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Report on Land Use
in the
ANDAMAN AND NICOBAR ISLANDS

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Introduction

This report is required to evaluate the impact of deforestation on the general environment of the Andaman and Nicobar Islands and to formulate guidelines for land use and conservation there. In broad outline these are the terms of reference that were presented in greater detail to the Multidisciplinary Team of 1975 (ref.1). This team consisted of senior government officers in the fields of botany, soil science, agriculture, soil conservation, climatology and hydrology with representatives of the Administration, Planning Commission and Department of Rehabilitation.

The present study has been less concerned with economic and administrative aspects and has concentrated upon the overall ecological situation in the islands. It extended over a period of six weeks from 5th February 1976 and involved four weeks' field work based on Port Blair, with coverage of the relevant literature and consultation with various specialists and other officers at IUCN headquarters in Switzerland, at New Delhi and Port Blair. The itinerary followed in the course of the field work is given in Appendix I.

In the Andaman group coverage of the main habitat types and the varieties of human activity was felt to be sufficient to enable most comment to be made at first hand but in the Nicobar Islands this was not so and more reliance had to be placed upon the available literature and upon hearsay evidence.

This report will not repeat the geographical statistics and summarised account of environmental factors that can be found in all recent reports and in various gazeteers (refs 1-5, 10-12).

Summary

1. The Andaman and Nicobar Islands are essentially forest terrain (U.S.D.A. land capability classes VI-VIII: production and protection forest) and unsuitable for large scale agricultural settlement or agriculture-based enterprises. The economy must be based on forestry and forest products if severe damage to the island environment is to be avoided. Subsidiary agricultural and fishery development is also indicated.
2. Further immigration for land settlement is inadvisable and limits will have to be set to further allocation for second generation settlers or other residents. In order to enable the necessary reappraisal and reorganisation to be undertaken a land resource and capability survey based on high quality aerial photography should be carried out.

3. Little Andaman and Katchal Island have a more favourable environment for settlement and agricultural development than the other islands because of their gentler topography and less intense dry season. The Nicobar Islands as a whole appear to be less liable to accelerated erosion and less likely to suffer from the drying up of surface water supplies, although great caution will have to be exercised here also.
4. The damage that has been done so far is most marked around Port Blair, Bakultala and Rangat, in the Betapur Valley and on the islands of Baratang and Neil. It consists of wasted forest resources, soil loss and reduced availability of surface water. Great forest wastage has also occurred on Little Andaman and Katchal. However, the situation is not yet out of control although vigorous action will be required if this is to be avoided.
5. There is considerable scope here for nature conservation based on the unique asset of virgin tropical forest adjoining the abundant marine life of fringing coral reefs in unpolluted seas. Although the larger species of indigenous animals are few, the islands are rich in birdlife and the smaller invertebrate forms which have not yet been studied adequately. Several species of birds and other animals are in need of special protection. The plant life of the forests is particularly rich, and study is only now revealing how rich, in endemic species, some of which may have great economic potential in plant breeding and the drug industry. Control of further plant and animal introductions, and of the movement between islands of those already introduced, is urgently needed.
6. Semi-detailed recommendations are also made for some changes in emphasis in forestry, active extension work in agriculture and soil conservation and for the establishment of a network of marine and terrestrial habitat reserves.

ENVIRONMENTAL IMPACT ASSESSMENT

1. Effect of deforestation on regional and local climate

1.1. It is still not entirely clear to what extent, if at all, the regional climates of the world, particularly those of the continents, may be affected by the presence or absence of forest cover. Current opinion seems to be that any effect is minimal. Where sub-oceanic islands, such as the Andaman and Nicobar groups are concerned, it is quite certain that the overall climate depends entirely upon the movement of large air masses over the oceans and would be exactly the same whatever the vegetation cover of the islands. That is to say that temperatures, humidities

rainfall and other parameters measured at standard climatological stations would be the same.

1.2. Local climates, such as are experienced in enclosed valleys, on slopes of different aspect on the one mountain and so on, can be affected to a slight extent by the presence or absence of surrounding forest. Most important, perhaps, rainfall as measured by a properly sited instrument will remain the same. The valley fogs experienced in early morning in many of the larger islands of the Andaman and Nicobar groups during the dry season might possibly be affected by complete removal of the forest and this will be considered further below (1.3.).

1.3. The climate of the air layer next to ground level, or of the air enclosed by a forest canopy (micro-climate) is the most important of all when considering the influence of deforestation. Removal of tree cover leads to increased air movement, wider temperature fluctuations, lower humidities and increased insolation and has profound effects upon soil composition, rainfall absorption and all plant and animal life. The amount of water available for absorption by plants during the dry season can also be reduced by the absence of fog drip from the tree canopy during periods of valley fog described above (1.2.).

1.4. This report endorses the opinion of the Multidisciplinary Team of 1975 (ref.1) that the number of climate recording stations in the islands is inadequate. In particular, the number of automatic rainfall recorders (pluviometers) should be increased as data on rainfall intensity is of vital importance in counter-erosion work and runoff control. On the other hand, there would seem to be little need for the sophisticated research on forest/climate/hydrology interactions that also has been suggested. Money and manpower would be better employed in applying principles of good land use already well established (3.3.).

2. Accelerated soil erosion

2.1. Under the undisturbed vegetation cover of the islands the rate of natural erosion is slow but perceptible. Evidence of soil movement from the steeper slopes into the valleys and out to sea is given by the existence of some deep alluvial soils and the coastal fringe of mangrove swamp. Erosion, deposition and colonisation by vegetation are in balance, however, so that little bare soil can be observed except where rock falls and landslips have taken place from mountains and sea cliffs.

2.2. Accelerated erosion began with deforestation around Port Blair over one hundred years ago and has gradually been extending and intensifying up to the present day. Compared to the catastrophic erosion that can be seen in other parts of the world with comparable soils and climate that of the Andaman and Nicobar

Islands could be regarded as trivial. Nevertheless, there are warning signs that soil loss is quickly increasing in the present phase of land development. Drying up of soil moisture and loss of soil structure and fertility are the first indications of impending erosion. Then come sheet wash of soil during heavy rain, rilling of slopes and finally the appearance of raw gashes and gullies, with deposition of some of the soil on top of the crops or vegetation below. At present the last stage has been reached only in a few places associated with roadworks or the "slash and burn" ground preparation for certain plantations and crops.

2.3. So far most erosion appears to be intermittent in the sense that periods of soil exposure are followed by periods of revegetation so that the gullies are disguised, e.g. by grass growth, until the next exceptionally heavy storm opens them up again. Visitors to the Port Blair area during the dry season could thus fail to observe the extent to which soil is being lost from the grassy slopes around the town which appear to be well covered and stable.

2.4. Probably the most serious erosion observed is the loss of the island's most fertile soils along the larger streams such as the Badam Nala and its tributaries in the Betapur valley. The original vegetation of the valley bottoms formed a natural water spreading system in time of flood. Since this has been destroyed in the course of settlement meanders are becoming accentuated and incised so that paddy and garden crops are slumping into the stream beds which are gradually increasing in width - in some places probably two or three times in five to ten years of settlement. This has happened although the greater part of the river catchment is still under dense forest; the effect of further clearance could be disastrous. It cannot be too strongly emphasised that once these processes have begun they are extremely difficult to arrest and that preventive/remedial action should be taken without further delay.

2.5. In some cases it is difficult to assess the extent of soil loss taking place without making an examination during the wet season. This is true, for example, in paddy land where bund repair and soil cultivation completely obliterate the evidence from one year to the next. Where attempts have been made at terracing of paddy land (e.g. near Wymberley Gunj) damage in the form of rilling and gullying is more evident. Soil loss from plantations, garden slopes and wasteland can also be readily seen. Deforestation by itself does not lead to accelerated erosion in the islands, although some gullying along extraction tracks was noted on short steep slopes on Smith Island. Preparation of the ground for teak, padauk (*Pterocarpus dalbergioides*) and softwood plantations does cause considerable soil loss although this may be only a temporary phase. Grassland and wastelands, once formed, can be relatively stable and show little soil loss if unburned and lightly grazed. Around Port Blair and elsewhere they are heavily grazed throughout the dry season and sometimes burned as well so that the first storms of the wet season fall on exposed soil. Grass fires around Port Blair are said not to be a problem, but in the particularly dry season of 1976 many accidental fires were noted, some of which had burned a little way into surrounding secondary jungle. The grass

lands of Kamorta, Nancowry and Katchal could not be examined. They have almost certainly been formed from an original forest cover at some time in the past.

2.6. A little natural coastal erosion occurs especially during the hurricane season. Wind shaping and stunting of the coastal trees does not occur on the east but is said to be a common feature of the west coast of the islands. Beach forest may be undercut by the waves so that trees fall on to the foreshore. Some sand blows inland. Tidal scour of mangrove mud takes place on the concave side of meandering creeks while mud builds up and is fixed by mangrove colonisation on the opposite bank. It has been part of forestry and settlement policy to leave a "green belt" between the shore and any timber coupe, road, village or cultivated land. This has not always been followed in recent development. The belt itself is often too narrow and subject to continued attrition by tree cutting and unrestricted grazing by village livestock. Increased sand movement, undercutting and deterioration of beach and mangrove vegetation and exposure of the settlements inland to the sea wind are all being allowed to take place. A related acceleration of tidal removal and deposition of beach sand was also observed at the Hut Bay jetty on Little Andaman where it has proved something of an embarrassment.

3. Water supplies, perennial and seasonal

3.1. Although a recent geological survey has been carried out, and maps are said to be available, little hydrological study has been done except in the neighbourhood of Port Blair. Some of the more porous sandstones and greywackes act as aquifers but the numerous shale and mudstone bands reduce their effectiveness. On the whole, the quantity of surface water available during the dry season is what one would expect to find in land areas of this size with moderately broken topography and a complete forest cover. Were this forest cover to be removed the actual water yield in terms of runoff to the sea would probably be increased but the water available for human use would be significantly reduced for one third of the year and catastrophic annual drought might become commonplace.

3.2. Soil surfaces were examined in virgin and logged forest, plantations, garden ground, grassland and paddy fields for evidence of permeability and surface flow. In most forest stands there are signs of abundant earthworm activity during the wet season, the casts, which are up to cricket ball size, producing a cloddy surface incorporating leaf and twig litter. This surface, together with worm and root channels, promotes good rain penetration and there is no sign of surface water flow. In young forest plantations, where there has been a period of disturbance and exposure to sunlight as well as slash burning, signs of earthworm activity are few.

In agricultural plantations, most heavily grazed grassland, garden ground and paddy fields earthworms appear to be absent although in the grassland and paddy the casts could simply have been broken down. Working of the cleared ground for crops also destroys tree root channels and other forms of soil structure to leave a more compact and less porous medium. In all vegetation types except virgin and regenerated forest there are manifest signs of surface wash. Earthworms also appear to be scarce in the untouched forest with heavy clay soil liable to waterlogging or with very porous sandy or stony ground. Some of the forest soils lacking abundant earthworms possess a natural stone mulch of pebbles or broken rock on the surface which can be almost as useful as wormcasts in promoting infiltration. This layer often covers a considerable depth of less stony soil and when it is disturbed during forest clearance the soil is immediately rendered more vulnerable to erosion.

3.3. Conversion of forest to plantations and crops or wasteland therefore leads to an immediate reduction in rain percolation and increased runoff. This in turn results in "flashier" stream flow, the drying up of springs and wells and general scarcity of water in the dry season. This would not be of such vital importance in a well watered terrain, but in the Andaman and Nicobar Islands it could mark the difference between "habitable" and "inhabitable". While water consumption by the vegetation which replaces the forest may be somewhat less than that of the original forest this is counterbalanced by the above effects so that less and not more water is available for human use. Only in the event of forest replacement by a strong grass turf in certain dry climates can it be demonstrated that percolation is not impaired and that more water is available in springs and streams. Research on the quantitative relationships of forest and water supply is difficult and time consuming and should be left to regions with resources sufficient to carry it through successfully. The role of the forest in regulating water supplies is important throughout stream catchments but particularly so towards the headwaters and especially in hilly terrain (7.1.).

3.4. In view of the inherent lack of natural sub-surface water storage in these islands one immediately thinks of the possibility of surface storage for both urban and industrial use and for irrigation. The Dhanikari reservoir has shown what can be achieved with a catchment of virgin forest and a good dam site. The irrigation scheme at Panchwatti in Middle Andaman has been less well endowed, for the best dam site on this small river is downstream from the cultivable land to be commanded by the rather shallow reservoir now planned. There is certainly scope for further schemes of this kind but the rarity of good dam sites with large catchments able to command substantial areas of flat land means that these will have to be small and inexpensively constructed. Small schemes could be quite acceptable in view of the shortness of the dry season but great care will have to be exercised in making provision

for the safe disposal of flood waters over the rest of the year. Water supplies for all purposes could readily be augmented by storage from quite small catchments such as the roofs of buildings and soil surfaces rendered less erodible by bitumen spraying or other waterproofing.

3.5. Stream gauging is already undertaken by the Central Water and Power Commission since 1968 on some of the larger nalas or in connection with specific schemes such as that at Panchwatti. This is commendable but any extension of the hydrological network, e.g. to the Nicobar Islands, cannot be advocated unless at the same time action is taken to correct deterioration of the stream beds (2.2.). It is also more important to correct the faulty land use practices leading to this situation than it is to collect data, although both activities should go together.

4. Forestry

4.1. Exploitation of the Andaman forests began in 1883 and was confined to selective felling of a few species of trees in accessible places until 1921. Clear felling was then also begun and attention was later paid to regeneration of the extracted areas from 1935. Selective felling gradually ceased as this method of working became uneconomic. In the technique of forest regeneration the proportion of desired species may be increased by "enrichment" planting or seed sowing. Unlike many virgin rain forests elsewhere those of the Andamans respond readily to this treatment provided it is carried out within a year or two of felling. It has become the standard system of sustained yield forestry here. Establishment of the tree seedlings on the forest floor appears to be satisfactory because surface litter and humus accumulation is lacking and earthworms activity provides a good seed bed. A backlog of clear-felled but unregenerated forest has built up over the years. This is more difficult and expensive to treat in order to obtain a stand of the desired species but some progress is being made.

4.2. Forest which has been logged but not regenerated within two years becomes a vine and creeper thicket resembling the natural hurricane-devastated areas of many tropical forests. In view of the occurrence of occasional hurricanes in the Andamans some representation of this forest type might be expected but it is apparently not present. A hurricane in 1844, which wrecked the English barques "Briton" and "Runnymede" on one of the islands of the Ritchies Archipelago (ref 9) is reported to have completely flattened the surrounding forest and probably devastated the entire Andaman group, does not appear to have left its mark on forest structure even eighty years later. It must therefore be supposed that secondary, hurricane-induced jungle recovers to high forest within this period and that clear-felled forest might do the same.

4.3. The area of teak, padauk and softwood plantation is being steadily increased as an alternative to regenerated mixed forest. After felling and removal of the commercial timbers the remainder is stacked and burned during the dry season. The desired species are then planted and the young stand tended for a number of years. This is regarded as giving better economic returns in the long term than regenerated forest although there is little local market for thinnings. Unfortunately, the more recent plantings of teak have suffered from outbreaks of leaf skeletonizer which causes malformation and some die-back of leading shoots with consequent loss of timber quality. There are also signs that teak stem borer, which can kill the young trees, is now on the increase. The climate is not ideal for teak and monoculture appears to be leading to increasing pest damage as well as loss of soil structure and accelerated erosion already noted (3.2.). Soils may stabilize after the initial phase but will clearly be vulnerable again at the end of the rotation. Should the venture be an economic failure the fate of the large areas now under teak can be regarded with some concern. Padauk and softwoods are less liable to pest attack although this does appear to be building up as a result of weed penetration on the heels of development, the weeds providing alternative hosts for the pest species.

4.4. Mangrove forest is clear felled, principally for firewood, on a thirty year rotation, leaving an uncleared belt along creeks and facing the sea. Natural regeneration is normally good but occasional failures can be seen especially in the neighbourhood of settlements. This appears to be due in the first instance to lack of seeds, which form more readily along the advancing edge of the thicket than in the interior, but, at a later stage, erosion or hardening of the mud may also cause seedling establishment to fail. It would be a simple operation to seed any areas where regeneration had not occurred after a few years. Some 18% of the land area of the Andamans is said to be occupied by mangroves. They are vital to coast protection and inshore fisheries; all forest operations and other human activities in them should on this account be carefully watched in order to correct any signs of deterioration.

4.5. The Andaman Forest Department has no official conservation function due to the fact that the organisation is not a "service" department. The suggestion has repeatedly been made (refs 1,2,4) that the present "commercial" function of the department should be taken over by a Timber Development Board in order to free it for this other role in common with the State Forest Departments. However, in the interest of a smooth transition and long term efficiency, it might prove more satisfactory for the Andaman department to take on a dual function. This has been done elsewhere. It would require some build up of staff which could be geared to the increase in amenity and protective forestry work.

4.6. The Forest Resources Unit is hampered in its work of forest resource appraisal by the lack of suitably detailed topographic maps and access to good quality aerial photographs. At present even the distribution of the various forest types that have been recognised is inadequately known. Existing aerial photographic cover (flown 1951) at a scale of 1:64.000 and 1:40.000 is already completely outdated and unlikely to be of the quality required. A special land use coverage of the islands, flown at a time of year and altitude to be agreed by the departments concerned in its use, should have top priority (ref 4).

4.7. "Protected" and "Reserved" forests are normally demarcated on the ground by cut lines and boundary pillars. This has not yet been done in the islands. It is urgently required but the task should be approached from the opposite direction and the non-forest rather than the forest land demarcated. If this is not done soon considerable encroachment by settlers and their domestic stock will have affected large areas of forest around the settlements and will have made the task extremely difficult to carry out at a later stage. While this is being done adequate provision should be made for the firewood and structural timber supply of the settlements by allocating areas of forest and plantation for these purposes. The inviolability of the national forests can thereby be more rigorously enforced.

5. Agriculture and settlement

5.1. Apart from the Port Blair colony, which was founded in 1858, the oldest agricultural settlements in other parts of the islands date back only some twenty years. The present phase of the extensive resettlement of exservicemen, repatriates and refugees began in 1964. At first the only criteria used in selecting areas for settlement were the presence of flat land suitable for paddy cultivation and a perennial water supply, together with some security against hostile tribes such as could be obtained on offshore islands. Soil surveys came to be carried out in connection with later settlements but these have tended to be "post hoc" and there is no evidence that any schemes have been shelved because of low fertility. On the other hand some land has been abandoned on Neil Island and Smith Island as a result of falling crop yields and general unsuitability of the chosen sites. The standard allocation per family is now eleven acres, composed of five acres paddy land, five acres garden ground and one acre house site. The garden ground is generally allocated on hill slopes bordering the paddy land but may be some distance away. More attention is now being paid, at least in theory, to the angle of slope of the land allocated for gardens and this is tending to bring about even greater separation of the two types.

5.2. In practically all settlements there is abundant evidence of too hasty action and a lack of proper planning. Developments have been piecemeal and coordination of forestry and agriculture

lacking. Especially in the remoter areas felling has completely outrun the capacity of the Forest Department to deal with it so that saleable timber as well as waste wood has been stacked and burned. The situation has been further aggravated by the introduction of heavy machinery capable of bulldozing logs and stumps into windrows and clearing the ground at a faster rate than hitherto. On the shallower soils and those of variable depth it is also difficult to avoid the burial of some topsoil in mechanised clearance. Some settlements like those at Diglipur have been laid out with no provision for roads to enable the cultivators to remove produce or the Forest Department to extract timber from the surrounding slopes.

5.3. Paddy has been the main crop from the beginning of settlement and seems likely to remain so. Nevertheless, it has been clear from the start that climate and lack of surface water virtually preclude any possibility of more than one crop per annum. On the more suitable soils yields were satisfactory in the first few years but have now fallen sharply especially with the introduction of improved strains of rice requiring high soil fertility for satisfactory growth. Crop fertilisation has not been carried out anywhere. Because of falling yields, even on the more fertile soils, plans for the progressive reduction of ration rice, as the settlers became established, has had to be abandoned in many places so that 60% overall self-sufficiency in the islands has never been exceeded and will probably drop in the future. Only the Diglipur area has been a net exporter of paddy. Waterlogging and increasing soil surface salinity are also said to be a problem in many coastal paddy lands.

5.4. The standard of cultivation of garden ground is low and often no higher than that of primitive shifting cultivators. Few if any soil conservation measures are practised. Experimental and demonstration farms at Sippighat, Jirkatang, Panchwatti and elsewhere have shown that a wide variety of food and cash crops can be grown on the hill slopes with simple counter-erosion techniques. Unfortunately these farms are on better than average soils and often have some capacity for dry season irrigation not open to the average settler. As is so often the case the gap between precept and practice gapes wide and there is urgent need for widespread extension work among the settlements.

5.5. In reviewing the present situation in the islands it is hard to escape the conclusion that it would have been less costly in terms of financial resources and manpower had the potential settlers been cared for entirely at Government expenses for the time necessary to carry out a proper land use survey and make adequate

plans for their reception. There is hardly a mistake that can be made in the opening up of tropical forest to human settlement that has not been made at least in the early years of the last decade. All the advantages of virgin terrain, uncomplicated by problems of land ownership, were there and these advantages have been thrown away. Fortunately the scale of the developments has been limited so that there is still time to rectify some of the damage that has been done.

5.6. A period of reappraisal and reorganisation is now required. Further immigration should be stopped and forest clearance limited to that required to meet the natural increase in population. At some stage, perhaps very soon, further land allocations must cease and all expansion take place in the wage-earning sector. There is thus still a need for the type of land capability survey that should have been carried out initially, starting with an aerial photographic survey and proceeding by way of land use assessment to an overall development plan. The possibility of international funds being made available should be investigated and consideration given to the employment of a team of expatriate specialists to work with local counterparts. Reorganisation should include the resettlement of families from the most unsuitable areas, the resumption of abandoned land for forest or agricultural plantation, return of all other waste land to forest or village "woodlot", counter-erosion work on all agricultural land, including some provision for the disposal of surplus water entering and leaving paddy land, contour terracing or bunding of garden ground and some control of free-range animal grazing on all vulnerable slopes.

5.7. The build up of domestic animal numbers, in parallel with the increase in human population, should be causing some anxiety. At present there is no control over this nor over the extent of the grazing range. The need for accurate demarcation of alienated land has already been mentioned (4.7.), some means must also be found of keeping grazing animals out of certain vulnerable areas such as coastal shelter belts if these are not to deteriorate rapidly and lose all value.

6. Plantation agriculture

6.1. The principal crops grown, or likely to be grown, under this category are coconut, areca nut, rubber and oil palm with subsidiary sugar cane, robusta coffee and spices. The first four suffer from the same soil erosion disadvantages as forestry plantations in that forest soil structure is initially destroyed by preparative felling and burning. On the other hand the greater economic value of the crop enables some investment to be made

in counter-erosion measures such as contour bunding and the sowing or planting of leguminous cover crops beneath the trees.

6.2. Rubber and oil palm plantations must be regarded as still in the experimental stages and, since little tapping of rubber has been carried out and the first crop has yet to be harvested from the oil palm, the experiments must be regarded as inconclusive. The oil palms appear to be establishing well but some of the older rubber plantations have been allowed to become derelict and the more recent have a high proportion of dead trees. Kudzu vine (Pueraria phaseoloides and P. javanica) provides a successful cover crop until the shade of the tree canopy develops. Other species such as Centrosema pubescens and Calopogonium mucunoides which have proved their worth in similar work in Malaysia, should be tested.

6.3. No soil erosion under coconut, rubber or oil palm was seen comparable to that in teak and padauk plantations but this may be due to the fact that only gentler slopes are used for plantation crops. The chief disadvantage of rubber and oil palm is that they require to be grown in large monocultural blocks to make them an economic proposition and the latter requires a local factory for the extraction of the oil. The present plan to clear some 2000 ha of virgin forest on Katchal for rubber plantation, when neither the prospects of an adequate crop nor of a good market are assured, seems both ecologically and economically unsound.

6.4. Of the remaining crops that have been suggested or tried on a small scale, sugar cane would be bound to occupy present or potential paddy land, thus reducing self-sufficiency in food without the prospect of providing a compensatory cash return. Others such as coffee and spices could have a future as cash crops on the present garden ground given attention to simple soil conservation measures.

7. Other development

7.1. The Grand Andaman Trunk (GAT) Road scheme is in abeyance at present. Even in its uncompleted state it facilitates forest working in a number of areas and provides a speedier alternative to sea communication between certain centres which is especially valuable during the southwest monsoon season. If it were to be completed these benefits would be increased greatly but the pros and cons of such a course of action can be assessed only in conjunction with the proposal to leave untouched all forest to the west of the GAT alignment in South and Middle Andaman and to call a halt to further settlement along the central axis in order to avoid further confrontation with the Jarawa tribe. Obviously, financial return on the present and any further investment will be reduced by limiting forestry in this way. On the other hand there are certain

advantages from the ecological point of view in that the forests to the west of the road clothe the headwaters of the main eastward flowing streams in both islands (3.3.).

7.2. The road itself is already providing a corridor for the spread of weeds and insect pests which would otherwise have failed to penetrate the heart of the forest. Too little attention is being given to the safe disposal of drainage water from the road surface, and roadside banks have been left unvegetated and open to erosion. In most places the development of roadside gullies threatens only the road itself as surplus water can be discharged into the jungle and there absorbed. Occasionally crops, plantations and houses stand in the path of the drainage water and its load of eroded soil. The worst examples seen have been on the steeper gradients on Baratang Island and between Uttara Jetty and the Yeratil Jig settlement where the road has required re-alignment and rebuilding in places. Part of the blame must be laid on adjacent teak plantations which discharge surface drainage water by way of short gullies into the roadside ditches. Cemented stone lining of the roadside drain was seen in one place only; cuts to deflect runoff from the top of roadside bankings were seen in another two. Efforts that have been made to plug developing gullies with crude wooden hurdles or loose stone rubble are quite ineffective. Spraying of exposed soil by the roadside with thin bitumen or waste oil would help stability until vegetation can be established. If no native creepers can be found which will colonized the exposed subsoil or trail down from the top of the bank, kikuyu grass (Pennisetum clandestinum), successfully used for this purpose in many tropical areas, could be tried.

7.3. On the whole it is considered that the present moratorium on GAT development should stand until the complete land use position can be re-assessed. The best solution might be gradual completion of the road to form a "Jarawa frontier" and line of long distance communication without further land settlement along it or forest working to the west.

7.4. Air pollution comes to the Andamans principally from outside in the form of smoke haze from vegetation burning on the continent (Burma or even further afield) during the dry season. The Nicobars escape the worst of this because of their position downwind from more permanently humid regions. The Chatham sawmill causes thin smog over Port Blair at the same time of year. Inshore sea pollution arises from eroded soil during the wet season wherever settlements and cultivation occur. Sawdust from the Chatham sawmill is dumped into the sea and spreads widely around the enclosed waters of Port Blair. It appears to have had little effect additional to the miscellaneous pollution arising from the town itself. In general the total effects of

water pollution on the fringing coral reefs and inshore fisheries appear to be slight.

7.5. Any forest, agriculture or fishery based industries that may be developed in future will have to be those that are independent of abundant supplies of fresh water. This effectively rules out such developments as paper pulp and palm oil mills so that the chances of further industrial pollution are slight.

7.6. There appears to be scope for modest tourist development in the islands and this, if it comes, is not likely to be on a scale with any adverse ecological effects. A centre in New Delhi (Andaman House) is to be set up during 1976-77 with the formation of a Tourist Corporation to encourage visitors to the islands. There is yet no sign of the necessary facilities appearing at Port Blair or elsewhere. Legislation regarding such activities as spear fishing and the collecting of corals and live sea shells for souvenirs may be required in the long term (9.1.).

CONSERVATION

8. Terrestrial habitats

8.1. Even up until the middle years of the present century the Andaman and Nicobar Islands have remained largely untouched by man. This is remarkable in view of the fate that has overtaken the indigenous plant and animal life of other oceanic and sub-oceanic islands such as Mauritius and neighbouring groups. Now that exploitation has at last begun to accelerate since 1964 it would be a mistake to dismiss the need for biological conservation here merely because the larger and more conspicuous animals (particularly mammals) are lacking. The unique feature of these islands lies in the close juxtaposition of so much still virgin rain forest with the abundant marine life and fringing coral reefs in seas as yet unpolluted by soil erosion or industrial activity.

8.2. Recording of the plant and animal life of these islands began over one hundred and fifty years ago. In the references that have been examined the animal records are scanty and extremely confused. Some of the earlier records are neither confirmed nor refuted in later accounts and their authenticity may be doubtful. The available information has been summarised in Appendix II.

8.3. The Botanical Survey of India has been operating a local office, herbarium and library in Port Blair since 1973. Collecting is at present concentrated on Great Nicobar, Katchal, Car Nicobar and Little Andaman. The total list of flowering plant species now stands at around 3000 with some 10% endemic to the two island groups and some of these highly localised on one or a few islands,

e.g. Ilex sp. confined to Interview Island. Another 500 species of non-flowering plants have also been collected. There are over 300 species of forest trees of which only some 10% are marketable (i.e. only some 20-30% of the natural forest stands have commercial timber). The flora of the northern islands has been shown to be related to that of India and Burma while that of the southern groups has greater affinity with Indonesia and Malaysia. Some Andaman and Nicobar species also extend their range as far as the Assam Himalaya (ref 13). Nine forest and scrub types have been described by Champion and Seth (ref 8). Other plant communities from those of the inshore seas to grasslands have been mentioned by Balakrishnan (ref.13).

8.4. No single plant species is known to be in immediate danger of extinction although the Multidisciplinary Team of 1975 produced a list of 123 "Rare and Endangered Species" (ref.1). Among the plant communities "giant evergreen forest" and various wetland associations, which were always limited in their distribution, are becoming rare as a result of clear felling and settlement of the flatter land.

8.5. The Nicobar megapode seems to be endangered largely as a result of egg collecting by the indigenous peoples as well as by the increasing numbers of settlers. No recent information is available on the numbers of Narcondam hornbill, said to have been around 200 in 1902 (ref 5) but a sub-species is now said to have been discovered in North Andaman. Collecting of edible birds' nests continues and unless many more caves exist than have been recorded this species of swallow could be locally endangered (Appendix III). The Andaman teal is given special protection at one breeding area around Dundas Point, South Andaman but little seems to be known about its present numbers or other breeding grounds. There is a reference to tens of thousands of these birds on a fresh water lake on North Reef Island in the mid-thirties (Ref.9) but even the existence of this lake proved to be unsuspected in Port Blair and time did not permit a visit to the island on the present survey. The teal also use a small body of fresh water on Neil Island which is now being investigated as a possible waterfowl sanctuary by the Andaman Forest Department (Appendix III).

8.6. In parallel with the numerous and ill-advised introductions of animals recorded in Appendix II there has been a considerable penetration of adventive and introduced plant species. While the Census of 1932 could record only two serious weeds at Port Blair, and the IUCN note of 1969 (ref 5) could still report "little penetration by weeds of cultivation" a variety of aliens is now widely distributed except on small islands well offshore and in the remoter parts of the main islands. The number continues to grow and only the presence of unbroken forest cover can check further colonisation.

8.7. Among the present human activities the least damaging to habitat and wildlife in the long run are forest felling and regeneration. Past selective timber extraction has done little but alter the balance of the tree species present in certain areas. Current regeneration techniques, begun in 1935, are bound to reduce floristic diversity although forest structure will probably return to near normal by the end of the rotation of 70-100 years. Loss of floristic diversity will probably be greatest among the tree species, especially where enrichment sowing or planting has been carried out and will depend to a great extent on the size of the coupe and the proximity of still virgin forest. Soil stability, hydrology and animal life appear to be little affected. At the other end of the scale monoculture plantations and agricultural crops bring about fundamental and deleterious changes in most of the natural environment. Even the surrounding inshore marine life could be already affected by soil carried out to sea during heavy rain storms and any increase in erosion could be disastrous for the continued existence of the fringing reefs (but see 7.4.).

8.8. Suggestions for the complete preservation of certain areas of virgin forest have come from the Multidisciplinary Team of 1975 (ref.1). These are: the northern half of Great Nicobar (400 sq km), the southwest portion of Little Andaman at present used by the Onge tribe of Dugong Bay (200 sq km), the entire Mt. Harriet peninsula north of Wright Myo (500 sq km), the west coast of Middle Andaman west of longitude 92 50'E (600 sq km), entire northern portion of north Andaman beyond a line from Hudson Bay to Landfall Island (700 sq km). The western slopes of the Mt. Harriet range have already been or are being felled, and, at least in part, regenerated. There is no intention to carry out felling on the difficult and isolated eastern slopes but there is already some slight modification of the forest around the Mahduban elephant training camp. The remaining suggestions seem sound but something more far-reaching is also required in the way of habitat conservation in these islands. The present survey has not been sufficiently detailed to enable many specific recommendations to be made in addition to the above but the general approach might be as follows. Substantial blocks of virgin forest should be left completely untouched. For the most part these could be areas that are too rugged or difficult of access for profitable working. Smaller blocks and strips of virgin forest should also be left untouched within forest working areas to allow ready recolonisation of the felled and regenerated forest by species of plants and animals affected adversely by the forest working. All the smaller islands (below 100 ha), not already felled, should automatically be scheduled as nature reserves. (Appendix IV). Islands larger than 100 ha which are too rugged or remote for profitable forest working should be added to this list. Other large islands not already felled should be investigated and a decision made as to whether they should be reserved or included in the sustained yield forestry programme. So far as possible the reserved islands should be grouped and, with their surrounding reefs, form part of a series of marine habitat reserves or parks. In addition to the above mainland forest reserves the entire Saddle Peak Range beyond present felling boundaries and the Jarawa areas of South Andaman to the west of the GAT road are also suggested for conservation.

8.9. Action is also required to halt the present indiscriminate introduction of plants and animals from the mainland as well as the movement of plants and animals between the islands and especially to those islands that have hitherto escaped all human interference. The Forest Department must share some of the guilt because of the way they dispose of super-annuated elephants on uninhabited islands. These old elephants are past breeding age but, because of their definite food preferences, they may alter the composition of island floras or conceivably bring about local plant extinctions.

8.10. Among the larger introduced animals chital have become an important article of diet throughout the Andaman group as well as causing some damage to forestry plantations and agricultural crops. They are at present scheduled as vermin in the Diglipur area although scarce and much hunted around Port Blair. The present status of all deer should be examined and a management policy for the chital formulated. The Forest Department of New Zealand recently released Mr. M.J.W. Douglas of the Forest and Range Experiment Station, Rangiora to carry out a similar study of introduced deer in Mauritius under F.A.O. auspices. The FAO could be approached with a view to inviting Mr. Douglas to carry out a similar study in the Andamans.

9. Marine habitats

9.1. To the layman the marine life of the Andaman inshore waters appears especially rich and varied and in no way inferior to that of the well-studied Great Barrier Reef of Australia. Only in the neighbourhood of Port Blair does the coral reef appear to have suffered any damage through disturbance, urban pollution and the suspended soil in flood waters. Definite information could not be obtained on the presence or otherwise of the Crown of Thorns starfish (Acanthaster planci) in Andaman waters. If present it would appear to be doing little damage to the coral as yet. Numbers may still be held in check by predatory molluscs whose influence elsewhere has been reduced by the collecting of live shells for the tourist souvenir market.

9.2. Numbers of salt water crocodiles appear to be on the increase following the extension of Indian wildlife legislation to the islands in 1973. The status of the dugong is unknown but it is probably endangered in these waters as it is elsewhere. Turtles are reported to be still relatively abundant but there is no information about the status of individual species. The Techno-Economic Survey of 1972 (ref.3) mentions a wide variety of fish which are caught for local sale, with some export after drying.

9.3. The mangrove swamps, sand beaches and "sea grass" meadows too, appear to be particularly fine and provide the habitat necessary for any encouragement of crocodiles, dugongs and turtles. There would seem to be considerable scope for the development of a marine biological station of international interest and at least one marine park or habitat reserve of substantial size (8.8.).

9.4. Besides marine biology other hitherto neglected fields in the natural history of the islands, such as freshwater biology, the insects other than butterflies, most invertebrate groups and the smaller reptiles and amphibia, require to be studied. The Botanical Survey of India collect algae, fungi, bryophytes and lichens but there is no-one to work on these collections at present. Links with overseas universities and research institutes should be sought to help with this immense task.

10. Indigenous tribes

10.1. Land use in the Andaman and Nicobar islands is complicated by the existence of indigenous peoples, some of whom are in the process of integration with present day life and others indifferent or openly hostile to the outside world. Two schools of thought exist regarding future policy towards the latter, one favouring almost forcible integration and the other treatment along the lines usually followed for "wildlife" in nature reserves. Neither of these extreme policies seems likely to lead to satisfactory results and the problem is a difficult and an unhappy one.

10.2. The first group is represented by the Nicobarese people of Car Nicobar and other islands of this group. They now number about 18'000 and the population is increasing. The Shompens of northern Great Nicobar are a much more primitive people now reduced to about 150 in number. They are not openly hostile but do not have the same receptive attitude towards the outside as the Nicobarese and some provision must be made for them in any plans for this island.

10.3. The Andamanese or "Great Andamanese" as they are called sometimes by the Indian Ethnographical Survey are the dying remnants of a group of tribes once widespread throughout the Andaman islands. They now number only 23 and are settled on Strait Island. The Onges of northern Little Andaman are again friendly but rather indifferent to outside influences and, although numbering only 110, will have to be provided for in plans for their island.

10.4. There are about 100 Sentinelese so called because they are now restricted to North Sentinel Island. They are openly hostile but present no immediate problem as they have the island to themselves. The last group, the Jarawas or Jerwas, range throughout the western portions of South and Middle Andaman. The size of the population can only be estimated and this has been put at about 300. They are the most actively hostile of all the tribes and cause considerable trouble to the local administration by occasionally attacking forestry and road workers and even police posts.

10.5. There would be no immediate difficulty about the creation of "Reserves" for the Andamanese, the Sentinelese, the Onges and the Shompens; in fact these already exist de facto if not de jure. The Jarawas present the most urgent problem and if the tract of territory over which they roam to the west of the GAT road alignment is to be allocated to them as well as regarded as a virgin forest reserve (8.8.) a period of some friction along this frontier will have to be accepted. Friction will certainly be reduced if the present local policy of halting development along the GAT road is continued but no-one knows if the territory available to them is sufficient for their needs. Much seems to depend upon the available supply of feral pigs which constitute the main source of animal protein for the Jarawas and which is being increasingly drawn upon by the incoming agricultural settlers. The Jarawas apparently do not utilize the chital for food even when these are abundant.

COMMENTS ON PREVIOUS REPORTS

11.1. Previous reports examined in the course of background studies for the present survey have contained a mixture of long-standing ecological misconceptions with many sound observations and valuable suggestions. Some of the misconceptions have already been dealt with under the appropriate headings and there would be no need to labour the points further were it not for the fact that they appear to be so deeply rooted in the recent Andaman literature.

11.2. The myth that luxuriant tropical forest necessarily indicates immense reserves of soil fertility persists into the Multidisciplinary Team Report of 1975 (ref.1.). In fact, many tropical forest soils are extremely impoverished and often cannot be distinguished from more fertile ones by any differences in forest development. Plant nutrients tend to be locked up in the standing crop of vegetation and lost in the process of forest clearance. Luxuriant growth has been possible only because these nutrients have been accumulated over a vast period of time and are kept in brisk circulation between the tree canopy and the soil surface as a result of leaf fall, rapid decomposition and nutrient absorption by the surface roots. Forest clearance breaks this cycle which cannot be re-established by any other type of vegetation. Deep fertile soils have developed mainly as the result of the accumulation of soil carried from hills and mountains to the valleys and plains through natural erosion acting over long periods of time. In the Andamans there are few valley flats but these did carry a taller forest type (giant evergreen forest of Champion and Seth, ref.8) which has now mostly been cleared.

11.3. The same report considered that "large scale clearance of tropical forests in these islands may eventually be accompanied by serious disturbances in weather patterns". This misconception has been discussed in 1.1. - 1.3. and reasons given in 1.4. for considering the allocation of resources to research on the "impact of felling on climate" as misdirected. In another section the team concludes "we may have to consider the degree of slope that can be managed and to what extent soil conservation measures

can be adopted". It should now be clear that the present report considers that such factors should have been taken into account and these measures adopted at the outset and that no further time should be lost in doing so. The "Task Force" suggested by the team, and which has now been set up, should not be regarded as a substitute for the complete land use survey based on aerial photography now advocated.

11.4. Miss Mani's report of 1974 (ref.2) draws largely upon that of Soni, 1970 (ref.4). Certain legislative measures recommended by her and relating to forests and wildlife had been implemented in the period between the two reports. Avoidance of a gap between forest felling and cropping will do little to delay the onset of soil erosion as she suggests. Avoidance of steep slopes and the application of good husbandry and simple soil conservation measures are likely to achieve much more. Her suggestion that clearance should be avoided in the catchment areas of perennial water sources is sound and to some extent the Forest Department now try to do this. Regeneration felling on the gentler slopes would have little effect on the hydrologic regime but virgin forest should certainly be retained on steep and broken ground whether the catchments act as the source of perennial or merely seasonal streams.

11.5. Comments by the Administration on Dr. Koteswaram's remarks on Miss Mani's report are extremely confused and self-contradictory. Once again there is the failure to distinguish regional and micro-climate and to note the important difference between increased runoff and water availability. Bad forestry practice is compared with good agricultural husbandry to the former's disadvantage where it would have been fairer in the present circumstances to have made comparison the other way round. The economic argument that favours agriculture as opposed to forestry fails to take into account that the majority of Andaman's soils are not fit for repeated cropping without soil conservation measures, fertilisation and skilled attention. The water supply problem is hardly "easily solved" because the dry season is relatively short. This paper ends with an appeal that the land under forest "should be put to profitable use and not retained for the sake of biological study, natural scenery and fear of species extinction or climatic upset". Present day opinion sees less conflict between these aims than hitherto and even economists are prepared to concede that there are some regions where the environmental factors are such that habitat conservation, with or without some harvesting of forest products, is in fact the most profitable use in the long run. At two 1974 forestry conferences at Oxford and Helsinki it was the Indian foresters Saroj Raj Choudhury and Krishna Murthy who put forward the most eloquent plea for this very point of view.

11.6. Soni felt that demarcation of the forest was urgently required, that aerial photography should be adopted to appraise forest resources and that the Forest Department should become a Service Department and its commercial function taken over by a

Timber Development Board. These recommendations have still to be acted upon and the present survey is in substantial agreement with them. Many of the fears expressed by Soni in 1970 regarding the acceleration of environmental damage have been justified in the intervening years. His suggestion regarding further introduction of jungle fowl and "a few herbivorous species" cannot be endorsed.

11.7. The Techno- Economic Survey of 1972 (ref 3) reported that the "soils of the Andamans are fertile as can be seen by the rich forest vegetation they support". It particularly recommended the extension of teak plantations as "they begin to yield after eighteen years". The present survey cannot agree with these conclusions. Active measures were called for to develop the economic utilisation of large quantities of miscellaneous hardwoods and wood waste as being crucial to forest profitability in the islands. The production of air-felted hardboard and particle board were particularly recommended as requiring little water for their manufacture. Boat building and the construction of packing cases for export were also put forward as appropriate industries. These suggestions would be ecologically acceptable. Reasons have been given in 6.4. and 7.5. for not accepting a further recommendation of the 1972 survey that 1'500 ha of sugar cane should be established together with a processing factory.

RECOMMENDATIONS

12.1. The present moratorium on forest felling for settlement or plantation agriculture should be continued pending completion of a comprehensive land use/capability survey based on aerial photography. There should follow a period of reappraisal and reorganisation during which intensification of effort on the existing cleared land and the repair of land laid waste by unwise settlement should be carried out. This may require resumption of some alienated land. Widespread extension work in crop husbandry and soil conservation will also be necessary.

12.2. The Forest Department in the islands should be reorganised along dual purpose lines and staff augmented to enable service functions, such as municipal tree planting around Port Blair, to be carried out.

12.3. The amount of teak, padauk and softwood plantation, particularly the first of these, should be reduced until the full economic and ecological consequences can be assessed towards the end of the rotation in the oldest plantations. Forestry effort should be concentrated on regeneration felling with or without enrichment sowing and planting. Under the dual purpose organisation there would also be greater opportunities for clearing the backlog of regeneration in the earlier clear-felled and selectively-felled forest as well as for carrying out "social planting" for amenity and firewood. Greater attention should be paid to

ensuring the regeneration of mangrove coupes, with planting of germinated seeds if necessary. Long standing bare areas should be fenced and planted.

12.4. During the period of reorganisation consideration should be given to eventual completion of the GAT road as a Jarawa frontier and as a means of long distance communication mainly. No further settlement should take place along it, however, and forest working should be confined to the eastern side. Attention should be given to counter-erosion work along the completed sections and in any subsequent construction.

12.5. Substantial areas of the virgin forest remaining should be set aside and regarded as inviolate. These areas should also cater for the tribes which have shown themselves either hostile to the outside world or incapable of successful integration before extinction intervenes (Jarawas, Sentinelese, Onges and Shompens). As far as possible these forest habitat reserves should consist of the remoter areas of the main islands which through steep topography or inaccessibility are not of immediate interest for economic exploitation. In North Andaman any such designation will have to wait upon the legal result of premature termination of the North Andaman forest lease in 1968. It is felt that many areas now regarded as virgin may have been selectively logged in the early days and records subsequently lost during the Japanese occupation. In the absence of detailed survey the following areas are tentatively suggested as suitable:

- (i) Saddle Peak Range beyond present felling boundaries
- (ii) Jarawa areas of South Andaman to west of GAT road
- (iii) Eastern slopes of Mt. Harriet Range
- (iv) Remaining four suggestions of Multidisciplinary Team.

12.6. Smaller blocks and belts of virgin forest should be set aside as reserves throughout the main areas of exploitation forest. These would serve as centres of dispersal for plant and animal species adversely affected by regeneration felling and enable at least some recolonisation to take place in the course of the rotation. These areas would often coincide with natural boundaries between coupes, areas of inaccessible, broken or steep ground or especially important water catchments such as that of the Dhanikari reservoir.

12.7. All offshore islands, including Barren Island, Narcondam and other outliers of the main archipelago, which have not already suffered substantial interference through tree felling or settlement, should also be declared as nature reserves. Groups of these islands with their fringing reefs should also be considered as marine habitat reserves or marine parks. A list of the main islands likely to be involved is given in Appendix IV. There is unlikely to be any dispute regarding timber exploitation on most of these under 100 ha in area nor on the larger islands lying far offshore.

A decision as to whether regeneration felling should be carried out on the readily accessible islands exceeding 100 ha, which have not so far been exploited, would be a matter for survey and negotiation.

12.8. A survey should be carried out to determine the finest areas of fringing reef, mangrove swamp and associated "sea grass" meadows and other marine habitats to be set aside as reserves. If these can be chosen to include groups of small islands with virgin forest so much the better (11.2.).

12.9. Special provision should be made within the nature reserve programme to cater for those plants and animals thought to be in immediate danger of extinction or with dangerously small populations, e.g. Narcondam hornbill, Nicobar megapode and cave swallow. Waterfowl refuges should be established on Neil and North Reef islands. Caves with guano deposits should be investigated biologically and archeologically before exploitation of the deposits. Edible birds' nest collecting should cease or be strictly controlled (Appendix III).

12.10. Legislation should be considered to check further deliberate introductions of plants and animals to the Andaman and Nicobar islands as a whole or the deliberate transfer of species between islands in the groups. Reserve areas should be particularly safeguarded against, for example, landing of chital or aged elephants.

12.11. The F.A.O. should be approached with a view to conducting a study of the status of chital in the Andaman group and a plan prepared for its proper conservation and economic exploitation. Subsidiary studies could also be included on wild pig, muntjac and other large introduced mammals.

12.12. Further consideration should be given to the development of small surface-water storage schemes for irrigation and other purposes. The search for suitable sites could form part of the proposed land use survey (12.1.).

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APPENDIX I

Itinerary

1976

February	5-8	Morges, Switzerland
	9-11	New Delhi
	12	In and around Port Blair. Corbyn's Cove
	13	Area to South of Port Blair. Wandoor, Dhanikari, Sippighat
	14	Bamboo Flat, Wymberly Gunj, Wright Myo, Mt. Harriet ridge.
	15	Jirkatang and GAT road to the north
	16	Neil Island
	17	Havelock Island
	18,19	Port Blair, Mahduban
	20	Long Island, Uttara Jetty, Middle Andaman and on to Yeratil Jig settlement by GAT road. Yerata Jetty and on to Bakultala
	21	Charlungta and along GAT road to north. Rangat
	22	Panchwatti, Betapur, Mayabundar, Port Cornwallis
	23	Diglipur, Smith Island
	24	Return Mayabundar, Betapur, Long Island
	25	Return Port Blair via Uttara Jetty, Nilambur
	26	Port Blair
	27	Little Andaman
	28	Katchal
	29	Great Nicobar
March	1	Car Nicobar
	2	Return Port Blair
	3	Chiriatapu
	4,5	Baratang Island, Wrafter's Creek
	6-8	Port Blair
	9-10	Calcutta
	10-13	New Delhi

APPENDIX II

Animal Records (in lit.)

Indigenous or Long Resident

+ Pig (feral) Local sspp?
Goat (") Barren Island 1873
+ Macaque (*M. nemestrina* ssp. *leonina*)
+ Macaque (*M. irus*) Nicobar ssp?
* Dugong
* Salt water Crocodile (Andamans)
* Fresh water Crocodile (Great Nicobar)
Water monitor (ssp ?)
Iguana (ssp ?)
Loggerhead turtle
Edible turtle
Hawk's Bill turtle
x Palm civet (endemic ssp ?)
*Python (Nicobar)
Cobra (Andaman)
Hamadryad (Andaman)
Blue Karait (Andaman)
Pit Viper (2 spp.) (Andaman)
Sea snakes (ssp ?)
* Dolphin
Common Indian toad
Gecko (*Phelsuma andamanese*) endemic
* Nicobar megapode (Nicobars)
* Narcondam hornbill (Narcondam end.)
0 * Andaman teal. endemic
* White bellied sea eagle (local ssp ?)
Serpent eagle (local ssp. ?)
Gannet (2 spp.)
Petrel (2 spp.)
* Emerald dove
* Oriole (Local ssp.)
Rail
* Owl
Drongo
Starling
Tree pie
Parakeet (local sspp ?)
Bulbul
Myna
Bittern egret
Grackle
Woodpecker
Roller
Tern
Kingfisher

0* Imperial pigeon
0* Green pigeon
* Whistling teal
+ Snipe
Giant clam (Tridacna gigas)
Robber (coconut) crab. S. Sentinel Island

Recent Introductions

+ Chital 1920
* Muntjac
Sambur
* Hog deer
Cattle (feral). Camorta
Water buffalo (feral). Camorta
* Indian elephant (feral)
Panther (2 males c 1955)
Jungle cat
House mouse
Black rat (6 forms)
* Pea fowl
* Jungle fowl
* Spur fowl
* Partridge
* Quail
Rhinoceros beetle
Giant African snail

Not in lit. Seen feb. 1976

Grey squirrel, Port Blair
Unknown small mammal, Great Nicobar
House gecko. Widespread
Earthworms (several spp ?)
Centipede (12 cm)
Fireflies
Frogs (incl. tree frogs?)
Moths (rich fauna ?)
Cave swallow

Animals Records - Summary

Land mammals 23 spp. Andamans

Insectivora 2 endemic Crocidura. 3 spp. Nicobars

Chiroptera 12 spp. (1 end. 6 ssp. end.). 10 spp. Nicobars

Reptiles 42 land spp. (1941) with subsequent additions. Andamans

Birds c. 80 spp. breed Andamans (6 endemic)

50 spp. breed Nicobars (3 endemic)

29 spp. confined to Nicobars, of which 14 are shared with the Andamans

Butterflies 217 spp. 1932 Andamans

* Protected under Schedules I-IV of Indian Wildlife Act since 1973

0 No close season

+ Close season

x Paguma larvata tytlery

APPENDIX III

Additional Notes

Caves

Caves have been reported from a number of localities including Baratang Island, Katchal, Interview and Car Nicobar and there are probably others to be discovered in limestone areas. One small cave in the coral limestone of Car Nicobar which was visited proved to be of little interest. A much larger cave in the hard limestone ridge to the northwest of Wrafter's Creek Jetty on Baratang Island contained small populations of bats and swallows. The floor of the cave consisted of some depth of cave earth and guano banked up towards the rear. The surface of the deposit was swarming with case-moth larvae. The swallows were incubating eggs and two men were there collecting the nests from the cave roof, with consequent destruction. A cave on Interview Island is also said to yield edible nests. Another cave containing 5'000 cu.ft. of bat guano was reported on Katchal in the 1932 Census (ref II) and the tribal Andamanese are said formerly to have collected edible nests from various caves (1951 Census, ref.10). There is no record of guano exploitation at any time but this cannot be long delayed and it would be advisable to carry out archaeological and biological investigations of the deeper deposits first. Some light may be thrown on the early history of the indigenous tribes. Old shell mounds were seen in the vicinity of the Baratang cave. The cave swallows may also be in need of protection as the populations are probably small and the price of the nests in Calcutta is very tempting.

Lakes

The small lake on Neil Island has a surface area of only a few hectares and is mostly shallow even in the wet season. There is one deeper hole with fringing reeds and a few plants of water lily (cf. Nymphaea nouchali). During the wet season it discharges through the narrow sand bar and in the dry season may become almost dried out. There may be some influx of salt water at high water of spring tides in the dry season. It thus appears to be essentially a sand-dammed lagoon lake with the same origin as many on the Indian mainland such as Chilka Lake, Orissa. The Forest Department have been considering clearing out the mud as part of a programme for founding a waterfowl sanctuary. However, the lake should be left as it is with its buffer zone of virgin forest protecting it from settlements which are encroaching on all three landward sides. Public access should remain limited to the right of way between two settlements which passes the lake along the shore.

The much larger lake which was reported from North Reef Island in the mid-thirties (ref.9) should be investigated and considered as another possible waterfowl sanctuary if the island itself is not included in the reserve list (12.7.).

APPENDIX IV

List of islands, mainly in the Andaman group, substantially untouched by man.

Under 100 ha

Channel	Snake	Blister	N.Spike
Pocock	Tree	Curlew	Mask
White Cliff	Trilby	Goose	Tuft
Thorn Hill	Turtle	Gander	Hump
Mayo	Jungle	Dot	Gurjan
Sugar Loaf	North	Oyster	Parkinson
Jub-Jub	Wharf	Oliver	Oyster (2)
Rowe	South	Orchid	Cone
Snark	Ox	Curlew	Round
Kwang Tung	Brush	Egg	Chengappa
Latouche	Craggy	Entrance	Stoat
Sea Serpent	Bamboo	Surat	Mangrove
Bingham	Baby	Bonig	Middle Button
North Button	South Button	Ariel	Duncan
Potanma	Patrice	Montgomery	Clyde
Snake (2)	Bird	Grub	Pluto
Rifleman	Belle	Chester	Passage
Sisters	North Brother	Api	Isle of Man
Mirce	Treis	Kobera	Pigeon
Walker	Megapod		

Over 100 ha

Tillingchong	Trak	Landfall	Dotterel
James	East	Ranger	Defence
West	Roper	Sandy	Reef
Bennett	Alexandra	Paget	South Reef
Hobday	Point	Anderson	Jolly Boys
Shearme	Flat	Malay	North Reef
Barren	Boat	Boudeville	Bluff
Redskin	Buchanan	Spike	Snob
Excelsior	Talakaicha	Tarmugli	Delgarno
East (Inglis)	North Sentinel	Temple	Wilson
Twins	Narcondam	Nicholson	Cinque
Sound	Sir High Rose	South Brother	Swamp
Petman	South Sentinel	Batti Maliv	