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CHANGES IN THE VEGETATION AND REPTILE POPULATIONS ON ROUND ISLAND, MAURITIUS, FOLLOWING ERADICATION OF RABBITS

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Abstract

Changes in the vegetation and reptile populations on Round Island, Mauritius are described using the results of expeditions in 1982 (when rabbits Oryctolagus cuniculus *were abundant) and 1989 (three years after their eradication). Changes in vegetation cover and composition are described, all directly or indirectly attributable to the eradication of rabbits. These changes include marked increases in the regeneration of three tree species (all endemic, or largely restricted, to Round Island) and plant species formerly grazed by rabbits. The increasing impact of plant species accidentally introduced to the island is documented. Recent increases in the populations of several endemic reptile species (five of which are threatened) are also described; these can be attributed to increases in habitat and food availability following the eradication of rabbits. In the light of these observations, projected changes are discussed and recommendations made for management.*

Keywords: Mauritius, Round Island, rabbits, changes, eradication.

INTRODUCTION

Round Island (151 ha) is a rugged and uninhabited volcanic island lying some 20 km NE of Mauritius (Fig. 1). Early studies of the fauna and flora by Vaughan and Wiehe (1937), Vinson (1950, 1953, 1964) and Vinson and Vinson (1969) drew attention to its exceptional biota. Many of the species and habitats on Round Island no longer occur on the Mauritian mainland. Interest in Round Island is international and of prime importance to conservation in Mauritius itself.

Merton *et al.* (1989) identified six important features of Round Island's conservation importance:

(1) It is one of the very few elevated tropical islands without introduced rodents.
(2) It has the largest area of native vegetation in Mauritius and is the only relatively large island in the Mascarene group free of major woody weeds.
(3) It supports the last remnant of palm savanna once characteristic of the northern plain of Mauritius.
(4) It supports at least 10 threatened native plant species including six endemic to Mauritius.
(5) It supports eight species of native reptiles including three that are endangered (one gecko and two snakes). Seven are endemic to the Mascarene Islands and four now only occur on Round Island.
(6) It is the only known breeding ground in the Indian Ocean for a rare subspecies of the herald petrel *Pterodroma arminjoniana arminjoniana*, and is an important breeding station for three other species of seabird.

The ecological history of Round Island, its climate, physical description, vegetation and reptile fauna have been described (Bullock, 1986; North & Bullock, 1986; Cheke, 1987; Merton *et al.*, 1989). Cheke (1987) documented the introduction of rabbits *Oryctolagus cuniculus* and goats *Capra hircus* to the island in the

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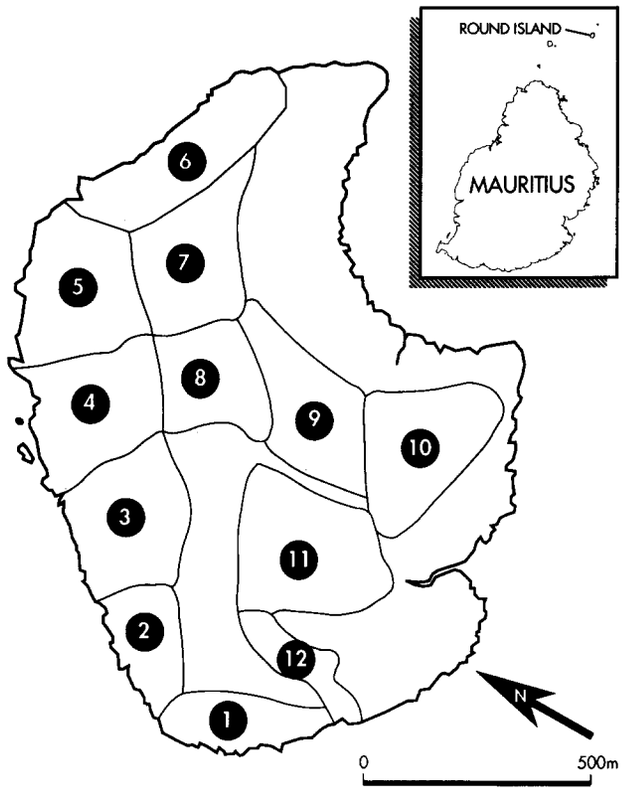

Fig. 1. Round Island showing the location of 12 study areas.

19th century. Their subsequent browsing and grazing has severely degraded the soil and vegetation, and caused major reductions (and some extinctions) of endemic or indigenous plants and reptiles (Vinson, 1964; Bullock, 1986; North & Bullock, 1986).

In 1975 and 1976 the rabbits were temporarily reduced by the combined effects of a severe cyclone and a shooting expedition. Around this time, the goats were also progressively reduced by shooting and the last one was shot in 1978. Palm regeneration and ground cover increased between 1975 and 1982; this was attributed to the reduced grazing and browsing pressure. However, a subsequent recovery of the rabbits (to an estimated density of 16–20 per ha) resulted in a continued decline of many plant and reptile species (Bullock, 1986; North & Bullock, 1986).

In 1986 rabbits were eradicated from Round Island (Merton, 1987) and it became the largest area in the Mascarene group free of introduced mammals. Here we describe and interpret some results of an expedition to Round Island in 1989, when the effects of eradicating rabbits were assessed. Comparisons are made with results of expeditions in 1975 (when both goats and rabbits were present), and 1982 (when only rabbits were present). Nomenclature follows North and Bullock (1988) for plants, and Vinson and Vinson (1969) for reptiles.

METHODS

Vegetation

In 1989 the vegetation of Round Island was analysed using the same methods as in 1975 and 1982 (North & Bullock, 1986), and at the same time of the year, July/August. Ground cover was recorded using series of parallel transects approximately 50 m apart in three study areas (areas 3, 7 and 11, Fig. 1) chosen as representative of the island. As the transects were walked, the dominant vegetation beneath each pace was used to calculate percentage cover of each vegetation type within each area. Percentage cover of plant species was also estimated by eye in 15 permanent quadrats established in 1975 that ranged in size from 1 × 3 m to 5 × 5 m.

The populations of the two most numerous tree species on Round Island, the native fan palm *Lantania loddigesii* and the native screwpine *Pandanus vandermeerschii*, were censused in four areas, when individuals were assigned to size classes as in previous expeditions (North & Bullock, 1986). The two rare endemic palms, the bottle palm *Hyophorbe lagenicaulis* and the hurricane palm *Dictyosperma album* var. *conjugatum*, were censused by detailed searches concentrated in areas where they had been recorded previously.

In addition to general surveys of trees and ground cover, we recorded the status of other threatened native plant species; these included the only remaining hardwood species *Gagnebina pterocarpa*, the shrub *Fernelia buxifolia*, the aloe *Lomatophyllum tormentorii*, two herbs (*Phyllanthus revaughanii* and *Asparagus umbellulatus*) and the grass *Chloris filiformis*. We also established the status of the only woody weed so far recorded on Round Island, *Desmanthus virgatus*.

Appendix 1 lists which plant species are endemic, native or introduced.

Reptiles

In 1989 indices of abundance of six reptile species on Round Island were determined using the same methods as in 1975 and 1982, i.e. mainly direct daytime counts in areas 3, 7 and 10. Teams of up to seven recorders worked up and down the slopes of each area, thoroughly searching all vegetation (including litter). Searches were only carried out in sunny weather and were timed to give an encounter rate for each species. For three species which are more active at night (the snake *Casarea dussumerii* and the geckos *Phelsuma guentheri* and *Nactus serpensinsula*) timed searches of suitable habitat were conducted between dusk and midnight using torches.

Immatures and adults of four species were recorded separately using the following criteria. Immatures had snout–vent lengths of ≤ 10 cm, ≤ 10 cm and ≤ 4 cm for the skink *Leiolopisma telfairii* and *P. guentheri* and *P. ornata* respectively. For *C. dussumerii*, immatures were separated from adults by their orange or orange-brown (as opposed to dark grey or grey-brown) colour. Immatures and adults of *Nactus* and the skink *Scelotes bojerii* were not separated.

Two species could not be studied in detail. The snake *Bolyeria multocarinata* has not been seen since 1975 (Bullock, 1977) and is probably extinct. The skink *Cryptoblepharus boutonii* is largely restricted to the

narrow coastal fringe on Round Island where it is uncommon. It is found on several other islands off Mauritius, and is pantropical in distribution (Vinson & Vinson, 1969).

RESULTS

Ground vegetation

On the western slopes (areas 3 and 7) between 1982 and 1989 there was a marked increase in vegetation cover due largely to a spectacular spread of the introduced grass *Chloris barbata* and the herb *Boerhavia* spp. (Table 1). In 1989, *C. barbata* was in fact widely distributed and abundant throughout the island whereas prior to the eradication of rabbits it was found as widely scattered tussocks on bare coastal fringes or in a few dense mats on inaccessible ledges. Release from grazing pressure, the availability of extensive areas of bare earth and the species' apparent ability to disperse rapidly have now enabled it to become a significant component of the vegetation. In 1989 there were also small increases of several other plant associations including *Ageratum conyzoides–Commelina benghalensis, Digitaria biformis, Solanum nigrum–Abutilon indicum* and creepers such as *Passiflora suberosa* and *Ipomea pes-caprae. Latania* thicket also expanded. Smaller increases in most of these plant associations were also noted on the south-east slopes (area 11) without any overall increase in vegetation cover (Table 1).

Several components in the ground vegetation decreased in extent between 1982 and 1989. These include the succulent herb *Portulaca oleracea* (especially in area 11), *Nicotiana tabaccum* (especially in area 7) and the grasses *Brachiaria reptans* (often associated with *Nicotiana*) and *Vetiveria arguta*, now confined to Round Island.

The dramatic change in abundance of *C. barbata* recorded in the general survey was corroborated in permanent quadrats (Fig. 2) with smaller but widespread

Table 1. Changes in percentage cover of ground vegetation in the three study areas on Round Island between 1982 and 1989
+ = trace (<1·0%). 1982 data based on between 2100 and 2900 sample points; 1989 data based on between 2752 and 4221 sample points.

	Percentage cover					
	Area 3		Area 7		Area 11	
	1982	1989	1982	1989	1982	1989
Bare earth/rock slab	79·2	66·3	54·9	50·4	40·1	42·7
Latania	3·9	7·8	3·3	5·6	+	+
Creeper	6·2	7·0	14·2	16·5	30·7	43·2
Vetiveria	9·3	5·8	14·0	9·7	5·1	1·2
Nicotiana/Brachiaria	+	0·0	11·3	+	2·1	0·0
Boerhavia/Chloris barbata	+	10·0	+	12·1	+	2·0
Ageratum/Commelina	+	1·7	+	2·3	2·9	6·1
Creeper/*Portulaca*	+	+	2·2	1·3	18·1	1·0
Digitaria biformis	0·0	+	0·0	+	0·0	1·0
Solanum nigrum/Abutilon	0·0	+	0·0	1·6	0·0	2·4
Total vegetation cover	20·8	33·6	45·1	49·6	59·9	57·3

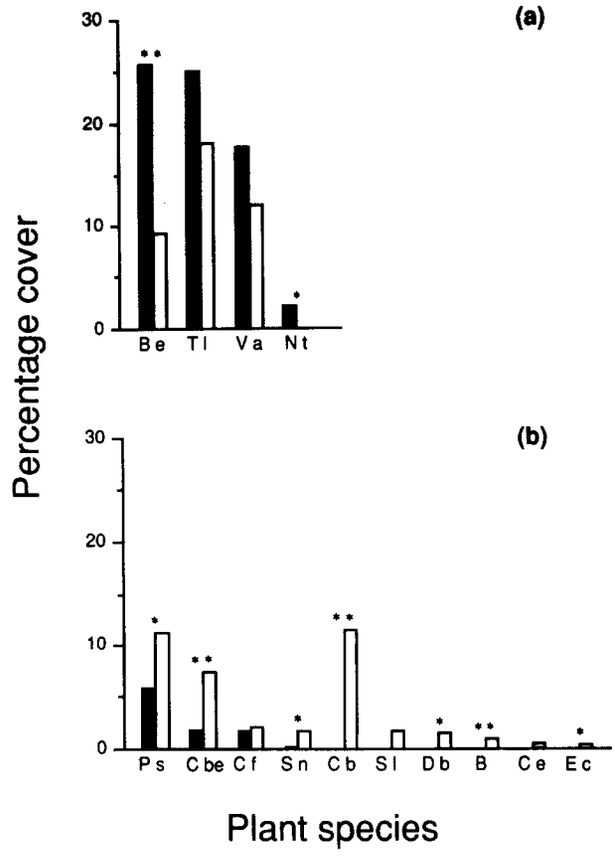

Fig. 2. Changes in the cover of selected plant species in 15 permanent quadrats on Round Island between 1982 (■) and 1989 (□) expressed as mean percentage cover. * and **, $p < 0.05$ and $p < 0.01$, respectively, using Wilcoxon's Matched Pairs test. Quadrat 1 was lost after 1982. (a) Species or cover that decreased: Be, bare earth; Tl, *Tylophora laevigata*; Va, *Vetiveria arguta*; Nt, *Nicotiana tabaccum*. (b) Species that increased: Ps, *Passiflora suberosa*; Cbe, *Commelina benghalensis*; Cf, *Chloris filiformis*; Sn, *Solanum nigrum*; Cb. *Chloris barbata*; Sl, *Solanum lycopersicum*; Db, *Digitaria biformis*; B, *Boerhavia* spp.; Ce, *Cenchrus echinatus*; Ec, *Erigeron canadensis*.

increases in *Digitaria, Passiflora, Commelina, Boerhavia* spp. and *S. nigrum*. There were also marked local increases in the frequency and/or cover of several recently introduced or non-native species including the 'cherry' tomato *Solanum lycopersicum*, the herb *Erigeron canadensis* (=*E. conyza*) and the grass *Cenchrus echinatus* (Fig. 2). Dramatic declines in percentage cover of bare earth, *Vetiveria, Tylophora* and *Nicotiana* were also observed (Figs 2 and 3).

Tree species

The decline in the number of the oldest (class 1) *Latania* observed in 1982 has continued, particularly on the south-eastern slopes; however, there have been marked increases in the numbers of younger (classes 2 and 4) individuals (Table 2). The most obvious change on Round Island between 1982 and 1989 has been the spectacular increase in the extent and density of *Latania* thicket on the western slopes. This is due to several cohorts of newly mature (class 2) *Latania* that arose during the periods of reduced grazing in 1975 and 1976 (North & Bullock, 1986); these cohorts are, impor-

(a)

(b)

Fig. 3. Changes in the vegetation of Quadrat 16 between 1982 (a) and 1989 (b). Note the almost complete disappearance of *Nicotiana*, and its replacement by *Chloris barbata* in 1989, three years after the eradication of rabbits. In 1975, the vegetation was similar to 1982 but with a lower percentage cover of *Nicotiana*.

tantly, the first marked recruitment to the *Latania* population for many decades. Increases in size classes 2 and 4 have been proportionally greater on the south-eastern slopes. In 1989 no *Latania* seedlings had been grazed, compared to 90% in 1982 (North & Bullock, 1986).

Table 2. Changes in the size and structure of the population of *Latania loddigesii* on the western slopes (area 3) and south-eastern slopes (areas 10 + 11 + 12) of Round Island between 1982 and 1989

	Number of *Latania*					
	Area 3			Areas 10, 11 & 12		
Size class[a]	1982	1989	% change	1982	1989	% change
4	738	1 129	+53·0	70	2 293	+3 176·0
3	3 989	3 162	−20·7	393	298	−24·2
2	102	699	+585·0	0	74	—
1	330	302	−8·5	275	237	−13·8

[a] Class 4, no trunk, >0·1 <0·6 m; Class 3, no trunk, ≥0·6; Class 2, trunk ≤3 m; Class 1, trunk >3 m.

Table 3. Changes in the size and structure of the population of *Pandanus vandermeerschii* on the western (area 3) and south-eastern (areas 10 + 11 + 12) slopes of Round Island between 1982 and 1989

	Number of *Pandanus*					
	Area 3			Areas 10, 11 & 12		
Size class[a]	1982	1989	% change	1982	1989	% change
4	1	8	+700·0	5	998	+19 860·0
3	30	45	+50·0	64	91	+42·2
2	20	16	−20·0	24	27	+12·5
1	2	3	+50·0	33	24	−27·3

[a] Class 4, >0·1 <0·6 m; Class 3, ≥0·6 <3·0 m; Class 2, >3 m, mature; Class 1, ≥3 m, mature, senescent.

Similar declines in the number of class 1 *Pandanus* and increases in the number of young (classes 3 and 4) trees were recorded in 1989. The latter was unexpected as we had found little evidence of browsing of *Pandanus* seedlings (whose leaves are edged with spines) in previous years (Table 3).

Between 1975 and 1989 the number of mature *Hyophorbe* on Round Island remained less than 20 (Table 4). In 1989 we recorded a large increase in the number of seedlings coincident with a total absence of grazing damage. This was in striking contrast to 1982. A progressive decline in the number of mature *Hyophorbe* has apparently been halted for the first time in recorded history by the addition of two newly mature trees that were seedlings in 1975. In addition, a small but increasing number of young *Hyophorbe* (> 0·3 m tall) have become established since 1975.

The status of the third and rarest palm on Round Island, *Dictyosperma*, did not change between 1982 and 1989. Only two trees survive, one of which fell between 1975 and 1982 but is still alive. Both trees continue to flower and fruit but searches in 1989 failed to reveal any regeneration.

Similar searches beneath the hardwood *Gagnebina* revealed the first recorded regeneration (two seedlings) since it was rediscovered in 1978. Only two mature bushes have been found in recent years, both on the western slopes. One of these was ring-barked and killed by rabbits shortly after the 1982 expedition (W. Strahm, pers. comm.).

Table 4. Changes in the population of *Hyophorbe lagenicaulis* on Round Island between 1982 and 1989

Data from 1984 to January 1989 courtesy W. Strahm. Figures in parentheses refer to additional individuals believed to derive from seed sown in 1987.

	Number of *Hyophorbe*							
	1975	1982	1984	1986	1987	1988	Jan 1989	Aug 1989
Seedlings (<0·3 m)	66	46	56	16	?	289	?	503 (3)
Young trees (≥0·3 m)	6	8	10	10	11	12	?	14(1)
Mature trees	15+2[a]	9	9	8	8	8	7	9

[a] Recently fallen but still alive.

Table 5. Numbers of individuals and encounter rates (x̄ no. per person-hour) for six reptile species on Round Island during surveys in 1982 and 1989

In 1982 and 1989, 59·3 and 116·8 person-hours were devoted to daytime searches in areas 3 + 7 + 10. In the same years, 24·8 and 48·8 person-hours, respectively, were devoted to night-time searches in gullies.

	S. bojerii		*L. telfairii*		*P. ornata*		*P. guentheri*		*N. serpensinsula*		*C. dussumerii*	
	1982	1989	1982	1989	1982	1989	1982	1989	1982	1989	1982	1989
Total no. of individuals[a]	883	1 363	465	993	562	1 173	41	76	10	210	8	37
% immature[a]	—	—	33·1	32·7	25·5	19·6	9·8	31·8	—	—	13·8[b]	47·7[b]
Encounter rate (daytime)[a]	13·0	10·9	8·8	10·3	6·7	9·0	0·5	0·5	0·1	1·3	0·1	0·3
Encounter rate (nighttime)[c]	0·0	0·0	0·0	0·7	0·0	0·7	<1·0	1·0	1·6	3·3	0·1	0·3

[a] Areas 3 + 7 + 10.
[b] % of all individuals seen in these years.
[c] Based on searches in gullies on the western and south-eastern slopes.

Other plant species

The status of other rare plants appears to have changed little since 1982. *Fernelia* and *Asparagus* remain represented by single specimens and *P. revaughanii* remains limited to one small colony with no indication of expansion. *Lomatophyllum*, confined to the north-west of the island, also shows no evidence of gross change in population size or distribution (383 rosettes in area 7 in 1989, compared with 392 in 1982). The grass *C. filiformis* has increased slightly within its limited distribution in the south-east of the island (Fig. 2). In contrast, since 1982 there have been marked and often spectacular increases in the abundance and distribution of several species accidentally introduced to the island in recent years. These include *Desmanthus* (first recorded in 1982), *S. lycopersicum* (first recorded in 1982), *Erigeron* (first recorded in 1986), *Phyllanthus amarus* (first recorded in 1982) and *Cenchrus* (first recorded in 1987).

Reptiles

The number of individuals of the five lizard species recorded during daytime counts increased between 1982 and 1989. Increases were particularly marked for *N. serpensinsula* (by a factor of 20), *L. telfairii* (114%), *P. ornata* (109%) and *P. guentheri* (85%) (Table 5). Daytime encounter rates changed little between 1982 and 1989 except for *N. serpensinsula* and *C. dussumerii*. Encounter rates at night increased for *L. telfairii, P. ornata, N. serpensinsula* and *C. dussumerii* (Table 5). The lack of increases for other species may have been due to the increased density and extent of both ground vegetation and *Latania* thicket in 1989. In that year more time was required to search the same area as consistently as in earlier years. The proportion of immature *P. ornata* and *L. telfairii* was similar to that recorded in 1982; however, the proportions of immatures of *P. guentheri* and *C. dussumerii* were much higher (31·8% and 47·7%) respectively, Table 5).

DISCUSSION

Several marked changes in the vegetation and reptile populations on Round Island occurred between 1982 and 1989. In the absence of any other dramatic ecological changes since 1982, we attribute most of these changes (directly or indirectly) to the eradication of rabbits in 1986.

The palms

Results from 1989 reveal a new phase of *Latania* seedling establishment which, following rabbit eradication, is likely to continue. The opportunity for sustained regeneration of *Latania* in turn bodes well for the long-term recovery of the palm savanna on Round Island and is in marked contrast to the pronounced decline described by visitors prior to 1982 (Vinson, 1964; Bullock, 1977; North & Bullock, 1986).

Monitoring of the *Latania* cohorts that originated in 1975/76 suggests that the initial rate of habitat recovery can be rapid. Newly mature *Latania* and *Latania* thickets develop in less than 20 years. The rate of regeneration is, however, likely to become increasingly limited by factors other than grazing. For example, the increase in the amount of regeneration has been substantially greater on the south-eastern slopes. This may be due to greater competition and shading on the western slopes from the denser *Latania* there (*Latania* seedlings do not appear to be shade-tolerant). Other factors which could become increasingly important are the scarcity of both 'parent' trees (particularly on the south, south-eastern and upper slopes) and suitable substrates for seedling establishment.

The recovery of *Latania* has been paralleled by a much smaller recovery of *Hyophorbe*. The potential for recovery is limited mainly by the scarcity of 'parent' trees and the restriction of the population to the western slopes. The substantial increase in *Pandanus* regeneration since 1982 is important for the recovery of palm savanna on the more exposed and degraded southern and eastern parts of the island where this tree is better able to regenerate and survive than *Latania*.

Responses of vegetation other than palms

Species which have increased since 1982 (including *C. barbata, Digitaria, Passiflora, Commelina, Boerhavia* spp. and *S. nigrum*) are all known to have been grazed by rabbits (Bullock & North, 1976). Conversely, most

of the species which have decreased over the same period were apparently favoured by the presence of rabbits. *Nicotiana, Vetiveria* and *Tylophora* were not grazed and *Nicotiana* was particularly associated with areas of high rabbit density with considerable soil disturbance. *Portulaca* and *Brachiaria* are both low-growing species which were apparently tolerant of grazing and favoured by the maintenance of open conditions. It seems likely that the factors which favoured these species have disappeared, as happened in the East Anglian Breckland (UK) following experimental removal of rabbits (Watt, 1961; see also Sumption & Flowerdew, 1985). As on Round Island, rabbit eradication on Australian tropical and subtropical islands has resulted in spectacular increases in both plant growth and plant species diversity (e.g. Hermes *et al.*, 1989). Species formerly recorded on Round Island or elsewhere, and apparently extinct, may now be re-discovered in the absence of mammalian herbivores and increasing soil accumulation.

The general increase in the extent of ground vegetation should increase overall productivity, reduce soil erosion and enhance water retention; however, most of the recent increases (and indeed much of the present ground vegetation) are composed of species which are not considered native to Round Island (North & Bullock, 1988). Of 63 plant species recorded since 1975, at least 22 (25%) are believed to be not native to Round Island (Bullock & North, 1991). Some of these have remained local (e.g. *Withania somnifera*) or have been removed by man (e.g. *Papaya carica*) but others, notably *C. barbata, Ageratum, Commelina, S. nigrum* and *Passiflora*, are now major components of the vegetation.

The proportion of non-native species will probably continue to increase. Seven non-native species were first recorded in 1982 or 1989. Of these, *Erigeron* and *S. lycopersicum* have spread rapidly, and species such as *Desmanthus, Desmodium incannum* and *Cenchrus* could do likewise. Some of these, as with *C. barbata*, may have been formerly suppressed by rabbits but it is more likely that they were introduced accidentally as a result of the increased human activity on the island in recent years. Some introduced species, such as the woody shrub *Desmanthus*, could become invasive on Round Island, as documented for the Mauritian mainland by Vaughan and Wiehe (1937). One of the main reasons for Round Island's conservation importance is the scarcity of alien plants, but adverse changes may now take place.

Ground vegetation cover will probably continue to increase in future years but the establishment of vegetation of large areas of steeply sloping or exposed rock slabs will inevitably be a very slow process, dependent on a small number of plant species. *Latania, Pandanus, Vetiveria* and *C. barbata* are important colonisers of rock crevices, while the creeper *Ipomea* can cover the rock slabs.

Finally, with the exception of the three commonest tree species, only two (*C. filiformis* and *Gagnebina*) of the seven other threatened native species have responded to the removal of rabbits. The potential for recovery of some other species such as *Asparagus, Fernelia* and *Dictyosperma* is probably limited by the few remaining specimens (only one or two in each case); other species may be limited by specific (but as yet unknown) habitat requirements. In the long term, increased vegetation cover may limit several low-growing species that occur in open habitats (e.g. *P. revaughanii, C. filiformis* and other native species such as *Aerva congesta* and *Phyllanthus mauritiana*). There are already indications that the formerly abundant and widespread native grass *Vetiveria* is declining where *C. barbata* has recently become established.

Response of reptile species

The increase in six reptile species since 1982 and 1989 is attributed indirectly to the eradication of rabbits through a subsequent increase in suitable habitat, and an assumed increase in food availability. The species which increased most were those that depended largely on microhabitats within palm savanna. *P. ornata* and *P. guentheri* are particularly associated with *Latania* thickets, trunks and crowns, and during the day *Nactus* is found most frequently in litter at the base of *Latania* thickets (Bullock, 1986). Increases of these lizards were most pronounced on the western slopes (areas 3 and 7) where the expansion of *Latania* thicket habitat over the same period was also greatest. Thus increased habitat availability may have been the cause of the recovery of these species; sustained increase in palm savanna could support further population increases.

Neither of the other two skinks, *Leiolopisma* and *Scelotes*, are associated with trees or thickets. Both may be adversely affected by the predicted long-term decline of open-ground habitats and increased shading by tall vegetation. *Scelotes*, which is strictly diurnal and heliothermic, is uncommon on the neighbouring island of Gunner's Quoin where ground-layer vegetation is denser, resulting in fewer potential basking sites (Bullock, 1986; North & Bullock, 1986) and less suitable habitat.

All lizard species on Round Island are wholly or largely insectivorous (Bullock, 1986). Until recently observations of the invertebrate fauna have been mainly qualitative so it is impossible to compare 1982 with 1989, when invertebrates were estimated quantitatively (Bullock & North, 1991). However, invertebrates are now the only herbivores on Round Island. This contrasts with the past when there were also rabbits and goats and, up until the early 18th century, giant tortoises *Geochelone* sp. (Cheke, 1987). Removal of the last vertebrate herbivore (the rabbit) in 1986 will presumably have increased the amount of primary production available for invertebrates, whose biomass may have increased since 1986, and with it, prey for insectivorous lizards.

The snake *Casarea* is a top predator on Round Island and adults are exclusively saurivorous (Bullock, 1986). *Casarea* is not apparently associated with any

specific habitats on the island, and its observed increase since 1982 may have been in response to increased availability of prey. The overall encounter rate and the proportion of young seen were both higher in 1989 than in 1982. A large female *Casarea* can lay 10 eggs per annum (S. Tonge, pers. comm.) and the species could respond rapidly to favourable changes.

Unfortunately, the recovery of the Round Island ecosystem appears to have come too late to prevent the extinction of the other endemic snake, *Bolyeria*. Intensive searches by several expeditions between 1982 and 1989 have failed to find any evidence of this species.

Conclusions and implications for future management

The general conclusion of the 1989 expedition is that the eradication of rabbits in 1986 has resulted in the rapid recovery of many of the features of conservation importance on Round Island though their rate of recovery may be slow, particularly on the more degraded southern and eastern slopes. Several endemic plant species remain extremely scarce and recolonisation by natural regeneration could be very slow even where suitable conditions exist. In addition, since many components of the original vegetation have been lost and others introduced, the developing ecosystem will differ from the one prior to the introduction of rabbits and goats, or indeed, when tortoises were present.

Active management is necessary to assist the restoration of Round Island. We consider that this should follow the guidelines of Atkinson (1990) for islands in the 'Minimum Impact' category. The primary conservation function of management should therefore be 'the protection of indigenous species and communities, particularly those distinct from mainland communities' (Atkinson, 1990). Acceptable management would include:

(1) Dispersal of seed or establishment of native trees where no seed source remains.
(2) Propagation and establishment of native plants that are now rare.
(3) Weeding out (and if possible eradication) of introduced plant species considered to be invasive or 'aggressive' competitors with native species.
(4) Reintroduction of plant species known to have occurred on Round Island in the past (although it may be some time before conditions are suitable for species such as ebonies *Diospyros* spp.).
(5) Removal of vegetation threatening certain low-growing endemic plant species which have small populations.

All these operations are included in the Management Plan for Round Island prepared at the request of the Mauritius Government (Merton *et al.*, 1989). However, this plan also contains proposals to introduce plant species which, although native to Mauritius, have never been recorded on Round Island. Some of these are able to colonise bare ground and have been selected to assist in the early stages of vegetation restoration (one species, *Dracaena concinna*, has already been introduced). These same 'pioneer' characteristics may also have unpredictable and undesirable impacts on species known to be native to Round Island (see Maunder, 1992 for a review of this topic). We therefore suggest that such introductions proposed in the present management plan be resisted, at least in the short term.

The reptile species on Round Island remain vulnerable to natural disasters (such as cyclones) and accidental introductions of predatory or competitive species (such as rats and house geckos). It remains important, therefore, that captive populations of endemic species are maintained and that consideration is given to establishing 'reserve' populations elsewhere in Mauritius.

Finally, the detailed ecological studies carried out since 1975 have encompassed a period of major ecological change during which the importance of Round Island for conservation and scientific study has increased. Round Island is probably the largest island in the world from which rabbits have been eradicated (Merton *et al.*, 1989). Continued monitoring and research is essential, not only to aid further rehabilitation efforts and to gauge the success of introductions, but also to provide a clear example of the benefits of eradication. Further research would also be important in the study of ecological processes associated with relatively simple tropical island ecosystems and with the recovery of a degraded tropical habitat. It is important to capitalise on the management and research that has been carried out thus far.

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Appendix 1 Vascular plant species noted in the text together with status as endemic, native or introduced on Round Island

North and Bullock (1988) and Bullock and North (1991) provide complete lists of species recorded prior to these dates. R = Extremely rare outside Round Island.

Amaranthaceae		Malvaceae	
Aerva congesta Balf. f.	Native R	*Abutilon indicum* (L.) Sweet	Introduced
Asclepiadaceae		Mimosaceae	
Tylophora laevigata Dcne	Native	*Desmanthus virgatus* (L.) Willd	Introduced
Caricaceae		*Gagnebina pterocarpa* Neik ex D.C.	Native R
Papaya carica L.	Introduced	Nyctaginaceae	
Commelinaceae		*Boerhavia* spp.	Native
Commelina benghalensis L.	Introduced	Palmae	
Compositae		*Dictyosperma album* var. *conjugatum* Wendl	Endemic
Ageratum conyzoides L.	Introduced	*Hyophorbe lagenicaulis* Bailey (Moore)	Endemic
Erigeron canadensis L.	Introduced	*Latania loddigesii* Mart.	Native R
Convolvulaceae		Pandaneae	
Ipomea pes-caprae (L) R. Br.	Native	*Pandanus vandermeerschii* Balf. f.	Native R
Ebenaceae		Papilionoideae	
Diospyros spp.	Native but extinct	*Desmodium incannum* D.C.	Introduced
Euphorbiaceae		Passifloraceae	
Phyllanthus amarus Schum & Thom	Introduced	*Passiflora suberosa* L.	Introduced
P. mauritianus Johnston	Native R	Portulacaceae	
P. revaughanii Coode	Native R	*Portulaca oleracea* L.	Native
Gramineae		Rubiaceae	
Brachiaria reptans (L) Gardner & Hubbard	Native	*Fernelia buxifolia* Lam.	Native
Cenchrus echinatus L.	Introduced	Solanaceae	
Chloris barbata Sw.	Introduced	*Nicotiana tabaccum* L.	Introduced
C. filiformis (Vahl) Poir	Native R	*Solanum esculentum* (Mill) Luckwill	Introduced
Digitaria biformis Willd	Native	*S. nigrum* L.	Introduced
Vetiveria arguta (Stevd) Hubbard	Native R	*Withania somnifera* (L) Dunal	Introduced
Liliaceae			
Asparagus umbellulatus Bresler	Native		
Dracaena concinna Kunth	Recently introduced		
Lomatophyllum tormentorii Marais	Native R		