

Plankton, its Diversity & Factors Governing its Productivity in Gulf of Mannar

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Abstract—The Gulf of Mannar is endowed with a rich and heterogeneous group of flora and fauna. There are about 3600 species identified so far, out of which the phytoplankton and zooplankton contributes 133 and 360 species respectively. The percentage composition of diatom dominates the other phytoplankton group by about 90%. The zooplankton biomass of the area is largely comprised of copepods. The Gulf of Mannar biosphere reserve consists of 21 islands, which is divided into four major groups. The plankton distribution is high in Mandapam group of islands comprising 74 phytoplankton and 60 zooplankton species. The productivity of phytoplankton is influenced by monsoon and the stability of the water column which varies seasonally. Nutrient introduction into the upper layer of seawater caused by coastal upwelling, driven by alongshore winds lead to high biological production which governs the productivity of zooplankton. The Gulf of Mannar is open at the southern end where water from Indian Ocean and the Arabian Sea get mixed. Shipping activities introduce contaminants, which include oil, trace metals, nutrients and organochlorine compounds. Moreover, the proposed Sethusamudram Ship Canal project is a potential threat ecologically, as the dredged material will be disposed at the dumping sites of 25-30m depth. These areas can be affected by any monsoon and the inflow of sediments can cause a drastic change in the plankton production. Koodankulam nuclear power plant remains as another major threat which can have high impact on plankton productivity.

Keywords: Gulf of Mannar – Plankton – Mandapam – Productivity – Sethusamudram Ship Canal Project - Koodankulam nuclear power plant.

1. INTRODUCTION

The Gulf of Mannar is situated in the southeastern coast of India extending from Rameshwaram in the north and kanyakumari in the south. The Gulf of Mannar Biosphere reserve is one of the world's richest biodiversity area located between Pampan and Thoothukudi. It is declared as Marine National Park in 1986 and later declared as Marine Biosphere Reserve in 1989. It is the first marine Biosphere Reserve in Southeast Asia. The total area of the coast is 10,500 sq km. The core area of Biosphere reserve is 94.2sq.km. It consists of 21 Islands and 47 fishing villages situated along the coast of Ramanathapuram and Thoothukudi districts. In Gulf of Mannar there are 3600 species of flora and faunas found. It consist of 126 phytoplankton sp, 360 zooplankton sp, 117

marine coral sp, 5 marine turtle sp, 480 fish sp, 79 shellfish sp, 100 sponges sp, 760 mollusks sp, 100 echinoderms sp, 13 sea grass sp, 12 mangrove sp. Plankton are very sensitive to the environment changes. Any alteration in the environment leads to the change in the plankton communities in terms of tolerance, abundance, diversity and dominance in the habitat. Thus, the observation of plankton population may be used as a tool to identify water stability and pollution indicator. More than 95% of the primary production in the oceanic waters is contributed by only phytoplankton (Lewis, 1974). Krishnamoorthy and Subramanian (1999) reported that the west coast current and conglomeration of open ocean influenced the highest species diversity of meroplankton in the Palk Bay and Gulf of Mannar.

2. PHYTOPLANKTON

Phytoplankton are free floating, unicellular photosynthetic microscopic organisms. They are the primary producers which play a major role by initiating the aquatic food-chain process and fuelling energy to the higher trophic level organisms. Some of the major groups of phytoplankton are diatoms, dinoflagellates, coccolithophores, silicoflagellates, cryptomonads, blue-green algae and green algae. In the tropical seas, the dominant group among the various phytoplankton groups is diatoms. Diatoms alone contribute about 90% of the total phytoplankton biomass. The distribution of these species shows wide spatial temporal variations. This is mainly due to the different effects of hydrographical factors on individual species and they serve as good indicators of water quality. Many factors reducing phytoplankton diversity may have direct detrimental effects on the amount and predictability of aquatic primary production. 126 species of phytoplankton were reported in the Gulf of Mannar region (Kannan, 1996). Out of this, 97 species of diatoms from 33 genera, 16 species of dinoflagellates from 6 genera, 7 species of blue-green algae from 5 genera, 3 species of green algae from 3 genera and 3 species other species were found. The population density varied from 34000 to 86000 cells/litre.

3. ZOOPLANKTON

Zooplankton are omnipresent in distribution. They form a vital link for turnover of organic matter. The rate of zooplankton production can be used as a tool to estimate the exploitable fish stock of an area. Micro zooplankton are a diverse group. Marine micro zooplankton are important in the transfer of material through coastal food webs. They act as a link between small phytoplankton and larger zooplankton. They graze between 30-50% of primary production in many marine systems. Their body size is between 20 and 200 microns. In the marine eco-systems, they act as phytoplankton grazers and nutrient regenerator. Seasonal variations of species composition and abundance of zooplankton vary with the phytoplankton productivity. The zooplankton biomass of the area is largely comprised of copepods and crustacean larvae followed by bivalve larvae and eggs. 360 species of zooplankton were reported in the Gulf of Mannar region (CMFRI, 1998). The population density of zooplankton varies from 8000 to 65000 nos./cu.m. The major phyla of zooplankton are Protozoa, Coelenterata, Ctenophora, Annelida, Chaetognatha, Mollusca, Echinodermata, Arthropoda, Chordata.

4. DISTRIBUTION OF PLANKTON IN GULF OF MANNAR REGION

4.1 Phytoplankton distribution

- 78 species of phytoplankton were recorded in Mandapam group of Islands. 59 species of Bacillariophyceae, 9 species of Dinophyceae, 4 species of Cyanophyceae and 2 species of Chlorophyceae.
- In the Keezhakarai group, 53 species of Bacillariophyceae, 9 species of Dinophyceae, 3 species of Cyanophyceae and 2 species of Chlorophyceae totaling 67 species were recorded.
- In the vembar group, 48 species of Bacillariophyceae, 11 species of Dinophyceae, 2 species of Cyanophyceae and 1 species of Chlorophyceae totaling 62 species were recorded.
- In the Tuticorin group, 57 species of Bacillariophyceae, 8 species of Dinophyceae, 4 species of Cyanophyceae and 1 species of Chlorophyceae totaling 70 species were recorded.

4.2 Zooplankton distribution

- 62 species of zooplankton were recorded in Mandapam group of islands. 46 species of Crustacea, 1 species of Granuloreticulosa, 1 species of Hydrozoa, 2 species of Polychaeta, 5 species of Polyhymenophora, 3 species of Sagittoidea and 2 species of Thaliacea.
- In the Keezhakarai group, 45 species of Crustacea, 1 species of Granuloreticulosa, 1 species of Hydrozoa, 3 species of Polychaeta, 1 species of Polyhymenophora, 1

species of Sagittoidea and 2 species of Thaliacea totaling 54 species were recorded.

- In the vembar group, 37 species of Crustacea, 1 species of Granuloreticulosa, 1 species of Hydrozoa, 1 species of Polychaeta, 1 species of Polyhymenophora, 3 species of Sagittoidea and 1 species of Thaliacea totaling 45 species were recorded.
- In the Tuticorin group, 46 species of Crustacea, 1 species of Granuloreticulosa, 1 species of Hydrozoa, 3 species of Polychaeta, 5 species of Polyhymenophora, 1 species of Sagittoidea and 2 species of Thaliacea totaling 59 species were recorded.

5. PRODUCTIVITY OF PHYTOPLANKTON

The coastal area in the Gulf of Mannar region is likely to be influenced by anthropogenic activity of rivers, estuaries and lagoons. The Gulf of Mannar is located between the low saline Bay of Bengal in the eastern side and relatively high saline Arabian Sea on its western side. During the Southwest Monsoon, Arabian Sea water enters into the Bay of Bengal and vice versa during the Northeast Monsoon (Murty et., al., 1992; Vinayachandran et al., 1999). This area is rich with nutrients such as Nitrate, Nitrite, Ammonium, and phosphate, due to the reversal of monsoon currents that affects the hydrodynamic features of the area. The stability of the water column also influences the productivity. In addition to this, nutrient introduction into the upper layer caused by coastal upwelling driven by alongshore winds lead to high biological production. A complex of physical (light, temperature and water circulation), chemical (pH, salinity, nutrients) and biological features (growth rate and grazing pressure) have been thought to control the phytoplankton community dynamics by determining species composition, species seasonality, species biomass and productivity biomass (Harris 1986).

The production of phytoplankton in the upper layer of tropical oceans is limited by the availability of nutrients. Therefore, physical processes that can bring nutrients into the photic zone are of prime importance. The gross primary productivity varied from 142 to 472 mg C m⁻³ day⁻¹ indicating that the Gulf of Mannar is biologically productive region (Anon 2005). The phytoplankton are the first group to respond to changes in nutrient conditions in an ecosystem. Being the base of the food chain all higher trophic groups ultimately depend on them.

6. TRACE METAL CONTAMINATION

The Gulf of Mannar is wide open at the southern end and subjected to water movement from Indian Ocean and the Arabian Sea (Prasad, 1954). Major and minor ports are present in this region. Shipping activities introduce contaminants like oil, trace metals, nutrients and organo-chlorine compounds (UNEP, 1990). The presence of fish processing units, salt pans,

textiles and petrochemical industries also contaminates the near shore waters. In addition, the famous pilgrim centers at Rameshwaram, Erwadi, Tuticorin, Uvari and Kanyakumari also possess a major threat to the inclusion of trace metal into the Gulf regions. Thus the quality of water and sediments affect all the living organisms in this diverse region. The contaminants such as trace metals, phosphorous, pesticides, PCBs and polycyclic aromatic hydrocarbons, get accumulated in the sediments and suspended matter in aquatic systems (Jenne, 1977; Forstner and Wittmann, 1981). Trace metal uptake by sediments and suspended matter occurs by three main mechanisms such as physico-chemical adsorption from water column, biological uptake and physical accumulation of metal enriched particulate matter (Barry, 1982).

7. SETHUSAMUDRAM SHIP CANAL PROJECT

The Sethusamudram ship canal project is a 167 km long shipping canal, by which the ships can pass through the Gulf of Mannar, the Palk Strait and the Palk Bay. It involves dredging an 89-kilometer stretch for a width of 300 meters and for a depth of 12 meters for ships less than 30,000 DWT with draft restricted to 10m. The Sethusamudram Ship Canal project envisages dredging the shallow sea bed of the Palk Bay (PB) and Adam's Bridge (AB) to a depth of 12 meters in order to make navigation possible for ships drawing a draught of 9.15 or 10.7m (Ramesh 2004). The calculated quantity of dredged material for the total length is 81.5 to 88.5 million m³. The annual volume of about 0.1 million m³ dredged material is calculated for the maintenance of the canal (NEERI EIA 2004).

The Adam's Bridge is 31 km long with an average depth range of less than 5 m and extends between Rameshwaram and the Mannar islands. It is very shallow and its depth varies between 3 to 15 m. The Palk bay is largely occupied by sand banks and shoals with two major coral reef formations. One is around 5.5 km long and from 1-2 m to 300 m wide extending between Munakad and Thonithurai. The other reef formation is 25 to 30 km long with a width generally less than 200 m; this extends between Thangachimadam and Agnitheertham (Rameshwaram) (Mahadevan and Nagappan Nair 1969). In contrast to the seabeds of Palk Bay and Adam's Bridge, the seabeds of the Gulf of Mannar in the south and the Bay of Bengal in the northeast have a very deep throw. Within a few kilometers from the Adam's Bridge and the Palk Strait, they fall steeply to depths of 1000 to 2000 m. So, the ocean beds of Palk Bay and Adam's Bridge can be thought of as highly elevated dam like structures that separate the deep ocean beds of Gulf of Mannar and Bay of Bengal (Sudarshan et. al. 2007). There is no vertical stratification in this region, due to its shallowness and wind mixing by the Northeast Monsoon.

The current proposal of disposing off the dredged material is 25-30m deep. But it is better to dispose at the depth of 50-60m (Krishnaswamy, 2006). Only physical properties like pH, electrical conductivity, salinity, temperature, turbidity, TSS (Total Suspended Solids) is being monitored and it also seems that it is being done only for marine water quality and not for sediment quality (Sudarshan et. al. 2007). Thus the plankton productivity and others like sea grass and coral ecosystems are not considered. Since the plankton are very sensitive to the environmental changes, they will be greatly affected by this proposed project.

8. KOODANKULAM NUCLEAR POWER PLANT

Koodankulam nuclear power plant remains as another major threat which can have high impact on plankton productivity. Each nuclear power unit requires four desalination units, which sucks a huge quantity of seawater. The phytoplankton and zooplankton get impinged, when they are taken into the intake pipe and get trapped against a screen covering the intake. According to the Sierra club, for every 378 liters of water a desalination plant takes in, it emits between 38 and 158 liters of highly concentrated saltwater or brine, which affects the productivity of the plankton.

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