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THE CORAL REEFS OF ANDAMAN AND NICOBAR ISLANDS

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(with 5 Plates & 1 Table)

INTRODUCTION

Hydrographic surveys of the seas around Andamans and Nicobars were made from 1889 to 1907 and again in 1926 and 1956 by the Marine Survey of India. Oceanographic work in the seas around these islands was largely that of I.N.S. *Investigator* (1887-1901) limiting mainly to deeper waters beyond reef limits. The text of these surveys was compiled in the Bay of Bengal Pilot. Though these surveys provide a useful guide for contours, depth and for general oceanographic and meteorological conditions, these add very little to the knowledge of reef characteristics and growth. Sewell (1938) and Scheer (1971) briefly mentioned the occurrence of shore reefs.

The results presented in this paper are obtained from a visit by the author together with the members of the survey party from September to November 1972. South Andaman and Cinque Islands in the Andamans, a few islands in the Richie's archipelago, Car Nicobar, Camorta and Nancowry in the Nicobars were examined with particular reference to reef structure, shore profiles, fauna and flora inhabiting reefs at these places.

PHYSIOGRAPHY

Andaman and Nicobar Islands are two groups of Islands formed in a sub-linear series in the Bay of Bengal. The sea on the west of the chain is referred as the Bay of Bengal and on the east as the Andaman sea. The Andaman ridge is broadly divided into North Andaman, Middle Andaman, South Andaman and Baratang Islands. The ridge was considered to have undergone folding, faulting and uplift. Towards the east coast of the South Andaman ridge are a group of islands called the Richie's archipelago. Further east of this group is a recent volcanic island, the Barren and to the north of this island lies another extinct volcanic island, the Narcondum.

The Andaman group of Islands are separated from the Nicobar group by a 296 km wide channel. The Nicobars are set obliquely towards the south-east. The northernmost is the Car Nicobar and the Southernmost, the Great Nicobar. The larger islands in the central group are Katchal, Camorta, Teressa, Bompoka and Tillachong while Battimalv and Choura are smaller islands located north of the Central group.

GEOMORPHOLOGY

The geomorphology of islands, reefs and other associated structures can be studied in two ways. *viz.* by visual observation and boring data. The following geomorphic structures are visible in these areas.

Reef platforms : A feature common to these islands, as elsewhere, is the development of benching condition formed by the peneplanation of shores by waves. These benches or platforms are usually absent on steep shores but are more often found on sloping landscapes. The shore rocks of sandstone, conglomerates and plutonic rocks are less porous and less soluable. The platforms formed around these rocks show more features of abrasion. The shore rocks consisting of limestone (Pl. IV a) and calcareous clays are more soluable and therefore show more features of solution. The structural and biological differences of the platforms in the two groups of islands are enumerated below.

Platforms of Andaman Islands (Pl. IIa): Usually platforms of about 500 m in width from shore occur. Shore rocks appear as relicts on these platforms, some in a pinnacle form and others in a vertically bedded state. Wide erosion channels, some 20 m in width intersect the platforms at various places. Surge channels of the type found in the Nicobars are absent. The platform edges are flat on the channel side and sloping on the windward side. Reef edges contain mostly the species of *Porites, Favia, Pocillopora* and *Acropora.* On the leeward shores. the boulders though usually small, are rounded. The alcyonarians, *Sarcophyton, Lobophytum* and *Sclerophytum* and the gorgonids *Isis hippuris, Melithea phillippinensis* and *Chalcogorgia* sp. occur in shallow shoals and at reef edges. The slow rise of tide on leeward shores provides a good habitat for the growth of the fragile species of *Acropora* and the sea cups, *Phyllospongia calciformis.* Andaman platforms favour thick growth of corals at reef edges and patchy growths at various places on the platforms.

Platforms of Nicobar Islands : (Pl. VI a; IV b) Platforms up to 1000-m in width from shore occur. These appear to be formed mainly by the dissolution of shore rocks. The platforms develop prominent landward and seaward inclinations. Surge channels of 1 m in depth and width at reef edges are found on the windward side. The reef edges are butressed and trenched. The slippery nature of reef edges is mainly

due to the presence of algae. *Porites*, *Favia*, *Acropora*, *Pocillopora*, *Heliopora*, *Tubipora* and *Montipora* are the most common among the boulder forming coral genera. Alcyonarians and gorgonaceans also occur.

Most shores of Andaman and Nicobar Islands contain the associated reef structures such as pinnacles which are mainly the submerged rocks of the island shores. At some places there are rubble terraces of 1.4 m thick which are formed usually by strong monsoonal winds or cyclones. Some of them may also be formed by wave action during high tide.

BORING DATA

Boring data on these islands are very few and are limited to bays where there is least coral growth as required for harbour development. One boring made on the 30 m width of the flat indicated a 6 m thickness of coral bed followed by 10 m thick hard clay bed (Shri Raju, Personal communication). Bore holes in a 4" size inner casing are known for four places (2 in Andamans and 2 in Nicobars) in the off reef areas to a depth of 15 m below the sea bed. The base rock is covered by a 10 m thick coarse sand which is again covered by a 3 m thick clay bed, containing loose coral boulders. The topmost layer near the surface is a 3.5 m cover of silt with occasional clay lumps. In the off-reef areas of Little Andamans at a depth of 15 m, the top layer of 7 m consisted of fine sand, followed by 5 m of loose clay and 3 m of hard clay. This hard clay was described as a very stiff grey silty clay which is said to have formed the base of the coral bed.

No data of borings on the reef platforms of Nicobars are available, but examination of growing reef fronts show not less than 10 m where huge columns of growing corals are visible as arms extending out into the sea, dipping down to the bottom from the reef rim. Boulders of *Montipora*, *Acropora*, *Porites* and *Favia* are seen rising from these extended areas upwards towards the sea level. This situation can be visualised in bright sunlight and calm weather all along the windward reef front at Car Nicobar.

Geomorphologically the following profiles of platforms may be distinguished especially in the Nicobar Islands.

1. High level conglomerate flats with prograding shores.
2. Unconsolidated conglomerate flats
3. Consolidated flat conglomerate
4. Unconsolidated irregularly shaped flats
5. Exposures of old beach rock, base rock recent or sub recent upraised reefs under severe erosion and beach retreat.

Sedimentologically, the following environments of deposition may also be distinguished as in the other tropical reefs.

1. Reef front or reef wall
2. Brecciatic zone
3. Reef-flat shoals or back reef shoals
4. Beach sediments or beach deposits.

Biologically, the following zones may be distinguished.

1. Supra-littoral
2. Littoral
3. Eulittoral (Sub-tidal)

Reefs

In the geometric classification of reefs as fringing, barrier and atoll, Andamans and Nicobars belong mostly to the fringing type. A barrier was reported earlier on the west of Andaman ridge (*vide* Sewell, 1938) but atoll reefs are absent. The following categories of reefs may be distinguished further in the Andaman and Nicobar Islands.

I. **Recent or sub-recent Reefs** : *Emergent reefs* : These are widely reported on many islands by earlier authors. At Car Nicobars, this reef is extensive on the north-east. Coral and *Tridacna* beds are found 2 m above the present sea level, and exposed *insitu* on the island rim at Keating point and all along the beach face. *Tridacna maxima* and a number of other bivalves occur in quarry pits of 3 m deep, some Tridaena reaching 1 m in length. Such reefs indicate negative eustatic movements.

II. **Modern Reefs** :

(a) *Windward reefs* : (Pl. IV b). Reefs growing in the direction of prevailing winds are called windward reefs. Andamans and Nicobars lie in the monsoonal belt. So these reefs grow chiefly in the direction of monsoon winds. Swell brought by other sources generally have a considerably less wave force, but may carry food supply to the reef. A reef growing windward is bevelled or sloped. The character of slope varies from place to place depending upon the oceanographic conditions. Such reefs are found on most islands on the windward side.

(b) *Channel reefs* : (Pl. II a; VI b) : Channels present in these islands are usually protected from winds due to the presence of islands on either side. These are therefore referred as leeward reefs. Because of less wind action, less wave action follows and flat growth of reef is developed. The reef edges are usually steep, not sloping as in windward reefs. *e. g.*, Channels of South Andamans and Kamorta-Nancowry complex.

(c) *Bay reefs* : These reefs are subjected to similar wind and wave action as the channel reefs but sediment deposition plays a large part

in the growth and death of these reefs. The bay is filling in nature both by upward coral growth and by sediment deposition and ultimately bringing the bay reef to the level of the channel reef. *Porites* and *Favia* are the chief reef builders. Alcyonarian growths are present but not abundant. Fragile *Acropora* occur in deeper bays. eg. Bays of Nancowry.

(d) *Knoll reefs* (coral knolls) : These are found in the midst of channels or to one side adjoining the main reef. These are circular topographic highs arising from about 20 m depth in these islands (Reddaih *et al*, 1974). Some of them are also found in the off-reef areas. The knoll is flat-topped with two hollows and two rims. It is a hard and compact hillock. *Porites* and *Favia* are the chief reef builders. Alcyonarian growths of *Sarcophyton, Lobophytum* and *Sclerophytum* are found on top of the knoll. *Acropora* grows on the periphery *e. g.*, channels of the Richie's archipelago.

(e) *Patch reefs* : These are also circular growths developed on the inner side of the main reef usually half to one fathom in low spring tides. Though they resemble knoll reefs, these are not compact. Almost all corals found in the vicinity but mostly the fragile forms grow indiscriminately and lie loose on top of the patch. Most of them collapse or break while walking over them. Alcyonarian growths are abundant. The patch may grow a foot higher than the adjoining main reef. The patch reefs are apparently the formative stages of knoll reefs. These are found in the back reef shoals of Nicobar Islands. *e. g.*, Camorta.

BIOLOGICAL CONSTITUENTS

Coelenterates : Most coelenterate groups occur. Of these, Scleractinia form the most important constituent among the reef builders in these shores. The Octocorallia and Milliporina are well represented. Hydroids occur mostly in deeper waters. Zoantharaia and Scyphozoa are less prominent. Of about 75 species of Scleractinian corals studied (*vide* table 1) about 15% are boulder forming, hard and wave resistant. Some species of *Acropora* (Pl. V a) and *Porites* (Pl. II b) are encrusting in nature. Most of these corals grow in the direction of prevailing winds.

Other reef builders : Molluscs are also important reef builders on these shores. Most boulders of *Favia* and *Porites* in the Nicobars and in the Richie's archipelago contain 10 to 20 specimens of *Tridacna crocea* or sometimes *T squamosa*. This genus is an important molluscan reef builder at the reef-flat level. Other species mostly *Turbo, Trochus, Lambis, Conus* and *Cypraea* occur at reef edges and flats. Sea cucumbers form an important constituent of leeward reefs, some species occurring in unusually large numbers and sizes. Foraminifera also occur in emerged sediments and beach deposits.

Algae. The marine algae (Chlorophyceae, Rhodophyceae and Phaeophyceae, also contribute in the formation of coral reefs. Though corallinalge occur, the part played by them is not so marked as in atoll reefs. *Lithothamnion* sp. and *Lithophyllum amplostratum* are conspicuous on the windward side at reef edges, forming important constituents of the butress zone. On the leeward shores, their presence is insignificant. Less wave action, lack of suitable base for their settlement and growth are some factors accounting for their absence but these are recorded at considerable depths by Sewell (1938). *Turbinaria* sp. occurs profusely on windward reef fronts but its part in reef ecology is not known. *Halimeda opuntia* is a very conspicuous semi-clacareous alga found on almost all reef-flats. *Ulva* and *Avernvillia* sp. grow in front of mangrove flats and act as sediment binders. *Sargassum, Laminaria, Codium, Gelidium* etc. and a number of other algal species occur on leeside of islands where there are deep shoals. In the shallow shoals near the shores, *Amphiroa* occurs abundantly.

Zonation of Corals

Detailed zonation patterns for the corals are difficult to obtain as the corals have the tendency to grow irregularly in any concievable place where there is some water in motion, Though transect studies have been attempted, these have not shown a clear pattern of zonation. Certain broad generalisations can be made. On the leeward shores, corals grow more freely as these are met with less interference from waves. Boulders of *Favia* and *Porites* are found growing for about 200 m up to almost near the reef rim. Their tops are flattish as their upward growth is checked by sub-aerial exposure (Pl. III b). These are rounded boulders when young but assume a flat top due to weathering and solvent action of rain water during sub-aerial exposure. These features can be seen in growths developed in front of the mangroves.

From about 20 m from the reef edge, there appears a succession of coral species running parallel to the reef edge, each species covering about 50 m in width (Pl. VI a). Thus it may be inferred that on windward shores, the reef edge zonation appears parallel but the zonation on the remaining parts of the reef flat is difficult to arrive at as these are metamorphosed after death and decay. Sometimes these may be present in shoals. It may be assumed that *Porites* and *Favia* are the chief flat builders growing perpendicularly to the shore for about half the width of the reef flat but after, a succession of various coral species, one after the other run parallel to the reef edge. In very wide shoal areas, *Acropora* grows in thickets and it is the shallowness and calm water that determine the extent of the fragile species of *Acropora.* Certain hardy species of Acropora such as *A. humilis* are encrusting on windward reef fronts

and are capable of resisting the most forceful wave effect. More information is needed before conclusive evidence is presented on zonation of corals in these shores.

MANGROVES

A unique feature of Andamans and Nicobars is the presence of mangroves in open shores also, while these are quite common in every channel and bay in sheltered places. These are absent, however, on certain islands like Car Nicobar which may be due to the severity of wave action that prevents settlement and growth. When erosion had cut back a number of open shores and channels, shoals may have developed close to shore by deposition seaward. These shoals today are filled with coral growths. Whether mangroves have settled first or the corals is difficult to conclude. More likely that the mangroves did so earlier supported by the appearance of mangrove seedlings in the spits formed in front of such recent shoals. *e. g.*, Tapong, Nancowry. Almost in every mangrove flat in open shores, bays and channels, corals are seen growing in front and behind mangroves so long as a few feet of water is present. Mangroves provide a sheltered environment for the corals from severe wave action and from abrupt deposition of land drawn sediment. The massive forms of *Porites* and *Favia* usually grow here to as much as 5.5 m and 2 m in diameter respectively. Where wave action is severe and deposition by flood is more, these defoliate and vanish.

TABLE 1. RELATIVE ABUNDANCE OF SCLERACTINIAN CORALS COLLECTED OR OBSERVED DURING THE SURVEY.

CORAL SPECIES (1)	ANDAMAN ISLES (2)	NICOBAR ISLES (3)
Family ACROPORIDAE		
Acropora nasuta (Dana)	abundant	not found
A. grandis (Brook)	,,	abundant
A. humilis (Dana)	,,	,,
A. palifera (Brook)	,,	,,
A. rectina Nomenzo	,,	,,
A. pacifica (Brook)	,,	,,
A. digitifera (Dana)	,,	,,
A. canalis (Quelch)	,,	,,
A. clavigera (Brook)	,,	,,
A. calamaria (Brook)	,,	,,
A. hyacinthus (Dana)	,,	,,
A. polymorpha (Brook)	,,	abundant
A. corymbosa (Lamark)	,,	,,
A. echinata (Dana)	not found	,,

(1)	(2)	(3)
A. robusta (Dana)	,,	,,
A. clathrata (Brook)	,,	,,
A. squarrosa (Ehrenberg)	abundant	abundant
A. cancellata (Brook)	not found	common
A. botryoides (Brook)	,,	,,
A. formosa (Dana)	common	common
A. variabilis (Klunzinger)	rare	,,
A. palmerae Wells	common	,,
A. monticulosa (Brüggemann)	rare	,,
A. diversa (Brook)	abundant	abundant
A. intermedia (Brook)	,,	,,
A. armata (Brook)	,,	,,
A. pulchra (Brook)	common	common
A. brueggemanni (Brook)	,,	,,
A. surculosa (Dana)	abundant	,,
A. conigera (Dana)	,,	,,
A. irregularis (Brook)	rare	unknown
Montipora fruiticosa Bernard	not found	abundant
M. hispida (Dana)	,,	common
M. composita Crossland	,,	abundant
M. foliosa (Pallas)	,,	,,
Montipora florida Nomenzo	,,	,,
Family : POCILLOPORIDAE		
Pocillopora elegans Dana	abundant	abundant
P. danicornis (L.)	,,	,,
Stylophora mordax (Dana)	,,	,,
Family : AGARICIDAE		
Pachyseris gemmae Nomenzo	not found	common
Pavona (*Polyastra*) *Obtusta* (Quelsh)	,,	,,
Leptoseris papyracea (Dana)	,,	,,
Family : MUSSIDAE		
Lobophyllia hemprichii (Ehrenberg)	,,	abundant
Mussa angulosa (Pallas)	common	not found
Euphyllia glabrescens Chamisso & Eysenhardt	unknown	common
Euphyllia sp.	,,	,,
Symphyllia recta (Dana)	abundant	not found
Family : MERULINIDAE		
Merulina ampliata (Ellis & Sol.)	not found	abundant
M. laxa Dana	abundant	,,
Family : FAVIIDAE		

(1)	(2)	(3)
Favia abdita (Ellis & Solander)	,,	not found
F. halicora (Ehrenberg)	,,	,,
F. speciosa (Dana)	,,	,,
F. pallida (Dana)	not found	abundant
Diploastrea heliopora (Lamark)	,,	,,
Platygyra daedalea (Ellis & Solander)	abundant	not found
P. sinensis (Milne Edwards & Haime)	,,	,,
Goniastrea pectinata (Ehrenberg)	,,	,,
G. planulata (Milne Edwards & Haime)	not found	common
G. benhami Vaughan	,,	,,
G. retiformis Lamark	,,	,,
Goniastrea sp.	,,	,,
Coelaseris magiri Vaughan	,,	not found
Family : OCCULINIDAE		
Galaxea fascicularis (L.)	abundant	abundant
Family : THAMNASTERIDAE		
Psammocora contigua	not found	common
Psammocora sp.	,,	,,
Family : PORITIDAE		
Alveopora sp.	common	commn
Porites porites (Pallas)	,,	,,
P. tenuis (Verill)	,,	,,
Porites nigrescens Dana	,,	,,
Goniopora Columna (Dana)	common	not found
G. tenuidens (Quelch)	,,	,,
G. stokesi Milne Edwards & Haime	,,	,,
G. peteolata Bernard	,,	,,
Family : PECTINIDAE		
Echiniphyllia aspersa (Ellis & Solander)	not found	,,
Family : FUNGIIDAE		
Fungia echinate (Pallas)	common	abundant
F. fungites (L.)	,,	,,
F. horrida (Dana)	not found	,,
Herpolitha limax (Esper)	,,	,,

SUMMARY

Coral reefs present in the representative groups of Andaman and Nicobar Islands namely, South Andaman, Cinque, Car Nicobar, Camorta, Nancowry and in the Richie's archipelago have been described. The geomorphology of island shores, reef platforms and their associated fauna and flora with special reference to reef building corals are elucidated. Some aspects of zonation of corals and the occurrence of mangroves are discussed.

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REFERENCES

SEWELL, R. B. S. 1935-38. Geographic and Oceanographic Research in. Indian water. in *Mem. Asiatic Soc. Bengal*, **9**: 1-539.

SCHEER, G. 1971. *Regional variations in Indian Ocean Coral Reefs* edited by D. R. Stoddart and C. M. Yonge. *Symp. Zool. Soc. Lond.*, 429. pp.

REDDIAH, K., SUBBARAO, N. V., P. T. CHERIAN, K. R. HALDER and T ROY. 1974. Two Indian Ocean Coral Knolls. *Indian, J. mar. Sci.* **3**: 67-71.