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Status of Bay of Bengal: An Ecological Point of View

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Abstract

The marine resources are a major source of food, a reservoir of minerals, major suppliers of oxygen, regulator of climate. It is 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. This has resulted in the changing environmental scenario of the world. The Bay of Bengal, 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. Further, the Bay is also known for its oligotrophic nature as well low productivity, thus resulting in high diversity of flora and fauna. The ecological status of the Bay has a direct bearing on the lifescape of the Bay, and therefore, a study was undertaken to understand abiotic and biotic factors with special reference to zooplankton. 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, Bay of Bengal, Physico-chemical parameters, zooplankton

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Introduction

Approximately 71% of the surface of the planet earth is covered with marine waters, with average depth 3.8 Km, volume about 1370 x 10^6 Km^3 (Prasad, 2000). 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. It is also used as ultimate dumping ground for the mounting burden of human waste material.

It is known that, 32 out of 33 animal phyla exist in sea. It is also said, 173 animal classes live in sea, 35 in freshwater and 33 on land (Nicoll, 1971). The possible reasons for the same are listed by May (1994). Grassle et al. (1991) have reported that, 13 out of 28 phyla found in marine environment are endemic to marine environment and only one of 11 phyla is endemic to terrestrial ecosystem. This makes marine ecosystem as single largest repository of living organisms. It is also the medium, in which various chemical reactions take place, both inside and outside living organisms (Nybakken, 1997).

Physico-Chemical Parameters

The Marine water consist of an average of 35g/1000 ml of dissolved compounds collectively called as 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 St^{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.

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, O_2 and CO_2 dissolved in sea water, has metabolic importance. Their solubility depends on temperature of the water.

Arctic sea, temperate northern Pacific, which show summer bloom and temperate north Atlantic sea, which exhibit spring

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Table 1. Sampling sites at Bay of Bengal (vertical sampling) (30M-0M)

Station No.	Day/ Night	Latitude	Longitude	Biomass ml/100M^3	Organisms/ 100M^3
01	D	20°24'00"N	88°39'00"E	0.9	1625
02	N	18°00'00"N	90°00'00"E	1.6	7468
03	D	17°00'00"N	90°00'00"E	0.5	4053
04	N	16°00'00"N	90°00'00"E	1.4	4676
05	D	15°00'00"N	90°00'00"E	1.5	5016
06	D	14°00'00"N	90°00'00"E	1.0	2445
07	N	13°00'00"N	90°00'00"E	1.5	6993
08	D	12°00'00"N	90°00'00"E	0.7	2638
09	N	11°00'00"N	90°00'00"E	1.1	8617
10	D	10°00'00"N	90°00'00"E	0.8	3880
11	D	09°00' 00"N	90°00'00"E	0.6	2744
12	D	08°00'00"N	90°00'00"E	0.5	3589
13	D	07°00'00"N	90°00'00"E	1.1	8165

Ocean Research Vessel, Sagar Kanya, had a pre-determined 13 stations, at Bay of Bengal.

At each station, conductivity, temperature-depth (CTD) profile system, with rosette samplers was lowered to 30M 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 thermo-salinograph 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

Table 2A. Physico-chemical parameters at Bay of Bengal (vertical sampling) (30M-0M)

Stn No.	pH	Temp (°C)	Salinity %o	Alkalinity (ppt)	Hardness (ppt)	Chloride (ppt)	Calcium (ppt)	Magnesium (ppt)
1	7.0	18.35	34.86	5	8	29	2	6
2	7.0	18.60	34.86	4	5	18	3	2
3	7.0	19.37	34.80	3	11	18	3	11
4	7.0	17.58	34.90	3	8	18	4	4
5	7.0	16.38	34.90	3	7	25	4	3
6	7.0	16.52	34.86	3	8	25	5	3
7	7.0	19.33	34.83	4	8	17	4	4
8	7.0	18.19	34,85	3	6	18	4	2
9	7.0	18.44	34.94	3	6	21	3	3
10	7.0	17.38	34.96	4	6	21	3	3
11	7.0	17.17	34.07	2	5	11	2	3
12	7.0	18.64	35.96	5	5	22	2	3
13	7.0	19.00	34.93	4	5	27	2	3

bloom (Parsons et al., 1984); but, tropical seas show thermal stratification. Thus, their productivity and biomass in general and zooplankton in particular is some what constant.

Further, there is a new widespread recognition that, chemical monitoring is not enough and that, pollution is essentially biological phenomenon (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 bio-indicators has been listed and discussed by Rosenberg and Resh (1993).

McAllister et al. (1994), while analyzing global distribution of coral reef fishes, have reported that in Indian subcontinent, Laccadive - Maldives-Chagos and Sri Lankan regions have high animal diversity but, sampling is weak in western Sumatra i.e., in Bay of Bengal in general.

Keeping in view of the above, to fill the lacunae in our knowledge on the ecology of Bay of Bengal, an attempt has been made to evaluate the same.

Materials 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

was also done by both vertical (30m to surface) and horizontal hauls (on water surface) by using bongo net (dia. 0.6M, length 2.5M, mesh width 300um). 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, 1989; Santanam and Srinivasan, 1994).

Results

The samples from all the 13 stations (Tables1 and 3) were collected by the following regular procedures: Table-2a, 2b, 3a and 3b provide information on physico-chemical parameters of Bay of Bengal. The data obtained, does not differ much with results obtained elsewhere, by working at other marine environment (Nybakken, 1997). Table 4 exhibits the presence of 433 number species collected in the surveyed area. The various data obtained on abiotic and biotic factors (Tables 2a, 2b, 3a, 3b, and 4) were compared with that of available earlier reports (Anonymous; 1981; Madhupratap, 1981; Vijayalaxmi, 1981) and the possibility of making use of modern tools such as

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Table 2B. Physico-chemical parameters at Bay of Bengal (vertical sampling) (30M-0M)

Stn. No.	Sulphate (ppt)	D.O. (mg/l)	Phosphate (umol/l)	Nitrate (umol/l)	Silicate (umol/l)
1	18	1.60	1.90	0.45	26.42
2	18	1.34	1.80	0.14	3012
3	17	1.57	2.10	0.16	3042
4	17	1.20	1.67	NT	23.26
5	16	1.32	1.54	NT	23.24
6	17	2.30	1.69	0.19	30.19
7	17	1.54	1.72	1.07	30.16
8	17	1.69	1.82	0.04	29.24
9	16	1.72	1.90	0.04	25.22
10	16	1.82	2.14	NT	30.18
11	18	1.90	1.10	0.11	30.24
12	18	2.14	1.15	NT	27.03
13	18	1.10	1.75	0.07	28.67

NT: Not traceable

Table 3A. Sampling sites at Bay of Bengal (horizontal sampling)

Stat. No.	Day/ Night	Latitude	Longitude	Biomass ml/100M^3	Organisms/ 100M^3
01	D	20^{0}24'00"N	88^{0}39'00"E	0.9	590
02	N	18^{0}00'00"N	90^{0}00'00"E	0.4	1622
03	D	17^{0}00'00"N	90^{0}00'00"E	0.5	288
04	N	16^{0}00'00"N	90^{0}00'00"E	1.5	2871
05	D	15^{0}00'00"N	90^{0}00'00"E	0.5	641
06	D	14^{0}00'00"N	90^{0}00'00"E	1.3	1374
07	N	13^{0}00'00"N	90^{0}00'00"E	2.0	5083
08	D	12^{0}00'00"N	90^{0}00'00"E	0.3	1256
09	N	11^{0}00'00"N	90^{0}00'00"E	0.9	4144
10	D	10^{0}00'00"N	90^{0}00'00"E	1.3	4033
11	D	09^{0}00'00"N	90^{0}00'00"E	2.0	7182
12	D	08^{0}00'00"N	90^{0}00'00"E	0.5	1581
13	D	07^{0}00'00"N	90^{0}00'00"E	0.5	2255

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 Bay.

Discussion

It is well known that, quality of an ecosystem can be assessed by analyzing its abiotic and biotic components. In a marine environment, it is not only oxygen, salinity and chlorides 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.2a, 2b, 3a and 3b) indicates, physico-chemical parameters analyzed are all on par with other ideal, unpolluted marine ecosystems. The values are in agreement with earlier findings. This indicates that, the Bay of Bengal has neither significantly changed nor polluted

Bio-indicators, 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 bio-indicators. Metallothioneins (Langston and Zhou, 1986) provides cellular indices (Moore et al., 1982; Moore, 1991) or at the individual level (Widdows et al., 1980).

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

As can be seen from Table 4, a rich fauna of zooplankton in general and bioindicator species such as Chaetognaths and other molluscs are present in abundance in Bay of Bangal. It can be judged that, biotic factors also functioning perfectly well in this Bay. It is quite understandable that, when zooplankton are present in abundance, there must be sufficient phytoplankton to feed on. Fuether, 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 Bay of Bengal, the ecosystem is a mature, complete, self regulating and self sustaining one.

Although the fact remains that, a large number of rivers from

Table 3B. Pysico-chemical parameters of Bay of Bengal (horizontal sampling)

Stn No.	pH	Temp (°C)	Salinity %o	Alkalinity (ppt)	Hardness (ppt)	Chloride (ppt)	Calcium (ppt)	Magnesium (ppt)
1	7.5	25.7	30.50	7	13	26	3	1
2	7.0	26.4	31.89	6	7	25	1	6
3	7.0	27.1	32.19	5	7	21	4	3
4	6.5	27.0	32.57	4	7	20	3	4
5	7.0	27.2	32.88	2	8	31	5	3
6	7.5	27.4	33.23	6	9	36	3	6
7	7.0	27.9	33.65	4	9	22	7	2
8	7.0	27.7	33,77	7	9	22	6	3
9	7.0	27.9	33.71	8	12	35	7	5
10	7.0	27.9	34.35	6	10	27	5	5
11	7.0	27.9	34.40	4	4	17	2	2
12	7.5	27.9	34.45	4	12	35	6	6
13	7.0	27.9	34.29	3	9	35	9	6

Table 3C. Pysico-chemical parameters of Bay of Bengal (horizontal sampling)

Stn. No.	Sulphate (ppt)	D.O. (mg/l)	Phosphate (umol/l)	Nitrate (umol/l)	Silicate (umol/l)
1	16	4.50	0.07	0.072	0.84
2	17	4.70	0.07	0.021	0.09
3	16	4.20	0.08	0.071	0.74
4	16	5.60	0.06	NT	2.66
5	17	5.20	0.05	NT	1.87
6	18	5.70	0.06	NT	1.92
7	18	4.20	0.06	0.071	1.42
8	18	4.90	0.08	NT	2.32
9	18	5.00	0.07	NT	3.24
10	17	4.80	0.05	NT	0.74
11	17	5.10	0.09	0.046	0.56
12	17	4.70	0.04	NT	1.04
13	18	4.30	0.06	0.060	0.78

Table 4. Number of zooplancton species observed in Bay of Bengal

Taxonomic Group		Number of Species Observed and Collected
Protozoa	*Foraminifera*	14
	Radiolarian	06
	Tintinnida	02
Coelenterata	*Hydrozoa*	15
	Schyphozoa	1
	Ctenophora	14
Nemertinia	*Enopla*	06
Annelida	*Errentia*	18
Chaetognatha		23
Arthropoda	*Cladocera*	06
	Ostracoda	19
	Calanoida	124
	Cyclopoida	27
	Herpecticoida	11
	Monstrilloida	13
	Mysidae	17
	Hyperildea	12
	Gemmaridea	17
	Euphausiacea	24
	Decapoda	18
Mollusca	*Heteropoda*	04
	Pteropoda	13
Chordata	*Prochordata*	11
	Appendicularia	13
	Thallacea	05
	Total	**433 Species**

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 its large size. It may also be due to, degradation of most of the pollutant, before they reach this area. It can also be suspected that, most of the heavy pollutants sink to the bottom of the sea, from where they can not disperse further, due to almost stagnant conditions of water. One more plausible reason is that, the countries surrounding the Bay of Bengal, have recently been industrialized, and the quantity of effluents released is not so much, so that, it could pollute the Bay to a significant level so far. But, one has to be careful to see that this water body does not get polluted.

However, as the Bay of Bengal environment is prone to pollution, at the rate at which, the coastal areas are becoming industrialized, one has to have a close, regular and careful monitoring of the ecology of Bay of Bengal. 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.

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