG	
67	*Ipomoea pes-caprae* (L.) R. Br.	N	A	BC	
Crassulaceae					
68	*Kalanchoe pinnata* (Lam.) Pers.	I	F	BC/PG	
69	*Kalanchoe* sp.	I	R	Cu	Only in gardens
Cucurbitaceae					
70	*Cucurbita* sp.	I	O	Cu	Only in gardens
71	*Trichosanthes cucumerina* L.	I	O	Cu	Only in gardens
Dilleniaceae					
72	*Dillenia ferruginea* (Bailon) Gilg.	E	A	HSc, HW	
Erythroxylaceae					
73	*Erythroxylum sechellarum* O. E. Schultz	E	A	HSc, HW	
Euphorbiaceae					
74	*Acalypha indica* L.	I	F	Cu	
75	*Acalypha wilkesiana* Mull. Arg.	I	O	Cu, PW	
76	*Codiaeum variegatum* L.	I	O	Cu, PW	
77	*Euphorbia hirta* L.	I	A	PG	
78	*Euphorbia ?hypericifolia* L.	I	R	Cu	
79	*Euphorbia prostrata* Ait.	I	C	Cu	
80	*Euphorbia pyrifolia* Lam.	N	F	Gl	
81	*Jatropha pandurifolia* L.	I	O	Cu	Only in gardens
82	*Manihot esculenta* Crantz	I	F	Cu, PW	
	Phyllanthus acidus (L.) Skeels	I	-	-	Listed in Robertson (1989); not seen
83	*Phyllanthus amarus* Schumach. & Thonn.	I	A	PG	
84	*Phyllanthus pervilleanus* (Baillon) Mull. Arg.	N	O	HSc	
	Ricinus communis L.	I	-	-	Listed in Robertson (1989); not seen
Flacourtiaceae					
85	*Flacourtia jangomas* (Lour.) Räuschel	I	R	PW	
	Hydnocarpus pentandra (Buch.-Ham.) Oken.	I	-	-	Listed in Robertson (1989); not seen
86	*Ludia mauritiana* Gmel. Var. *sechellensis* F. Friedmann	E (var.)	R	HW	
Gesneriaceae					
87	*Episcia cupreata* (Hook.) Hanst.	I	R	Cu	Only in gardens
Goodeniaceae					
88	*Scaevola sericea* Vahl.	N	C	BC	

	Species	Status	Abund.	Habitats	Notes
Guttiferae					
89	*Calophyllum inophyllum* L.	N	A	PW, BC, HW	
Hernandiaceae					
90	*Hernandia nymphaeifolia* (Presl) Kubitzki	N	R	PW	
Labiatae					
91	*Ocimum ?canum* Sims.	I	R	Cu	Only in gardens
92	*Plectranthus amboinicus* (Lour.) Spreng.	?I	R	PG	
Lauraceae					
93	*Cassythea filiformis* L.	N	O	BC	
94	*Cinnamomum verum* Presl.	I	A	PW, HW	
95	*Persea americana* Mill.	I	O	PW	
Lecythidaceae					
96	*Barringtonia asiatica* (L.) Kurtz	N	R	BC	
Loranthaceae					
	Bakerella clavata (Desrouss.) S. Balle ssp. *sechellensis* (Baker) S. Balle	E(ss)	-	-	Listed in Robertson (1989); now possibly extinct
Malvaceae					
97	*Hibiscus rosa-sinensis* L.	I	O	Cu	Only in gardens
98	*Hibiscus schizopetalus* (Mast.) Hook.	I	R	Cu	Only in gardens
99	*Hibiscus tiliaceus* L.	N	F	BC, PW	
100	*Sida acuta* Burm. f.	I	F	PG, Cu	
101	*Sida cordifolia* L.	?N	O	Gl	
102	*Thespesia populnea* (L.) Soland. ex Correa	N	F	PW, BC	
Melastomataceae					
103	*Memecylon elaeagni* Blume	E	F	HW	
Meliaceae					
104	*Swietenia* sp.	I	F	PW	
105	*Xylocarpus granatum* Koenig	N	O	Mg	
106	*Xylocarpus moluccensis* (Lam.) Roem.	N	F	Mg, BC	
Mimosaceae					
	Acacia confusa Merr.	I	-	-	Listed in Robertson (1989); not seen
107	*Adenanthera pavonina* L.	I	A	PW, HW	
108	*Leucaena leucocephala* (Lam.) de Wit	I	A	PW, HW	
109	*Mimosa pudica* L.	I	C	PG	
110	*Paraserianthes falcataria* (L.) Niels.	I	C	PW, HW	
111	*Pithecollobium unguis-cati* (L.) Benth.	I	C	PW	
Moraceae					
112	*Artocarpus altilis* (Parkins.) Fosb.	I	O	PW	
113	*Artocarpus heterophyllus* Lam.	I	O	PW	
114	*Ficus lutea* Vahl.	N	F	HW, Gl	
115	*Ficus reflexa* Thunb. *seychellensis* (Baker)	E (ss)	R	PW	
116	*Ficus rubra* Vahl	N	O	PW	
Moringaceae					
117	*Moringa oleifera* Lam.	I	O	PW	
Myrtaceae					
118	*Eucalyptus* sp.	I	R	HW	
119	*Psidium guajava* L.	I	R	PW	
120	*Syzygium malaccense* (L.) Merr. & Perry	I	O	PW	

	Species	Status	Abund.	Habitats	Notes
121	*Syzygium samarangense* (Bl.) Merr. & Perry	I	O	PW	
122	*Syzygium wrightii* (Baker) A. J. Scott	E	F	HW, HSc	
Nyctaginaceae					
123	*Bougainvillea* cultivars	I	R	PW, Cu	
Onagraceae					
124	*Ludwigia octovalvis* (Jacquin) Raven	?I	F	Ma	
Oxalidaceae					
125	*Averrhoa bilimbi* L.	I	O	Cu, PW	
Papilionaceae					
126	*Abrus precatorius* L.	?N	A	HW, HSc	
127	*Canavalia cathartica* Thouars.	N	F	BC	
128	*Crotalaria pallida* Ait.	?I	O	PG	
129	*Dendrolobium umbellatum* (L.) Benth.	N	F	BC	
130	*Desmodium incanum* DC.	I	C	PW, PG, HSc	
131	*Desmodium triflorum* (L.) DC.	I	F	PG	
132	*Erythrina ?variegata* L.	?N	R	PG	
133	*Gliricidia sepium* (Jacq.) Walp.	I	F	PG	
134	*Pterocarpus indicus* Willd.	I	R	HW	
135	*Tephrosia noctiflora* Bojer ex Baker	I	O	Gl	
136	*Teramnus labialis* (L.) Spreng.	I	C	PG	
137	*Vigna marina* (Burm.) Merr.	N	F	BC	
Passifloraceae					
138	*Passiflora foetida* L.	I	F	PG	
139	*Passiflora suberosa* L.	I	F	PG, PW	
Plantaginaceae					
140	*Plantago major* L.	I	O	Cu	Only in gardens
Portulacaceae					
141	*Portulaca grandiflora* Hook.	I	O	Cu	Only in gardens
142	*Portulaca oleracea* L.	N	F	PG	
143	*Portulaca ?pilosa* L.	I	O	Gl	
Punicaceae					
144	*Punica granatum* L.	I	R	Cu	Only in gardens
Rhamnaceae					
145	*Colubrina asiatica* (L.) Brogn.	N	F	PG	
Rhizophoraceae					
146	*Bruguiera gymnorrhiza* (L.) Lam.	N	F	Mg	
147	*Ceriops tagal* (Perrotet) C. B. Robins.	N	F	Mg	
148	*Rhizophora mucronata* Lam.	N	A	Mg	
Rosaceae					
149	*Rosa* sp.	I	R	Cu	Only in gardens
Rubiaceae					
150	*Canthium bibractatum* (Baker) Hiem.	N	A	PW, HW, [BC]	
151	*Guettarda speciosa* L.	N	O	BC	
152	*Ixora coccinea* L.	I	O	Cu	Only in gardens
153	*Mitracarpus hirtus* (L.) DC.	I	O	PG	
154	*Morinda citrifolia* L.	?I	F	PW	
155	*Tarenna sechellensis* (Baker) Summerh.	E	O	HW	
156	*Paragenipa wrightii* (Baker) F. Friedmann	E	A	HW, HSc	

	Species	Status	Abund.	Habitats	Notes
	Psychotria pervillei Baker	E	-	-	Listed in Carlström (1996a, b); not seen
157	*Tarenna sechellensis* (Baker) Summerh.	E	O	HW	
Rutaceae					
158	*Citrus reticulata* Blanco	I	R	PW	
159	*Citrus sinensis* (L.) Osbeck	I	F	PW	
Sapindaceae					
160	*Dodonea viscosa* Jacq.	N	F	HSc	
Sapotaceae					
161	*Mimusops sechellarum* (Oliv.) Hemsl.	E	O	PW	
162	*Northea hornei* (M. M. Hartog) Pierre	E	F	HSc	
Scrophulariaceae					
	Striga asiatica (L.) Kuntze	I	-	-	Listed in Robertson (1989); not seen
Solanaceae					
163	*Capsicum frutescens* L.	I	O	Cu	Only in gardens
164	*Solanum lycopersicum* L.	I	O	Cu	Only in gardens
165	*Solanum melongena* L.	I	O	Cu	Only in gardens
Sterculiaceae					
166	*Heritiera littoralis* Ait.	N	C	BC	
Surianaceae					
	Suriana maritima L.	N	-	-	Listed in Robertson (1989); not seen
Turneraceae					
167	*Turnera angustifolia* Miller	I	C	HSc, HW	
Verbenaceae					
168	*Premna serratifolia* L.	N	O	BC	
169	*Stachytarpheta jamaicensis* (L.) Vahl.	I	A	PG, PW	
170	*Stachytarpheta urticifolia* (Salisb.) Sims.	I	A	PG, PW	
171	*Vitex trifolia* L.	I	R	PG	
ANGIOSPERMAE: Monotyledons					
Agavaceae					
172	*Agave sisalana* (Perr. ex Engelm.) Drum. & Prain	I	C	PW, HSc	
173	*Furcraea foetida* (L.) Haw.	I	F	PW	
Amaryllidaceae					
	Crimum amabile Ker.-Gawl.	?I	-	-	Listed in Robertson (1989); not seen
174	*Hymenocallis littoralis* Salisb.	?I	C	PW	
Araceae					
175	*Alocasia macrorrhiza* (L.) G. Don.	I	C	PW	
176	*Anthurium* sp.	I	R	Cu	Only in gardens
177	*Caladium bicolor* (Dryand.) Vent	I	R	Cu	Only in gardens
178	*Colocasia esculenta* (L.) Schott.	I	O	PW	
179	*Dieffenbachia sequine* (Jacq.) Schott	I	R	Cu	Only in gardens
180	*Syngonium ?podophyllum* Schott.	I	R	Cu	Only in gardens
Bromeliaceae					
181	*Ananas comosus* (L.) Merr.	I	F	PW	
Cannaceae					
182	*Canna* hybrids	I	O	Cu	Only in gardens
Commelinaceae					
183	*Commelina* sp.	?I	F	Ma	
184	*Tradescantia spathacea* Swartz	I	O	Cu	Only in gardens

	Species	Status	Abund.	Habitats	Notes
Cyperaceae					
185	*Bulbostylis barbata* (Rottb.) C. B. Cl.	N	C	HSc	
186	*Cyperus halpan* L.	?	F	Ma, HSc	
187	*Cyperus?rotundus* L.	?	C	Ma	
188	*Eleocharis dulcis* (Burm. f.) Trin.	N	O	Ma, HSc	
189	*Fimbristylis cymosa* R. Br.	?	C	BC, PW, Gl	
190	*Fimbristylis* sp. 2 (glacis sedge)	?	F	HSc	
191	*Kyllinga polyphylla* Willd. ex Kunth	N	C	PG	
192	*Kyllinga* sp. 2	?	O	PW	
193	*Lophoschoenus hornei* (C. B. Cl.) Stapf.	E	A	HSc	
194	*Mariscus dubius* (Rottb.) Fischer	N	A	PG	
195	*Mariscus pennatus* (Lam.) Domin.	N	F	Ma	
196	*Scleria sumatrensis* Retz.	N	C	Ma	
197	*Scleria* sp. 2	?	C	PW	
198	*Thoracostachyum floribundum* (Nees) C. B. Cl.	E	F	HW, PW	
Dioscoreaceae					
199	*Dioscorea alata* L.	I	O	PW	
Flagellariaceae					
200	*Flagellaria indica* L.	N	F	PW	
Gramineae					
201	*Bambusa vulgaris* Schrad. Ex Wendl.	I	R	PG	
202	*Brachiara umbellata* (Trin.) W. D. Clayton	N	A	HW, HSc, PW	
203	*Chloris barbata* (L.) Sw.	?	F	PG	
204	*Cymbopogon* sp.	I	R	Cu, PW	
205	*Dactyloctenium ctenoides* (Steud.) Bosser	?	F	PG	
206	*Digitaria ?horizontalis* Willd.	?	C	PG	
207	*Eleusine indica* (L.) Gaertn.	?	F	PG	
208	*Enteropogon sechellensis* (Baker) Dur. & Schinz	N	C	Gl	
209	*Eragrostis tenella* (L.) P. Beuv.	?	F	BC, Mg	
210	*Heteropogon contortus* (L.) P. Beuv.	?	C	Gl	
211	*Hyparrhenia rufa* (Nees) Stapf.	?	F	HSc, Gl	
212	*Ischaenum heterotrichum* Hack.	?	F	BC	
213	*Oplismenus compositus* (L.) P. Beuv.	N	C	PW	
214	*Panicum brevifolium* L.	N	C	PG, PW	
215	*Panicum maximum* L.	?	O	PG	
216	*Paspalum conjugatum* Berg	N	F	PG	
217	*Pennisetum polystachyon* (L.) Schult.	?	F	Gl	
218	*Saccharum officinarum* L.	I	O	Cu	Only in gardens
219	*Sporobolus diander* (Retz.) P. Beuv.	?	F	Gl, BC	
220	*Sporobolus virginicus* (L.) Kunth.	N	A	BC, PG	
221	*Stenotaphrum dimidiatum* (L.) Brogn.	N	A	PG	
Hypoxidaceae					
222	*Curculigo sechellensis* Boj.	E	C	HSc	
223	*Hypoxidia rhizophylla* (Baker) Dur. & Schinz	E	C	HW, HSc	
Lilaceae					
224	*Cordyline fruticosa* L. (A. Chev.)	I	R	Cu	Only in gardens
225	*Dianella* sp. (varieg.)	I	R	Cu	Only in gardens

	Species	Status	Abund.	Habitats	Notes
226	*Dracaena reflexa* Lam. var. *angustifolia* Baker	N	A	HW, PW	
227	*Sansevieria trifasciata* Hort. ex Prain	I	R	Cu	Only in gardens
Marantaceae					
228	*Maranta arundinacea* L.	I	O	PW	
Musaceae					
229	*Musa* sp.	I	F	Cu, PW	
Orchidaceae					
230	*Cynorkis ?fastigiata* Thouars	N	R	HSc	
231	*Disperis tripetaloides* (Thouars) Lindl.	N	F	HW	
	Vanilla phalaenopsis Reichb. f.	E	-	-	One 19th century record (M. North; in Carlström, 1996; now locally extinct
232	*Vanilla planifolia* Andrews	I	C	HW, PW	
Palmae					
233	*Cocos nucifera* L.	N	C	BC, PG	
234	*Deckenia nobilis* Wendl	E	F	HSc	
235	*Lodoicea maldivica* (Gmel.) Pers	E	A	HSc, HW, [HW]	
	Nephrosperma vanhoutteanum (Wendl. ex van-Houtt.) Balf.	E	-	-	Listed in Robertson (1989), Carlström (1996a, b); not seen
236	*Phoenicophorium borsigianum* (K. Koch) Stuntz	E	A	HW, PW	
Pandanaceae					
237	*Pandanus balfourii* Mart.	E	O	BC, PW	
238	*Pandanus hornei* Balf. f.	E	F	BC, PW	
239	*Pandanus multispicatus* Balf. f.	E	A	HSc	
240	*Pandanus utilis* Bory	I	R	PW	
Typhaceae					
241	*Typha javanica* Schnitzl. ex Zoll.	N	C	Ma	
Zingiberaceae					
242	*Alpinia purpurata* (Vieill.) Schumann	I	O	Cu	Only in gardens

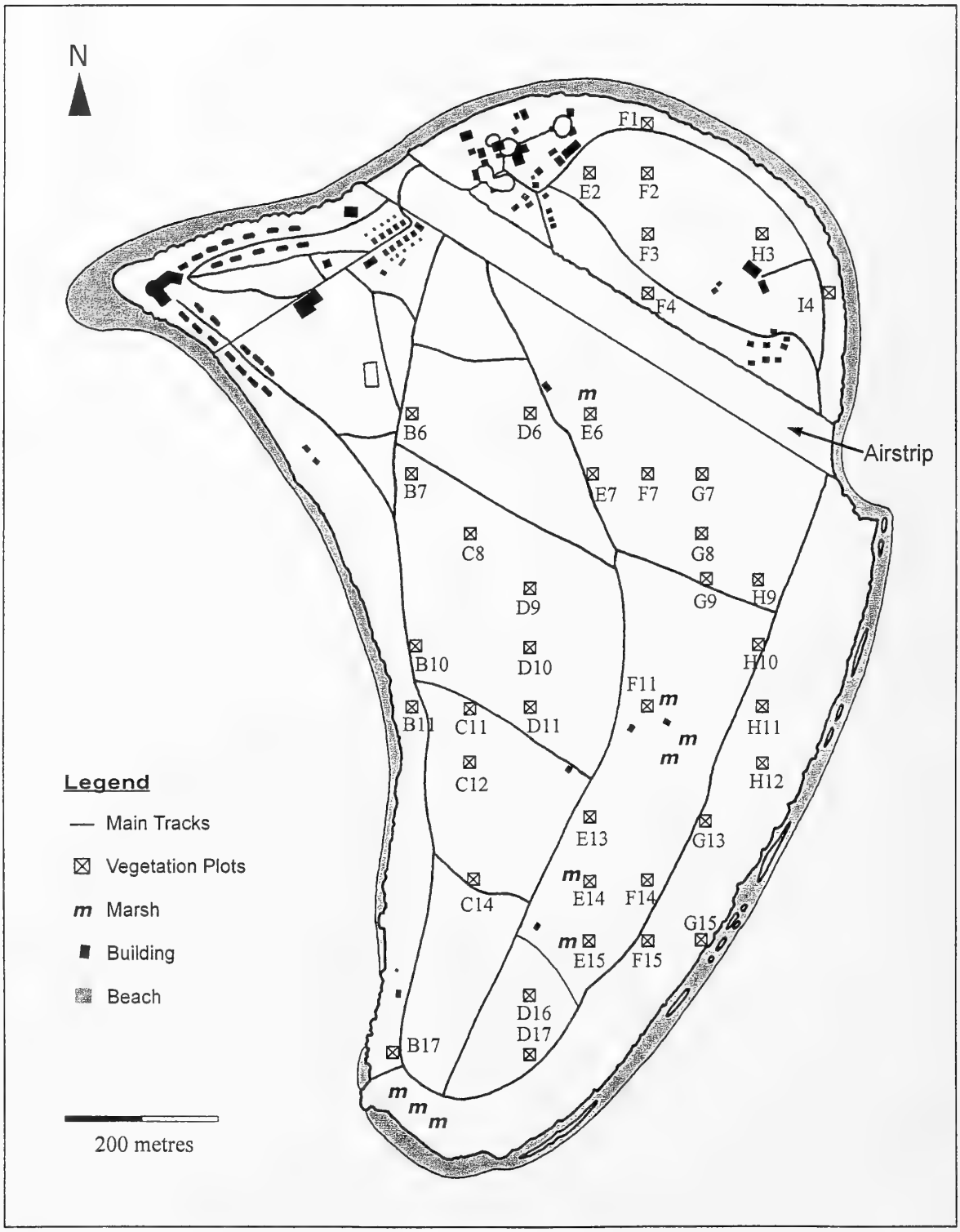

Figure 1. Denis Island: Physical map, with locations of vegetation plots.

DENIS

BY

MICHAEL J. HILL[1], TERENCE M. VEL[1], KATHRYN J. HOLM[2], STEVEN J. PARR[3] and NIRMAL J. SHAH[1]

GEOLOGY, TOPOGRAPHY AND CLIMATE

Denis is one of the northernmost islands of the Seychelles lying around 80 kilometres North of Mahé, the largest of the granitic Seychelles, at the northern edge of the Seychelles Bank. It is approximately 140 ha in area (Directorate of Overseas Survey (UK)/Seychelles Government, unpublished data), although there is evidence of rapid erosion in the past (Fryer, 1910). The maximum elevation is less than 4 m above sea level and average surface elevation is probably around 2.5 m (Stoddart and Fosberg, 1981).

Unlike the majority of islands on the Seychelles Bank, Denis has no granite and it is formed entirely of reef-derived sands. The deposition of guano on sand deposits has led to the formation of phosphatic sandstone over 80% of the island's surface (Fryer, 1910; Baker, 1963). Much of the guano that originally overlaid this cemented layer has now been removed for export (Stoddart and Fosberg, 1981). Guano removal left parts of the island bare of soil (Baker, 1963). In phosphatic sandstone areas where soil cover has survived, soils of the Jemo Series occur; the rest of the island has Shioya series soils (Piggott, 1968). In some wetland areas, brown loams rich in phosphate (leached from phosphatic rocks) occur (Baker, 1963).

Denis has a number of marsh areas, although the extent of marshland appears to have been greater in the recent past (Stoddart and Fosberg, 1981, show a photograph of *Typha* swamp on Denis). At the time of the surveys, wetlands were limited in extent and most showed some marine influence.

Compared to the granitic islands to the south, Denis Island is relatively remote. The nearest island is the coralline Bird Island, approximately 50 km to the west. The nearest large island in the granitic group is Praslin, 54 km to the south.

The Seychelles islands experience a seasonal humid tropical climate (Walsh, 1984). Climate data for Denis Island are incomplete. As it is low and remote from other higher islands of the granitic Seychelles, total annual rainfall is lower than on the high islands such as Mahé and Praslin; Stoddart (1971), using a series of data from 1951-1962, gives a mean annual rainfall of 1,729.5 mm for Denis. Incomplete data for the period 1976-84 gives mean annual rainfall of 1,582.0 mm (see Table 1); for the period 1978-84, Praslin Grand Anse received a mean annual rainfall of 1,757.1 mm (National Meteorological Services of Seychelles, unpublished data).

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The annual rainfall pattern of Denis also differs from that of the granitic Seychelles and coralline islands to the south. On Denis, rainfall is more evenly distributed through the year than on Mahé; there are fewer dry months than on islands to the south (Walsh, 1984).

Table 1. Denis Island: monthly rainfall (mm), 1976-1984.
(Data: National Meteorological Services, Seychelles, unpublished data).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	173.5	133.4	n/a	n/a	n/a	48.0	19.1	35.6	22.1	11.2	11.9	241.8
1977	366.0	341.5	n/a	168.5	71.5	45.0	56.5	64.5	8.9	272.0	58.5	332.6
1978	n/a	195.5	37.0	n/a	74.0	26.0	18.5	n/a	39.0	106.0	n/a	n/a
1983	275.0	78.0	n/a	n/a	n/a	49.6	116.5	287.1	491.5	192.0	176.5	243.7
1984	252.0	247.6	57.0	96.0	0.0	47,5	25.5	107.0	109.5	159.0	150.0	354.1
Mean	266.6	199.2	47.0	132.3	48.5	43.2	47.2	123.6	134.2	148.0	99.2	293.0

HISTORY

The island was discovered in 1773 by Denis de Trobriand and named for himself. He found an island with abundant sea turtles, land tortoises, sea lions (or dugong) and birds (Bradley, 1940). His records suggest that the original vegetation of the island was high forest with species including *Pisonia grandis* or a similar tree (Stoddart and Fosberg, 1981). The existence of extensive guano deposits (Baker, 1963) implies the presence of large colonies of nesting seabirds, possibly tree-nesters.

In the 19th and 20th centuries the island underwent complete transformation, first through the cultivation of coconuts, planted from around 1890 (Stoddart and Fosberg, 1981), then guano extraction (from 1929-41; Baker 1963), and finally by the extensive replanting of coconuts.

In 1975, the island was sold to a new owner. An airstrip was built and a small tourist lodge opened. Today, the coconut plantation on Denis is no longer managed for production and the island is managed as a resort with 25 villas. The permanent population of the island (50-70 people) is employed in the hotel and tourists travel to Denis by small plane from Mahé.

The flora, fauna and ecology of Denis (and Bird Island) were the subject of a detailed paper in the 1980s (Stoddart and Fosberg, 1981). The two islands were visited by earlier naturalists including Coppinger (1885) and Fryer (1910); unfortunately, some of the early reports seem to be characterised by confusion between the two islands.

FLORA AND VEGETATION

Flora

A total of 179 plant species were recorded on Denis Island, including four ferns, one gymnosperm (introduced) and 174 angiosperms (Appendix 1). Of the angiosperms, 119 (68.4%) species are regarded as introduced (Friedmann, 1994) and 37 (21.3%)

native. No species endemic to Seychelles was recorded. At least 55 ornamental or edible species were restricted to garden areas.

While few previous records of the flora of Denis Island exist, a number of workers have collected specimens, or made observations on the island. Many of the species recorded in 1999/2000 were not listed by previous workers; these include a number of ornamental species undoubtedly introduced to enhance the hotel grounds in recent years. Some species were probably overlooked in earlier surveys, including the fig *Ficus lutea*, tamarind *Tamarindus indica,* and agati *Adenanthera pavonina* (all represented today by large trees).

Twelve species recorded by earlier visitors were not observed (see Appendix). At least two of these species were probably synonyms of species recorded in the 1999/2000 survey; others are now extinct and some may never have occurred on Denis Island. In some early records (notably Fryer, in Christensen, 1912; Summerhayes, 1931) there appears to be some confusion between Bird and Denis Islands, thus some species which have probably never occurred on Bird (mangrove fern *Acrostichum aureum* and bulrush *Typha javanica*) are recorded for that island. *Tribulus cistoides*, listed for Denis by Summerhayes (1931), may have been a record from Bird Island where the species still occurs (or this may refer to an extinct population). Excluding locally extinct species, probable synonyms, and species that probably never occurred there, the total plant list for Denis Island stands at 185 species. Compared to the flora of the granitic islands, that of Denis is notable for its lack of endemic species and the dominance of introduced plants (of the total Seychelles flora, around 54% are introduced and 9% endemic: Procter, 1984).

Of the introduced plants established on Denis Island, only seven are generally regarded as invasive weedy species (Carlström, 1996a; Fleischmann, 1997). One of these, lantana *Lantana camara,* is present in relatively small numbers but has the potential to become a serious weed of open areas. At least two others, fatak grass *Panicum maximum* and *Passiflora suberosa*, are herbaceous species which can be displaced by native woody vegetation. The most widespread and well-established woody introduced species is casuarina *Casuarina equisetifolia,* which appears more invasive here than it is on the granitic islands. Papaya *Carica papaya* is also widespread in coconut woodland on Denis.

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. One species of interest is the rampant liana *?Tylophora coriacea* (provisional identification), a rare native species known from Aldabra and Silhouette (Friedmann, 1984) but found to be abundant on Denis, often climbing *Casuarina* trees to a height of 15 m or more.

Vegetation

The extents of major vegetation types on Denis Island are shown in Table 2, and Figure 2. The whole island is dominated by former coconut plantations, but the north west of the island has a high proportion of *Casuarina equisetifolia*, and areas around the airstrip and the east by broad-leaved trees, especially *Terminalia catappa*.

In total, 40 vegetation plots were completed, 20 in October and 20 in April. These covered 4,000 m^2 or 0.28% of the island's surface. The 40 plots were located randomly within habitats excluding grassland, garden and marsh: the survey covered 0.37% of the targeted area. A summary of results is shown in Table 3.

The vegetation of Denis Island had a relatively low density of trees and the tree layer was species-poor. A total of 12 tree species was recorded, seven of which were probably native. Three species together accounted for 70% of all individuals. The most abundant tree was bwa torti *Morinda citrifolia,* a species that is possibly introduced (Friedmann, 1994); 51 of 174 trees (29.3%) were *M. citrifolia*. Other abundant species were *Cocos nucifera* (45 of 174 trees, 25.9%) and *Casuarina equisetifolia* (25 trees, 14.4%). The most widespread species of the shrub layer were *Cocos nucifera* (in 38 of 40 plots, mean cover 33.1%), *Morinda citrifolia* (in 33 plots, mean cover 16.5%), and *Carica papaya* (eight plots, mean cover 3.2%). The herb layer was particularly dense and was dominated by *Nephrolepis* sp., which occurred in 39 of 40 plots (mean cover 36.7%). Three other species occurred in more than 12 plots: *Cocos nucifera* (in 30 of 40 plots, mean cover 4.6%), *Phymatosorus scolopendra* (29 plots, mean cover 23.9%) and *Morinda citrifolia* (27 plots, mean cover 2.5%).

Table 2. Extent of major vegetation types, Denis Island.

Vegetation type	Approx. area (ha)
Coconut with scrub	73.0
Scrub (exotic)	0.3
Broadleaf woodland (exotic)	3.4
Broadleaf woodland (native)	27.7
Beach crest vegetation	5.9
Marsh	0.5
Grassland/garden	32.2

Table 3. Vegetation plot summary, Denis 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	40	<5	435	46.9	61.9	36.9	1.2	1.35

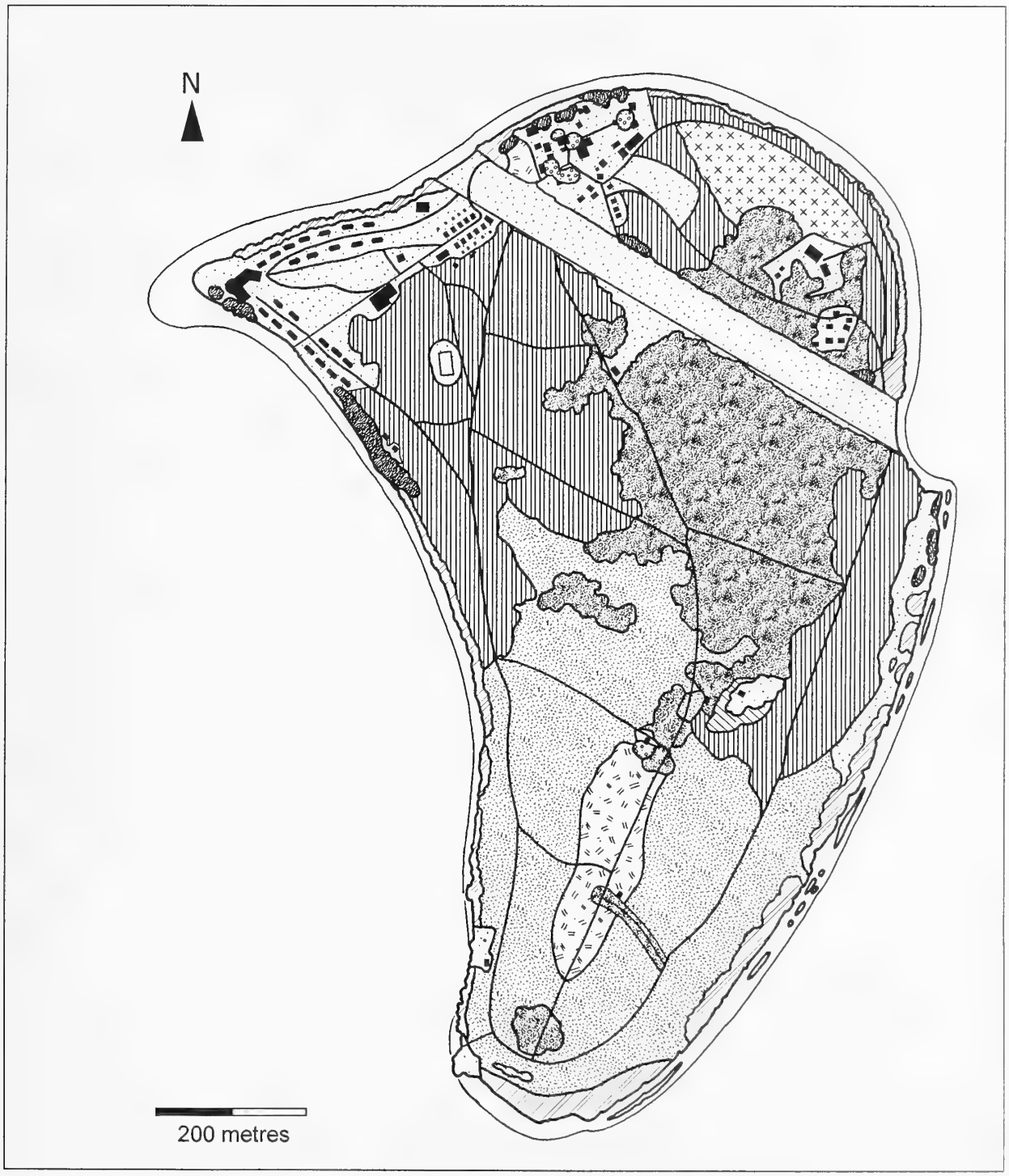

Figure 2. Denis Island: vegetation.

Compared to that of the other coralline island studied (Bird Island), the vegetation of Denis Island is rather diverse. Stoddart and Fosberg (1981) recognised four different vegetation units on Denis: Littoral hedge (beach crest), *Casuarina* woodland, coconut woodland and marsh. Today, at least three further vegetation types occur: broadleaf woodland, grassland and ornamental gardens.

Broadleaf woodland occurs in two relatively large areas, to the north and south of the airstrip. In much of this woodland *Terminalia catappa* is the dominant tree, with *Casuarina, Cocos* and *Calophyllum*. An area to the north of the airstrip is composed of *Tabebuia pallida*. Grassland areas, dominated by a variety of grass species and low herbs include the airstrip, village and farm. The airstrip is maintained by mowing, other areas by cattle grazing. Gardens are situated around habitation in the north and west of the island. The tourist operation, which was small at the time of Stoddart and Fosberg's visit, has grown and the area devoted to gardens has increased. A number of ornamental plants unrecorded in the 1970s are now present on the island although most are not found away from cultivated areas. The few ornamentals that have found their way into the flora of wild habitats on Denis were earlier introductions, including *Ipomoea hederifolia* and *Euphorbia cyathophora*

The dominant vegetation type of the island is sparse open woodland of *Cocos nucifera* and *Morinda citrifolia*, with occasional trees of other species including *Casuarina*, *Ficus lutea* and *Terminalia catappa*. The shrub and herb layers of this vegetation were usually dense and were dominated by *Morinda* and *Nephrolepis*. Of the vegetation units recognised by Stoddart and Fosberg, that which has shown the most change is the marshland. Although wet areas were still present in 1999 and 2000, they appear reduced in extent (see map) and several of the marsh areas were heavily shaded by *Terminalia catappa* and *Cocos nucifera*, with few aquatic macrophytes surviving. *Acrostichum* sp. was still abundant and widespread. *Typha javanica* was restricted to one small pond, heavily shaded by coconut regrowth. Few marshes had any open water, and in these, water levels varied with the tide.

INVERTEBRATES

Pitfall Trapping

The pitfall trap assemblages were large (Table 4). Overall pitfall assemblages were larger in April than October. Assemblages on Denis Island were larger than those on the granitic islands in both seasons. As on all other islands, assemblages were dominated by ants: ants formed 54.8% of the total number of individuals in October, 76.4% in April. The most abundant species in both seasons was an ant *Odontomachus troglodytes* (which made up 52.9% of individuals in October and 70.3% in April). However, excluding the ants, assemblages on Denis were still larger than those of the granitic islands. Crustacea (mainly Amphipoda), Dermaptera and Blattodea all formed significant parts of the overall assemblage (Fig. 3). Blattodea are favoured food items of the Seychelles magpie-robin.

The crazy ant *Anoplolepis gracilipes* was present on the island, but only two individuals were collected in pitfall traps, in plots E13 and F11, suggesting that this pest species was uncommon. On nearby Bird Island, an extremely high population density of this ant has caused many conservation problems including the death of native trees (Hill, in prep.) and the eradication of native reptiles from large parts of the island (Feare, 1999a). The status of crazy ants on Denis Island should be monitored, and control methods used if necessary.

Table 4. Pitfall assemblages from Denis Island.
only invertebrates over 2 mm body length counted
(number in parentheses: excluding ants).

Island	Habitat	Mean no. individuals per 5 traps	
		SE season (Oct)	NW season (Apr)
Denis	Plateau woodland/scrub	110.0 (49.7)	137.9 (32.7)
Granitic islands (mean)		61.8 (9.4)	61.1 (16.0)

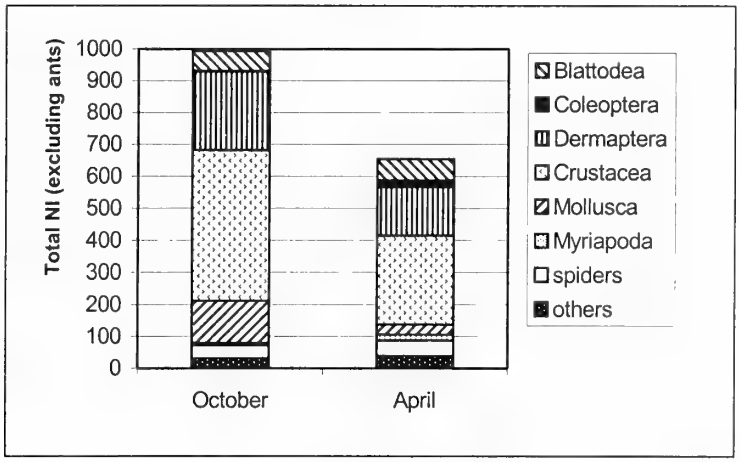

Figure 3. Composition of pitfall assemblages on Denis Island.

Leaf-insect Counts

Leaf-insect counts were carried out for 11 tree and shrub species, four of these in both seasons (Table 5). For all trees counted in both seasons, the populations of invertebrates on leaves were at a higher density in the wet north west monsoon season. The highest counts were for the native tree *Pisonia grandis*, which is uncommon on Denis Island (only one individual tree was found in the vegetation plots). As found on some other islands, the shrub *Morinda citrifolia* (status uncertain; possibly introduced) also had very high leaf counts. *Morinda* is the most abundant tree on Denis Island and dominates the island's vegetation. One introduced tree, *Tabebuia pallida*, also showed high leaf counts per square metre of leaf.

Table 5. Density of invertebrates on foliage, Denis Island.
n = no. of leaves counted; NI = Number of individual invertebrates.

Species	SE season (October)			NW season (April)		
	n	mean NI leaf^{-1}	mean NI m^{-2}	n	mean NI leaf^{-1}	Mean NI m^{-2}
Introduced species						
Carica papaya	0			200	0.555	9.82
Tabebuia pallida	0			300	0.667	131.92
Native species						
Calophyllum inophyllum	100	0.230	23.92	50	0.300	30.81
Cordia subcordata	50	0.400	31.85	100	0.340	35.11
Guettarda speciosa	100	0.960	47.61	0		
Hibiscus tiliaceus	0			100	0.370	25.56
Pisonia grandis	0			50	63.02	3373.66
Scaevola sericea	0			50	0.300	28.49
Terminalia catappa	400	0.423	24.81	650	0.741	52.20
Thespesia populnea	50	0.300	23.95	0		
?Status unknown						
Morinda citrifolia	2450	1.118	111.14	2500	5.974	496.42

Malaise Trapping

Malaise trapping was carried out in both seasons. Four Malaise traps were run in October 1999 and five in April 2000. Assemblages were large and slightly larger in October (mean NI = 946.5) than in April (mean NI = 828). Malaise trap assemblages included members of 13 invertebrate orders. In both seasons, the Diptera were dominant (Diptera accounted for 41.3% of individuals in October, 45.9% in April). Other important orders included Hymenoptera (15.3% of the assemblage in October, 37.9% in April) and Lepidoptera (16.9% of the assemblage in October, 12.5% in April). Assemblages also contained Orthoptera and Blattodea. The majority of taxa collected have yet to be identified to species level.

Observation

Most invertebrates observed on Denis Island were of introduced or cosmopolitan species (Table 6). One Seychelles endemic cricket *Pelerinus rostratus,* not otherwise known outside the granitic islands, was probably introduced. At least four species of Odonata were observed, sometimes in large numbers. Observations were most frequent over the airstrip, but observations of dragonflies and damselflies around the island's wetlands suggest that some species may breed on the island. Few other invertebrates were observed in wetland areas: the water snail *Melanoides* was found in large numbers, along with mosquito larvae, in April.

Table 6. Invertebrates observed, Denis Island

Order	Family	Species	Notes
Mollusca:			
Gastropoda	Subulinidae	*Subulina octona* Bruguière, 1792	Very common, pitfall traps
	Thiaridae	*Melanoides tuberculata* (Müller, 1774)	Abundant, 'freshwater' marsh
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	Occasionally in rat traps
		Coenobita rugosus H. Milne-Edwards, 1837	Mainly close to shore
		Coenobita perlatus H. Milne-Edwards, 1837	Red hermit
	Grapsidae	*Grapsus tenuicrustatus* (Herbst, 1783)	On rocks, sea's edge
		Geograpsus crinipes (Dana, 1851)	Regularly seen near beaches
	Ocypodidae	*Ocypode ceratophthalmus* (Pallas, 1772)	On beaches
		Ocypode cordimana Desmarest, 1825	Abundant in all habitats, diurnal and nocturnal
Myriapoda:			
Chilopoda	Scolopendridae	*Scolopendra subspinipes* (Leach, 1918)	
Diplopoda	Paradoxosomatidae	*Oxidus* (Orthomorpha) *gracilis* (K. Koch, 1847)	In pitfall traps
	Trigoniulidae	*Spiromanes braueri* (Attems, 1900)	In pitfall traps
		Spiromanes ?seychellarum Saussure & Zehntner, 1902	In pitfall traps
Insecta:			
Coleoptera	Scarabaeidae	*Oryctes monoceros* (Olivier, 1789)	Frequent
		Protaetia maculata (Fabricius, 1775)	
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)	
	Formicidae	*Anoplolepis gracilipes* (Smith, 1857)	In pitfall traps
		Cardiocondyla emeryi Forel, 1881	In pitfall traps
		Odontomachus troglodytes Santschi, 1914	In pitfall traps
		Paratrechina sp.	In pitfall traps
		Plagiolepis sp.	In pitfall traps
		Technomyrmex albipes (Smith, 1861)	In pitfall traps
		Tetramorium sp.	In pitfall traps
	Vespidae	*Polistes olivaceus* (De Geer 1773)	
Lepidoptera	Lycaenidae	*Zizeeria knysna* (Trimen, 1862)	Collected April, not abundant
	Nymphalidae	*Hypolimnas misippus* L. 1764	Observed April
Neuroptera	Myrmeleontidae	*Myrmeleon obscurus* Rambur, 1853	To light, 10/99
Odonata	Coenagrionidae	*Ceriagrion glabrum* (Burmeister, 1839)	One damselfly observed at marsh, 12/10/99
	Libellulidae	*Diplacodes trivialis* (Rambur, 1842) or *Orthetrum stemmale wrightii* (Selys, 1877)	One individual observed over airstrip, April
		?Pantala flavescens (Fabricius, 1798)	Large, orange-brown dragonfly observed over airstrip, April. Several indivs observed
		Tramea limbata (Selys, 1869)	Two indivs. observed,
Orthoptera	Phasgonuridae	*Ruspolia differens* (Serville, 1838)	To light
	Tettigonidae	*Pelerinus rostratus* (Brunner, 1878)	To light

VERTEBRATES

Reptiles and Amphibians

Six reptile species were observed on Denis; four lizards, a snake and a giant tortoise (see Table 7). At least three of these species, *Gehyra mutilata, Geochelone gigantea,* and *Ramphotyphlops braminus*, are introduced. A giant tortoise species, presumably one of the taxa endemic to the granitic Seychelles, was present in 1773 (Bour, 1984), but this population is now extinct. Fossil giant tortoise eggs from Denis have been dated to 1308±85 yr BP (Burleigh, 1979).

In addition to the land reptiles, two species of marine turtle breed regularly on Denis Island: the green sea turtle *Chelonia mydas* (L.) (Frazier, 1984) and hawksbill *Eretmochelys imbricata* (L.).

Table 7. Reptiles observed, Denis Island.
Status: E =endemic, I = introduced, N = native (in central Seychelles).

Family	Species		Status
Gekkonidae	*Gehyra mutilata* (Wiegmann, 1835)	Pacific house gecko	I
	Phelsuma sundbergi Rendahl, 1939	day gecko	E
	Phelsuma sp. (*?P. astriata* Tornier, 1901)	day gecko	E
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	Seychelles skink	E
Testudinidae	*Geochelone gigantea* (Schweigger, 1812)	Aldabra giant tortoise	I
Typhlopidae	*Ramphotyphlops braminus* (Daudin, 1803) Robb, 1966	Brahminy blind snake	I

Birds

In total, 17 land birds and waders were recorded of which six were resident species (Table 8). Three of these resident species were obvious introductions (barred ground dove, common mynah, Madagascar fody). One species (turtle dove) is likely to have been introduced although it was recorded on the island early in the twentieth century (Fryer, 1910). The individuals observed showed grey heads and relatively large size, characteristics of the introduced Madagascan race *S. picturata picturata* rather than the Seychelles endemic form *S. picturata rostrata* (which appears effectively extinct throughout its former range; Gaymer *et al.*, 1969). Only one endemic species was observed (Seychelles blue pigeon). Together with the moorhen, this seems to comprise the entire native bird fauna. Stoddart and Fosberg (1981) suggest that the Denis population of the latter species is introduced but, if so, the introduction must have occurred prior to 1866, when Newton obtained three live specimens (Newton, 1867).

In 1908, a sunbird Cinnyris sp. was recorded (Fryer, 1910), Stoddart and Fosberg (1981) suggest that this was the souimanga sunbird *Nectarinia sovimanga*. However, the nearest extant populations of this species are on Aldabra and Cosmoledo (Sinclair and Langrand, 1998): a much more likely species would appear to be Seychelles sunbird *Nectarinia dussumieri,* which is widespread on islands of the granitic Seychelles. No sunbirds were observed during the current survey, and it appears that this population is now extinct. In general, sunbirds appear relatively resistant to extinction caused by human intervention; there are no known extinctions of *N. sovimanga* populations in the

Aldabra group (Diamond, 1984), despite massive environmental degradation on some of the islands.

Two of the land bird species observed, common mynah and Seychelles blue pigeon, were not recorded by Fryer (1910), and appear to be more recent invaders or introductions. One of the introduced land bird species recorded (common mynah), is a potential nest predator of endemic birds.

Eight seabird species were recorded (Table 9). The most abundant species was the fairy tern *Gygis alba*; during the October 1999 survey, thousands were observed roosting in tall *Casuarina* trees, together with smaller numbers of brown noddy *Anous stolidus*. Other seabirds were much less abundant. In April 2000, there was evidence of breeding of fairy terns, brown noddies, and white-tailed tropic birds (the latter species nesting in *Casuarina* trees).

Domestic hens and quail are kept caged in a large poultry unit on the island; there appeared to be no free-living fowl.

Table 8. Land birds and waders observed on Denis Island.
M = migrant species; V = vagrant species; E = Seychelles endemic species.

Species		Notes
Anas querquedula V	garganey	One bird, east of airstrip, 10-12/10/99
Gallinula chloropus	common moorhen	One bird seen in freshwater marsh, 11/10/99. Not seen April 2000
Dromas ardeola M	crab plover	Several birds seen 11/10/99. Group of three birds on beaches, 9/4/00
Charadrius leschenaultii M	greater sandplover	Several birds seen regularly on airstrip, October and April. Distinguished from *C. mongolus* by call
Pluvialis squatarola M	grey plover	Seen regularly, on airstrip and beaches, both October and April
Numenius phaeopus M	whimbrel	Seen regularly, especially on airstrip, both October and April. Flock of 17 birds seen, E. end of airstrip, 12/4/00
Numenius arquata M	Eurasian curlew	One bird on airstrip 16/04/01
Tringa nebularia M	common greenshank	One bird in shallow sea, eastern end of airstrip, 12/10/99
Xenus cinereus M	terek sandpiper	One bird with Curlew Sandpipers on airstrip, 7/10/99
Actitis hypoleucos M	common sandpiper	One individual, E. end of airstrip, 12/10/99
Arenaria interpres M	ruddy turnstone	Seen regularly, on airstrip and beaches, in groups of up to 30, both October and April
Calidris ferruginea M	curlew sandpiper	Seen regularly, on airstrip and beaches, in groups of up to 10 (October only)
Hirundo rustica V	barn swallow	One individual seen flying over airstrip, 11/4/00
Streptopelia picturata ssp.	turtle dove	Seen regularly. Doves on Denis Island have features close to the introduced Madagascan subspecies *S. p. picturata*, rather than the endemic *S. p. rostrata*
Geopelia striata	barred ground dove	Seen regularly
Alectroenas pulcherrima E	Seychelles blue pigeon	Seen occasionally, especially around the village. Reported common
Acridotheres tristis	common mynah	Seen regularly
Foudia madagascariensis	Madagascar fody	Seen regularly, many nests observed (some with young chicks present) in October

Table 9. Seabirds observed, Denis Island.
† = species breeding on island

Species		Notes
Phaeton lepturus †	white-tailed tropicbird	A few individuals seen. Reported to nest in casuarinas on the island. Observed nesting 16/04/01
Fregata minor	great frigatebird	One adult male seen flying low over airstrip, 11/10/99. Juvenile and female frigatebirds (*F. minor* or *F. ariel*) regularly observed in October. Both species probably occur
Sterna bergii	greater crested tern	Regularly seen on rocks close to island (October only)
Anous stolidus †	brown noddy	Roosting in casuarinas (October). Breeding April: one well-grown chick observed dead beneath casuarina 6/4/00, large fledgling observed on forest floor 6/4/00
Anous tenuirostris	lesser noddy	Seen flying in to roost, October and April. Around 35 birds observed roosting in tall coastal casuarina, 9/4/00
Sterna anaethus	bridled tern	Around 10 birds roosting in tall casuarinas, Muraille Bon Dieu, 6/4/00
Sterna fuscata	sooty tern	Regularly seen close to island, October and April
Gygis alba †	fairy tern	Large numbers of birds (hundreds) roosting in casuarinas, October. Evidence of breeding in April: chicks and eggs observed. Most nesting appears to occur in tall casuarinas

VERTEBRATES: MAMMALS

Mammals observed in the course of fieldwork were recorded (Table 10). In addition, rodent trapping was carried out in October 1999 and April 2000 (Table 11). Two traplines were established, both in coconut woodland (former plantation). Two species of rodent were trapped. Ship rat *Rattus rattus* was the most frequent, while house mouse *Mus domesticus* were taken in small numbers (a total of six mice taken in 279 trap-nights). Overall trapping rates were relatively high with higher rates in October (at the end of the dry season when food and water stress are greatest).

Table 10. Mammal species recorded on Denis.

	Status 1999/2000	Status August 2001
Felis catus L.	A large population present: five individuals seen on one occasion (at pig farm).	?Extinct
Rattus rattus L.	Widespread	Extant
Mus domesticus L.	Collected in rat traps, and regularly seen in woodland habitats. Also in buildings and anthropogenic habitats.	Extant
Bos taurus L.	c. 30 individuals, usually tethered	Extant
Sus domesticus Erxleben	c. 100 animals	Extant

Table 11. Results of rat trapping

Dates	Trap-nights	No. of rats	Rats per 100 trap-nights (uncorrected)	Rats per 100 trap-nights (corrected)*
7 - 12/10/99	140	50	35.7	64.9
7 – 12/4/00	139	46	33.1	34.5
All islands	1893	595	31.4	

*Corrected to account for the effect of closed traps: Cunningham and Moors, 1996

In July 2000, a rat and cat eradication programme was undertaken on the island by staff of the New Zealand Department of Conservation, in a project coordinated by the Seychelles Ministry of Environment and Transport. Initially, the project appeared to be successful in eradicating rats on Denis, but trapping in August 2001 revealed small populations of rats in at least two areas of the island, and rats have since spread to most areas of the island. It is possible that rats invaded the island following a successful eradication. Mice probably survived the eradication: although they were not recorded until early 2001, they were found to be abundant and widely distributed around the island by August 2001. A small number of cats (possibly only two individuals) survived the cat and rat eradication of 2000, but were killed in 2001. Cats now appear to be extinct on the island.

The herd of cattle on Denis Island (numbering about 30) appeared to have a limited impact on the island's ecosystems, because the animals were usually kept tethered in open grassy areas on the east coast of the island or in grassland near the pig farm. Their major impact was on fresh water marsh areas which are limited in extent and fragile. Cattle appeared to cause physical disturbance and eutrophication of the marsh (especially that at CL 5215 7915).

CONSERVATION RECOMMENDATIONS

Although Denis is a coralline island with a history as a coconut plantation, it now has relatively extensive coastal forest dominated by native tree species, and the remaining coconut plantation areas are undergoing succession to woodland. Native trees support high densities of invertebrates on their foliage which could provide food for introduced small insectivores such as Seychelles warbler *Acrocephalus sechellarum*, Seychelles white-eye *Zosterops modestus* and Seychelles fody *Foudia sechellarum*. The woodland is particularly rich in badamier *Terminalia catappa* and is rather marshy, resembling woodland on La Digue which supports the major population of black paradise flycatcher *Terpsiphone corvina* (Watson, 1981). The island could at present support around 10 pairs of this highly endangered species (Currie *et al.* in prep.), and this number would rise with appropriate management of marshland and woodland habitats. Ground-dwelling invertebrate assemblages were also relatively large and similar in composition to those of Cousin Island which supports a population of Seychelles magpie-robin *Copsychus sechellarum*, suggesting that this species could survive on Denis if translocated. Since

magpie-robins forage on the ground, some clearance of dense coconut regrowth would be necessary to increase the area of suitable habitat available to the birds.

Management for conservation on Denis Island should include the encouragement of forest succession through the removal of coconut and planting of native broadleaf trees including *Terminalia* and *Pisonia. Pisonia* probably made up the original vegetation of the island prior to human settlement. However, most importantly, complete eradication of introduced predators will be necessary before translocation of endemic bird populations can occur. The most important predators remaining on the island are ship rats, although mynahs might also present a hazard to an establishing population of Seychelles magpie-robin as they are known to be nest competitors and nest predators of magpie-robins.

Assessment work suggests that Denis could easily support viable populations of some of Seychelles' most endangered endemic birds, but the translocation of Seychelles endemic birds to Denis would not be a classic "reintroduction" of a species to sites in its former range where it has been extirpated by introduced predators or environmental change. None of the endangered endemic birds of the granitic Seychelles have ever been recorded on Denis Island: the endemic fauna has been restricted to two common species, the Seychelles blue pigeon and Seychelles sunbird (the latter now locally extinct). It is generally advised that translocations of endangered animals should generally be kept within the species' known range, in locations where it has died out (reintroduction rather than introduction; IUCN, 1998). Translocations within a species' known historical range have a better chance of success than those outside (Towns *et al.*, 1990). However, the conservation of species threatened with extinction may justify translocation outside the natural range. While introductions to pristine islands that have never had alien predators can be detrimental to existing habitats and species (Towns *et al*, 1990), this is less likely to be the case where the island concerned has previously suffered major habitat disruption and the introduction of alien predators (as on Denis). In the Seychelles, at least two circumstances favour the translocation of bird species outside those islands which can be precisely defined as the species' former range:

1) Historical records of bird distribution are poor with very little information before 1865 (Rocamora and Skerrett, 2001) by which time much human-mediated environmental change had already occurred. Alien predators were introduced with, or even before, the first human settlement in 1770, and were responsible for the loss of island populations of several species (Newton, 1867; Diamond, 1984).

2) Most of the land area of the archipelago is currently unsuitable for many of the rarer species, and likely to remain so; 78% of the granitic Seychelles' land area is contained in the two islands Mahé and Praslin where it is impossible to eradicate alien predators.

While the Seychelles biota as a whole shows a high degree of endemism (Stoddart, 1984), there is little evidence of island endemism, especially on the low coralline islands where the majority of the flora and fauna is made up of widely-distributed species (Stoddart and Fosberg, 1984). The absence of endemic species on islands such as Denis can be advantageous to translocations of endemic vertebrates,

ensuring little conflict of interest with the conservation of pre-existing populations of other endemic taxa (Atkinson, 1990).

In this situation, the coralline island of Denis would appear to offer an excellent opportunity to establish additional populations of some endemic birds as part of ongoing species recovery programmes. At least two endemic land birds have been translocated to coralline islands in the past and become established; the Seychelles magpie-robin survived on Alphonse for 60 years before being driven to extinction by habitat change and/or the introduction of cats in the 1950s (Collar and Stuart, 1985). The Seychelles fody was introduced to D'Arros in 1965 (Penny, 1974).

The isolation of Denis imposes special conditions on any translocation programme. Because of the remoteness of the island, birds translocated here will remain isolated and cannot disperse to other islands in the group. Populations will necessarily be artificially managed and it is essential that any habitat management be initiated before birds are translocated.

Appendix 1. Plant species recorded from Denis (excluding seagrasses)

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: PG = Grassland; W = Woodland; Sc = Scrub; BC = Beach Crest; Ma = Marsh; Cu = Garden.
Previous records (in Notes): 1 = Stoddart and Fosberg, 1981; 2 = Fryer in Summerhayes, 1931; 3 = Fryer, 1910; 4 = collections by Jeffrey (no date), cited by Stoddart and Fosberg, 1981.

	Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA					
Adiantaceae					
1	*Acrostichum aureum* L.	N	A	Ma	
Davalliaceae					
2	*Nephrolepis biserrata* (Sw.) Schott	N	A	W	
	Nephrolepis cf. *hirsutula* (Forst.f.) Presl.	?	-	-	Recorded 1977[1], not current survey. Same as *N. biserrata?*
Polypodiaceae					
3	*Phymatosorus scolopendria* (Burm. f.)	N	A	W	
Psilotaceae					
4	*Psilotum ?nudum* Sw.	N	F	W	
GYMNOSPERMAE					
5	*Cycas thuarsii* Gaud.	I	R	Cu	Only in gardens
ANGIOSPERMAE: Dicotyledons					
Acanthaceae					
6	*Asystasia* sp. B (*sensu* Friedmann)	?I	A	G	
	Asystasia bojeriana Nees	?	-	-	Recorded 1977[1], not current survey. Same as *A.*sp. B?
7	*Pseuderanthemum carruthersii* (Seem.) Guillaumin	I	F	Cu	Only in gardens
Amaranthaceae					
8	*Achyranthes aspera* (L.) DC.	I	A	W, G	
9	*Alternanthera brasiliana* (L.) O. Kuntze	I	O	Cu	Only in gardens
10	*Amaranthus dubius* Mart. ex Thell.	I	A	G	
11	*Celosia argentea* L.	I	R	Cu	Only in gardens
Anacardiaceae					
12	*Spondias cytherea* Sonn.	I	R	Cu	Only in gardens
Annonaceae					
13	*Annona muricata* L.	I	R	Cu	Only in gardens
14	*Annona squamosa* L.	I	F	W, Cu	
Apocynaceae					
15	*Catharanthus roseus* (L.) G. Don.	I	A	G, W	

	Species	Status	Abund.	Habitats	Notes
16	*Nerium oleander* L.	I	R	Cu	Only in gardens
17	*Ochrosia oppositifolia* (L.) K. Schum.	N	R	G	
18	*Plumeria rubra* L.	I	O	Cu	Only in gardens
19	*Thevetia peruviana* K. Schum.	I	R	Cu	Only in gardens
Araliaceae					
20	*Polyscias* sp.	I	R	Cu	Only in gardens
Asclepiadaceae					
21	*Calotropis gigantea* (L.) Aiton f.	I	F	G, Sc, Cu	
22	*Tylophora ?coriacea* Marais	N	C	W	
Balsaminaceae					
23	*Impatiens balsamina* L.	I	O	Cu	Only in gardens
24	*Impatiens wallerana* Hook. F.	I	F	Cu	Only in gardens
Bignoniaceae					
25	*Tabebuia pallida* (Lindl.) Miers.	I	A	W	
Boraginaceae					
26	*Cordia sebestena* L.	I	O	Cu	Only in gardens
27	*Cordia subcordata* Lam.	N	C	W, BC	
28	*Tournefortia argentea* L. f.	N	C	BC	
Cactaceae					
29	*Opuntia* sp.	I	O	Cu	Only in gardens
Caesalpiniaceae					
30	*Caesalpinia pulcherimma* (L.) Sw.	I	F	Cu	Only in gardens
31	*Cassia/Senna* sp.	I	F	Cu	Only in gardens
32	*Delonix regia* (Hook.) Raf.	I	R	Cu	Only in gardens
33	*Senna occidentalis* (L.) Link	I	C	PG	
34	*Tamarindus indica* L.	I	O	Cu, W	
Campanulaceeae					
35	*Hippobroma longiflora* (L.) G. Don	I	F	Ma, G	
Capparidaceae					
36	*Cleome gynandra* L.	I	F	BC, G	
Caricaceae					
37	*Carica papaya* L.	I	A	W, Cu	
Casuarinaceae					
38	*Casuarina equisetifolia* J. R. & G. Foster	I	A	W	
Combretaceae					
39	*Terminalia catappa* L.	?N	A	W	
Compositae					
40	*Bidens pilosa* L.	I	C	G	
41	*Coreopsis lanceolata* L.	I	C	Cu	Only in gardens
42	*Melanthera biflora* (L.) Wild	?N	C	G	
43	*Synedrella nodiflora* (L.) Gaertn.	I	A	G	
44	*Tithonia diversifolia* (Hemsl.) A. Gray	I	R	Cu	Only in gardens
45	*Vernonia cinerea* (L.) Less.	I	A	W, G	
Convulvulaceae					
46	*Ipomoea hederifolia* L.	I	O	G	
47	*Ipomoea macrantha* Roem. Et Schult.	N	C	W, Ma	
48	*Ipomoea obscura* (L.) Ker Gawl.	I	F	G, W	
49	*Ipomoea pes-caprae* (L.) R. Br.	N	C	BC, G	
Crassulaceae					
50	*Kalanchoe pinnata* (Lam.) Pers.	I	C	G	
51	*Kalanchoe blossfeldiana*	I	R	Cu	Only in gardens

	Species	Status	Abund.	Habitats	Notes
Cucurbitaceae					
	Cucurbita cf. *maxima* Duch. ex Lam.	I	-	-	Recorded 1977[1], not current survey; extinct on Denis?
52	*Cucurbita moschata* (Duch. ex Lam.) Duch ex Poir	I	O	Cu	Only in gardens
	Mukia maderaspatana (L.) M. J. Roem.				Recorded 1910[2] (as Melothria maderaspatana)
53	*Trichosanthes cucumerina* L.	I	O	Cu, Ma	
Euphorbiaceae					
54	*Acalypha indica* L.	I	A	G	
55	*Acalypha wilkesiana* Muell. Arg.	I	F	Cu	Only in gardens
56	*Codiaeum variegatum* L.	I	F	Cu	Only in gardens
57	*Euphorbia cyathophora*	I	A	G	
58	*Euphorbia hirta* L.	I	A	G	
	Euphorbia microphylla Heyne ex Roth.	?	-	-	Recorded 1910[2]. = *E. stodartii* Fosberg? (Robertson, 1989)
59	*Euphorbia prostrata* Ait.	I	C	G	
60	*Jatropha pandurifolia* Andr.	I	O	Cu	Only in gardens
61	*Pedilanthus tithymaloides* (L.) Poit.	I	F	G, Cu	
62	*Phyllanthus amarus* Schumach. & Thonn.	I	F	G	
63	*Phyllanthus maderaspatensis* L.	I	C	G	
64	*Phyllanthus pervilleanus* (Baillon) Müll. Arg.	N	C	W	
65	*Ricinus communis* L.	I	A	G, W	
Gesneriaceae					
66	*Episcia cupreata* (Hook.) Hanst.	I	O	Cu	Only in gardens
Goodeniaceae					
67	*Scaevola sericea* Vahl.	N	A	BC	
Guttiferae					
68	*Calophyllum inophyllum* L.	N	F	W	
Hernandiaceae					
69	*Hernandia nymphaeifolia* (Presl) Kubitzki	N	O	BC	
Labiatae					
70	*Ocimum basilicum* L.	I	O	G	
71	*Solenostemon* cultivar	I	F	Cu	Only in gardens
Lauraceae					
72	*Cassythea filiformis* L.	N	A	BC, Sc, W	
73	*Persea americana* Mill	I	R	Cu	Only in gardens
Lecythidaceae					
74	*Barringtonia asiatica* (L.) Kurtz	N	F	W, BC	
Lythraceae					
	Pemphis acidula Forst.	?	-	-	Recorded 1910[2, 3]; Never occurred?
Malvaceae					
75	*Abutilon indicum* (L.) Sweet	?I	C	W, G	
76	*Gossypium hirsutum*	I	C	W, G	
77	*Hibiscus rosa-sinensis* L.	I	F	Cu	Only in gardens
78	*Hibiscus tiliaceus* L.	N	A	W, BC	
79	*Malvaviscus arboreus* Cav.	I	R	Cu	Only in gardens

	Species	Status	Abund.	Habitats	Notes
80	*Sida acuta* Burm. f.	I	O	G	
81	*Sida pusilla* Cav.	?N	A	G	
82	*Thespesia populnea* (L.) Soland. ex Correa	N	C	W, BC	
Mimosaceae					
83	*Adenanthera pavonina* L.	I	C	W	
84	*Leucaena leucocephala* (Lam.) de Wit	I	C	W	
Moraceae					
85	*Artocarpus altilis* (Parkins.) Fosb.	I	O	G, Cu	
86	*Ficus benghalensis* L.	I	F	G	
87	*Ficus elastica* Roxb.	I	O	Cu	Only in gardens
88	*Ficus lutea* Vahl.	N	F	W	
Moringaceae					
89	*Moringa oleifera* Lam.	I	F	Cu, G	
Myrtaceae					
90	*Psidium guajava* L.	I	R	Cu	Only in gardens
91	*Syzygium samarangense* (Bl.) Merr. & Perry	I	R	Cu	Only in gardens
Nyctaginaceae					
92	*Boerhavia repens* L.	?N	A	G	
93	*Bougainvillea* sp. cultivars	I	F	Cu	Only in gardens
94	*Mirabilis jalapa* L.	I	F	G, Cu	
95	*Pisonia grandis* R. Br.	N	C	W	
Oxalidaceae					
96	*Averrhoa bilimbi* L.	I	O	G, Cu	
Papilionaceae					
97	*Canavalia cathartica*	N	F	BC	
	Canavalia gladiata DC.	I	-	-	Recorded 1910[3]; now extinct on Denis?
98	*Crotalaria pallida* Ait. (or *C. trichotoma* Bojer, H. M)	?I	C	G	
99	*Desmodium incanum* DC.	I	A	G, W	
100	*Gliricidia sepium* (Jacq.) Walp.	I	F	Cu	Only in gardens
Passifloraceae					
101	*Passiflora edulis* Sims	I	O	Cu	Only in gardens
102	*Passiflora foetida* L.	I	O	W	
103	*Passiflora suberosa* L.	I	A	W, G	
Portulacaceae					
104	*Portulaca grandiflora* Hook.	I	F	Cu	Only in gardens
105	*Portulaca oleracea* L.	N	A	G, BC	
Rhamnaceae					
106	*Colubrina asiatica* (L.) Brogn.	N	O	W	
Rubiaceae					
107	*Guettarda speciosa* L.	N	C	BC	
108	*Morinda citrifolia* L.	?I	A	W	
109	*Mussaenda* sp.	I	R	Cu	Only in gardens
	Spermacoce repens (DC.) Fosb. and Powell	?	-	-	Recorded 1977[1]; possibly *Mitracarpus hirtus*? (Robertson, 1989)
Rutaceae					
110	*Citrus* sp.	I	F	G, Cu	
111	*Murraya koenigii* (L.) Spreng.	I	F	G, Cu	
Sapindaceae					
112	*Cardiospermum halicacabum*.L.	?N	O	W	

	Species	Status	Abund.	Habitats	Notes
Scrophulariaceae					
113	*Striga asiatica* (L.) O. Kuntze	?I	F	G	
Solanaceae					
114	*Capsicum frutescens* L.	I	R	Cu	Only in gardens
115	*Physalis angulata* L.	I	R	W	
116	*Solanum americanum* Mill.	I	O	G, W	
117	*Solanum lycopersicum* L.	I	F	Cu	Only in gardens
118	*Solanum melongena* L.	I	F	Cu	Only in gardens
119	*Solanum torvum* Sw.	I	O	G, W	
Surianaceae					
120	*Suriana maritima* L.	N	F	BC	
Turneraceae					
121	*Turnera angustifolia* Miller	I	A	W	
Verbenaceae					
122	*Lantana camara* L.	I	F	Sc, G, W	
123	*Phyla nodiflora* (L.) Greene	I	A	G, Ma	
124	*Stachytarpheta jamaicensis* (L.) Vahl.	I	C	G	
Zygophyllaceae					
	Tribulus cistoides L.	I	-	-	Recorded 1910[2] (as T. terrestris); extinct on Denis?
ANGIOSPERMAE: Monotyledons					
Agavaceae					
125	*Agave sisalana* (Perr. Ex Engelm.)	I	C	G	
126	*Furcraea foetida*	I	O	G	
Amaryllidaceae					
127	*Crinum ?amabile* Ker-Gawl.	?I	C	G, Cu	
128	*Crinum asiaticum* L.	I	F	Cu	Only in gardens
129	*Zephyranthes rosea* Lindl.	I	C	G, Cu	
Araceae					
130	*Alocasia macrorrhiza* (L.) G. Don.	I	C	W	
131	*Colocasia esculenta* (L.) Schott	I	O	Ma	
Commelinaceae					
132	*Commelina* sp.	?I	O	Ma	
133	*Tradescantia spathacea* Swartz	I	A	Cu, W	
134	*Zebrina pendula* Schnitzl.	I	R	G	
Cyperaceae					
135	*Cyperus conglomeratus* Rottb.	N	C	BC	
136	*Cyperus rotundus* L.	?	A	G	
137	*Cyperus* sp.	?	A	G	
138	*Fimbristylis cymosa* R. Br.	?	A	G, BC	
139	*Kyllinga alba* Nees.	?	F	W	
140	*Kyllinga polyphylla* Willd. ex Kunth	N	F	W	
141	*Mariscus dubius* (Rottb.) Fischer	N	A	G	
142	*Mariscus ligularis* (L.) Urb.	?N	F	G	
143	*Pycreus polystachyos* (Rottb.) P. Beauv.	?	R	Ma	
Dioscoreaceae					
144	*Dioscorea alata* L.	I	R	W	
Gramineae					
145	*Brachiara umbellata* (Trin.) W. D. Clayton	N	R	Sc	
146	*Cenchrus echinatus* L.	?	C	G	
147	*Chloris ?barbata* (L.) Sw.	?	C	G	
148	*Cymbopogon* sp.	I	O	Cu	Only in gardens
149	*Cynodon dactylon* (L.) Pers.	?	A	G, BC	

	Species	Status	Abund.	Habitats	Notes
150	*Dactyloctenium ctenoides* (Steud.) Bosser	?	C	G	
151	*Digitaria* sp. (*D. ?horizontalis* Willd.)	?	A	G	
152	*Eleusine indica* (L.) Gaertn.	?	A	G	
153	*Enteropogon sechellensis* (Baker) Dur. & Schinz	N	C	G	
	Enteropogon monostachyos (Vahl.) S. & E.	?	-	-	n.d.[4]; same as *E. sechellensis?*
	Eragrostis ciliaris (L.) R. Br.	?	-	-	n.d.[4]
154	*Eragrostis tenella* (L.) P. Beuv.	?	A	G	
155	*Eragrostis tenella* var. *insularis* Hubb.	?	C	G	
156	*Lepturus* sp.	?	A	G, W	
157	*Panicum maximum* L.	?	F	G	
158	*Panicum ?repens* L.	?	R	G	
159	*Pennisetum polystachyon* (L.) Schult.	?	A	G	
160	*Pennisetum* sp. (purple var.)	?I	O	Cu	Only in gardens
161	*Rhynchelytrum repens* (Willd.) C. E. Hubb.	?	C	G	
162	*Saccharum officinale* L.	I	O	Cu	Only in gardens
163	*Sporobolus virginicus* (L.) Kunth.	N	C	BC	
164	*Stenotaphrum dimidiatum* (L.) Brogn.	N	A	G	
	Stenotaphrum micranthum (Des.) C. E. Hubb.	N	-	-	n.d.[4]
Liiaceae					
165	*Dianella* sp.	I	R	Cu	Only in gardens
166	*Dracaena reflexa* Lam.	N	O	Cu	Only in gardens: introduced on Denis
167	*Pleomele reflexa variegata*	I	O	Cu	Only in gardens
168	*Sansevieria thyrsifolia* Thunb.	I	O	Cu	Only in gardens
169	*Yucca* sp.	I	O	Cu	Only in gardens
Musaceae					
170	*Musa ?sapientum* L.	I	F	Cu, W, G	
Orchidaceae					
171	*Vanilla planifolia* Andrews	I	C	W	
Palmae					
172	*?Areca catechu* L.	I	R	Cu	Only in gardens
173	*Cocos nucifera* L.	N	A	PG, W, Sc, BC	
174	*Ptychosperma macarthurii* (Wendl.) Nichols.	I	R	Cu	Only in gardens
175	*Pritchardia pacifica*	I	F	Cu	Only in gardens
176	*?Thrinax* sp.	I	R	Cu	Only in gardens
Pandanaceae					
177	*Pandanus sanderi* Hort.	I	R	Cu	Only in gardens
178	*Pandanus* sp.	I	R	Cu	Only in gardens
Typhaceae					
179	*Typha javanica* Schnitzl. ex Zoll.	N	O	Ma	

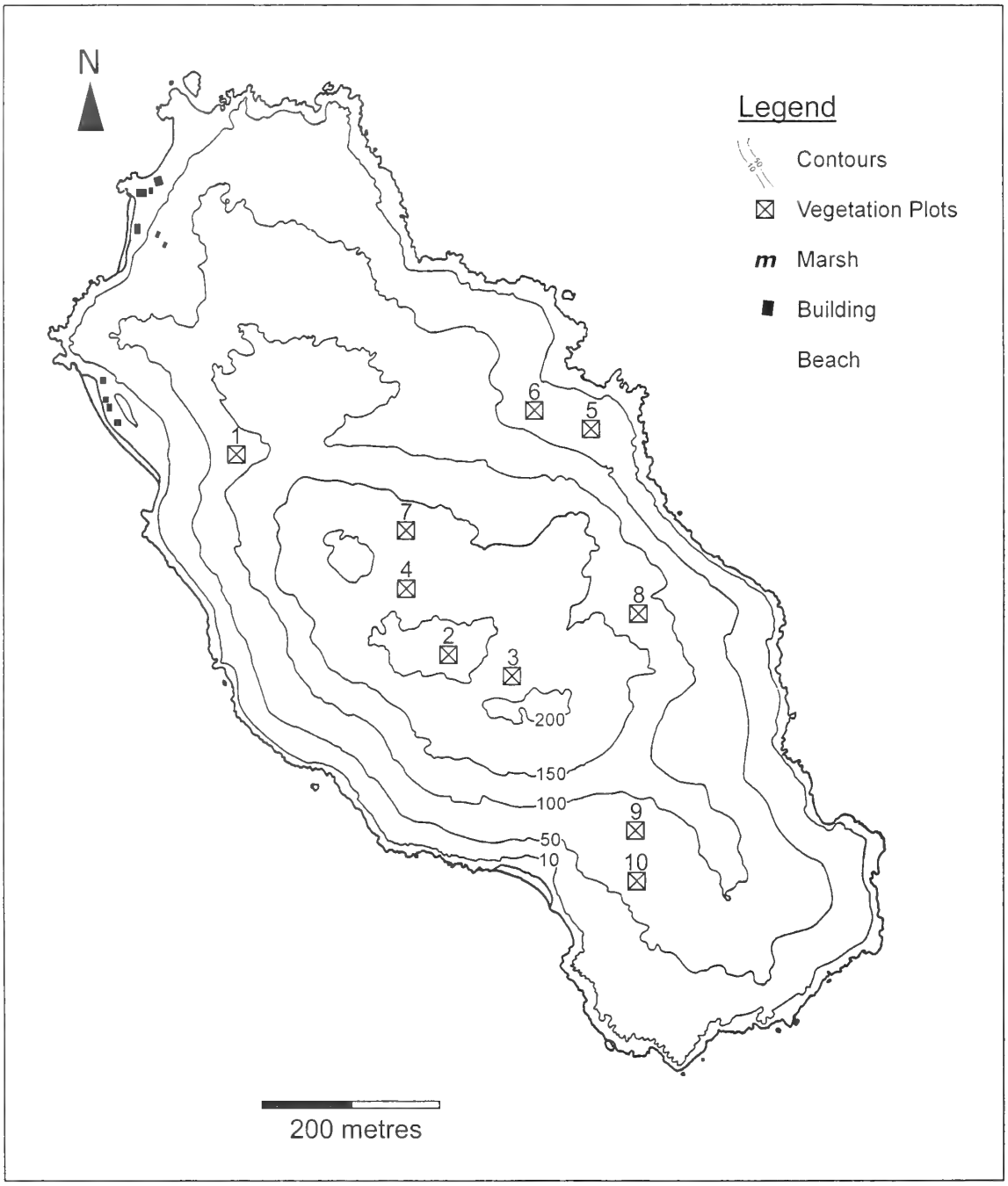

Figure 1. Félicité: physical, showing locations of vegetation plots.

FÉLICITÉ

BY

MICHAEL J. HILL[1], DAVID R. CURRIE[1], TERENCE M. VEL[1] and RODNEY FANCHETTE[1]

GEOLOGY, TOPOGRAPHY AND CLIMATE

Félicité, covering 268 ha, is the sixth largest of the granitic Seychelles Islands. At its highest point it reaches 231.5 m above sea level although most of the island is below 100 m (Table 1). Much of the island is high and rocky, made up of reddish-grey granites similar to those of Praslin (Braithwaite, 1984). In the north and east are two small low-lying "plateau" areas of more recent origin. The plateaux are made up of calcareous sediments, in part overlain by marsh and alluvial deposits.

Large parts of the upland area are rocky with poor conditions for soil creation and retention. In glacis and rocky areas, soils are restricted to pockets between boulders. However, lateritic red earth soils are present over at least half of the hill area (D.O.S., 1966). There are also small areas of alluvial soil associated with temporary stream beds. The plateaux (apart from marshy areas) are made up of Shioya soils.

There are no permanent water bodies on the island, although seasonal stream beds exist (all were dry at the time of survey), and there is a small marsh on the plateau at Petite Anse (grid ref. CL 743 222); this too was without standing water at the time of the survey. The nearest large inhabited island is La Digue, 3.2km from Félicité. Praslin is 8.6km away.

Few weather records exist for Félicité, but rainfall data for 1958 and 1959 suggest that the island is drier than low-altitude sites on Praslin or Silhouette; mean annual total rainfall for these years was 1,428 mm on Félicité (Table 2). Annual rainfall at Praslin Grande Anse in 1958 was 1,847.1 mm (compared to 1,491.0 mm on Félicité) and mean annual total rainfall for 1958-9 on Silhouette (La Passe) was 1,609.4 mm (Seychelles Meteorological Office, Unpublished data).

Table 1. Area of Félicité by altitude (calculated from map published by UK Directorate of Overseas Survey/Seychelles Government, 1980).

Altitude range (m. asl.)	Area (ha)	Percentage total area
200 - 250	7	2.6
150 - 200	41	15.3
100 - 150	45	16.8
50 - 100	82	30.6
10 - 50	58	21.6
0 - 10	35	13.1

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Table 2. Félicité: monthly rainfall (mm), 1958-1959.
(Data: National Meteorological Services, Seychelles, unpublished data).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1958	177.0	84.3	101.1	41.7	309.9	387.1	53.3	32.3	21.8	48.8	113.3	120.4	1491.0
1959	269.5	46.5	84.1	112.8	57.7	22.6	22.6	42.2	206.3	112.0	191.8	196.9	1365.0
mean	223.3	65.4	92.6	77.3	183.8	204.9	38.0	37.3	114.1	80.4	152.6	158.7	1428.0

HISTORY

Early records of Félicité suggest that it was a rather dry barren island. The Marion Dufresne expedition of 1768 (prior to settlement of the Seychelles) visited the island, although records were restricted to the exploitable resources. It was noted that the island was not as well wooded as La Digue, and that timber was poorer (Lionnet, 1984). In 1787, the island was said to be well wooded with bwa-d-nat *Mimusops sechellarum* and takamaka *Calophyllum inophyllum* (the latter on the coast only), with endemic giant tortoises on the hill, but lacking any fresh water in the dry season (Malavois, 1787 in Fauvel, 1909). Following the permanent settlement of the Seychelles, Félicité became a private estate. In the nineteenth century, the estate was abandoned and annexed by the colonial government (in Mauritius) before 1866. Timber from the island was used by the colonial government (Newton, 1867).

When the island was visited by Edward Newton in 1866, rats and cats had already been introduced (Newton, 1867). Although there was still "very considerable forest" on the south west side of the island, Newton found only two species of land bird, the Seychelles sunbird *Nectarinia dussumieri* and feral chickens *Gallus gallus.* In contrast, the nearby island of Marianne (still predator-free) had 12 species of Seychelles endemic birds. At that time, Félicité was leased to small farmers, with the government retaining control of forest reserves over part of the island for the protection of timber and water supplies. In 1895 a 30-year lease was given to Harold Baty, who extended the existing coconut plantations. In 1898, Harold Baty wrote (in a letter to the Administrator of Seychelles) that the island produced 30,000 coconuts per month and that he had introduced "valuable plants" to the island including cloves *Syzygium aromaticum*, rubber *Hevea brasiliensis*, bamboo (probably *Bambusa vulgaris*), raffia *Raphia farinifera*, vacoa *Pandanus utilis* and pepper *Piper nigrum*. He added that experiments with coffee (*Coffea liberica*) had been unsuccessful (letter of 23/10/1898 in Seychelles Archive).

In 1908, Félicité was reputed to support 100–150 acres (60.8 ha) of native forest, dominated by *Mimusops sechellarum* and *Intsia bijuga,* with over 1,000 trees reaching 18 inches (46 cm) in diameter (Anon. 1908). In 1910, the lessces applied for the right to fell some of the forest trees remaining on the island and were granted the use of 130 acres (52.6 ha) of forest land, the government reserving the right to purchase all timber felled. This area was later planted with coconuts by the lessee.

In 1921-24 the government itself felled takamaka trees on approximately 100 acres (40.5 ha). In 1923, representatives of the lessee illegally cut timber (*Mimusops* and *Intsia*) within the government reserve, some being removed to Grande Soeur Island

(which was managed by the same lessee, the Society des Iles Soeurs) and some sent to Mauritius. The trees were regarded as valuable as they were "getting extremely scarce".

In 1927, the lessee Louis Bessin applied for, and received, permission to fell most of the forest trees remaining in the reserve areas. An area of 29 acres (11.7 ha) at Glacis Rouillé was to be left untouched. In addition, he introduced herds of free-roaming cattle and goats. In 1934, the Director of Agriculture, Mr P. R. Dupont, visited Felicité and found that the forest reserve had been exhausted and, with the exception of a few hundred trees left standing, was only fit for firewood. Undercropping had inhibited natural regeneration and encouraged erosion, and even trees bordering streams had been felled. He suggested replanting with Albizzia (probably *Paraserianthes falcataria*), sangdragon *Pterocarpus indicus*, bois de table *Heritiera littoralis* and agati *Adenanthera pavonina*, which had little commercial value but would survive on the dry island. It is unclear whether these suggestions were acted upon.

By 1959, coconuts were planted throughout the island although some takamaka *Calophyllum inophyllum*, kapisen *Northea hornei,* gayac and bwa-d-nat survived (Swabey, 1961). Although goats appear to have become extinct on the island (as elsewhere in the granitic islands), it appears that the free-ranging cattle introduced in the 1930s persisted until the late 1980s, when they were culled (island manager, *pers. comm.*). In 1984, there were 33 animals (Racey & Nicoll, 1984).

Currently the island is managed as a small and exclusive resort with a staff of around ten permanent inhabitants. Settlement is now restricted to the plateau area to the north east of the island and many of the buildings dating from the plantation period are now abandoned. Some coconuts are still harvested from the palms (particularly around the settlement), and plateau vegetation is managed, but the majority of the former plantation has been abandoned.

FLORA AND VEGETATION

Flora

A total of 187 plant species were recorded on Félicité, including 11 ferns, one gymnosperm (cultivated), and 175 angiosperms (Appendix 1). Of the angiosperms, 86 (49.1%) were introduced, 73 (41.7%) native and 23 of these (13.1% of total) endemic. Compared to other islands on the survey, the proportion of the total flora made up of introduced species was small while the proportion of Seychelles endemics was high (for the total Seychelles flora, around 54% is introduced and 9% endemic: Procter, 1984). The high proportion of endemic species reflects Félicité's topography and history. For much of the nineteenth and twentieth centuries, parts of the island were protected as forest reserves (see above). The size of the island and inaccessibility of some areas allowed a number of endemic species to survive the expansion of agriculture on the island. One endemic species, coco-de-mer *Lodoicea maldivica,* was introduced to Félicité (its natural range appears restricted to Praslin, Curieuse, and nearby islets). However, the Félicité coco-de-mer population includes mature fruiting palms and young plants suggesting that it is established on the island.

Of the introduced plants established on Félicité, 13 are invasive weedy species. Among the most successful alien plants on Félicité were cocoplum *Chrysobalanus icaco* and cinnamon *Cinnamomum verum*, which are the most widespread and invasive woody weed species on the smaller islands of the granitic Seychelles (Hill, 2001).

A small proportion of the total flora (around 23 species, 13.1%) consisted of ornamental species (most of recent introduction) confined to the landscaped areas around the hotel buildings. Twelve species recorded in previous botanical collections on Félicité were not recorded in the current survey. Most of these species were probably still present on the island but were not discovered in the short time of the survey. One previous record is doubtful, however: bwa bannan *Gastonia crassa* was recorded by Procter (1974), who did not record *G. sechellarum* from Félicité. In his revision of the genus Friedmann (1994) records *G. sechellarum sechellarum* but not *G. crassa* from Félicité. When not in flower, these *Gastonia* species can be difficult to differentiate. The addition of 12 species brings the flora of Félicité to 199 species, 26 of which are endemic.

Vegetation

The extent of major vegetation types on Félicité is shown in Table 3, and Figure 2. The vegetation is dominated by hill woodland rich in native species, scrub (mainly the introduced cocoplum *Chrysobalanus icaco*) and glacis (bare rock with a number of endemic species but heavily invaded by *Chrysobalanus icaco* in many places). Coconut plantations and fruit tree orchards are now largely abandoned and overgrown with the exception of coconut groves around the inhabited area. Invasive coconut regrowth occurs particularly along the coastal strip.

The 10 vegetation plots completed were carried out in hill woodland/scrub (glacis was avoided). Only 1,000 m^2 of the island fell within the vegetation plots (0.04% of the total island area, 0.08% of Félicité's upland forest). Fifty-two species were recorded (0.052 species m^{-2}), of which the majority were native or endemic (28 species, 53.8% of total species, were native or endemic).

In the tree layer, 12 species were recorded, nine of which (75%) were native or endemic. Fifty-three individual trees were recorded, giving a mean density of 530 trees ha^{-1}. Almost half of all trees recorded belonged to the two most abundant species, both native; takamaka *Calophyllum inophyllum* (15 trees, 28.3% of all trees) and bwa dir rouz *Canthium bibracteatum* (11 trees, 20.8% of all trees). Introduced species made up only a small proportion of the canopy layer (only 17%), the commonest being cashew *Anacardium occidentale.* All tree species recorded showed signs of natural regeneration, and were represented in the shrub and/or herb layer.

In the shrub layer the most widespread species were *Canthium bibracteatum* (represented in nine of 10 plots), *Chrysobalanus icaco* (in eight plots), *Cocos nucifera* (in eight plots) and *Allophyllus pervillei* (in six plots). Of these species, *Cocos* was the most dominant locally; in plots where it occurred, *Cocos* formed on average 17.9% of shrub layer coverage (compared to *Canthium,* 9.5%; *Chrysobalanus,* 9.8%; and *Allophyllus,* 10.3%).

Table 3. Extent of major vegetation types, Félicité.

	Vegetation type	Area (ha)
Hill	Woodland (predominantly native)	126.3
> 10 m asl	Coconut plantation	1.3
	Scrub (Introduced)	30.3
	Bare rock	29.3
Plateau	Woodland (predominantly native)	4.3
< 10 m asl	Coconut plantation	0.9
	Coconut with regeneration	5.2
	Freshwater marsh	0.2
	Beach crest vegetation	1.7
	Grassland/garden	1.7
	Bare rock	20.7

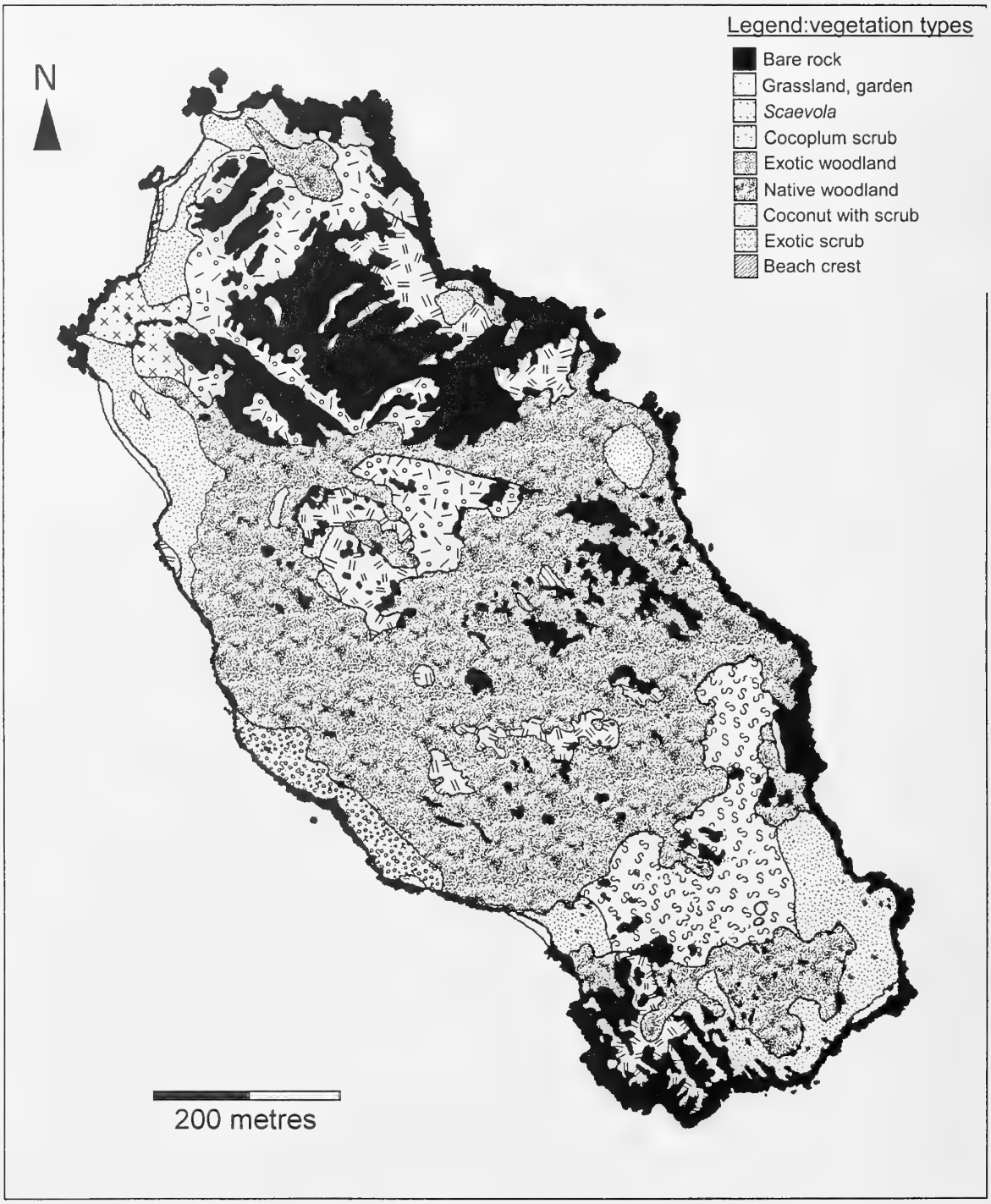

Figure 2. Félicité vegetation.

INVERTEBRATES

Pitfall Trapping

Pitfall trap assemblages were similar in size (number of individuals) to the overall mean for the season. The mean number of individuals per five traps was 72, compared to the mean for the season (all islands): 68.2 individuals per five traps. However, the major part of each assemblage was made up of ants; mean assemblage size excluding ants was 8.6 individuals (compared to the seasonal mean of all islands: 15.12). Abundance of invertebrates other than ants was relatively low.

Assemblages were dominated by the introduced crazy ant *Anoplolepis gracilipes*. This species, introduced to the Seychelles in the early 1960s, occupied 60% of the area of Félicité in 1994. It is a domestic and agricultural pest with effects on natural ecosystems that are difficult to gauge (Haines *et al.*, 1994). Of 720 individual invertebrates caught, 567 (78.8%) were *A. gracilipes* (Fig. 3). Of the total assemblage 86.8% was made up of ants, 3.2% earwigs (Dermaptera), 3.1% snails, and 2.9% flies (Diptera), mainly larvae. *A. gracilipes* has a major effect on the composition of ground invertebrate communities and, at high densities, may cause changes in the vegetation composition of islands (Hill, in prep).

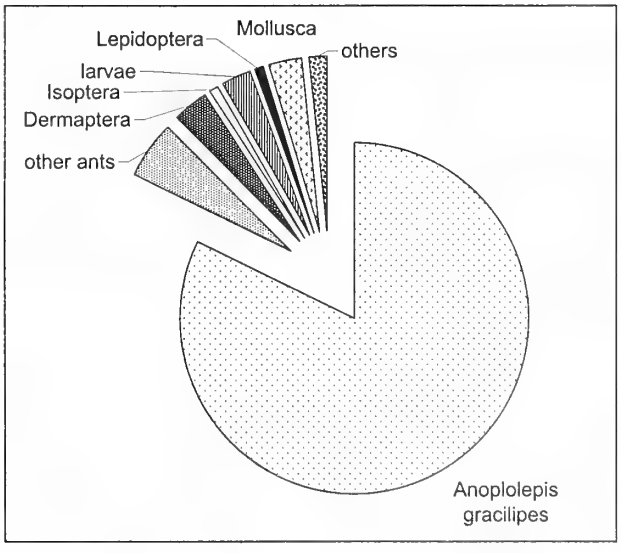

Figure 3. Taxonomic composition of pitfall assemblages from Félicité. Only invertebrates of body length > 2 mm included.
'Others' group includes Blattodea, Diptera (adults), Hemiptera, Myriapoda and Orthoptera.

Leaf-insect Counts

Leaf-insect counts were carried out for 11 tree and shrub species (Table 4). The highest leaf counts were for the introduced *Citrus* due to high levels of infestation of mealy bugs and scale insects (both tended by ants) on these species. The endemic *Erythroxylum sechellarum* also had particularly high values for invertebrate densities.

Table 4. Density of invertebrates on foliage, Félicité.

Species	No. leaves counted	Mean insects leaf $^{-1}$	Mean insects m^{-2}
Introduced species			
Anacardium occidentale	150	0.207	31.92
Chrysobalanus icaco	100	0.030	8.75
Citrus sp.	200	0.290	198.21
Mangifera indica	150	0.033	5.76
Native species			
Allophyllus pervillei	150	0.093	29.13
Calophyllum inophyllum	500	0.232	26.37
Canthium bibracteatum	450	0.033	15.42
Erythroxylum sechellarum	50	0.060	27.84
Memecylon elaeagni	100	0	0
Paragenipa wrightii	50	0.420	63.09
?Status unknown			
Morinda citrifolia	50	0.200	26.41

Malaise Trapping and Other Methods

Two malaise traps were in place for three nights each in hill woodland habitats. Malaise trap assemblages were large (179 and 185 individual invertebrates) and included members of nine invertebrate orders. The dominant orders were the Lepidoptera (48.4% of all individuals), Hymenoptera (19.8%) and Diptera (17.3%). The majority of taxa collected have yet to be identified to species level. A number of other invertebrate species were identified and are shown in Table 5.

Table 5. Invertebrate species identified, Félicité.

Order	Family	Species	Notes
Mollusca:			
Gastropoda	Achatinidae	*Achatina fulica* (Bowditch, 1822)	Introduced species, abundant
		Achatina pantera Ferrusac, 1822	Introduced species, abundant
	Subulinidae	*Subulina octona* Bruguière, 1792	
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	
	Gecarnicidae	*Cardisoma carnifex* (Herbst, 1784)	Occasional, plateau
	Ocypodidae	*Ocypode ceratophthalmus* (Pallas, 1772)	On beach and beach crest
		Ocypode cordimana Desmarest, 1825	
Myriapoda	Trigoniulidae	*?Spiromanes braueri* (Attems, 1900)	In pitfall traps
Insects:			
Odonata	Anisoptera	*Diplacodes trivialis* (Rambur, 1842)	Observed flying over glacis
Lepidoptera	Nymphalidae	*Melanitis leda africana* (Linnaeus, 1758)	In hill woodland
		Hypolimnas misippus (Linnaeus, 1764)	
	Lycaenidae	*Leptotes pirithous* Linnaeus, 1767	
		Zizeeria knysna (Trimen, 1862)	In grassland, mainly on plateau
	Hesperiidae	*Borbo* sp.	
Coleoptera	Buprestidae	*Belionota prasina* Thunberg, 1789	Caught in Malaise trap, hill woodland
	Rhipiceridae	*Callirrhipis philiberti* Fairemaire, 1891	Endemic. Caught in Malaise trap, hill woodland
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)	
	Apidae	*Apis mellifera adansoni* Latreille, 1804	
	Formicidae	*Anoplolepis gracilipes* (Smith, 1857)	Abundant on vegetation and in leaf litter. In pitfall traps
		Cardiocondyla emeryi Forel, 1881	In pitfall traps
		Monomorium ?floricola (Jerdon, 1851)	In pitfall traps
		Odontomachus troglodytes Santschi, 1914	In pitfall traps
		Tapinoma melanocephala (Fabricius, 1793)	Occasional, in pitfall traps
		Technomyrmex albipes (Smith, 1861)	Abundant on vegetation and in leaf litter. In pitfall traps
	Vespidae	*Polistes olivaceus* (de Geer, 1773)	
Phasmatodea	Phasmatidae	*Carausius sechellensis* (Bolivar, 1895)	Collected in sweep samples

VERTEBRATES

Reptiles

A total of eight species (six lizards, one tortoise and one snake) was observed (Table 6), but there are probably further species present that were not recorded. At least two of these (Aldabra giant tortoise and Brahminy blind snake) are introduced species. Giant tortoises, presumably a species of the granitic Seychelles, were present in the late eighteenth century but became extinct before 1875 (Bour, 1984). Neither of the Seychelles' two endemic snakes (Nussbaum, 1984a) was observed although they are likely to occur here given the island's size and relatively undisturbed nature.

In addition to land reptiles, at least one marine turtle appears to nest on the island. A single hawksbill *Eretmochelys imbricata* (L.) was observed on the beach at Grand'Anse.

Table 6. Reptiles observed on Félicité.
Status: E =endemic, I = introduced, N = native (in central Seychelles).

Family	Species		Status
Gekkonidae	*Ailuronyx seychellensis* (Dumeril & Bibron, 1836)	bronze-eyed gecko	E
	Phelsuma sundbergi Rendahl, 1939	day gecko	E
	Phelsuma sp. (*?P. astriata* Tornier, 1901)	day gecko	E
	Urocotyledon inexpectata (Steiner, 1893)	sucker-tail gecko	E
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	Seychelles skink	E
	Janetaescincus braueri (Boettger, 1896) or *Pamelaescincus gardineri* Boulenger, 1909	burrowing skink	E
Testudinidae	*Geochelone gigantea* (Schweigger, 1812)	Aldabra giant tortoise	I
Typhlopidae	*Rhamphotyphlops braminus* (Daudin, 1803) Robb, 1966	Brahminy blind snake	I

Birds

Extensive surveys of the island were carried out for two endemic species, Seychelles scops owl *Otus insularis* and Seychelles black paradise flycatcher *Terpsiphone corvina* The available map of Félicité (Directorate of Overseas Survey UK/Seychelles Government, 1980) is plotted on a 100 m x 100 m grid. Forty-one of these squares were selected randomly representing 13% of the island's area. Where the random squares consisted exclusively of glacis, or were coastal with less than 50% land, they were excluded and other squares were selected.

Both sexes of Seychelles black paradise flycatcher respond well to the playback of male song and individuals frequently approach to within a few metres of the recorder. Male song was played continuously for five minutes in each of the 41 randomly selected squares (11-17 November 1999, 0830h-1600h) and any response noted. In addition, we also noted the presence of any other bird species detected during the five minutes of playback.

Scops owls also respond well to playback of conspecific calls, often approaching to within a few metres of the recorder. Scops owl calls were played at c.200 m intervals at seven points for 10 minutes along a transect on 12 November (1820-2030h).

No flycatchers were observed in any of the random squares in response to the playback and, furthermore, none were observed in the extensive coverage of island during the sampling. The Seychelles sunbird *Nectarina dussumieri* was the most common species observed in the random squares occurring in 31 squares (76%), followed by the blue pigeon *Alectroenas pulcherrima* found in 22 squares (54%) and the common mynah *Acridotheres tristis* found in 10 squares (24%) (Table 7). In six squares (15%), no birds were detected. There was no response to the scops owl playback.

Table 7. Bird species recorded during the sampling of 41 random squares (each 100 m x 100 m) on Félicité 8th-14th November 1999. Percentages given in parentheses.

Species		No. squares species recorded
Nectarina dussumieri	Seychelles sunbird	31 (76)
Alectroenas pulcherrima	Seychelles blue pigeon	22 (54)
Acridotheres tristis	common mynah	10 (24)
Streptopelia picturata	Madagascar turtle dove	4 (10)
Foudia madagascariensis	Madagascar fody	2 (5)
Geopelia striata	barred ground dove	1 (2)
Butorides striatus	green-backed heron	1 (2)

Few endemic land bird species have ever been recorded on Félicité (Table 8). In 1866, only one endemic species was recorded (Newton, 1867). Diamond (1984) suggests that up to six endemic species may have occurred here although one of the species he lists as present (Seychelles bulbul *Hypsipetes crassirostris*) was not recorded in the current survey and Shah *et al.* (1998) suggest that it has never been recorded on Félicité.

Reports of the Seychelles scops owl (Diamond and Feare, 1980) have not been confirmed, and it is possible that the records were of barn owl *Tyto alba*.The Seychelles kestrel *Falco araea* was reported by Shah *et al.* (1998), but was not observed in the current extensive survey; it seems likely that the species is again extinct on the island. There are various records of the black paradise flycatcher on the island from 1936 to the 1980s (Collar and Stuart, 1985), but recent records probably refer to vagrants from La Digue (Diamond, 1984).

Table 8. The current and prior status of endemic land-birds of the inner Granitics on Félicité. Current status based on observations from visit to the island 8-14th November. Prior status based on Shah *et al.* (1998).

Species		Current status	Prior Status
Falco araea	Seychelles kestrel	Absent	2
Alectroenas pulcherrima	Seychelles blue pigeon	Common	2
Coracopsis nigra barklyi	Seychelles black parrot	Absent	1
Otus insularis	Seychelles scops owl	Absent	3
Collocalia elaphra	Seychelles swiftlet	Absent	3
Hypsipetes crassirostris	Seychelles bulbul	Absent	1
Copsychus sechellarum	Seychelles magpie-robin	Absent	1
Acrocephalus sechellensis	Seychelles warbler	Absent	1
Terpsiphone corvina	Seychelles black paradise flycatcher	Absent	3
Nectarinia dussumieri	Seychelles sunbird	Very common	2
Zosterops modestus	Seychelles white-eye	Absent	1
Foudia sechellarum	Seychelles fody	Absent	1

Prior status: 1 = never recorded; 2 = present; 3 = bred or present in the past but not recorded in recent years.

Three species of seabird were observed; two of these (white-tailed tropicbird *Phaeton lepturus* and fairy tern *Gygis* alba) may breed on Félicité. A third species (a frigate bird *Fregata* sp.) was observed flying over the island.

Mammals

Four mammal species were observed in the course of fieldwork, one endemic (the Seychelles fruit bat *Pteropus seychellensis*) and three introduced (domestic dog *Canis familiaris*, domestic and feral cats *Felis catus* and ship rats *Rattus rattus*). The large herd of feral cattle (*Bos taurus*) previously recorded on Félicité (Racey & Nicoll, 1984) was exterminated in the late 1980s or early 1990s.

Rodent trapping was carried out with two traplines, one on the plateau and one running through hill glacis/cocoplum scrub habitat. A total of 112 trap-nights were carried out and 31 individual rats caught, giving a capture rate of 27.68 rats per 100 trap-nights (unadjusted) or 33.33 per 100 trap-nights (adjusted to account for the effects of closed traps: Cunningham and Moors, 1996). This rate of trapping was slightly lower than average for the season (overall mean for all islands in season is 33.64 rats per 100 trap-nights unadjusted). *Rattus rattus* is a widespread species in Seychelles that can have a significant impact on bird populations as it is a proficient climber (Racey and Nicoll, 1984).

DISCUSSION

Félicité is a relatively large high island supporting a large area of predominantly native woodland. In recent history, native woodland has been more extensive but clearance for timber and coconut plantation in the twentieth century reduced the area of this habitat. Many endemic and native plant species survived the enlargement of plantations (Swabey, 1961) and the economic decline of coconut plantations, as elsewhere in the granitic islands, has already allowed partial recovery of semi-natural woodland. On the plateaux, coconut plantations are still actively managed for production.

While the upland forest retains a "natural" appearance, the composition appears to be very different from that recorded in the early twentieth century. The dominant species recorded in vegetation plots in the current survey (takamaka and *Canthium bibracteatum*) were native but the two species regularly recorded in the early twentieth century (*Intsia bijuga* and *Mimusops sechellarum*) were not recorded in the tree layer of plots. *Intsia* was recorded in the shrub layer of one plot, *Mimusops* was not observed although probably still present on the island.

In addition to the native species recorded, the upland woodland contains a number of introduced plant species, the establishment of which has probably been favoured by previous woodland clearance including cinnamon and cocoplum. Takamaka is a long-lived shade-bearing tree (Friedmann, 1986) that may compete effectively with invasive introduced species. However, takamaka is threatened throughout the granitic islands by the current outbreak of takamaka vascular wilt disease (Ivory *et al.*, 1996). The disease is not yet present on Félicité although it occurs on neighbouring islands, including Praslin and La Digue (Hill *et al.*, submitted), and it seems that, with time, it will reach most

islands in the archipelago that have takamaka. If and when it invades Félicité, tree death and the subsequent opening of the forest canopy are likely to encourage the spread of a number of trees and shrubs, largely invasive alien species.

The invasive alien crazy ant *Anoplolepis gracilipes* is widespread on the island. Unfortunately it was not possible to compare the current extent or severity of the crazy ant infestation with that recorded by previous workers (see Haines *et al.*, 1994), but it seems unlikely that the infestation has progressed beyond the 60% of the island recorded in the 1990s. *Anoplolepis* undoubtedly affects the invertebrate communities of islands where it is present although, on (relatively) complex islands such as Félicité, ant-free areas are likely to occur and it would seem unlikely that the presence of ants would drive any invertebrate species to extinction.

The early introduction of alien mammals probably accounts for the small number of endemic vertebrates recorded on the island.

CONSERVATION RECOMMENDATIONS

Félicité has great potential for conservation. Compared to the other small- and medium-sized islands considered in the island assessment process, it is relatively large with large areas of semi-natural woodland. Its existing biodiversity value for groups other than birds is high: it supports a large number of endemic plants, and some of the invertebrate species identified are also endemic. The limited traffic to and from the island would reduce the potential for reintroduction of alien species (once eradicated) and the island's small human population has a relatively limited effect on the island environment.

Few endemic birds have been recorded on Félicité but this is probably the result of the early introduction of rats and cats. It seems highly likely that a number of endemic species occurred in the past and rehabilitation would allow the introduction of several bird species.

The predominance of native tree species, which support a large number of invertebrates, suggest that several endemic bird species which feed primarily on insects among foliage could survive on the island in the absence of predators. Examples include Seychelles warbler, white-eye, and black paradise flycatcher. Because of the large size of the island, more than one of these species could be considered for introduction. However, the continued spread of takamaka wilt disease between islands threatens the island's takamaka and, if the disease were introduced, would necessitate extensive habitat rehabilitation work (including replanting of other native trees) before reintroductions could occur.

Seychelles magpie-robins feed primarily on invertebrates on the ground. Initial pitfall trap data suggest that invertebrate densities, excluding ants, at the time of sampling were relatively low so the island would not be ideal for introduction of the species. While these pitfall data were from a limited number of sites (10) and trapping was carried out at the end of a particularly dry season, it is certainly the case that hill habitats tend to have lower densities of ground invertebrates than do plateaux. The plateau area of Félicité is small and heavily modified and a large area of the island is made up of glacis, which is of little value to magpie-robins. Although the island is large, population densities of magpie-robins on Félicité would be lower than those on islands with large plateaux. Therefore,

the island should not be considered a priority for introduction of magpie-robins and further study of potential food supply would certainly be necessary if the reintroduction of magpie-robins was considered desirable.

In order for the conservation potential of the island to be realised, the following major actions would be needed:

- Eradication of alien mammals (rats and cats);
- Removal of invasive alien plants, and coconuts (cocoplum and cinnamon are among the most troublesome alien weeds present but there are also large numbers of fruit trees including citrus and mango);
- Further research, especially on food supply for Seychelles magpie-robin;
- Monitoring of crazy ant population density and extent of infestation; and
- Monitoring of takamaka wilt disease.

Appendix 1. Plant species recorded from Félicité (excluding seagrasses)

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: Cu = Cultivated area (includes garden weeds and ornamentals); PG = Plateau grassland (includes coconut plantation); PW = Plateau woodland; HW = Hill Woodland; HSc = Hill Scrub; HG = Hill Grassland (includes coconut plantation); Gl = Glacis; BC = Beach Crest; Ma = Marsh.
Previous records from [1]Procter, 1974; [2]Averyanov & Kudriavtzeva, 1987; [3]Robertson, 1989; [4]Carlström 1996a.

Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA				
Adiantaceae				
1 *Acrostichum aureum* L.	N	C	Ma	
2 *Pellaea ?doniana* Hooker	N	C	HW, Gl	
Davalliaceae				
3 *Davallia denticulata* (Burm.) Mett.	N	C	HW	
4 *Nephrolepis biserrata* (Sw.) Schott	N	A	HW	
Gleicheniaceae				
5 *Dicranopteris linearis* Burm.	N	F	Gl	
Lomariopsidaceae				
6 *?Bolbitis bipinnatifida* (Mett. Ex Kuhn) Ching	?N	R	PSc	
Lycopodiaceae				
7 *Lycopodium cernuum* L.	?N	R	Gl	
Parkeriaceae				
8 *Ceratopteris cornuta* (Pal.) Lepr.	N	F	Ma	
Polypodiaceae				
9 *Phymatosorus scolopendria* (Burm. f.)	N	A	HW, PW	
Psilotaceae				
10 *Psilotum nudum* Sw.	N	O	HW	
Selaginellaceae				
11 *Selaginella* sp.	N	O	HW	
GYMNOSPERMAE				
12 *Cycas thuarsii* Gaud.	I	R	Cu	Only in gardens
ANGIOSPERMAE: Dicotyledons				
Acanthaceae				
13 *Asystasia* sp. B (*sensu* Friedmann)	?I	A	PG, HW, Gl	
14 *Justicia gendarussa* Burm. f.	?I	R	PG	
Anacardiaceae				
15 *Anacardium occidentale* L.	I	A	Gl, HSc, HW	
16 *Mangifera indica* L.	I	A	HW	
17 *Spondias cytherea* Sonn.	I	R	PG	
Annonaceae				
18 *Annona muricata* L.	I	O	HW	

	Species	Status	Abund.	Habitats	Notes
Apocynaceae					
19	*Catharanthus roseus* (L.) G. Don.	I	C	Gl	
20	*Ochrosia oppositifolia* (L.) K. Schum.	N	F	HW	
21	*Plumeria obtusa* L.	I	R	Cu	Only in gardens
22	*Plumeria rubra* L.	I	O	Cu	Only in gardens
23	*Tabernaemontana coffeoides* Boj. ex. A. DC.	N	C	HW, HSc	
24	*Thevetia peruviana* K. Schum.	I	O	Cu	Only in gardens
Araliaceae					
	Gastonia crassa (Hemsl.) F. Friedmann	E	-	-	Previous record[1]; in error for *G. sechellarum?*
25	*Gastonia sechellarum* (Baker) Harms.	E	C	HW, HSc	
26	*Polyscias* sp.	I	O	Cu	Only in gardens
Asclepiadaceae					
27	*Sarcostemma viminale* (L.) Alton	N	O	Gl	
Bignoniaceae					
28	*Tabebuia pallida* (Lindl.) Miers.	I	C	PW	
Bombacaceae					
29	*Ceiba pentandra* (L.) Gaertn.	I	R	Cu	Only in gardens
Boraginaceae					
30	*Cordia subcordata* Lam.	N	F	BC	
31	*Tournefourtia argentea* L. f	N	R	BC	
Brexiaceae					
32	*Brexia madagascariensis* (Lam.) Ker Gawl. subsp. *microcarpa* (Tul.) F. Friedmann	E (ss)	O	HW	
Cactaceae					
33	*Opuntia vulgaris* Mill.	I	R	PG, Gl	
34	*Rhipsalis baccifera* (J. Mill.) Stearn	N	R	Gl	
Caesalpiniaceae					
35	*Caesalpinia bonduc* (L.) Roxb.	N	R	HW	
36	*Caesalpinia pulcherimma* (L.) Sw.	I	R	Cu	Only in gardens
37	*Intsia bijuga* (Colebr.) O. Kuntze	N	F	HSc, HW	
38	*Senna occidentalis* (L.) Link	I	R	PG	
39	*Tamarindus indica* L.	I	F	PG, HW	
Capparaceae					
	Cleome viscosa L.	I	-	-	Previous record[3]
Caricaceae					
40	*Carica papaya* L.	I	O	Cu, PG, HW	
Casuarinaceae					
41	*Casuarina equisetifolia* J. R. & G. Foster	I	F	Gl	
Chrysobalanaceae					
42	*Chrysobalanus icaco* L.	I	A	HW, HSc, Gl	
Combretaceae					
43	*Terminalia catappa* L.	?N	A	BC, HW	
Compositae					
44	*Coreopsis lanceolata* L.	I	R	Cu	Only in gardens
45	*Elephantopus mollis* H. B. K.	I	F	HW	
46	*Emilia sonchifolia* (L.) Wight	I	F	PG	
47	*Melanthera biflora* (L.) Wild	?N	O	PG	
48	*Vernonia cinerea* (L.) Less.	I	A	PG	
Convulvulaceae					
49	*Ipomoea batatas* (L.) Lam.	I	O	Cu	Only in gardens

	Species	Status	Abund.	Habitats	Notes
50	*Ipomoea obscura* (L.) Ker Gawl.	I	F	PG, HW	
51	*Ipomoea macrantha* Roem. & Schultes	N	C	HW	
52	*Ipomoea mauritiana* Jacq.	?I	C	HW, HG	
53	*Ipomoea pes-caprae* (L.) R. Br.	N	A	BC	
Crassulaceae					
54	*Kalanchoe pinnata* (Lam.) Pers.	I	C	HW	
Ebenaceae					
55	*Diospyros seychellarum* (Hiern.) Kosterm.	E	C	HW, HSc	
Erythroxylaceae					
56	*Erythroxylum sechellarum* O. E. Schulz	E	C	HW, HSc	
Euphorbiaceae					
57	*Acalypha hispida* Burm. f.	I	R	Cu	Only in gardens
58	*Acalypha wilkesiana* Muell. Arg.	I	F	Cu	Only in gardens
59	*Euphorbia hirta* L.	I	A	PG	
60	*Euphorbia pyrifolia* Lam.	N	C	Gl	
61	*Euphorbia thymifolia* L.	I	O	BC, PG	
	Excoecaria benthamiana Hemsl.	E	-	-	Previous record[4]
62	*Jatropha curcas* L.	I	R	PG	
63	*Jatropha pandurifolia* L.	I	R	Cu	Only in gardens
64	*Manihot esculenta* Crantz	I	O	Cu, HW	
65	*Pedilanthus tithymaloides* (L.) Poit.	I	O	PG, Cu	
66	*Phyllanthus acidus* (L.) Skeels	I	R	Cu	Only in gardens
67	*Phyllanthus* sp.	I	C	PG, Gl	
Flacourtiaceae					
	Aphloia theiformis (Vahl.) Benn ssp. *madagascariensis* (Clos.) H. Perr. var. *seychellensis* (Clos.) Friedmann	E (var.)	-	-	Previous record[4]
68	*Ludia mauritiana* Gmel. var. *sechellensis* F. Friedmann	E (var.)	A	HW	
Goodeniaceae					
69	*Scaevola sericea* Vahl.	N	C	BC	
Guttiferae					
70	*Calophyllum inophyllum* L.	N	A	HW, BC	
Hernandiaceae					
71	*Hernandia nymphaeifolia* (Presl) Kubitzki	N	F	BC	
Labiatae					
72	*Plectranthus amboinicus* (Lour.) Spreng.	?I	C	Gl	
Lauraceae					
73	*Cinnamomum verum* Presl.	I	O	HW	
Lecythidaceae					
74	*Barringtonia asiatica* (L.) Kurtz	N	O	BC	
Loganiaceae					
75	*Strychnos spinosa* Lam.	I	C	HSc, PG, HW	
Malvaceae					
76	*Hibiscus rosa-sinensis* L.	I	O	Cu	Only in gardens
77	*Hibiscus tiliaceus* L.	N	F	BC	
78	*Sida acuta* Burm. f.	I	F	PG	
79	*Sida cordifolia* L.	?N	R	Gl	
80	*Thespesia populnea* (L.) Soland. ex Correa	N	F	BC	
Melastomataceae					
81	*Memecylon elaeagni* Blume	E	A	HSc, HW	

	Species	Status	Abund.	Habitats	Notes
Meliaceae					
82	*Xylocarpus moluccensis* (Lam.) Roem.	N	F	BC	
Mimosaceae					
83	*Adenanthera pavonina* L.	I	C	HW	
84	*Mimosa pudica* L.	I	A	PG, HSc	
Moraceae					
85	*Artocarpus altilis* (Parkins.) Fosb.	I	F	PG	
86	*Artocarpus heterophyllus* Lam.	I	R	PG	
	Ficus bojeri Baker	N	-	-	Previous record[1]
87	*Ficus lutea* Vahl.	N	C	HW, Gl, PG	
88	*Ficus reflexa* Thunb. ssp. *seychellensis* (Baker) Berg	E (ss)	C	HW, Gl, PG	
89	*Ficus rubra* Vahl.	N	F	Gl, HW	
Moringaceae					
90	*Moringa oleifera* Lam.	I	F	PG, HW	
Myrtaceae					
91	*Psidium guajava* L.	I	O	PG, HSc	
92	*Syzygium samarangense* (Bl.) Merr. et Perry	I	R	Cu	
93	*Syzygium wrightii* (Baker) A. J. Scott	E	F	Gl, HW	
Nyctaginaceae					
94	*Bougainvillea* sp. cultivars	I	O	Cu	Only in gardens
Onagraceae					
	Ludwigia erecta (L.) Hara	I	-	-	Previous record[3]
95	*Ludwigia octovalvis* (Jacquin) Raven	?I	F	Ma	
Oxalidaceae					
96	*Averrhoa bilimbi* L.	I	O	HW	
Papilionaceae					
97	*Abrus precatorius* L.	?N	A	HW, HSc	
98	*Canavallia cathartica* Thouars.	N	F	BC, PG	
99	*Dendrolobium umbellatum* (L.) Benth.	N	O	BC	
100	*Desmodium incanum* DC.	I	A	PG, HSc	
101	*Desmodium triflorum* (L.) DC.	I	C	PG	
102	*Gliricidia sepium* (Jacq.) Walp.	I	F	PG, HW	
103	*Indigofera tinctoria* L.	I	C	PG	
104	*Mucuna gigantea* (Willd.) DC.	N	O	HW	
105	*Teramnus labialis* (L.) Spreng.	I	C	PG, HSc	
106	*Vigna marina* (Burm.) Merr.	N	O	BC, PG	
Passifloraceae					
107	*Passiflora foetida* L.	I	F	HW	
108	*Passiflora suberosa* L.	I	A	PG, HSc, HW	
Portulacaceae					
109	*Portulaca oleracea* L.	?N	R	PG	
Rhamnaceae					
110	*Colubrina asiatica* (L.) Brogn.	N	F	BC, HW	
Rubiaceae					
111	*Canthium bibractatum* (Baker) Hiem.	N	A	HW, HSc	
112	*Mitracarpus hirtus* (L.) DC.	I	F	Gl	
113	*Morinda citrifolia* L.	?I	C	HW, Gl	
114	*Paragenipa wrightii* (Baker) F. Friedmann	E	C	HW, Gl	
	Pentodon pentandrus (Schumach. & Thonn.)	I	-	-	Previous record[3]
115	*Tarenna sechellensis* (Baker) Summerh.	E	C	HW	
Rutaceae					
116	*Citrus* spp.	I	A	HW, Cu	

	Species	Status	Abund.	Habitats	Notes
Sapindaceae					
117	*Allophyllus pervillei* Blume	N	A	HW	
118	*Dodonea viscosa* Jacq.	N	O	HSc	
Sapotaceae					
	Mimusops sechellarum (Oliv.) Hemsl.	E	-	-	Previous record[1]
119	*Northea hornei* (M. M. Hartog) Pierre	E	R	HW	
Scrophulariaceae					
120	*Striga asiatica* (L.) O. Kuntze	?I	C	HG, HSc	
Sterculiaceae					
121	*Heritiera littoralis* Ait.	N	R	HW	
Tiliaceae					
122	*Triumfetta rhomboidea* Jacq.	I	O	Gl	
Turneraceae					
123	*Turnera angustifolia* Miller	I	C	PG, HSc	
Umbelliferae					
124	*Centella asiatica* (L.) Urb.	?I	C	Ma	
Verbenaceae					
125	*Premna serratifolia* L.	N	A	HW, Gl	
126	*Stachytarpheta jamaicensis* (L.) Vahl.	I	A	PG	
127	*Stachytarpheta urticifolia* (Salisb.) Sims.	I	C	HW	
128	*Vitex trifolia* L.	I	R	PG	
ANGIOSPERMAE: Monotyledons					
Agavaceae					
129	*Agave sisalana* (Perr. ex Engelm.) Drum. & Prain	I	C	HW	
130	*Furcraea foetida* (L.) Haw.	I	C	Gl, HSc	
Amaryllidaceae					
131	*Crinum ?asiaticum* L.	?I	O	Cu	Only in gardens
132	*Hymenocallis littoralis* (Jacq.) Salisb.	?I	C	Cu, HW	
Araceae					
133	*Colocasia esculenta* (L.) Schott	I	F	Ma	
134	*Dieffenbachia sequine* (Jacq.) Schott	I	R	Cu	Only in gardens
135	*Epipremnum pinnatum* (L.) Engel. cv. aureum	I	R	Cu	Only in gardens
136	*Protarum sechellarum* Engl.	E	O	HW	
Bromeliaceae					
137	*Ananas comosus* (L.) Merr.	I	F	Gl	
Commelinaceae					
138	*Commelina* sp.	?I	C	Gl	
139	*Tradescantia spathacea* Swartz.	I	F	Cu	Only in gardens
Cyperaceae					
140	*Cyperus halpan* L.	?	O	Ma, Gl	
	Cyperus iria L.	?	-	-	Previous record[2]
141	*Cyperus ?difformis* L.	?	O	HW	
142	*Eleocharis* sp.	N	C	Ma	
143	*Fimbristylis ?complanata* (Retz.) Link	?	C	Gl	
144	*Fimbristylis cymosa* R. Br.	?	A	PG	
145	*Fimbristylis ?dichotoma* (L.) Vahl	?	O	Gl	
146	*Fimbristylis* sp. (glacis sedge)	?	O	Gl	
147	*Kyllinga polyphylla* Willd. ex Kunth	N	C	HSc	
	Kyllinga tenuifolia Steud.	?			Previous record[2]
148	*Lophoschoenus hornei* (C. B. Cl.) Stapf.	E	C	Gl	
149	*Mariscus dubius* (Rottb.) Fischer	N	A	BC, PG, HSc	

	Species	Status	Abund.	Habitats	Notes
	Mariscus paniceus (Rottb.) Vahl.	N	-	-	Previous record[3]
150	*Mariscus pennatus* (Lam.) Domin.	N	O	Ma	
151	*Pycreus polystachyos* (Rottb.) P. Beauv.	?	C	Ma	
152	*Thoracostachyum floribundum* (Nees) C.B.Cl.	E	F	HW	
Flagellariaceae					
153	*Flagellaria indica* L.	N	C	HW	
Gramineae					
154	*Brachiara umbellata* (Trin.) W. D. Clayton	N	A	PG, HW, HSc	
155	*Cymbopogon* sp.	I	O	Cu	Only in gardens
156	*Dactyloctenium ?ctenoides* (Steud.) Bosser	?	C	BC	
157	*Digitaria didactyla* Willd.	N	O	BC	
158	*Digitaria* sp.	?	O	PG	
159	*Enteropogon sechellensis* (Baker) Dur. & Schinz	N	C	Gl, PG	
160	*Eragrostis tenella* (L.) P. Beuv.	?	C	BC, PG	
161	*Eragrostis ?tenella* var. *insularis* Hubb.	?	C	BC, PG	
162	*Heteropogon contortus* (L.) P. Beuv.	?	A	Gl	
163	*Ischaenum heterotrichum* Hack.	?	A	PG	
164	*Oplismenus compositus* (L.) P. Beuv.	N	A	HW, HSc	
165	*Panicum brevifolium* L.	N	A	HW	
166	*Panicum maximum* L.	?	C	PG, HG	
167	*Paspalum* sp.	?	C	Gl	
168	*Pennisetum polystachyon* (L.) Schult.	?	C	Gl	
169	*Saccharum officinarum* L.	I	O	Cu	Only in gardens
170	*Sporobolus ?virginicus* (L.) Kunth.	N	O	BC	
171	*Stenotaphrum dimidiatum* (L.) Brogn.	N	A	PG, HW	
Hypoxidaceae					
172	*Hypoxidia rhizophylla* (Baker) Dur. & Schinz	E	O	Gl	
Liliaceae					
173	*Dracaena reflexa* Lam. var. *angustifolia* Baker	N	A	HW, Gl	
Lemnaceae					
	Lemna perpusilla Torrey	?	-	-	Previous record[2]
Musaceae					
174	*Musa* sp. *(M.?sapientum)*	I	F	HW, Cu	
Orchidaceae					
175	*Cynorkis ?seychellarum* Aver.	E	F	HW	
176	*Oeoniella aphrodite* Schltr.	N	F	HW	
177	*Vanilla phalaenopsis* Reichb. f.	E	A	HW	
178	*Vanilla planifolia* Andrews	I	C	HW	
Palmae					
179	*Cocos nucifera* L.	N	A	PG, BC, HW	
180	*Deckenia nobilis* Wendl.	E	C	HW	
181	*Lodoicea maldivica* (Gmel.) Pers	E	O	HW	
182	*Phoenicophorium borsigianum* (K. Koch) Stuntz	E	F	HW	
183	*Phoenix dactylifera* L.	I	R	Cu	One old palm, in garden
Pandanaceae					
184	*Pandanus balfourii* Mart.	E	C	Gl, BC	
185	*Pandanus multispicatus* Balf. f.	E	O	Gl	
186	*Pandanus sechellarum*	E	F	HW	
187	*Pandanus utilis*	I	O	PG	

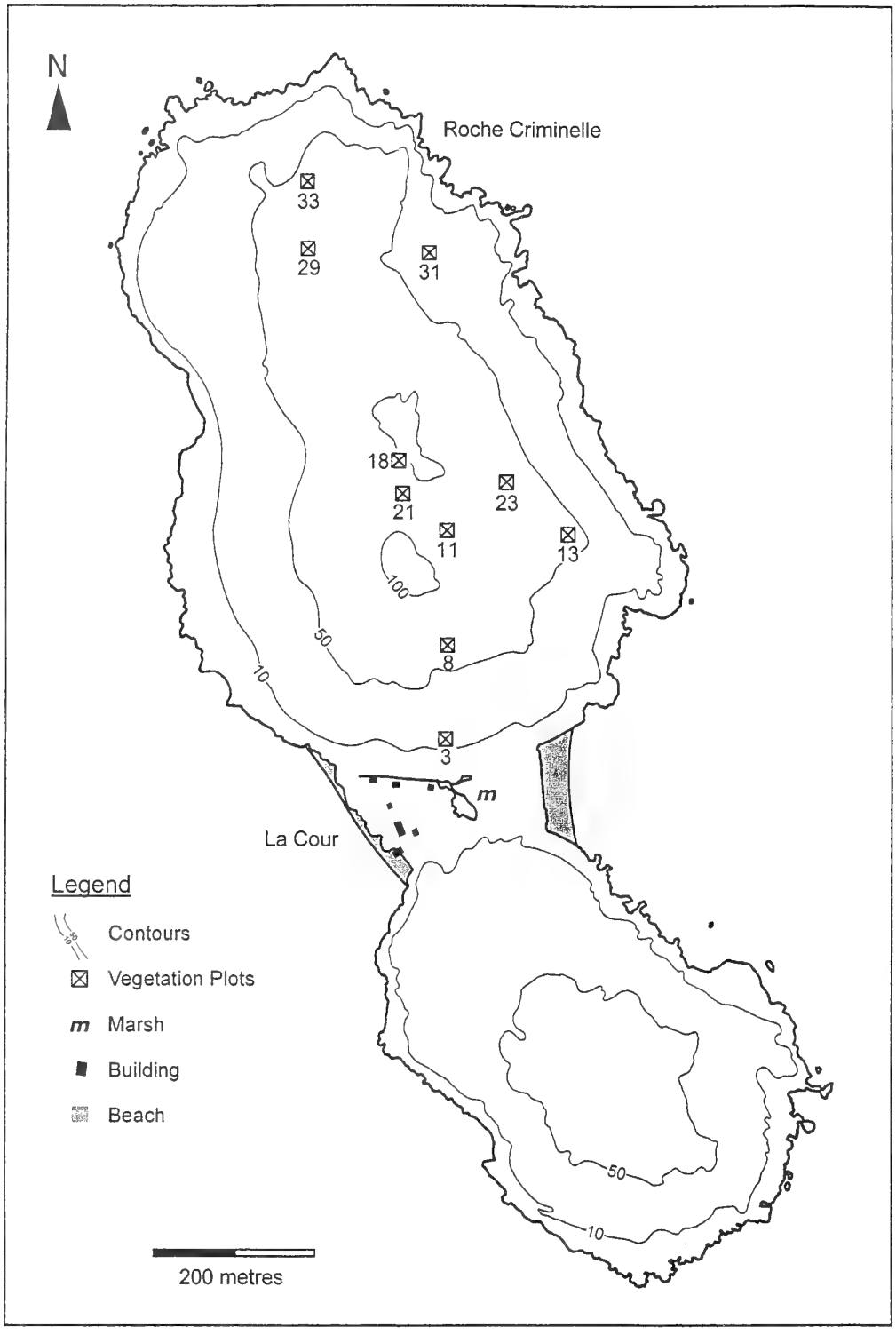

Figure 1. Grande Soeur: Physical, showing location of vegetation plots.

GRANDE SOEUR

BY

MICHAEL J. HILL[1], TERENCE M. VEL[1], STEVEN J. PARR[2] and NIRMAL J. SHAH[1]

GEOLOGY, TOPOGRAPHY AND CLIMATE

Grande Soeur is an island of approximately 84 ha situated 6 km from La Digue. Its nearest neighbouring island is Petite Soeur (34 ha), little over 700 m distant. Grande Soeur consists of two granite hills rising steeply to 111.5 m and 89 m above sea level, separated by a low-lying area of "plateau" (Table 1).

Much of the island is high and rocky made up of reddish-grey granites similar to those of Praslin (Braithwaite, 1984). In the North, at Roche Criminelle (CL 7445 2673) these rocks form a dramatic cliff-like outcrop. In places phosphate rocks have formed by the action of seabird guano on granite soils (Baker, 1963). The plateau area is made up of recent calcareous sediments and weathering products from the hill areas.

Large parts of the upland area (including all the southern hill) are rocky with poor conditions for soil creation and retention. In glacis and rocky areas, soils are restricted to pockets between boulders. On the northern hill, areas of red earth soils are present, with a broad band of these soils from north west to south east of the northern hill, and a second main area at low altitudes on the eastern side of this hill where the gradient is shallow (D.O.S., 1966). There are also small areas of alluvial soil associated with temporary stream beds. The plateau has eroded red earth soils, with organic deposits in the marsh.

The granite hills are rather dry with no permanent fresh water although seasonal stream beds exist. On the plateau, there is a small marsh, which is permanent but has a marine influence, having a drainage ditch which almost connects it to the sea. There is evidence for a gradient of salinity within the marsh although it is only 200 m from the sea at most. Close to the sea along the drainage ditch the salt tolerant fern *Acrostichum aureum* grows. However, the main body of the marsh supports a number of other species more common in fresh water (for example, *Ceratopteris cornuta, Cyperus halpan*).

No weather records exist for Grande Soeur but it is probable that the island's weather patterns follow those of the other La Digue satellite islands, Marianne and Félicité.

Table 1. Area of Grande Soeur by altitude (calculated from maps published by Directorate of Overseas Survey(UK)/Seychelles Government).

Altitude range (m. asl.)	Area (ha)	Percentage total area
100 - 150	1.3	1.5
50 - 100	27.8	33.1
10 - 50	37.1	44.2
0 - 10	17.8	21.2

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[2] Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, UK.

HISTORY

In 1768, the Marion Dufresne expedition only noted that Grande Soeur had little woodland with small trees (Lionnet, 1984). At that time, the central plateau was probably largely marshland and the western beach (now used for landing at La Cour) protected by a fringing reef. Giant land tortoises were present until at least 1787 (Malavois, 1787 in Fauvel, 1909), and breeding populations of seabirds (probably tree-nesting species) occurred.

Coconut plantations were not begun on the island until the late nineteenth-early twentieth century. A lease for Grande Soeur and neighbouring Petite Soeur was acquired in 1910 by Lanier and Lemarchand, who also held the lease for nearby Félicité Island.

The existing coconut palms were planted on the plateau from the 1930s onward and were said to vary in age from 25 to 40 years in 1976. Presumably, plantations on the granite hill date from the same period. In 1976, productivity of palms on the hill was said to be low as the palms were closely spaced and often infected with termites. However, 187,000 nuts (23.7 tons of copra) were collected in 1975 from Grand and Petite Soeur together (Düvel, 1976).

At the time of the survey, most of the former plantation had been abandoned. The plateau area, and the western side of the larger northern hill, retained the appearance of coconut plantations but were not economically exploited. There was a small human population (less than 10 people) all living on the plateau and the island was a popular destination for tourist day-trips from La Digue and Praslin.

FLORA AND VEGETATION

Flora

A total of 120 plant species were recorded on Grande Soeur, including four ferns and 116 angiosperms (Appendix 1). Of the angiosperms, 67 (57.8%) were introduced and 38 (32.8%) native. The native species included six endemic to Seychelles (5.2% of the flora were endemic). The proportion of the flora made up of introduced species was slightly higher than that for the Seychelles as a whole and the proportion of endemics smaller (for the total Seychelles flora, around 54% was introduced and 9% endemic; Procter, 1984). The small number of endemic species recorded is probably due to the island's relatively small size. Of the introduced plants established on Grande Soeur, 12 are invasive weedy species. Among the most widespread and abundant alien plants on Grande Soeur were cocoplum *Chrysobalanus icaco* and cinnamon *Cinnamomum verum*, which are the most widespread and invasive woody weeds on smaller islands.

Vegetation

The extents of major vegetation types on Grande Soeur are shown in Table 2 and Figure 2. In the twentieth century, coconuts and fruit trees were planted throughout the island wherever soil conditions would allow. These plantations are now largely abandoned and the vegetation is in a state of change. The hills are dominated by open

rock, hill woodland (primarily takamaka *Calophyllum inophyllum*) and scrub (mainly the introduced *Chrysobalanus icaco*), with many coconut palms and fruit trees surviving. On the plateau and west of the northern hill, coconut plantations are maintained with close-mown grassland under palms on the plateau. Marsh vegetation is restricted to the edges of the open water, although it was probably more extensive in the past. The beach crest of the eastern beach (Grand'Anse) supports a narrow strip of beach crest vegetation including the introduced *Agave sisalana* and native *Scaevola sericea* and *Tournefourtia argentea*. The latter species is uncommon on the granitic islands but abundant on the coralline Seychelles (Friedmann, 1994). On the western beach, large takamaka and *Terminalia catappa* trees occur with *Cordia subcordata* and *Hibiscus tiliaceus*.

The 10 vegetation plots completed were carried out in hill woodland/scrub (glacis was avoided). Only 1,000 m^2 of the island fell within the vegetation plots (0.001% of the total island area, 0.2% of Grande Soeur's upland woodland/scrub). A total of 27 species were recorded (0.027 species m^{-2}), of which the majority were native.

In the tree layer, 10 species were recorded. Tree density varied greatly between plots, from one tree (equivalent density of 100 trees ha^{-1}) to 23 trees (equivalent density of 2300 trees ha^{-1}) per plot. The mean density was 570 trees ha^{-1}. The tree layer was dominated by introduced species; the majority of trees (31 individuals, 54.4% of trees) were of introduced species. The single most abundant tree species was *Cinnamomum verum* (introduced). Of the trees, 36.8% were *Cinnamomum*; 21.0% were *Calophyllum inophyllum* (native); and 15.8% were *Cocos nucifera* (coconut palms remaining from former plantations).

In the shrub layer (0.5-5 m), plots had an average cover of 58%. Fourteen species were represented in this layer, five of which were introduced. The most widespread species (both in eight of 10 plots) were *Cocos nucifera* and *Chyrysobalanus icaco*. *Cocos* was widespread and abundant but did not dominate the plots in terms of percentage cover (mean coverage of *Cocos* in plots where it occurred was 12.9%), whereas *Chrysobalanus* showed greater dominance of space in the shrub layer (mean coverage of *Chrysobalanus* in plots where it occurred was 49.9%).

Table 2. Extent of major vegetation types, Grande Soeur.

	Vegetation type	Approx. area (ha)
Hill	Woodland (predominantly native)	18.7
(>10 m asl.)	Woodland (predominantly introduced)	0.7
	Scrub (mixed)	28.0
	Scrub (introduced)	3.1
	Beach crest vegetation (*Scaevola* scrub)	0.2
	Grassland/garden	0.3
	Bare rock	8.6
Plateau	Woodland (predominantly native)	1.8
(<10 m asl.)	Coconut with regeneration	2.8
	Coconut plantation	2.6
	Scrub (mixed)	0.6
	Beach crest vegetation	0.9
	Freshwater marsh	0.2
	Grassland/garden	0.5
	Bare rock	7.9

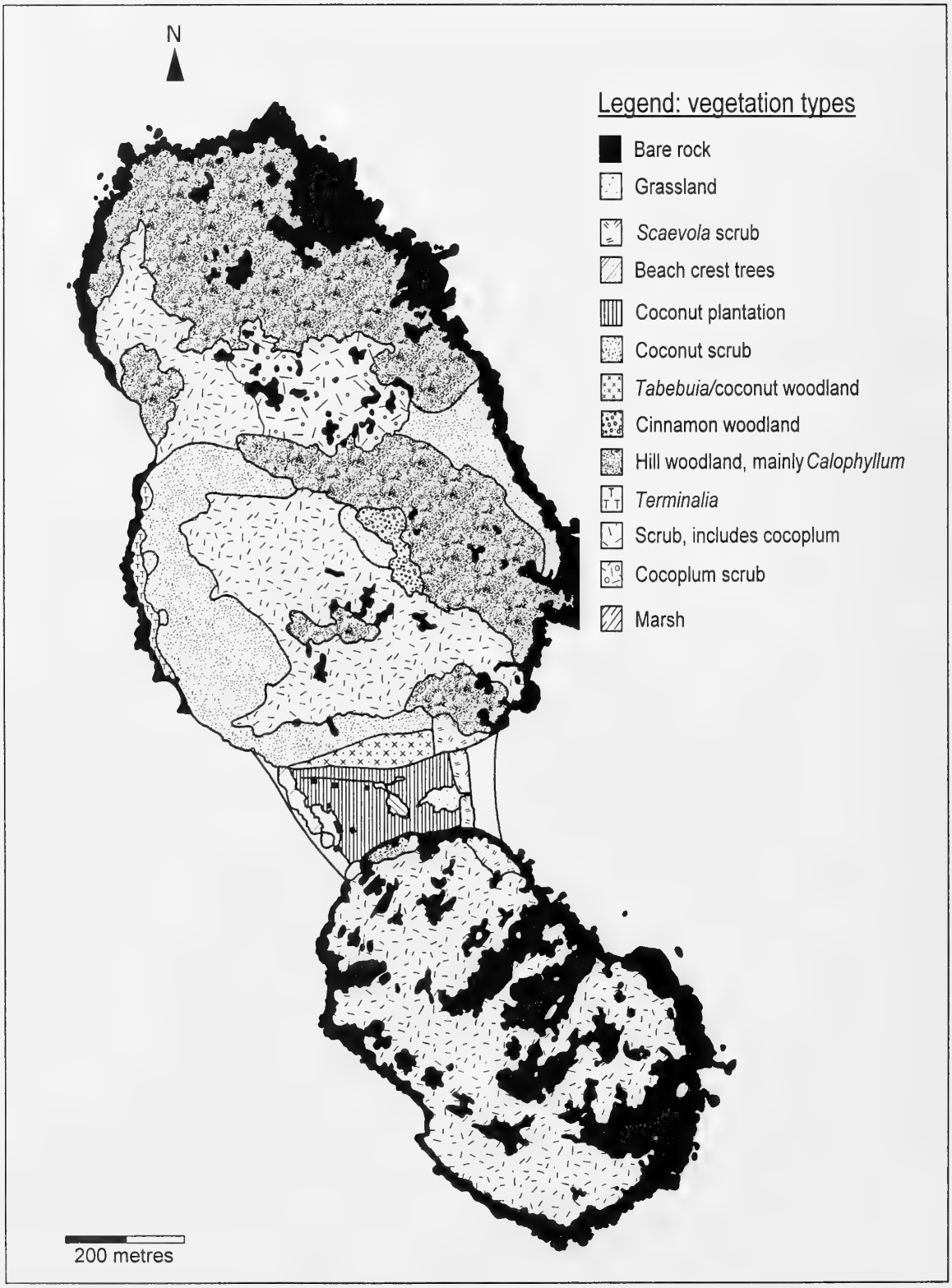

Figure 2. Grande Soeur: vegetation.

The herb layer (<0.5 m) included 21 species, of which the most frequent were the native ferns *Phymatosorus scolopendria* (in seven plots) and *Nephrolepis biserrata* (in six plots). Vegetation cover in this layer was rather sparse (mean cover 30.1%) with similar proportions of open leaf litter (38.5%) and bare rock (31.8%).

INVERTEBRATES

Pitfall trapping

Pitfall trap assemblages were very small. The mean number of individuals per five traps was 20.5, compared to mean for season (all islands) of 68.18 individuals per five traps. Assemblages were dominated by ants (78% of all invertebrate individuals were ants), the most abundant species being *Odontomachus troglodytes* (78 individuals; 38.0% of total). *Technomyrmex albipes,* the dominant ant species in collections from Grande Soeur made by Mühlenberg *et al.* (1977), was also collected (25 individuals, 12.2% of total). Other taxonomic groups represented included Orthoptera (7.8% of total individuals), Dermaptera (6.3%), Isoptera and Blattodea (each 2.0%), molluscs and Coleoptera (each 1.0%) and four other groups represented by only one individual each. The crazy ant *Anoplolepis gracilipes,* which has been introduced to other agricultural islands, was not collected.

Leaf-insect Counts

Leaf-insect counts were carried out for seven tree and shrub species. Results are shown in Table 3. The highest leaf counts were on the native tree *Terminalia catappa.* However, invertebrates were also abundant on the introduced cinnamon. Most invertebrates on cinnamon were ants (22%) and soft bugs Sternorrhyncha (75%).

Table 3. Density of invertebrates on foliage, Grande Soeur.

Species	No. leaves counted	Mean inverts leaf^{-1}	Mean insects m^{-2}
Introduced			
Chrysobalanus icaco	150	0.107	29.82
Cinnamomum verum	200	0.495	72.74
Tabebuia pallida	100	0.030	4.19
Native			
Calophyllum inophyllum	450	0.609	51.79
Canthium bibracteatum	340	0.079	27.89
Terminalia catappa	160	1.588	81.65
?Status unknown			
Morinda citrifolia	160	0.525	37.34

Malaise Trapping

Three malaise traps were in place for three nights each in hill woodland habitats. Malaise trap assemblages were very large (mean number of invertebrates was 762), and included members of 10 invertebrate orders. The dominant orders were the Lepidoptera (53.4% of all individuals), Diptera (18.2%) and Hemiptera (14.5%). The majority of taxa collected have yet to be identified to species level. A number of invertebrate species were observed (Table 4).

Table 4. Invertebrate species identified.

Order	Family	Species	Notes
Mollusca:			
Gastropoda	Achatinidae	*Achatina ?fulica* (Bowditch, 1822)	Many empty shells, hill woodland
	Helicinidae	*Helicina theobaldiana* Nevill, 1871	Endemic. In pitfall traps
	Subulinidae	*Subulina striatella* (Rang, 1831)	Introduced. in pitfall traps
	Thiaridae	*Melanoides tuberculata* (Müller, 1774)	One specimen
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	Commonly caught in rat traps
	Grapsidae	*Grapsus crinipes* (Dana, 1851)	
	Ocypodidae	*Ocypode ceratophthalmus* (Pallas, 1772)	Abundant on Grande Anse
		Ocypode cordimana Desmarest, 1825	
Myriapoda:			
Chilopoda	Scolopendridae	*Scolopendra subspinipes* Leach, 1918	One individual observed
Diplopoda	Spirostreptidae	*Seychelleptus seychellarum* (Desjardins, 1834)	Several individuals seen (by day) in hill woodland
	Trigoniulidae	*Spiromanes braueri* (Attems, 1900)	In pitfall traps
Insecta:			
Blattodea	Blattidae	*Periplanata* sp.	Abundant on plateau
Lepidoptera	Lycaenidae	*Leptotes pirithous* Linnaeus, 1767	Several specimens caught
		Zizeeria knysna (Trimen, 1862)	Several specimens caught
	Hesperiidae	*Borbo* sp.	One individual observed
Odonata	Libellulidae	*Diplocodes trivialis* (Rambur, 1842)	Observed at plateau marsh
		Orthetrum stemmale wrightii (Selys, 1877)	Observed flying over hill
		Tholymis tillarga (Fabricius, 1798)	Over marsh at dusk
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)	
	Apidae	*Apis mellifera adansoni* Latreille 1804	
	Formicidae	*?Pachycondyla melanaria* (Emery, 1894)	In pitfall traps
		Camponotus grandieri Forel, 1886	In pitfall traps
		Cardiocondyla emeryi Forel, 1881	In pitfall traps
		Odontomachus troglodytes Santschi, 1914	In pitfall traps
		Technomyrmex albipes (Smith, 1861)	In pitfall traps
	Vespidae	*Polistes olivaceus* (de Geer 1773)	

VERTEBRATES

Amphibians, Reptiles and Fish

A total of six species (one amphibian, three lizards, one tortoise and one freshwater fish) was observed (Table 5); several other species have been recorded in the past (Cheke, 1984) and are probably still present. The status of terrapins *Pelusios* sp., introduced from La Digue in the mid-late 1990s, is unknown. Two species recorded by earlier workers were not observed in the current survey: the gecko *Urocotyledon inexpectata,* and the burrowing skink *Pamelaescincus gardineri* (Cheke, 1984). Both of these lizards are easily overlooked and probably survive on the island. Giant tortoises, presumably one of the species of the granitic islands, were present on 'Les Soeurs') in the late eighteenth century (Bour, 1984); the date of their extinction is unknown. A herd of giant tortoises, probably the Aldabra species, was noted by General Gordon in 1881 (Stoddart and Peake, 1979). In 1999, a small group of Aldabra giant tortoises was kept in a pen on the plateau.

The exposed eastern beach of Grande Soeur is reportedly used for nesting by Hawksbill sea turtles *Eretmochelys imbricata* (Frazier, 1984).

Table 5. Amphibians, reptiles and fish observed.
Status: E =endemic, I = introduced, N = native (in central Seychelles).

Family	Species		Status
Amphibians			
Raniidae	*Ptychadaena mascareniensis* (Dumeril & Bibron, 1836)	Mascarene frog	?I
Reptiles			
Gekkonidae	*Gehyra mutilata* (Wiegmann, 1835)	Pacific house gecko	I
	Phelsuma sp. (*?P. astriata* Tornier, 1901)	day gecko	E
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	Seychelles skink	E
Testudinidae	*Geochelone gigantea* (Schweigger, 1812)	Aldabra giant tortoise	I
Fishes			
Rivulidae	*Pachypanchax playfairii* Günther, 1866	Seychelles killifish	E

Birds

In total, 15 land birds and waders were recorded (Table 6). Only two endemic species were observed. In addition to sight records, tape playback was used to determine presence/absence of three endemic species: Seychelles white-eye *Zosterops modestus,* Seychelles scops owl *Otus insularis* and Seychelles black paradise flycatcher *Terpsiphone corvina.* There were no positive responses.

At the time of the survey, domestic fowl were a notable feature of Grande Soeur: the plateau area supported a large number of domestic birds (over 150 individuals) of six species, the most abundant being ducks and chickens. The birds were fed regularly but eggs were not collected and (apparently) birds are rarely, if ever, killed for human

consumption. There appeared to be few checks on population growth. The birds roamed freely on the plateau and had a major impact on plateau ecosystems (especially the marsh), although they rarely appeared to enter semi-natural habitats on the hills.

Few endemic land bird species have ever been recorded on Grande Soeur; the island appears to have been little-visited by naturalists before extensive habitat change. Endemic birds that may have occurred on Grande Soeur in the past include the chestnut-flanked white-eye *Zosterops mayottensis semiflava* (only known from Marianne and now extinct), Seychelles magpie-robin *Copsychus sechellarum* and Seychelles black paradise flycatcher *Terpsiphone corvina.* All these species have formerly been recorded on satellite islands of La Digue (Newton, 1867; Collar and Stuart, 1985).

The presence of phosphatic rocks on parts of the island (Baker, 1963) suggests that seabird colonies must have been a prominent feature of the island's past biota, but today only one or two species appear to breed, at low densities.

Table 6. Wild terrestrial birds and waders observed on Grande Soeur.
M = migrant species; V = vagrant species; E = Seychelles endemic species.

Species		Notes
Butorides striatus	green-backed heron	Seen regularly around the plateau marsh, in both July and December.
Ixobrychus sinensis	yellow bittern	Seen once at plateau marsh, 19/7/99
Gallinula chloropus	common moorhen	A small number occur at the plateau marsh
Pluvialis squatarola M	grey plover	Seen on reconnaissance trip May 1999 (LD). Two individuals seen on Grand' Anse and marsh, 14/12/99.
Gallinago ?gallinago V	snipe	One individual seen feeding in plateau marsh, 15/12/99.
Numenius phaeopus M	whimbrel	Seen once, at Grand Anse 22/7/99
Tringa nebularia M	common greenshank	One individual seen feeding in plateau marsh, 15/12/99.
Calidris alba M	sanderling	Flock of 5-6 seen on Grand' Anse, 14/12/99
Arenaria interpres M	ruddy turnstone	Flock of 10 seen on plateau, 15/12/99.
Streptopelia picturata ssp.	turtle dove	Very common on the plateau: flock of around 30 individuals seen around buildings 18/7/99
Geopelia striata	barred ground dove	Occasional on plateau
Alectroenas pulcherrima E	Seychelles blue pigeon	Seen regularly in hill woodland, and on the plateau
Nectarinia dussumieri E	Seychelles sunbird	Very common in hill woodland and on the plateau
Acridotheres tristis	common mynah	Very common on the plateau, feeding around houses and on the beach
Foudia madagascariensis	Madagascar fody	A few birds were seen, on plateau-edge/glacis habitats

Table 7. Seabirds recorded on Grande Soeur.

Species		Notes
Puffinus pacificus	wedge-tailed shearwater	Calls heard at night
Puffinus lherminieri	Audubon's shearwater	Calls heard at night
Phaeton lepturus	white-tailed tropicbird	A few individuals seen, flying close to the island by day. On occasion, flew around trees on plateau.
Gygis alba	fairy tern	Breeding birds present in trees in hill woodland July 1999.

Mammals

Mammals observed in the course of fieldwork were recorded (Table 8). In addition, rodent trapping was carried out with two traplines, both in plateau scrub habitat. A total of 140 trap-nights were carried out and 91 individual rats caught, giving a capture rate of 65 rats per 100 trap-nights (unadjusted) or 99.45 per 100 trap-nights (adjusted to account for the effects of closed traps; Cunningham and Moors, 1996). This rate of trapping was the highest for any island throughout the survey (overall mean for all islands in season was 33.64 rats per 100 trap-nights unadjusted). The exceptionally high capture rate was probably an indication of a high population density but was also likely to be a function of seasonal effects. During the south east season, and particularly in July, rats were under greater food and water stress than at other times and were therefore more likely to be caught. Rodent eradication programmes in 2000 were deliberately carried out at that time of year to exploit the increased uptake of bait then (Don Merton, *pers. comm*). The only rodent species recorded on the island was the ship rat *Rattus rattus,* a widespread species in Seychelles that can have significant impacts on bird populations as it is a proficient climber (Racey and Nicoll, 1984).

Table 8. Mammals observed, Grand Soeur.

Species	Status
Canis familiaris L.	Three domestic dogs were kept at the settlement
Felis catus L.	Feral cats were reported by people living on the island, and cat scat was observed on rocks at the edge of the plateau, although the animals were not seen
Oryctolagus cuniculus L.	At least one rabbit kept (caged) at the settlement
Pteropus seychellensis Milne Edwards	In July 1999, a roost of at least 40 individuals was found close to the North-East coast of the island at L'Enclos (Grid reference CL 7465 2645)
Rattus rattus L.	Widespread

CONSERVATION RECOMMENDATIONS

At the time of the survey, Grande Soeur had little conservation interest. Some endemic species of plant and invertebrate were recorded. However, a high density of rats and the presence of cats appeared to have destroyed any endangered endemic land birds

that may have once survived on the island, and probably had a negative impact on reptile species. The presence of a large population of domestic fowl probably caused enhanced rat populations and influenced the biodiversity of the marsh ecosystem. Invasive alien plant species, most introduced during the plantation period, undoubtedly displaced native and endemic species, although the number of endemic plants present was probably always rather small due to the island's size.

Because of the lack of biological records of the island in the past, any attempt to reconstruct island ecosystems is based largely on conjecture. From written records, it seems that the island was probably never well-wooded, and that large areas of open rock and shrubby forest may have supported breeding colonies of seabird species. Endemic birds in addition to the two species recorded in the current survey were probably present. With correct management, the island could be rehabilitated to an extent. The most urgent action for endemic vertebrates is the eradication of mammalian predators. Removal of predators would allow the introduction of endemic land birds and allow breeding colonies of seabirds to develop. The reduction of populations of domestic birds would enhance the conservation value of the freshwater marsh, reducing disturbance and eutrophication. The removal or control of invasive weed species would be desirable, although eradication of some species is probably impossible due to the broken terrain. However, some introduced species (especially cinnamon) have relatively high densities of invertebrates on their foliage, and removal of these species would not be necessary for the introduction of small insectivorous birds such as Seychelles white-eye *Zosterops modestus* and Seychelles warbler *Acrocephalus sechellensis.* The Seychelles black paradise flycatcher may have occurred on the island in the past (records exist for nearby Praslin, La Digue, Félicité and Marianne; Collar and Stuart, 1995), but the limited area of woodland vegetation on the island would probably support only a small population.

The small pitfall trap assemblages suggest that the potential food supply for Seychelles magpie-robins is poor, at least on the hill. While the plateau area (and possibly, areas of the hill with particularly fertile soils) could be managed to form suitable habitat, the total population of birds that the island could support is small. Grande Soeur is not a priority island for Seychelles magpie-robin management.

Appendix 1. Plant species recorded from Grande Soeur

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: Cu = Cultivated; PG = Plateau grassland; HW = Hill Woodland; Sc = Hill Scrub; Gl = Glacis; BC = Beach Crest; Ma = Marsh.

Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA				
Adiantaceae				
1 *Acrostichum aureum* L.	N	F	Ma	
Davalliaceae				
2 *Nephrolepis biserrata* (Sw.) Schott	N	A	HW	
Polypodiaceae				
3 *Phymatosorus scolopendria* (Burm. f.)	N	A	HW	
Psilotaceae				
4 *Psilotum ?nudum* Sw.	N	C	HW	
ANGIOSPERMAE: Dicotyledons				
Acanthaceae				
5 *Asystasia* sp. B (*sensu* Friedmann)	?I	A	Sc, Gl, HW	
Amaranthaceae				
6 *Alternanthera sessilis* (L.) DC.	I	C	Ma	
Anacardiaceae				
7 *Anacardium occidentale* L.	I	O	HW	
8 *Mangifera indica* L.	I	F	PG, HW	
9 *Spondias cytherea* Sonn.	I	R	HW	
Apocynaceae				
10 *Catharanthus roseus* (L.) G. Don.	I	F	PG	
11 *Plumeria rubra* L.	I	R	PG	Only in garden
Araliaceae				
12 *Gastonia ?sechellarum* (Baker) Harms.	E	R	HW	
Bignoniaceae				
13 *Tabebuia pallida* (Lindl.) Miers.	I	C	HW, [PG]	
Boraginaceae				
14 *Tournefortia argentea* L. f.	N	O	BC	
Cactaceae				
15 *?Hylocereus undatus* (Haw.) Britt. et Rose	I	R	Cu	Only in garden
16 *Opuntia* sp.	I	O	PG	
Caesalpiniaceae				
17 *Intsia bijuga* (Colebr.) O. Kuntze	N	O	HW	
18 *Senna occidentalis* (L.) Link	I	F	HW, PG	
Caricaceae				
19 *Carica papaya* L.	I	R	PG	
Casuarinaceae				
20 *Casuarina equisetifolia* J. R. & G. Foster	I	F	HW	
Chrysobalanaceae				
21 *Chrysobalanus icaco* L.	I	A	Sc, HW, Gl	

Species	Status	Abund.	Habitats	Notes
Combretaceae				
22 *Terminalia catappa* L.	?N	C	PG, HW	
Compositae				
23 *Emilia sonchifolia* (L.) Wight	I	O	PG, Sc	
24 *Tridax procumbens* L.	I	R	PG	
25 *Vernonia cinerea* (L.) Less.	I	A	PG, Sc	
Convulvulaceae				
26 *Ipomoea aquatica* Forssk.	I	F	Ma	
27 *Ipomoea batatas* (L.) Lam.	I	O	Cu	
28 *Ipomoea macrantha* Roem. & Schultes	N	O	HW	
29 *Ipomoea obscura* (L.) Ker Gawl.	I	R	PG	
30 *Ipomoea pes-caprae* (L.) R. Br.	N	C	BC, Gl	
Crassulaceae				
31 *Kalanchoe pinnata* (Lam.) Pers.	I	R	PG	
Euphorbiaceae				
32 *Euphorbia hirta* L.	I	C	PG, Sc	
33 *Euphorbia thymifolia* L.	I	O	Cu	
34 *Pedilanthus tithymaloides* (L.) Poit.	I	O	Cu	Only in garden
35 *Phyllanthus acidus* (L.) Skeels	I	R	PG	
36 *Phyllanthus amarus* Schumach. & Thonn.	I	F	PG, HW	
Goodeniaceae				
37 *Scaevola sericea* Vahl.	N	C	BC	
Guttiferae				
38 *Calophyllum inophyllum* L.	N	A	HW, PG	
Hernandiaceae				
39 *Hernandia nymphaeifolia* (Presl) Kubitzki	N	O	BC	
Labiatae				
40 *Plectranthus amboinicus* (Lour.) Spreng.	?I	R	PG	
Lauraceae				
41 *Cassythea filiformis* L.	N	R	BC	
42 *Cinnamomum verum* Presl.	I	A	HW	
43 *Persea americana* Mill.	I	R	PG	Only in garden
Malvaceae				
44 *Hibiscus tiliaceus* L.	N	F	BC	
45 *Thespesia populnea* (L.) Soland. Ex Correa	N	R	BC	
Meliaceae				
46 *Xylocarpus moluccensis* (Lam.) Roem.	N	R	BC	
Mimosaceae				
47 *Adenanthera pavonina* L.	I	C	HW	
48 *Leucaena leucocephala* (Lam.) de Wit	I	F	HW	
Moraceae				
49 *Artocarpus altilis* (Parkins.) Fosb.	I	O	PG	
50 *Ficus lutea* Vahl.	N	C	HW, Gl	
51 *Ficus reflexa* Thunb. Ssp. *Seychellensis* (Baker) Berg	E (ss)	F	HW, Gl	
52 *Ficus rubra* Vahl.	N	R	HW	
Moringaceae				
53 *Moringa oleifera* Lam.	I	R	PG**	
Myrtaceae				
54 *Eucalyptus* sp.	I	F	PW	
55 *Psidium guajava* L.	I	O	Cu	
56 *Syzygium wrightii* (Baker) A. J. Scott	E	R	HW	

	Species	Status	Abund.	Habitats	Notes
Onagraceae					
57	*Ludwigia octovalvis* (Jacquin) Raven	?I	F	Ma	
58	*Ludwigia erecta* (L.) Hara	I	O	Ma	
Oxalidaceae					
59	*Averrhoa bilimbi* L.	I	F	HW	
Papilionaceae					
60	*Abrus precatorius* L.	?N	C	HW, Sc	
61	*Canavalia cathartica* Thouars.	N	O	BC	
62	*Centrosema pubescens* Benth.	I	A	HW, PG	
63	*Crotalaria pallida* Ait.	?I	F	PG	
64	*Desmodium incanum* DC.	I	C	HW	
65	*Desmodium triflorum* (L.) DC.	I	A	HW	
66	*Indigofera tinctoria* L.	I	F	PG, HW	
67	*Tephrosia noctiflora* Bojer ex Baker	I	O	HW	
68	*Teramnus labialis* (L.) Spreng.	I	F	PG	
Passifloraceae					
69	*Passiflora edulis* Sims	I	R	Cu	
70	*Passiflora suberosa* L.	I	C	PG, HW	
Portulacaceae					
71	*Portulaca oleracea* L.	N	F	Ma, PG	
Rubiaceae					
72	*Canthium bibractatum* (Baker) Hiem.	N	A	HW [PG]	
73	*Coffea canephora* Froehner	I	O	HW	
74	*Guettarda speciosa* L.	N	O	HW	
75	*Morinda citrifolia* L.	?I	F	HW, Gl	
76	*Paragenipa wrightii* (Baker) F. Friedmann	E	F	HW	
Rutaceae					
77	*Citrus sinensis* (L.) Osbeck	I	F	HW, PG	
Scrophulariaceae					
78	*Striga asiatica* (L.) O. Kuntze	?I	F	PG	
Tiliaceae					
79	*Triumphetta rhomboidea* Jacq.	I	O	HW	
Turneraceae					
80	*Turnera angustifolia* Miller	I	A	PG	
Umbelliferae					
81	*Centella asiatica* (L.) Urb.	?I	O	Ma	
Verbenaceae					
82	*Phyla nodiflora* (L.) Greene	I	A	PG	
83	*Premna serratifolia* L.	N	F	HW	
84	*Stachytarpheta jamaicensis* (L.) Vahl.	I	F	PG, HW	
85	*Stachytarpheta urticifolia* (Salisb.) Sims.	I	A	PG, HW	
86	*Vitex trifolia* L.	I	R	PG	
ANGIOSPERMAE: Monotyledons					
Agavaceae					
87	*Agave sisalana* (Perr. Ex. Engelm.) Drumm. & Prain	I	F	PG, Gl	
88	*Furcraea foetida* (L.) Haw.	I	R	PG, Gl	
Amaryllidaceae					
89	*Hymenocallis littoralis* L.	?I	F	PG	
Bromeliaceae					
90	*Ananas comosus* (L.) Merr.	I	R	PG	
Cyperaceae					
91	*Cyperus halpan* L.	?	F	Ma	

	Species	Status	Abund.	Habitats	Notes
92	*?Cyperus* sp.	?	R	HW	
93	*Fimbristylis cymosa* R. Br.	?	F	Gl, HW	
94	*Fimbristyis dichotoma* (L.) Vahl.	?	C	PG	
95	*Kyllinga polyphylla* Willd. ex Kunth	N	C	PG, Ma	
96	*Mariscus dubius* (Rottb.) Fischer	N	C	PG	
97	*Mariscus pennatus* (Lam.) Domin.	N	F	Ma	
98	*Pycreus polystachyos* (Rottb.) P. Beauv.	?	F	Ma	
99	*Thoracostachyum floribundum* (Nees) C.B.Cl.	E	O	HW	
Gramineae					
100	*Brachiara umbellata* (Trin.) W. D. Clayton	N	A	HW	
101	*Dactyloctenium ctenoides* (Steud.) Bosser	?	F	BC, PG	
102	*Digitaria* sp.	?	A	PG, HSc	
103	*Echinochloa colonum* (L.) Link	?	O	PG	
104	*Enteropogon sechellensis* (Baker) Dur. & Schinz	N	C	PG, HSc	
105	*Eragrostis tenella* var. *insularis* Hubb.	?	O	PG	
106	*Panicum brevifolium* L.	N	A	HW	
107	*Panicum maximum* L.	?	F	HW, Gl	
108	*Paspalum conjugatum* Berg	N	F	PG	
109	*Pennisetum polystachyon* (L.) Schult.	?	O	Gl	
110	*Saccharum officinarum* L.	I	O	PG	
111	*Sporobolus ?virginicus* (L.) Kunth.	N	A	BC, PG	
112	*Stenotaphrum dimidiatum* (L.) Brogn.	N	A	PG	
Liliaceae					
113	*Cordyline fruticosa* (L.) A. Chev.	I	R	PG	
114	*Dracaena reflexa* Lam. var. *angustifolia* Baker	N	A	HW, Gl	
Musaceae					
115	*Musa* sp.	I	R	Cu	
Orchidaceae					
116	*Disperis tripetaloides* (Thouars)Lindl.	N	R	HW	
117	*Vanilla planifolia* Andrews	I	C	HW	
Palmae					
118	*Cocos nucifera* L.	N	A	PG, HW	
Pandanaceae					
119	*Pandanus balfourii* Mart.	E	C	Gl, HW	
120	*Pandanus utilis* Bory	I	C	Cu	

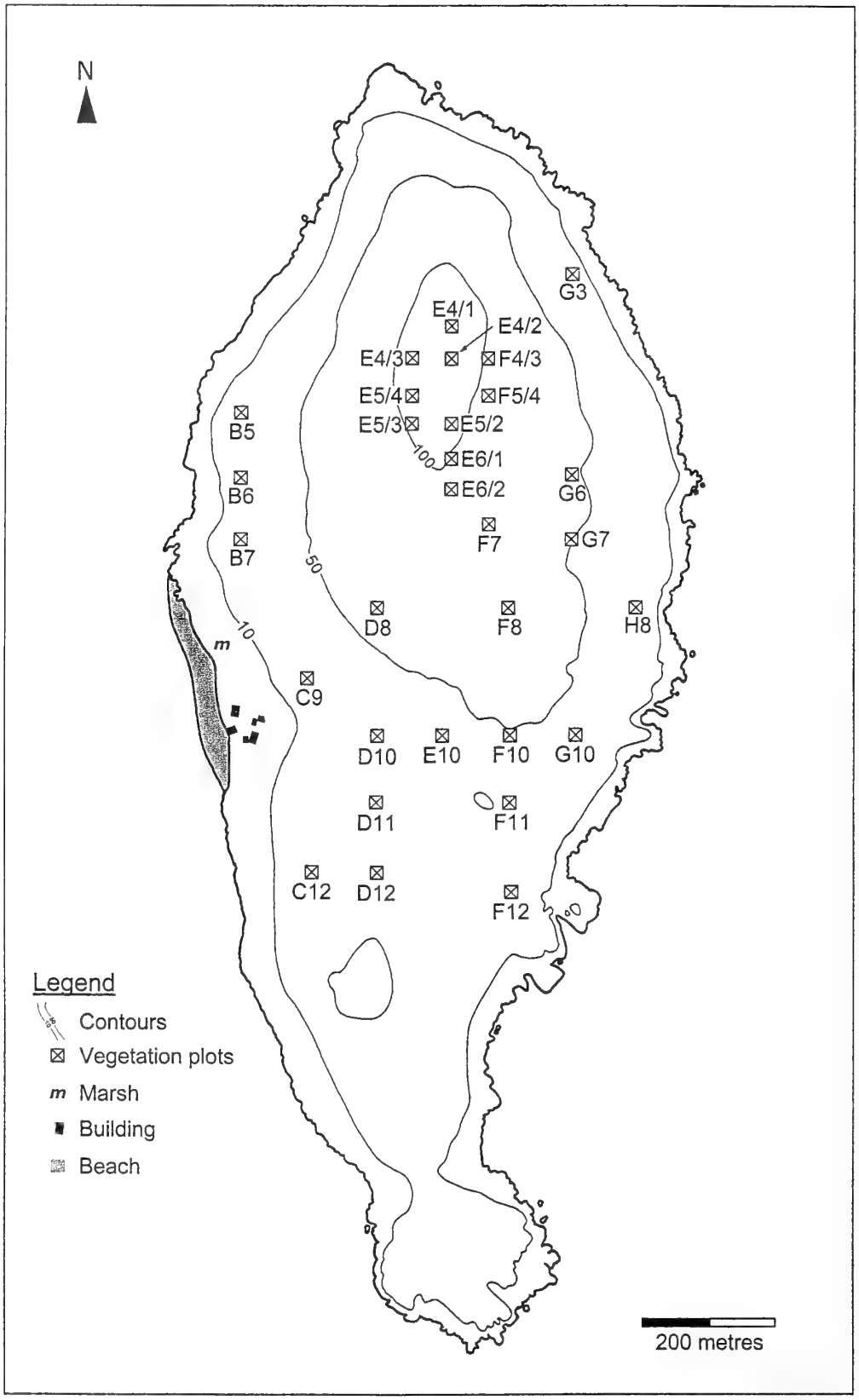

Figure 1. Marianne: physical, with locations of vegetation plots.

MARIANNE

BY

MICHAEL J. HILL[1], PAT MATYOT[2], TERENCE M. VEL[1], STEVEN J. PARR[3] and NIRMAL J. SHAH[1]

GEOLOGY, TOPOGRAPHY AND CLIMATE

Marianne has an area of 94.7 ha, and is the twelfth largest of the granitic Seychelles Islands. At its highest point (Estel Hill, grid ref. CL8034 2068) it reaches 130 m above sea level. A second lower peak (about 85 m) occurs to the South (grid ref. CL8023 1977). Most of the island is gently sloping land below 50 m (see Table 1).

The island is made up of porphyritic granite, which differs slightly from that of the other islands in the Praslin-La Digue group. Traversing the island in a northwesterly direction is a dyke of closely jointed metadolerite rock. On the northern slopes of the island, brown earthy rocks occur, the result of guano deposition on granite soils (Baker, 1963). On the western side of the island is a small "plateau" with a fringing reef. The plateau is made up of recent calcareous sediments and marsh deposits. The island's gentle slopes have allowed the accumulation of red earth soils throughout, excluding only some areas of coastal glacis, where little or no soil occurs. The plateau has soils of the Shioya series (DOS, 1966).

Fresh water on the island is limited, especially during the dry season. At the site of the main former settlement (La Cour), there are two shallow wells. Much of the plateau area supports marsh vegetation (mainly sedges and *Ludwigia*), but in October 1999 there was no standing water. In March, after heavy rain, most of the plateau area was under fresh water to a depth of several centimetres. The marsh must occasionally be inundated; Shah and Parr (1998) reported the presence of mullet *Mugil cephalus*. On coastal glacis in the South of the island near Pointe Grande Glacis (grid ref. CL8035 1925), standing pools of fresh water were present in October.

Marianne is the most remote of the La Digue group of islands. The nearest island is Félicité, 3.8km away. The nearest large inhabited island is La Digue, 7.2km from Marianne.

The Seychelles islands experience a seasonal humid tropical climate (Walsh, 1984). While no weather data exist for Marianne, it could be predicted that the climate of the island follows a similar pattern to that of Félicité, with lower total rainfall than coastal sites on the larger islands.

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Table 1. Area of Marianne by altitude (calculated from maps published by Directorate of Overseas Survey (UK)/Seychelles Government).

Altitude range (m. asl.)	Approx. area (ha)	Percentage total area
100 - 150	3	3.2
50 - 100	24	25.5
10 - 50	49	52.1
0 - 10	18	19.1

HISTORY

The Marion Dufresne expedition of 1768 (prior to settlement of the Seychelles) made only a short note on Marianne Island, recording that only a little woodland was present (Lionnet, 1984). They also recorded the presence of giant tortoises (Bour, 1984).

In the earliest days of the colony, the lack of fresh water (perhaps combined with difficult access) probably restricted development on the island, although it passed into private hands in the early nineteenth century. By the 1830s, maize was being produced on Marianne Island in quantity (McAteer, 2000), but natural habitats remained; in 1866, the visiting naturalist Edward Newton recorded that the north side of Marianne appeared 'tolerably wooded, but...not with any very large trees' (Newton, 1867), although it seems that during his short stay he remained on the western side of the island around the settlement at La Cour. At the time of his visit, the human population of Marianne was one family of five people. During a short stay on the island he recorded seven endemic species of birds, two of which (Seychelles fody *Foudia sechellarum* and the chestnut-flanked white-eye *Zosterops mayottensis semiflava*) were new to science. He noted that the island had no cats or rats, while the nearby Félicité Island, although well-wooded (it was government-owned and supplied timber for other Seychelles islands at the time of his visit) had few birds and had populations of introduced predators. Noting that the owner of Marianne (M. Choppy) intended to start a coconut plantation on the island, he suggested that this act could be as destructive to the native avifauna (which was obviously outstanding for the period) as the introduction of predators.

Native vegetation and endemic species prevailed on Marianne for longer than on neighbouring islands. In 1890, most of the endemic birds recorded by Newton were still present (Ridgway, 1895). However, in the early twentieth century plantations replaced native forest; in the 1920s, extensive stands of the Seychelles endemic tree bwa-d-nat *Mimusops sechellarum* were cleared for firewood (Procter, 1974). By 1940, the human population of the island was 60 (Bradley, 1940). Marianne's extensive plantations supplied copra, fruit and other crops such as sweet potatoes until 1983, when coconut palms on the island were hit by disease (thought to be caused by a combination of insect pests, drought and high winds). A five-month quarantine was imposed on the island, banning the removal of agricultural produce. At the time, Marianne was said to be one of the major copra-producing plantations in Seychelles, and the quarantine caused a significant reduction in Seychelles' copra exports for the year (Seychelles Nation, 7/10/83).

Marianne Island is still privately owned, but its plantations have fallen into disuse. At the time of the survey visit, the island was uninhabited although a caretaker occasionally stayed overnight and had planted crops (including pumpkins, cassava and aubergine) on part of the plateau. The island was occasionally visited by day-trippers from La Digue and local fishermen.

FLORA AND VEGETATION

Flora

A total of 152 plant species were recorded on Marianne, including six ferns and 146 angiosperms. Of the angiosperms, 81 (53.3%) species are regarded as introduced in Seychelles (Friedmann, 1994) and 48 (32.9%) native. Of the native species, eight were endemic to the Seychelles (5.5% of the angiosperm flora). At least seven species of introduced plant (4.6% of the total flora) recorded on Marianne were restricted to cultivated areas of the plateau, where they had been planted in 1999. They were observed nowhere else on the island and would probably become extinct were cultivation to cease.

The proportion of the angiosperm flora made up of Seychelles endemics was lower than the average for the Seychelles as a whole (of the total Seychelles flora, around 54% are introduced and 9% endemic: Procter, 1984). The low proportion of endemics reflects the island's relatively small size and also the destruction of the natural vegetation of the island in the twentieth century. The surviving endemic species were restricted to the rockiest parts of the island when the plantation was functioning, although some have begun to spread out from these refugia. Both *Gastonia sechellarum* and *Tarenna sechellensis* were found as young plants amongst *Canthium* scrub in the former plantation. *Mimusops sechellarum,* which was among the dominant trees of the original native forest (Procter, 1974) was uncommon but several extremely large trees (two of which each reached around 20 m) were observed in predominantly native vegetation in the north of the island. Regeneration of this species appeared poor, perhaps as a result of seed predation by rats (Carlström, 1996a). No endemic palms were found.

Of the introduced plants established on Marianne, 15 are invasive weedy species. Compared to other granitic islands, Marianne had relatively few woody weed species. The cocoplum *Chrysobalanus icaco* was notably absent and cinnamon *Cinnamomum verum*, although present was very rare. Only a handful of mature cinnamon trees were observed, with some regeneration. This was an extremely unusual situation; on other islands, cinnamon appears extremely invasive and has come to dominate large areas. Previous work on the flora of Marianne has been limited. Robertson (1989) includes some records from the island, but lists no species not recorded in the current survey.

Vegetation

The extents of major vegetation types on Marianne are shown in Table 2 and Figure 2. The vegetation has undergone great change since the plantation was abandoned and much of the island is characterised by tall, dense scrub regenerating beneath coconut or fruit trees. Areas on the east coast of the island still have the appearance of a managed

coconut plantation, with scrub invasion restricted by exposure to salt spray. Throughout the former plantation many of the old coconut palms are dead, probably through a combination of exposure, drought and insect attack. At higher altitudes, almost all old palms are dead. Near the summit of Estel Hill and to the north, there is an area of native woodland with very few palms or introduced plants.

Table 2. Extent of major vegetation types, Marianne Island.

	Vegetation type	Approx. area (ha)
Hill	Woodland (predominantly native)	7
(>10 m asl)	Woodland (mixed)	7
	Coconut plantation	1
	Coconut with regeneration	22
	Scrub (native)	7
	Scrub (mixed)	29
	Grassland/garden	2
	Bare rock	< 1
Plateau	Woodland (predominantly native)	< 1
(<10 m asl)	Woodland (exotic)	3
	Coconut plantation	4
	Coconut with regeneration	1
	Scrub (native)	< 1
	Scrub (mixed)	< 1
	Beach crest vegetation	3
	Freshwater marsh	< 1
	Grassland/garden	< 1
	Bare rock	< 1

Ten plots were established in native woodland, with a combined area of 1,000 m^2 (approximately 1.4% of the total area of this vegetation type), and 20 in the former plantation covering 2000 m^2 or 0.3% of the total area of the habitat. A summary of results is shown in Table 3.

Native woodland plots had a relatively mature aspect with a high density of trees and sparse shrub and herb layers. The tree layer was dominated by two native species, takamaka *Calophyllum inophyllum* (36 trees, 35% of total trees) and *Canthium bibracteatum* (26 trees, 25.2% of total trees). Only one (possibly) non-native tree species was present in the tree layer, *Morinda citrifolia* (seven trees, 6.8% of total trees). Only one mature *Cocos* was found although many fallen stems indicated that they were formerly abundant here.

The most widespread species of the shrub layer were *Canthium bibracteatum* (in all 10 plots), coconut *Cocos nucifera* (in nine of 10 plots), *Dracaena reflexa* and *Premna serratifolia* (each in eight of 10 plots). Of these, *Cocos* was the most dominant species; in plots where it occurred, it formed on average 19.6% cover in the shrub layer. *Canthium* had an average of 4.9% cover. In the shrub layer, only one individual plant (of 335) was introduced (*Citrus* sp.); all others were native or possibly native (five individuals were *Morinda citrifolia*).

The 20 plots surveyed in the former plantations had a relatively sparse tree layer and dense shrub and herb layers. Compared to the native forest, the tree layer had a more

varied composition with 23.8–34.3% of all trees introduced, and 9.1% *Cocos*. Most of the larger trees were introduced plantation species; of trees with DBH 10 cm or over, only

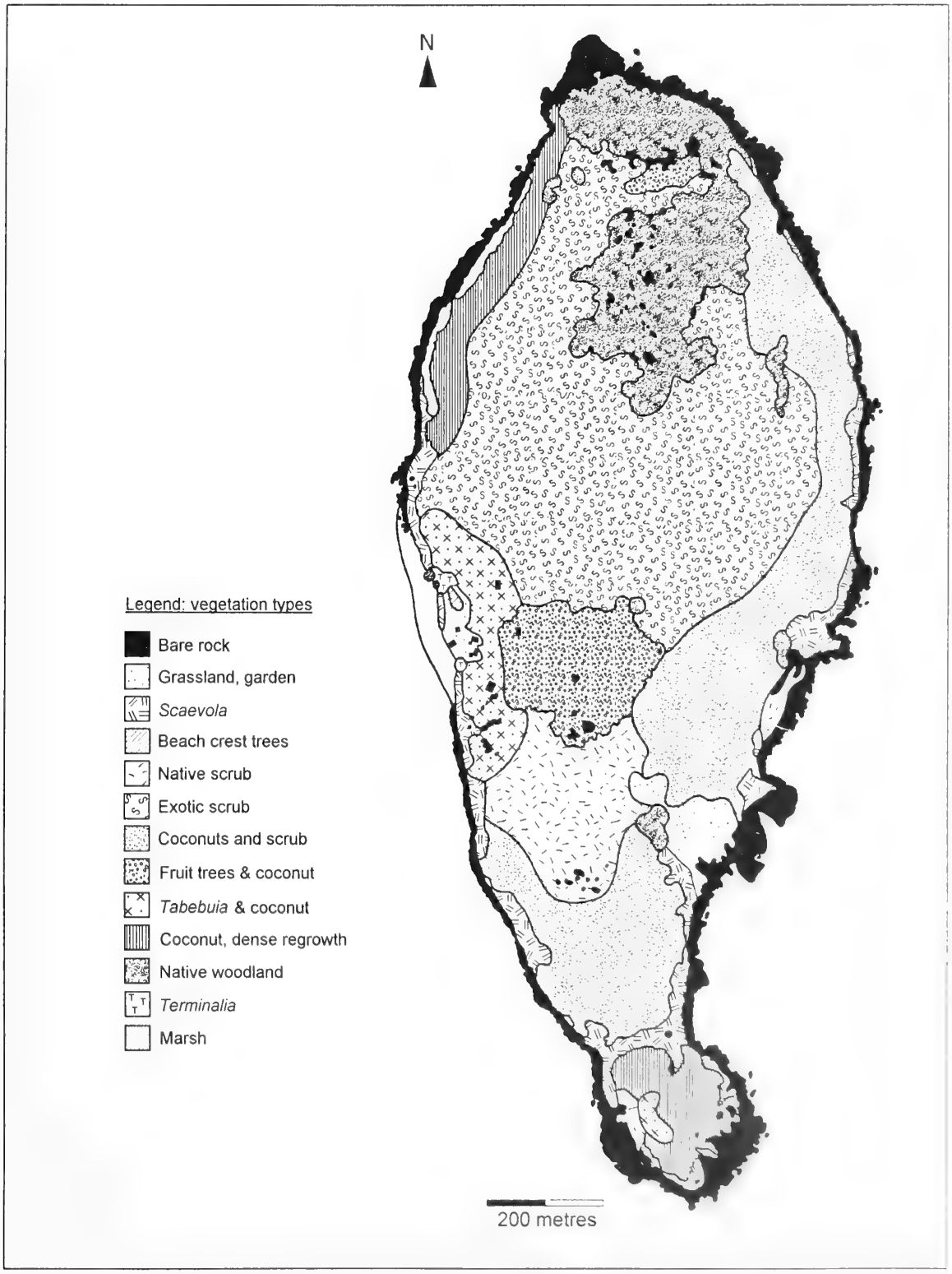

Figure 2. Marianne: vegetation.

19% were native broad-leafed species. However, the most abundant species in the tree layer were *Canthium bibracteatum* (52 individuals, 36.4%) and *Premna serratifolia* (21 individuals, 14.7%), both small native trees. This indicates a rapid growth of native early-successional species following the abandonment of the plantation.

In the shrub layer, only 94 individuals (6.9%) belonged to introduced species. However, the most widespread species in the shrub layer was *Cocos nucifera* (found in all 20 plots) with mean coverage of 45%. *Canthium bibracteatum* was present in 18 of 20 plots and *Morinda citrifolia* in 12.

Table 3. Vegetation plot summary.

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)
Native woodland	10	110	1030	36.2	34.4	37.8	27.8	3.0
Former plantation	20	40	477	67.6	57.3	24.3	18.4	3.6

The dense herb and shrub layers of the former plantation sites show that this environment is dynamic. The end point of such a process is difficult to predict; although the tree layer is now dominated by native broad-leaf species, these are small trees adapted to early succession conditions. The strong germination and growth of *Cocos* will probably cause some areas to become dense single-species stands shading out other species.

INVERTEBRATES

Pitfall Trapping

The pitfall trap assemblages were generally small compared to those of other granitic islands (Table 4). In native woodland, assemblages were considerably smaller than in the mixed former plantation areas, perhaps because the native woodland was at high altitudes, more exposed and drier than the plantation sites. The richness of plantation sites (which have a greater proportion of introduced plant species) suggests that ground invertebrate density is not dependent upon native or endemic vegetation.

The composition of assemblages also differed between the native and mixed woodland, although both were dominated by ants (Hymenoptera: Formicidae). In native woodland, the most abundant invertebrate in both seasons was the native ant *Odontomachus troglodytes,* which formed 29.7% of all individuals in the south east and 58.8% of all individuals in the north west monsoon. In mixed former plantation, the dominant species was the introduced crazy ant *Anoplolepis gracilipes* (which formed 48.1% and 66.0% of all individuals). This ant was the most abundant species overall in pitfall collections from Marianne (51.4% of individuals were *A gracilipes*) but it was rare in native woodland. *Anoplolepis gracilipes,* introduced to the Seychelles in the early 1960s, is a domestic and agricultural pest with effects on natural ecosystems that are

difficult to gauge (Haines *et al.*, 1994). Densities of the ant can become extremely high and, because the ants encourage soft bugs on foliage and stems, they can cause tree dieback and death, altering the composition of woodland (Hill, in prep.).

Pitfall assemblages contained representatives of 15 taxonomic groups other than ants. The most abundant groups were Dermaptera (earwigs), Collembola (springtails) and Blattodea (cockroaches) (Fig. 3). Several endemic species were collected in pitfall trap assemblages. Perhaps the most notable was the pill millipede *Cyliosomella furciparum*, believed extinct on Marianne (Gerlach, 1997). Three individuals were collected, two in native woodland (at 120 m and 100 m asl) and one at a slightly lower altitude (87 m asl) in mixed woodland adjacent to native woodland.

Table 4. Pitfall assemblages from Marianne: only invertebrates >2 mm body length included (numbers in parentheses: excluding ants).

	Habitat	Mean no. individuals per 5 traps	
		SE season	NW season
Marianne	Native woodland	21.6 (9.0)	20.6 (3.4)
	Former plantation	49.6 (12.7)	67.9 (12.1)
All granitic islands		61.8 (9.4)	61.1 (16.0)

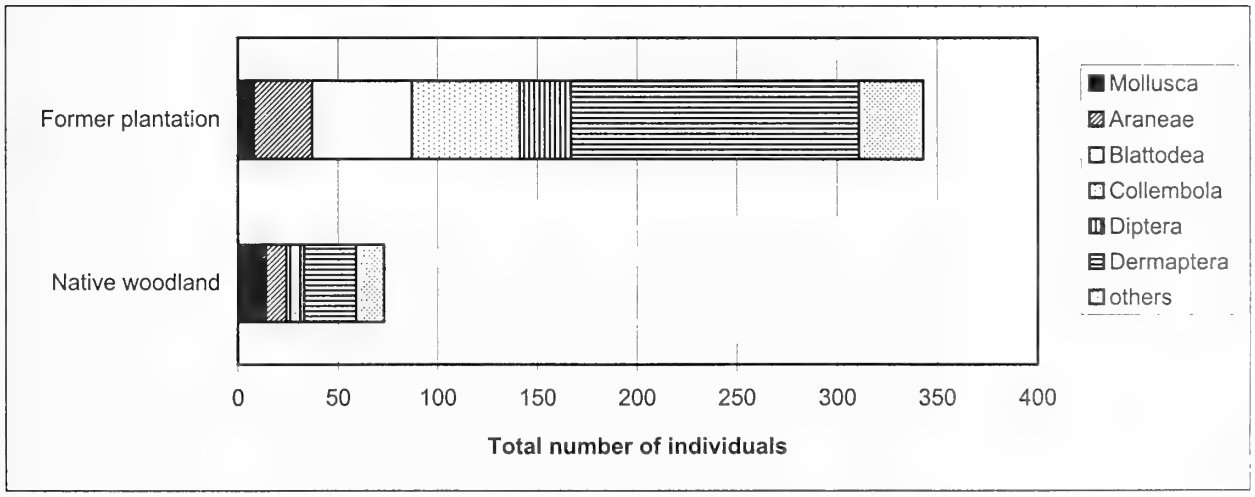

Figure 3. Total pitfall assemblages from Marianne, excluding ants.

Leaf-insect Counts

Leaf-insect counts were carried out for 16 tree and shrub species, seven of these in both seasons. Results are shown in Table 5. Extremely high counts occur for *Morinda citrifolia* (status uncertain; possibly introduced) and Chinese guava *Psidium cattleianum* (introduced) in October, due to high numbers of soft bugs. In general, the highest leaf counts were for native species and a few fruit tree species (e.g. *Citrus, Psidium*) which are favoured by ants culturing soft bugs (mealy bugs and scale insects).

Table 5. Density of invertebrates on foliage, Marianne.
n = no. of leaves counted; NI = number of individual invertebrates.

Species	SE season (October)			NW season (March)		
	n	Mean NI leaf^{-1}	mean NI m^{-2}	n	mean NI leaf^{-1}	mean NI m^{-2}
Introduced species						
Annona muricata	50	0.020	4.51	0		
Citrus sp.	150	0.140	42.47	100	0.170	72.57
Mangifera indica	150	0.053	8.46	50	0.060	9.56
Psidium cattleianum	50	1.280	495.16	0		
Tabebuia pallida	0			100	0.210	45.89
Native species						
Calophyllum inophyllum	350	0.183	20.05	550	0.140	17.03
Canthium bibracteatum	700	0.060	21.94	1002	0.042	15.21
Euphorbia pyrifolia	0			100	0.140	59.67
Gastonia sechellarum	50	0.520	8.54	0		
Paragenipa wrightii	0			50	0.480	71.02
Premna serratifolia	650	0.503	78.41	500	0.218	28.94
Scaevola sericea	0			50	1.980	262.08
Tarenna sechellensis	50	0.040	15.29	0		
Tabernaemontana coffeoides	0			100	0.010	1.30
Terminalia catappa	50	0.12	16.77	50	1.240	119.98
?Status unknown						
Morinda citrifolia	400	8.510	725.80	300	0.756	123.01

Malaise Trapping

Malaise trapping was carried out in native woodland and former plantation habitats. Four Malaise traps (two in each habitat) were run in October 1999 and three (one in mixed former plantation, two in native woodland) in March 2000. Assemblages were slightly larger in March (mean number of individuals (NI) = 430) than in October (mean NI = 398), but there was no consistent pattern between habitats. Malaise trap assemblages included members of 13 invertebrate orders. The dominant orders were the Lepidoptera (43.7% of all individuals) and Diptera (28.7% of individuals). The majority of taxa collected have yet to be identified to species level: Hymenoptera (excluding ants) are currently being identified by Dr John Noyes of the Natural History Museum, London.

Observation

A list of species observed or collected is given in Table 6. Invertebrates of the highly disturbed areas of the plateau tended to be introduced or cosmopolitan species. Inland a greater number of endemic species were found. In general, the mixed woodland and scrub of abandoned plantation areas appeared richer than the native hill woodland on Estel Hill and the north of the island. Notable species included the endemic cricket *Seychellesia longicercata* normally found associated with endemic palms (Matyot, 1998).

At Pointe Grande Glacis, freshwater pools were present in October, when the marsh area was dry. Live mosquito larvae and dragonfly larvae were present. One adult dragonfly was observed flying over the pools, but could not be caught. Two dead insects were collected here: *Myriochile melancholica perplexa* (Coleoptera, Cicindelidae) and *Perissosoma grande* (Coleoptera, Scarabaeidae). This is apparently the first record of *M. m. perplexa* in Seychelles since the 1908-9 Percy Sladen Trust expedition (Scott, 1912). The species is widespread, occurring as a variety of different forms in Africa. The endemic chafer *P. grande* was formerly only known from Praslin, where it is often found in endemic palm forest. Due to the exposed position of this site, these insects could have originated outside Marianne.

In early March, the plateau marsh varied greatly in size from a small area of damp mud to a wide pool of freshwater with a depth of several centimetres covering much of the plateau (following heavy rain). Several dragonfly species were observed at this time. Specimens of one water beetle (unidentified) were collected and a species of water boatman (Hemiptera: Notonectidae) observed.

Table 6. Insects observed, Marianne Island.

Order	Family	Species
Arachnida		
Araneae	Tetragnathidae	*Nephila inaurita* (Walckenaer, 1841)
Crustacea		
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852
	Gecarcinidae	*Cardisoma carnifex* (Herbst, 1784)
	Grapsidae	*Grapsus tenuicrustatus* (Herbst)
	Ocypodidae	*Ocypode ceratophthalma* (Pallas, 1772)
Mollusca	Cyclophoridae	*Cyathopoma blanfordi* Adams, 1868
	Streptaxidae	*Streptosele* sp.
	Subulinidae	*Subulina octona* Bruguière, 1792
Myriapoda		
Chilopoda	Scolopendridae	*Scolopendra subspinipes* (Leach, 1918)
Diplopoda	Spirostreptidae	*Seychelleptus seychellarum* (Desjardins, 1834)
	Sphaerotheridae	*Cyliosomella furciparum* (Brölemann, 1896)
	Trichopolydesmidae	*Cylindrodesmus hirsutus* (Pocock, 1888)
	Trigoniulidae	*Spiromanes ?braueri* (Attems, 1900)
Insecta		
Blattodea	Blattidae	*Periplaneta americana* (Linnaeus, 1758)
		Periplaneta australasiae (Fabricius, 1775)
Coleoptera	Cerambycidae	*Olenecamptus bilobus* (Fabricius)
	Cicindelidae	*Myriochile melancholica perplexa* (Dejean, 1825)
	Curculionidae	*Cratopus griseovestitus* Linell, 1897
		Cratopus aurostriatus Fairmaire, 1892
	Rhipiceridae	*Callirhipis philiberti* Fairmaire, 1891
	Scarabaeidae	*Oryctes monoceros* (Olivier, 1789)
		Perissosoma grande (Scott, 1912)
		Protaetia maculta (Fabricius, 1775)
Hemiptera	Cicadoidea	*Antankaria* (Chremistica) *pulverulenta* (Distant, 1905)
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)
	Apidae	*Apis mellifera adansoni* Latreille, 1804
	Formicidae	*Anoplolepis gracilipes* (Smith, 1857)
		Cardiocondyla emeryi Forel, 1881
		Monomorium ?fossulatum Emery, 1894
		Monomorium floricola (Jerdon, 1851)

Table 6 (cont.)

Order	Family	Species
Hymenoptera (cont.)	Formicidae (cont.)	*Odontomachus troglodytes* Santschi, 1914
		Plagiolepis ?alluaudi Emery, 1894
		Tapinoma melanocephalum (Fabricius, 1793)
		Technomyrmex albipes (Smith, 1861)
	Megachilidae	*Chalcidoma disjuncta* (Fabricius, 1781)
	Sphecidae	*Trypoxylon* sp. (*T. errans* or *T. scutifrons*)
	Vespidae	*Delta alluaudi* (Perez, 1895)
		Polistes olivaceus (de Geer, 1773)
		Rhynchium brunneum (Fabricius, 1773)
Lepidoptera	Lycaenidae	*Leptotes pirithous* Linnaeus, 1767
		Zizeeria knysna (Trimen, 1862)
		Zizula hylax (Fabricius, 1775)
	Noctuidae	*Achaea mercatoria* (Fabricius, 1775)
		Anticarsia irrorata Fabricius, 1781
		Trigonodes hyppasia (Cramer, 1780)
	Nymphalidae	*Hypolimnas misippus* (Linnaeus, 1764)
		Hypolimnas ?bolina Drury, 1773
		Melanitis leda africana (Linnaeus, 1758)
	Pyralidae	*Spoladea recurvalis* (Fabricius, 1787)
		Diaphana indica (Saunders, 1851)
		Endotricha mesenterialis mahensis Whalley
	Sphingidae	*Acherontia atropos* (Linnaeus, 1758)
		Cephnodes hylas virescens (Wallengren, 1865)
Neuroptera	Myrmeleonidae	*Myrmeleon obscurus* Rambur, 1842
Odonata	Libellulidae	*Orthetrum stemmale wrightii* (Selys, 1877)
		?Pantala flavescens (Fabricius, 1798)
		Tramea limbata Selys, 1878
Orthoptera	Gryllidae	*Gryllodes supplicans* (Walker, 1859)
	Mogoplistidae	*Ornebius elegantulus* (Boliver, 1912)
	Phalangopsidae	*Seychellesia longicercata* (Boliver, 1912)
	Tettigonidae	*Ruspolia differens* (Serville, 1838)
		Conocephalus iris (Serville, 1838)

VERTEBRATES

Reptiles

Four species were recorded, all lizards: two day geckos (*Phelsuma sundbergi* and a smaller species, possibly *P. astriata*), a third gecko (a pink-bodied juvenile, observed on ruined buildings on the plateau: probably a young Pacific house gecko *Gehyra mutilata*), and one skink, *Mabuya sechellensis*. A fifth species, bronze-eyed gecko *Ailuronyx seychellensis*, has been recently recorded (Shah and Parr, 1998) although not observed during the current study. Both *A. seychellensis* and the large skink *Mabuya wrightii* were collected on Marianne by Lantz in 1877 (Cheke, 1984) and *M. wrightii* now appears to be extinct, probably due to the introduction of rats since 1877. No snakes were recorded, although the introduced fossorial snake *Ramphotyphlops braminus* is likely to be present as it was commonly spread to agricultural islands (Nussbaum, 1984a). Giant tortoises, presumably an endemic taxon of the granitic islands, were recorded in 1787 but had become extinct before 1875 (Bour, 1984).

Birds

Birds were surveyed by observation and using tape playback. In October 1999, playback of taped calls was used in locations around the island to give an indication of the number of individuals of the endemic Black Paradise Flycatcher. Tape playback of Scops Owl *Otus insularis* was carried out on one night (27/10/99).

The endemic Black Paradise flycatcher was observed on several occasions in three locations:

1) In mango trees at/near plot D10, once spontaneously (22/10/99) and once to tape (26/10/99);
2) At the northern end of the island, to tape (26/10/99);
3) Peak of Estel Hill, to tape (27/10/99, 28/10/99).

All responding individuals were females. It is possible that these were multiple records of the same bird, but seems more likely that there were at least two individuals.

Among the granitic islands, Marianne is unique in the quality of records of its bird fauna. Because plantation development occurred later here than on other islands in the group, naturalists of the 19th century were able to record the extant fauna, at a time when endemic species were extinct, or were being lost, on most other islands. The most complete records are those of Newton (1867). Abbott collected specimens on Marianne (and other islands) in 1890 (Ridgway, 1895). The past and present endemic avifauna of Marianne Island are summarised in Table 7.

Table 7. Past and present endemic land birds, Marianne Island.

Species		Late 19th – early 20th century	1999-2000
Falco araea	Seychelles kestrel	Present 1866[1]	
Streptopelia picturata rostrata	Seychelles turtle dove**	Present 1866[1]	Subspecies effectively extinct
Alectroenas pulcherrima	Seychelles blue pigeon	Present 1866[1]	Present
Coracopsis nigra barklyi	Seychelles black parrot**	Reported numerous prior to 1866, but locally extinct by then[1]	
Hypsipetes crassirostris	Seychelles bulbul	Present 1866[1]	
Copsychus sechellarum	Seychelles magpie-robin	Present 1866[1] and 1890[2]	
Acrocephalus sechellarum	Seychelles warbler	(?) Recorded 1936[3]	
Terpsiphone corvina	Seychelles black paradise flycatcher	Present 1890[2], 1936[3]	Present, rare
Nectarinia dussumieri	Seychelles sunbird	Numerous 1866[1]	Present
Zosterops mayottensis semiflava	Chestnut-flanked white-eye**	Present 1866[1] (first described from Marianne specimen) and 1890[2]	Seychelles subspecies extinct
Foudia sechellarum	Seychelles fody	Present 1866[1] (first described from Marianne specimen) and 1890[2]	

** Endemic subspecies

[1] Newton, 1867 [2] Ridgway, 1895 [3] Vesey-Fitzgerald, 1936

In total, 12 land birds and waders were observed on the island during the current survey (Table 8), including three endemic species. Seabirds observed included fairy terns *Gygis alba* (common in breadfruit trees around the settlement, where they probably breed), common noddy *Anous stolidus,* white-tailed tropicbird *Phaeton lepturus* and frigate birds *Fregata* spp. (all observed occasionally offshore). In March 2002 a wedge-tailed shearwater *Puffinus pacificus* was heard calling in flight over the plateau at 8pm.

Table 8. Land birds and waders recorded on Marianne.
M = migrant species; E = Seychelles endemic species.

Species		Notes
Butorides striatus	green-backed heron	Up to three individuals regularly observed in rocky shallows near La Cour; one (abandoned) nest in *Euphorbia.*
Gallus gallus	domestic chicken	Several feral individuals, both sexes and young.
Dromas ardeola M	crab plover	One individual on beach, 18/10/99
Numenius phaeopus M	whimbrel	One individual on beach, 21/10/99. Two individuals regularly on beach, March.
Actitis hypoleucos M	common sandpiper	One individual on beach, 25/10/99
Arenaria interpres M	ruddy turnstone	Seen on two occasions, on glacis at the southern tip of the island. Seen regularly on beach, March
Streptopelia picturata picturata	Madagascar turtle dove	Observed fairly regularly around La Cour in *Tabebuia* forest.
Geopelia striata	barred ground dove	A few individuals observed, in disturbed or open habitats.
Alectroenas pulcherrima E	Seychelles blue pigeon	In October, only one individual observed 26/10/99, feeding on *Canthium* berries. In March seen more frequently, especially in fig trees.
Terpsiphone corvina E	Seychelles paradise flycatcher	October: at least three individual female birds found in an extensive survey of the island using tape playback of calls. March: several females observed.
Nectarinia dussumieri E	Seychelles sunbird	Very common everywhere. Several nests found, March.
Acridotheres tristis	common mynah	Common.
Foudia madagascariensis	Madagascar fody	Apparently rare: one male in breeding plumage observed 21/10/99. Females occasionally seen in *Tabebuia* forest near La Cour.

Mammals

Table 9 shows mammals observed in the course of the survey. In addition, rodent trapping was carried out in October 1999 and March 2000 (Table 10). Two trap-lines were established, both in hill woodland/scrub (former plantation). Only one species of rodent, the ship rat *Rattus rattus,* was trapped. Trapping rates were relatively low, although slightly higher in October than in March. Marianne has abundant fruit trees (especially mangoes and oranges) with fruit in season on both visits, and the availability of alternative food sources could influence the readiness of rats to enter traps.

Table 9. Mammal species observed, Marianne.

Species		Notes
Bos taurus L.	Cattle	One individual
Felis catus L.	Domestic cat	Rarely observed
Pteropus seychellensis Milne-Edwards	Seychelles fruit bat	Abundant, observed travelling between Marianne and other nearby islands (including La Digue, Félicité)
Rattus rattus L.	Ship rat	Abundant

Table 10. Results of rat trapping.

Dates	Trap-nights	No. of rats	Rats per 100 trap-nights (uncorrected)	Rats per 100 trap-nights (corrected)*
23 – 28/10/99	140	31	22.14	25.20
10 – 14/3/00	112	20	17.86	19.80
Total (SE)			35.34	
Total (NW)			25.56	

*Corrected to account for the effect of closed traps: Cunningham and Moors, 1996

CONSERVATION RECOMMENDATIONS

Given Marianne's documented history, it is of great conservation interest. Perhaps less than 100 years ago the island supported a greater range of endemic birds than any other of the central Seychelles islands. The loss of habitat, combined with the introduction of predators, caused the local extinction of most species. In addition, the presence of phosphatic rocks suggests that substantial colonies of seabirds existed.

Marianne is obviously capable of supporting viable populations of endemic land birds, but two major factors have to be addressed before re-introductions could be considered: introduced predators and habitat suitability. Specific actions that need to be taken include the control or eradication of introduced predators (particularly rats and cats) and the removal of introduced plant species and coconut scrub regenerating under the former coconut plantation. The introduced crazy ant *Anoplolepis gracilipes* is a potential threat on the island. Areas of the forest were dominated by this ant species which can have extreme effects on plant and invertebrate communities (Hill *et al.*, in prep.) with probable higher-order effects for vertebrates. At present, there are no instances of established populations of crazy ants being eradicated in the Seychelles.

The presence of Seychelles black paradise flycatchers on the island is of particular interest, given that the bird was thought to be restricted to La Digue prior to 1999. Records of the species by Shah and Parr (1998) and the current survey suggest that the number of individuals on the island is small; no adult males were recorded on visits in 1999 and 2000, although it is possible that juvenile males (with plumage similar to the female) were present. Even if males occur there, the small population on Marianne is undoubtedly vulnerable to extinction, especially given the presence of predators (rats and cats) on the island. However, these predators should not necessarily preclude the survival

of the paradise flycatcher on Marianne; on La Digue, a large, established population of the bird survives alongside a range of predators (including Seychelles bulbul, absent from Marianne). In order to encourage the paradise flycatcher to establish a viable population on Marianne, thus extending the species' range and reducing the possibility of extinction, the population of birds on Marianne could be enhanced by managed translocations, preferably in combination with attempts to reduce populations of introduced predator species.

Appendix 1. Plant species recorded from Marianne

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: Cu = Cultivated area; Ma = Marsh; PG = Plateau Grassland; HW = Hill Woodland/scrub; HG = Hill Grassland; Gl = Glacis; BC = Beach Crest.

	Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA					
Adiantaceae					
1	*Acrostichum aureum* L.	N	O	BC	
2	*Pityrogramma calomelanos* (L.) Link.	?I	R	HW	
Davalliaceae					
3	*Davallia denticulata* (Burm.) Mett.	N	O	HW	
4	*Nephrolepis biserrata* (Sw.) Schott	N	A	HW, HG	
Polypodiaceae					
5	*Phymatosorus scolopendria* (Burm. f.)	N	A	HW	
Psilotaceae					
6	*Psilotum ?nudum* Sw.	N	F	HW	
ANGIOSPERMAE: Dicotyledons					
Acanthaceae					
7	*Asystasia* sp. B (*sensu* Friedmann)	?I	A	HW, Gl	
Amaranthaceae					
8	*Achyranthes aspera* (L.) DC.	I	O	HW	
9	*Alternanthera sessilis* (L.) DC.	I	O	Ma	
Anacardiaceae					
10	*Anacardium occidentale* L.	I	O	HW	
11	*Mangifera indica* L.	I	A	HW, PG	
12	*Spondias cytherea* Sonn.	I	O	HW	
Annonaceae					
13	*Annona muricata* L.	I	A	HW, PG	
14	*Annona reticulata* L.	I	F	HW	
15	*Annona squamosa* L.	I	O	HW	
Apocynaceae					
16	*Catharanthus roseus* (L.) G. Don.	I	C	HW, Gl	
17	*Ochrosia oppositifolia* (Lam.) Schum.	N	R	HW	
18	*Tabernaemontana coffeoides* Boj. ex A. DC.	N	C	HW	
Araliaceae					
19	*Gastonia sechellarum* (Baker) Harms. var. *sechellarum*	E	C	HW	
Asclepiadaceae					
20	*Sarcostemma viminale* (L.) Alton	N	O	HW, Gl	
Avicenniaceae					
21	*Avicennia marina* (Forssk.) Vierh.	N	R	BC	
Bignoniaceae					
22	*Tabebuia pallida* (Lindl.) Miers.	I	A	HW	

	Species	Status	Abund.	Habitats	Notes
Boraginaceae					
23	*Cordia subcordata* Lam.	N	O	PG, BC	
Caesalpiniaceae					
24	*Caesalpinia bonduc* (L.) Roxb.	N	F	HW	
25	*Senna occidentalis* (L.) Link	I	O	PG, HW	
26	*Tamarindus indica* L.	I	O	HW	
Capparidaceae					
27	*Cleome viscosa* L.	I	O	Gl	
Caricaceae					
28	*Carica papaya* L.	I	O	Cu, HW	
Casuarinaceae					
29	*Casuarina equisetifolia* J. R. & G. Foster	I	O	BC	
Combretaceae					
30	*Terminalia catappa* L.	?N	C	BC, PG, HW	
Compositae					
31	*Emilia sonchifolia* (L.) Wight	I	C	PG, Gl	
32	*Synedrella nodiflora* (L.) Gaertn.	I	A	PG	
33	*Tagetes patula* L.	I	R	Cu	Only in garden
34	*Vernonia cinerea* (L.) Less.	I	A	PG	
Convulvulaceae					
35	*Ipomea batatas* (L.) Lam.	I	F	Cu	
36	*Ipomoea macrantha* Roem & Schult.	N	F	HW	
37	*Ipomoea pes-caprae* (L.) R. Br.	N	A	BC, PG	
Cucurbitaceae					
38	*Cucurbita moschata* (Lam.) Poir.	I	F	Cu	Only in garden
39	*Lagenaria siceraria* (Molina) Standl.	I	F	Cu	Only in garden
Euphorbiaceae					
40	*Acalypha indica* L.	I	A	PG	
41	*Euphorbia hirta* L.	I	A	PG, Cu	
42	*Euphorbia pyrifolia* Lam.	N	F	HW, Gl	
43	*Euphorbia thymifolia* L.	I	C	PG, Cu	
44	*Jatropha curcas* L.	I	O	HW	
45	*Manihot esculenta* Crantz	I	O	Cu, HW	
46	*Pedilanthus tithymaloides* (L.) Poit.	I	R	HW	
47	*Phyllanthus amarus* Schumach. & Thonn.	I	A	PG	
48	*Phyllanthus pervilleanus* (Baillon) Müll. Arg.	N	F	HW	
Flacourtiaceae					
49	*Flacourtia jangomas* (Lour.) Räuschel	I	F	HW	
Goodeniaceae					
50	*Scaevola sericea* Vahl.	N	A	BC, HW	
Guttiferae					
51	*Calophyllum inophyllum* L.	N	A	HW, BC	
Labiatae					
52	*Ocimum basilicum* L.	I	O	Gl	
53	*Ocimum ?tenuiflorum* L.	I	O	Gl	
54	*Plectranthus amboinicus* (Lour.) Spreng.	?I	F	Gl, HG	
55	*Plectranthus prostratus* Gürke	I	R	Sc	
56	*Solenostemon scutellarioides* (L.) Codd	I	R	Cu	Only in garden
Lauraceae					
57	*Cinnamomum verum* Presl.	I	R	HW	
58	*Persea americana* Mill.	I	O	HW	
Lecythidaceae					
59	*Barringtonia asiatica* (L.) Kurtz	N	O	BC	

	Species	Status	Abund.	Habitats	Notes
Malvaceae					
60	*Abutilon indicum* (L.) Sweet	?I	R	HW	
61	*Hibiscus tiliaceus* L.	N	O	HW	
62	*Sida acuta* Burm. F.	I	A	PG, HW	
63	*Sida cordifolia* L.	?N	C	Gl	
64	*Thespesia populnea* (L.) Soland. Ex. Correa	N	F	BC, PG	
65	*Urena lobata* L.	?I	A	PG, HW	
Meliaceae					
66	*Xylocarpus moluccensis* (Lam.) Roem.	N	F	BC	
Mimosaceae					
67	*Adenanthera pavonina* L.	I	O	HW	
68	*Leucaena leucocephala* (Lam.) de Wit	I	F	HW	
69	*Pithecollobium unguis-cati* (L.) Benth.	I	O	HSc	
Moraceae					
70	*Artocarpus altilis* (Parkins.) Fosb.	I	O	PG	
71	*Ficus lutea* Vahl.	N	C	HW	
72	*Ficus reflexa* Thunb. ssp. *seychellensis* (Baker) Berg	E (ss)	F	HW, PG	
73	*Ficus rubra* Vahl.	N	C	HW, PG	
Moringaceae					
74	*Moringa oleifera* Lam.	I	O	HW	
Myrtaceae					
75	*Psidium guajava* L.	I	C	PG, HW	
76	*Syzygium wrightii* (Baker) A. J. Scott	E	O	HW	
Onagraceae					
77	*Ludwigia octovalvis* (Jacquin) Raven	?I	C	Ma	
Papilionaceae					
78	*Abrus precatorius* L.	?N	A	HW	
79	*Desmodium incanum* DC.	I	A	HW	
80	*Desmodium triflorum* (L.) DC.	I	C	HW	
81	*Teramnus labialis* (L.) Spreng.	I	C	HW	
82	*Vigna marina* (Burm.) Merr.	N	F	PG, Ma	
Passifloraceae					
83	*Passiflora foetida* L.	I	F	HW	
84	*Passiflora suberosa* L.	I	C	HW	
Portulacaceae					
85	*Portulaca oleracea* L.	?N	F	PG, Gl	
Rubiaceae					
86	*Canthium bibractatum* (Baker) Hiem.	N	A	HW, Gl	
87	*Guettarda speciosa* L.	N	O	BC	
88	*Morinda citrifolia* L.	?I	A	HW	
89	*Paragenipa wrightii* (Baker) F. Friedmann	E	F	HW	
90	*Pentadon pentandrus* (Schumach. & Thonn.) Vatke	I	R	Gl	
91	*Tarenna sechellensis* (Baker) Summerh.	E	C	HW	
Rutaceae					
92	*Citrus aurantifolia* (Christm.) Swingle	I	O	HW	
93	*Citrus medica* L.	I	O	HW	
94	*Citrus reticulata* Blanco	I	F	HW	
95	*Citrus sinensis* (L.) Osbeck	I	A	HW	
96	*Murraya koenigii* (L.) Spreng.	I	R	HW	
97	*Murraya paniculata* (L.) Jack	I	F	HW	

	Species	Status	Abund.	Habitats	Notes
Sapindaceae					
98	*Allophyllus pervillei* Blume	N	R	HG, HW	
99	*Cardiospermum halicacabum* L.	?N	F	HW, Gl	
Sapotaceae					
100	*Mimusops sechellarum* (Oliv.) Hemsl.	E	F	HW	
Scrophulariaceae					
101	*Striga asiatica* (L.) O. Kuntze	?I	O	HG	
Solanaceae					
102	*Capsicum frutescens* L.	I	R	Cu	Only in garden
103	*Datura metel* L.	I	C	PG	
104	*Physalis angulata* L.	I	O	PG	
105	*Solanum melongena* L.	I	F	Cu	Only in garden
Tiliaceae					
106	*Triumphetta rhomboidea* Jacq.	I	C	Gl, PG	
Turneraceae					
107	*Turnera angustifolia* Miller	I	A	HW	
Verbenaceae					
108	*Phyla nodiflora* (L.) Greene	I	O	PG	
109	*Premna serratifolia* L.	N	A	HW	
110	*Stachytarpheta jamaicensis* (L.) Vahl.	I	O	HG, PG	
111	*Stachytarpheta urticifolia* (Salisb.) Sims.	I	A	HW	
112	*Vitex trifolia* L.	I	C	PG, Ma	
ANGIOSPERMAE: Monotyledons					
Agavaceae					
113	*Furcraea foetida* (L.) Haw.	I	O	HW	
Amaryllidaceae					
114	*Hymenocallis littoralis* (Jacq.) Salisb.	?I	F	PG	
115	*Zephyranthes rosea* Lindl.	I	R	PG	
Araceae					
116	*Alocasia macrorrhiza* (L.) G. Don.	I	O	HW	
Bromeliaceae					
117	*Ananas comosus* (L.) Merr.	I	O	HW, Gl	
Commelinaceae					
118	*Commelina* sp.	?	O	HW	
Cyperaceae					
119	*Cyperus compressus* L.	?	O	PG, Gl	
120	*Fimbristylis cymosa* R. Br.	?	C	Gl	
121	*Fimbristylis dichotoma* (L.) Vahl.	?	A	PG	
122	*Fimbristylis* sp. (glacis sedge)	?	C	Gl	
123	*Kyllinga alba* Nees	?	F	HW	
124	*Kyllinga polyphylla* Willd. ex Kunth	N	C	HW, Gl	
125	*Mariscus dubius* (Rottb.) Fischer	N	C	HW, PG, Gl	
126	*Mariscus pennatus* (Lam.) Domin.	N	C	Ma	
127	*Pycreus polystachyos* (Rottb.) P. Beauv.	?	C	Ma, Gl	
128	*Thoracostachyum floribundum* (Nees) C. B. Cl.	E	O	HW	
Gramineae					
129	*Bambusa vulgaris* Scrad. ex Wendl.	I	R	HW	
130	*Brachiara umbellata* (Trin.) W. D. Clayton	N	A	HW, Gl	
131	*Cenchrus echinatus* L.	?	O	PG	
132	*Chloris barbata* (L.) Sw.	?	O	Gl	
133	*Dactyloctenium ?ctenoides* (Steud.) Bosser	?	A	PG	
134	*Digitaria ?didactyla* Willd.	N	A	HG	
135	*Digitaria ?horizontalis* Willd	?	F	PG	

	Species	Status	Abund.	Habitats	Notes
136	*Enteropogon sechellensis* (Baker) Dur. & Schinz	N	A	PG, Gl	
137	*Eragrostis ?tenella* (L.) P. Beuv. *insularis* Hubb.	?	O	Gl	
138	*Oplismenus compositus* (L.) P. Beuv.	N	O	HW	
139	*Paspalum ?scrobiculatum* L.	?	O	HW	
140	*Pennisetum polystachyon* (L.) Schult.	?	O	Gl	
141	*Sporobolus virginicus* (L.) Kunth.	N	C	BC	
142	*Stenotaphrum dimidiatum* (L.) Brogn.	N	C	HW	
143	*Stenotaphrum micranthum* (Desv.) C. E. Hubb.	?	A	HG	
144	sp. indet. (*?Brachiaria* sp.)	?	C	HW	
Liliaceae					
145	*Dracaena reflexa* Lam. var. angustifolia Baker	N	A	HW	
Musaceae					
146	*Musa sapientum* L.	I	F	Cu, HW	
Orchidaceae					
147	*Disperis tripetaloides* (Thouars)Lindl.	N	F	HW	
148	*Vanilla planifolia* Andrews	I	A	HW	
Palmae					
149	*Cocos nucifera* L.	N	A	HW, HG, PG, BC	
Pandanaceae					
150	*Pandanus balfourii* Mart.	E	O	BC, HW	
151	*Pandanus utilis* Bory	I	C	HW	
Taccaceae					
152	*Tacca leontopetaloides* (L.) O.Kuntze	?	F	HW	

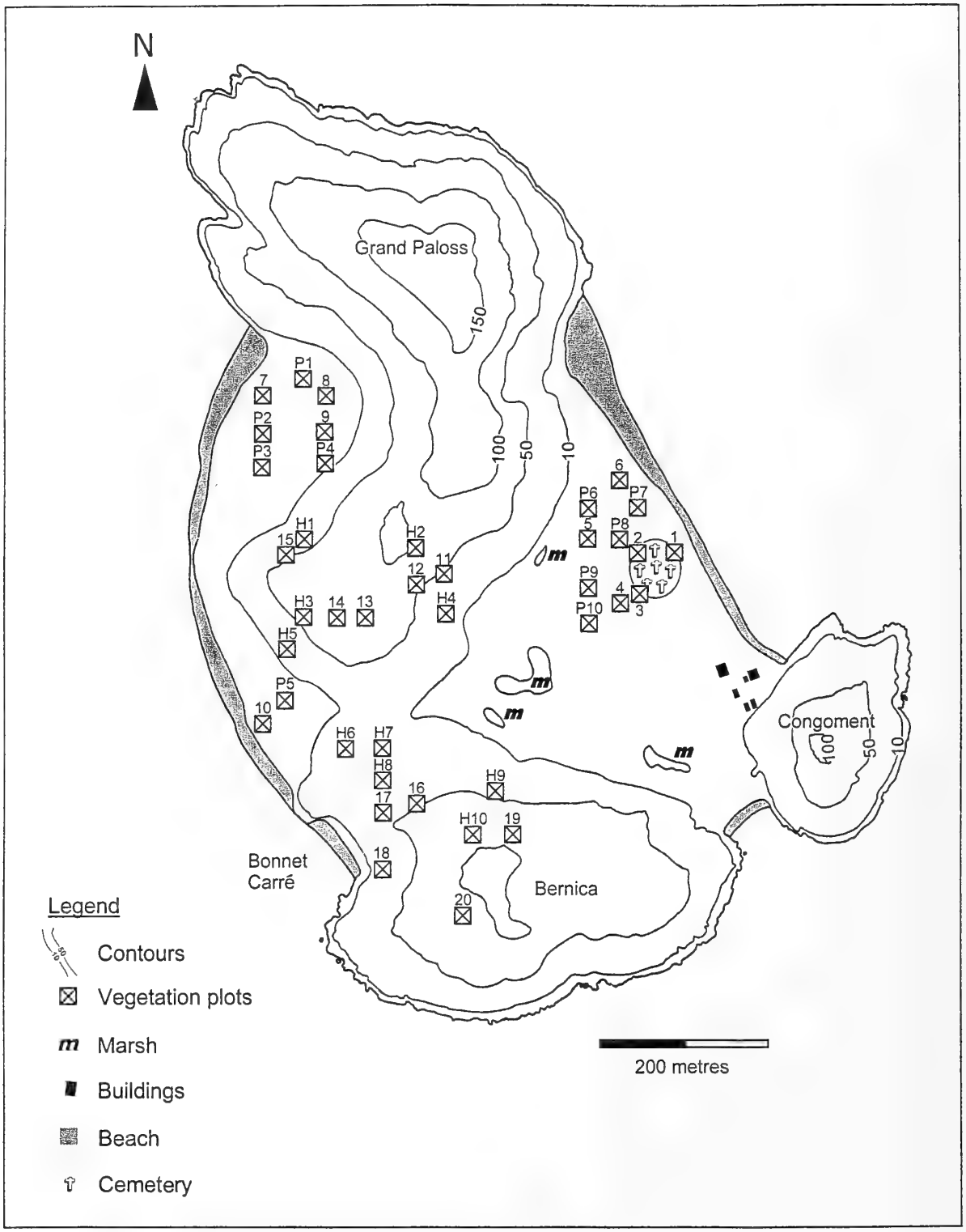

Figure 1. North Island physical, with locations of vegetation plots.

NORTH ISLAND

BY

MICHAEL J. HILL[1], TERENCE M. VEL[1], KATY HOLM[2], K., STEVEN J. PARR[3] and NIRMAL J. SHAH[1]

GEOLOGY, TOPOGRAPHY AND CLIMATE

North Island has an area of 201 ha, and is the ninth largest of the granitic Seychelles Islands. At its highest point (Grand Paloss) it reaches over 180 m above sea level. The island's north-south axis is made up of raised rocky hills with an outlier (Congoment) to the east. Along the eastern and western sides of the island are two large low-lying "plateau" areas.

Geologically, the island differs from most of the granitic islands of Seychelles apart from its nearest neighbour Silhouette. Both islands are made up of syenite resulting from volcanic activity. These rocks are of much more recent origin than the bulk of Seychelles granite; Mahé and Praslin granites have been dated at about 650 million years old (Braithwaite, 1984) and Silhouette syenite at 63 million years old (Stephens, 1996). The plateaux are made up of recent calcareous sediments covered (on the landward side) with 20–30 cm depth of weathering products from the syenite hills (Baker, 1963) and, in places, marsh deposits.

The island's soils are varied. On the lower slopes of the hills Bernica and Basin Jean, and parts of the eastern plateau, Seychelles red earths occur, with some river valley soils in seasonal stream beds. On the western plateau, soils are of the Jemo series. The eastern plateau has soils of the Shioya series (DOS, 1966). Around the base of the hill, on the eastern plateau, is a complex of marshes varying in extent according to season. North Island is relatively remote. The nearest island is Silhouette, *c.* 7 km away.

The Seychelles islands experience a seasonal humid tropical climate (Walsh, 1984). Historical weather data for North Island are limited, although more complete data have been collected in recent years. Monthly rainfall for the period 1975-80 is shown in Table 2. Total rainfall on North Island for this period was considerably lower than that on the nearby higher island of Silhouette which reaches an altitude of 621 m asl (annual mean rainfall for Silhouette = 2,082.5 mm: North Island = 1,516.9 mm).

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Table 1. Area of North Island by altitude (calculated from maps published by Directorate of Overseas Survey (UK)/Seychelles Government).

Altitude range (m. asl.)	Area (ha)	Percentage total area
150 - 200	5	2.5
100 - 150	17	8.5
50 - 100	51	25.4
10 - 50	61	30.3
0 - 10	67	33.3

Table 2. North Island: monthly rainfall (mm), 1975-1980.
(Data: National Meteorological Services, Seychelles, unpublished data).
n/a = not available.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1975	454.9	151.6	65.7	30.4	84.8	15.4	6.3	48.7	n/a	3.8	286.0	224.0
1976	260.1	366.0	50.0	78.0	20.3	35.5	21.0	29.7	20.3	26.9	n/a	279.4
1977	315.7	142.7	51.8	174.7	65.0	29.2	76.5	48.3	15.0	223.3	132.1	125.2
1978	349.0	220.5	84.8	246.9	66.3	40.9	24.4	0.8	39.1	95.8	397.3	n/a
1979	240.0	159.5	290.8	208.0	17.8	10.4	83.1	21.3	0.0	159.0	n/a	169.7
1980	127.5	330.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Mean	291.2	228.5	108.6	147.6	50.8	26.3	42.3	29.8	18.6	101.8	271.8	199.6

HISTORY

Written references on the island's history are few although it was one of the first islands to be visited by man. On the fourth voyage of the East India company in 1609, the granitic Seychelles were first discovered by western mariners (Lionnet, 1986). In a written account of the voyage by John Jourdain, there are records of landings on two islands, one of which (later identified as North Island by W. Wharton) had no fresh water but did have giant land tortoises, which were collected for food (Foster, 1905).

"Pirate markings" inscribed on rocks on Congoment may pre-date official settlement of the Seychelles islands, which occurred in 1770. Within 17 years of permanent human settlement of the archipelago, North Island was overrun by rats, although the tortoises mentioned by Jourdain were still present. Malavois (1787: in Fauvel, 1909) records that North Island

> "...is now little wooded, having been burned down several years ago. In the small plain...one would find sufficient land to have a small habitation, but it would require the destruction of rats that now populate the island. The most beautiful tortoises of the archipelago are to be found there, and [green] turtles also come ashore. But Caret [hawksbill turtle] is almost never seen."

The tortoises, presumably species of the granitic islands, became extinct before 1875 (Bour, 1984). In the early twentieth century, North Island guano was exploited on a

small scale for export. The guano was low grade; it was reported to contain 2-3% iron oxide and was also unusually rich in magnesium and aluminium as a result of contamination with syenitic soil (Baker, 1963). Evidence of guano processing remains in physical features and soils; an artificial mound at Petite Anse (between Congoment and Bernica) is labelled "guano siftings" on the map of 1976 (Seychelles Government and UK Directorate of Overseas Surveys, 1976). The eastern plateau of North Island has Jemo series soils (DOS, 1966), which form on the plateaux of seabird islands and are also found on Cousin, Cousine, Aride and Frégate.

In the late nineteenth or early twentieth century, extensive plantations of coconut and fruit trees were made over the plateau areas. North Island exported a variety of agricultural produce to Mahé. In recent years, the plantations of North Island have declined and been abandoned; in 1997, there was one family managing a small farm with domestic animals on the island (Shah and Parr, 1997). North Island was bought by Wilderness Safaris Ltd. in 1997, with the purpose of developing a tourism and conservation project. Since this time there has been intermittent human presence on the island and some domestic animals survive in a feral state.

FLORA AND VEGETATION

Flora

In total, 188 plant species were recorded on North Island, including 12 ferns, one cycad and 175 angiosperms (Appendix 1). Of the angiosperms, 108 species (61.7%) are regarded as introduced (Friedmann, 1994) and 42 (24.0%) native. Only one of these native species (*Pandanus balfourii*) was endemic to the Seychelles, although the list also included an endemic subspecies (*Ficus reflexa seychellensis*).

The flora of North Island shows a greater proportion of introduced species and a smaller number of endemics than the flora of Seychelles as a whole (of the total Seychelles flora, around 54% are introduced and 9% endemic; Procter, 1984). Within the granitic Seychelles, larger islands tend to have more endemic species, but the number on North Island was similar to that on a much smaller island, Cousin (29 ha). The small number of endemic taxa probably reflects the island's history of cultivation and the accessibility of most of the island (compared with, for example, the broken rocky topography of Félicité). Fire may also have contributed to the loss of endemic species; in 1972, a bush fire destroyed vegetation throughout the northern hill including Grand Paloss and Basin Jean. The area destroyed by fire included the highest parts of the island and those of lesser economic value where endemic species might have survived.

It has been suggested that an endemic labiate (called *Coleus subfrutectosus* Summerhayes by Robertson, 1989) survives on North Island. However, this plant is probably a vigorous variety of the introduced *Plectranthus amboinicus* (Friedmann, 1994). Of the introduced plants established on North Island, at least 16 can be regarded as invasive weedy species (Carlström, 1996a: Fleischmann, 1997). The most abundant are lantana *Lantana camara,* cocoplum *Chrysobalanus icaco*, guava *Psidium guajava,* strawberry (Chinese) guava *Psidium cattleianum,* and *Alstonia macrophylla.* One potentially invasive species *Clidemia hirta* appears to be a recent introduction from

Silhouette, probably arriving as bird-sown seed. 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.

Several previous workers have produced plant species lists for North Island; species recorded in the past but not in the current survey are shown in Appendix 1. While some of these species (notably cultivated herbs) may now be extinct, others such as fruit trees probably survive in small numbers, and grasses may have been overlooked in the current survey. Eighteen species recorded by previous authors may survive on North Island (13 of these introduced species), bringing the total species list to 206.

Vegetation

The extents of major vegetation types on North Island are shown in Table 3 and Figure 2. The plateaux are dominated by former coconut plantations, with a dense shrub layer of *Lantana camara* and *Psidium gujava.* The plateau also has areas of native woodland (mainly takamaka *Calophyllum inophyllum* and *Terminalia catappa*), mixed woodland (rich in fruit trees) and marshland vegetation. The hills are generally dominated by mixed coconut woodland and scrub with large areas of open rock.

In total, 40 vegetation plots were completed, 20 in August and 20 in January-February. In total, these covered 4,000 m^2 or 0.2% of the island's surface. Twenty vegetation plots were in plateau broad-leaf woodland (excluding areas identified on the map as coconut), covering 2,000 m^2 or 0.8% of this habitat type. Twenty vegetation plots were in hill woodland/scrub (excluding areas identified on the map as bare rock), covering 2,000 m^2 or 0.2% of this habitat type. A summary of results is shown in Table 4.

Table 3. Extent of major vegetation types, North Island.

	Vegetation type	Approx. area (ha)
Hill	Woodland (predominantly native)	4
(>10 m asl)	Woodland (predominantly introduced)	86
	Coconut with regeneration	2
	Scrub (mixed)	12
	Scrub (introduced)	9
	Bare rock	22
Plateau	Woodland (predominantly native)	12
(<10 m asl)	Woodland (predominantly introduced)	12
	Coconut with regeneration	28
	Scrub (introduced)	2
	Beach crest vegetation	< 1
	Freshwater marsh	1
	Grassland/garden	3
	Bare rock	9

Table 4. Vegetation plot summary.

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)
Plateau woodland	20	<5	785	31.2	33.5	60.8	1.8	0.3
Hill woodland	20	54.6	445	25.9	52.4	18.3	29.7	0.4

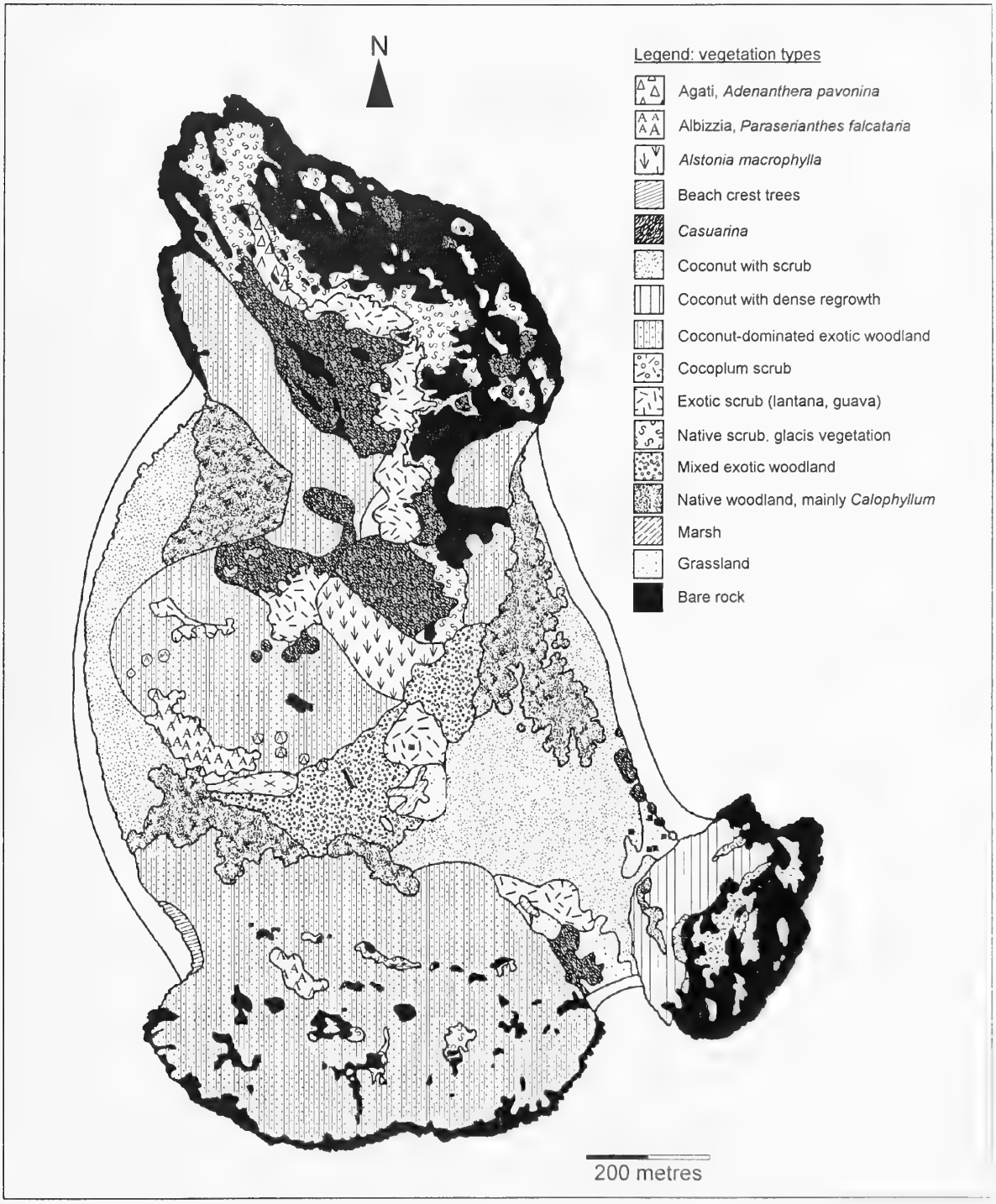

Figure 2. North Island vegetation.

Plateau woodland plots had a relatively high density of trees and sparse shrub and herb layers. The tree layer was dominated by native trees: 92.4% of individual trees were native. The most abundant species was takamaka *Calophyllum inophyllum* (124 trees, 78.5%). The second most abundant species was *Cocos nucifera* (18 trees, 11.4%) indicating that plateau woodland is expanding into areas of former coconut plantation.

The most widespread species of the shrub layer were *Cocos* (in 17 of 20 plots with mean cover of 6% in plots where it occurred), *Calophyllum* (in 15 of 20 plots with mean cover of 19% in plots where it occurred), and *Psidium guajava* (in nine plots, mean cover 19%).

The herb layer of plateau woodland was relatively species-rich containing a total of 45 species in 2,000 m^2. The most widespread species was *Cocos,* which occurred in 16 of 20 plots. However, *Cocos* was not the major component of the herb layer in terms of percentage cover; the mean percentage cover per plot was 4%. *Calophyllum* occurred in 12 plots with a mean cover of 4%. The native fern *Nephrolepis biserrata* occurred in the herb layer of 12 plots with an average of 24% plot cover where it occurred.

The 20 plots carried out in hill woodland and scrub were much more open than those on the plateau with a lower number of trees and shrubs but with a dense herb layer. The tree layer was more mixed than the takamaka-dominated plateau woodlands; a total of 12 tree species were recorded (as opposed to eight on the plateau) but had many more introduced trees; 48.3% of individual trees belonged to introduced species. The most abundant plant in the tree layer was *Cocos* (35 trees, 39.3% of all trees). *Casuarina* was also abundant (16 trees, 18.0% of all trees). *Cocos* was also the most widespread species in the shrub layer occurring in 17 of 20 plots with a mean coverage (in plots where it occurred) of 19%. The herb layer was dominated by *Nephrolepis biserrata,* which occurred in all plots with a mean coverage of 39%. *Cocos* occurred in 12 plots with mean cover of 10%.

Although plateau woodland contains some introduced fruit tree species, it is dominated by native trees and shows signs of natural expansion into areas of coconut plantation. Unfortunately, a large number of takamaka trees have been affected by the takamaka wilt disease, probably caused by the fungus *Leptographium* (Verticillium) *calophylli* (Ivory *et al.,* 1996; Wainhouse, 1998). This disease was not recorded in 1997 (Shah and Parr, 1997). In May 1999, a few infected trees were noticed in the vicinity of the marsh. In August, a larger number of trees with symptoms of the disease were observed on the western plateau, around the marsh and in takamaka woodland to the west of the cemetery. In January 2000, the area of infection on the eastern plateau had noticeably spread and was visible from Congoment peak. A total of 126 trees showing 50% or greater loss of foliage were counted on the eastern plateau with at least two affected trees located on the western plateau. Some trees showed signs of regrowth but many appeared dead. In some patches of dead takamaka, the growth of saplings was affected by cattle grazing but in some places a range of saplings were present including *Alstonia, Chrysobalanus, Calophyllum*, *Terminalia* and fruit trees. The worst-affected forest areas were inland, with few beach-crest trees suffering symptoms. Takamaka wilt disease probably spread to North Island from Silhouette.

Most of the hill has *Cocos*-woodland dominated by palms and introduced species occurring at low densities. On the northern hills, some of the older palms show signs of

blackening that probably occurred in the 1972 fire, showing that some trees survived this event.

INVERTEBRATES

Pitfall Trapping

The pitfall trap assemblages were large compared to those of other islands (Table 5). Generally, pitfall assemblages were larger in plateau woodland than hill woodland or scrub and higher in the northwest monsoon season. The composition of assemblages also differed between the plateau and hill woodland (Fig. 3).

Table 5. Pitfall assemblages from North Island: only invertebrates >2 mm included. (numbers in parentheses = excluding ants.

	Habitat	Mean no. individuals per five traps	
		SE season	NW season
North	Plateau woodland	93.5 (16.2)	113.3 (20.9)
	Hill woodland/scrub	44.6 (4.7)	68.5 (14.6)
All granitic islands		61.8 (9.4)	61.1 (16.0)

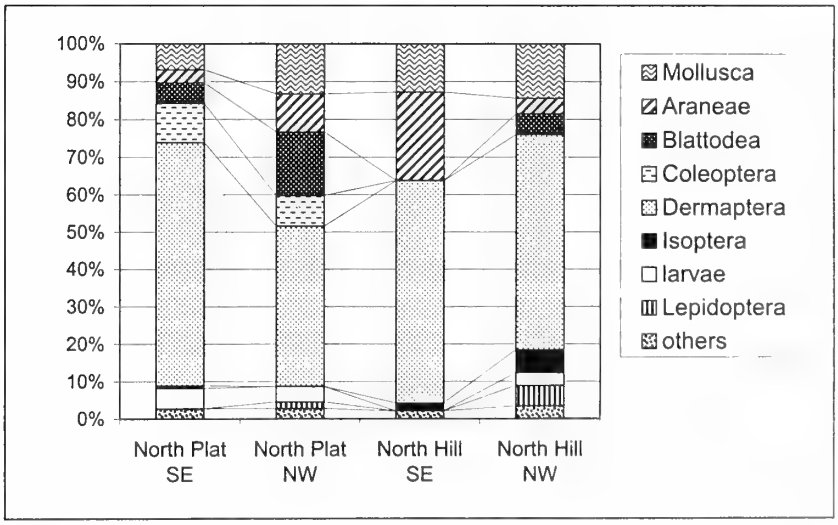

Figure 3. Composition of pitfall assemblages on North Island (including allinvertebrates over 2 mm body length, except ants).
"Others" group includes Diptera, Hemiptera, Myriapoda, and wasps (Hymenoptera, exc. ants).

Plateau woodland sites were dominated by ants which made up 72% of pitfall assemblages. The most abundant species was the native *Technomyrmex albipes* (35% of individuals) followed by *Odontomachus troglodytes*, which formed 31% of all individuals. Assemblages excluding ants were dominated by Dermaptera (earwigs) which made up 43% of plateau assemblages in the northwest monsoon season and 65% in the

southeast season. Blattodea (cockroaches) were also abundant on the plateau, forming up to 17% of the assemblage (in the northwest season).

Hill sites were also dominated by earwigs, which formed 58-60% of the assemblage. Araneae (spiders) made up a larger part of the hill assemblage but cockroaches were less important.

The crazy ant *Anoplolepis gracilipes* was not collected in pitfall assemblages suggesting that this introduced pest species is not present on the island. Since its arrival in Seychelles in the early 1960s (Haines *et al.*, 1994), this ant has been introduced to many islands including Marianne and Félicité. On Bird Island especially high concentrations of ants have caused tree death (Hill, in prep.) and the eradication of native reptiles from large parts of the island (Feare, 1999). If North Island is free of crazy ants as these data suggest, it is important that efforts are made to prevent invasion.

Leaf-insect Counts

Leaf-insect counts were carried out for 13 tree and shrub species, seven of these in both seasons (Table 6). Six of the trees surveyed in both seasons had higher leaf counts in the August survey; only one had higher counts in the north west monsoon (Jan-Feb). As found on some other islands, the highest counts were for the shrub *Morinda citrifolia* (status uncertain-possibly introduced; Friedmann, 1994). *Morinda* is uncommon on North Island. Some introduced fruit tree species show exceptionally high counts, particularly in the dry season (August). High counts for *Annona muricata* are due to large numbers of soft bugs (Hemiptera; Sternorrhyncha) attended by ants.

Table 6. Density of invertebrates on foliage, North Island.
n = no. of leaves counted; NI = number of individual invertebrates.

Species	SE season (August)			NW season (Jan-Feb)		
	n	mean NI leaf^{-1}	mean NI m^{-2}	n	mean NI leaf^{-1}	mean NI m^{-2}
Introduced species						
Alstonia macrophylla	100	4.95	385.33	150	5.85	444.95
Anacardium occidentale	300	1.12	167.51	350	0.66	84.44
Annona muricata	300	4.00	1024.79	800	1.90	452.52
Chrysobalanus icaco	50	0.20	42.11	0		
Ixora finlaysoni	50	0.10	18.94	0		
Mangifera indica	150	0.31	62.62	100	0.32	55.88
Psidium cattleianum	0			350	0.09	20.97
Psidium guajava	200	0.98	267.56	450	0.44	118.79
Tabebuia pallida	0			300	1.29	226.30
Native species						
Calophyllum inophyllum	650	1.45	188.95	1350	1.40	167.13
Ficus lutea	310	8.76	616.31	150	4.73	338.74
Terminalia catappa	150	3.62	58.43	0		
Status unknown						
Morinda citrifolia	150	65.75	5571.75	0		

Malaise Trapping

Malaise trapping was carried out in hill and plateau woodland habitats in both seasons. Four Malaise traps (two in each habitat) were run in August 1999 and four in January/February 2000. Assemblages were larger in August (mean number of individuals (NI) = 830) than in Jan/Feb (mean NI = 346), but there was no consistent pattern between habitats. In August catches were higher on the plateau, and in January on the hill.

Malaise trap assemblages included members of 12 invertebrate orders. In both seasons, the Diptera dominated assemblages (Diptera accounted for 80.3% of individuals in August, 66.7% in Jan/Feb). Other important orders included Lepidoptera (9.2% of assemblage in August, 8.0% in Jan/Feb) and Hymenoptera (5.9% of the assemblage in August, 16.5% in Jan/Feb).

Observation

A list of species observed or collected is given in Tables 7 and 8. Most invertebrates observed on North Island were of introduced or cosmopolitan species. In contrast to a previous recent list (Shah & Parr, 1997), no endemic species of butterfly (Lepidoptera, Rhopalocera) were recorded, suggesting that none are resident on the island. One lycaenid species, *Zizula hylax,* was present in extremely large numbers on plateau grassland/scrub habitats. This species, together with another of the lycaenids collected, *Leptotes pirithous* are recorded as using *Lantana camara* as a larval food plant (Davis & Barnes, 1991) although in Africa both take a wide range of plant species, especially members of the families Leguminosae (Fabaceae) (*L. pirithous*) and Acanthaceae (*Z. hylax*) (Larsen, 1996). On North Island, larvae of one lycaenid species (?*Zizula hylax*) were observed being attended by ants under fallen coconuts in short-cropped turf (including *Desmodium* and *Stenotaphrum*) at the settlement.

Dragonflies (Odonata) were common throughout the island, especially close to the wetland areas, on every visit. A total of eight species were observed (Table 7) most of which were captured and detailed colour notes made. There was evidence for breeding of at least four species. Wain *et al.* (1999) made a list of nine species for North Island (including *Rhyothemis semihyalina* and *Anax guttatus,* not recorded in the present survey). Larvae of two dragonfly species were collected in an underwater light trap in February. Other invertebrates observed in the marsh included water bugs (Hemiptera: ?Veliidae) and water boatmen (Hemiptera; Notonectidae).

Table 7. Invertebrates: Odonata.

		Evidence for breeding	Dates
Coenagrionidae	*Ceriagrion glabrum* (Burmeister, 1839)	Egg laying, August	August
	Ischnura senegalensis (Rambur, 1842)	-	January
Aeshnidae	*Hemianax ephippiger* (Burmeister, 1839)	-	August
Libellulidae	*Diplocodes trivialis* (Rambur, 1842)	Egg laying, January	August, January
	?Pantala flavescens (Fabricius, 1798)	-	January
	?Orthetrum stemmale wrightii (Selys, 1869)	-	August, January
	Tholymis tillarga (Fabricius, 1798)	Egg laying, January	August, January
	Tramea limbata (Selys, 1869)	Egg laying, January	August, January

Table 8. Invertebrates observed, excluding Odonata.

Order	Family	Species	Notes
Mollusca:			
Gastropoda	Subulinidae	*Lamellaxis ?javanicum* (Reeve)	In pitfall traps
		?Opeas sp.	In pitfall traps
		Subulina octona Bruguière, 1792	In pitfall traps
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	
	Ocypodidae	*Ocypode ceratophthalmus* (Pallas, 1772)	On beaches
		Ocypode cordimana Desmarest, 1825	
Arachnida:			
Scorpiones	Buthidae	*Isometrus maculatus* (de Geer, 1778)	
Araneae	Tetragnathidae	*Nephila inaurita* (Walckenaer, 1841)	
Myriapoda:			
Diplopoda	Trigoniulidae	*Spiromanes braueri* (Attems, 1900)	In pitfall traps
Chilopoda	Geophilidae	*?Mecistophalus* sp.	In pitfall traps
	Scolopendridae	*Scolopendra subspinipes* Leach, 1918	Observed eating skink
Insecta:			
Coleoptera	Scarabaeidae	*Oryctes monoceros* (Olivier, 1789)	
Diptera	Chironomidae	?	Larvae in marsh
Hemiptera	Cicadoidea	*?Antankaria* (Chremistica) *pulverulenta* (Distant, 1905)	Heard on E. plateau, Jan.
	Notonectidae	Water boatman	Observed in marsh, August
	?Veliidae	Water bug	Specimens collected, May
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)	
	Apidae	*Apis mellifera adansoni* Latreille 1804	
	Formicidae	*Camponotus hova* Forel, 1891	In pitfall traps
		Cardiocondyla emeryi Forel, 1881	In pitfall traps
		Monomorium ?fossulatum Emery, 1894	In pitfall traps
		Odontomachus troglodytes Santschi, 1914	In pitfall traps
		Plagiolepis ?alluaudi Emery, 1894	In pitfall traps
		Tapinoma melanocephalum (Fabricius, 1793)	In pitfall traps
		Technomyrmex albipes (F. Smith, 1861)	In pitfall traps
		Technomyrmex ?foreli Emery, 1893	In pitfall traps
		Tetramorium bicarinatum (Nylander, 1846)	In pitfall traps
	Vespidae	*Polistes olivaceus* (de Geer 1773)	
Lepidoptera	Lycaenidae	*Zizula hylax* Fabricius, 1775	Abundant, grassland
		Zizeeria knysna Trimen, 1862	Abundant, grassland
		Leptotes pirithous Linnaeus, 1767	Abundant, grassland
	Hesperiidae	*Borbo* sp.	Abundant, grassland

VERTEBRATES

Reptiles and Amphibians

Five terrestrial reptiles and one amphibian were observed (Table 9). At least three of these species are introduced on North Island. Since breeding seabirds occurred there in the recent past, it is likely that Wright's skink *Mabuya wrightii* also occurred on the island at least until alien mammals were established.

In addition to the land reptiles, two sea turtle species breed on the beaches of North Island: green sea turtle *Chelonia mydas* (L.) and hawksbill *Eretmochelys imbricata.* (L.). Tracks of the latter species were observed on the western beach in August. One of the native land tortoise species of the granitic Seychelles was recorded on North Island in 1609 and again in 1787, but the species had become extinct by 1875 (Bour, 1984). The Aldabra giant tortoise was introduced to the island in the twentieth century and a few large free-ranging individuals were present at the time of the survey. There was also evidence of successful breeding; two young tortoises (both with plastron length under 10 cm) were found.

Table 9. Reptiles and amphibians, North Island.
Status: E =endemic, I = introduced, N = native (in central Seychelles).

Family	Species		Status
Amphibians			
Raniidae	*Ptychadaena mascareniensis* (Dumeril & Bibron, 1836)	Mascarene frog	?I
Reptiles			
Gekkonidae	*Gehyra mutilata* (Wiegmann, 1835)	Pacific house gecko	I
	Phelsuma sp. [*?P. longinsulae* (Rendahl, 1939)]	day gecko	E
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	Seychelles skink	E
Testudinidae	*Geochelone gigantea* (Schweigger, 1812)	Aldabra giant tortoise	I
Typhlopidae	*Ramphotyphlops braminus* (Daudin, 1803) Robb, 1966	Brahminy blind snake	I

Birds

In total, 17 land birds and waders were recorded (Table 10). Three endemic species were observed; two of these (Seychelles sunbird and kestrel) undoubtedly breed on the island but one (Seychelles swiftlet) was only recorded for a few days, and these birds were probably temporary visitors from Mahé (the species is absent from Silhouette; Rocamora and Skerrett, 2001). Two of the introduced bird species recorded, barn owl and common mynah, are potential nest predators of endemic birds. Barn owls were regularly observed on the island (by day and night), and 11 pellets were retrieved from one roost site. None of the pellets contained bird remains; all included rat bones and hair and three pellets had small pieces of cockroach (*Periplaneta* sp.) exoskeleton.

In addition to sight records, tape playback was used to give data on presence or absence of four species. In both August 1999 and January 2000, calls of black paradise flycatcher *Terpsiphone corvina*, Seychelles white-eye *Zosterops modestus*, Seychelles scops owl *Otus insularis* and barn owl *Tyto alba* were played. There was a positive response for only one of these species, the barn owl (two birds flew to a palm close to the tape when calls were played on the night of 31/1/00).

Table 10. Land birds and waders recorded, North Island.
M = migrant species; E = species endemic species.

Species		Notes
Butorides striatus	Green-backed heron	Common at marsh. One nest on Congoment May
Nycticorax nycticorax	Black-crowned night heron	One individual observed on eastern plateau, 10/5/99
Falco araea E	Seychelles kestrel	At least one pair, around Congoment (above settlement)
Gallus gallus	Domestic (feral) chicken	At least seven birds present (R. Slater-Jones, *pers. comm.*)
Gallinula chloropus	Common moorhen	Abundant at marsh (at least 30 individuals)
Dromas ardeola M	crab plover	One individual, 30/1/00 and 1/2/00
Pluvialis squatarola M	grey plover	One on E. beach 23/8/99. Two or more individuals, on beaches, January
Numenius phaeopus M	Whimbrel	One regularly at marsh and E. beach (August). Several, marsh and beaches (January)
Calidris alba M	Sanderling	One individual with other shore birds, Grande Anse, January
Arenaria interpres M	Ruddy turnstone	One, in marsh, 7/5/99. Several on beaches, January
Geopelia striata	Barred ground dove	Common on plateau
Streptopelia picturata picturata	Madagascar turtle dove	Very common on plateau, especially in plateau and low hill woodland
Tyto alba	barn owl	One individual seen on Bernica, pellets found in two locations (May). One individual in two locations by day (Bernica and Basin Jean), pellets collected (August). Heard regularly from settlement (January), two individuals responding to taped call 31/1/00, marsh.
Collocalia elaphra E	Seychelles swiftlet	Two individuals flying over settlement for several days in August.
Nectarinia dussumieri E	Seychelles sunbird	Rarely observed. One group of five seen on Bernica (May)
Acridotheres tristis	Common mynah	Common on plateau, especially in plateau coconut plantation
Foudia madagascariensis	Madagascar fody	Occurring throughout the island, particularly glacis. Three nests observed. Occasionally in large groups (12-15).

Table 11. Seabirds observed on North Island.

Species		Notes
Phaeton lepturus	white-tailed tropicbird	Several observed flying over the island, especially on the North and West sides of Grand Paloss.
Fregata sp.	(?great) frigatebird	Large group of frigatebirds (40 or more) observed in flight over Grand Paloss, January (KH).
Anous tenuirostris	lesser noddy	One dead individual on western plateau (?shot), May 99. Feeding flock of noddies (?common or lesser) observed off eastern beach August 99.
Gygis alba	fairy tern	One observed at sea off eastern coast, May 99: several observed in a feeding flock of noddies, off eastern beach August 99.

Although the presence of guano deposits on North Island suggests that colonies of seabirds occurred in the past, few seabird species were observed in the current survey (Table 11), and there was no evidence of breeding in any species.

Mammals

Mammals observed in the course of fieldwork were recorded (Table 12). In addition, rodent trapping was carried out in May and August 1999 and January 2000 (Table 13). On all occasions, only one species of rodent, the ship rat *Rattus rattus,* was trapped. Two traplines were established, one in coconut plantation on the eastern plateau (on DOS map of North Island, series DOS 104, edition 1-DOS 1976, grid ref. CL 0580 1428 – CL 0550 1425), and one in hill woodland (grid ref. CL 0513 1420 – CL 0495 1414). Trapping rates were highest in May, with very low rates in January/February. This observation fits the trend for rats to be more easily trapped in the dry season when water and food stress is more acute (Merton, 1999).

Rats have a considerable conservation impact as do several other species present on the island including cats (as predators of vertebrates) and cattle. The herd of feral cattle on North Island (numbering about 30 individuals) has a great impact upon plateau ecosystems, destroying beach-crest vegetation (especially *Scaevola*) and freshwater vegetation (through grazing on *Typha* when marsh water levels are low), and causing physical disturbance and eutrophication of the marsh. Overgrazing and selective grazing may have favoured the establishment of an understorey of *Lantana* over much plateau grassland and the animals are responsible for distributing guava *Psidium guajava* around the plateau. Cattle also appear to have inhibited succession in some areas including the marsh and woodland habitats where heavy grazing and disturbance by cattle must have restricted the regeneration of *Cocos*. These effects are not entirely detrimental; disturbance of the marsh has probably prevented successional change and browsing affects mainly introduced species. However, if habitat restoration were to be initiated, cattle would have to be removed. In this case, an increase in the number of land tortoises would help to maintain open water in the marsh.

Table 12. Mammals observed, North Island.

Species	Status
Bos taurus L.	20-30 individuals
Felis catus L.	several individuals observed around settlement, one individual caught in rat trap 1/2/00
Mus domesticus Rutty, 1772	not trapped on island, but a single individual found in grocery box prior to disembarkation to island May 2000
Pteropus seychellensis Milne Edwards 1887	common throughout the island
Sus domesticus Erxleben, 1777	at least one individual survived in 2000: not seen, but signs observed
Rattus rattus L.	abundant

Table 13. Results of rat trapping.

Dates	Trap-nights	No. of rats	Rats per 100 trap-nights (uncorrected)	Rats per 100 trap-nights (corrected)*
14/5 – 19/5/99	47	38	74.5	-
23/8 – 28/8/99	140	39	27.9	33.8
27/1 – 1/2/00	140	5	3.6	3.8

*Corrected to account for the effect of closed traps; Cunningham and Moors, 1996.

DISCUSSION

North Island has been radically changed by human activities. Repeated fire, the early introduction of rats (prior to permanent human settlement) and plantation agriculture together destroyed almost all natural vegetation and nesting seabird colonies. The endemic flora and fauna (which originally included giant tortoises) were largely eliminated by these factors with only a small number of native and endemic species surviving (some of these species, such as takamaka *Calophyllum inophyllum* and *Ochrosia oppositifolia* probably owe their present abundance or occurrence to deliberate planting). The remaining endemic flora of the island is equivalent to that of a far smaller island.

Although little remains of the original vegetation of the island, the Jemo series soils of the eastern plateau suggest that this area was formerly covered with *Pisonia grandis* forest and supported breeding colonies of seabird (Fosberg, 1954). Lower hill slopes would probably have included species such as takamaka *Calophyllum inophyllum, Mimusops sechellarum, Ficus lutea* and *Ficus reflexa.* Native scrub on upper slopes would have included a number of shrub species no longer found on the island.

At the time of the survey, the island was dominated by coconut and introduced trees and shrubs. The only areas of semi-natural vegetation were hill glacis vegetation and the plateau takamaka forests. Glacis vegetation had been heavily invaded by introduced species, and was poor in native taxa. The plateau takamaka forest was threatened by wilt disease and invasion by introduced tree species. Plateau takamaka forests probably offer the most suitable habitat on the island for Seychelles magpie-robin. Some introduced tree species support large numbers of invertebrates on their foliage (especially mealy bugs and scale insects) so they could be valuable for small insectivorous endemic birds such as the Seychelles white-eye. However, introduced plants tend to be invasive, displacing native plants and generally supporting introduced and pantropical invertebrates, rather than endemic invertebrate species.

CONSERVATION RECOMMENDATIONS

Despite its current condition, North Island has great potential for the conservation of endemic birds (and other taxa). Its large coastal plateau area and marsh system, if appropriately restored, would provide suitable conditions for a number of endangered endemic species including Seychelles' rarest land bird the magpie-robin and, with

appropriate habitat restoration, the Seychelles black paradise flycatcher, currently restricted to La Digue and Marianne.

Although, at the time of the survey described, the island was abandoned and uninhabited, it had been purchased for the development of a tourist resort and concurrent habitat restoration with the aim of introducing some endemic bird species. Development has now begun on the island. Major conservation actions that must be undertaken before such translocations can occur are outlined below:

1) Control of introduced animals

Ship rats, cats and barn owls must be removed before bird introductions can take place. Cattle should be removed, or controlled, before attempting vegetation rehabilitation.

2) Rehabilitation of coconut plantation

Former plantation areas on coastal plateaux should be cleared of invasive shrubs and coconut palms and succession to native-dominated forest encouraged.

3) Clearing invasive plant species

Hill woodland is of lesser conservation importance. However, as it is dominated by exotic species and coconut palms, it acts as a reservoir of seed for invasion of lowland forest. Exotic species growing on the hills should be removed and replaced with native species such as *Ficus* spp. The most invasive species (e.g. *Alstonia macrophylla*) should be targeted. *Clidemia hirta* (at the time of the survey, restricted to a few plants on the plateau) should be destroyed before it becomes established. Some alien fruit trees have high invertebrate counts on foliage: less invasive species could be left to provide a food source for endemic insectivorous birds.

4) Control of takamaka wilt

Takamaka wilt disease was already well established on North Island in 2000, and control would be difficult or impossible. However, affected trees should be removed to allow areas of forest which have been badly affected (e.g., on the east plateau) to be planted with other native species (probably *Terminalia catappa*).

5) Replanting

To encourage rapid succession to native forest (especially where takamaka wilt has taken hold) replanting should be considered. Some species should be reintroduced including *Pisonia grandis, Morinda citrifolia* and *Mimusops sechellarum*.

Beach crest vegetation (especially *Scaevola sericea*) should be replanted. Beach crests have been particularly badly grazed by cattle. Replanting will provide shelter for inland plantings and inhibit coastal erosion.

6) Animal reintroductions

The large ground invertebrate assemblages suggest that food supply would be adequate for Seychelles magpie-robin *Copsychus sechellarum*. Old plateau takamaka forest would have provided an ideal foraging habitat, due to its open structure. owever, this habitat is threatened by takamaka wilt disease. Replanting of the takamaka area

should use *Terminalia catappa* or other native species which support dense populations of invertebrates.

Leaf-invertebrate counts were also particularly high on North Island, including on introduced trees. Birds that feed by gleaning invertebrates from leaves, including Seychelles warbler *Acrocephalus sechellensis,* Seychelles white-eye *Zosterops modestus* and black paradise flycatcher *Terpsiphone corvina* could be introduced. Leaf-invertebrates were dominated by soft bugs (mainly mealy bugs) and ants but the Seychelles white-eye has been observed feeding on mealy bugs (Feare, 1975) and the warbler on ants (Bathe, 1982). These bird species would be particularly appropriate for reintroduction.

The Seychelles blue pigeon *Alectroenas pulcherrima* was not observed on the island; North Island was the only one of the granitic islands visited where this species appeared to be absent. Although not endangered, this endemic species could be introduced if native fruit trees and shrubs were planted (for example, *Canthium bibracteatum*).

Reptiles that should be considered for reintroduction include the Seychelles terrapins *Pelusios castanoides* or *P. subniger*, provided that sustained searches for the species demonstrate that it is absent. The North Island herd of *Geochelone gigantea* could be supplemented to fill the ecological role of cattle.

Appendix 1. Plant species recorded from North Island

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: Se = Settlement area (on buildings); PG = Plateau grassland; PW = Plateau woodland; HW = Hill Woodland; Gl = Glacis; BC = Beach Crest; Ma = Marsh.
Prior records (in notes): 1 = in Robertson, 1989; 2 = Shah and Parr, 1997.

	Species	Status	Abund.	Habitats	Notes
PTERIDOPHYTA					
Adiantaceae					
1	*Acrostichum aureum* L.	N	O	BC, Gl	
2	*Pellaea ?doniana* Hooker	N	O	HW, Gl	
3	*Pteris tripartita* Sw.	?	O	PW	
4	*Pteris vittata* L.	I	R	Se	
Aspleniaceae					
5	*Asplenium* sp. (cf. *A. pellucidum* Lam.)	N	O	HW	
6	*Pityrogramma calomelanos* (L.) Link.	N	C	HW	
Davalliaceae					
7	*Davallia denticulata* (Burm.) Mett.	N	R	HW	
8	*Nephrolepis biserrata* (Sw.) Schott	N	A	HW, PW, Gl, [PG]	
Parkeriaceae					
9	*Ceratopteris cornuta* (Pal.) Lepr.	N	F	Ma	
Polypodiaceae					
10	*Phymatosorus scolopendria* (Burm. f.)	N	A	HW, PW	
Psilotaceae					
11	*Psilotum nudum* Sw.	N	F	HW, PW	
Thelypteridaceae					
12	*?Thelypteris* sp.	?N	R	PW	
GYMNOSPERMAE					
13	*Cycas thuarsii* Gaud.	I	R	PG	
ANGIOSPERMAE: Dicotyledons					
Acanthaceae					
14	*Asystasia* sp. B (*sensu* Friedmann)	?I	A	Gl	
	Asystasia gangetica (L.) T. Anders.	?	-	-	Prior record[1]; = *A.* sp. B[2]
15	*Justicia gendarussa* Burm. f.	?I	R	PW	
Aizoaceae					
16	*Glinus oppositifolius* (L.) A. DC.	?N	A	Ma	
Amaranthaceae					
17	*Achyranthes aspera* (L.) DC.	I	O	HW	
	Amaranthus dubius Thell.	I	-	-	Prior record
18	*Alternanthera sessilis* L. DC.	I	C	Ma	
19	*Amaranthus viridis* L.	I	O	Ma	

	Species	Status	Abund.	Habitats	Notes
Anacardiaceae					
20	*Anacardium occidentale* L.	I	A	HW	
21	*Mangifera indica* L.	I	F	PW, [HW]	
22	*Spondias cytherea* Sonn.	I	O	PW	
Annonaceae					
	Annona cherimola Mill.	I	-	-	Prior record[1]
23	*Annona muricata* L.	I	A	PW	
24	*Annona reticulata* L.	I	F	PW	
25	*Annona squamosa* L.	I	O	PW	
Apocynaceae					
26	*Alstonia macrophylla* Wall ex G. Don.	I	A	HW	
27	*Catharanthus roseus* (L.) G. Don.	I	C	PG, Gl [HW]	
28	*Nerium oleander* L.	I	O	PG	
29	*Ochrosia oppositifolia* (L.) K. Schum.	N	F	PW, Gl	
30	*Plumeria rubra* L.	I	C	HW	
31	*Tabernaemontana coffeoides* Boj. ex A. DC.	N	C	Gl	
Asclepiadaceae					
32	*Sarcostemma viminale* (L.) Alton	N	F	Gl	
Bignoniaceae					
33	*Tabebuia pallida* (Lindl.) Miers.	I	A	PW, HW	
Boraginaceae					
34	*Cordia subcordata* Lam.	N	O	BC	
35	*Heliotropium indicum* L.	I	A	PG, PW, Ma	
Cactaceae					
36	*?Hylocereus undatus* (Haw.) Britt. & Rose	I	O	HW	
37	*Rhipsalis baccifera* (J. Mill.) Stearn.	N	R	Gl	
Caesalpiniaceae					
38	*Caesalpinia bonduc* (L.) Roxb.	N	O	PW, HW	
39	*Delonix regia* (Hook.) Raf.	I	O	PG	
40	*Peltophorum pterocarpum* (DC.) Hayne	I	O	PW	
41	*Senna occidentalis* (L.) Link	I	C	PG, Ma	
42	*Tamarindus indica* L.	I	F	PG, PW, HW	
Capparidaceae					
43	*Cleome viscosa* L.	I	O	PG, Gl	
Caricaceae					
44	*Carica papaya* L.	I	R	PG	
Caryophyllaceae					
45	*Drymaria cordata* (L.) Roem. & Schult.	I	O	PW	
Casuarinaceae					
46	*Casuarina equisetifolia* J. R. & G. Foster	I	A	BC, HW	
Chrysobalanaceae					
47	*Chrysobalanus icaco* L.	I	A	HW, Gl	
Combretaceae					
48	*Terminalia catappa* L.	?N	C	PW, HW [BC]	
Compositae					
49	*Ageratum conyzoides* L.	I	O	PG, Ma	
50	*Emilia sonchifolia* (L.) Wight	I	F	Gl, PG	
51	*Melanthera biflora* (L.) Wild	?N	R	PG	
52	*Synedrella nodiflora* (L.) Gaertn.	I	C	PG, [Ma]	
53	*Tridax procumbens* L.	I	C	PG	

	Species	Status	Abund.	Habitats	Notes
54	*Vernonia cinerea* (L.) Less.	I	A	PG	
Convulvulaceae					
55	*Ipomoea aquatica* Forssk.	I	O	Ma	
56	*Ipomoea mauritiana* Jacq.	?I	F	PG, PW, HW	
57	*Ipomoea pes-caprae* (L.) R. Br.	N	C	BC, Gl	
Crassulaceae					
58	*Kalanchoe pinnata* (Lam.) Pers.	I	F	PG, HW	
Cucurbitaceae					
59	*Momordica charantia* L.	I	R	PG	
60	*Trichosanthes cucumerina* L.	I	R	PG	
Ebenaceae					
61	*Diospyros philippensis* (Desr.) Gürke	I	R	HW	
Euphorbiaceae					
62	*Acalypha indica* L.	I	F	PG	
63	*Euphorbia hirta* L.	I	A	PG	
64	*Euphorbia ?hypericifolia* L.	?I	R	PG	
65	*Euphorbia thymifolia* L.	I	A	PG	
66	*Euphorbia tirucalli* L	I	O	PG	
67	*Jatropha curcas* L.	I	F	PG, PW	
	Manihot esculenta Crantz	I	-	-	Prior record[2]; now extinct?
68	*Phyllanthus amarus* Schumach. & Thonn.	I	F	PG, PW, HW	
69	*Phyllanthus pervilleanus* (Baillon) Müll. Arg.	N	C	HW, Gl	
70	*Phyllanthus urinaria* L.	I	F	PG	
Goodeniaceae					
71	*Scaevola sericea* Vahl.	N	F	BC	
Guttiferae					
72	*Calophyllum inophyllum* L.	N	A	PW, HW [BC]	
Hernandiaceae					
73	*Hernandia nymphaeifolia* (Presl) Kubitzki	N	O	PG	
Labiatae					
	Leonotis nepetifolia (L.) R. Br.	I	-	-	Prior record[1]; now extinct?
74	*Leucas lavendulifolia* J. E. Sm.	I	F	PG, Gl	
75	*Ocimum basilicum* L.	I	R	Ma	
	Ocimum gratissimum L.	I	-	-	
76	*Plectranthus amboinicus* (Lour.) Spreng.	?I	O	HW, PG	
Lauraceae					
	Cinnamomum verum Presl.	I	-	-	Prior record[2]; if still present, very rare
77	*Persea americana* Mill.	I	R	PW	
Lecythidaceae					
78	*Barringtonia asiatica* (L.) Kurtz	N	O	BC	
Malvaceae					
79	*Abutilon indicum* (L.) Sweet	?I	R	PG	
80	*Hibiscus tiliaceus* L.	N	O	HW, Gl	
81	*Sida acuta* Burm. f.	I	A	PG, PW	
82	*Sida pusilla* Cav.	?N	F	PG, BC	
83	*Sida rhombifolia* L.	?I	C	PG	
	Sida stipulata Cav.	I	-	-	Prior record[1]

	Species	Status	Abund.	Habitats	Notes
84	*Urena lobata* L.	?I	O	PW	
Melastomataceae					
85	*Clidemia hirta* (L.) D. Don.	I	O	HW	
Meliaceae					
	Sandoricum koetjape (Burm. f.) Merrill	I	-	-	Prior record[1]
86	*Xylocarpus moluccensis* (Lam.) Roem.	N	O	BC	
Mimosaceae					
87	*Adenanthera pavonina* L.	I	C	HW	
88	*Albizia lebbeck* (L.) Benth.	I	F	HW	
89	*Paraserianthes falcataria* (L.) Niels.	I	C	HW	
Moraceae					
90	*Artocarpus altilis* (Parkins.) Fosb.	I	F	PW	
	Artocarpus heterophyllus Lam.	I	-	-	Prior records[1,2]
91	*Ficus lutea* Vahl.	N	C	HW	
92	*Ficus reflexa* Thunb. ssp. *seychellensis* (Baker) Berg	E (ss)	O	HW	
93	*Ficus rubra* Vahl.	N	O	HW	
Myrtaceae					
94	*Eugenia uniflora* L.	I	C	PW, Gl	
95	*Psidium cattleianum* Sabine	I	C	PW, HW	
96	*Psidium guajava* L.	I	A	PG	
97	*Syzygium malaccense* (L.) Merr. & Perry	I	F	PW	
Nyctaginaceae					
98	*Boerhavia repens* L.	?N	C	PG	
Onagraceae					
99	*Ludwigia erecta* (L.) Hara	I	F	Ma, Gl	
100	*Ludwigia octovalvis* (Jacquin) Raven	?I	A	Ma	
Oxalidaceae					
101	*Averrhoa bilimbi* L.	I	C	PW, HW	
Papilionaceae					
102	*Abrus precatorius* L.	?N	C	PG, PW	
103	*Canavalia cathartica* Thouars	N	F	HW, BC	
104	*Crotalaria retusa* L.	I	O	Gl	
105	*Desmodium incanum* DC.	I	A	PG	
106	*Desmodium triflorum* (L.) DC.	I	A	PG	
	Indigofera suffruticosa Mill.	I	-	-	Prior record[1]
107	*Teramnus labialis* (L.) Spreng.	I	C	PG	
Passifloraceae					
108	*Passiflora foetida* L.	I	F	PG [HW]	
109	*Passiflora suberosa* L.	I	C	HW, PG	
Polygonaceae					
110	*Antigonon leptopus* Hook. et Arn.	I	R	HW	
111	*Polygonum senegalense* Meisn.	?N	O	Ma	
Portulacaceae					
112	*Portulaca oleracea* L.	?N	F	Ma	
Rhamnaceae					
113	*Colubrina asiatica* (L.) Brogn.	N	O	PG, PW	
Rubiaceae					
114	*Coffea canephora* Froehner	I	O	PW	
115	*Guettarda speciosa* L.	N	F	BC	
116	*Hedyotis goreensis* DC.	?I	O	Ma	
117	*Ixora finlaysoniana* G. Don.	I	C	PW	
118	*Morinda citrifolia* L.	?I	C	Gl, HW	

	Species	Status	Abund.	Habitats	Notes
	Pentodon pentandrus (Schumach. & Thonn.)	I	-	-	Prior record[1]
119	*Vangueria madagascariensis* J. F. Gmel	I	C	PW, HW	
Rutaceae					
120	*Citrus aurantifolia* (Christ.) Swing.	I	O	PG, PW	
121	*Citrus aurantium* L.	I	O	PG	
122	*Citrus limon* (L.) Burm.	I	O	PG	
123	*Citrus medica* L.	I	O	PG, PW	
	Citrus paradisi Macfad.	I	-	-	Prior record[1]
124	*Citrus reticulata* Blanco	I	R	PG	
	Citrus sinensis (L.) Osbeck	I	-	-	Prior record[1]
125	*Murraya koenigii* (L.) Spreng.	I	R	PG	
Sapindaceae					
	Cardiospermum halicacabum L.	?N	-	-	Prior record[1]
Scrophulariaceae					
126	*Striga asiatica* (L.) O. Kuntze	?I	O	PG	
Solanaceae					
127	*Datura metel* L	I	F	PG	
128	*Physalis angulata* L.	I	R	PW	
129	*Solanum americanum* Mill.	I	R	PG	
130	*Solanum lycopersicum* L.	I	R	PG	
Sterculiaceae					
131	*Heritiera littoralis* Ait.	N	O	PG	
Tiliaceae					
132	*Triumphetta rhomboidea* Jacq.	I	F	Gl	
Turneraceae					
133	*Turnera angustifolia* Miller	I	C	PG, PW, HW	
Umbelliferae					
134	*Centella asiatica* (L.) Urb.	?I	A	PG	
Verbenaceae					
135	*Lantana camara* L.	I	A	PG, Gl	
136	*Phyla nodiflora* (L.) Greene	I	A	Ma. PG	
137	*Stachytarpheta jamaicensis* (L.) Vahl.	I	F	PG	
138	*Stachytarpheta urticifolia* (Salisb.) Sims.	I	A	PW, HW	
ANGIOSPERMAE: Monotyledons					
Agavaceae					
139	*Furcraea foetida* (L.) Haw	I	F	PW, Gl	
Amaryllidaceae					
140	*?Crinum* sp.	?I	R	PG	
141	*Zephyranthes rosea* Lindl.	I	O	PG	
Araceae					
142	*Alocasia macrorrhiza* (L.) G. Don.	I	F	PW	
143	*Epipremnum pinnatum* (L.) Engl. Cv. Aureum	I	O	PW	
Bromeliaceae					
144	*Ananas comosus* (L.) Merr.	I	O	Gl	
Commelinaceae					
145	*Commelina benghalensis* L.	?I	C	Ma	
	Commelina diffusa Burm. f.	?I	-	-	Prior record
Cyperaceae					
146	*Cyperus alopecuroides* Rottb.	?	O	Ma	
147	*Cyperus articulatus* L.	N	O	Ma	
148	*Cyperus compressus* L.	?	O	Gl	
149	*Cyperus rotundus* L.	?	A	PG	

	Species	Status	Abund.	Habitats	Notes
150	*Fimbristylis complanata* (Retz.) Link	?	C	Gl	
151	*Fimbristylis cymosa* R. Br.	?	A	PG	
152	*Fimbristylis* sp. (glacis sedge)	?	O	Gl	
153	*Kyllinga alba* Nees	?	F	PW	
154	*Kyllinga monocephala* Rottb.	?	C	Ma, PW	
155	*Kyllinga polyphylla* Willd. Ex Kunth	N	F	PG, Ma	
156	*Mariscus dubius* (Rottb.) Fischer	N	A	PG, Gl	
157	*Pycreus polystachyos* (Rottb.) P. Beauv.	?	C	Ma	
Gramineae					
	Axonopus compressus (L.) P. Beuv.	?	-	-	Prior record[1]
158	*Bambusa vulgaris* Scrad. Ex Wendl.	I	R	PG	
	B. vulgaris var. *aureo-variegata*	I	R	PG	
159	*?Brachiaria* sp.	?	O	PW	
160	*Chloris barbata* (L.) Sw.	?	C	PG	
161	*Chrysopogon aciculatus* (Retz.) Trin.	?	F	PG	
162	*Dactyloctenium ctenoides* (Steud.) Bosser	?	A	PG	
163	*Digitaria ?didactyla* Willd.	N	O	PG	
	Digitaria radicosa (Presl.) Miq.	?	-	-	Prior record[1]
164	*Digitaria* sp.	?	F	PG	
165	*Echinochloa colonum* (L.) Link	?	C	PG, Ma	
166	*Eleusine indica* (L.) Gaertn.	?	A	PG	
167	*Eragrostis tenella* (L.) P. Beuv.	?	F	PG	
	Eragrostis tenella var. *insularis* Hubb.	?	C	PG	
168	*Lepturus radicans* (Steud.) Camus	?	F	PG	
169	*Oplismenus compositus* (L.) P. Beuv.	N	A	PW, HW	
170	*Panicum brevifolium* L.	N	A	HW, Gl	
171	*Paspalidium geminatum* (Forsk.) Stapf.	N	F	Ma	
172	*Paspalum conjugatum* Berg	N	O	PG	
173	*Paspalum scrobiculatum* L.	?	O	PG	
174	*Pennisetum polystachyon* (L.) Schult.	?	C	Gl	
175	*Rhynchelytrum repens* (Willd.) C. E. Hubb.	?	C	Gl	
	Saccharum officinarum L	I	-	-	Prior record[1]; now extinct?
	Setaria barbata (Lam.) Kunth.	?	-	-	Prior record[1]
176	*Sporobolus virginicus* (L.) Kunth.	N	F	BC, Gl	
177	*Stenotaphrum dimidiatum* (L.) Brogn.	N	A	PG	
	Urochloa paspaloides Presl.	?	-	-	Prior record[1]
Lemnaceae					
178	*Lemna* sp.	?	F	Ma	
Liliaceae					
	Dracaena reflexa Lam.	N	-	-	Prior record[1]
179	*Gloriosa superba* L.	I	O	PG, HW	
Marantaceae					
	Maranta arundinacea L.	I	-	-	Prior record[1]
Musaceae					
	Musa sp.	I	-	-	Prior records[1,2]; now extinct?
Najadaceae					
180	*Najas ?australis* Bory ex Rendle	?	C	Ma	
Orchidaceae					
181	*Vanilla planifolia* Andrews	I	F	HW	
Palmae					
182	*Cocos nucifera* L.	N	A	PG, PW, HW, Gl	

	Species	Status	Abund.	Habitats	Notes
183	*Latania lontaroides* Gaertn.	I	F	PG	
184	*Phoenix* sp. (*?P. dactylifera* L.)	I	R	PG	
Pandanaceae					
185	*Pandanus balfourii* Mart.	E	F	Gl, HW	
186	*Pandanus utilis*	I	R	PG	
Typhaceae					
187	*Typha javanica* Schnitz. ex Zoll.	N	A	Ma	
Zingiberaceae					
188	*?Zingiber zerumbet*	I	O	PW	

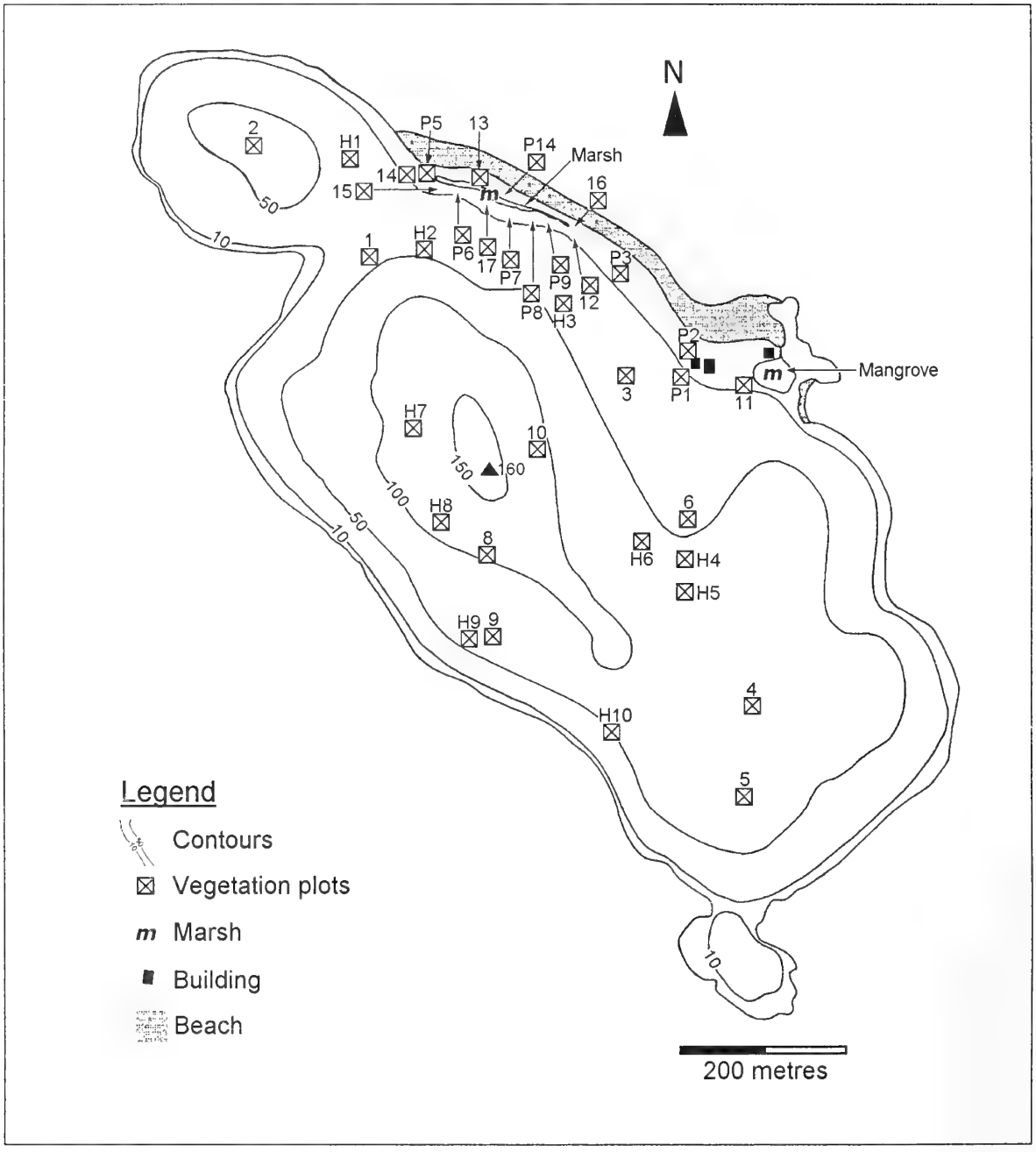

Figure 1. Thérèse Island: physical, showing site of vegetation plots.

THÉRÈSE

BY

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GEOLOGY, TOPOGRAPHY AND CLIMATE

Thérèse has an area of 73.9 ha. It is situated 700 m from the east coast of Mahé, the largest of the granitic Seychelles islands. At its highest point (Thérèse Peak) it reaches 160 m above sea level. The island is dominated by sloping ground. There are two main hills: Thérèse Peak and a lower hill to the north (60 m). The south west has a raised, level area of open rock (glacis) at 50-70 m above sea level. The north east shore of the island has a sandy beach backed by a narrow coastal plain (plateau). Most of the land is sloping ground between 10 and 100 m above sea level (Table 1).

Table 1. Area of Thérèse by altitude (calculated from maps published by Directorate of Overseas Survey(UK)/Seychelles Government).

Altitude range (m. asl.)	Area (ha)	Percentage total area
>150	0.1	0.1
100 - 150	0.8	1.1
50 - 100	36.7	49.7
10 - 50	26.1	35.3
0 - 10	10.2	13.8

Geologically, the island is similar to the nearby west coast of Mahé. The hills are made up of porphyritic granite (Braithwaite, 1984) while the coastal plateau is made up of recent calcareous deposits mixed with weathering products of the granite and overlain (in places) with marsh deposits. The soils of Thérèse are mainly red earths, strongly eroded on steeper slopes. On the open glacis areas, soils are restricted to pockets.

Standing water on the island is limited. The coastal plateau has a narrow marsh (dimensions approximately 90 metres by 10 metres wide) running parallel to the coast and separated from the sea by a raised sandy berm. Water in this marsh is saline and the water level varies with tides, although the marsh is superficially not open to the sea. A small mangrove pool (see Fig. 1) is open to the sea. Behind this pool, a small fresh-water stream drains the hill and glacis, widening to form rocky freshwater pools at the base of the hill. While stream flow appeared seasonal, water was present in both September and February, and flowing or standing water is probably present here for much of the year.

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The Seychelles islands experience a seasonal humid tropical climate (Walsh, 1984). While no weather data exist for Thérèse, it could be predicted that the climate of the island follows a similar pattern to that of nearby Mahé. Port Glaud, on the west coast of Mahé opposite Thérèse, has lower annual rainfall than Beau Vallon to the north or Victoria to the east (Walsh, 1984). Although it is in the generally wetter northern part of Mahé, it is sheltered from the prevailing winds (in particular the north west wind of the rainy season) by hills.

HISTORY

In 1787, relatively soon after the first permanent human settlement of the Seychelles, Malavois recorded that landing was possible on Thérèse throughout the year and that the island had fresh water all year round. Land tortoises, which had been recorded in 1776 (Bour, 1984) were absent at that time (although still present on the nearby, less accessible Conception Island) and green sea turtles did not breed there, although hawksbill turtles were reported to visit the island (in Fauvel, 1909). The relative accessibility of the island from Mahé made exploitation of the island possible, but the small plateau was not suitable for agriculture on any scale. There are no records of the earliest settlement of Thérèse but coconut plantations were probably begun in the nineteenth or early twentieth century when a range of other species including cinnamon and vanilla were probably introduced.

Today, the island has no permanent human population and is managed as a resort with day-trippers visiting from Mahé. There are restaurant and water sports facilities. Few distinct paths exist and most tourists stay on the beach or the small coastal plateau.

FLORA AND VEGETATION

Flora

In total, 183 plant species were recorded on Thérèse, including eight ferns and 175 angiosperms (Appendix 1). Of the angiosperms, 94 (53.7%) species are regarded as introduced (Friedmann, 1994) and 65 (37.1%) native. Of the native taxa, 17 species or subspecies are endemic to the Seychelles (9.7% of the angiosperm flora).

The proportions of the total flora made up of introduced and endemic species were similar to those for the Seychelles as a whole (of the total Seychelles flora, around 54% are introduced and 9% endemic; Procter, 1984). Compared to the flora of other small islands, Thérèse is relatively rich in endemic species. This high endemicity is due to the proximity of the island to Mahé, where almost all the endemic plant species of Seychelles are represented. The steep slopes of the island and presence of open glacis and scrub on soils of little agricultural value may also have contributed to the survival of a number of endemic plants here.

Few previous botanical surveys have been carried out on the island and Robertson (1989) lists just three species for Thérèse: *Erythroxylum sechellarum* (as *E. longifolium*), *Intsia bijuga,* and *Cocos nucifera.* All were recorded in the current survey.

Of the introduced plants established on Thérèse, 17 are invasive weedy species. Several of the woody weeds which are most invasive on the smaller islands of Seychelles were present, including cocoplum *Chrysobalanus icaco* and cinnamon *Cinnamomum verum* (both abundant). *Alstonia macrophylla* was also well established in open hill woodland along with casuarina *Casuarina equisetifolia* and cashew *Anacardium occidentale.* Coconuts *Cocos nucifera* were common, especially on the plateau and lower hills. Albizzia *Paraserianthes falcataria* was represented by a few old trees on the plateau but there was strong regeneration present. One tree species which was abundant (mainly on the plateau), *Trema orientalis,* was regarded as an invasive introduced species by Carlström (1996a) but as a native species by Friedmann (1994).

At least 31 species of introduced plants (17.7% of the angiosperm flora) recorded on Thérèse were restricted to the gardens around the restaurant and were not found away from cultivation. Most are recent introductions on Thérèse and would probably become extinct were cultivation to cease.

Vegetation

The extent of major vegetation types on Thérèse is shown in Table 2 and Figure 2. The vegetation of Thérèse is varied with some habitats, such as mangrove, glacis, and native scrub, dominated by native plants.

Table 2. Extent of major vegetation types, Thérèse Island.

	Vegetation type	Approx. area (ha)
Hill	Woodland (predominantly introduced)	10
(>10 m asl)	Native palm forest	2
	Coconut with regeneration	6
	Scrub (native)	20
	Scrub (mixed)	18
	Scrub (introduced)	1
	Bare rock	5
Plateau	Woodland (predominantly introduced)	2
(<10 m asl)	Coconut plantation	1
	Coconut with regeneration	1
	Scrub (native)	< 1
	Mangrove	< 1
	Brackish marsh	< 1
	Beach crest vegetation	1
	Grassland/garden	< 1
	Bare rock	4

The vegetation survey concentrated on areas of greatest value for endemic bird conservation: woodland and scrub. Twenty plots were carried out in hill woodland/scrub/coconut with a combined area of 2,000 m^2 (approximately 0.3% of the total area of hill habitats excluding bare rock) and 17 in plateau woodland scrub beach

crest covering 1,700 m^2 or 4.3% of the total area of the habitat. A summary of results is shown in Table 3.

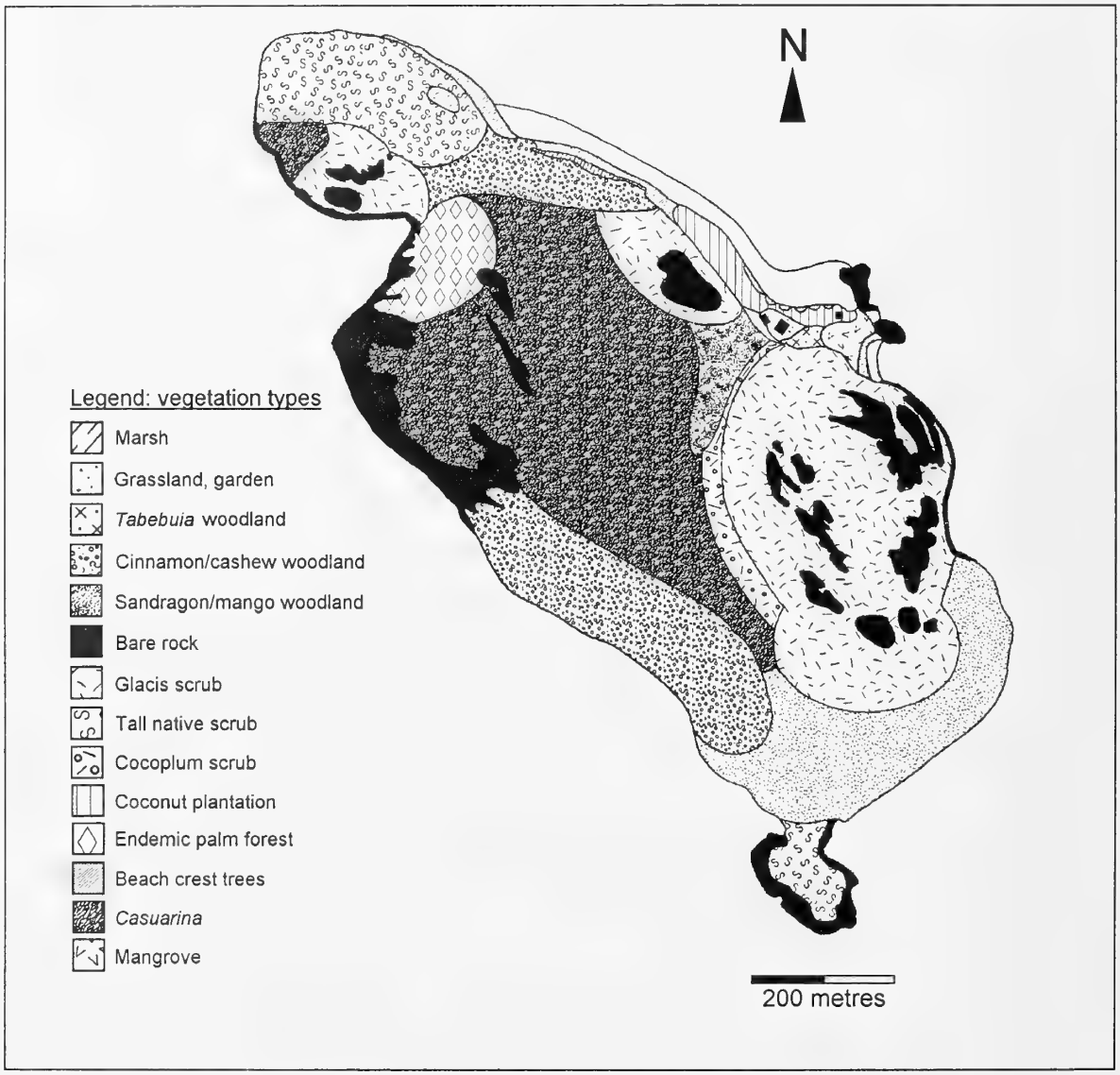

Figure 2. Thérèse Island: vegetation.

Table 3. Thérèse vegetation plot summary.

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)
Plateau	17	<5	571	45.9	78.3	14.8	9.1	1.3
Hill	20	67	625	48.9	45.4	39.3	14.9	1.2

Plateau plots had a relatively low density of trees with a relatively sparse canopy (mean canopy cover = 52%). The tree layer was dominated by two introduced species, *Tabebuia pallida* and *Cinnamomum verum* (Table 4). The shrub layer was species-rich with 29 species represented, many of them native, but the most widespread species were *Cocos nucifera* (in 13 plots) and *Cinnamomum verum* (in 10 plots) (Table 5). The dense vegetation cover in the herb layer (78%) included species of coastal grassland (such as the grasses *Stenotaphrum dimidiatum* and *Ischaemum heterotrichum*) as well as woodland herbs (such as *Nephrolepis* sp.). The most widespread species of the herb layer was *Nephrolepis* sp. in 15 (of 17) plots. *Cinnamomum* and *Phymatosorus scolopendra* each occurred in 14 plots.

Plots in low hill woodland had a higher density of stems although canopy cover was similar to that of plateau plots. As in plateau woodland, exotic trees were dominant although *Tabebuia* was not present. Nineteen species were present in the tree layer of hill plots (as opposed to 15 in plateau plots).

The shrub layer of hill woodland showed high species richness with 28 species represented, including many native and endemic plant species. The most widespread species were again *Cinnamomum verum* and *Cocos nucifera,* each in 18 plots. The introduced cocoplum *Chrysobalanus icaco* was less widespread but, where it was found, it was more dominant. It formed around 25% of the shrub layer in plots where it occurred. The most widespread native species was the endemic palm *Phoenicophorium borsigianum* (Table 5).

The herb layer of the hill woodland was less densely vegetated than that of the plateau with more open leaf litter visible. The most widespread species in the herb layer were *Cinnamomum verum* and the native fern *Nephrolepis* sp. (each in 17 of 20 plots). The fern *Phymatosorus scolopendra* occurred in 16 of 20 plots.

Table 4. Thérèse Island: most abundant tree species.
All trees having >5 stems shown.

	Hill		Plateau	
	No stems	% stems	No stems	% stems
Introduced species				
Anacardium occidentale	9	7.2	1	1.0
Casuarina equisetifolia	10	8.0	0	
Cinnamomum verum	54	43.2	22	22.7
Tabebuia pallida	0		24	24.7
Native species			0	
Canthium bibracteatum	7	5.6	0	
Cocos nucifera	5	4.0	17	17.5
Dracaena reflexa	7	5.6	0	
Hibiscus tiliaceus	0		7	7.2
Paragenipa wrightii	7	5.6	1	1.0
Tabernaemontana coffeoides	8	6.4	0	
Terminalia catappa	0		7	7.2
Total	125		97	

Table 5. Thérèse Island: most widespread shrub species.
Shrubs occurring in >5 plots shown. Percentage shrub cover is the mean cover by the species for those plots in which the species occurs.

	Hill		Plateau	
	No. plots	% shrub cover	No. plots	% shrub cover
Introduced species				
Chrysobalanus icaco	8	24.5		
Cinnamomum verum	18	7.5	10	14.1
Native species				
Calophyllum inophyllum	6	4.2	6	1.3
Canthium bibracteatum	10	4.2		
Cocos nucifera	18	11.2	13	12.9
Dracaena reflexa			7	1.1
Memecylon elaeagni	10	9.5		
Paragenipa wrightii	13	5.2		
Phoenicophorium borsigianum	15	12.3		
Premna serratifolia	10	4.3	6	4.6
Scaevola sericea			5	8.8
Total	**20**		**17**	

Discussion: Flora and Vegetation

The flora of Thérèse is similar to that of nearby parts of Mahé Island. Some species present on nearby coastal areas and hills of Mahé but rare on other islands include the endemic *Allophyllus sechellensis* and the (probably) native *Dianella ensifolia*.

The vegetation of plateau forest on Thérèse is not distinct from that of the hill except for a narrow coastal strip of beach crest woodland including species such as *Hibiscus tiliaceus* and *Guettarda speciosa*. Takamaka *Calophyllum inophyllum* is still a constituent of this coastal strip and it is also found in hill woodland. However, most of the takamaka trees on the coastal strip show symptoms of takamaka wilt disease caused by the fungus *Leptographium* (*Verticillium*) *calophylli* (Ivory *et al.,* 1996; Wainhouse *et al.,* 1998). Many of the trees along the beach crest are already dead although some have shown signs of foliage regrowth after extensive dieback (J. Etienne, *pers. comm.*).

Plateau and hill forest are dominated by introduced species (especially cinnamon) but they also have a high diversity of native and endemic species including endemic palms (there is an area of endemic palm forest on the north west of the island). Native and endemic shrub species are abundant suggesting that much of the native vegetation of the island would be scrub that has been invaded by introduced trees such as cinnamon, becoming high forest in the process.

INVERTEBRATES

Pitfall Trapping

The total size of pitfall assemblages (numbers of invertebrates caught) are shown in Table 6. Only invertebrates over 2 mm body length are included (excluding minute invertebrates such as Collembola).

Both hill and plateau habitats were dominated by ants (Hymenoptera; Formicidae), which made up 63.5% of all invertebrates captured. The earwigs (Dermaptera) made up 25.5% of the invertebrates caught. The remaining 11% of individuals included spiders (Araneae), insect larvae, Lepidoptera, Blattodea, Coleoptera, Crustacea, Isoptera, Mollusca, Myriapoda, Orthoptera, Psocoptera and Hymenoptera (excluding ants). The most abundant invertebrate species was the ant *Odontomachus troglodytes,* which formed 47.5% of individuals overall. An unidentified earwig species made up 14.9% of total invertebrates and was the second most abundant taxon.

Invertebrate counts excluding ants were higher in the north west monsoon and higher on the plateau than the hill. Lowest invertebrate counts came from hill woodland in the dry south east season.

A single individual of the introduced crazy ant *Anoplolepis gracilipes* was collected in one pitfall trap on the plateau. This species is widespread on Mahé, where it is regarded as a nuisance (Haines *et al.,* 1994) and on Bird Island it has negative effects on the island's ecosystems and conservation status (Feare, 1999a; Hill, in prep.). Since only one individual was caught it is probable that the species is not established on Thérèse.

Table 6. Pitfall assemblages from Thérèse.
Only invertebrates of body length >2 mm included.
(number in parentheses = number of invertebrates excluding ants).

	Habitat	Mean no. individuals per five traps	
		SE season	NW season
Thérèse	Plateau woodland	49.7 (12.0)	44.9 (19.0)
	Hill woodland	13.2 (6.2)	24.9 (9.4)
Mean for all granitic islands		61.8 (9.4)	61.1 (16.0)

Leaf-insect Counts

Leaf-insect counts were carried out for 20 tree and shrub species, 11 of these in both seasons (Table 7). The large number of tree species counted reflected the island's high tree species richness. The highest density of invertebrates (in terms of individuals per square metre of leaf) was on the native coastal shrub *Scaevola sericea* (plants showed high levels of infestation by aphids at the time of counting in September). *Scaevola* is abundant at the beach crest and in some areas of low hill scrub. *Morinda citrifolia*, a species of doubtful status (possibly introduced in Seychelles; Friedmann, 1994) which is

uncommon on Thérèse, also showed high invertebrate densities. The endemic species *Erythroxylum sechellarum* had the highest invertebrate density in February.

Ten of the 11 species counted in both seasons showed highest density of invertebrates in September rather than February. This runs counter to the trend on most islands where leaf counts are significantly greater in the wetter north west monsoon, and may reflect weather conditions specific to Thérèse for the 1999/2000 season.

Although the trees showing highest densities of invertebrates in both seasons were native, some introduced species also showed relatively high invertebrate densities, especially *Cinnamomum* and *Tabebuia.*

Table 7. Density of invertebrates on foliage, Thérèse.
n = no. of leaves counted; NI = number of individual invertebrates.

Species	SE season (September)			NW season (February)		
	n	Mean NI Leaf^{-1}	Mean NI m^{-2}	n	mean NI leaf^{-1}	mean NI m^{-2}
Introduced species						
Alstonia macrophylla	50	0.36	32.55	0		
Anacardium occidentale	149	0.34	33.04	100	0.13	13.51
Chrysobalanus icaco	100	0.14	42.81	50	0.08	25.16
Cinnamomum verum	900	0.48	76.78	1850	0.20	29.78
Psidium cattleianum	50	0	0	0		
Tabebuia pallida	50	0.26	87.84	0		
Native species						
Calophyllum inophyllum	250	0.26	24.39	200	0.18	19.65
Canthium bibracteatum	340	0.08	48.73	300	0.01	6.94
Erythroxylum sechellarum	0			50	1.28	335.08
Ficus lutea	50	0.16	22.54	0		
Guettarda speciosa	0			50	0.32	11.54
Hibiscus tiliaceus	50	0.16	11.59	0		
Memecylon elaeagni	250	0.05	71.64	500	0.05	63.01
Paragenipa wrightii	200	0.62	90.64	500	0.12	14.20
Premna serratifolia	250	0.27	31.63	200	0.06	9.46
Scaevola sericea	100	14.02	649.68	200	0.08	4.58
Tabernaemontana coffeoides	100	0.18	41.47	0		
Terminalia catappa	50	0.46	28.29	50	0.92	45.59
Trema orientalis	100	0.41	61.90	200	0.09	19.50
Status unknown						
Morinda citrifolia	50	5.14	285.87			

Malaise Trapping

Malaise trapping was carried out in plateau and hill woodland habitats, in both seasons. Main results are summarised in Table 8. As for the leaf counts, invertebrate

assemblages were greater in September than in February. Assemblages were larger in plateau locations than in hill plots.

The most abundant taxonomic groups were Diptera, Lepidoptera, Hymenoptera and Collembola. Other Invertebrate groups represented included arachnids (spiders and mites), Blattodea, Coleoptera, Dermaptera, Embioptera, Orthoptera, Hemiptera, Psocoptera and Thysanoptera.

Table 8. Malaise trap assemblages, Thérèse.
NI = number of Individuals.

	SE (September)		NW (February)	
	Hill	Plateau	Hill	Plateau
No. traps	1	2	2	2
Mean NI trap^{-1}	1180.0	3534.5	112.0	635.5
Total NI Diptera	891	6156	98	510
Total NI Hymenoptera	87	196	42	92
Total NI Lepidoptera	107	389	53	489
Total NI Collembola	32	137	4	31
Total NI (others)	63	191	27	149

Observation

A number of invertebrates were identified from observation and/or collection (Table 9). Among the endemic species recorded was the snail *Stylodonta unidentata* (also on Conception).

Invertebrate collection took place in and around the aquatic habitats on the island in both September and February. The large brackish marsh on the plateau had few aquatic species. The vegetation was dominated by the mangrove fern *Acrostichum aureum* and a filamentous alga. Adults of two dragonfly species were observed around this marsh, as well as the crab *Cardisoma carnifex*. The most abundant invertebrate was the water snail *Melanoides tuberculata*. Other invertebrates collected (in September) include aquatic mites.

Pools in the fresh-water stream (which had no aquatic macrophytes) had abundant invertebrate life in February, including water skaters (Hemiptera; Gerridae), water beetles, chironomid larvae (Diptera; Chironomidae) and a freshwater crab (*?Sesarma impressum*).

Discussion: Invertebrates

Invertebrate assemblages in pitfall trap assemblages were relatively large but the plateau of Thérèse, the richest area for ground invertebrates, is small. Invertebrates on vegetation and in flight-intercept (Malaise) traps were more abundant in September than in February, contrary to expectations. The fact that both methods showed this decline suggests that it was a real effect, perhaps caused by local environmental conditions (especially weather conditions) in 1999/2000.

Although few endemic species were collected in the current survey, Thérèse probably supports a large endemic invertebrate fauna in addition to the introduced or cosmopolitan species found on most islands of the Seychelles. The island is close to Mahé, which has a large endemic fauna, and supports a range of endemic plants including native palms (which provide important microhabitats for endemic invertebrate species in leaf axils).

Table 9. Invertebrates observed, Therese Island.

Order	Family	Species	Notes
Mollusca	Acavidae	*Stylodonta unidentata* (Chemnitz, 1795)	Occasional shells in hill woodland
	Achatinidae	*Achatina fulica* (Bowditch, 1822)	Abundant
	Subulinidae	*Subulina octona* Bruguière, 1792	
	Thiaridae	*Melanoides tuberculata* (Müller, 1774)	In saline marsh
Arachnida:			
Araneae	Tetragnathidae	*Nephila inaurita* (Walckenaer, 1841)	
Crustacea:			
Decapoda	Coenobitidae	*Coenobita brevimanus* Dana, 1852	
	Gecarcinidae	*Cardisoma carnifex* (Herbst, 1784)	In saline marsh and mangrove
	Grapsidae	*Neosarmatium ?meinerti* (De Man, 1887)	In mangrove
		Sesarma impressum H. Milne Edwards, 1837	In freshwater stream
	Ocypodidae	*Ocypode ceratophthalmus* (Pallas, 1772)	On beach
Myriapoda:			
Chilopoda	Scolopendridae	*Scolopendra subspinipes* (Leach, 1918)	
Diplopoda	Trigoniulidae	*Spiromanes ?braueri* (Attems, 1900)	
Insecta:			
Coleoptera	Scarabaeidae	*Perissosoma aenescens* Waterhouse, 1875	
	Lampyridae	*Luciola laeta* Gerstaecker, 1871	Rare, in hill woodland
Hymenoptera	Anthophoridae	*Xylocopa caffra* (Linnaeus, 1767)	
	Apidae	*Apis mellifera adansoni* Latreille, 1804	
	Formicidae	*Anoplolepis gracilipes* (Smith, 1857)	In pitfall traps
		Camponotus hova Forel, 1891	In pitfall traps
		?Camponotus thomasetti Forel, 1912	In pitfall traps
		Cardiocondyla emeryi Forel, 1881	In pitfall traps
		Odontomachus troglodytes Santschi, 1914	In pitfall traps
		Paratrechina sp.	In pitfall traps
		Plagiolepis ?alluaudi Emery, 1894	In pitfall traps
		?Plagiolepis exigua Forel, 1894	In pitfall traps
		Technomyrmex albipes (Smith, 1861)	In pitfall traps
	Vespidae	*Polistes olivaceus* (de Geer, 1773)	
Lepidoptera	Lycaenidae	*Leptotes pirithous* Linnaeus, 1767	
		Zizeeria knysna (Trimen, 1862)	
	Hesperiidae	*Borbo ?gemella* Mabille, 1884	
	Nymphalidae	*Melanitis leda africana* (Linnaeus, 1758)	
Odonata	Agrionidae	*Ceriagrion glabrum* (Burmeister, 1839)	
	Coenagrionidae	*Agriocnemis pygmaea* (Rambur, 1842)	
	Libellulidae	*Diplacodes trivialis* (Rambur, 1842)	
		Orthetrum stemmale wrightii (Selys, 1877)	
		Pantala flavescens (Fabricius, 1798)	
		Tramea limbata Selys, 1878	

VERTEBRATES

Reptiles and Amphibians

Reptiles and amphibians observed during the course of fieldwork were recorded and a list of species identified is given in Table 10. The list includes three lizards, one tortoise and one frog. At least two of these species are introduced on Thérèse, the Pacific house gecko and the Aldabra giant tortoise, the latter represented by a small group of individuals kept in a pen.

One species previously recorded from the island was not seen: the bronze-eyed gecko *Ailuronyx seychellensis* (Cheke, 1984). This species is cryptic and nocturnal and is only common on rat-free islands (Cheke, 1984); it may have been overlooked. None of the three snakes known from Seychelles (Nussbaum, 1984a) were recorded, although these are rarely seen and may occur on the island. Given the proximity of Thérèse to Mahé, it is possible that one of the Seychelles' endemic caecilians survives on the smaller island (the most likely species is *Hypogeophis rostratus:* Nussbaum, 1984b).

Table 10. Reptiles and amphibians, Thérèse Island.
Status: E =endemic, I = introduced, N = native (in central Seychelles).

Family	Species		Status
Amphibians			
Raniidae	*Ptychadaena mascareniensis* (Dumeril & Bibron, 1836)	Mascarene frog	?I
Reptiles			
Gekkonidae	*Gehyra mutilata* (Wiegmann, 1835)	Pacific house gecko	I
	Phelsuma spp.	day gecko	E
Scincidae	*Mabuya sechellensis* (Dumeril & Bibron, 1836)	Seychelles skink	E
Testudinidae	*Geochelone gigantea* (Schweigger, 1812)	Aldabra giant tortoise	I

Birds

In total, 10 land birds and waders were recorded (Table 11). Three of these were Seychelles endemics but two of these endemic species (Seychelles blue pigeon and Seychelles sunbird) are currently widespread and common within the granitic islands. One (the Seychelles kestrel *Falco araea*) is endangered.

In addition to sight records, tape playback was used to give data on presence or absence of two species. In September 1999, calls of Seychelles scops owl *Otus insularis* were played and in February 2000, calls of the scops owl and barn owl *Tyto alba* were played. There were no positive responses.

There was no evidence of seabirds breeding on Thérèse island, although it is possible that some pairs of fairy tern *Gygis alba* nest there. However, in the September study period a number of seabird species were observed off the island, between Thérèse and Mahé. These birds included feeding flocks of fairy tern and noddies (*Anous* sp.), and occasional highflying frigatebirds (*Fregata* sp.). On some evenings, large numbers of shearwaters were observed flying over this stretch of water to the North: most of these

birds appeared to be wedge-tailed shearwaters (*Puffinus pacificus*) but Audubon's shearwater (*Puffinus lherminieri*) were also present. Seabirds were also observed (although less frequently) in February: one tern (probably common tern *Sterna hirundo*) was resident on the island. Fairy terns were occasionally seen and one white-tailed tropicbird (*Phaeton lepturus*) was seen flying over the island.

Table 11. Land birds and waders observed on Thérèse.
M = migrant; E = Seychelles endemic species.

Species		Notes
Butorides striatus	green-backed heron	August: at least two individuals in mangrove and neighbouring beach
Falco araea E	Seychelles kestrel	August: at least one pair, around tall *Paraserianthes* tree. February: one individual, flying over glacis
Numenius phaeopus M	whimbrel	August and February: one seen regularly on beach
Arenaria interpres M	ruddy turnstone	August and February: on beaches and glacis. Group of 8 individuals seen on glacis 10/9/99
Streptopelia picturata picturata	Madagascar turtle dove	Regularly seen on plateau around settlement.
Geopelia striata	barred ground dove	A few birds regularly seen on plateau.
Alectroenas pulcherrima E	Seychelles blue pigeon	Frequently seen in woodland and scrub habitats.
Nectarinia dussumieri E	Seychelles sunbird	Regularly seen in mangrove and woodland.
Acridotheres tristis	common mynah	Regularly seen on beach, around buildings, around glacis and in woodland/scrub.
Foudia madagascariensis	Madagascar fody	Commonly seen.

Mammals

Mammals observed in the course of fieldwork were recorded (Table 12). In addition, rodent trapping was carried out in September 1999, and February 2000 (Table 13). Two traplines were established, one in plateau woodland (grid ref. CK 2285 8375 – CK 2250 8390) and one in hill woodland/scrub (dominated by cinnamon *Cinnamomun verum* at lower altitudes with mixed scrub at higher altitudes) (grid ref. CK 2250 8390 – CK 2232 8400). Only one species of rodent, the ship rat *Rattus rattus,* was trapped.

Trapping rates were low in September, perhaps in part due to interference with traps by resident dogs. Rates were higher in September although in general rates were lower in the north west Monsoon and higher in the south east period when food and water stress were greater and rats more likely to be trapped. The island had the largest number of mammalian predators of any of those studied.

Table 12. Mammals, Thérèse Island.

Species	Status
Canis familiaris L.	4-6 individuals
Felis catus L.	several individuals observed, also tracks and scat on beaches and glacis
?Mus domesticus Rutty	observed once: possibly juvenile black rat
Pteropus seychellensis Milne Edwards	common in February; rarely seen in September
Tenrec ecaudatus Schreber	fresh bones collected
Rattus rattus L.	Abundant

Table 13. Results of rat trapping, Thérèse Island.

Dates	Trap-nights	No. of rats	Rats per 100 trap-nights (uncorrected)	Rats per 100 trap-nights (corrected)*
9 – 14/9/99	139	20	14.39	17.47
10 – 15/2/00	140	55	39.29	63.22
Total (SE)			35.34	
Total (NW)			25.56	

*corrected to account for the effect of closed traps: Cunningham and Moors, 1996

CONSERVATION RECOMMENDATIONS

Thérèse is a relatively small island which has conservation interest principally because of its proximity to the islands of Mahé and Conception. Its proximity to Mahé (and its hilly terrain) has allowed the development of a flora (and probably invertebrate fauna) rich in endemic species. Nearby Conception has a population of the Seychelles white-eye *Zosterops modestus,* an endangered endemic bird. The white-eye has never been recorded on Thérèse, probably due to the early introduction of ship rats which are a likely nest predator (on Conception only the Norway rat *Rattus norvegicus* is present).

The introduction of white-eyes to Thérèse would require the eradication of rats and cats, which are also present. The presence of introduced predators would appear to be the chief barrier to the survival of white-eyes on the island. White-eyes feed mainly on gleaned invertebrates although they also take small fruit. The species survives on an island dominated by introduced cinnamon (Conception) so it is not dependent upon native vegetation. The high leaf invertebrate counts on Thérèse suggest food supply would not be limiting for a translocated population although planting of *Morinda citrifolia* and other native shrubs would increase the available food supply. White-eyes are currently found on only two islands and translocation to establish new populations is an urgent priority.

Calophyllum inophyllum on Thérèse is threatened by the takamaka wilt disease *Leptographium calophylli,* which is probably spread by a native bark beetle (Wainhouse *et al.,* 1998). The disease has caused dieback and death of most coastal trees on the island, although some have shown signs of recovery. To prevent enhanced erosion of the coastal plateau, planting of other native coastal trees should be carried out at the beach crest. Most trees in hill forest showed no signs of the disease but on Mahé, trees at high altitudes also suffer from the disease (personal observation). Removal of dead and dying wood may reduce the rate of spread on Thérèse but is unlikely to eradicate the disease due to the ease of reinvasion from Mahé where the disease is very well established.

Appendix 1. Plant species recorded from Thérèse

Taxonomy of dicotyledons as given by Friedmann (1994). Of monocotyledons, as in Robertson (1989). Families arranged in alphabetical order. Species observe only in cultivation around the buildings are listed separately, below.

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: PG = Plateau grassland; PW = Plateau woodland; HW = Hill Woodland; HSc = Hill Scrub; Gl = Glacis; BC = Beach Crest; Ma = Marsh; Mg = Mangrove; Cu = Cultivated area; Cu* = species only recorded in cultivation.

	Species	Status	Abund.	Habitats
PTERIDOPHYTA				
Adiantaceae				
1	*Acrostichum aureum* L.	N	A	Ma
Davalliaceae				
2	*Davallia denticulata* (Burm.) Mett.	N	A	HW, PW, Gl
3	*Nephrolepis biserrata* (Sw.) Schott	N	A	HW, PW, Gl
Gleicheniaceae				
4	*Dicranopteris linearis* Burm.	?	A	HSc
Polypodiaceae				
5	*Phymatosorus scolopendria* (Burm. f.)	N	A	HW, PW
Psilotaceae				
6	*Psilotum nudum* Sw.	N	O	HW
Selaginellaceae				
7	*Selaginella* sp.	N	O	HW, PW
Vittariaceae				
8	*?Vittaria* sp.	N	O	Gl
ANGIOSPERMAE: Dicotyledons				
Acanthaceae				
9	*Asystasia* sp. B (*sensu* Friedmann)	?I	A	PG, HW
Amaranthaceae				
10	*Celosia argentea* L.	I	O	Cu*
Anacardiaceae				
11	*Anacardium occidentale* L.	I	A	HW
12	*Mangifera indica* L.	I	F	PW, HW
13	*Spondias cytherea* Sonn.	I	O	PG
Apocynaceae				
14	*Allamanda cathartica* L.	I	R	Cu*
15	*Alstonia macrophylla* Wall ex G. Don.	I	C	HW, Gl
16	*Catharanthus roseus* (L.) G. Don.	I	F	Gl, Cu
17	*Nerium oleander* L.	I	O	Cu*
18	*Plumeria rubra* L.	I	R	Cu*
19	*Tabernaemontana coffeoides* Boj. ex. A. DC.	N	A	HW
20	*Tabernaemontana divaricata* (L.) Roem. & Schult.	I	R	Cu*
Araliaceae				
21	*Polyscias* spp.	I	R	Cu*

Species	Status	Abund.	Habitats
Asclepiadaceae			
22 *Sarcostemma viminale* (L.) Alton	N	F	Gl, HW
Avicenniaceae			
23 *Avicennia marina* (Forssk.) Vierh.	N	F	Mg
Bignoniaceae			
24 *Tabebuia pallida* (Lindl.) Miers.	I	C	PW
Boraginaceae			
25 *Cordia subcordata* Lam.	N	F	BC
26 *Tournefourtia argentea* L. f	N	O	BC
Caesalpiniaceae			
27 *Caesalpinia pulcherimma* (L.) Swartz	I	O	Cu*
28 *Intsia bijuga* (Colebr.) O. Kuntze	N	F	HW, HSc
29 *Senna alata* (L.) Roxb.	I	R	Cu*
30 *Tamarindus indica* L.	I	R	PG
Campanulaceae			
31 *Hippobroma longiflora* (L.) G. Don	I	F	PG
Caricaceae			
32 *Carica papaya* L.	I	F	Cu, PW
Casuarinaceae			
33 *Casuarina equisetifolia* J. R. & G. Foster	I	A	HW, Gl
Chrysobalanaceae			
34 *Chrysobalanus icaco* L.	I	A	HW, HSc, Gl
Combretaceae			
35 *Lumnitzera racemosa* Willd.	N	F	Mg
36 *Terminalia catappa* L.	?N	C	BC, PW
Compositae			
37 *Emilia sonchifolia* (L.) Wight	I	O	PG, Cu
38 *Vernonia cinerea* (L.) Less.	I	A	PG, Cu
Convulvulaceae			
39 *Ipomoea macrantha* Roem. & Schultes	N	F	PW
40 *Ipomoea obscura* (L.) Ker Gawl.	I	F	PG
41 *Ipomoea pes-caprae* (L.) R. Br.	N	A	BC, Gl
42 *Ipomoea venosa* (Desr.) Roem. & Schultes	N	F	Gl
Crassulaceae			
43 *Kalanchoe pinnata* (Lam.) Pers.	I	F	Gl
Ebenaceae			
44 *Diospyros seychellarum* (Hiern.) Kosterm.	E	C	HSc
Erythroxylaceae			
45 *Erythroxylum sechellarum* O. E. Schulz	E	F	HW, HSc, PW
Euphorbiaceae			
46 *Acalypha wilkesiana* Müll. Arg.	I	F	Cu*
47 *Codiaeum variegatum* L.	I	C	Cu*
48 *Euphorbia hirta* L.	I	C	Cu, PG
49 *Euphorbia ?hypericifolia* L.	I	R	Cu
50 *Euphorbia pyrifolia* Lam.	N	C	Gl
51 *Jatropha pandurifolia* L.	I	O	Cu*
52 *Phyllanthus acidus* (L.) Skeels	I	R	PG
53 *Phyllanthus pervilleanus* (Baillon) Müll. Arg.	N	F	PG, HW
54 *Phyllanthus urinaria* L.	I	O	Cu, PG
Flacourtiaceae			
55 *Flacourtia jangomas* (Lour.) Räuschel.	I	R	PG
Goodeniaceae			
56 *Scaevola sericea* Vahl.	N	C	BC

Species	Status	Abund.	Habitats
Guttiferae			
57 *Calophyllum inophyllum* L.	N	C	BC [PW, HW]
Hernandiaceae			
58 *Hernandia nymphaeifolia* (Presl) Kubitzki	N	O	BC
Labiatae			
59 *Plectranthus amboinicus* (Lour.) Spreng.	?I	O	Gl
Lauraceae			
60 *Cinnamomum verum* Presl.	I	A	PW, HW
61 *Persea americana* Mill.	I	R	PG
Lecythidaceae			
62 *Barringtonia asiatica* (L.) Kurtz	N	O	BC
Malvaceae			
63 *Hibiscus rosa-sinensis* L.	I	O	Cu*
64 *Hibiscus tiliaceus* L.	N	F	BC, PW
65 *Sida stipulata* Cav.	I	R	PG
66 *Thespesia populnea* (L.) Soland. ex Correa	N	F	BC/Mg
Melastomataceae			
67 *Melastoma malabathricum* L.	?I	O	Gl
68 *Memecylon elaeagni* Blume	E	A	HSc, HW
Meliaceae			
69 *Xylocarpus moluccensis* (Lam.) Roem.	N	O	Mg
Mimosaceae			
70 *Adenanthera pavonina* L.	I	C	HW
71 *Albizzia lebbeck* (L.) Benth.	I	R	HW
72 *Paraserianthes falcataria* (L.) Niels.	I	F	PW
Moraceae			
73 *Ficus lutea* Vahl.	N	C	HW, PW
74 *Ficus reflexa* Thunb. ssp. *seychellensis* (Baker) Berg	E (ss)	F	HW
75 *Ficus rubra* Vahl.	N	O	Gl
Myrtaceae			
76 *Eucalyptus* sp. (?*E. camaldulensis* Dehn.)	I	R	HW
77 *Eugenia uniflora* L.	I	O	PG
78 *Psidium cattleianum* Sabine	I	F	Cu, PW, HW
79 *Psidium guajava* L.	I	O	Cu, PW
80 *Syzygium malaccense* (L.) Merr. & Perry	I	R	PG
81 *Syzygium wrightii* (Baker) A. J. Scott	E	F	HW, HSc
Nyctaginaceae			
82 *Mirabilis jalapa* L.	I	R	Cu*
Oxalidaceae			
83 *Averrhoa bilimbi* L.	I	F	Cu, HW
Papilionaceae			
84 *Abrus precatorius* L.	?N	A	PG, PW, HW
85 *Alysicarpus vaginalis* (L.) DC.	I	O	PG
86 *Canavalia cathartica* Thouars.	N	C	BC, PG
87 *Desmodium incanum* DC.	I	A	BC, PG
88 *Desmodium triflorum* (L.) DC.	I	C	BC, PG
89 *Indigofera suffruticosa* Mill.	I	F	PG
90 *Pterocarpus indica* Willd.	I	O	HW, PW
91 *Sophora tomentosa* L.	N	F	BC
92 *Teramnus labialis* (L.) Spreng.	I	O	PW, HW
93 *Vigna marina* (Burm.) Merr.	N	O	BC
Passifloraceae			
94 *Passiflora edulis* Sims	I	F	Cu, PW
95 *Passiflora foetida* L.	I	C	PW, HW

	Species	Status	Abund.	Habitats
96	*Passiflora suberosa* L.	I	A	PG, PW, HSc, HW
Portulacaceae				
97	*Portulaca grandiflora* L.	I	C	Cu*
Rhamnaceae				
98	*Colubrina asiatica* (L.) Brogn.	N	F	BC, PW
Rubiaceae				
99	*Canthium bibractatum* (Baker) Hiem.	N	A	HW, HSc, PW
100	*Guettarda speciosa* L.	N	O	BC
101	*Mitracarpus hirtus* (L.) DC.	I	A	PG, HW
102	*Morinda citrifolia* L.	?I	C	PG, HW, Gl
103	*Paragenipa wrightii* (Baker) F. Friedmann	E	A	HW, HSc, Gl
104	*Pentodon pentandrus* (Schumach. & Thonn.) Vatke	I	O	Cu
Rutaceae				
105	*Citrus* spp.	I	R	Cu, PG
106	*Murraya koenigii* (L.) Spreng.	I	R	Cu*
Sapindaceae				
107	*Allophyllus sechellensis* Summerh.	E	F	PW, HW, HSc
108	*Dodonea viscosa* Jacq.	N	O	HSc
Sapotaceae				
109	*Mimusops sechellarum* (Oliv.) Hemsl.	E	O	HW
Scrophulariaceae				
110	*Russellia equisetiformis* Cham. & Schlect.	I	C	Cu*
111	*Striga asiatica* (L.) O. Kuntze	?I	F	PG
Sterculiaceae				
112	*Heritiera littoralis* Ait.	N	R	PW
Turneraceae				
113	*Turnera angustifolia* Miller	I	A	PG, HSc, HW
Ulmaceae				
114	*Trema orientalis* (L.) Bl.	N	F	PW, HW
Verbenaceae				
115	*Clerodendron speciosissimum* Morren	I	O	PW
116	*Lantana camara* L.	I	O	HSc,
117	*Premna serratifolia* L.	N	A	HW, HSc, PW
118	*Stachytarpheta jamaicensis* (L.) Vahl.	I	A	HW, PG
119	*Stachytarpheta urticifolia* (Salisb.) Sims.	I	F	PG
ANGIOSPERMAE: Monotyledons				
Agavaceae				
120	*Furcraea foetida* (L.) Haw.	I	F	Gl
Amaryllidaceae				
121	*Hymenocallis littoralis* (Jacq.) Salisb.	?I	F	BC
122	*Zephyranthes candida* Herb.	I	F	Cu*
Araceae				
123	*Alocasia macrorrhiza* (L.) G. Don.	I	O	Cu*
124	*Anthurium* sp.	I	O	Cu*
125	*Caladium bicolor* (Dryand.) Vent.	I	O	Cu*
126	*Dieffenbachia sequine* (Jacq.) Schott	I	R	Cu*
Bromeliaceae				
127	*Ananas comosus* (L.) Merr.	I	F	Cu, Gl
Commelinaceae				
128	*Tradescantia spathacea* Swartz	I	F	Cu*
Cyperaceae				
129	*Cyperus* sp.	?	F	HW
130	*Cyperus* sp. 2	?	C	Mg

	Species	Status	Abund.	Habitats
131	*Fimbristylis cymosa* R. Br.	?	A	BC, PG, HW
132	*Fimbristylis ?dichotoma* (L.) Vahl.	?	F	PG
133	*Fimbristylis* sp. (glacis sedge)	?	C	Gl
134	*Kyllinga alba* Nees	?	C	PG, PW
135	*Kyllinga polyphylla* Willd. ex Kunth	N	A	PG
136	*Lophoschoenus hornei* (C. B. Cl.) Stapf.	E	C	Gl
137	*Mariscus dubius* (Rottb.) Fischer	N	A	BC, PG
138	*?Mariscus pennatus* (Lam.) Domin.	N	R	Mg
139	*Pycreus polystachyos* (Rottb.) P. Beauv.	?	C	Mg, Gl
Gramineae				
140	*Bambusa vulgaris* Schrad. ex Wendl. var. *aureo-variegata*	I	R	PG
141	*Brachiara umbellata* (Trin.) W. D. Clayton	N	A	PG, PW, HW, HSc
142	*Cymbopogon* sp.	I	O	Cu*
143	*Dactyloctenium ctenoides* (Steud.) Bosser	?	F	BC
144	*Digitaria ?horizontalis* Willd.	?	C	BC, PG
145	*Digitaria ?radicosa* (Presl.) Miq.	?N	F	PG
146	*Eragrostis tenella* var. *insularis* Hubb.	?	F	Gl
147	*?Ischaemum heterotrichum* Hack.	?	F	PG
148	*Oplismenus compositus* (L.) P. Beuv.	N	A	HW, PW
149	*Panicum brevifolium* L.	N	A	HW
150	*Panicum maximum* L.	?	C	PG, PW, HW
151	*Paspalum conjugatum* Berg.	N	C	PG
152	*Pennisetum polystachyon* (L.) Schult.	?	C	Gl
153	*Rhynchelytrum repens* (Willd.) C. E. Hubb.	?	F	Gl
154	*Sacciolepis curvata* (L.) Chase	?	C	HW
155	*Sporobolus diander* (Retz.) P. Beuv.	?	O	BC
156	*Sporobolus virginicus* (L.) Kunth.	N	F	BC
157	*Stenotaphrum dimidiatum* (L.) Brogn.	N	A	BC, PG, PW
Hypoxidaceae				
158	*Curculigo sechellensis* Boj.	E	O	Gl
Liliaceae				
159	*Cordyline fruticosa* L. (A. Chev.)	I	O	Cu*
160	*Dianella ensifolia* (L.) DC.	N	A	HW
161	*Dracaena reflexa* Lam. var. *angustifolia* Baker	N	A	HW, Gl
162	*Gloriosa superba* L.	I	O	Cu*
163	*Ophiopogon ?intermedius* D. Don	I	R	Cu*
164	*Pleomele* sp.	I	R	Cu*
Marantaceae				
165	*Maranta arundinacea* L.	I	O	Cu*
Musaceae				
166	*Heliconia psittacorum* L.	I	O	Cu*
167	*Musa* sp.	I	F	Cu, PG
Orchidaceae				
168	*Angraecum eburneum* Bory subsp. *brongniartianum* (Thours.) H. Perrier	E (ss)	R	PW
169	*Cynorkis ?fastigiata* Thouars	N	O	HSc, HW
170	*Disperis tripetaloides* (Thouars) Lindl.	N	R	HW
171	*Spathoglottis plicata* Blume	I	O	Cu*
172	*Vanilla phalaenopsis* Reichb. f.	E	O	Gl
173	*Vanilla planifolia* Andrews	I	C	HW
Palmae				
174	*Cocos nucifera* L.	N	A	PG, BC, PW, HW
175	*Deckenia nobilis* Wendl.	E	C	HW

	Species	Status	Abund.	Habitats
176	*Latania ?lontaroides* Gaertn.	I	R	PG
177	*Nephrosperma vanhoutteanum* (Wendl. ex van Houtt.) Balf.	E	C	HW, Gl
178	*Phoenicophorium borsigianum* (K. Koch) Stuntz	E	C	HW
179	*Raphia farinifera* (Gaertn.) Hylander	I	R	HSc
Pandanaceae				
180	*Pandanus balfourii* Mart.	E	C	Gl, HW
181	*Pandanus multispicatus* Balf. f.	E	O	Gl
Taccaceae				
182	*Tacca leontopetaloides* (L.) O. Kuntze	I	C	PG
Zingiberaceae				
183	*Alpinia purpurata* (Vieill.) Schumann	I	R	Cu*

SPIDERS (ARACHNIDA, ARANEAE) COLLECTED BY BIRDLIFE GEF ISLAND ASSESSMENT PROJECT 1999-2000

BY

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ABSTRACT

During the BirdLife GEF Island Assessment project 1999-2000 a total of 2,725 spider specimens were collected. Of these, 887 were adult specimens and 1,838 juveniles. The great majority of specimens (98%) could be determined down to species level. In all, the collection included 68 species belonging to 23 families. Five species new to science were collected.

METHODS

Spiders were collected by a variety of methods, including pitfall trapping, sweeping and beating, and were occasionally taken in Malaise traps (see Hill, this volume, for more details), on the ten islands described in the above reports, and also on Aride (pitfall trapping only) in 2000. Specimens collected were sorted and stored in 70% ethanol for later identification.

RESULTS

Overall, a total of 2,725 specimens were sorted for identification. Of these, 887 were adult and 1,838 juvenile; 98% of specimens could be determined to species. Sixty-eight species were represented in the collection, belonging to 23 families; at present, a total of 191 spider species (in 39 families) are known on the granitic Seychelles, with further species from the coralline islands (the latter mainly from families Araneidae, Oonopidae, Tetragnathidae and Theridiidae; Roberts 1983, Saaristo 2001b). A summary table showing representation of different spider families in this material is shown below (Table 1). Five previously undescribed taxa were identified, and these will be described at a later date. A checklist of taxa recovered, with their distribution outside the Seychelles, and known distribution within Seychelles, is given below.

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Table 1. Summary of spider specimens collected.

	Family	No. of species	
		This material	Seychelles
01	Araneidae	6	17
02	Clubionidae	2	3
03	Corinnidae	2	3
04	Cryptothelidae	1	1
05	Gnaphosidae	2	5
06	Linyphiidae	4	4
07	Liocranidae	1	1
08	Lycosidae	2	2
09	Miturgidae	1	1
10	Ochyroceratidae	2	6
11	Oonopidae	7	32
12	Oxyopidae	1	2
13	Pholcidae	2	9
14	Salticidae	10	25
15	Scytodidae	1	6
16	Selenopidae	1	1
17	Sparassidae	2	7
18	Symphytognatidae	1	2
19	Tetragnathidae	5	11
20	Theridiidae	11	24
21	Theridiosomatidae	1	3
22	Thomisidae	2	2
23	Uloboridae	1	2
	TOTAL	68	169

CHECKLIST

Abbreviations of island names (islands in **bold** were visited in the course of this project, islands with asterisk are coralline):

Aldabra*	Ald	Frégate	FR
Anonyme	AO	**Grande Soeur**	**GS**
Aride	**AR**	La Digue	LD
Assumption*	Asn	Long Island	LO
Astove*	Ast	Mahé	MH
Bird	**BI**	**Marianne**	**MA**
Cerfs	CF	**North**	**NO**
Coetivy*	Coe	Petite Soeur	PS
Conception	**CC**	Poivre*	Pov
Cousin	**CS**	**Praslin**	**PR**
Cousine	CE	Providence*	Prd
Curieuse	**CR**	St Pierre	SP
Denis	**DE**	St Joseph*	StJ
Desroches*	Dsr	Silhouette	SI
Farquhar*	Faq	**Thérèse**	**TE**
Félicité	**FE**	Île aux Vaches	VA

DI = Global distribution according to Platnick (2000)
OR = Old records from Seychelles
BLS = New records (this collection)

(f) = female specimens, (j) = juvenile specimens, (m) = male specimens.

SUBORDER ARANEOMORPHA (true spiders)

01 Family ARANEIDAE Simon, 1895 - orbweb weavers

Cyrtophora Simon, 1864

C. citricola (Forskol, 1775)

DI: Old World

OR: Ald, AR, CF, CR, LD, PR, SI (Simon 1898; Hirst 1911; Saaristo1978; Grasshoff 1980; Roberts 1983; Gerlach *et al.*1997; Bowler *et al.* 1999; Saaristo 1999)

BLS: CC, FE, MA, NO

Larinia Simon, 1874

L. bifida Tullgren, 1910

DI: Central, Eastern and Southern Africa

OR: AR, CE, MH, SI (Grasshoff 1980; Gerlach *et al.*1997; Bowler *et al.*1999; Saaristo 1999)

BLS: BI, CC, CS, DE, FE, MA

Neoscona Simon, 1864

N. morelii (Vinson, 1863)

DI: Cuba to Argentina, Africa to Seychelles

OR: SP (Grasshoff 1980)

BLS: BI

N. subfusca (C. L. Koch, 1837)

DI: Old World

OR: CR, MH, PR, SI (Grasshoff 1980; Saaristo 1999)

BL: CS

Prasonica Simon, 1895

P.seriata (Simon, 1895)

DI: Africa, Madagascar

OR: MH, PR, SI (Grasshoff 1980; Saaristo 1999)

BLS: CC, CR, DE, FE, MA, NO

Thelacantha Hasselt, 1882

T. brevispina (Doleschall, 1875)

DI: Madagascar, India to Philippines, Australia

OR: MH (Saaristo 1999)

BLS: CC

02 Family CLUBIONIDAE Wagner, 1887 - sac spiders

Clubiona Latreille, 1804

C. n. sp.

DI: Endemic(?)

OR: CE, SI (Saaristo 1999, as *Clubiona sp. ign.*)

BLS: BI, CC, CS, DE, FE, MA, NO

"Clubiona"

"C." nigrimaculosa Blackwall, 1877

DI: Endemic

OR: AO, AR, CS, MH, SI (Simon 1893; Hirst 1911; Saaristo 1995)

BLS: CS

03 Family CORINNIDAE Karsch, 1880 - dark sac spiders

Oedignatha Thorell, 1881

O. mogamoga Marples, 1955

DI: Malaysia, Seychelles, Borneo, Samoa

OR: AR, CE, PR, MH, SI (Saaristo 1978; Bowler *et al.* 1999; Saaristo 1999, all as *O. scrobiculata*).

BLS: AR, BI, CS, CR, DE, MA, NO, TE

Corinna C. L. Koch, 1842

C. gulosa (Thorell, 1878)

DI: Myanmar

OR: CE, SI (Saaristo 1999, as Corinnidae *Genus ign. 2., sp. ign.*)

BLS: AR, CS

04 Family CRYPTOTHELIDAE L. Koch, 1872 - litter spiders

Cryptothele L. Koch, 1872

C. alluaudi Simon, 1893

DI: Endemic

OR: CE, FR, LD, MH, PR, SI (Simon 1893; Simon 1898; Hirst 1911; Benoit 1978d; Saaristo 1999)

BLS: CC

05 Family GNAPHOSIDAE Banks, 1882 - flat-bellied ground spiders

Camillina Berland, 1919

C. cordifera (Tullgren, 1910)

DI: Central and Southern Africa, Seychelles

OR: AR, CE, CR, MH, PR, SI (Saaristo 1978; Platnick 1981; Bowler *et al.*1999; Saaristo 1999)

BLS: AR, BI, CR, CS, CR, DE, MA

Xerophaeus Purcell, 1907

X. espoir Platnick, 1981

DI: Endemic

OR: CE, MH (Platnick 1981; Saaristo 1999)

BLS: CS

06 Family LINYPHIIDAE Blackwall, 1859 - dwarf or money spiders

Microbathyphantes van Helsdingen, 1988

M. palmarius (Marples, 1955)

DI: Sri Lanka, Seychelles, Myanmar, Polynesia

OR: CS, MH, SI (van Helsdingen 1988, as *M. asiaticus*; Saaristo 1995; Saaristo 1999, as *M. spedani*)

BLS: DE

Neonesiotes Millidge, 1991

N. remiformis Millidge, 1991

DI: Marshall Is., Caroline Is., Cook Is., Fiji, Samoa

OR: CE, MH, SI (Saaristo 1999)

BLS: DE, MA, NO

Nesioneta Millidge, 1991

N. benoiti (van Helsdingen, 1978)

DI: Sri Lanka, Seychelles

OR: AR, CS, CE, LD, MH, PS, PR, SI (van Helsdingen 1978, as *Meioneta b.*; Saaristo 1995; Bowler *et al.*1999; Saaristo 1999)

BLS: AR, BI

Thoea Saaristo, 1995
T. tricaudata (Locket, 1982)
DI: Seychelles, Malaysia
OR: CE, MH, SI (Saaristo 1995; Saaristo 1999)
BLS: CR, MA

07 Family LIOCRANIDAE Simon, 1897
Othobula Simon, 1897
O. impressa Simon, 1896
DI: Sri Lanka
OR: AR, CE, MH, SI (Bowler *et al.*1999, as Corinnidae: *Genus ign. 1. sp. 1.*; Saaristo 1999, as Corinnidae: *Genus ign. 1. sp. ign.*)
BLS: CS (j)

08 Family LYCOSIDAE Sundevall, 1833 - wolf spiders
Bristowiella Saaristo, 1980
B. seychellensis (Bristowe, 1973)
DI: Seychelles, Comoro Is.
OR: AR, CE, LD, PR, MH, SI (Bristowe 1973; Saaristo 1978; Alderweilert 1988; Bowler *et al.*1999; Saaristo 1999)
BLS: CS, NO
Trochosa C. L. Koch, 1848
T. urbana (O. Pickard-Cambridge, 1878) CS, DE
DI: Africa to India
OR: AR, Ast, CF, CE, FE, MH, PR, SI, SP (Simon 1898; Hirst 1911, as *Lycosa urbana*; Bowler *et al.* 1999; Saaristo 1999)
BLS: CS, DE

09 Family MITURGIDAE Lehtinen, 1967 - forest-floor spiders
Palicanus Thorell, 1897
P. caudatus Thorell, 1897
DI: China, Myanmar, Indonesia
OR: SI (Saaristo 1999, as Miturgidae: *Gen. sp. ign.*)
BLS: DE

10 Family OCHYROCERATIDAE Fage, 1912 - midget ground weavers
Roche Saaristo, 1998
R. roche Saaristo, 1998
DI: Endemic
OR: MH (Saaristo 1998)
BLS: CS
Theotima Simon, 1893
T. minutissima (Petrunkevitch, 1929)
DI: Pantropical
OR: CE, MH, SI (Brignoli 1980, as *Speocera bonaspei*; Saaristo 1998, 1999)
BLS: AR

11 **Family OONOPIDAE** Simon, 1890 - dwarf hunting spiders

Brignolia Dumitresco & Georgesco, 1983

B. cubana Dumitresco & Georgesco, 1983

DI: Cuba

OR: AR, CE, MH, Pov, SI (Bowler *et al.*1999; Saaristo 1999, 2001b)

BLS: BI

Ischnothyreus Simon, 1892

I. peltifer (Simon, 1891)

DI: USA to Panama, West Indies, St. Helena

OR: AR, CS, CE, MH, NO, SI (Benoit 1979, as *Ischnothyreus sechellorum*, Bowler *et al.*1999; Saaristo 1999, 2001b)

BLS: DE, NO

I. sp. (j)

BLS: BI, CR

Lionneta Benoit, 1979

L. sp. (j)

BLS: MA

Lionneta n. sp.

DI: Endemic

OR: None

BLS: CC(f), CR(m), GS(m)

Lisna Saaristo, 2001

L. trichinalis (Benoit, 1979)

DI: Endemic

OR: AR, CE, MH, PS, SI (Benoit 1979, as *Gamasomorpha trichinalis*, Bowler *et al.*1999 and Saaristo 1999, as *"Gamasomorpha" trichinalis*; Saaristo 2001b)

BLS: DE

Opopaea Simon,1891

O. deserticola Simon,1891

DI: USA, West Indies

OR: Asn, CS, CE, Faq, Pov (Saaristo 2001b)

BLS: BI

O. lena Suman, 1965

DI: Hawaii

OR: AR, CE, MH, PS, PR, SI (Benoit 1979, as *Gamasomorpha ladiguei*; Bowler *et al.*1999; Saaristo 1999, as *"Gamasomorpha" ladiguei*; Saaristo 2001b)

BLS: BI

Orchestina Simon, 1882

O. justini Saaristo, 2001

DI: Endemic

OR: SI (Saaristo 1999, as *Orchestina sp. ign.*; Saaristo 2001b)

BLS: CC, CS, NO

12 Family OXYOPIDAE Thorell, 1878 - lynx spiders
Oxyopes Latreillei, 1804
O. dumontii (Vinson, 1863)
DI: Africa, Madagascar to Seychelles
OR: AR, MH, PR, SI (Benoit 1978b; Bowler *et al.*1999; Saaristo 1999)
BLS: BI, FE, MA

13 Family PHOLCIDAE C. L. Koch, 1851 - daddy-long-legs spiders
Cenemus Saaristo, 2001
C. n. sp.
DI: Endemic
OR: None
BLS: MA
Modissimus Simon, 1893
M. culicinus (Simon, 1893)
DI: North, South America, Congo, Hawaii, Marshal Is.
OR: AR. CS, CE, CR, GS, MH, PS, PR, SI (Bowler *et al.*1999; Saaristo 1999, as *Hedypsilus culicinus*; Saaristo 2001a)
BLS: NO

14 Family SALTICIDAE Blackwall, 1841 - jumping spiders
Baviola Simon, 1898
B. spatulata Wanless, 1984
DI: Endemic
OR: MH, SI (Wanless 1984; Saaristo 1999)
BLS: CR, FE

15 Family SCYTODIDAE Blackwall, 1864 - spitting spiders
Soeuria Saaristo, 1997
S. soeur Saaristo, 1997
DI: Endemic
OR: CE, PS, SI (Saaristo 1997, 1999)
BLS: BI, CC, DE, MA, NO

16 Family SELENOPIDAE Simon, 1897 - flatters or wall spiders
Selenops Dufour, 1817
S. secretus Hirst, 1911
DI: Endemic
OR: AR, CE, FR, LO, MH, PR, SI (Simon 1898, as *S. radiata*; Hirst 1911; Benoit 1978d; Bowler *et al.*1999; Saaristo 1999)
BLS: CR, DE, MA, NO

17 Family SPARASSIDAE Simon, 1874 (= Heteropodidae Thorell, 1874) - giant crab spiders
Heteropoda Latreillei, 1804
H. venatoria (Linnaeus, 1758)
DI: Pantropical
OR: BI, CE, Dsr, MH, Pov, PR, SI (Simon 1898, as *H. regia*; Hirst 1911, as *H. regia*; Benoit 1978c; Saaristo 1999)
BLS: BI, CC, MA, NO

Rhacocnemis Simon, 1898
R. guttata (Blackwall, 1877)
DI: Endemic
OR: CF, CR, MH, PR, SI (Blackwall 1877, as *Sparassus guttata*; Simon 1898; Hirst 1911, as *S. guttatus* & *S. elegans*; Benoit 1978c)
BLS: CC, CR, FE, MA, NO

18 Family SYMPHYTOGNATHIDAE Hickman, 1931 - dwarf orb-weavers
Anapistula Gertsch, 1941
A. seychellensis Saaristo, 1996
DI: Endemic
OR: SI (Saaristo 1996)
BLS: CR

19 Family TETRAGNATHIDAE Menge, 1866 - long-jawed orbweavers and golden orbweb and silver marsh spider
Leucauge Darwin in White, 1839
L. argyrescens Benoit, 1978
DI: Endemic
OR: MH, PR, SI (Benoit 1978b; Saaristo 1999)
BLS: CR, DE, FE, MA, NO
Nephila Leach, 1815
N. inaurata (Walckenaer, 1841) [palm spider]
DI: South Africa to Seychelles
OR: Ald, AR, Coe, CE, CR, FR, LD, MH, Pov, PR, SI, StJ (Blackwall 1877, as *N. inaurata* and *N. plumipes*; Simon 1893, as *N. madagascariensis*; Simon 1898, as *N. madagascariensis*; Hirst 1911; Saaristo 1978; Benoit 1978b as *N. inaurata* ssp. *Madagascariensis*; Roberts 1983; Bowler *et al.*1999; Saaristo 1999)
B. vanmoli Wanless, 1894
DI: Endemic
OR: MH, SI (Wanless 1984; Saaristo 1999)
BLS: CC, FE
Cosmophasis Simon, 1901
Cosmophasis n. sp.
DI: Endemic(?)
OR: None
BLS: BI
Epocilla Thorell, 1887
Epocilla n. sp.
DI: Endemic(?)
OR: None
BLS: CC
Goleba Wanless, 1890
G. pallens (Blackwall, 1877)
DI: Endemic
OR: Ald, DE, MH, SI (Blackwall 1877, as *Lyssomanes pallens*; Hirst 1911, Wanless 1980, 1984, all as *Asamonea pallens*; Saaristo 1999)
BLS: CC, CS, CR, DE, FE, MA, NO

Hasarius Simon, 1871
H. adamsonii (Audouin, 1826)
DI: Cosmopolitan
OR: CE, CR, MH, PR, SI (Saaristo 1978, as *H. albocircumdatus*; Wanless 1984; Saaristo 1999)
BLS: CS, CR, DE, FE, TE
Heliophanus C. L. Koch, 1833
H. activus (Blackwall, 1877)
DI: Endemic
OR: AR, CR, MH, PR, SI (Blackwall 1877, as *Salticus a.*; Simon 1893; Saaristo 1978; Wanless 1984; Bowler *et al.*1999; Saaristo 1999)
BLS: CC, CS, CR, DE, FE, GS, MA, NO
Hyllus C. L. Koch, 1846
H. acutus (Blackwall, 1877)
DI: Endemic
OR: AR, DE, CF, CE, MH, PR, Prd, SI (Blackwall 1877, as *Salticus a.*; Saaristo 1978, as *"Salticus" a.*; Wanless 1984; Bowler *et al.*1999; Saaristo 1999)
BLS: BI, CC, DE, FE, MA
Myrmarachne MacLeay, 1838
M. constricta (Blackwall, 1877)
DI: Endemic
OR: AR, DE, LO, MH, PR, SI (Blackwall 1877, as *Salticus a.*; Wanless 1984; Gerlach *et al.*1997; Bowler *et al.*1999; Saaristo 1999)
BLS: CC, CS, CR, DE, FE, MA, NO

Plexippus C. L. Koch, 1846
P. paykullii (Audouin, 1826)
DI: Cosmopolitan
OR: BI, Coe, CE, LD, VA, MH, PR, SI (Simon 1898; Hirst 1911; Wanless 1984; Saaristo 1999)
BLS: FE, MA
Tetragnatha Latreillei, 1804
T. demissa L. Koch, 1872
DI: South Africa, Australia to Tonga
OR: Ald (Roberts 1983, as *T. grenda*)
BLS: CC
T. mandibulata Walckenaer, 1842
DI: West Africa, Bangladesh to Philippines, Australia
OR: Coe, LD, MH, PR, SI (Blackwall 1877, as *T. minax*; Simon 1893, as *T. minax*; Hirst 1911; Saaristo 1978; Benoit 1978a; Saaristo 1999)
BLS: NO
T. marginata (Thorell, 1890)
DI: Myanmar to New Caledonia
OR: MH, SI (Saaristo 1978, 1999)
BLS: CS
Tetragnatha sp. (j)
BLS: DE, FE

20 Family THERIDIIDAE Sundevall, 1833 - cobweb spiders

Achearanea Strand, 1929

A. labarda Roberts, 1983

DI: Endemic
OR: Ald, AR (Roberts 1983; Bowler *et al.*1999)
BLS: CS, DE, MA

Argyrodes Simon, 1864

A. argyrodes (Walckenaer, 1837)

DI: Mediterranean to West Africa, Seychelles
OR: Ald, MH (Saaristo 1978; Roberts 1983; Saaristo 1999, 2000)
BLS: FE, TE

A. cognatus (Blackwall, 1877)

DI: Endemic
OR: MH, PR, SI (Blackwall 1877, as *Epeira cognatus*; Simon 1898; Hirst 1911; Saaristo 1978; Roberts 1978; Gerlach *et al.* 1997; Saaristo 1999, 2000)
BLS: CC, FE, NO

A. recurvatus Saaristo, 1978

DI: Endemic
OR: MH, SI (Saaristo 1978; Roberts 1978; Gerlach *et al.*1997; Saaristo 2000)
BLS: DE, MA

A. rostratus Blackwall, 1877

DI: Endemic
OR: MH, PR, SI (Blackwall 1877, as *Epeira rostratus*; Simon 1893; Hirst 1911; Saaristo 1978; Roberts 1978; Gerlach *et al.* 1997; Saaristo 1999, 2000)
BLS: CC, CR, DE, FE, MA, NO

Coleosoma O. Pickard-Cambridge, 1882

C. adamsoni (Berland, 1935)

DI: Pantropical
OR: CE, MH, SI (Saaristo 1978; Roberts 1978, as *Theridion a.*; Saaristo 1999)
BLS: DE, MA, NO

C. blandum O. Pickard-Cambridge, 1882

DI: Cosmopolitan
OR: AR, MH, SI (Saaristo 1978, as *Crysso acrobeles*; Roberts 1978; Bowler *et al.*1999; Saaristo 1999)
BLS: CS, DE, FE, MA, NO

C. floridana (Banks, 1900)

DI: Pantropical, greenhouses in Europe
OR: AR, CE, LD, MH, PR, SI (Saaristo 1978; Roberts 1978; Bowler *et al.*1999; Saaristo 1999)
BLS: CC, CS, CR, DE, FE, MA, NO

Dipoena Thorell, 1869
D. menustya Roberts, 1983
DI: Endemic
OR: Ald (Roberts 1983)
BLS: MA
D. spundana Roberts, 1978
DI: Endemic
OR: AR, LD, SI (Roberts 1978; Bowler *et al.*1999; Saaristo 1999)
BLS: DE, NO
Theridion Walckenaer, 1805
T. clabnum Roberts, 1978
DI: Endemic
OR: AR, CE, LD, MH, PR, SI (Roberts 1978; Bowler *et al.*1999; Saaristo 1999)
BLS: CC, CR, DE, NO

21 Family THERIDIOSOMATIDAE Simon, 1881 - ray spiders
Theridiosomatidae sp.
BLS: GS(j.)
Andasta Simon, 1895
A. benoiti (Roberts, 1978)
DI: Endemic
OR: MH (Roberts 1978)
BLS: CC, DE, FE, MA, NO

22 Family THOMISIDAE Sundevall, 1833 - crab spiders
Firmicus Simon, 1895
F. insularis (Blackwall, 1877)
DI: Endemic
OR: MH, SI (Blackwall 1877, as *Thomisus insularis*; Simon 1898, as *F. marginatus*; Hirst 1911; Benoit 1978e)
BLS: DE
Thomisus Walckenaer, 1805
T. stenningi Pocock, 1900
DI: Africa
OR: AR, CR, MH, PR, SI (Simon 1898 and Benoit 1978e, as *Thomisus citrinellus*; Bowler *et al.*1999, Saaristo 1999)
BLS: DE, FE, NO

23 Family ULOBORIDAE Thorell, 1869 (3; 20-252) - hackled-orbweb weavers
Uloborus Latreillei, 1806
U. plumipes Lucas, 1846
DI: Old World
OR: AR, CR, MH, PR, SI (Blackwall 1877, as *U. luteola*; Saaristo 1978, as *Uloborus sp. 1.*; Benoit 1978b; Gerlach *et al.*1997; Bowler *et al.*1999; Saaristo 1999)
BLS: BI, CC, CS, CR, DE, FE, GS, MA

ASSESSING CONSERVATION VALUE OF ISLANDS IN THE CENTRAL SEYCHELLES

BY

MICHAEL J. HILL[1]

ABSTRACT

Data gathered in the island assessment process are used to prioritise the islands visited (and, by extrapolation, other islands in the central Seychelles) for conservation value, particularly in regard to conservation of endemic land birds. Several criteria of particular importance for endemic bird conservation are identified, and these could be used in more rapid assessment of other islands in the area for conservation.

INTRODUCTION

Several authors have attempted to formalise criteria to evaluate land for conservation purposes in order that the most appropriate sites can be selected for protection (see, for example, Smith and Theberge, 1986; Usher, 1986). There is no simple consensus that can be applied in all situations although a number of biological and physical indicators that are commonly cited include the presence of rare species of animals and plants, or rare habitats, diversity (of species or habitats), size, "representativeness" or "naturalness", and the relative fragility of an area or habitat (Bibby, 1998). In addition, social, cultural and management practicalities need to be considered, especially where an area has multiple use (such as scientific research or recreation in addition to conservation).

While many criteria emphasise existing conservation values, the concept of "potential value" (Ratcliffe, 1977) or, in this case, "rehabilitation value", is particularly important for the islands of the granitic Seychelles. The original habitats of all islands have been profoundly altered in the past 200 years. Active human intervention is likely to be necessary to realise the conservation value of any of the small or medium-sized islands. However, the term *restoration* (implying a return to the original state) is probably inappropriate for any such process involving the removal of alien species and introduction (or re-introduction) of native species. Instead, a partial restoration or *rehabilitation* is probably the most that can be achieved (Simberloff, 1990). The original vegetation and habitats of the smaller islands are likely to remain the subject of speculation; written records of island biota prior to human settlement are patchy and equivocal in nature and, while a fossil record may exist, conditions for preservation of biological remains such as pollen are more likely to occur on the larger, wetter islands.

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The island assessment procedure quantified various aspects of the current flora and vegetation, and fauna of the islands visited and these data can be used to develop priorities for island (and species) conservation in the Seychelles. In this report, data gathered on the 10 islands described in individual island reports will be considered.

A large number of biological factors need to be considered in determining priority islands for conservation. Major factors include:

1) island size;
2) proximity of other islands;
3) island topography;
4) range of habitats (existing and potential);
5) extent of natural or near-natural vegetation (existing and potential);
6) existing biodiversity values;
7) invertebrate prey availability (existing and potential);
8) presence/absence of invasive introduced animals;
9) presence/abundance of invasive introduced plants;
10) pollutants and pathogens (existing and potential).

BIOLOGICAL AND PHYSICAL FACTORS

Island Size

Island size is an important factor contributing to conservation value, through its influence on biological/historic features including:

- potential populations of endemic species;
- possibility of successful eradication of introduced species (human population also important);
- range of available habitats and climate (geology, altitude range also important);
- history of exploitation (accessibility, human population also important).

Drawing on the theories of island biogeography (MacArthur and Wilson, 1967), it is often recommended that protected areas should be as large as possible to protect larger populations of individual species and to maximise the number of different species protected (Bibby, 1998). Larger populations are less vulnerable to extinction through stochastic events than smaller populations and may contain greater genetic diversity than smaller populations (Lande & Barrowclough, 1987).

The central Seychelles is a small, isolated archipelago with a high degree of endemism among its species (Nussbaum, 1984b). The granitic islands, together with Bird and Denis, have a total land area of only 23,140 ha (approximately 90 square miles) (Seychelles Survey/Directorate of Overseas Surveys, unpublished data). This small potential range means that technically all endemic birds of the Seychelles qualify as threatened under IUCN criteria (Collar *et al.*, 1994). Within the granitic Seychelles, island size varies considerably. Although there are over 40 islands (excluding unvegetated rocks), most are very small (Fig. 1). Only four islands exceed 1,000 ha in size and the largest individual island, Mahé, accounts for 66% of the total land area.

While the largest islands of the Seychelles would appear to offer greatest potential for conservation, several factors act to reduce their importance for conservation of endemic land birds. Mahé, Praslin and La Digue all have large human populations and associated problems: multiple ownership, pressure of development (especially important on coastal plateaux), the presence of large populations of domestic and feral animals, and regular traffic of cargo between islands (increasing the probability of transfer of alien predators and exotic plants). This increases the difficulty of eradicating introduced mammalian predators and the likelihood of re-invasion.

The smallest islands, and even some of the unvegetated rocks, may have considerable conservation value as many have escaped the introduction of introduced predators and few have human populations. Such islands are of greatest value as nesting sites for seabirds and for some species of native reptiles and invertebrates that can tolerate arid conditions but cannot survive in the presence of introduced predators.

The island assessment work concentrated on small- to medium-sized islands (between 28 and 286 ha in size) which offer some of the benefits of smaller islands (single ownership, small or no human population, potential for eradication of introduced species) but are large enough to support viable populations of endemic birds. Within the size range considered, larger islands are likely to offer the greatest opportunity for rehabilitation of a range of native ecosystems and endemic species.

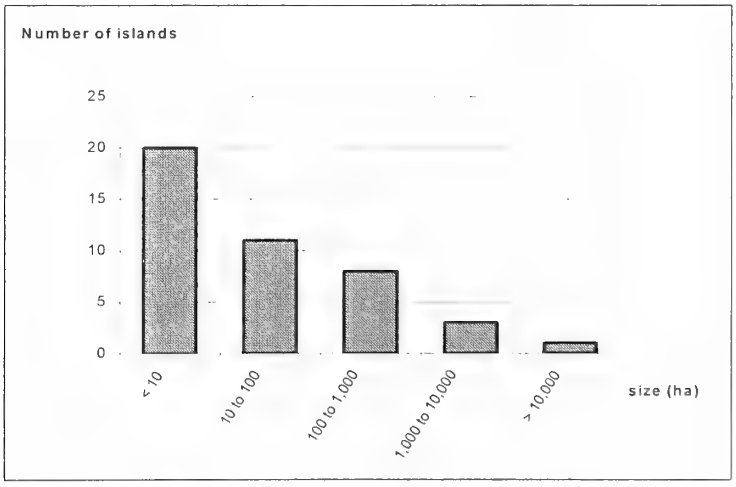

Figure 1. Size distribution of islands in the central Seychelles.

Proximity of Other Islands

The proximity of other islands helps to determine the rates of invasion by species (MacArthur and Wilson, 1967). Neighbouring islands can act as a source of invasion, especially by mobile organisms such as birds (and hence, for example, bird-distributed plant species). The proximity of Thérèse and Conception to the island of Mahé (which supports most of the endemic plants of Seychelles) probably contributes to the large number of endemic plant species on these small islands.

In theory, a cluster of small proximate islands under conservation management could provide important conservation benefits, especially for vagile organisms such as

birds. Occasional natural transfer of individuals between islands could ensure continued gene flow between populations and allow populations to function as a single, large population (such transfers have been observed in Seychelles magpie-robin: Shah and Parr, 1999). This might be particularly important for Seychelles birds; eradication of introduced pests and management for conservation is much easier on smaller, rather than large, multiple-owner islands. Groups of proximate islands could be gradually established a part of a long-term conservation strategy.

Proximity does, however, carry a number of disadvantages; in particular, it allows the spread of diseases and the invasion of exotic species. Thérèse Island, less than 1 km from Mahé, has an established infection of takamaka wilt disease, while Conception, further from the mainland, does not (although takamaka trees are found there). But proximity alone cannot determine invasion of such harmful species. Factors such as wind direction also play a role in dispersal/invasion: North Island, 7 km from Silhouette, has both takamaka wilt and the invasive weedy shrub *Clidemia hirta*, both probably invaders from Silhouette (carried by mobile vectors). Some invasive species are carried by human vectors, for example the crazy ant *Anoplolepis gracilipes*, carried to new islands with plants or other cargo. In this case, the amount of human traffic (and the nature of cargoes moving between islands) will influence invasion to a greater extent than absolute distance.

Island Topography

Island topography (range of altitudes, presence/absence of "plateau") has an important influence on the rehabilitation potential of islands.

In general, maximum island altitude is closely correlated to island size (Pearson Correlation Coefficient = 0.828; $p < 0.001$). For larger islands such as Mahé, altitude has an important influence on rainfall; rainfall is greater at higher altitude stations and also at lower stations that are not in the rain shadow of hills (Walsh, 1984). Constant high humidity and high rainfall allow mist forests to thrive on the hills of Mahé and Silhouette. However, on smaller (lower) islands altitudes are probably less important in determining climate. More important factors influencing the length and severity of dry seasons include an island's position relative to high islands (rain shadow effects, etc.) and its position within the archipelago (islands to the north have a shorter dry season than those further south: Walsh, 1984). Maximum altitude alone is a probably poor indicator of rehabilitation potential for islands.

However, topography (and, in particular, size of plateau) has a greater degree of biological importance. The plateaux are composed of recent (less than 6,000 years old) calcareous deposits. On some islands (including Cousin, Frégate, Bird) these have combined with guano to form cemented sandstone (Braithwaite, 1984). In addition to the calcareous deposits of plateaux, alluvial deposits occur at the mouth of rivers and streams. These conditions are rare on small islands and tend to be marked by mangrove habitats. The alkaline soils of plateaux are generally more fertile than those of uplands (Braithwaite, 1984). The productivity of terrestrial invertebrates appears higher in plateau habitats than on hills, so birds feeding on ground invertebrates (such as Seychelles magpie-robins) are likely to reach greater densities on plateaux and islands with large plateaux to support larger populations.

Plateaux are also easier to manage effectively than hill habitats. While plateau woodland can be dense (especially where there is heavy regeneration of coconut), plateaux are not physically inaccessible as rocky slopes and glacis can be. Figure 2 shows the extent of land in altitude categories for all islands studied. Table 1 has approximate extents of true coastal "plateaux" (areas of predominantly coralline deposits of altitude 5 m asl or less).

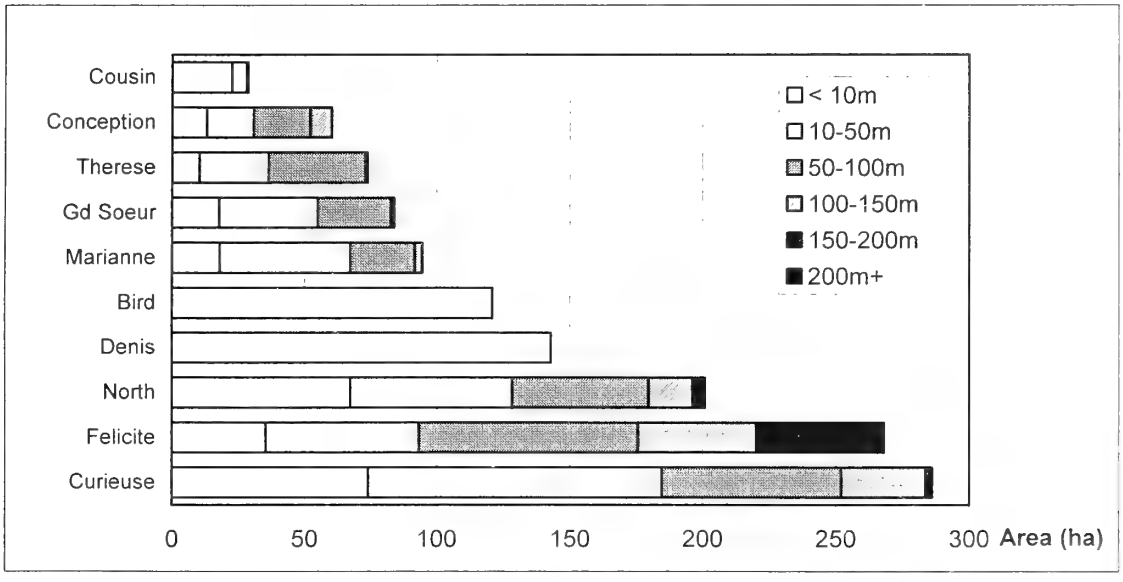

Figure 2. Altitude distribution of land area.
From maps of Seychelles, Directorate of Overseas Surveys/Seychelles Survey.

Table 1. Area of coastal plateau. Figures in parentheses = area excluding mangrove habitats.

Island	Approx. area (ha.)
Denis	143
Bird	121
North	49
Curieuse	48 [39]
Cousin	19 [18]
Félicité	4
Grande Soeur	4
Thérèse	3
Marianne	2
Conception	0

Coralline islands are similar to the plateaux of granitic islands; Denis Island even has freshwater marsh, a feature of coastal areas on granite islands. Of the granitic islands, those with the largest plateaux are Curieuse and North islands. For both these islands, the

plateaux alone are larger than an island such as Conception. Although Félicité is larger than North, it has a significantly smaller plateau and is a much higher island. This may explain why Félicité has a number of endemic plant species not present on North Island (see "Existing Biodiversity Values", below).

Range of Habitats

Habitat diversity is a commonly used criterion for ranking land for conservation purposes (Bibby, 1998). In general, it is felt preferable to conserve areas with the widest range of habitat types. The greater the number of habitats protected, the greater are the opportunities to preserve a wide range of plant and invertebrate species (although not all habitats are equally important to conservation: see below). However, small islands cannot conserve all the habitats represented in the Seychelles; high-altitude biomes are entirely unrepresented on the islands assessed.

In general, larger islands have a greater range of habitat types than smaller ones and granitic islands have a larger range of habitat types than coralline islands of similar size.

Extent of Natural or Near-Natural Habitats

All islands in the granitic Seychelles have been altered (usually to a large extent) by human intervention and the greatest change has occurred at middle to lower altitudes (below about 500 m). Thus, there are no examples of small, pristine islands to act as blueprints for island restoration, and records of early travellers offer little useful information. The original vegetation and habitat structure of islands cannot be exactly reconstructed. However, habitats can be broadly classified according to their degree of "naturalness"; most islands have been cleared for coconut plantation and, where this has fallen into disuse, the regenerating forest and scrub habitats are dominated by either introduced or native species. "Near-natural" habitats can be defined as those dominated by native species, in vegetation types which would persist on islands prior to human interference (usually, woodland or scrub). Generally, islands with a greater number of different near-natural habitats and larger areas of near-natural habitats should be preferred to those which are dominated by anthropogenic habitats. Of these habitats, woodland is probably the most important for endemic birds.

Table 2 shows the approximate extent of near-natural habitats on the islands studied. Habitats are separated into native woodland, scrub (including beach crest vegetation), mangrove and other wetland. Wetlands, especially freshwater wetlands, have conservation importance for a number of reasons:

- They provide habitat for a number of endemic freshwater invertebrates and vertebrates (Stevenson *et al.,* 1997);
- Invertebrates with aquatic larvae often have winged adults which may be taken as food by endemic insectivorous birds (e.g. black paradise flycatcher; Watson, 1991); and
- They are nationally threatened (since most wetlands in Seychelles are small, they are easily threatened by pollution, drainage and other human impacts: Stevenson *et al.,* 1997; Shah, 1997).

Table 2. Approximate extent of near-natural habitats on islands studied.

Island	Area (ha)				
	Native woodland	Native scrub (including beach crest veg.)	Mangrove	Other wetland	Total
Bird	18	50	0	0	68
	0	4	0	0	4
Cousin	20	4	1	<1	25
Curieuse	55	87	5	1	148
Denis	28	6	0	<1	34
Félicité	131	2	0	< 1	135
Grande Soeur	21	1	0	< 1	22
Marianne	7	7	0	< 1	14
North	16	1	0	1	17
Thérèse	2	1	1	< 1	4

The largest extent of near-natural habitats is on Curieuse which has the most woodland/scrub and the greatest area of wetlands.

Existing Biodiversity Values

Biological diversity is one of the most frequently used measures of conservation value (Bibby, 1998). It can be expressed as the total number of species (species richness), or (more useful for conservation purposes) the number of endemic, restricted-distribution or threatened species (Stattersfield *et al.,* 1998). Because areas of high biodiversity for different taxonomic groups often overlap (Bibby, 1998), conservation of areas of high biodiversity value in well-studied groups will often lead to conservation of less well-known taxa. Thus, in Seychelles, many endemic invertebrates are associated with endemic plants (especially palms and *Pandanus* species). During the island assessment work, species lists were made for a number of different taxonomic groups, the most complete being for plants and land birds. The importance of islands for conservation of these groups is compared below.

Plants. The majority of plant species identified were exotic. Of 428 species identified, at least 262 (61.2%) are non-native. However, the proportion of the total flora composed of exotic species varied between islands (Table 3). In general, the islands that have the greatest proportion of exotics are coralline islands with a restricted natural flora (Bird, Denis), or those with a history of agricultural production (North). Islands with no permanent human population (Thérèse, Conception, Marianne) tend to have floras less dominated by exotic species.

Table 3. Composition of angiosperm flora of central Seychelles islands.

	Total no. species	Percentage of total flora		
		Introduced	Native	Endemic
Bird	103	68.9	21.4	0
Conception	84	44.0	41.7	10.7
Cousin	92	51.1	34.8	2.2
Curieuse	230	57.0	35.2	10.0
Denis	174	68.4	21.3	0
Félicité	175	49.1	41.7	13.1
Grande Soeur	116	57.8	32.8	5.2
Marianne	146	53.3	32.9	5.5
North	175	61.7	24.0	1.1
Thérèse	173	53.7	37.1	9.7

The plant species of greatest conservation concern are those endemic to the Seychelles and a small number of species that, while not endemic, are threatened with extinction nationally or globally. Procter (1974) recognised 72 species endemic to the Seychelles, but some of these taxa were revised by Friedmann (1994). Carlström (1996a) suggests that the original number of endemic taxa found on the islands was 84 of which eight are now extinct.

Endemic species can be found in a range of habitats from sea level to the highest peaks although the largest number of species are found at intermediate altitudes, 300 – 600 m above sea level (Carlström, 1996a). Most of the smaller islands in the archipelago are lower than 300 m at the highest point and their potential endemic flora is therefore restricted. In addition, environmental change on small islands has tended to be more complete than on the larger islands which may have led to local extinctions of more specialised endemics.

In the current survey, 31 endemic taxa (27 full species, four subspecies or varieties) were recorded. No endemic plants were recorded on the two coralline islands Bird and Denis. On the granitic islands the number of endemic taxa ranged from two (on Cousin and North Islands) to 23 (on Curieuse and Félicité). The most widespread endemics were *Pandanus balfourii* and *Ficus reflexa* ssp. *seychellensis* which occurred on all of the granitic islands surveyed. While larger islands tend to support a greater number of endemics than smaller ones, other factors also appear important including distance to large islands and environmental history.

In addition to her work on threatened endemic plants of the granitic islands, Carlström (1996a) identified 16 native (non-endemic) species that she regarded as threatened on the basis of declining population and/or small area of occurrence within Seychelles. Three of the species concerned were identified in the current study, *Lagrezia madagascariensis* ("Critically endangered") on Conception, *Disperis tripetaloides* ("Vulnerable") on Marianne, Grande Soeur, Curieuse and Thérèse; and *?Tylophora coriacea* ("Vulnerable") on Denis. However, given the previous paucity of data on the distribution of plants (especially inconspicuous herbs such as *L. madagascariensis* and *D. tripetaloides*) on smaller islands of Seychelles, the designation of these three species should be regarded as provisional. *D. tripetaloides,* in particular, appears relatively

widespread although probably often overlooked due to its small stature and ephemeral flowering stems.

Land birds. The short period of time on each island did not allow a comprehensive list of migrant and vagrant species to be made but most resident species were recorded. In total, 37 species of land birds (including waders and herons) were recorded. Of these, two were vagrants, 14 were migrants and 21 were resident species. Of the resident birds, 10 species were endemic, six introduced and five native. However, the only ubiquitous species were four introduced birds: barred ground dove *Geopelia striata*; Madagascar turtle dove *Streptopelia picturata*;, common mynah *Acridotheres tristis*; and Madagascar fody *Foudia madagascariensis*. Five endemic species were recorded on only one of the islands surveyed. The most widespread endemic birds were Seychelles blue pigeon *Alectroenas pulcherrima* (nine islands) and Seychelles sunbird *Nectarinia dussumieri* (eight islands).

For resident land birds, there is no significant relationship between island area and the number of resident species. However, there is a linear inverse relationship between the species richness and distance to the nearest large island (defined as islands over 1000 ha) ($p = 0.030$) and a similar relationship with distance to the nearest island of any size ($p = 0.049$). These results contrast with those of Diamond (1984), who found that isolation was a better predictor of *original* species richness of bird communities but not significant for *current* species richness which was better explained by island area. However, Diamond omitted some islands such as Cousin and Cousine from his calculations on the basis that they were too close to Praslin to be treated as independent.

In fact, species number alone gives little insight into the conservation importance of islands. North Island supports the same number of native species as Cousin, but whereas Cousin has five endemics, including three endangered endemics, only three endemic species were recorded on North Island and one of these species (Seychelles Swiftlet *Collocallia elaphra*) did not appear to be normally resident. Table 4 shows the number of endemic land bird taxa (species and subspecies) recorded on each island, and ranks the islands studied for importance.

Table 4. Number of endemic and threatened species (plants and birds) identified.

	No. endemic plants	No. threatened native plants	Rank (plants)	No. endemic land birds	Rank (birds)
Bird	0	0	10	0	11
Conception	9	1	4	3	5
Cousin	2	0	7.5	5	1
Curieuse	23	1	1	3	5
Denis	0	1	9	1	10
Félicité	23	0	2	2	8.5
Grande Soeur	6	1	6	2	8.5
Marianne	8	1	5	3	5
North	2	0	7.5	3	5
Thérèse	17	1	3	3	5

There is no significant correlation between endemic plant and bird richness (Spearman rank correlation coefficient $r_s = 0.418$, $p>0.10$). The lack of correlation between importance ratings for plants and birds stems from the different factors underlying their distributions. For several endangered endemic land birds (including Seychelles magpie-robin, warbler and fody) the primary factor determining current distribution appears to be introduced mammalian predators, principally cats and rats. The distribution of endangered endemics is thus partially a relict (due to survival of birds on predator-free islands such as Frégate and Cousin) and in part an artificial construct as further islands (such as Cousine, Aride) were freed of introduced predators and endemics translocated. Predation may also play a role in the decline of endangered endemic plants through the destruction of flowers and fruit before maturity (Carlström, 1996a). However, direct predation appears to be less of a threat to the survival of plant species than it is to birds. Grazing mammals, such as goats, are not presently a threat to endangered plant communities in the granitic Seychelles. The major threats to endemic and endangered plants are habitat destruction and invasive plants (Fleischmann, 1997), although for certain species direct exploitation may also be significant (Shah, 1997).

However, although the ranking of islands for bird and plant conservation differ, there are some similarities between the lists in Table 4. The coralline islands Bird and Denis, which are remote from other islands in the archipelago, have low habitat diversity and were most comprehensively affected by human intervention, emerge as the islands with lowest biodiversity rating for both groups. While restoration of granitic islands of the central Seychelles may include the enhancement of existing endemic floras, this would probably be inappropriate on the coralline islands. The lack of endemic species would not in itself prevent these islands being used for translocations of endemic birds (indeed, it might allow a greater degree of environmental intervention prior to translocation and would eliminate the possibility of negative interactions between translocated and pre-existing endemic taxa) but would probably reduce the overall conservation gain.

Invertebrate Prey Availability

Invertebrates were collected using several different methods to provide data on prey abundance for insectivorous birds. The techniques giving comparative data of greatest importance for endemic birds are pitfall trapping and leaf-invertebrate counts.

Pitfall trapping. Results suggested that invertebrate density was highest on coralline islands, followed by the plateaux of granitic islands. Hills on granitic islands had lower invertebrate density. There appeared to be no significant association between vegetation parameters and the pitfall catch, although trapping was carried out within a narrow range of conditions (in woodland and scrub). While the taxonomic composition of assemblages on coralline islands differed from those on most granitic islands, they were similar to those on Cousin Island (which already supports a population of Seychelles magpie-robin). This suggests that the priority islands for Seychelles magpie-robin introduction are the coralline islands (Denis, Bird) or islands with large plateaux (Curieuse, North) irrespective of the nativeness of their vegetation.

However, invertebrate density is only one aspect of magpie-robin feeding ecology. Food availability is also dependent on the suitability of habitat for feeding. On Frégate, magpie-robins feed primarily in open areas free of herbaceous vegetation (Watson *et al.*, 1992). On Denis Island, herbaceous and shrub layer vegetation was generally dense with little ground free of ferns (*Nephrolepis* and *Phymatosorus*) and young coconuts *Cocos nucifera*. Management of Denis Island's vegetation would be necessary before introduction. On Bird Island, the high density of crazy ants *Anoplolepis gracilipes* is likely to influence magpie-robin behaviour, possibly disrupting feeding and nesting.

Leaf invertebrate counts. These counts give information on the food availability for small insectivorous birds including Seychelles warbler, paradise flycatcher and white-eye. The density of invertebrates on leaves varies greatly between wet and dry seasons but, in general, native plants have a higher density of invertebrates associated with them than do introduced species. Densities of invertebrates on *Morinda citrifolia* are comparable with those on native rather than introduced species. There is no significant difference in invertebrate density between trees in hill and plateau locations. Islands with the greatest potential food supply for small insectivorous species are those with the largest number of native trees (Félicité, Curieuse). However, the smallest island studied (Cousin) supports a population of Seychelles warbler suggesting that (with habitat restoration) any of the islands studied would be large enough to support this species.

Presence/Absence of Introduced Animals

Animal communities of remote oceanic islands tend to be more susceptible to invasion than communities on continental land masses (Elton, 1958) and introduced species of animals and plants have a disproportionately large impact upon island ecosystems (Williamson, 1996). Exotic species can have far-reaching effects; introduced animal species, through patterns of grazing and predation, often favour the establishment and spread of exotic plant species over native flora (Stone *et al.*, 1992). In general, only a small proportion of alien species become established as serious pests. However, since there are no native terrestrial mammals in the Seychelles, it is likely that all of these species have an impact upon natural communities (Racey and Nicoll, 1984).

In addition to mammals, animal introductions to the granitic Seychelles have included birds (seven species established; Diamond, 1984; Skerrett *et al.*, 2001), reptiles and amphibians (at least four species established; Cheke, 1984; Nussbaum, 1984a and b), freshwater fish (one or more species established) and an unknown number of invertebrate species. For many of these species, it is impossible to assess their ecological impact. Information is more complete for the more conspicuous vertebrates, particularly mammals and birds.

In Seychelles, the mammal species with the greatest ecological impact are cats *Felis catus* and rats *Rattus* spp., which are predators of native species and (to a lesser extent) rabbits *Oryctolagus cuniculus*, which can destroy native vegetation. Cats and rats are widely established on islands in the archipelago and were among the earliest introductions to the islands; cats and ship rats *Rattus rattus* were probably first introduced around the time of the earliest permanent human settlement of the Seychelles in the late eighteenth century. The Norway rat *Rattus norvegicus* is a more recent introduction with

a relatively restricted distribution (Hill, in prep). These alien predators have long been associated with the loss of endemic birds (Newton, 1867: Diamond, 1984). Rats and cats have been implicated in the extinction of at least 27 populations of Seychelles land birds (Diamond and Feare, 1980). Feral rabbits are today restricted to one small seabird island, although domesticated animals are commonly kept in captivity on larger islands. Other alien mammals are less destructive or less firmly established: these include black-necked hares *Lepus nigricollis*, mice *Mus domesticus,* tenrecs *Tenrec ecaudatus*, dogs *Canis familiaris*, cattle *Bos taurus* and pigs *Sus domesticus*.

Of the small number of introduced land bird taxa surviving in the Seychelles, several appear to have minimal impact on native species. Three species (barred ground-dove *Geopelia striata,* common waxbill *Estrilda astrild* and Madagascar fody *Foudia madagascariensis*) are largely restricted to open, anthropogenic habitats. The Madagascar turtle dove *Streptopelia picturata picturata* appears to have caused the effective extinction of the endemic race of the same taxon (*S. p. rostrata*) but there is no evidence of ecological differences between the races so any effects on other species are likely to be limited. The most recent land bird species to become established, the ring-necked (rose-ringed) parakeet *Psitticula krameri* appears restricted in population and ecological influence at present (Skerrett *et al.,* 2001).

Two introduced bird species with important ecological effects in near-natural habitats are the barn owl *Tyto alba* and common mynah *Acridotheres tristis.* Barn owls were introduced from East Africa in 1949-52 (Blackman, 1965) in an unsuccessful attempt to control introduced rats. In addition to rats, they take most small birds (in particular, fairy terns *Gygis alba*: Penny, 1974). Mynahs are omnivorous but are nest predators of Seychelles magpie-robin (McCulloch, 1996) and possibly other endemic bird species.

There are many introduced invertebrate species in the Seychelles, some deliberately introduced to provide biological control of agricultural pests (for example, beetles of the family Coccinellidae to control scale insects on crop plants) while other introductions were accidental. At least one introduced invertebrate is known to have important deleterious effects to conservation: the crazy ant *Anoplolepis gracilipes* (Haines *et al,* 1994; Hill in prep). Table 5 shows the distribution of six introduced animals of particular conservation concern, between islands studied.

Table 5. Introduced animal species present on the islands assessed.
Bir = Bird; Con = Conception; Cou = Cousin; Cur = Curieuse; Den = Denis; Fel = Félicité; GSo = Grande Soeur; Mar = Marianne; Nor = North; The = Thérèse
+ = present; (+) = present early 2000, probably eradicated by mid-2001; ? = probably present but not recorded during island assessment survey

	Bir	Con	Cou	Cur	Den	Fel	GSo	Mar	Nor	The
Felis catus	-	+	-	(+)	(+)	+	+	+	+	+
Rattus norvegicus	-	+	-	-	-	-	-	-	-	-
Rattus rattus	-	-	-	+	+	+	+	+	+	+
Acridotheres tristis	+	+	+	+	+	+	+	+	+	+
Tyto alba	-	?	?	+	-	?	?	?	+	?
Anoplolepis gracilipes	+	+	+	-	+	+	-	+	-	+
TOTAL	2	4-5	2-3	3	3	4-5	3-4	4-5	4	4-5

The presence/absence of species on islands does not fully reflect their conservation impact except perhaps for mammalian predators. For non-mammals, density of populations (and hence, impact) may vary greatly between islands. Thus, while *Anoplolepis gracilipes* forms vast colonies and dominates near-natural habitats on Bird Island, it is widely present on other islands without having such severe impacts. The common mynah is found on all islands but is rather rare on Cousin. In the case of cats and ship rats, however, there is usually a simple relationship between the presence of the species on an island and the loss of susceptible native bird species.

Although introduced mammals have a great impact upon native species, it is feasible to eradicate populations. The removal of alien predators in the Seychelles has been directly responsible for the continued survival of at least one endangered endemic bird species, Seychelles magpie-robin. The last surviving population of this species was threatened by the introduction of cats to Frégate in 1958. In 1960, over 80 cats were killed (Penny, 1968), clearing the island of mammalian predators (at least temporarily). In New Zealand, cats have been eradicated on islands as large as 3,000 ha (Veitch and Bell, 1990). Only two of the granitic Seychelles exceed this size (and both of the large islands have permanent human populations, making it difficult to eradicate cats). In July-August 2000, rat and cat eradication was attempted on three medium-sized islands in the Seychelles archipelago, by Don Merton and colleagues from the New Zealand Department of Conservation. Anticoagulant baits were applied aerially (for rats) and ground-baiting and trapping were used to remove cats from Curieuse and Denis Islands. On Frégate Island, only rat baiting was used (no cats present). Cats appear to have been successfully eradicated on Curieuse and Denis and Norway rats on Frégate but, by mid-2001, ship rats were again recorded on Curieuse and Denis. It is not clear whether eradications were unsuccessful on these islands, or these rats represent subsequent reinvasion.

Invasive Weed Species

On most small islands of the Seychelles the flora is dominated by introduced species which form 44-69% (or more) of the plant list on the islands studied. Procter (1984) estimated that nationally around 165 exotic plant species had become established in the wild (forming 22% of the flora) and a further 249 (33%) were known only in cultivation. The latter figure has certainly increased as new species are constantly being added to the garden flora of Seychelles (Shah, 1997). Globally, only a small proportion of introduced species become established in wild communities with only 10% of introduced, established species becoming pests in their new environment (Williamson, 1996). Procter's figures suggest that a higher-than-expected proportion of species imported into Seychelles have become established, perhaps due to Seychelles climate or the relative invadability of species-poor island vegetation, especially when modified by human activities.

It is difficult to estimate the number of exotic species that have become serious invasive weeds in the granitic Seychelles in part because weediness is hard to define in the context of some fundamentally altered ecosystems. Thus, while agricultural weeds are easily identified, as are species invading largely natural ecosystems (such as glacis habitats which may be invaded by *Alstonia macrophylla*: Carlström, 1996a), in most mid-

altitude forests on the large islands native trees have been replaced by exotic plant species.

In natural ecosystems, invasive exotics are a threat to native vegetation through displacement and shading. Because, in general, introduced plant species support an impoverished insect fauna compared to that of native plant species, large-scale replacement of natives by naturalised species is likely to lead to higher-order effects, such as reducing the food supply of endemic birds.

Both Carlström (1996a) and Fleischmann (1997) attempted to identify species most threatening to native vegetation in Seychelles (particularly, the larger islands). Twenty-six invasive plant species thought to threaten native habitats are listed by Carlström (1996a) including one fern, two grasses, 10 shrubs and 13 trees. However, this list includes several species of doubtful origin including one tree regarded by Friedmann (1994) as native (*Trema orientalis*) and one grass regarded by Robertson (1989) as native (*Brachiaria umbellata*).

Fleischmann (1997) regarded 34 introduced species as invasive in his survey of Mahé and Silhouette; most of these species were trees, but seven shrubs, three climbers, a bamboo and two herbaceous species were also included. Fleischmann's list included one native species, *Cocos nucifera,* which probably showed restricted distribution prior to human colonisation. The two lists share 15 species in common, and both suggest that the greatest threat to native ecosystems (at least on large islands in Seychelles) comes from cinnamon *Cinnamomum verum* and Chinese guava *Psidium cattleianum.* However, both earlier lists are primarily concerned with invasive species in native forest habitats of the larger islands (Mahé and Silhouette in the case of Fleischmann, 1997). On smaller, drier islands, the relative importance of different weed species is likely to differ.

In order to assess the weed status of introduced species on smaller islands of the granitic Seychelles, data from plant species lists and vegetation plots were used to provide a measure of distribution and density of populations. While introduced species form a significant part of the flora of smaller islands, most are not widespread; 98 of 295 species recorded in species lists (33%) were found on only one of 11 islands. Only 58 species (20%) occurred on six or more islands. Many of the introduced species are ornamentals which may persist if cultivation were abandoned (as in the case of *Codiaeum variegatum* which survives around the ruins of the leper colony on Curieuse Island), but are unlikely to actively spread into near-natural vegetation. Ornamentals seem less of a threat to natural ecosystems than species introduced for economic purposes; only two of the invasive species listed by Fleischmann (1997) are likely to have originated as ornamentals (*Acalypha wilkesiana, Lantana camara*).

Data from vegetation plots identify those species that have successfully entered near-natural plant communities on a wider scale. Figure 3 shows measures of distribution between 10 islands and within islands (for islands on which species present, percentage of random vegetation plots in which the species was recorded) for all species which are definitely, or probably introduced (definitions of introduced status from Friedmann, 1994). In addition, *Cocos nucifera* was included as its present distribution is largely the result of plantation agriculture of the nineteenth and twentieth centuries. Species are divided by life-form, as this has a bearing on the relative importance of species as weeds: trees, shrubs and large lianas are more likely to reach pest status in woodland and scrub

habitats. Species found in 20% or more of vegetation plots on islands on which they occur are identified.

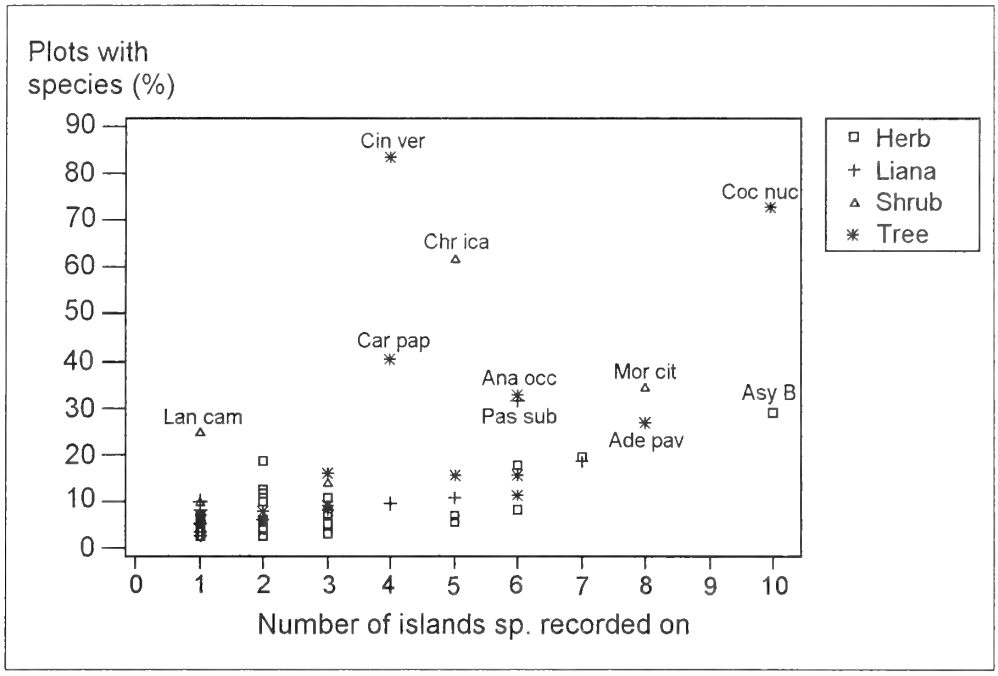

Figure 3. Distribution of introduced species between and within islands.

These data suggest that the most invasive alien species on small islands are *Cinnamomum verum* (Cin ver) and *Chrysobalanus icaco* (Chr ica). *Cocos nucifera* is ubiquitous and regenerates strongly to form a dense scrub of little value to endemic species. *Asystasia* "species B"(*sensu* Friedmann, 1994) occurs on all islands but its impact is probably minor. *Lantana camara* (Lan cam) was recorded in species lists from several islands but only occurred in vegetation plots on one island (North). It is a fast-growing, weedy shrub of open ground that has come to dominate former coconut plantations on North Island but probably cannot survive heavy shade and is not a significant problem in established woodland habitats. The same is likely to be true of *Clidemia hirta,* identified as a weed species on Silhouette and Mahé (Gerlach, 1996a), and a recent invader of North Island. *Morinda citrifolia* (Mor cit) is doubtfully native (Friedmann, 1994; Gerlach, 1996b; Sauer, 1967), supports an extensive insect fauna and has fruit favoured by feeding giant tortoises. *Psidium cattleianum* (P. littorale), identified by Fleischmann (1997) as the second most prominent invasive species on Silhouette and parts of Mahé (after *Cinnamomum verum*), was only recorded in vegetation plots on two islands where it occurred in six (of 77) plots surveyed. In all, only four trees of over five metres were recorded.

The vegetation plot analysis suggests that a small number of (mainly) woody species are the major invasive plants of conservation concern, at least in near-natural woodland and scrub habitats. Vegetation plots were not carried out in other habitats, most notably glacis, a naturally open habitat threatened by a small number of invaders including *Alstonia macrophylla* (Carlström, 1996a), and freshwater habitats. The latter

support a range of exotic species that have become pests in parts of Seychelles, including *Pistia stratiotes, Eichornia crassipes* and *Ipomoea aquatica* (Stevenson *et al.*, 1997).

Data on introduced weeds are summarised in Table 6, showing species in four categories:

a) those woody species which are currently widespread and invasive;

b) species which have the potential to become widespread weeds but are currently restricted in distribution (from Carlström, 1996a; Fleishmann, 1997);

c) species which are potentially invasive in open, glacis habitats (from Carlström, 1996a; Fleishmann, 1997; Friedmann, 1986; and personal observation); and

d) species which are potentially invasive in wetlands (from Stevenson *et al.*, 1997).

Species which were not recorded on any island (probably restricted to the larger islands) are omitted.

In general, coralline islands and small islands have the lowest score for invasive species. The highest scores were for larger granitic islands with a history of cultivation. The lowest score on any of the granitic islands was for Cousin (a nature reserve) but the island of Marianne also had a relatively low score. Marianne had a wide range of weeds but several species (such as *Cinnamomum*) were only present in small numbers and *Chrysobalanus* appeared to be absent.

Table 6. Introduced invasive plant species on the islands assessed.
For island names, see Table 5.
Extent of invasion:
1 = present in small numbers (usually less than 100 individuals per island);
2 = 100-1000 individuals, strong regeneration from seed or vegetative propagation, species dominating small areas of habitat to the exclusion of native species;
3 = very invasive (1000+ individuals, very strong regeneration, large proportions of island dominated by the species, to the exclusion of native species).

	Bir	Con	Cou	Cur	Den	Fel	GSo	Mar	Nor	The
Woody species invading woodland and scrub habitats										
Adenanthera pavonina		2	1	2	2	2	2	1	2	2
Anacardium occidentale		2		2		2	1	1	2	2
Carica papaya	3		3	2	3	1	1	1	1	2
Chrysobalanus icaco		2		3		3	3		2	3
Cinnamomum verum		3		3		2	3	1		3
*Cocos nucifera**	3	3	2	3	3	3	3	3	3	3
Lantana camara					2				3	1
Passiflora suberosa	2	2		2	2	2	2	2	2	2
Species potentially invasive of woodland or scrub habitats										
Clidemia hirta									1	
Psidium guajava				1	1	1	1	2	3	1
Psidium cattleianum		1							2	1
Paraserianthes falcataria				2					2	1
Syzygium jambos		2								
Vanilla planifolia		2		2	2	2	2	2	2	2
Species potentially invasive of glacis or open habitats										
Alstonia macrophylla		2		2					3	2
Ananas comosus		2	2	2		2	1	1	1	2
*Dicranopteris linearis**				3		2				2
Furcraea foetida		2		2	1	2	1	1	2	2
Panicum maximum		2	1	1	2	2	2			2
Species potentially invasive of wetlands										
Ipomoea aquatica							2		1	
Total	8	27	9	32	18	26	24	15	32	33

* Native or doubtfully native species: see Gerlach (1996b), Friedmann (1994).

Pollutants and Pathogens

Pollution and the presence of pathogens all have an impact on individual native species. In some cases, pollutants have been identified (or inferred) as major contributors to a decline in endangered species. On Mauritius, it has been suggested that declines in the populations of the endemic Kestrel and Cuckoo-shrike were caused by the use of organochlorine pesticides (Safford and Jones, 1997). In Seychelles, a range of persistant organic (and inorganic) compounds were used in the twentieth century for pest control on plantations. There is little evidence regarding the levels of use although it is likely that usage in Seychelles was less intense than in Mauritius.

A range of natural pathogens are important to individual species, and thus to habitats. An example is the wilt disease of takamaka *Calophyllum inophyllum*, probably caused by the fungus *Leptographium calophyli* (Ivory *et al.,* 1996; Wainhouse *et al.*, 1998). Takamaka is a native tree, which commonly grows at beach crests, helping to protect them from erosion (for example, on Mahé, Praslin, Curieuse, Grande Soeur). It often forms dense stands in coastal plateau forest (on La Digue, Curieuse, North Island), and occurs in hill forest (on Marianne, Grande Soeur, Curieuse). The wilt fungus causes extensive wilting and dieback of takamaka trees, and can lead to complete defoliation and death of trees within months (Ivory *et al.,* 1996). Wilt disease was first noted on Mahé in 1994, but has now spread to a number of islands (Hill *et al.,* in prep.), some of which have lost many of their takamaka trees (see Table 7). The endemic bark beetle *Cryphalus trypanus* probably acts as a vector of the disease (Wainhouse *et al.,*1998).

Table 7. Current status of takamaka and takamaka wilt disease on islands studied. From Hill *et al.,* in prep.

Island	Takamaka	Wilt disease
Bird	Only one or two trees, planted	Absent
Conception	Occasional component of hill woodland	Absent
Cousin	Few trees	Absent
Curieuse	Many trees, large areas of takamaka forest on plateau and trees in mixed hill woodland	First symptoms observed 1999, extensive death in one area of forest
Denis	Few trees	First symptoms observed 2001
Félicité	Important component of hill woodland	Absent
Grande Soeur	Important part of hill woodland, old trees present on beach crest	Absent
Marianne	Significant component of hill woodland	Absent
North	Many trees, large areas of takamaka forest on plateau and trees in mixed hill woodland	Present, causing death of hundreds of trees
Thérèse	Found in hill woodland, old trees present on beach crest	Present. Most beach crest trees dead, trees on hill survive

Takamaka is one of the most widespread native trees in the archipelago and is a component of near-natural ecosystems on most of the small islands. Loss of trees to takamaka wilt is of particular importance on islands where it forms a major component of plateau woodland, for example, La Digue and North Island. On both these islands, takamaka and badamier *Terminalia catappa* dominate plateau woodland but many mature takamaka trees have been affected by the disease. The longer-term effects of takamaka wilt are unknown; there is some evidence that a proportion of trees recover without human intervention (FAO, 1997). In areas of high landscape value on large islands, trees have been treated with fungicides but this is a labour-intensive and expensive method inappropriate for use on a larger scale. Early eradication attempts and the introduction of regulations prohibiting the inter-island transfer of takamaka wood may have had some effect in delaying the establishment of the disease on the second largest island of the

granitic Seychelles, Praslin, but personal observation suggests that takamaka wilt is now well established there.

A second novel wilt disease affecting sandragon *Pterocarpus indicus,* has recently been recorded on Mahé (Seychelles Nation, 8th May 2000). Sandragon is an introduced tree and is less widespread on smaller islands than takamaka so the disease is of less conservation concern than takamaka wilt but on certain islands (such as Frégate), sandragon is an important component of woodland vegetation.

The source of such novel pathogens in Seychelles is unknown (Ivory *et al.* 1996) but once introduced even strict quarantine measures seem unable to control the spread of virulent pathogens to a large number of islands. While it seems likely that higher levels of human movement between islands increases the risk of transfer of pathogens (probably accounting for the appearance of takamaka wilt on Denis, a remote coralline island), diseases can reach even relatively remote uninhabited islands such as North Island. The true threat to native species and ecosystems from such factors is difficult to predict and resolve.

CONCLUSIONS: ASSIGNING CONSERVATION VALUES

A range of biological and physical factors considered above are summarised for each island surveyed in Table 8. The aim of the table is to illustrate the overall conservation value of each island, including both potential (rehabilitation) values and existing values. Some of these values (size of island and plateau) are unchanging whereas others (number of alien animals, invasive weeds, extent of semi-natural vegetation) may be increased by active management.

Large granitic islands, and coralline islands, emerge as having particularly high conservation values in this simple ranking. The largest islands, such as Curieuse and Félicité, have a wide range of native habitats and relatively large areas of plateau forest which would be suitable for introduction of Seychelles magpie-robin (and possibly black paradise flycatcher). In both cases, existing biodiversity values are high so the removal of introduced vegetation and other conservation management would protect a range of endemic forms.

The coralline islands Bird and Denis were both severely impacted by guano mining and coconut planting in the twentieth century (Stoddart and Fosberg, 1981) and today are dominated by former coconut plantations, although Denis has large areas of badamier *Terminalia catappa* woodland and Bird has some *Pisonia grandis*. While both islands have introduced crazy ants, on Denis these occurred in a restricted area and could be controlled. On Bird Island, the infestation is extensive and is having a serious effect on biodiversity.

Both coralline islands appear to be outside the natural range of many of the endangered endemic birds of Seychelles. The only endemic species to have been recorded on the coralline islands are a sunbird *Nectarinia* sp. (Stoddart and Fosberg, 1981) and Seychelles blue pigeon *Alectroenas pulcherrima*. While reconstructing former ranges of birds is difficult as early ornithological records for the Seychelles are sketchy before 1865 (Rocamora and Skerrett, 2001), it seems likely that few of the granitic Seychelles endemic birds were ever present on the close coralline islands. However,

coralline islands appear to be suitable for some of the endemic land birds and previous translocations of endemic birds to coralline islands within the Seychelles have been successful. The Seychelles magpie-robin survived for over 50 years on the coral island of Alphonse before being exterminated by introduced predators or habitat change in the mid-twentieth century (Collar and Stuart, 1985) and the Seychelles fody was translocated to D'Arros in 1965 (Penny, 1974), where the species survives (BirdLife International, 2000). The eradication or control of alien predators and rehabilitation of woodland habitats dominated by native tree species would increase the likelihood of success of such translocations. Translocations to coralline islands could be used as part of a strategy to extend the range and increase populations of endemic birds requiring less intensive input than captive management.

The remoteness of the coralline islands from the central granitics could be advantageous (allowing isolation from diseases) but would also act as a barrier to natural recolonisation of further islands.

Table 8. Overall island rankings based on criteria discussed above.

	1	2	3	4	5	6	Total	Total rank
Bird	5	2	3	10	1	1	22.0	2
Conception	9	10	9.5	4	7	8.5	48.0	10
Cousin	10	5	5	7.5	2	2	31.5	5
Curieuse	1	4	1	1	8.5	3.5	19.0	1
Denis	4	1	4	9	4	3.5	25.5	3
Félicité	2	6	2	2	6	8.5	26.5	4
Grande Soeur	7	7	6	6	5	5	36.0	7
Marianne	6	9	8	5	3	8.5	39.5	8
North	3	3	7	7.5	8.5	6	35.0	6
Thérèse	8	8	9.5	3	10	8.5	47.0	9

1 = size of islands. 1=largest, 10 = smallest
2 = area of true coastal plateau: 1 =large, 10 = small
3 = area of existing near-natural habitat: 1= large, 10 = small.
4 = existing number of endemic/threatened plant species: 1 = many, 10 = few
5 = score for existing introduced weed species: 1 = few, 10 = many
6 = existing number of introduced animal species: 1 = few, 10 = many

Although Cousin is already managed for conservation and has a high proportion of its land area under semi-natural forest, its small size means that it does not emerge strongly in this particular analysis. North Island, although much larger with a larger plateau, ranks lower overall because most of its near-natural habitat has been lost over the island's long history of human use. North Island's existing biodiversity values are low. A small proportion of the flora is native and there are only two endemics. However, given active management for conservation, its potential value for conservation of a variety of endemic birds is high.

The small, rocky islands of Thérèse and Conception are identified as having the lowest rehabilitation values. These islands are predominantly open rocky hills with a high

proportion of glacis. However, despite the island's small size and dominance by introduced species, Conception supports the major population of one of Seychelles' endangered endemic bird species, the Seychelles white-eye *Zosterops modestus*. Were introduced predators to be eliminated and habitat rehabilitation to be implemented, both of these smaller islands could support small insectivorous bird species such as Seychelles warbler and white-eye. While populations would necessarily be smaller than those on larger islands, the founding of new populations would in itself reduce the likelihood of extinction of these species. Both Therese and Conception support a number of endemic plant species absent on much larger islands because they are positioned relatively close to Mahé, the largest island of the archipelago and one of the islands having the greatest endemic biodiversity. While limited resources available to conservation might be better directed at medium-sized islands with large plateau areas that could support a number of endemic species, under appropriate management regimes even the smallest of the islands surveyed could have a role in the conservation of Seychelles endemic land birds.

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PLATES

Plate 1. Major habitat types on smaller islands of the granitic Seychelles: *a* Coastal plateau dominated by coconut plantation, North Island; *b* Coconut plantation (with introduced ornamental palm *Latania* sp. In foreground); *c* Abandoned coconut plantation, showing death of many mature palms and regrowth of dense mixed scrub beneath, Marianne Island; *d* View of native-dominated lowland forest, Curieuse. Endemic *Pandanus multispicatus* and palm *Phoenicophorium borsigianum* in foreground; *e* View of native-dominated lowland forest and ruins of leprosarium, Curieuse. Trees are takamaka *Calophyllum inophyllum; f* Death of takamaka trees caused by takamaka wilt disease, North Island. Invasive alien tree *Alstonia macrophylla* in foreground. Photos © BirdLife Seychelles.

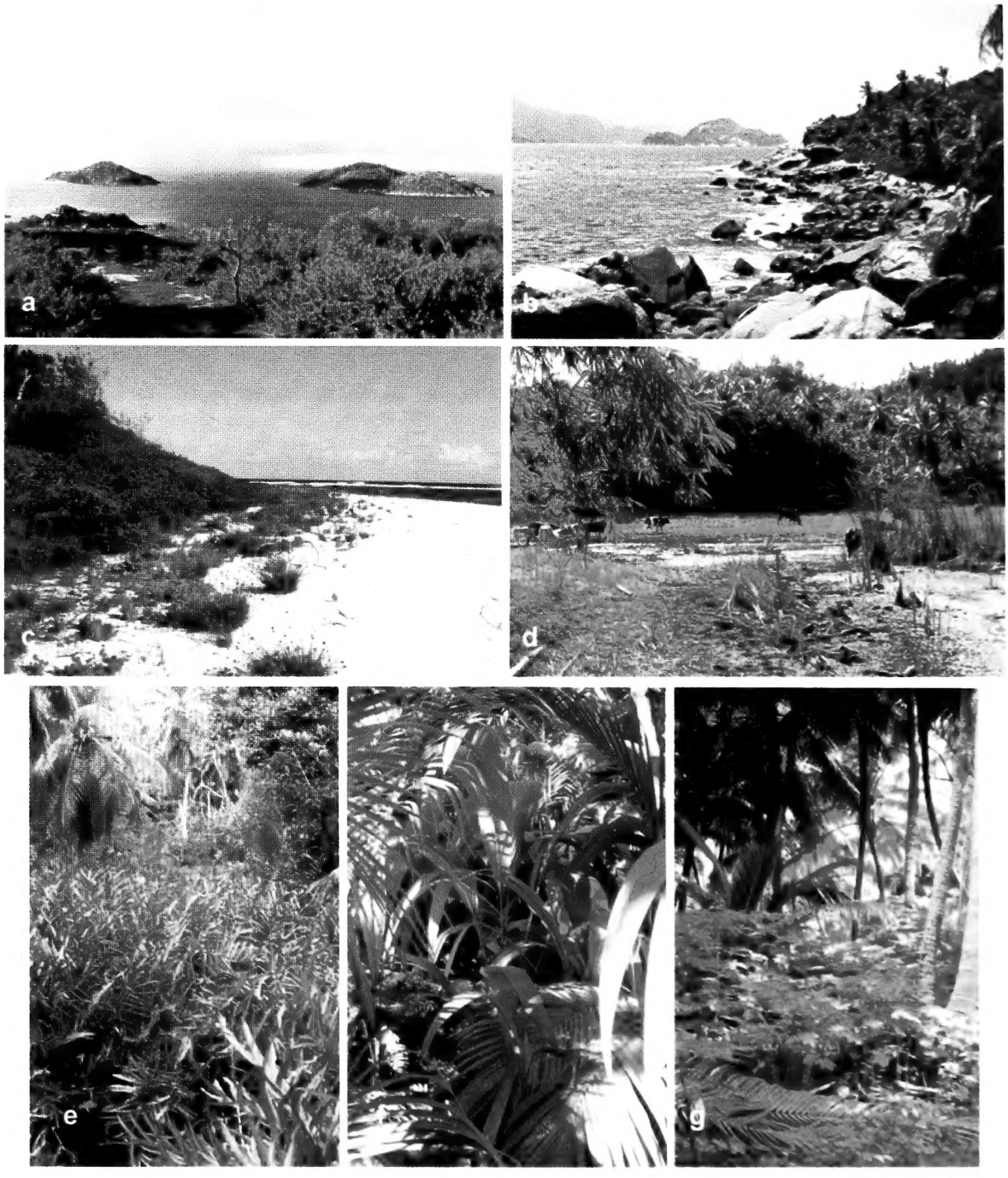

Plate 2. Major habitat types on smaller islands of the granitic Seychelles: *a* Open glacis with introduced shrub cocoplum *Chrysobalanus icaco*, Félicité with views to Grande Soeur (right) and Petite Soeur (left); *b* Rocky shore with coastal 'beach crest' vegetation, predominantly *Scaevola sericea*, Conception; *c* Beach crest vegetation on Denis Island: sedges and *Ipomoea pes-caprae* on seaward side, with *Suriana* and *Scaevola* behind; *d* Freshwater marsh with *Typha* and grazing cattle, North Island; *e* Tidal marsh with dense growth of *Acrostichum* sp., Thérèse; *f* Dense growth of young coconuts beneath abandoned plantation, Denis; *g Carica papaya* growing under abandoned coconut plantation, Bird Island. Photos © Birdlife Seychelles.

Plate 3. Endangered endemic birds of the granitic Seychelles with potential for inter-island translocations: *a* Seychelles magpie-robin *Copsychus sechellarum; b* Seychelles fody *Foudia sechellarum; c* Seychelles black paradise flycatcher *Terpsiphone corvina,* female bird; *d* Seychelles warbler *Acrocephalus sechellensis; e* Seychelles white-eye *Zosterops modestus.*
Photos *a – d* © BirdLife Seychelles, photo *e* © Dr Dave Currie.

ATOLL RESEARCH BULLETIN

NO. 495

ISSUED BY
NATIONAL MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C., U.S.A.
JULY 2002