

Full Length Research Paper

Ecology of Andaman Sea: Past, present and future

PAI IK

Department of Zoology, Goa University. Goa-403 206, India. E-mail: ikpai@unigoa.ac.in.

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The marine resources are a major source of food, a reservoir of minerals, major suppliers of oxygen, regulator of climate and also an ultimate dumping ground for the mounting burden of human waste material. Due to unchecked anthropogenic activity in recent years, the physico-chemical and biological status of the marine environments have changed significantly, which in turn resulted in the changing environmental scenario of the world. The Bay of Bengal, of which Andaman sea is a part, is one of the largest Bay in the world known to receive large flow of sediments from several rivers and other water bodies from India, Bhutan, Bangladesh, Myanmar, Indonesia etc., Many of these rivers bring along with them, a large quantity of effluents from cities / towns located on either side of these rivers, thus making the Bay nutrient rich. This Bay also plays a major role in determining the climatic conditions of India and other South East Asian countries. Thus its ecology is of paramount interest. Apart from the above, the Bay is also known for its oligotrophic nature as well as low productivity, thus resulting in high diversity of flora and fauna. In addition to the above, the marine zooplankton species, known to act as bioindicators, indicates the quality of water / environment. The ecological status of the Bay has a direct bearing on the lifescape of the Bay, and therefore, a study was undertaken to understand the ecological status of the Bay and to understand the marine bio-indicators, that will throw light on the status of abiotic factors of the Bay. Based on the observations, the study recommends certain appropriate measures to be taken to conserve the ecology of one of the largest Bay in the world.

Key words: Ecology, Andaman Sea, zooplankton.

INTRODUCTION

Approximately 71% of the surface of the planet earth is covered with marine waters, with average depth of 3.8 km, volume about $1370 \times 10^6 \text{ km}^3$ (Prasad, 2000) and innumerable species of organism. Only recently, it has been recognized as a promising and a major source of food, a reservoir of minerals, a major supplier of oxygen, and a regulator of climate and ultimate dumping ground for the mounting burden of human waste material, for years to come.

It is known that 32 out of 33 animal phyla exist in sea. It is also said that 173 of animal classes live in sea, 35 in freshwater and 33 on land (Nicoll, 1971) and for May (1994). While Grassle (1991) has reported that, 13 out of 28 phyla found in marine environment are endemic to marine environment. Thus, highlighting the importance of marine environment with regard to its lifescape, it is a single largest ecosystem for the marine organisms, where the water is the substance, that surrounds all marine organisms and it composes the bulk of the bodies of the marine plant and animals, and is also the medium in which various chemical reactions takes place, both inside and outside living organism (Nybakken, 1997).

Physico-chemical Parameters

The sea water consist of an average of 35 g/1000 ml of dissolved compounds collectively called salts or practical salinity units (psu) which include Cl^- (55.04%), Na^+ (30.61%), SO_4^{2-} (7.68%), Mg^{2+} (3.69%), Ca^{2+} (1.16%), K^+ (1.10%) as major constituents and HCO_3^- (0.41%), Br (0.19%), H_3BO_3 (0.07%) and Si^{2+} (0.04%) apart from 0.01% of dissolved substances of several inorganic salts needed for living of the organisms in sea.

Martin (1994) has reported that some of the organisms like diatoms and radiolarians show their existence in a place where there is availability of silicon dioxide, which is required for construction of their skeleton. Thus acts as bio-indicator. Similarly in contrast to most ions, NO_3^- (nitrates), and PO_4^- (phosphates) do not exist in constant ratio with other elements or ions, and tend to be in short supply in surface waters. Thus, such a kind of varying in abundance will result in biological activity as many a times become a limiting factor mainly for plant production.

While, the other elements such as Fe, Mn, Ca, Cu, though may exist in trace amounts, but can very well act

as limiting factor for sustenance of life (Martin, 1994). Among gases, O₃ and CO₂ dissolved in sea water has metabolic importance. Their solubility also varies and depends on temperature of the water, because, cold waters will have high solubility, hence O₂ are more in cold waters.

Unlike in the places like Arctic sea, temperate northern Pacific, which show summer bloom and temperate north Atlantic sea which exhibit spring bloom (Parsons et al., 1984), as tropical seas show thermal stratification, their productivity and biomass in general and zooplankton in particular is somewhat constant. Thus knowledge on zooplankton diversity will be of utmost importance.

Further, there is a new wide spread recognition that chemical monitoring is not enough and that pollution is essentially biological phenomenon because of its impact on the living organisms (Wright et al., 1994) and the need for biological methods has been accepted (Newman et al., 1992; Rosenberg and Resh, 1993). At community level too, use of biological approach is already well established and accepted (Cairns and Pratt, 1993) further, the advantage of using these bioindicators has been listed and discussed by Rosenberg and Resh (1993).

Literature indicates that, there can be three major categories of environmental stress viz., natural, imposed and environmental manipulation (mainly by anthropogenic activities) and will be reflected in the biotic system. There are pollutants effects at various levels like at cellular / molecular level. To look into all these aspects even software packages have been developed to predict and classify the system (Wright et al., 1994)

McAllister et al. (1994), while analyzing global distribution of coral reef fishes have reported that in Indian subcontinent, Laccadive-Maldives- Chagos and Sri Lankan region have high animal diversity and have also reported that sampling is weak in western Sumatra that is, eastern Andaman sea in particular and Andaman sea in general.

Keeping in view of the above, to fill the lacunae in our knowledge on the ecology of Andaman Sea, an attempt has been made to evaluate the past ecological status of Andaman Sea with that of present and foresee the future of the same.

MATERIAL AND METHODS

Department of Ocean development (DOD) (Government of India) and National Institute of Oceanography regularly organize cruises to various part of the country. Cruise no. SK-118 on Ocean Research Vessel, Sagar Kanya, which had a pre-determined area of operation as Andaman Sea covered 18 stations both near and far shores surrounding entire groups of Andaman Islands. The present study is based on the sampling done in all these 18 stations.

At each station, conductivity, temperature-depth (CTD) profile system with rosette samplers was lowered to 30 M depth for recording the relevant data. Water samples were collected from that depth by triggering the sample bottles from control panel on deck. Bathythermograph and thermosalinograph were also run at all the stations to record the parameters. The water thus collected was analyzed for various physico-chemical parameters such as temperature, pH, oxygen contents, salinity, chlorides, sodium, sulphates, magnesium, calcium, potassium, bicarbonates, bromide,

boric acid, strontium etc., by following standard analyses methods (APHA, 1992). Results obtained for three samples each, at every station were pooled.

Simultaneously, at every station, sampling for zooplankton was also done by both vertical (30 m to surface) and horizontal hauls (on water surface) by using bongo net (dia. 0.6 M, length 2.5 M, mesh width 300 µm). A pre-calibrated flow meter (T. S. Flow meter no.4512), was also attached to the net mouth, to calculate the actual quantity of water filtered during the operation. Thus collected samples were brought to the deck and later isolated and separated in the laboratory on board of the vessel. Later, the samples were preserved in 4% formalin and were brought to land laboratory for taxonomic identification and classification by following available literature (Kasturirangan, 1963., Mon, 1964., Daniel, 1985., Zheng Zong, 1989, Santanam and Srinivasan, 1994).

RESULTS

The samples obtained from all the 18 stations were collected by following regular procedures. Table 1 provides information on physico-chemical parameters of Andaman Sea. The data obtained, does not differ much with results obtained elsewhere by working at other marine environment (Nybakken, 1997). Table 2 exhibits the data on number of species collected in each from the present survey at the Andaman Sea.

The various data obtained on biotic and abiotic factors (Tables 1 and 2) were compared with that of available earlier reports (Anonymous, 1981; Madhupratap, 1981; Vijayalaxmi, 1981) and the possibility of making the use of modern tools such as ANPP (Anal Net Primary Productivity), AVRIS (Air borne visible Infra-Red Imaging Spectrometer), BIOCLIM (Biological Climate analyses and prediction system), ERIN (Environmental Resources Information Net work), GEMS (Global Environmental Monitoring System), GRID (Global Resource Information Database), HRV/MLA (High Resolution Visible Multispectral Linear Array), MSCP (Multiple Species Conservation Plan), MSS (Multiple Spectral Scanner), RAP (Rapid Assessment Procedures) etc., to have a constant monitoring of the ecology of this sea.

Table 1. Physico-chemical parameters of andaman sea.

Temperature	2.0 ± 50C
pH	7.9 ± 0.4
Oxygen	5.1 ± 6 ml / lt
Salinity	34.3 ± 0.7psu
Chlorides (Cl)	55.09 ± 1.3%
Sodium (Na ⁺)	30.11 ± 0.6%
Soleplate (SO ₄ ²⁻)	7.70 ± 0.2%
Magnesium (Mg ²⁺)	3.66 ± 0.1%
Calcium (Ca ²⁺)	1.15 ± 0.03%
Potassium (K ⁺)	1.16 ± 0.02%
Bicarbonate	0.46 ± 0.002%
Bromide(Br)	0.21 ± 0.001%
Boric acid (H ₃ B0 ₃)	0.08 ± 0.0003%
Strontium	0.03 ± 0.0002%

DISCUSSION

It is well known that, quality of an ecosystem can be assessed by analyzing its components namely abiotic and biotic ones. In a marine environment it is not only the oxygen, salinity and chlorides that are important yard sticks as major components, but even minor components such as calcium, strontium, potassium, bicarbonate, bromide also would hold a key to the success of flora and fauna of the area as limiting factors (Nybakken, 1997). In the present studies, the results (Table.1) indicate that physico-chemical parameters analyzed are all on par with other ideal, unpolluted marine ecosystems. Further, the comparison of the present data with the earlier results obtained by earlier workers does not show significant variation. This indicates that the Andaman Sea has neither significantly changed nor polluted

Bioindicators at lower levels of organization correlates more directly with environmental levels of known stress than those at the higher level. Many organisms have been used as bioindicators, apart from being used as sources of bioindicator molecules such as metallothioneins (Langston and Zhou, 1986), providers of cellular indices (Moore et al., 1982; Moore, 1991) or at individual levels (Widdows et al., 1980).

Using of gastropods, barnacles in general, *Mytilus edulis* in particular as bio-indicator is in vogue since 1939 (Moore and Kitching, 1939; Southward and Crisp, 1954, 1956), Dogwelks *Nucella lapillus* and *Nassarius obsoleta* are helpful in analyzing Tributyltin induced pollution (Hawkins et al., 1994), mussel egg has also been identified as an indicator of mutagen (Dixon and Pascoe, 1994). *Patella vulgata*, *P. dispersa*, *Monodonta lineata*, *Littorina* spp. etc., are some of the well known bio-indicators of oil spill and red tides (Southward and Southward, 1978). Further, Southward (1984) indicated the role of *Sagitta setosa* and *S. elegans* as bio-indicators, particularly for phosphates.

As can be seen from Table 2, a rich fauna of zooplankton, in general, and bioindicator species such as chaetognaths and other molluscs are present in abundance in Andaman Sea. It can be judged that biotic factors also functioning perfectly well in this sea. It is quite understandable that, when zooplankton are present in abundance, there must be sufficient phytoplankton to feed on and in turn there must also be sufficient secondary consumers, like fish and other higher organisms, which feeds on these zooplankton, thus completing a marine food chain systematically. This shows that at Andaman Sea the ecosystem is a mature, complete, self regulating and self sustaining one.

Although the fact remains that a large number of rivers from adjoining lands bring in large run-offs along with pollutants to Bay of Bengal, the reasons for not recording noticeable pollution in this area may be due to the distance from shore to this Andaman Sea area. It may also be due to degradation of most of the pollutant before they

Table 2. Number of zooplankton species observed in Andaman sea

Taxonomic Group		Number of species observed and collected
Protozoa	Foraminifera	16
	Radiolarian	06
	Tintinnida	
Coelenterata	Hydrozoa	15
	Schizophozoa	21
	Ctenophora	14
Nemertinea	Enopla	06
Annelida	Errentia	18
Chaetognatha		26
Arthropoda	Cladocera	06
	Ostracoda	19
	Calanoida	120
	Cyclopoida	27
	Herpecticoida	09
	Monstrilloida	13
	Mysidae	19
	Hyperildea	12
	Gemmaridea	19
	Euphausiacea	22
Decapoda	17	
Mollusca	Heteropoda	03
	Pteropoda	12
Chordata	Prochordata	11
	Appendicularia	13
	Thalassacea	05

reach this area from coasts of Myanmar, India and Bhutan, Bangladesh, Indonesia etc., It can also be suspected that due to sinking of most of the heavy pollutants to the bottom of the sea, from where they can not disperse further due to almost stagnant conditions of water. Apart from the above, one more plausible reason is that the countries surrounding the Andaman Sea have recently been industrialized, and the quantity of effluents released is not so much, so that it could pollute Andaman Sea to a significant level so far. It could be done by using modern techniques such as ANPP, AVIRIS, BIOCLIM, ERIN, GEMS, GRID, HRVIMLA, MSCP, MSS, RAP etc., apart from regular survey, sampling for biological organism as well for physico-chemical parameters to see that this pristine environment remains unpolluted for years to come.

REFERENCE

- Anonymous (1981). Andaman Sea. Ind. J. Mar. Sci. 10 (7):209-210.
 APHA (1992). Standard method for examination of water and waste water 18th Ed. American Public health Association, AWWA, WPCP, Washington, DC.

- Cairns J, Pratt JR (1993). A history of biological monitoring using benthic macro-invertebrates. In freshwater bio-monitoring and benthic Macro-invertebrates (Eds. Rosenberg DM and Rash VH), Chapman and Hall, New York. pp. 10-27
- Daniel R (1985). Fauna of India. Coelenterata; hydrozoa, siphonophora, Z. S. I. Calcutta.
- Dixon DR, Pascoe PL (1994). Mussel eggs as indicators of mutagen exposure in coastal and estuarine marine environment. In: Water quality and stress indicators in marine and fresh water Systems: Linking levels of organization (Ed: Sutcliffe DW. Freshwater Biol. Assoc. UK): pp. 124-137.
- Grassle JF, Lessrre P, McIntyre AD, Ray GC (1991). Marine biodiversity and ecosystem function. Biol. Internat. Special Issue 23: 1-19.
- Hawkins SJ, Proud SV, Spence SK, Southward AJ (1994). From the individuals to the community and beyond; water analysis, stress indicators and key species in coastal ecosystem. In: Water quality and stress indicators in marine and fresh water systems: Linking levels of organization (Ed: D.W. Sutcliffe, Freshwater Biol. Assoc. UK). Pp. 35-62.
- Kasturirangan LR (1963). A key for the identification of the more common planktonic copepods of Indian coastal waters. CSIR, New Delhi, India.
- Langston WJ, Zhou M (1986). Evaluation of significance of metal binding proteins in gastropods *Littorina littorea*. Mar. Biol. 92: 505-515.
- Madhupratap M (1981). Thermocline and zooplankton distribution. Ind. J. Mar. Sci. 10(7): 262-265.
- Martin J (1994). Testing the iron hypothesis in ecosystem of the equatorial Pacific. Nature. 371:123-129.
- May RM (1994). Biological diversity differences between land and Sea. *Phil. Trans. Roy. Soc. Lond. B* 343:105-111.
- McAllister DE, Schueler FW, Roberts CM, Hawkins JP (1994). Mapping and GIS analysis of the global distribution of coral reef fishes on an equal area grid. In: Mapping the diversity of Nature (Ed: Miller RI, Chapman and Hall Publ. London: 155-175).
- Moore MN (1991). Lysosomal changes in the response of molluscan hepato-pancreatic cells to extra-cellular signals. *Histochem. J.* 23: 495-500
- Moore MN, Kitching JA (1939). The biology of *Chthamalus stella* (Poli). J. Mar. Biol. Assn. UK. 23: 521-541.
- Moore MN, Pipe RK, Farrar SV (1982). Lysosomal and microsomal responses to environmental factors in *Littorina littorea* from Sullom. Mar. Poll. Bull. 13: 340-345
- Mon T (1964). The pelagic copepods from neighboring waters of Japan, Tokyo. The Soyo Co.
- Newman PJ, Piavaux MA, Sweeting RA (Ed) (1992). River water quality-Ecological assessment and control CEC, Brussels: p. 751.
- Nicol D (1971). Species, class and phylum diversity of animals. Q. Jl. Fla. Acad. Sci. 34: 191-194.
- Nybakken JW (1997). Marine biology; an ecological approach. IV Ed. Addison Wesley Longman Inc. California.
- Parsons TR, Takahashi M, Hargrove B (1984). Biological oceanographic processes. 3rd Ed. Pergmon Press, New York.
- Prasad SN (2000). Marine Biology, Campus Books, New Delhi, India.
- Rosenberg DM, Resh VH (Ed) (1993). Freshwater biomonitoring and benthic macroinvertebrates. Chapman & Hall, New York .p. 488.
- Santhanam R, Srinivasan A (1994). A manual of marine zooplankton, Oxford and IBH Publ. Bombay.
- Southward AJ (1984). Fluctuations in the indicator chaetognath *Sagitta elegans* and *Sagitta setosa* in the western channel. *Oceanologia acta.* 7: 229-239.
- Southward AJ, Crisp DJ (1954). Recent change in distribution of the inter-tidal barnacles *Chthamalus stellatus* Poli and *Balananus halanoides* L. in the British Isle. J. Ani. Ecol. 23: 163-177.
- Southward AJ, Crisp DJ (1956). Fluctuations in the distribution and abundance of inter tidal barnacles. J. Mar. Biol. Assn. UK. 35: 211-229.
- Southward AJ, Southward EC (1978). Re-colonization of rocky shores in Cornwall after use of toxic dispersant to clean up the Torrey canyon spill. J. Fish Res. Board. Canada. 35: 682-706.
- Vijayalaxmi (1981). Chaetognatha of Andaman Sea. Ind. J. Mar. Sci. 10(3): 270-273.
- Widdows J, Phelps DK, Galloway W (1980). Measurement of physiological conditions of mussel transplanted along a pollution gradient in Narragansett Bay. Mar. Env. Res. 4: 181-194.
- Wright JF, Furse MT, Armitage PD (1994). Use of macro invertebrate communities to detect environmental stress in running water. In water quality and stress indicators in marine and fresh water systems: Linking levels of organization (Ed; DW Sutcliffe, Freshwater Biol. Assoc. UK): 15-34.
- Zheng Z (1989). Marine Planktology. China Ocean Press, Beijing.