THE STATUS AND ECOLOGY OF SEA TURTLES IN THE ANDAMAN AND NICOBAR ISLANDS

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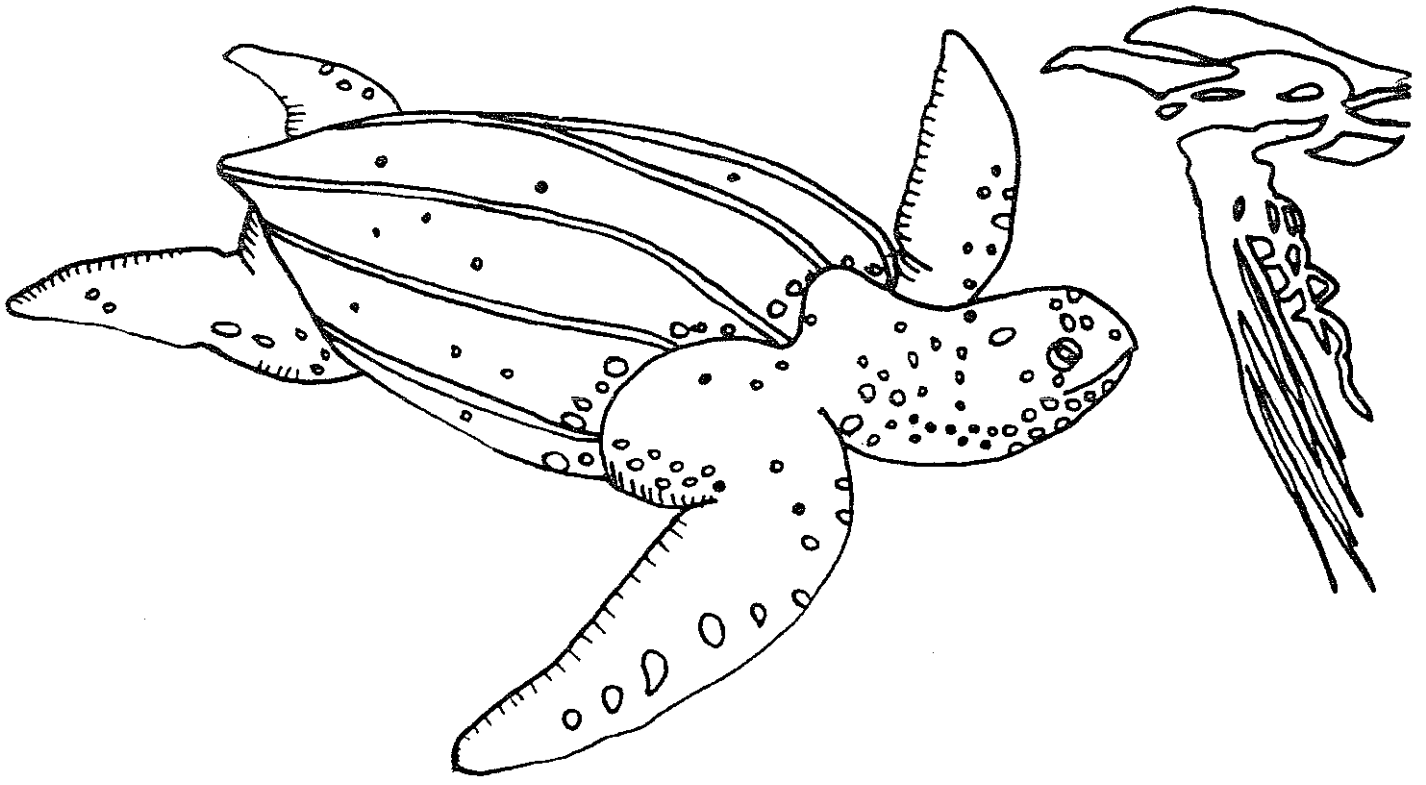

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Cover: Leatherback sea turtle (*Dermochelys coriacea*). © Indraneil Das.

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THE ANDAMAN AND NICOBAR ISLANDS

SUMMARY

The Andaman and Nicobar islands are an archipelago of over 350 islands spanning latitudes 13° 40' N to 6° 40' N (extent 740 km) and longitudes 92° 10' E to 94° E (extent 190 km). These islands are covered by rain forest, surrounded by and coral reefs of immense diversity as well as mangroves in sheltered areas. Described taxa of the islands include 250 birds, 80 reptiles, 60 mammals, 750 fish and thousands of invertebrates and plants. At least a quarter of the plants and animals are endemic. Due to geographic location, the faunal components include taxa from India as well as South-east Asia, Myanmar and the Indonesian regions, beside the endemics.

The human population constitutes around 300,000 settlers and five of the last "pure" races of tribes on earth. Two of these tribes are still largely hostile and refuse contact with the outside world. Of the land area of 8293 sq. km., 90% has been set aside as Reserve and Protected Forests, 36% of which earmarked as 'Primitive Tribal Reserve'.

Status surveys of sea turtles in the Andaman and Nicobar archipelago recorded India's best nesting beaches for three species - the leatherback (*Dermochelys coriacea*), the hawksbill (*Eretmochelys imbricata*) and the green turtle (*Chelonia mydas*). Also found were nests of a fourth species, the olive ridley (*Lepdochelys olivacea*) (Bhaskar, 1979a; 1979b; 1981; 1984a; 1984b and Tiwari, 1991). The presence of green turtle and hawksbill feeding areas was confirmed.

The Indian Wildlife (Protection) Act provides complete legal protection for all sea turtle species in India, by their inclusion in Schedule I, but at least up to 1984, enforcement proved difficult in the remote areas. The gazettement of the Wandoor Marine National Park, invaluable as it was, came too late to halt the decimation of turtles in this feeding and nesting area.

All tribals are exempt from the Act - a privilege that need not necessarily deplete turtle stocks, given the tribals' relatively low population, their abstinence from commerce in turtles and eggs, and the equilibrium tribals have presumably achieved with turtle populations over centuries of subsistence hunting. All tribal areas are Reserves, with restrictions on entry by non-tribals. That this has saved several populations of sea turtles from collapse - especially the leatherback - is clear from the fact that all the prime nesting sites that endure today exist on Tribal Reserves or on uninhabited islands. However, the Nicobarese - for whom, as for most or all of the other tribals, turtles and eggs have traditionally been a valuable protein source - have been increasing rapidly in population.

Turning points in sea turtle status and conservation in the Islands

1. Establishment of British, settler and convict populations in the Andamans ..... 1857 onwards

2. Introduction of dogs (which prey on turtle eggs and hatchlings) and cattle (which inadvertently compact nest sand) 1860

3. Edward Blyth records the occurrence of three turtle species in the Andamans: the olive ridley, the green turtle and the hawksbill, in an Appendix to Mouat's paper. 1863

4. Use of dogs by Andamanese 1865

5. Introduction of spotted deer into the Andamans. (Deer have spread to several outlying turtle-nesting islands, and their hooves compact nest sand and often attract poachers who may also arrive with their dogs). ..... Early 1900's

6. Arrival of refugees from present-day Bangladesh. (Bengalis more than other non-native populations, onwards relish turtle meat). ..... 1947 onwards

7. Introduction of elephants into Interview Island. (Elephants compact nest sand at the most important of Great Andaman's nesting beaches for green turtles here). ..... 1950's

8. Accelerating demand for nesting beach sand for construction purposes. ..... 1950's

9. Influx of non-native human populations into Little Andaman, Great Nicobar and Katchal Islands. ..... 1950's

10. Construction of the East-West Highway (43 km long) and the North-South Highway (51 km long) on Great Nicobar Island. (These roads give easy access to leatherback and olive ridley nesting beaches at the mouths of the Alexandria, Dagmar and Galathea Rivers; the latter road also gives access to the hawksbill nesting beach at Indira Point). ..... 1960's and 1970's

11. Construction of the Andaman Trunk Road (slated to be 300 km long). ..... Early 1970's

12. Sea turtles accorded total legal protection by inclusion in Schedule I of the Indian Wildlife (Protection) Act. 1972

13. Burgeoning of shallow-draft mechanized dugouts. ..... 1970's

14. Wildlife Wing of the Andaman and Nicobar Forest Department established. ..... around 1975

15. North Reef and South Sentinel: first turtle nesting islands in the Andamans notified as Sanctuaries, albiet primarily for the protection of, respectively, the Andaman Teal and the Robber Crab. 1977

16. Surveys to locate nesting beaches, and discovery of leatherback and olive ridley nests on the islands. 1978

17. Closure of curio trade in turtle products. 1978

18. North Button, Middle Button and South Button National Parks notified. (All three are turtle nesting islands) 1979

19. Wandoor Marine National Park notified. The Park includes important feeding habitat for turtles, two major nesting islands for hawksbills (the Twin Islands) and a leatherback nesting beach on Rutland Island, but excluded an important hawksbill nesting beach on Rutland's south-east corner. 1979

20. Translocation of Car Nicobarese to Harminder Bay, Little Andaman. (This brought the important leatherback nesting beaches at West Bay and South Bay within easy reach of humans). 1980

21. Last recorded instance of a leatherback nesting on Great Andaman shores, excluding Rutland. (at Cuthbert Bay) ....1980's

22. Interview and Tillongchang Islands (both important to nesting hawksbills and green turtles) notified as Sanctuaries. 1985

23. Notification of 94 islands as Sanctuaries. Of these, 30 are presently confirmed to host nesting turtles. The only important nesting sites now remaining outside sanctuaries lie in the Nicobars - on 5 or 6 inhabited islands (Little Nicobar, Katchal, Teressa, Trinkat, Kamorta and possibly Chowra) and on three seasonally uninhabited islands (Meroe, Trak and Treis), in addition to three beaches on the east coasts of North and Middle Andaman (Coffeedera, Karmatang and Cuthbert Bay). 1987

24. Great Nicobar Biosphere Reserve notified. 1989

25. Campbell Bay and Galathea National Parks notified. These Parks include most of the important nesting beaches now remaining on Great Nicobar Island. ....Around 1991

26. Establishment of the Coastal Regulation Zone. Within this zone, which extends 200 metres from the high tide line, all construction is prohibited. 1991

27. North Cinque Sanctuary opened to public tourism. This was the first uninhabited turtle island opened to overnighting tourists on an experimental basis, but has since been closed. 1992

List of 30 turtle–nesting islands notified as Wildlife Sanctuaries in 1987

Cinque*	Inglis	Hump	Landfall
Latouche	North Reef	Pocock	Reef
Snark	Sisters*	South Reef	Delgarno
East	Flat	Kwangtung	Trilby
North Brother	Paget	Point	West
Sir Hugh Rose	South Brother	South Sentinel	Excelsior
White Cliff	Tillongchang	Turtle Islands	

* Cinque consists of two islands (North Cinque and South Cinque) as also the Sisters and the Turtle Islands.

Evidence of the decline of sea turtles in the Islands

There can be little doubt that sea turtles have declined since the turn of the century, when it was reported that "the sea round the Islands swarm with fish and turtles" (Portman, 1899).

The green turtle was "particularly common at Car Nicobar" (Mackey, 1847) where "the natives - (turn nesting green turtles) on their 'carapans' – (and) leave them in that position till next day, when they carry them home". Nesting is now rare at Car Nicobar. Referring to Andamanese from Rutland Island's southern side, Portman reports that "their camp – (had) some large turtles which abound there, and are principally their food". Also, "on 12 November 1892 a party of eight Andamanese (from the South Andaman 'mainland') went to Rutland Island to catch turtle".

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A steady decline in the number of hawksbill nests on Rutland's south-west corner has been evident since 1978. Ten nests were counted in a survey in October 1978, but only five in January 1984 (Bhaskar, 1984).

Mining of beach sand for construction purposes is today a major, if not the most important activity threatening the survival of sea turtles in the Islands. Even islands in the Jarawa Reserve have not been spared, an example being Bluff Island, which was mined at least during one year, 1985. Corbyn, writing in about 1860 notes that there existed at the site of present-day Corbyn's Cove "a large sandy beach" (Portman, 1899). Today, spring tides lap at the base of the strand that has been constructed here, along most of the length of the beach, leaving little habitat for nesting olive ridleys.

The occupation and settlement of the Islands has reduced, and often eliminated, nesting at several locations. A specific example is the beach at Karmatang No.9, where leatherbacks ceased nesting in 1974, when the last two nesters utilizing this beach were killed (Saw George, *pers. comm.*).

At Cuthbert Bay, two leatherback nests were seen in 1978. The last surviving nester was seen repeatedly by Forest Department officials over the course of several nesting seasons after that, but failed to remigrate to nest in the late 1980's.

Reduced nesting has been confirmed to occur even on some uninhabited islands over the span of nine years, between 1984 and 1993. Counts of hawksbill nests on three such islands were:

TABLE A: Decline of hawksbill nests

Island	1984	1993
North Reef	19	10
Kwangtung	27	20
Snark	39	less than 34

Dogs reared by settlers are now major predators of turtles eggs and hatchlings in the Islands, as are feral dogs even on uninhabited islets). Prime examples are dogs that belong to personnel maintaining the lighthouse at Indira Point, Great Nicobar, situated just behind an important hawksbill nesting beach.

Portman reports that "in the year 1865, – (the South Andamanese) first used dogs for pig hunting, which they learnt from some runaway Burmese convicts". The feral dogs which now prey on turtle eggs on Interview Island may have descended from dogs used by native Interview islanders in the latter half of the nineteenth century. These islanders then numbered several hundred at least, as can be inferred from the sighting of a visiting fishing party of Andamanese "several hundred" strong on South Reef Island (which, like neighbouring Interview Island is an important nesting site for hawksbills and green turtles on 31 December 1857 (Mouat, 1863). Feral and domestic dogs now prey on turtle eggs and young at leatherback and olive ridley nesting beaches at the mouth of the Galathea River, Great Nicobar Island, among other areas. In several remote areas, dogs become feral when their owners are transferred, as has often occurred at Indira Point.

Comments on nesting locations

I am unaware of even a single nest of an olive ridley having been made on the entire western coast of the Great Andaman Islands, from Landfall to Rutland. Neither are leatherback nests known from any of Great Andaman western shores, except on Rutland Island, where nesting turtles have a reef-free approach to the shore that lies opposite the Twin Islands. Practically the entire western shore of Great Andaman is fringed by relatively extensive coral reefs, which, however, do not inhibit hawksbills, and to a lesser extent green turtles, from nesting on these shores.

Hawksbills typically favour small, isolated islands to nest on, though Interview Island and the nesting beach at Indira Point are exceptions (as also was the south-west corner of Rutland Island).

On Great Nicobar and Little Andaman Islands, most of the currently important leatherback nesting beaches lie on the west coasts (the Galathea beach is an exception), well away from major human settlements. As is the case elsewhere in the world, leatherbacks that nest in the Andamans and Nicobars do so most often on beaches that straddle the mouths of rivers or streams, possibly because silt deposited by these water bodies allow these large turtles to approach the shore over a silty sea-bed, rather than over corals or rocks. However, at least one leatherback nest was found at a site where the sea approach ended in an apparently dangerous but short (seven m) swim over a reef on the south-eastern shore of Teressa Island.

Nests of the hawksbill and the green turtle have been found on the same beach at several sites in the Islands, prime examples being South Brother, South Reef, Snark and Meroe islands. Leatherback and olive ridley nests are frequently met with on the same beach, examples being those at the mouths of the Alexandria and Dagmar Rivers in Great Nicobar Island, and the beach at South Bay, Katchal Island.

Green turtles and olive ridleys both nest at individual beaches at Smith Island and Cuthbert Bay, but the only beach where three species still definitely nest is at Saphed

Balu ("White Sands") about 5 km south of the Galathea Beach, where low-intensity nesting by leatherbacks, green turtles and hawksbills occurs.

Method used to estimate annual nesting populations

To estimate the number of turtles nesting each year in the Andamans and Nicobars, nest counts for each species have been divided by the following factors which represent the average number of times an individual turtle nests within a season (based on surveys conducted in 1992 and 1993):

Olive ridley : 1.5
Leatherback : 4.9
Hawksbill : 2.852
Green turtle : 4

The factors, especially for the green turtle, are based on small sample sizes and should be revised as more data become available.

Tagging

The tags used for all species were metal wire plastic moulded tags (DALTON HENLEY, ENGLAND, Pat. No. 894413) inscribed with numbers, for example, AN 301. Tagging was not attempted before the turtle began dropping eggs, except in the case of non-nesting turtles that were about to re-enter the sea. The site of the tag was the first large scale on the trailing edge of the left fore-flipper, except for *Dermochelys* which was tagged on the membrane between the tail and the left rear flipper. No injuries suggesting loss of a tag were noticed on any of the turtles, at least in one nesting season.

Estimates of annual nesting populations for each species

Nest counts given below are all one-time counts (i.e., they did not cover an entire nesting season at any beach), with three exceptions: hawksbill and green turtle nest counts at South Reef Island; olive ridley and leatherback nest counts at Galathea beach on Great Nicobar Island and olive ridley nest counts at Cuthbert Bay (Misra, 1990), each of which covered at least the major portion of the nesting seasons for the species involved. Survey dates are therefore given for each count, so that the counts can be viewed from the perspective of the phase and span of the nesting season. Nests preyed upon by animals and humans have been included in the counts. Instances in which turtles came ashore but obviously failed to nest are, of course, not included in the counts, but a few of the 'nests' counted could have been false nests, especially in the case of hawksbills in the drier months (January to April), and in the case of green turtles and leatherbacks. Olive ridley turtles were found to nest practically every time they came ashore, but also sometimes made 'false' nests before nesting.

The nest counts listed are the most recent available for each site. Though nests may now have decreased at some of the sites surveyed in the 1970's and 1980's, it is certain that the overall total of nests estimated for each species here is on the conservative side, even allowing for the accidental inclusion of 'false' nests.

Hawksbill nesting season: Round the year, but mainly July to December. Peak in September to October.

TABLE B: Hawksbill nests

Island	Date(s) of survey	Nests	Comments
Hump	3 April 1993	8	Minimum count
South Reef	12 Sept. 1992 to 4 April 1993	131	
Interview	3 to 11 December 1983	17	
North Reef	23 to 25 March1993	10	Down 9 from 1984
Latouche	24 March and 7 April 1993	12	Static from 1984
Kwangtung	7 to 8 April 1993	20	Down 7 from 1984
Snark	8 April 1993	29	Down 10 from 1984
Point	8 April 1993	3	
Paget	8 to 9 April 1993	1	
Reef	9 April 1993	3	
White Cliff	9 April 1993	4	
West	10 April 1993	6	
East	11 to 12 April 1993	4	
Landfall	12 April 1993	10	
Pocock	12 April 1993	3	
Excelsior	13 April 1993	4	
Delgarno	13 April 1993	12	
E. Turtle	13 April 1993	5	
Rutland	16 January 1984	10	Aug. 1992: 10 nests
W. Twin	2 November 1983	12	Up 8 from 1978
E. Twin	22 to 23 November 1983	13	Down 3 from 1978
N. Cinque	10 January 1984	18	
S. Cinque	9 to 11 January 1984	20	
Sisters	11 January 1984	4	
N. Brother	11 January 1984	78	
S. Brother	11 January 1984	37	
	TOTAL	474	

This total of 474 nests made annually by hawksbills in the Andamans is therefore a composite estimate obtained from data relating to two separate nesting seasons, namely, 1983 to 1984 and 1992 to 1993. Adding an estimated 100 nests for the remaining unsurveyed islands in the Andaman group, the estimate goes up to 574 nests.

The estimated nesting population in the Andamans in one year is therefore 574 divided by 2.852, which equals 201 nests.

In the light of our knowledge of the hawksbills nesting season, it is now clear that nest count surveys will be most fruitful if undertaken in end-November. Pending such surveys in the Nicobars, it can be assumed, from the available data, that these islands support less than a quarter of the numbers that nest in the Andamans. The overall number of hawksbills that nest each year in the Andamans and Nicobars is therefore estimated to be 250. The overall nesting population of hawksbills in these Islands, as also those of the three remaining species, can be estimated only after their remigration intervals are known.

Olive ridley nesting season: October to March, the peak being January to February.

In the list given below, nest counts for three sites known to be prime olive ridley nesting areas have not been included. The sites are Ramnagar beach in North Andaman

(which has not been visited by me) and Smith and Trilby islands, where all the nest sites surveyed in April 1993 were old and had also suffered human predation. Scattered nests on the east coasts of North, Middle and South Andaman islands have also not been included.

TABLE C: Olive ridley nests

Nesting Areas	Nests	Dates of survey	Source
Coffeedera (in North Andaman)	13	2 to 13 April 1993	
Cuthbert Bay (in Middle Andaman)	338	October 1988 to March 1989	Misra, 1990
Karmatang No 9 (in Middle Andaman)	14	27 March 1993	
Little Andaman	5	29 March 1978 to 5 January 1979	
Katchal Island	9	7 to 11 February 1979	
Teressa Island	8	12 March 1979	
Great Nicobar	280	12 December 1991 to 22 April 1992	
TOTAL	667		

The population that nests in one year is therefore estimated to be 667 divided by 1.5, that is, 445 turtles.

Any future surveys aimed at obtaining counts of olive ridleys nests in the islands will be most productive if undertaken in the last week of February and the first week of May. In Great Andaman (excluding Rutland Island), counts need be confined to the east coast alone.

Leatherback nesting season: In the Nicobars, mainly November to February, peaking in January, maximum nesting observed in Rutland from September to December. For the Andamans and the Nicobars as a whole, nests have also been found in all other months except May.

As the following Table will show, a fair idea of the numbers nesting in the Islands in a year can be obtained from nest counts exclusively on three islands: Great Nicobar, Little Andaman and Little Nicobar, to be undertaken in March.

Nest counts for South Sentinel Island, where leatherbacks are reported to nest (I. H. Khan, *pers. comm.*, 1993), are unavailable.

TABLE D: Leatherback nests

Island	Nests	Dates of survey	Source
*Rutland, west coast	5	25 August 1992	
Little Andaman, west coast	84	12 to 14 January 1984	
Little Andaman, South Bay	10	26 February 1981	
Katchal	5	7 to 11 February 1979	
Teressa	4	12 March 1979	
Great Nicobar	811	12 December 1991 to 22 March 1992	
Little Nicobar	49	19 April 1991	Tiwari, 1991
TOTAL	968		

* 161 nests were found during a Forest Department survey between February 1990 and March 1991 (A. Saxena, *pers. comm.*, 1994).

The number of leatherbacks that nest in a year in the Andaman and Nicobar Islands is therefore estimated to be 968 divided by 4.9, that is 198 turtles.

Green turtle nesting season: Round the year, but with most nesting believed to occur during the two monsoons from June to November, with a peak in July.

The nest counts listed below omit those obtained from the Nicobars, where surveys have until now been undertaken in the less-productive 'dry' season. At least four islands in the Nicobars, namely, Tillongchang, Trak, Treis and, most importantly, Meroe are known to have substantial populations of nesting green turtles. In the Andamans, counts are unavailable for the important nesting island of South Sentinel, where green turtles were seen nesting in February 1973 and March 1974 (Davis and Altevogt, 1975).

Portman also describes a visit on 20 April 1884 to South Sentinel where "turtle are to be got in great numbers, for, being undisturbed here (no traces of the aborigines were here), it appears to be one of their favourite breeding places".

TABLE E: Green turtle nests

Island	Nests	Dates of survey
Hump	35	3 April 1993
South Reef	69	12 September 1992 to 4 April 1993
Interview	105	3 to 11 December 1983
Latouche	4	24 March and 7 April 1993
Snark	15	8 April 1993
Point	3	8 April 1993
Paget	1	9 April 1993
Reef	3	9 April 1993
White Cliff	4	9 April 1993
West	6	10 April 1993
East	5	11 to 12 April 1993
East	5	11 to 12 April 1993
Landfall	5	12 April 1993
Pocock	3	12 April 1993
Sound	5	15 April 1993
Craggy	1	15 April 1993
Smith	13	13 to 15 April 1993
Ross (by Smith)	2	14 April 1993

TABLE E: (Contd)

Island	Nests	Dates of survey
Dolgarno	7	13 April 1993
Excelsior	3	13 April 1993
Rutland	4	25 August 1992
West Twin	1	23 November 1992
South Brother	37	11 January 1984
Little Andaman	2	12 January 1984
TOTAL	333	

The number of green turtles nesting in one year in the Andaman Islands (excluding the Nicobars) is therefore estimated to be 333 divided by 4 = 83 turtles.

Turtling areas referred to in Portman (1899):

The references to Rutland Island have been mentioned earlier.

Little Andamanese are recorded to have regularly visited South Brother Island for turtles "in the same way as the Andamanese in Port Mouat go to Termugli" (Tarmugli Island). "On 10 September 1889, Port Mouat Andamanese had gone out to hunt for turtles - (around) Lekera, about 10 miles north of the outer harbour of Port Mouat". Also, "about the month of January the dugong shows itself in Port Mouat Bay, coming to feed upon a species of seaweed, which is also relished by the turtles".

"On 19 August 1894 - a part of Andamanese - had been turtle hunting - (around) Port Campbell".

The "hundreds of skulls of turtles" found by Portman on Temple Island (where today the nesting beach on the islands's south-western end is barely 75 metres long) must have been derived from turtles caught in the sea around the bay at present-day Diglipur.

On South Brother Island on 27 October 1880 "there were traces of a number of people having recently been on the island and from the amount of tortoise-shell about I should imagine their (the Little Andamanese) reason for coming to procure turtle —".

Again, on 11 November 1891, Onges from Little Andaman "were turtling on South Brother Island".

"It is the custom of the Onges living at the north of Little Andaman to come up for turtle, to as far as the Cinque Islands every third or fourth year, during the break of calm weather which occurs at the change of monsoons in October, and to return — in the following February or March".

In April 1867 Rutland Islanders stated that they "frequently went" (to the Cinque Islands and Passage Island) "to get turtle and large fish".

In addition to the above, there exists a record in Mouat (1863) that " in a tolerably large hut (on Craggy Island) — the skulls of pig and turtle were suspended from the roof".

RECOMMENDATIONS

1. The removal of beach sand for construction purposes at all the areas allotted for settlement between Campbell Bay and the 35 kilometre stretch along the north-South road on Great Nicobar has summarily eliminated nesting habitat, especially for *Dermochelys coriacea* on this section of coast. Nesting presently occurs predominantly on beaches outside the settlement areas; fortunately, these beaches will fall under the protection of the two recently- gazetted National Parks on the island. However, in the absence of alternative sources of sand for construction, the sand on these beaches will always remain vulnerable to legal or illegal exploitation. Safeguarding of sand and background vegetation at existing nesting beaches is of paramount importance.

2. Feral and itinerant dogs take a heavy toll of turtle eggs and especially of hatchlings at the Galathea beach, at Saphed Balu and at Indira Point. Elimination or control of these dogs throughout the duration of the nesting and hatching seasons is vital.

3. Introduced species such as rats need to be immediately eradicated from South Reef Island.

4. On the beaches on Great Nicobar's west coast, for example, Renhong, Pulo Bet and at the Dagmar and Alexandria beaches, domestic pigs and dogs prey heavily on turtle eggs and hatchlings. A conservation education programme aimed at the small Nicobari communities at Renhong, Rokoret, Pulo Bet, Pulo Kunji and at Kopen Heat will help to reduce this drain.

5. At least two nesting beaches on Great Nicobar are in use as picnic spots - the Galathea beach and the Indira Point area. Nest sand is inadvertently compacted by human feet. This interferes with gas exchange within nests. Hatchlings also find it difficult to break free and emerge from the compacted sand above their egg chambers. Cattle that stray onto nesting beaches, especially the Galathea beach, also compact sand. Human use of nesting beaches should be restricted to the zone of hard-packed intertidal sand only (where turtles do not nest) when tides permit. Unfenced pathways leading down to this zone across the nesting zone need to be marked out and used during the nesting and hatching seasons.

6. The continued presence of investigators on a turtle beach deters or at least inhibits humans from exploiting eggs and turtles there. This was the case at the Galathea beach following establishment of the field camp on 16 Dec. 1991. No turtles and only three nests were taken by humans up to 7 March 1992 when the camp was shut down. The presence of conservationists and Forest Department staff through the nesting and hatching seasons is recommended.

7. Tree stumps and debris (both naturally dispersed debris and sawn timber) that are washed up by the sea during storm surges and high tides or are brought down by rivers and deposited along a zone otherwise favoured by nesting turtles adversely affect the latter in three ways: they restrict nesting space, resulting in congestion of nests; they injure nesters, causing abrasions that may invite predation by sharks; and they may force turtles to nest at sub-optimal sites such as those prone to erosion by the sea, to seepage by saline water which can kill hatching eggs. Debris-strewn beaches exist at the three

most important nesting areas for *Dermochelys coriacea* and *Lepidochelys olivacea* at Great Nicobar, at the mouths of the Alexandria, Dagmar and Galathea rivers. Removal of the debris in early November before the start of the nesting seasons for these species is strongly recommended.

8. Vegetation behind nesting beaches should remain inviolate since it provides optimal sand conditions (temperature, moisture and firmness) at nest sites and may be one of the cues that help orient emerged hatchlings towards the sea.

9. From the standpoint of hawksbill and green turtle conservation, the islands listed in Table F urgently need to be set aside as sea turtle sanctuaries. Other prominent fauna that will receive incidental protection by doing so are listed. The following activities are to be totally prohibited on these islands:

- Mining of beach sand.
- Tourism.
- Construction of wells, roads and permanent or temporary structures on or within one and a half kilometres of each island.
- Felling of timber, small trees, and clearing of vegetation including seashore vegetation.
- Visits by humans by day and by night except with prior permission from the Forest Department.
- Plying of boats within one and a half kilometre of the islands coast.

10. To locate unrecorded sea turtle nesting areas, surveys need to be undertaken at several islands, which are listed on page 13.

11. All known turtle islands need to be re-surveyed once in four years.

12. Involving local youths/tribals by engaging them as temporary guards/watchmen during the peak nesting season on various major beaches (this has already been experimented in Cuthbert Bay and Dhaninala areas of Middle Andaman with good success), for doing night patrolling and also keeping a watch on nests/predation by dogs etc.

TABLE F

Proposed islands to be designated sanctuaries for sea turtles	Sea turtle species and other fauna that will be protected by the proposed designation
Meroe *	Hawksbill turtle, coconut crab, green turtle, sea krait, megapode
Trak *	Hawksbill Turtle, green turtle
Treis *	Hawksbill turtle, green turtle

* Camping by Nicobarese, who have traditionally used these islands to fish and to harvest coconuts, should be permitted, but not the use of firearms and dogs.

TABLE G

Islands designated sanctuaries	Sea turtle species and other fauna present in the designated sanctuaries
Snark	Hawksbill turtle, sea kraits
Kwangtung	Hawksbill turtle, sea kraits
South Reef	Hawksbill turtle, sea kraits, green turtle (*Chelonia mydas*)
North Reef	Hawksbill turtle, sea kraits, Andaman teal (*Anas gibberifrons albogularis*)
Latouche	Hawksbill turtle, sea kraits
Interview	Hawksbill turtle, sea kraits, green turtle, Andaman pig (*Sus andamanensis*) King cobra (*Ophiophagus hannah*), Andaman greyrumped swiftlet (*Collocalia fuciphaga inexpectata*)
North Cinque	Hawksbill turtle, fruit bat (*Pteropus giganteus*)
South Cinque	Hawksbill turtle
West Twin	Hawksbill turtle, sea kraits, green turtle
East Twin	Hawksbill turtle, sea kraits, green turtle
North Brother	Hawksbill turtle, green turtle
South Brother	Hawksbill turtle, green turtle
South Senthinel	Hawksbill turtle, coconut crab (*Birgus latro*), green turtle
Tillanchong *	Hawksbill turtle, coconut crab, Andaman pig, green turtle, sea kraits, megapode (*Megapodius freycinet*), saltwater crocodile (*Crocodylus porosus*), reticulated python (*Python reticulatus*)

Islands and areas to be surveyed for nesting turtles

The following is a detailed checklist of islands and areas that have not been covered by turtle surveys:

South Sentinel	Kyd	Batti Malv	Bompoka
North Button	Petman	Chowra	Kabra
Middle Button	Neill	Duncan	Menchal
South Button	Sir Hugh Rose	Passage	

On partially surveyed islands, the following areas remain to be covered:

Kamorta	(the west, north and north-eastern sides)
Little Nicobar	(most of the coastline)
Great Nicobar	(the north-east coast)
Inglis	(the north-western side)
Outram	(east and south coasts)
Havelock	(the southern end)
Henry Lawrence	(the eastern coast)
John Lawrence	(the eastern coast)
Wilson	(the western coast)
Little Andaman	(north and north-east coasts and two beaches south of Jackson Creek)

The west coast of the Jarawa Reserve includes several good turtle beaches. In addition, the following islands that lie within Tribal Reserves in the Andamans have not been surveyed for sea turtles:

North Sentinel	Defence	Bluff	Sandy
Montgomery	Petrie	Spike	Flat
North Passage (east coast)			

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GREAT NICOBAR ISLAND

Summary

Great Nicobar is the most favoured of the five islands known to be regularly used by nesting leatherback turtles (*Dermochelys coriacea*) in India. The other four are, in order of importance, Little Andaman, Little Nicobar, Rutland and Katchal, all in the Indian Union Territory of the Andaman and Nicobar Islands.

Nesting of lower intensity also occurs at three other islands in the Union Territory namely, Teressa, North Cinque and South Cinque islands, but has ceased on at least two other beaches since surveys were undertaken in 1978, namely, Karmatang No.9 and at Cuthbert Bay (near Betapur No.2), both in Middle Andaman where human settlements have proliferated.

Both leatherbacks and olive ridleys (*Lepidochelys olivacea*) nest at least during the period November to April, the peak of the nesting seasons for both species being January to February.

On Great Nicobar Island, 811 excavations made by nesting leatherbacks were counted on 8 of 9 nesting beaches on the island. A conservative estimate of the nesting population on the island in the 1991-92 season is 166 leatherbacks.

Great Nicobar is believed to be the second-most important nesting island for olive ridley turtles in the Andaman and Nicobar group, next only to Middle Andaman where 338 nests were reported from Cuthbert Bay during the 1988-89 season. Four well-frequented olive ridley nesting beaches exist at Great Nicobar, on three of which a total of 280 nests were counted. A conservative estimate of the nesting population on the island in the 1991-92 season is 187 turtles.

Tagging studies of nesting olive ridley turtles at the Galathea beach suggested that 50% nested twice within the season, the other half nesting once.

The reasons for low hatchling emergence percentages in leatherback and olive ridley nests at the Galathea beach were primarily:

a) predation of eggs and hatchlings by dogs and to a lesser extent by ocypode crabs

b) natural spoilage of hatching eggs by tidal sea water

c) compaction of nest sand by the movement of cattle and humans on the beach. Compaction decreases nest aeration and also physically obstructs emergent hatchlings.

The Leatherback Turtle

Available for the first time is a workable though conservative figure for the nesting population of the leatherback turtle in any one nesting season on Great Nicobar Island (15 November 1991 to 17 May 1992) the most important of India's nesting areas for this species (Bhaskar, 1979, 1980 & 1984; Tiwari, *pers. comm.*, 1991). Of the nine leatherback nesting beaches here, eight that were surveyed gave a total count of 811 'excavations'. (The term 'excavation' here includes nests and false nests. The latter may constitute 10%

nests. The latter may constitute 10% of all excavations). Twenty- five of the estimated thirty-two leatherbacks that nested at the beach of the mouth of the Galathea River (one of four beaches on the island where nesting preponderates) were tagged. Based on studies here, an estimated 166 individual leatherbacks nested on Great Nicobar this season. Each female nested 4.9 times on an average, range 1 to 7 times (n = 27 turtles), at an average renesting interval of 10.14 days, range 8 to 14 days (n = 59 intervals involving 17 turtles). Only 64.3% of leatherback nests emerged at Galathea beach, due to spoilage of nests by tides, predation by dogs, and infiltration of *Ipomoea* and *Pandanus* roots into nests. Hatchlings from only 27.4% of the total eggs laid emerged from nests.

Nesting Season

Though field work commenced at the Galathea beach about one month after the start of the leatherback nesting season, the date of the season's onset was determined quite precisely from the date of emergence of the season's first leatherback hatchlings, the night of 19/20 January 1992 and from a knowledge of the 'emergence period' (incubation period plus time taken between hatching and emergence of the hatchlings onto the beach surface) for a selected nest, 63 days. The first nest was therefore laid on or about 17/18 December 1991. At the Galathea beach, the peak of the leatherback nesting season covered the 10-night period 16/17 January 1992 to 25/26 January, during which 21 excavations were made. However, the maximum number of excavations in one night was five during the two nights of 11/12 January 1992 and 1/2 February. The limits of the nesting season are now known, with allowances to be made for natural year-to-year fluctuations. A fresh excavation was found at Betapur No.2, Middle Andaman on 15 November 1978 (Bhaskar, 1979) and on 7 April 1979 at Saphed Balu, Great Nicobar. Regular field work at the Galathea beach ended on 6/7 March 1992 and the last untagged turtles encountered were tagged on 29 February/1 March, added evidence that nesting spills into April. The present survey confirmed that the majority of nests (over 90%) are made between December and March, though the season extends from November to April.

At the Galathea beach, a nest with well-developed embryos opened by predators was found on 10 December 1991, suggesting that this nest had been laid about one and a half months earlier, around 26 October 1991. On 10 October 1991, coastguard personnel sighted three leatherbacks at sea off Pulo Babi on Great Nicobar's west coast, at about one minute intervals. All the turtles were swimming towards the coast (*pers. comm.*, Dy. Commandant S. B. Singh of the Coast Guard) (Table 1). Three more excavations were recorded on the Galathea beach on the far side of the Galathea River from the study beach. A total of 158 *Dermochelys coriacea* excavations were found at the Galathea beach during the survey.

Table 2 refers to nests preyed upon by domestic pigs (p), dogs (d), unspecified animals (a) and to those collected by man (m) namely, by Nicobarese, who are presently exempt from the provisions of the Indian Wildlife Protection Act, 1972, which provides total legal protection to sea turtles, their eggs and derived products.

Counts at the Galathea beach and at Saphed Balu were nearly exact but those at all other beaches were very on the conservative since the surveys there were undertaken towards the end of the nesting season, before which several nest sites had been

obliterated by wind-blown sand, by rain, and by the tracks of turtles, pigs, dogs and man. Table 3 shows details from nests that emerged.

Possible explanations for the discrepancy in emerged nests between number of empty eggshells and number of hatchling tracks visible:

A. Predation by *Ocypode* crabs on developing or pipped eggs or on hatchlings inside the nest. Eggs in nest opened by predators may dry during the incubation period and the eggshells may present the appearance of hatched eggs.

B. Hatchling predation on the beach by crabs and other predators.

C. Overlooking of tracks of hatchlings, or their obliteration by wind, rain or nesting turtles.

The discrepancy may arise from a combination of these reasons.

The Olive Ridley Turtle (*Lepidochelys olivacea*)

For the first time, a practical estimate of the 1991-92 season's nesting population of the olive ridley at Great Nicobar is available. Of the four major olive ridley beaches on the island, three that were surveyed showed a total of 280 nests. Tagging studies revealed that 50% of females nested at least twice within the same season. The other half nested once. This gives a minimum population estimate of 187 nesting turtles on Great Nicobar during the 1991-1992 nesting season. 338 nests were reported from Cuthbert Bay, Middle Andaman during the 1988-89 season (Misra, 1990).

A turtle bearing tag number AN 18 renested after an interval of 13 days, believed to be the shortest interval ever recorded for this species. Of the 42 turtles tagged, 12 encountered renesting showed an average internesting interval of 18.3 days, range 13-28 days (n = 12).

Only 49% of nests emerged at the Galathea beach. Hatchling emergence percentage was 76.5% (n = 6 nests) of all eggs laid in nests that eventually emerged. 'Emerged' nests and 'emerged' hatchlings refer here to nests from which at least one hatchling emerged onto the beach surface, and to live hatchlings that emerged onto the beach or reached within 20 cm of the beach surface. In contrast 'hatched' turtles refer to hatchlings that merely escaped from their eggshells. Only 37.5% of all eggs laid resulted in hatchlings that emerged (Table 4).

Size of the smallest nesting female: CCL 62.5 cm, CCW 63.5 cm. This provides an idea of the size at sexual maturity at the Galathea beach. A slightly larger turtle (CCL 64.5 cm and CCW 63.5 cm) that was weighed after oviposition scaled 29 kg. The olive ridleys nesting at Gahirmatha are significantly larger (Table 5). All carapace measurements were conventional standard dimensions.

Renesting intervals for *Lepidochelys olivacea* at Galathea beach

Ridleys found renesting at the Galathea beach had renesting intervals of shorter duration, range 13-28 days, average 18.25 (n = 12) than those recorded at Gahirmatha by Kar & Dash range 46-58 days, average 53 days, (n = 9). The intervals at the Galathea beach were 13, 14, 14, 15, 15, 15, 17, 18, 19, 25, 26 and 28 days. The average renesting interval at the Galathea beach remains uncertain as it is unclear whether the 25, 26 and 28-day intervals each result from two nestings or three. Individual ridley's that nested thrice within a season have been tagged in Surinam.

Population estimates

Of 91 nesting visits made by olive ridleys to the Galathea beach from the commencement of the tagging programme in December 1991 upto the night of 6/7 March 1992, 52 (i.e., 57.14% of the 91) visits were encountered by tagging personnel. Had all the 42 tagged turtles renested once each, the number of investigator-turtle encounters involving these turtles would have been 42 x 52/91 = 24.

Since only 12 tagged turtles were encountered, it follows that only 50% of the 42 tagged turtles renested. Extrapolating these figures, we obtain for a nesting population that made 103 nests during the season, a figure 103 x 2/3 = 69 turtles.

This is an estimate of the minumum population of olive ridleys that nested at the Galathea beach during the 1991-92 season.

280 olive ridley nests were found on Great Nicobar. The estimated number of turtles involved 280 x 2/3 = 187.

Encounter percentage

Thirty-eight out of 91 nesting emergences were missed by tagging personnel during the period 23/24 December 1991 to 6/7 March 1992, giving an investigator-turtle encounter percentage of 58.24.

Emergence periods

Two natural nests that hatched on 24/25 February and 25/26 February 1992 emerged in 55 and 54 days respectively, at the Galathea beach.

'Incubation periods' of 66 to 67 days 1 to 2 days have been reported for ten olive ridley nests that were fenced-in to thwart predators, at Betapur, Middle Andaman (Misra, 1990). The disparity in emergence periods at the two beaches provided evidence that such fencing-in of nests reduces incubation temperatures by over 2° C, resulting in males. It is believed that almost all the fenced hatchlings that reached the sea at Betapur were males.

Hatchling production

Hatchling production at the Galathea beach during the 1991-92 season = Total number of nests x percentage of total nests that emerged x average number of (emerged H + AINs) per nest.

% Hatchling emergence in emerged nests = ((H emerged + AINs)/clutch size) x 100 = 512/669 x 100 = 76.53% (n = 6 nests)

Since only 49% of total nests emerged, the overall hatchling emergence percentage for all nests = 76.53 x 49/100 = 37.5%

Hatching % = ((H emerged + AINs + DINs)/clutch size) x 100
= 514/669 x 100 = 76.83% (n = 6 nests)

SOUTH REEF ISLAND

Description

From the air, South Reef is shaped roughly like a boat viewed side-on, with its long axis oriented NNE-SSW. It is situated at about 12° 46' N, 92° 40' E, nearly one and a half km SSW from the southern tip of Interview Island. The longest dimension - along the east coast - is 440 metres and the greatest width 90 metres. The island is surrounded by a fringing coral reef except for narrow gaps at its northern end, where individual coral heads exist. Landing by any but small boats (less than 3/4 metre draft) is impractical or difficult, and even this requires favourable tides and weather which, however, prevails from about mid-November to mid-May. Between June and mid-November, landings are safe only during calm spells, on the east coast. The island is well forested despite the presence near the east coast of three small clearings, the sites of temporary camps apparently used by divers and fishermen. The fringing reef is broadest (about 250 m) off the island's western coast, where most of the beach sand is confined to a 20 metre long, 5 metre broad stretch near the island's centre. Nesting by sea turtles mainly occurs on the 440 metre eastern beach and on the contiguous 90 metre long south-western beach. Nesting also occurs on the 75 metre long northwestern beach. Except for the 20 metre stretch alluded to, most of the islands's western shore is characterized by large fallen trees, some coral rubble and very little exposed sand, on which turtles do not often nest except when disturbed off the more favoured eastern, north-western and south-western beaches.

Other than rats, a few civet cats and a species of small bat, no mammals appear to live on the island. Scorpions and centipedes occur but are not commonly seen. Two beehives were found, the bees obtaining at least some of their nectar from blossoms of morning glory (*Ipomoea pes-caprae*), a convolvulus which is also important to nesting turtles because it helps bind beach sand, facilitating the building of egg chambers by nesting turtles in the dry season, and retarding sea erosion.

Overview

During a sea turtle survey in 1983-84 (Bhaskar, 1984) at least 335 hawksbill nests were counted on ten islands in the Andamans. South Reef still remains nine years later, among the three most important of these, the other two being North Brother Island and Snark Island. The other islands were Kwangtung, Interview, North Reef, Latouche, the two Cinque Islands, and South Brother. In addition, the two Twin Islands were reconfirmed to be favoured by nesting hawksbills. The south-west corner of Rutland Island, which was also an excellent hawksbill nesting area upto the 1980's is now practically devoid of beach sand as a result of sand mining. It is feared that South Cinque Island will also cease to be used by nesting hawksbills with the expansion of tourism there.

In the Nicobars, the island most favoured by nesting hawksbills is undoubtedly Meroe. In addition, Tillanchong, the southern tip (Pygmalion or Indira Point) of Great Nicobar Island, Trak, Treis and to a lesser extent Menchal and Pulo Milo are all used by nesting hawksbills (Table 12). Nesting at Car Nicobar has been practically eliminated by human exploitation of turtles and turtle eggs. Surveys remain to be conducted on Little

Nicobar, Chowra, Batti Malv and on parts of Kamorta. In addition, all the Nicobar islands remain to be resurveyed, to update the status of nesting turtles there.

During the 1983-84 survey, at least 191 green turtle nests were recorded, from four islands: Interview - 105, South Reef- 40, South Brother -370 and Snark -12.

Summary

South Reef Island in the Andaman group is believed to rank among the islands most favoured by nesting hawksbill turtles (*Eretmochelys imbricata*) in India. An estimated 41 hawksbills made 116 nests and 11 green turtles made 45 nests on the island during the period 7 July to 12 December 1992.

Nesting occurs throughout the year for both species, with peaks in September to October for hawksbills and June to July for green turtles.

The degree of nesting by both species has remained steady over the nine year period following a survey in 1983 with 80 hawksbill nests and 40 green turtle nests were counted.

A conservative first estimate of the nesting hawksbill population of 1992 in the entire Andamans is 205 turtles, of which a 20% nested on South Reef. The estimate for the entire Andaman and Nicobar group is 250 nesting hawksbills per season.

Preliminary tagging studies at South Reef suggest that, hawksbills nested an average of 2.85 times within a season, and green turtles an average of four times.

Average clutch size for the hawksbill was 131 eggs range 46 to 213, (n = 58 nests) and for the green turtle 91 eggs range 52 to 144, (n = 22 nests). The clutch containing 213 eggs is the largest recorded for any sea turtle nest in India.

Excluding nests from which no hatchlings emerged (preyed upon, sea-eroded and flooded nests), the overall percentage of eggs that hatched was 88% for the hawksbill and 89% for the green turtle.

The estimated hatchling production from nests made on South Reef Island between 7 July and 12 December is 12,100 for hawksbills and 3,300 for green turtles. These figures take into account the loss of 11 hawksbill nests due to egg predation, sea erosion and flooding of nests, and of 4 green turtle nests due to egg predation.

The percentage of non-nesting crawls made by hawksbills was 21.6% (22 out of 102 crawls) and by green turtles 23.1% (6 out of 26).

The maximum number of nestings observed at South Reef for an individual hawksbill was 4, and for an individual green turtle, 6. Several turtles were seen only once, but only 56.25% (45 of 80) nesting visits by hawksbills were intercepted by the investigators. Thirteen out of 14 i.e. 93% of nesting visits by green turtles were intercepted.

On the average, hawksbill hatchlings emerged onto the beach surface 61 days after oviposition range 55 to 73 (n = 15 nests), in control and temperatures that averaged 28.8° C, range 27 to 30.1° C (n = 15 nests).

Nesting ecology and reproductive effort

Hawksbills tended to nest lower down the beach than green turtles, usually on exposed sand above the spring hightide line or among *Ipomoea* or *Vigna* creepers. Over 80% of green turtle nests were made under the shade of *Scaevola taccada* bushes.

The average depth of the base of the egg chamber (measured from the sand surface) in hawksbill nests was 46 cm, range 32 to 60 cm (n = 53 nests) and in green turtle nests 70 cm, range 60 to 81 cm (n = 17 nests).

Track widths of hawksbill hatchlings ranged from 6 to 8.5 cm and those of green turtle hatchlings from 10 to 11 cm. Green turtle nests typically showed a 'leaving pit' (crater or 'body pit') that was greater than 25 cm deep. Those made by hawksbills were less than 20 cm in depth.

Nesting by turtles, in particular by hawksbills was very infrequent on nights following daytime visits to the island by boat crews, unlike on nights that followed 'undisturbed' days. However, the frequences were not quantified.

Nesting by both species was also found to be infrequent on otherwise favoured beaches where humans moved about during the day or used torches at night. Individuals of both species have been observed swimming parallel to the shore, and less than two metres from it, in shallow water less than half a metre deep, as they are silhouetted against the sandy sea bed in bright moonlight with the moon near its zenith. These turtles are clearly intent on selecting a nesting site; disturbed turtles frequently nested on unsuitable shores of the island, usually on the side opposite to the site of the disturbance where the nests were subject to excessively low temperature regimes and to flooding and erosion by the sea. Some disturbed turtles apparently chose to nest on a neighbouring island. Having done this, at least one individual (a green turtle) renested later on South Reef Island.

The degree of nesting both by hawksbills and by green turtles on South Reef has remained remarkably constant at least over the last 9 years. However, on the previously important hawksbill nesting beach on the south-west corner of Rutland, nesting has been drastically reduced or even eliminated by mining of beach sand, and probably also by egg collection and capture of turtles at sea and of nesters on land. The impact of tourism on the Cinque Islands, which were important hawksbill nesting islands upto 1983 at least, remains to be evaluated.

No large predators of turtle eggs or hatchlings (e.g., monitor lizards or wild pig) occur on South Reef, which is also usually uninhabited by humans. However, the island has numerous rats (*Rattus rattus*) some of which prey on emerged and emergent hatchlings. A family of civet cats (*Paradoxurus* sp.) destroyed four hawksbill nests during the three-month study period. Visiting parties of divers and fishermen took another eight nests (four of each species). It cannot be doubted that the degree of predation by humans, and visits to the island, will be higher during the period of calm weather, January to April.

Other than the boat belonging to the Forest Department, only three boats - all mechanized dugouts or 'dongies' were seen near the environs of South Reef Island during the period of rough weather ending on 16 November 1992. One of these boats,

owned by divers, was based near Mayabunder. The others, based at 'Goltikri' belonged to shark fishermen, who made two round trips past the South Reef area. After 16 November (when the weather calmed) and upto 12 December, five parties of divers, from the Webi area near Mayabunder came ashore or were seen near South Reef Island.

Other than our turtle camp, there existed on South Reef the abandoned remains of three temporary camps, apparently those of fishermen or divers.

An estimated 800 individual sea kraits (*Laticauda* spp.) including both sexes came up from the sea and entered the forested parts of the island during the period September to December. Courtship, temperature regulation and moulting were observed, but no mating. Two species - *Laticauda colubrina* and an unidentified species of the genus *Laticuada* - used the island, their relative abundance being about 200:1 respectively. No sea krait hatchlings or eggs were found on the island during the period 24 August - 12 December 1992.

Nesting seasons

Evidence from nest counts between 12 September and 12 December 1992 (80 nests) and from nests that emerged during the period 12 September to 11 November (36 nests) points to a start of the hawksbills main nesting season in July. The earliest hatchlings we saw came from hawksbill nests that erupted onto the beach surface on 12 September. Assuming an 'emergence' period (i.e., incubation period + time taken for hatchlings to emerge onto the beach surface) of 55 days, these nests were made on about 19 July. However, it is practically certain that nesting began earlier than 19 July. Table 8 shows the monthly nesting intensities for *E. imbricata*. September and October are the peak nesting months. Nesting by hawksbills in the Andamans has now been recorded in every month of the year except in June, during which surveys remain to be undertaken. Round-the-year nesting is likely.

As is the case of hawksbills, green turtle nests have now been found, or their occurrence established, in every month of the year except June, for which surveys are lacking. Nesting most probably occurs round the year. There is a peak in the nesting season in July. It is to be confirmed whether or not this peak includes the month of June also (Table 9).

Nesting population estimates

An estimated 41 hawksbills made 116 nests on South Reef during the period around July to 12 December 1992. Of these, 27 nesters were tagged, between 15 September and 12 December, during which period 77 nests were recorded. The rate of weekly nesting is shown in Table 6.

Eighty of the 116 nests were made while the investigators were on the island, 12 September to 2 December. Fifty-five days was found to be the minimum hatchling 'emergence period' (HEP), so that an additional 36 nests that emerged during the 55-day period following 12 September conclusively proved that at least 36 nests had been made by hawksbills prior to our arrival.

Average number of nests per hawksbill (a minimum estimate for 1 season)

= Total nests made after tagging commenced/Number of hawksbills tagged = 77/27 = 2.852

Population of 1992's nesting hawksbills on South Reef Island = 116/2.852 = 41

Nesting population estimate for the entire Andamans and Nicobars:

Assuming that the 1983-84 numbers have been maintained, the following approximate extrapolations can be made:

South Reef accounted for 80 out of 335 nests counted on 10 Islands in 1984. Therefore, the number of nests on these ten islands in 1992 = (116/80) x 335 = 486

Adding a conservative figure of 100 nests for the two Twin Islands, the remaining 20-odd unsurveyed islands in the Andamans, and for stray nesting: Total number of hawksbill nests in the Andamans in 1992 = 586.

Number of nesting hawksbills for the year 1992 = 586/2.852 = 205

Internesting interval was 14.2 days, range 12 to 17 (n = 5) renestings by tagged turtles.

Based on the 1992 surveys of this species, the numbers that nested in 1992 in the Nicobars may be less than one fourth this figure. A yearly nesting population of about 250 hawksbills in the Andamans and Nicobars is therefore a conservative first estimate. Total nesting populations will be estimated after remigration intervals are known.

For the green turtle at South Reef Island, an estimated 11 individuals made 45 nests during the period around 9 July to 12 December 1992. Of these, five nesters were tagged, between 15 September and 12 December, during which period 20 nests were made. As was reasoned for hawksbills, nest emergences proved that at least 25 green turtle nests were made before our arrival on 12 September. Table 7 shows details from hatched nests for green turtles.

Average number of nests per green turtle was 4, range 1 to 6 (n = 5). Internesting interval was 13.4 days, range 12 to 15 (n = 13 renestings) (Table 10).

Population of 1992's nesting green turtles on South Reef Island = 45/4 = 11

Pending surveys in June, believed to be one of the peak months for nesting, population estimates for the entire Andamans and Nicobars have not been attempted.

Turtle-investigator encounter percentage

Encounter percentage = Number of nestings seen during a given period / Number of nests made during this period = (45/80) x 100 = 56.25% for hawksbills.
For green turtles, encounter percentage = (13/14) x 100 = 92.86%

Size and weight

The only hawksbill weighed, Tag number AN 318, scaled 36.5 kg. At CCL/CCW measuring 71.25 /65.5 cm, this was a small individual: only 4 of the remaining 26 tagged

hawksbills were smaller, at 71/65.5, 71.5/62.5 and 71.5/58.5 cm. It is estimated that the last individual, the smallest, weighed about 34 kg. However, in December 1983, a hawksbill measuring 65.5/60 cm was recorded nesting on South Reef. This remains the smallest hawksbill found nesting in India and can be regarded as being close to the minimum size of sexually mature females of this species.

The largest tagged hawksbill (Tag number AN 316) measured 85.25/79.25 cm, but this was still slightly smaller than the smallest of the 5 tagged green turtles (Tag number AN 85, measuring 86.5/81 cm) (Table 11).

The largest of five nesting green turtles measured only 93.5/81.25 cm whereas at Nancowry and Trinkat Islands in the Nicobars 6 of 9 green turtle shells measured in 1979 were larger. Three of these measured over 100 cm CCL, the largest being 108/94 cm. Green turtles in the South Reef area apparently do not grow to large sizes, possibly due to predation by sharks, by humans, or by both.

Non-nesting crawls

Percentage of non-nesting crawls = (Number of NNC / Total crawls) x 100
For hawksbills, NNC percentage = (22/102) x 100 = 21.57%
For green turtles, NNC percentage = (6/26) x 100 = 23.1%

Clutch size

For hawksbill nests that emerged, the average clutch size, 131.2 eggs, range 46 to 213 (n = 58) was found to be almost identical to that for hawksbills listed in Bhaskar, 1984 (131.5 eggs, n = 6 nests). The average hatching percentage was about 5% lower in 1992 compared to that for the 6 nests in 1984 : 88.1% versus 93.3%.

For green turtle nests that emerged, the average clutch size was about 40 eggs less than for hawksbills - 90.6 eggs, range 52 to 144 (n = 22 nests).

Temperature dependence of hatchling emergence period

Hawksbill hatchlings from two nests made on the same night 27/28 September, and containing comparable numbers of eggs (82 and 114) emerged 8 days apart (in 60 and 68 days) in control sand temperatures measuring 29.5° C and 28° C, respectively. A 1.5° C difference in control temperature therefore altered HEP by 8 days, and doubtlessly also may have resulted in differing hatchling sex ratios (Fig.1). The number of hatched eggs in the respective clutches - a measure of metabolic heating of the clutch during incubation - were 75 and 100. During the period September - December, hawksbill nests took an average of 61.47 days to emerge, range 55 - 73 (n = 15 nests) at an average control sand temperature of 28.8° C (range 27-30.1° C, n = 15 sites). The largest rise in temperature due to metabolic heat, 3.4° C, was recorded for a hawksbill nest for which temperature at emergence was 30.6° C and control sand temperature 27.2° C. The number of eggs in this clutch was not recorded. However, for a nest containing 121 eggs, a 2.5° C rise was recorded.

The only green turtle nest for which temperature data was collected after emergence showed metabolic heating of at least 2° C (nest temperature = 30.8° C, control

sand temperature = 28.8° C). Only one nest was monitored for hatchling emergence period. This nest emerged on 11 November, 53 days after oviposition.

Predators

South Reef and several other islands important to nesting hawksbills in the Andamans and Nicobars are characterized by the absence of monitor lizards and wild pig, which are the main natural predators on turtle eggs and hatchlings on land at less favoured nesting sites. The island is usually uninhabited by humans, and feral dogs - elsewhere another major predator on turtle eggs and hatchlings - would not survive on the waterless island. A family of civet cats (*Paradoxurus* sp.) living on the island's northern end took four hawksbill nests during the three month period 12 September to 12 December. Ghost crabs (*Ocypoda* sp.) burrow into nests and take hatchlings and eggs, and also take hatchlings on the beach surface, but their net effect is low (estimated predation less than 5% of eggs laid).

Rats (*Rattus rattus*) abound on the island and take a small number (less than 3%) of emerged and emergent hatchlings. The nest of a white-bellied sea eagle (*Haliaetus leucogaster*) exists on a tree on the island's western shore (where less turtles nest than on the eastern shore), but the eagle was never observed preying on turtle hatchlings on land or at sea. Several species of sharks occur in the waters around South Reef Island, including the Tiger shark (*Galeocerdo cuvieri*), one individual of which had the head and flipper of an adult hawksbill in its stomach (Bhaskar,1984). A hawksbill carapace was removed from the stomach of a White-tipped shark caught off Cuthbert Bay, in February 1989 (A. Saxena, *pers. comm.* 1994). Despite the recent spurt in shark fishing in the area (for the shark-fin market), these fish are believed to be responsible for much of the natural predation that turtles and their young suffer at sea. Several barnacle-infested hawksbills were among those that nested, but none with shark-bite injuries or missing appendages were seen, except for one with a 14 cm wide, 3 cm deep bite-shaped indentation on the edge of its carapace.

Parties of humans (divers and fishermen) who visited the island took a total of 8 nests, including four each of hawksbills and green turtles. Three were taken in September and five in December. Fishing activity in the area in the months preceding 12 December was low: no turtles were captured in the area and no nesters came up with evidence of harpoon injury on their carapaces, unlike the case in 1984 when two of three nesting females seen had spear injuries. The nearest permanent human presence still remains at the police camp situated about 10 km away on Interview Island's western shore, and a Forest Department camp also about 10 km away, on Interview's eastern shore.

Tidal inundation of nests

During the survey period, three nests, all made by hawksbills were lost to inundation by tides - one on the island's western coast and two on its north-western coast, where erosion by the sea was heaviest. Loss of nests to flooding and erosion is of minor consequence at South Reef during this period (three out of 80 nests, i.e. 3.75%).

Time of nesting

Over 95% of nesting by hawksbills took place before 0145 hours. Nesting began well after nightfall in all instances except one, where a hawksbill emerged to nest at 1500

hours on 1 October 1992. This is the first record of daylight nesting by a hawksbill in India. All other hawksbills stranded later than 1800 hours. The first nesting turtles tended to arrive progressively earlier each night as the winter solstice approached. Green turtles usually arrived a bit later than hawksbills, and being heavier and deeper in 'draft' (and therefore more prone to injury on the fringing reef) were more dependent on the proximity of time of high water than were hawksbills. Despite this, individuals of both species occasionally stranded at or around the time of low tide. One such hawksbill crossed a 70 metre stretch of exposed, rugged intertidal reef in order to nest on the island's western coast.

Emergence of hatchlings

Unlike at the leatherback and olive ridley nesting beach at the mouth of the Galathea River on Great Nicobar, it was found impossible to count with any accuracy the tracks of individual hatchlings that had emerged from hatched nests, especially in the case of hawksbills, which are smaller and lighter than green turtles. The estimated hatchling production at South Reef, 21,100 for hawksbills and 3,300 for green turtles, is based on counts of egg shells and not of hatchling tracks. However, the figures are believed to be reasonably accurate.

All except three of 103 nests (79 hawksbill nests and 24 green turtle nests) are believed to have emerged during the night. One hawksbill nest emerged at 1430 hours on an overcast day, and one of each species on other days at 1630 and 1645 hours respectively.

NORTH, MIDDLE AND SOUTH ANDAMAN

Introduction

Thirty-seven islands off the Andaman coast were surveyed over the period 5 February to 15 April 1993 for nesting by sea turtles. All except five, namely, Aves, East, Smith, Sound and Ross (near Port Blair) are uninhabited.

Of the thirty-seven, twenty-four that were surveyed by the Madras Crocodile Bank for the first time have received no previous published attention relating to sea turtle nesting, though it is likely that earlier surveys have been conducted by the Forest Department on at least some of these islands.

Also surveyed were three of the four main nesting areas of the olive ridley on the 'mainland' coasts of North Andaman and of Middle Andaman - those at Coffeedera, Karmatang and Cuthbert Bay.

Findings

The total number of nests found in North and Middle Andaman excluding Cuthbert Bay and Ramnagar beaches (where the Forest Department had hatcheries) was 536*. Less than 74 of these were nests of the olive ridley. The rest, i.e., more than 462 were those of green turtles and hawksbills. Individual totals for the latter two species could not be ascertained.

The most important nesting island newly located during the survey was uninhabited Hump, where on 3 April evidence of 48 nests was found. Over 35 of these belonged to green turtles, the rest being hawksbill nests. Six of the 48 nests had visible tracks - those of green turtles - associated with them.

Hump Island now stands at par with South Reef, South Brother and Snark as a prime nesting island for the green turtle in the Andaman Islands, next only to Inverview. The island is ringed by a prominent sandy beach about 600 metres long and lies within the Jarawa Reserve, less than one and a half kilometre off the Middle Andaman 'mainland' - a situation that affords its turtles considerable safety from exploitation by settlers. However, fresh human footprints and a green turtle carapace with a hole in it were present on the beach, evidence that Jarawas on occasion swim or raft across to Hump Island during calm seas apparently in order to capture nesting turtles. This level of exploitation appears negligible.

On uninhabited Snark Island, nesting intensity has been maintained over the nine years following the 1983 survey. A decrease in Hawksbill nests was accompanied by an increase in *Chelonia mydas* nests. The encircling nesting beach is scarcely 400 metres long. Forty-nine nests were counted (on 8 April 1993), a high nesting density, as was the case on 28 December 1983 when thirty-nine nests were counted (Bhaskar 1984). At least fifteen of the forty-nine nests were those of green turtles, the remaining being hawksbill nests. Nine green turtle nests had visible tracks associated with them.

*Including an estimated 200 at South Reef Island, estimated during surveys from July 1992 to December 1992.

South Reef Island was revisited twice in 1993, from 21 to 22 March and 2 to 4 April. During the two-week period 21 March to 4 April green turtles came ashore only thrice and hawksbills twice. Sand temperatures measured on 22 March at nest depth were in excess of 30° C even under *Scaevola* bushes. Dry surface sand that collapsed into egg chambers being dug by turtles thwarted at least seven nesting attempts on these five occasions. A green turtle was tagged on 2 April. 116 hawksbill nests were estimated on South Reef for the period mid-July 1992 to 12 December 1992. Assuming that hawksbills then nested at the rate of one clutch per week upto 4 April 1993, we arrive at an estimated 131 hawksbill nests for the period mid-July 1992 to 4 April 1993. Also estimated were 45 green turtle nests for the period mid-July 1992 to 12 December 1992. On the assumption that green turtles then made three nests every two weeks upto 4 April 1993, we obtain an estimate of 69 green turtle nests for the period mid- July 1992 to 4 April 1993. The estimated total for this period on South Reef is 200 nests, the sum of 131 and 69.

The following is the location-wise breakup of nests found:

Location	Dates of survey in 1993	Total number of nests
Hump Island	3 April	48
South Reef Island	22 to 23 March and 2 to 4 April	200*
North Reef Island	23 to 25 March	13
Latouche Island	24 March and 7 April	16
Kwangtung Island	7 to 8 April	22
Snark Island	8 April	49
Point Island	8 April	6
Paget Island	8 to 9 April	2
Reef Island	9 April	6
Whitecliff Island	9 April	8
West Island	10 April	12
East Island	11 to 12 April	9
Landfall Island	12 April	15
Pocock Island	12 April	6
Coffeedera	12 to 13 April	13**
Excelsior Island	13 April	8
Delgarno Island	13 April	23
Trilby Island	13 April	15
East Turtle Island	13 April	8
Smith Island 13 to	15 April	21
Ross Island near Diglipur	14 April	4
Craggy Island	15 April	1
Sound Island	15 April	17
Karmatang No. 9	27 March	14**
OVERALL TOTAL		536

* estimated

** all olive ridley nests

Hatchlings emerged from an olive ridley nest at the tourist resort of Corbyns Cove on 23 February 1993. Only one nesting turtle, possibly the one that made the nest mentioned above, was observed by hotel staff at Corbyns Cove, in January.

No nests were found on the following islands that were surveyed, though this does not rule out the possibility of sporadic nesting:

Island	Date of survey	Island	Date of survey
Tree Island (near Hump)	3 April	Thornhill Island	9-10 April
Channel Island	12 April	Temple Island	13 April
Tree Island	13 April	W. Turtle Island	13 April
Ross Island	13 March	Aves Island	5 April
(near Port Blair)		Snake Island	5 February &
Jolly Boys Island	2 March	(near Corbyns Cove)	26 February
Brush Island	14 April	Oyster Island	15 April

In addition, a prominent sandspit (apparently unnamed) situated to the west of Louis Inlet and two rock-and-sand outcrops, one situated south of East Island, the other north of the Turtle Islands were surveyed but showed no evidence of nesting by turtles.

Predation of nests

Practically every nest on the following islands had been preyed upon by humans, dogs brought by humans, and monitor lizards: East Island, Excelsior Island, Delgarno Island, Trilby Island and East Turtle Island. Predation on nests was less heavy but still severe on several other islands namely, Point, Paget, Reef, North Reef, Latouche, Kwangtung, Whitecliff, Thornbill, West Island, Pocock and Sound.

Islands known to be important for nesting hawksbills in the archipelago in 1983 were South Reef, North Brother, Snark, South Brother, Kwangtung, North Cinque, South Cinque, East Twin, West Twin, Rutland, Interview, Latouche and Great Nicobar. In addition to these thirteen, four more islands in the Nicobars namely, Meroe, Trak, Treis and Tillanchong were confirmed in 1992 and 1993 to be important nesting locations for the species.

The most favoured green turtle nesting beaches in the Andaman and Nicobar group are believed to occur on Interview, South Reef, South Brother, South Sentinel and Meroe islands.

Factors adversely affecting turtles in the islands surveyed

Predation on eggs and on turtles at islands that are relatively remote from heavily settled areas poses almost as great a problem as that at easily accessible islands because of the absence of sea-going boats and a shortage of adequate personnel in the Forest Department.

The skeletal remains of 14 olive ridley turtles were present in a *Casuarina* plantation that backs the nesting area near the site of the turtle hatchery at Cuthbert Bay. This suggests that protection staff is spread too thinly even at key areas on the Middle Andaman 'mainland'.

Beach sand mining for construction purposes continues at several good turtle nesting locations. The nesting beach at Karmatang No.9 is an example.

Illegal felling of trees on uninhabited islands such as seen at West Island will, if not curtailed, eventually ruin the islands' ecosystems.

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TABLE 1: *Dermochelys coriacea* nesting intensity at the Galathea beach

Period	Start of season Season around 17/18 Nov. to 12 Dec. 1991	12/13 to 21/22 Dec.	22-31 Dec.	1-10 Jan.	11-20 Jan.	21-30 Jan.	31 Jan. to 9 Feb.	10-19 Feb.	20-29 Feb.	1-10 Mar.
Excavations	32	13	17	18	16	19	17	9	11	3

TABLE 2: *Dermochelys coriacea* excavation counts at eight major nesting beaches on Great Nicobar. The figures include predated nests, the numbers of which are in parenthesis.

Beach	Renhong	Rokoret	Pulo Bet	Pulo Kunji	Dagmar	Alexandria	Galathea	Saphed Balu
Survey dates	11-3-92	11-3-92	13-3-92	13-3-92	13-3-92 & 14-3-92	14-3-92 & 22-3-92	12-12-91 to 7-3-92	16-12-91 to 5-1-92
Excava-tions	86 (64p, 6m)	13 (6p)	0	21 (1p, 11m)	171 (25a,45m)	343 (82a, 45m)	158 (13d)	19 (0)

p = pigs, d = dogs, a = unspecified animals and m = man

TABLE 3: Data from *Dermochelys coriacea* nests that emerged

Parameter	N	Range	Average	Sample S.D.
Clutch size (big eggs)	35	39-148	90.4	22.402
Nest depth (cm)	29	49-86	70.07	7.682
Yolkless eggs	28	3-79	24.61	18.88
Eggshells in hatched nests	35	4-108	54.7	32.06
Hatchlings emerged onto beach plus AINs	26	2-97	37.04	27.39
DIN	35	0-26**	1.57	4.546
UH	35	4-104	35.43	26.17
VE (subset of UH)	34	0-57	11.68	11.89
NVE (subset of UH)	34	1-91	24.06	25.24
"Excess" eggshells***	26	0-41	12.31	12.96
% excess eggshells/total eggshells	26	0-71.4	24.64	22.61
For each clutch, (% emerged Hs + AINs/clutch size)	21	3.28-84.31	40.6	26.46
For each clutch, (% that hatched/clutch size)	35	6.31-95.74	58.65	29.71
DPE	34	0-10	0.68	1.804
AINs checked 12 hours after emergence of the first batch, including 96 AINs from one nest	28	0-96	7.54	17.9
AINs excluding 96	27	0-17	4.26	4.528

Hs = Hatchlings
UH = Unhatched eggs
DIN = Hatchlings dead in nest
DPE = Embryos dead in pipped eggs
NVE = Eggs containing no visible embryos
VE = Eggs containing visible embryos
AIN = Hatchlings alive in nest
APE = Embryos alive in pipped eggs

*In the above table, row 6, AINs have been included because emerged nests were opened by the investigator in most cases on the day following emergence of the first hatchlings onto the beach, whereas in nests left to emerge naturally hatchlings may emerge in batches upto 5 days after emergence of the first batch from the clutch.

** The average for DINs would have been 0.94 but for the fact that in a single nest 23 pre-emergent hatchlings died of overheating by the sun, just below the beach surface.

*** A count of egg shells from each hatched nest tallied with total hatchlings seen in the nest plus hatchling tracks leading to the sea in only 5 out of 26 i.e. in 19.23% of emerged nests. The number of egg shells exceeded or was equal to the above total.

TABLE 4: Data from emerged *Lepidochelys olivacea* nests

Parameter	N	Range	Average	Sample S. D.
Clutch size	17	83-129	109.1	16.48
Nest depth (cm)	13	29.5-43	37	3.777
Emerged H tracks + AINs	6	54-125	85.33	30.00
Eggshells (hatched eggs + eggs taken by crabs)	18	39-125	93.4	25.48
DIN	13	0-2	0.46	0.7763
UH	17	3-62	12.3	14.03
VE	17	0-20	3.76	5.84
NVE	17	1-62	9.88	16.05
Excess eggshells	6	0-58	11	23.22
% Excess eggshells/total eggshells	6	0-51.8	9.63	20.74
% Emerged Hs/clutch size	6	50-96.9	77.2	22.03
% Hatched eggs/clutch size	6	48.28-96.9	77.56	22.24
DPE	14	0-5	0.857	1.46

Hs = Hatchlings
UH = Unhatched eggs
DIN = Hatchlings dead in nest
DPE = Embryos dead in pipped eggs
NVE = Eggs containing no visible embryos
VE = Eggs containing visible embryos
AIN = Hatchlings alive in nest

TABLE 5: Sizes of nesting *Lepidochelys olivacea* at Galathea beach and at Gahirmatha, Orissa

At the Galathea beach

Parameter	N	Range	Average	r-1
Standard CCL (cm)	43	62.5-74	68.16	2.45
Standard CCW (cm)	43	63-71.5	67.42	2.17

CCL - Carapace curved length
CCW - Carapace curved width

At the Galathea and Gahirmatha beaches

Location	N	CCL (cm)			CCW (cm)			Minimum weight (kg.)
		Average	Max.	Min	Average	Max.	Min.	
Galathea beach	43	68.16	74	62.5	67.42	71.5	63	29** (n = 1)
Gahirmatha*	277	72.64 ±2.18	76.5	66.0	77.64 ±2.29	77.5	64.5	35.6*** (n = 50)

* Data from Kar & Dash, 1990.
** After oviposition.
*** It is not stated whether this was before or after oviposition. A clutch weight >5 kg is rare.

TABLE 6: Weekly number of *Eretmochelys imbricata* nests and non- nesting crawls at South Reef in 1992

Period	Number of days	Number of nests	Number of NNC's
Upto 24 August	c. 34	20	?
25 August to 11 September	18	16	?
12 to 18 September	7	9	2
19 to 25 September	7	7	1
26 September to 2 October	7	14	2
3 to 9 October	7	7	2
10 to 16 October	7	10	1
17 to 23 October	7	5	1
24 to 30 October	7	6	3
31 October to 5 November	7	6	5
6 to 12 November	7	4	0
13 to 19 November	7	3	0
20 to 26 November	7	4	1
27 November to 3 December	7	2	1
4 to 11 December	8	3	3
	144	116	22 (minimum)

TABLE 7: *Chelonia mydas* data from hatched nests

Parameter	Number	Range	Average	Total	Sample SD
Clutch size (number of eggs)	22 nests	55-144	90.59	1993	21.14
Nest depth (base) (cm)	18 nests	40-81	68.53	1234	9.878
Nest depth (base) deleting a 40 cm nest (cm)	17 nests	60-81	70.2	1194	7.058
Egg shells in hatched nests	20 nest	44-137	81.95	1639	23.01
Hatching % (Egg shells x 100)/Clutch size	20 nests	70.13-96.9	88.44	1769	6.604
Overall hatching % (egg shells x 100)/Clutch size	1639 eggs out of 1840	-	89.08	-	-
Unhatched eggs UH (= VE + NVE)	20 nests	4-23	10.05	201	5.256
'Infertile' eggs (NVE)	17 nests	0-6	2.4	41	1.583
'Infertile' egg % ((NVE/Clutch size) x 100)	17 nests	0-7.79	2.82	47.9	1.942
Overall 'infertile' eggs %	41 out of 1566 eggs	-	2.62	-	-
DIN hatchlings	20 nests	0-1	0.1	2	0.308
AIN hatchlings	19 nests	0-2	0.42	8	0.769

VE = Eggs containing visible embryos; NVE = Eggs containing no visitble embryos; DIN = Hatchlings dead in nest

TABLE 8: Monthly nesting intensities of *Eretmochelys imbricata*

Month	Number of days	Number of nests	Average number of nests per day
July	c.11	8	0.727
August	31	16	0.516
September	30	37	1.23
October	31	32	1.032
November	30	19	0.633
December	11	4	0.364
	144	116	0.806

TABLE 9: Monthly nesting intensities of *Chelonia mydas* on South Reef in 1992

Month	Number of days	Number of nests	Average number of nests per day
July	c.11	16	1.455
August	31	7	0.226
September	30	5	0.167
October	31	5	0.161
November	30	9	0.3
December	11	4	0.273
	144	45	0.313

TABLE 10: Measurements and renesting intervals of *Chelonia mydas*

Tag number	CCL (cm)	CCW (cm)	Tagged on	Renesting intervals RI (days)	Average RI (days)
AN 312	90	83.5	9 October	13, 14, 12, 12, 13	12.8
AN 315	89.5	84	12 October	12	12
AN 76	93	85.25	26 October	15, 13, 12	13.33
AN 77	93.25	81.25	16 November	15	15

TABLE 11: Individual measurements and dates of tagging of *Eretmochelys imbricata*.

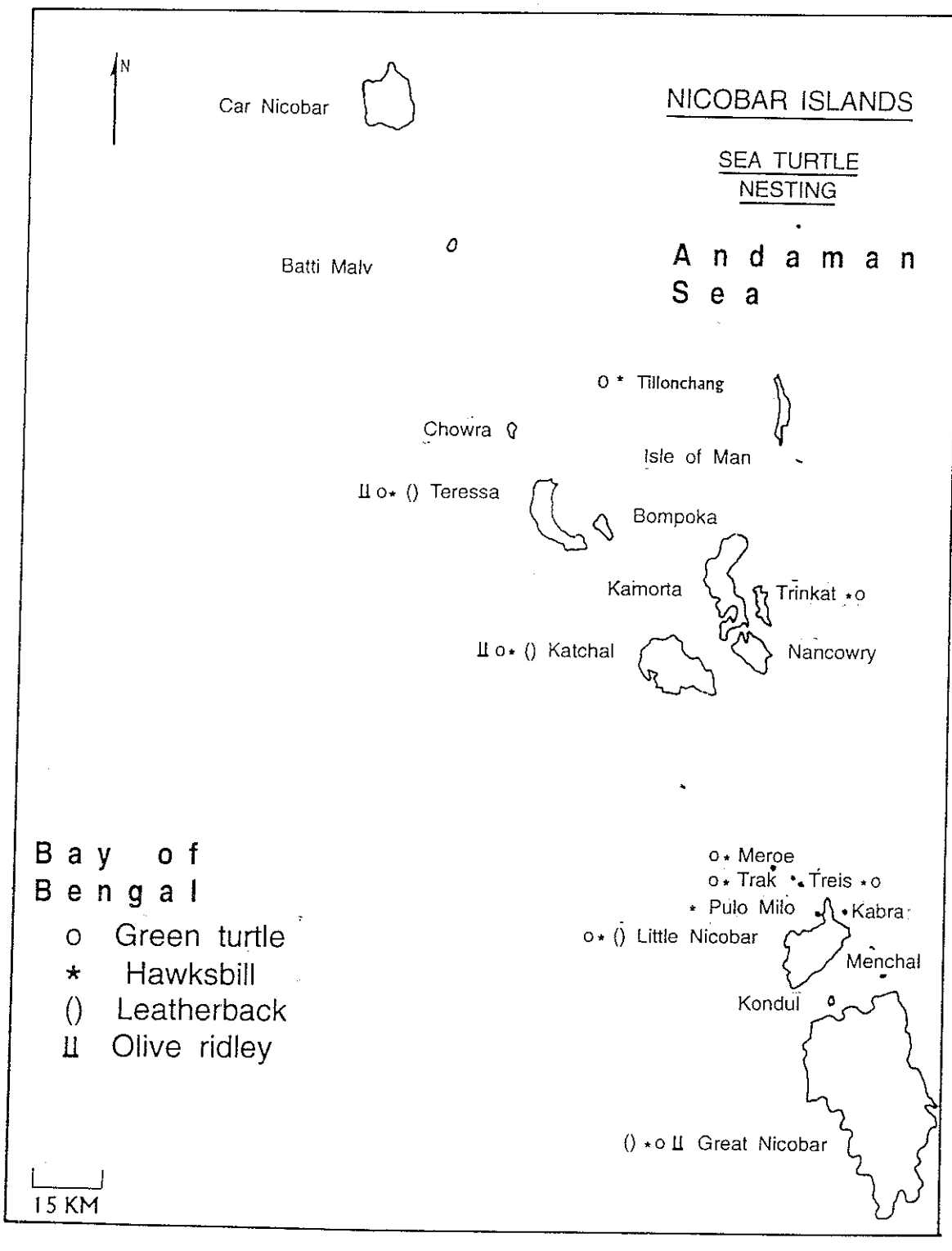
Tag number*	Standard CCL (cm)	Standard CCW (cm)	Date of tagging in 1992
301	84	72	16 September
302	71.5	62.5	17 "
303	74.5	66.5	18 "
304	81	69.25	18 "
305	83.25	78	22 "
306	76.5	65	23 "
307	78.5	69.25	25 "
308	80.5	72	27 "
309	79.5	70	27 "
310	71.5	62	28 "
311	74	65.75	1 October
313	76	67	10 "
314	79	67	11 "
316	85.25	79.25	13 "
317	76.5	66	13 "
318	71.25	65.5	13 "
319	78.5	69.5	21 "
320	84	76	22 "
78	71.5	58.5	27 "
79	71	65.5	1 November
80	79.75	65.75	1 "
81	80	71	1 "
82	78.5	69	2 "
83	77	68.5	3 "
84	75	75.75	10 "
86	83	73.5	2 December
**87,88	77	69	6 "

* The number on each tag was preceded by the letters 'AN'.
** Double tagged turtle.
CCL = Curved carapace length; CCW = Curved carapace width.

TABLE 12: Nesting counts on islets surveyed

Islands	Meroe	Trak	Treis	Tillonchang	Pulo Milo
Survey dates	31-3-92 to 4-4-92	4-4-92	4-4-92	9/10-4-92 to 5-4-92	26-3-92
Eretmochelys imbricata nests	10 (4)	23 (2)	3 (0)	4 (0)	1 (1)
Eretmochelys imbricata or *Chelonia mydas* nests	8 (0)	0	0	12 (0)	0

Figures in parenthesis are the number of sets of turtle tracks visibly associated with the nests recorded.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Bompoka
Kamorta
Trinkat
Katchal
Nancowry
Bay of
Bengal
o Green turtle
* Hawksbill
() Leatherback
Olive ridley
o * Meroe
o * Trak
Treis * o
* Pulo Milo
Kabra
o * () Little Nicobar
Menchal
Kondul
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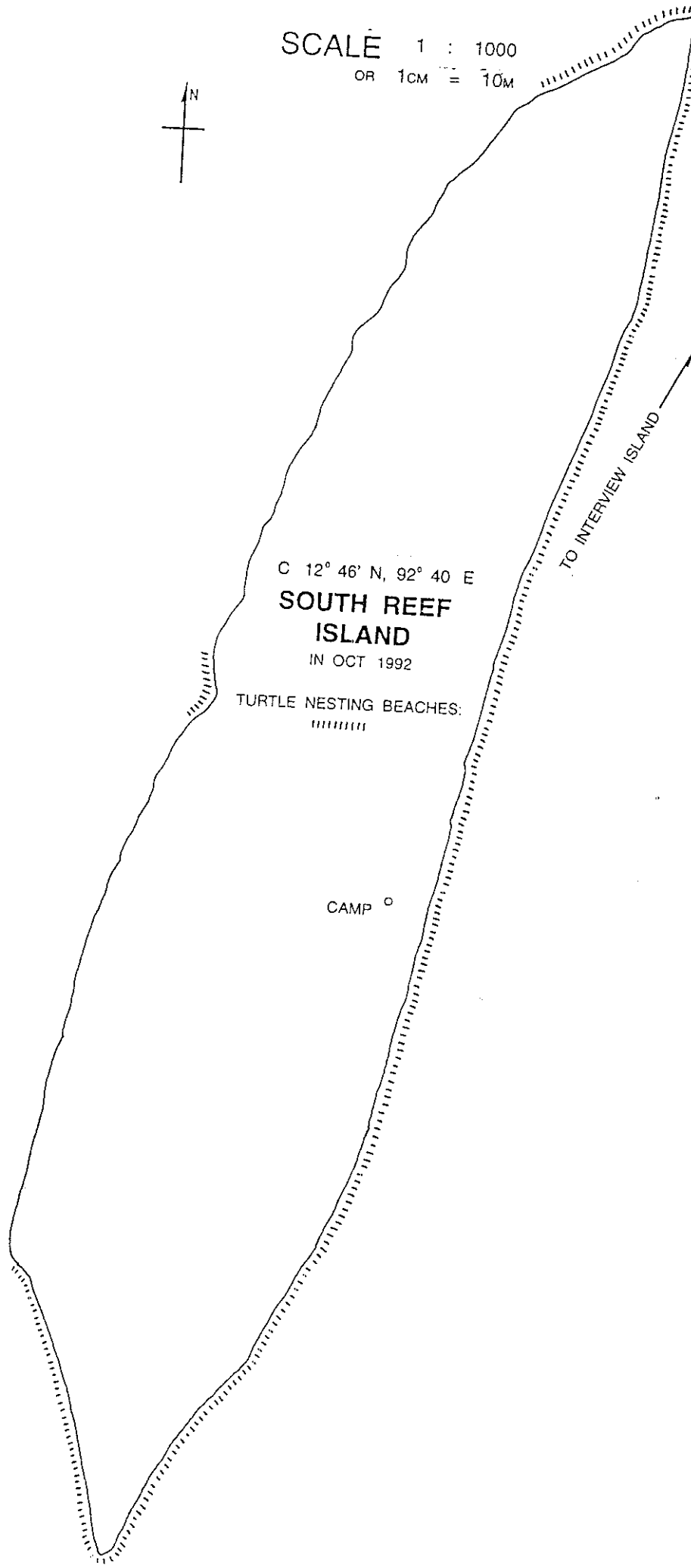
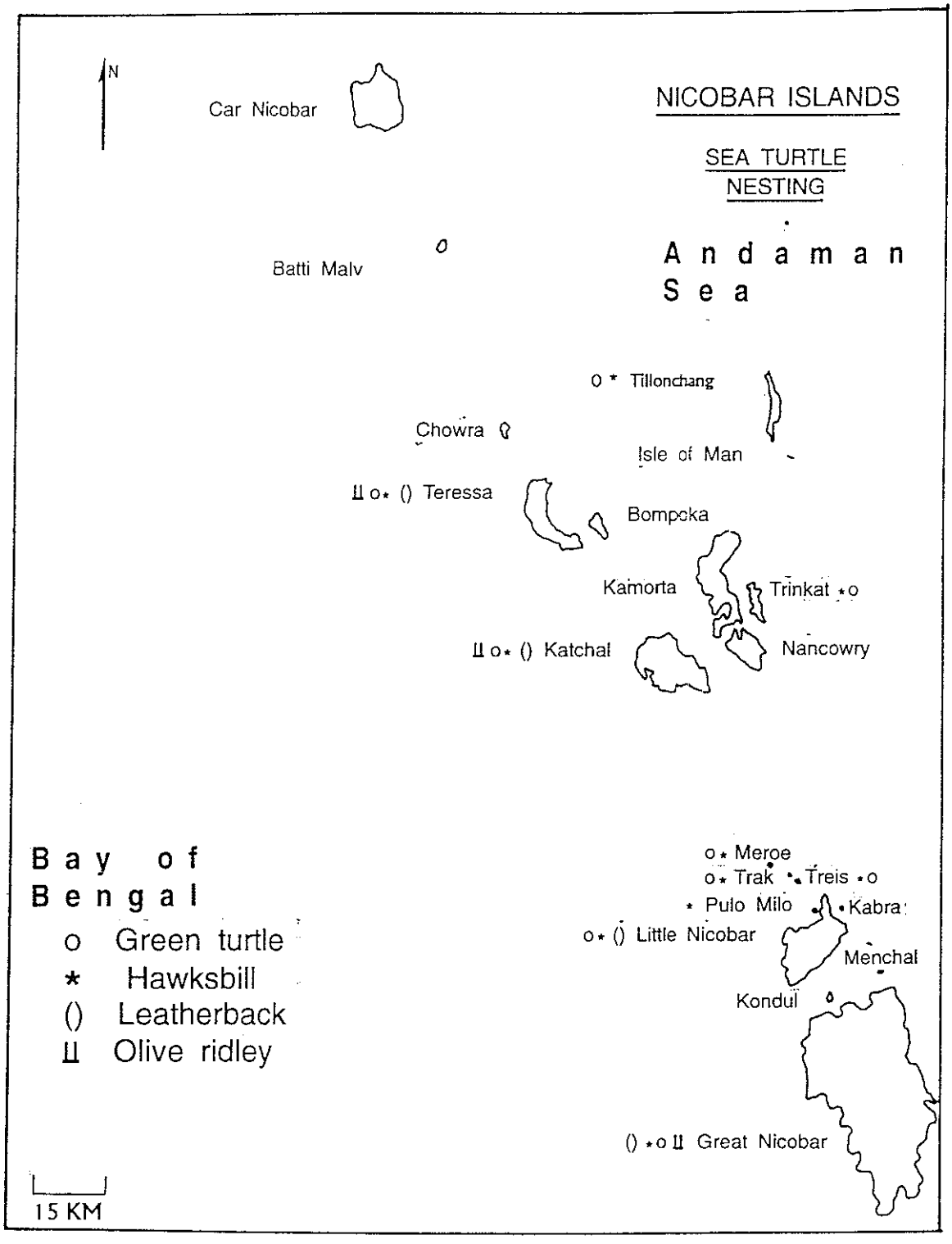
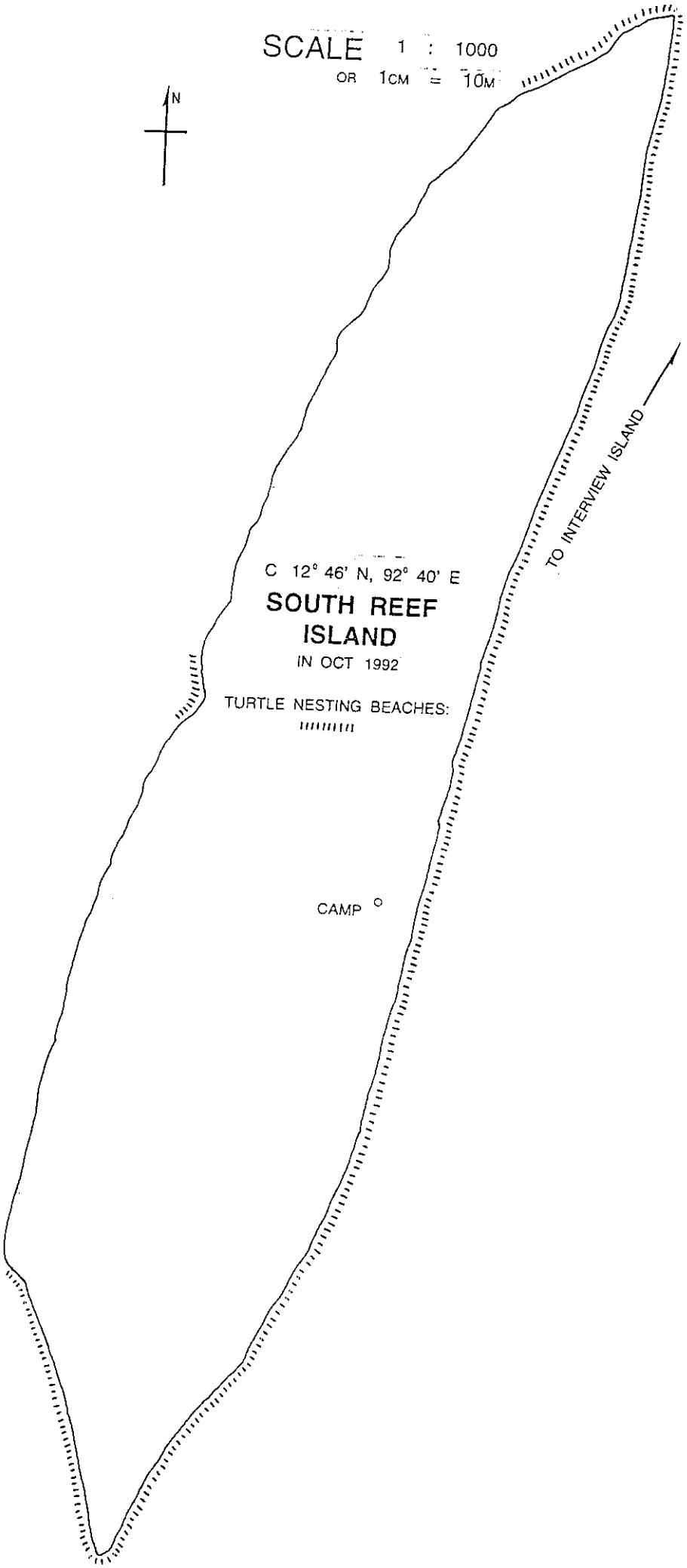
15 KM


SCALE 1 : 1000
OR 1CM = 10M
N
C 12° 46' N, 92° 40 E
SOUTH REEF ISLAND
IN OCT 1992
TURTLE NESTING BEACHES:
CAMP
TO INTERVIEW ISLAND


N
Car Nicobar
NICOBAR ISLANDS
SEA TURTLE
NESTING
Batti Malv
Andaman
Sea
o * Tillonchang
Chowra
Isle of Man
Ш o* () Teressa
Bompoka
Kamorta
Trinkat *o
Ш o* () Katchal
Nancowry
Bay of
Bengal
o Green turtle
* Hawksbill
() Leatherback
Ш Olive ridley
o* Meroe
o* Trak
Treis *o
* Pulo Milo
Kabra
o* () Little Nicobar
Menchal
Kondul
() *o Ш Great Nicobar
15 KM


SCALE 1 : 1000
OR 1CM = 10M
N
C 12° 46' N, 92° 40' E
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