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# GLIMPSES OF AQUATIC BIODIVERSITY

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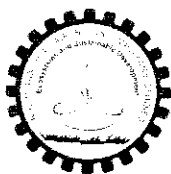
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## **MARINE BIORESOURCES AND THEIR CONSERVATION IN INDIA**

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Life in its diversity is the greatest resource on our planet and represents the very foundation of human existence. Only in the last two decades we have become aware of the dimension of bioresources. New and exciting species are being discovered everyday and at the same time a dramatic loss of biodiversity is observed globally. Despite numerous conservation efforts in the past, evidence pointed to a continued decline in almost all species worldwide. Owing to the mass extinction of numerous species in the past, the world community is striving since few years to conserve these species which are on the brink of becoming extinct. Subsequently, biodiversity emerged as an environmental issue in the early 1980s, culminating in the Conference on Sustainable Development held in Rio de Janeiro in 1992. At the same time, biological diversity was recognized as an essential parameter, in particular for the agro and pharmaceutical industries. This raised ethical questions about the conservation of biological diversity and patenting of living beings. Therefore, biodiversity became a framework for considering and discussing the whole range of questions raised by human relationships with other species and natural environments – a kind of ‘mediator’, as it were, between ecological systems and social systems. Independently of this new role, biodiversity remains one of the major concerns relative to global environment. Conservation is necessarily based on knowledge of ecology and involves human feelings, beliefs and attitudes as well as science and technology.

### **Marine Wealth**

India's wealth of bioreources is found in highly diverse marine and coastal habitats. Until today marine diversity is less known than terrestrial biodiversity due to the logistic difficulties of explorations, underwater surveys and collections. With 7500 km of coastline, 200 km wide Economic Exploitation Zone, the Bay Island of Andaman & Nicobar and the atoll island group of Lakshadweep, in India, astonishingly we know little about marine life even in the most familiar seascapes. The Indian Ocean accounts for 29% of the global oceans, 13% of the marine organic carbon synthesis, 10% of the capture fisheries, 90% of the culture fisheries, 30% of the local reefs, 10% of mangroves. India has 246 estuaries draining a hinterland greater than 200 km<sup>2</sup> besides coastal lagoons, mangroves and backwaters.

Research on marine bio-resources in India dates back to the 18<sup>th</sup> century, which initially started with surveys and expeditions conducted by the westerners, particularly by the British. This initiative has blossomed further and has witnessed advancements in marine research, in parallel to the developed nations. It is pertinent to note that among the Asian countries, India is perhaps the only one that has a long record of inventorisation of marine biodiversity so far; investigation of fauna and flora have been conducted especially along the mainland coasts where some of the premier research institutes and universities are located. Further, many institutions administered under the Ministry of Environment and Forests (MoEF), Department of Ocean Development (DOD), Department of Science and Technology (DST), Department of Biotechnology (DBT), Department of Space (DoS), Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR), Universities under the network of the University Grants Commission (UGC),

science, technology and environment departments in various states, non-governmental organisations like Bombay Natural History Society (BNHS), M.S. Swaminathan Research Foundation (MSSRF) and others are currently involved in diverse fields of research and development in India's marine biodiversity.

Microorganisms represent the largest reservoir of biodiversity and research on marine microbes is just booming. A recent paper titled "Recent advances in marine microbiology- the Indian scenario" gives a clear picture of microbes of the seas which includes mycological and bacteriological aspects covering near, offshore and deep sea waters (Chandramohan, 1997).

Among Plantae, marine phytoplankton, the pastures of the sea, are the major sustaining components of ecosystem processes and responsible for the biogeochemical reactions that drive our climate changes. Apart from the substantial contributions of NIO and Universities, CMFRI has played a major role in the investigations on phytoplankters, since its inception in 1947. Initially, a total of 156 species belonging to 15 families and 64 genera of Bacillariophyceae were listed by Subrahmanyam (1946). Subsequently, Subrahmanyam (1958; 1959) published an account of 365 species of phytoplankton organisms of the Arabian Sea comprising 226 species of 67 genera of diatoms; 121 species of 67 genera of Dinophyceae and 19 species of 14 genera of other microalgae. Later a detailed taxonomic appraisal was given by him on Dinophyceae of the Indian waters (1968 & 1971), 67 species were reported for the genus *Ceratium* and 114 species of the family Peridiniaceae under 7 genera. Gopinathan (1975) and Gopinathan and Pillai (1975) published 33 diatom species of 22 genera belonging to 12 families and 25 species of Dinophyceae of 11 genera under 8 families, respectively from the sea off Cochin. Subsequently, 109 diatom species of 40 genera under 13 families were registered from the southwest coast of India (Gopinathan, 1984). Altogether over 800 species of phytoplankton were recorded for the Indian seas.

Marine macro-algae from Indian coasts have been well surveyed since several decades. The revised checklist of Indian marine algae by Oza and Zaidi (2000) has recorded 844 species (including forms and varieties) distributed among 217 genera. However, recently Kaliaperumal and Kalimuthu (2004) have recorded 1153 species under 271 genera. Kannan *et al.* (1999) have recorded 14 species of sea grasses from Indian seas with *Thalassia* and *Syringodium* dominant in coral reef areas. Studies made by Kathiresan (1999) revealed that a total of 39 mangrove species are known from India and this has been incorporated in an atlas entitled "Mangrove atlas and status of species of India".

Out of the total 32 animal phyla, 15 are represented by the taxa in the marine ecosystem. They may constitute either migratory or resident species. The former includes pelagic crustaceans, coelentrates (medusae), cephalopods, molluscs, fishes, reptiles, birds and mammals. The zooplankton communities of the Indian seas presented under phyla Chaetognatha, Arthropoda, Annelida, Cnidaria, Echinodermata, Hemichordata and Chordata were studied in detail by CMFRI, NIO and universities to build up a data bank on relevant species and also to know the species inhabiting our waters and their habitats, seasonality and numerical abundance. Copepods are the most predominant among the zooplankton community and are most widely studied among the planktonic crustaceans contributing about 540 species in Indian waters. Bensam (1991) has published an appraisal of the studies conducted so far on the early developmental stages of marine Osteichthyes in India with suggestions for future research. More than 380 species of fish larvae were identified and listed till date.

The benthic macro fauna comprises resident species of polychaetes, molluscs, sipunculids and mud-burrowing fishes. Among invertebrates, sponges, corals and echinoderms generally do not prefer estuarine ecosystem. Papers on the poriferan faunal diversity of India recorded 486

species (Thomas, 1986; 1998). Contemporary studies on hard corals are those of Pillai (1986; 1996) and Venkataraman *et al.* (2003) which list a total of 218 species of hard corals under 60 genera and 15 families. Although 89 species are reported from Indian seas, the studies by Thomas and Rani (1986) revealed that 31 species referable to 19 genera and 9 families form the main study of Indian gorgonid fishery. According to Rao and Kamala Devi (2003) a total of 150 soft corals are reported to be occurring in India. Among echinoderms, Sastry (1998) has recorded 765 species. Further, James (2000) reported 200 species of holothuroidae in the seas around India. 75 species are located in the shallow waters within 20 m and dozen are commercially important.

In India, estuarine species diversity seems to be maximum in molluscs. In 1996, Appukuttan has recorded 3271 species of molluscs distributed among 220 families and 591 genera, of which 1900 are gastropods, 1100 bivalves, 210 cephalopods, 41 polyplacophores and 20 scaphopods. Subsequently, 3370 species of molluscs have been recorded by Rao (1998) from marine habitats. Another important taxa, polychaeta are represented with maximum diversity in the much studied Hoogly-Matlah estuary (West Bengal). However, around 1093 species representing 8.66 % of the global number 12, 620 are reported to be occurring in India (Achary *et al.*, 2005). They recorded 23 species from the mangrove areas. Meiofauna of Indian estuaries are flagellates, ciliates, nematodes, ostracods, harpacticoid copepods, rotifers, gastrotriches and arachnids.

Free swimmers or nekton are important components of marine biodiversity and constitute important fisheries of the world. The dominant taxa in the nekton are fish, others being crustaceans, molluscs, reptiles and mammals. Out of a total 22,000 species, it has estimated that about 4,000 species occur in the Indian Ocean of which 2546 species are from the Indian seas (Talwar, 1991). Majority of the nektonic species is found in the coastal waters. It is estimated that 40 species of sharks and 250 species of bony species represented the oceanic fishes. India is one of the major contributors of the world estimate of crustacean species diversity.

According to Venkataraman and Krishnamoorthy (1998), out of the 2934 species of crustaceans that have been reported so far, marine species contribute maximum (94.85%) to this diversity. Suseelan (1996) listed 150 species of decapod crustaceans from the Indian seas in his paper on crustacean biodiversity, conservation and management. In this account he has recorded 118 species of prawns under 33 genera belonging to penaeidea of which 63 species are littoral and 27 are deep water forms. Among the 17 species and 6 genera of lobsters, 6 are deep water species and 11 are from the littoral environments. Later, additions from the coastal waters have increased the number from 17 to 26 (Venkataraman and Wafar, 2005). Although, Suseelan (1996), reported 640 species of marine crabs from India, of which 12 species are edible and support commercial fishery, Venkataraman and Wafar (2005) has stated that 705 brachyuran crabs are recorded from Indian seas. The pioneering monograph of Kemp (1913) reported 97 species of stomatopod fauna from the Indo-Pacific region and 54 species from the Indian seas.

Among reptiles, sea snakes and turtles are important and represented worldwide by 57 species respectively. There are seven recognized species of sea turtles in the world, of which five species are reported in India. Four species of turtles-Olive Riddleys (*Lepidochelys olivacea*) Green turtle (*Chelonia mydas*), Leather back (*Dermochelys coriacea*) and Hawksbill (*Eretmochelys imbricata*) nest on Indian coasts. There are a few reports of logger heads (*Caretta caretta*) from Indian waters, but no known nesting beaches (Rajagopal, 1996).

The seashore offers a variable feeding and breeding ground for a number of birds. From the available data it has been inferred that there are 12 families, 38 genera and 145 species, which occur in the coastal ecosystem.

Marine mammals belong to three orders, Sirenia, Cetacea and Carnivora. About 120 species are estimated to occur in world seas and of these 30 are reported from seas around India. But majority of these is oceanic forms and occasionally a few individuals may get stranded on the shore. Sea cow occurs in near shore waters.

## **Conservation Status**

There have been several past and ongoing endeavours for the conservation of coastal and marine diversity in India, prominent among which are initiatives by the government and autonomous bodies which are presented here in a nut shell.

**1. Government:** The Government of India has brought into force a number of laws for conservation of living organisms and their habitats. Almost all these laws are applicable to the marine realm also. The Indian Wildlife Protection Act, 1972 with its subsequent amendments accords protection to all marine mammals, five species of marine turtles, fifty species of molluscs, nine species of sharks, all species of sea horses and sclerectinian corals among others. The Coastal Regulation Zone Act, 1991 seeks to conserve marine habitats along the coasts, according protection to beaches, mangroves and other marine habitats. Various Marine Fisheries Regulation Acts (MFRAs) were enacted by the maritime states of the country under a model bill circulated by Govt. of India in 1979 to safeguard the marine bioresources through mesh size regulations and licensing of fishing activity. Along with the provision of the Act, all maritime state governments in India impose a trawling ban lasting two months during the monsoon every year to protect spawners and juveniles. The Central Pollution Control Board, set up in 1974 functions under the purview of the Water Prevention and Control of Pollution (WPCP) Act, 1974, and the Air Prevention and Control of Pollution (APCP) Act, 1981. All issues related to pollution in coastal marine areas come under its jurisdiction. The Indian Coast Guard and various Port Trust authorities is the implementing arm for WPCP Act as well as for international legislation such as International Convention for the Prevention of Pollution from ships (MARPOL) and United Nations Convention on the Law of the Sea (UNCLOS) for controlling pollution in the sea.

Taking cognizance of the provisions of the CBD, and to deal with extensive pressure on our biological resources because of recent biotechnological developments, India has enacted an umbrella legislation called the Biodiversity Act, 2002, and also notified the biodiversity Rules, 2004. The act and rules are for guidance of and complacence by various stake holders, including Union and State Governments, Non-state sectors and individuals. The National Biodiversity Authority, India based in Chennai and with arms in all states has been set up under the provisions of this Act.

Apart from legislations, the government has set up 115 marine protected areas (MPAs) in exclusion of two marine biosphere reserves, the Gulf of Mannar and another the Nicobar islands. Currently there are 12 marine national parks in various states and 103 wild life sanctuaries. Of the 115 MPAs, 105 lie in the Andaman and Nicobar islands. Monitoring and upkeep of the MPAs comes under the purview of central Indian Forest Services and various state Forest Departments.

The Union Ministry of Environment and Forests has formed the All-India Coordinated Project on Coastal and Marine Biodiversity, the main agenda of which is to inventorize the coastal and marine biodiversity of India along with subsidiary objectives of capacity-building in taxonomy, creation of databases, networking and website hosting on biodiversity-related themes and promotion of participatory monitoring and management. Also under this Ministry's programmes is the Indian Coral Reef Monitoring Network (ICRMN) whose task is to continuously monitor the health of the coral reef ecosystems through biophysical and environmental surveys, and to develop infrastructure and human resources needed for this purpose. Evolving management options for coastal regions, wetlands and estuaries is part of the remote sensing application project National Natural Resource Management System (NNRMS).

India abides by the CITES which prohibits the trade in turtle products. At present, all the 5 species of turtles are protected as they are placed in the Indian Wildlife (Protection) Act, 1972. The largest rookery in the world of olive Ridley turtles, which is at Gahirmatha, Bhitarkanika in Orissa have been declared as National Parks. Various turtle nesting beaches in the Andaman and Nicobar are also within the purview of marine protected areas. However, there are many historical records of sea turtles from the Indian coasts. There are also species records in the ZSI and CMFRI archives and the district gazettes of various shades along west and east coast with special reference to trade in hawksbill, green and Olive Ridley turtles. There is also considerable documentation of the trade in Olive Ridley eggs from Orissa to West Bengal.

All cetaceans and sirenians are protected under the Indian Wildlife Act, 1972. Of the 25 species, according to IUCN the status of 1 species is endangered, 4 species is vulnerable and 20 species is insufficiently known. The dugong is considered as vulnerable. However, Indian Wildlife Act (1972 and amended in 1991) has listed only three species of cetaceans (Irrawaddy dolphin, Ganges River dolphin and Sperm Whale) and the dugong in Schedule I due to lack of adequate scientific information (Rajagopal and Menon, 2003).

The Department of Biotechnology functioning under the Union Ministry of Science and Technology established the National Bioresource Development Board (NBDB) in 1999 with the policy framework of effective application of biotechnological and related scientific approaches for research & development and sustainable utilization of bioresources, especially for the development of new products and processes using the modern tools of biosciences. The Board also envisages to evolve effective *ex situ* conservation strategies for bioresources of potential scientific and economic value and to develop predictive groupings of biological resources through molecular lineages and to construct gene maps of bioresources. Several conservation efforts have been initiated under this programme. The erstwhile Department of Ocean Development (now the Ministry of Earth Sciences) has basic programmes for assessment of marine living resources including fishery resources along the continental slope, deep scattering layer, toxic algal blooms, benthic productivity studies and development of technologies for harvesting deep sea resources. The DOD also conducts Environmental Impact Assessment studies for mega-projects involving the utilization of oceanic resources. The DOD has an Ocean Biodiversity Resource Group which studies different faunal and floral groups of the marine realm and suggest ways for their conservation and sustainable use. It's Drugs from the Sea programme aims at assessing marine organisms with bioactive potential. The DOD has been running the Coastal Ocean Monitoring and Prediction System (COMAPS) since 1989 to monitor pollutants along the Indian coasts. A large number of stations were used for regular sampling of physical, chemical and biological parameters. As a result of this programme 'hotspots' of pollution along the Indian coasts have been identified.

The Central Marine Fisheries Research Institute under the Indian Council of Agricultural Research, Ministry of Agriculture has the most intensive network of monitoring marine biodiversity exploitation and is also obliged to carry out assessments of the exploited fish stocks and manage them at sustainable levels (Mohan Joseph and Jayaprakash, 2003). The fishery resource is constituted by a total of 1570 species of finfishes from the Indian seas, which form 62.8% of the total number of fish species known from the country (CMFRI, 1997). However, the updated 'Fishbase' shows a total of 1704 marine fishes from India out of which 189 are pelagic and 149 are deep water species; the threatened accounts for 43, dangerous 277 and reef associated fishes 831. Further, marine fisheries in India is mainly supported by a few commercially important targeted species which form the bulk of the landings, namely oil sardine, Indian mackerel, anchovies, seer fish, ribbonfish, Bombay duck, carangids, elasmobranchs, sciaenids, perches, silver bellies, lizard fish, penaeid shrimps, cephalopods and bivalve molluscs. During the 1980s and 1990s, serious concerns

were expressed that the unrestricted growth of the fishing industry might become counter productive (Devaraj & Vivekanandan, 1999) and therefore, the management strategy started aiming at sustaining the fisheries. Marine Fisheries Regulation Acts (MFRA) were promulgated in the 1980s for all the maritime states with the focus on controlling the fishing areas, fishing gears, enforcing mesh-size regulations and closed seasons. The Institute has assisted the Government of India in formulating a comprehensive Marine Fisheries Policy; rendered advice to maritime states in Coastal Zone Regulation (CZR) guidelines and on National Biodiversity policy. Furthermore, it has rendered policy advice on lobster conservation, on denotification of ban of certain species of elasmobranchs and molluscs by MoEF and also played a lead role on the ban of endangered species such as corals, sea cucumbers and ornamental gastropods.

In 1984, CMFRI and Madras Crocodile Bank conducted a workshop in Madras at which the status and threats to marine turtles were discussed. Further, a national sea turtle advisory group was formed for conservation and management of sea turtles. Several research programmes were conducted and Government of India launched a national sea turtle conservation project funded by UNDP.

The National Bureau of Fish Genetic Resources (NBFGR), established in 1983 is responsible for developing DNA Barcodes of marine fish species from India as well as in documenting genetic variation at intra-specific level of finfishes and shellfishes. The Fishery Survey of India, another agency under this Ministry conducts exploratory surveys for new fish stocks in offshore waters with the aim of relieving fishing pressure from coastal stocks.

**2. Autonomous institutions:** The CSIR funded National Institute of Oceanography (NIO) based in Goa is the nodal agency for co-ordinating the programmes of marine environment aspects under the National Biodiversity Strategy and Action Plan (NBSAP). It has initiated inventorisation and conservation efforts in collaboration with worldwide programmes such as CoML and Ocean Biogeographic Information System (OBIS). It has an ongoing project for establishment of a gene library for marine organisms. Under the Indian Coral Reef Monitoring Network programme, the NIO has begun regular monitoring of coral reefs of Lakshadweep since 1999. The National Chemical Laboratory (NCL), Pune, initiated work in the area of biodiversity informatics in the year 2000. It currently hosts the largest bioinformatics database for marine organisms in India.

Apart from these institutions, a large number of autonomous and state run universities are actively involved in research on marine biodiversity and conservation. The Council of Scientific and Industrial Research (CSIR) and DOD fund a large number of projects aimed at the same. Prominent among these are the School of Marine Sciences of Cochin University of Science and Technology, Kochi, Andhra University, Visakhapatnam and Centre of Advanced Studies in Marine Biology, Annamalai University, Parangipettai.

**3. NGO's:** The Bombay Natural History Society (BNHS), Mumbai is one of the oldest NGOs for nature conservation in India, having come into existence in 1883. It is actively involved in marine species and ecosystem conservation. Along with mangrove and wetland conservation programmes, it currently runs a programme for conservation of giant clams in the Lakshadweep and is also involved in turtle conservation. It works in collaboration with international agencies such as the Darwin Initiative and the U.S. Fish and Wildlife Services. The Wildlife Protection Society of India (WPSI) was formed in 1994 at New Delhi to provide additional support and information required to combat escalating illegal wildlife trade and runs a Sea Turtle Protection Programme. Reefwatch India, a Bombay based organization runs several programmes based on studying marine organisms and conservation issues. Their focus of operations is the Andaman and Nicobar islands.

Reefwatch India also had involved in marine conservation activities particularly that of marine reptiles such as salt water crocodiles and turtles in the Madras Crocodile Bank Trust (MCBT), which is partly funded by the National Geographic Society and the Andaman and Nicobar Environmental Trust. The MCBT conducts 'turtle walks' for college students and young adults which focuses on conservation of marine turtle eggs during the arribada season based on collection of eggs and protection of nests. Another NGO with a section for studies on marine diversity and conservation is the Bangalore based Asoka Trust for Research in Ecology and Environment (ATREE). Also involved in marine conservation issue in the Andamans is the Save Andaman and Nicobar Ecology (SANE). Greenpeace India is active in campaigning for coastal area and pollution issues. A very large number of NGOs have come up in Tamil Nadu, especially with the coming into being of the Sethusamudram Project.

Other NGOs which are indirectly involved with marine conservation are those representing fishermen's rights such as the National Fish worker's Forum and its subsidiaries in all maritime states, and NGOs such as Kalpavriksh which was the nodal agency for co-ordinating the National Biodiversity Strategy and Action Plan (NBSAP) for India.

### **Key Challenges**

Conservation of marine biodiversity in India, can be best managed by the following guidelines:

1. Revitalising the 200 year tradition of marine biodiversity inventorying in order to interpret, manage, conserve and use bioresources in a sustainable manner.
2. Reconstruction of lost habitats.
3. Reduction of discards, by-catch being thrown overboard.
4. Establishment and management of Marine Protected Areas.
5. Ecosystem based fisheries management.
6. Formulation of effective policy measures.
7. Economic values of biological resources of coral reef ecosystem of India in the international market and impact due to export revaluated.

### **Conclusion**

The bioresources of many habitats is under threat and although seas cover the major part of our planet's surface, far less is known about the bioresources of marine environments than that of terrestrial systems. It is also not clear whether many of the patterns known to occur on land also occur in the sea. Until we have a firmer idea of the diversity of a wide range of marine habitats and what controls it, we have little hope of conserving biodiversity, or determining the impact of human activities such as mariculture, fishing, dumping of waste and pollution. Therefore, recognition of the scale of problems, the nature of the underlying causes, and the limited resources available to counteract powerful destructive trends will definitely lead to a best way of conserving the marine biological diversity of India.

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