

Oceanographic Coverage of Andaman and Nicobar Seas

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Andaman and Nicobar seas have not been systematically studied which is essential for a better understanding of their oceanographic features and their variability. While discussing the oceanographic achievements of any area the two factors of prime consideration are the range of exploration and the exploitation potential. In this aspect the studies carried out in the Andaman and Nicobar waters are not adequate. In this paper an attempt has been made to project the picture of Andaman and Nicobar for the awareness and planning the future programmes effectively.

Before discussing further on data of these waters it is worthwhile having a look at the oceanographic history of this area. Oceanographic research in the Andaman and Nicobar seas dates back to 1869 when Francis Day a well known army officer and fishery biologist visited these islands. He recorded the occurrence of 136 species of fish in these waters. The Andaman and Nicobar (two groups of islands) are comprised of 321 islands, of which only 38 are inhabited. They collectively have an area of 8293 sq km although this figure does not include a number of exposed islets and rocks. Andaman seas occupies an approximate area of 6.02×10^5 sq km and have a volume of 6.6×10^5 km³ with an average depth of 1096 meters (TR 2/80)¹. Though some studies have been

conducted in these waters there were sharp discontinuity between each studies so far done. The present slow pace in understanding the oceanic features and their variability of this area is a result of nothing but the sharp gap between the major studies conducted so far. This can be seen from Table-1, showing the cruises so far carried out with in the period of observtions. Fig-2 shows the cruise tracks.

Table 1: Cruises So far carried out in Andaman Seas

Expedition	Country	Ship Name & Code	Cruise No	Month & Year	Data Types	
IIOE	INDIA	Kistna (KI)	6	Feb-Mar 1963	P, C, B	
		(KI)	19, 20	June-Aug-Sept	P, C, B	
		(KI)	14	1964, Sept 1963	C	
	"	USA	ANTON	1	Mar-May 1963	P, C, B
			BRUUN (AO)			
	"	USA	PIONEER (PI)	81	Apr-May 1964	P, C, B
			SERANO (SR)	639	April 1961	P, C, B
	"	USSR	ORALIC	C33	Nov-Dec 1961	C
			VITYAZ (VI)	33	Mar 1964	P, C, B
	"	USSR	VITYAZ (VI)	35	Jan-Feb 1961	P, C, B
VITYAZ (VI)			35	Sept-Oct 1962	P, C, B	
MONEX		PRILIV (PI)	2	July 1973	P, C, B	
National Program	INDIA	R.V. (GV) Gaveshani	51	Feb 1979	P, C, B	
"	INDIA	(GV)	52	Feb 1979	P, C, B	
"	INDIA	(GV)	66	Jan 1980	P, C, B	
"	INDIA	(GV)	67	Jan 1980	P, C, B	
"	INDIA	(GV)	68	Jan 1980	P, C, B	
"	INDIA	(GV)	120	May 1983	P, C,	
"	INDIA	(GV)	124	Sept-Oct 1983	P, B	
"	INDIA	(GV)	125	Oct 1983	P	
"	INDIA	(GV)	126	Nov 1983	P	
"	INDIA	(GV)	127	Nov 1983	P, C, B	
"	INDIA	ORV Sagar Kanya (SK)	9	Sept 1984	P, C	
"	INDIA	(SK)	10	Sept-Oct 1984	P, C,	
"	INDIA	(SK)	18	Sept 1985	P	
"	INDIA	(SK)	19	Nov 1985	P	

P—Physical Parameters C—Chemical Parameters B—Biological Parameters

Data Source

The data available in Indian National Oceanographic Data Centre (INODC) for Andaman and Nicobar seas have been screened thoroughly for getting inventory level and original data information.⁴⁵ Both these levels of information are sorted first for getting the parameterwise picture and then for getting seasonal and annual pictures. Again, to check the parameter wise balance in the station coverage throughout the total period of observations bar diagrams have been prepared. For projecting the seasonal gap the station locations have been plotted for different seasons and combining all these plots a final map showing coverage in all the three seasons is prepared.

OCEANOGRAPHIC CHARACTERISTICS—A RESUME

Some major characteristics in marine disciplines are mentioned here.

PHYSICAL CHARACTERISTICS

Temperature Distribution

In late winter over west of the northern Andaman sea the surface temperature is greater than 28°C except in some isolated pockets where it exceeds 29°C. In the north western region as well as in the southern region the temperature is less than 28°C. The thickness of the surface layer over this region varies from 30-60m (TR 2/80¹ and Ramesh Babu *et al.*²)

Salinity Distribution

In late winter salinity increases from 31.0% in the northern region to 32.8% in the southern region of the northern Andaman sea. Very low salinities are obviously due to river discharges during monsoon and postmonsoon periods. Below the surface, salinity increases rapidly and a strong halocline develops in the depth range of 10-60m all along this region in post monsoon period. Below the halocline, salinity shows a gradual increase and a zone of salinity maximum is seen between 200-600m. Below this zone of salinity maximum, the salinity decreases gradually upto 1600m and below this it is almost constant. The low salinities are reported

during south west and post monsoon period due to maximum river discharges from Gangetic and the Arakan hills. (TR 2/80¹ and Ramesh Babu *et al.*²)

CHEMICAL CHARACTERISTICS

Chemical data were collected during the cruise numbers 51, 52, 66, 67, 68, 120 and 127 of R.V. Gaveshani and cruises 9 and 10 of ORV Sagar Kanya and by ships Pioneer, Kistna, Anton Bruun and Vityaz during 110E period and by Priliv in Monex of 1973. The data collected during February 1979 indicate that water masses on the eastern and western margins of the Andaman and Nicobar islands have similar hydrographic features to a depth of about 1500m and deeper water masses in the central Andaman basin are separated from the rest of the region by shallow sills and are relatively stagnant.

Oxygen

Oxygen values lower than 0.2 ml/l have been observed in deeper depths. Even at the deeper layers oxygen values are lower than those at the corresponding depth in other regions. This indicates that the central Basin of the Andaman Sea is cut off from its northern and southern regions by shallow sills, which result in poor oxygen exchange and relatively stagnant water with low oxygen concentration. The oxygen minimum layer varies from 150-600m on the north, east and south of the islands. On the western side the oxygen minimum layer extends from 100 to 800m which is very similar to the conditions in the open Bay of Bengal (TR 2/80)¹.

Nitrate-Nitrogen

The range of nutrients are almost uniform extending to the bottom. However on the East and the South, a maximum nitrate-nitrogen concentration was observed at an intermediate depth. These indicate the stagnant nature of the deeper waters at certain parts of the Andaman Sea due to poor renewal of water over the sill depth. The average concentration of nitrate is 20.2 $\mu\text{g-at/l}$ with hardly any difference between its concentrations in the waters on the eastern and western sides at the Andaman and Nicobar islands (TR 2/80)¹.

Phosphate—Phosphorous

On the east and the south of the island a maximum phosphate-phosphorous at an intermediate depth with almost uniform concentrations extending to the bottom are observed. The magnitude of values for phosphate-phosphorous are relatively higher than those recorded for the corresponding depths in the Arabian Sea. In the upper 50m, nitrite-nitrogen is absent, while some phosphate-phosphorous is still present in the water. However at the stations nearer the coast both nitrite-nitrogen and phosphate-phosphorous have been observed to be absent. The silicate-phosphate relationship for the set of data from Gaveshani cruises 51 and 52 gives a ratio of 29:1 by atoms (TR 2/80)¹.

Silicate

The water masses from 0 to 100m have silicate concentrations ranging from about zero to 25 $\mu\text{g-at/l}$, whereas in the Arabian Sea this range of silicate values was observed at 200m. The water masses from 101 to 500m have silicate values from 25 to 50 $\mu\text{g-at/l}$, which compares well with observation in Arabian Sea. At depth interval 500 to 1000m the silicate ranges between 30 to 75 $\mu\text{g-at/l}$ and between 1000 and 1500m silicate ranges from 75 to 97.5 $\mu\text{g-at/l}$. This deeper layer in this region has lower silicate concentration as compared to similar depths in the Arabian sea (TR 2/80)¹.

BIOLOGICAL CHARACTERISTICS

Primary Production and Chlorophyll

On the basis of data collected until 1985 the average picture shows that surface primary production ranged from 0.09-67 mg C/m^3 with an average of 7.58 mgC/m^3 and in the euphotic column it is 3.0-1167 $\text{mgC/m}^2/\text{day}$ (average of 329.9). Surface chlorophyll ranged from 0.01 to 0.59 mg/m^3 (Av.0.0487) and column chlorophyll ranged from 0.430 to 20.00 mg/m^2 (Av. 4.188). Detrital carbon in the Andaman sea constitutes about 92% of the total particulate carbon while phytoplankton and zooplankton constitute small fractions of the total suspended matter. Latitudinal relationship between phytoplankton and zooplankton was found to be inverse. (TR 2/80)¹.

Phytoplankton Population

Navicula spp, *Peridinium* spp, *Trichodesmium thiebauti* and flagellates dominated the phytoplankton population. Dinoflagellates form an important constituent of phytoplankton in the Andaman sea. Movachan (1973)⁷ has recorded that throughout the Andaman sea dinoflagellates were rich during and after northeast monsoon. The surface phytoplankton varied from 1200 to 5000 cells/litre. Extracellular production by phytoplankton in the Andaman sea varies from 0 to 1.2 mg C/m³/hr at different depths representing a loss of 0 to 85% of photosynthate (TR 2/80)¹.

Zooplankton

Zooplankton biomass in terms of volume was found to vary from 3.6 to 21.6 ml/m²/day during February 79. This is almost within the same range as reported earlier in the IIOE period. The average zooplankton biomass is generally poor compared to east and west coast of India. Copepods formed the dominant component followed by chaetognatha and tunicate. The average standing crop of zooplankton was estimated to be of the order of 288.8 mg C/m² for the upper 200m column (TR 2/80)¹.

Particulate Organic Carbon (POC)

At the surface its level ranged from undetected to 465 mg/m³. The average value was 132 mg/m³. Column POC varied from 0 to 13.19 gc/m² with an average of 4.59.

Fish Production

As given by Qasim (1977)⁸ and TR 2/80¹ for the open ocean 0.1% of primary production and 1% of secondary production are to be taken for estimating fish production. The mean of the primary production (6×10^7 tonnes C/year) and secondary production (31.73×10^6 tonnes C/year) gave a value of 18.70×10^4 Tonnes of C/year for calculating the tertiary production. In terms of live weight the figure would be 18.70×10^5 Tonnes/year (using factor of 10). Therefore 25% of potential yield could be taken as exploitable stock. This would amount to 4,70,000 tonnes of fish/year (TR 2/80)¹. The average fish landing in Andaman and Nicobar islands is about 10,000 tonnes/year. Hence a considerable increase

in the total yield is possible.

Benthic Fauna

Macrobenthic fauna of the Andaman sea in the depth zone of 30 to 2,750m comprised of 20 faunal taxa. Of these, polychaetes were the most dominant group and contributed 83%. The distribution of macrofauna was substrate specific with maximum (410m) population in clayey deposits and minimum (266m) in sandy coralline areas. Biomass of infauna was considerably lower than those of the epifauna and onfauna. Qualitative and quantitative improvement of the benthic macrofauna is a direct consequence of low temperature and oxygen deficient bottom waters (TR 2/80)¹.

Microbiology

Microbial studies on the sediments from the Andaman sea showed wide variation in total bacterial counts from 2.1×10^3 to 3.7×10^6 . There was no significant correlation between organic carbon values and activity of heterotrophs. The ratio of gram positive to gram negative bacteria was 1:15.4 and the majority of isolates (51.11%) were coccobacillic followed by pleomorphic forms (26.26%) (TR 2/80)¹.

PRESENT STATUS OF AREAWISE COVERAGE-GAP IN THE EEZ OF ANDAMAN AND NICOBAR ISLANDS

EEZ around Andaman and Nicobar island is divided into 68 one degree square grids. The maximum gaps are in this region, where eleven of such grids are not covered in any season. These grids are (lat 14-15N, long 94-95E), (lat 12-13N, long 95-96E), (lat 13-14N, long 95-96E), (lat 9-10N, long 90-91E), (lat 7-8N, long 89-90E), (lat 4-5N, long 90-93E), (lat 8-9N, long 95-96E), (lat 5-6N, long 93-94E) and (lat 7-8N, long 91-92E) (Fig. 3). The maximum gap in the region is during monsoon where 18.87% of the total area is not covered. During premonsoon period it is 13.65% and during postmonsoon period it is 11.25% of the total area.

The gaps are shown in various figures as defined below:

Figure-1 shows the depth contours around the Andaman and Nicobar islands. It can be noticed that the depth suddenly increases and shallow water area is very less. The area of

Andaman sea and its volume are 6.02×10^5 sq km and 6.6×10^5 km respectively.

Figure-2 shows the cruises carried out with their tracks. Besides 12 cruises during IIOE and Monex-73, 10 cruises of R.V. Gaveshani and ORV Sagar Kanya have been undertaken.³⁻⁶

Figure-3 shows area covered during the three seasons. This pertains to physical, chemical and biological parameters. A total of 227 stations were occupied but geological work has not been done.³⁻⁵

Figure-4 shows locations of stations covered by RV. Gaveshani (small dots-144) and by ORV Sagar Kanya (open circles 35) for physical and chemical data.³⁻⁵

In seasonwise coverage, Fig. 5 indicates the locations and number of stations occupied for physical and chemical parameters (both are generally taken together in multidisciplinary cruises). The stations covered by RV Gaveshani are 144, by ORV Sagar Kanya are 35 and during IIOE the stations are 44.

Figure-6 shows the situation in regard to biological work. Primary production, phytoplankton pigments and particulate organic carbon, zooplankton, benthos and microbiological studies have been undertaken in the Andaman sea during Jan (1961, 80), Feb (1961, 63, 79), Sept (1962, 83, 64), Nov (1983), Oct (1962), Feb-Mar (1963, 64), April (1961, 63, 64) and July (1973). A total of 17 cruises have been undertaken where biological parameters have been collected. These include seven of RV Gaveshani and 10 cruises are during IIOE and Monex-73. The seasonal gap is shown in Figures-5, 6.

This shows that biological studies have not been undertaken during monsoon period in this water since 1973. It also shows that in a season all the months are not studied for biological discipline. Therefore, efforts are to be made for studying atleast for parameters like primary productivity, zooplankton and phytoplankton.

These analyses show that minimum work has been done in monsoon followed by post monsoon and premonsoon.

Similarly Figures 7 and 8 show the number of stations covered in each cruise yearwise by the two ships.

There is no coverage in the EEZ of Andaman and Nicobar Islands during August and December months of any year. The data is staggered and discontinuous and therefore difficult to draw

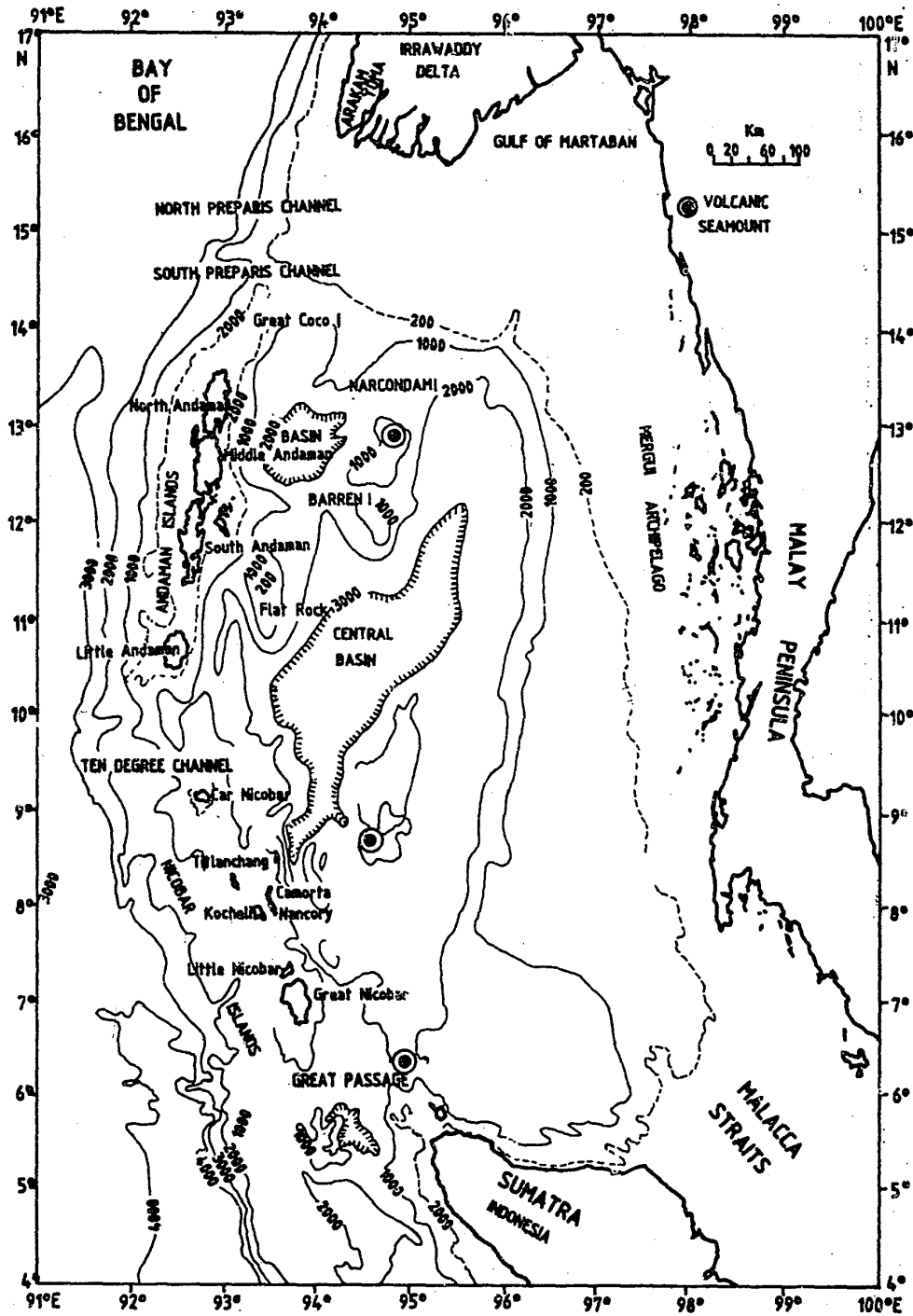


Fig. 1 Bathymetric map of seas around Andaman and Nicobar Islands (from Encyclopedia of Oceanography)

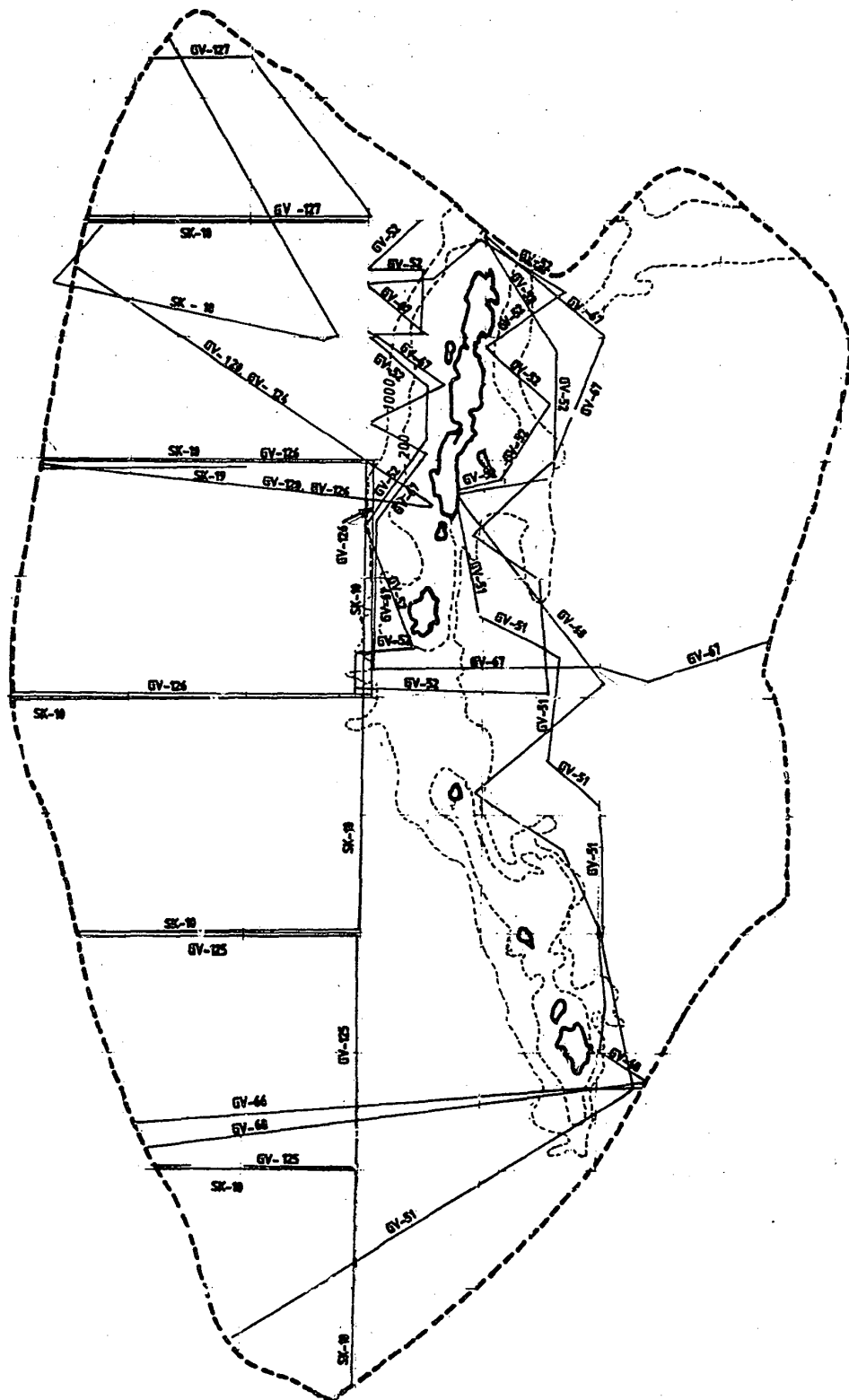


FIG. 2 CRUISE TRACKS OF R.V. GAVESHANI (1976-1986) & O.R.V. SAGAR KANYA (1983-1986).

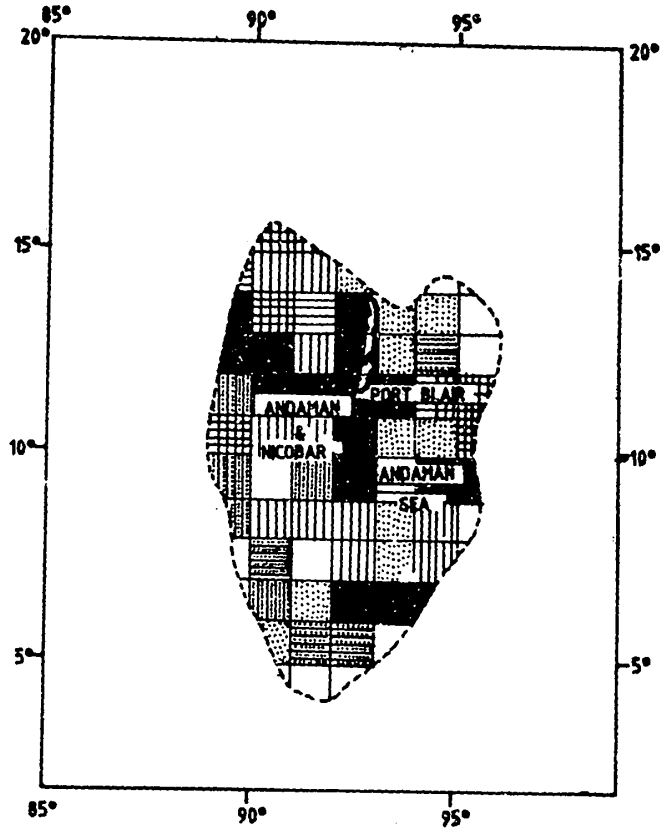


Fig. 3 - Seasonal coverage in EEZ around Andaman & Nicobar Islands

ONE DEGREE SQUARE GRIDS COVERED BY STATION DATA DURING
 PRE-MONSOON + MONSOON PRE-MONSOON+MONSOON + POST MONSOON
 PRE-MONSOON + POST MONSOON MONSOON + POST MONSOON
 ONLY PRE-MONSOON ONLY MONSOON ONLY POST MONSOON

Data source (R. Gaveshani 1976-1986) (O.R.V. Sagar Kanya 1983 - 1986)
 and (I.I.O.E. 1959 - 1964)

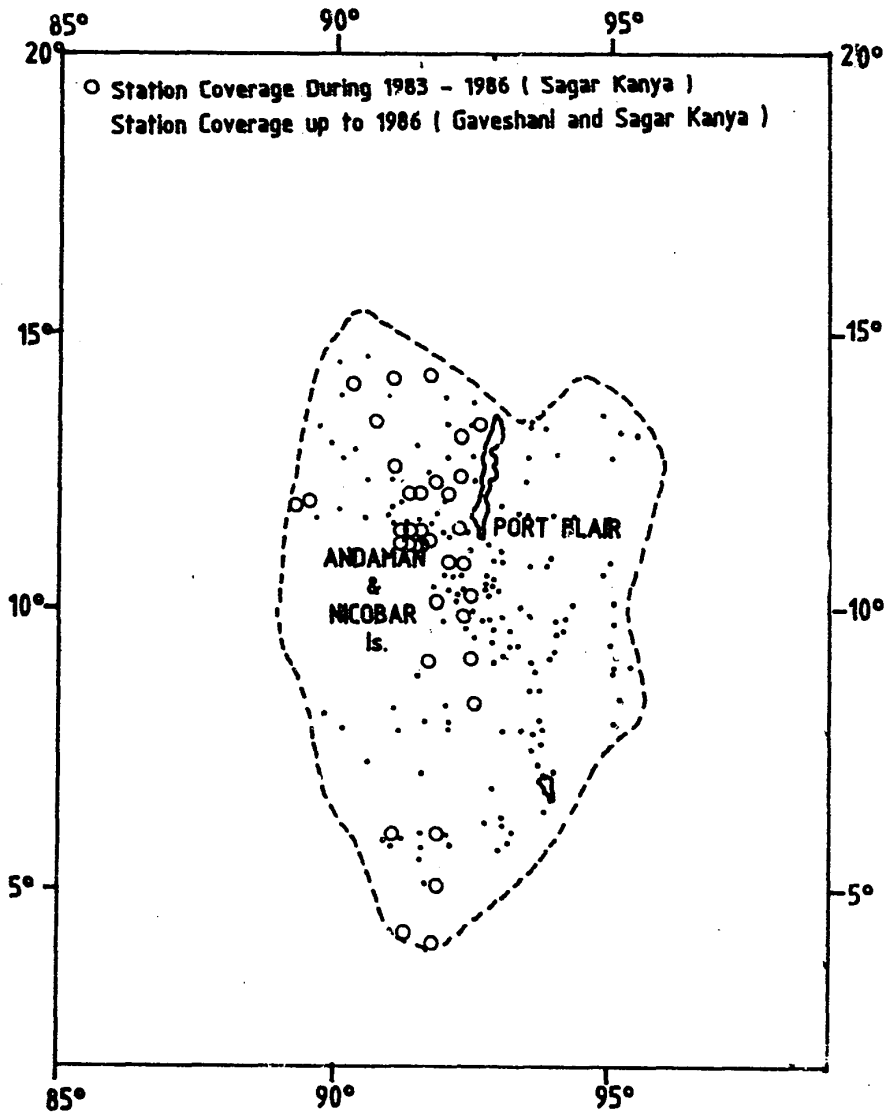


FIG. 4 PRESENT STATUS OF TIME VARIABLE OCEANOGRAPHIC DATA (PHYSICAL/CHEMICAL/BIOLOGICAL) OF R.V.GAVESHANI (1976-86) AND O.R.V.SAGAR KANYA (1983-86) IN THE EEZ OF ANDAMAN & NICOBAR Is.

○ R. V. GAVESHANI (1976-86) & O. R. V. SAGAR KANYA (1983-86)
+ INTERNATIONAL INDIAN OCEAN EXPEDITION (1959-65)
DURING

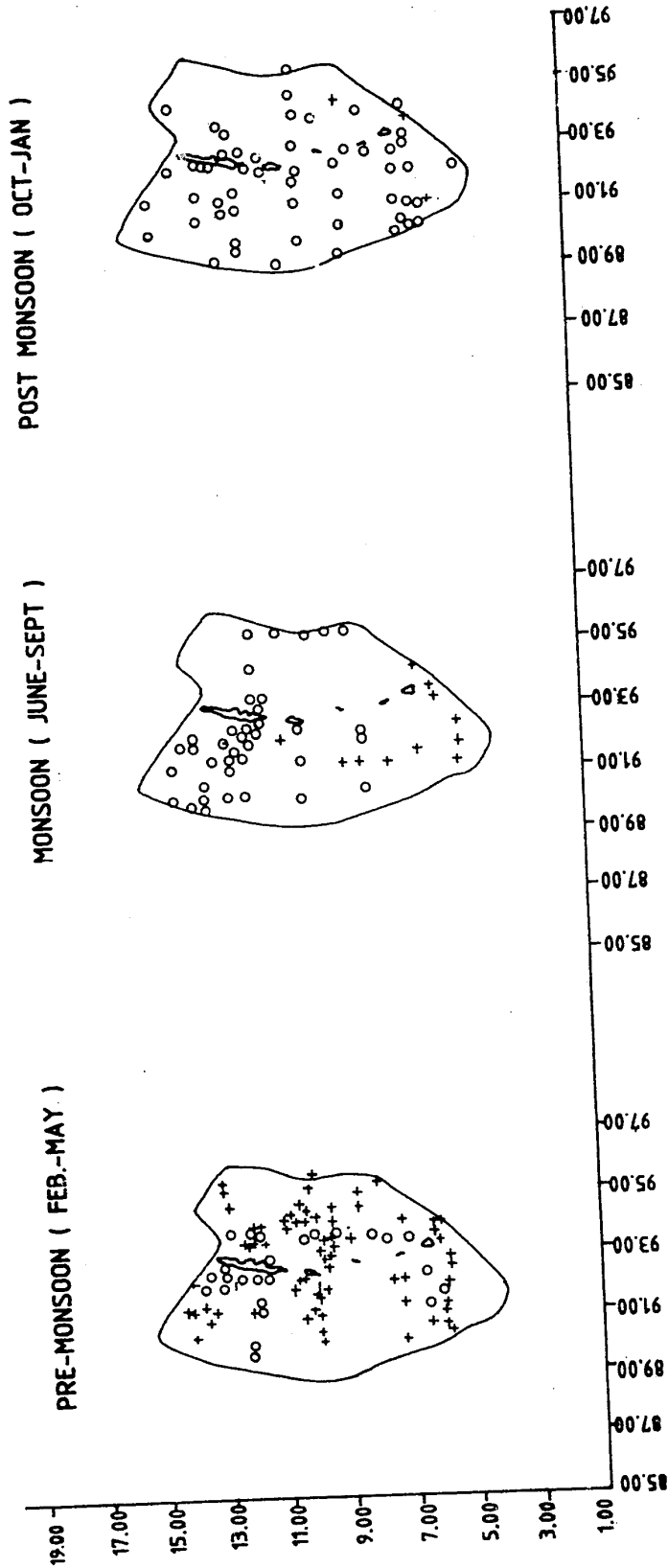


FIG. 5 SEASONWISE STATION LOCATION FOR PHYSICAL & CHEMICAL PARAMETERS

○ R.V. GAVESHANI (1976-86) & O.R.V. SAGAR KANYA (1983-86)
+ INTERNATIONAL INDIAN OCEAN EXPEDITION (1959-65)

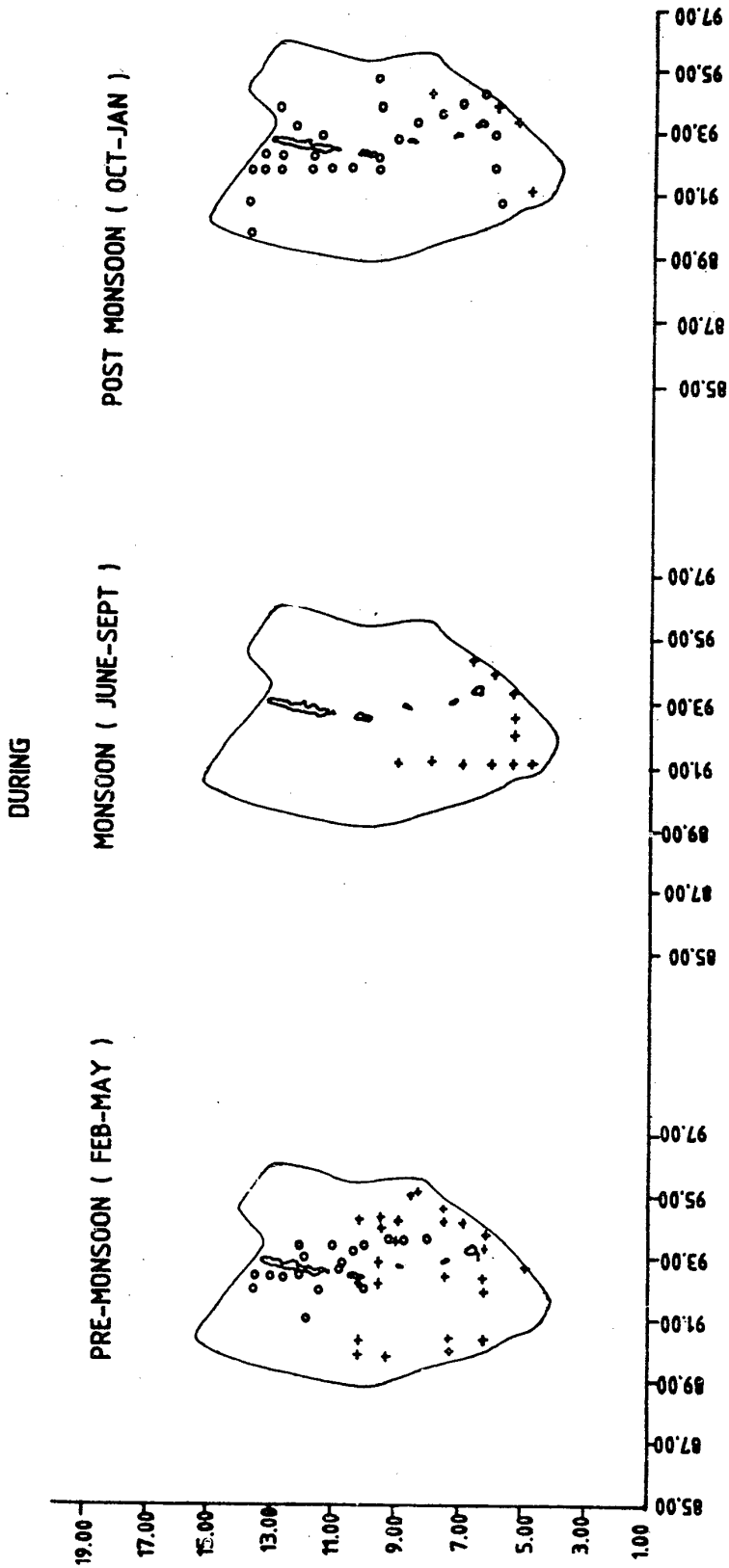


FIG. 6 SEASONWISE STATION LOCATION FOR BIOLOGICAL PARAMETERS

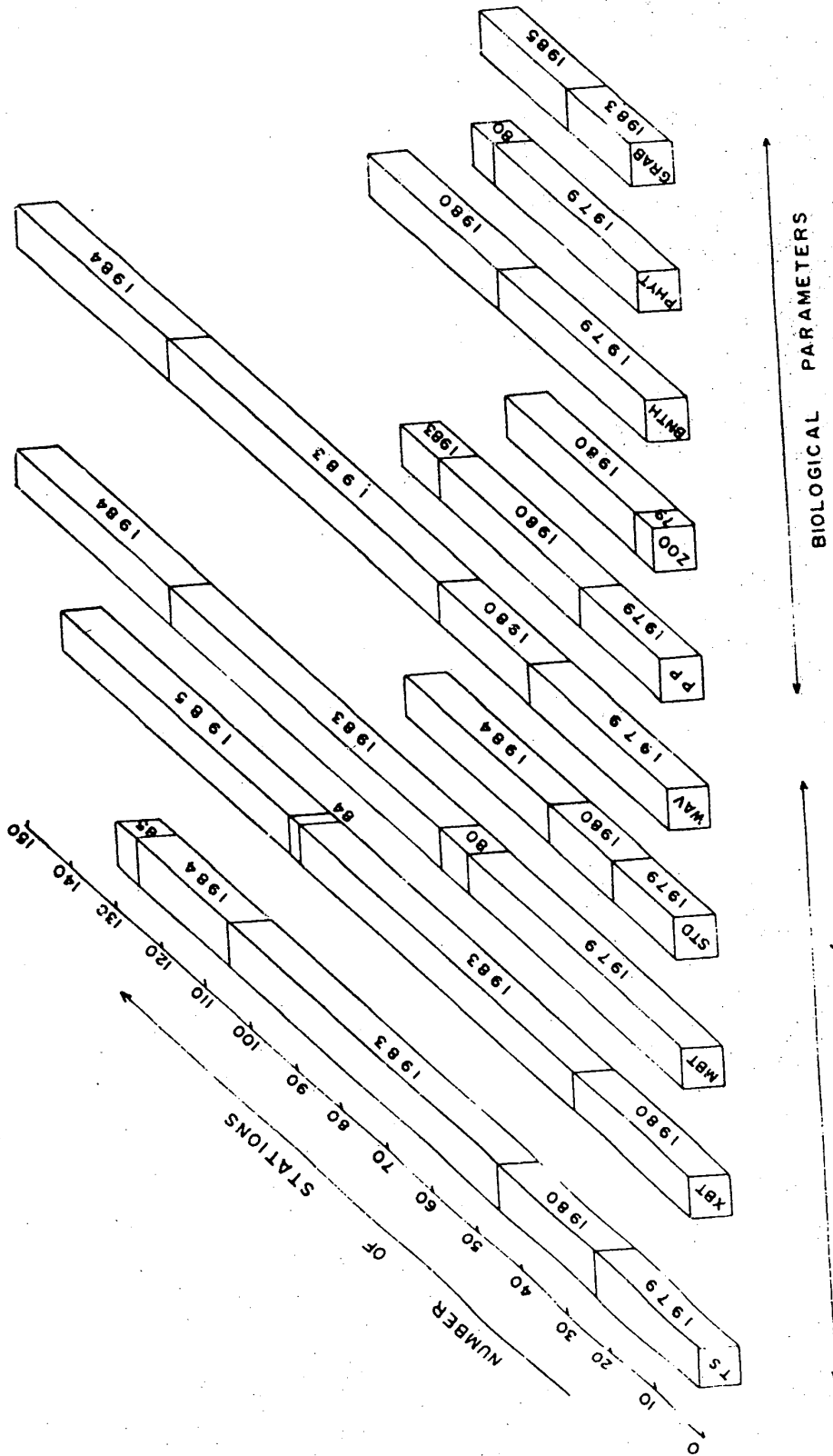


Fig. 7 Status of physical and biological parameters No of stations- Yearwise
 Data Source R. V. Gaveshani (1976-1986) .O. R. V. Sagar Kanya (1983-1986)

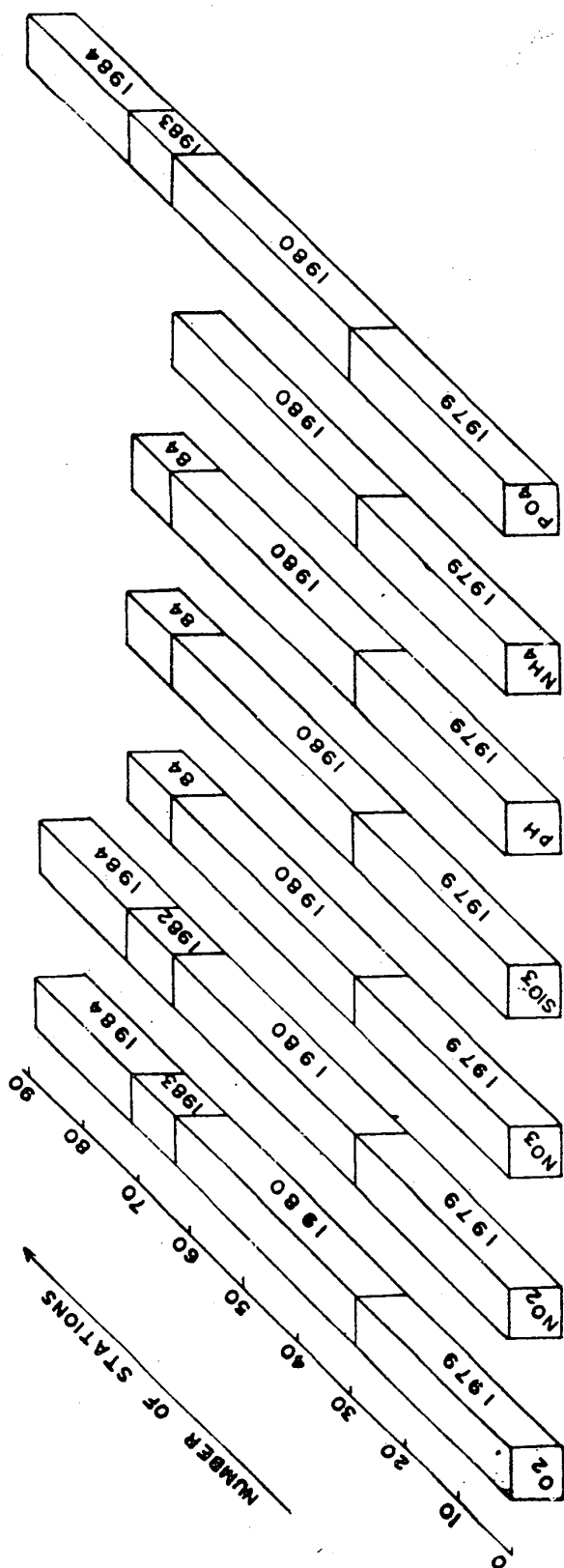


Fig. 8 Status of chemical parameters No of stations - Yearwise

Data Source : R.V. Gavesham (1976-1986), O.R.V. Sagar Kanya (1983-1986)

any valid conclusion. Therefore, future cruises should be planned in such a way that atleast complete area and seasonwise coverage could be completed in near future for the proper utilization of the Island seas.

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