

THE DISTRIBUTION, STATUS AND CONSERVATION OF THE NICOBAR MEGAPODE *Megapodius nicobariensis*

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(Received 21 January 1994; revised version received 18 May 1994; accepted 7 June 1994)

Abstract

The mound-nesting Nicobar megapode occurs as two subspecies *Megapodius nicobariensis nicobariensis* and *M. n. abbotti*, both endemic to the Nicobar Islands. Thought to be endangered, this survey found it on almost all Nicobar islands where it historically occurred and concluded that, as a species, it was currently not threatened, and has probably become extinct only on inhabited Pilo Milo island. While *M. n. abbotti* is secure other than on small outlying islets, *M. n. nicobariensis* is threatened on all but three islands of its range. Loss of population in *M. n. nicobariensis* was indicated both by significantly lower mound densities and by a higher proportion of abandoned to active mounds, when compared with *M. n. abbotti*. Data were collected for 127 active mounds of *M. n. abbotti* and 85 active mounds of *M. n. nicobariensis*, and it was estimated that 849 and 312 active mounds, respectively are present, the population of the species being between 4500 and 8000 adult birds.

Though hunting and collection of eggs exists, the main threat to megapodes is loss of habitat, mainly due to conversion of coastal forest, the megapode's primary nesting habitat, to coconut plantations. Expanding urbanization and construction of coastal roads are other serious problems. The single largest threat is a proposal to make Great Nicobar a free-trade port which, if implemented, will destroy the Andaman and Nicobar islands.

Keywords: megapodes, Nicobar megapode, Andaman and Nicobar islands.

INTRODUCTION

The family Megapodidae consists of 19 species in six genera, most of which are island forms occurring in Australia, New Guinea, eastern Indonesia, the Philippines, Niuafou'u (Tonga), the Palau and Mariana islands and the Nicobar islands in India (Dekker, 1990). Throughout their distribution, megapodes are threatened by habitat destruction, introduction of predators, and over-exploitation of their eggs (Dekker, in press), and nine of these 19 species are threatened (Jones, 1989; Jones & Birks, 1992).

The Nicobar megapode *Megapodius nicobariensis* was considered to be seriously endangered (Jones,

1989; Jones & Birks, 1992), and has featured in several lists of endangered species (e.g. Collar & Andrew, 1988). The megapode is therefore protected under Schedule I of the Indian Wildlife Protection Act (1972) whereby hunting and trade is prohibited. The ethnic tribes of the Nicobar islands (Nicobareses and Shompen) are exempt from the Act. In 1988, the extinction of the megapode from Kondul was reported, a population of less than 400 birds from Great Nicobar was estimated and the extinction of this species was predicted in the next 10 years (Anon., 1988). However, Dekker (1992) estimated the population of *M. n. abbotti* at about 780 breeding pairs (if not more) in the coastal area of Great Nicobar and concluded that it was not threatened there. The status of the species on other islands, however, was still unknown.

The purpose of the paper is to document precisely the present distribution and status of the Nicobar megapode (*M. n. nicobariensis* and *M. n. abbotti*) and to identify threats to this species.

Study area

The Andaman and Nicobar islands (latitudes 6°45' and 13°41' and longitudes 92°12' and 93°57') in the Bay of Bengal arch from Arakan Yoma in Myanmar in the north to Sumatra in Indonesia in the south (Saldanha, 1989; Dagar *et al.*, 1991). The islands cover an area of 8249 km², with a total coastline of 1962 km—the Andaman group with more than 325 islands (21 inhabited) covering 6408 km², and the Nicobar group (Fig. 1) with over 24 islands (12 inhabited) with an area of 1841 km² (Singh, 1981; Saldanha, 1989).

The Nicobar islands can be subdivided into three distinct subgroups. To the south the Great Nicobar group consists of two islands over 100 km² in area, nine islets of less than 5 km², and a few rocks. Four islands are inhabited. The human population on Great Nicobar (6831 people) has both tribal (8%) and mainland Indians including settlers. The tribals are thinly distributed along the southern, western and northern coasts. Of the mainlanders, 55% are in the township Campbell Bay midway up the east coast, and the remainder pursue agrarian livelihoods along the southeastern coast. Little Nicobar has no mainland settlers and the tribals are distributed all around the island. Kondul and Pilo Milo

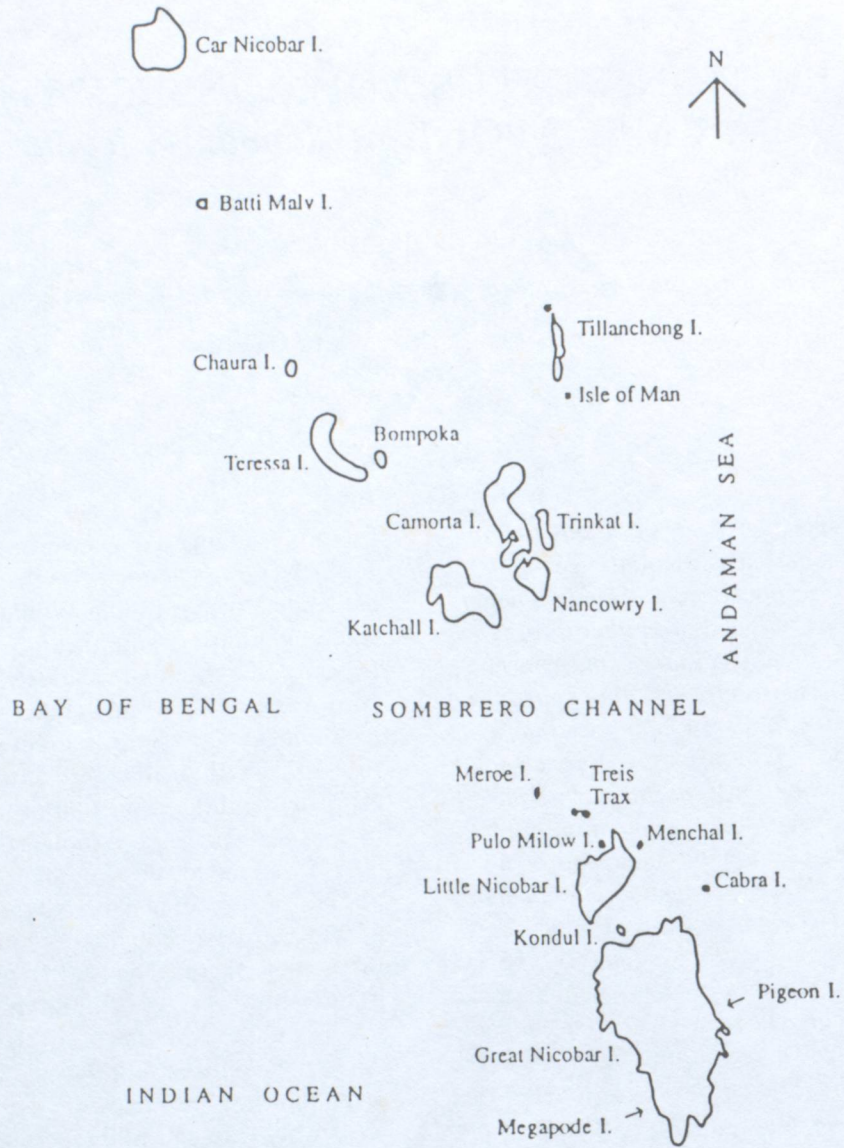


Fig. 1. The Nicobar group of Islands.

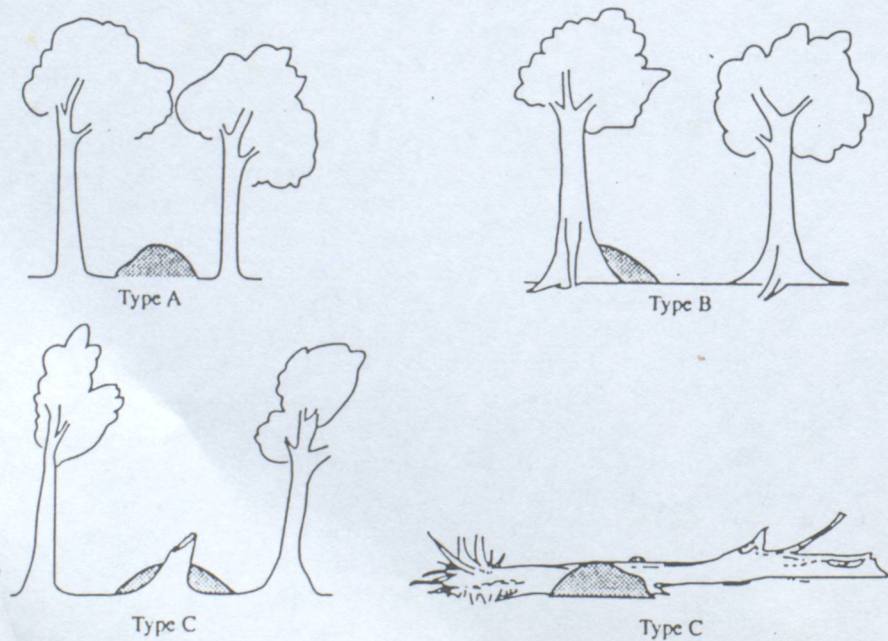


Fig. 2. Mound types in the Nicobar megapode.

Table 1. Summary of details of islands in this survey

Island	Area (km ²)	Coastline (km)	No of transects	Transects (km)	% coast surveyed	Survey days	Population	
							Tribal	Mainlander
Great Nicobar	1045.1	213	19	30.4	14	56	536	6295
Little Nicobar	159.1	78	12	12.7	16	18	295	13
Megapode Island	0.125	2.4	1	1.0	42	1	0	0
Meroe	<3	5.25	1	5.25	100	3	0	0
Treis	<1	2.7	1	2.7	100	0.5	0	0
Trak	<0.2	1.2	1	1.2	100	0.25	0	0
Menchal	<2	3.3	1	1.5	46	2	0	0
Kondul	4.6	7.5	1	2	27	2	139	8
Pilo Milo	1.3	3.0	1	2.5	83	2	109	13
Camorta	188.2	112.5	8	12.2	11	17	1406	1567
Trinkat	36.3	30	2	4.0	23	5	350	0
Nancowry	66.9	44.3	4	10.25	7	4	907	107
Katchall	174.4	78.0	3	8	10	8	2491	2581
Teressa	101.4	53.25	5	11.95	22.4	12	1617	162
Bompoka	13.3	12.75	1	2.2	17.3	2	51	0
Tillanchong	16.82	42	4	6.2	14.8	7	0	0

are inhabited islets; Meroe, Treis, Trax, Menchal, Megapode, Cabra and Pigeon are uninhabited.

The Nancowry group (middle Nicobar islands), 58 km north of the Great Nicobar group, consists of three islands larger than 100 km², two of 36 and 67 km², three less than 17 km², two small islets and a few rocks. Seven islands in the Nancowry group are inhabited, with a population of 12,464 comprised of both tribals (64%) and mainlanders. The tribals are distributed all around the islands. Mainlanders do not own land in the nancowry group, and about 80% are either employed by various government agencies, tribal co-operative societies or trade sectors. Twenty percent of mainlanders in the Nancowry group are Sri Lankan repatriates who have been settled on Karchall and who work on the 600-ha rubber plantation. Tillanchong is the only uninhabited island of the group.

The northernmost subgroup, composed of Batti Malv and Car Nicobar, is 88 km north of the Nancowry group. Batti Malv is uninhabited and Car Nicobar has a population of over 19,000 people, 80% of whom are tribals. The mainlanders are mainly employed in government and trade sectors.

The habitat characteristics of the islands vary. In the Great Nicobar group, all islands are completely forested. A small proportion of the coast of the larger islands is mangrove. In the Nancowry group of islands, the central portion of all islands, except Katchall and Tillanchong, are grasslands (over 60% of Trinkat and Teressa, 30–50% of Camorta and at least 20% of Nancowry and Bompoka), often extending to the coast itself. Within the grasslands there are patches of forest. A substantial amount of the coastline of Camorta, Trinkat and Nancowry is mangrove. Thus habitat available for the megapode is considerably less in the Nancowry group than in the Great Nicobar group.

Four islands in the Nicobar group have areas protected as wildlife preserves, and most islands are tribal reserves. Tillanchong, Batti Malv and Megapode Island, all

uninhabited, are Wildlife Sanctuaries. Great Nicobar is a Biosphere Reserve (885 km²), whose two core areas are National Parks (536 km²).

The mound of the Nicobar megapode

The Nicobar megapode builds mounds of sand, loam, coral bits and rotting vegetation within which eggs are laid. Mounds vary in height from 10 cm to 2.1 m and in basal circumference from 7 to 45 m. Basically three types of mounds are built by the Nicobar megapode and have been described by Dekker (1992) as: type 'A' mounds or true mounds, regular in shape and built on an open spot away from trees; type 'B' mounds, irregular in shape, built against the buttress or stem of a large living tree; type 'C' mounds, also irregular in shape but built against, around, under or over a dead rotting tree stump or log (Fig. 2).

Mounds are usually made close to the shore but may also be present some distance inland (Hume & Marshall, 1878; Baker, 1930). This preference for nesting near the beach is common to at least one other species, *M. freycinet* (Stuebing & Zazuli, 1986). Of the 188 active mounds for which measurements were taken during this study, 97% were found within 100 m (80% within 60 m) of the beach. A few mounds were further inland (as far as 15 km inland on Great Nicobar), but these were difficult to find because of hilly terrain and much lower densities.

METHODS

The historical distribution of the Nicobar megapode was learnt from literature and this was followed by a survey of the Nicobar group of islands from 10 December 1992 to 5 April 1993, and 20 December 1993 to 31 March 1994. The coastline of 17 islands was sampled by walking around each island so that the entire range of this species was covered. Distances between sampling sites varied between 5 and 8 km on larger islands and the entire coast of small islands was surveyed (Table 1).

As mounds are stationary, inanimate and represent breeding, the best way to estimate and monitor megapode populations is by assessing the number of active mounds (those in use), identified by signs of recent digging. When such signs were not obvious, as when rains obliterated marks, the state of a mound was identified by checking whether the soil was compact and hard (abandoned) or if the soil was loose and easily penetrable with a stick (active). A mound that was not active (i.e. not in use) was considered abandoned. I preferred this classification over Dekker (1992), who called such mounds inactive, because 'inactive' implies that a mound is periodically inactive and active, while in reality most abandoned mounds had not been used for considerable periods, were in stages of obliteration, and often had vegetation growing on them. This indicated that in the Nicobar megapode, few if any mounds are brought back into use after being abandoned.

As mounds are predominantly placed in a narrow strip of forest along the seashore (Dekker, 1992; this study), the survey concentrated on forests abutting the beach. The census consisted of two observers walking between 30 and 50 m abreast parallel to the seashore, with the observer closest to the sea about 20–30 m from the beach. As mounds within 20 or 30 m of the observer are easily located, most mounds within a belt of forest about 100 m wide starting from the beach were thus counted. The length of this modified belt transect was about 1.5–2 km (av. 1.7 km, SD = 1.3 km, range 0.2–8 km, $n = 64$). Only three transects were less than 0.5 km, in terrain where available habitat was limited to the length of the transect, e.g. small bays amidst cliffs. The data from such transects have not been appended to other transects.

The census data consisted of three parameters: (a) length of the transect; (b) distance between mounds; and (c) distance between the mound and the beach. I calculated mound density (per km²) by the equation, $D = m/l \times w$, where m = number of active mounds, l = length of transect (km) and w = width (100 m) as 97% of mounds in coastal forests were found within 100 m of the beach. Mounds beyond 100 m from the beach were excluded from the estimates.

To estimate the total number of active mounds, the coastline of each island was divided into segments based on similarity of habitat. This was necessary because the distribution of mounds was not uniform and they were not present or were very rare where cliffs or mangrove swamps abutted the shore or the forest was low-lying and periodically inundated (e.g. dominated by *Areca* or *Pandanus* palms), or the forest has been replaced by coconut. Thus, a segment was based on judging overall similarities in habitat and its suitability for megapodes. The total number of mounds for the forest abutting the coast (probably comprising 75% of mounds in Great and Little Nicobar, Katchall, Bom-poka and Tillanchong, and over 90% of Camorta, Trinkat, Nancowry, and Teressa) was then calculated by the equation:

$$\sum_{i=1}^n \frac{M_i}{L_i} \times S_i,$$

where n = number of segments, i denotes a particular segment, S_i = length of segment, L_i = total length of transects within a segment, M_i = total number of active mounds within L_i .

Megapodes also occur in the forests in the interior of the islands, and in the larger fragments of forests within grasslands in the Nancowry group. These populations have not been considered in my estimates.

Measurements of distances were approximate. Distances in the field were measured using a pedometer set at 45 cm, arrived at by comparing strides taken to survey 1.5 km of megapode habitat abutting a metal road, and on the road. Distances between the mound and the beach were measured either by pacing, or visual estimates. Coastlines were measured from 1:150,000 scale hydrographic charts. Signs of predation, both natural and human, were recorded for every active mound seen.

RESULTS AND DISCUSSION

Distribution

M. nicobariensis, endemic to the Nicobar islands, is geographically isolated, with its nearest congeneric about 1600 km away (Olson, 1980). Two subspecies are recognized — *M. n. nicobariensis*, present on the Nancowry group of islands north of the Sombrero Channel, and *M. n. abbotti*, on the Great Nicobar group of islands to the south (Ali & Ripley, 1983; Fig. 1). As the two subspecies have significant dialectic differences in their vocalizations, subspecific identification is possible in the field (this study).

The Nicobar megapode occurred on most Nicobar islands (Hume, 1874; St John, 1899; Kloss, 1903) but was not found on Car Nicobar (Butler, 1899) and Chaura (Abdulali, 1967). There were a few records from the Andaman group of islands (Hume, 1874; Butler, 1899; Sewell, 1922) and from the Coco islands further north (Kloss, 1903; Abdulali, 1964). None of the records from the Andaman group are of recent origin and the species is believed to be absent there.

Three theories have been put forward for the absence of megapodes from the Andaman islands. Kloss (1903) believed that megapodes were introduced to the Nicobars by the Malays and explained their absence from the Andamans because voyagers were deterred from those islands by hostile natives, thus preventing their introduction. Olson (1980) suggests that megapode distribution is a result of competitive exclusion by other galliforms, but as wild galliforms are absent in the Andamans, this does not explain their absence there. Dekker (1989) argued that because mound-nesting megapodes are unable to survive in the presence of large carnivores, their absence in the Andamans might be explained by the introduction of the palm civet *Paguma hermaphroditus* and masked palm civet *P. larvata* (Kloss, 1903; Dekker, 1992), and considers the Nicobar megapode as a relict population. However, of

the two civets in the Andamans only *P. hermaphroditus* is introduced; *P. larvata tytleri* is a subspecific endemic, and it is therefore possible that megapodes were not able to colonise the Andamans at all.

Whether the megapode existed in the Andaman group needs confirmation as there are no specimens from those islands and shooting records appear to be hearsay. It is possible that the mound reported by Hume (1878) was a nest of the king cobra *Ophiophagus hannah*, a likely error if one had not seen a megapode mound before. Spot sampling in South Andamans failed to reveal old mounds (this study), traces of which can be present for over 1000 years (Stone, 1991). Many taxa are exclusive either to the Nicobars or the Andamans and this is probably also true for the Nicobar megapode. Tangible evidence, in the form of abandoned mounds, is needed before we can conclude that this species indeed existed in the Andaman group of islands.

I found the Nicobar megapode to be present on all but one island (Pilo Milo, where it is probably extinct) in the Nicobars from where it had been reported. It may have existed on Car Nicobar (78 km north of Teressa, the nearest megapode population) a century ago (Kloss, 1903; this study) but I found no traces of mounds. Chaura is only 11.5 km from Teressa and considering the megapode's occurrence on the more remote Tillanchong there is no reason why it should not have existed there. Even if it did occur in the past, both Car Nicobar and Chaura are much too densely populated for the species to exist there now.

Status

Crucial to a population estimate is the number of pairs that use a mound in a year, whether larger mounds attract more pairs, differences in types of mounds and in the number of pairs using them, presence of mound tenacity, egg-laying frequency, number of eggs laid and duration of reproductive period. This information is as yet unavailable and any population estimate will be tenuous. Thus, the best indicator of the status of megapodes is an estimate of the number of active mounds in an island. However, Dekker (1992) estimated an average of two pairs per mound (for all three types), and emphasized that this was an absolute minimum, indicative of the breeding population for the month of March only. As the breeding is said to be through the year (Ali & Ripley, 1983), the actual number of pairs that use a mound in a year would be more (cf. Dekker, 1992). That more than two pairs use the same mound was also evident from trappers who had snared several birds from the same mound. In two other mound-building megapodes, a maximum of four and five pairs have been estimated as using the same mound (Rand & Gillard, 1967; Stuebing & Zazuli, 1986). Thus for the population estimate, I used two pairs per mound for the lower limit and 3.5 pairs per mound for a conservative upper limit (the mean of the minimum of pairs per mound for *M. nicobariensis* and the maximum recorded for megapodes in the literature).

Megapodius nicobariensis abbotti

On Great Nicobar, *M. n. abbotti* was believed to have disappeared from all areas colonised by mainlanders (Dekker, 1992). However, megapodes still survive there and four active mounds were located over a distance of 11 km. In areas not colonised by mainlanders, active mounds were present in all forests abutting the shore, as was the case with all of that part of Little Nicobar which has no mainland settlers. I estimated over 800 active mounds in Great and Little Nicobar and a population of adult breeding birds between 3300 and 5750 birds (Table 2).

Dekker (1992) estimated 390 active mounds on Great Nicobar as against this study's 515, though sampling intensities were similar (26 and 30.4 km, respectively). Dekker, however, surveyed three areas, whereas I sampled 19 locations all round the island. In his study the west coast was under-sampled (3 km at one location); this coast had the least disturbance and the best megapode habitats (I surveyed 12 km at nine locations). His other two transects pass (one partly) through habitat that had been subjected to human activity such as road building or quarrying and are not representative of mound abundance. Lastly, by dividing the coast into segments (this study) a truer estimate of mound numbers was obtained than by a simple arithmetical extrapolation (Dekker, 1992).

Seven of nine islets in the Great Nicobar group had habitat suitable for megapodes and two (Cabra and Pigeon) were too small. Over 50% of the forests of uninhabited Meroe, Treis, Trak, Menchal and Megapode Island have been converted to coconut plantation by the inhabitants of neighbouring islands. On Megapode Island and Meroe only one active mound each was found and a high proportion of abandoned mounds was indicative of a dwindling population. A dense ground cover of germinating coconut on Meroe has ruined potential mound-building areas. Only Treis and Trax, with four and three active mounds each, had a satisfactory megapode population. Less than 10% of Menchal's coast is suitable for megapode as most of the island is rocky. Only one active mound was found there. The only level area in Kondul is inhabited and of the three active mounds found, one was just behind the South Point village. About half of Pilo Milo is inhabited, and the islet is mostly under coconut palms. Megapodes are apparently extinct on this islet, though reports of calls heard indicate that it may still survive. The number of active mounds in the outlying islets in the Great Nicobar group is estimated to be 23, with an adult breeding population between 90 and 160 birds (Table 2). Thus the population of *M. n. abbotti* is between 3400 and 6000 birds.

Megapodius nicobariensis nicobariensis

M. n. nicobariensis occurs on seven islands of the Nancowry group. On Camorta, Katchall and Trinkat, it was patchily distributed, with very few locations having active mounds and even fewer where mounds were abundant. For instance, on Camorta, only one location,

Table 2. Population estimate of the Nicobar megapode

	Estimated no. of active mounds	Estimate of number of breeding pairs (range) ^a
<i>M. n. Abbotti</i>	849	1698-2972
Great Nicobar	515	1030-1802
Little Nicobar	311	622-1088
Megapode Island	2	4-7
Pilo Milo	0	0
Meroe	1	2-4
Treis	4	8-14
Trak	3	6-11
Menchal	2	4-7
Kondul	11	22-39
<i>M. n. nicobariensis</i>	312	624-1093
Camorta	20	40-70
Trinkat	8	16-28
Nancowry	60	120-210
Katchall	69	138-242
Teressa	119	238-417
Bompoka	26	52-91
Tillanchong	10	20-35

^aLower limit at two pairs per mound, upper limit at 3.5 pairs per mound.

a small promontory near Kakana village, had a high density of active mounds. Elsewhere in the island, active mounds were either very rare or absent. Very few active mounds were located on Trinkat. At Katchall, considered by Kloss (1903) to be the home of the megapode, a few mounds were distributed through much of the coast, but only a single location had a high density. The southern half of Nancowry had mound densities similar to that of Great and Little Nicobar. I estimated over 150 active mounds of *M. n. nicobariensis* in these four islands, and an adult breeding population of between 600 and 1100 birds (Table 2).

It was only on Teressa and Bompoka that good populations of megapode existed, with a similar density

of active mounds as that of Great and Little Nicobar (Table 3). Tillanchong is mainly hilly with very little level coastal forest; thus megapodes are naturally scarce except in the level forests. The small population that exists is apparently secure. Thus the total population of adult breeding birds of *M. n. nicobariensis* is estimated to be between 1200 and 2100 birds and the number of active mounds to be a little over 300.

Population loss

To assess which islands have undergone population loss, and the reasons behind the reductions, the mean density of mounds and the proportion of abandoned to active mounds for each of the transects traversed were calculated, and comparisons made between islands.

The densities of active mounds are similar for six islands, Great and Little Nicobar, Trax, Nancowry, Teressa and Bompoka, where densities ranged between 30 and 36 mounds km² (Table 3). In all other islands, densities ranged between 3 and 22 mounds km². In the best habitats, active mounds were encountered at least once every 200 m, and similar densities have been reported for *M. reinwardt* (Lincoln, 1974; Crome & Brown, 1979) and for *M. cunningii* (Stuebing & Zazuli, 1986). The significantly lower densities in *M. n. nicobariensis* in Camorta, Trinkat and Katchall and of *M. n. abboti* in the outlying islets of the Great Nicobar group thus poses the question whether the lower number of mounds encountered for the northern subspecies is natural or whether there has been a loss or reduction in the populations.

Reduction in the populations is best indicated by the proportion of abandoned mounds. The two islands with the least damage to coastal forests are Great and Little Nicobar, of which Great Nicobar had a greater proportion of undisturbed coast. All other islands had

Table 3. Summary of census data of megapode mounds

	<i>M. n. abboti</i>									<i>M. n. nicobariensis</i>						
	GN	MI	LN	PM	MR	TR	TA	MN	KN	CM	TR	NN	KT	TS	BP	TI
No. of active mounds																
Type A	20	1	23	0	1	3	1	1	0	7	2	9	11	18	6	4
Type B	25	0	14	0	0	0	0	0	1	1	0	2	1	3	0	2
Type C	21	0	12	0	0	1	2	0	2	0	0	3	2	12	1	2
Total	66	1	49	0	1	4	3	1	3	8	2	14	14	33	7	8
No. of abandoned mounds	50	3	78	4	14	14	13	0	5	44	16	15	29	113	25	14
Mean % abandoned mounds	40	75	57	100	93	78	81	0	63	82	90	53	70	72	78	67
Mean mound density (km ²)	3.3	10	36	—	3	16	30	7	15	10	4	30	22	30	32	13
% mounds with signs of egg collection	7.5	0	2	—	0	0	0	0	0	0	0	0	0	0	0	0
% mounds with snares	12	0	18	—	0	0	0	0	0	0	0	8	0	0	14	38
% mounds with monitor lizard signs	18	0	18	—	0	0	0	0	0	0	0	0	0	0	0	0
No. active mounds (extrapolated)	515	2	311	0	1	4	3	2	11	20	8	60	69	119	26	13

GN, Great Nicobar; MI, Megapode Island; LN, Little Nicobar; PM, Pilo Milo; MR, Meroe; TR, Treis; TA, Trak; MN, Menchal; KN, Kondul; CM, Camorta; TR, Trinkat; NN, Nancowry; KT, Katchall; TS, Teressa; BP, Bompoka; TI, Tillanchong.

undergone considerable conversion of forest to coconut plantations. The proportion of abandoned to active mounds in the other islands was between 1.6 and 2.3 times that of Great Nicobar, and 1.2–1.6 times that of Little Nicobar (Table 3). The only exception was Nancowry where the proportion of abandoned mounds was similar to Great and Little Nicobar.

The highest number of abandoned mounds were present in those areas where primary forest has been converted into coconut plantations. In one plantation on Camorta, of the 16 mounds seen in a 1.5-km transect, 14 (87.5%) were abandoned, in another on Teressa 56 were abandoned and four active mounds were seen in 2.75 km, and in very old plantations only traces of abandoned mounds were visible. However, where there was a mixture or mosaic of coconut and forest, or the ground vegetation was not cleared, megapodes built mounds. They apparently abandon pure stands of coconut because they require sufficient ground and middle-storey vegetation cover, and probably also because mounds become unworkable due to the cover of dead coconut fronds, and falling and germinating nuts.

Teressa and Bompoka are exceptions because while mound densities are similar to that in Great and Little Nicobar, they have a significantly greater proportion of abandoned mounds (Table 3), since much of the coast on these islands has been converted to coconut. There is, however, an adequate interspersed of natural habitat within the plantations and large tracts of optimal megapode habitat.

The first sign of a declining population is perhaps a high proportion of abandoned mounds, followed by a decline in the density of active mounds and culminating in population loss. This can be seen as a continuum in the larger islands (Table 3), which also corresponds to the availability and quality of habitat. Great Nicobar had a high density of active mounds and the least proportion of abandoned mounds while Little Nicobar had a high mound density but a greater proportion of abandoned mounds. Teressa and Bompoka had high mound densities but high proportions of abandoned mounds, Katchall with a lower mound density and a high proportion of abandoned mounds and Camorta and Trinkat with both low mound densities and high proportions of abandoned mounds.

Threats

The main threats to the Nicobar megapode can be classified into hunting of birds for meat and egg collection, predation and habitat loss.

Hunting and egg collection

Because megapodes have spiritual and medicinal values attached to them, the Nicobarese do not hunt or collect eggs of this species extensively. There were, however, inter- and intra-island differences. In some villages hunting or egg collection is present (e.g. Tahiyuol, on Little Nicobar), while in others it is not (e.g. Pilo Pakka, also on Little Nicobar). Hunting was greatest

on the west coast of Little Nicobar and rare or uncommon over much of the Nancowry group, particularly Kondul, where continued adherence to traditional values resulted in lesser levels of exploitation. Where traditional values have been eroded (as by the complete domination of Christianity), localised heavy to excessive hunting pressures may exist. At Tahiyuol, 71 legs, presumably of 36 megapodes, had been strung up and shot during the week of a full moon. Such hunting pressures, however, were exceptional, and in the entire range of the species were seen only at two locations (Tahiyuol and Pilo Milo). Megapodes are also shot on Meroe and Treis, thus seriously threatening already depleted populations.

Megapode eggs are apparently not an important source of food. Thus, unlike other species where high egg collection pressures exist (Bishop, 1978; Todd, 1983; Stuebing & Zazuli, 1986; Dekker & Wattel, 1987; Jones, 1989), a low number of mounds had been excavated for eggs (Table 2). The Shompen and some Nicobarese do occasionally collect eggs (but apparently all Nicobarese do not collect (or eat?) megapode eggs and egg collection is only done occasionally.) Bompoka is an exception, and megapode eggs from there are gifted to people on neighbouring Teressa. Localised, heavy hunting pressures on the megapode by Nicobarese are a recent phenomenon, because of the popularisation of airguns. The traditional method, with a cross bow, was rare and I saw it being used only on Bompoka and at one location in Katchall. Most Nicobarese do not use snares, and its use is even resented because pigs and chicken get caught or injured by the nylon nooses.

Mainlanders, particularly labourers on construction projects, trap megapodes, e.g. on Great Nicobar while work on Project Yatrik (which opened up the island to colonisation) was under way. With the phasing out of the project, and the better implementation of Wildlife Protection laws, hunting pressures have declined. I did not come across any sign of mainlanders digging up mounds for eggs.

Very high hunting pressure, albeit localised, was from Thai poachers who camp in isolated parts of Tillanchong, Great and Little Nicobar. Snares for megapode and wild pig *Sus scrofa nicobarica* had been placed extensively in the northeastern coast of Great Nicobar and most mounds near Thai camps had snares on them. Several active mounds where building was infrequent were also indicative of a population that had suffered recent losses. About 5% of Great Nicobar's coast is affected in this manner. Thai poachers also collect eggs.

Predation

Having evolved in habitats free of large carnivores, megapodes are particularly vulnerable to predators (Dekker, 1989). In the Nicobars, introduced wild predators are absent. Only the monitor lizard *Varanus salvator*, the reticulate python *Python reticulatus* and species of raptors are potential predators of megapodes

and their eggs. The monitor lizard excavates mounds both to prey on eggs and to lay its own eggs (cf. Dekker, 1992). However, this is not a problem and as monitor lizards are extensively hunted for meat, the numbers of this predator are kept in check.

Dekker (1992) suggested that cats and dogs pose a threat to megapodes in the Nicobar islands. I made a few observations that were contrary to this, the most striking of which was an active type 'A' mound within 30 m of an inhabited hut with five dogs and four cats. At night the megapodes roosted on an adjacent tree. Todd (1983) also stated that in the 100-odd years that cats have been resident of Niuafo'ou, *M. pritchardii* has not become extinct. Dogs and cats are currently not a threat to the Nicobar megapode, except on Meroe, where cats were released in 1991 to control a very high population of rats that were seriously damaging the coconut crop. The most visible change on Meroe since then has been a flush of germinating coconut palms, 1.5–2 m high, forming a dense ground cover, greatly reducing the area available for mound building. Because of the density of ground cover, the essentially cursorial megapode will also be increasingly incapable of avoiding predators.

Habitat loss

The primary threat to most species of megapodes is loss of habitat (e.g. Bishop, 1978; Dekker, 1990), and this is also true for the Nicobar megapode. Demographic changes in the Nicobars have resulted in widespread loss of habitat, being most acute in the Nancowry group of islands.

The Nicobarese subsist on coconut and have cleared forest to plant banana, papaya and tuber-bearing plants. As tribal populations are the highest in the nancowry group, most damage has occurred there. An approximately 35-km long strip of forest along the southeastern coast has been depleted on Great Nicobar due to settlement of mainland Indians. Over 600 ha of primary forests were replaced by rubber plantations on Katchall. Expanding townships and villages, roads, airstrips and infrastructure of defence establishments have all resulted in the loss of habitat, which is the single biggest threat to megapodes.

Conservation perspectives

The long-term perspective for the Nicobar megapode is bleak due to persisting loss of habitat. The problem is most acute in the Nancowry group where suitable habitat, both for megapodes and humans is considerably less than in the Great Nicobar group. Control over habitat loss due to tribals is not possible in the Nicobars, even where areas have been declared as protected reserves, because the tribals are exempt from Forest and Wildlife laws. The population of the ethnic tribes inhabiting the Great Nicobar group is low, and an immediate threat of significant alteration of primary forest is minimal. As further mainlander settlement has been stopped on Great Nicobar, the damage has been contained to forests already lost or degraded.

Though megapodes are not being extensively hunted (or their eggs collected) in the Nicobar Group of Islands, intensive localised hunting pressures exist and may cause localised rarity or extinction. The situation, however, is not yet alarming.

The most immediate threat in the Nicobars is the proposal to make Great Nicobar a free port and to create a dry dock and refuelling base for international shipping at the mouth of the Galathea river. If and when implemented, all the Nicobar islands will be lost to conservation.

The Nicobar megapode, as a species, is not endangered. The only two criteria (IUCN criteria for threatened status; Collar et al., 1994) for which the species qualifies are B2c (continuing decline in area, extent and quality of habitat) and C1 (decline over the last 10 years may be greater than 20%, though there are no data for this). The species should therefore not be classified as threatened, but as it qualifies for one of the B codes, I propose that it be classified as vulnerable and its status be periodically re-evaluated.

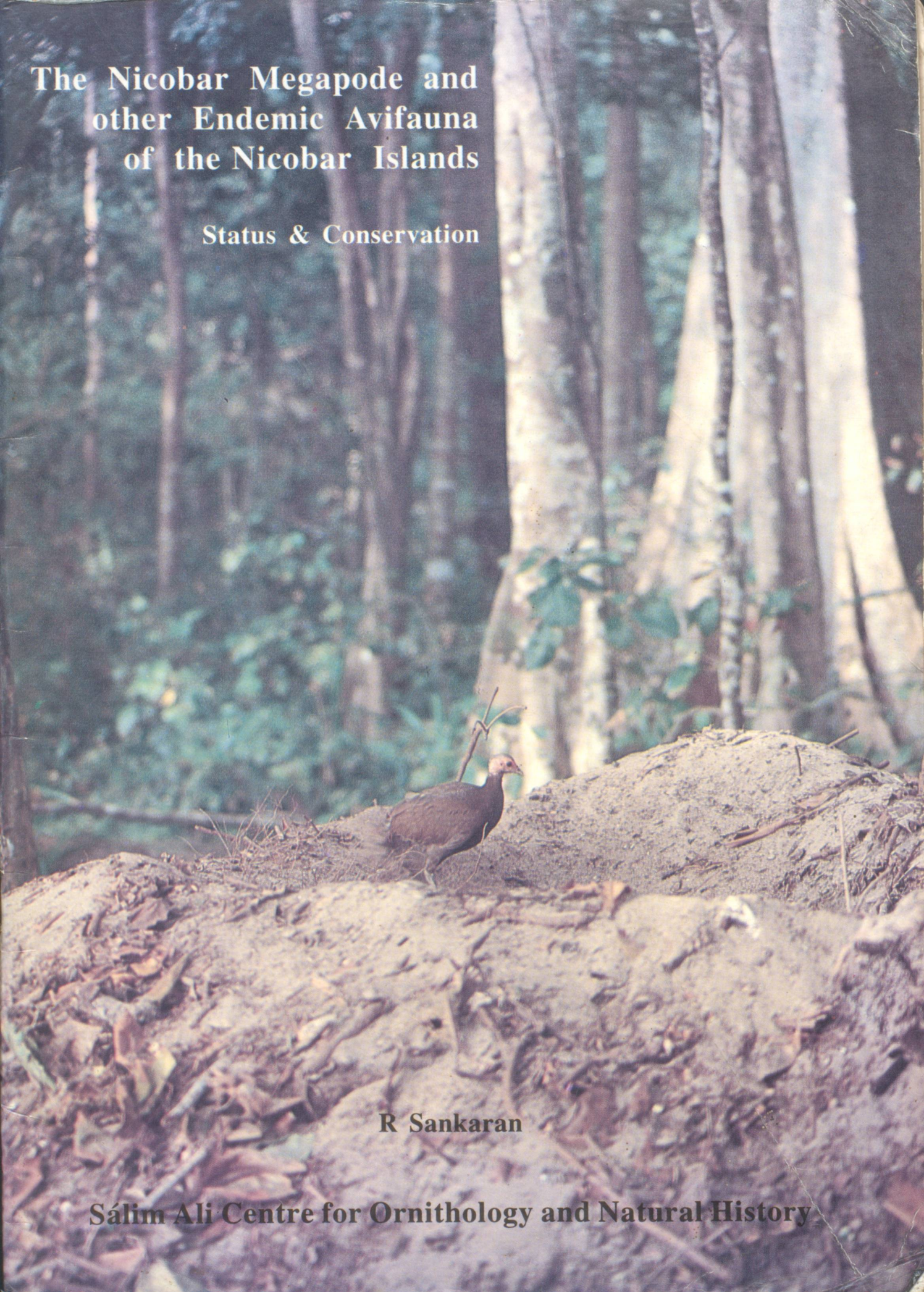
ACKNOWLEDGEMENTS

I would like to acknowledge the help, support and discussions of A. K. Wahal, Ajai Saxena, T. Nautiyal, M. Parida, the Andaman and Nicobar Forest Department and Public Works Department, V. S. Vijayan, Lalitha Vijayan, Ajith Kumar, S. N. Prasad, N. K. Ramachandran, H. S. Das, R. W. R. J. Dekker, V. Gokula, Jugulu Maheto, N. Illangoan and two anonymous referees. This study was possible due to a grant from the Ministry of Environment and Forests, Government of India.

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A photograph of a brown Megapode bird standing on a mound of earth in a forest. The bird is facing right, and its body is covered in brown feathers. The background shows a dense forest with tall, thin trees and green foliage. The ground is a mix of brown soil and dry leaves.

**The Nicobar Megapode and
other Endemic Avifauna
of the Nicobar Islands**

Status & Conservation

R Sankaran

Sálim Ali Centre for Ornithology and Natural History

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other endemic Avifauna
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P. Shikha

Status and Conservation

A study funded by the Ministry of Environment and Forests, Government of India

R Sankaran

SACON - Technical Report 2

Sálim Ali Centre for Ornithology and Natural History
Coimbatore, India.

1995

R Sankaran is a Scientist in the Division of Avian Ecology. He was awarded a Doctorate from the Bombay University for his studies on the breeding behaviour of the Lesser Florican *Sypheotides indica* and Bengal Florican *Houbaropsis bengalensis*. He has worked in diverse habitats that include the *terai* of Uttar Pradesh, the subhumid grasslands of western India, the Thar desert, and the Himalayas. He is currently working on a project on the endemic avifauna of the Andaman & Nicobar islands and is involved in the conservation of the Lesser Florican.

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1995

Published by : Director
Sálim Ali Centre for Ornithology & Natural History
Kalampalayam P.O., Coimbatore 641 010. India.
Phone: (91) (422) 392273, 395383; Fax: (91) (422) 398232
Grams : SACON; e-mail (internet): centre@sacon.ernet.in

Typesetting by : K.K. Ramakrishnan

Cover picture : The Nicobar Megapode on the mound, Great Nicobar.

Back cover : Rain forest, Great Nicobar.

Printed at Kalaikathir achchagam, Coimbatore

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Acknowledgments

I wish to thank the Forest Department Andaman & Nicobar islands, without whose active involvement this study would not have been possible. I wish to particularly thank the Chief Wildlife Wardens, Mr A.K. Wahal, and Mr H.C. Dhawan, and the Deputy Conservators of Forests, Mr Ajai Saxena, Mr Tarun Kumar and Mr Pankaj Asthana, and Mr Chatterjee ACF (Silviculture), for their help and support.

Special thanks are due to Mr T. Nautiyal, ACF (Wildlife), Nicobar district for all his help and the insights he gave me into the conservation problems in the Nicobar islands. I wish to thank all his staff, particularly the Range Officers Mr Martin, Mr Padmadeo, Mr Choudhary and Mr Vijayan, the Foresters Mr Wimbrite, Mr Chakravarthy, Mr Uriel, and the chowkidaars Ilyajar, Manuel, Julius Topo, Lawrence, Robert and Jonal for their help.

I thank Mr M Parida, ex. Deputy Commissioner and Mr A. Lal, DC, and other officers of the district administration for their assistance. While in 'town' accommodation was provided by the Andaman PWD, and I am grateful to Mr Pushpa Kumar, Mr Subramaniam, Mr Harish Chandra and their staff. Dr Prasad of the Campbell Bay hospital treated me for such virulent fevers as the *falsiparum* malaria. Dr M. Rajan's knowledge proved invaluable to my understanding of the Nicobar islands. I received assistance and hospitality from several Nicobaris. Of special mention are Mark Paul, Mathieu, Paul Joora, Peter, Abel, Paul, Morrison, James, Jonah Curtis, Mohammed, Feroze, Crispin Harry, Rev. Isaac, Victor Roi, Amber, Rok, Benjamin, Solom, and Ulysses.

All my colleagues at SACON were very supportive. I am grateful to Dr V.S. Vijayan, Director, Dr (Mrs) Lalitha Vijayan, Dr Ajith Kumar, Dr S.N. Prasad, Dr N.K. Ramachandran, Mr H.S. Das, Dr P.A. Azeez, Dr C.P. Geevan, Dr D.F. Singh, Dr P. Balasubramanian, Dr N. Sivaganesan, Mr S. Muralidharan, Mr V. Santharam, Mr K.K. Ramakrishnan, Mr V. Gokula and Mr A. Rajasekaran. who have contributed in many ways to my study. Discussions on certain aspects of this study during SACON's Research Advisory Committee meeting in October 1993 proved to be very useful. I wish to acknowledge the contributions made by Mr. H.S. Panwar, Dr. M.K. Ranjitsinh, Mr. S.C. Dey and Mr. S. Deb Roy. Dr R.W.R.J. Dekker, National Museum of Natural History, Leiden, The Netherlands, has greatly helped our research on megapodes by sending relevant literature. I thank Dr A.R. Rahmani, Centre for Wildlife and Ornithology, Aligarh Muslim University for commenting on an earlier manuscript, and two anonymous referees for their criticisms on a paper on the Status of the Nicobar Megapode. Discussions I had with Dr Nigel Collar and Mr Mike Crosby of BirdLife International helped greatly in developing the chapter on endemic avifauna of the Nicobar islands. My wife, R. Rajyashri, has been a source of encouragement and also helped by proof reading this manuscript and in the artworks.

Above all, I wish to thank my local assistants without whom this extensive survey would not have been possible. Jugulu Maheto and Prem worked with me in the Great Nicobar group. N. Illangoan was my field assistant in the Nancowry group. I could not have asked for better.

About the study

SACON has submitted a project proposal titled 'A study on the ecology, status and conservation perspective of certain rare endemic avifauna of the Andaman & Nicobar Islands' to the Ministry of Environment and Forests, Government of India, for funding. The principal investigator of the project is Dr. (Mrs) Lalitha Vijayan and the co-investigator is Dr. R. Sankaran. The objectives of the proposed study are:

1. To assess the status of endemic avifauna in the Andaman & Nicobar Islands and to identify taxa which are rare, threatened or endangered.
2. To study the ecology of the Nicobar Megapode (*Megapodius nicobariensis nicobariensis* & *M. n. abbotti*), Narcondam Hornbill (*Aceros narcondami*) and the Andaman (or Grey) Teal (*Anas gibberifrons albogularis*).
3. To prepare a conservation management plan for rare endemic avifauna of the Andaman & Nicobar Islands.

However, realizing the urgent need for a detailed survey of the Andaman & Nicobar Islands, funds were granted from SACON to launch the first phase of the study, namely assessment of the Nicobar Megapode, the endemic avifauna and the conservation issues currently threatening the Nicobar group of islands. The survey, between December 1992 and April 1993, covered eight islands. Further funds were made available by the Ministry of Environment and Forest, Government of India, to complete the first phase of the study and, between December 1993 and April 1994, 10 islands were surveyed. This report is based on data collected during those surveys, and covers all but three uninhabited islands of the Nicobar group of islands.

A version of the chapter on the Nicobar Megapode is in press in Biological Conservation.

Foreword

Geographical isolation of islands has resulted in the evolution of numerous endemic species of flora and fauna, many of which are restricted to one or a few islands and these ecosystems are so fragile and finely tuned that they are easily vulnerable to perturbations. The Andaman & Nicobar islands in the Bay of Bengal are no exception. Of the 270 species and subspecies of birds recorded, nearly 39% are endemic, many of which are highly restricted in range. Concerned about this and the rapid colonisation by the mainlanders and the subsequent development activities in the recent decades, SACON initiated a long-term study on the status, ecology and conservation perspectives of certain rare and endemic species of avifauna of the Andaman & Nicobar Islands.

Nicobar group of islands were selected, as a prelude to the major project, to assess the status of the Nicobar Megapode in particular, and the other endemic avifauna in general. This report documents the status of the Nicobar Megapode and conservation perspectives of other endemic avifauna of the Nicobar islands. It also highlights the threats that the habitat and avifauna of the Nicobar islands are subject to.

The findings of this study evoke mixed reactions. Although there is evidence of a decline in populations in some species, the status of most species of avifauna is not disturbing. What is alarming, however, is the proposed development plans for the Nicobar islands, particularly the building of a dry dock and refuelling base for international shipping in the Galathea bay and making Great Nicobar a free port. If implemented, the island ecosystem will be irrevocably damaged and the biodiversity lost, as the islands are much too small to sustain any significant impact on them. Further alteration of the ecosystem can only adversely affect all endemic species, and accelerate the extinction of endemic avifauna, including the Nicobar Megapode.

We feel that the Nicobar islands are biologically much too rich to be jeopardised by commercially attractive but ecologically hazardous projects. We thus recommend that no unsustainable development projects be undertaken in the Nicobar islands.

I record my appreciation on the hard work by Dr R. Sankaran of our Avian Ecology Division. In spite of the inclement weather and tough field conditions he completed the survey as scheduled. We rejoice, moreover, his recovery from the *Falsiparum* malaria that he contracted while in the islands. It could neither hamper his survey seriously nor make him 'extinct'.

Dr V.S. Vijayan
Director

Abstract

The Nicobar Megapode, a mound nesting megapode, occurs as two subspecies, *Megapodius nicobariensis nicobariensis* and *M. n. abbotti*, endemic to the Nicobar Islands. Thought to be endangered, this survey found it on almost all Nicobar islands where it historically occurred and concluded that, as a species, it is currently not endangered. It has probably become extinct only on inhabited Pilo Milo island. While *M. n. abbotti* is secure other than on small outlying islets, *M. n. nicobariensis* is threatened on all but 3 islands of its range. Loss of population of *M. n. nicobariensis* was indicated both by significantly lower mound densities and by a higher proportion of abandoned mounds to active mounds when compared with *M. n. abbotti*. Data were collected for 127 active mounds of *M. n. abbotti* and 85 active mounds of *M. n. nicobariensis*, and it was estimated that 848 and 312 active mounds respectively are present, and the population of the species is between 4500 and 8000 adult birds. Although hunting and collection of eggs existed, the main threat is the loss of habitat, particularly coastal forest which is the megapode's primary nesting habitat, to coconut plantations.

Of the 176 species of birds that are endemic to the zoogeographic subregion of the Indian peninsula and its environs, 14 are endemic to the Andaman and Nicobar islands. Thus while the Andaman & Nicobar islands account for only 0.2% of the land mass of South Asia, it has approximately 8% of the endemic avifauna of the region, thus making the islands a high priority area in the conservation of India's avifauna. The new IUCN criteria for assigning threat status, have been applied to each species and subspecies endemic to the Nicobar islands. The application of the criteria on 45 species and subspecies indicates that 18 species or subspecies endemic to the Nicobar islands are endangered (1), vulnerable (6) or near threatened (11). Six species and subspecies are data deficient and 21 are of less concern or abundant. Six bird species have been introduced in the Nicobar islands. Of these, four are from the mainland and two from the Andaman islands. The introduced Andaman Redwhiskered Bulbul may result in the extinction of the endemic Nicobar Bulbul.

Although as much as 80 % of the Nicobar islands are still covered by primary forest, and that at least 60 % are relatively undisturbed, the trend over the last decade gives rise to grave concern. Based on the number of endemics present, the Nancowry group of islands was identified to be of primary importance to endemic avifauna followed by the Great Nicobar and Car Nicobar groups. The priority islands for avian conservation are Great Nicobar, Camorta, Katchall, Nancowry and Car Nicobar. A protected area network whereby the Nicobars will receive the necessary legislature to ensure their long-term survival is proposed. Two issues, population growth and development were identified as of primary concern of the Nicobar group of islands. Specific issues of concern that have grave implications to the Nicobar islands are given. The single largest threat is a proposal to make Great Nicobar a free trade port and to build a dry dock and refuelling facility in the Galathea bay which, if implemented, will destroy the Nicobar islands.

Keywords: Megapodes, Nicobar megapode, endemics, avifauna, Andaman & Nicobar Islands

The Andaman & Nicobar Islands

Introduction

Over 10% of all bird species are threatened with extinction, the majority of which are found in tropical forests and islands (Mountford 1988). About 93% of all avian extinction since AD 1600 have been island species, and most endangered avian taxa are island endemics (King 1981). Island ecosystems, in their natural state, tend to be finely tuned as the limits on the resource base are acute (Carew-Reid 1990). This ecological refinement makes them particularly vulnerable to changes resulting from human activities. Increased human populations, and increasing demands on resources have resulted in fragile island ecosystems being severely threatened.

India has two main groups of islands, the Andaman & Nicobar Islands off the east coast and Lakshadweep Islands off the west coast. The increase over recent decades in human activity through the expansion of agriculture by settlers, exploitation of natural resources, forestry operations, introduced flora and fauna, and increased tourism has resulted in concern over the fate of several of the endemic taxa in these Islands.

Geography

The Andaman & Nicobar islands in the Bay of Bengal are peaks of a submerged mountain range, arching from Arakan Yoma in Burma in the north to Sumatra in Indonesia in the south, between latitudes $6^{\circ} 45'$ and $13^{\circ} 41'$ and longitudes $92^{\circ} 12'$ and $93^{\circ} 57'$ (Saldanha 1989, Dagar *et al.* 1991), and are a southern extension of the Arakan Yoma mountain range. The island group comprises over 300 named and unnamed islands and over 260 named and unnamed rocks (Singh 1981), with a total coastline of about 1962 km. The entire island group covers 8,249 sq km; the Andaman group with over 325 islands (21 inhabited) covering 6,408 sq km, and the Nicobar group with more than 24 islands (12 inhabited) with an area of 1,841 sq km.

The climate of the islands can be defined as humid, tropical coastal climate. Proximity to the equator and the sea ensures a hot, humid, and uniform climate (Saldanha 1989). The islands receive rainfall from both the south-west and north-east monsoons. Maximum precipitation is between May and December, the driest period being between January and April. The mean annual rainfall is about 3800 mm (Saldanha 1989). Despite abundant rainfall, the only perennial river is on Great Nicobar. Temperature variations are low from a minimum of 20°C to a maximum of about 32°C (Dagar *et al.* 1991).

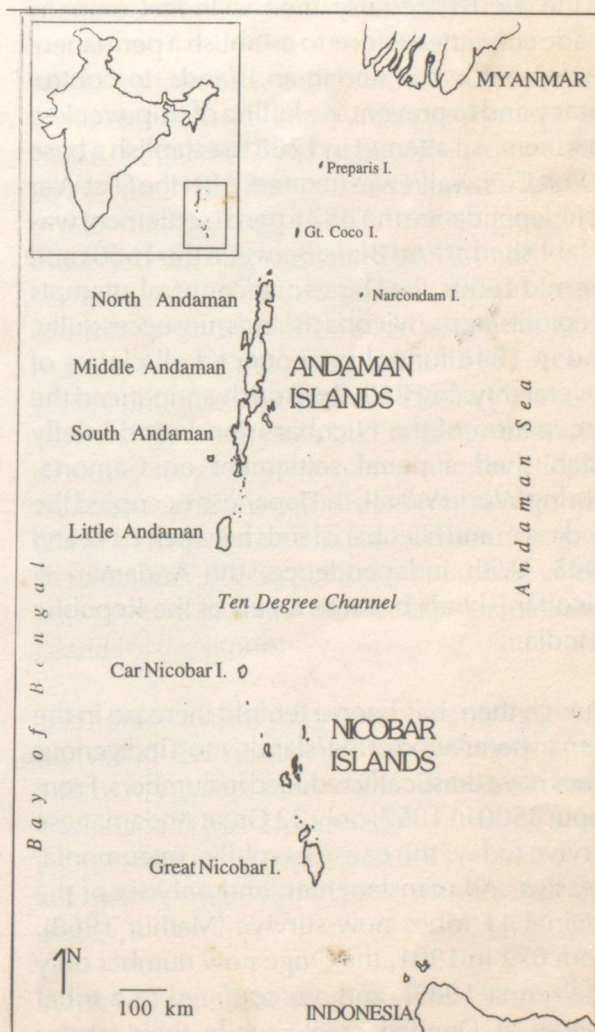


Figure 1. The Andaman & Nicobar Islands

People

The original inhabitants of the Andaman group of islands were tribes of negrito origin. Three broad groups were recognised. The Great Andamanese occupying the main Andaman islands were segregated into the Cheriar, Kora, Toba, Yere, Kede, Juwai, Kol, Bojigyab, Bea, Balawa and Jarawa; the Onge occupied Little Andaman, and the Sentinelese inhabited North Sentinel (Mathur 1968). The Nicobar group was colonised by people of mongoloid origin 'sometime before the Christian era' (Singh 1978). Two distinct groups of people are present. The Nicobarese, who are essentially horticulturists inhabit the coast of 12 islands in the Nicobars with dialectic and cultural variations between different islands and island groups. The Shompen are essentially an interior forest dwelling tribe and only inhabit Great Nicobar.

In the late 18th century, the East India Company made concerted efforts to establish a permanent settlement in the Andaman Islands, to control piracy and to prevent the killing of shipwrecked mariners. An attempt in 1788 to establish a base at Port Cornwallis was aborted. After the First War of Independence in 1857 a penal settlement was established at Port Blair. Between the 1600s and the mid 1800s, the Danes made several attempts at colonising the Nicobar islands, unsuccessfully, and in 1848 formally renounced all claims of sovereignty. In 1869, the British announced the occupation of the Nicobar islands and briefly established a penal settlement on Camorta. During World War II, the Japanese occupied the Andaman and Nicobar islands between 1942 and 1945. With Independence, the Andaman & Nicobar islands became a part of the Republic of India.

Though there has been a tenfold increase in the human population of the islands, most indigenous tribes have drastically reduced in numbers. From about 3500 in 1857, only 32 Great Andamanese survive today; the cause - syphilis, pneumonia, measles and manslaughter, and only six of the original 11 tribes now survive (Mathur 1968). From 672 in 1901, the Onge now number only 98 (Verma 1989), and are confined to a tribal reserve at Dugong creek, while their former territories are now occupied by both mainland

and Nicobari settlers (Saldanha 1989). Both the Jarawas and Sentinelese continue to be hostile to outsiders, though friendly contact has been made (Awaradi 1990, Pande *et al.* 1991). The Shompens were believed to number 348 in 1901, but declined to 212 in 1981 and 149 in 1989 (Verma 1989). Only the Nicobarese have been able to adjust to mainland civilizations and their numbers have increased over the years.

The increase in human population of the islands has mainly been due to immigrant mainlanders. Until 1941 the annual population growth rate was 0.5%. The post 1950 period saw an enormous population increase from 30,971 in 1951 to 1,88,741 in 1981 (Singh 1981). 88% of this increase has been in the Andaman group and has largely been due to immigrants from mainland India, refugees from Bangladesh and repatriates from Sri Lanka (Saldanha 1989).

Vegetation

The forest type of the Andaman & Nicobar Islands can be broadly classified as tropical evergreen, with minor variations from north to south depending on rainfall, type of soil and degree of salinity (Balakrishnan 1989).

About 15% of the total area of the islands is mangroves, dominated by *Rhizophora mucronata*, *R. conjugata*, *Bruguiera gymnorhiza*, *B. parviflora* and *Ceriops tagal*. Based on the proximity to the sea and salinity of the soil, Balakrishnan (1989) classified the vegetation into littoral and inland. Strand vegetation occupies the sandy coastal belt and includes herbaceous dune formations and wooded beach forests. *Ipomoea pes-caprae* normally dominates the outermost belt of herbaceous plants which grows just beyond the reach of the waves. Adjacent to or behind this, the vegetation is dominated by the dense shrubby growth of *Scaevola sericea* and its associate species. Where *I. pes-caprae* formations are absent, as in retreating coast lines, *Barringtonia* formations are seen. The beach forest which occurs behind the sand-dune zone and the *Barringtonia* formations is dominated by trees such as *Hernandia peltata*, *Thespesia populnea*, *Manilkara littoralis*, *Intsia bijuga*, *Syzigium samarangense*, *Sophora tomentosa* and *Glochidion calocarpum*.

Tidal or swamp forests occur in lowland coastal areas where the soil is wet or marshy but not flooded by the sea except during very high tides, and is characterised by small erect aerial roots emerging from the mud. The dominant trees in this forest type are *Cerbera odollam*, *Heritiera littoralis*, *Barringtonia racemosa*, and their associates like *Ficus retusa*.

Inland forests are comprised of two types. Evergreen forests are dominated by species like *Dipterocarpus griffithii*, *D. turbinatus*, *Hopea odorata*, *Sideroxylon longepetiolatum*, *Endospermum malaccense*, and *Planchonia andamanica*, with an understorey of smaller trees such as *Baccaurea sapida*, *Myristica glaucescens*, *M. andamanica* and *Buchanania platyneura*. Deciduous forests occupy hilly region and are dominated by *Pterocarpus dalbergioides* or the Padauk. *Terminalia* spp., *Canarium euphyllum*, *Ailanthus kurzii*, *Parishia insignis* and *Albizia lebbek* are also common.

The vegetation of the Nicobars shows striking dissimilarities with that of the Andamans. The genera *Dipterocarpus* and *Pterocarpus*, wide spread in the Andamans, are not present in the Nicobars. Genera such as *Cyathea*, *Otanthera*, *Astronia*, *Cyrtandra*, *Stemonurus*, *Bentinckia*, and *Rhopaloblate* present in the Nicobars are absent in the Andamans (Balakrishnan 1989).

Endemism

Of the 5357 species of fauna covering all major groups recorded by Rao (1989), 487 (9%) are endemic. If marine species are excluded (none of which are endemic), 13% (487 of 3704) are endemic. Endemism is very high in some faunal groups such as birds where 39% of the 270 species and subspecies recorded from the islands are endemic (Abdulali 1964a, 1964b, 1966, 1967, 1971, 1974, 1978, Das 1971, Dasgupta 1976, Ripley 1982). Other vertebrates also show high degrees of endemism; 60% of 58 species of mammals, 31.94% of 83 species of reptiles and 20% of 10 species of amphibians recorded are endemic (Rao 1989). High endemism is also seen in the flora; of the 1454 taxa of angiosperms 221 are endemic, 60 of which are only known from type specimens and 22 only from type localities

(Rao 1986, Balakrishnan 1989).

The Nicobar group of Islands

The Nicobar islands can be divided into three distinct subgroups. To the south is the Great Nicobar group consisting of two islands larger than 100 sq km, nine islets smaller than five sq km, and a few rocks. Four islands are inhabited. The human population on Great Nicobar (6831 people) has both tribal (8%) and mainland Indians. The tribals are thinly distributed along the southern, western, and northern coasts. 55% of the mainlanders are in the township Campbell Bay midway up the east coast, and the remainder pursue agrarian livelihoods along the south-eastern coast. Little Nicobar has no mainland settlers and the tribals are distributed all around the island. Kondul and Pilo Milo are inhabited islets. Meroe, Treis, Trax, Menchal, Megapode, Cabra and Pigeon are uninhabited islets.

About 58 km north of the Great Nicobar group is the Nancowry group which consists of three islands larger than 100 sq km, two of 36 and 67 sq km, three less than 17 sq km, two islets and a few rocks. Seven islands in this group are inhabited with a population of 12,464 people comprised of both tribals (64%) and mainlanders. The tribals are distributed all around the islands. Mainlanders do not own land in the Nancowry group, and about 80% are either employed by Government Agencies, Tribal Cooperative Societies or trade sectors. 20% of mainlanders in the Nancowry group are Sri Lankan repatriates who have been settled on Katchall and who work on the 600 hectare rubber plantation there. Tillanchong and the Isle of Man are the only uninhabited islands of the group.

The northern most subgroup comprising of Batti Malv and Car Nicobar is 88 km north of the Nancowry group. Batti Malv is uninhabited and Car Nicobar has a population of over 19,000 people, 80% of whom are tribals. The mainlanders are mainly employed in Government and trade sectors.

While most Nicobar islands have been designated as tribal areas under the Protection of Aboriginal Tribals Act (1957), there has been colonisation

and a continuing inflow of mainlanders. The settlement of ex-service men in Great Nicobar began in 1969 and 337 families were settled on Great Nicobar for which 1499.65 ha. of forest was cleared on the southeastern coast of Great Nicobar, each family receiving 4.45 ha (Saldanha 1989). However, the actual loss of forest was far more because of the construction of roads (the North South road is 51 km long, with settlements up to km 35, and the East West road is 41 km long with settlements up to km 8). 268 families of Sri Lankan repatriates were settled in Katchall in the early 1970s, and necessary infrastructure was built. With the opening up of these islands, there has been a rapid growth in the labour, fishing and trading sector. Thus, there is no inhabited island in the Nicobar islands which is free of mainland influences. Every Island, and most tribal villages, have some form of mainland activity and include powerhouses to generate electricity, schools, primary health centres, mainland fishermen or other floating mainlanders who stop by, use resources of, trade with or work for the Nicobaris.

The habitat characteristics of the islands vary. In the Great Nicobar group, all islands are completely forested. A small proportion of the coast of the larger islands is mangrove. In the Nancowry group of islands, the central portion of all islands, excepting Katchall and Tillanchong, are grasslands (over 60% of Trinkat and Teressa, 30-50% of Camorta and at least 20% of Nancowry and Bompoka), often extending to the coast itself. Various explanations exist for the occurrence of these grasslands, primarily that they are man made. However, there is no historic evidence that colonisers cleared forests for animal husbandry. Indeed, the existence of the endemic Nicobar Blue Breasted Quail *Coturnix chinensis trinkutensis* in these grasslands is an indication that these grasslands are so old that not only did colonisation take place, but speciation occurred as well. Within the grasslands there are patches of forest. A substantial area of the coast of Camorta, Trinkat and Nancowry is mangrove.

There are significant differences in the faunal profiles of these two groups, although they remain largely similar. For instance, the Blyth's Nicobar Parakeet *Psitacula caniceps* occurs on Great Nicobar, Little Nicobar, Kondul and Menchal but

is absent in the Nancowry group. The Nicobar Bulbul *Hypsipetes nicobariensis* is present in the Nancowry group but is absent in the Great Nicobar Group. The Nicobar Megapode occurs as two distinct subspecies; *Megapodius nicobariensis nicobariensis* in the Nancowry group and *M. n. abbotti* in the Great Nicobar group. The Nicobar Racket-tailed Drongo occurs on Great and Little Nicobar, Katchall, and Car Nicobar, but is absent on other islands of the Nancowry group. The differences are also evident in the herpetofauna; Pit vipers are common on the Nancowry group but are either absent or very rare in the Great Nicobar group. The endemic Nicobar Crab Eating Macaque is present only on Great Nicobar, Little Nicobar, and Katchall.

Three islands in the Nicobar group, namely, Tillanchong, Batti Malv and Megapode Island, all uninhabited are wildlife sanctuaries. Great Nicobar is a Biosphere Reserve (885 sq km) whose core area consists of two National Parks (536 sq km).

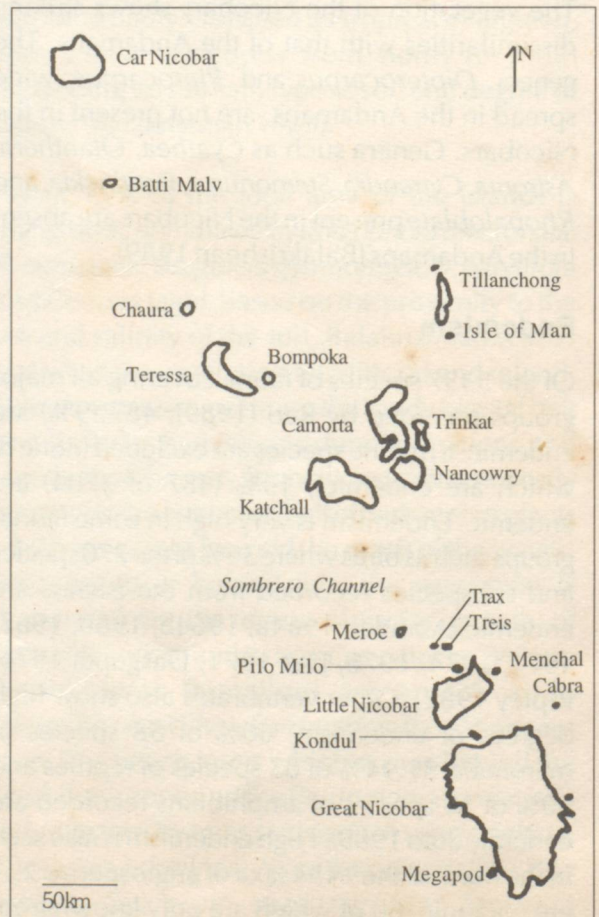


Figure 2. The Nicobar group of islands

The Status and Conservation of the Nicobar Megapode

Introduction

The family Megapodiidae consists of 19 species in six genera, most of which are island forms occurring in Australia, New Guinea and surrounding islands, eastern Indonesia, the Philippines, Niuafo'ou island, the Palau and Mariana islands and the Nicobar islands (Dekker 1990). Nine of these 19 species are currently threatened by habitat destruction, introduction of predators and over exploitation of eggs (Jones 1989).



Figure 3. The Nicobar Megapode

Megapodes incubate their eggs in mounds of rotting leaves or in burrows at sun or geothermally heated grounds (Dekker & Wattel 1987). The chicks, on hatching, are fully feathered and are able to fly immediately and post-hatching parental care is absent. Within the group itself there are variations in the incubation and breeding strategies. *Macrocephalon* and *Eulipoa* lay eggs at communal nesting grounds where sun or volcanic activity provides heat for incubation. *Talegalla*, *Aephypodius*, *Alectura* and *Leipoa* build mounds of forest litter where organic decomposition provides necessary heat (Dekker 1990). *Megapodius* nest both communally in geothermally heated grounds as well as in mounds built by them (Dekker 1990).

The average weight of eggs varies between 75 gm (*Megapodius pritchardii*; Todd 1983) and 232 gm (*Macrocephalon maleo*; Dekker 1990); between 10-17% of the female's body weight (Vleck *et al.* 1984). The yolk content is as high as 50-67%, with burrow nesters having higher yolk content than mound builders (Clark 1964). This high yolk content in megapode eggs is probably due to the selection for extreme precocity (the chicks are independent of parents on hatching) during the evolutionary history of megapodes (Clark 1964, Seymour

1985). In contrast, chicken eggs weigh about 50-60 g and have a yolk content of only 30%. Thus, megapode eggs are a sought after food, and may play a significant role in local economies (Dekker & Wattel 1987).

Though habitat loss is a major threat, the primary cause for the drastic reduction in megapode populations has been overexploitation of their eggs. The problem is particularly severe for species that have communal nesting grounds. In *Macrocephalon maleo*, 9705 eggs were harvested from a single communal nesting ground in a season in North Sulawesi, but 30 years later only 2 to 3 eggs were laid there per day (MacKinnon 1981). The number of eggs harvested by the inhabitants of a single village from a nesting ground of *Megapodius eremita* in New Guinea was estimated at 18,000 eggs per month (Dekker 1990), and 30,000 eggs were collected at another location per season (MacKinnon 1981). While egg collection had been regulated in the past, changing demographic, cultural, and social patterns have resulted in uncontrolled exploitation of eggs (Dekker & Wattel 1987). Mound building megapodes suffer heavy egg losses as well but the problem is not as acute because mounds are scattered through primary,

and often inaccessible, forest and not all mounds are discovered (Dekker 1990).

Conservation of megapodes is relatively easy because restoration of populations can be achieved by the artificial or protected incubation of eggs collected from the wild, and the immediate release of the precocial young (Dekker & Wattel 1987). For instance, in Sulawesi, in two communal nesting grounds of *Macrocephalon maleo*, an estimated 3,500 eggs were laid by a population of 150-200 pairs, during the 1985/1986 breeding season, but the hatching success was close to zero under natural conditions. With the construction of protected hatcheries, and sustained patrolling at nesting grounds, the hatching success rose to 55 and 75% respectively and over 700 Maleos were hatched.

Historical distribution

The Nicobar Megapode, *Megapodius nicobariensis*, endemic to the Nicobar islands is geographically isolated, with its nearest congeneric about 1,600 km away (Olson 1980). Two subspecies are recognized; *M. n. nicobariensis* which is present on the Nancowry group of islands north of the Sombrero Channel, and *M. n. abbotti* on the Great Nicobar group of islands south of it (Ali & Ripley 1983; Fig. 2).

The Nicobar Megapode occurred on most Nicobar islands (Hume 1874, St John 1899, Kloss 1903) but not on Car Nicobar (Butler 1899) and Chaura (Abdulali 1967). It is said to have occurred on Batti Malv (Butler 1899). There were a few records from the Andaman group of islands (Hume 1874, Butler 1899, Sewell 1922) and from the Coco islands further north (Kloss 1903, Abdulali 1964). None of the records from the Andaman group are of recent origin and the species is believed to be absent there.

Three hypothesis can explain the absence of megapodes from the Andaman islands. Kloss (1903) believed that megapodes were introduced to the Nicobars by the Malays and explained their absence from the Andamans because voyagers were deterred from those islands by hostile natives, thus preventing their introduction. Olson

(1980) suggests that megapode distribution is a result of competitive exclusion by other galliformes, but as wild galliformes are absent in the Andamans, this does not explain the absence of megapodes there. Dekker (1989) argued that because mound nesting megapodes are unable to survive in the presence of large carnivores, their absence in the Andamans might be explained by the introduction of the Palm Civet *Paradoxurus hermaphroditus* and Masked Palm Civet *Paguma larvata* (Dekker 1992, also by Kloss 1903), and considers the Nicobar Megapode as a relict population. Of the two civets in the Andamans only *P. hermaphroditus* is introduced, while *P. larvata tytleri* is a subspecific endemic, and it is therefore possible that megapodes could not colonise the Andamans at all.

Whether the megapode existed in the Andaman group needs confirmation as there are no specimens from those islands and shooting records appear to be hearsay. The mound reported from the Andamans (Hume 1874) could have been a nest of the King Cobra *Ophiophagus hannah*, a likely error if one has not seen a megapode mound before. Spot sampling during this survey in South Andamans failed to reveal old mounds, traces of which can be present for over 1000 years (Stone 1991). Many species are exclusive either to the Nicobars or the Andamans and it is probably true for the Nicobar Megapode as well. Tangible evidence, in the form of abandoned mounds, is needed before we can conclude that this species indeed existed in the Andaman group of islands.

The mound of the Nicobar Megapode

The Nicobar Megapode builds mounds of sand, loam, coral bits and rotting vegetation within which eggs are laid. Mounds vary in height from 10 cm to 2.1 m and in basal circumference from 7 m to 45 m. Basically three types of mounds are built by the Nicobar Megapode and have been described by Dekker (1992) as: type 'A' mounds or true mounds, regular in shape and built on an open spot away from trees; type 'B' mounds, irregular in shape, built against the buttress or stem of a large living tree; type 'C' mounds, also irregular in shape but built against, around, under or over a dead rotting tree stump or log (Fig. 4). Mounds are usually

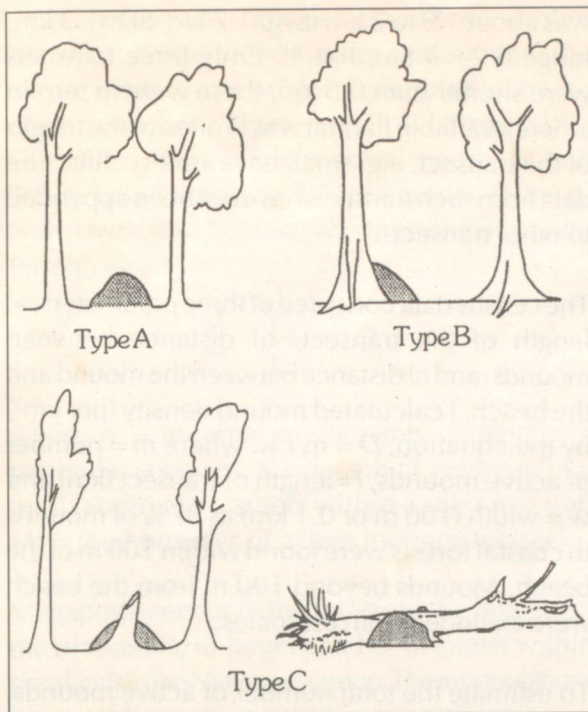


Figure 4. Mound types in the Nicobar Megapode

made close to the shore but are also present some distance inland (Hume & Marshall 1878, Baker 1930). This preference for nesting near the beach is common to at least one other species, *M. freycinet* (Stuebing & Zazuli 1986). Of the 188 active mounds for which measurements were taken during this study, 97% were found within 100 m (80% within 60 m) of the beach (Fig. 5). A few mounds were further inland (as far as 15 km inland on Great Nicobar), but these were difficult to find because of the hilly terrain and much lower densities.

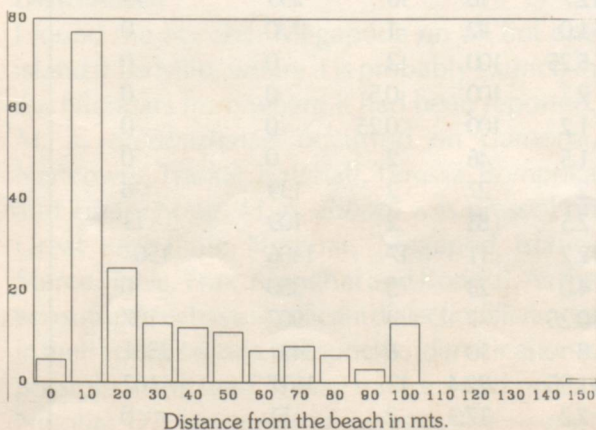


Figure 5. Frequency distribution of Nicobar Megapode mounds with respect to distance from the beach.

Status and Conservation

Throughout their distribution megapodes are threatened by habitat destruction, introduction of predator species, and over exploitation of their eggs (Dekker in press). The Nicobar Megapode is no exception. It is listed under Schedule I of the Indian Wildlife Protection Act (1972), and has featured in several lists of endangered species (Collar & Andrews 1988, Collar *et al.* 1994). In 1988, the Andaman and Nicobar chapter of INTACH (The Indian National Trust for Art and Culture) reported the extinction of the Nicobar Megapode from Kondul, estimated a population of fewer than 400 birds from Great Nicobar and predicted the extinction of the species in the next 5-10 years (Anon. 1988). Dekker (1992), however, estimated a population of about 780 breeding pairs in the coastal area of Great Nicobar and concluded that the megapode population on Great Nicobar is not threatened. However, the status of *M. n. abbotti* on Little Nicobar and the other islands was still unknown. Of greater concern was the absolute lack of information on *M. n. nicobariensis*.

Objectives

1. To assess the present distribution and population status of the Nicobar Megapode (*Megapodius nicobariensis nicobariensis* & *M. n. abbotti*).
2. To examine habitats presently holding these birds, estimate the area of available habitat and to identify threats to these habitats.

Methods

The Nicobar islands were surveyed between 10 December 1992 and 5 April 1993, and 20 December 1993 and 31 March 1994. 17 Islands were sampled by walking around each island and this survey covered the entire range of this species. Distances between sampling sites varied between 5 and 8 km on large islands and the entire coast of small islands was surveyed. A summary of the survey is given in Table 1.

As mounds are stationary, inanimate and represent breeding, the best way to estimate and monitor populations of megapodes is by assessing the number of active mounds (those in use). Active mounds were identified by signs of recent digging

by megapodes. When digging signs were not obvious as when rains obliterated marks, the state of a mound was identified by checking whether the soil was compact and hard (abandoned mounds) or loose and easily penetrable with a stick (active mounds). A mound that was not active was considered abandoned. I prefer this classification over Dekker (1992) who called such mounds inactive, because inactive implies that a mound is periodically inactive and active, while in reality most abandoned mounds had not been used for considerable periods, were in stages of obliteration, and often had vegetation growing on them. This indicated that in the Nicobar Megapode, few mounds are brought back into use after being abandoned.

As mounds are predominantly placed in a narrow strip of forest along the seashore (Dekker 1992, this study), the survey concentrated on forests abutting the beach. The census consisted of two observers walking between 30 and 50 m abreast parallel to the seashore, with the observer closest to the sea about 20 to 30 m from the beach. As mounds within 20 or 30 m of the observer are easily located, most mounds within a belt of forest about 100 m wide starting from the beach were counted. The length of this modified belt transect

was about 1.5 to 2 km (avg. 1.7 km, SD=1.3 km, range 0.2 - 8 km, n=64). Only three transects were shorter than 0.5 km, these were in terrain where available habitat was limited to the length of the transect, e.g. small bays amidst cliffs. The data from such transects have not been appended to other transects.

The census data consisted of three parameters: a) length of the transect, b) distance between mounds, and c) distance between the mound and the beach. I calculated mound density (per km²) by the equation, $D = m/l.w$, where m = number of active mounds, l = length of transect (km) and w = width (100 m or 0.1 km) as 97% of mounds in coastal forests were found within 100 m of the beach. Mounds beyond 100 m from the beach were excluded from estimates.

To estimate the total number of active mounds, the coastline of each island was divided into segments based on similarity of habitats. This was necessary because the distribution of mounds was not uniform and were absent or very rare where cliffs or mangrove swamps abutted the shore or the forest was low-lying and periodically inundated (dominated by *Areca* or *Pandanus* palms), or the forest had been replaced by coconut. Thus, a

Table 1. Summary of details of the survey

Island	Area (sq km)	Coastline (km)	Transect		% Coast surveyed	Survey days	Population	
			No.	km			Tribal	Mainlander
Great Nicobar	1045.1	213	19	30.4	14	56	536	6295
Little Nicobar	159.1	78	12	12.7	16	18	295	13
Megapode Island	0.13	2.4	1	1.0	42	1	0	0
Meroe	<3	5.25	1	5.25	100	3	0	0
Treis	<1	2.7	1	2.7	100	0.5	0	0
Trax	<0.2	1.2	1	1.2	100	0.25	0	0
Menchal	<2	3.3	1	1.5	46	2	0	0
Kondul	4.6	7.5	1	2	27	2	139	8
Pilo Milo	1.3	3.0	1	2.5	83	2	109	13
Camorta	188.2	112.5	8	12.2	11	17	1406	1567
Trinkat	36.3	30	2	4.0	23	5	350	0
Nancowry	66.9	44.3	4	10.25	7	4	907	107
Katchall	174.4	78.0	3	8	10	8	2491	2581
Teressa	101.4	53.25	5	11.95	22.4	12	1617	162
Bompoka	13.3	12.75	1	2.2	17.3	2	51	0
Tillanchong	16.82	42	4	6.2	14.8	7	0	0
Car Nicobar	126.9	-	-	-	-	4	15781	3555

segment was based on judging overall similarities in habitat and its suitability for megapodes. The total number of mounds for the forest abutting the coast (probably comprising 75% of mounds in Great and Little Nicobar, Katchall, Bompoka, and Tillanchong, and over 90% of Camorta, Trinkat, Nancowry, and Teresa) was then calculated by the equation:

$$\sum_{i=1}^n \frac{M_i}{L_i} \times S_i$$

where n = number of segments, i denotes a particular segment, S_i = length of segment, L_i = total length of transects within a segment, and M_i = total number of active mounds within L_i .

Megapodes occur in the forests to the interior of the islands and in larger patches of forests within grasslands in the Nancowry group. These populations have not been considered in my estimates.

Measurements of distances have been approximate. Distances in the field were measured using a pedometer set at 45 cm, a setting arrived at by comparing strides taken to survey 1.5 km of megapode habitat abutting a metal road, and while walking on the road. Distances between the mound and the beach were measured either by pacing, or visually. Coastlines were measured from 1:150,000 scale hydrographic charts. Signs of predation, both natural and human, were recorded for every active mound seen.

Results and Discussion

Distribution

I found the Nicobar Megapode on all but one island (Pilo Milo, where it is probably extinct) in the Nicobars from where it had been reported. *M. n. nicobariensis* occurred on Camorta, Nancowry, Trinkat, Katchall, Teresa, Bompoka and Tillanchong. *M. n. abbotti* was present on Great and Little Nicobar, Megapod Island, Meroe, Treis, Trax, Menchal and Kondul. As the two subspecies have significant dialectic differences in their vocalizations, subspecific identification is possible in the field. It may have existed on Car Nicobar (78 km north of Teresa, the nearest megapode population) a century ago but I found no traces of mounds. Chaura is only 11.5 km from

Teresa and, considering its occurrence on more remote Tillanchong, there is no reason why the megapode should not have existed there. Even if it did occur in the past, both Car Nicobar and Chaura are much too densely populated for the species to exist there now.

Status

Crucial to the population estimate is the information on number of pairs that use a mound in a year, whether larger mounds attract more pairs, differences in types of mounds and in the number of pairs using them, presence of mound tenacity, egg-laying frequency, number of eggs laid, and duration of reproductive period. This information is as yet unavailable and any population estimate will be tenuous. Thus, the best indicator of the status of megapodes is an estimate of the number of active mounds in an island.

However, Dekker (1992) estimated an average of two pairs per mound (for all three types) and emphasized that this was an absolute minimum, indicative of the breeding population for the month of March only. As the breeding is said to be through the year (Ali & Ripley 1983), the actual number of pairs that use a mound in a year would be more (cf. Dekker 1992). That more than two pairs use the same mound was also evident from trappers who had snared several birds from the same mound. In two other mound building megapodes, a maximum of four and five pairs have been estimated as using the same mound (Rand & Gilliard 1967, Stuebing & Zazuli 1986). Thus, for the population estimate I used two pairs per mound for the lower limit and 3.5 pairs per mound for a conservative upper limit (the mean of minimum number of pairs per mound for *M. nicobariensis* and the maximum recorded for megapodes in literature).

Megapodius nicobariensis abbotti

On Great Nicobar, *M. n. abbotti* was believed to have disappeared from all areas colonised by mainlanders (Dekker 1992). However, megapodes still survive there and four active mounds were located over a distance of 11 km. In areas not colonised by mainlanders, active mounds were present in all forests abutting the shore as was the case with all of Little Nicobar which has no mainland settlers. I estimated that there are over

Table 2. Population estimate of the Nicobar Megapode

Islands	Estimated no. of active mounds	Estimated no. of Breeding pairs (range)#
Great Nicobar ¹	515	1030-1802
Little Nicobar ¹	311	622-1088
Megapode Island ¹	2	4-7
Pilo Milo ¹	0	0
Meroe ¹	1	2-4
Treis ¹	4	8-12
Trak ¹	3	6-11
Menchal ¹	2	4-7
Kondul ¹	11	22-39
Camorta ²	20	40-70
Trinkat ²	8	16-28
Nancowry ²	60	120-210
Katchall ²	69	138-242
Teressa ²	119	238-417
Bompoka ²	26	52-91
Tillanchong ²	10	20-35

¹ *M. n. abbotti*; ² *M. n. nicobariensis*

Lower limit at 2 pairs per mound, upper limit at 3.5 pairs per mound.

800 active mounds in Great and Little Nicobar, and the population of adult breeding birds to be between 3300 and 5750 birds (Table 2, Appendix 1 for map showing important megapode areas).

Dekker (1992) estimated 390 active mounds on Great Nicobar as against this study's 515, although sampling intensity were similar (26 and 30.4 km respectively). The reasons for this difference are that Dekker surveyed three areas while I sampled 19 locations all around the island. In his study the west coast was under sampled (three km at one location); this coast had the least disturbance and the best megapode habitats (I surveyed 12 km at nine locations). His other two transects pass (one partly) through habitat that had been subjected to human activity like road building or quarrying and are not representative of mound abundance. Lastly, by dividing the coast into segments (as in this study), a truer estimate of mounds was arrived at than by a simple arithmetical extrapolation (Dekker 1992).

Seven of nine islets in the Great Nicobar group had habitat suitable for megapodes and the remaining two (Cabra and Pigeon) were too small. Over 50% of the forests of uninhabited Meroe,

Treis, Trax, Menchal and Megapode Island have been converted to coconut plantation by the inhabitants of neighbouring islands. Only one active mound each was found on Megapode Island and Meroe, and the high proportion of abandoned mounds was indicative of a dwindled population. A dense ground cover of germinating coconut on Meroe has ruined potential mound building areas. Only Treis and Trax, with four and three active mounds respectively, had a satisfactory megapode population. Less than 10% of Menchal's coast is suitable for megapode as most of the island is rocky. The only level area in Kondul is inhabited and one active mound was found just behind the South Point village. About half of Pilo Milo is inhabited, and the islet is mostly under coconut palms. Megapodes are apparently extinct on this islet, although reports of calls heard indicate that it may still survive. The number of active mounds in the outlying islets in the Great Nicobar group is estimated to be about 23, with an adult breeding population between 90 and 160 birds (Table 2). Thus the population of *M. n. abbotti* is between 3400 and 6000.

Megapodius nicobariensis nicobariensis

M. n. nicobariensis occurs on seven islands of the Nancowry group. On Camorta, Katchall and Trinkat, *M. n. nicobariensis* was patchily distributed with very few locations having active mounds and even fewer where mounds were abundant. For instance, on Camorta, only one location, a small promontory near Kakana village, had a high density of active mounds. Elsewhere in the island, active mounds were either very rare or absent. On Trinkat too very few active mounds were located. At Katchall, considered by Kloss (1903) to be the home of the megapode, though a few mounds were present through much of the coast, only a single location had a high density of mounds. The southern half of Nancowry had mound densities similar to that of Great and Little Nicobar. I estimate that there are over 150 active mounds of *M. n. nicobariensis* in these four islands, and the adult breeding population to be between 600 and 1100 birds (Table 2; Appendix 2 for map showing important megapode areas).

It was only on Teressa and Bompoka that good

populations of megapode existed, and the density of active mounds was akin to that of Great and Little Nicobar (Table 3). Tillanchong is mainly hilly with very little level coastal forest, thus megapodes are naturally scarce except in the level forests. The small population that exists is apparently secure. Thus the population of adult breeding birds of *M. n. nicobariensis* is estimated to be between 1200 and 2100 birds and the number of active mounds to be a little over 300.

Loss of population

To assess loss of population, and the reasons behind the reductions, the mean density of mounds and the proportion of abandoned mounds to active mounds for each of the transects traversed were calculated, and comparisons made among islands.

The densities of active mounds are similar for six islands, Great and Little Nicobar, Trax, Nancowry, Teresa and Bompoka which ranged between 30 and 36 mounds per km² (Table 3). On all other

islands, density ranged between 3 and 22 mounds per km² (Table 3). In the best habitats active mounds were encountered at least once every 200m, and similar densities have been reported for *M. reinwardt* (Lincoln 1974, Crome & Brown 1979) and for *M. cumingii* (Stuebing & Zazuli 1986). The significantly lower densities in *M. n. nicobariensis* in Camorta, Trinkat and Katchall and of *M. n. abbotti* in the outlying islets thus posed a question. Was lower number of mounds encountered in the northern subspecies natural or has there been a loss or reduction in populations?

Reduction in populations is best indicated by the proportion of abandoned mounds. The two islands with the least damage to coastal forests are Great and Little Nicobar, of which the former had a greater proportion of undisturbed coast. All other islands have undergone considerable conversion of forest to coconut plantations. The proportion of abandoned mounds to active ones in the other islands was between 1.6 to 2.3 times that of Great Nicobar, and 1.2 to 1.6 times of Little Nicobar

Table 3. Summary of census data of megapode mounds

	<i>M. n. abbotti</i>						<i>M. n. nicobariensis</i>									
	CN	MI	LN	PM	MR	TR	TA	MN	KN	CM	TT	NN	KT	TS	BP	TI
No. of active mounds	66	1	49	0	1	4	3	1	3	8	2	14	14	33	7	8
No. Type A	20	1	23	0	1	3	1	1	0	7	2	9	11	18	6	4
No. Type B	25	0	14	0	0	0	0	0	1	1	0	2	1	3	0	2
No. Type C	21	0	12	0	0	1	2	0	2	0	0	3	2	12	1	2
No. Abandoned	50	3	78	4	14	14	13	0	5	44	16	15	29	113	25	14
Mean % Abandoned mounds	40	75	57	100	93	78	81	0	63	82	90	53	70	72	78	67
Mean mound density (km ²)	33	10	36	-	3	16	30	7	15	10	4	30	22	30	32	13
% mounds with signs of egg collection	7.5	0	2	-	0	0	0	0	0	0	0	0	0	0	0	0
% mounds with snares on them	12	0	18	-	0	0	0	0	0	0	0	8	0	0	14	38
% mounds with monitor lizard signs	18	0	18	-	0	0	0	0	0	25	0	8	0	3	28	13
No. of active mounds (extrapolated)	515	2	311	0	1	4	3	2	11	20	8	60	69	119	26	13

GN=Great Nicobar; MI=Megapode Island; LN=Little Nicobar; PM=Pilo Milo; MR=Meroe; TR=Treis; TA=Trax; MN=Menchal; KN=Kondul; CM=Camorta; TT=Trinkat; NN=Nancowry; KT=Katchall; TS=Teresa; BP=Bompoka; TI=Tillanchong

(Table 3). The only exception was Nancowry where the proportion of abandoned mounds was similar to that of Great and Little Nicobar.

The highest number of abandoned mounds were present in those areas where primary forest had been converted into coconut plantations. In one plantation on Camorta, of the 16 mounds seen in a 1.5 km transect, 14 (87.5%) were abandoned, in another on Teressa 56 abandoned mounds and 4 active ones were seen in 2.75 km, and in very old plantations only traces of abandoned mounds were visible. However, where there was a mosaic of coconut and forest, or the ground vegetation was not cleared, megapodes built mounds. Megapodes apparently abandon pure stands of coconut because they require sufficient ground and middle storey vegetation cover, and mounds become unworkable due to dead coconut fronds covering mounds, and nuts falling and germinating on mounds.



Figure 6. An abandoned mound in a coconut plantation.

Teressa and Bompoka are exceptions because while mound densities are similar to that in Great and Little Nicobar, they have a significantly greater proportion of abandoned mounds (Table 3). Though much of the coast has been converted to coconut in Teressa and Bompoka, there is adequate interspersion of natural habitat within coconut plantations and large tracts of optimal megapode habitat for it not to reflect on mound density. But as several large tracts of prime megapode habitat has been converted to coconut plantations, a high proportion of abandoned mounds are present.

The first signs of a declining population is perhaps a high proportion of abandoned mounds, followed by a decline in the density of active mounds culminating in a loss of population. This can be seen as a continuum in the larger islands (Table 3), which also corresponds to the availability and quality of habitat. Great Nicobar had a high density of active mounds and the least proportion of abandoned mounds while Little Nicobar had a high mound density but a greater proportion of abandoned mounds. Teressa and Bompoka had high mound densities but high proportions of abandoned mounds, Katchall had a lower mound density and a high proportion of abandoned mounds, and Camorta and Trinkat had both low mound densities and high proportions of abandoned mounds.

Threats

The main threats to the Nicobar Megapode are hunting of birds for meat and egg collection, predation and habitat loss.

Hunting and egg collection

The Nicobarese do not hunt or collect eggs of this megapode extensively because megapodes have spiritual and medicinal values. There were, however, inter and intra island differences. In some villages hunting or egg collection is prevalent (e.g. Tahiyuol, Little Nicobar), while in others it is not (e.g. Pilo Pakka, Little Nicobar). Greatest hunting pressure was on the west coast of Little Nicobar and was rare or uncommon over much of the Nancowry group. Continued adherence to traditional values resulted in lesser levels of exploitation which explained the continued

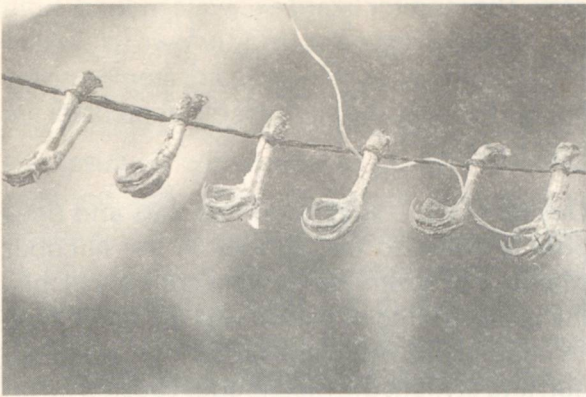


Figure 7. Legs of megapode strung up like a streamer at Tahiyuol on Little Nicobar.



Figure 8. The increasing use of airguns is proving to be a threat to the Nicobar Megapode and other avifauna.

existence of the megapode on Kondul. Where traditional values have been eroded (as by the complete domination of Christianity), localised heavy to excessive hunting pressures may exist. At Tahiyuol 71 legs, presumably of 36 megapodes, had been strung up, these having been shot over the week of a full moon. Such hunting pressures,



Figure 9. Although the eggs of the Nicobar Megapode are eaten, egg collection is apparently not a major threat.

however, were exceptional and was seen only at two locations (Tahiyuol and Pilo Milo). Megapodes are also shot on Meroe and Treis, thus seriously threatening already depleted populations.

Megapode eggs are apparently not an important source of food. Thus, unlike other species where high egg collection pressures exist (Bishop 1978, Todd 1983, Stuebing & Zazuli 1986, Dekker & Wattel 1987, Jones 1989), a low number of mounds had been excavated for eggs (Table 3). The Nicobarese and Shompen do collect eggs but apparently not all Nicobarese collect (or eat?) megapode eggs, and egg collection is only done occasionally. Bompoka is an exception and megapode eggs from there are gifted to people on neighbouring Teresa.

Localised heavy hunting pressures on the megapode by Nicobarese is a recent phenomenon because of the popularisation of airguns. The traditional method, with a cross bow, was rare and I saw it being used only on Bompoka and at one location in Katchall. Most Nicobarese do not use snares, and its use is even resented because pigs and chicken get caught or injured by the nylon nooses. Mainlanders, particularly labourers on construction projects, trap megapodes. High hunting pressures by mainlanders existed on Great Nicobar while work on Project Yatrik (which opened up the island to colonisation) was under way. With the phasing out of the project, and the better implementation of Wildlife Protection laws, hunting pressures on megapodes have declined. I did not come across any sign of mainlanders digging up mounds for eggs.



Figure 10. Thai poachers snare the megapode and have severely depleted populations on the north-eastern coast of Great Nicobar.

Very high hunting pressure, albeit localised, was from Thai poachers who camp in isolated parts of Tillanchong, Great and Little Nicobar. Snares for megapode and wild pig *Sus scrofa nicobarica* had been extensively placed in the north-eastern coast of Great Nicobar and most mounds near Thai camps had snares on them. Several active mounds that were infrequently worked upon was also indicative of a population that had suffered recent losses. About 5% of Great Nicobar's coast is affected in this manner.

Predation

Having evolved in habitats that were free of large carnivores, megapodes are particularly vulnerable to predators (Dekker 1989). In the Nicobars, introduced wild predators are absent. Only the monitor lizard *Varanus salvator*, the reticulate python *Python reticulatus*, and species of raptors are potential predators of megapodes and their



Figure 11. Monitor Lizards burrow into Megapode mounds both to eat eggs as well as to lay their own.

eggs. The monitor lizard excavate mounds both for preying on eggs and to lay its own (cf Dekker 1992). However, as monitor lizards are extensively hunted for meat, the numbers of this predator are kept in check.

Dekker (1992), suggested that cats and dogs pose a threat to megapodes in the Nicobar islands. My observations were contrary to this, the most striking of which was an active type 'A' mound that was within 30 m of an inhabited hut, and at night the megapodes roosted on an adjacent tree. This household had five dogs and four cats. Todd (1983) also stated that in the 100 odd years that cats have been resident on Niuafou'ou extinction of *M. pritchardii* has not taken place. With the exception of Meroe, dogs and cats are currently not a threat to the Nicobar Megapode. Cats were released on Meroe in 1991 to control rats that were seriously damaging the coconut crop. The most visible change since then, is in a flush of germinating coconut palms, forming a dense ground cover. As a result, the area available for mound building is greatly reduced and because of the dense ground cover, the cursorial megapode would be increasingly incapable of avoiding predators.

Habitat loss

The primary threat to most species of megapodes is loss of habitat (e.g. Bishop 1978, Dekker 1990), and this is true for the Nicobar Megapode as well. Demographic changes in the Nicobars have resulted in widespread loss of habitat, this being most acute in the Nancowry group of islands.

The Nicobarese subsist on coconut and have converted coastal forests abutting their villages into coconut plantations and have clear felled forest to plant banana, papaya and tuber-bearing plants. As tribal populations are the highest in the Nancowry group, most damage has occurred there. A 35 km long strip of forest along the southeastern coast has been depleted on Great Nicobar due to settlement of mainland Indians. Over 600 ha. of primary forests were replaced with rubber plantations on Katchall. Expanding townships and villages, roads, airstrips, and infrastructure for defence establishments have all resulted in the loss of habitat. The single biggest threat to megapodes is the loss of habitat.

Conservation perspectives

The long-term perspective for the Nicobar Megapode is bleak because of the persisting loss of habitat. A growing tribal population and the resultant conversion of primary forest to coconut and other plantations continues to encroach into megapode habitat. The problem is most acute in the Nancowry group where suitable habitat, both for megapodes and humans is considerably less than in the Great Nicobar group. Control over habitat loss due to tribals is not possible in the Nicobars, not even where areas have been declared as protected reserves, because the tribals are exempt from Forest and Wildlife laws. The population of the ethnic tribes inhabiting the Great Nicobar group is low and hence an immediate threat of a significant alteration of primary forest is minimal. As further mainlander settlement has been stopped on Great Nicobar, the damage has been contained to forests already lost or degraded.

Though megapodes are not being extensively hunted (or their eggs collected) in the Nicobar islands, intensive localised hunting pressures exist and may cause localised rarity or extinction. The situation, however, is not yet alarming.

The most immediate threat in the Nicobars is the proposal to make Great Nicobar a free port and to create a dry dock and refuelling base for international shipping at the mouth of the Galathea river. If and when implemented, all the Nicobar islands will be lost to conservation.

Conclusion

The Nicobar Megapode was considered to be a seriously endangered bird (Jones 1989). This was found to be untrue as has already been documented for the status of this species in Great Nicobar (Dekker 1992). This is particularly the case with the South Nicobar Megapode, which in places is a common bird. The Nicobar Megapode, as a species, is not under any threat of immediate extinction, and is unlikely to become endangered in the near future.

The status of the northern subspecies *M. n. nicobariensis* gives rise to concern. Though the bird is present on all of the islands where it used to occur, there has been a decline in numbers. This was reflected both in the few number of active mounds and also in the high proportion of inactive mounds present. However, there were certain pockets within each island where megapodes were apparently doing well.

The only real threat to megapodes in the present context is the loss of habitat. This might not be a problem in the Great Nicobar group in the near future, as the islands are thinly populated and are still mostly pristine. In the Nancowry group, however, the situation is very different. Larger human populations and scarcity of land have resulted in megapode habitat being converted to coconut plantations. Though there is no information on the rate of land use change, apparently a significant proportion of the coastal forest cover has already disappeared, and more areas are or will come under coconut plantations. The problem is exacerbated in the Nancowry group (excepting Katchall), as a large amount of the Islands are grassland (over 60% of Trinkat and about 30% of Camorta), and a substantial area of the coast is mangrove. Thus available or optimal habitat for the megapodes is proportionately much less than in the Great Nicobar group. The available habitat is also prime coconut plantation land, and I fear that in a few decades there will be little habitat left for the North Nicobar Megapode to survive in. As the land in the Islands belong to the tribals, and rightly so, controlling or regulating the conversion of forest to coconut will be difficult if not impossible to achieve.

Megapodes are not being extensively hunted (or their eggs collected) in the Nicobar Group of Islands, but localized pressures may be quite high. Unlike other megapode species, egg collection is a far lesser problem than hunting of adult birds. The pressures are localised and once the Thai problem is solved, it will be considerably reduced. The hunting pressures exerted by villages such as Pilo Milo and Tahiyuol may cause localised rarity or even localised extinction of megapodes, but as yet the situation is not alarming.



Figure 12. Most islands of the Nancowry group have very little fresh water. Teresa, however, was a notable exception as there were several streams and rivulets all along the coast. Some, like the waterfall above, strengthen a growing conviction that the future of the Nicobar islands lies in its conservation.

The Status of the Endemic Avifauna of the Nicobar islands

Introduction

Geographically isolated island groups are of particular importance in the conservation planning of a country because the substantial number of endemic species present make a significant contribution to the nation's biodiversity. The Andaman & Nicobar group of islands is no exception. Of the 176 species that are endemic to the zoogeographic subregion of the Indian peninsula and its environs (Ali & Ripley 1983), 14 are endemic to the Andaman and Nicobar islands. Thus, while the Andaman & Nicobar islands account for only 0.2% of the land mass of South Asia, it has approximately 8% of the endemic avifauna of the region, making the islands a high priority area in the conservation of India's avifauna.

A major lacuna in our knowledge about the avifauna of the Andaman & Nicobar islands is the lack of adequate information about the assemblage of avifauna on different islands and their status. A prerequisite to the conservation of the avifauna is the identification of taxa that are threatened, and of the islands or island groups which, if conserved, will result in the preservation of the maximum number of endemic species. This will play a fundamental role in the planning of a protected area network in the Andaman & Nicobar islands.

Methods

The checklist of the avifauna (Table 5; Appendix 3) of the Nicobar islands is based on all confirmed sightings in the field and from a literature review that incorporated information from Abdulali (1964a, 1964b, 1966, 1967, 1971, 1974, 1978); Das (1971), Dasgupta (1976), Ripley (1982), and Ali & Ripley (1983).

The list of endemic avifauna

Taxonomy: The inclusion of species or subspecies as endemic is based on Abdulali (op cit.)

even though many of these are not confirmed or accepted. Most disputed classifications of the avifauna in the Andaman & Nicobar islands can be attributed to the paucity of an adequate collection of skins in museums. Till such time this is accomplished, there is a need to include all species/subspecies that have been identified as distinctive in the literature. The current taxonomic status is from Howard & Moore (1991).

The historical status: The population status of each species in literature has been taken from Hume (1874), Butler (1899), and Abdulali (op cit).

Sight records: The relative abundance of a species is indicated by the number of times a species was sighted or heard during this survey. A flock was considered as a single sighting.

Status: The new IUCN criteria for assigning threat status, modified for preparing Red Data Books for birds (Collar *et al.* 1994), have been applied to each species and subspecies endemic to the Nicobar islands. However, due to the lack of quantitative data on population, application of the criteria in the Nicobar group can be misleading as in small inhabited islands almost all species would qualify as either Endangered or Vulnerable. Moreover, many of the criteria call for purely qualitative judgements which were unsatisfactory to this analysis. Thus, numerical thresholds for certain criteria were devised whereby the status of species of avifauna could be judged.

To assess whether a species is threatened, six criteria with various numerical and qualitative thresholds have been defined (Collar *et al.* 1994). Criteria A: Rapid decline; B: Small range, plus any two of: fragmented, declining and fluctuating [habitat]; C: Small population and declining; D1: Very Small or restricted population; D2: Very Small range; and E: Unfavourable PVA (Collar *et al.* 1994). As data on population trends of species in the Nicobar islands is lacking, criteria other than B cannot be effectively

applied. Under Criteria B, a continuing decline in area, extent and quality of habitat of a species with an area of occupancy of less than 500 km² qualifies it to be classified as endangered and that with an area of occupancy less than 2,000 km² as vulnerable.

The two major problems in applying this criteria in estimating loss and rate of loss of habitat were: a) there are no numeric thresholds by which to make this assessment, and b) the absence of data on time frames over which habitat has been lost. I addressed these problems by equating a reduction in area of occupancy with the loss of habitat in the Nicobar islands (i.e. forest that had been cleared or degraded for human use or grasslands that had been planted with trees) irrespective of the time involved and the rate of habitat loss with the rate of human population increase. I then incorporated a numeric threshold for both these factors by which decline in habitat can be judged.

Loss of habitat due to mainlanders was estimated using existing records and visual evaluations (Appendix 4). Three islands have had significant loss of habitat due to mainlanders. The majority of a 35 km long and approximately 2 km wide strip of forest was cleared on Great Nicobar to settle mainlanders, and further areas were cleared to develop other infrastructure. On Katchall about 600 ha of forests were cleared to develop a rubber plantation and further areas were cleared for a township etc. Camorta has undergone habitat loss due to the development of a township. Habitat loss due to Nicobarese was primarily due to the conversion of coastal forest into coconut and other plantations. Typically, a strip of forest not more than 200 m from the beach is cleared for plantation. During the survey I assessed the amount of coastline on each island that was under plantation, and assumed a standard width of 0.5 km to estimate area of habitat loss due to Nicobaris. Thus, a rough estimate of the amount of habitat lost till date could be made (Appendix 4).

Barring loss of habitat due to mainlanders, over 80% of which occurred between 1969 and 1975, the time frame of habitat loss due to

Nicobaris cannot be fixed, as the process of converting forest to coconut plantations has continued over several decades. Thus, while it is possible to estimate how much habitat has been lost till date, the time over which this occurred is not known. However, as both tribal and mainlanders are dependent on the natural resources of the islands, the rate of increase of pressure on the forest resources can be related to the rate of increase in human density. The greater the rate of density increase, the greater the increase in pressures on the habitat.

The numerical thresholds incorporated in this analysis are those of criteria C, that is a decline in population of 20% within 10 years qualifies a species as vulnerable and 20% over five years as endangered. I incorporated these values into the assessment of decline in extent and quality of area of occupancy by assuming that where there has been a 20% loss of habitat with a 20% increase in human density over the last 10 years, there has been a decline in area, extent and/or quality of habitat, and that the species should be treated as vulnerable. A doubling of any one of the above two factors, that is a 40% habitat loss or a 40% increase in human density, will qualify a species as endangered.

Though the priority for conservation should be full species endemics, this analysis is concerned with the conservation of all avian taxa unique to the Nicobar islands. Hence, all endemic subspecies are included in the analysis. The status of each species or subspecies has been inferred from Table 5, which gives its area of occupancy (= island group), Appendix 4 which gives the proportion of habitat lost, and Appendix 5 which gives the increase in human density.

Endemic species that were sighted more than 100 times have been considered as not threatened unless undergoing a specific threat like hunting, as sighting frequency is indicative of abundance.

Due to the highly restricted range of most endemics in these islands, and as even a small change in Governmental policy or any other extrinsic factor can result in a collapse in

populations, very few can be declared secure when medium (20 years) to long term (50 years) prospects are envisaged. Thus, a species that does not qualify as threatened automatically qualifies as near threatened unless populations (indicated by frequency of sighting) are really very large, and are not subject to pressures like hunting.

Results & Discussion

Endemism

The total number of species and subspecies of avifauna recorded from the Andaman & Nicobar Islands is 270 of which 105 are endemic (Sankaran & Vijayan 1993). The high proportion of endemics (38.9%) however, is due to the very high number of endemic subspecies. Of the endemic 105 species and subspecies, only 14 full species (with 17 subspecies) are endemic. Of the endemics, 82 (or 78.1%) are subspecies of species found on neighbouring mainlands. Of the 14 full species endemic to the Andaman & Nicobar islands, five are exclusive to the Nicobar islands, six to the Andaman islands, and three are common to both.

There are more endemic species exclusive to the Andaman group than the Nicobar islands (Table 4). However, if geographical area is taken into consideration, the ratio of exclusive endemic species or subspecies per sq km is higher in the Nicobars than in the Andamans (Nicobars 0.021 spp. per sq km, Andamans = 0.008 spp. per sq km). Similarly, the ratio of endemics per number of islands is higher in the Nicobar group (Nicobars 1.63 spp. per island, Andamans 0.16 per island).

Thus, while the avifauna of the Nicobars has been considered as an impoverished subset of the Andaman group (Ripley & Beehler 1989), it is clear from the available data that the Nicobars are a high priority area for the conservation of avifauna.

The distribution pattern of the endemic avifauna within the Nicobar group of islands points to the existence of three distinct subgroups: the Car Nicobar, Nancowry and Great Nicobar subgroups (Table 5). The Blyth's Nicobar Parakeet is exclusive to the Great Nicobar group while the

Table 4. Number of Bird species recorded from the Andaman & Nicobar Islands

Total spp. & subspp. recorded from A&N	270	
Total spp. & subspp. endemic to A&N	105	
Spp. & subspp. endemic to Andaman group	49	
Spp. & subspp. endemic to Nicobar group	39	
Endemics common to both groups	17	
Endemic full spp. (with 17 sub-species)	14	
Endemic Subspecies	98	
Island group	Total spp.	Exclusive spp.
Andaman	214	126
Nicobars	144	56

Nicobar Bulbul is exclusive to the Nancowry group. The Nicobar Shikra and the Nicobar Megapode are common to both groups. Though Car Nicobar has no full species endemic, there are a few exclusive subspecific endemics.

Status of the Endemic Avifauna

Considerable concern has been expressed about the status of the avifauna in the Andaman & Nicobar islands. Recently, Collar *et al.* (1994) considered four species as globally Vulnerable and 10 species as globally Near Threatened in the Andaman & Nicobar islands. Of the four species considered Vulnerable, two are endemic to the Nicobar group, and six of 10 species considered Near Threatened are present in the Nicobar group, three of which are endemic to the Nicobar islands.

The application of the criteria that designate species as threatened on 45 endemic species and subspecies of the Nicobar islands indicates that 18 species or subspecies endemic to the Nicobar islands are either endangered (1), vulnerable (6), or near threatened (11). Six species and subspecies are data deficient and 21 are of less concern.

Of the species and subspecies that are either Endangered or Vulnerable, four are full species endemics, three of which have subspecies on other island subgroups which are Near Threatened (2) or of less concern (1). Of the Near Threatened

species and subspecies, three are subspecies of species endemic to the Nicobar islands. Thus of the five species and their subspecies endemic to the Nicobar group of islands, four are either Endangered, Vulnerable, or Near Threatened. Only one full species endemic, the Blyth's Nicobar Parakeet, is of less concern. Of the three species and their subspecies endemic to both the Andaman & Nicobar islands, two are either Vulnerable or Near threatened. Seven endemic subspecies of species found outside the Andaman & Nicobar islands are either Vulnerable or Near Threatened.

Some species (or subspecies) are threatened or vulnerable in some islands but are of less concern in others. Species, subspecies or populations occurring in the Nancowry or Car Nicobar subgroup are more likely candidates for threatened status than those in the Great Nicobar subgroup.

The list of the endemic avifauna

1. Nicobar Tiger Bittern *Gorsachius melanolophus minor*

Taxonomy: Subspecies separated because it is smaller than *G. melanolophus melanolophus*. Now considered to be *G. melanolophus*, which ranges from India to Greater Sunda. **Historical status:** Apparently uncommon, less than 10 specimens present. **Sight records:** No confirmed sighting, but possibly seen on Tillanchong. **Status:** Data Deficient.

2. Car Nicobar Shikra *Accipiter badius butleri* Nicobar Shikra *A. b. obsoletus*

Taxonomy: Now considered to be a full species endemic, *A. butleri*, to the Nicobar islands. *A. b. butleri* is endemic to Car Nicobar, and *A. b. obsoletus* to the Nancowry and Great Nicobar subgroups. **Historical status:** Has been collected on Katchall, Camorta & Great Nicobar. Butler found *A. b. butleri* to be not 'uncommon' on Car Nicobar, the status of *A. b. obsoletus* has not been mentioned. **Sight**

Note.

Taxonomy: Recent taxonomic classification from Howard & Moore (1991).

Historical status: From Hume (1874), Butler (1899) and Abdulali (1964a, 1964b, 1966, 1967, 1971, 1974, 1978). **Status:** A1c-decline of population due to actual or potential levels of exploitation. A1d-decline due to effects of introduced taxa. B2c-continuing decline in area extent and/or quality of habitat. C1-continuing decline in population. Data deficient: Inadequate information to make assessment.

records: 20-25. Not sighted on Car Nicobar. **Status:** *A. b. butleri* Endangered [B2c]. *A. b. badius* Near threatened.

3. Andaman Pale Serpent Eagle *Spilornis cheela davisoni* Nicobar Crested Serpent Eagle *S. c. minimus* Great Nicobar Crested Serpent Eagle *Spilornis klossi*

Taxonomy: This species has been reclassified into *S. c. davisoni* and *S. elgini* from the Andamans, and *S. minimus* from the Nicobars. *S. minimus* occurs as two subspecies, *S. m. minimus* from the central Nicobar islands and *S. m. klossi* from Great Nicobar island. There is apparently only one record of *S. elgini* from the Nicobar, but this may be a case of wrong labelling (Abdulali 1967). **Historical status:** Not numerous. **Sight records:** *S. m. klossi* 30-35 times. *S. m. minimus* no sightings. **Status:** *S. m. klossi* Near threatened. *S. m. minimus* Vulnerable [B2c].

4. North Nicobar Megapode *Megapodius nicobariensis nicobariensis* South Nicobar Megapode *M. n. abbotti*

Taxonomy: Originally called *Megapodius freycinet*, is now an endemic full species. **Historical status:** Common. **Sight records:** *M. n. nicobariensis* 45-50; *M. n. abbotti* >150. **Population:** *M. n. nicobariensis* 600-2100 breeding birds and *M. n. abbotti* 3400-6000 breeding birds. **Status:** *M. n. nicobariensis* Vulnerable/Endangered [B2c, C1]. *M. n. abbotti* Near threatened.

5. Nicobar Bluebreasted Quail *Coturnix chinensis trinkutensis*

Taxonomy: Unchanged. Endemic to the Nancowry and Car Nicobar groups. **Historical status:** Common on Car Nicobar, Trinkat & Camorta. **Sight records:** 12-15. Not sighted on Teressa and Bompoka, but are said to be present there. Grassland habitat not visited on Car Nicobar. **Status:** Of less concern.

6. Button Quail *Turnix tanki albiventris*

Taxonomy: Now considered to be *Turnix tanki tanki*, which is not endemic. **Historical status:** Common on islands with grasslands. **Sight records:** Not specifically identified but quails were flushed several times. **Status:** Of less concern.

7. Andaman Bluebreasted Banded Rail *Rallus striatus obscurior* Nicobar Bluebreasted Banded Rail *R. s. nicobariensis*

Taxonomy: The Nicobar subspecies is now considered to be the same as the Andaman one, *Rallus striatus*

obscurior. **Historical status:** Common. **Sight records:** A rail sp. seen once on Camorta and once on Tillanchong. Marshland habitat not surveyed by me. **Status:** Data deficient.

8. Andaman Whitebreasted Waterhen
Amaurornis phoenicurus insularis
Whiteheaded Waterhen *A. p. leucocephalus*
Whiteheaded Waterhen *A. p. midnicobaricus*

Taxonomy: Both *Amaurornis phoenicurus leucocephalus* & *A. p. midnicobaricus* are now not accepted, and all whitebreasted waterhens from the Andaman & Nicobar islands are considered to be *A. p. insularis*. There is merit in Abdulali's segregation of birds from Car Nicobar as *A. p. leucocephalus*, as those birds have the head down to the nape entirely white, though a few individuals have some dark blotches on the hind neck. **Historical status:** Common. **Sight records:** Great Nicobar >50, Nancowry group 30-35, Car Nicobar 40-50. **Status:** Of less concern.

9. Andaman Pompadour Pigeon *Treron pompadora chloroptera*

Taxonomy: Unchanged. **Historical status:** Abundant. **Sight records:** Great Nicobar group 35-40. Nancowry group 30-35. Car Nicobar 10-12. A common species on many of the Nicobar islands. **Threats:** Extensively hunted with airguns. **Status:** Near threatened.

10. Nicobar Green Imperial Pigeon *Ducula aenea nicobarica*

Taxonomy: Unchanged. Howard & Moore have not mentioned *D. a. andamanica* in their list, which is the subspecies endemic to the Andaman group. **Historical status:** Very common. On some islands 'simply swarming'. **Sight records:** Great Nicobar group >250, Nancowry group 150-200. Car Nicobar 10-15. An exceedingly common pigeon in the Nicobar islands, with islands like Tillanchong teeming with them. **Threats:** Extensively hunted with airguns. On some islands (e.g. Car Nicobar) there has apparently been a severe decline in numbers due to severe hunting pressures. **Status:** Near threatened.

11. Nicobar Woodpigeon *Columba palumboides nicobarica*

Taxonomy: Now not a recognised race, but a single full species endemic *C. palumboides* is recognised from the Andaman & Nicobar islands. **Historical status:** Not common (?). **Sight records:** I found this species almost impossible to differentiate in the field

from the Green imperial pigeon. **Threats:** Hunting with airgun. **Status:** Near threatened.

12. Andaman Cuckoo-Dove *Macropygia rufipennis andamanica*
North Nicobar Cuckoo-Dove *M. r. rufipennis*
Nicobar Cuckoo-Dove *M. r. tiwarii*

Taxonomy: *Macropygia rufipennis* is a full species endemic from the Andaman & Nicobar islands. *M. r. andamanica* and *M. r. rufipennis* are now considered to be the same and endemic to Andaman & North Nicobars and *M. r. tiwarii* as endemic to Great Nicobar. **Historical status:** Common. 'Less abundant than in the Andamans'. **Sight records:** Great Nicobar group 10-15, Nancowry group 20-25. Mostly seen in pairs and apparently a naturally scarce species. **Status:** *M. r. rufipennis* Vulnerable [B2c]. *M. r. tiwarii* Of less concern.

13. Nicobar Emerald Dove *Chalcophaps indica augusta*

Taxonomy: Howard and Moore have not mentioned this species from the Nicobar islands and probably consider it the same as the Andaman race *C. i. maxima*. **Historical status:** Common. **Sight records:** 70-75. **Status:** Of less concern / Near Threatened.

14. Nicobar Pigeon *Caloenas nicobarica nicobarica*

Taxonomy: *C. n. nicobarica* is not considered endemic and occurs up to New Guinea islands. **Historical status:** Common (?). 'Breeds in the thousands on Batti Malv'. **Sight records:** Great Nicobar 70-80, Nancowry group 35-40. **Threats:** Hunting by airgun (?). **Status:** Near threatened. **Additional notes:** 3 birds seen drinking sea water from pool left behind by receding tides.

15. Blyth's Nicobar Parakeet *Psittacula caniceps*

Taxonomy: Unchanged. **Historical status:** ? **Sight records:** 150-200. **Status:** Of less concern.

16. Nicobar Redcheeked Parakeet *Psittacula longicauda nicobarica*

Taxonomy: Unchanged. **Historical status:** Extremely common. **Sight records:** >500. **Status:** Of less concern.

17. Andaman Koel *Eudynamis scolopacea dolosa*

Taxonomy: Howard & Moore do not mention this species from the Nicobar islands. **Historical status:** Very common. **Sight records:** 300-350. **Status:** Of less concern.

18. Nicobar Scops Owl *Otus scops nicobaricus*

Taxonomy: Howard & Moore do not record this species from the Nicobars. Abdulali states that 'it appears evident that some form of scops other than *Otus balli* (Andaman Scops Owl) is present in the Nicobars'. **Historical status:** Scarce (?). **Status:** Data deficient.

19. Brown Hawk-Owl *Ninox scutulata obscura*

Taxonomy: Unchanged. **Historical status:** ? **Status:** Data deficient.

20. Nicobar Hawk-Owl *Ninox affinis isolata*

Nicobar Hawk-Owl *Ninox affinis*
rexpimenta

Taxonomy: A full species endemic to the Andaman & Nicobar islands. *N. a. isolata* is present in the Nicobar islands excepting Great Nicobar where *N. a. rexpimenta* is present. **Historical status:** Not very common (?). **Status:** Data deficient.

21. Andaman Greyrumped Swiftlet *Collocalia fuciphaga inexpectata*

Taxonomy: Name changed to *Aerodramus fuciphagus*. Not considered endemic and distribution extends up to Greater Sunda and Timor Islands. **Historical status:** Less common in the Nicobars than in the Andamans. **Sight records:** >100 on Tillanchong, <10 totally on all other islands. **Threats:** Excessive nest collection. **Status:** Vulnerable [A1c]. **Additional notes:** This species, belongs to the 'white nest swiftlet' group, whose nests are made entirely of agglutinated saliva, and are of a very high commercial value in the international market. At Port Blair a kg of nests (one kg normally consists of about 70 nests) fetches between Rs 5000 and 8000 or more. Virtually all colonies are exploited, and nests are collected irrespective of whether there are eggs or chicks in them, with presumably serious effects on the species.

22. Whitebellied Swiftlet *Collocalia esculenta affinis*

Taxonomy: Unchanged. **Historical status:** Abundant. **Sight records:** >100. A common species in most islands, far more numerous than the Andaman Greyrumped Swiftlet. **Status:** Of less concern.

23. Andaman Three-toed Kingfisher *Ceyx erithacus macrocarus*

Taxonomy: Unchanged. **Historical status:** 10 specimens have been collected on Great Nicobar. Apparently common in the Nicobars, particularly Great & Little Nicobars; only 3 records from the Andamans. **Sight records:** Though I boated over 10 km up the Galathea

river, and for a couple of kilometres on the Alexandra river, I did not see any. **Status:** Data deficient.

24. Nicobar Storkbilled Kingfisher *Pelargopsis capensis intermedia*

Taxonomy: Now called *Halcyon capensis intermedia*. **Historical status:** A common species on Great & Little Nicobar. Absent in the Nancowry & Car Nicobar groups. Distribution of this species curious as another subspecies is present in the Andaman group. **Sight records:** >75 **Status:** Of less concern

25. Nicobar Whitecollared Kingfisher *Halcyon chloris occipitalis*

Taxonomy: Unchanged. **Historical status:** Present throughout the Nicobar islands. More common in the Nancowry & Car Nicobar group than in the Great Nicobar group. **Sight records:** >100. **Status:** Of less concern. **Additional notes:** Seen nesting in termite (ant ?) nests on trees.

26. Nicobar Greenbreasted Pitta *Pitta sordida abbottii*

Taxonomy: Unchanged. **Historical status:** ?. Endemic only to Great & Little Nicobar. **Sight records:** 25-30. Not common, more often heard than seen. Apparently naturally scarce. **Status:** Of less concern.

27. Nicobar Blacknaped Oriole *Oriolus chinensis macrourus*

Taxonomy: Unchanged. **Historical status:** Common. **Sight records:** >125. Common in the Nicobars, exceedingly so on Car Nicobar. **Status:** Of less concern.

28. Nicobar Racket-Tailed Drongo *Dicrurus paradiseus nicobariensis*

Taxonomy: Unchanged. **Historical status:** Common. **Sight records:** Great Nicobar group 125-150. Katchall 4-5. Car Nicobar 1. **Status:** Of less concern. **Additional notes:** Curiously distributed in the Nicobar group. Common on Great & Little Nicobar, Megapode island, Kondul, Pilo Milo & Menchal; it is present on Car Nicobar and Katchall, but on no other island of the Nancowry group. Uncommon in the latter two.

29. Small Andaman Drongo *Dicrurus andamanensis andamanensis?*

Taxonomy: Unchanged. **Historical status:** Not recorded from the Nicobars. **Sight records:** 3 individuals in Katchall in the paddy field close to the jetty and 3-4 in Car Nicobar in an area cleared for plantation. Identity to be confirmed. **Status:** ? Excluded from the analysis.

30. Andaman Glossy Stare *Aplonis panayensis tytleri*

Glossy Tree Stare *A. p. albiris*

Taxonomy: The Nicobar race is now considered to be the same as the Andaman one, *Aplonis panayensis tytleri*. **Historical status:** Abundant. **Sight records:** >500. **Status:** Abundant.

31. Nicobar Whiteheaded Myna *Sturnus erythropygius erythropygius*

Katchall Whiteheaded Myna *S. e. katchalensis*

Taxonomy: A full species endemic to the Andaman & Nicobar Islands. Currently classified as *S. e. erythropygius* endemic to Andamans, *S. e. andamanensis* endemic to Car Nicobar and *S. e. katchalensis* endemic to Katchall. **Historical status:** The Whiteheaded Myna was considered to be rare by Hume on Car Nicobar, but Butler found it to be common on that island. The Whiteheaded Myna was introduced to Camorta in the late 1800s, but it has apparently died out. **Sight records:** Katchall 10-12, Car Nicobar 20-25. Common on Car Nicobar but less so on Katchall. **Status:** Near threatened.

32. Andaman Hill Myna *Gracula religiosa andamanensis*

Nicobar Hill Myna *G. r. halibrecta*

Taxonomy: The Andaman & Nicobar birds are now considered to be a single endemic race *Gracula religiosa andamanensis*. **Historical status:** Common (?). **Sight records:** Great Nicobar group 250-300, Nancowry group 12-15. **Status:** Near threatened.

33. Nicobar Pied Cuckoo-Shrike *Coracina nigra davisoni*

Taxonomy: Now called *Lalage nigra davisoni*. **Historical status:** Not uncommon. **Sight records:** <10. Sighted only on Camorta and Katchall. An uncommon or rare species. **Status:** Vulnerable [B2c].

34. Fairy Blue-bird *Irena puella andamanica*
Ali & Ripley quote Butler and include the Nicobars in its distribution, but this species has not been recorded from there by Davison and Abdulali, I am unable to locate Butler's reference, and have excluded this species from the analysis.

35. Andaman Red-whiskered Bulbul *Pycnonotus jocosus whistleri*

Taxonomy: Unchanged. **Historical status:** This species is said to have been introduced into the Nicobars from

the Andamans. Davison saw it being released on Car Nicobar and saw a small party on Camorta. **Sight records:** >200. Excepting Tillanchong and Bompoka, they are now present on all Nancowry group islands and Car Nicobar. **Status:** Common. **Additional notes:** There is record of its introduction on only two islands. In the last century it has apparently spread to islands as far as 50 km from the island where it was introduced. Needs to be eradicated from the Nicobar islands.

36. Nicobar Bulbul *Hypsipetes nicobariensis*

Taxonomy: Unchanged. **Historical status:** This full species endemic has been specifically recorded from all islands in the Nancowry group, and from Pilo Milo in the Great Nicobar group. I believe the sight record from Pilo Milo to be erroneous as this species was neither seen by me nor in the past from either Great or Little Nicobar. Said to be common in the past. **Sight records:** Camorta 4-5, Nancowry 1, Katchall 15-20 (1 flock > 100 birds) Tillanchong 1, Teresa 15-20. **Threats:** The introduced Andaman Redwhiskered Bulbul, which has spread throughout the Nancowry group and is very common, has probably resulted in the rarity of the Nicobar Bulbul because of competition for the same ecological niche. **Status:** Vulnerable [A1d, B2c].

37. Paradise Flycatcher *Terpsiphone paradisi nicobarica*

Taxonomy: Unchanged. **Historical status:** Davison found this species rare in both the Andaman & Nicobar islands, but Butler found them to be numerous in the Nicobars. Abdulali did not record it. **Sight records:** 5. **Status:** Near threatened.

38. Car Nicobar Blacknaped Monarch

Monarcha azurea idiochroa

Nicobar Blacknaped Monarch *M. a. nicobarica*

Taxonomy: Now known as *Hypothymis azurea idiochroa* and *H. a. nicobarica*. **Historical status:** Common. **Sight records:** 90-100. **Status:** Of less concern.

39. Nicobar Ground Thrush *Zoothera citrina albogularis*

Taxonomy: Unchanged. **Historical status:** Butler said they were fairly common throughout the Nicobars, but shy and difficult to procure. Specifically recorded from Trinkat, Nancowry, Camorta and Katchall. **Sight records:** 1 on Katchall. **Status:** Near threatened / Data Deficient.

40. Central Nicobar Olivebacked Sunbird

Nectarinia jugularis klossi

Car Nicobar Olivebacked Sunbird *N. j. proselia*

Taxonomy: Unchanged. **Historical status:** Common.

Sight records: >500. **Status:** Of less concern.

41. Nicobar Yellowbacked Sunbird *Aethopyga*

siparaja nicobarica

Taxonomy: Unchanged. **Historical status:** Common.

Sight records: 70-75. **Status:** Of less concern.

42. Nicobar White-eye *Zosterops palpebrosa*

nicobarica

Taxonomy: Unchanged. **Historical status:** Common.

Sight records: >10. **Status:** Of less concern.

43. Nicobar Whitebacked Munia *Lonchura*

striata semistriata

Taxonomy: Unchanged. **Historical status:** Common.

Sight records: <10. **Status:** Of less concern.

Status of Introduced species

Several species of avifauna have been introduced in the Andaman & Nicobar islands. The Andaman group has had a greater number of introductions than the Nicobar group, and of the 12 mainland species introduced, 10 were in the Andaman group and four in the Nicobar group. Additionally, two Andaman endemics have been introduced into the Nicobar islands.

There are several examples of introduced species causing extinction or rarity of endemic species in island ecosystems (e.g. Atkinson 1989, Olson 1989, Carew-Reid 1990, Baker 1991). It is crucial to the long-term survival of several endemic species of the Nicobar islands that the introduced species are either eradicated from the islands or their populations are controlled.

Blue Rock Pigeon : Introduced to Car Nicobar in 1898. Not widespread, but domestic strains are common around habitations in Car Nicobar.

Less than a 100 are present on Great Nicobar.

House Crow: *Corvus macrorhynchos* was introduced into the penal settlement at Camorta (c. 1890) as was *Corvus splendens* where they both died out. Now the only island where the House Crow is present is on Car Nicobar (year of introduction ?), where it is common around habitations, but absent or scarce in the forest.

Andaman Whiteheaded Myna: Year of introduction into Camorta unknown. I did not see this species there.

Indian Myna: Introduced in 1867, first introduced into Port Blair and from there to Camorta. This species has apparently died out and I did not see it on Camorta.

Andaman Redwhiskered Bulbul: Year of introduction in Camorta unknown. In the 100 odd years of its presence it has spread to Nancowry, Trinkat, Katchall, Teressa, and Car Nicobar where it is very common at places.

House Sparrow: Was introduced in 1895 into Car Nicobar where it is now common.

Conclusion

About 36% of the endemic species and subspecies present on the Nicobar islands are either endangered (2%), vulnerable (12%) or near threatened (22%), eliciting grave concern about their long-term survival. While there is still adequate habitat available for most species, the trend of increasing human pressure on natural resources, particularly because the limits on the resource base is so acute, will soon result in the disappearance of populations and subsequently of species. Conservation measures need to be taken to ensure that adequate habitat is preserved to ensure that the endemic avifauna of the Nicobar islands survive.

Table 5. Distribution of endemic avifauna in the Nicobar group of islands

	GN	MI	LN	PM	MR	TR	TA	MN	KN	CA	CM	TR	NN	KT	TS	BP	TI	CN	FE	SE
Nicobar Tiger Bittern ✓	#									#	#	#								4
Nicobar Shikra ✓	+		+	+							+				+	+	+	+	#	@ 1,4
Nicobar Crested Serpent Eagle ✓	+		+				+				#	#	#	#	#					@ 2,3
Nicobar Megapode ✓	+	+	+		+	+	+	+	+		+	+	+	+	+	+	+			@ 2,3
Nicobar Bluebreasted Quail											+	+	+					#		4
Button Quail											#	#			#			#		5
Bluebreasted Banded Rail													#					#		4
Whitebreasted Waterhen ✓	+							+			+	+	+	+	+		+	+		1,4
Andaman Pompadour Pigeon ✓	+		+	+					+		+	+	+	+	+	+	+	+	+	5
Nicobar Green Imperial Pigeon ✓	+		+	#	+	#	#	+	+		+	+	+	+	+	+	+	+		4
Nicobar Woodpigeon	#		?								#	#	#					#	*	4
Nicobar Cuckoo-dove ✓	+	+	+	+							+	+	+	+	+	+	+	+		* 4
Nicobar Emerald Dove ✓	+		+								+	+	+	+	+	+	#	+		4
Nicobar Pigeon ✓	+			#	+		+				#		+		+	+	+	#		5
Blyth's Nicobar Parakeet ✓	+		+					+	+										@	3
Nicobar Redcheeked Parakeet ✓	+		+	+	+	+	+	?	?		+	+	+	+	+	+	+	+		4
Andaman Koel ✓	+	+	+	+	+	+	+	+			+		+	+	+	+	+	+		5
Nicobar Scops Owl	#										#									4
Nicobar Brown Hawk-owl ✓											#		#					#		5
Nicobar Hawk-owl ✓	#										#	#						#	*	4
Andaman Greyrumped Swiftlet ✓	+		+								+		+		+	+	+	#		5
Whitebellied Swiftlet ✓	+		+	+							+		+	+	+	+		+		5
Andaman Three-toed Kingfisher ✓	#		#																	5
Nicobar Storkbilled Kingfisher ✓	+		+	+	+						?									3
White-collared Kingfisher ✓	+										+	+	+	+	+	+	+	+		4
Nicobar Greenbreasted Pitta ✓	+		+	+																3
Nicobar Blacknaped Oriole ✓	+	+	+	+							+	+	+	+	+	+	+	+		4
Nicobar Racket-tailed Drongo	+	+	+	+					+					+				+		4
Andaman Glossy Tree Stare ✓	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+		5
Nicobar Whiteheaded Myna														+				+		1,2
Nicobar Hill Myna ✓	+		+					+			+	+	+	+						4
Nicobar Pied Cuckoo-shrike											+	#	+							2
Andaman Red-whiskered Bulbul											+	+	+	+	+			+		5
Nicobar Bulbul											+	#	+	+	+	#	+		@	2
Paradise Flycatcher ✓	+										+	#	#	+						5
Nicobar Blacknaped Monarch ✓	+		+		+				+		+		+	+	+	+	+	+		1,4
Nicobar Ground Thrush	#										#		#	+				#		4
Nicobar Olivebacked Sunbird ✓	+	+	+	+		+	+		+	+	+	+	+	+	+	+	+	+		1,4
Nicobar Yellowbacked Sunbird ✓	+		+	+	#				+											3
Nicobar White-eye ✓	+											#	+	+	+			+		5
Nicobar Whitebacked Munia											+	+		+				#		4
Total number of endemics	32	7	22	15	9	6	8	6	10	1	32	23	26	28	22	17	18	27		

Key: GN Great Nicobar, MI Megapode Island, LN Little Nicobar, PM Pilo Milo, MR Meroe, TR Treis, TA Trax, MN Menchal, KN Kondul, CA Cabra, CM Camorta, TR Trinkat, NN Nancowry, KT Katchall, TS Teressa, BP Bompoka, TI Tillanchong, CN Car Nicobar.

FE: @ = Full species endemic to the Nicobar islands; * = Full species endemic to the Andaman & Nicobar islands.

+ = Sighted by me; # = In literature, not seen by me.

SE: Subspecies endemic to: 1=Car Nicobar group, 2=Nancowry group, 3=Great Nicobar group, 4=two or more Nicobarisland groups, 5=common to Andaman islands.



Figure 13. There can be no greater case made for the preservation of Great Nicobar than that of the Shompen (above), a tribe of hunter-gatherers who number barely 150. The loss or degradation of their forests can only result in the extinction of this tribe.

Conserving the Nicobar islands

Introduction

Biodiversity is the total variety of life on earth, and is highly threatened; in the economic sense biodiversity represents unimaginable wealth, in the ethical sense it is priceless (ICBP 1994). Where avian endemism is pronounced, there appears to be a high degree of endemism in other life forms (ICBP 1994), and therefore Endemic Bird Areas are of critical importance. Of the 27 major endemic Bird Areas in Asia (and of 221 in the world) the Nicobar islands is one, and thus is an important component of the biological wealth of India.

Although as much as 80% of the Nicobar islands are still covered by primary forest, and at least 60% is still relatively undisturbed, the trend over the last decade gives rise to grave concern. Three major issues need to be addressed immediately. First, the kind of development programmes that the islands are increasingly being subjected to and second, the growth of human population, particularly that of mainlanders. The third issue is the planning and implementation of a protected area network in the Nicobar islands, whereby the survival of the endemic species of the islands effectively ensured.

Important Islands / Island Groups

The primary difficulty while planning the conservation of islands is in the identification of islands or island groups that need action on a priority basis, as different islands, or island groups have their own distinct flora and fauna, all of which merit preservation. The only way to ensure their long-term survival is by developing conservation programmes for important islands and island groups, setting aside areas as wildlife reserves, where all but the barest of human use is excluded. Islands and island groups have been prioritised for conservation based on the number of endemic species and subspecies and also the number of Threatened or Near Threatened taxa.

Island Groups: From the data available (Tables 6 & 7), it is apparent that all three island groups are crucial to the endemic avifauna of the Nicobar islands, as all island groups have unique taxa. However, the Nancowry group of islands must perforce take first priority, as it not only has the highest number of endemic species and subspecies, but also the highest number of vulnerable taxa (Tables 6 & 7). Of second priority is the Great Nicobar group, as it also possesses a high number of endemics and the highest number of Near Threatened taxa (Table 6 & 7). The Car Nicobar group has the third priority because the island has the least number of endemics, only one of which is threatened.

Islands: The most important island for conservation in the Nicobar islands is Great Nicobar, as it has the highest number of endemic taxa (Table 5 & 7). It is also the largest island in the Nicobars, and large island size decreases the probability of extinction (Adler 1994). Three islands of the Nancowry group, Camorta, Katchall and Nancowry

Table 6. Number of endemic avifauna species and subspecies according to island groups.

Island groups	A	B	C	D	E
Great Nicobar	32	1	5	17	9
Nancowry	36	1	4	19	12
Car Nicobar	27	0	5	10	11

- A Total no. of endemics present
- B Endemic species exclusive to the subgroup
- C Endemic subspecies exclusive to the subgroup
- D Endemic species/subspecies common to other Nicobar Islands
- E Endemic species/subspecies common to Andaman Islands

Table 7. Number of Endangered, Vulnerable, and Near Threatened avifauna species according to island group.

Island group	En	Vu	NT
Great Nicobar	0	0	10
Nancowry	0	6	9
Car Nicobar	1	1	6

En - Endangered; Vu - Vulnerable; NT - Near Threatened

are ranked as second highest on the priority list, despite their inequality in number of endemics, because the conservation of these three islands will benefit all endemic species occurring in the Nancowry group. The only endangered bird, the Car Nicobar Shikra, in the Nicobar group of islands is on Car Nicobar, thus qualifying it as the third priority island.

Developing a Protected Area Network

In their monograph on planning a protected area network for India, Rodgers and Panwar (1988) state 'The scale of biological value in the Andaman & Nicobar islands is so great, that all protected area proposals must be seen as a major priority'. To ensure the long-term survival of the endemic avifauna of the Nicobar Islands it is imperative that a protected area network be developed whereby the habitats of most endemic taxa receive protection.

Existing Protected Areas

Only four of the 24 islands in the Nicobar group have Protected Areas. Batti Malv (2 sq km), Tillanchong (17 sq km) and Megapode Island (0.25 sq km), all uninhabited, are Wildlife Sanctuaries. Great Nicobar is a Biosphere Reserve (885 sq km), with two core areas; the Campbell Bay National Park (426.23 sq km), and the Galathea National Park (110 sq km). A part of Great Nicobar has been designated as a Tribal Reserve (119 sq km) for the Shompen (Pande *et al.* 1991), but much of this falls within the Biosphere Reserve.

Proposed Protected Area Network in the Nicobar group of islands

The existing protected area network in the Nicobar islands is inadequate for two reasons. Firstly, island groups which have both a large number of Andaman & Nicobar endemics and exclusive endemics are not adequately protected, and secondly, the design of the existing Great Nicobar Biosphere Reserve is flawed. I propose the creation of the Nancowry Biosphere Reserve, the redesigning of the Great Nicobar Biosphere Reserve and the inclusion of offshore waters into the two Biosphere Reserves.

Creation of the Nancowry Biosphere Reserve:

Even though the Nancowry group has the highest number of endemics and is first on the priority list, only uninhabited Tillanchong island is protected as a Wildlife Sanctuary. Thus, only less than 3% of the area of the Nancowry group is protected. There is a need for a Biosphere Reserve in the Nancowry group, that encompasses all islands within the group. The core areas of the proposed Nancowry Biosphere Reserve should be the three islands that are of high priority, (Camorta, Katchall, and Nancowry), by whose conservation most endemic species in the Nicobar islands will be benefited (Fig. 14). Tillanchong, already a Wildlife Sanctuary, can form the fourth core area (Fig. 14).

Redesigning the Great Nicobar Biosphere Reserve:

Although a little over 50% of Great Nicobar has been protected as National Parks and about 85% as Biosphere Reserve (885 sq km) (Fig. 15), this is inadequate. The buffer zones of Biosphere Reserves are designated as areas of multiple use. Although less than 10% of Great Nicobar is under human use, 35% of Great Nicobar has been designated as a buffer zone. Moreover, the National Parks protect only the central portion and less than 15% of the coastal areas of Great Nicobar. The National Parks also leave unprotected a broad strip of primary undisturbed forest between them through which the East-West road passes.

The apparent flaws in the design of the National Parks on Great Nicobar are:

- a) On islands, particularly hilly ones, the first area to be destroyed are coastal forests. This habitat, crucial to the survival of the Nicobar megapode is insufficiently protected (Fig. 14).
- b) The southern tip of Great Nicobar, which is unprotected, comprises the largest uninhabited flat coastal forest in the Nicobar group and harbours large populations of species such as the Great Nicobar Crested Serpent Eagle, Nicobar Megapode, Blyth's Nicobar Parakeet and the Nicobar Pigeon.
- c) The central portion of Great Nicobar is also unprotected.

About 40% of the coast of Great Nicobar and most of the southern tip and the central portion is uninhabited. These relatively undisturbed primary forests must be protected because any future change in policy can result in these areas being destroyed. Thus, a single National Park must be created in Great Nicobar merging the two existing ones and including the southern tip of the Island (Fig. 15). The buffer zone on the west coast can cover the areas used by the Nicobarese, and that on the east the areas where mainlanders have been settled.

The management of the buffer zones of the proposed National Park can follow two strategies according to the inhabitants of the zones. Those areas where the Nicobarese live must be left strictly alone because they interact with the forests in a relatively non-destructive manner. In

the buffer zone on the east coast, which the mainlanders inhabit, programmes of afforestation and sustainable use of resources can be implemented. This will be necessary because in the future, with increasing human populations, there will be a great deal of pressure on the limited resources of the island.

The design of the Great Nicobar Biosphere reserve is inadequate also because it only covers absolutely pristine areas where the influence of mainlanders is non-existent and the influence of the tribals minimal. On Great Nicobar, the tribal populations are very small (fewer than 450 people, and most hamlets have barely 2 or 3 families), and it was evident that the pressures that they exert on the forests were well within sustainable limits. Thus, the existing Biosphere Reserve does not address the real needs which is

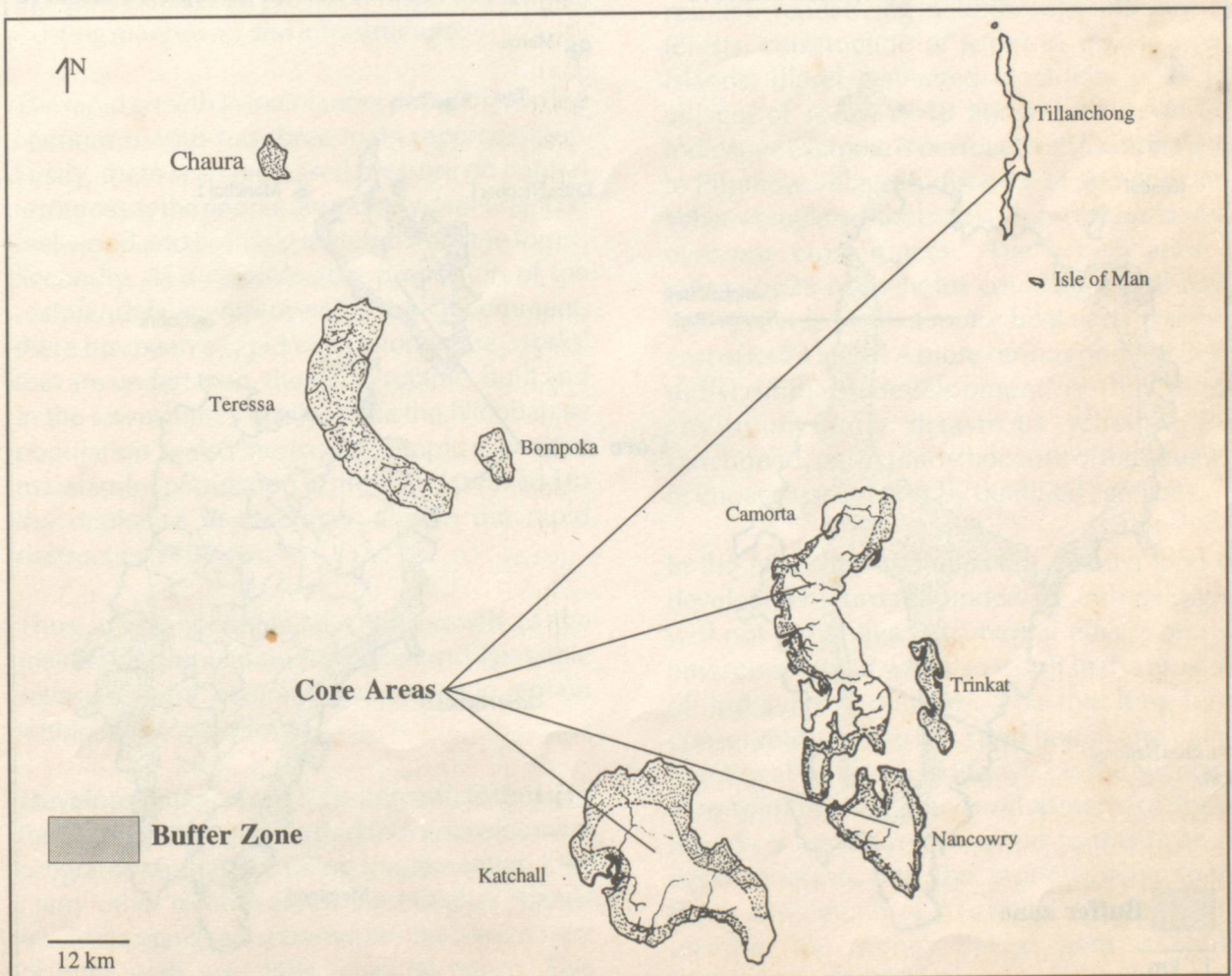


Figure 14. Proposed Nancowry Biosphere Reserve

cover areas that are used to a larger extent by man. The proposed Biosphere Reserve should cover the other Islands in the Great Nicobar Group, namely Kondul, Pilo Milo, Little Nicobar, Meroe, Treis, Trak and Menchal. Little Nicobar, currently unprotected, can have a satellite core zone as well (Fig. 15). The designation of Little Nicobar as a National Park has also been recommended by Rodgers & Panwar (1988).

Conserving offshore waters: The seas around each island are very rich in marine life and resources, many of which are of very high commercial value. There is, therefore, a greater need to provide some form of protection to offshore waters whereby utilisation of marine resources can be regulated at sustainable levels. The incorporation of the sea up to a distance of

two nautical miles from the shore and the waters between islands into the Biosphere Reserves is probably the best solution. Alternately, a Marine National Park comprising the waters between the islands can be formed.

Specific Conservation Issues

Human population: Every document on the Andaman & Nicobar islands records a great deal of concern about the continuous inflow of mainlanders into the island group. All but two islands of the Nicobar islands are designated as tribal areas under the Protection of Aboriginal Tribes Act (1957). Therefore, on all islands, excepting Great Nicobar and Katchall, the presence of mainlanders is to primarily facilitate administration. But the growth in mainlander

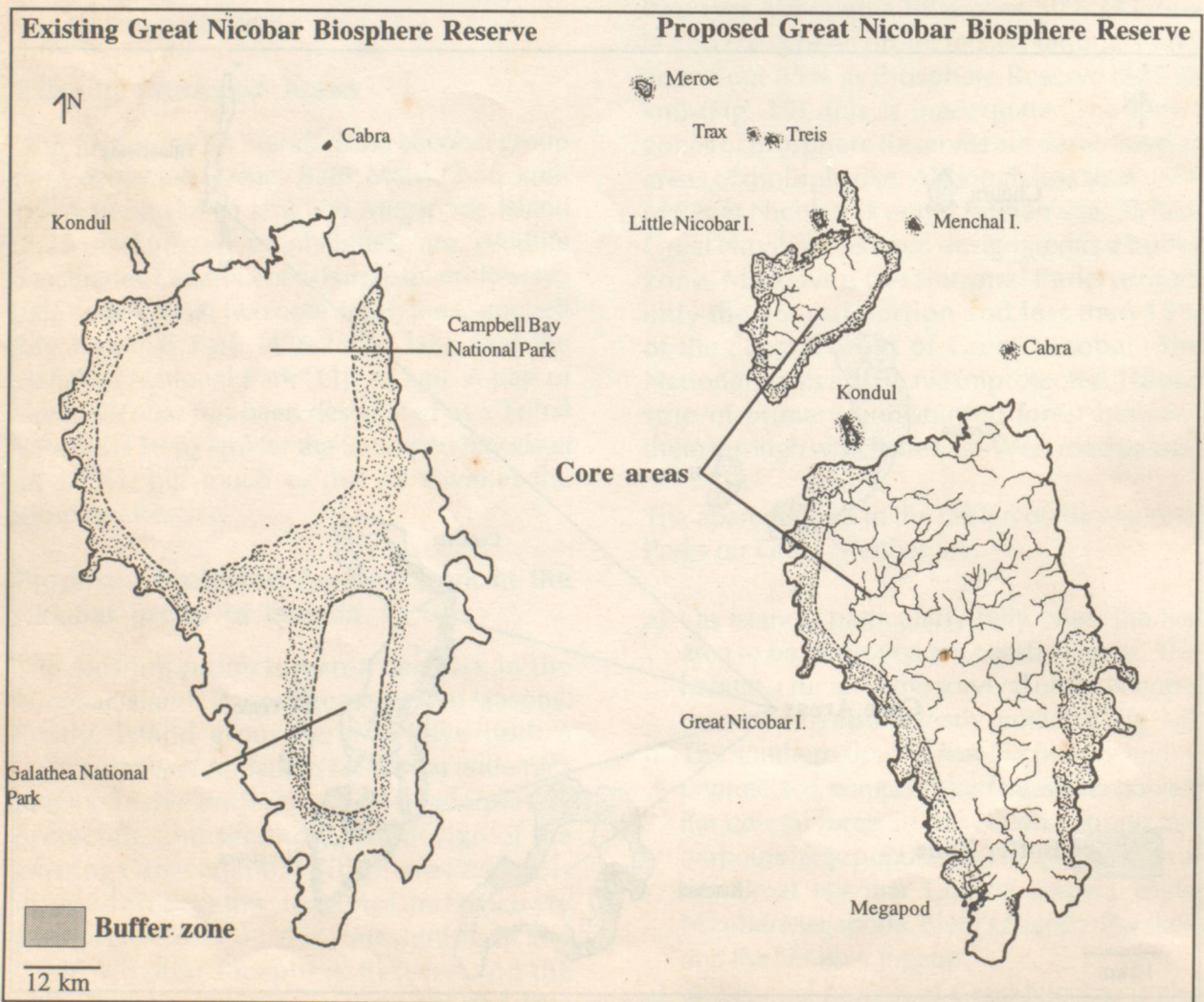


Figure 15. Proposed redesigning of the Great Nicobar Biosphere Reserve

population in the Nicobar islands is not commensurate with the growth of the tribal population. The density of mainlanders has grown from 4.7 per sq km to 7.3 per sq km between 1981 and 1991, an increase of 55%, whereas for the same decade the density of Tribals has increased from 10.8 per sq km to 12.8 per sq km, an increase of only 18.5% (Fig. 16, Appendix 5). The situation is most alarming on islands which are on the priority list for avian conservation where the growth in mainlander population has been greater than 50%, while the growth in tribal population has been less than 20%. The entire appeal against the growth of mainlander population can be illustrated with the case of Camorta. Given the fact that Camorta is a tribal area, and that mainlanders are primarily meant to facilitate the administration of the islands, for a population of 1406 tribals, there are 1567 mainlanders. Clearly there is an imbalance between the institutional manpower necessary for administration and the existing manpower and infrastructure.

The rapid growth in mainlander population in the Nicobar islands has three main repercussions. Firstly, there is an increased pressure on natural resources as the people are entirely dependent on fuel wood and building material from the forest. Secondly, as a considerable proportion of the mainlanders is employed by the Government, there has been a rapid expansion in the 'works' that are undertaken, the infrastructure built and in the townships. Thirdly, since the Nicobarese population is also increasing, a rapid growth of mainlander population in the islands will add to the depletion of resources and in the rapid destruction of forests.

Thus, it is imperative that the growth of the mainlander population is checked and if possible reversed if the natural resources are to remain within sustainable limits.

Development projects: The immediate threat to the Nicobar islands lies in the kind of development programmes that are being implemented. Like many other remote areas, the Nicobar islands receives a significant subsidy from the Government of India with very little financial return. This

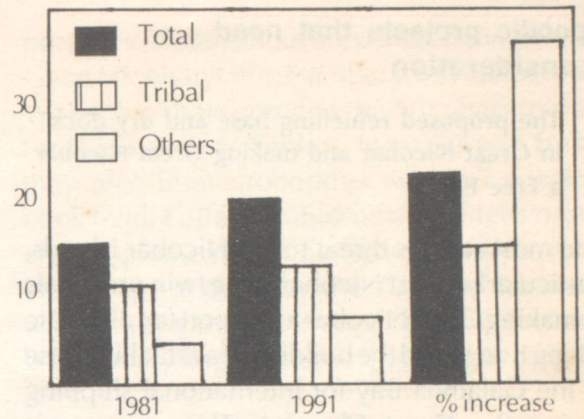


Figure 16. The increasing human population density in the Nicobar group of islands

disparity has resulted in a great deal of pressure on the administration to find ways and means by which money can be generated, which in turn has resulted in an acceleration of development. As development essentially means construction, this results in roads being made through undisturbed forests, construction of jetties to service small islands, diesel generated electricity grids for villages of as few as 19 houses and so on. An indicative example is the road from Camorta jetty to Pilpillow village, a distance of about 30 km. When completed, the road will cost the exchequer over one crore rupees. The beneficiaries, a village of 29 households could very well have been provided with a motor boat each at only a cost of Rs 24 lakhs! A more serious problem with indiscriminate development is that many environmentally disastrous schemes are sanctioned, particularly because of the absence of impact assessments by qualified agencies.

In the Nicobars, it is apparent that the kind of development currently underway and envisaged will not only have detrimental effects on the environment but will also result in the erosion of indigenous cultures. For the long-term conservation of the flora and fauna, and of the traditional cultures and lifestyles in the Nicobars a re-thinking on the development of these islands is necessary. Inherent to this is an in depth analysis into the money being spent there, how much of it is really required, and whether the money being spent is really beneficial to the Nicobarese and the Shompen.

Specific projects that need reconsideration

1. The proposed refuelling base and dry dock in Great Nicobar and making Great Nicobar a Free Port.

The most serious threat to the Nicobar islands, particularly Great Nicobar is the twin proposals of making Great Nicobar a free port (an alternate 'Hong Kong') and the building of a refuelling base at the Galathea Bay for international shipping plying the Great Channel. The consequent expansion in mainlander population for the building of necessary infrastructure, trade and other sectors will exert an enormous pressure on the resources of the islands. The worst affected will be the forests and the endemic flora and fauna. More alarming, these projects will have serious adverse repercussions on the shy Scheduled Tribe, the Shompens who hunt and fish in these forests.

Necessary action must be taken to ensure that Great Nicobar is left undisturbed, and that adequate safe guards are put in place which will ensure that such ecologically and socially disastrous projects are never permitted either now or in the future.

2. Roads

Accessibility inevitably results in greater levels of exploitation. As the forests in the Nicobar islands are vulnerable to human use a blanket moratorium on the construction of roads in the Nicobar islands needs to be set in place.

Specifically:

a) *Re-alignment of the road leading to the Light House at Indira Point*

Just after 'km 46' on the North-South Road, (0 km = Campbell Bay and 51 km is the light house at Indira point), the road curves along a cliff face for a distance of about 200 m. While GREF, during Project Yatrik, had made a sea wall for part of the distance, sea action on the un-walled part has resulted in

the road being cut away. There is a proposal to realign the road in order to by pass this cliff face by constructing a new road through forest further inland. It was understood that the repairing of the existing road, and the shoring of the cliff face is not only possible but will cost only a fraction of that of the new road. This road, from 'km 41' to light house, appears to serve the sole purpose of letting picnickers and other visitors reach the lighthouse situated at the southern tip of India. The cost of loss forest far outweighs the benefits of this road and hence should not be permitted.

b) *The East West Road*

The East West road in Great Nicobar links mainlanders settled on the east coast with Nicobarese on the west coast and runs through Shompen territory. Currently the road is not in use because bridges have broken down and the road is being reclaimed by the forests, but it is likely that the east west road will be made usable in the future. A serious reconsideration must be given as to whether this road is a desirable one, because it gives very easy access to the Nicobarese on the west coast and will bring the mainlanders into greater contact with Shompen. It is likely that greater contact will only have negative effects on the Shompens and the Nicobarese, and thus it would be preferable to leave this road as unusable.

c) *Proposed road in Katchall*

A proposal to construct a new road (about 25 km long) from Katchall jetty to West Bay Katchall along the eastern and southern coast has been proposed. This road passes through the habitat which is amongst the last remnant undisturbed coastal forests in the Nancowry group and where one of the few viable populations of the North Nicobar Megapode exists. As the construction of the road will result in the loss of primary habitat and be detrimental to the threatened North Nicobar Megapode, it is urged that the plans for this road be dropped.

General Issues

Hunting

Hunting is widespread in the Nicobar islands. The tribals are legally permitted to hunt, but an alarming trend in recent times is the increasing use of airguns to shoot pigeons. This has resulted in pigeon populations being severely depleted on several islands. A closed season during the breeding period needs to be immediately effected if the tribals are to 'harvest' pigeons in a sustainable manner.

Although, legally, mainlanders are not permitted to hunt, hunting of the wild boar is prevalent. Apart from wildboar, mainlanders did not appear to hunt other animals on a large scale, nor was there any evidence of hunting crocodiles for their skins in the Nicobar islands. While there is a stricter monitoring of hunting in Great Nicobar (because of the presence of the A.C.F. Wildlife there), there is apparently much less control in the Nancowry group. This needs to be looked into.

The most serious problem however, is from Thai

poachers. Three islands are particularly affected, Great Nicobar, Little Nicobar and Tillanchong. While the Thais come to the Nicobars to dive for shells such as Tockus, Nautilus and Turbo they also hunt crocodiles (which are taken back live), collect Edible-nest Swiftlet's nests, and supplement their diet from the forest. A lot of damage is done by the Thais in the areas where they camp. The control of this menace is of primary importance in the Nicobar islands.

Infrastructure for the Forest Department

The infrastructure that the Forest Department currently has in the Nicobars is clearly inadequate. The Wildlife Guards are neither armed, nor does the Department have a single seaworthy vessel. Their mobility and capability of handling conservation issues or patrolling are thus greatly impaired. It is of paramount importance that both these facilities are immediately provided. One readily available source of seaworthy vessels are those confiscated from Thai poachers which can be put to good use by the Forest Department.

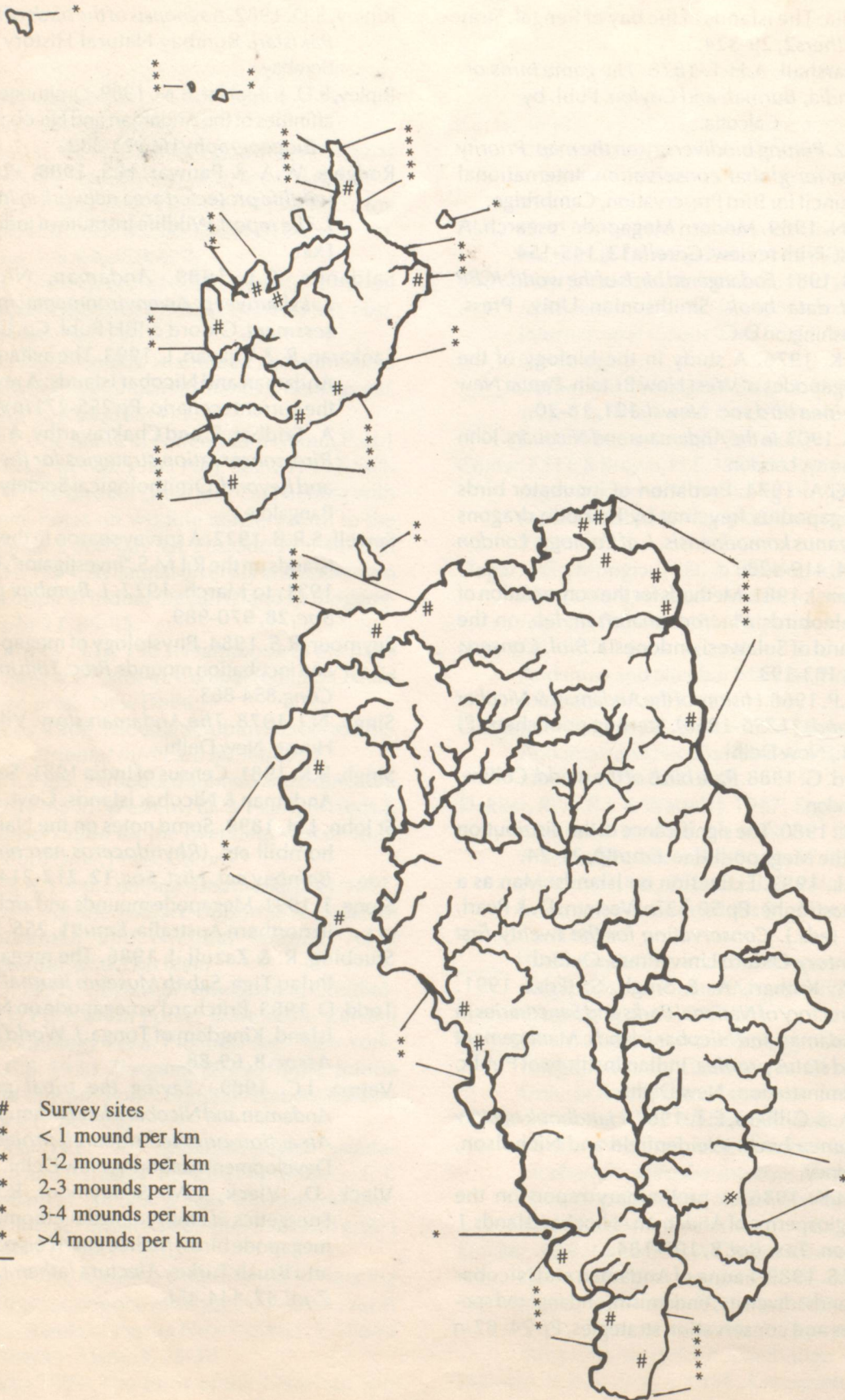
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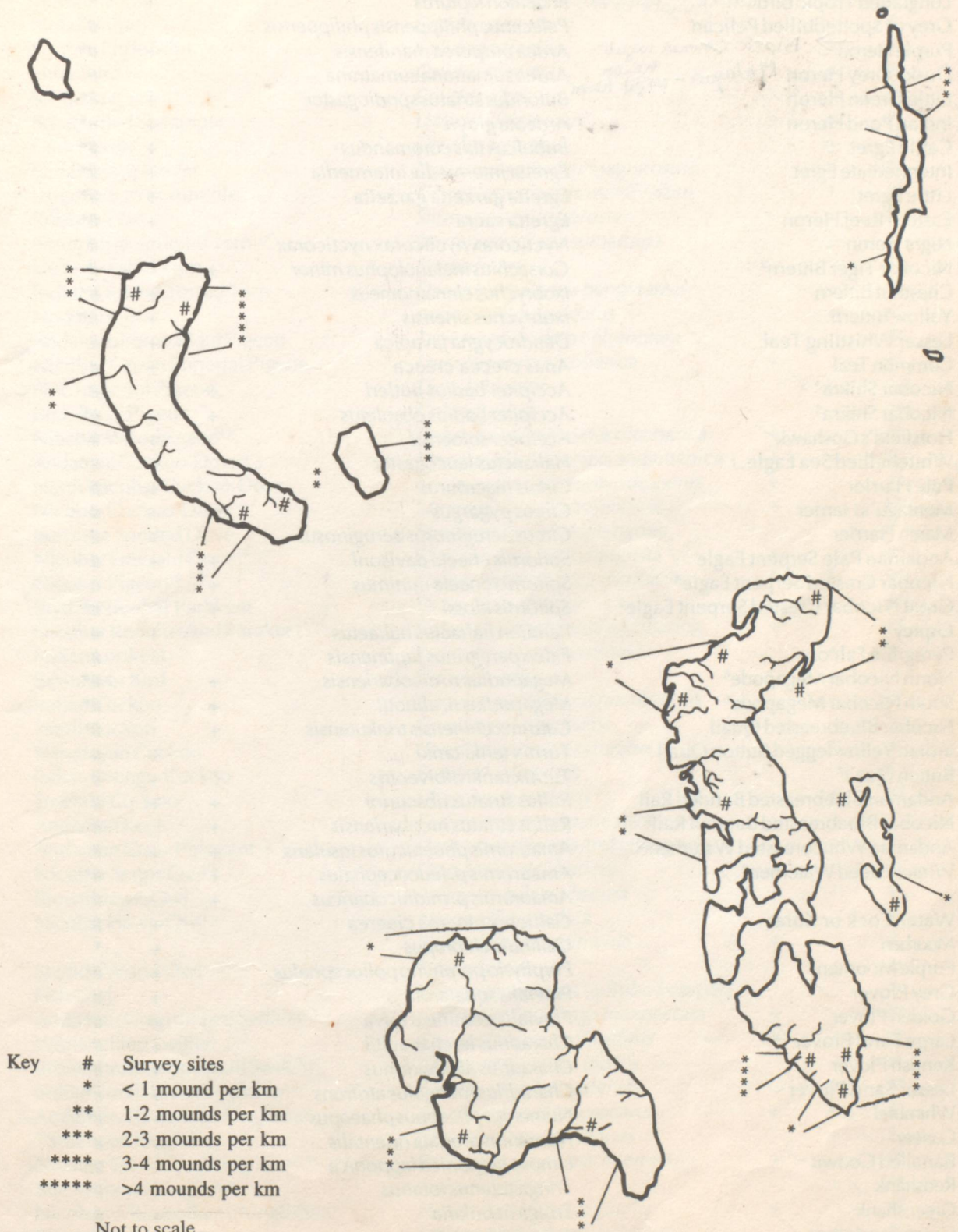
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Appendices

1. Distribution and encounter rate of active mounds in the Great Nicobar group of islands.



2. Distribution and encounter rate of active mounds in the Nancowry group of islands.



3. The birds of the Nicobars - a review of literature and sightings of this survey

Commonname	Species	E	A	Ref.
Red-tailed Tropic-bird <i>(dark brown)</i>	<i>Phaethon rubricauda rubricauda</i>			#
Longtailed Tropic bird <i>(Laysan Puffin-like bird)</i>	<i>Phaethon lepturus</i>		+	*
Grey or Spottedbilled Pelican	<i>Pelecanus philippensis philippensis</i>			#
Purple Heron <i>(Black-crowned night heron)</i>	<i>Ardea purpurea manilensis</i>		+	#*
Dusky Grey Heron <i>(Malayan - night heron)</i>	<i>Ardea sumatrana sumatrana</i>			#
Little Green Heron	<i>Butorides striatus spodiogaster</i>		+	#*
Indian Pond Heron	<i>Ardeola grayii</i>		+	#*
Cattle Egret	<i>Bubulcus ibis coromandus</i>		+	#*
Intermediate Egret	<i>Egretta intermedia intermedia</i>		+	#*
Little Egret ¹	<i>Egretta garzetta garzetta</i>		+	#*
Eastern Reef Heron	<i>Egretta sacra</i>		+	#*
Night Heron	<i>Nycticorax nycticorax nycticorax</i>			#
Nicobar Tiger Bittern ² ✓	<i>Gorsachius melanolophus minor</i>	+		#
Chestnut Bittern	<i>Ixobrychus cinnamomeus</i>		+	#*
Yellow Bittern	<i>Ixobrychus sinensis</i>		+	#*
Lesser Whistling Teal	<i>Dendrocygna javanica</i>		+	#
Common Teal	<i>Anas crecca crecca</i>		+	#
Nicobar Shikra ³ ✓	<i>Accipiter badius butleri</i>	+		#
Nicobar Shikra ³	<i>Accipiter badius obsoletus</i>	+		#*
Horsfield's Goshawk	<i>Accipiter soloensis</i>		+	#
Whitebellied Sea Eagle ✓	<i>Haliaeetus leucogaster</i>		+	#*
Pale Harrier	<i>Circus macrourus</i>		+	#
Montagu's Harrier	<i>Circus pygargus</i>		+	#
Marsh Harrier	<i>Circus aeruginosus aeruginosus</i>		+	#
Andaman Pale Serpent Eagle ✓	<i>Spilornis cheela davisoni</i>	+	+	#
Nicobar Crested Serpent Eagle ⁴ ✗	<i>Spilornis cheela minimus</i>	+		#
Great Nicobar Crested Serpent Eagle ⁵ ✓	<i>Spilornis klossi</i>	+		#*
Osprey	<i>Pandion haliaetus haliaetus</i>		+	#
Peregrine Falcon	<i>Falco peregrinus japonensis</i>			#
North Nicobar Megapode ⁶	<i>Megapodius n. nicobariensis</i>	+		#*
South Nicobar Megapode ⁶ ✓	<i>Megapodius n. abbotti</i>	+		#*
Nicobar Bluebreasted Quail	<i>Coturnix chinensis trinkutensis</i>	+		#*
Indian Yellowlegged Button Quail	<i>Turnix tanki tanki</i>		+	#
Button Quail ⁷	<i>Turnix tanki albiventris</i>	?	+	#
Andaman Bluebreasted Banded Rail	<i>Rallus striatus obscurior</i>	+	+?	#
Nicobar Bluebreasted Banded Rail ⁸	<i>Rallus striatus nicobariensis</i>	+		#
Andaman Whitebreasted Waterhen ✗	<i>Amaurornis phoenicurus insularis</i>	+	+	#
Whiteheaded Waterhen ⁹ ✓	<i>Amaurornis p. leucocephalus</i>	+		#*
	<i>Amaurornis p. midnicobaricus</i>	+		#
Water Cock or Kora	<i>Gallixrex cinerea cinerea</i>		+	#
Moorhen	<i>Gallinula chloropus</i>		+	*
Purple Moorhen	<i>Porphyrio porphyrio poliocephalus</i>		+	#*
Grey Plover ✓	<i>Pluvialis squatarola</i>		+	#
Golden Plover	<i>Pluvialis dominica fulva</i>		+	#*
Large Sand Plover ✓	<i>Charadrius leschanaultii</i>		+	#
Kentish Plover	<i>Charadrius alexandrinus</i>		+	#*
Lesser Sand Plover ✓	<i>Charadrius mongolus atrifrons</i>		+	#*
Whimbrel ✓	<i>Numenius phaeopus phaeopus</i>		+	#*
Curlew ✓	<i>Numenius arquata orientalis</i>		+	#
Bartailed Godwit ✓	<i>Limosa lapponica lapponica</i>			#*
Redshank ✓	<i>Tringa totanus totanus</i>		+	#*
Greenshank ✓	<i>Tringa nebularia</i>		+	#
Green Sandpiper ✓	<i>Tringa ochropus</i>		+	#

*Dark Thrush
Greater Aegialia
Ashy Drongo*

Common name	Species	E	A	Ref.
Wood Sandpiper	<i>Tringa glareola</i>		+	#
Common Sandpiper ¹⁰	<i>Tringa hypoleucos</i>		+	#*
Turnstone ✓	<i>Arenaria interpres interpres</i>		+	#*
Pintail Snipe ¹¹	<i>Capella stenura</i>		+	#
Eastern Little Stint	<i>Calidris ruficollis</i>		+	#
Little Stint	<i>Calidris minuta</i>		+	#*
Sanderling	<i>Calidris alba</i>			#
Broadbilled Sandpiper	<i>Limicola falcinellus</i>		+	#
Crab Plover ✓	<i>Dromas ardeola</i>		+	#*
Great Stone Plover	<i>Esacus magnirostris magnirostris</i>		+	#
Large Indian Pratincole	<i>Glareola pratincola maldivarum</i>		+	#*
Roseate Tern	<i>Sterna dougallii korustes</i>		+	#
Eastern Blacknaped Tern ✓	<i>Sterna sumatrana sumatrana</i>		+	#*
Large Crested Tern	<i>Sterna bergii</i>			#*
Indian Lesser Crested Tern	<i>Sterna bengalensis bengalensis</i>		+	#
Noddy Tern ✓	<i>Anous stolidus pileatus</i>		+	#*
Andaman Pompadour Pigeon ✓	<i>Treron pompadora chloroptera</i>	+		#*
Nicobar Green Imperial Pigeon ✓	<i>Ducula aenea nicobarica</i>	+		#*
Pied Imperial Pigeon ✓	<i>Ducula bicolor</i>		+	#*
Blue Rock Pigeon	<i>Columba livia</i>			#*
Nicobar Woodpigeon ¹²	<i>Columba palumboides nicobarica</i>	+		#*
Andaman Cuckoo-Dove ¹³	<i>Macropygia rufipennis andamanica</i>	+	+	#
North Nicobar Cuckoo-Dove	<i>Macropygia rufipennis rufipennis</i>	+		#*
Nicobar Cuckoo-Dove ✓	<i>Macropygia rufipennis tiwarii</i>	+		H*
Burmese Spotted Dove	<i>Streptopelia chinensis tigrina</i>			#
Nicobar Emerald Dove ¹⁴ ✓	<i>Chalcophaps indica augusta</i>	+		#*
Nicobar Pigeon ¹⁵ ✓	<i>Caloenas nicobarica nicobarica</i>	?	?	#*
Blyth's Nicobar Parakeet ✓	<i>Psittacula caniceps</i>	+		#*
Nicobar Redcheeked Parakeet ✓	<i>Psittacula longicauda nicobarica</i>	+		#*
Indian Lorikeet	<i>Loriculus vernalis vernalis</i>		+	#
Brainfever Bird	<i>Cuculus varius</i>		+	*
Indian Cuckoo ✓	<i>Cuculus micropterus micropterus</i>		+	#*
Small Cuckoo	<i>Cuculus poliocephalus</i>			*
Himalayan Cuckoo	<i>Cuculus saturatus saturatus</i>		+	#
Indian Drongo-Cuckoo	<i>Surniculus lugubris</i>			#
Emerald Cuckoo	<i>Chalcites maculatus</i>		+	#*
Andaman Koel ✓	<i>Eudynamis scolopacea dolosa</i>	+		#
Andaman Crow Pheasant ✓	<i>Centropus sinensis andamanensis</i>		+	#
Nicobar Scops Owl ¹⁶	<i>Otus scops nicobaricus</i>	+		#
Brown Hawk-Owl ✓	<i>Ninox scutulata obscura</i>	+	+	#
Nicobar Hawk-Owl ✓	<i>Ninox affinis isolata</i>	+		#
	<i>Ninox affinis rexpimenta</i>	+		#
Spotted Wood Owl ✓	<i>Strix selaputo</i>			#
Fish Owl	<i>Ketupa javanensis (= Bubo ketupa?)</i>			#
Andaman Greyrumped Swiftlet ¹⁷ ✓	<i>Collocalia fuciphaga inexpectata</i>	+		#*
Whitebellied Swiftlet ✓	<i>Collocalia esculenta affinis</i>	+	+	#*
Brownthroated Spinetail Swift ¹⁸ ✓	<i>Chaetura gigantea indica</i>		+	#
Indian Small Blue Kingfisher ✓	<i>Alcedo atthis bengalensis</i>		+	#*
Andaman Three-toed Kingfisher ✓	<i>Ceyx erithacus macrocarus</i>	+	+	#
Three-toed Kingfisher ✓	<i>Ceyx erithacus erithacus</i>		+	#
Nicobar Storkbilled Kingfisher ¹⁹ ✓	<i>Pelargopsis capensis intermedia</i>	+		#*
Blackcapped Kingfisher ✓	<i>Halcyon pileata</i>		+	#*
Nicobar Whitecollared Kingfisher ✓	<i>Halcyon chloris occipitalis</i>	+		#*
Bluetailed Bee-eater	<i>Merops philippinus philippinus</i>		+	#*

Common name	Species	E	A	Ref.
Nicobar Greenbreasted Pitta ✓	<i>Pitta sordida abbottii</i>	+		#*
Swallow ✓	<i>Hirundo rustica gutturalis</i>		+	#*
Brown Shrike ✓	<i>Lanius cristatus cristatus</i>		+	#
Philippine Shrike	<i>Lanius cristatus lucionensis</i>		+	#*
Nicobar Blacknaped Oriole ✓	<i>Oriolus chinensis macrourus</i>	+		#*
Grey or Ashy Drongo ✓	<i>Dicrurus leucophaeus</i>	?		#
Crowbilled Drongo	<i>Dicrurus annectans</i>			#
Nicobar Racket Tailed Drongo ✓	<i>Dicrurus paradiseus nicobariensis</i>	+		#*
Andaman Glossy Stare ✓	<i>Aplonis panayensis tyleri</i>	+	+	#
Glossy Tree Stare ²⁰ ✓	<i>Aplonis panayensis albiris</i>	+		#*
Nicobar Whiteheaded Myna ²¹	<i>Sturnus erythropygius erythropygius</i>	+		#*
Katchall Whiteheaded Myna	<i>Sturnus erythropygius katchalensis</i>	+		#*
Daurian Myna	<i>Sturnus sturninus</i>			#
Indian Myna	<i>Acridotheres tristis tristis</i>		+	#
Andaman Hill Myna ✓	<i>Gracula religiosa andamanensis</i>	+	+	#
Nicobar Hill Myna ²² ✓	<i>Gracula religiosa halibreata</i>	+		#*
Nicobar Pied Cuckoo-Shrike ²³	<i>Coracina davisoni nigra</i>	+		#*
House Crow	<i>Corvus splendens</i>			*
Ashy Minivet	<i>Pericrocotus divaricatus</i>		+	*
Fairy Bluebird ²⁴	<i>Irena puella andamanica</i>	+	+	#
Andaman Redwhiskered Bulbul	<i>Pycnonotus jocosus whistleri</i>	+	+	#*
Nicobar Bulbul	<i>Hypsipetes nicobariensis</i>	+		#*
Olive Flycatcher	<i>Rhinomyias brunneata nicobarica</i>		?	#*
Paradise Flycatcher ✓	<i>Terpsiphone paradisi nicobarica</i>	+	+	#*
Car Nicobar Blacknaped Monarch ²⁵	<i>Monarcha azurea idiochroa</i>	+		#*
Nicobar Blacknaped Monarch ²⁵ ✓	<i>Monarcha a. nicobarica</i>	+		#*
Malay Streaked Fantail Warbler	<i>Cisticola juncidis malaya</i>			#*
Pallas's Grasshopper Warbler	<i>Locustella certhiola centralasiae</i>		+	#
Streaked Grasshopper Warbler	<i>Locustella lanceolata</i>		+	#
Thickbilled Warbler	<i>Phragmaticola aedon aedon</i>	+		#
Palelegged Leaf Warbler	<i>Phylloscopus tenellipes</i>			#
Indian Blue Rock Thrush	<i>Monticola solitarius pandoo</i>		+	#
Nicobar Ground Thrush	<i>Zosterops citrina albogularis</i>	+		#
Redthroated Pipit	<i>Anthus cervinus</i>		+	#
Forest Wagtail ✓	<i>Motacilla indica</i>		+	*
Greyheaded Yellow Wagtail ✓	<i>Motacilla flava thunbergi</i>		+	#
Blueheaded Yellow Wagtail	<i>Motacilla flava beema</i>		+	#
Grey Wagtail ✓	<i>Motacilla c. caspica (c. cinerea)</i>		+	#*
Nicobar Olivebacked Sunbird ✓	<i>Nectarinia jugularis klossi</i>	+		#*
Car Nicobar Olivebacked Sunbird ✓	<i>Nectarinia jugularis proselia</i>	+		#*
Nicobar Yellowbacked Sunbird ✓	<i>Aethopyga siparaja nicobarica</i>	+		#*
Nicobar White-eye ✓	<i>Zosterops palpebrosa nicobarica</i>	+	+	#*
House Sparrow	<i>Passer domesticus</i>		+	#*
Nicobar Whitebacked Munia	<i>Lonchura striata semistriata</i>	+		#*
Yellowbreasted Bunting	<i>Emberiza aureola aureola</i>			#

n.b. Sightings during this survey only at the species level.

Key: E = (+) endemic to Andaman & Nicobar Islands, A = (+) occurs in the Andaman group also; Ref. = # from literature * sighted during this survey.

Source: Abdulali (1964a, 1964b, 1966, 1967, 1971, 1974, 1978), Das (1971), Dasgupta (1976), Ripley (1982). Ali & Ripley (1983).

Notes on species in Appendix 3. Given below are changes in names and current taxonomic classifications in Howard & Moore (1991). The numbers below correspond to those against species in Appendix 3.

- 1 Name changed to *Egretta garzetta schistacea*.
- 2 Not accepted; consider it to be *Gorsachius melanolophus*, which does not have any sub-species and which ranges from India to Greater Sunda.
- 3 Name changed to *Accipiter butleri butleri* and *Accipiter butleri obsoletus*
- 4 The Crested serpent eagle found in the Nicobar islands is now a single endemic species with two sub-species. *Spilornis minimus minimus* in the North Nicobar islands and *Spilornis minimus klossi* from Great Nicobar.
- 5 *Spilornis minimus klossi* on Great Nicobar.
- 6 Originally called *Megapodius freycinet*.
- 7 Not accepted; considered to be *Turnix tanki tanki*, which is found on mainland India.
- 8 Not accepted; considered to be *Rallus striatus obscurior*, the same as the Andaman race.
- 9 Do not accept both *Amaurornis phoenicurus leucocephalus* & *A. p. midnicobaricus*.
- 10 *Actitis hypoleucos*.
- 11 *Gallinago stenura*.
- 12 Do not differentiate *Columba palumboides* into sub-species. Instead a single species endemic to both Andaman & Nicobar islands.
- 13 Not accepted; consider *Macropygia rufipennis rufipennis* as endemic to Andaman & North Nicobars and *M. r. tiwarii* as endemic to Great Nicobar
- 14 Do not accept this subspecies and presumably consider it the same as *Chalcophaps indica maxima* of the Andaman group.
- 15 *Caloenas nicobarica nicobarica* is not endemic and occurs up to New Guinea islands.
- 16 Do not accept. Presumably consider the Nicobar birds as the same as those from Andamans *Otus scops modestus*.
- 17 Name changed to *Aerodramus fuciphagus*. Also not considered endemic and is distributed up to Greater Sunda and Timor Islands.
- 18 Now called *Hirundapus gigantea indicus*.
- 19 Now called *Halcyon capensis intermedia*.
- 20 Do not accept and consider Nicobar birds the same as *Aplonis panayensis tytleri* from the Andamans.
- 21 Consider *Sturnus erythropygius erythropygius* as endemic to Andamans, and *S. e. andamanensis* as endemic to Car Nicobar.
- 22 Do not accept. Consider Andaman & Nicobar birds as a single endemic race *Gracula religiosa andamanensis*.
- 23 Call it *Lalage nigra davisoni*.
- 24 Do not mention this species for Andaman & Nicobar islands!
- 25 Call it *Hypothymis azurea idiochroa* and *H. a. nicobarica*.

Total no. of Spain 18 global
between 27.12.95
and 28.4.98 are 65 spp.

4. A rough estimate of habitat loss in the Nicobar group of islands.

	Area (sq km)	Forest (sq km) ¹	Forest loss (sq km) ²		% habitat loss	
			Mainlander	Nicobari	Forest	Grassland
Car Nicobar	126.9	124	5	50	45	0
Batti Malv	2.1	2	0	0	0	-
Chaura	8.2	8	0	6	73	-
Teressa	101.4	40	0	15	37	<5
Bompoka	13.3	10	0	2	20	-
Tillanchong	16.82	16	0	1	6	-
Katchall	174.4	174	10	20	17	-
Camorta	188.2	115	3	15	16	<4
Nancowry	66.9	54	0	10	18	0
Trinkat	36.3	15	0	10	65	0
Great Nicobar	1045.1	1045	75	15	9	-
Little Nicobar	159.1	159	0	12	8	-
Kondul	4.6	4	0	1.5	33	-
Pilo Milo	1.3	1	0	1	77	-
Megapode I.	0.13	0.1	0	0.05	50	-
Meroe	2	2	0	0.8	40	-
Treis	0.5	0.5	0	0.3	50	-
Trax	0.2	0.2	0	0.1	50	-
Menchal	1.5	1.5	0	1	67	-
Car Nicobar Group	129	126	5	50	44	-
Nancowry Group	605.52	432	13	79	21	3
Great Nicobar Group	1214.43	1213	75	32	9	-
Nicobargroup	1948.95	1771	93	161	14	3
Nancowry + Great Nicobar groups	1819.95	1645	88	111	123	
Nancowry + Car Nicobar groups	734.52	558	18	129	263	

n.b.

1. This figure is hypothetical (i.e. area of forest prior to colonisation) and is used to assess % loss of forest till date on each island. Area under forest for islands without grasslands was considered to be the entire island. On islands with grasslands, forest cover is area of island minus that under grassland (rough estimate).

2. Estimates of habitat loss and forest cover are very crude approximations and must be treated as such. See methods for details of assessing habitat loss due to mainlanders and Nicobaris.

[-] Habitat not present on the island.

5. Changes in human population in the Nicobar islands between 1981 and 1991.

	1981 population census			1991 population census			1991 density(sqkm)			Density/sqkm		
	Total	Tribal	Others	Total	Tribal	Others	Total	Tribal	Others	1981	1991	%increase
Car Nicobar	15486	13514	1972	19336	15781	3555	152.4	124.4	28	122	152	24.6
Chaura	1118	1114	4	1225	1196	29	149.4	145.9	3.5	136	149	9.6
Teressa	1217	1165	52	1779	1617	162	17.5	15.9	1.6	12	18	50
Bompoka	53	50	3	51	51	0	3.8	3.8	0	4	4	0
Katchall	3702	2084	1618	5072	2491	2581	29.1	14.3	14.8	21	29	33.3
Camorta	2256	1269	987	2973	1406	1567	15.8	7.5	8.3	12	16	33.3
Nancowry	711	621	90	1014	907	107	15.2	13.6	1.6	11	15	36.4
Thinkat	378	377	1	350	350	0	9.6	9.6	0	10	9.6	0
Great Nicobar	4976	474	4502	6831	536	6295	6.5	0.5	6.0	5	7	40
Little Nicobar	298	298	0	308	295	13	1.9	1.9	0.1	2	2	0
Kondul	143	129	14	147	139	8	32	30.2	1.7	31	32	3.2
Pilo Milo	89	89	0	122	109	13	93.8	83.8	10	68	94	40.6
Car Nicobar Group	15486	13514	1972	19336	15781	3555	150	122	28	120	150	25
Nancowry group	9435	6680	2755	12464	8018	4446	21	13	7	16	21	31.3
Great Nicobar Group	5506	990	4516	7408	1079	6329	6	1	5	5	6	20
Nicobar islands	30427	21184	9243	39208	24878	14330	20.1	12.8	7.4	15.6	20.1	28.8

*Source: Government of India Census

About SACON

Salim Ali Centre for Ornithology and Natural History (SACON) is a society registered under the Society Registration Act, 1960. The objectives of SACON are : (1) to study India's biological diversity so as to promote its conservation and sustainable use; (2) to study the ecology of the Indian avifauna with special reference to its conservation; (3) to foster the development of managers; and (4) to function as a regional nodal agency for the dissemination of information on biodiversity and its conservation. The centre is an autonomous Centre of Excellence, aided by the Ministry of Environment and Forests, Government of India. The administration of SACON is vested in the Governing Council which includes the Secretary, and Financial Advisor to the Ministry of Environment and Forests, Government of India. SACON's research activities are moderated by a Research Advisory Council, constituted by renowned wildlife scientists, forest managers and policy makers.

The scientific staff is organized into Divisions of Avian Ecology, Conservation Biology, Ecotoxicology, Environmental Impact Assessment, Extension and Education, Library and Information, Modelling and Simulation, Terrestrial Ecology and Wetland Ecology. The research projects of each Division come under a few major themes or initiatives to which the Division is committed. SACON is presently located at Kalampalayam, nine kilometres northwest of Coimbatore City, but will shift to its own campus at Anaikatti shortly.

A review of an ongoing study of the Nicobar Megapode *Megapodius nicobariensis*

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Preface

The family Megapodiidae consists of 19 species in 6 genera, most of which are island forms occurring in Australia, New Guinea, eastern Indonesia, the Philippines, Niuafo'ou (Tonga), the Palau and Mariana islands and the Nicobar islands in India (Dekker, 1990). Throughout their distribution megapodes are threatened by habitat destruction, introduction of predators, and over exploitation of their eggs (Dekker, in press), and nine of these 19 species are threatened (Jones, 1989; Jones & Birks, 1992). The Nicobar Megapode *Megapodius nicobariensis*, a mound nesting megapode, is endemic to the Nicobar group of Islands in the Bay of Bengal, over 1500 km from its nearest congeneric. Two subspecies are recognized; *Megapodius nicobariensis nicobariensis* which is found in the Nancowry group of islands north of the Sombrero channel, and *M. n. abbotti* which is found on the Great Nicobar group of islands lying south of the Sombrero channel (Hume & Marshall 1878, Abdulali 1964, Ali & Ripley 1983). The Nicobar megapode *Megapodius nicobariensis* was considered to be seriously endangered (Jones, 1989; Jones & Birks, 1992), and has featured in several lists of endangered species (e.g. Collar & Andrews, 1988). The megapode is, therefore, protected under Schedule I of the Indian Wildlife Protection Act (1972) whereby hunting and trade is prohibited. The ethnic tribes of the Nicobar islands (Nicobari and Shompen) are exempt from the Act. In 1988, the extinction of the megapode from Kondul was reported, a population of less than 400 birds from Great Nicobar was estimated and the extinction of this species was predicted in the next 10 years (Anon., 1988). However, Dekker (1992) estimated the population of *M. n. abbotti* at about 780 breeding pairs (if not more) in the coastal area of Great Nicobar and concluded that it was not threatened there. The status of the species on other islands however, was still unknown.

Megapode mounds are amongst the largest structures made by any non-colonial animal, and represent the harnessing of the energy produced by microbial respiration (Seymour *et al.* 1986, Jones 1989), and/or solar radiation (Frith 1956) by concentrating suitable material to provide optimal incubation conditions at about 33-34° C (Dekker 1992). In some species microbial respiration and solar radiation may be used sequentially to create incubation conditions (Frith 1956). Birds incubate their eggs in a narrow temperature range, though short term drops in temperature are tolerated in naturally incubated eggs (in Booth 1987), but exposure of eggs to both high or low temperatures is fatal. Incubation temperatures in megapode mounds do show considerable fluctuation, and while such temperature fluctuations are largely offset by having a variable incubation period, (an increase in temperature decreases incubation periods (Booth 1987)), there are strategies to balance both heat loss and gain (Jones 1989, Jones & Birks 1992). While mound maintenance by megapodes is thought to play a role in maintaining incubation temperature, Seymour (1985) proposed that heat production and heat loss tends to stabilize mound temperatures at an equilibrium state due to the great thermal inertia of mounds once it crosses a certain size dimension, has

adequate moisture content and ^{receives} ~~with~~ the regular incorporation of fresh moist organic material in the mound. This model has gained further support from other studies (Jones 1989, Jones & Birks 1992). Thus, megapode mound incubation strategy can be broadly summarized as: (1) Heat is provided by microbial respiration and solar radiation. (2) Extreme fluctuations in mound temperatures is avoided either by mound maintenance or by mound homeothermy due to the great thermal inertia of mounds.

The Nicobar megapode builds mounds of sand, loam, coral bits and rotting vegetation within which eggs are laid. Mounds vary in height from 10 cm to 2.1 m and in basal circumference from 7 m to 45 m. Basically three types of mounds are built by the Nicobar megapode and have been described by Dekker (1992) as: Type 'A' mounds or true mounds, regular in shape and built on an open spot away from trees. Type 'B' mounds, irregular in shape, built against the buttress or stem of a large living tree. Type 'C' mounds, also irregular in shape but built against, around, under or over a dead rotting tree stump or log (Fig. 2).

The precise role of the various mound types in the megapodes breeding strategy, and why such differences exists is unclear. For instance in the Orange-footed bush turkey, Crome & Browne (1979) found that the type C mounds were not used for laying and considered these to be smaller subsidiary mounds whose function was not clear. However, in the Nicobar Megapode, Dekker (1992) found that the Type C and Type B mounds were used for laying eggs, and there were apparently no major differences in the function of the three mound types. If mounds built fulfil the same purpose, i.e. structures to incubate eggs within, then one possible reason for the differences in mound types may be in habitat differences at the mound location.

The existence of different types of mounds in the Nicobar Megapode (Dekker 1992, Sankaran 1995) is of considerable conservation and academic interest, as it raises the immediate question of why these three types are constructed. If sources of temperature and its regulation and stability vary with mound types and dimensions, then this would have a significant effect on the number of pairs that use a mound, the number of eggs laid, and hatching success.

From the data available (literature and preliminary field observations), it seems probable that mounds differ in their source of heat. In some, it is probable that microbial activity maintains incubation temperatures while in others it is solar energy. A third possibility is heat generated by root respiration (but as this is difficult to partition from microbial respiration, these are being clumped together). It is also likely that the heat source harnessed differs according to mound type and dimension. It is probable that mounds that fall below the size dimension where mound homeothermy (Seymour 1995) can take place, will have considerable decomposing material and microbial activity within them to create incubation conditions. Conversely, mounds of dimensions where mound homeothermy occurs, probably can rely more on solar heat to create incubation conditions. Because direct sunlight falls only for shorter durations on mounds, heat gained from solar radiation in smaller mounds would dissipate rapidly. Thus, smaller mounds would require a more constant heat source to keep temperatures raised, which is probably harnessed from microbial activity. In larger mounds, heat gained would dissipate much more slowly, and hence solar radiation alone may be an

adequate heat source. This, however, would be determined by the amount and duration over which sunlight falls on the mound.

There will probably be a correlation between mound type, dimension and heat source and with the degree of temperature fluctuation that the mound is subjected to. If such is the case, it is probable that the number of pairs that use a mound will be determined by how stable mound temperatures are.

Though Nicobar Megapode is monogamous, the mounds are shared by several pairs. However, pairs show agonistic behaviour to both other pairs and solitary birds. The mound and areas immediately around it as well as areas further away from mounds are fiercely contested, with as many as three or more pairs engaging in vicious fights. There is indication that pairs are territorial, though what form this territory takes is not known. This poses an anomaly. Sharing of resources does not normally result in fiercely contested territories, and this area of the behaviour of the megapodes requires closer scrutiny. It is possible that some form of hierarchial dominance, either spatial or temporal, exists, and that this hierarchy is related to the position of mound with respect to territories.

Objectives

In this paper, we give details of some of the major studies that we have undertaken, whose specific objectives are:

1. To document precisely the present distribution and status of the Nicobar megapode (*M. n. nicobariensis* and *M. n. abbotti*) and to identify threats to this species.

2. To describe the mounds built by the Nicobar Megapode, and examine the differences in location, and habitat of the three types of active mounds in order to understand whether these characteristics determine the construction of various mound types.

3. Our premise regarding the incubation conditions within mounds is that the sources of heat vary between mound types and dimensions, and that greater number of birds use those mounds where heat sources provide the most stable incubation conditions. We are testing this hypothesis by answering the following questions:

- a. Do heat sources that create incubation conditions vary between the different mound types and dimensions? Which sources of heat provide the most stable incubation conditions?
- b. Whether heat sources, mound types and dimensions have a bearing on the number of pairs that use a mound, the number of eggs laid, and the hatching success?

4. To understand the social organisation and more particularly the territorial system and hierarchy of the Nicobar Megapode, we address two questions:

- a) What relation does home range and/or territory of a pair have to the location of mounds and other resources?
- b) Do home range and territories vary between breeding and non-breeding

phases?

Methods

Status

As mounds are stationary, inanimate and represent breeding, the best way to estimate and monitor populations of megapodes is by assessing the number of active mounds (those in use). This study assessed the population of the Nicobar Megapode based on a mound census in a 100m strip of forest abutting the beach, as mounds are predominantly placed in a narrow strip of forest along the seashore (Dekker, 1992; this study). See Sankaran (1995) for a detailed account of the methods used.

Micro-habitat of mounds

The data on mound location and micro habitat presented in this paper was collected between 10 December 1992 and 5 April 1993, and 20 December 1993 and 31 March 1994 during a status survey of the Nicobar Megapode (see Sankaran, 1995).

The following parameters were measured for active mounds (see also Sankaran 1995): 1) Height and basal circumference of the mounds 2) the distance from the beach by either pacing it out or by visual estimation^{on} and 3) intra mound distances.

The vegetation cover around the mound was estimated using 3 broad classifications. a) Ground cover was all vegetation less than 1 m high. This was visually estimated within a radius of about 10 m and expressed in percentage. b) Density of saplings, young trees and large bushes/shrubs (<8 m high whose circumference were usually less than 30 cm) were estimated by the circular plot method (Mueller-Dumbois & Ellenberg 1974) with a radius of 5 m. c) The density of trees (>10 m high) at the mounds was estimated using the Point Centre Quadrat method (Mueller-Dumbois & Ellenberg 1974). The girth at breast height of these trees were also measured. d) Canopy cover over the mound was measured using a convex mirror that had been divided into 32 equal squares. The canopy cover was estimated by the number of squares that were covered more than half by the reflection of the canopy overhead. This was then expressed as percentages.

Incubation conditions

The basal circumference, height and diameter of mounds were measured once a month. The mound size, expressed as a volume, is derived from the equation for the volume of a cone:

$$1/3\pi r^2h$$

where r is the radius and h the height.

In 1996, we permanently implanted four temperature probes at depths between 20 cm and 75 cm, in 7 mounds that we had selected for intensive studies. However, after about two months these probes malfunctioned, probably due to high humidity and rainfall. In 1997, we used a temperature probe placed at

the tip of a 1 m long steel tube, which was inserted to depths of 30, 60 & 90 cm where temperatures were measured. In this method we measured the temperature of all mounds in our study area once a month, and for the target mounds once every 10 or 15 days.

We measured microbial activity, by measuring the soil respiration, assuming that in those mounds where microbial activity was high greater amounts of CO₂ would be emitted. Soil respiration was measured using a soil respirometer (PP Systems EGM-1 Environmental Gas Monitor with a SRC-1 Soil Respiration System. Soil respirometer which measures the CO₂ change in a fixed volume over a known time and fits a quadratic equation to the data to arrive at a value 'SR' which is the soil respiration rate in g CO₂/m²/hour. Soil respiration was measured for seven mounds that were under intensive study.

We have collected soil samples of the mounds, to assess the amount of organic content, which we believe will also indirectly tell us how much microbial activity takes place within the mound. This data is not presented here.

The intensity of light falling upon the mound was measured using a Lux metre, at different times of the day. We also indirectly determined the amount of light that falls upon the mound, by measuring the canopy cover above the mound. We have also measured Photosynthetically Active Radiation (PAR) falling on the mound, and being reflected from the mound. This data is not presented here.

All mounds in the study area were visited twice a day, and the activity at that mound was recorded, as a result of which we were able to identify quite precisely the number of eggs that were laid in mound. Whenever possible, a newly laid egg was located by digging into the mound, and marked. The egg was monitored by relocating it once every 15 days. Temperature at the egg chamber was measured once every 15 days, to determine optimal incubation temperatures.

Territory & Social organisation

The basic approach to this study is a map based one.

1. We have made a detailed map of the study area and plotted all mounds on the map. All sightings and calls heard of megapodes, as well as fights that take place are plotted on this map.

2. We have colour marked 23 birds, we represent 18 pairs and two solitary birds and are specifically plotting their locations on the maps, their mound use patterns, and the duration of their pair bonds..

Study Area

The Nicobar islands

The Andaman and Nicobar islands (latitudes 6° 45' and 13° 41' and longitudes 92° 12' and 93° 57') in the Bay of Bengal arch from Arakan Yoma in Myanmar in the north to Sumatra in Indonesia in the south (Saldanha, 1989; Dagar *et al.*, 1991). The islands cover an area of 8,249 sq km, with a total coastline of 1962 km; the Andaman group with more than 325 islands (21 inhabited) covering 6,408 sq km, and the Nicobar group with over 24 islands (13 inhabited) with an area of 1,841 sq. km (Singh, 1981; Saldanha, 1989).

The Nicobar islands can be subdivided into three distinct subgroups based on ornithological affinities (Sankaran 1997). To the south is the Great Nicobar group consisting of two islands over 100 sq km in area, 9 islets less than five sq km in size, and a few rocks. Four islands are inhabited. The human population on Great Nicobar (6831 people) has both tribal (8%) and mainland Indians including settlers. The tribals are thinly distributed along the southern, western and northern coasts. 55% of the mainlanders are in the township Campbell Bay midway up the east coast, and the remainder pursue agrarian livelihoods along the southeastern coast. Little Nicobar has no mainland settlers and the tribals are distributed all around the island. Kondul and Pilo Milo are inhabited islets. Meroe, Treis, Trax, Menchal, Megapode, Cabra and Pigeon are uninhabited islets.

58 km north of the Great Nicobar group is the Nancowry group (middle Nicobar islands), which consists of three islands larger than 100 sq km, two of 36 and 67 sq km, three less than 17 sq km, 2 small islets and a few rocks. Seven islands in the Nancowry group are inhabited with a population of 12,464 people comprised by both tribals (64%) and mainlanders. The tribals are distributed all around the islands. Mainlanders do not own land in the Nancowry group, and about 80% are either employed by various Government Agencies, Tribal co-operative societies or trade sectors. 20% of mainlanders in the Nancowry group are Sri Lankan repatriates who have been settled on Katchall and who work on the 600 hectare rubber plantation there. Tillanchong is the only uninhabited island of the group.

The northernmost subgroup comprises of Batti Malv and Car Nicobar is 88 km north of the Nancowry group. Batti Malv is uninhabited and Car Nicobar has a population of over 19000 people, 80% of whom are tribals. The mainlanders are mainly employed in government and trade sectors.

The habitat characteristics of the islands vary. In the Great Nicobar group, all islands are completely forested. A small proportion of the coast of the larger islands is mangrove. In the Nancowry group of islands, the central portion of all islands, excepting Katchall and Tillanchong, are grasslands (over 60% of Trinkat and Teressa, 30-50% of Camorta and at least 20% of Nancowry and Bompoka), often extending to the coast itself. Within the grasslands there are patches of forest. A substantial amount of the coastline of Camorta, Trinkat and Nancowry is mangrove. Thus habitat available for the megapode is considerably less in the Nancowry Group than in the Great Nicobar group.

Four islands in the Nicobar group have areas protected as wildlife preserves, and most islands are tribal reserves. Tillanchong, Batti Malv and Megapode Island, all uninhabited, are Wildlife Sanctuaries. Great Nicobar has two National Parks (536 km²) and is also a Biosphere Reserve (885 km²), whose core areas are the National Parks.

Intensive study area

Our study area, where we have been studying the ecology of the Nicobar Megapode since December 1995, lies at the southern tip of Great Nicobar Island (Fig*). Our study area lies on the coast, is about 4 km long, and is bisected by a disused metal road, which ends at the light house at Indira Point. The intensive study area, where the mounds are present is a narrow strip of forest between 40 m and 300 m wide, that is bounded by the beach to the east and to the west by either wetlands, or forests that are inundated. The soil

within this strip of forest is sandy and loamy, and the dominant trees are *Barringtonia asiatica*, *B. recemosa*, *Terminalia bilata*, *Terminalia catappa*, *Syzygium samarangense*, *Thespesia populnea*, *Macranda* spp. The study area has dense stands of *Pandanus tectorius* and *P. odoratissimus* in patches, and the road is fringed by stands of *Lea angulata* *L. grandifolia*, and *Draceana* spp. There are a few patches where the ground is open and with little vegetation. The soil of the forest type to the west of this coastal forest, is wet and clayey and covered with *Areca catechu* as well as trees like *Ixora barbata*, *Bongama pinnata*, *Alstonia kurzii*, *Adentania paranina*, *Aisandra butyracea*, *Horsfieldia irya*, *Myristica andamanica*, *Celtis timorensis* etc.

Results and Discussion

I. Status & Distribution of the Nicobar Megapode (excerpted from Sankaran 1995)

Distribution

The Nicobar megapode occurred on most Nicobar islands (Hume, 1874; St John, 1899; Kloss, 1903) but was not found on Car Nicobar (Butler, 1899) and Chaura (Abdulali, 1967). There were a few records from the Andaman group of islands (Hume, 1874; Butler, 1899; Sewell, 1922) and from the Coco islands further north (Kloss, 1903; Abdulali, 1964). None of the records from the Andaman group are of recent origin and the species is believed to be absent there. I found the Nicobar megapode to be present on all but one island (Pilo Milo, where it is probably extinct) in the Nicobars from where it had been reported. It may have existed on Car Nicobar (78 km north of Teressa, the nearest megapode population) a century ago (Kloss, 1903; this study) but I found no traces of mounds. Chaura is only 11.5 km from Teressa and considering the megapode's occurrence on more remote Tillanchong there is no reason why it should not have existed there. The signs of one old mound was seen on Chaura. However, both Car Nicobar and Chaura are much too densely populated for the species to exist there now.

Status & Conservation

The Nicobar megapode *Megapodius nicobariensis* was considered to be seriously endangered (Jones, 1989; Jones & Birks, 1992; Collar & Andrews, 1988). The megapode is, therefore, protected under Schedule I of the Indian Wildlife Protection Act (1972) whereby hunting and trade is prohibited. The ethnic tribes of the Nicobar islands (Nicobarese and Shompen) are exempt from the Act. Dekker (1992) estimated the population of *M. n. abbotti* at about 780 breeding pairs (if not more) in the coastal area of Great Nicobar and concluded that it was not threatened there. The status of the species on other islands however, was still unknown.

Megapodius nicobariensis abbotti

On Great Nicobar, *M. n. abbotti* was believed to have disappeared from all areas colonised by mainlanders (Dekker, 1992), but they continue to survive, and 4 active mounds were located over a distance of 11 km. In areas not colonised by mainlanders, active mounds were present in all forests abutting the shore as was the case with all of Little Nicobar which has no mainland settlers. Seven of nine islets in the Great Nicobar group had habitat suitable for megapodes and two (Cabra and Pigeon) were too small. Over 50% of the forests of uninhabited Meroe, Treis, Trak, Menchal and Megapode Island have

been converted to coconut plantation. About half of Pilo Milo is inhabited, and the islet is mostly under coconut palms. Megapodes are apparently extinct on this islet, though reports of calls heard indicate that it may still survive. The population of *M. n. abbotti* is between 3400 and 6000 birds (Table *).

Megapodius nicobariensis nicobariensis

M. n. nicobariensis occurs on seven islands of the Nancowry group. On Camorta, Katchall and Trinkat, *M. n. nicobariensis* was patchily distributed, with very few locations having active mounds and even fewer where mounds were abundant. Good populations of megapodes exist on Teressa and Bompoka and the density of active mounds was akin to that of Great and Little Nicobar (Table 2). Tillanchong is mainly hilly with very little level coastal forest, thus megapodes are naturally scarce except in the level forests. The small population that exists is apparently secure. Thus the estimated population of adult breeding birds of *M. n. nicobariensis* is estimated to be between 1200 and 2100 birds and the number of active mounds to be a little over 300.

Threats

The main threats to the Nicobar megapode can be classified into hunting of birds for meat and egg collection, predation and habitat loss.

Hunting and egg collection

Because megapodes have spiritual and medicinal values attached to them, there were, inter and intra island differences in hunting and egg collection pressures. Greatest hunting pressure was on the west coast of Little Nicobar and was rare or uncommon over much of the Nancowry group. Continued adherence to traditional values resulted in lesser levels of exploitation, which explained the existence of the megapode on Kondul. Where traditional values were eroded (as by the complete domination of Christianity), localised heavy to excessive hunting pressures may exist. Megapodes are also shot on Meroe and Treis thus seriously threatening already depleted populations. Megapode eggs are apparently not an important source of food. Thus, unlike other species where high egg collection pressures exist (Bishop, 1978; Todd, 1983; Stuebing & Zazuli, 1986; Dekker & Wattel, 1987; Jones, 1989), a low number of mounds had been excavated for eggs (Table 2). Localised, heavy hunting pressures on the megapode by Nicobarese is a recent phenomenon, because of the popularisation of airguns.

Mainlanders, particularly labourers on construction projects, trap megapodes. High hunting pressures by mainlanders existed on Great Nicobar while work on Project Yatrik (which opened up the island to colonisation) was under way. With the phasing out of the project, and the better implementation of Wildlife Protection laws, hunting pressures on megapodes have declined.

Very high hunting and egg collection pressures, albeit localised, was from Thai poachers who camp in isolated parts of Tillanchong, Great and Little Nicobar. About 5% of Great Nicobar's coast is affected in this manner.

Habitat loss

The primary threat to most species of megapodes is loss of habitat (e.g. Bishop, 1978; Dekker, 1990), and is true for the Nicobar megapode as well.

The Nicobarese subsist on coconut and have converted coastal forests abutting

their villages into coconut plantations and have clear felled forest to plant banana, papaya and tuber-bearing plants. As tribal populations are the highest in the Nancowry group, most damage has occurred there. An approximately 35 km long strip of forest along the southeastern coast has been depleted on Great Nicobar due to settlement of mainland Indians. Over 600 hectares of primary forests were replaced by rubber plantations on Katchall. Expanding townships and villages, roads, airstrips and infrastructure of defence establishments has all resulted in the loss of habitat. The single biggest threat to megapodes is the loss of habitat.

Conservation perspectives

The long-term perspective for the Nicobar megapode is bleak due to persisting loss of habitat. A growing tribal population and the resultant conversion of primary forest to coconut and other plantations continues to encroach into megapode habitat. The problem is most acute in the Nancowry group where suitable habitat, both for megapodes and humans is considerably less than in the Great Nicobar group. Control over habitat loss due to tribals is not possible in the Nicobars, even where areas have been declared as protected reserves, because the tribals are exempt from Forest and Wildlife laws. The population of the ethnic tribes inhabiting the Great Nicobar group is low, and an immediate threat of a significant alteration of primary forest is minimal. As further mainlander settlement has been stopped on Great Nicobar, the damage has been contained to forests already lost or degraded.

II. The Incubation mound of the Nicobar Megapode (excerpted from Sivakumar & Sankaran 1996)

Mound types

Of the 214 mounds located during this survey Type 'A' accounted for 50%, Type 'B' 23% and Type 'C' 27%. There were differences between islands and between subspecies in the proportion of the different types of mounds (Table 1).

A few mounds could not be categorically classified into the above three types. Some mounds are very like a Type 'A' but are large enough to extend into the buttress or stem of a nearby tree ($n=3$). Or are similar to type 'A' but have a dead log across them ($n=2$). Some type 'B' mounds also have a dead log or branch fallen across it giving it the appearance of a type 'C' mound ($n=5$).

Five mounds were unusual and could not be classified as any of the above. The first two were type 'C', in that they were built at the base of a rotting stump. However, the mound was not high, less than 15 cm, and the birds had apparently been digging into ground as if they were burrowing. The third and fourth could be likened to type 'A' mounds. What was unusual was that they had been built under copra making machans (platforms). While one was on the edge of the forest and a hillock began almost immediately behind it, the other was in a coconut plantation. The fifth mound was built within a cave that was open at both ends, towards the forest and the sea. The mound was built just inside the cave near the entrance towards the forest. This opening was partially screened by vegetation.

Location of Mounds

Mounds are usually made close to the shore but are also present some distance inland (Hume & Marshall, 1878; Baker, 1930). This preference for

nesting near the beach is common to at least one other species, *M. freycinet* (Stuebing & Zazuli, 1986). Of the 188 active mounds for which measurements were taken during this study, 52 % of mounds were located within 15 m of the beach, 77 % of mounds within 50 m of the beach and 97 % of the mounds within 100 m of the beach. No differences were seen between mound types and their locations with respect to distance from the beach (Fig 2). Mounds are built throughout the island in suitable habitat but in lesser densities than that in the coastal forest.

Height and Basal circumference of mounds

The heights of all three types of mounds varied (Table 1, Fig. 3). Both type 'A' and type 'B' mounds were significantly taller than type 'C' but were not significantly different between themselves (Table 1 & 2). The basal circumference of type 'A' mounds was significantly greater than both type 'B' and 'C' and type 'B' had a larger circumference than type 'C' (Table 1 & 2, Fig. 3). Thus type 'A' was larger than type 'B' which was larger than type 'C'. There was no correlation between increasing height and basal circumference of mounds.

Intra mound type differences in choice of micro habitat

We found that ground cover, density of small and big trees and canopy cover showed no differences between the three types of mounds indicating that the vegetation profile of a site did not determine the type of mound built. The only parameter which showed statistical differences was the girth at breast height of the four nearest trees. Type 'B' mounds had the largest girthed trees around the mound, type 'C' the next, while of the three type 'A' had the smallest girth class of trees around (Table 7 & 8).

III Mounds in our intensive study area

In January 1996, at the start of our study there were 18 mounds which were active (Fig. *). All the mounds except one were Type C mounds, and the exception was a type A. Between January and June 1996, 4 additional mounds were constructed, two of which were type 'B' mounds, one of which was merely a burrow in the ground at the base of a rotten tree stump, and the fourth was a type 'C' mound. Between December 1996 and June 1997, an additional 8 mounds were constructed (Fig *), 6 of which were type 'C', and two of which were built against the metal road. 2 mounds had been abandoned between June 1996 and December 1996. In September - October 1997 two more type 'C' mounds were constructed (Fig *). As of November 1997, our study area has 30 active mounds, and 2 mounds which were active at the commencement of this study have been abandoned.

While mounds are present through out the study area, some degree of clustering is discernible. Of the 32 mounds studied, 8 clusters are present, one of four, one of three and six of two mounds each respectively. Of the 14 new mounds built, 8 were built so as to add on to an existing cluster (n=2), or form a new cluster (n=6). There does not appear to be a relationship between the size of the mound, and the propensity for additional mounds to be built so as to form a cluster.

The size of mounds varied during the season. Of the 27 mounds for which size has been monitored, two mounds which were later abandoned and three active

mounds showed no size change, and three mounds have become smaller. 19 mounds have become larger by between 0.5 to nearly 25 times the original size.

IV. Incubation conditions and hatching success

Optimal incubation temperature

We monitored temperature of the egg chamber of 26 eggs in 12 mounds, and determined the incubation period for 23 eggs. Three eggs did not hatch. We found that the shortest incubation period was 72 days, which also had the largest number of eggs ($n=6$) from our sample (Fig *). The mean temperature at 72 days was 32.1°C , and we assume that the optimal incubation temperature in the Nicobar Megapode is 32°C . Though our sample size is small, the data is interpreted as indicating that as temperature either decreases or undergoes greater fluctuation, incubation period increases (Fig. *).

The effects of mound size on incubation temperature

We studied the effect of mound size on temperature in 27 mounds (Fig. *). The mound size of these 27 mounds varied from 0.006 m^3 to 24.27 m^3 with a mean mound size of 3.48 m^3 . We found that small mounds, below the average size are more likely to have a variable temperature, that range from 29.2°C to 34.4°C (mean = 31.44°C and $\text{SE}=1.6$, $n=19$), than larger mounds where the temperatures range from 31.9°C to 35.02°C (mean= 33.44°C , $\text{SE}=0.32$, $n=8$). We conclude that the smaller mounds are less likely to have optimal incubation temperatures than larger mounds.

The role of soil respiration and light intensity on incubation temperatures

The development and maintenance of incubation conditions within mounds is complex. As much of the finer analysis to arrive at discernible patterns is yet to be done, we do not present details here. Moreover, as in our study area virtually all the mounds are type 'C' mounds, the initial hypotheses that sources of heat vary between mound types could not be evaluated. Our data is based on 6 type 'C' mounds and one type 'A' mound.

Primary data analysis reveals that solar energy probably plays no role in creating incubation temperatures within mounds. This is evidenced by the fact that the surface temperature of mounds is usually 2°C less than the temperature within the core of the mound. We believe that the role of solar energy is restricted to warming the surface of the mound, whereby dissipation of heat is reduced. Solar energy does not directly increase mound core temperatures.

The relationship between microbial activity (evidenced by soil respiration) and incubation temperatures is complex. The increase in microbial activity within mounds and the consequent increase in mound temperature between 1996 and 1997 (Table *) indicates that microbial activity is the primary source of heat in mounds. However, our subsequent analysis showed no discernible pattern. The lack of an expected clear relation between microbial activity and mound temperature may indicate that while microbial activity is the source of heat, it may not play a role in either the optimisation or the stabilisation of mound core temperatures. Our data indicates that optimisation and stabilisation of mound temperatures is probably governed by mound sizes (Fig. *).

Mound size, egg laying and hatching success

Of the 32 mounds that have been active in the study area either in 1996 or

1997, eggs have been laid in at least 30, and we are not sure about two. 22 mounds were active and in all of which eggs had been laid in 1996. However, 5 of these were not used for egg laying in 1997, two of which were abandoned, and in three of which megapodes did come and work on the mounds, albeit rarely.

There appears to be a relation between the number of eggs laid in a mound and the mound size (Fig *). The smallest mounds (<1 m³) have the least number of eggs laid in them (mean=1.63, SE=0.56, n=16), though there are exceptions and two mounds in this sample had 6 and 8 eggs respectively. The large mounds (1-5 m³) have a greater number of eggs laid in them (mean=6.67, SE=1.35, n=6), while the largest mounds had the greatest number of eggs (mean=8.16, SE =1.74, n=6). However, we interpret the peaks and troughs in the graph (Fig *), as indicating that size alone is not the determining criteria, and quality of mound would need to be considered. The number of pairs which use a mound, and which appears to be somewhat independent of mound size is another determining factor.

Hatching success, was determined in 18 mounds, in most of which only one egg was monitored per mound. Our clumped data indicates that the highest hatching success is in the smallest mounds (Table *). However, we intend further verifying this before making any conclusions.

V. Mound use, territory & social organisation

Mound use

Most mounds are used by more than one pair of megapode. The mean number of pairs per mound was 2.28 (SE=0.3, n=29). 10 mounds had one pair each, and most of these were small in size. However, further to colour marking we realised, that there were several more pairs that used a mound. As most of the mounds do not have colour marked birds, it is likely that there would be more pairs using the mounds.

Nicobar Megapodes usually arrive at the mound at dawn and work up to noon and again after about 1500 hours. However, often the birds worked on the mound through the day. Typically, the bird(s) come to the mound and first check the pits in the mound, and subsequently select one pit for digging. Often the male of a pair worked one pit while the female worked another. Or the pair would just come to the mound scratch about a bit before leaving, or visit, climb onto the mound, check it and leave, as many as 6-8 times within a morning. Generally, the megapodes dug innumerable shallow pits (<30 cm), often covering them up instantly. However, if ready to lay an egg the megapodes would dig a deep pit which could be as deep as 110 cm. Usually such pits are dug by both partners together. Most of the deep pits and egg pits occupied the centre of the mound or where the organic material was high (Fig. *), shallow pits were positioned at the periphery of the mound. Shallow pits towards the centre, were more often than not converted into a deep pit.

On an average the megapode paid 4.78 visits to the mound before digging a deep pit, and in only one of every 2 deep pits dug was an egg laid. Both pairs and solitary birds visit and work on the mound. Both pairs and solitary birds lay eggs in the mound, though the latter is rare.

Territory

The following account on the territory of the Nicobar Megapode are generalisations based on detailed observation of 23 colour marked birds which represent 18 pairs, and two solitary birds.

The Nicobar Megapode is a strongly territorial species. During the breeding season, two forms of territory are evident. The kind of the territories that we have studied have within it a mound(s) which is used by the pair (Figs * to *). Two or more territories overlap at the mound, where the majority of the territorial disputes take place (Fig *). The size and quality of the territories vary between pairs. The position of the territory varies between egg laying and non egg laying periods. While in some cases, it seems that the territory merely shrinks to exclude the mound, in others it appears that the birds establish a new territory away from the mound. However, we have not been able to establish this empirically.

There appears to be a strong hierarchy between pairs that are using a mound at any given time, and this hierarchy varies temporally and spatially. The Alpha pair usually spends the most time around the mound, is more involved in mound defence, and is more likely to disrupt the Beta pairs while they are in the process of laying eggs. However, the Alpha pair maintains its position at the mound only as long as it is laying eggs, subsequent to which its hierarchial position is occupied by either a Beta pair which was already present at the mound, or by a new pair. A few Beta pairs shifted territories to occupy a different mound. Alpha pairs as a rule do not shift territories, but we have one instance when an Alpha pair of one mound laid an egg at another some distance away. After the end of the breeding season, the Alpha pair which occupied the mound during the optimal breeding period (February to April), re-occupied the mound. A few pairs occupied territories that had within them more than 1 mound, and some of these pairs laid eggs in more than 1 mound.

While more often than not, the pairs visit the mounds at discrete times, there have been instances when all the colour marked birds of a mound visiting and fighting at the mound.

Solitary birds of either sex do not defend territories, but usually attach themselves to a mound, working on it when pairs that use that mound are absent.

Defence of territory is through frequent duetting of the pairs, and physical fights and chases. The duet is usually started by the female and taken up by the male. Often 3-4 pairs will aggregate and call vociferously, and on one occasion we have seen 9 birds probably of 4 pairs and a solitary aggregate within an area of 5m radius and each calling aggressively. Solitary birds as a rule do not vocalise. Physical fights often break out between pairs, or between solitary birds and a pair. In both instances we strongly suspect that aggression is sex based, with fights and calls between pairs being directed to the opposite member of the same sex. However, there have been occasional instances when the fights have not been sex based. Defence of a territory requires equal participation of both sexes, and we suspect that Alpha pairs are those in which both the male and the female are dominant.

Pair Bond, Pair Formation, Copulation & Displays

We had thought that the Nicobar Megapode is strictly monogamous. However, of the 18 pairs that have been colour marked, only in 3 have both partners been colour marked. Two of these were trapped and ringed in 1996, and the third were two solitary birds which subsequently formed a pair.

The two pairs (L8 and P8) that were colour marked in 1996, had by the commencement of the 1997 season, separated from their original partners and had taken new partners. The female of L8 had paired with an unknown male, and laid two egg in the mound that it used in 1996, when along with the male L8 was the Alpha pair. The male of L8 had paired with an unknown female who was later ringed (GO8), and who laid two eggs while paired with male L8, during the same period that female L8 was using the mound. Male L8 and GO8 were the Alpha pair. Subsequently male L8 and female L8 rejoined and became the Alpha pair of the mound, and together laid two more eggs. GO8 combined with an unknown male and continued to use the mound, and became Alpha pair when the L8 pair had completed egg laying.

We have only one instance of a new pair being formed during our study. In this case, both the sexes were solitary at the time of trapping. The male built a new mound adjacent to an existing one where the solitary female had attached herself. We suspect, that to form a pair a solitary bird either has to attach itself to a mound, or construct a new one. The frequent fights between solitary birds and pairs, and the intra-sex defence that takes place during such encounters, may indicate that solitary birds attempt to steal mates from existing pairs. One of our solitary birds has now remained unpaired for nearly 2 years, though it briefly formed a pair for about a week. This male has a homerange that covers at least 3 main mounds.

Extra-pair copulation take place in the Nicobar Megapode. In one instance, the male of one pair repeatedly raped the female of another during a fight that lasted nearly three hours. The two other observations of copulations were when a male chased its partner and mated with her repeatedly, and the second when after a fight with another pair, the male returned after chasing the loser and mated with his partner.

We have not observed any displays between male and female megapodes from within the pair. On one occasion the male exposed food 2-3 times while working on the mound and the female came up and ate it. The maintenance and confirmation of the pair bond appears to lie solely in the duetting, the joint defence of territories and mounds, and in the digging of mounds. Some pairs constantly keep in touch by low contact calls, but other do not.

General

Predators

Monitor lizard *Varanus salvator*, the Nicobar Serpent Eagle *Spilornis minimus*, the Nicobar Hawkowl *Ninox affinis*, and the Nicobar Shikra *Accipiter butleri* are the natural predators of megapodes. While the monitor lizard apparently mainly preys on megapode eggs, the others prey on megapode chicks. Dogs and cats are present in our study area, and we have observed them chasing megapodes while they were working on the mound, but have no record of a kill having taken place.

The pattern of monitor lizards preying on megapode mounds is interesting (Fig *). In January and February, monitor lizard rarely visit mounds, and if they do so it is largely to lay eggs. Monitor lizard start increasingly visiting mounds as the megapode egg load of the mound increases (Fig *), when they have an uncanny knack of arriving at the mound soon after the megapodes have laid eggs.

Chicks

The Nicobar Megapode chicks crawl out of the mound at an average speed of 0.8cm per hour.

Of the 22 chicks that we observed at the mound, in five an opaque membrane was present over the eye which rendered the bird blind. Three of these we could cure, by immersing them in sea water, while the other two died. We suspect that the two dead chicks that we found near mounds were also those which had been hatched with the eye disorder. Considering how alert the chicks are, we suspect that those preyed upon by the raptors were also born with the eye disorder.

Mound	Size (cu.m)	Visits	N. Pits Shallow	N Pits Deep	N Eggs Laid
11a	0.1	15	1	3	0
11	3.9	25	1	6	2
7	4.7	11	1	5	1
6	7.1	19	0	7	3
2	10.8	18	0	6	4
9a	13.2	63	1	7	4
1	13.4	23	2	9	4
8	14.7	140	10	3	12
14	17.8	55	6	17	9
3	20.2	49	4	9	6
12a	27.1	43	7	18	8
9	28.5	96	4	24	9
12	29.1	66	1	8	4
4	49.9	40	1	7	4
13	52.6	96	3	13	8
10	88.6	112	3	16	10

Table 1.
Summary of census data of megapode mounds

	GN ¹	MI ¹	LN ¹	PM ¹	MR ¹	TR ¹	TA ¹	MN ¹	KN ¹	CM ²	TR ²	NN ²	KT ²	TS ²	I	T
No. of active mounds	66	1	49	0	1	4	3	1	3	8	2	14	14	33	7	8
No. Type A	20	1	23	0	1	3	1	1	0	7	2	9	11	18	6	4
No. Type B	25	0	14	0	0	0	0	0	1	1	0	2	1	3	0	2
No. Type C	21	0	12	0	0	1	2	0	2	0	0	3	2	12	1	2
No. Abandoned	50	3	78	4	14	14	13	0	5	44	16	15	29	113	82	1
Mean % Abandoned mounds	40	75	57	100	93	78	81	0	63	82	90	53	70	72	87	6
Mean mound density (km ²)	33	10	36	-	3	16	30	7	15	10	4	30	22	30	23	1
% mounds with signs of egg collection	7.5	0	2	-	0	0	0	0	0	0	0	0	0	0	0	0
% mounds with snares on them	12	0	18	-	0	0	0	0	0	0	0	8	0	0	81	3
% mounds with monitor lizard signs	18	0	18	-	0	0	0	0	0	25	0	8	0	3	82	1
No. active mounds (extrapolated)	515	2	311	0	1	4	3	2	11	20	8	60	69	119	62	1
Estimated Population	M. n. abbotti ->								M. n. nicobariensis->							
Upper limit	1802	7	1088	0	4	12	11	7	39	70	28	210	242	417	59	3

Lower limit 1030 4 622 2 8 6 4 22 40 16 120 138 238 52 20

GN=Great Nicobar; MI=Megapode Island; LN=Little Nicobar; PM=Pilo Milo; MR=Meroe; TR=Treis; TA=Trak;
 MN=Menchal; KN=Kondul;
 CM=Camorta; TR=Trinkat; NAN=Nancowry; KAT=Katchall; TS=Teressa; BP=Bompoka; TI=Tillanchong

¹ = *Megapodius nicobariensis abbotti*, ² = *M. n. nicobariensis*

Lower limit at 2 pairs per mound, upper limit at 3.5 pairs per mound.

Table 2. Population estimate of the Nicobar Megapode

	Estimated number of active mounds	Estimate of number of breeding pairs (range) [#]
<i>M. n. abbotti</i>	849	1,698-2,971
Great Nicobar	515	1030-1802
Little Nicobar	311	622-1088
Megapode Island	2	4-7
Pilo Milo	0	0
Meroe	1	2-4
Treis	4	8-12
Trak	3	6-11
Menchal	2	4-7
Kondul	11	22-39
<i>M. n. nicobariensis</i>	312	624-1092
Camorta	20	40-70
Trinkat	8	16-28
Nancowry	60	120-210

Katchall	69	138-242
Teressa	119	238-417
Bompoka	26	52-91
Tillanchong	10	20-35

* Lower limit at 2 pairs per mound, upper limit at 3.5 pairs per mound.

Table 3
Basic statistics for Type A, B & C mounds

Mound types	A		B		C	
	Ht.	Bc.	Ht.	Bc.	Ht.	Bc.
N	53.0	52.0	32.0	32.0	25.0	25.0
Minimum (m)	0.2	9.0	0.3	7.0	0.1	9.1
Maximum (m)	2.1	45.0	1.6	27.0	1.3	24.8
Mean	0.9	18.1	0.8	14.5	0.6	15.2
SD	0.45	6.76	0.33	4.16	0.32	4.01
SE	0.06	0.94	0.06	0.74	0.06	0.80

Ht. = height; Bc. = Basal circumference

Table 4
Do different types of mounds differ in Height and Basal Circumference? Mann-Whitney U test for differences.

Height

Mound types	A		B		C	
	U	P	U	P	U	P
B	823.5	0.937				
C	872.0	0.015	549.0			0.016

Basal circumference

Mound types	A		B		C	
	U	P	U	P	U	P
B	1191.0	0.001				
C	911.0	0.005	388.5			0.034

Mann Whitney U test, df = 1

Table 5

Basic statistics of the micro-habitat of A, B & C mounds

	Ground ¹ cover	woody sp ² <10m ht.	Trees ³ >10m ht.	Canopy ⁴ cover	Girth at ⁵ breast ht.
Mound type A					
N	22	20	11	22	42
Minimum	5.0	18	1.3	12.5	0.9
Maximum (m)	40.0	113	13.5	65.6	7.3
Mean	16.82	64.63	4.66	28.69	2.37
SD	11.91	25.67	3.30	14.16	1.42
SE	2.54	5.74	1.00	3.02	0.22
Mound type B					
N	21	17	11	21	45
Minimum (m)	5.0	29	2.2	6.0	1.0
Maximum (m)	50.0	197	14.1	53.1	12.6
Mean	20.0	68.63	6.28	27.38	3.98
SD	15.65	44.92	4.7	10.36	3.1
SE	3.42	10.89	1.42	2.26	0.46
Mound type C					
N	19	16	13	19	48
Minimum (m)	2.0	17	0.8	9.4	0.8
Maximum (m)	25.0	114	14.95	65.6	11.2
Mean	11.68	55.917	4.12	33.22	2.9
SD	7.49	27.9	3.5	17.87	2.15
SE	1.72	6.98	0.97	4.1	0.31

¹ Ground cover around the mounds expressed as percentages² Saplings, trees, palms etc. less than 10 m tall. Numbers recorded within a 5 m radius of the mound.³ Trees greater than 10 m tall. Density measured by the Point Centre Quadrat method with the mound as the centre point.⁴ Canopy cover expressed as % open.⁵ Girth at breast height of the four (>10m) trees measured by PCQ.

Figure 2. The history of 27 incubation mounds of the Nicobar Megapode

M#	1996					1997					Size								
	J	F	M	A	M	J	J	F	M	A	M	J	J	O	J	J	J	J	O
1	-----														0.4	0.4	0.6	0.3	0.3
1a																		0.8	0.03
1b																		1.3	0.4
2	-----														0.4	0.4	0.4	0.4	0.4
3	-----														4.1	2.8	1.4	3.2	4.8
4	-----														6.5	6.9	7.9	14.7	14.4
6	-----														0.8	0.7	0.8	1.8	1.9
6a															0.1	0.2	0.3	0.2	0.2
7	-----														0.1	0.1	0.1	0.5	0.5
7a	-----														0.1	0.8	0.8	0.8	0.8
8	-----														4.5	4.0	3.7	6.2	14.6
8a	-----														0.1	0.1	0.1	0.1	0.1
10	-----														25.6	28.1	25.6	24.1	23.3
10a																0.2	0.2	4.4	0.5
11	-----														0.2	0.2	0.2	0.3	0.3
11a	-----														0.1	0.1	0.1	0.1	0.1
12	-----														0.8	0.8	0.9	4.3	4.1
12a	-----														0.9	1.5	1.6	5.7	5.7
12b																	2.3	7.1	6.9
13	-----														11.1	12.8	13.3	13.1	13.1
13a																	1.8	1.8	
13b																	0.4	0.5	
14	-----														6.5	5.9	8.8	4.2	9.9
9	-----														5.2	5.6	2.1	7.3	4.7
9a	-----														0.2	0.2	0.2	2.2	2.5
9b															0.1	0.1	0.1	0.1	
9c															0.1	2.2	2.5		

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(LS)

The Status and Conservation
of the Nicobar Scrubfowl
Megapodius nicobariensis

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October 1993

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Little, South, Middle and North Andamans and some of the smaller islands nearer to the main ones. The result was an alarmingly low number of 43 individuals sighted at seven localities. However, a few localities could not be visited while I missed them in a few areas though sighted recently by reliable people and, a few promising sites were dry and hence they might have moved away. On the whole, their population will be only about 200.

Since their habitats are freshwater streams, ponds or reservoirs and brackishwater swamps, tidal creeks or estuaries, human disturbance is the maximum because of the various activities such as irrigation fishing, other uses by man and cattle. Habitat loss due to reclamation for agriculture and plantations, and hunting are the probable major reasons for its decline.

Very few of its habitats are within the protected areas. Protection measures have to be enforced more effectively providing proper facilities to the protection staff and by inculcating awareness among the local community so that they should take charge of the protection as their privilege and responsibility. Proper incentives may also be given to them for undertaking such responsibilities and developing employment generating schemes with locally available resources.

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DISTRIBUTION, STATUS AND CONSERVATION OF THE NICOBAR MEGAPODE

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The Nicobar megapode, a mound nesting megapode, occurs as two subspecies *Megapodius nicobariensis nicobariensis* and *M. n. abbotti*, both endemic to the Nicobar Islands. Thought to be endangered, this survey found it on almost all Nicobar islands where it historically occurred and concluded that, as a species, was currently not threatened. It has probably become extinct only on inhabited Pilo Milo island. While *M. n. abbotti* is secure other than on small out-lying islets. *M. n. nicobariensis* is threatened on all but 3 islands of its range. Loss of population in *M. n. nicobariensis* was indicated both by significantly lower mound densities and by a higher proportion of abandoned mounds to active mounds, when compared with *M. n. abbotti*. Data was collected for 127 active mounds of *M. n. abbotti* and 85 active mounds of *M. n. nicobariensis*, and it was estimated that 848 and 312 active mounds respectively are present, and the population of the species is between 4500 and 8000 adult birds.

Though hunting and collection of eggs existed, the main threat to megapodes is loss of habitat which was mainly due to conversion of coastal forest, the megapode's primary nesting habitat, to coconut plantations. Expanding urbanization and construction of coastal roads are other serious problems. The single largest threat is a proposal to make Great Nicobar a free trade port which, if implemented, will destroy the Andaman and Nicobar islands.

CONSERVATION OF THE NARCONDAM HORNBILL

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The Narcondam Hornbill *Rhyticeros (Aceros) narcondami* is endemic to the 6.5 sq.km Narcondam Island, situated among the Andaman group of islands in Bay of Bengal, about 350 km from the Burmese mainland and about 150 km from North Andaman. The island has a volcanic origin and has a largely mountainous terrain with dense evergreen forest on the upper slopes and hill tops and moist deciduous forest on the lower slopes. The littoral vegetation is seen on its limited shores. The island emerges abruptly from the sea and there is little flat area on it. The shore is very narrow and full of boulders.

The Hornbills were discovered by Hume in 1876. The first estimate of its population was done by Osmaston in 1905 when he estimated about 200 birds. Hussain (1972) estimated a population of about 400 birds. A population of 350-400 birds was estimated during the present survey conducted during March 1993. The population has remained fairly stable over the years.

Conservation problems

Present status of the species appears to be rather safe. However, there are a few problems:

Presence of Man on the Island: There is a police outpost maintained by the Andaman and Nicobar administration since 1968. The outpost is manned by 20 personnel from the Andaman and Nicobar special force. The police force has cleared an area of about 500 sqm. where they have made the barracks and have raised a small plantation of Banana and Coconut. They grow some vegetables for their own use. The police also keeps about 90 goats, mainly for meat and milk. The police personnels are no threat to the birds as they do not kill or harm the Hornbills. They do cut some trees for fuel but this does not seem to harm the forest much. Increase in their number could have an adverse impact on the forest.

Presence of Goats on the island: There are about 250 goats on the island of which about 90 are reared by the policemen. The rest are feral and they roam freely. These goats were released on the island during 1968 for the benefit of the survivors of any ship disaster. The goats are known to be notorious for degrading the habitat by overgrazing but at the moment there are no signs of overgrazing or effect on the regeneration of natural vegetation. The goats are known to multiply very fast but their numbers are kept down by the policemen who regularly shoot the feral ones for eating. Fortunately since 1968 no spurt in their population has been noticed. The

susceptible to human induced ecological changes, introduction of exotics etc. systematic surveys and monitoring are required to study the ecological impact of these factors on the level of endemism of avifauna in these islands.

Designing of reserves for conservation of bird species diversity: In Andaman and Nicobar Islands, 102 sites have been identified as reserves (94 Sanctuaries and 8 National Parks). This form about 19.5% of total forested area. They mainly comprise islets except the Galathia and Campbell Bay National Parks. It is not known, as to whether these reserves encompass the full range of biodiversity of these islands. Predictions from the theory of Island Biogeography can be helpful in designing network of reserves. Detailed field surveys are required to study the relationship between island's size, their distances and the avifaunal population they support. This would help us in networking of these reserves based on scientific consideration of conservation of species diversity.

Preparation of conservation management plan for avifauna of Andaman and Nicobar Islands: As increasing pressure on the fragile island ecosystem poses a major threat to the fauna, a conservational management plan for these islands becomes a necessity. Proper management of a Wildlife reserve requires an adequate data base, which can be obtained only by appropriate scientific research. The wildlife wing of Andaman and Nicobar Islands is not yet fully strengthened to carry out field research. We shall like some of the scientific organisations from mainland to come forward in helping us formulate those plans to draw conservational strategies for the rich biodiversity of the island ecosystem.

AVIFAUNA OF THE ANDAMAN & NICOBAR ISLANDS

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Geographically isolated island groups are of particular importance in the conservation planning of a country because of the large number of endemic species found there. The Andaman & Nicobar islands are no exception. Of the 270 species and subspecies recorded from the Andaman & Nicobar Islands, 105 (38.2%) are endemics, but is due to the high number of endemic subspecies. Of the 105 species and subspecies recorded as endemic, only 14 full species (with 17 subspecies) are endemic to the islands. Of the endemics, 82 (or 78.1%) are subspecies of species found on neighbouring mainlands. Of the 14 full species endemic to the Andaman & Nicobar islands, 5 are exclusive to the Nicobar islands, 6 to the Andaman islands and 3 are common to both.

The Andaman & Nicobar islands are a high priority area for the conservation of Avifauna. Though the Andaman group has a greater number exclusive endemics than the Nicobar islands, if we take area into consideration, then we find that the ratio of exclusive endemic species or subspecies per sq km is higher in the Nicobars than in the Andamans (Nicobars 0.021 spp. per sq km, Andamans = 0.008 spp. per sq km). Similarly, if we consider the ratio of endemic per number of islands then too Nicobar has a greater degree of endemism (Nicobars 1.63 spp. per island, Andamans 0.16 spp. per island). Thus in the implementation of conservation programmes within the island group, particular attention must be given to the Nicobar group of islands.

Having been colonised by non-ethnic people for over a century, several species of avifauna have been introduced in the Andaman & Nicobar islands. The Andaman group has had a greater number of introductions than the Nicobar group. Two species introduced from the mainland, the Common Myna and the House Sparrow have become common today in many islands. The Nicobars have fortunately not had many introductions from mainland India, with only the Blue Rock Pigeon having been introduced into Car Nicobar, and domestic strains now being present on Great Nicobar as well. The Nicobars have had introductions from the Andaman group. The two introductions, the Andaman Red-whiskered Bulbul, an endemic form has now become very common in the Nancowry group, and the Andaman Whiteheaded Myna, another endemic, was supposed to be common on Camorta but this species was not seen there.

Only four species, the Andaman teal *Anas gibberifrons albobularis*, the Andaman Grey-rumped Swiftlet *Collocalia fuciphaga inexpectata*, the North Nicobar scrubfowl and the Nicobar Bulbul *Hypsipetes nicobariensis* the latter a full species endemic and the former three subspecies endemics are threatened. While the Andaman Grey-rumped Swiftlet occurs throughout the Andaman & Nicobar islands, the Nicobar Bulbul is endemic to Nancowry, Camorta, Katchall and Trinkat islands of the Nancowry group, and the Andaman teal is present only in the Andaman group.

The introduction of the Andaman Red Whiskered Bulbul in the Nancowry group of islands has probably resulted in the rarity of the Nicobar Bulbul possibly because of competition for the same ecological niche with the Andaman Red-whiskered Bulbul. The Andaman Grey-rumped Swiftlet has become rare in the Andaman and Nicobars primarily due to over-exploitation of the nests. The Andaman Teal has become rare due to habitat loss and hunting. As surface fresh water is scarce in the islands, human pressures on available water is high, with the resultant reclamation or disturbances. As a species, the Nicobar scrubfowl is not threatened. However, of the two subspecies present in the Nicobar group of Islands, *M. n. nicobariensis* has become rare primarily due to the conversion of its habitat to coconut plantations. The Narcondam Hornbill *Aceros narcondami*, was also found to be common on Narcondam Island (V. Prakash pers. comm.), but is a species whose numbers need to be monitored because it is endemic to one island of less than 7 sq km.

As yet, the endemic avifauna of the Andaman & Nicobar islands are not under immediate threat. However, if conservation is not implemented now, the future will be bleak. Most of the endemic avifauna of the islands are forest dwelling species and some endemics are restricted to very small islands. As the limits on the resource base are acute due to strict geographical limits any change of vegetation cover will prove detrimental to the endemics.

There are three primary conservation problems in the island group. The first is by the settlements of mainlanders who have cleared forest to farm. The second is through the development of infrastructure such as roads for the mainlanders who have settled in the islands. These often pass through pristine habitats and are detrimental to the survival of species like the megapode. The third is the forestry operations that are currently underway in the islands, as a result of which, the vegetation profiles have been altered. But the biggest threat is the possible declaration of Andaman & Nicobar islands as a free port, and the building of a dry dock on Great Nicobar. If these projects are implemented then most endemic species of the Andaman & Nicobar islands are likely to be threatened with extinction.

Clear Felling of Primary Forest at the Light House at Indira Point, Great Nicobar Island - Ameliorative Measures

Introduction

A light house exists at the southern most tip of India, Indira Point. The light house is situated in about 8 - 10 ha of primary rain forest, of which about 2 - 3 ha, had been cleared to erect the light house and quarters for the personnel who maintain the light house. The existing forest within the light house land is contiguous with primary forest that extends into the Galathea National Park. More importantly, the forest within the light house land is contiguous with the most important breeding ground in the Nicobar islands of the endemic and vulnerable Nicobar Megapode *Megapodius nicobariensis*, and other important endemic species such as the Great Nicobar Crested Serpent Eagle *Spilornis minimus* and the Blyth's Nicobar Parakeet *Psitacula abbotti*. The beach adjacent to the light house is also an important nesting ground for Green Sea turtles and Hawksbill Turtles. Thus, the land in which the light house is situated is part of the most important and richest wildlife habitats on Great Nicobar.

The Problem

The Department of Light Houses and Light Ships have proposed to upgrade the existing light house at Indira Point to include a Radio Beacon. The Project involves the erection of a tower for the Radio Beacon, a power house to generate electricity, and 8 quarters for the staff who will man the upgraded facility. Required environmental clearances have been obtained from the Ministry of Environment and Forest, Government of India, which has stipulated that any construction must be done 200 m from the high tide mark. Construction has commenced, and the tower for the radio beacon has been erected and a power house for electricity generation has been constructed adjacent to the existing light house, within 200 m of the high tide mark.

Only the quarters for the light personnel are to be constructed in compliance with the MoEF directive, and about 2 acres of primary forest has been clear felled for the same 200 m from the high tide mark. Moreover, it is proposed that the remaining primary forest between the proposed quarters and the Light house and power house will also be clear felled.

Thus the very purpose of the CRZA and CZMP, based on which the MoEF had issued directives is defeated as the entire forest within the light house land is to be clear felled, adversely affecting existing populations of endemic and endangered species, most of which are in Schedule I of the Wildlife Protection Act.

The Solution

The serious adverse effect that the existing project has can be ameliorated by the following.

1. A one time exemption of the CRZA be made so that the quarters of the Light House personnel are constructed adjacent to the Light House, where clear land devoid

of forest cover is already present. This would result in forests to the interior being preserved, and damage to important habitats is minimised.

2. If the above is not possible, then the construction of quarters be done in the patch earmarked patch that has already been clear felled 200 m, on the condition that no further felling of trees and clearing of vegetation is permitted.